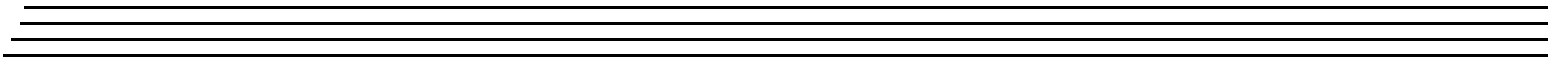
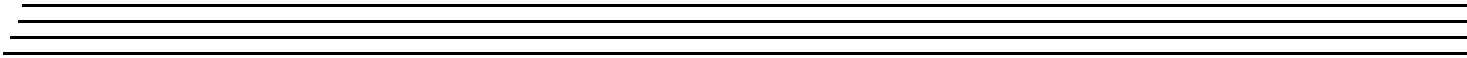
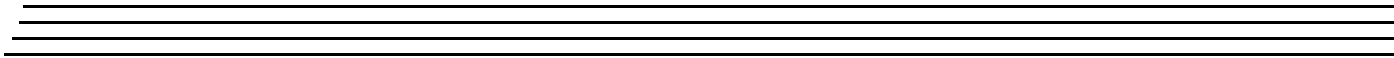


DATA TRANSLATION[®]
A MEASUREMENT COMPUTING COMPANY

UM-25656-N

DT9857 and DT9857E
User's Manual



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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 DT9857 or DT9857E module and device driver, and verify that your module is working properly.

The second part of this manual describes the features of the DT9857 and DT9857E modules, the capabilities of the DT9857 Device Driver, and how to program the DT9857 or DT9857E module using the DT-Open Layers for .NET Class Library™ software. Troubleshooting information is also provided.

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

Intended Audience

This document is intended for engineers, scientists, technicians, or others responsible for using and/or programming a DT9857 or DT9857E module for data acquisition operations in the Microsoft® Windows Vista®, Windows 7, Windows 8, or Windows 10 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 DT9857 and DT9857E modules, as well as the supported software and accessories for the modules.
- [Chapter 2, “Setting Up and Installing the Module,”](#) describes how to apply power to the module, connect one or more modules to a host computer, and configure the DT9857 Device Driver.
- [Chapter 3, “Wiring Signals,”](#) describes how to wire signals to a DT9857 or DT9857E module.
- [Chapter 4, “Verifying the Operation of a Module,”](#) describes how to verify the operation of a DT9857 or DT9857E module using the QuickDAQ application.
- [Chapter 5, “Principles of Operation,”](#) describes all of the features of the DT9857 and DT9857E modules.
- [Chapter 6, “Supported Device Driver Capabilities,”](#) lists the data acquisition subsystems and the associated features accessible using the DT-Open Layers for .NET Class Library with the DT9857 and DT9857E modules.
- [Chapter 7, “Troubleshooting,”](#) provides information that you can use to resolve problems with the DT9857 or DT9857E module and DT9857 Device Driver, should they occur.

- [Chapter 8, “Calibration,”](#) describes how to calibrate the analog I/O circuitry of the DT9857 or DT9857E module.
- [Appendix A, “Specifications,”](#) lists the specifications of the DT9857 and DT9857E modules.
- [Appendix B, “Connector Pin Assignments and LED Status Indicators,”](#) lists the pin assignments of the connectors on the DT9857 and DT9857E modules, describes the screw terminal assignments of the STP25 screw terminal panel, and describes the LED status indicators on the DT9857 and DT9857E 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 DT9857 module:

- *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 a DT-Open Layers data acquisition module.
- *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.
- *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 Vista, Windows 7, Windows 8, or Windows 10 documentation.
- USB web site (<http://www.usb.org>).

Where To Get Help

Should you run into problems installing or using a DT9857 or DT9857E module, the Technical Support Department is available to provide technical assistance. Refer to [Chapter 7](#) for more information. If you are outside the United States or Canada, call your local distributor, whose number is listed on our web site (www.mccdaq.com).



Overview

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Hardware Features

The DT9857 and DT9857E modules are high-accuracy, dynamic signal analyzers for the USB (Ver. 3.0, 2.0, or Ver. 1.1) bus. Available with either 8 or 16 IEPE inputs and two stimulus waveform output channels, these modules are ideal for noise, vibration, and acoustic measurements. [Figure 1](#) shows the DT9857 module. [Figure 2](#) shows the DT9857E module. The DT9857E module is also available without waveform output channels.



Figure 1: DT9857 Module (DT9857-16 Module Shown)



Figure 2: DT9857E Module (DT9857E-16 Module Shown)

Note that OEM versions of the modules are also available. The OEM versions of the modules do not include an enclosure or an external power supply.

The key features that are common to both the DT9857 and DT9857E modules are as follows:

- Simultaneous analog input and waveform analog output operations
- Analog input subsystem:
 - Up to eight analog input channels on the DT9857-8 and DT9857E-8 modules and up to 16 analog input channels on the DT9857-16 and DT9857E-16 modules.
 - One 24-bit A/D converter per analog input channel.
 - Programmable throughput rate from 195.3125 Samples/s to 105.469 kSamples/s.
 - Input range of ± 10 V with software-selectable gains of 1 and 10 for an effective input range of ± 10 V and ± 1 V.

- Support for IEPE (Integrated Electronic Piezoelectric) inputs, including use of a 4 mA current source with 24 V compliance voltage for AC or DC coupling.
- In continuous scan mode, supports a start trigger for acquiring pre-trigger samples and a reference trigger for acquiring post-trigger samples. You can specify the number of post-trigger samples to acquire before stopping the operation.
- For the start trigger, supports a software-programmable trigger source (software, external digital trigger, threshold trigger, or Sync Bus). For the threshold trigger, you can program the threshold value from -10 V to $+10$ V.
- For the reference trigger, supports a software-programmable trigger source (external digital trigger, threshold trigger, or Sync Bus).
- Supports the ability to return the value of the tachometer, general-purpose counter/timer, measure counters, and digital input port in the analog input data stream, allowing you to measure a variety of signals synchronously with analog input measurements.
- Analog output subsystem:
 - Up to two stimulus analog output channels.
The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions are designed without analog output functionality.
 - One 32-bit D/A converter per analog output channel.
 - Single value, waveform, and continuous streaming output.
 - Programmable output rate from 30 kSamples/s to 216 kSamples.
 - Output range of ± 10 V.
 - Software-programmable trigger source (software trigger or external digital trigger) to start the analog output operation.
 - Supports the ability to update the digital output port synchronously with the analog output channels.
- Eight digital input lines and eight digital output lines. For synchronous measurements, you can return the value of the digital input port with your analog input data and/or update the value of the digital output port with the analog output channels.
- One tachometer input signal. The value of the tachometer input signal is returned in the analog input data stream for synchronous measurements.
- One general-purpose counter/timer for performing event counting, up/down counting, edge-to-edge measurement, continuous edge-to-edge measurement, rate generation, and pulse output operations. You can read the value of the counter/timer directly or through the analog input data subsystem, as the counter/timer can be included in the analog input data stream for synchronous measurements.
- Two measure counters. You can program the edge that starts the measurement and the edge that stops the measurement. Many edge types are supported. The data from the measure counters is returned in the analog input data stream for synchronous measurements.

- Sync Bus for connecting and synchronizing multiple modules.
- Locking USB connector.
- External power supply.

The key differences between the DT9857 and DT9857E modules are listed in [Table 1](#).

Table 1: Key Differences Between the DT9857 and the DT9857E

Feature	DT9857 Specification	DT9857E Specification
External Power Supply	The DT9857 module requires a +5 V power supply that is connected to the DIN connector on the module.	Both the DT9857E and DT9857E-OEM require a +4.75 to +28 V power supply that can be connected to either the DIN connector or the 3-position Phoenix connector on the module.
Synchronization	All the analog input channels of up to four modules can be synchronized using the Sync Bus. The Sync Bus is implemented with one RJ45 connector on each module and an optional RJ45 distribution panel, with four RJ45 connectors.	All the analog input channels of up to four modules can be synchronized using the Sync Bus and all the analog output channels of up to four modules can be synchronized using the Sync Bus. The Sync Bus is implemented with two RJ45 connectors on each module No patch panel is required.
External Digital (TTL) Input Trigger	Provided on Digital connector	Provided on BNC input
Tachometer Input	Provided on BNC input	Provided on Digital connector

Supported Software

The following software is available for use with the DT9857 and DT9857E modules and is included on the Data Acquisition OMNI CD:

- **DT9857 Series Device Driver** – The DT9857 Series Device Driver allows you to use a DT9857 or DT9857E module with any of the supported software packages or utilities.
- **DT9857 Calibration Utility** – This utility, described in [Chapter 8](#) starting on [page 133](#), allows you to calibrate the analog input and analog output circuitry of the DT9857 and DT9857E modules.
- **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, 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.
- **Quick DataAcq application** – The Quick DataAcq application provides a quick way to get up and running using a DT9857 or DT9857E module. Using this application, you can verify key features of the modules, display data on the screen, and save data to disk. (Note that this application does not support configuring AC/DC coupling or the excitation current source for IEPE inputs.)
- **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 DT9857 or DT9857E modules 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 DT9857 or DT9857E module using Windows Vista, Windows 7, Windows 8, or Windows 10; the DataAcq SDK 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** – A link to LV-Link is included on the Data Acquisition OMNI CD. Use LV-Link if you want to use the LabVIEW graphical programming language to access the capabilities of a DT9857 or DT9857E module.

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

Supported Accessories

The following optional accessories are available for a DT9857 or DT9857E module:

- **STP25 screw terminal panel** – A screw terminal panel that connects to the Digital connector on the DT9857 or DT9857E module using the 25-pin, 1.5-meter, EP403 cable that is included with the STP25 screw terminal panel.

Figure 3 shows the STP25 and EP403 cable.

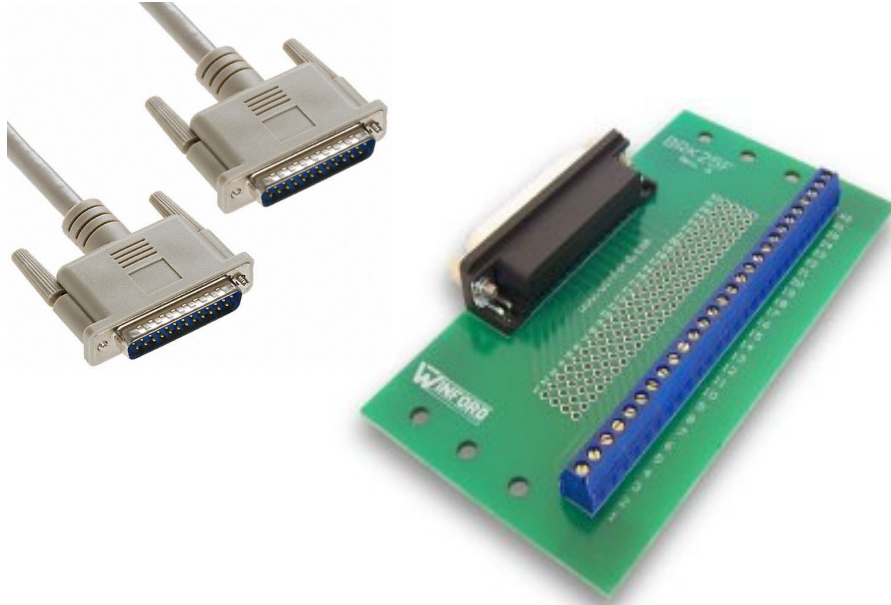


Figure 3: STP25 Screw Terminal Panel and EP403 Cable

- **EP386 panel** – (For the DT9857 and DT9857-OEM modules only.) The EP386 panel, shown in [Figure 4](#), contains four RJ45 connectors that are wired in parallel, making it useful when attaching up to four DT9857 modules together using the Sync Bus connector. Refer to [page 105](#) for more information on using this panel.

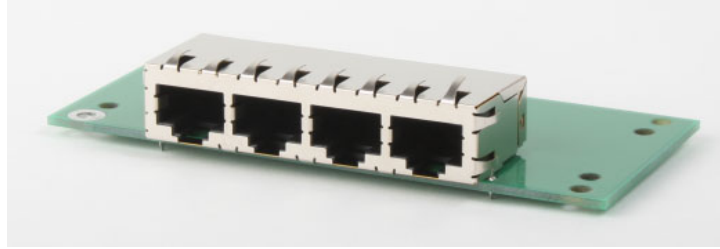


Figure 4: EP386 Panel

Note: The EP386 is not used with the DT9857E and DT9857E-OEM modules.

- **EP402 Rack Mount Kit** – The EP402 Rack Mount Kit allows you to mount the DT9857 or DT9857E in a 19-inch rack. The kit includes mounting clips, screws, and instructions. The rail is not included.

Getting Started Procedure

The flow diagram shown in [Figure 5](#) illustrates the steps needed to get started using a DT9857 or DT9857E module. This diagram is repeated in each Getting Started chapter; the shaded area in the diagram shows you where you are in the getting started procedure.

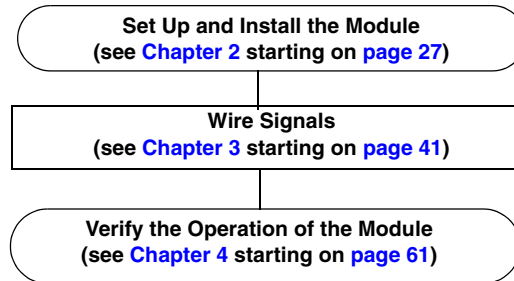


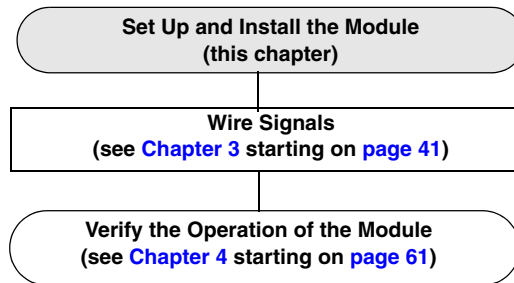
Figure 5: Getting Started Flow Diagram

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:

- DT9857-8, DT9857-16, DT9857E-8, DT9857E-8-xAO, DT9857E-16, or DT9857E-16-xAO module, or the OEM version of the module
- EP361 +5 V power supply (not supplied with the OEM version of the module)
- USB cable (EP365)
- Data Acquisition OMNI CD-ROM

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 our web site (www.mccdaq.com).

Note: DT9857 and DT9857E modules are factory-calibrated. If you decide that you want to recalibrate the analog input or analog output circuitry, refer to the instructions in [Chapter 8](#).

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 10, Windows 8, Windows 7, Windows Vista (32- and 64-bit)
- Disk Space: 4 GB

Applying Power to the Module

The DT9857 module works with a +5 VDC power supply. The DT9857E module works with a +4.75 VDC to +28 VDC power supply. The EP361 +5 V power supply and cable is shipped with the standard version of the DT9857 and DT9857E modules.

Applying Power to the DT9857 Module

To apply power to the DT9857 module, do the following:

1. Ground the chassis of the module to earth ground by connecting a grounding strap to the grounding stud on the rear panel of the module, as shown in [Figure 6](#).



Figure 6: Connect a Grounding Strap to the Grounding Stud on the DT9857 Module

2. Connect the EP361 power supply to the power connector on the DT9857 module, as shown in [Figure 7](#).
3. Plug the power supply into a wall outlet.



Connect the EP361 Power Supply to the Module and to the Wall Outlet



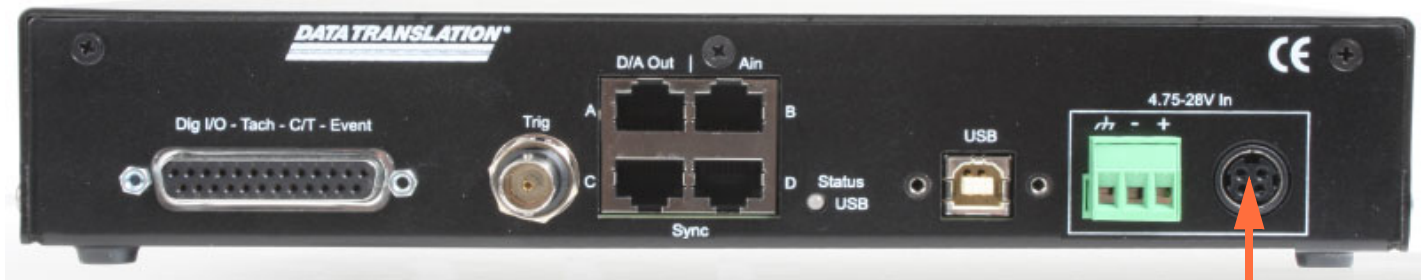
Figure 7: Attaching an External Power Supply to the DT9857 Module

Applying Power to the DT9857E Module

To apply power to the DT9857E module, do the following:

1. Connect the EP361 power supply to the DIN power connector on the DT9857E module, as shown in [Figure 8](#), or connect your own 4.75 VDC to 28 VDC power supply to the 3-position power terminal block.

DT9857E Module Rear Panel



Connect the EP361 Power Supply
OR
Connect Your Own +4.75 VDC to +28 VDC Power Supply



Connect your own +4.75 VDC or
+28 VDC Power Supply

Figure 8: Attaching an External Power Supply to the DT9857E Module

2. Plug the power supply into a wall outlet.

Attaching Modules to the Computer

This section describes how to attach a DT9857 or DT9857E module to the host computer.

Note: Most computers have several USB ports that allow direct connection to USB devices. If your application requires more DT9857 or DT9857E 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 35](#).

You can unplug a module, 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 for your module before connecting the module(s) to the host computer. Run the installation program on your Data Acquisition OMNI CD to install the device driver and other software for the module.

Connecting Directly to the USB Ports

To connect a DT9857 or DT9857E module directly to a USB port on your computer, do the following:

1. Make sure that you have attached an external power supply to the module.
2. Attach one end of the USB cable (EP365) to the USB port on the module, as shown in [Figure 9](#). The DT9857 and DT9857E modules support an optional locking USB cable if desired. You can purchase this cable separately from vendors such as Newnex Technology Corporation (part number UHRB-B00A-U60).



Figure 9: Attaching the USB Cable to the Module (DT9857 Module Shown)

3. Attach the other end of the USB cable to one of the USB ports on the host computer.
The operating system automatically detects the USB module 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**.

Note: Windows 7, Windows 8, and Windows 10 find the device automatically.

5. Repeat these steps to attach another DT9857 or DT9857E module to the host computer, if desired.

Note: Once you have applied external power to the DT9857 or DT9857E module and connected your module to the host computer, the Power LED on the module turns solid green. In addition, the USB LED on the module turns solid green once the module is enumerated.

Connecting to an Expansion Hub

Expansion hubs are powered by their own external power supply. The practical number of DT9857 or DT9857E modules that you can connect to a single USB port depends on the throughput you want to achieve.

To connect multiple DT9857 or DT9857E modules to an expansion hub, do the following:

1. Make sure that you have attached an external power supply to the module.
2. Attach one end of the USB cable to the module and the other end of the USB cable to an expansion hub.
3. Connect the power supply for the expansion hub to an external power supply.
4. Connect the expansion hub to the USB port on the host computer using another USB cable.
The operating system automatically detects the USB module and starts the Found New Hardware wizard.

5. *For Windows Vista:*
 - a. Click **Locate and install driver software (recommended)**.
The popup message "Windows needs your permission to continue" appears.
 - b. Click **Continue**.
The Windows Security dialog box appears.
 - c. Click **Install this driver software anyway**.

Note: Windows 7, Windows 8, and Windows 10 find the device automatically.

6. Repeat these steps until you have attached the number of expansion hubs and modules that you require. Refer to [Figure 10](#).
The operating system automatically detects the USB devices as they are installed.

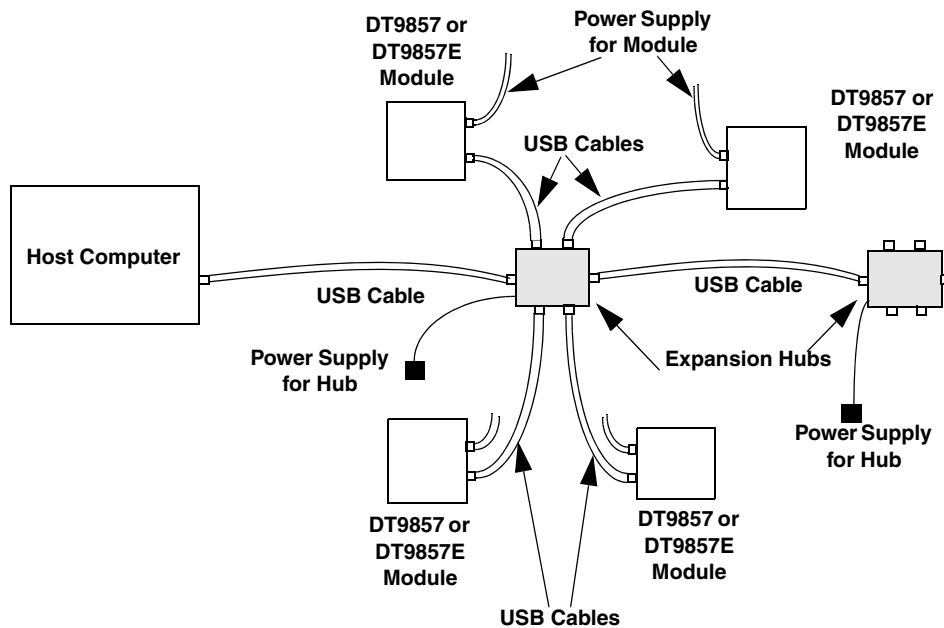


Figure 10: Attaching Multiple DT9857 or DT9857E Modules Using Expansion Hubs

Note: If you are using a USB 3.0 hub to connect to the DT9857E module, be aware of the back power.

The DT9857E receives power from the USB 3.0 hub when the external power supply is off and the USB 3.0 cable is plugged into the computer. The back power is only 4.6 V but it prevents the module from getting a proper USB reset. (The DT9857E operates from 4.75 V to 28 V and the sense circuit is set at 4.6 V because of tolerances.)

To solve this problem, you must use a 2 A diode in series with the USB 3.0 hub power supply. This will also ensure that a reverse power supply will not cause any damage.

Once you have applied external power to the DT9857 or DT9857E module and connected your module to the host computer, the Power LED on the module turns solid green. In addition, once the module is enumerated, the USB LED on the module turns solid green.

Configuring the DT9857 Series Device Driver

Note: In Windows 7, Windows 8, Windows 10, and Windows 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, Windows 10, and Vista (32-bit)

C:\Windows\System32\Dtolcpl.cpl

Windows 7, Windows 8, Windows 10, and Vista (64-bit)

C:\Windows\SysWOW64\Dtolcpl.cpl

To configure the device driver for a DT9857 or DT9857E module, do the following:

1. If you have not already done so, power up the host computer and all peripherals.
2. From the Windows Start menu, select **Settings | Control Panel**.
3. From the Control Panel, double-click **Open Layers Control Panel**.
The Data Acquisition Control Panel dialog box appears.
4. If you want to rename the module, click the name of the module that you want to rename, click **Edit Name**, enter a new name for the module, and then click **OK**. The name is used to identify the module in all subsequent applications.
5. Select the module that you want to configure, and then click **Advanced**.
The Measurement Options dialog box appears.
6. For the Coupling type, select **AC** for AC coupling or **DC** for DC coupling for each analog input channel.
7. For the Current Source, select **Enabled** to enable the internal excitation current source or **Disabled** to disable the internal excitation current source for each analog input channel.

Note: If you enable the use of the internal excitation current source, it is recommended that you choose AC coupling. Refer to [page 48](#) for more information on wiring IEPE inputs.

8. If you are using the DT9857E module, you can click the **Identify Device** button to turn the Power LED on the front of the module amber, helping you identify which module you are configuring. This button is especially helpful when you are using multiple DT9857E modules. [Figure 11](#) shows the Power LED on the DT9857E module.



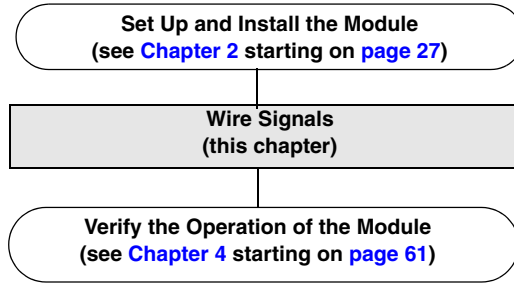
Figure 11: Power LED on the Front Panel of the DT9857E Module

9. If you are using multiple DT9857E modules connected together using the Sync Bus, the first and last module in the chain must be terminated with a 100 Ω resistor. Check the **Sync Bus Termination** checkbox to enable the termination resistor, or uncheck the **Sync Bus Termination** checkbox to disable the termination resistor for the selected module.
10. When you are finished, click **OK** to close the Measurement Options dialog box.
11. Repeat steps 4 to 10 for the other modules that you want to configure.
12. When you are finished configuring the modules, click **Close** to close the Control Panel.



Wiring Signals

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Preparing to Wire Signals

This section provides recommendations and information about wiring signals to a DT9857 or DT9857E module.

Wiring Recommendations

Keep the following recommendations in mind when wiring signals to a DT9857 or DT9857E module:

- Follow standard ESD procedures when wiring signals to the module.
- Separate power and signal lines by using physically different wiring paths or conduits.
- To avoid noise, do not locate the module and cabling next to sources that produce high electromagnetic fields, such as large electric motors, power lines, solenoids, and electric arcs, unless the signals are enclosed in a mumetal shield.
- Prevent electrostatic discharge to the I/O while the module is operational.
- Connect all unused analog input channels to analog ground.

Warm-Up Time

The DT9857 and DT9857E modules are ideal for acoustic measurements due to their AC coupling and frequency characteristics. They were not designed for DC stability; therefore, ensure that you allow the module to warm up for 1 hour before use.

Wiring Signals to the Module

[Figure 12](#) shows the connectors on the front and rear panels of the DT9857 module. [Figure 13](#) shows the connectors on the front and rear panels of the DT9857E module.

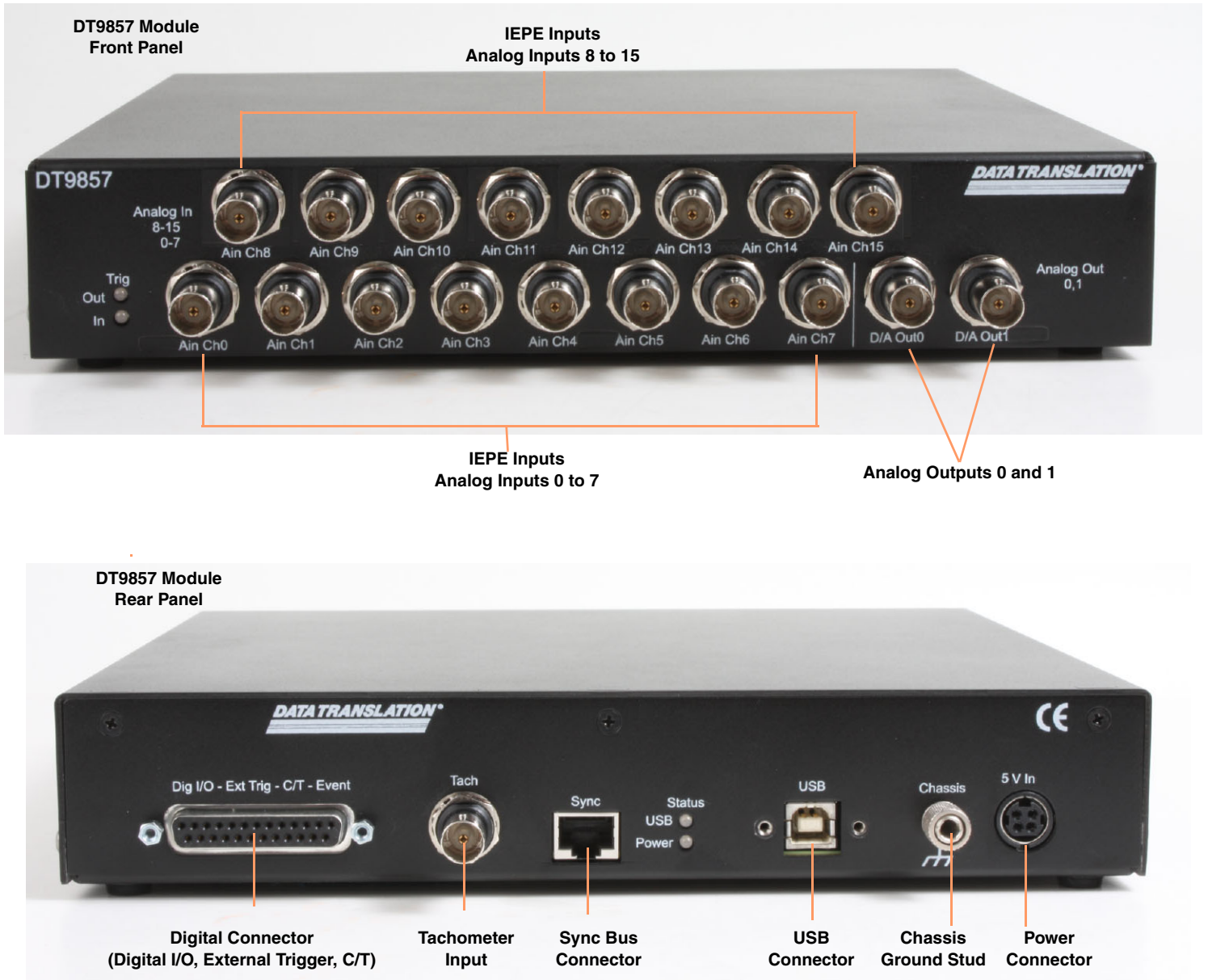


Figure 12: Connectors on the Front and Rear Panels of the DT9857 Module

1

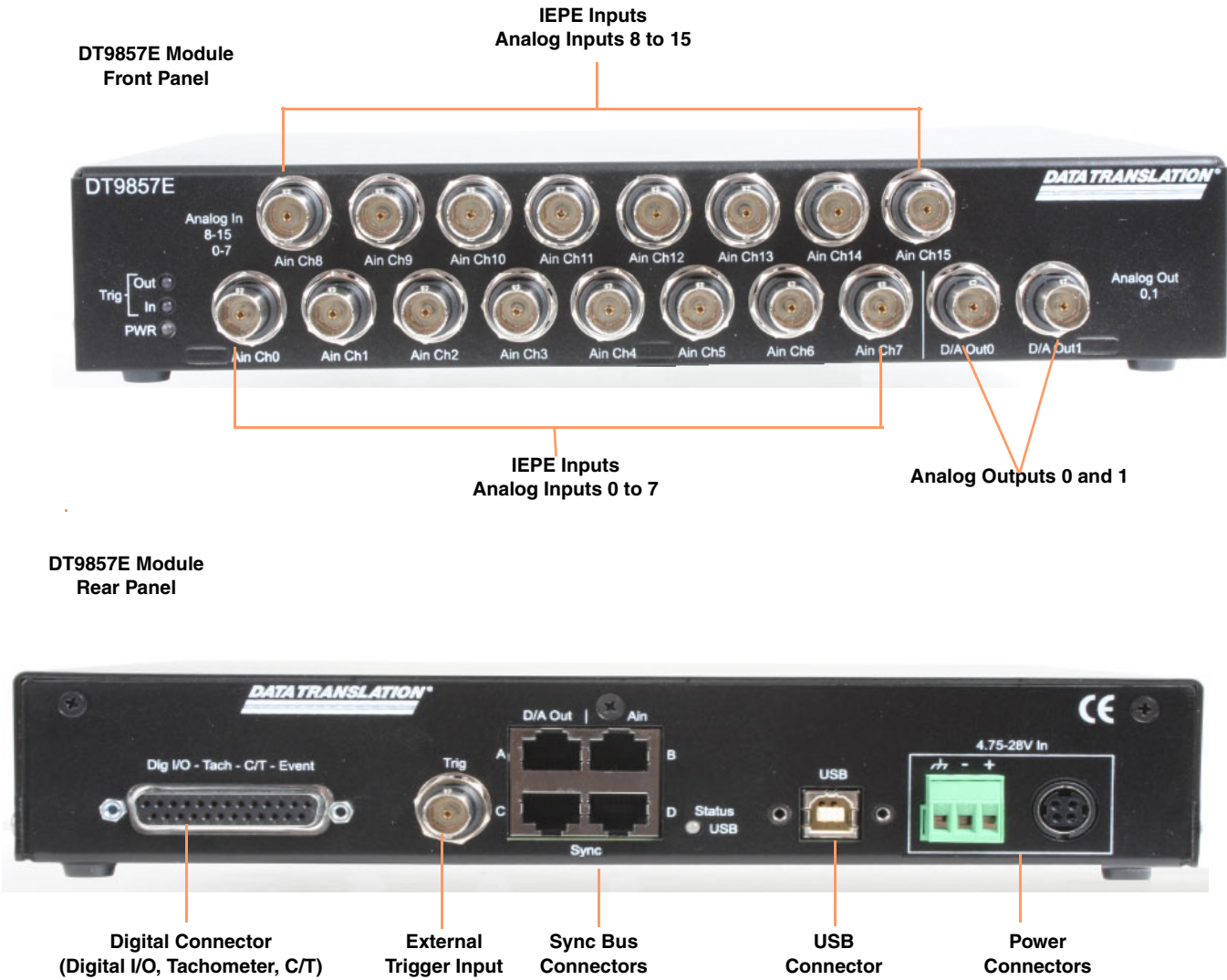


Figure 13: Connectors on the Front and Rear Panels of the DT9857E Module

Note: The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions are designed without analog outputs 0 and 1.

A 25-pin Digital connector is provided for attaching digital I/O, external trigger, and counter/timer signals. [Figure 14](#) shows the layout of the 25-pin Digital connector on the DT9857 and DT9857E modules.

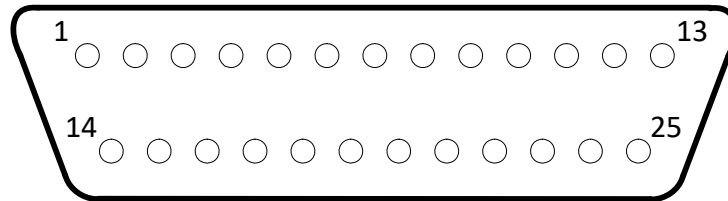


Figure 14: Layout of the Digital Connector

To make wiring easier, you can connect the STP25 screw terminal panel to the Digital connector on the DT9857 or DT9857E module as shown in [Figure 15](#).

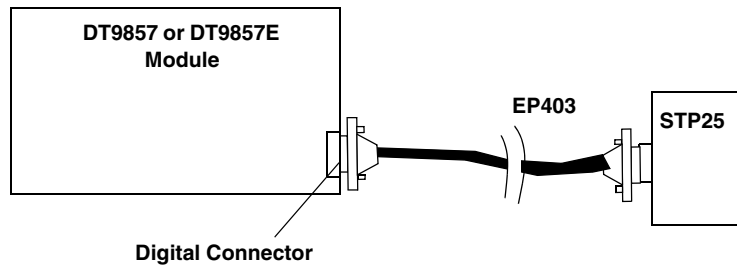
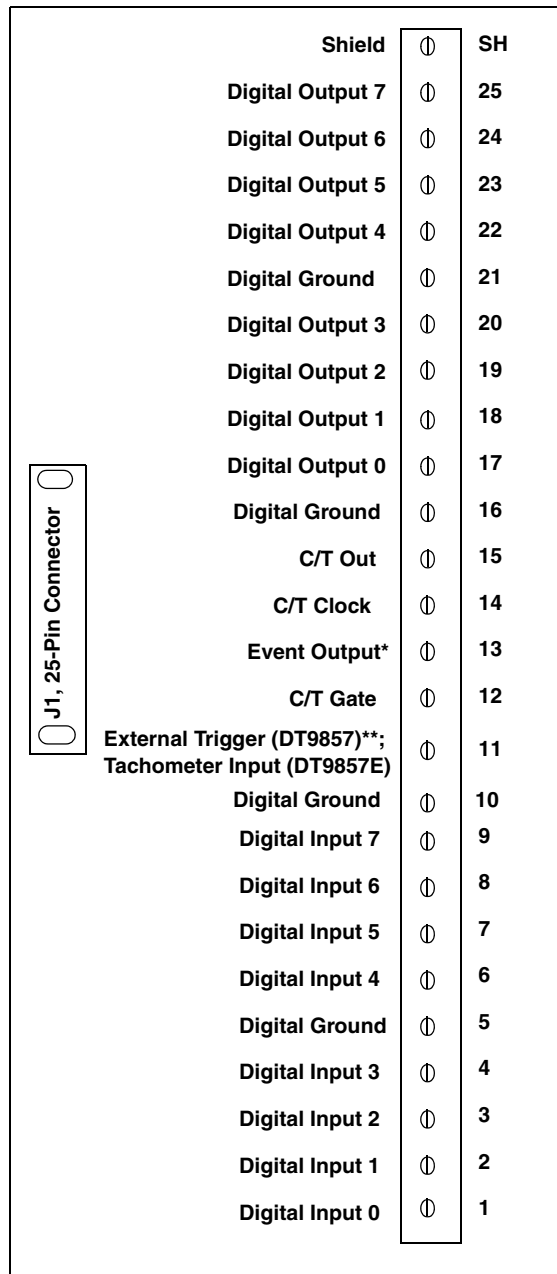


Figure 15: Connecting the STP25 to the DT9857 or DT9857E Module

The STP25 contains one 25-pin connector and a screw terminal block. The 25-pin connector provides access to the signals from the Digital connector on the DT9857 and DT9857E modules. [Figure 16](#) shows the layout of the STP25 and lists the screw terminal assignments.



*Currently, the event output function is disabled and the output is driven low.

**For the DT9857, pin 11 is the external trigger input and the tachometer input is a BNC connector on the module. For the DT9857E, pin 11 is the tachometer input and the external trigger input is a BNC connector on the module.

Figure 16: Layout of the STP25 Screw Terminal Panel

Connecting Analog Input Signals

For the DT9857-8 and DT9857E-8 modules, you can connect up to eight analog input signals (or IEPE sensors) to the BNC connectors on the module. For the DT9857-16 and DT9857E-16 modules, you can connect up to 16 analog input signals (or IEPE sensors) to the BNC connectors on the module. Internally, these signals are connected in single-ended mode. The DT9857 and DT9857E modules support an input signal range of ± 10 V (using a gain of 1) or ± 1 V (using a gain of 10).

Note: If you enable the use of the internal excitation current source for IEPE inputs, it is recommended that you choose AC coupling. Refer to [page 76](#) for more information on IEPE inputs.

[Figure 17](#) shows how to connect an analog input signal (channel 0, in this case) to a BNC connector on the DT9857 or DT9857E module.

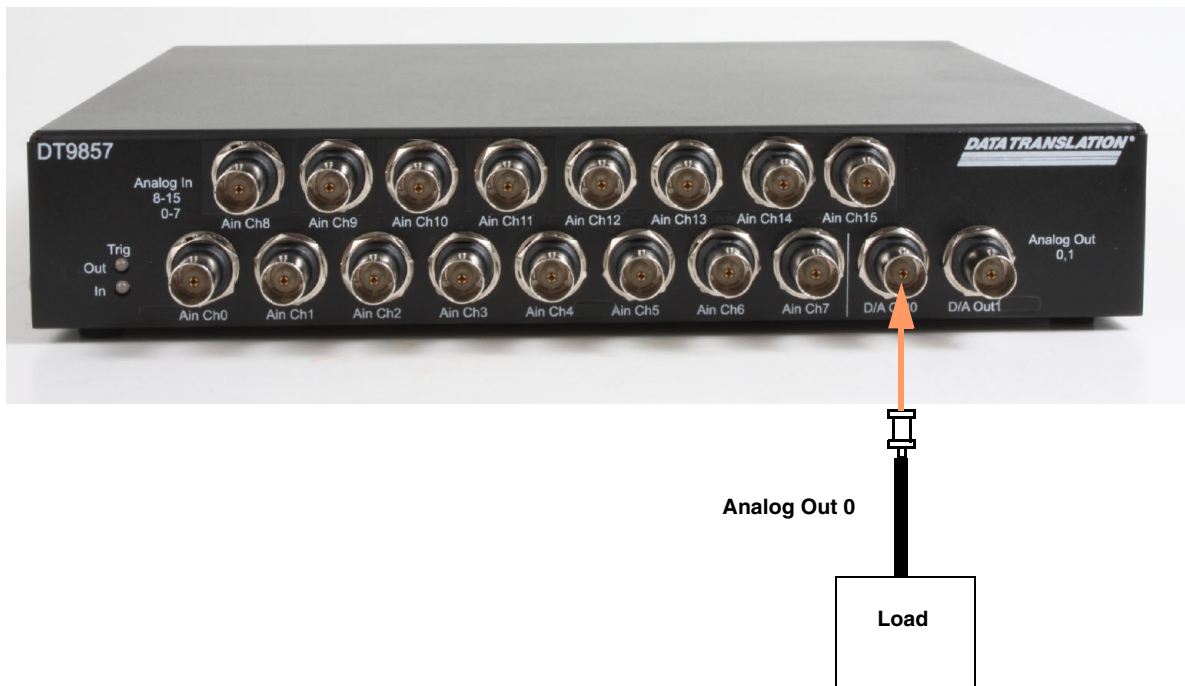


Figure 17: Connecting Analog Input Signals

Connecting Analog Output Signals

The DT9857 and DT9857E modules provide up to two analog output channels. The output channels have an output range of ± 10 V.

Figure 18 shows how to connect an analog output signal to a DT9857 or DT9857E module.



Note that the connector automatically connects the Analog Ground signal appropriately.

Figure 18: Connecting an Analog Output Signal

Note: The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions are designed without analog outputs 0 and 1.

Connecting a Tachometer Input Signal

You can connect a ± 30 V tachometer input signal to the DT9857 or DT9857E module. On the DT9857, you connect the tachometer to a BNC connector, as shown in [Figure 19](#). On the DT9857E, you connect the tachometer input signal to pin 11 of the STP25 screw terminal panel, which is connected to the DT9857E module, as shown in [Figure 20](#). Refer to [Figure 16 on page 47](#) for the screw terminal assignments of the STP25 screw terminal panel.

Note: In software, you can read tachometer measurements as part of the analog input channel list. Refer to [page 90](#) for more information on tachometer measurements.

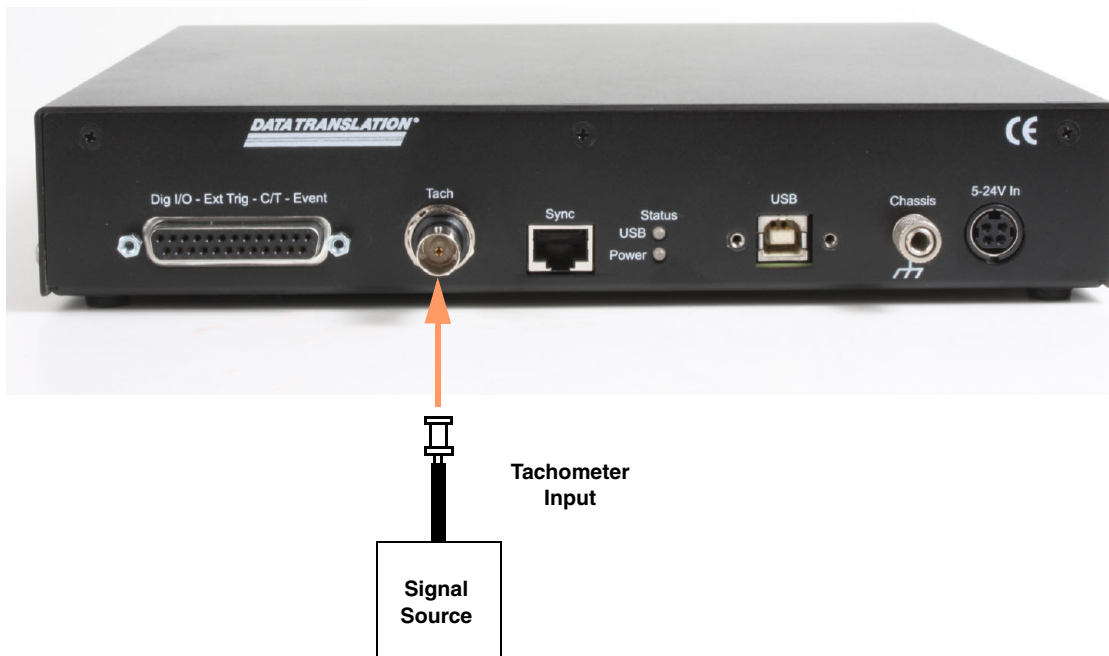


Figure 19: Connecting a Tachometer Input Signal to the DT9857 Module

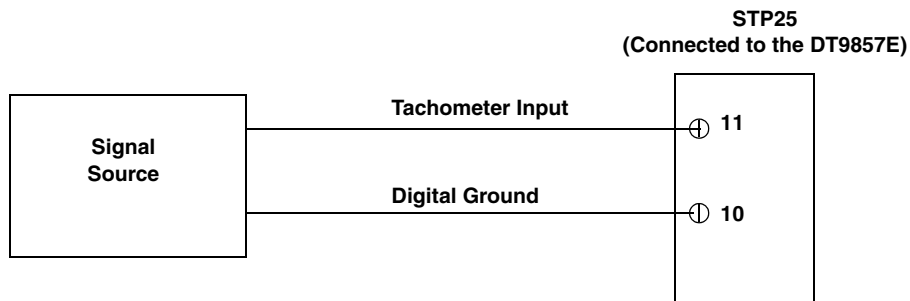


Figure 20: Connecting a Tachometer Input Signal to the DT9857E Module

Connecting Digital Input Signals

Figure 21 shows how to connect digital input signals (lines 0 and 1, in this case) to the STP25 screw terminal panel. Refer to [Figure 16 on page 47](#) for the screw terminal assignments of the STP25 screw terminal panel.

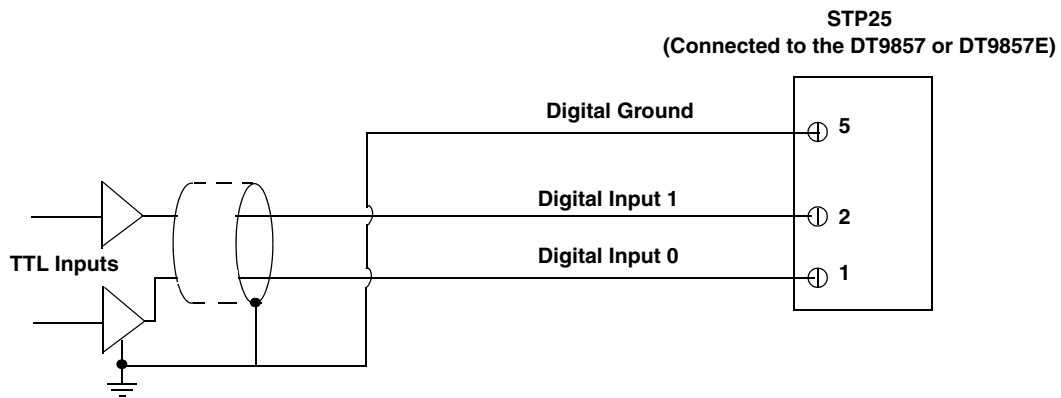
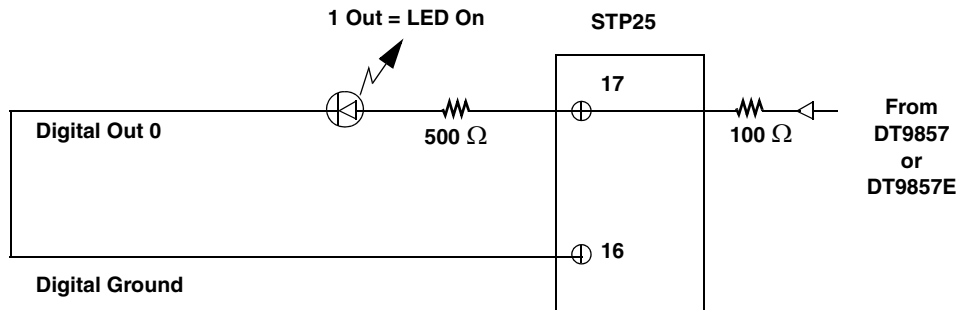


Figure 21: Connecting Digital Inputs

Connecting Digital Output Signals

Figure 22 shows how to connect a digital output (line 0, in this case) to the STP25 screw terminal panel. Refer to Figure 16 on page 47 for the screw terminal assignments of the STP25 screw terminal panel.



The output current is determined using the following equation:

$$Current_{Out} = \frac{Voltage_{Out} - Voltage_{LED}}{R_{Internal} + R_{External}}$$

In this example, if the maximum output voltage is 3.3 V, the LED voltage drop is 0.7 V, the internal resistor is 100 Ω, and the external resistor is 500 Ω, the maximum output current is 4.33 mA. Using the minimum output voltage of 2.4 V with the same resistor values, the minimum output current is 2.83 mA.

Figure 22: Connecting Digital Outputs

Connecting Counter/Timer Signals

The DT9857 and DT9857E modules provide a general-purpose counter/timer (C/T 0) that you can use to perform the following operations:

- Event counting
- Up/down counting
- Pulse width/period measurement
- Edge-to-edge measurement
- Continuous edge-to-edge measurement
- Pulse output (continuous, one-shot, and repetitive one-shot)

The C/T signals are available through the Digital connector on the DT9857 and DT9857E modules. You can access these signals using the STP25 screw terminal panel, described on [page 47](#).

Event Counting

[Figure 23](#) shows how to connect counter/timer signals to the STP25 screw terminal panel to perform an event counting operation on C/T 0 using an external gate.

The counter counts the number of rising edges that occur on the Counter 0 Clock input when the Counter 0 Gate signal is in the active state (as specified by software). Refer to [page 95](#) for more information on event counting operations.

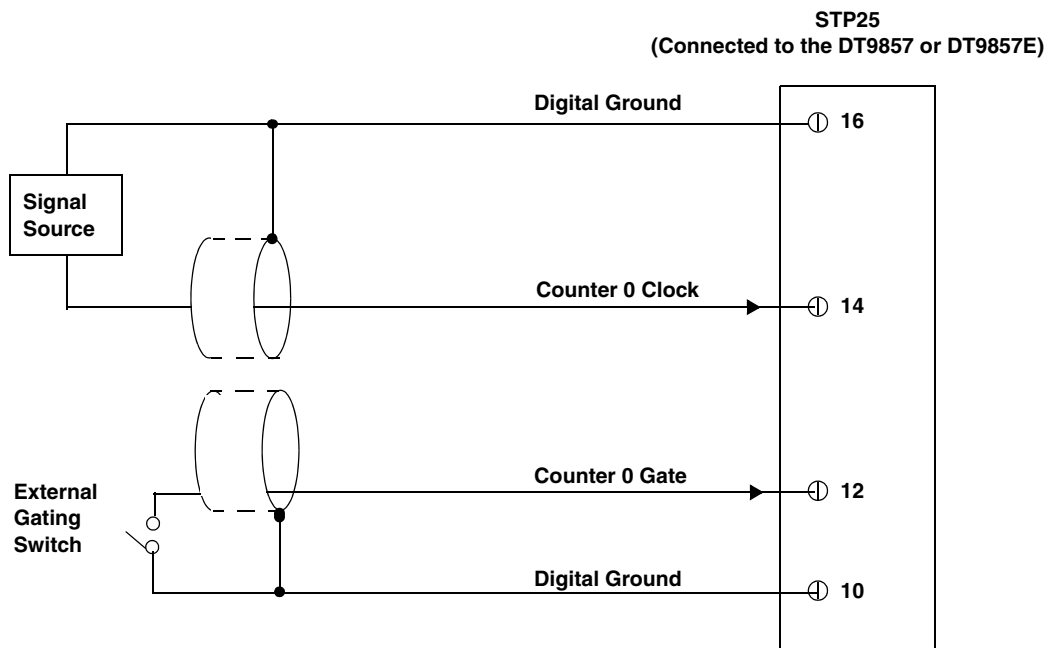


Figure 23: Connecting Counter/Timer Signals for an Event Counting Operation Using an External Gate

Figure 24 shows how to connect counter/timer signals to the STP25 screw terminal panel to perform an event counting operation on C/T 0 without using a gate. The counter counts the number of rising edges that occur on the Counter 0 Clock input.

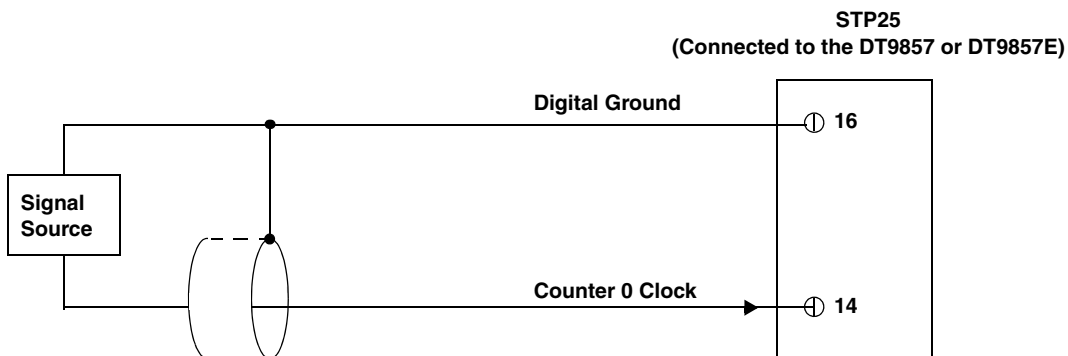


Figure 24: Connecting Counter/Timer Signals for an Event Counting Operation Without Using a Gate

Up/Down Counting

Figure 25 shows how to connect counter/timer signals to an STP25 screw terminal panel to perform an up/down counting operation on C/T 0. The counter keeps track of the number of rising edges that occur on the Counter 0 Clock input. The counter increments when the Counter 0 Gate signal is high and decrements when the Counter 0 Gate signal is low. Refer to page 95 for more information about up/down counting operations.

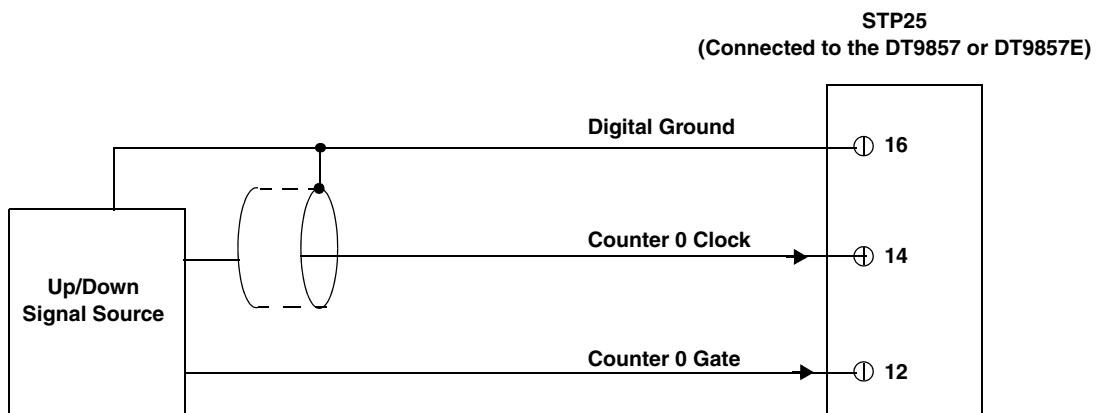


Figure 25: Connecting Counter/Timer Signals for an Up/Down Counting Operation

Period/Pulse Width Measurement

Figure 26 shows how to connect counter/timer signals either to the STP25 screw terminal panel to perform a period/pulse width measurement operation on C/T 0. You specify the active pulse (high or low) in software. The pulse width is the percentage of the total pulse period that is active. Refer to [page 94](#) for more information about pulse periods and pulse widths.

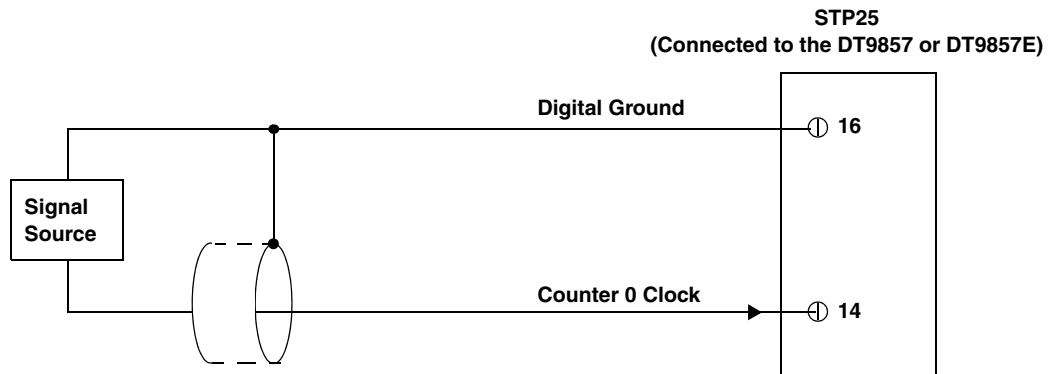


Figure 26: Connecting Counter/Timer Signals for a Period/Pulse Width Measurement Operation

Edge-to-Edge Measurement

Figure 27 shows how to connect counter/timer signals to the STP25 screw terminal panel to perform an edge-to-edge measurement operation using two signal sources. The counter measures the number of counts between the start edge (in this case, a rising edge on the Counter 0 Clock signal) and the stop edge (in this case, a falling edge on the Counter 0 Gate signal).

You specify the start edge and the stop edge in software. Refer to [page 96](#) for more information on edge-to-edge measurement mode.

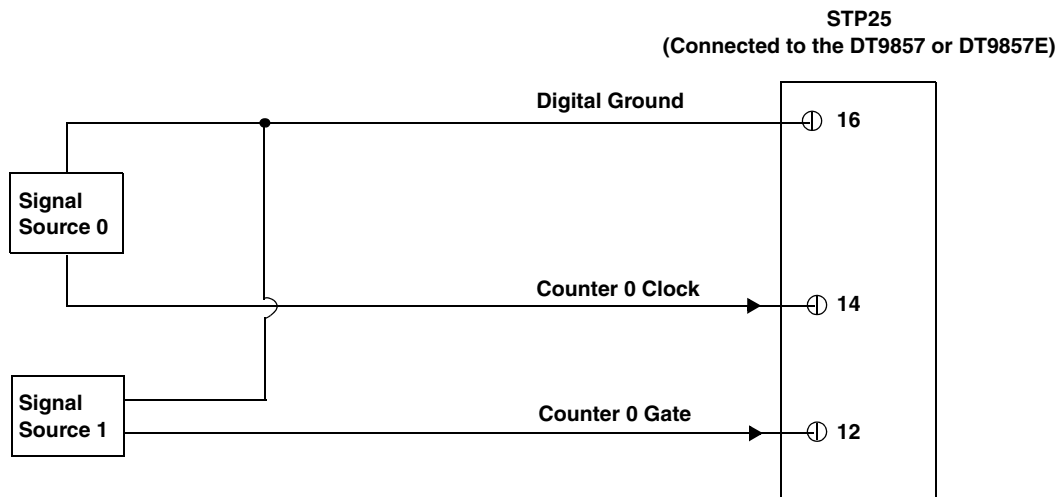


Figure 27: Connecting Counter/Timer Signals for an Edge-to-Edge Measurement Operation

Continuous Edge-to-Edge Measurement

Figure 28 shows how to connect counter/timer signals to the STP25 screw terminal panel to perform a continuous edge-to-edge measurement operation. The counter measures the number of counts between two consecutive start edges (in this case, a rising edge on the Counter 0 Clock signal).

You specify the start edge in software. Refer to [page 96](#) for more information on continuous edge-to-edge measurement mode.

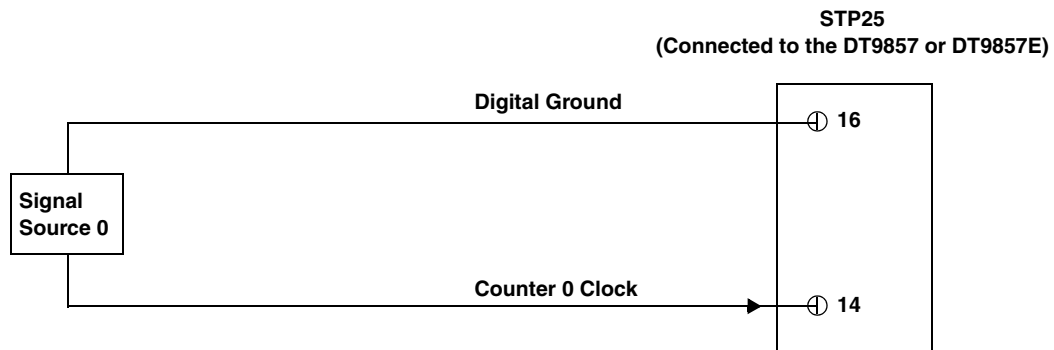


Figure 28: Connecting Counter/Timer Signals for a Continuous Edge-to-Edge Measurement Operation

Pulse Output

Figure 29 shows how to connect counter/timer signals to perform a pulse output operation on counter/timer 0; in this example, an external gate is used. Refer to [page 97](#) through [page 98](#) for more information about pulse output operations.

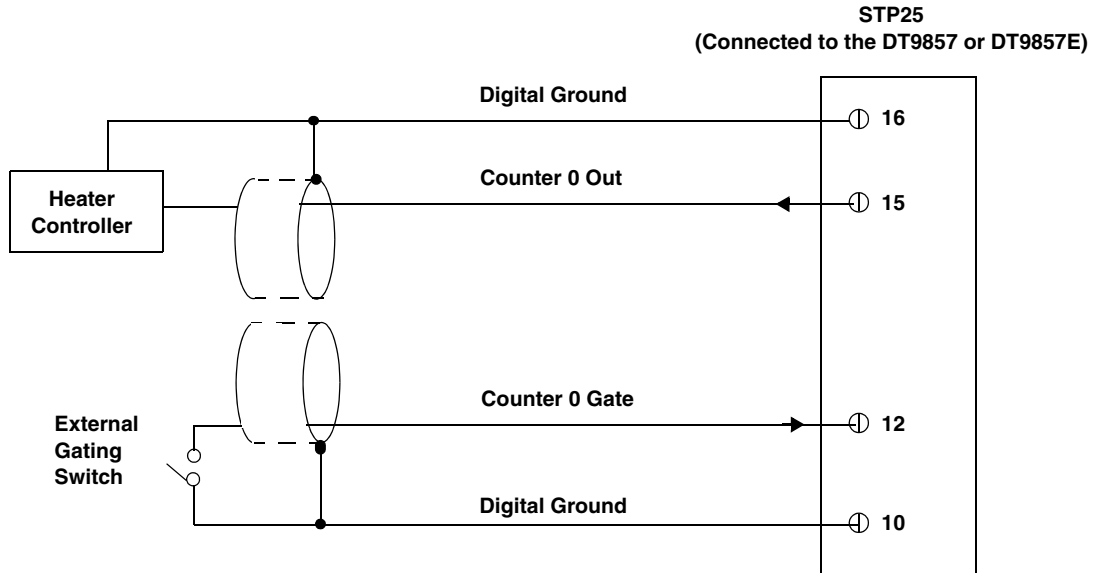


Figure 29: Connecting Counter/Timer Signals for a Pulse Output Operation Using an External Gate

Connecting Signals for Measure Counter Operations

The DT9857 and DT9857E modules provide two measure counters (C/T 1 and 2) that you can use to measure the frequency, period, or pulse width of a single signal or the time period between two signals and return the value in the analog input stream.

Using software, you must define a signal to start the continuous edge-to-edge measurement operation and a signal to stop the continuous edge-to-edge measurement operation. A variety of signals are supported. How you wire the signals depends on the signals that you want to use. [Table 2](#) lists the possible start and stop signals and the connections that are required for each signal type.

Table 2: Possible Start and Stop Signals

Signal	Connection Required
A/D conversion complete	No connection required
Tachometer input (falling edge or rising edge)	For the DT9857, connect to Tachometer input BNC on the DT9857. For the DT9857E, connect pin 11 of the Digital Connector on the DT9857E
Digital input 0 (falling edge or rising edge)	Connect to Pin 1 of the Digital Connector
Digital input 1 (falling edge or rising edge)	Connect to Pin 2 of the Digital Connector
Digital input 2 (falling edge or rising edge)	Connect to Pin 3 of the Digital Connector
Digital input 3 (falling edge or rising edge)	Connect to Pin 4 of the Digital Connector
Digital input 4 (falling edge or rising edge)	Connect to Pin 6 of the Digital Connector
Digital input 5 (falling edge or rising edge)	Connect to Pin 7 of the Digital Connector
Digital input 6 (falling edge or rising edge)	Connect to Pin 8 of the Digital Connector
Digital input 7 (falling edge or rising edge)	Connect to Pin 9 of the Digital Connector
C/T 0 Clock input (falling edge or rising edge)	Connect to Pin 14 of the Digital Connector
C/T 0 Gate input (falling edge or rising edge)	Connect to Pin 12 of the Digital Connector

Figure 30 shows an example of connecting signals for a continuous edge-to-edge measurement operation using a measure counter. In this example, the signal that starts the measurement is the rising edge of the digital input signal connected to digital input 7. The signal that stops the measurement is the rising edge of the clock input signal connected to C/T 0. (You configure the signals/edges in software).

In this example, measure counter 1 is set up to measure the number of counts between the starting edge (the rising edge of the signal connected to digital input 7) and the stopping edge (the rising edge of the clock input signal connected to C/T 0). By including measure counter 1 in the analog input channel list, you can read the count and determine the time period between the two signals. Refer to [page 99](#) for more information on measure counters.

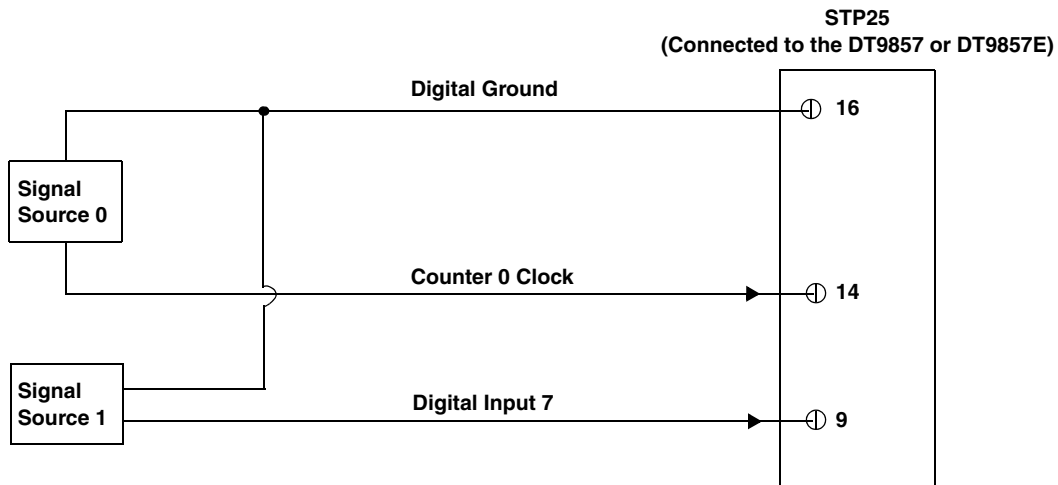
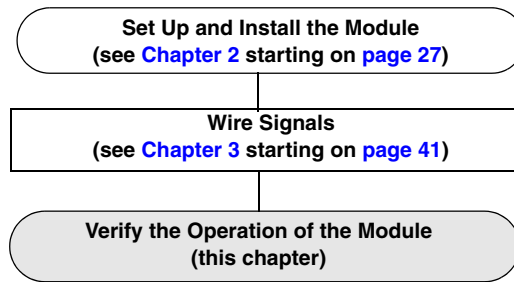


Figure 30: An Example of Connecting Signals for a Continuous Edge-to-Edge Measurement Operation Using a Measure Counter



Verifying the Operation of a Module

Select the Device	63
Acquire Data from an Analog Output Channel	65



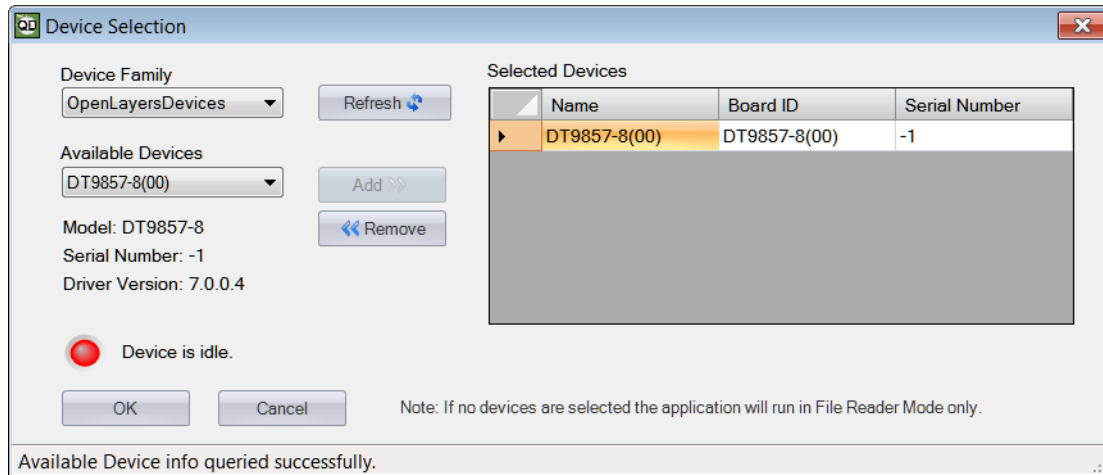
You can verify the operation of a DT9857 or DT9857E module using the QuickDAQ application.

QuickDAQ allows you to acquire and analyze data from all Data Translation USB and Ethernet devices, except the DT9841 Series, DT9817, DT9835, and DT9853/54. This chapter describes how to verify the operation of a DT9857 or DT9857E module using the QuickDAQ base version.

Select the Device

To get started with your DT9857 or DT9857E module and the QuickDAQ application, follow these steps:

1. Connect the DT9857 or DT9857E module to the USB port of your computer, and connect your sensors to the module.
2. Start the QuickDAQ application.
The Device Selection window appears.



3. For the Device Family selection, select **OpenLayersDevices**.
By default, the application "discovers" all devices that are available for the specified device family and displays the module name for the USB devices in the drop-down list. If you want to refresh this list to determine if other devices are available, click **Refresh**.
4. Select the module name for the module that you want to use from the list of Available Devices, and click **Add**.
Information about the device, including the model number, serial number, firmware version, driver version, and scanning status is displayed.
5. (Optional) If you want to remove a device from list of selected devices, click the Row Selector button for the device, and then click **Remove**.
6. Once you have added all the devices that you want to use with the application, click **OK**.
The latest state is saved and used when the application is next run, and the interface of the QuickDAQ application is displayed.

The screenshot displays the QuickDAQ 2014 software interface, which is divided into several functional panels:

- Acquisition Config Panel (Left):** Contains settings for file generation (Filename-Sequence, Start #, Filename Base), acquisition duration (00:00:00:10), and X-axis span (00:00:00:10). It also shows available disk space (184262 MB) and acquisition options like 'Enable Continuous Acquisition'.
- Channel List (Top Center):** A table with columns for Channel Name, Visible, Sample, Statistics, Show, Plot, and Signal Group. The channel 'DT9857-8(0)' is selected.
- Plotting Performance Panel (Middle Center):** Offers controls for 'Plot update rate' (1 update per second), 'Smooth scrolling', and 'Disable plotting during acquisition'. It also allows selection of 'Time domain X axis units' (Sample number, Relative time, Absolute time) and '24 Hour' or '12 Hour' display options.
- Channel Plot Panel (Right):** Features a 'Test Data' plot with a grid. The y-axis ranges from -10.00 to 10.00, and the x-axis shows time intervals from 00:00:00.000 to 00:00:09.000. The plot title is 'DT9857-8(0), Ain 0'.
- Acquisition Status Panel (Bottom):** Shows the current status as 'Idle'.

Acquire Data from an Analog Output Channel

The following steps describe how to use the QuickDAQ application to monitor the output of the analog output signal using an analog input channel.

In this example, a 10 V sine wave is output on analog output channel 0 of a DT9857-8 module. The analog output channel is connected to analog input channel 0 on the DT9857-8 module.

Configure the Analog Output Settings

For this example, configure the analog output channel as follows:

1. Click the **Output** tab of the Acquisition and Config window.

Acquisition Config

Recording | Acquisition | **Output**

Enable	Channel Name	Waveform	Peak Voltage	Offset
<input checked="" type="checkbox"/>	DT9857-08(0...	Fixed	10	0
<input type="checkbox"/>	DT9857-08(0...	Fixed	10	0

Waveform

Signal Type: Sine

Frequency: 10.00 Hz

Output Mode: Continuous

Repeat burst

Options

Burst On Time: 1.0000 Sec

Burst Off Time: 0.00000 Sec

Lock to acquisition time

Ramp Up Time: 0.00000 Sec

Ramp Down Time: 0.00000 Sec


Start/Stop Method: With Acquisition

Trigger Source: Software

Start [Speaker icon]


Acquisition info

Sample rate: 10000 Hz
 Sample interval: .0001 Sec
 Number of scans: 10000

2. Select the **Enable** checkbox to enable the analog output channel on the module.
3. For the **Waveform** type, select **Fixed**.
4. For **Peak Voltage**, enter **10** to output a ± 10 V signal.
5. For **Offset**, enter **0**.
6. For **Signal Type**, select **Sine** to output a sine wave.
7. For **Output Mode**, select **Continuous** to output a waveform that repeats continuously.
8. For **Frequency**, select **10 Hz**; this is the frequency of the output waveform.
9. For **Ramp Up Time**, enter **0**.
10. For the **Start/Stop Method**, select **With Acquisition**.
The analog output operation will start when you start acquisition.
11. If desired, hide the Acquisition Config window by clicking the Auto-Hide pin () in the top, right corner of the window.

Configure the Analog Input Channel

Configure the analog input channel as follows:

1. Ensure that the output from analog output channel 0 is connected to the input of analog input channel 0.
2. Configure the analog input channel by clicking the **Input Channel Configuration** toolbar button () or by clicking the **Configuration** menu and clicking **Input Channel Configuration**.
3. Enable analog input channel 0 by clicking the **Enable** checkbox next to the channel.

The screenshot shows the 'Configure Devices' dialog box with three sections: Analog Input Channels, Tach Channels, and Counter Channels.

Analog Input Channels

Channel	Enable	Channel Name	Range	Coupling	Current Source	Engineering Unit (EU)	mV/EU	EU Offset	Point #	Dir
DT9857-08(00)-0	<input checked="" type="checkbox"/>	Ain 0	-10V to 10V	DC	<input type="checkbox"/>	V	1000	0	1	Scalar
DT9857-08(00)-1	<input type="checkbox"/>	Ain 1	-10V to 10V	DC	<input type="checkbox"/>	g	1000	0	2	X+
DT9857-08(00)-2	<input type="checkbox"/>	Ain 2	-10V to 10V	DC	<input type="checkbox"/>	g	1000	0	3	X+
DT9857-08(00)-3	<input type="checkbox"/>	Ain 3	-10V to 10V	DC	<input type="checkbox"/>	g	1000	0	4	X+
DT9857-08(00)-4	<input type="checkbox"/>	Ain 4	-10V to 10V	DC	<input type="checkbox"/>	g	1000	0	5	X+
DT9857-08(00)-5	<input type="checkbox"/>	Ain 5	-10V to 10V	DC	<input type="checkbox"/>	g	1000	0	6	X+
DT9857-08(00)-6	<input type="checkbox"/>	Ain 6	-10V to 10V	DC	<input type="checkbox"/>	g	1000	0	7	X+
DT9857-08(00)-7	<input type="checkbox"/>	Ain 7	-10V to 10V	DC	<input type="checkbox"/>	g	1000	0	8	X+
DT9857-08(00)-12	<input type="checkbox"/>	Din 0			<input type="checkbox"/>	Bits				

Tach Channels

Channel	Enable	Channel Name	Engineering Unit (EU)	Ticks/Rev	Max RPM	RPM Multiplier	Max mSec/Hz	Tach Edge
DT9857-08(00)-8	<input type="checkbox"/>	Tach 0	RPM	100	1000	1		Rising

Counter Channels

Channel	Enable	Channel Name	Engineering Unit (EU)	Max mSec/Hz	Start Edge	Stop Edge
DT9857-08(00)-9	<input type="checkbox"/>	CT 0	Hz	1000	Gate Rising	Gate Falling
DT9857-08(00)-10	<input type="checkbox"/>	CT 1	Hz	1000	A/D Complete	Tach Falling
DT9857-08(00)-11	<input type="checkbox"/>	CT 2	Hz	1000	A/D Complete	Tach Falling

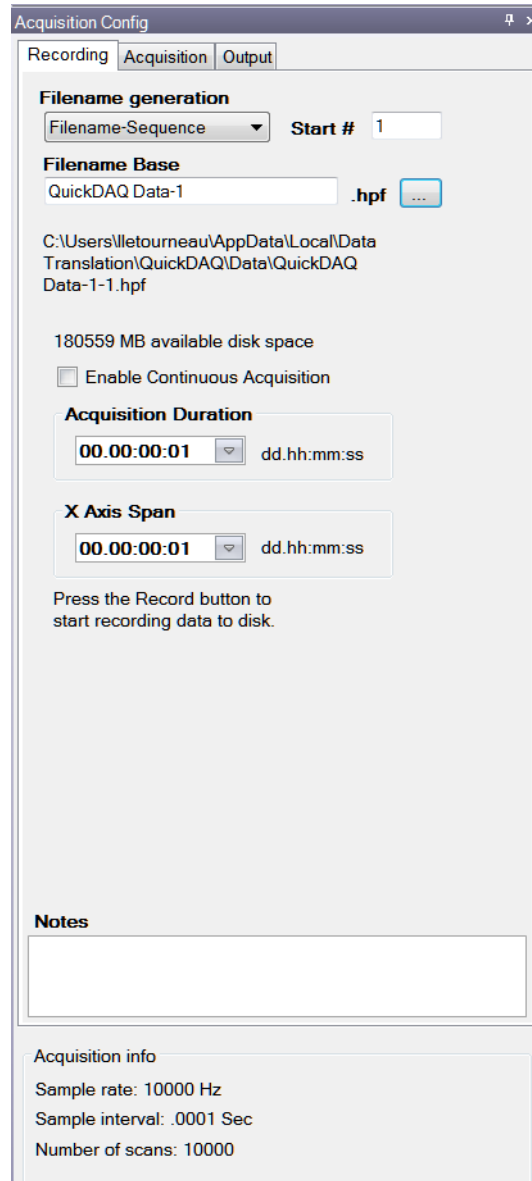
A 'Close' button is located at the bottom right of the dialog box.

- Under the **Channel Name** column, leave the default channel name as Ain 0.
- Under the **Range** column, select the input range for analog input channel.
In this example, ± 10 V is used.
- Under the **Coupling** column, select the coupling type (AC or DC) for your sensor.
Since this example is monitoring a voltage input, DC is used.
- Under the **Current Source** column, select whether to enable or disable use of the 4 mA current source on the data acquisition device.
*Since this example is monitoring a voltage input, the **Current Source** checkbox is not checked (disabled) for the analog input channel.*
- Under the **Engineering Units** column, select the engineering units for the input.
In this example, V is used.
- Enter the number of mV per engineering unit in the **mV/EU** field.
In this example, 1000 is used.
- If an offset is specified for the input, enter the value in the **EU Offset** field.
In this example, no offset (0) is specified.
- If desired, enter a test point value for the channel.
In this example, 1 is used.
- If desired, enter a sensor direction for each channel.
In this example, Scalar is used.
- Click **Close** to close the Configure Devices dialog box.

Configure the Recording Settings

For this example, configure the recording settings as follows:

1. Click the **Recording** tab of the Acquisition Config window.

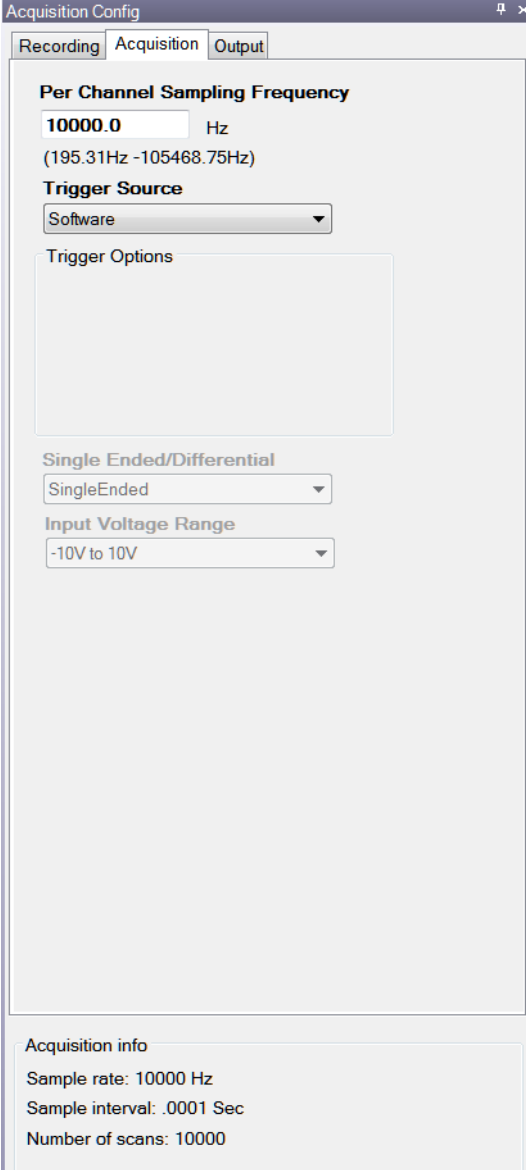


2. For **Filename generation**, use the default **Filename** option.
3. For **Filename**, use the default name for the data file.
4. Leave the **Enable Continuous Acquisition** checkbox unchecked.
5. For **Acquisition Duration**, select **1 second**.
The number of seconds for the total run and the amount of available disk space are shown.
6. For **X Span Axis**, select **1 second**.

Configure the Acquisition Settings

For this example, configure the acquisition settings as follows:

1. Click the **Acquisition** tab of the Acquisition Config window.



Acquisition Config

Recording Acquisition Output

Per Channel Sampling Frequency
10000.0 Hz
(195.31Hz -105468.75Hz)

Trigger Source
Software

Trigger Options

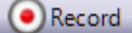
Single Ended/Differential
SingleEnded

Input Voltage Range
-10V to 10V

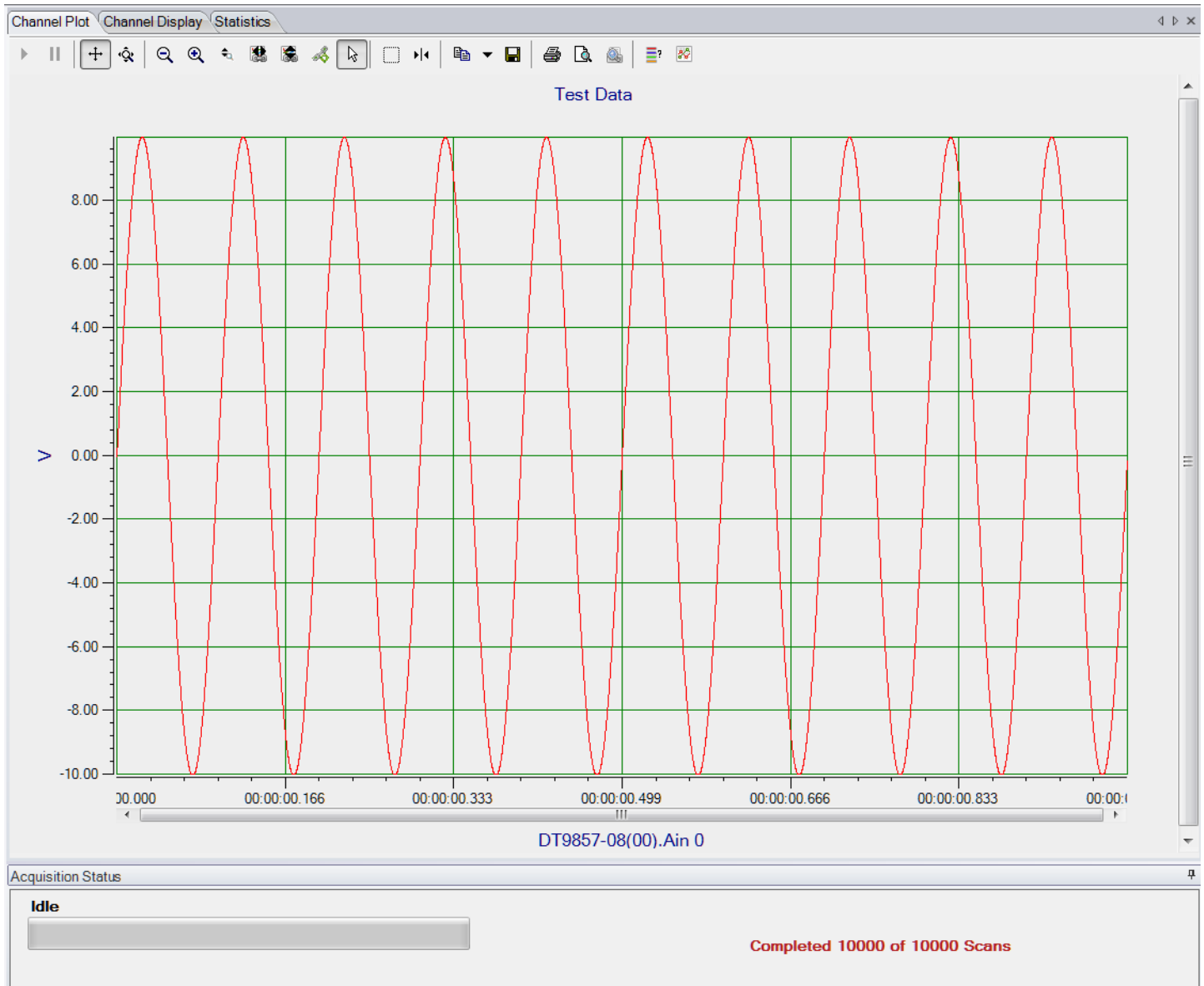
Acquisition info
Sample rate: 10000 Hz
Sample interval: .0001 Sec
Number of scans: 10000

2. For the **Per Channel Sampling Frequency** text box, enter **10000**.
The sampling rate, sample interval, and number of scans are displayed.
3. For the **Trigger Source** check box, select **Software** to ensure that the measurement starts as soon as the **Record** button is clicked.

Start the Operation

Once you have configured the channels and the application parameters, click the **Record** toolbar button () or press the **F5** key to start the operation.

Results similar to the following are displayed in the Channel Plot window, showing the output of analog output channel 0 as measured by analog input channel 0.



Note: Many additional options are provided in QuickDAQ for measuring and analyzing the data. Refer to the *QuickDAQ User's Manual* for detailed information.

Part 2: Using Your Module



Principles of Operation

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Block Diagram

Figure 31 shows a block diagram of the DT9857 module and Figure 32 shows a block diagram of the DT9857E module.

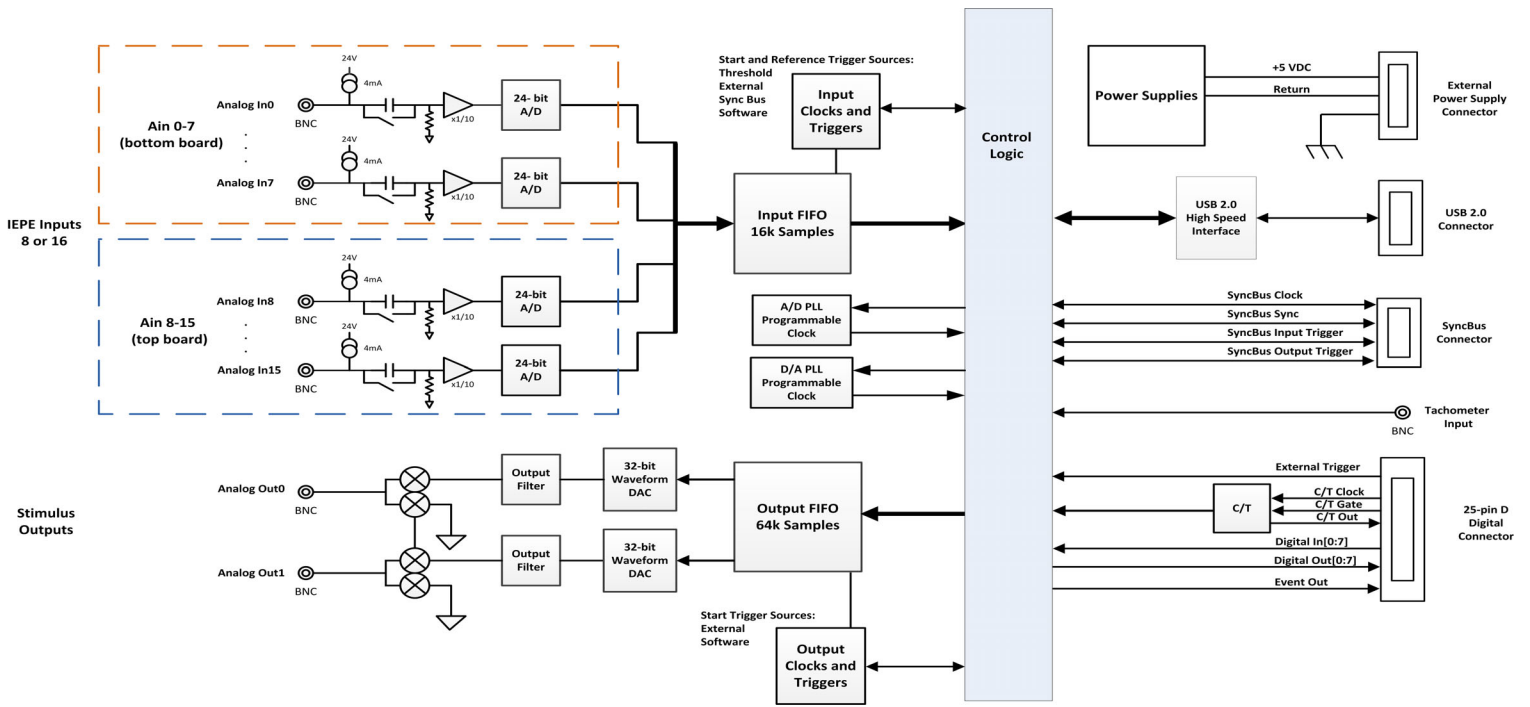


Figure 31: Block Diagram of the DT9857 Module

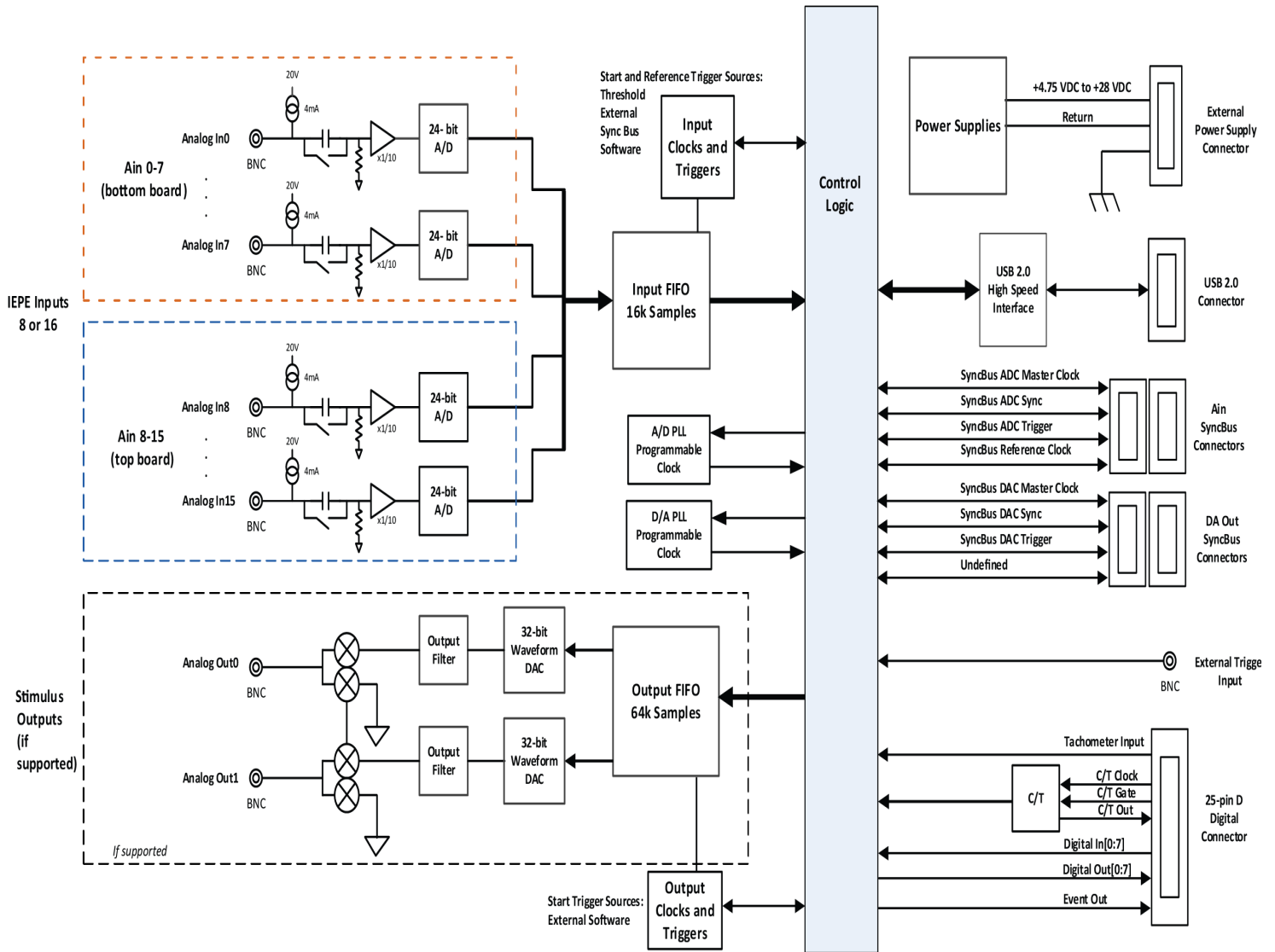


Figure 32: Block Diagram of the DT9857E Module

Analog Input Features

This section describes the following features of analog input (A/D) subsystem on the DT9857 and DT9857E modules:

- Analog input channels, described on this page
- Input ranges and gains, described on this page
- IEPE functions, described on [page 77](#)
- Input resolution, described on [page 77](#)
- Input sample clock source, described on [page 77](#)
- Analog input conversion modes, described on [page 78](#)
- Input triggers, described on [page 80](#)
- Data format and transfer, described on [page 83](#)
- Error conditions, described on [page 83](#)

Analog Input Channels

The DT9857-8 and DT9857E-8 modules provides eight analog input channels (channels 0 to 7) and the DT9857-16 and DT9857E-16 modules provides 16 analog input channels (channels 0 to 15). These are single-ended channels; you can connect IEPE sensors to these inputs, if desired; refer to [page 77](#) for more information on IEPE functions.

Note: To maintain simultaneous operation, all analog input connections on the DT9857 and DT9857E modules must have the same lead lengths.

The DT9857 and DT9857E modules use Delta-Sigma analog-to-digital converters (ADCs) that provide anti-aliasing filters based on the clock rate. These filters remove *aliasing*, which is a condition where high frequency input components erroneously appear as lower frequencies after sampling.

Using software, you can acquire a single value from a single analog input channel, a single value from all the analog input channels simultaneously, or multiple values from a one or more analog input channels, the tachometer, measurement counters, general-purpose counter/timer, and/or the digital input port. Refer to “[Analog Input Conversion Modes](#)” on [page 78](#) for more information on specifying and reading data from these channels.

Input Ranges and Gains

The DT9857 and DT9857E modules provide an input range of ± 10 V and software-selectable gains of 1 and 10. This provides effective input ranges of ± 10 V (when the gain is 1) and ± 1 V (when the gain is 10).

IEPE Functions

Applications that require accelerometer, vibration, noise, or sonar measurements often use IEPE sensors. IEPE conditioning is built-in to the analog input circuitry of the DT9857 and DT9857E module. The modules support the following software-programmable IEPE functions for each analog input channel:

- Excitation current source – The DT9857 and DT9857E modules provide an internal excitation current source of 4 mA. You can enable or disable the use of a internal excitation current source using software. By default, the excitation current source is disabled.
- Coupling type – You can select whether AC coupling or DC coupling is used. By default, DC coupling is selected for the DT9857 and DT9857E modules.

DT9857 and DT9857E modules provide +24 V of compliance voltage.

For information on wiring IEPE inputs, refer to [page 48](#).

Note: If you enable the use of the internal excitation current source, it is recommended that you choose AC coupling.

Input Resolution

The resolution of the analog input channels is fixed at 24 bits; you cannot specify the resolution in software.

Input Clock Source

The DT9857 and DT9857E modules support a 48 MHz internal clock source, which is derived from the 24 MHz USB crystal oscillator. The same internal 48 MHz clock signal is used for the both the analog input and analog output subsystems.

For the analog input subsystem, use software to specify the internal clock source and the frequency at which to pace the input operation and to start the sample clock. The sampling frequency can range from 195.3125 Hz to 105.469 kHz.

Note: According to sampling theory (Nyquist Theorem), specify a frequency that is at least twice as fast as the input's highest frequency component. For example, to accurately sample a 20 kHz signal, specify a sampling frequency of at least 40 kHz to avoid aliasing.

The sample frequencies for the A/D and D/A subsystems are independently programmable and are derived from the same 48 MHz reference clock. Therefore, it is possible to establish a fixed relationship between the A/D and D/A subsystem sample frequencies, including setting them to the same frequency (30 kHz to 105.469 kHz). However, the subsystems are not designed to be synchronous with each other.

Once the sample clock is started, the module requires 39 conversions before the first A/D sample is valid. The valid sample is aligned with the A/D trigger.

Note: The DT9857 and DT9857E modules have two power modes: low power mode and high power mode. Low power mode is used when you specify a sampling frequency less than 52.734 kHz. High power mode is used when you specify a sampling frequency greater than or equal to 52.734 kHz. If you change the power mode from low to high power or from high power to low power, and then configure the device, the module is self-calibrated. You may notice that it takes time after the device is configured to complete the calibration process.

Analog Input Conversion Modes

The DT9857 and DT9857E modules support single-value, single-values, and continuous scan mode to acquire and convert analog input data. This section describes each of these conversion modes.

Single-Value Operations

Single-value operations are simpler to use than continuous operations. Using software, you specify the analog input channel and the gain that you want to use. For the DT9857-8 and DT9857E-8, specify channel 0 to 7; for the DT9857-16 and DT9857E-16, specify channel 0 to 15. The module acquires the data from the specified channel and returns the data immediately.

For single-value operations, you cannot specify a clock frequency, trigger source, scan mode, or buffer. Single-value operations stop automatically when finished; you cannot stop a single-value operation.

Single-Values Operations

For the DT9857-8, DT9857E-8, DT9857-16, or DT9857E-16 module, you may prefer to read a single value from all the analog input channels simultaneously using one software call. This is called a single-values operation. You specify the analog input subsystem and the gain that you want to use for the channels (not the channels themselves). The module then acquires a value from each input channel simultaneously; the data is returned as an array of input values.

For single-values operations, you cannot specify a clock frequency, trigger source, scan mode, or buffer. Single-values operations stop automatically when finished; you cannot stop a single-values operation.

Note: Data is returned from the analog input channels only.

Continuous Scan Mode

In continuous scan mode, you can acquire data from all the entries in the channel-gain list continuously. Using software, you can specify a channel list, clock frequency, start trigger, reference trigger, post-trigger scan count, and buffer using software.

On the DT9857-8 and DT9857E-8 modules, you can enter up to 13 entries in the channel list: analog input channels 0-7, the tachometer input (channel 8), general-purpose counter 0 (channel 9), measure counter 1 (channels 10), measure counter 2 (channel 11), and the digital input port (channel 12). On the DT9857-16 and DT9857E-16 modules, you can enter up to 21 entries in the channel list: analog input channels 0 to 15, the tachometer input (channel 16), general-purpose counter 0 (channel 17), measure counter 1 (channel 18), measure counter 2 (channel 19), and the digital input port (channel 20). Using software, specify the channels that you want to sample in sequential order.

When it detects the start trigger, the module samples all the channels in the list simultaneously.

If a reference trigger is not specified, data that is acquired after the start trigger is post-trigger data. The sampled data is placed in the allocated buffer(s). The operation continues until you stop it or until no more buffers are available.

If a reference trigger is specified, data that is acquired after the start trigger is pre-trigger data; when the reference trigger occurs, pre-trigger data acquisition stops and post-trigger acquisition starts at the next sample. The sampled data is placed in the allocated buffer(s). The operation continues until the number of scans that you specify for the post-trigger scan count have been acquired; at the point, the operation stops. Note that the sample at which the trigger occurs is not counted as a post-trigger sample. Refer to [page 80](#) for more information about start and reference triggers.

The conversion rate is determined by the frequency of the input sample clock; refer to [page 77](#) for more information about the input sample clock.

Using software, you can stop a scan by performing either an orderly stop or an abrupt stop. In an orderly stop, the module finishes acquiring the current buffer, stops all subsequent acquisition, and transfers the acquired data to host memory; any subsequent triggers are ignored. In an abrupt stop, the module stops acquiring samples immediately; the current buffer is not completely filled, it is returned to the application only partially filled, and any subsequent triggers are ignored.

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

- Specify the data flow as Continuous
- Specify the channels to acquire in the analog input channel list
- Specify the sampling frequency (refer to [page 77](#))
- Specify the start trigger source (refer to [page 81](#))
- Specify the reference trigger source (refer to [page 82](#))
- Specify the post-trigger scan count (the number of post-trigger samples to acquire after the reference trigger occurs).

Figure 33 illustrates continuous scan mode (using a start and reference trigger) with a channel list of three entries: channel 0 through channel 2. In this example, pre-trigger analog input data is acquired when the start trigger is detected. When the reference trigger occurs, the specified number of post-trigger samples (three, in this example) are acquired.

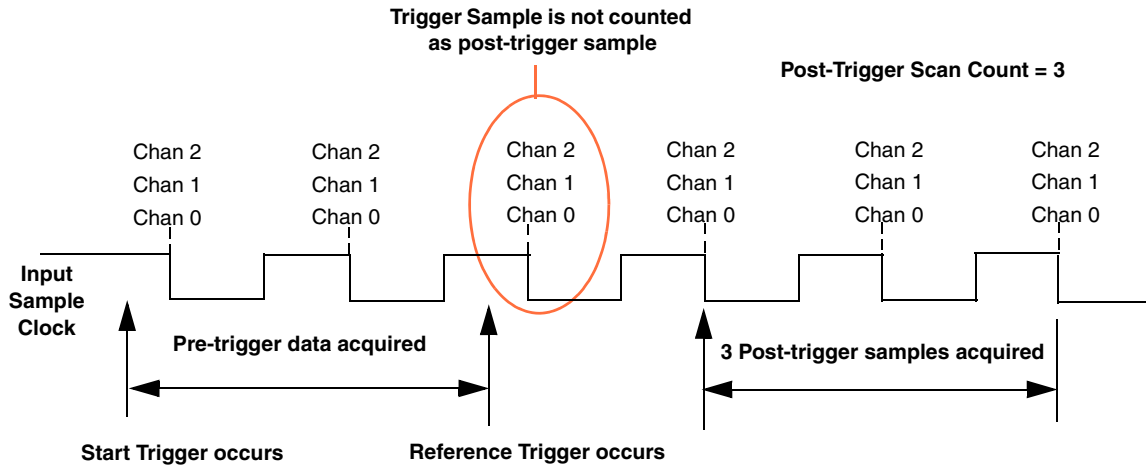


Figure 33: Continuous Scan Mode on the DT9857 and DT9857E Modules Using a Start and Reference Trigger

Note: The Input Trigger LED on the module, shown on [page 176](#), is amber to indicate an armed condition when the module is waiting for an external digital trigger, threshold trigger, or Sync Bus trigger (the module must have been configured for one of these trigger types), green when the module has been triggered, or off when the module is idle.

Input Triggers

A trigger is an event that occurs based on a specified set of conditions.

If you are using continuous scan mode, described on [page 79](#), you must specify a start trigger to start acquisition. If you want to acquire pre-trigger and post-trigger data, you must also specify a reference trigger. In this case, pre-trigger data is acquired when the start trigger occurs. When the reference trigger occurs, pre-trigger acquisition stops and post-trigger acquisition starts. The operation continues until the number of scans that you specify for the post-trigger scan count are acquired; at the point, the operation stops.

The following sections describe the start and reference trigger sources that you can configure.

Note: The Input Trigger LED on the module, shown in [page 176](#), is amber to indicate an armed condition when the module is waiting for an external digital trigger, threshold trigger, or Sync Bus trigger (the module must have been configured for one of these trigger types), green when the module has been triggered, or off when the module is idle.

Start Trigger Sources

DT9857 and DT9857E modules support the following sources for the start trigger:

- **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 start trigger source as a software trigger.
- **External digital (TTL) trigger** – For the DT9857 module, an external digital (TTL) trigger event occurs when the module detects a rising- or falling-edge transition on the signal connected to the External Trigger pin (pin 11) of the Digital connector on the module. For the DT9857E module, an external digital (TTL) trigger event occurs when the module detects a rising- or falling-edge transition on the External Trigger BNC input of the module.

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

- **Threshold trigger** – The start trigger event occurs when the signal attached to a specified analog input channel in the channel list rises above or falls below a user-specified threshold value. Using software, specify the following parameters:
 - Start trigger source – Specify a positive (low-to-high transition) threshold trigger if you want to trigger when the signal rises above a threshold level, or a negative (high-to-low transition) threshold trigger if you want to trigger when the signal falls below a threshold level.
 - Threshold channel – Specify any one of the analog input channels as the threshold input channel.
 - Threshold level – Specify a value between ± 10 V for a gain of 1 or ± 1 V for a gain of 10 as the threshold level.

Note: If you choose a threshold trigger as both the start trigger and the reference trigger, the threshold channel and threshold level must be the same. The polarity of the trigger (positive or negative going) can be different for each trigger source.

- **Sync Bus trigger** – When multiple DT9857 or DT9857E modules are connected together using the Sync Bus (RJ45) connectors, you can use the Sync Bus trigger as the start trigger of the analog input subsystem on the slave module by setting the synchronization mode of the analog input subsystem of the module to Slave. In this configuration, any other start trigger for the slave module is ignored. Refer to [page 105](#) for more information on this configuration.

Reference Trigger Sources

DT9857 and DT9857E modules support the following trigger sources for the reference trigger:

- **External digital (TTL) trigger** – For the DT9857 module, an external digital (TTL) trigger event occurs when the module detects a rising- or falling-edge transition on the signal connected to the External Trigger pin (pin 11) of the Digital connector on the module. For the DT9857E module, an external digital (TTL) trigger event occurs when the module detects a rising- or falling-edge transition on the External Trigger BNC input of the module.

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

- **Threshold trigger** – The reference trigger event occurs when the signal attached to a specified analog input channel in the channel list rises above or falls below a user-specified threshold value. Using software, specify the following parameters:
 - Reference trigger source – Specify a positive (low-to-high transition) threshold trigger if you want to trigger when the signal rises above a threshold level, or a negative (high-to-low transition) threshold trigger if you want to trigger when the signal falls below a threshold level.
 - Threshold channel – Specify any one of the analog input channels as the threshold input channel.
 - Threshold level – Specify a value between ± 10 V for a gain of 1 or ± 1 V for a gain of 10 as the threshold level.

Note: If you choose a threshold trigger as both the start trigger and the reference trigger, the threshold channel and threshold level must be the same. The polarity of the trigger (positive or negative going) can be different for each trigger source.

- **Sync Bus trigger** – When multiple DT9857 or DT9857E modules are connected together using the Sync Bus (RJ45) connector, you can set the reference trigger of the analog input subsystem of a slave module to Sync Bus if you want to receive a Sync Bus trigger from one of the other modules to stop pre-trigger acquisition and start post-trigger acquisition. Refer to [page 105](#) for more information on this configuration.

Data Format and Transfer

DT9857 and DT9857E modules use offset binary data encoding, where 000000 represents negative full-scale, and FFFFFFFh represents positive full-scale. Use software to specify the data encoding as binary. The ADC outputs FFFFFFFh for above-range signals, and 000000 for below-range signals.

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 continuous analog input operations. Data is written to multiple allocated input buffers continuously; when no more empty buffers are available, the operation stops. The data is gap-free.

Note: DT9857 and DT9857E modules have a 16 kSample input FIFO that is used to store the acquired data before it is sent to the host.

Error Conditions

DT9857 and DT9857E modules report any overrun errors by sending an overrun event to the application program. This event indicates that data buffers are not being sent from the module to the host fast enough, and the A/D converter ran out of buffers. To avoid this error, try one or more of the following:

- Reduce the clock rate of the A/D
- Increase the size of the buffers
- Increase the number of buffers
- Close any other applications that are running
- Run the program on a faster computer

If one of these error conditions occurs, the module stops acquiring and transferring data to the host computer.

Analog Output Features

This section describes the following features of analog output operations:

- Analog output channels, described below
- Output ranges and gains, described below
- Output resolution, described below
- Output clocks, described below
- Output conversion mode, described on [page 85](#)
- Output triggers, described on [page 88](#)
- Data format and transfer, described on [page 89](#)
- Error conditions, described on [page 89](#)

Analog Output Channels

DT9857 and DT9857E modules support two analog output channels (0 and 1) through analog output subsystem 0. You can also update the digital output port in the analog output stream by specifying channel 2 in the analog output channel list.

DT9857 and DT9857E modules provide a two-pole, 120 kHz Butterworth filter and quiet start circuitry to prevent noise from interfering with the output signal.

The analog output channel powers up to a value of $0\text{ V} \pm 10\text{ mV}$.

Note: The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions are designed without analog output functionality.

Output Range and Gain

DT9857 and DT9857E modules can output bipolar analog output signals in the range of $\pm 10\text{ V}$ using a gain of 1.

Output Resolution

The resolution of the analog output channel is fixed at 32-bits; you cannot specify the resolution in software.

Output Clocks

The DT9857 and DT9857E modules support a 48 MHz internal clock source, which is derived from the 24 MHz USB crystal oscillator. The same internal 48 MHz clock signal is used for the both the analog input and analog output subsystems.

For the analog output subsystem, use software to specify the internal clock source and the output frequency. The output frequency can range between 30 kHz and 216 kHz.

Note: The sample frequencies for the A/D and D/A subsystems are independently programmable and are derived from the same 48 MHz reference clock. Therefore, it is possible to establish a fixed relationship between the A/D and D/A subsystem sample frequencies, including setting them to the same frequency (30 kHz to 105.469 kHz). However, the subsystems are not designed to be synchronous with each other.

The DT9857 and DT9857E modules require 36 sample clock periods once the output subsystem has been triggered before the first D/A conversion is completed. The clock is always running.

Output Conversion Modes

DT9857 and DT9857E modules support single-value, waveform, and continuous analog output operations.

Single-Value Mode

Single-value mode is the simplest to use but offers the least flexibility and efficiency. Use software to specify the analog output channel that you want to update, and the value to output from that channel. The value is output from the specified channel immediately.

For a single-value operation, you cannot specify a clock frequency, trigger source, or buffer. Single-value operations stop automatically when finished; you cannot stop a single-value operation.

Waveform Generation Mode

The DT9857 and DT9857E modules support the ability to generate a waveform (specified in a single buffer) from the output channels.

If you want the hardware to output the waveform without USB bus intervention, ensure that the waveform is equal to or less than the size of the output FIFO on the module (64 kSamples). In this case, the waveform pattern can range from 2 to 64K (65536) samples if you specify one output channel, 2 to 32K (32768) samples for two output channels, or 21.3K (21845) samples for three output channels (two analog output channels and the digital output port).

If your waveform is larger than the size of the output FIFO (64K samples), the driver will manage the buffer for you. However, USB bus intervention is required in this case.

Use software to fill the output buffer with the values that you want to write to the channels in the output channel list.

Note: If you are using the DataAcq SDK, you must specify the data in a particular order. For example, if your output channel list contains analog output channels 0 and 1 and the digital output port (channel 2), specify the values in the output buffer as follows: the first output value for analog output channel 0, the first output value for analog output channel 1, the first value for the digital output port (channel 2), the second output value for analog output channel 0, the second output value for analog output channel 1, the second value for the digital output port (channel 2), and so on.

This is not required in the DT-Open Layers for .NET Class Library.

The waveform pattern size must be the same for all output channels, and the total number of samples must be a multiple of the total number of output channels.

If the waveform pattern is equal to or less than the size of the output FIFO on the module, the host computer transfers the entire waveform pattern to the output FIFO. When it detects a trigger, the module starts writing output values to the output channels, as determined by the output channel list, at the specified clock rate. The channels are updated simultaneously. The module recycles the data, allowing you to output the same pattern continuously without any further CPU or USB bus activity. When it reaches the end of the FIFO, the module returns to the first location of the FIFO and continues outputting the data. This process continues indefinitely until you stop it.

If the waveform pattern is greater than the size of the output FIFO, the buffer resides on the host computer. When it detects a software trigger, the module starts writing output values to the output channels, as determined by the output channel list, at the specified clock rate using CPU and USB bus intervention. The driver manages the buffer, allowing you to output the same pattern continuously. When it reaches the end of the buffer, the software returns to the first location of the buffer and continues outputting the data. This process continues indefinitely until you stop it.

To select waveform generation mode, use software to specify the following parameters:

- Specify the data flow as Continuous
- Specify WrapSingleBuffer as True to use a single buffer
- Specify the clock source as internal and specify the clock frequency. Refer to [page 84](#) for more information about the clock source and frequency.
- Specify the trigger source as any of the supported output trigger sources. Refer to [page 88](#) for more information about the supported output trigger sources.

The DT9857 and DT9857E hardware supports the ability to mute the output voltage to 0 V. Muting the output does not stop the analog output operation; instead, the analog output voltage is reduced to 0 V over 1020 samples. When desired, you can use unmute the output voltage to its current level. Refer to your software documentation for more information on muting and unmuting the output voltage.

Continuous Analog Output Operations

Use continuously paced analog output mode to output buffered values to the analog output channels and/or the digital output port continuously at a specified clock frequency. The DT9857 and DT9857E modules support the ability to start continuous analog output operations and continuous analog input operations simultaneously.

Note: If you are using the DataAcq SDK, you must specify the data in a particular order. For example, if your output channel list contains analog output channels 0 and 1 and the digital output port (channel 2), specify the values in the output buffer as follows: the first output value for analog output channel 0, the first output value for analog output channel 1, the first value for the digital output port (channel 2), the second output value for analog output channel 0, the second output value for analog output channel 1, the second value for the digital output port (channel 2), and so on.

This is not required in the DT-Open Layers for .NET Class Library.

When it detects a trigger, the module starts writing the values from the output buffer to the channels specified in the output channel list at the specified clock frequency. The operation repeats continuously until all the data is output from the buffers or you stop the operation.

Note: Make sure that the host computer transfers data to the output channel list fast enough so that the list does not empty completely; otherwise, an underrun error results.

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

- Specify the data flow as Continuous.
- Specify WrapSingleBuffer as False to use multiple buffers.
- Specify the D/A output frequency. Refer to [page 84](#) for more information.
- Specify the trigger source as any of the supported output trigger sources. Refer to [page 88](#) for more information about the supported output trigger sources.
- To start the analog input and analog output operations simultaneously using the DT-Open Layers for .NET Class Library, use the **SimultaneousStart.AddSubsystem**, **SimultaneousStart.PreStart**, and **SimultaneousStart.Start** methods. Refer to the documentation for the DT-Open Layers for .NET Class Library for more information.

We recommend that you allocate a minimum of two buffers for a continuously paced analog output operation. Data is written from multiple output buffers continuously; when no more buffers of data are available, the operation stops. The data is gap-free.

Note: The Output Trigger LED on the module, shown in [page 176](#), is amber when the module is armed and waiting for an external digital or Sync Bus trigger (the module must have been configured for one of these trigger types), green when the module has been triggered, or off when the module is idle.

The DT9857 and DT9857E hardware supports the ability to mute the output voltage to 0 V. Muting the output does not stop the analog output operation; instead, the analog output voltage is reduced to 0 V over 1020 samples. When desired, you can use unmute the output voltage to its current level. Refer to your software documentation for more information on muting and unmuting the output voltage.

To stop a continuously paced analog output operation, you can stop queuing buffers for the analog output system, 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 specified number of samples, and then stops; all subsequent triggers are ignored. In an abrupt stop, the module stops outputting samples immediately; all subsequent triggers are ignored.

Output Trigger

DT9857 and DT9857E modules support the following trigger sources for starting analog output operations:

- **Software trigger** – A software trigger event occurs when you start the analog output operation (the computer issues a write to the module to begin conversions). Using software, specify the trigger source for the D/A subsystem as a software trigger.
- **External digital (TTL) trigger** – For the DT9857 module, an external digital (TTL) trigger event occurs when the module detects a rising- or falling-edge transition on the signal connected to the External Trigger pin (pin 11) of the Digital connector on the module. For the DT9857E module, an external digital (TTL) trigger event occurs when the module detects a rising- or falling-edge transition on the External Trigger BNC input of the module.

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

- **Sync Bus trigger** – When multiple DT9857E modules are connected together using the Sync Bus (RJ45) connectors, you can use the Sync Bus trigger as the trigger source of the analog output subsystem on the slave module by setting the synchronization mode of analog output subsystem of the module to Slave. In this configuration, any other start trigger for the slave module is ignored. Refer to [page 105](#) for more information on this configuration.

Data Format and Transfer

Data from the host computer must use offset binary data encoding for analog output signals, where 00000000 represents the negative full-scale voltage, and FFFFFFFFh represents the positive full-scale voltage. Using software, specify the data encoding as binary.

Error Conditions

DT9857 and DT9857E modules report any underrun errors by sending an underrun event to the application. This event indicates that the data buffers are not being sent from the host to the module fast enough, and the D/A converter ran out of data. To avoid this error, try one or more of the following:

- Reduce the clock rate of the analog output operation
- Close any other applications that are running
- Run the program on a faster computer

Tachometer Input Features

You can connect a tachometer signal with a range of ± 30 V to a DT9857 or DT9857E module. On the DT9857 module, you connect this signal to a BNC connector; on the DT9857E module, you connect this signal to pin 11 of the Digital connector. This signal has a maximum frequency of 1 MHz and a minimum pulse width of 0.4 μ s. The threshold voltage is fixed at +2 V with 0.5 V of hysteresis.

You can measure the frequency or period of the tachometer input signal to calculate the rotation speed for high-level (± 30 V) tachometer input signals. An internal 12 MHz counter is used for the measurement, yielding a resolution of 83 ns (1/12 MHz).

You can read the number of counts between two consecutive starting edges of the tachometer input signal by including channel 8 for the DT9857-8 or DT9857E-8 module, or channel 16 for the DT9857-16 or DT9857E-16 in the analog input channel list. The starting edge is programmable (either rising or falling).

Using software commands, you can specify the following parameters for the tachometer input:

- The starting edge of the tachometer input signal to use for the measurement (rising or falling edge).
- A flag (called Stale) indicating whether or not the data is new. If the Stale flag is set as Used (the default value), the most significant bit (MSB) of the value is set to 0 to indicate new data; reading the value before the measurement is complete returns an MSB of 1. If the Stale flag is set to Not Used, the MSB is always set to 0.

When the operation is started, the internal 12 MHz counter starts incrementing when it detects the first starting edge of the tachometer input and stops incrementing when it detects the next starting edge; at that point, the counter stores and resets the count. The stored count is maintained until it is read as part of the input data stream or until a new count is stored. The next tachometer measurement operation is started automatically.

If the sample rate of the input subsystem is faster than the tachometer input frequency, then the stored count retains the current value when the count is read by the input subsystem. The operation of the Stale flag in this case is described as follows:

- If another input subsystem sample occurs before another measure completes and the Stale flag is enabled, then the Stale flag is set and the stale measure count is written into the input data stream.
- If another input subsystem sample occurs before another measure completes and the Stale flag is disabled, then the Stale flag is not set and the stale measure count is written into the input data stream.

If the input sample rate is slower than the tachometer input frequency, then as each period measurement completes, a new count value is stored. When the input subsystem sample occurs, the most recently stored measure count is written into the input data stream.

A data pipeline is used in the hardware to compensate for the A/D group delay and synchronizes the value of the tachometer input with the analog input measurements, so that all measurements are correlated in time. The tachometer input is treated like any other channel in the analog input channel list; therefore, all the triggering and conversion modes supported for analog input channels are supported for the tachometer input.

When you read the value of the tachometer input as part of the analog input data stream, you might see results similar to the following:

Table 3: An Example of Reading the Tachometer Input as Part of the Analog Input Data Stream

Time	A/D Value	Tachometer Input Value	Status of Operation
10	5002	0	Operation started, but is not complete
20	5004	0	Operation not complete
30	5003	0	Operation not complete
40	5002	12373	Operation complete
50	5000	12373	Next operation started, but is not complete
60	5002	12373	Operation not complete
70	5004	12373	Operation not complete
80	5003	14503	Operation complete
90	5002	14503	Next operation started, but is not complete

Using the count that is returned from the tachometer input, you can determine the following:

- Frequency of a signal pulse (the number of periods per second). You can calculate the frequency as follows:
 - $\text{Frequency} = 12 \text{ MHz} / (\text{Number of counts} - 1)$
where 12 MHz is the internal counter/timer clock frequency

For example, if the count is 21, the measured frequency is 600 kHz (12 MHz/20).
- Period of a signal pulse. You can calculate the period as follows:
 - $\text{Period} = 1 / \text{Frequency}$
 - $\text{Period} = (\text{Number of counts} - 1) / 12 \text{ MHz}$
where 12 MHz is the internal counter/timer clock frequency

General-Purpose 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 93](#)
- Gate types, described on [page 93](#)
- Pulse types and duty cycles, described on [page 94](#)
- C/T operation modes, described on [page 94](#)

C/T Channels

DT9857 and DT9857E modules provide one 32-bit, general-purpose counter/timer (C/T 0). The counter/timer accepts a clock input signal and gate input signal and outputs a pulse (pulse output signal), as shown in [Figure 34](#).

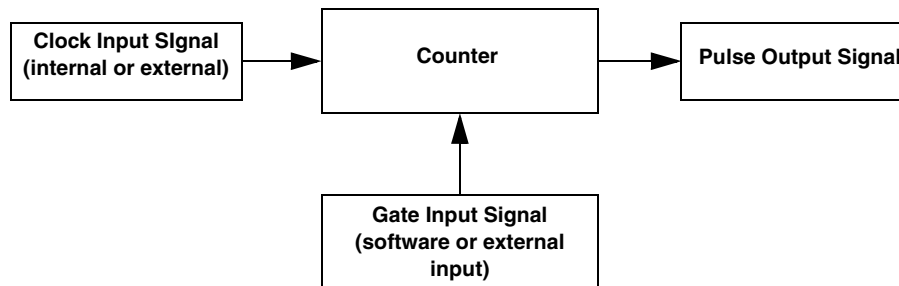


Figure 34: Counter/Timer Channel

Using software, specify C/T subsystem element 0 to set up the parameters for the general-purpose counter/timer. To read the counter/timer, specify channel 9 for the DT9857-8 or DT9857E-8 or channel 17 for the DT9857-16 or DT9857E-16 in the analog input channel list.

C/T Clock Sources

The following clock sources are available for the general-purpose counter/timer:

- **Internal C/T clock** – The internal C/T clock always uses a 48 MHz time base. Through software, specify the clock source as internal, and specify the frequency at which to pace the operation (this is the frequency of the counter's output signal).
- **External C/T clock** – An external C/T clock is useful when you want to pace counter/timer operations at rates not available with the internal C/T clock or if you want to pace at uneven intervals. The frequency of the external C/T clock can range from 0.0112 Hz to 10 MHz.

Connect the external clock to the C/T 0 clock input signal of the Digital connector on the DT9857 or DT9857E module. Counter/timer operations start on the rising edge of the clock input signal.

Using software, specify the clock source as external and specify a clock divider between 2 and 4,924,967,296. Internally, the base frequency of C/T clock, which is 48 MHz, is divided by the specified clock divider to program the frequency of the external C/T clock.

Note: You typically use the external C/T clock (the clock connected to the C/T 0 Clock input signal of the Digital connector) to measure frequency (event counting), or to measure the time interval between edges (measure mode).

If you specify a counter/timer in the analog input channel list, the A/D clock determines how often you want to read the counter value. Refer to [page 77](#) for more information about the A/D clock.

Gate Types

The edge or level of the counter gate signal determines when a counter/timer operation is enabled. DT9857 and DT9857E modules provide the following gate types:

- **None** – A software command enables any counter/timer operation immediately after execution.
- **Logic-low level external gate input** – Enables a counter/timer operation when the counter's gate signal is low, and disables the counter/timer operation when the counter's gate signal is high. Note that this gate type is used for event counting and rate generation modes; refer to [page 94](#) for more information about these modes.
- **Logic-high level external gate input** – Enables a counter/timer operation when the counter's gate signal is high, and disables a counter/timer operation when the counter's gate signal is low. Note that this gate type is used for event counting and rate generation modes; refer to [page 94](#) 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's gate signal. In software, this is called a low-edge gate type. Note that this gate type is used for edge-to-edge measurement, one-shot, and repetitive one-shot mode; refer to [page 94](#) 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's gate signal. In software, this is called a high-edge gate type. Note that this gate type is used for edge-to-edge measurement, one-shot, and repetitive one-shot mode; refer to [page 94](#) for more information about these modes.

Specify the gate type in software.

Pulse Output Types and Duty Cycles

DT9857 and DT9857E modules can output the following types of pulses from each counter/timer:

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

You specify the pulse output type in software.

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

[Figure 35](#) illustrates a low-to-high pulse with a duty cycle of approximately 30%.

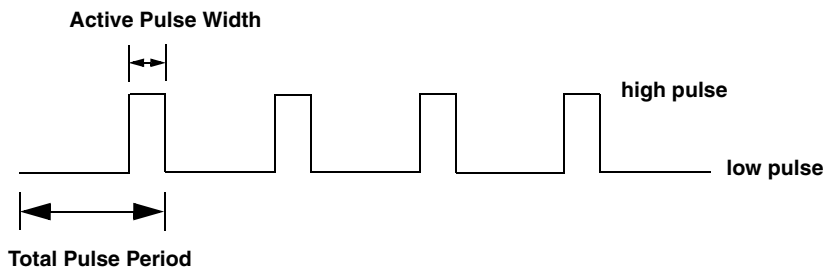


Figure 35: Example of a Low-to-High Pulse Output Type

Counter/Timer Operation Modes

Counters on the DT9857 and DT9857E module support the following counter/timer operation modes:

- Event counting
- Up/down counting
- Edge-to-edge measurement
- Continuous edge-to-edge measurement
- Rate generation

- One-shot
- Repetitive one-shot

Note: The active polarity for each counter/timer operation mode is software-selectable.

The following subsections describe these modes in more detail.

Event Counting

Use event counting mode if you want to count the number of rising edges that occur on the counter's clock input when the counter's gate signal is active (low-level or high-level). Refer to [page 93](#) 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.

Using software, specify the counter/timer mode as event counting (count), the C/T clock source as external, and the active gate type as low-level or high-level.

Make sure that the signals are wired appropriately. Refer to [page 53](#) for an example of connecting an event counting application.

Up/Down Counting

Use up/down counting mode if you want to increment or decrement the number of rising edges that occur on the counter's clock input, depending on the level of the counter's gate signal.

If the gate signal is high, the C/T increments; if the gate signal is low, the C/T decrements.

Using software, specify the counter/timer mode as up/down counting (up/down), and the C/T clock source as external. Note that you do not specify the gate type in software.

Make sure that the signals are wired appropriately. Refer to [page 54](#) for an example of connecting an up/down counting application.

Note: Initialize the counter/timer so that the C/T never increments above FFFFFFFFh or decrements below 0.

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 and the stop edge can occur on the rising edge of the counter's gate input, the falling edge of the counter's gate input, the rising edge of the counter's clock input, or the falling edge of the counter's clock input. 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 use edge-to-edge measurement to measure the following:

- Pulse width of a signal pulse (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:
 - $\text{Pulse width} = \text{Number of counts} / 48 \text{ MHz}$
- Period of a signal pulse (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:
 - $\text{Period} = 1 / \text{Frequency}$
 - $\text{Period} = \text{Number of counts} / 48 \text{ MHz}$
- Frequency of a signal pulse (the number of periods per second). You can calculate the frequency as follows:
 - $\text{Frequency} = 48 \text{ MHz} / \text{Number of Counts}$

Using software, specify the counter/timer mode as edge-to-edge measurement mode (measure), the C/T clock source as internal, the start edge type, and the stop edge type.

Make sure that the signals are wired appropriately. Refer to [page 56](#) for an example of connecting an edge-to-edge measurement application.

Continuous Edge-to-Edge Measurement

In continuous edge-to-edge measurement mode, the counter starts incrementing when it detects the specified start edge. When it detects the next start edge type, the value of the counter is stored and the next edge-to-edge measurement operation begins automatically.

Every time an edge-to-edge measurement operation completes, the previous measurement is overwritten with the new value. When you read the counter as part of the analog input data stream, the current value (from the last edge-to-edge measurement operation) is returned and the value of the counter is reset to 0. Refer to the previous section for more information on edge-to-edge measurement mode.

Note: If you read the counter before the measurement is complete, 0 is returned.

To select continuous edge-to-edge measurement mode, use software to specify the counter/timer mode as continuous measure, the C/T clock source as internal, and the start edge type.

Rate Generation

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

The pulse output operation is enabled whenever the counter's gate signal is at the specified level. While the pulse output operation is enabled, the counter outputs a pulse of the specified type and frequency continuously. As soon as the operation is disabled, rate generation stops.

The period of the output pulse is determined by the C/T clock source (either internal using a clock divider, or external). You can output pulses using a maximum frequency of 24 MHz (if using the internal C/T clock) or 5 MHz (if using the external C/T clock). Refer to [page 93](#) for more information about the C/T clock sources.

Note: The integrity of the signal degrades at frequencies greater than 10 MHz.

Using software, specify the counter/timer mode as rate generation (rate), the C/T clock source as either internal or external, the clock divider (for an internal clock), the polarity of the output pulses (high-to-low transition or low-to-high transition), the duty cycle of the output pulses, and the active gate type (low-level or high-level). Refer to [page 94](#) for more information about pulse output signals and to [page 93](#) for more information about gate types.

Make sure that the signals are wired appropriately. Refer to [page 58](#) for an example of connecting a rate generation application.

One-Shot

Use one-shot mode to generate a single pulse output signal from the counter's output line when the specified edge is detected on the counter's gate signal. You can use this pulse output signal as an external digital (TTL) trigger to start other operations, such as analog input or analog output operations.

After the single pulse is output, the one-shot operation stops. All subsequent clock input signals and gate input signals are ignored.

The period of the output pulse is determined by the C/T clock source (either internal using a clock divider, or external). Note that in one-shot mode, the internal C/T clock is more useful than an external C/T clock; refer to [page 93](#) for more information about the C/T clock sources.

Using software, specify the counter/timer mode as one-shot, the clock source as internal (recommended), the clock divider, the polarity of the output pulse (high-to-low transition or low-to-high transition), and the active gate type (rising edge or falling edge). Refer to [page 94](#) for more information about pulse output types and to [page 93](#) for more information about gate types.

Note: In the case of a one-shot operation, a duty cycle of 100% is set automatically.

Make sure that the signals are wired appropriately. Refer to [page 58](#) for an example of connecting a one-shot application.

Repetitive One-Shot

Use repetitive one-shot mode to generate a pulse output signal from the counter's output line whenever the specified edge is detected on the counter's gate signal. You can use this mode to clean up a poor clock input signal by changing its pulse width, and then outputting it.

The module continues to output pulses until you stop the operation. Note that any gate signals that occur while the pulse is being output are not detected by the module.

The period of the output pulse is determined by the C/T clock source (either internal using a clock divider, or external). Note that in repetitive one-shot mode, the internal C/T clock is more useful than an external clock; refer to [page 93](#) for more information about the C/T clock sources.

Using software, specify the counter/timer mode as repetitive one-shot, the polarity of the output pulses (high-to-low transition or low-to-high transition), the C/T clock source as internal (recommended), the clock divider, and the active gate type (rising edge or falling edge). Refer to [page 94](#) for more information about pulse output types and to [page 93](#) for more information about gates.

Note: In the case of a repetitive one-shot operation, a duty cycle of 100% is set automatically.

Make sure that the signals are wired appropriately. Refer to [page 58](#) for an example of connecting a repetitive one-shot application.

Measure Counter Features

DT9857 and DT9857E modules provide two measure counters (counters 1 and 2). Using these counters, you can measure the frequency, period, or pulse width of a single signal or the time period between two signals and return the value in the analog input stream. This is useful for correlating the analog input data with digital positional data, measuring the frequency of a signal, or as a tachometer. An internal 48 MHz counter is used for the measurement, yielding a resolution of 20 ns (1/48 MHz).

To use measure counter 1, specify channel 10 for the DT9857-8 and DT9857E-8 module, or channel 18 for the DT9857-16 or DT9857E-16 module in the analog input channel list. To use measure counter 2, specify channel 11 for the DT9857-8 or DT9857E-8 module, or channel 19 for the DT9857-16 or DT9857E-16 module in the analog input channel list.

Using software commands, you can configure the following parameters for counter 1 and/or counter 2:

- The operation mode as continuous edge-to-edge measurement mode.
- The signal that starts the measurement. The following signals are supported:
 - A/D conversion complete
 - Tachometer input falling edge
 - Tachometer input rising edge
 - Digital input 0 falling edge
 - Digital input 0 rising edge
 - Digital input 1 falling edge
 - Digital input 1 rising edge
 - Digital input 2 falling edge
 - Digital input 2 rising edge
 - Digital input 3 falling edge
 - Digital input 3 rising edge
 - Digital input 4 falling edge
 - Digital input 4 rising edge
 - Digital input 5 falling edge
 - Digital input 5 rising edge
 - Digital input 6 falling edge
 - Digital input 6 rising edge
 - Digital input 7 falling edge
 - Digital input 7 rising edge
 - C/T 0 Clock input falling edge
 - C/T 0 Clock input rising edge
 - C/T 0 Gate input falling edge

- C/T 0 Gate input rising edge
- The signal that stops the measurement. The following signals are supported:
 - A/D conversion complete
 - Tachometer input falling edge
 - Tachometer input rising edge
 - Digital input 0 falling edge
 - Digital input 0 rising edge
 - Digital input 1 falling edge
 - Digital input 1 rising edge
 - Digital input 2 falling edge
 - Digital input 2 rising edge
 - Digital input 3 falling edge
 - Digital input 3 rising edge
 - Digital input 4 falling edge
 - Digital input 4 rising edge
 - Digital input 5 falling edge
 - Digital input 5 rising edge
 - Digital input 6 falling edge
 - Digital input 6 rising edge
 - Digital input 7 falling edge
 - Digital input 7 rising edge
 - C/T 0 Clock input falling edge
 - C/T 0 Clock input rising edge
 - C/T 0 Gate input falling edge
 - C/T 0 Gate input rising edge

When the selected start edge is the same as the selected stop edge, the internal 48 MHz counter starts incrementing when it detects the first start edge of the selected input signal and stops incrementing when it detects the selected stop edge (which is the same as the start edge, in this case); at that point, the counter stores and resets the count. The stored count is maintained until it is read as part of the input data stream or until a new count is stored. Since the stop edge is the same as the start edge in this case, the stop edge for the current measurement is the start edge for the next measurement; therefore, no waveform periods are missed. The value of the measure count depends on the input subsystem sample frequency, described as follows:

- If the input subsystem sample frequency is faster than the selected input frequency, then the stored measure count retains the current value when it is read by the input subsystem.

- If the input subsystem sample frequency is slower than the selected input frequency, then the new measure count value is stored as each period measurement completes. When an input subsystem sample occurs, then the most recently stored measure count is written into the input data stream.

When the selected start edge is not the same as the selected stop edge, the internal 48 MHz counter starts incrementing when it detects the selected start edge and stops incrementing when it detects the next selected stop edge; at that point, the counter stores and resets the count. The stored count is maintained until it is read as part of the input data stream or until a new count is stored. The value of the measure count depends on the input subsystem sample frequency, described as follows:

- If the input subsystem sample rate is faster than the selected measurement period, then the stored count retains the current value when the count is read by the input subsystem.
- If the input subsystem sample rate is slower than the selected measurement period, then a new count value is stored as each period measurement completes. When an input subsystem sample occurs, the most recently stored measure count is written into the input data stream.

A data pipeline is used in the hardware to compensate for the A/D group delay and synchronizes the value of the measure counters with the analog input measurements, so that all measurements are correlated in time. The measure counters are treated like any other channel in the analog input channel list; therefore, all the triggering and conversion modes supported for analog input channels are supported for the measure counters.

When you read the value of the measure counters as part of the analog input data stream, you might see results similar to the following:

Table 4: An Example of Reading a Measure Counter as Part of the Analog Input Data Stream

Time	A/D Value	Measure Counter Values	Status of Operation
10	5002	0	Operation started, but is not complete
20	5004	0	Operation not complete
30	5003	0	Operation not complete
40	5002	12373	Operation complete
50	5000	12373	Next operation started, but is not complete
60	5002	12373	Operation not complete
70	5004	12373	Operation not complete
80	5003	14503	Operation complete
90	5002	14503	Next operation started, but is not complete

Using the count that is returned from the measure counter, you can determine the following:

- Frequency between the start and stop signals/edges. You can calculate the frequency as follows:
 - $\text{Frequency} = 48 \text{ MHz} / (\text{Number of counts} - 1)$
where 48 MHz is the internal measure counter frequency

For example, if the count is 201, the measured frequency is 240 kHz (48 MHz/200).
- Period between the start and stop signals/edges. You can calculate the period as follows:
 - $\text{Period} = 1 / \text{Frequency}$
 - $\text{Period} = (\text{Number of counts} - 1) / 48 \text{ MHz}$
where 48 MHz is the internal measure counter frequency
- Pulse width of the start and stop signal/edges (rising to falling edge or falling edge to rising edge). You can calculate the period as follows:
 - $\text{Pulse width} = 1 / \text{Frequency}$
 - $\text{Pulse width} = (\text{Number of counts} - 1) / 48 \text{ MHz}$
where 48 MHz is the internal measure counter frequency

Digital I/O Features

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

- Digital I/O lines
- Operation modes

Digital I/O Lines

DT9857 and DT9857E modules support one digital input port, consisting of 8 digital input lines (lines 0 to 7) and one digital output port, consisting of 8 digital output lines (lines 0 to 7). The resolution is fixed at 8 bits.

You can specify the digital I/O line that you want to read or write in a single-value digital I/O operation. Refer to [page 103](#) for more information about single-value operations.

In addition, you can perform a continuous digital input operation by specifying the digital input port in the analog input channel list, or a continuous digital output operation by specifying the digital output port in the analog output channel list.

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 and a high value (1) is read from each of the digital input lines if the lines are not connected.

Operation Modes

DT9857 and DT9857E modules support the following digital I/O operation modes:

- **Single-value operations** are the simplest to use but offer the least flexibility and efficiency. You use software to specify the digital I/O port and a gain of 1 (the gain is ignored). Data is then read from or written to all the digital I/O lines. For a single-value operation, you cannot specify a clock or trigger source.

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

- **Continuous digital input** takes full advantage of the capabilities of the DT9857 and DT9857E modules. Enter the digital input port (all 8 digital input lines) as channel 12 for the DT9857-8 or DT9857E-8 module, or channel 20 for the DT9857-16 or DT9857E-16 module in the analog input channel list. You can specify a clock source, scan mode, trigger source, buffer, and buffer wrap mode for the digital input operation. The input sample clock (internal or external) paces the acquisition of data from the digital input port as well as the analog input channels, tachometer input, general-purpose counter/timer, and the measure counters if they are specified in the analog input channel list; refer to [page 79](#) for more information.
- **Continuous digital output** takes full advantage of the capabilities of the DT9857 or DT9857E module. Enter the digital output port (all 8 digital output lines) as channel 2 in the analog output channel list. You can specify a clock source, trigger source, buffer, and buffer wrap mode for the digital output operation. The analog output sample clock paces the analog output and digital output operation. Refer to [page 85](#) for more information.

Triggering Acquisition on Multiple Modules

Note: You can synchronize acquisition on multiple DT9857 or DT9857E modules using the Sync Bus, described on [page 105](#).

The internal clock on the DT9857 and DT9857E modules when the synchronization mode is none (see [page 105](#)), is derived from the 48 MHz crystal oscillator and provides the timing for both the analog input and analog output subsystems on the module.

You can start acquisition on multiple modules by connecting all modules to a shared external trigger input, as shown in [Figure 36](#). When triggered, the modules start acquiring data at the same time.

Using this connection scheme, the measurements of one module may not be synchronous with the measurements of another module due to logic delays in the clocking and USB circuitry.

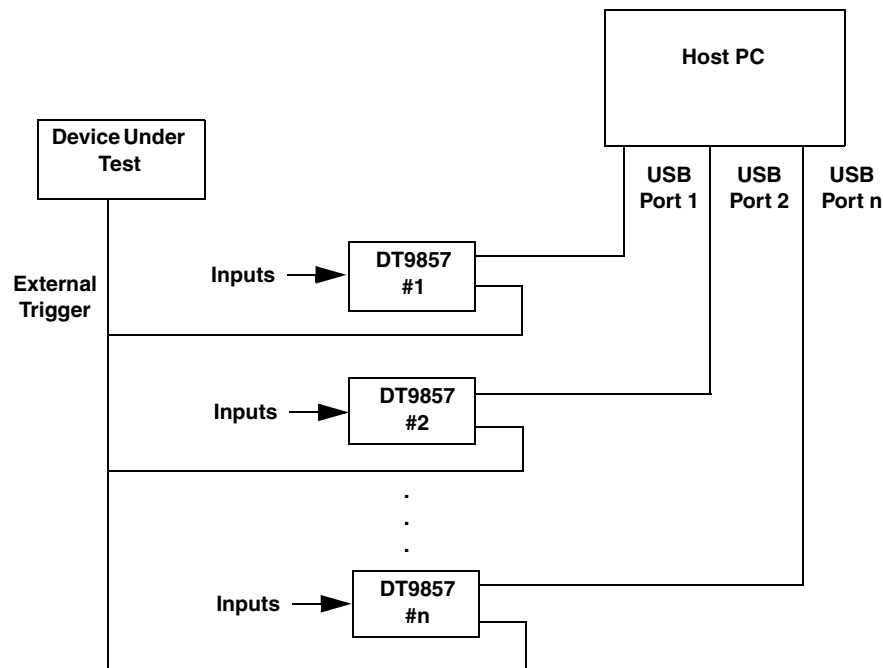


Figure 36: Triggering Multiple Modules Using an External Trigger Source

Synchronizing Acquisition on Multiple Modules

DT9857 modules provide a Sync Bus (RJ45) connector that you can use to connect and synchronize the analog input subsystems of up to four DT9857 modules. DT9857E modules provide four Sync Bus (RJ45) connectors that you can use to connect and synchronize the analog input and/or the analog output subsystems of up to four DT9857E modules. The following sections describes how to use the Sync Bus connectors to synchronize the analog input and/or analog output subsystems of multiple modules.

Synchronizing the Analog Input Subsystems of Multiple DT9857 Modules

When synchronizing the analog input subsystems of up to four DT9857 modules, one module is the master and the other modules are slaves. You specify the synchronization mode (master, slave, or none) of the analog input subsystem using software.

When configured as a master, the Sync Bus connector outputs trigger and clock signals to connected slave modules. When configured as a slave, the Sync Bus connector accepts trigger and clock signals from the master; the start trigger source on the slave module is ignored in this configuration since the Sync Bus is used as the start trigger. When configured as none (the default mode), the DT9857 module uses the 48 MHz reference clock instead of the Sync Bus connector. The synchronization mode remains set until changed or until the application exits.

You can connect multiple modules in one of two ways. [Figure 37](#) shows how to connect a maximum of two DT9857 modules by daisy chaining them together through the Sync Bus connector. [Figure 38](#) shows how to connect a maximum of four DT9857 modules by using an RJ45 distribution panel, such as the EP386, where the panel contains four RJ45 connectors that are wired in parallel.

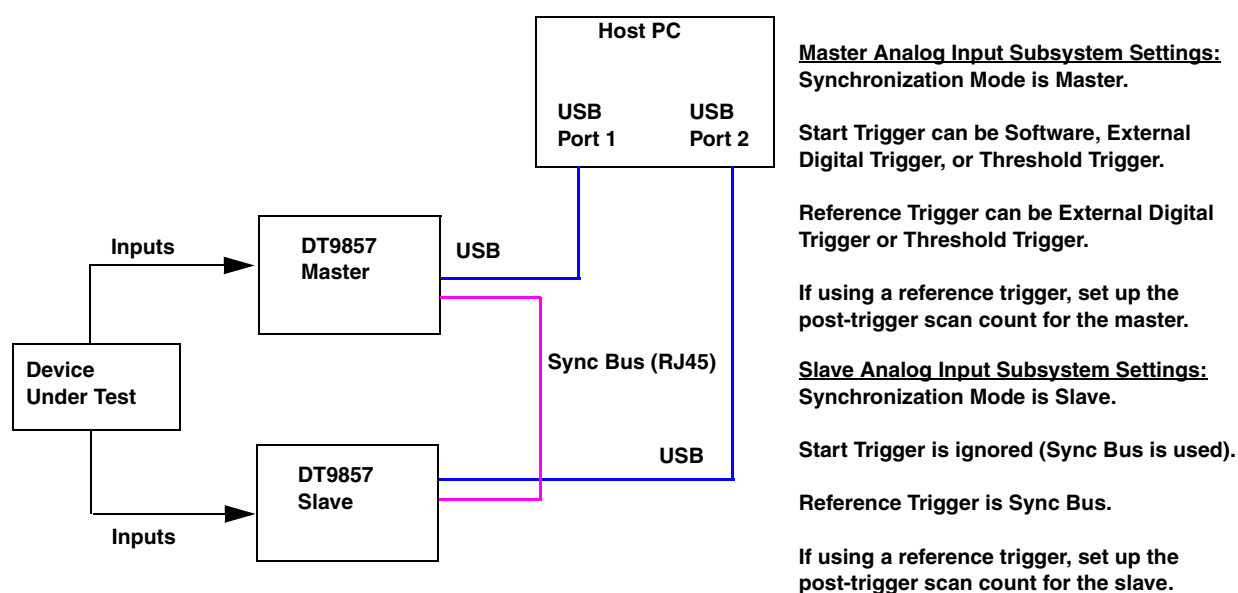


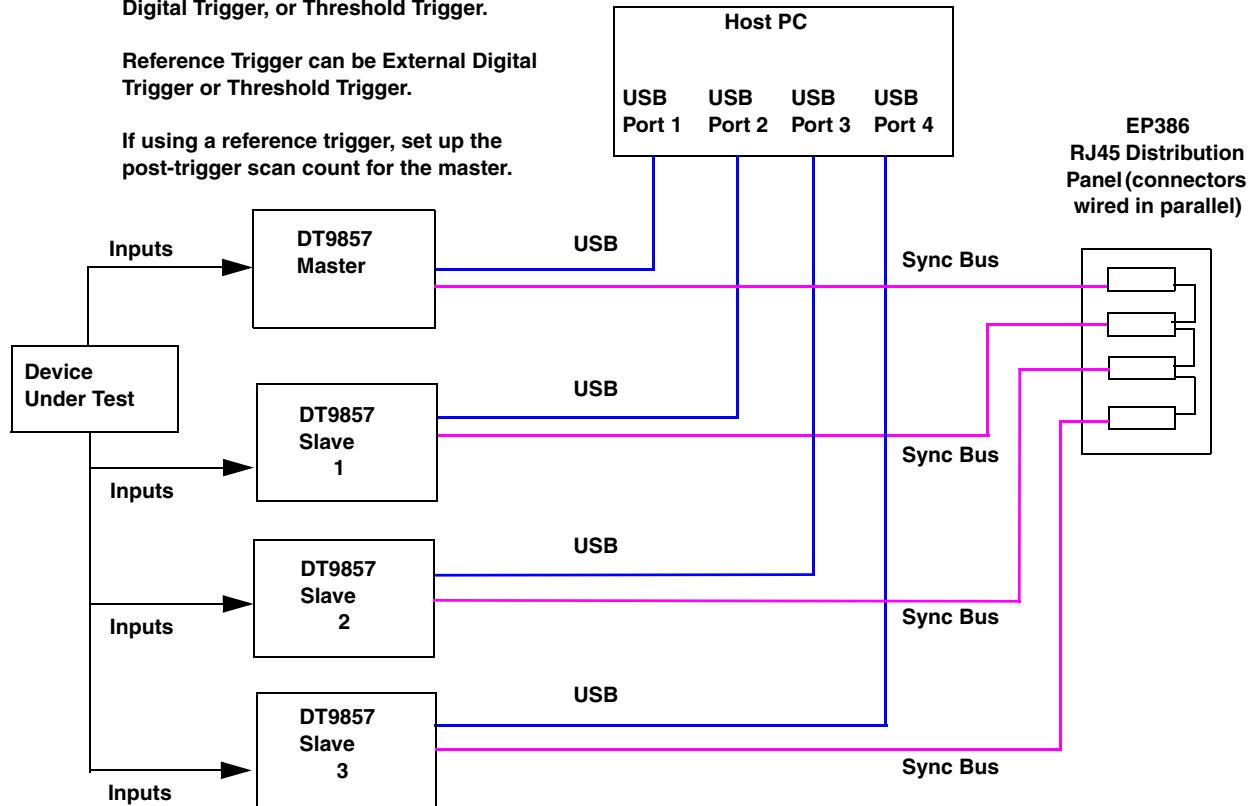
Figure 37: Synchronizing the Analog Input Subsystems of Two DT9857 Modules by Daisy Chaining the Sync Bus Connectors

Master Analog Input Subsystem Settings:
Synchronization Mode is Master.

Start Trigger can be Software, External Digital Trigger, or Threshold Trigger.

Reference Trigger can be External Digital Trigger or Threshold Trigger.

If using a reference trigger, set up the post-trigger scan count for the master.



Slave Analog Input Subsystem Settings:
Synchronization Mode is Slave.

Start Trigger is ignored (Sync Bus is used).

Reference Trigger is Sync Bus.

If using a reference trigger, set up the post-trigger scan count for the slave.

* The RJ45 cables must be less than 1 foot in length. For minimum clock skew, the master module must be less than 4 inches away from the RJ45 distribution panel.

Figure 38: Synchronizing the Analog Input Subsystems of Four DT9857 Modules Using the EP386 RJ45 Distribution Panel (Shown Using an External Trigger)

When synchronizing the analog input subsystems of multiple DT9857 modules, start the slave modules before starting the master module. When the master DT9857 module is triggered (using the software trigger, external digital trigger, or threshold trigger), both the master and the slave modules start acquiring data at the same time (within one A/D conversion of the clock). If you specified a reference trigger (external digital trigger or threshold trigger for the master, and the Sync Bus for the slaves), the master and the slaves will start acquiring the specified number of post-trigger scans when the reference trigger is detected on the master (you must specify the number of post-trigger scan count for the master and the slaves). Note that you can set the clock rate to be the same or different on each module but correlation of the data will be difficult if the clock rates are not the same or are not multiples of each other.

Note: It is important that you start the slave modules first, followed by the master module so that the slave receives the appropriate clock and trigger signals from the master.

If you start the master module before the slaves, the slaves never start; you will see a delay of approximately 20 seconds if you try to stop or abort the analog input operation on a slave module that is waiting for a trigger.

If you are not using a reference trigger and you stop the master module, the slaves continue to run and return data until you stop the analog input subsystem on the slave modules. Be sure to stop the analog input subsystems on all slave modules before disconnecting the cable from the Sync Bus connectors.

Synchronizing the Analog Input and/or Analog Output Subsystems of Multiple DT9857E Modules

As shown in [Figure 39](#), each DT9857E module provides four Sync Bus (RJ45) connectors that you can use to connect and synchronize the analog input and/or analog output subsystems of up to four DT9857E modules.

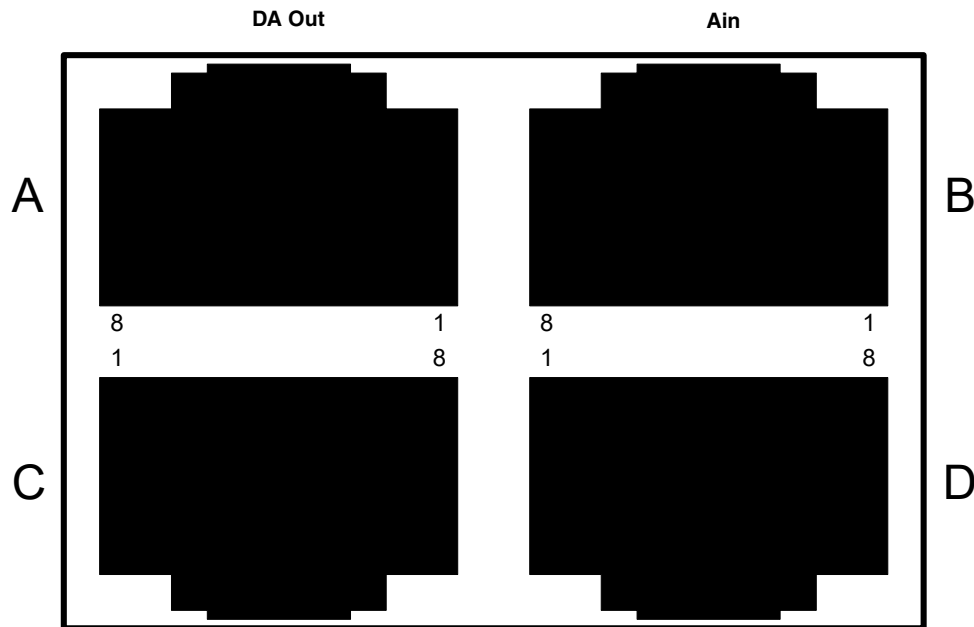


Figure 39: Sync Bus Connectors on the DT9857E Modules

If you want to synchronize the analog input channels of multiple DT9857E modules, you must connect a cable from the Ain Sync Bus connector (B or D) on one module to the Ain Sync Bus connector (B or D) on the next module.

If you want to synchronize the analog output channels on multiple modules, you must connect a cable from the Ain Sync Bus connector (B or D) on one module to the Ain Sync Bus connector (B or D) on the next module, and then connect a cable from the DA Out Sync Bus connector (A or C) on one module to the DA Out Sync Bus connector (A or C) on the next module.

Note: The Ain Sync Bus connectors provide the reference clock that the D/A subsystem requires for synchronization.

Refer to [page 171](#) for more information on the pin assignments of these connectors.

If you want to synchronize all the analog input subsystems of multiple DT9857E modules, use software to specify the synchronization mode of the A/D subsystem of each module as a master or slave. If you want to synchronize the analog output subsystems of multiple DT9857E modules, specify the synchronization mode of the D/A subsystem of each module as master or slave. Use a synchronization mode of none (the default value) if you do not want to synchronize the subsystem.

Notes: The analog input subsystems are synchronized with each other and the analog output subsystems are synchronized with each other. However, the analog inputs and analog outputs are not guaranteed to be synchronized with each other; but, they will correlate with each other from run to run.

The synchronization modes of the A/D and D/A subsystems are independent from each other; however, the same device cannot have one subsystem configured as the master and the other subsystem configured as the slave or an error will be reported.

When configured as a master, the Sync Bus connector outputs trigger and clock signals. When configured as a slave, the Sync Bus connector accepts trigger and clock signals from the master; the start trigger source on the slave module is ignored in this configuration since the Sync Bus is used as the start trigger. When configured as none (the default mode), the DT9857E module uses the 48 MHz reference clock instead of the Sync Bus connector. The synchronization mode remains set until changed or until the application exits.

[Figure 40](#) shows how to connect a maximum of 16 DT9857E modules to synchronize all the analog input channels.

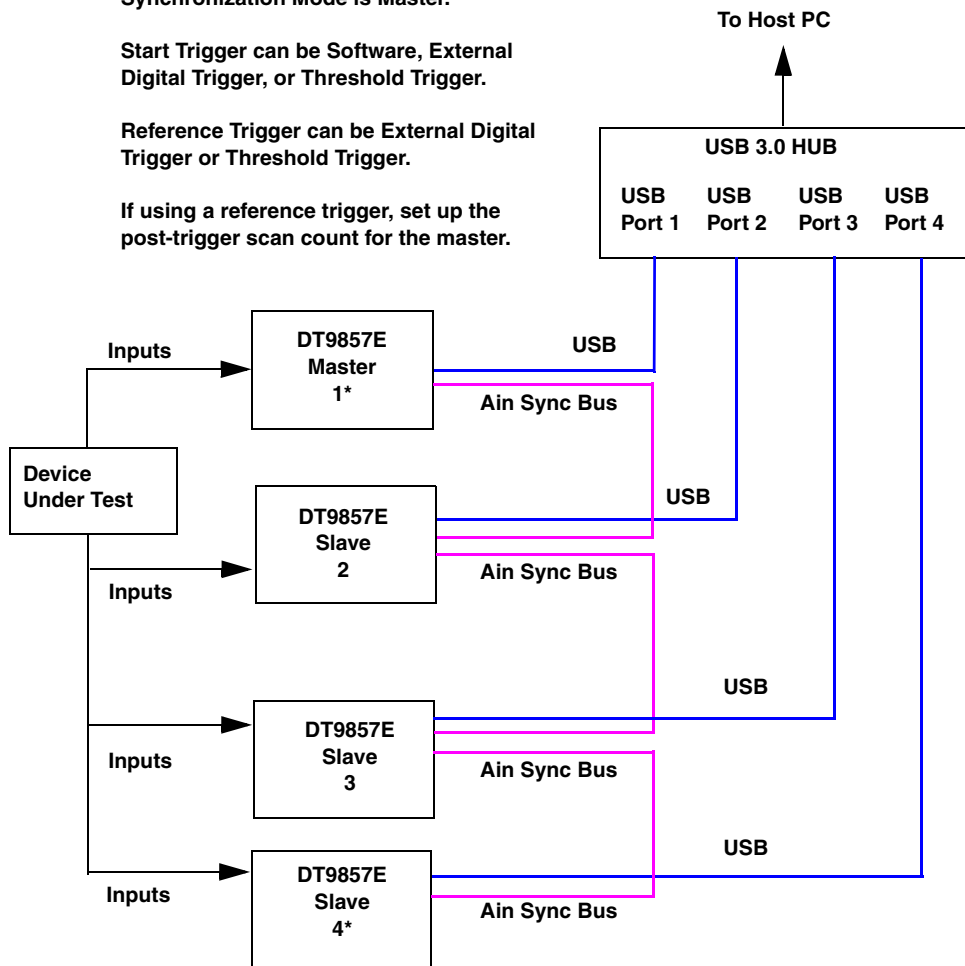
Note: The following diagrams show USB 3.0 hubs connected to the host computer. However, if you are using fewer modules, you can connect modules directly to the USB 2.0 or USB 3.0 ports of your host computer as long as your host computer provides enough USB ports.

Master Analog Input Subsystem Settings:
Synchronization Mode is Master.

Start Trigger can be Software, External Digital Trigger, or Threshold Trigger.

Reference Trigger can be External Digital Trigger or Threshold Trigger.

If using a reference trigger, set up the post-trigger scan count for the master.



Slave Analog Input Subsystem Settings:
Synchronization Mode is Slave.

Start Trigger is ignored (Sync Bus is used).

Reference Trigger is Sync Bus.

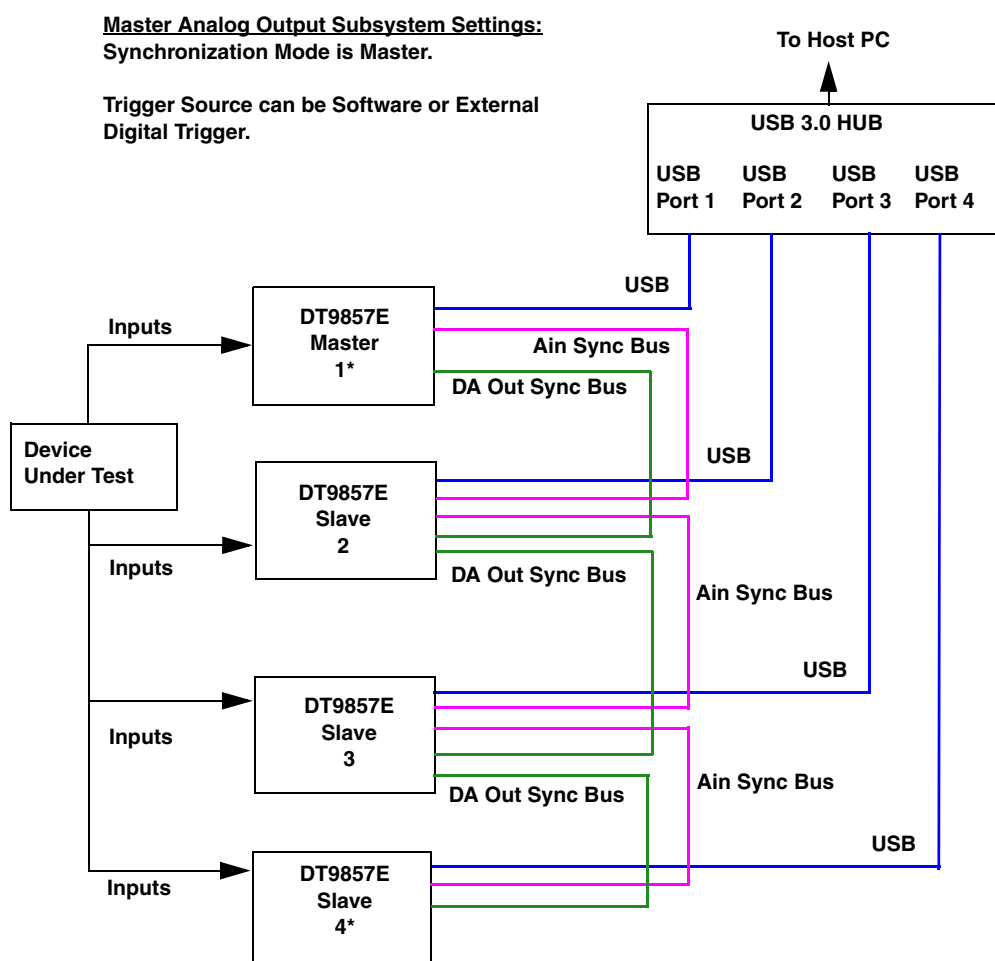
If using a reference trigger, set up the post-trigger scan count for the slave.

*Note that first and last module in chain must be terminated with $100\ \Omega$ using the Control Panel applet; see [page 38](#) for more information.

The RJ45 cables must be less than 1 foot in length.

Figure 40: Synchronizing the Analog Input Subsystems of Up to Four DT9857E Modules

Figure 41 shows how to connect a maximum of four DT9857E modules to synchronize all the analog output subsystems. If you wanted to synchronize all the analog input subsystems and all the analog output subsystems, you would also use the wiring diagram shown in Figure 41.



Slave Analog Output Subsystem Settings:
Synchronization Mode is Slave.

Trigger source is ignored (Sync Bus is used).

*Note that first and last module in chain must be terminated with $100\ \Omega$ using the Control Panel applet; see page 38 for more information.

The RJ45 cables must be less than 1 foot in length.

Figure 41: Synchronizing the Analog Output Subsystems of Up to Four DT9857E Modules

Note: When synchronizing the analog output channels, cables between the Ain Sync Bus connectors (B and D) are required because the reference clock is provided by the Ain Sync connectors.

When synchronizing multiple DT9857E modules, start the slave modules before starting the master module. When the master DT9857E module is triggered, both the master and the slave modules start acquiring or outputting data at the same time (within one A/D or D/A conversion of the clock). If you specified a reference trigger (external digital trigger or threshold trigger for the master, and the Sync Bus for the slaves), the master and the slaves will start acquiring the specified number of post-trigger scans when the reference trigger is detected on the master (you must specify the number of post-trigger scan count for the master and the slaves). Note that you can set the clock rate to be the same or different on each module but correlation of the data will be difficult if the clock rates are not the same or are not multiples of each other.

Note: It is important that you start the slave modules first, followed by the master module so that the slave receives the appropriate clock and trigger signals from the master.

If you start the master module before the slaves, the slaves never start; you will see a delay of approximately 20 seconds if you try to stop or abort the analog input operation on a slave module that is waiting for a trigger.

If you are not using a reference trigger and you stop the master module, the slaves continue to run and return data until you stop the analog input subsystem on the slave modules. Be sure to stop the analog input subsystems on all slave modules before disconnecting the cable from the Sync Bus connectors.



Supported Device Driver Capabilities

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The DT9857 Series Device Driver provides support for the analog input (A/D), analog output (D/A), digital input (DIN), digital output (DOUT), counter/timer (C/T), and tachometer (TACH) subsystems. For information on how to configure the device driver, refer to [page 38](#).

Table 5: DT9857 and DT9857E Subsystems

DT9857 and DT9857E Modules	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Total Subsystems on Module	1	1 or 0 ^a	1	1	3 ^b	1	0

- a. The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.
- b. C/T element 0 is the general-purpose counter (counter 0), element 1 is measure counter 1, and element 2 and measure counter 2.

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the DT9857 and DT9857E 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 6: Data Flow and Operation Options

DT9857 and DT9857E	A/D	D/A ^a	DIN	DOU	C/T	TACH	QUAD
Single-Value Operation Support SupportsSingleValue	Yes	Yes	Yes	Yes			
Simultaneous Single-Value Output Operations SupportsSetSingleValues							
Continuous Operation Support SupportsContinuous	Yes	Yes	Yes ^b	Yes ^c	Yes ^d	Yes ^e	
Continuous Operation until Trigger SupportsContinuousPreTrigger							
Continuous Operation before & after Trigger SupportsContinuousPrePostTrigger							
Waveform Operations Using FIFO Only SupportsWaveformModeOnly		Yes ^f					
Simultaneous Start List Support SupportsSimultaneousStart	Yes ^g	Yes ^f					
Supports Programmable Synchronization Modes SupportsSynchronization	Yes ^h	Yes ⁱ	Yes ^g		Yes	Yes	
Synchronization Modes SynchronizationMode	None Master Slave	None Master Slave					
Interrupt Support SupportsInterruptOnChange							
FIFO Size, in samples FifoSize	16 kSamples ^j	64 kSamples					
Muting and Unmuting the Output Voltage SupportsMute		Yes					
Auto-Calibrate Support SupportsAutoCalibrate							

- a. The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.
- b. The DIN subsystem supports continuous mode by allowing you to read the digital input port (all 16 digital input lines) using the analog input channel list.
- c. The DOU subsystem supports continuous mode by allowing you to output data from the digital output port (all 16 digital output lines) using the output channel list.
- d. The C/T subsystems support continuous mode by allowing you to read the value of the general-purpose counter/timer and/or the measure counters using the analog input channel list.
- e. The TACH subsystem supports continuous mode by allowing you to read the value of the tachometer input using the analog input channel list.
- f. DT9857 and DT9857E modules support continuous analog output operations in addition to waveform mode.
- g. DT9857 and DT9857E modules support the ability to start continuous A/D and continuous D/A operations simultaneously.
- h. You can synchronize input data from multiple devices if the A/D subsystem of one module is configured as a master and the A/D subsystems of the other modules are configured as slaves. You specify the channels to acquire in the analog input channel list for each device.
- i. On the DT9857E, you can synchronize the output data from multiple devices if the D/A subsystem of one module is configured as the master and the D/A subsystems of the other modules are configured as slaves. You specify the output channels to update in the output list for each device.
- j. The DT9857 Series Device Driver automatically adjusts the FIFO half-full flag based on the size of the first user buffer on the queue rather than on the size of the A/D FIFO on the module. This ensures that each sample is transferred from the hardware FIFO to the user buffer without any additional time delay. Therefore, you will always achieve timely buffer complete messages regardless of the sampling rate you choose.

Buffering

Table 7: Buffering Options

DT9857 and DT9857E	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Buffer Support SupportsBuffering	Yes	Yes					
Single Buffer Wrap Mode Support SupportsWrapSingle	Yes	Yes					
Inprocess Buffer Flush Support SupportsInProcessFlush	Yes						

a. The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.

Triggered Scan Mode

Table 8: Triggered Scan Mode Options

DT9857 and DT9847E	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 9: Data Encoding Options

DT9857 and DT9857E	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Binary Encoding Support SupportsBinaryEncoding	Yes	Yes	Yes	Yes			
Twos Complement Support SupportsTwosCompEncoding							
Returns Floating-Point Values ReturnsFloats							

a. The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.

Channels

Table 10: Channel Options

DT9857 and DT9857E	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Number of Channels NumberOfChannels	13 or 21 ^b	3 ^c	1	1	3 ^d	1	
SE Support SupportsSingleEnded	Yes	Yes					
SE Channels MaxSingleEndedChannels	8 or 16 ^a	2 ^b					
DI Support SupportsDifferential							
DI Channels MaxDifferentialChannels	0	0					
Maximum Channel-Gain List Depth CGLDepth	13 or 21 ^a	3 ^b					
Simultaneous Sample-and-Hold Support SupportsSimultaneousSampleHold	Yes						
Channel-List Inhibit SupportsChannelListInhibit							
Support MultiSensor Inputs SupportsMultiSensor							
Bias Return Termination Resistor Support SupportsInputTermination							

- a. The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.
- b. The DT9857-8 and DT9857E-8 support eight analog input channels (channels 0 to 7), the tachometer input (channel 8), general-purpose counter 0 (channel 9), measure counter 1 (channel 10), measure counter 2 (channel 11), and the digital input port (channel 12). The DT9857-16 and DT9857E-16 support 16 analog input channels (channels 0 to 15), the tachometer input (channel 16), general-purpose counter 0 (channel 17), measure counter 1 (channel 18), measure counter 2 (channel 19), and the digital input port (channel 20).
- c. DT9857 and DT9857E modules support two analog output channels (0 and 1), and the digital output port (channel 2).
- d. C/T 0 is the general-purpose counter/timer and C/T 1 and C/T 2 are the measure counters.

Gain

Table 11: Gain Options

DT9857 and DT9857E	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Programmable Gain Support SupportsProgrammableGain	Yes						
Number of Gains NumberOfSupportedGains	2	1	0	0	0	0	
Gains Available SupportedGains	1 and 10 ^b	1					

- a. The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.
- b. This provides effective input ranges of ± 10 V (gain of 1) and ± 1 V (gain of 10).

Ranges

Table 12: Range Options

DT9857 and DT9857E	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Number of Voltage Ranges NumberOfRanges	1	1	0	0	0	0	
Available Ranges SupportedVoltageRanges	±10 V ^b	±10 V					
Current Output Support SupportsCurrentOutput							

- a. The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.
- b. By applying a gain of 1, the effective input range is ±10 V. By applying a gain of 10, the effective input range is ±1 V.

Resolution

Table 13: Resolution Options

DT9857 and DT9857E	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Software Programmable Resolution SupportsSoftwareResolution							
Number of Resolutions NumberOfResolutions	1	1	1	1			
Available Resolutions SupportedResolutions	24	32	8	8	32	31	

- a. The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.

Current and Resistance Support

Table 14: Current and Resistance Support Options

DT9857 and DT9857E	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							

Table 14: Current and Resistance Support Options (cont.)

DT9857 and DT9857E	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Software Programmable Internal Excitation Current Source SupportsInternalExcitationCurrentSrc							
Available Excitation Current Source Values SupportedExcitationCurrentValues							

Thermocouple, RTD, and Thermistor Support

Table 15: Thermocouple, RTD, and Thermistor Support Options

DT9857 and DT9857E	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Thermocouple Support SupportsThermocouple							
RTD Support SupportsRTD							
Thermistor Support SupportsThermistor							
Voltage Converted to Temperature SupportsTemperatureDataInStream							
Supported Thermocouple Types ThermocoupleType							
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 Data Filters SupportsTemperatureFilters							
Temperature Filter Types TemperatureFilterType							

IEPE Support

Table 16: IEPE Support Options

DT9857 and DT9857E	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
IEPE Support SupportsIEPE	Yes						
Software Programmable AC Coupling SupportsACCoupling	Yes						
Software Programmable DC Coupling SupportsDCCoupling	Yes						
Software Programmable External Excitation Current Source SupportsExternalExcitationCurrentSrc							
Software Programmable Internal Excitation Current Source SupportsInternalExcitationCurrentSrc	Yes						
Available Excitation Current Source Values SupportedExcitationCurrentValues	.004 A						

Bridge and Strain Gage Support

Table 17: Bridge and Strain Gage Support Options

DT9857 and DT9857E	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 18: Start Trigger Options

DT9857 and DT9857E	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Software Trigger Support SupportsSoftwareTrigger	Yes	Yes	Yes ^b	Yes ^c	Yes ^d	Yes ^e	
External Positive TTL Trigger Support SupportsPosExternalTTLTrigger	Yes	Yes	Yes ^a	Yes ^b	Yes ^c	Yes ^d	
External Negative TTL Trigger Support SupportsNegExternalTTLTrigger	Yes	Yes	Yes ^a	Yes ^b	Yes ^c	Yes ^d	
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	Yes ^f		Yes ^g		Yes ^h	Yes ⁱ	
Negative Threshold Trigger Support SupportsNegThresholdTrigger	Yes ^e		Yes ^f		Yes ^g	Yes ^h	
Digital Event Trigger Support SupportsDigitalEventTrigger							
Threshold Trigger Channel SupportedThresholdTriggerChannel	0 to 7 or 0 to 15 ^e	0 to 7 or 0 to 15 ^e					

- a. The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.
- b. Supported if the digital input port is included in the analog input channel list.
- c. Supported if the digital output port is included in the analog output channel list.
- d. Supported if a counter is included in the analog input channel list.
- e. Supported if the tachometer is included in the analog input channel list.
- f. If you choose a threshold trigger, you can program the threshold level as a value between ± 10 V (gain of 1) or ± 1 V (gain of 10). You can use any of the analog input channels as the threshold channel (channel 0 to 7 on the DT9857-8 or DT9857E-8, or channel 0 to 15 on the DT9857-16 or DT9857E-16).
- g. If the digital input port is included in the analog input channel list, the threshold trigger on the specified analog input channel is supported.
- h. If the counter is included in the analog input channel list, the threshold trigger on the specified analog input channel is supported.
- i. If the tachometer is included in the analog input channel list, the threshold trigger on the specified analog input channel is supported.

Reference Triggers

Table 19: Reference Trigger Options

DT9857 or DT9857E	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
External Positive TTL Trigger Support SupportsPosExternalTTLTrigger	Yes		Yes ^a		Yes ^b	Yes ^c	
External Negative TTL Trigger Support SupportsNegExternalTTLTrigger	Yes		Yes ^a		Yes ^b	Yes ^c	
Positive Threshold Trigger Support SupportsPosThresholdTrigger	Yes ^d						
Negative Threshold Trigger Support SupportsNegThresholdTrigger	Yes ^d						
Digital Event Trigger Support SupportsDigitalEventTrigger							
Sync Bus Support SupportsSyncBusTrigger	Yes		Yes ^a		Yes ^b	Yes ^c	
Threshold Trigger Channel SupportedThresholdTriggerChannel	0 to 7 or 0 to 15 ^d						
Post-Trigger Scan Count SupportsPostTriggerScanCount	Yes ^e						

- Supported if the digital input port is included in the analog input channel list.
- Supported if a counter is included in the analog input channel list.
- Supported if the tachometer is included in the analog input channel list.
- If you choose a threshold trigger for the reference trigger on the DT9857 or DT9857E module, you can program the threshold level as a value between ± 10 V for a gain of 1 or ± 1 V for a gain of 10, and any of the supported analog input channels can be used as the threshold channel.

If you choose a threshold trigger as both the start trigger and the reference trigger, the threshold channel and threshold level must be the same. The polarity of the trigger (positive or negative going) can be different for each trigger source.

- You can specify how many post-trigger samples to acquire after the reference trigger by specifying the post-trigger scan count in software.

Clocks

Table 20: Clock Options

DT9857 or DT9857E	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Internal Clock Support SupportsInternalClock	Yes	Yes			Yes		
External Clock Support SupportsExternalClock					Yes ^b	Yes	
Simultaneous Input/Output on a Single Clock Signal SupportsSimultaneousClocking	Yes						
Base Clock Frequency BaseClockFrequency	27 MHz ^c	27 MHz ^b	0	0	48 MHz	12 MHz	
Maximum Clock Divider MaxExtClockDivider	1.0	1.0	1.0	1.0	4,294,967,296	1.0	
Minimum Clock Divider MinExtClockDivider	1.0	1.0	1.0	1.0	2	1.0	
Maximum Frequency MaxFrequency	105.469 kHz	216 kHz	0	0	24 MHz ^d	1 MHz	
Minimum Frequency MinFrequency	195.3125 Hz	30 kHz	0	0	0.0112 Hz	0.00559 Hz	

- a. The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.
- b. You can connect an external clock to general-purpose counter/timer 0.
- c. A 48 MHz reference clock is used to generate the base clock frequency.
- d. The integrity of the signal degrades at frequencies greater than 10 MHz.

Counter/Timers

Table 21: Counter/Timer Options

DT9857 or DT9857E	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Cascading Support SupportsCascading							
Event Count Mode Support SupportsCount					Yes ^a		
Generate Rate Mode Support SupportsRateGenerate					Yes ^a		
One-Shot Mode Support SupportsOneShot					Yes ^a		
Repetitive One-Shot Mode Support SupportsOneShotRepeat					Yes ^a		
Up/Down Counting Mode Support SupportsUpDown					Yes ^a		
Edge-to-Edge Measurement Mode Support SupportsMeasure					Yes ^a		
Continuous Edge-to-Edge Measurement Mode Support SupportsContinuousMeasure					Yes		
High to Low Output Pulse Support SupportsHighToLowPulse					Yes ^a		
Low to High Output Pulse Support SupportsLowToHighPulse					Yes ^a		
Variable Pulse Width Support SupportsVariablePulseWidth					Yes ^b		
None (internal) Gate Type Support SupportsGateNone					Yes ^a		
High Level Gate Type Support SupportsGateHighLevel					Yes ^{a,c}		
Low Level Gate Type Support SupportsGateLowLevel					Yes ^{a,c}		
High Edge Gate Type Support SupportsGateHighEdge					Yes ^{a,c}		
Low Edge Gate Type Support SupportsGateLowEdge					Yes ^{a,c}		
Level Change Gate Type Support SupportsGateLevel							
Clock-Falling Edge Type SupportsClockFalling					Yes ^a		
Clock-Rising Edge Type SupportsClockRising					Yes ^a		
Gate-Falling Edge Type SupportsGateFalling					Yes ^a		

Table 21: Counter/Timer Options (cont.)

DT9857 or DT9857E	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Gate-Rising Edge Type SupportsGateRising					Yes ^a		
Measure Mode Edge Types SupportedEdgeTypes					GateRising ^d GateFalling ^d ClockRising ^d ClockFalling ^d ADCConversionComplete ^e TachometerInputFalling ^e TachometerInputRising ^e DigitalInput0Falling ^e DigitalInput0Rising ^e DigitalInput1Falling ^e DigitalInput1Rising ^e DigitalInput2Falling ^e DigitalInput2Rising ^e DigitalInput3Falling ^e DigitalInput3Rising ^e DigitalInput4Falling ^e DigitalInput4Rising ^e DigitalInput5Falling ^e DigitalInput5Rising ^e DigitalInput6Falling ^e DigitalInput6Rising ^e DigitalInput7Falling ^e DigitalInput7Rising ^e CT0ClockInputFalling ^e CT0ClockInputRising ^e CT0GateInputFalling ^e CT0GateInputRising ^e		
Interrupt-Driven Operations SupportsInterrupt							

- a. Supported for the general-purpose counter (C/T 0) only.
- b. In one-shot mode and repetitive one-shot mode, the duty cycle is set to 100% automatically.
- c. High-edge and low-edge are supported for one-shot and repetitive one-shot modes. High-level and low-level are supported for event counting, up/down counting, edge-to-edge measurement, continuous edge-to-edge measurement, and rate generation modes.
- d. These edges apply to counter/timer 0 when in measure or continuous measure mode.
- e. These edges apply to measure counters 1 and 2.

Tachometers

Table 22: Tachometer Options

DT9857 or DT9857E	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Tachometer Falling Edges SupportsFallingEdge						Yes	
Tachometer Rising Edges SupportsRisingEdge						Yes	
Tachometer Stale Data Flag SupportsStaleDataFlag						Yes	



Troubleshooting

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General Checklist

Should you experience problems using a DT9857 or DT9857E 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 on [page 30](#).
4. Check that you have installed your hardware properly using the instructions in [Chapter 2](#).
5. Check that you have installed and configured the device driver for your module 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.

If you still experience problems, try using the information in [Table 23](#) to isolate and solve the problem. If you cannot identify the problem, refer to [page 130](#).

Table 23: Troubleshooting Problems

Symptom	Possible Cause	Possible Solution
Module is not recognized	You plugged the module into your computer before installing the device driver.	From the Control Panel > System > Hardware > Device Manager, uninstall any unknown devices (showing a yellow question mark). Then, run the setup program on your OMNI CD to install the USB device drivers, and reconnect your USB module to the computer.
Module does not respond	The module configuration is incorrect.	Check the configuration of your device driver; see the instructions in Chapter 2 .
	The module is damaged.	Contact Data Translation for technical support; refer to page 130 .
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 156 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 23: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Device failure error reported	The DT9857 or DT9857E 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 DT9857 or DT9857E 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 module is set up for differential inputs while the transducers are wired as single-ended inputs or vice versa.	Check your wiring and ensure that what you specify in software matches your hardware configuration; see the instructions in Chapter 3 .
	The module is out of calibration.	DT9857 and DT9857E modules are calibrated at the factory. If you want to readjust the calibration of the analog input or analog output circuitry, refer to Chapter 8 .
USB is not recognized	Your operating system does not have the appropriate Service Pack installed.	Ensure that you load the appropriate Windows Service Pack. If you are unsure of whether you are using USB 3.0, 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 operation. Consult Microsoft for more information.

Technical Support

If you have difficulty using a DT9857 or DT9857E 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 Applications 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 analog models can be obtained for a fee (certificate must be requested at time of RMA# assignment).



Calibration

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DT9857 and DT9857E 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 every six months using the DT9857 Calibration Utility.

Note: Ensure that you installed the device driver for your module using the Data Acquisition OMNI CD prior to using the calibration utility.

This chapter describes how to calibrate the analog input and output subsystems of a DT9857 or DT9857E module using the calibration utility.

Using the Calibration Utility

Start the DT9857 Calibration Utility as follows:

1. Click **Start** from the Task Bar.
2. For the DT9857 or DT9857E module, select **Programs | Data Translation, Inc | Calibration | DT9857 Calibration Utility**.

The main window of the DT9857 Calibration Utility appears.

Once the calibration utility is running, you can calibrate the analog input circuitry (either automatically or manually), described on [page 136](#), or the analog output circuitry of the module, described on [page 139](#).

Calibrating the Analog Input Subsystem

This section describes how to use the calibration utility to calibrate the analog input subsystem of a DT9857 or DT9857E module.

DT9857 and DT9857E modules have separate calibration for each A/D input channel.

Warming up the Module

Before calibrating the analog input circuitry, ensure that the module has been powered on for at least one hour.

Connecting a Precision Voltage Source

To calibrate the analog input circuitry, you need to connect an external +9.3750 V precision voltage source to the DT9857 or DT9857E module. Connect the precision voltage source to the first channel you want to calibrate; for example, Analog In 0 (AD Ch0).

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 Calibration** tab of the calibration utility.
2. Under the **Calibration Settings** area of the window, select the sampling frequency, in Hertz, and the gain that you want to use.

Notes: The DT9857 and DT9857E modules have two power modes: low power mode and high power mode. Low power mode is calibrated when you specify a sampling frequency less than 52.734 kHz. High power mode is calibrated when you specify a sampling frequency greater than 52.734 kHz. Ensure that you calibrate the board for both high and low power mode if you are using sampling frequencies below and above 52.734 kHz.

By default, this utility uses DC coupling with the current source disabled. This is the recommended setting for most users. While changing these settings is not advised for most users, users with unique applications can change these settings by clicking the **Advanced** button.

3. Under the Automatic Calibration area of the window, select the channel that you want to calibrate from the **Type of Calibration** drop-down list box, and then click the **Start** button. *A message appears notifying you to verify that 0.0000 V is applied to the channel.*
4. Verify that the supplied voltage to your selected channel is 0.0000 V, 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 the channel to +9.3750 V.*
5. Check that the supplied voltage to your selected channel is +9.3750 V, and then click **OK**. *The gain value is calibrated and a completion message appears.*

- Repeat steps 3 to 5 for each analog input channel on the module.

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 for each channel:

- Select the **A/D Calibration** tab of the calibration utility.
- Under the **Calibration Settings** area of the window, select the sampling frequency, in Hertz, and the gain that you want to use.

Notes: The DT9857 and DT9857E modules have two power modes: low power mode and high power mode. Low power mode is calibrated when you specify a sampling frequency less than 52.734 kHz. High power mode is calibrated when you specify a sampling frequency greater than 52.734 kHz. Ensure that you calibrate the board for both high and low power mode if you are using sampling frequencies below and above 52.734 kHz.

By default, this utility uses DC coupling with the current source disabled. This is the recommended setting for most users. While changing these settings is not advised for most users, users with unique applications can change these settings by clicking the **Advanced** button.

- Under the Manual Calibration area of the window, select the channel that you want to calibrate, and then click the **Start** button.
- Adjust the offset as follows:
 - Verify that 0.0000 V is applied to the channel that you want to calibrate.
The current voltage reading for this channel is displayed in the AD Value box.
 - Adjust the offset by entering values between 0 and 255 in the **Offset** edit box, or by clicking the up/down buttons until the **AD Value** is 0.0000 V.
- Adjust the gain as follows:
 - Verify that +9.3750 V is applied to the channel that you want to calibrate.
The current voltage reading for this channel is displayed in the AD Value box.
 - Adjust the gain by entering values between 0 and 255 in the **Gain** edit box, or by clicking the up/down buttons until the **AD Value** is 9.3750 V.
- When you have finished calibrating the channel, click the **Stop** button.
- Repeat steps 3 to 6 for each analog input channel on the module.

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.

Once you have finished this procedure, continue with [“Calibrating the Analog Output Subsystem.”](#)

Calibrating the Analog Output Subsystem

To calibrate the analog output circuitry, you need to connect an external precision voltmeter to the analog output channels of the DT9857 or DT9857E module.

Note: The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.

Do the following to calibrate the analog output circuitry:

1. Select the **D/A Calibration** tab of the calibration utility.
2. Under the **Calibration Settings** area of the window, select the output frequency, in Hertz.
3. Under the **Channel Selection** area of the window, select the analog output channel to calibrate.
4. Connect an external precision voltmeter to the selected analog output channel.
5. In the **DAC Output Voltage** box, select **0 V**.
6. Under the **Calibration Controls** area of the window, adjust the offset by entering values between 0 and 255 in the **DAC Offset** edit box or by clicking the up/down buttons until the voltmeter reads 0 V.
7. In the **DAC Output Voltage** box, select **9.375 V**.
8. Under the **Calibration Controls** area of the window, adjust the gain by entering values between 0 and 255 in the **DAC Gain** edit box or by clicking the up/down buttons until the voltmeter reads 9.375 V.
9. Repeat steps 2 to 7 for each analog output channel on the module.

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 calibration utility, click the close box in the upper right corner of the window.



Specifications

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Analog Input Specifications

Table 24 lists the specifications for the analog input subsystem on the DT9857 and DT9857E modules. Unless otherwise noted, specifications are typical at 25° C.

Table 24: Analog Input Subsystem Specifications

Feature	DT9857 Specifications	DT9857E Specifications
Number of analog input channels DT9857-8: DT9857-16:	8, single-ended 16, single-ended	8, single-ended 16, single-ended
Resolution	24 bits	24 bits
Ranges and gains Gain of 1: Gain of 10:	± 10 V ± 1 V	± 10 V ± 1 V
A/D type	Delta Sigma	Delta Sigma
Data encoding	Offset binary	Offset binary
Maximum sample rate	105.469 kS/s	105.469 kS/s
Minimum sample rate	195.3125 S/s	195.3125 S/s
ADC master clock range	100 kHz to 27 MHz	100 kHz to 27 MHz
Sampling frequency < 52.734 kHz: 52.734 kHz to 105.469 kHz:	512 x sample frequency 256 x sample frequency	512 x sample frequency 256 x sample frequency
Group delay	39/sample rate, in seconds	39/sample rate, in seconds
ADC Delta Sigma filter ^a Passband, -3 dB: Passband ripple, ± 0.005 dB: Stopband, -100 dB:	0.49 x sample frequency, Hz 0.453 x sample frequency, Hz 0.547 x sample frequency, Hz	0.49 x sample frequency, Hz 0.453 x sample frequency, Hz 0.547 x sample frequency, Hz
Analog filter ^a Low pass cutoff, -3 dB: High pass cutoff, -3 dB (AC coupling):	400 kHz 0.5 Hz	400 kHz 0.5 Hz
Channel-to-channel crosstalk ^b Input Signal = 10 kHz:	> -110 dB with 50 Ω termination > -105 dB with 1 k Ω termination	> -110 dB with 50 Ω termination > -105 dB with 1 k Ω termination
Input impedance	1 M Ω 20 pF ^c	1 M Ω 20 pF ^c
Coupling	AC/DC (software-selectable per channel)	AC/DC (software-selectable per channel)
IEPE current source	4 mA $\pm 0.5\%$	4 mA $\pm 0.5\%$
IEPE compliance voltage	24 V	24 V
IEPE current source noise DC to 1 kHz	5 nARMS	5 nARMS

Table 24: Analog Input Subsystem Specifications (cont.)

Feature	DT9857 Specifications		DT9857E Specifications	
DC Accuracy				
Offset error ^d	±1 mV		±1 mV	
Offset error temperature coefficient	±(7.2 μV/°C) / Gain) ± 100 μV/°C		±(7.2 μV/°C) / Gain) ± 100 μV/°C	
Gain error Gain of 1: Gain of 10:	±0.02% ±0.5%		±0.02% ±0.5%	
Gain error temperature coefficient	50 ppm/°C		50 ppm/°C	
ADC Integral Non-Linearity error, INL	±0.0006% of full-scale range		±0.0006% of full-scale range	
ADC Differential Non-Linearity error, DNL	Monotonic to 24 bits		Monotonic to 24 bits	
Dynamic Performance^e	Gain of 1	Gain of 10	Gain of 1	Gain of 10
Effective Number of Bits, ENOB ^f (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	15.5 bits 16.4 bits	15.4 bits 15.9 bits	15.9 bits 16.4 bits	15.8 bits 16.2 bits
Signal to Noise and Distortion Ratio, SINAD ^g (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	94 dB 94 dB	93 dB 91 dB	97 dB 94 dB	96 dB 93 dB
Signal to Noise Ratio, SNR ^h (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	98 dB 94 dB	96 dB 91 dB	98 dB 94 dB	97 dB 93 dB
Total Harmonic Distortion, THD ⁱ (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	–96 dB –104 dB	–96 dB –101 dB	–104 dB –110 dB	–103 dB –109 dB
Spurious Free Dynamic Range, SFDR ^j (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	98 dBFS 110 dBFS	98 dBFS 109 dBFS	105 dBFS 118 dBFS	105 dBFS 118 dBFS
Noise Floor (50 Ω input termination, 105.5 kSPS)	58 μVRMS	7.5 μVRMS	58 μVRMS	7.5 μVRMS
Overvoltage Protection				
Overvoltage protection Power on: Power off:	+40 V to –20 V ±40 V		+40 V to –20 V ±40 V	
ESD protection Arc: Contact:	8 kV 4 kV		8 kV 4 kV	

a. The total frequency response is the combined frequency response of the ADC Delta Sigma filter and the analog filter.

b. Channel 0 is the reference channel with a 20 V_{pp} signal and a maximum sample rate of 105.469 kSamples/s.

c. Cable capacitance of 30 pF per foot (typical) must be added.

d. Offset errors are referred to the input.

- e. ENOB, SINAD, SNR, THD, and SFDR measurements were made with a 16384 point FFT with a minimum 4-term Blackman Harris window.
- f. Effective Number of Bits (ENOB) is calculated from the SINAD value with adjustment for level below full-scale of the input signal.

$$ENOB = \frac{(SINAD - 1.76 + IBFS)}{6.02}$$

where, IBFS is a positive value in dB, representing the ratio of a full-scale signal to the input signal.

- g. Signal to Noise and Distortion (SINAD) is the ratio of the RMS value of the input signal to the RMS sum of all other spectral components, excluding DC.
- h. Signal to Noise Ratio (SNR) is the ratio of the RMS value of the input signal to the RMS sum of all other spectral components, excluding harmonics and DC.
- i. Total Harmonic Distortion (THD) is the ratio of the RMS value of the input signal to the RMS sum of all harmonics.
- j. Spurious Free Dynamic Range (SFDR) is the ratio of the RMS full-scale range to the RMS value of the largest peak spurious component, including harmonics.

Figure 42 shows the full system accuracy of the DT9857 module as measured by QuickDAQ. In this example, a -1 dB input signal is connected to the DT9857 module and is sampled at 105.469 kHz using a gain of 1. The effective number of bits (ENOB) is 15.54.

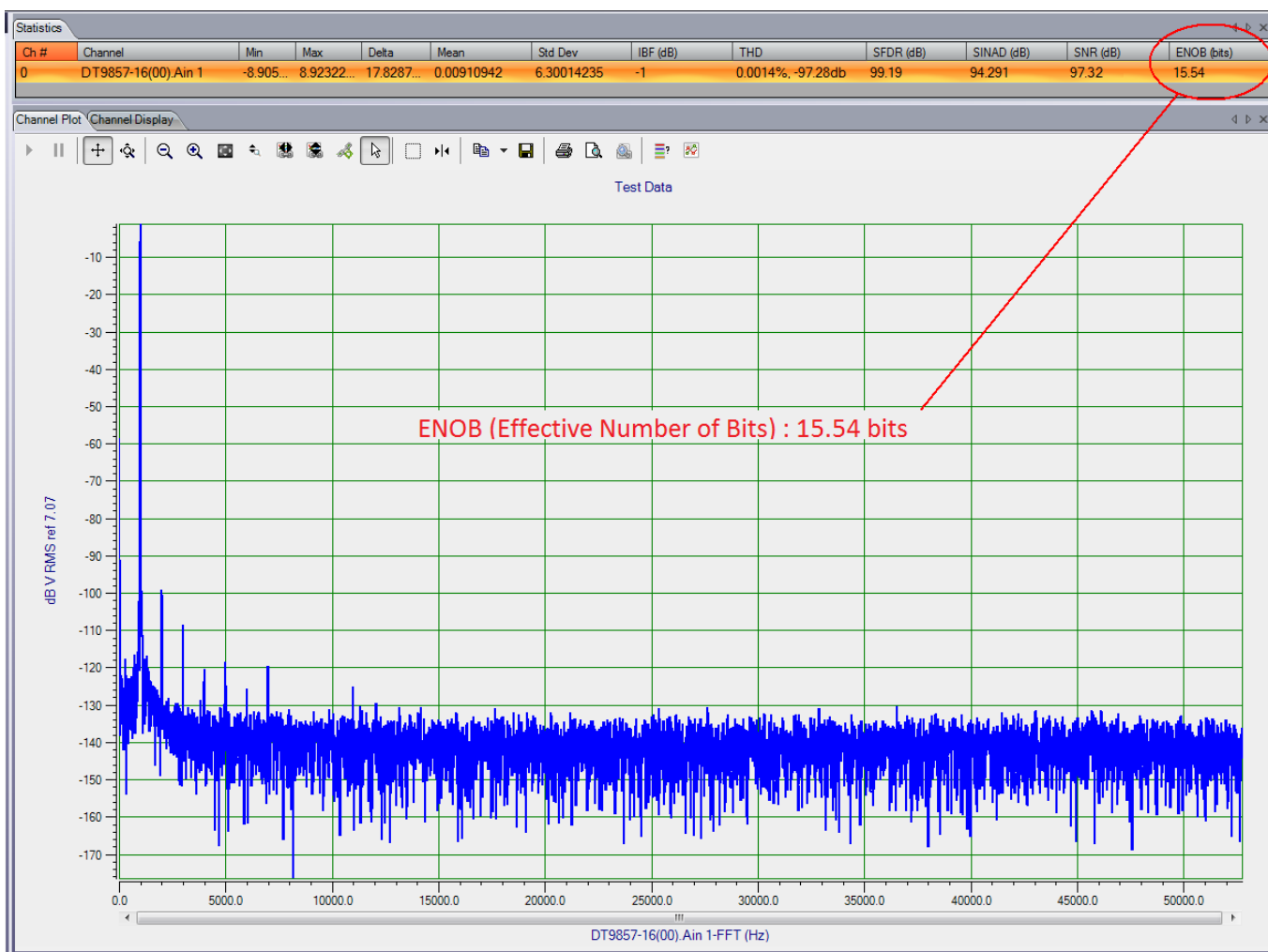


Figure 42: Dynamic Performance of the DT9857 Module Measured Using QuickDAQ

Figure 43 shows the noise performance of the DT9857 module using QuickDAQ. In this example, the input channel was shorted with $50\ \Omega$ and sampled at 105.469 kHz using a gain of 1. The noise is $52\ \mu\text{VRMS}$.

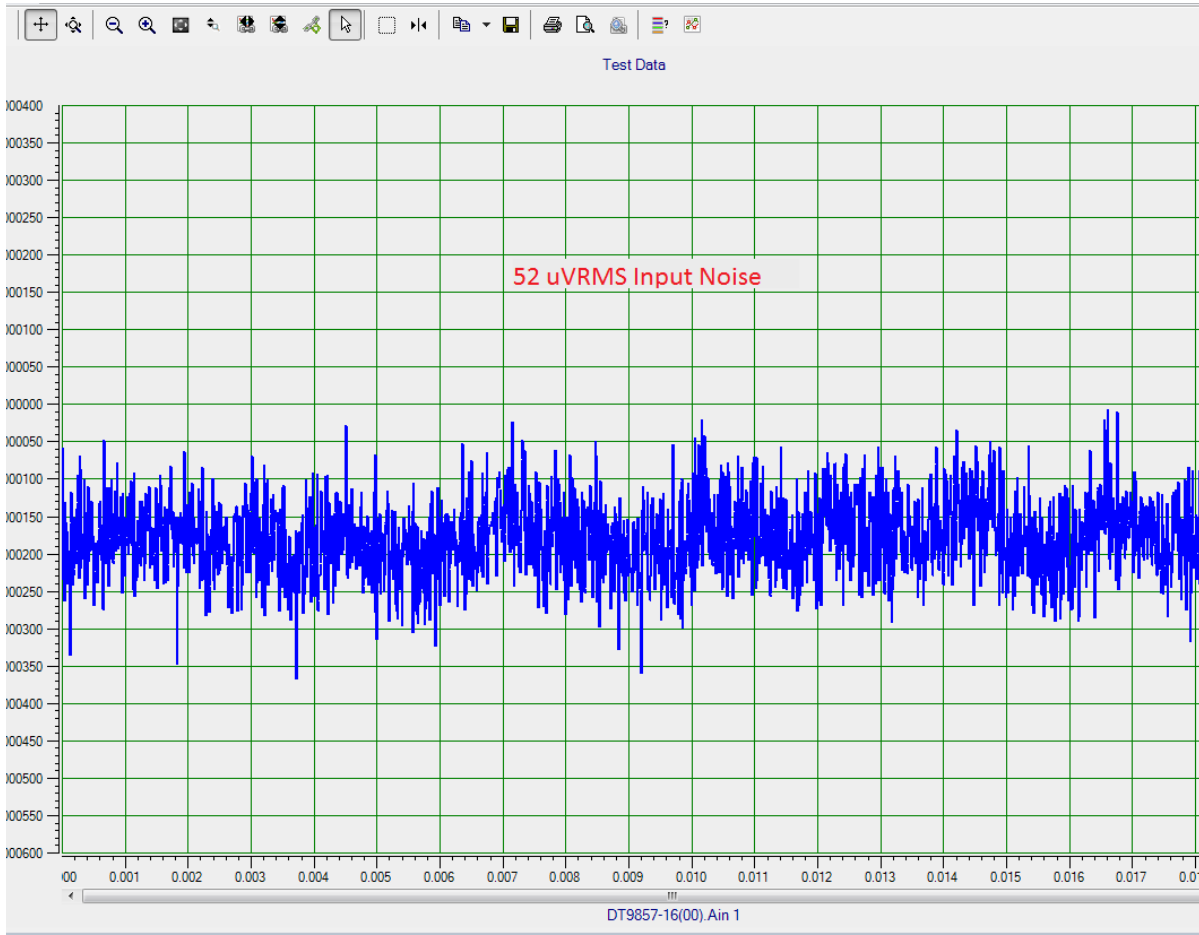


Figure 43: Noise Level of the DT9857 Measured Using QuickDAQ

Figure 44 shows the analog input passband response of the DT9857 and DT9857E modules using a sampling rate of 48 kS/s.

DT9857 and DT9857E Analog Input Passband Response ($F_s = 48$ kSPS)

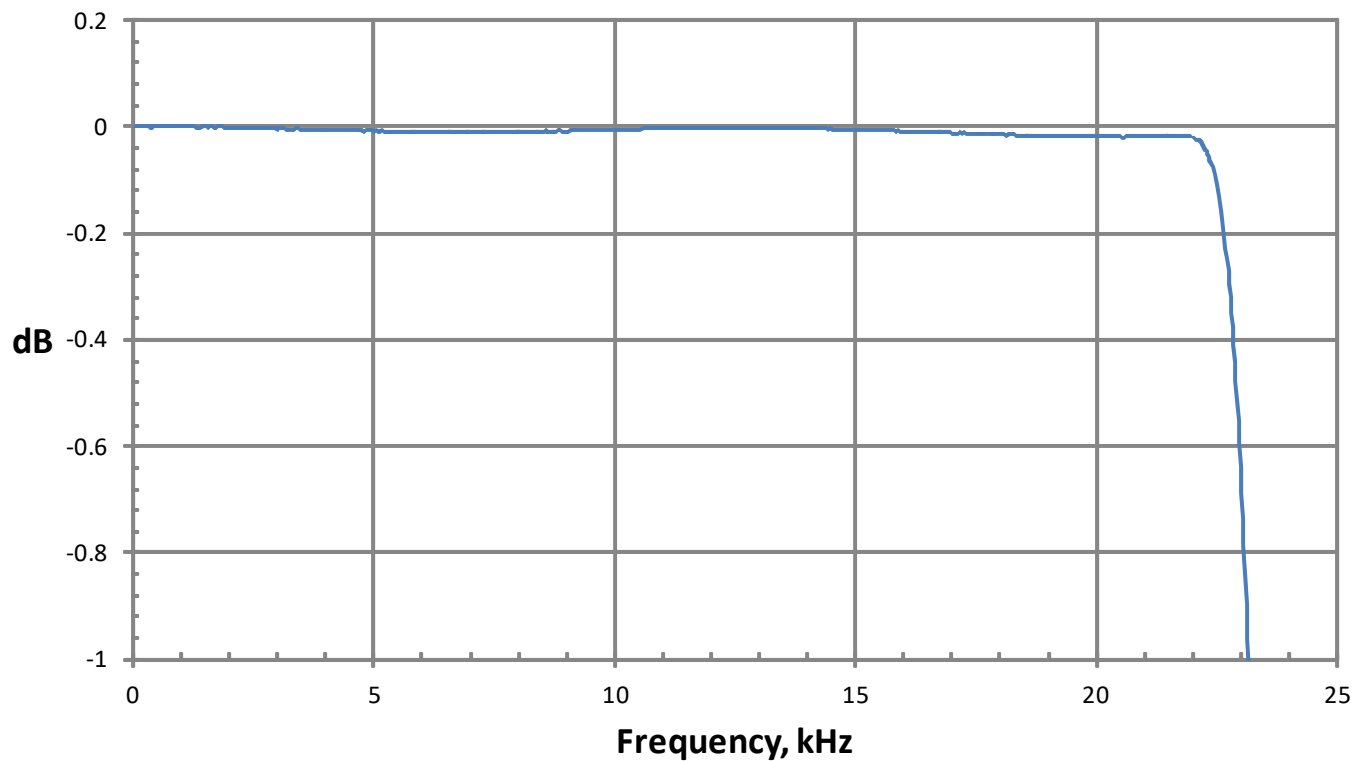


Figure 44: Analog Input Passband Response of the DT9857 and DT9857E Modules

Analog Output Specifications

Table 25 lists the specifications for the analog output subsystem on the DT9857 and DT9857E modules. Unless otherwise noted, specifications are typical at 25° C.

Note: The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.

Table 25: Analog Output Subsystem Specifications

Feature	DT9857 and DT9857E Specifications
Number of analog output channels	2, single-ended ^a
Resolution	32 bits
D/A type	Delta Sigma
Output range	±10 V
Data encoding	Offset binary
Minimum sample frequency	30 kHz
Maximum sample frequency	216 kHz
D/A master clock range	13.824 MHz to 27.648 MHz
Sampling Frequency 30 kHz to 54 kHz: 54 kHz to 108 kHz: 108 kHz to 216 kHz:	512 x sample frequency 256 x sample frequency 128 x sample frequency
Group delay (typical)	36/sample rate, in seconds
DAC Delta Sigma filter ^b Passband, -3 dB: Passband ripple, ±0.005 dB: Stopband Stopband attenuation, -100 dB: Stopband attenuation, -95 dB: Stopband attenuation, -90 dB:	0.49 x sample frequency, Hz 0.454 x sample frequency, Hz 0.546 x sample frequency, Hz Sample frequency ≤ 44.1 kHz Sample frequency ≤ 96 kHz Sample frequency ≤ 192 kHz
Analog filter ^b	120 kHz, 2-pole, low-pass Butterworth
Output current	±3 mA maximum load (10 V across 3.3 kΩ)
Output FIFO	64 kSamples
Idle channel noise (216 kSPS)	30 μVRMS
Total Harmonic Distortion, THD ^c (216 kSPS -1 dBFS, 1 kHz output, 3.3 kΩ load: -6 dBFS, 1 kHz output, 3.3 kΩ load:	-100 dB -110 dB

Table 25: Analog Output Subsystem Specifications (cont.)

Feature	DT9857 and DT9857E Specifications
Spurious Free Dynamic Range, SFDR ^c (216 kSPS) -1 dBFS, 1 kHz output, 1 k Ω load: -6 dBFS, 1 kHz output, 1 k Ω load:	102 dB 118 dB
Offset error	± 0.5 mV
Offset error temperature coefficient	130 $\mu\text{V}/^\circ\text{C}$
Gain error	$\pm 0.03\%$ of output
Gain error temperature coefficient	55 ppm/ $^\circ\text{C}$
Power fault and reset	Goes to 0 V ± 0.5 mV if the USB cable is removed, external power fails, USB power is reset, or the system is rebooted
ESD protection Arc: Contact:	8 kV 4 kV

- a. The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions do not support the analog output (D/A) subsystem.
- b. The total frequency response is the combined frequency response of the DAC Delta Sigma filter and the analog filter.
- c. THD and SFDR measurements were made with a 16384 point FFT with a minimum 4-term Blackman Harris window.

Digital I/O Specifications

Table 26 lists the specifications for the digital I/O subsystems on the DT9857 and DT9857E modules.

Table 26: Digital I/O Specifications

Feature	DT9857 and DT9857E Specifications
Number of digital I/O lines	16 (8 in, 8 out)
Number of ports	2 (8 bits each)
Input voltage range	0 to 3.3 V; 5 V tolerant
Logic sense	Positive true
Inputs Input type: Input logic load: High input voltage: Low input voltage: Low input current: Termination:	Level-sensitive 1 LVTTTL 2.0 V minimum 0.8 V maximum 0.2 mA maximum 22 k Ω pull-up to 3.3 V
Outputs Output type: High output: Low output: High output current: Low output current: Short circuit protected:	LVTTTL 2.4 V minimum 0.4 V maximum –10 mA maximum 4 mA maximum 33 mA
Clocked with sample clock	Yes, if included in the analog input or analog output channel list
Software I/O selectable	No

Tachometer Input Specifications

Table 27 lists the specifications for the tachometer input on the DT9857 and DT9857E modules.

Table 27: Tachometer Input Specifications

Feature	DT9857 and DT9857E Specifications
Number of channels	1
Resolution	31 bits per channel
Input voltage range	± 30 V
Threshold voltage	+2 V with 0.5 V hysteresis
Input termination	None
Maximum input frequency	1 MHz ^a
Minimum pulse width high/low (minimum amount of time it takes a C/T to recognize an input pulse)	0.4 μ s
Clock frequency for tachometer measurements	12 MHz (83 ns resolution)

a. Limited by signal integrity and input signal conditioning.

Measure Counter Specifications

Table 28 lists the specifications for the measure counters (counters 1 and 2) on the DT9857 and DT9857E modules.

Table 28: Measure Counter Specifications

Feature	DT9857 and DT9857E Specifications
Number of measure counters	2
Resolution	31 bits per channel
Clock frequency for measurement counters	48 MHz (20.8 ns resolution)
Maximum input frequency	10 MHz ^a
Minimum pulse width high/low	50 ns (0.4 μ s if the tachometer input is used for the starting edge and stopping edge)
Start and stop signals/edges	A/D conversion complete Tachometer input (falling or rising edge) Digital inputs 0 to 7 (falling or rising edge) C/T 0 Clock input (falling or rising edge) C/T 0 Gate input (falling or rising edge)

a. Limited by signal integrity and input signal conditioning.

General-Purpose Counter/Timer Specifications

Table 27 lists the specifications for the general-purpose counter/timer (C/T 0) on the DT9857 and DT9857E modules.

Table 29: General Purpose Counter/Timer Specifications

Feature	DT9857 and DT9857E Specifications
Number of general-purpose counter/timers	1
Internal reference clock	48 MHz
Resolution	32 bits per channel
Clock divider Minimum: Maximum:	2 4,294,967,296
Clock output Minimum: Maximum:	0.0112 Hz 24 MHz
Maximum clock or gate input frequency	24 MHz ^a
Minimum pulse width (minimum amount of time it takes a C/T to recognize an input pulse)	50 ns
Input voltage range	0 to 3.3 V (+5 V tolerance)
Inputs Input logic load: High input voltage: Low input voltage: Low input current: Input termination:	1 LVTTTL 2.0 V minimum 0.8 V maximum –0.2 mA maximum 22 k Ω
Outputs Output type: High output: Low output: High output current: Low output current: Short circuit protected:	LVTTTL 2.4 V minimum 0.4 V maximum –10 mA maximum 4 mA maximum 33 mA

a. The integrity of the signal degrades at frequencies greater than 10 MHz.

Trigger Specifications

Table 30 lists the specifications for the triggers on the DT9857 and DT9857E modules.

Table 30: Trigger Specifications

Feature	DT9857 and DT9857E Specifications
Trigger sources Internal software trigger: External digital trigger: Threshold trigger:	Software-initiated Software-selectable Software-selectable
External trigger (digital) Input type: Input termination: Logic family: Input logic load: Lower threshold: Upper threshold: Hysteresis: Input sink current: Minimum pulse width high/low: Maximum input signal:	Edge-sensitive, rising- or falling-edge trigger (software-selectable) None LVTTTL inputs 1 LVTTTL 1.1 V 1.3 V 0.2 V 33 μ A 250 ns ± 30 V
Threshold trigger Type: Threshold level: Hysteresis:	Rising- or falling-edge threshold trigger on any analog input channel (software-selectable) -10 V to $+10$ V @ gain of 1; ± 1 V @ gain of 10 100 mV
Trigger delay	1 conversion period maximum

Master Oscillator Specifications

Table 31 lists the specifications for the master oscillator on the DT9857 and DT9857E modules.

Table 31: Master Oscillator Specifications

Feature	DT9857 and DT9857E Specifications
Frequency	48 MHz ^a
Accuracy at 25° C	±30 ppm
Drift over temperature 0 to 70° C (Total)	±50 ppm
Aging (first year)	±5 ppm
Maximum error (first year)	±85 ppm

- a. The sample frequencies for the A/D and D/A subsystems are independently programmable and are derived from the same 48 MHz reference clock. Therefore, it is possible to establish a fixed relationship between the A/D and D/A subsystem sample frequencies, including setting them to the same frequency (30 kHz to 105.469 kHz). However, the subsystems are not designed to be synchronous with each other.

Power, Physical, and Environmental Specifications

Table 32 lists the power, physical, and environmental specifications for the DT9857 and DT9857E modules.

Table 32: Power, Physical, and Environmental Specifications

Feature	DT9857 and DT9857E Specifications
Power DT9857: DT9857E:	+5 VDC @ 10 W +4.75 VDC to +28 VDC
Warm-up time	1 hour
Physical Dimensions --DT9857 OEM (board only) Length of Bottom Board: Width of Bottom Board: Thickness of Bottom Board: Weight of DT9857-8-OEM: Length of Top Board (used by DT9857-16-OEM only): Width of Top Board (used by DT9857-16-OEM only): Thickness of Top Board (used by DT9857-16-OEM only): Weight of DT9857-16-OEM:	Card-cage mountable in 6 U cage; 8 channel = 4HP; 16 channel = 8HP; 0.8" (20.3 mm) spacing in center 8.661 in (220 mm) 9.187 in (233.3 mm) 0.063 in (1.6 mm) 487.2 g (17.2 oz) 5.473 in (139 mm) 9.187 in (233.3 mm) 0.063 in (1.6 mm) 800 g (28.2 oz)
Physical Dimensions - DT9857E Enclosure Length: Width: Height: Weight of DT9857-8: Weight of DT9857-16:	Rack-mountable in 19" x 1U rack with EP402 kit 8.795 in (223.4 mm) 9.719 in (246.9 mm) 1.72 in (43.7 mm) 1155 g (40.8 oz) 1475.5 g (52.0 oz)
Physical Dimensions --DT9857E OEM (board only) Length of Bottom Board: Width of Bottom Board: Thickness of Bottom Board: Weight of DT9857-8-OEM: Length of Top Board (used by DT9857E-16-OEM only): Width of Top Board (used by DT9857E-16-OEM only): Thickness of Top Board (used by DT9857E-16-OEM only): Weight of DT9857E-16-OEM:	Card-cage mountable in 6 U cage; 8 channel = 8HP; 16 channel = 8HP; 0.8" (20.3 mm) spacing in center 8.661 in (220 mm) 9.187 in (233.3 mm) 0.063 in (1.6 mm) 516 g (18.2 oz) 5.473 in (139 mm) 9.187 in (233.3 mm) 0.063 in (1.6 mm) 833 g (29.4 oz)
Environmental Operating temperature range: Storage temperature range: Relative humidity: Altitude:	0° C to 55° C -25° C to 85° C To 95%, noncondensing To 10,000 feet

Regulatory Specifications

The DT9857 and DT9857E modules are CE-compliant. [Table 33](#) lists the regulatory specifications for the DT9857 and DT9857E modules.

Table 33: Regulatory Specifications

Feature	DT9857 and DT9857E 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> EN61000-4-2:2009 Electrostatic Discharge (ESD) 4 kV contact discharge, 8 kV air discharge, 4 kV horizontal and vertical coupling planes EN61000-4-3:2006 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 EN61000-4-4:2004 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)

Connector Specifications

Table 34 lists the connector specifications for the DT9857 and DT9857E modules.

Table 34: Connector Specifications

Connector	Part Number of Connector on Module	Mating Connector
Analog I/O BNC connectors	TE Connectivity 5227161-9	–
External power supply On the DT9857: On the DT9857E module in enclosure:	Kycon KPJX-4S-S (DIN connector) Kycon KPJX-4S-S (DIN connector) Phoenix Contact 1757255 (3-position header)	Kycon KPPX-4P Kycon KPPX-4P Phoenix Contact 1757022
Sync Bus connector (RJ45) On the DT9857: On the DT9857E:	Molex part number 44661-0001 TE Connectivity 5569255-1	– –
USB connector ^a	TE Connectivity 292304-2	–
Digital connector	TE Connectivity 5747846-4	–

- a. The standard version of the DT9857 and DT9857E modules supports an optional locking USB cable (the OEM version does not support a locking USB cable). You can purchase a locking USB cable separately from vendors such as Newnex Technology Corporation (part number UHRB-B00A-U60). See <http://ntcdistributing.com/products/usb-locking-screws.htm> for more information.

External Power Supply Specifications

Table 35 lists the specifications for the EP361 +5 V external power supply that is used with the DT9857 and DT9857E modules.

Table 35: Specifications for the EP361 External Power Supply

Feature	Specifications
Type	Total Power medical power supply (TPEMG24-S050400-7)
Input voltage	Typical 90 - 264 V AC
Input current	Typical 0.347 A at 115 V AC, 0.215 A at 230 V AC
Frequency	47 to 63 Hz
Inrush current	6.274 A RMS at 230 V AC
Output voltage	5 V DC
Output current	4.0 A
Output wattage	Typical 20 - 24 W
Noise and ripple	1% peak to peak
Regulatory specifications	UL, ITE, CE, FCC Class B, Energy Star compliant

Table 36 lists the specifications for the external power supply that is used with the DT9857E module.

**Table 36: Specifications for the External Power Supply
Used with the DT9857E Module**

Feature	Specifications
Output voltage	4.75 VDC to +28 VDC
Output current 5 V: 12 V: 28 V:	1.56 A with 4 A surge capability 0.62 A 0.29 A
Noise and ripple	50 mV peak to peak



Connector Pin Assignments and LED Status Indicators

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Analog Input Connectors

Figure 45 shows the layout of the analog input connectors on the DT9857 and DT9857E modules.

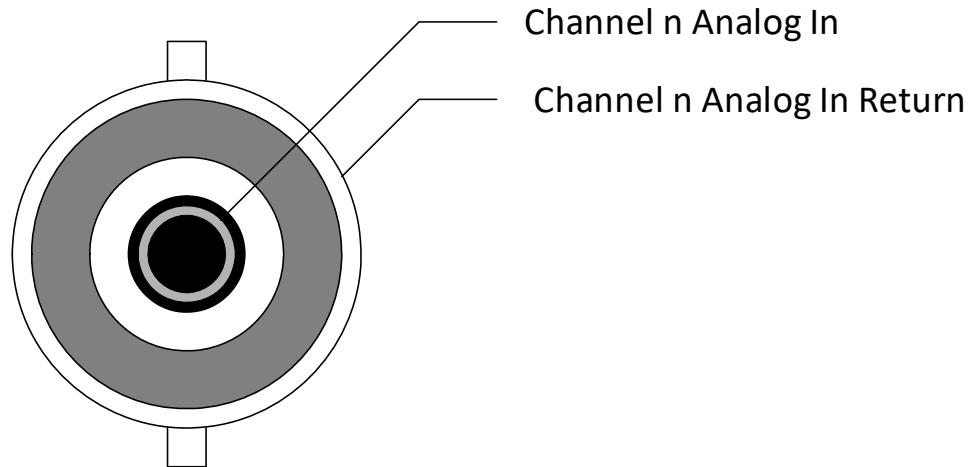


Figure 45: Analog Input Connectors

Analog Output Connectors

Figure 46 shows the layout of the analog output connectors on the DT9857 and DT9857E modules.

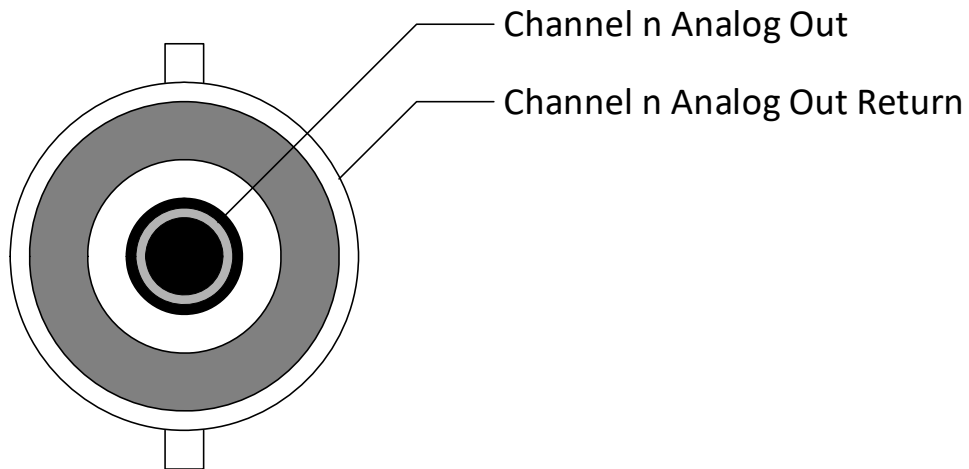


Figure 46: Analog Output Connectors

Note: The DT9857E-8-xAO, DT9857E-16-xAO and their OEM versions are designed without analog output functionality.

Tachometer Connector (DT9857 Only)

Figure 47 shows the layout of the tachometer connector on the DT9857 module. Note that on the DT9857E, the tachometer input is provided on pin 11 of the Digital connector.

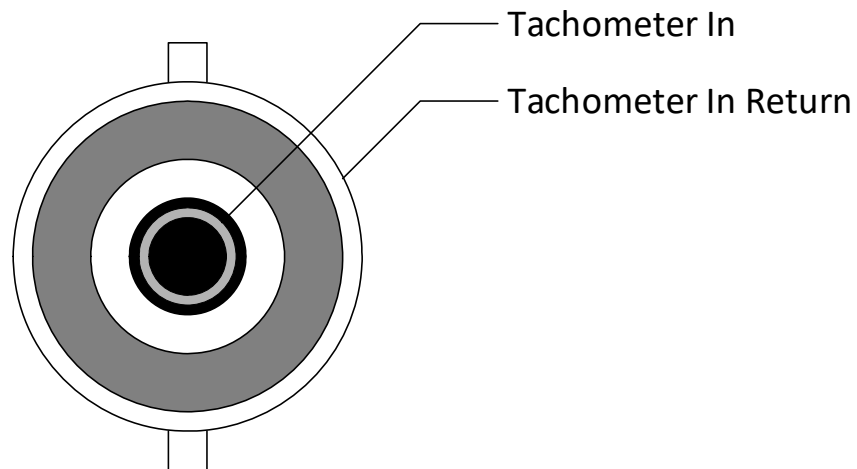


Figure 47: Tachometer Connector (DT9857 Only)

External Trigger Connector (DT9857E Only)

Figure 48 shows the layout of the external digital (TTL) connector on the DT9857E module. Note that on the DT9857, the external digital (TTL) input is provided on pin 11 of the Digital connector.

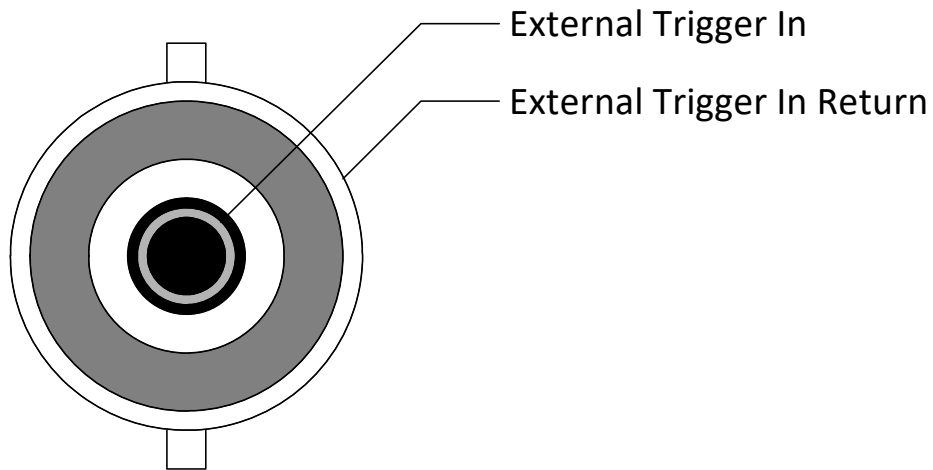


Figure 48: External Trigger Connector (DT9857E Module Only)

Digital Connector

Figure 49 shows the layout of the 25-pin, D-shell, Digital connector on the DT9857 and DT9857E modules.

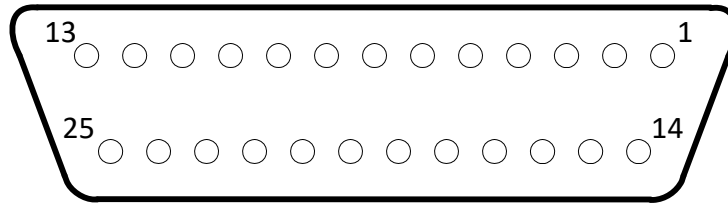


Figure 49: Layout of the Digital Connector

Table 37 lists the pin assignments for the Digital connector on the DT9857 and DT9857E modules.

Table 37: Pin Assignments for the Digital Connector

Connector Pin Number ^a	Signal Description	Connector Pin Number	Signal Description
1	Digital Input 0	14	C/T 0 Clock
2	Digital Input 1	15	C/T 0 Out
3	Digital Input 2	16	Digital Ground
4	Digital Input 3	17	Digital Output 0
5	Digital Ground	18	Digital Output 1
6	Digital Input 4	19	Digital Output 2
7	Digital Input 5	20	Digital Output 3
8	Digital Input 6	21	Digital Ground
9	Digital Input 7	22	Digital Output 4
10	Digital Ground	23	Digital Output 5
11	External Trigger on DT9857; Tachometer Input on DT9857E	24	Digital Output 6
12	C/T 0 Gate	25	Digital Output 7
13	Event Out ^b		

a. The outer shell of the connector provides cable shield to chassis ground.

b. Currently, the event output function is disabled and the output is driven low.

External USB Connector

Figure 50 shows the layout of the external USB connector on the DT9857 and DT9857E modules.

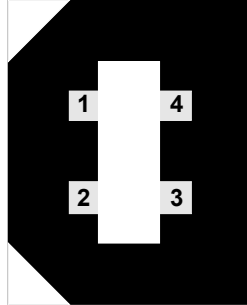


Figure 50: Layout of the USB Connector

Table 38 lists the pin assignments for the USB connector on the DT9857 and DT9857E modules.

Table 38: Pin Assignments for the USB Connector

Connector Pin Number	Signal Description	Connector Pin Number	Signal Description
1	USB +5 V	3	USB Data +
2	USB Data –	4	USB Ground

External Power Connectors

The following sections describe the power connectors that are provided for the DT9857 and DT9857E modules.

External Power Connector on the DT9857 Module

The DT9857 module provides a DIN connector for connecting an external +5 V power supply; the EP361 power supply connects to the DIN connector.

Figure 51 shows the layout of the DIN power connector. (Refer to [page 158](#) for detailed specifications of the EP361 power supply.)

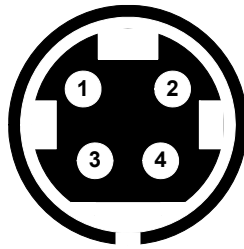


Figure 51: Layout of the DIN Power Connector

Table 39 lists the pin assignments for the DIN power connector on the DT9857 module.

Table 39: Pin Assignments for the DIN Power Connector on the DT9857 Module

Connector Pin Number ^a	Signal Description
1	+5 VDC
2	+5 VDC
3	Ground
4	Ground

a. The outer shell of the connector provides cable shield to chassis ground.

External Power Connectors on the DT9857E Module

Both the standard DT9857E module and the OEM version of the DT9857E module provide two connectors for attaching a +4.75 VDC to +28 VDC external power supply: a DIN connector and a 3-position Phoenix header.

Figure 52 shows the layout of the DIN power connector.

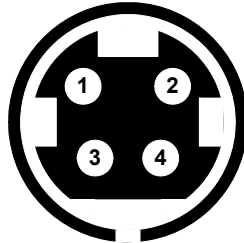


Figure 52: Layout of the DIN Power Connector

Table 40 lists the pin assignments for the DIN power connector on the DT9857E module.

Table 40: Pin Assignments for the DIN Power Connector on the DT9857E Module

Connector Pin Number ^a	Signal Description
1	+4.75 VDC to +28 VDC
2	+4.75 VDC to +28 VDC
3	Ground
4	Ground

a. The outer shell of the connector provides cable shield to chassis ground.

Figure 53 shows the layout of the 3-pin Phoenix header on the DT9857E module.

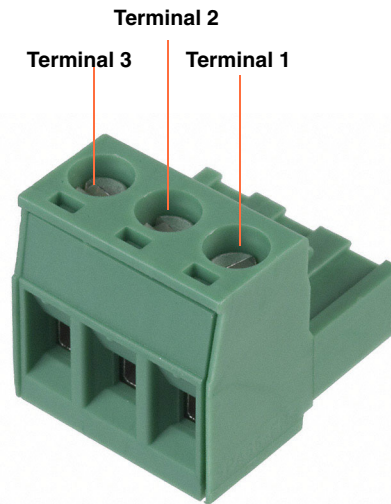


Figure 53: Layout of the 3-Position Phoenix Header

Table 41 lists the terminal assignments for the 3-position header on the DT9857E module.

Table 41: Terminal Assignments for the 3-Position Header on the DT9857E Module

Terminal Number	Signal Description
1	+4.75 VDC to +28 VDC
2	Ground
3	Chassis Ground

Note that you must connect an external power supply to this header that meets the specifications described on [page 160](#).

Sync Bus Connector

The following sections describe the Sync Bus connectors on the DT9857 and DT9857E modules.

Sync Bus Connector on the DT9857 Module

Figure 54 shows the Sync Bus (RJ45) connector on the DT9857 module.

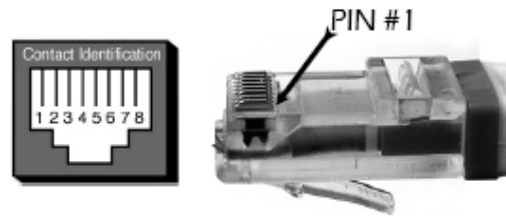


Figure 54: Sync Bus (RJ45) Connector

Table 42 lists the pin assignments for the Sync Bus connector on the DT9857 module.

Table 42: Sync Bus Connector Pin Assignments

Pin	Description
1	48 MHz Reference Clock +
2	48 MHz Reference Clock –
3	Input Subsystem Trigger +
4	Sync +
5	Sync –
6	Input Subsystem Trigger –
7	Output Subsystem Trigger +
8	Output Subsystem Trigger –

Sync Bus Connector on the DT9857E Module

Figure 55 shows the Sync Bus (RJ45) connectors on the DT9857E module.

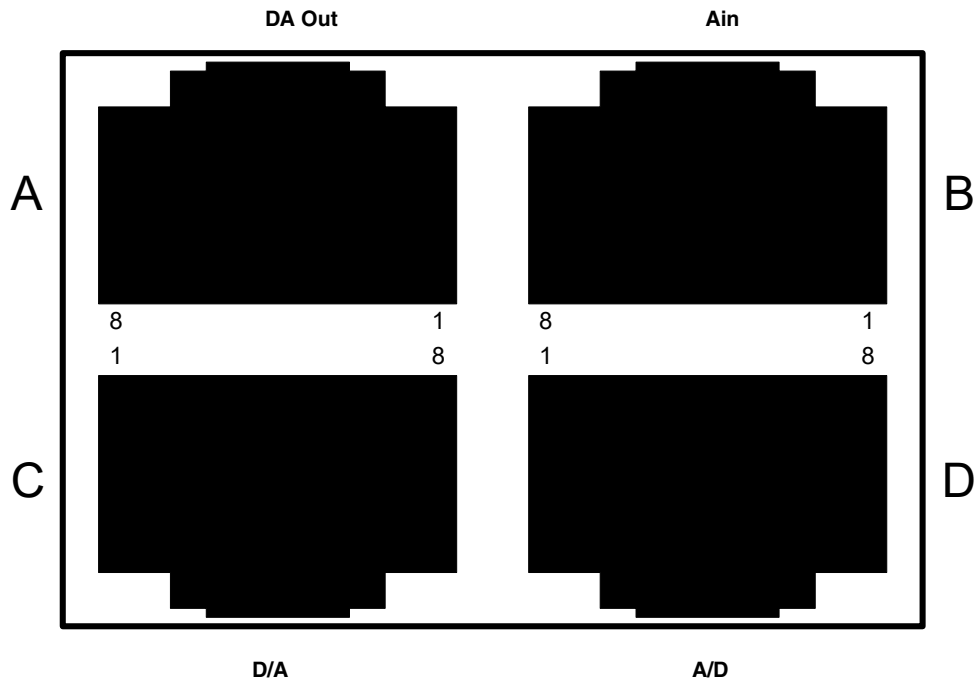


Figure 55: Sync Bus (RJ45) Connectors

If you want to synchronize the analog input channels of multiple modules, you must connect a cable from the Ain Sync Bus connector on one module to the Ain Sync Bus connector on the next module.

If you want to synchronize the analog output channels on multiple modules, you must connect a cable from the Ain Sync Bus connector (B or D) on one module to the Ain Sync Bus connector (B or D) on the next module, and then connect a cable from the DA Out Sync Bus connector (A or C) on one module to the DA Out Sync Bus connector (A or C) on the next module.

Note: The Ain Sync Bus connectors (B and D) provide the reference clock that the D/A subsystem requires for synchronization.

The pin assignments of Ain Sync Bus connectors (B and D) on the DT9857E are listed in [Table 43](#).

Table 43: Sync Bus Connector Pin Assignments

Pin	Description
1	48 MHz Reference Clock +
2	48 MHz Reference Clock –
3	A/D Trigger +
4	A/D Sync +
5	A/A Sync –
6	A/D Trigger –
7	A/D Master Clock +
8	A/D Master Clock –

The pin assignments of DA Out Sync Bus connectors (A and C) on the DT9857E are listed in [Table 44](#).

Table 44: Sync Bus Connector Pin Assignments

Pin	Description
1	Not Connected +
2	Not Connected –
3	D/A Trigger +
4	D/A Sync +
5	D/A Sync –
6	D/A Trigger –
7	D/A Master Clock +
8	D/A Master Clock –

Refer to [page 108](#) for more information on synchronizing multiple modules.

STP25 Screw Terminal Panel

The STP25 contains one 25-pin connector and a screw terminal block (TB1). The 25-pin connector provides access to the signals from the Digital connector on the DT9857 and DT9857E modules.

Figure 56 shows the layout of the STP25 screw terminal panel.

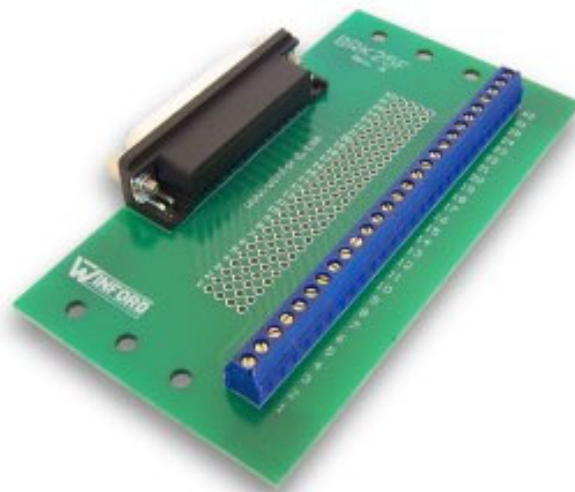


Figure 56: Layout of the STP25 Screw Terminal Panel

Table 45 lists the screw terminal assignments for the STP25 screw terminal panel.

Table 45: Screw Terminal Assignments for the STP25 Screw Terminal Panel

Screw Terminal	Signal Description
SH	Shield
25	Digital Output 7
24	Digital Output 6
23	Digital Output 5
22	Digital Output 4
21	Digital Ground
20	Digital Output 3
19	Digital Output 2
18	Digital Output 1
17	Digital Output 0
16	Digital Ground
15	C/T Out
14	C/T Clock
13	Event Out ^a
12	C/T Gate
11	External Trigger on the DT9857; Tachometer Input on the DT9857E
10	Digital Ground
9	Digital Input 7
8	Digital Input 6
7	Digital Input 5
6	Digital Input 4
5	Digital Ground
4	Digital Input 3
3	Digital Input 2
2	Digital Input 1
1	Digital Input 0

a. Currently, the event output function is disabled and the output is driven low.

LED Status Indicators

This section describes the LED status indicators on the DT9857 and DT9857E modules.

LED Status Indicators on the DT9857 Module

The DT9857 module has LED indicators on the front and rear panels. [Figure 57](#) shows the LEDs on the front panel of the DT9857 module. [Figure 58](#) shows the LEDs on the rear panel of the DT9857 module.



Figure 57: LEDs on the Front Panel of the DT9857 Module



Figure 58: LEDs on the Rear Panel of the DT9857 Module

The LEDs are described in [Table 46](#).

Table 46: LED Status Indicators on the DT9857 Module

LED	Color of the LED	Status Description	Location
Input Trigger LED	Off	Idle	Front Panel (Bottom)
	Solid amber	Input subsystem armed; it is waiting for an external digital trigger, threshold trigger, or Sync Bus trigger (the module must have been configured for one of these trigger types)	
	Solid green	Input subsystem has been triggered	
Output Trigger LED	Off	Idle	Front Panel (Top)
	Solid amber	Output subsystem armed; it is waiting for an external digital trigger, threshold trigger, or Sync Bus trigger (the module must have been configured for one of these trigger types)	
	Solid green	Output subsystem has been triggered	
Power LED	Off	Power off	Rear Panel (Bottom)
	Solid green	Power on (requires both the USB cable and the external power to be plugged in as the module is held in reset until both conditions are true)	
	Solid amber	(Used on the DT9857E module only.) DT9857E module has been identified through the Control Panel applet.	
USB LED	Off	Module not opened	Rear Panel (Top)
	Solid green	Module enumerated as a USB device (requires both the USB cable and the external power cable to be connected)	

LED Status Indicators on the DT9857E Module

The DT9857E module has LED indicators on the front and rear panels. [Figure 59](#) shows the LEDs on the front panel of the DT9857E module. [Figure 60](#) shows the LEDs on the rear panel of the DT9857E module.



Figure 59: LEDs on the Front Panel of the DT9857E Module

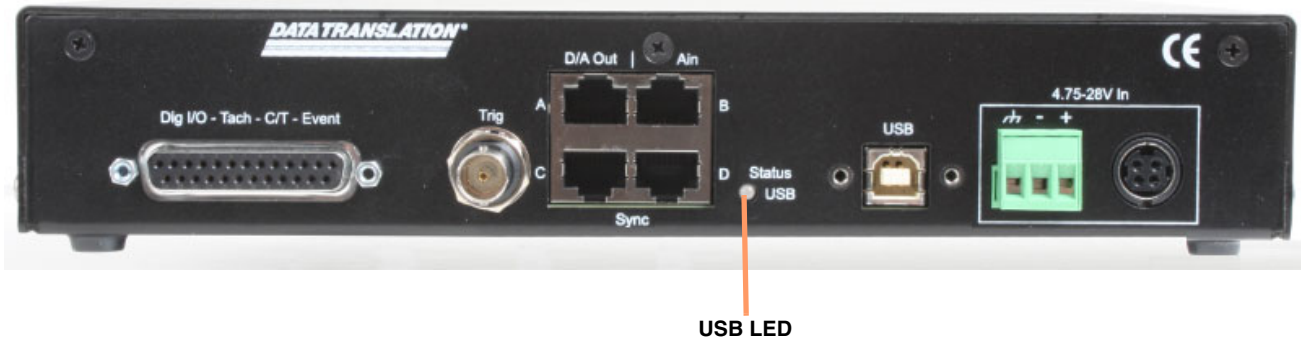


Figure 60: LEDs on the Rear Panel of the DT9857E Module

These LEDs are described in [Table 47](#).

Table 47: LED Status Indicators on the DT9857E Module

LED	Color of the LED	Status Description	Location
Input Trigger LED	Off	Idle	Front Panel
	Solid amber	Input subsystem armed; it is waiting for an external digital trigger, threshold trigger, or Sync Bus trigger (the module must have been configured for one of these trigger types)	
	Solid green	Input subsystem has been triggered	
Output Trigger LED	Off	Idle	Front Panel
	Solid amber	Output subsystem armed; it is waiting for an external digital trigger, threshold trigger, or Sync Bus trigger (the module must have been configured for one of these trigger types)	
	Solid green	Output subsystem has been triggered	
Power LED	Off	Power off	Front Panel
	Solid green	Power on (requires both the USB cable and the external power to be plugged in as the module is held in reset until both conditions are true)	
USB LED	Off	Module not opened	Rear Panel
	Solid green	Module enumerated as a USB 2.0 high-speed device	
	Solid amber	Module enumerated as a USB 1.1 full-speed device	



Register-Level Programming

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Writing to the EEPROM Register

If you want to change the default values for the coupling type, current source, and Sync Bus termination that are defined in the Open Layers Control Panel programmatically, you can use the Data Acq SDK function **oldDiagWriteReg** to write to the EEPROM register of each DT9857 and DT9857E module.

The Open Layers Control Panel has controls for setting the following parameters, which are stored in 8 consecutive bytes of EEPROM:

- Coupling type. The values `COUPLING_TYPE_AC` or `COUPLING_TYPE_DC` are stored as constants for these controls.
- Current source. The values `EXCITATION_CURRENT_SRC_INTERNAL` or `EXCITATION_CURRENT_SRC_DISABLED` are stored as constants for these controls.
- Sync Bus termination (supported on the DT9857E module only). The value is `0x01`.

These controls may also be “uninitialized” if, for some reason, the DT9857 or DT9857E module skipped the post-manufacturing initialization process.

To access the storage locations programmatically, use the **oldDiagReadReg()** and **oldDiagWriteReg()** functions. The following code shows the location of these controls in the register map:

```
#define I2C_MEM_BASE      0x00000000
// Coupling storage offsets relative to the base address for the
// analog input channels
#define EEPROM_OFFSET_COUPLING      0x0020
#define EEPROM_OFFSET_COUPLING_END  0x002F
// Current source storage offsets relative to the base address for
// the analog input channels
#define EEPROM_OFFSET_CURRENT_SOURCE      0x0040
#define EEPROM_OFFSET_CURRENT_SOURCE_END  0x004F
// Sync Bus termination offset from the base address
#define EEPROM_OFFSET_SYNC_TERMINATION    0x0C490
```

To update the coupling type, use the **oldDiagWriteReg()** command as follows:

```
OLSTATUS olStatus = oldDiagWriteReg(m_hDev, I2C_MEM_BASE +
    EEPROM_OFFSET_COUPLING + channelNumber, couplingType, 1);
```

To read the coupling type, use the **oldDiagReadReg()** command as follows:

```
OLSTATUS olStatus = oldDiagReadReg(m_hDev, I2C_MEM_BASE +
    EEPROM_OFFSET_COUPLING + channelNumber, couplingType, 1);
```

To update the current source, use the **oldDiagWriteReg()** command as follows:

```
OLSTATUS olStatus = oldDiagWriteReg(m_hDev, I2C_MEM_BASE +
    EEPROM_OFFSET_CURRENT_SOURCE + channelNumber, currentSource, 1);
```

To read the current source, use the **olDiagReadReg()** command as follows:

```
OLSTATUS olStatus = olDiagReadReg(m_hDev, I2C_MEM_BASE +  
    EEPROM_OFFSET_CURRENT_SOURCE + channelNumber, currentSource, 1);
```

To update the Sync Bus termination on the DT9857E module, use the **olDiagWriteReg()** command as follows:

```
OLSTATUS olStatus = olDiagWriteReg(m_hDev, I2C_MEM_BASE +  
    EEPROM_OFFSET_SYNC_TERMINATION, syncBusTermination, 1);
```

To read the Sync Bus termination on the DT9857E module, use the **olDiagReadReg()** command as follows:

```
OLSTATUS olStatus = olDiagReadReg(m_hDev, I2C_MEM_BASE +  
    EEPROM_OFFSET_SYNC_TERMINATION, &syncBusTermination, 1);
```

The parameters of these commands are defined as follows:

- *m_hDev* is the handle to the device that is being opened.
- *channelNumber* is the A/D channel whose EEPROM location is to be updated.
- *couplingType* is either `COUPLING_TYPE_AC` (for AC coupling) or `COUPLING_TYPE_DC` (for DC coupling)
- *currentSource* is either `EXCITATION_CURRENT_SRC_INTERNAL` (to enable the internal excitation source) or `EXCITATION_CURRENT_SRC_DISABLED` (to disable the excitation current source).
- *syncBusTermination* is `0x01` for enabling termination; if any other value is specified, Sync Bus termination is disabled.

Note: These settings take effect the next time the driver loads (either when the USB plug is removed and plugged back in or the module is powered up).

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