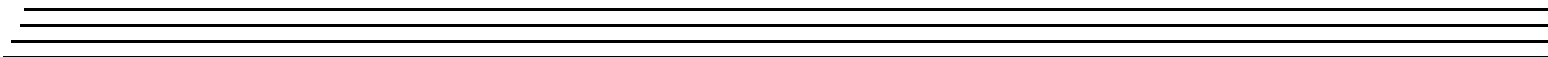
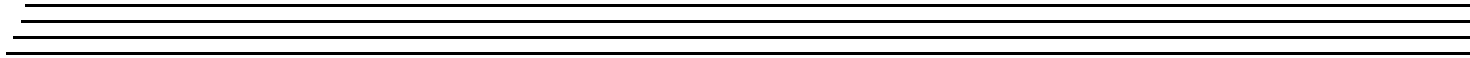
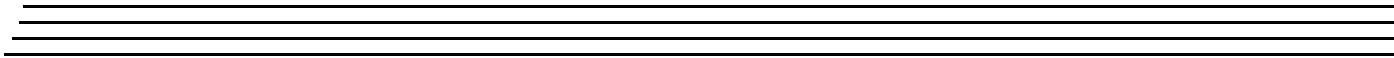


DATA TRANSLATION[®]
A MEASUREMENT COMPUTING COMPANY

UM-24847-L

DT9847 Series User's Manual



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Canadian Department of Communications Statement

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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 DT9847 Series module and device driver, and verify that your module is working properly.

The second part of this manual describes the features of the DT9847 Series modules, the capabilities of the DT9847 Series Device Driver, and how to program the DT9847 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 DT9847 Series 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 DT9847 Series module, as well as the supported software and accessories for the modules.
- [Chapter 2, "Setting Up and Installing the Module,"](#) describes how to install a DT9847 Series module, how to apply power to the module, and how to configure the DT9847 Series Device Driver.
- [Chapter 3, "Wiring Signals,"](#) describes how to wire signals to a DT9847 Series module.
- [Chapter 4, "Verifying the Operation of a Module,"](#) describes how to verify the operation of a DT9847 Series module with the QuickDAQ application.
- [Chapter 5, "Principles of Operation,"](#) describes all of the features of the DT9847 Series module and how to access them in your application.
- [Chapter 6, "Supported Device Driver Capabilities,"](#) lists the data acquisition subsystems and the associated features accessible using the DT9847 Series Device Driver.
- [Chapter 7, "Troubleshooting,"](#) provides information that you can use to resolve problems with the DT9847 Series module and DT9847 Series Device Driver, should they occur.
- [Chapter 8, "Calibration,"](#) describes how to calibrate the analog I/O circuitry of the DT9847 module.

- [Appendix A, “Specifications,”](#) lists the specifications of the DT9847 Series module.
- [Appendix B, “Connector Pin Assignments and LED Status Indicators,”](#) lists the pin assignments of the connectors on the DT9847 Series module, the screw terminal assignments of the STP15 screw terminal panel, and describes the LED status indicators on the DT9847 Series module.
- [Appendix C, “Powering OEM Modules,”](#) describes how to apply power to OEM modules.
- [Appendix D, “Register-Level Programming,”](#) describes how to write to the registers of the DT9847 Series modules to change the default settings that are defined in the Open Layers Control Panel programmatically.
- 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 DT9847 Series module:

- *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 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 DT9847 Series 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

DT9847 Series modules are high-accuracy, dynamic signal acquisition modules for the USB (Ver. 2.0 or Ver. 1.1) bus. These modules are ideal for acoustic measurements due to their AC coupling and frequency characteristics. Figure 1 shows the DT9847-3-1 module.

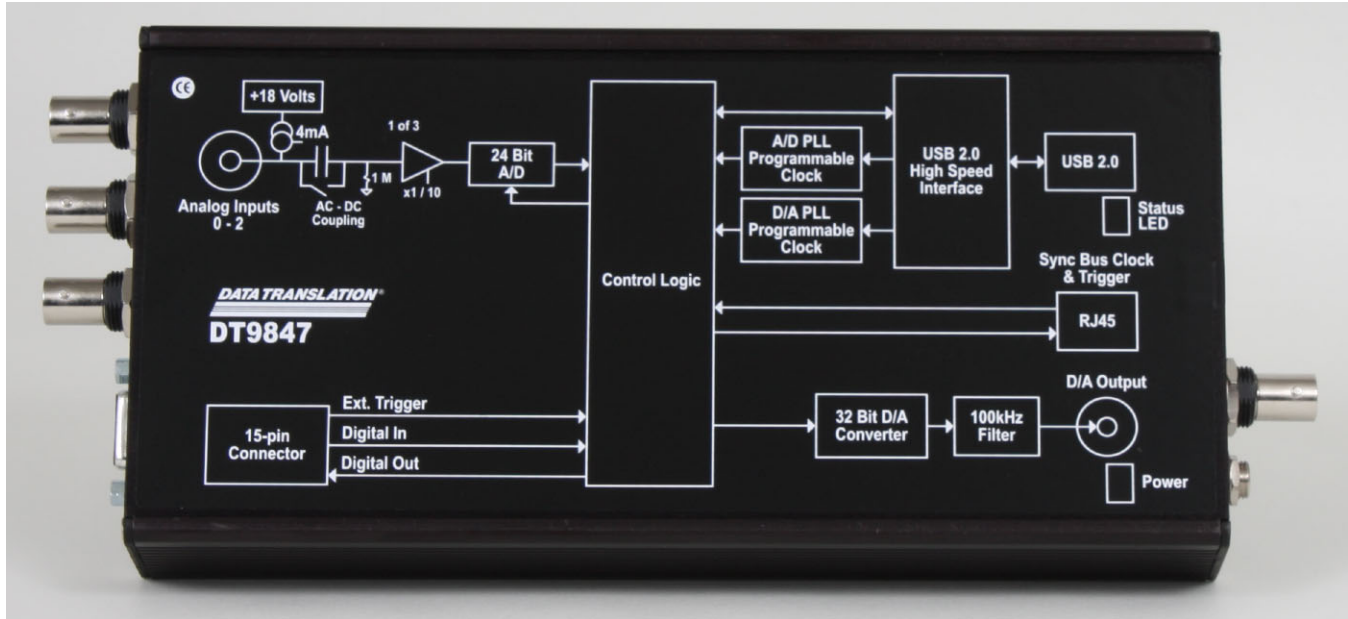


Figure 1: DT9847-3-1 Module

Table 1 lists the major differences between the modules.

Table 1: Major Differences Between the DT9847 Series Modules

Feature	DT9847-1-1	DT9847-2-2	DT9847-3-1
Number of Analog Input Channels	1	2	3
Number of Analog Output Channels	1	2	1
Power	USB Power ^a	External Power ^b	External Power ^b

a. Using USB-Y cable.

b. Using a 5 V to 24 V external power supply at 5 W.

Key Features of the DT9847-1-1

The key features of the DT9847-1-1 module are as follows:

- Simultaneous analog input and waveform analog output operations
- Operates on internal USB power using a USB-Y cable
- Analog input subsystem:
 - One 24-bit A/D converter
 - Throughput rate from 1 kSamples/s to 216 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 18 V compliance voltage for AC or DC coupling
 - 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, or a positive- or negative-going analog threshold trigger. For the threshold trigger, you can program the threshold value from -10 V to $+10$ V.
 - For the reference trigger, supports an external digital trigger or a positive- or negative-going analog threshold trigger. You can program the threshold value from -10 V to $+10$ V.
- Analog output subsystem:
 - One 32-bit D/A converter
 - Single value, waveform, and continuous streaming output
 - Programmable output rate from 30 kSamples/s to 216 kSamples/s
 - Output range of ± 3 V or ± 10 V, software-programmable
 - Software-programmable trigger source (software trigger or external digital trigger) to start the analog output operation
- Internal clock source (shared between the analog input and analog output subsystems)
- Four digital input lines and 4 digital output lines
- Sync Bus (RJ45) connector for synchronizing acquisition on up to four DT9847 Series modules

Key Features of the DT9847-2-2

The key hardware features of the DT9847-2-2 module are as follows:

- Simultaneous analog input and analog output operations (continuous or waveform mode)
- Operates on external USB power
- Analog input subsystem:
 - Two, simultaneous 24-bit A/D converters
 - Throughput rate from 1 kSamples/s to 216 kSamples/s for simultaneous, high-resolution measurements
 - 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 18 V compliance voltage for AC or DC coupling
 - 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, or a positive- or negative-going analog threshold trigger on any of the analog input channels). For the threshold trigger, you can program the threshold value from -10 V to $+10$ V.
 - For the reference trigger, supports an external digital trigger or a positive- or negative-going analog threshold trigger on any of the analog input channels. You can program the threshold value from -10 V to $+10$ V.
- Analog output subsystem:
 - Two 32-bit D/A converters
 - Single value, waveform, and continuous streaming output
 - Programmable output rate from 30 kSamples/s to 216 kSamples/s
 - Output range of ± 3 V or ± 10 V, software programmable
 - Software-programmable trigger source (software trigger or external digital trigger) to start the analog output operation
- Internal clock source (shared between the analog input and analog output subsystems)
- Sync Bus (RJ45) connector for synchronizing acquisition on up to four DT9847 Series modules
- Requires use of an external +5 VDC to +24 VDC power supply

Key Features of the DT9847-3-1

The key hardware features of the DT9847-3-1 module are as follows:

- Simultaneous analog input and analog output operations (continuous or waveform mode)
- Operates on external USB power
- Analog input subsystem:
 - Three, simultaneous 24-bit A/D converters
 - Throughput rate from 1 kSamples/s to 216 kSamples/s for simultaneous, high-resolution measurements
 - 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 18 V compliance voltage for AC or DC coupling
 - 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, or a positive- or negative-going analog threshold trigger on any of the analog input channels). For the threshold trigger, you can program the threshold value from -10 V to $+10$ V.
 - For the reference trigger, supports an external digital trigger or a positive- or negative-going analog threshold trigger on any of the analog input channels. You can program the threshold value from -10 V to $+10$ V.
- Analog output subsystem:
 - One 32-bit D/A converter
 - Single value, waveform, and continuous streaming output
 - Programmable output rate from 30 kSamples/s to 216 kSamples/s
 - Output range of ± 3 V or ± 10 V, software programmable
 - Software-programmable trigger source (software trigger or external digital trigger) to start the analog output operation
- Internal clock source (shared between the analog input and analog output subsystems)
- Sync Bus (RJ45) connector for synchronizing acquisition on up to four DT9847 Series modules
- Requires use of an external +5 VDC to +24 VDC power supply

Supported Software

The DT Omni installer includes the following software for use with the DT9847 Series modules:

- **DT9847 Series Device Driver** – The DT9847 Series Device Driver allows you to use a DT9847 Series module with any of the supported software packages or utilities.
- **DT9847 Series Calibration Utility** – This utility, described in [Chapter 8](#) starting on [page 105](#), allows you to calibrate the analog input and analog output circuitry of a DT9847 Series module.
- **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 DT9847 Series 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 DT9847 Series module using Visual Studio 2003-2012; the class library complies with the DT-Open Layers standard.
- **DataAcq SDK** – Use the Data Acq SDK if you want to use Visual Studio 6.0 and Microsoft C or C++ to develop your own application software for a DT9847 Series module using Windows Vista, Windows 7, or Windows 8; the DataAcq SDK complies with the DT-Open Layers standard.
- **DAQ Adaptor for MATLAB** – A link to the DAQ Adaptor for MATLAB is included from the DT Omni installer. 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 from the DT Omni installer. Use LV-Link if you want to use the LabVIEW graphical programming language to access the capabilities of the DT9847 Series module.

Refer to the web site www.mccdaq.com for information about selecting the right software package for your needs.

Supported Accessories

The following optional accessories are available for the DT9847 Series:

- **STP15 screw terminal panel** – A screw terminal panel that accepts digital input signals and an external trigger input signal and provides connections for digital output signals.

The 15-pin, 2-meter, EP337 cable is included with the STP15 screw terminal panel. The EP337 cable allows you to attach the STP15 screw terminal panel to the Digital I/O and External Trigger connector on a DT9847 Series module.

Figure 3 shows the STP15 and EP337 cable.



Figure 2: STP15 Screw Terminal Panel and EP337 Cable

- **EP386 panel** – The EP388 panel, shown in [Figure 3](#), contains four RJ45 connectors that are wired in parallel, making it useful when attaching up to four DT9847 Series modules together using the Sync Bus connector. Refer to [page 79](#) for more information on using this panel.

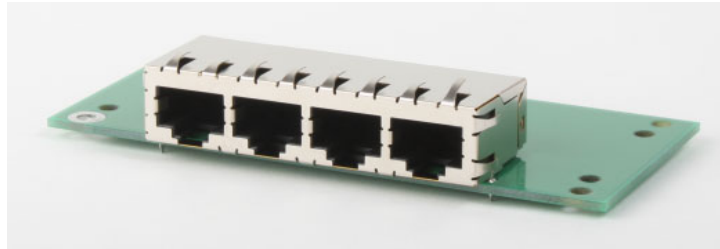


Figure 3: EP386 Panel

- **BNC DIN Rail Kit** – The BNC DIN Rail Kit, shown in [Figure 4](#), allows you to mount USB modules that are packaged in metal boxes in a DIN rail. The kit includes mounting clips, screws, and instructions. The rail is not included.

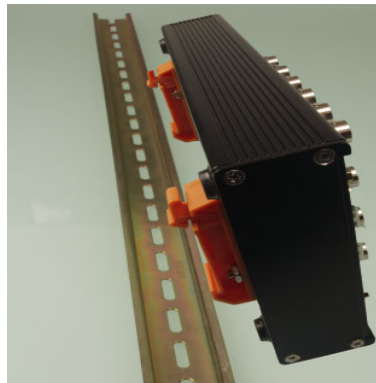


Figure 4: BNC DIN Rail Kit

Getting Started Procedure

The flow diagram shown in [Figure 5](#) illustrates the steps needed to get started using a DT9847 Series 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.

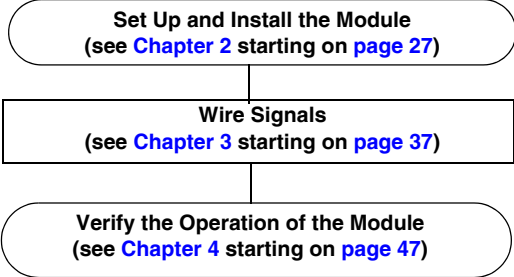


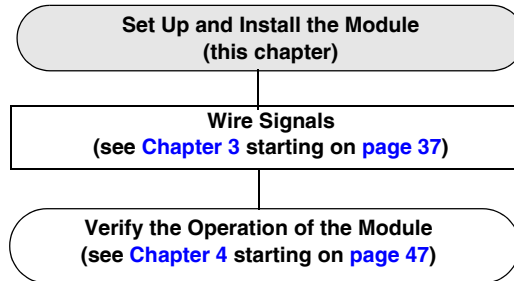
Figure 5: Getting Started Flow Diagram

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:

- DT9847-1-1, DT9847-1-1-OEM, DT9847-2-2, DT9847-2-2-OEM, DT9847-3-1, or DT9847-3-1-OEM module
- If you ordered a DT9847-1-1 or DT9847-1-1-OEM module, the EP399 USB-Y cable is included. Optionally, you can use a +5 V external power supply (not included) to power the DT9847-1-1-OEM module.

CAUTION:

Ensure that the maximum voltage of the external supply is +5 V \pm 0.30 V. @ 600 mA. Higher voltages will destroy the DT9847-1-1-OEM module.

- If you ordered a DT9847-2-2 or DT9847-3-1 module, the EP365 USB cable and EP394 +5 V external power supply are included.
- If you ordered a DT9847-2-2-OEM or DT9847-3-1-OEM module, the EP365 USB cable is included. To power the module, you must use a 5 V to 24 V external power supply (not included).

If an item is missing or damaged, contact Data Translation. If you are in the United States, call the Customer Service Department at (508) 956-5100. 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 (see www.mccdaq.com for more information).

Note: The DT9847 Series 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 DT9847-1-1 module runs on USB power and does not use an external power supply. The DT9847-2-2 and DT9847-3-1 modules require an external power supply and are shipped with an EP394 +5V power supply and cable.

Note: If you are using the OEM version of a DT9847 Series module, refer to [Appendix C](#) starting on [page 133](#) for information on powering the module.

To apply power to the module, do the following:

1. Connect the EP394 +5 V power supply to the external power connector on the DT9847 Series module. Refer to [Figure 6](#).

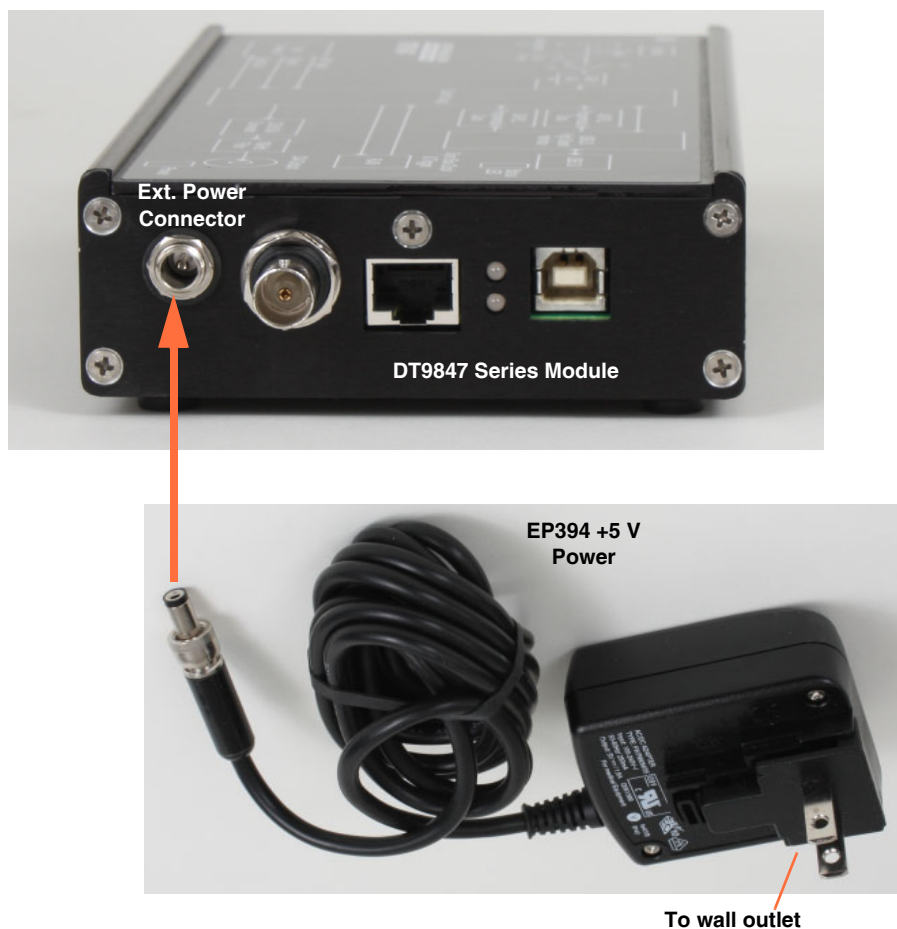


Figure 6: Attaching a +5 V Power Supply to the DT9847 Series Module

2. Plug the power supply into a wall outlet.

Attaching Modules to the Computer

This section describes how to attach a DT9847 Series module to the host computer.

Note: Most computers have several USB ports that allow direct connection to USB devices. If your application requires more DT9847 Series 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 34](#).

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.

The DT9847 Series modules use less than 500 mA; therefore, they do not require an external power supply.

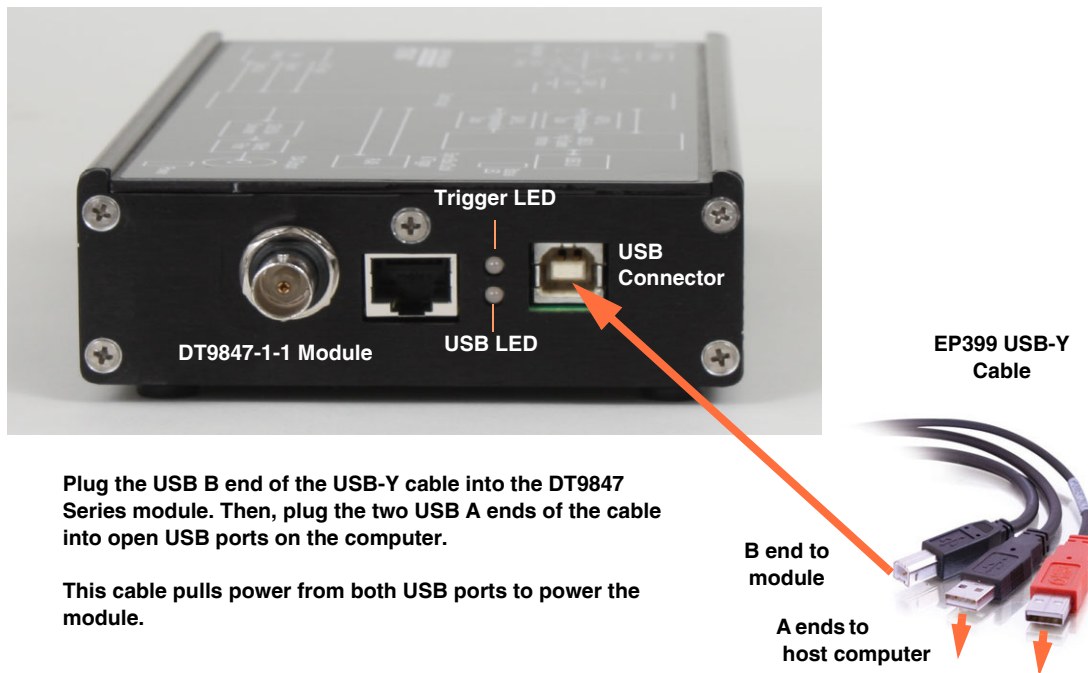
You must install the device driver for your module before connecting the module(s) to the host computer. Run the DT Omni software to install the device driver and other software for the module.

Connecting Directly to the USB Ports

To connect a DT9847 Series module directly to a USB port on your computer, perform the following steps:

1. Attach one end of the USB cable to the USB port on the module and the other end to the USB port on your host computer.

If you are using the DT9847-1-1, use the EP399 USB-Y cable to connect the module to two USB ports on the host computer, as shown in [Figure 7](#).



Plug the USB B end of the USB-Y cable into the DT9847 Series module. Then, plug the two USB A ends of the cable into open USB ports on the computer.

This cable pulls power from both USB ports to power the module.

Figure 7: Attaching the DT9847-1-1 Module to the Host Computer

Once the module is connected to the host computer, the operating system automatically detects the USB module and starts the Found New Hardware wizard.

2. *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.

3. Repeat these steps to attach another DT9847 Series module to the host computer, if desired.

Note: Once you have connected your module to the host computer, power is turned on to the module when your application program opens the module. The USB LED on the module turns green to indicate that power is turned on.

Power is turned off to the module when your application program terminates its connection to the module.

Connecting to an Expansion Hub

Expansion hubs are powered by their own external power supply. The practical number of DT9847 Series modules that you can connect to a single USB port depends on the throughput you want to achieve.

To connect multiple DT9847 Series modules to an expansion hub, do the following:

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

If you are using the DT9847-1-1, use the EP399 USB-Y cable to connect the module to two USB ports on the expansion hub, as shown in [Figure 8](#).

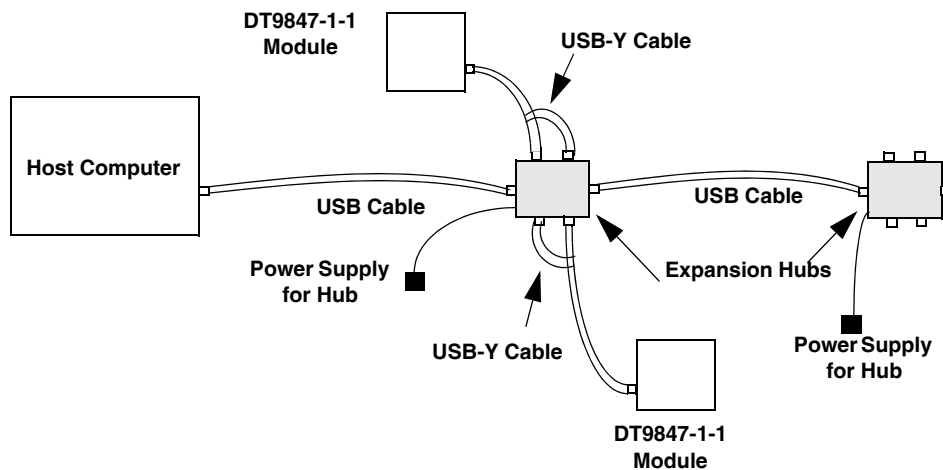


Figure 8: Attaching Multiple DT9847-1-1 Modules Using Expansion Hubs

2. Connect the power supply for the expansion hub to an external power supply.
3. Connect the expansion hub to the USB port on the host computer using another USB cable. [Figure 9](#) shows how to attach DT9847-2-2 and DT9847-3-1 modules to an expansion hub.

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

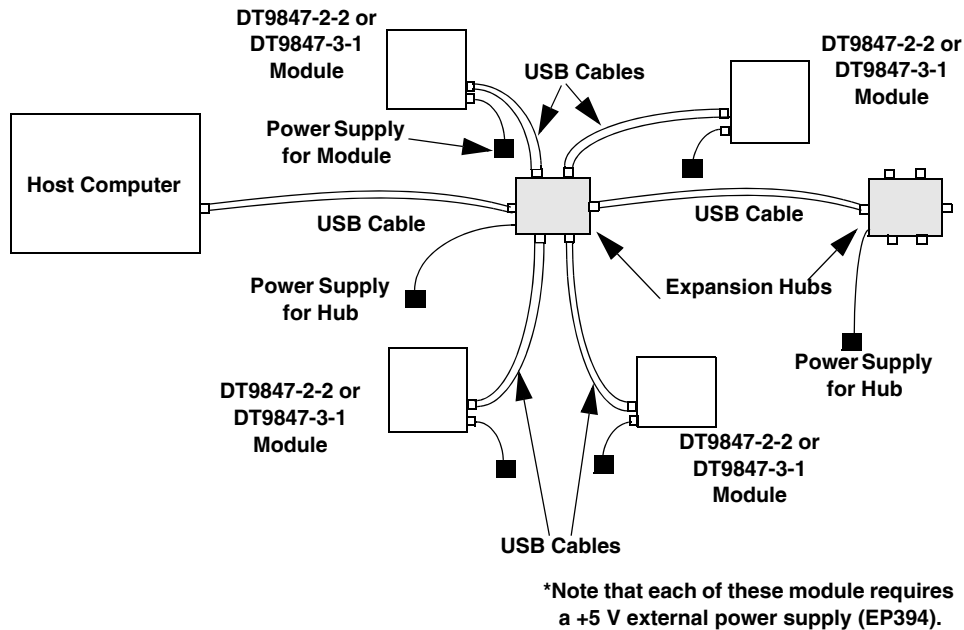


Figure 9: Attaching Multiple DT9847-2-2 and DT9847-3-1 Modules Using Expansion Hubs

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 until you have attached the number of expansion hubs and modules that you require.
The operating system automatically detects the USB devices as they are installed.

Note: Once you have connected your module to the host computer, power is turned on to the module when your application program opens a connection to the module. The LED on the module turns green to indicate that power is turned on.

Power is turned off to the module when your application program terminates its connection to the module.

Configuring the DT9847 Series Device Driver

Note: In Windows, 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 (32-bit)

C:\Windows\System32\Dtolcpl.cpl

Windows (64-bit)

C:\Windows\SysWOW64\Dtolcpl.cpl

To configure the device driver for a DT9847 Series 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.

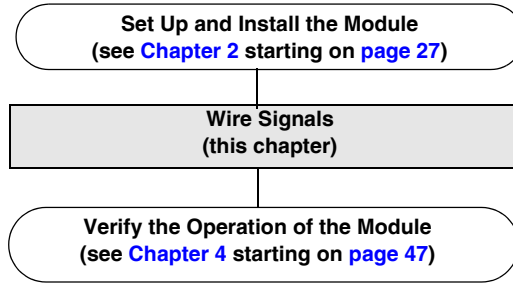
Note: If you enable the use of the internal excitation current source, it is recommended that you choose AC coupling. Refer to [page 40](#) for more information on wiring IEPE inputs.

8. When you are finished, click **OK** to close the Measurement Options dialog box.
9. Repeat steps 4 to 8 for the other modules that you want to configure.
10. When you are finished configuring the modules, click **Close** to close the Control Panel.



Wiring Signals

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Connecting an Analog Output Signal	41
Connecting Digital I/O Signals	43



Preparing to Wire Signals

This section provides recommendations and information about wiring signals to a DT9847 Series module.

Wiring Recommendations

Keep the following recommendations in mind when wiring signals to a DT9847 Series 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 DT9847 Series is ideal for acoustic measurements due to its AC coupling and frequency characteristics. It is not designed for DC stability; therefore, ensure that you allow the module to warm up for 15 minutes before use.

Wiring Signals to the Module

Figure 10 shows the connectors on the DT9847-3-1 module. Note that the DT9847 has only one analog input connector and one analog output connector, while the DT9847-2-2 has two analog input connectors and two analog output connectors, and the DT9847-3-1 has three analog input connectors and one analog output connector. The remaining sections of this chapter describe how to attach signals to these connectors.

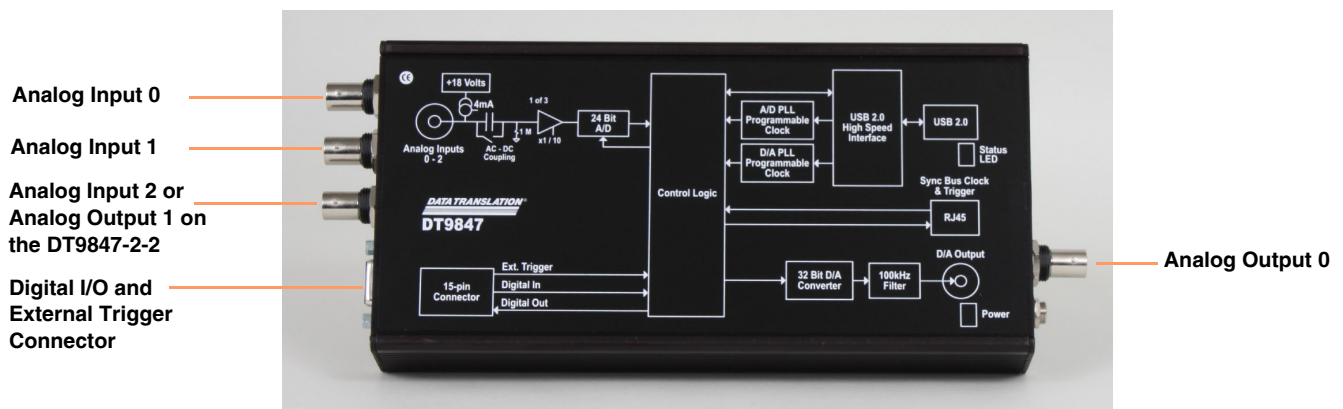


Figure 10: Connectors on the DT9847 Series Module

Connecting Analog Input Signals

For the DT9847-1-1 module, you can connect one analog input signal (or IEPE sensor) to the BNC connector on the module. For the DT9847-2-2 module, you can connect up to two analog input signals (or IEPE sensors) to the BNC connectors on the module. For the DT9847-3-1 module, you can connect up to three analog input signals (or IEPE sensors) to the BNC connectors on the module. Internally, these signals are connected in single-ended mode. The DT9847 Series 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 64](#) for more information on IEPE inputs.

[Figure 11](#) shows how to connect an analog input signal (channel 0, in this case) to a BNC connector on the DT9847 Series module.

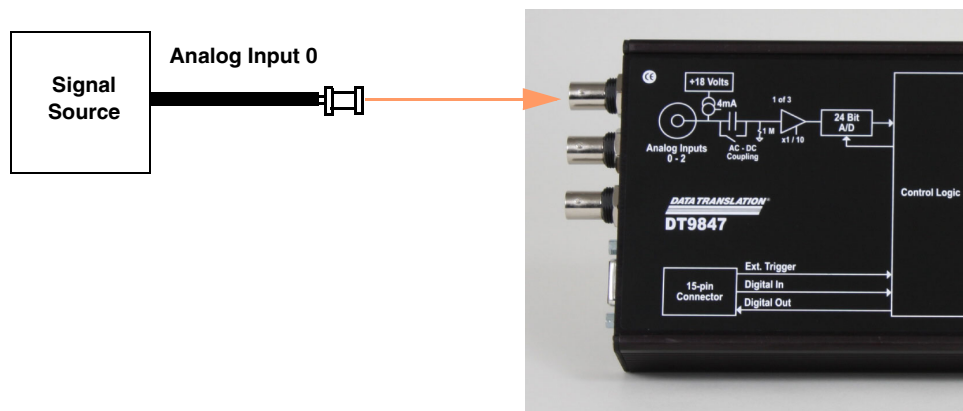


Figure 11: Connecting Analog Inputs to a DT9847 Series Module

Connecting an Analog Output Signal

The DT9847-1-1 and DT9847-3-1 modules provide one analog output channel. The DT9847-2-2 modules provides two analog input channels. The output channels have an output range of ± 3 V.

Figure 12 shows how to connect an analog output signal to the DT9847-1-1 or DT9847-3-1 module.

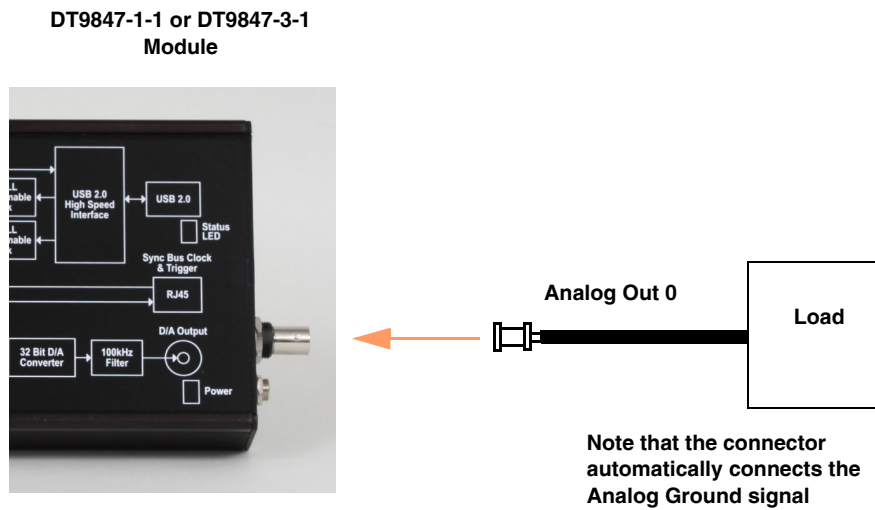


Figure 12: Connecting an Analog Output Signal to the DT9847-1-1 or DT9847-3-1 Module

Figure 13 shows how to connect analog output signals to the DT9847-2-1 module.

DT9847-2-2 Module

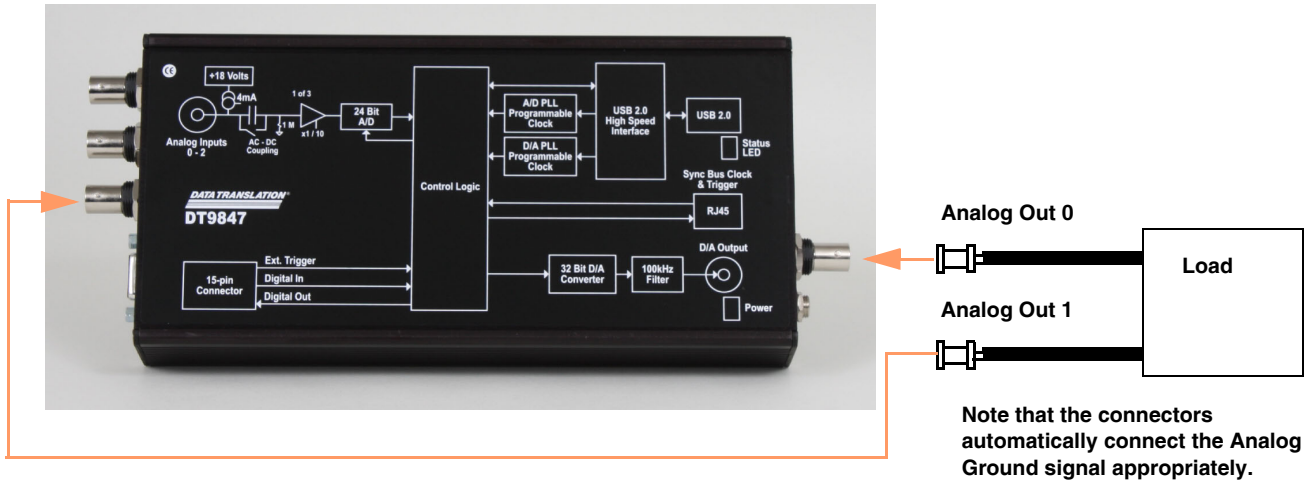


Figure 13: Connecting Analog Output Signals to the DT9847-2-2 Module

Connecting Digital I/O Signals

Figure 14 shows the layout of the 15-pin Digital I/O and External Trigger connector on the DT9847 Series modules.

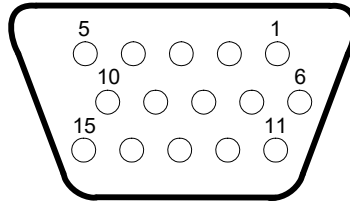


Figure 14: Layout of the Digital I/O and External Trigger Connector

To make wiring easier, connect the STP15 screw terminal panel to the Digital I/O and External Trigger connector on the DT9847 module as shown in Figure 15.

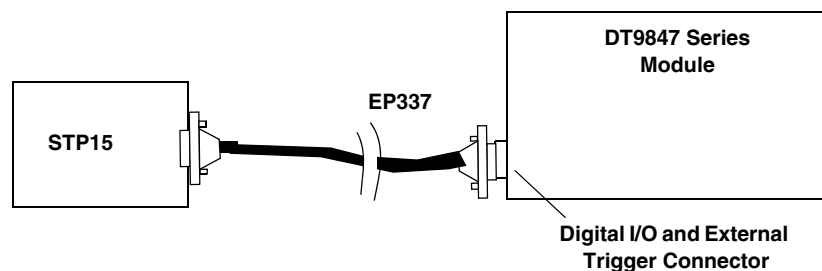
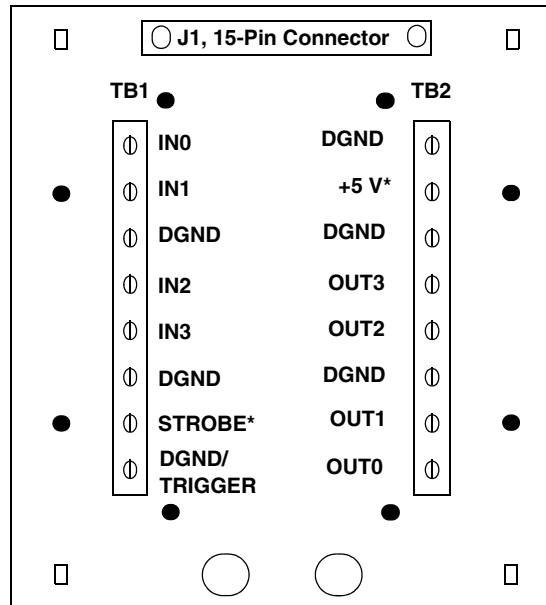


Figure 15: Connecting the STP15 to the DT9847 Series Module

The STP15 contains one 15-pin connector and two screw terminal blocks (TB1 and TB2). The 15-pin connector provides access to the signals from the Digital I/O and External Trigger connector on the DT9847 module. Figure 16 shows the layout of the STP15 and lists the screw terminal assignments.



*These signal are not used on the DT9847 Series modules.

Figure 16: Layout of the STP15 Screw Terminal Panel

IN refers to digital input signals, OUT refers to digital output signals, DGND refers to digital ground signals, and TRIGGER refers to the external trigger signal. STROBE and +5 V are not used on the DT9847 Series modules.

Figure 17 shows how to connect digital input signals (lines 0 and 1, in this case) to terminal block TB1 of the STP15 screw terminal panel.

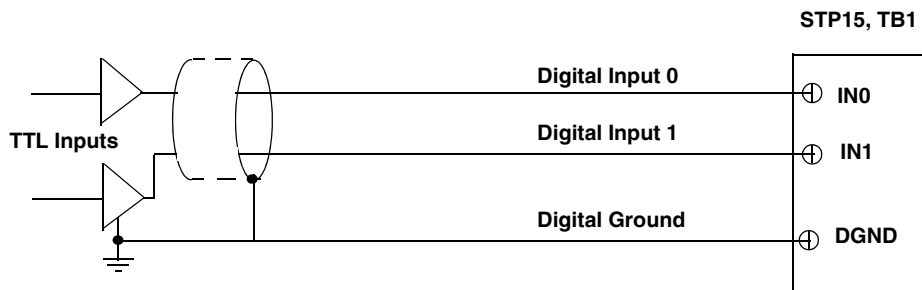
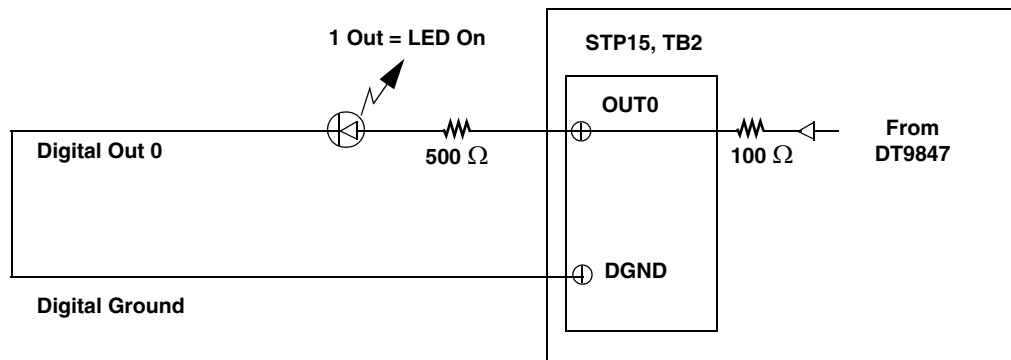


Figure 17: Connecting Digital Inputs to the STP15 Screw Terminal Panel

Figure 18 shows how to connect a digital output (line 0, in this case) to terminal block TB2 of the STP15 screw terminal panel.



The output current is determined using the following equation:

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

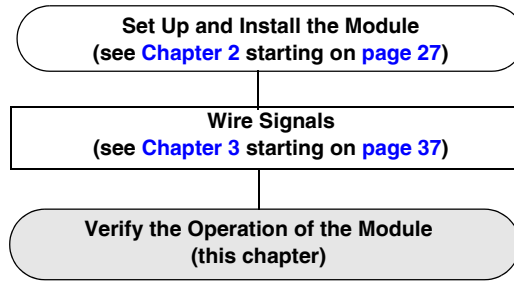
In this example, if the maximum output voltage is 3.3 V, the internal resistor is 100 Ω and the external resistor is 500 Ω, the maximum output current is 5.5 mA. Using the minimum output voltage of 2.0 V with the same resistor values, the minimum current output current is 3.3 mA

Figure 18: Connecting Digital Outputs to the STP15 Screw Terminal Panel



Verifying the Operation of a Module

Select the Device	49
Acquire Data from an Analog Output Channel	52



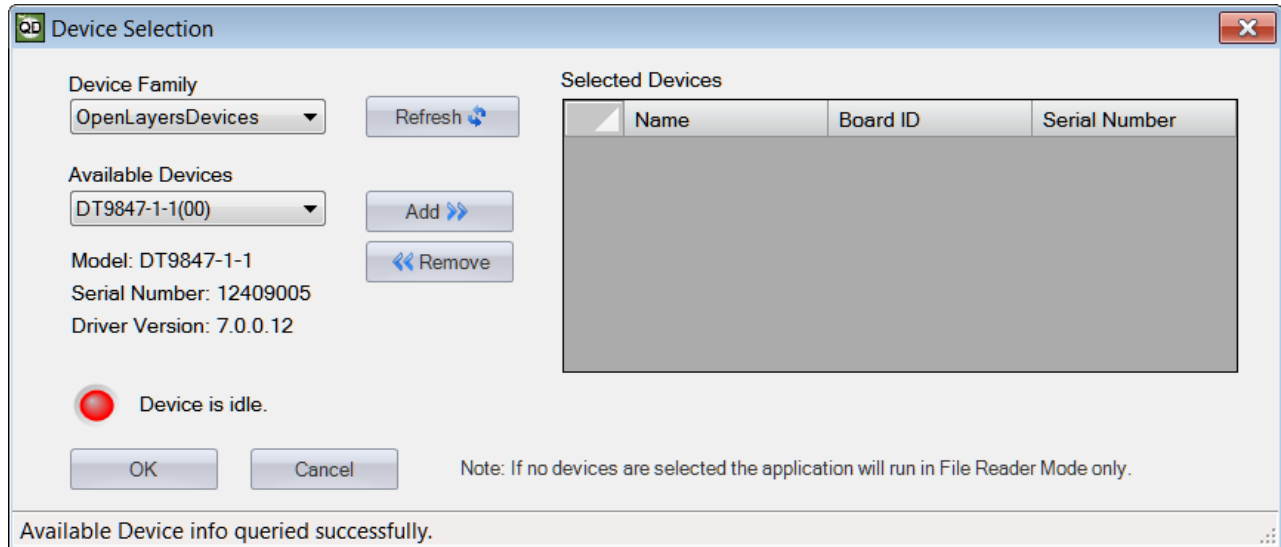
You can verify the operation of a DT9847 Series module using the QuickDAQ application.

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 DT9847 Series module using the QuickDAQ base version.

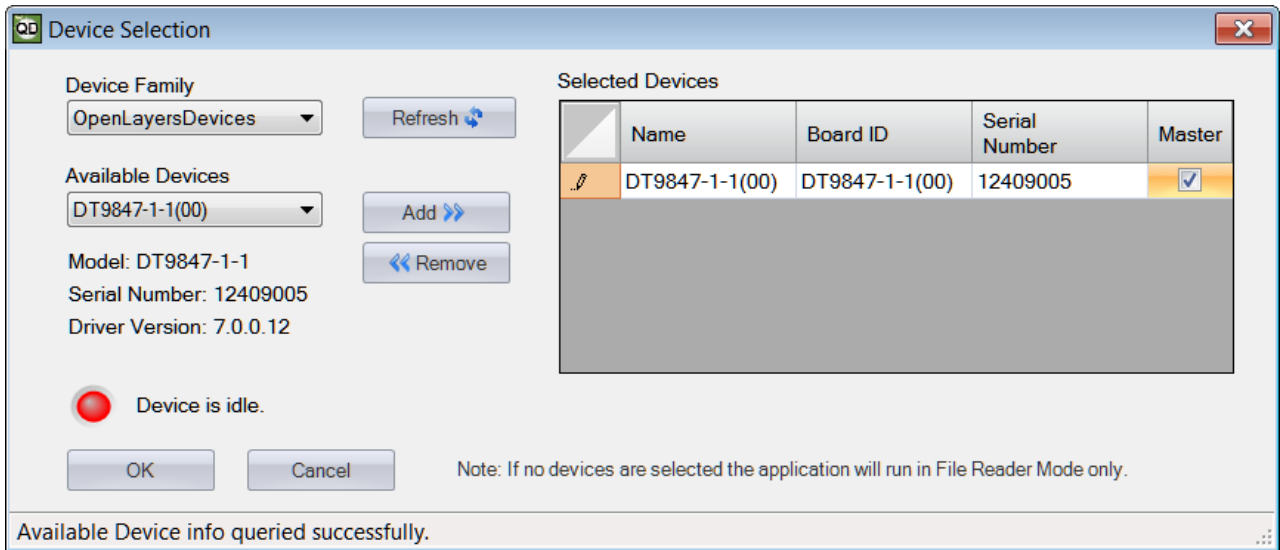
Select the Device

To get started with your DT9847 Series module and the QuickDAQ application, follow these steps:

1. Connect the DT9847 Series 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 DT9847 Series 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. If you want to rename your device, do the following:
 - a. Click the Row Selector button for the device.
 - b. Click the IP address or module name in the **Name** column to highlight it and enter a meaningful name to represent each available device.
6. If you are using multiple devices, you must configure one device as the clock and trigger master, as follows:
 - a. Click the Row Selector button for the device that you want to be the clock and trigger master.
 - b. For the clock and trigger master device, check the box under the **Master** column.

Note: Only one device can be the clock and trigger master. If you are using a single device, the application automatically configures the device as the master.

DT9847 Series modules support that capability of synchronizing up to four devices. If you are using more than one of these devices, ensure that you connect the devices together using network cables and the Sync Bus (RJ45) connector on each device. Then, configure one device as the master and the other devices as slaves. The software automatically drives out the appropriate clock and trigger signals. Refer to [page 79](#) for more information on synchronizing devices.

7. (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**.
8. 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:** Contains settings for filename generation (Filename-Sequence, Start # 1), filename base (QuickDAQ Data), and acquisition duration (00:00:00:10). It also shows X Axis Span (00:00:00:10) and a note to press the Record button to start recording data to disk.
- Plot and Data Config Panel:** Features a table for channel configuration:

Channel Name	Visible Plot	Visible Isople	Visible Statistics	Show Cursor	Plot Column	Signal Group
DT9847-1-1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1	N...

 Below the table are controls for plotting performance, including plot update rate (1 update per second), smooth scrolling, and disabling plotting during acquisition. Time domain X axis units are set to Relative time, and the time scale is 12 Hour. A plot height slider is also present.
- Channel Plot Panel:** Shows a plot titled "Test Data" with a y-axis ranging from -10.00 to 10.00 and an x-axis ranging from 00:00:00.000 to 00:00:09.000. The plot area is currently empty, indicating no data has been recorded yet.
- Acquisition Status Panel:** Located at the bottom right, it shows the 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 3 V sine wave is output on analog output channel 0 of a DT9847-1-1 module. The analog output channel is connected to analog input channel 0 on the DT9847-1-1 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.

The screenshot shows the 'Acquisition Config' window with the 'Output' tab selected. The window contains a table for channel configuration and several sections for waveform and timing settings.

Enable	Channel Name	Waveform	Peak Voltage	Offset
<input checked="" type="checkbox"/>	DT9847-1-1(00...	Fixed	3	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

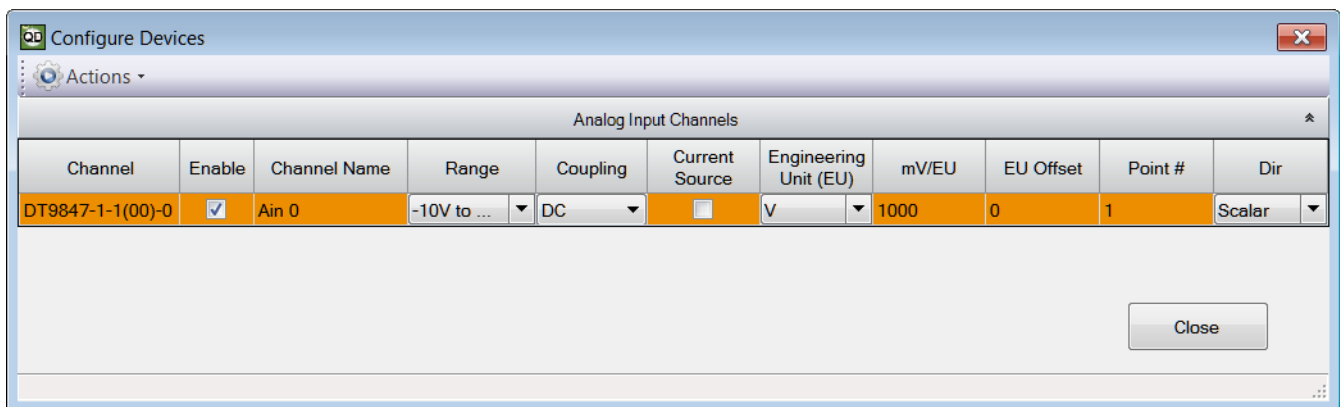
Buttons: [Speaker icon] [Start]

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 3 to output a ± 3 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.



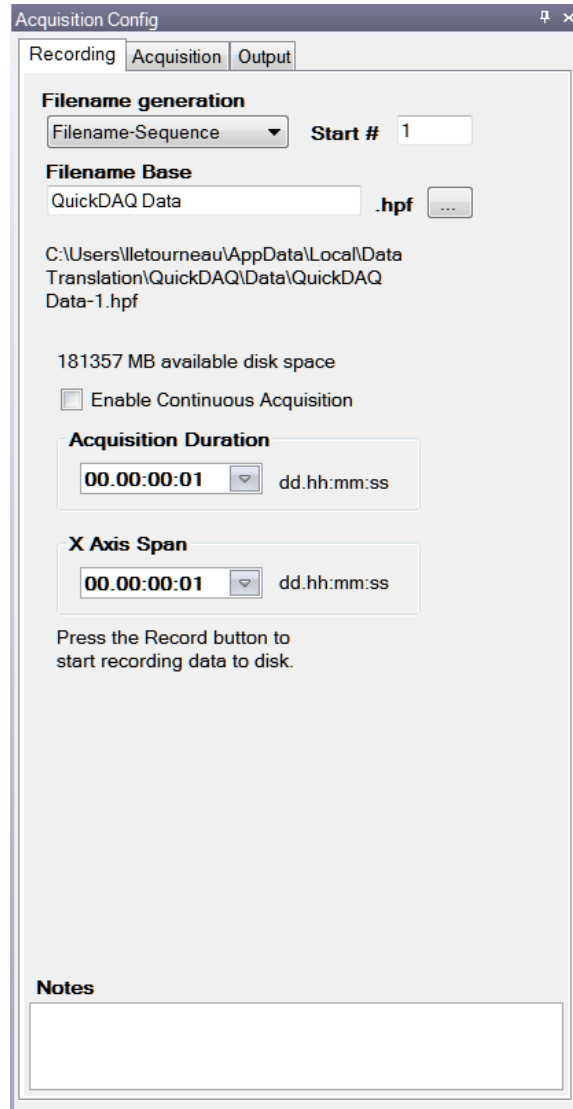
4. Under the **Channel Name** column, leave the default channel name as Ain 0.
5. Under the **Range** column, select the input range for analog input channel.
In this example, ± 10 V is used.
6. Under the **Coupling** column, select the coupling type (AC or DC) for your sensor.
Since this example is monitoring a voltage input, DC is used.

7. 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.*
8. Under the **Engineering Units** column, select the engineering units for the input.
*In this example, **V** is used.*
9. Enter the number of mV per engineering unit in the **mV/EU** field.
*In this example, **1000** is used.*
10. If an offset is specified for the input, enter the value in the **EU Offset** field.
*In this example, no offset (**0**) is specified.*
11. If desired, enter a test point value for the channel.
*In this example, **0** is used.*
12. If desired, enter a sensor direction for each channel.
*In this example, **Scalar** is used.*
13. 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.

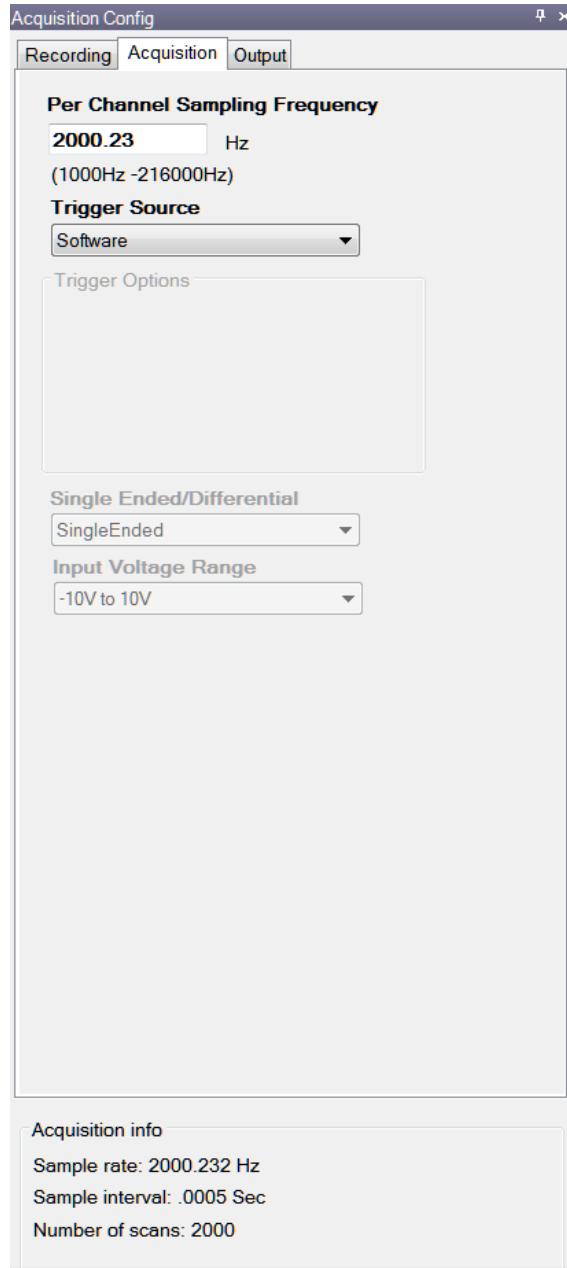


2. For **Filename generation**, use the default **Filename** option.
3. For **Filename**, use the default name for the data file.
4. Leave the **Enable Continuous Acquisition** checkbox unchecked.
5. For **Acquisition Duration**, select **1 second**.
The number of seconds for the total run and the amount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

Configure the Acquisition Settings

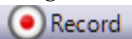
For this example, configure the acquisition settings as follows:

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

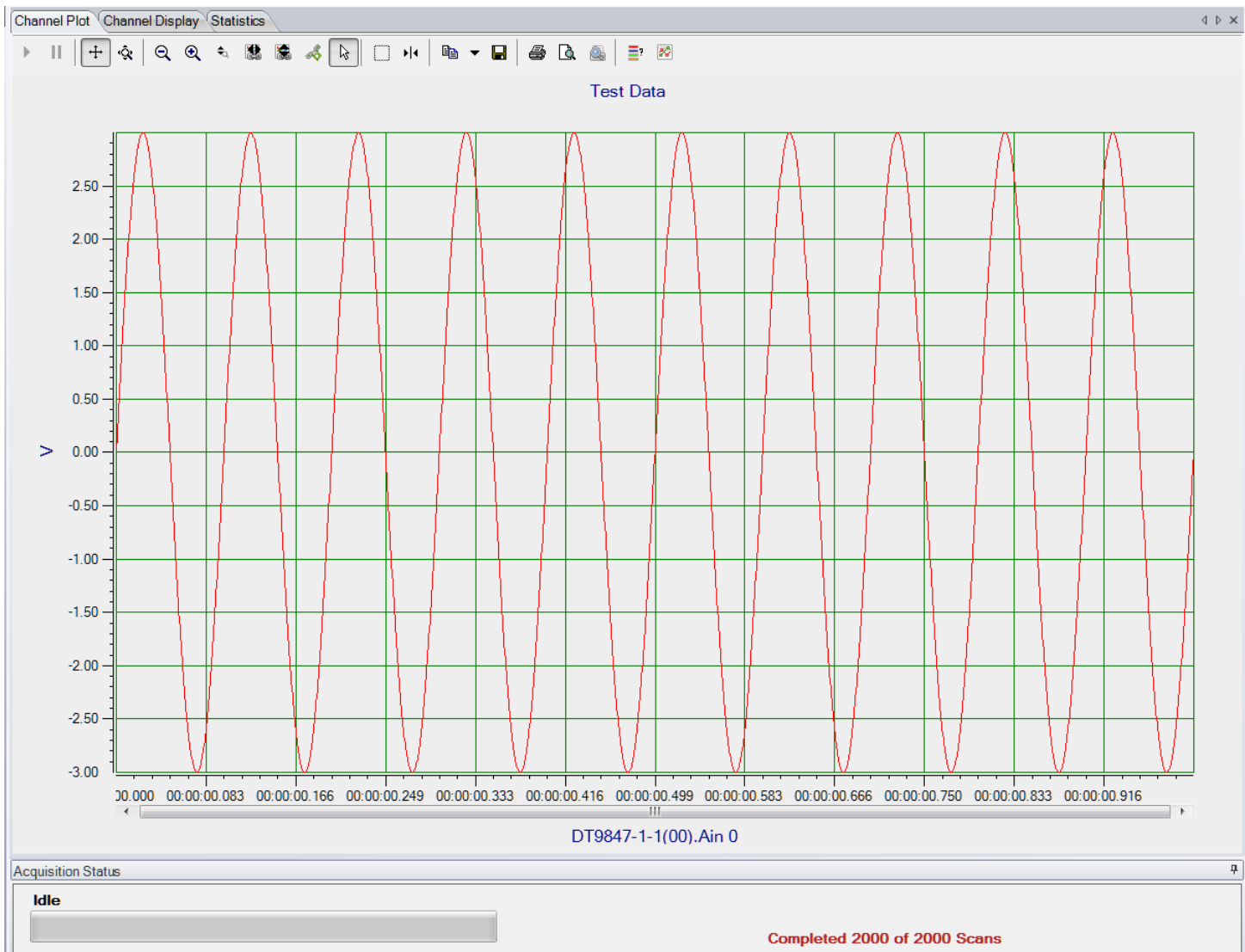


2. For the **Per Channel Sampling Frequency** text box, enter **2000**.
The application snaps the value to closest sampling frequency. The sampling rate, sample interval, and number of scans are displayed.
3. For the **Trigger Source** check box, select **Software** to ensure that the measurement starts 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

Analog Input Features	64
Analog Output Features	72
Digital I/O Features	77
Triggering Acquisition on Multiple Modules	78
Synchronizing Acquisition on Multiple DT9847 Series Modules	79

Figure 19 shows a block diagram of the DT9847-1-1 module.

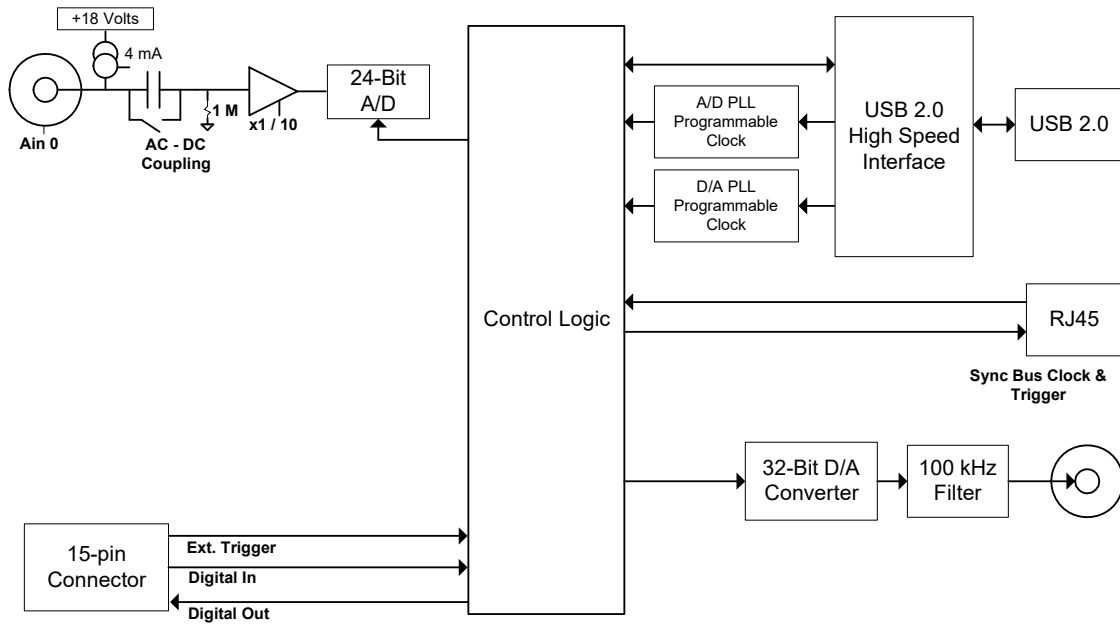


Figure 19: Block Diagram of the DT9847-1-1 Module

Figure 20 shows a block diagram of a DT9847-2-2 module.

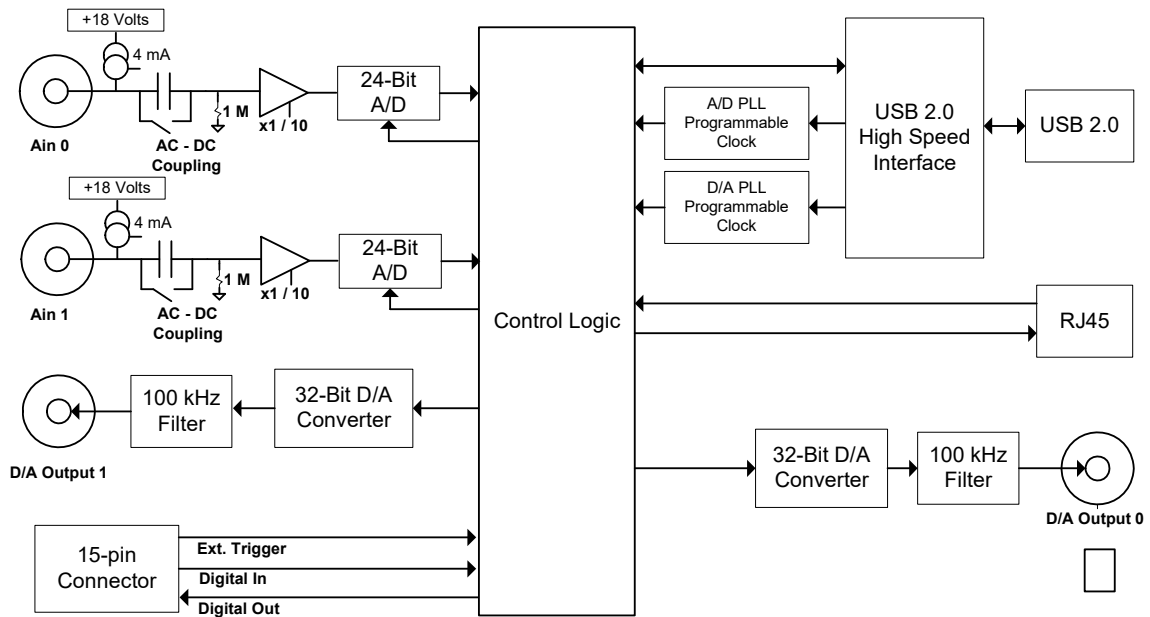


Figure 20: Block Diagram of the DT9847-2-2 Module

Figure 21 shows a block diagram of the DT9847-3-1 module.

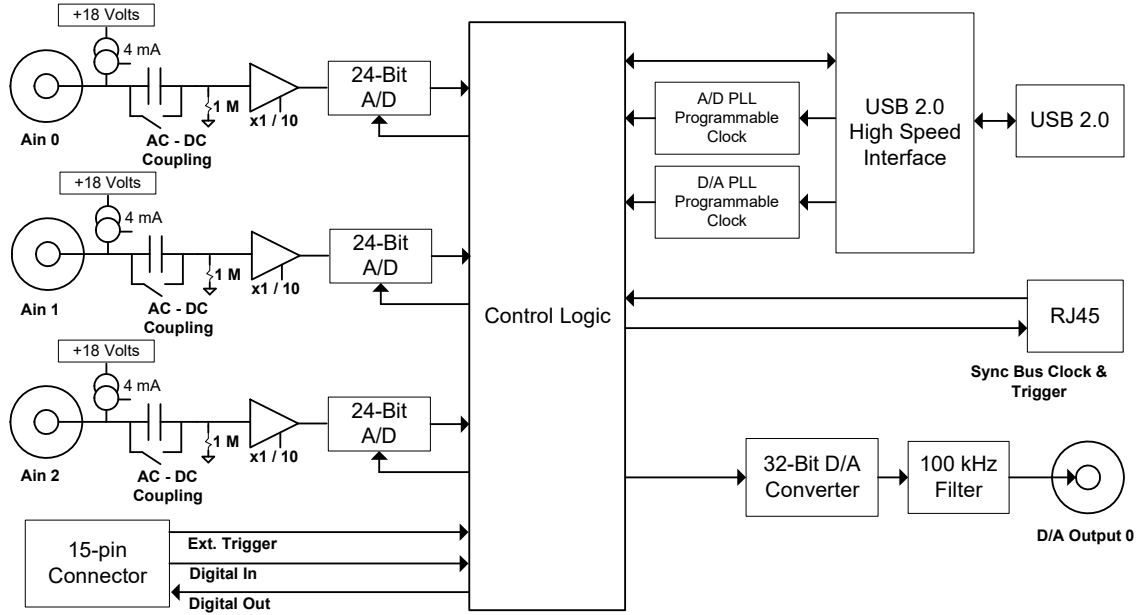


Figure 21: Block Diagram of the DT9847-3-1 Module

Analog Input Features

This section describes the following features of analog input (A/D) subsystem on the DT9847 Series modules:

- Analog input channels, described on this page
- IEPE functions, described on [page 65](#)
- Input resolution, described on [page 65](#)
- Input ranges and gains, described on [page 64](#)
- Input sample clock sources, described on [page 65](#)
- Analog input conversion modes, described on [page 66](#)
- Input triggers, described on [page 69](#)
- Data format and transfer, described on [page 71](#)
- Error conditions, described on [page 71](#)

Analog Input Channels

The DT9847-1-1 module provides one analog input channel (channel 0), the DT9847-2-2 provides two analog input channels (channels 0 and 1), and the DT9847-3-1 provides three analog input channels (channels 0 to 2). These are signal-ended channels; you can connect IEPE sensors to these inputs, if desired; refer to [page 65](#) for more information on IEPE functions.

Note: To maintain simultaneous operation, all analog input connections on the DT9847 Series modules must have the same lead lengths.

The DT9847 Series 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 (for the DT9847-2-2 and DT9847-3-1), or multiple values from a one or more analog input channels. Refer to “[Analog Input Conversion Modes](#)” on [page 66](#) for more information on specifying and reading data from these channels.

Input Ranges and Gains

The DT9847 Series 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 DT9847 Series modules. The modules support the following software-programmable IEPE functions for each analog input channel:

- Excitation current source – The DT9847 Series 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 DT9847 Series modules.

For information on wiring IEPE inputs, refer to [page 40](#).

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 DT9847 Series 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 operations and to start the sample clock. The sampling frequency ranges from 1 kHz to 216 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 216 kHz). However, the subsystems are not designed to be synchronous with each other.

Once the sample clock is started, the module requires 63 conversions before the first A/D sample is valid. The valid sample is aligned with the A/D trigger.

On the DT9847 Series, the sampling frequency is generated by a programmable clock chip rather than a divider off the reference clock for better flexibility and accuracy.

Configuration Delay

Due to the design of the A/D converter on the DT9847 Series, you may notice a delay after you configure the sampling frequency on the module (when the Config command is called). The delay is more significant at slower sampling frequencies.

The configuration delay is determined as follows:

- Sampling rate \leq 50 kHz:
Configuration delay = 8719 Samples/Sampling rate
- Sampling rate \leq 100 kHz:
Configuration delay = 17423 Samples/Sampling rate
- Sampling rate \leq 216 kHz:
Configuration delay = 34831 Samples/Sampling rate

For example, if you specify a sampling frequency of 1 kHz (sampling rate is 1 kSamples/s), the delay after you configure the sampling rate is 8.719 s, determined as follows:

$$8719 \text{ Samples}/1 \text{ kSamples/s} = 8.719 \text{ s}$$

Similarly, if you specify a sampling frequency of 216 kHz (sampling rate is 216 kSamples/s), the delay after you configure the sampling rate is 0.161 s, determined as follows:

$$34831 \text{ Samples}/216 \text{ kSamples/s} = 0.161 \text{ s}$$

Analog Input Conversion Modes

DT9847 Series modules support single-value, single-values, and continuous scan conversion modes. 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 DT9847-1-1, specify channel 0; for the DT9847-2-2, specify channel 0 or 1; for the DT9847-3-1, specify channel 0, 1, or 2. The module acquires the data from the specified channel and returns the data immediately.

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

Single-Values Operations

For the DT9847-2-2 or DT9847-3-1 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 source, trigger source, scan mode, or buffer. Single-values operations stop automatically when finished; you cannot stop a single-values operation.

Continuous Scan Mode

Continuous scan mode takes full advantage of the capabilities of the DT9847 Series modules. You can specify a channel list, clock source, start trigger, reference trigger, post-trigger scan count, and buffer using software.

On the DT9847-1-1 module, you can enter up to one entry in the channel list (analog input channel 0). On the DT9847-2-2 module, you can enter up to two entries in the channel list (analog input channels 0 and 1). On the DT9847-3-1 module, you can enter up to three entries in the channel list (analog input channels 0 to 2). Using software, specify the channels 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 69](#) for more information about triggers.

The conversion rate is determined by the frequency of the input sample clock; refer to [page 65](#) 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 clock source as internal and specify the clock frequency (refer to [page 65](#))
- Specify the start trigger (refer to [page 69](#))
- Specify the reference trigger (refer to [page 70](#))
- Specify the post-trigger scan count (the number of post-trigger samples to acquire after the reference trigger occurs)

[Figure 22](#) 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 (3, in this example) are acquired.

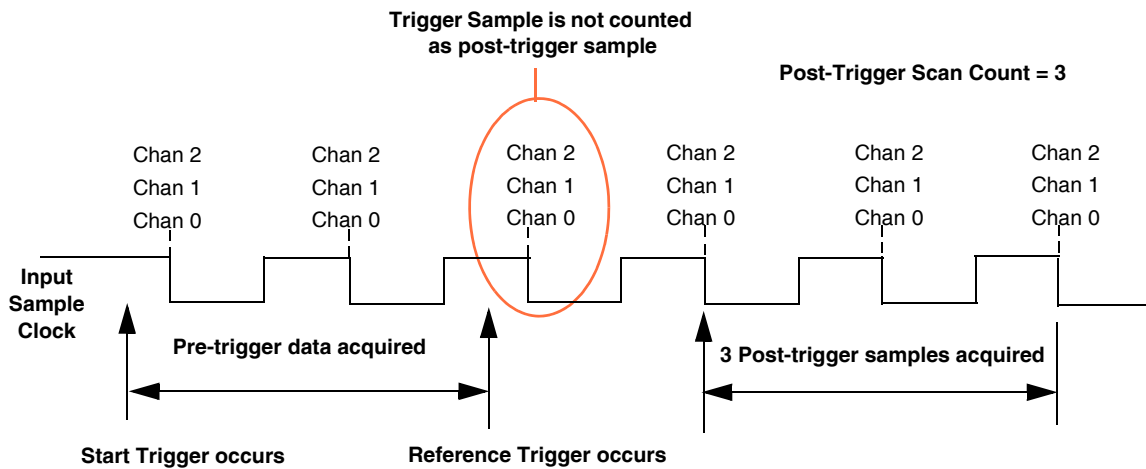


Figure 22: Continuous Scan Mode on the DT9847 Series Modules Using a Start and Reference Trigger

Note: The USB LED, shown in [Figure 34 on page 132](#), blinks amber while the module is acquiring data.

The Trigger LED on the module, shown in [Figure 34 on page 132](#), is green 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.

On the DT9847 Series modules, you can specify a start trigger source and a reference trigger source. Pre-trigger data acquisition starts when the start trigger event occurs. When the reference trigger event occurs, pre-trigger data acquisition stops and post-trigger acquisition starts. Post-trigger acquisition stops when the number of samples you specify for the post-trigger scan count has been reached. Refer to [page 67](#) for more information.

The Trigger LED on the module, shown in [Figure 34 on page 132](#), is green 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), red when the module has been triggered, or off when the module is idle.

Start Trigger Sources

The DT9847 Series 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** – 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 13) of the Digital I/O and External Trigger connector on the module. Using software, specify the trigger source as an external, positive digital (TTL) trigger to detect the trigger on the rising edge or an external, negative digital (TTL) trigger to detect the trigger on the falling edge.

Note: If you configure the synchronization mode as slave, the Sync Bus connector accepts trigger and clock signals from the master; you cannot use the Ext Trig connector on the slave module. Refer to [page 79](#) for more information.

- **Analog 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 that are included in the channel list 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 DT9847 Series modules (or multiple DT9847 Series and DT9837 Series or DT9838 modules) are connected together using the Sync Bus (RJ45) connector, you can use the Sync Bus trigger as the start trigger of the slave module by setting the synchronization mode of module to Slave. In this configuration, any other start trigger for the slave module is ignored. Refer to [page 79](#) for more information on this configuration.

Reference Trigger Sources

The DT9847 Series modules support the following sources for the reference trigger:

- **External digital (TTL) trigger** – The reference trigger event occurs when the module detects a rising- or falling-edge transition on the signal connected to the External Trigger pin (pin 13) of the Digital I/O and External Trigger connector on the module. Using software, specify the reference trigger source as an external, positive digital (TTL) trigger to detect the trigger on the rising edge or an external, negative digital (TTL) trigger to detect the trigger on the falling edge.
- **Analog 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 that are included in the channel list 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 DT9847 Series modules (or multiple DT9847 Series and DT9837 Series or DT9838 modules) are connected together using the Sync Bus (RJ45) connector, you can set the reference trigger of a slave DT9847 Series 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 79](#) for more information on this configuration.

Data Format and Transfer

DT9847 Series 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: DT9847 Series modules have an 8 kSample input FIFO that is used to store the acquired data before it is sent to the host.

Error Conditions

DT9847 Series 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 73](#)
- Output triggers, described on [page 75](#)
- Data format and transfer, described on [page 76](#)
- Error conditions, described on [page 76](#)

Analog Output Channels

The DT9847-1-1 and DT9847-3-1 modules support one analog output channel (0) through analog output subsystem 0. The DT9847-2-2 module supports two analog output channels (0 and 1) through analog output subsystem 0.

The DT9847 Series modules provide a two-pole, 250 kHz Butterworth filter to prevent noise from interfering with the output signal.

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

Output Ranges and Gains

The DT9847 Series modules can output bipolar analog output signals in the range of \pm 3 V or \pm 10 V. The output range is software programmable. The gain is 1.

Note: Older versions of the module may support only the \pm 3 V range.

Output Resolution

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

Output Clocks

The DT9847 Series 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 216 kHz). However, the subsystems are not designed to be synchronous with each other.

Due to the group delay of the Delta-Sigma D/A converter, the DT9847 Series modules require 36 clock pulses once the analog output sample clock is started before the first D/A conversion is completed.

Output Conversion Modes

The DT9847 Series 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 source, trigger source, or buffer. Single-value operations stop automatically when finished; you cannot stop a single-value operation.

Waveform Generation Mode

Waveform generation mode is supported on the DT9847 Series modules. In this mode, a waveform, which is specified in a single buffer, is output repetitively. The waveform pattern can range from 2 to 8192 samples if you are using one analog output channel or from 2 to 4096 if you are using two analog output channels. 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, 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 second output value for analog output channel 0, the second output value for analog output channel 1, and so on.

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

The host computer transfers the entire waveform pattern to the 8 kSample output FIFO on the module. When it detects a software trigger, the module starts writing output values to the analog output channels at the specified clock rate. 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.

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 72](#) for more information about the clock source and frequency.
- Specify a software trigger source, described in the next section

The DT9847 Series 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 continuously output buffered values to the analog output channel at a specified clock frequency. The DT9847 Series 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, 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 second output value for analog output channel 0, the second output value for analog output channel 1, 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 clock source as internal and specify the clock frequency. Refer to [page 72](#) for more information about the clock source and frequency.
- Specify the trigger source as any of the supported trigger sources. Refer to [page 75](#) for more information about the supported 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 USB LED, shown in [Figure 34 on page 132](#), blinks amber while the module is streaming the data to the analog output channels in continuous mode.

The DT9847 Series 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

The DT9847 Series 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** – 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 13) of the Digital I/O and External Trigger connector on the module.

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

Note: If you configure the synchronization mode as slave, the Sync Bus connector accepts trigger and clock signals from the master; you cannot use the Ext Trig connector on the slave module. Refer to [page 79](#) for more information.

- **Sync Bus trigger** – When multiple DT9847 Series modules (or multiple DT9847 Series and DT9837 Series or DT9838 modules) are connected together using the Sync Bus (RJ45) connector, you can use the Sync Bus trigger as the start trigger of the slave module by setting the synchronization mode of module to Slave. In this configuration, any other start trigger for the slave module is ignored. Refer to [page 79](#) 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

The DT9847 Series 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

Digital I/O Features

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

- Digital I/O lines, described below
- Operation modes, described below

Digital I/O Lines

The DT9847 Series modules support one digital input port, consisting of 4 digital input lines (lines 0 to 3) and one digital output port, consisting of 4 digital output lines (lines 0 to 3). The resolution is fixed at 4 bits; you cannot change the resolution in software.

You can read all 4 digital input lines or write all 4 digital output lines with a single-value digital I/O operation.

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.

Operation Modes

The DT9847 Series modules support single-value digital I/O operations. You use software to specify the digital I/O port (the gain is ignored). Data is then read from or written to all the digital I/O lines.

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

Triggering Acquisition on Multiple Modules

Note: For DT9847 Series modules, you can synchronize acquisition on multiple modules using the Sync Bus (RJ45) connector, described on [page 79](#).

The internal clock on the DT9847 Series modules when the synchronization mode is none (see [page 79](#)), is derived from the USB clock 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 23](#). 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.

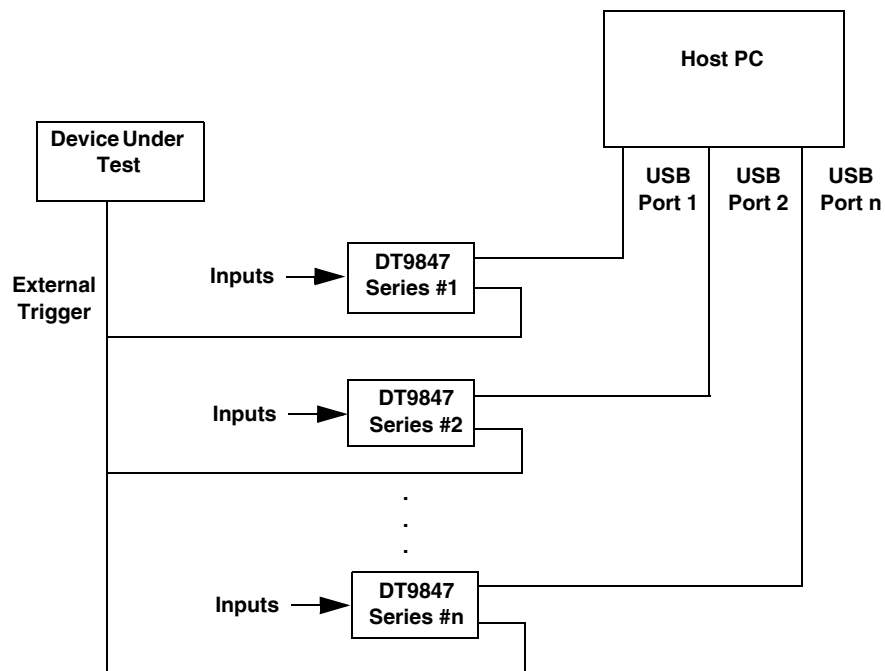


Figure 23: Triggering Multiple Modules Using an External Trigger Source

Synchronizing Acquisition on Multiple DT9847 Series Modules

DT9847 Series modules provide a Sync Bus (RJ45) connector that you can use to connect and synchronize multiple DT9847 Series modules.

Note: Note that you can also connect DT9837A, DT9837B, DT9837C, and/or DT9838 modules to a DT9847 Series module in this configuration. Refer to the *DT9837 Series User's Manual* and the *DT9838 User's Manual* for more information.

In this scheme, one module is the master and the other modules are the slave. You specify the synchronization mode (master, slave, or none) of the A/D subsystem using software.

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 DT9847 Series module uses the USB 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 24](#) shows how to connect a maximum of two DT9847 Series modules by daisy chaining them together through the Sync Bus connector. [Figure 25](#) shows how to connect a maximum of four DT9847 Series modules by using an RJ45 distribution panel, such as the EP386, where the panel contains four RJ45 connectors that are wired in parallel.

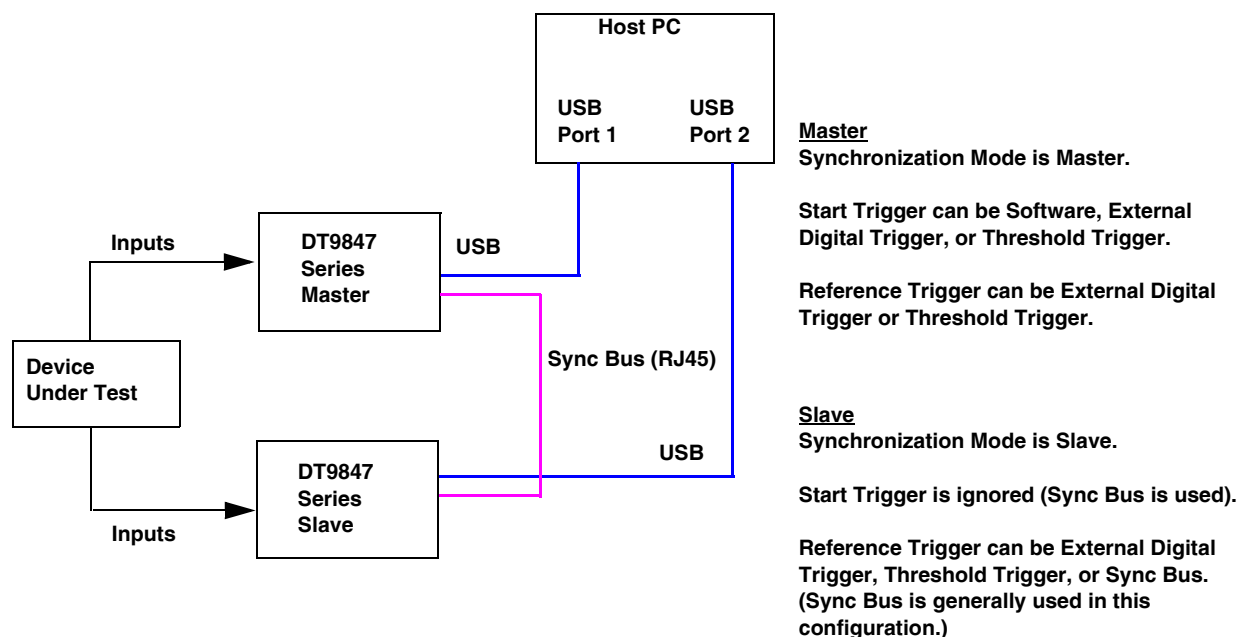
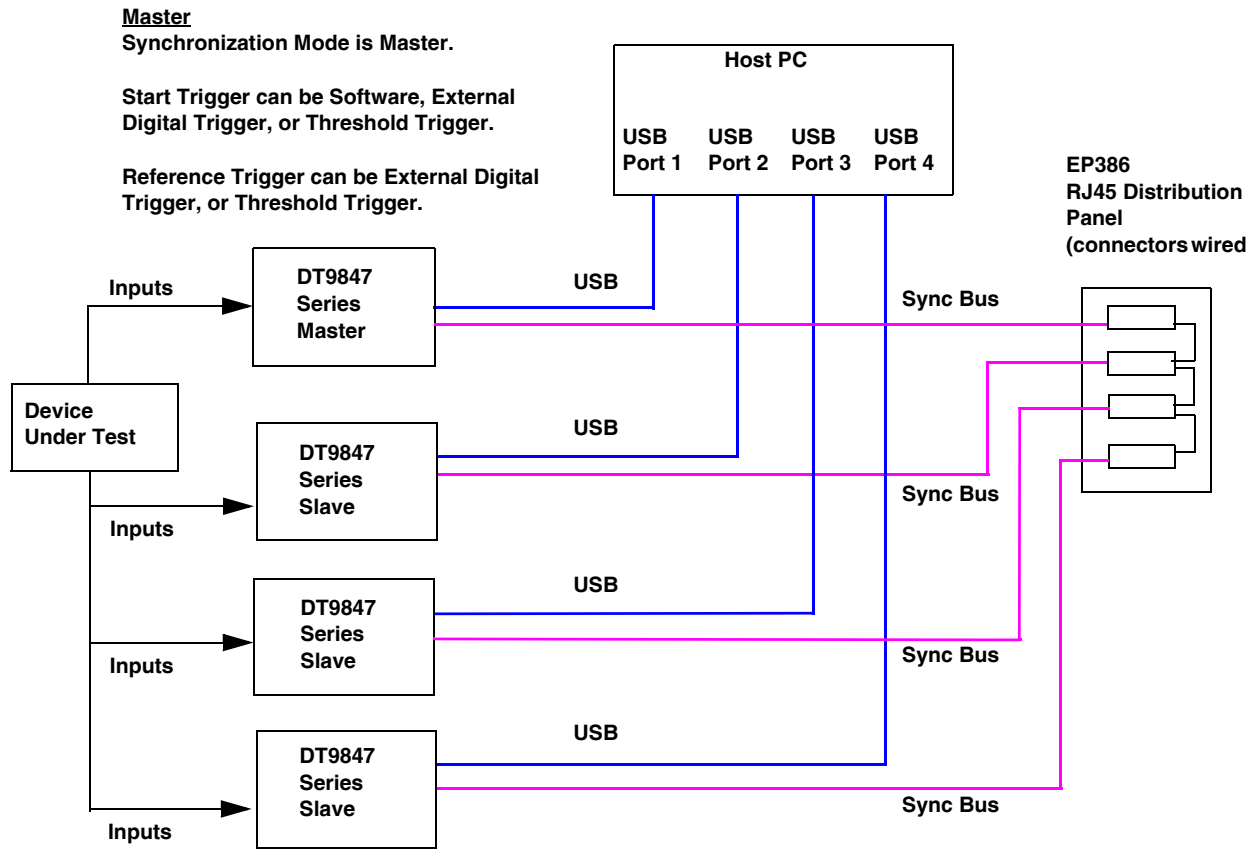


Figure 24: Synchronizing Two DT9847 Series Modules by Daisy Chaining the Sync Bus Connectors



Slave
Synchronization Mode is Slave.

Start Trigger is ignored (Sync Bus is used).

Reference Trigger can be External Digital Trigger, Threshold Trigger, or Sync Bus. (Sync Bus is generally used in this

* 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 25: Synchronizing Four DT9847 Series Modules Using the EP386 RJ45 Distribution Panel (Shown Using an External Trigger)

When synchronizing multiple modules, start the slave modules before starting the master module. When the master DT9847 Series 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). Note that you can set the clock rate to be the same or different on each module.

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.

When 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.

Triggering DT9847 and DT9837 Series Modules Using the Sync Bus

If you are connecting the DT9847 Series module to a DT9837 Series module using the Sync Bus connector, be aware of triggering limitations.

Note: There are no triggering limitations when connecting a DT9847 Series module to a DT9838 module using the Sync Bus connector; follow the instructions on [page 80](#) when connecting a DT9838 module.

The DT9837 Series supports the following start trigger sources: software, external digital trigger, and threshold trigger. For the reference trigger, the DT9837 Series supports only the threshold trigger source. When configured as a slave, the DT9837 Series processes a single Sync Bus trigger; the Sync Bus trigger is considered the start trigger and is received and/or driven out as such.

Consider the case where the DT9847 Series module is the master and a DT9837 Series module is the slave, as shown in [Figure 26](#).

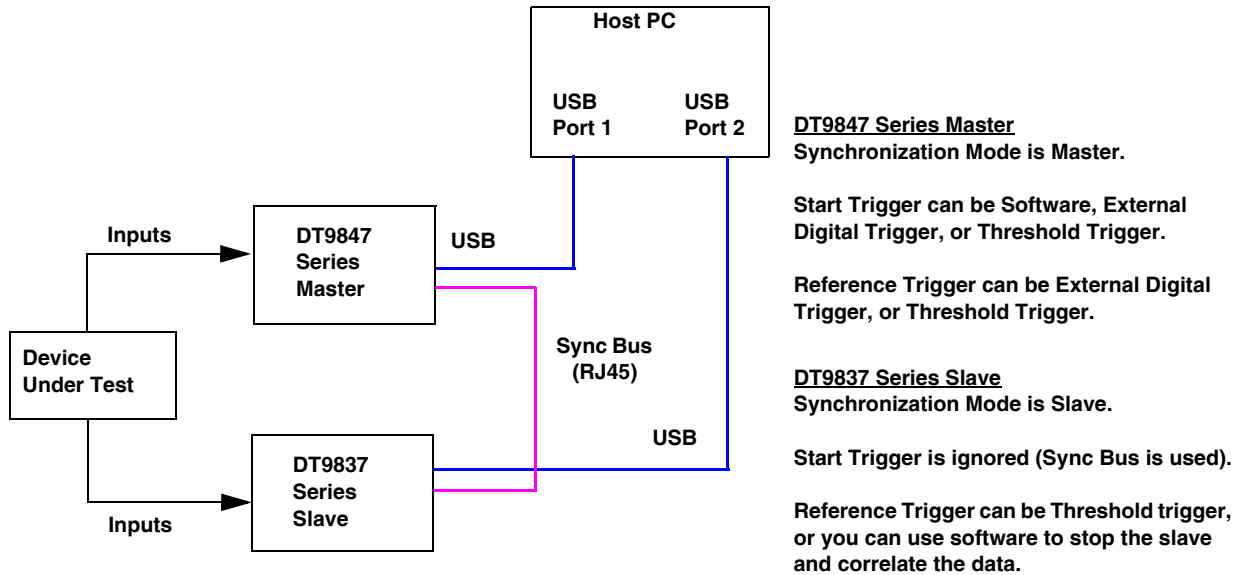


Figure 26: Synchronizing a Master DT9847 Series Module and a Slave DT9837 Series Module Using the Sync Bus Connector

In this case, the start trigger on the master DT9847 Series module can be a software trigger, external digital trigger, or threshold trigger. The reference trigger on the master DT9847 Series module can be an external digital trigger or threshold trigger.

The start trigger on the slave DT9837 Series module is ignored, since the Sync Bus is used as the start trigger. The reference trigger on the slave DT9837 Series can be the threshold trigger, or you can use software to stop the DT9837 Series module and correlate the data.

Now, consider the case where the DT9837 Series is the master and a DT9847 Series module is the slave, as shown in [Figure 27](#).

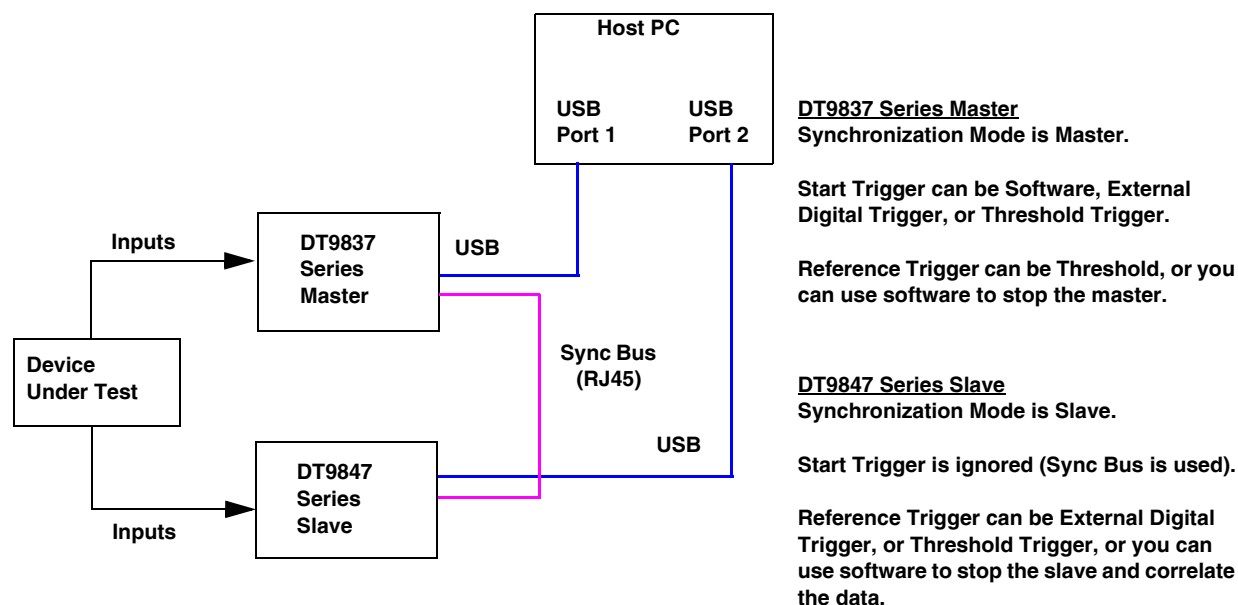


Figure 27: Synchronizing a Master DT9837 Series Module and a Slave DT9847 Series Module Using the Sync Bus Connector

In this case, the start trigger on the master DT9837 Series module can be a software, external digital, or threshold trigger. The reference trigger on the master DT9837 Series module can be the threshold trigger.

The start trigger on the slave DT9847 Series module is ignored, since the Sync Bus is used as the start trigger. The reference trigger on the slave DT9847 Series module can be an external digital trigger or threshold trigger (the Sync Bus trigger is not supported as a reference trigger in this configuration), or you can use software to stop the DT9847 Series module and correlate the data.



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The DT9847 Series Device Drivers provide support for the analog input (A/D) and analog output (D/A) subsystems. For information on how to configure the device drivers, refer to [page 36](#).

Table 2: DT9847 Series Subsystems

DT9847 Series Modules	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Total Subsystems on Module	1	1	1	1	0	0	0

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the DT9847 Series modules. The DT-Open Layers for .NET Class Library provides properties that return support information for specified subsystem capabilities.

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

Note: The following tables include the capabilities that can be queried. However, some capabilities may not be supported by your device. Blank fields represent unsupported options.

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

Data Flow and Operation Options

Table 3: Data Flow and Operation Options

DT9847 Series Modules	A/D	D/A	DIN	DOUT	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					
Continuous Operation until Trigger SupportsContinuousPreTrigger							
Continuous Operation before & after Trigger SupportsContinuousPrePostTrigger							
Waveform Operations Using FIFO Only SupportsWaveformModeOnly		Yes ^a					
Simultaneous Start List Support SupportsSimultaneousStart	Yes ^b	Yes ^b					
Supports Programmable Synchronization Modes SupportsSynchronization	Yes						
Synchronization Modes SynchronizationMode	None, Master, Slave						
Interrupt Support SupportsInterruptOnChange							
FIFO Size, in samples FifoSize	8 kSamples	8 kSamples					
Muting and Unmuting the Output Voltage SupportsMute		Yes					
Auto-Calibrate Support SupportsAutoCalibrate							

a. The DT9847 Series modules support continuous analog output operations in addition to waveform mode.

b. The DT9847 Series modules support the ability to start continuous A/D and continuous D/A operations simultaneously.

Buffering

Table 4: Buffering Options

DT9847 Series Modules	A/D	D/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						

Triggered Scan Mode

Table 5: Triggered Scan Mode Options

DT9847 Series Modules	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 6: Data Encoding Options

DT9847 Series Modules	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Binary Encoding Support SupportsBinaryEncoding	Yes	Yes	Yes	Yes			
Twos Complement Support SupportsTwosCompEncoding							
Returns Floating-Point Values ReturnsFloats							

Channels

Table 7: Channel Options

DT9847 Series Modules	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Number of Channels NumberOfChannels	1, 2, or 3 ^a	1 or 2 ^b	1	1			
SE Support SupportsSingleEnded	Yes	Yes	Yes	Yes			
SE Channels MaxSingleEndedChannels	1, 2, or 3 ^a	1 or 2 ^b	1	1			
DI Support SupportsDifferential							
DI Channels MaxDifferentialChannels	0	0	0	0			
Maximum Channel-Gain List Depth CGLDepth	1, 2, or 3 ^a	1 or 2 ^b	0	0			
Simultaneous Sample-and-Hold Support SupportsSimultaneousSampleHold	Yes						
Channel-List Inhibit SupportsChannelListInhibit							
Support MultiSensor Inputs SupportsMultiSensor							
Bias Return Termination Resistor Support SupportsInputTermination							

- a. The DT9847-1-1 supports one analog input channel; the DT9847-2-2 supports two analog input channels; and the DT9847-3-1 supports three analog input channels.
- b. The DT9847-1-1 and DT9847-3-1 modules support one analog output channel, and the DT9847-2-2 module supports two analog output channels.

Gain

Table 8: Gain Options

DT9847 Series Modules	A/D	D/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	1					

Ranges

Table 9: Range Options

DT9847 Series Modules	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Number of Voltage Ranges NumberOfRanges	1	1	0	0			
Available Ranges SupportedVoltageRanges	$\pm 10 \text{ V}^a$	$\pm 3 \text{ V}$ or $\pm 10 \text{ V}^b$					

- a. By applying a gain of 1, the effective input range is $\pm 10 \text{ V}$. By applying a gain of 10, the effective input range is $\pm 1 \text{ V}$.
- b. Software-programmable. Older versions of the module may support only the $\pm 3 \text{ V}$ range.

Resolution

Table 10: Resolution Options

DT9847 Series Modules	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Software Programmable Resolution SupportsSoftwareResolution							
Number of Resolutions NumberOfResolutions	1	1	1	1			
Available Resolutions SupportedResolutions	24	32	4	4			

Current and Resistance Support

Table 11: Current and Resistance Support Options

DT9847 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Current Support SupportsCurrent							
Current Output Support SupportsCurrentOutput							
Resistance Support SupportsResistance							
Software Programmable External Excitation Current Source for Resistance SupportsExternalExcitationCurrentSrc							
Software Programmable Internal Excitation Current Source SupportsInternalExcitationCurrentSrc							
Available Excitation Current Source Values SupportedExcitationCurrentValues							

Thermocouple, RTD, and Thermistor Support

Table 12: Thermocouple, RTD, and Thermistor Support Options

DT9847 Series	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 13: IEPE Support Options

DT9847 Series	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 14: Bridge and Strain Gage Support Options

DT9847 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Bridge Support SupportsBridge							
Supported Bridge Configurations BridgeConfiguration							
Strain Gage Support SupportsStrainGage							
Supported Strain Gage Bridge Configurations StrainGageBridgeConfiguration							
External Excitation Voltage SupportsExternalExcitationVoltage							
Internal Excitation Voltage SupportsInternalExcitationVoltage							
Shunt Calibration SupportsShuntCalibration							
Voltage Excitation Per Channel SupportedPerChannelVoltageExcitation							
Minimum Excitation Voltage MinExcitationVoltage							
Maximum Excitation Voltage MaxExcitationVoltage							

Start Triggers

Table 15: Start Trigger Options

DT9847 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Software Trigger Support SupportsSoftwareTrigger	Yes	Yes	Yes	Yes			
External Positive TTL Trigger Support SupportsPosExternalTTLTrigger	Yes	Yes					
External Negative TTL Trigger Support SupportsNegExternalTTLTrigger	Yes	Yes					
External Positive TTL Trigger Support for Single-Value Operations SupportsSvPosExternalTTLTrigger							
External Negative TTL Trigger Support for Single-Value Operations SupportsSvNegExternalTTLTrigger							
Positive Threshold Trigger Support SupportsPosThresholdTrigger	Yes ^a						
Negative Threshold Trigger Support SupportsNegThresholdTrigger	Yes ^a						
Digital Event Trigger Support SupportsDigitalEventTrigger							
Threshold Trigger Channel SupportedThresholdTriggerChannel	0 (DT9847-1-1), 0 or 1 (DT9847-2-2, 0, 1, 2 (DT9847-3-1) ^a	0					

a. If you choose a threshold trigger for the start trigger on the DT9847 Series 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.

Reference Triggers

Table 16: Reference Trigger Options

DT9847 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
External Positive TTL Trigger Support SupportsPosExternalTTLTrigger	Yes						
External Negative TTL Trigger Support SupportsNegExternalTTLTrigger	Yes						
Positive Threshold Trigger Support SupportsPosThresholdTrigger	Yes ^a						
Negative Threshold Trigger Support SupportsNegThresholdTrigger	Yes ^a						
Digital Event Trigger Support SupportsDigitalEventTrigger							
Sync Bus Support SupportsSyncBusTrigger							
Threshold Trigger Channel SupportedThresholdTriggerChannel	0 (DT9847-1-1), 0 or 1 (DT9847-2-2, 0, 1, 2 (DT9847-3-1) ^a						
Post-Trigger Scan Count SupportsPostTriggerScanCount	Yes ^b						

- a. If you choose a threshold trigger for the reference trigger on the DT9847 Series 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.
- b. 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 17: Clock Options

DT9847 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Internal Clock Support SupportsInternalClock	Yes	Yes					
External Clock Support SupportsExternalClock							
Simultaneous Input/Output on a Single Clock Signal SupportsSimultaneousClocking	Yes						
Base Clock Frequency BaseClockFrequency	13.824 MHz	27.648 MHz	0	0			
Maximum Clock Divider MaxExtClockDivider	1.0	1.0	1.0	1.0			
Minimum Clock Divider MinExtClockDivider	1.0	1.0	1.0	1.0			
Maximum Frequency MaxFrequency	216 kHz	216 kHz	0	0			
Minimum Frequency MinFrequency	1 kHz	30 kHz	0	0			

Counter/Timers

Table 18: Counter/Timer Options

DT9847 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Cascading Support SupportsCascading							
Event Count Mode Support SupportsCount							
Generate Rate Mode Support SupportsRateGenerate							
One-Shot Mode Support SupportsOneShot							
Repetitive One-Shot Mode Support SupportsOneShotRepeat							
Up/Down Counting Mode Support SupportsUpDown							
Edge-to-Edge Measurement Mode Support SupportsMeasure							
Continuous Edge-to-Edge Measurement Mode Support SupportsContinuousMeasure							
High to Low Output Pulse Support SupportsHighToLowPulse							
Low to High Output Pulse Support SupportsLowToHighPulse							
Variable Pulse Width Support SupportsVariablePulseWidth							
None (internal) Gate Type Support SupportsGateNone							
High Level Gate Type Support SupportsGateHighLevel							
Low Level Gate Type Support SupportsGateLowLevel							
High Edge Gate Type Support SupportsGateHighEdge							
Low Edge Gate Type Support SupportsGateLowEdge							
Level Change Gate Type Support SupportsGateLevel							
Clock-Falling Edge Type SupportsClockFalling							
Clock-Rising Edge Type SupportsClockRising							
Gate-Falling Edge Type SupportsGateFalling							
Gate-Rising Edge Type SupportsGateRising							
Interrupt-Driven Operations SupportsInterrupt							

Tachometers

Table 19: Tachometer Options

DT9847 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Tachometer Falling Edges SupportsFallingEdge							
Tachometer Rising Edges SupportsRisingEdge							
Tachometer Stale Data Flag SupportsStaleDataFlag							



Troubleshooting

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General Checklist

Should you experience problems using a DT9847 Series module, do the following:

1. Read all the documentation provided for your product, including any "Read this First" information.
2. Check the DT Omni software 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 Knowledgebase in the Support section of the web site (at www.mccdaq.com) for an answer to your problem.

If you still experience problems, try using the information in [Table 20](#) to isolate and solve the problem. If you cannot identify the problem, refer to [page 102](#).

Table 20: 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 DT Omni setup program to install the USB device drivers, and reconnect your USB module to the computer.
Module does not respond	The module configuration is incorrect.	Check the configuration of your device driver; see the instructions in Chapter 2 .
	The module is damaged.	Contact Data Translation for technical support; refer to page 102 .
Intermittent operation	Loose connections or vibrations exist.	Check your wiring and tighten any loose connections or cushion vibration sources; see the instructions in Chapter 3 .
	The module is overheating.	Check environmental and ambient temperature; consult the module's specifications on page 122 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 20: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Device failure error reported	The DT9847 Series module cannot communicate with the Microsoft bus driver or a problem with the bus driver exists.	Check your cabling and wiring and tighten any loose connections; see the instructions in Chapter 3 .
	The DT9847 Series 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.	DT9847 Series 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 2.0 is not recognized	Your operating system does not have the appropriate Service Pack installed.	Ensure that you load the appropriate Windows Service Pack. If you are unsure of whether you are using USB 2.0 or USB 1.1, run the Open Layers Control Panel applet, described in Chapter 2 .
	Standby mode is enabled on your PC.	For some PCs, you may need to disable standby mode on your system for proper USB 2.0 operation. Consult Microsoft for more information.

Technical Support

If you have difficulty using a DT9847 Series 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 software that 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 (Data Translation is a Measurement Computing company). Customers outside the USA must contact their local distributor for a return procedure. Calibration certificates for most analog models can be obtained for a fee (certificate must be requested at time of RMA# assignment).



Calibration

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DT9847 Series modules are calibrated at the factory and should not require calibration for initial use. We recommend that you check and, if necessary, readjust the calibration of the analog input and analog output circuitry every six months using the DT9847 Series Calibration Utility.

Note: Ensure that you installed the device driver for your module using the Omni software prior to using the calibration utility.

This chapter describes how to calibrate the analog input and output subsystems of a DT9847 Series module using the calibration utility.

Using the Calibration Utility

Start the DT9847 Series Calibration Utility as follows:

1. Click **Start** from the Task Bar.
2. For the DT9847 module, select **Programs | Data Translation, Inc | Calibration | DT9847 Series Calibration Utility**.
The main window of the DT9847 Series Calibration Utility appears.
3. Select the module to calibrate, and then click **OK**.

Note: When you first run the DT9847 Series Calibration Utility, you may notice a delay before you can start using the utility. This is the configuration delay that is related to the sampling frequency, as described on [page 66](#).

Once the calibration utility is running, you can calibrate the analog input circuitry (either automatically or manually), described on [page 108](#), or the analog output circuitry of the module, described on [page 110](#).

Calibrating the Analog Input Subsystem

This section describes how to use the calibration utility to calibrate the analog input subsystem of a DT9847 Series module.

DT9847 Series 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 DT9847 Series 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.

Note: 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 0.000 V is applied to the channel.
4. Verify that the supplied voltage to your selected channel is 0.000 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 +9.375 V.
5. Check that the supplied voltage to your selected channel is +9.375 V, and then click **OK**.
The gain value is calibrated and a completion message appears.
6. Repeat these steps 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:

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.

Note: 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 Manual Calibration area of the window, select the channel that you want to calibrate, and then click the **Start** button.
4. Adjust the offset as follows:
 - a. Verify that 0.000 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.
 - b. 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 0.000 V.
5. Adjust the gain as follows:
 - a. Verify that +9.375 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.
 - b. 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.
6. When you have finished calibrating the channel, click the **Stop** button.
7. Repeat these steps 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 DT9847 Series module.

Do the following to calibrate the analog output circuitry:

1. Select the **D/A Calibration** tab of the calibration utility.
2. Under the Channel Selection area of the window, select the analog output channel of the DT9847 Series module to calibrate
3. Connect an external precision voltmeter to the selected analog output channel.
4. In the DAC Output Voltage box, select **0 V**.
5. Adjust the offset by entering values between 0 and 255 in the **Offset** edit box or by clicking the up/down buttons until the voltmeter reads 0 V.
6. In the DAC Output Voltage box, select **2.75 V**.
7. Adjust the gain by entering values between 0 and 255 in the **Gain** edit box or by clicking the up/down buttons until the voltmeter reads 2.75 V.
8. 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 21 lists the specifications for the analog input subsystem on the DT9847 Series modules. Unless otherwise noted, specifications are typical at 25° C.

Table 21: Analog Input Subsystem Specifications

Feature	DT9847 Specifications
Number of analog input channels DT9847-1-1: DT9847-2-2: DT9847-3-1:	1, single-ended 2, single-ended 3, single-ended
Resolution	24 bits
Ranges and gains Gain of 1: Gain of 10:	±10 V ±1 V
A/D type	Delta Sigma
Data encoding	Offset binary
Maximum sample frequency	216 kHz
Minimum sample frequency	1 kHz
Group delay	63/sample rate, in seconds
ADC Delta Sigma filter ^a Passband, -3 dB: Passband ripple, ±0.001 dB: Passband ripple, ±0.003 dB: Passband ripple, ±0.007 dB: Stopband, -120 dB:	0.4535 x sample frequency, Hz 48 kHz 96 kHz 192 kHz 0.547 x sample frequency, Hz
Analog filter ^a Low pass cutoff: High pass cutoff, -3 dB (AC coupling):	500 kHz (+3 dB); 1.6 MHz (-3 dB) 0.1 Hz
Channel-to-channel crosstalk ^b Input Signal = 10 kHz:	> -110 dB with 50 Ω termination > -105 dB with 1 kΩ termination
Input impedance	1 MΩ // 20 pF
Coupling	AC/DC (software-selectable per channel)
IEPE current source	4 mA ±0.5%
IEPE compliance voltage	18 V
IEPE current source noise DC to 1 kHz	5 nARMS

Table 21: Analog Input Subsystem Specifications (cont.)

Feature	DT9847 Specifications	
DC Accuracy		
Offset error ^c	1.5 mV	
Offset error temperature coefficient	$(2 \mu\text{V}/^\circ\text{C} \times \text{Gain}) + 400 \mu\text{V}$	
Gain error Gain of 1: Gain of 10:	$\pm 0.02\%$ $\pm 0.5\%$	
Gain error temperature coefficient	150 ppm// ^o C	
Dynamic Performance^d	Gain of 1	Gain of 10
Effective Number of Bits, ENOB ^e (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	14.6 bits 15.6 bits	14.9 bits 15.7 bits
Signal to Noise and Distortion Ratio, SINAD ^f (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	89 dB 90 dB	91 dB 90 dB
Signal to Noise Ratio, SNR ^g (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	96 dB 91 dB	95 dB 91 dB
Total Harmonic Distortion, THD ^h (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	–90 dB –96 dB	–93 dB –98 dB
Spurious Free Dynamic Range, SFDR ⁱ (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	93 dBFS 104 dBFS	96 dBFS 106 dBFS
Noise Floor (50 Ω input termination, 105.5 kSPS)	90 μVRMS	10 μVRMS
Overvoltage Protection		
Overvoltage protection (power on/off)	$\pm 40\text{ V}$	
ESD protection Arc: Contact:	8 kV 4 kV	

- a. The total frequency response is the combined frequency response of the ADC Sigma Delta filter and the analog filter.
- b. Channel 0 is the reference channel with a 20 V PP signal and a maximum sample rate of 216 kSamples/s.
- c. Offset errors are referred to the input.
- d. ENOB, SINAD, SNR, THD, and SFDR measurements were made with a 16384 point FFT with a minimum 4-term Blackman Harris window.

- e. 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.

- f. 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.
- g. 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.
- h. Total Harmonic Distortion (THD) is the ratio of the RMS value of the input signal to the RMS sum of all harmonics.
- i. 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 shows the full system accuracy of the DT9847 Series module as measured by QuickDAQ. In this example, a -1 dB input signal is connected to the DT9847 Series module and is sampled at 216 kHz using a gain of 1. The effective number of bits (ENOB) is 14.62.

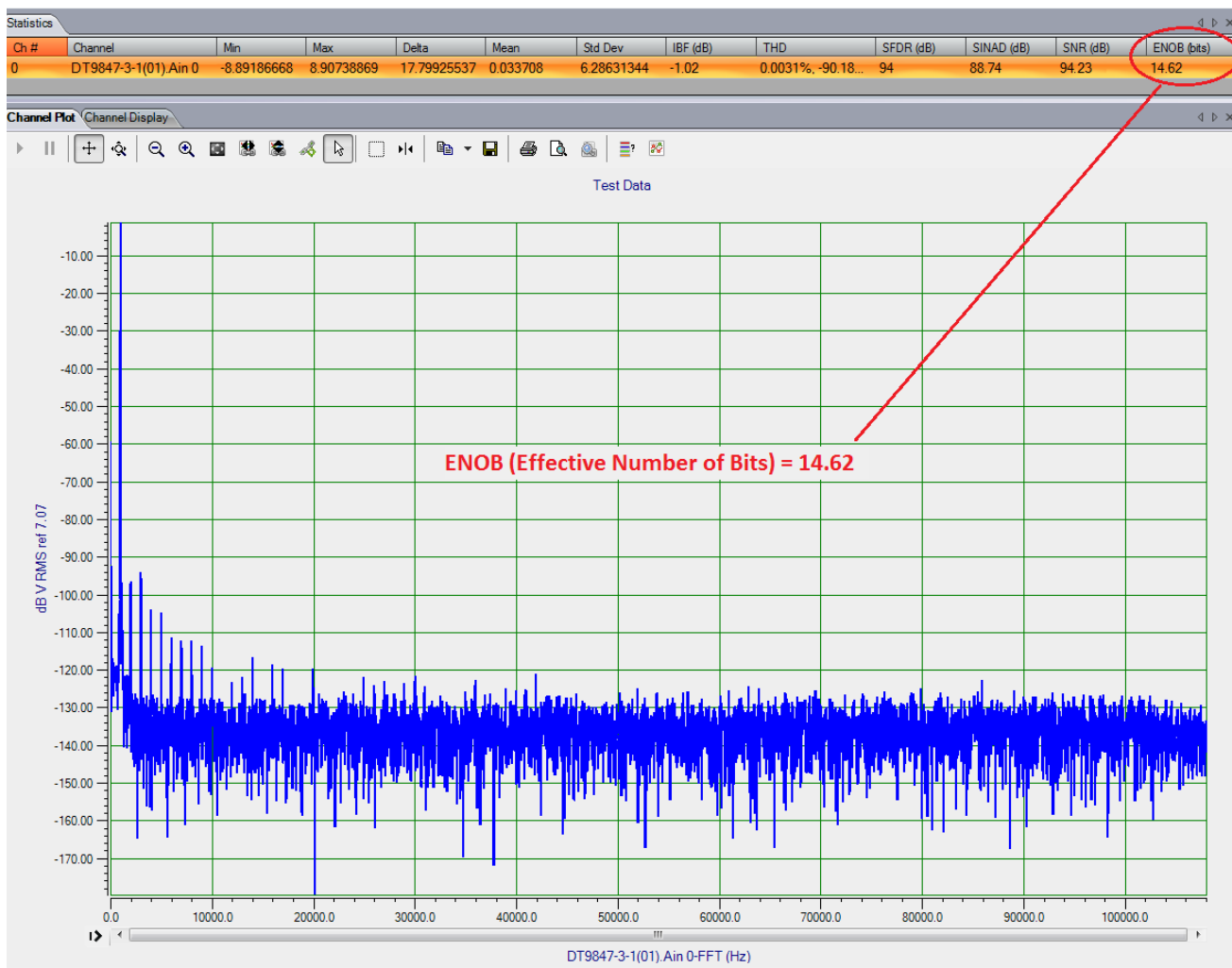


Figure 28: Dynamic Performance of the DT9847 Series Modules Measured Using QuickDAQ

Figure 29 shows the result of vector averaging data in QuickDAQ (FFT package). Vector averaging performs mathematical operations in the complex domain. This process cancels non-coherent noise components while allowing coherent signal components to remain.

In this example, a -10 dB input signal is connected to the DT9847 Series and is sampled at 50 kHz. You can clearly see the harmonics pulled out of the noise; the noise floor is below 150 dB.

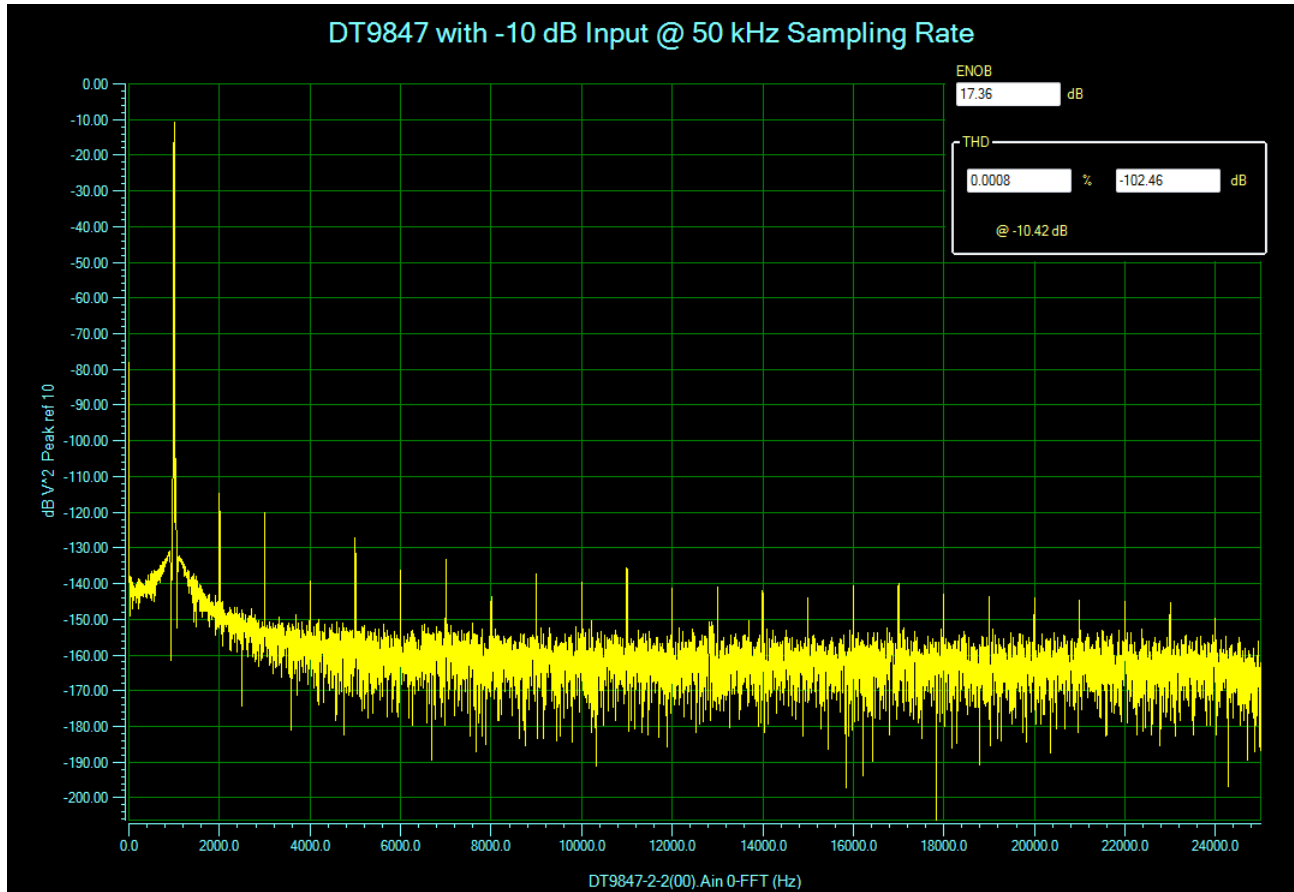


Figure 29: Vector Averaging in QuickDAQ Allows Users to Isolate Coherent Signal Components

Analog Output Specifications

Table 22 lists the specifications for the analog output subsystem on the DT9847 Series modules. Unless otherwise noted, specifications are typical at 25° C.

Table 22: Analog Output Subsystem Specifications

Feature	DT9847 Series Specifications	
Number of analog output channels DT9847-1-1: DT9847-2-2: DT9847-3-1:	1, single-ended 2, single-ended 1, single-ended	
Resolution	32 bits	
D/A type	Delta Sigma	
Output range	± 3 V or ± 10 V, software programmable ^a	
Data encoding	Offset binary	
Minimum sample frequency	30 kHz	
Maximum sample frequency	216 kHz	
Group delay (typical)	36/sample rate, in s	
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	250 kHz, 2-pole, low-pass Butterworth	
Output current	± 3 mA maximum load (3 V across 1 k Ω ; 10 V across 3.3 k Ω)	
Output FIFO	8 kSamples	
Idle channel noise (216 kSPS)	± 3 V range 15 μ VRMS	± 10 V range 30 μ VRMS
Total Harmonic Distortion, THD ^c (216 kSPS) -1 dBFS, 1 kHz output, 3.3 k Ω load: -6 dBFS, 1 kHz output, 3.3 k Ω load:	± 3 V range -102 dB -110 dB	± 10 V range -106 dB -110 dB
Spurious Free Dynamic Range, SFDR ^c (216 kSPS) -1 dBFS, 1 kHz output, 3.3 k Ω load: -6 dBFS, 1 kHz output, 3.3 k Ω load:	± 3 V range 103 dB 107 dB	± 10 V range 108 dB 115 dB
Offset error	± 1 mV	
Offset error temperature coefficient	± 3 V range 100 μ V/ $^{\circ}$ C	± 10 V range 130 μ V/ $^{\circ}$ C
Gain error	$\pm 1.0\%$	

Table 22: Analog Output Subsystem Specifications (cont.)

Feature	DT9847 Series Specifications				
Gain error temperature coefficient	<table border="0"> <tr> <td style="text-align: center;"><u>±3 V range</u></td> <td style="text-align: center;"><u>±10 V range</u></td> </tr> <tr> <td style="text-align: center;">30 ppm/° C</td> <td style="text-align: center;">55 ppm/° C</td> </tr> </table>	<u>±3 V range</u>	<u>±10 V range</u>	30 ppm/° C	55 ppm/° C
<u>±3 V range</u>	<u>±10 V range</u>				
30 ppm/° C	55 ppm/° 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:	<table border="0"> <tr> <td style="text-align: center;">8 kV</td> </tr> <tr> <td style="text-align: center;">4 kV</td> </tr> </table>	8 kV	4 kV		
8 kV					
4 kV					

- a. Older versions of this module may support only the ±3 V range.
- b. The total frequency response is the combined frequency response of the DAC Sigma Delta 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 23 lists the specifications for the digital I/O subsystems on the DT9847 Series modules.

Table 23: Digital I/O Specifications

Feature	Specifications
Number of digital I/O lines	8 (4 in, 4 out)
Number of ports	2 (4 bits each)
Logic family	LVTTL (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 LVTTL 2.0 V minimum 0.8 V maximum 0.4 mA maximum None
Outputs Fan out: High output: Low output: High output current: Low output current:	24 mA 2.0 V minimum 0.8 V maximum -12 mA maximum 12 mA maximum
Clocked with sample clock	No
Software I/O selectable	No

Trigger Specifications

Table 24 lists the specifications for the trigger on the DT9847 Series modules.

Table 24: Trigger Specifications

Feature	DT9847 Specifications
Trigger sources Internal software trigger: External digital trigger: Analog threshold trigger:	Software-initiated Software-selectable Software-selectable
External digital trigger Input type: 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) LVTTTL inputs 1 LVTTTL 1.1 V 1.3 V 0.2 V 33 μ A 1.3 μ s \pm 30 V
Analog 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; \pm 1 V @ gain of 10 100 mV
Trigger delay	1 conversion period maximum

Master Oscillator Specifications

Table 25 lists the specifications for the master oscillator on the DT9847 Series modules.

Table 25: Master Oscillator Specifications

Feature	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 216 kHz). However, the subsystems are not designed to be synchronous with each other.

Power, Physical, and Environmental Specifications

Table 26 lists the power, physical, and environmental specifications for the DT9847 Series modules.

Table 26: Power, Physical, and Environmental Specifications

Feature	DT9847 Series Specifications
Power DT9847-1-1 and DT9847-1-1-OEM:	5 V \pm 0.30 V @ 600 mA ^a
DT9847-2-2, DT9847-2-2-OEM, DT9847-3-1, and DT9847-3-1-OEM:	+5 V to 24 V @ 5 W ^b
Warm-up time	1 hour
Physical Dimensions - Enclosure Length: Width: Height: Weight:	10.025 inches (254.63 mm) 4.170 inches (105.92 mm) 1.575 inches (40 mm) 22.62 ounces (641.5 g)
Physical Dimensions - OEM (board only) Length: Width: Height: Weight:	10.025 inches (254.63 mm) 3.937 inches (100 mm) 0.712 inches (18.08 mm) 6.5 ounces (184.2 g)
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

- a. The DT9847-1-1 requires a USB-Y cable (EP399) to ensure that adequate power is provided. Refer to [page 33](#) for more information on connecting the USB-Y cable. The DT9847-1-1-OEM can be powered with USB power using the EP399 USB-Y cable or by using an external power supply connected to screw terminal block TB1 (this requires a jumper); refer to [page 134](#) for more information.
- b. To power the DT9847-2-2 and DT9847-3-1, connect the EP394 external power supply to the barrel power connector on the module. To power the DT9847-2-2 OEM and DT9847-3-1-OEM modules, connect the EP394 external power supply either to the barrel power connector on the module or to screw terminal block TB1 on the module, as described on [page 136](#).

Regulatory Specifications

The DT9847 Series is CE-compliant. [Table 27](#) lists the regulatory specifications for the DT9847 Series modules.

Table 27: Regulatory Specifications

Feature	DT9847 Series Specifications
Emissions (EMI)	FCC Part 15, Class A EN55011:2007 (Based on CISPR-11, 2003/A2, 2006)
Immunity	EN61326-1:2006 Electrical Equipment for Measurement, Control, and Laboratory Use <u>EMC Requirements</u> EN61000-4-2:2009 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 28 lists the connector specifications for the DT9847 Series modules.

Table 28: Connector Specifications

Feature	Specifications
Analog I/O BNC connectors	TE Connectivity 5227161-9
External power supply	Jack on the module: Switchcraft #L722RA Mating plug assembly, 0.08 inch: Switchcraft #S761K
Sync Bus connector (RJ45)	Molex part number 44661-0001
USB connector	TE Connectivity 292304-2
Digital I/O connector	Kycon K66X-E15S-N

External Power Supply Specifications

Table 29 lists the specifications for the EP394 +5 V external power supply that is used with the DT9847 Series modules.

Table 29: External Power Supply (EP394) Specifications

Feature	Specifications
Type	FRIWO medical power supply (GPP 10)
Input voltage	100 to 240 V AC ($\pm 10\%$)
Input current	250 mA
Frequency	50 to 60 Hz
Efficiency	80% typical at full load
Output voltage	5 V
Output current	1600 mA
Output ripple voltage	75 mVpp
Regulatory standards	UL, VDE, CE, Energy Star compliant



Connector Pin Assignments and LED Status Indicators

Digital I/O and External Trigger Connector	128
External USB Connector	129
External Power Connector	130
STP15 Screw Terminal Panel	131
LED Status Indicators	132

Digital I/O and External Trigger Connector

Figure 30 shows the layout of the 15-pin Digital I/O and External Trigger connector on the DT9847 Series modules.

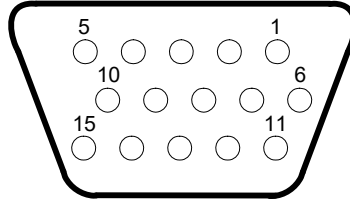


Figure 30: Layout of the Digital I/O and External Trigger Connector

Table 30 lists the pin assignments for the Digital I/O and External Trigger connector on the DT9847 Series modules.

Table 30: Pin Assignments for the Digital I/O and External Trigger Connector on the DT9847 Series Modules

Connector Pin Number	Signal Description
1	Digital Input 0
2	Digital Input 1
3	Digital Input 2
4	Digital Input 3
5	Ground
6	Digital Output 0
7	Digital Output 1
8	Digital Output 2
9	No Connect
10	Ground
11	Digital Output 3
12	No Connect
13	External Trigger
14	No Connect
15	Ground

External USB Connector

Figure 31 shows the layout of the external USB connector on the DT9847 Series modules.

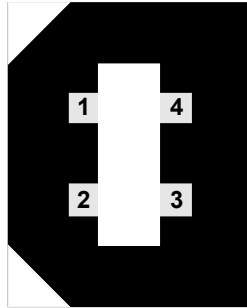


Figure 31: Layout of the USB Connector

Table 31 lists the pin assignments for the USB connector on the DT9847 Series modules.

Table 31: Pin Assignments for the USB Connector on the DT9847 Series Modules

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 Connector

Figure 32 shows the layout of the external +5 V to +24 VDC power connector (barrel connector) on the DT9847-2-2 and DT9847-3-1 modules.

Note: The DT9847-1-1 module operates on USB power; therefore, the external power connector is not provided on that module.

If you are using the DT9847-1-1-OEM, DT9847-2-2-OEM, or DT9847-3-1-OEM module, you can also power the module by connecting an external power supply to screw terminal block TB1; refer to [Appendix C](#) starting on [page 133](#) for more information.

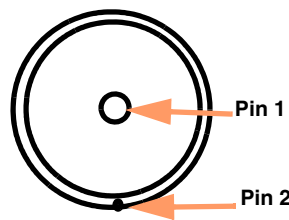


Figure 32: Layout of the External Power Connector

Table 32 lists the pin assignments for the external power connector on the DT9847-2-2 and DT9847-3-1 modules.

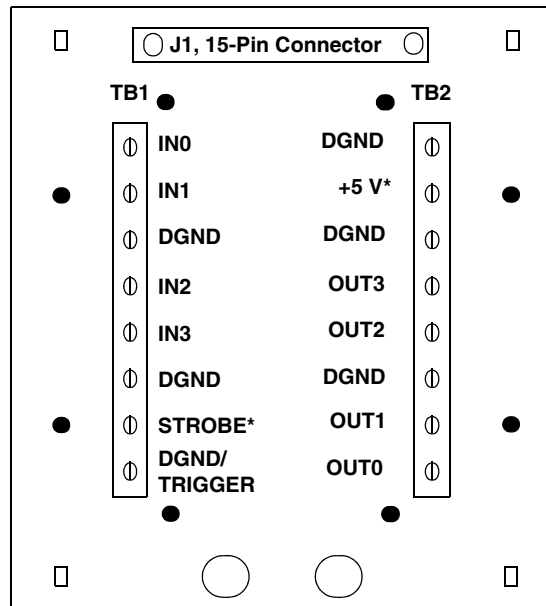
Table 32: Pin Assignments for the External Power Connector on the DT9847-2-2 and DT9847-3-1 Modules

Connector Pin Number	Signal Description
1	+5 VDC to +24 VDC
2	Ground

STP15 Screw Terminal Panel

The STP15 contains one 15-pin connector and two screw terminal blocks (TB1 and TB2). The 15-pin connector provides access to the signals from the Digital I/O and External Trigger connector on the DT9847 module.

Figure 33 shows the layout of the STP15 and lists the screw terminal assignments.



*These signal are not used on the DT9847 Series modules.

Figure 33: Layout of the STP15 Screw Terminal Panel

Note: The dark filled circles in Figure 33 represent holes that you can use to mount the STP15 on a DIN rail. To mount the STP15 on a DIN rail, you need two DIN rail mount adapters (Phoenix Contact part number 1201578), and four thread form screws (Bossard part number BN2724M3x8).

LED Status Indicators

The DT9847 Series has a two bi-color LEDs on the module, shown in [Figure 34](#).



Figure 34: LEDs on DT9847 Series Modules

These LEDs are described in [Table 33](#).

Table 33: LED Status Indicators on the DT9847 Series Modules

LED	Color of the LED	Status Description
USB LED	Green	Module is powered
	Blinking amber	Module is active (acquiring data from the analog input channels or streaming data to the analog output channels in continuous mode) ^a
Trigger LED	Green	Module is 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)
	Red	Module has been triggered

- a. When only waveform analog output operations are in progress, this LED is not lit because this operation does not require USB activity.



Powering OEM Modules

Powering the DT9847-1-1-OEM Module	134
Powering the DT9847-2-2-OEM or DT9847-3-1-OEM Module	136

Powering the DT9847-1-1-OEM Module

The DT9847-1-1-OEM module can be powered with USB power using the EP399 USB-Y cable, as shown in [page 32](#).

By default, jumper W3, shown in [Figure 35](#), is installed on the module when it is shipped from the factory to select USB power. (This jumper is near the analog output connector on the module.)

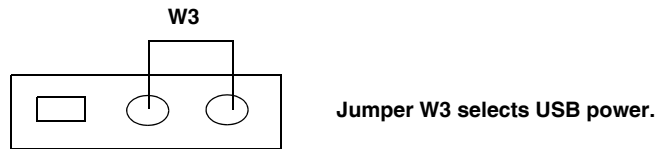


Figure 35: Installing Jumper W3 to Select USB Power

Note: On revision 3 or newer of the PCB, this jumper is labelled W3. On earlier revisions of the PCB, this jumper is labelled W5.

Optionally, you can use an external +5 V power supply to power the DT9847-1-1-OEM module. To use external power, do the following:

1. Remove jumper W3 and install jumper W2 on the module, as shown in [Figure 36](#). (This jumper is near the analog output connector on the module.)

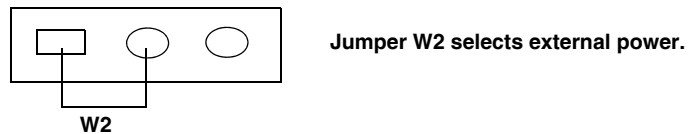
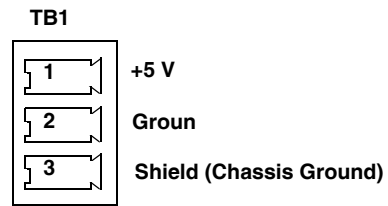


Figure 36: Installing Jumper W2 to Select External Power

Note: On revision 3 or newer of the PCB, this jumper is labelled W2. On earlier revisions of the PCB, this jumper is labelled W4.

2. Connect an external power supply to the three-position screw terminal block (TB1) on the module, as shown in [Figure 37](#). (TB1 is near the analog output connector on the module.)



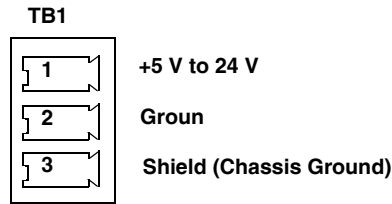
On the DT9847-1-1-OEM, ensure that the maximum voltage of the external supply is +5 V \pm 0.30 V @ 600 mA. Higher voltages will destroy the module.

Figure 37: Connecting an External Power Supply to Screw Terminal TB1 on the Module

Powering the DT9847-2-2-OEM or DT9847-3-1-OEM Module

The DT9847-2-2-OEM or DT9847-3-1-OEM module must be externally powered with a +5 V to 24 V @ 5 W power supply.

You can connect an external power supply either to the barrel power connector on the module, as shown on [page 31](#), or to the three-position screw terminal block (TB1) on the module, as shown in [Figure 38](#).



The DT9847-2-2-OEM and DT9847-3-1-OEM modules accept an +5 V to 24 V @ 5 W external power supply.

Figure 38: Connecting an External Power Supply to Screw Terminal TB1 on the Module



Register-Level Programming

Writing to the EEPROM Register..... 138

Writing to the EEPROM Register

If you want to change the default values that are defined in the Open Layers Control Panel programmatically, you can use the Data Acq SDK function `olDiagWriteReg` to write to the EEPROM register of the module.

On the DT9847 Series modules, the Open Layers Control Panel has controls for setting the following parameters, which are stored in 8 consecutive bytes of EEPROM:

- Channel 0, 1, and 2 coupling type. The values AC or DC are stored as constants for these controls.
- Channel 0, 1 and 2 current source. The values INTERNAL, EXTERNAL or DISABLED are stored as constants for these controls. Note that while the control panel has only two states (Enabled and Disabled), three states are actually defined, as follows:
 - INTERNAL = Enabled (used by the control panel)
 - EXTERNAL = Disabled
 - DISABLED = Disabled (used by the control panel)

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

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

```
#define EEPROM_MEM_BASE          0x100000
// Coupling storage offsets relative to the base address for the
// three analog input channels
const EEPROM_OFFSET_COUPLING_0 = 0x0020;
const EEPROM_OFFSET_COUPLING_1 = 0x0021;
const EEPROM_OFFSET_COUPLING_2 = 0x0022;
// Current source storage offsets relative to the base address for
// the three analog input channels
const EEPROM_OFFSET_CURRENT_SOURCE_0 = 0x0024;
const EEPROM_OFFSET_CURRENT_SOURCE_1 = 0x0025;
const EEPROM_OFFSET_CURRENT_SOURCE_2 = 0x0026;
```

Note: `olDiagReadReg()` and `olDiagWriteReg()` require a ULONG value for the data parameter, but we are reading and writing only a single byte (last parameter).

```
// For example, to read the current source power-up default for
// channel 2, use the following code:
ULONG Channel_2_Current_Source;
OLSTATUS olStatus = olDiagReadReg(m_hDev, EEPROM_MEM_BASE +
    EEPROM_OFFSET_CURRENT_SOURCE_2, &Channel_2_Current_Source, 1);

// For example, to set the coupling power-up default for channel 0
// to AC, use the following code:
OLSTATUS olStatus = olDiagWriteReg(m_hDev, EEPROM_MEM_BASE +
    EEPROM_OFFSET_COUPLING_0, (ULONG) AC, 1);
```

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