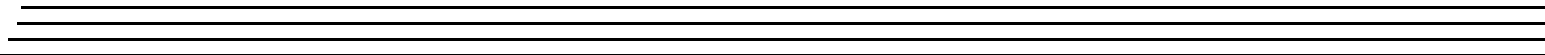
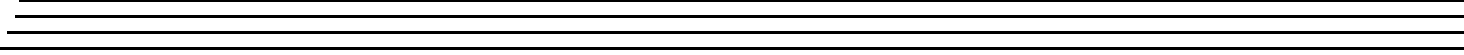
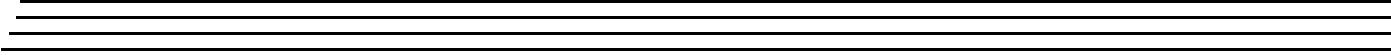


DATA TRANSLATION[®]
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UM-22417-AK

DT9837 Series User's Manual



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About this Manual

The DT9837 Series includes the DT9837, DT9837A, DT9837B, and DT9837C modules. The first part of this manual describes how to install and set up your DT9837 Series module and device driver, and verify that your module is working properly.

The second part of this manual describes the features of the DT9837 Series modules and the capabilities of the DT9837 Series Device Drivers in Windows. Troubleshooting and calibration information is also provided.

Intended Audience

This document is intended for engineers, scientists, technicians, or others responsible for using and/or programming a DT9837 Series module for data acquisition operations. It is assumed that you have some familiarity with data acquisition principles and that you understand your application.

Note: The majority of this manual assumes that you are using DT-Open Layers in Windows to communicate with your device. If you want to program your device using the Linux or macOS operating system, disregard the Windows usage sections in this manual and refer to [Appendix D](#) starting on [page 145](#).

How this Manual is Organized

This manual is organized as follows:

- [Chapter 1, “Overview,”](#) describes the major features of the DT9837 Series modules, as well as the supported software and accessories for the modules.
- [Chapter 2, “Setting Up and Installing the Module,”](#) describes how to install a DT9837 Series module, how to apply power to the module, and how to configure the DT9837 Series Device Drivers in Windows.
- [Chapter 3, “Wiring Signals,”](#) describes how to wire signals to a DT9837 Series module.
- [Chapter 4, “Verifying the Operation of a Module \(Windows Only\),”](#) describes how to verify the operation of a DT9837 Series module with the Quick DataAcq application in Windows.
- [Chapter 5, “Principles of Operation,”](#) describes all of the features of the DT9837 Series modules and how to access them in your application.
- [Chapter 6, “Supported Device Driver Capabilities \(Windows Only\),”](#) lists the data acquisition subsystems and the associated features accessible using the DT9837 Series Device Drivers in Windows.
- [Chapter 7, “Troubleshooting,”](#) provides information that you can use to resolve problems with the DT9837 Series modules and DT9837 Series Device Driver, should they occur.

- [Chapter 8, “Calibration \(Windows Only\),”](#) describes how to calibrate the analog I/O circuitry of the DT9837 Series modules in Windows.
- [Appendix A, “Specifications,”](#) lists the specifications of the DT9837 Series modules.
- [Appendix B, “Connector Pin Assignments and LED Status Indicators,”](#) lists the pin assignments of the connectors on the DT9837 Series modules.
- [Appendix C, “Register-Level Programming,”](#) describes the registers for the DT9837 Series modules.
- [Appendix D, “Programming in Linux or macOS,”](#) provides information about programming the DT9837A, DT9837B, and DT9837C modules using the Linux or macOS operating systems rather than Windows.
- 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 DT9837 Series modules:

- *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 in Windows.
- *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 for Windows, 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 in Windows, 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 in Windows.
- *UL for Linux Online Help* (<https://github.com/mccdaq/uldaq>). This help file describes how to use the Universal Library from Measurement Computing with the DT9837A, DT987B, or DT9837C module using the Linux or macOS operating system.

Where To Get Help

Should you run into problems installing or using a DT9837 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

The DT9837, DT9837A, DT9837B, and DT9837C are high-performance, multifunction data acquisition modules for the USB (Ver. 2.0 or Ver. 1.1) bus.

Table 1 lists the major differences among the modules.

Table 1: Major Differences Among the DT9837 Series Modules

Feature	DT9837	DT9837A	DT9837B	DT9837C
Connectors	BNC	BNC	BNC	BNC (on the DT9837C-BNC) or Mini XLR (on the DT9837C-XLR)
Maximum A/D Throughput	52.734 kHz	52.734 kHz	105.469 kHz	105.469 kHz
AC Coupling at -3 dB	0.5 Hz	0.1 Hz	0.5 Hz	1 Hz
Current Source	4 mA	4 mA	4 mA	2 mA
A/D Threshold Trigger ^a	Fixed	Programmable	Programmable	Programmable
Number of Tachometer Counters	1	2 (C/T 0 and 1)	2 (C/T 0 and 1)	0
Number of Gate Inputs	0	1 ^b (C/T 2)	1 ^c (C/T 2)	0
Number of Analog Output Channels	1	1	0	1
Analog Output Readback Capability	No	Yes	No	No
Maximum Analog Output Throughput	46.875 kHz (fixed)	52.734 kHz	–	96 kHz
Analog Output Voltage	10 V @ 1 mA	10 V @ 3 mA	–	±3 V @ 2 mA
Analog Output Trigger Types	Software trigger only	Software trigger, external digital trigger	None	Software trigger, external digital trigger
RJ45 Synchronization Connector	No	Yes	Yes	Yes

a. For the start trigger on the DT9837, the threshold channel is channel 0 and the threshold level is fixed at 1.0 V.

For the start trigger on the DT9837A and DT9837B, the threshold channel is channel 0 and the analog threshold level is programmable from 0.2 V to 9.8 V with 0.1 V of hysteresis.

For the start trigger on the DT9837C, the threshold channel can be any of the analog input channels and the threshold level is programmable between ±10 V for a gain of 1 and ±1 V for a gain of 10.

For the reference trigger on all modules, the threshold channel can be any of the analog input channels and the threshold level is programmable between ±10 V for a gain of 1 and ±1 V for a gain of 10.

b. Available on the DT9837A-OEM version.

c. Available through a BNC connector on the DT9837B module.

Key Features of the DT9837

Figure 1 shows the layout of the DT9837 module.

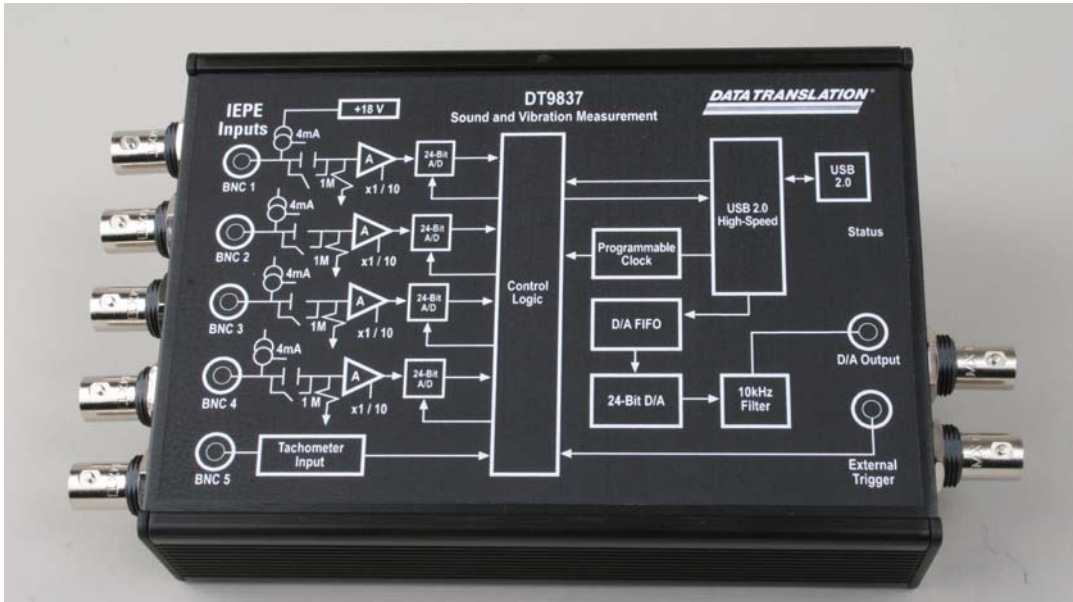


Figure 1: DT9837 Module

The key features of the DT9837 module are as follows:

- Simultaneous analog input and waveform analog output operations
- Analog input subsystem:
 - Four, simultaneous 24-bit A/D converters
 - Throughput rate up to 52.734 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 and AC or DC coupling
 - The ability to return the value of tachometer counter 0 in the analog input data stream, allowing you to measure the period or frequency of the tachometer input signal synchronously with analog input measurements
 - 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-going analog threshold trigger on analog input channel 0). The threshold level is fixed at 1.0 V for the analog threshold trigger.

- For the reference trigger, supports 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 $+10\text{ V}$.
- Analog output subsystem:
 - One 24-bit D/A converter
 - Waveform capability of up to 8,192 sample
 - Output rate of 46.875 kSamples/s
 - Output range of $\pm 10\text{ V}$
 - A software trigger starts the analog output operation
- Internal clock source (shared between the analog input and analog output subsystems)

Key Features of the DT9837A

Figure 2 shows the layout of the DT9837A module.

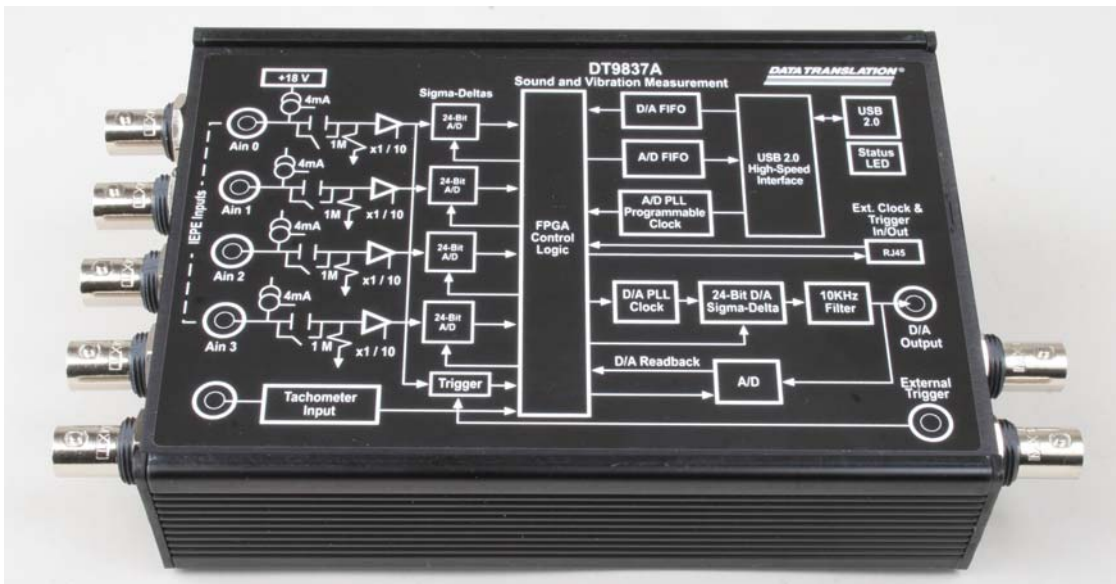


Figure 2: DT9837A Module

The key hardware features of the DT9837A module are as follows:

- Simultaneous analog input and analog output operations (continuous or waveform mode)
- Analog input subsystem:
 - Four, simultaneous 24-bit A/D converters
 - Throughput rate up to 52.734 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
- The ability to return the value of tachometer counter 0 in the analog input data stream, allowing you to measure the period or frequency of the tachometer input signal synchronously with analog input measurements
- The ability to read the value of tachometer counter 1 in the analog input data stream, allowing you to precisely correlate tachometer measurements with analog input measurements
- Optional OEM version of this module, called the DT9837A-OEM, supports the ability to read the value of gate counter 2 in the analog input data stream, allowing you to precisely correlate gate input measurements with analog input measurements
- Supports reading analog output values in the analog input data stream, allowing you to correlate input and output values
- 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-going analog threshold trigger on analog input channel 0). You can program the analog input threshold value from 0.2 V to 9.8 V with 0.1 V of hysteresis.
- For the reference trigger, supports 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 24-bit D/A converter
 - Single value, waveform, and continuous streaming output
 - Programmable output rate from 10 kSamples/s to 52.734 kSamples/s
 - Output range of ± 10 V
 - Software-programmable trigger source (software trigger, external digital trigger, or analog threshold trigger) to start the analog output operation.
- Internal clock source (shared between the analog input and analog output subsystems)
- RJ45 synchronization (LVDS) connector for synchronizing acquisition on up to four DT9837A modules

Key Features of the DT9837B

Figure 3 shows the layout of the DT9837B module.

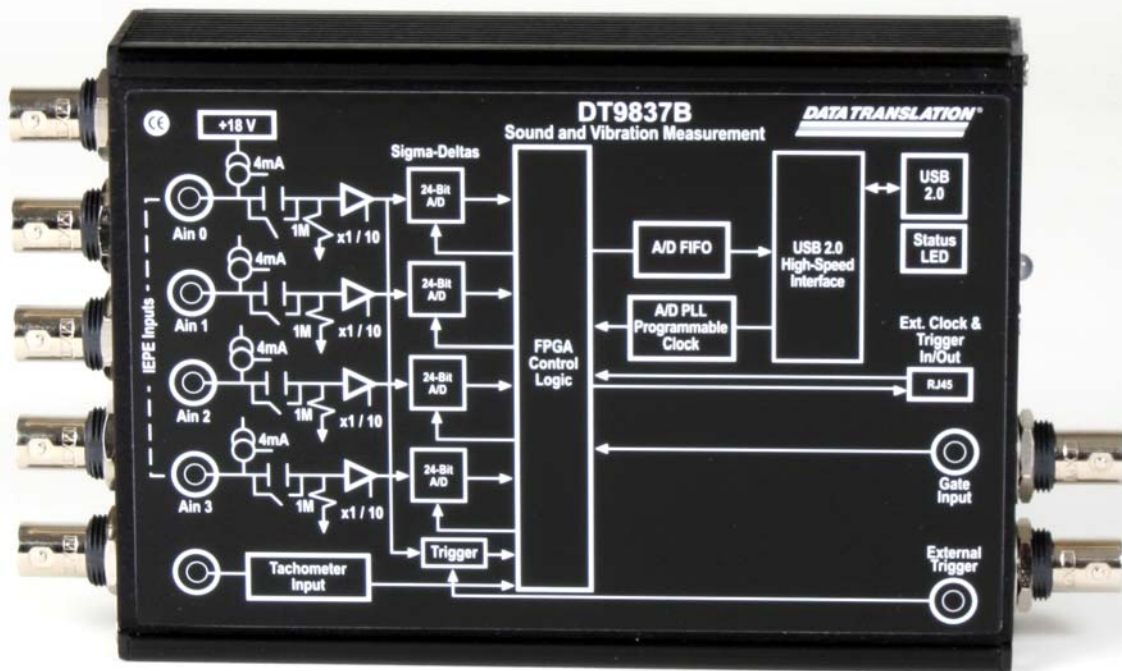


Figure 3: DT9837B Module

The key hardware features of the DT9837B module are as follows:

- Four, simultaneous 24-bit A/D converters
- Internal clock source with a throughput rate up to 105.469 kSamples/s for simultaneous, high-resolution analog input 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
- The ability to return the value of tachometer counter 0 in the analog input data stream, allowing you to measure the period or frequency of the tachometer input signal synchronously with analog input measurements
- The ability to read the value of tachometer counter 1 in the analog input data stream, allowing you to precisely correlate tachometer measurements with analog input measurements
- The ability to read the value of gate counter 2 in the analog input data stream, allowing you to precisely correlate gate input measurements with analog input measurements

- 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-going analog threshold trigger on analog input channel 0). You can program the analog input threshold value from 0.2 V to 9.8 V with 0.1 V of hysteresis.
- For the reference trigger, supports 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.
- RJ45 synchronization (LVDS) connector for synchronizing acquisition on up to four DT9837B modules

Key Features of the DT9837C

Figure 4 shows the layout of DT9837C module. The model shown is the board-level, OEM version with mini-XLR connectors.

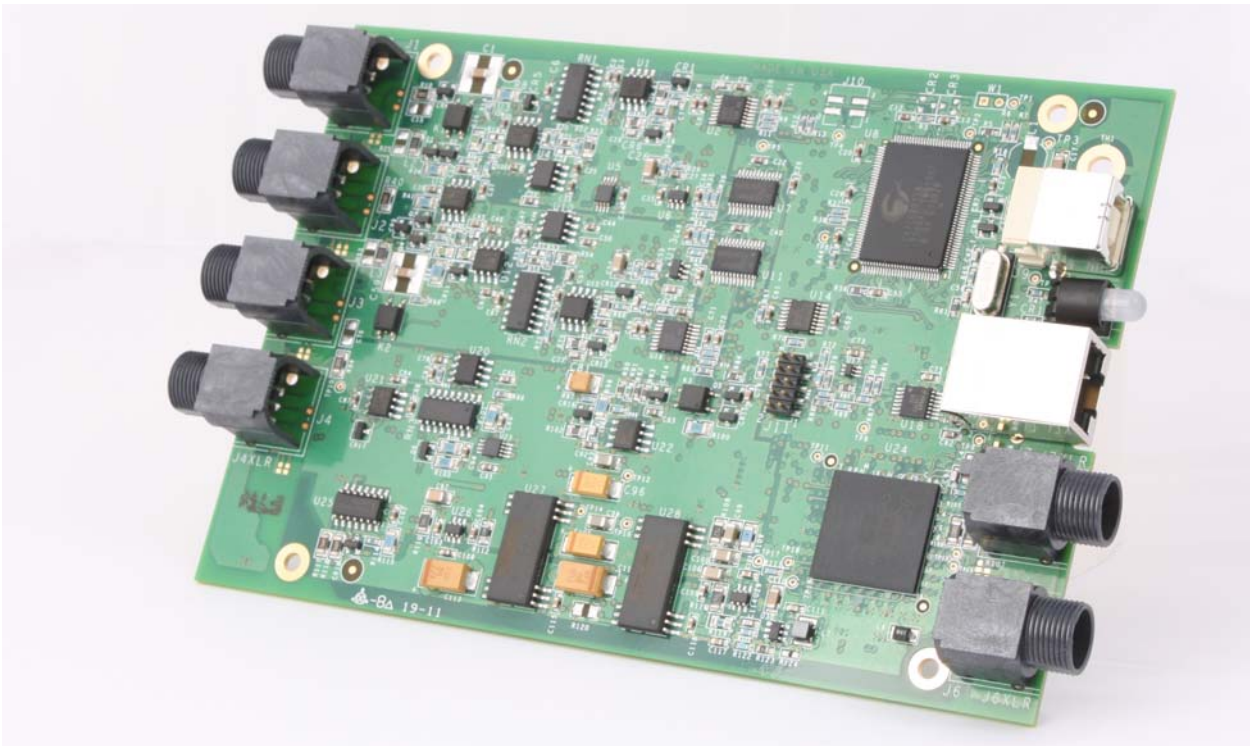


Figure 4: DT9837C Module

The key hardware features of the DT9837C module are as follows:

- Simultaneous analog input and analog output operations (continuous or waveform mode)
- Mini-XLR connectors (on the DT9837C-XLR) or BNC connectors (on the DT9837C-BNC) for connecting audio inputs
- Analog input subsystem:
 - Four, simultaneous 24-bit A/D converters
 - Throughput rate up to 105.469 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 2 mA current source with 18 V compliance voltage for AC and DC coupling
 - 1 Hz high-pass filter
 - 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 analog threshold trigger). You can program the analog input threshold trigger to come from any analog input channel, to be positive- or negative-going, and to have a threshold value from -10 V to $+10$ V.
 - For the reference trigger, supports 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 24-bit D/A converter
 - Single value, waveform, and continuous streaming output
 - Programmable output rate from 10 kSamples/s to 96 kSamples/s
 - Output range of ± 3 V
 - ± 2 mA output current
 - Software-programmable trigger type (software trigger, external digital trigger, or analog threshold trigger) to start the analog output operation.
- Internal clock source (shared between the analog input and analog output subsystems)
- RJ45 synchronization (LVDS) connector for synchronizing acquisition on up to four DT9837C modules

Supported Software

This section describes compatible software for the Windows, Linux, and macOS operating systems.

Windows Software

The following software is available for use with the DT9837 Series modules in Windows and is included on the Data Acquisition OMNI CD:

- **DT9837 Series Device Drivers** – Two device drivers are provided in the DT9837 Series: one for the DT9837 module and one for the DT9837A, DT9837B, and DT9837C modules. The DT9837 Series Device Drivers allow you to use a DT9837, DT9837A, DT9837B, or DT9837C module with any of the supported software packages or utilities.
- **DT9837 Series Calibration Utility** – This utility, described in [Chapter 8](#) starting on [page 111](#), allows you to calibrate the analog input and analog output circuitry of a DT9837 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 with the FFT Analysis option 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 DT9837 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 DT9837 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 DT9837 Series module using Windows Vista, Windows 7, or Windows 8; the DataAcq SDK complies with the DT-Open Layers standard.
- **DAQ Adaptor for MATLAB** – Data Translation’s DAQ Adaptor provides an interface between the MATLAB Data Acquisition (DAQ) subsystem from The MathWorks and Data Translation’s DT-Open Layers architecture.
- **LV-Link** – A link to LV-Link is included on the Data Acquisition OMNI CD. Use LV-Link if you want to use the LabVIEW graphical programming language to access the capabilities of the DT9837 Series module.

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

Linux or macOS Software

If you want to program the DT9837A, DT9837B, or DT9837C in Linux or macOS, the Universal Library (UL) for Linux available from Measurement Computing Corporation is available.

Refer to [Appendix D](#) starting on [page 145](#) for more information about using UL for Linux.

Supported Accessories

The EP386 panel, shown in [Figure 5](#), is available for use with the DT9837A, DT9837B, and DT9837C modules.

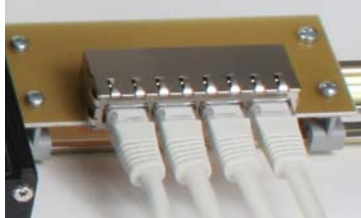


Figure 5: EP386 Panel

This RJ45 distribution panel contains four RJ45 connectors that are wired in parallel, making it useful when attaching up to four DT9837A, DT9837B, or DT9837C modules together. Refer to [page 88](#) for more information on using this panel.

Note: You must have revision H or later of the DT9837A module or revision F or later of the DT9837A-OEM module to be able to attach four modules together. You can identify the revision of your module by looking at the serial number label on your module.

If you have revision G or earlier of the DT9837A or revision E or earlier of the DT9837A-OEM, you can attach a maximum of two modules together.

Getting Started Procedure

The flow diagram shown in [Figure 6](#) illustrates the steps needed to get started using a DT9837 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.

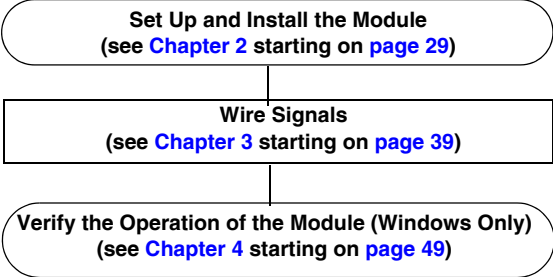


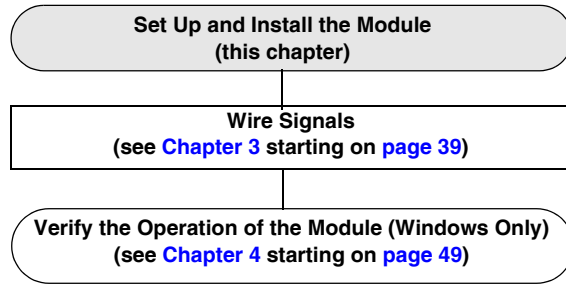
Figure 6: Getting Started Flow Diagram

Part 1: Getting Started



Setting Up and Installing the Module

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Configuring the DT9837 Series Device Drivers (Windows Only)	36



Unpacking

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

- DT9837, DT9837A, DT9837B, or DT9837C module
- EP365 USB cable
- Data Acquisition OMNI CD-ROM (needed only if you are programming in Windows)

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 DT9837 Series modules are factory-calibrated. If you decide that you want to recalibrate the analog input or analog output circuitry in Windows, refer to the instructions in [Chapter 8](#).

System Requirements

If you are using Windows, 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

If you are using Linux or macOS, refer to <https://github.com/mccdaq/uldaq> for information on supported Linux and macOS distributions.

Attaching Modules to the Computer

This section describes how to attach a DT9837 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 DT9837 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 DT9837 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. If you are using Windows, run the installation program on your Data Acquisition OMNI CD to install the device driver and other software for the module. If you are using Linux or macOS, refer to the instructions from github at <https://github.com/mccdaq/uldaq> to build and install UL for Linux.

Connecting Directly to the USB Ports

To connect a DT983 Series module directly to a USB port on your computer, do the following:

1. Attach one end of the USB cable to the USB port on the module.
2. Attach the other end of the USB cable to one of the USB ports on the host computer, as shown in [Figure 7](#).

The operating system automatically detects the USB module.

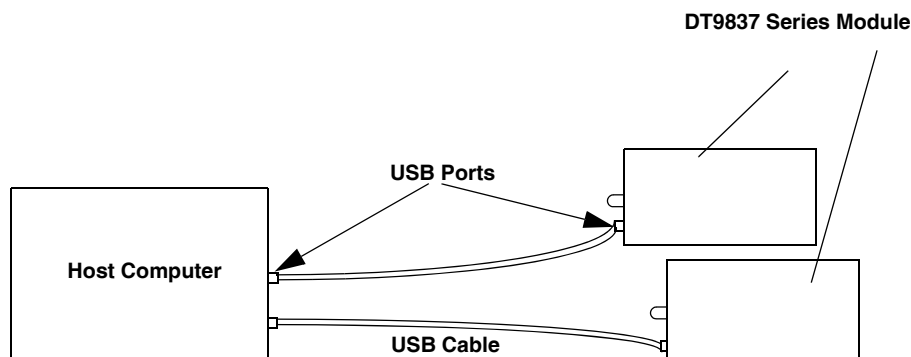


Figure 7: Attaching the Module to the Host Computer

3. *For Windows Vista only:*
 - 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**.
4. Repeat these steps to attach another DT9837 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 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 DT9837 Series modules that you can connect to a single USB port depends on the throughput you want to achieve.

To connect multiple DT9837 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.
2. Connect the power supply for the expansion hub to an external power supply.
3. Connect the expansion hub to the USB port on the host computer using another USB cable.
The operating system automatically detects the USB module.
4. *For Windows Vista only:*
 - 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**.
5. Repeat these steps until you have attached the number of expansion hubs and modules that you require. Refer to [Figure 8](#).
The operating system automatically detects the USB devices as they are installed.

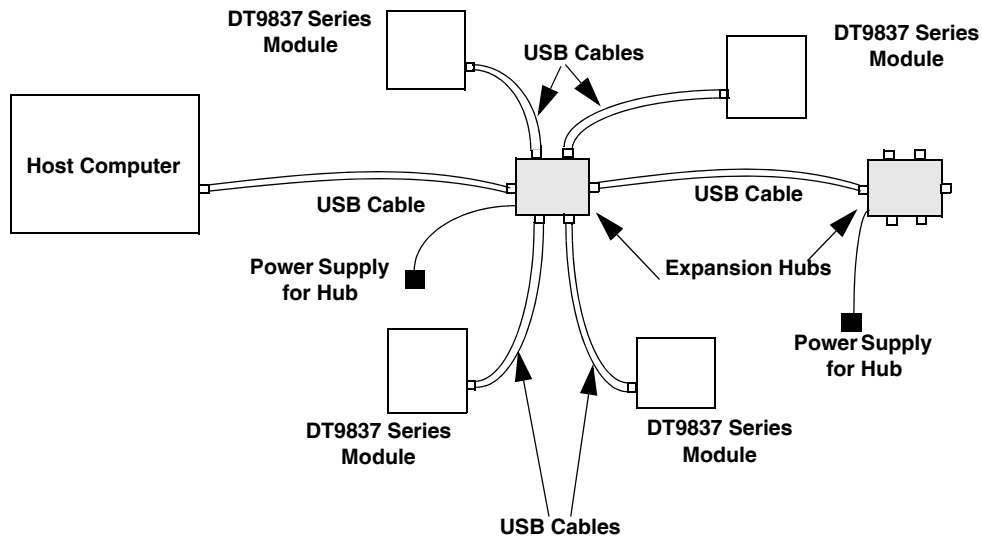


Figure 8: Attaching Multiple Modules Using Expansion Hubs

Note: Once you have connected your module to the host computer, power is turned on to the DT9837 Series module when your application program opens 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 DT9837 Series Device Drivers (Windows Only)

This section applies to Windows only. If you are using Linux or macOS, refer to [Appendix D](#) starting on [page 145](#) for more information.

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 DT9837 Series module in Windows, 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. Check the **Power Always On** box if you want to enable high power mode or uncheck this box to disable high power mode (the default). Turning off the high-power circuitry helps to conserve power, which may be useful when the module is used with a laptop. However, to ensure that the module is warmed up and that any settling time errors of the IEPE current source are minimized, it is recommended that you check this option to keep the module's high-power circuitry always turned on.

7. You can read the number of counts between two consecutive starting edges of the tachometer input signal by including channel 4 (tachometer counter 0) in the analog input channel list. On the DT9837 module, the starting edge is always rising; on the DT9837A and DT9837B modules, the starting edge is programmable (either rising or falling). See [page 82](#) for more information.

For the DT9837, skip to step 11. For the DT9837A and DT9837B modules, configure the Tach.CT0 measurement parameters as follows:

- a. From the **Start Select** combo box, select the edge (**Rising Edge** or **Falling Edge**) of the tachometer input signal that you want to use to start the measurement.
 - b. From the Measure Mode combo box, select **Zeros** if you want to read a value of 0 between measurements, or select **Previous Measurement** if you want to read the previous measurement value if the new measurement value is not yet complete.
 - c. From the **Stale Data** combo box, select **Used** if you want to indicate whether or not the measurement value is new, or select **Not Used** if you do not want to indicate whether the measurement value is new. If you select **Used**, the most significant bit (MSB) of the measurement value is set to 0 when the value is new and set to 1 when the measurement is not yet complete. If you select **Not Used**, the MSB of the measurement value is always 0.
8. On the DT9837A and DT9837B modules, you can measure the phase of the tachometer input signal in relation to the A/D sample by specifying channel 5 (tachometer counter 1) in the analog input channel list; see [page 84](#) for more information. Configure the Tach.CT1 measurement parameters as follows:

- a. From the **Start Select** combo box, select the signal that you want to use to start the measurement (**A/D Sample**, **Tach Input Rising Edge**, or **Tach Input Falling Edge**).
- b. From the **Stop Select** combo box, select the signal that you want to use to stop the measurement (**A/D Sample**, **Tach Input Rising Edge**, or **Tach Input Falling Edge**).

Note that if you choose to start the measurement using the A/D sample, choose a tachometer edge to stop the measurement. Likewise, if you choose to stop the measurement using the A/D sample, choose a tachometer edge to start the measurement.

- c. From the **Self Clear** combo box, select **Clear to zero** if you want to return a value of 0 between measurements, or select **Keep last Value** if you want to return the previous measurement value between readings.

9. For the DT9837A-OEM and DT9837B modules, you can also measure the phase of the gate input signal in relation to the A/D sample by specifying channel 6 (gate counter 2) in the analog input channel list; see [page 85](#) for more information. Configure the Gate.CT2 measurement parameters as follows:
 - a. From the **Start Select** combo box, select the signal that you want to use to start the measurement (**A/D Sample**, **Gate Rising Edge**, or **Gate Falling Edge**).
 - b. From the **Stop Select** combo box, select the signal that you want to use to stop the measurement (**A/D Sample**, **Gate Rising Edge**, or **Gate Falling Edge**).

Note that if you choose to start the measurement using the A/D sample, choose a gate edge to stop the measurement. Likewise, if you choose to stop the measurement using the A/D sample, choose a gate edge to start the measurement. If you choose the start and stop the measurement using the same gate edge, you will measure the pulse width of the gate signal; be aware that the stopping edge does not restart the measurement; the next starting edge will start the next measurement.
 - c. From the **Self Clear** combo box, select **Clear to zero** if you want to return a value of 0 between measurements, or select **Keep last Value** if you want to return the previous measurement value between readings.
10. For the Coupling type, select **AC** for AC coupling or **DC** for DC coupling.
11. For the Current Source, select **Enabled** to enable the internal excitation current source or **Disabled** to disable the internal excitation current source.

Note: If you enable the use of the internal excitation current source, it is recommended that you choose AC coupling. Refer to [page 44](#) for more information on wiring IEPE inputs.

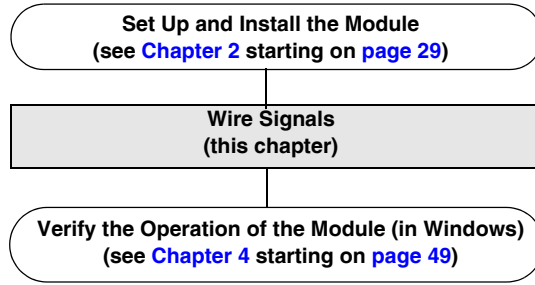
12. When you are finished, click **OK** to close the Measurement Options dialog box.
13. Repeat steps 4 to 11 for the other modules that you want to configure.
14. When you are finished configuring the modules, click **Close** to close the Control Panel.

Note: If you need to configure these settings programmatically instead of using the Open Layers Control Panel, you can write to the registers of the module (see [Appendix C](#) starting on [page 135](#)) or you can use UL for Linux (see [Appendix D](#) starting on [page 145](#)).



Wiring Signals

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Connecting a Gate Input Signal	47



Preparing to Wire Signals

This section provides recommendations and information about wiring signals to a DT9837 Series module.

Wiring Recommendations

Keep the following recommendations in mind when wiring signals to a DT9837 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.

Wiring Signals to the Module

The DT9837 module contains five BNC connectors on one end of the module, and two BNC connectors and a USB connector on the other end of the module as shown in [Figure 9](#).

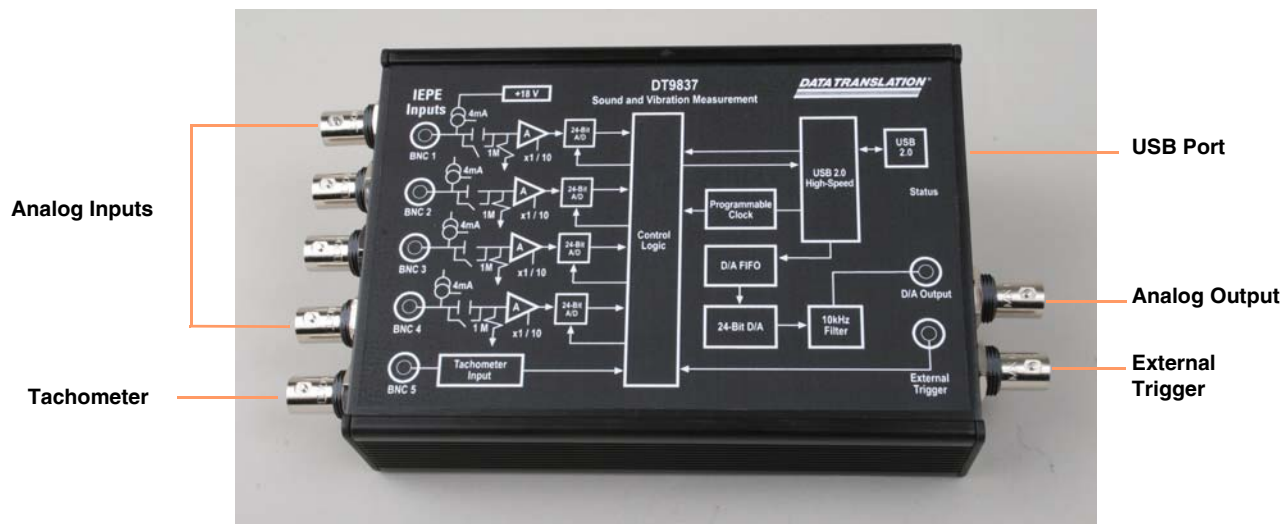


Figure 9: Connectors on the DT9837 Module

The DT9837A module, shown in Figure 10, provides all of these connectors and an additional RJ45 LVDS connector for connecting multiple modules. The OEM version of the DT9837A, shown in Figure 17 on page 47, also provides an additional gate input connector.

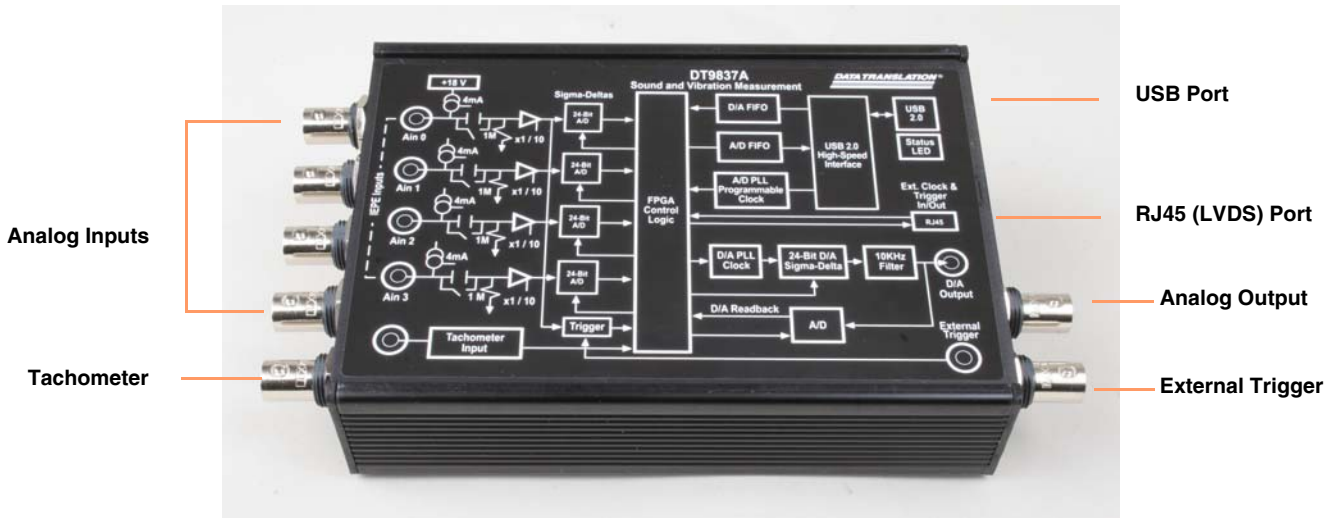


Figure 10: Connectors on the DT9837A Module

Figure 11 shows the connectors on the DT9837B module.

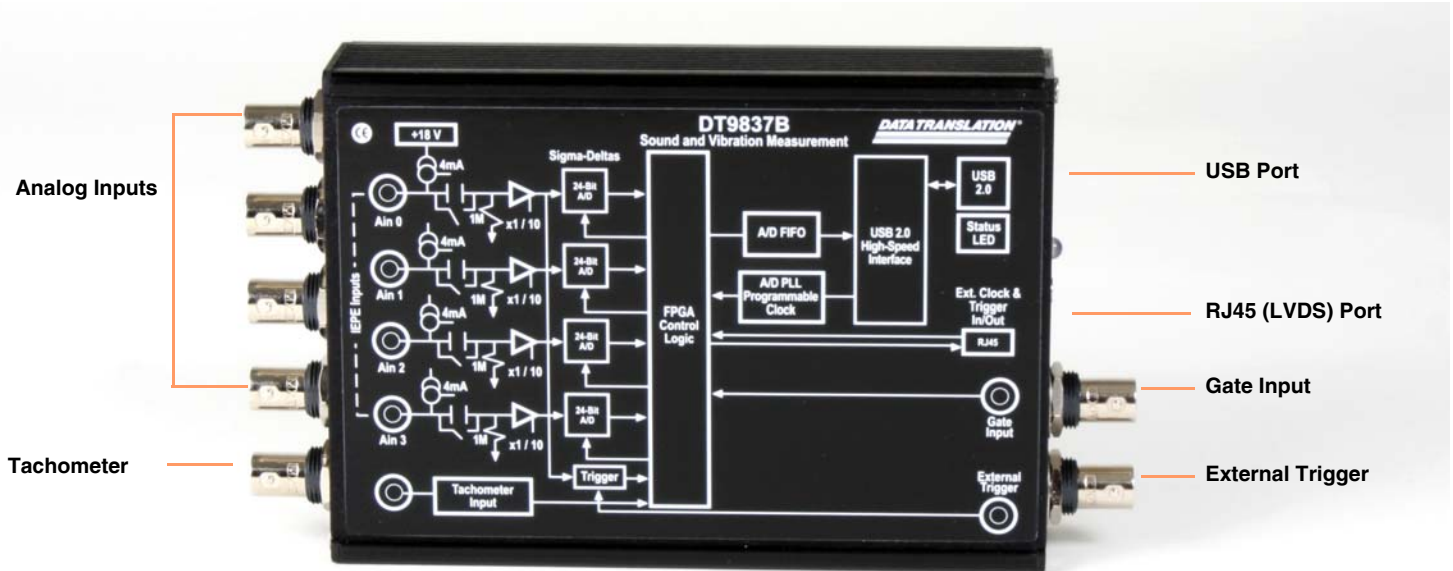


Figure 11: Connectors on the DT9837B Module

Figure 12 shows the connectors on the DT9837C-BNC module (the board-level, OEM version of the module is shown).



Figure 12: Connectors on the DT9837C-BNC Module

Figure 13 shows the connectors on the DT9837C-XLR module (the board-level, OEM version of the module is shown).

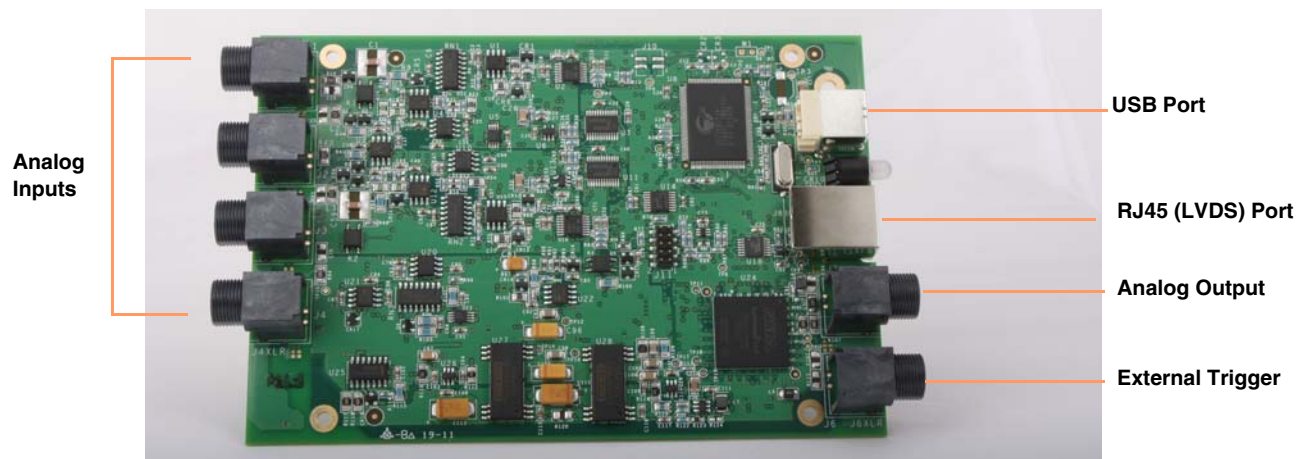


Figure 13: Connectors on the DT9837C-XLR Module

The remaining sections of this chapter describe how to attach signals to these connectors.

Connecting Analog Input Signals

You can connect up to four analog input signals (or IEPE sensors) to the BNC connectors on a DT9837 Series module. Internally, these signals are connected in single-ended mode. The DT9837 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 68](#) for more information on IEPE inputs.

[Figure 14](#) shows how to connect analog inputs (channels 0 and 1, in this case) to the connectors on the DT9837 Series modules.

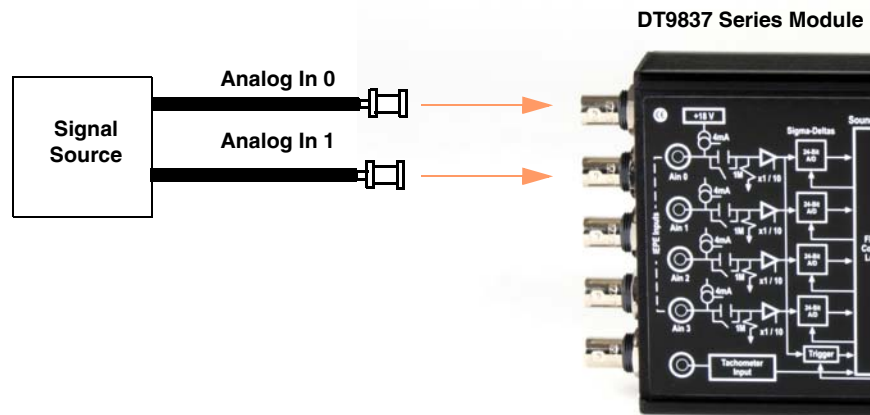


Figure 14: Connecting Analog Inputs to a DT9837 Series Module

Connecting an Analog Output Signal

The DT9837, DT9837A, and DT9837C modules provide one analog output channel. [Figure 15](#) shows how to connect an analog output signal to the DT9837, DT9837A, or DT9837C module.

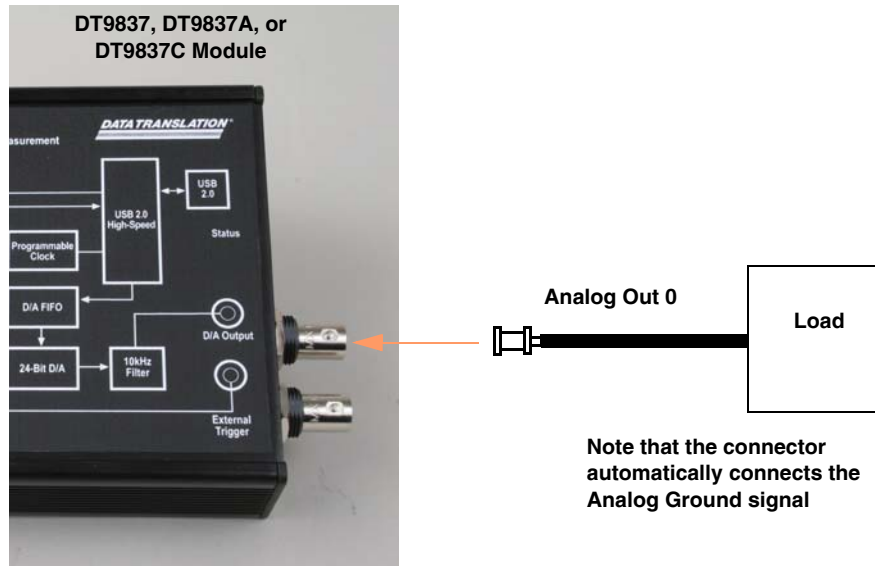


Figure 15: Connecting an Analog Output Signal to a DT9837, DT9837A, or DT9837C Module

Connecting a Tachometer Input Signal

You can connect a ± 30 V tachometer input signal to the tachometer input BNC on a DT9837, DT9837A, or DT9837B module, as shown in [Figure 16](#).

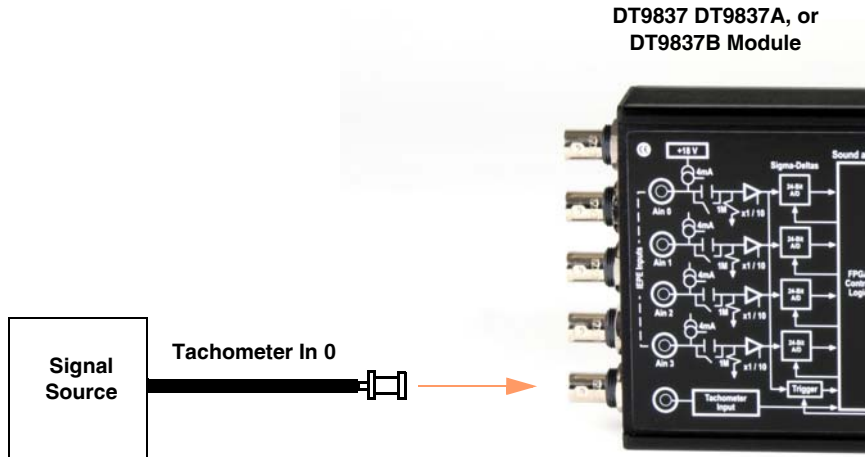


Figure 16: Connecting a Tachometer Input Signal to a DT9837, DT9837A, or DT9837B Module

Connecting a Gate Input Signal

The DT9837A-OEM module provides a 4-pin Gate Input connector for measuring period, frequency, and pulse width values. The DT9837B provides a BNC connector for attaching a gate input signal. [Figure 17](#) shows how to connect a TTL gate input signal to the DT9837A-OEM module.

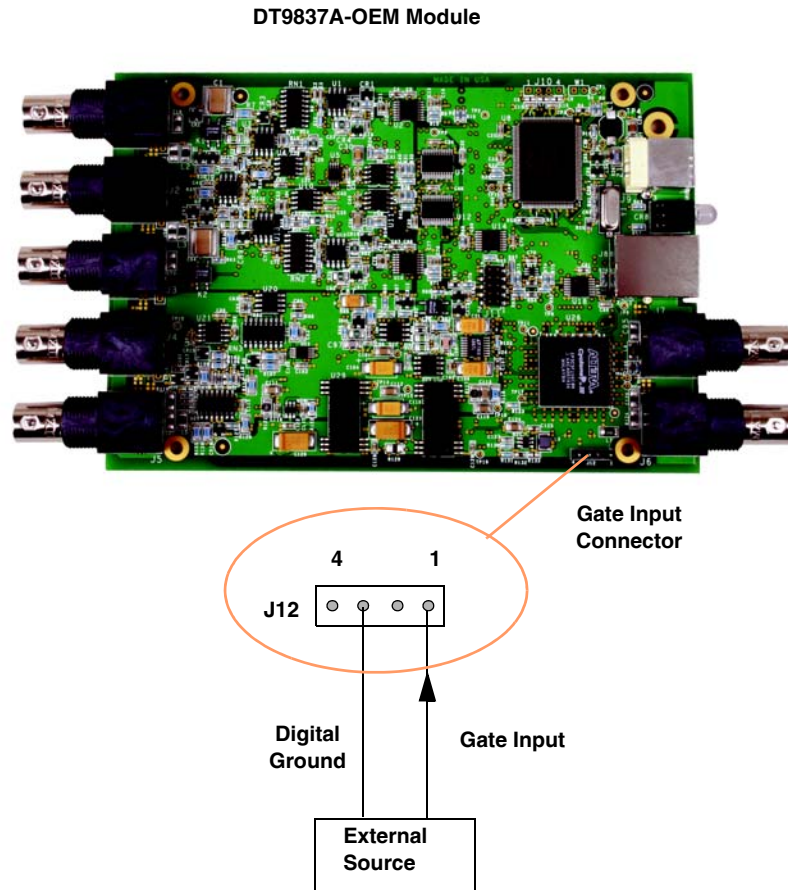


Figure 17: Connecting a Gate Input Signal to the DT9837A-OEM Module

Figure 18 shows how to attach a TTL gate input signal to a DT9837B module.

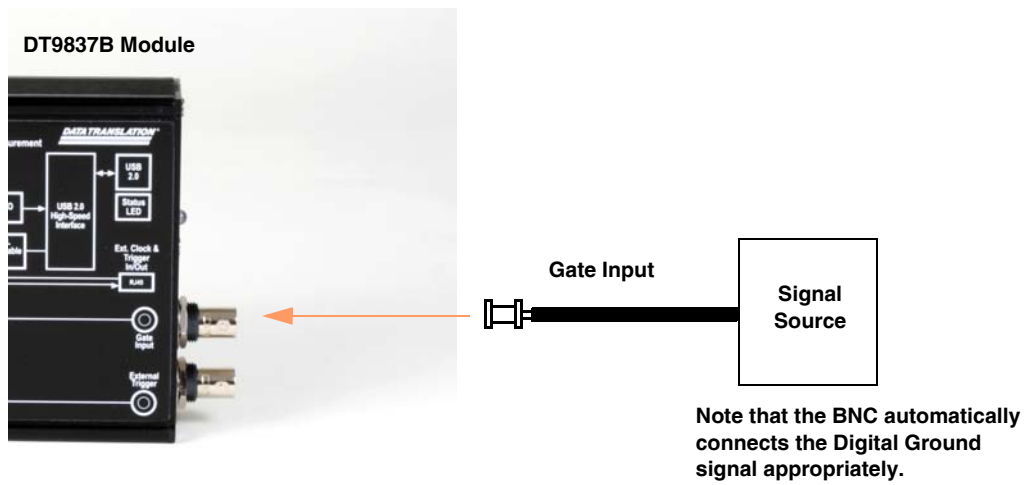
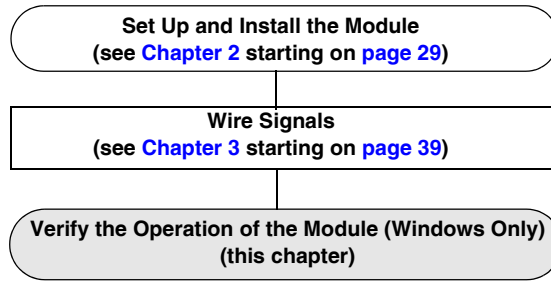


Figure 18: Connecting a Gate Input Signal to a DT9837B Module



Verifying the Operation of a Module (Windows Only)

Overview	51
Select the Device	52
Acquire Data from an Analog Output Channel	55



Overview

Note: This chapter applies only if you are using a DT9837 Series device in Windows.

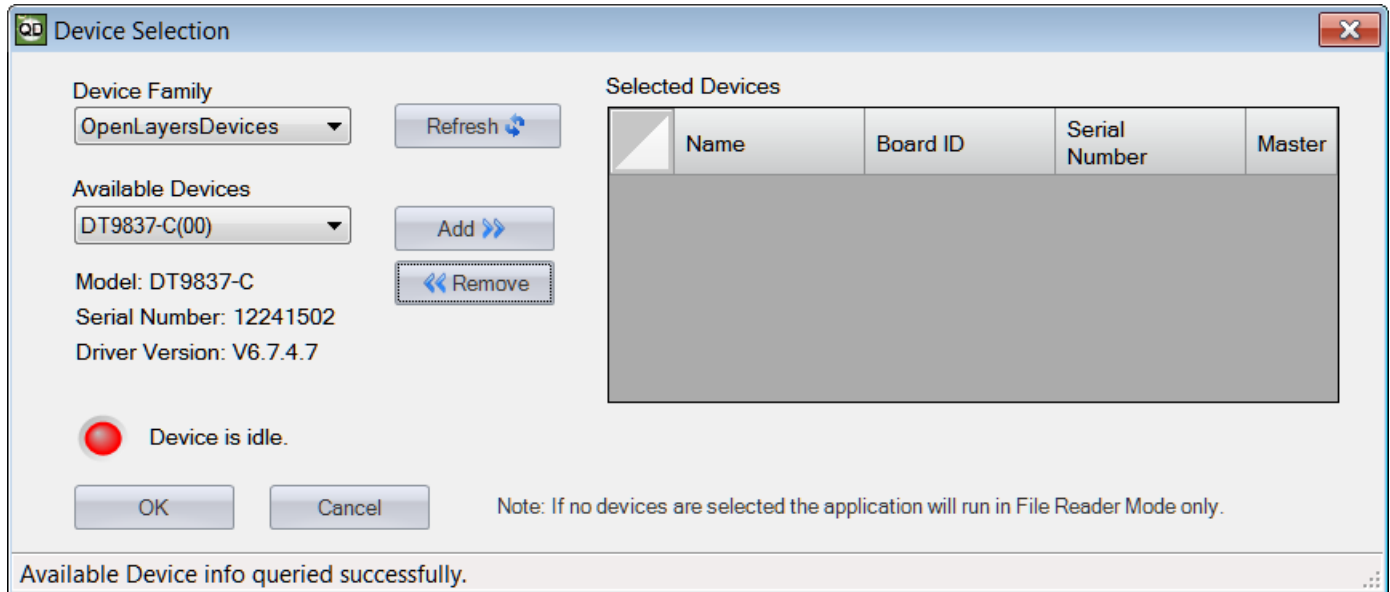
You can verify the operation of a DT9837 Series module using the QuickDAQ application.

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 DT9837 Series module using the QuickDAQ base version.

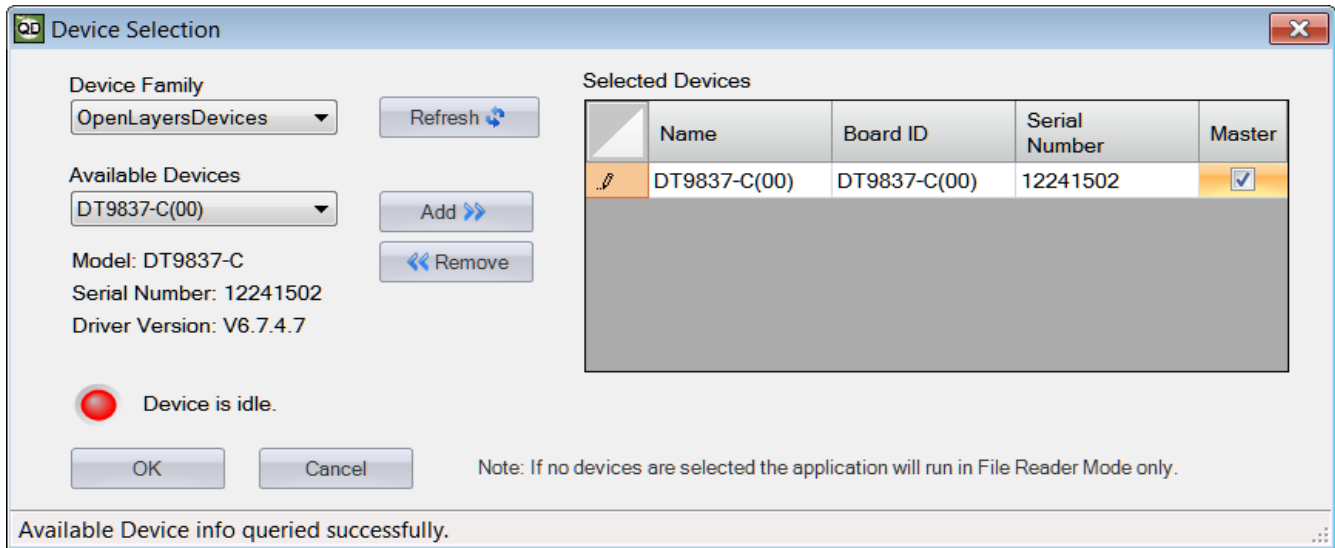
Select the Device

To get started with your DT9837 Series module and the QuickDAQ application, follow these steps:

1. Connect the DT9837 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.

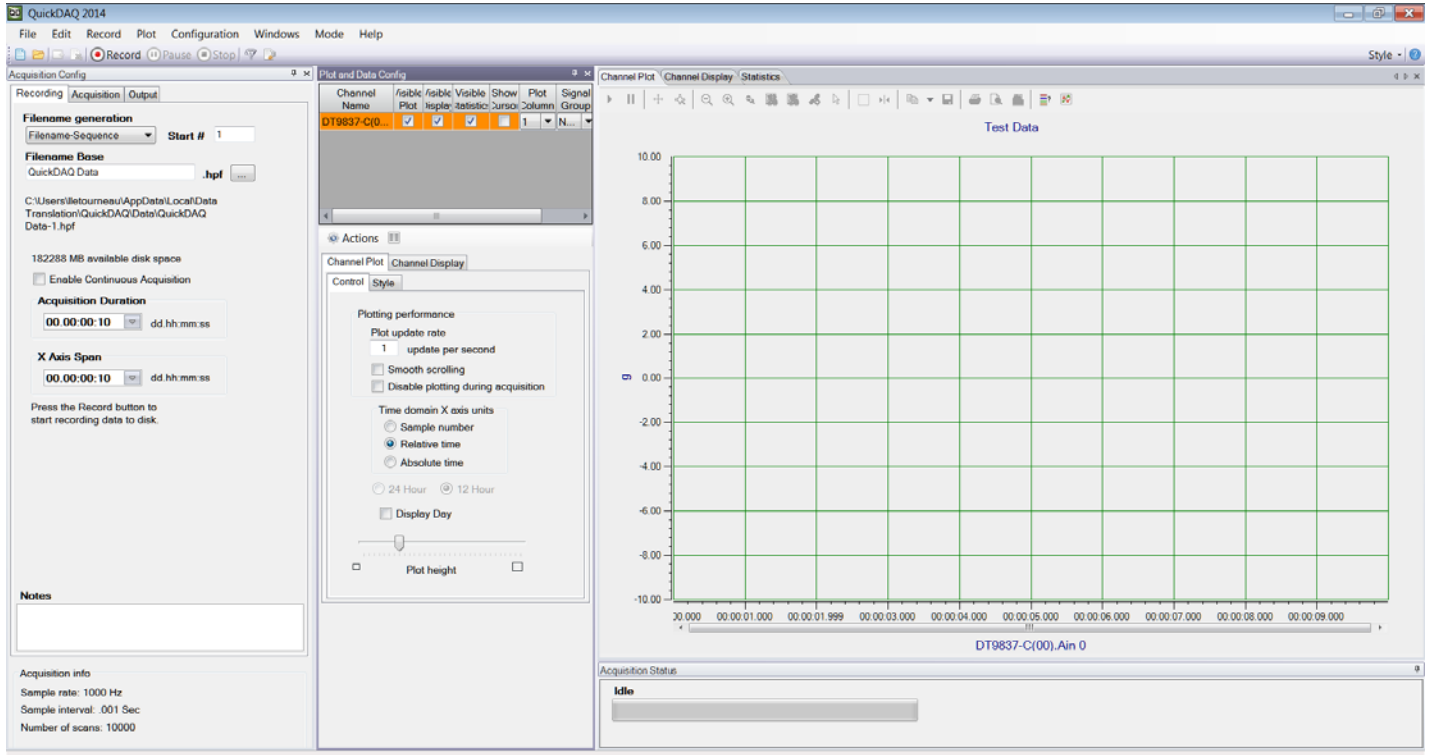


3. For the Device Family selection, select **OpenLayersDevices**.
By default, the application "discovers" all devices that are available for the specified device family and displays the module name for the USB devices in the drop-down list. If you want to refresh this list to determine if other devices are available, click **Refresh**.
4. Select the module name for the DT9837 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.



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.
5. 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.
6. (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**.
7. 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; the interface of the QuickDAQ application is displayed.*



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.

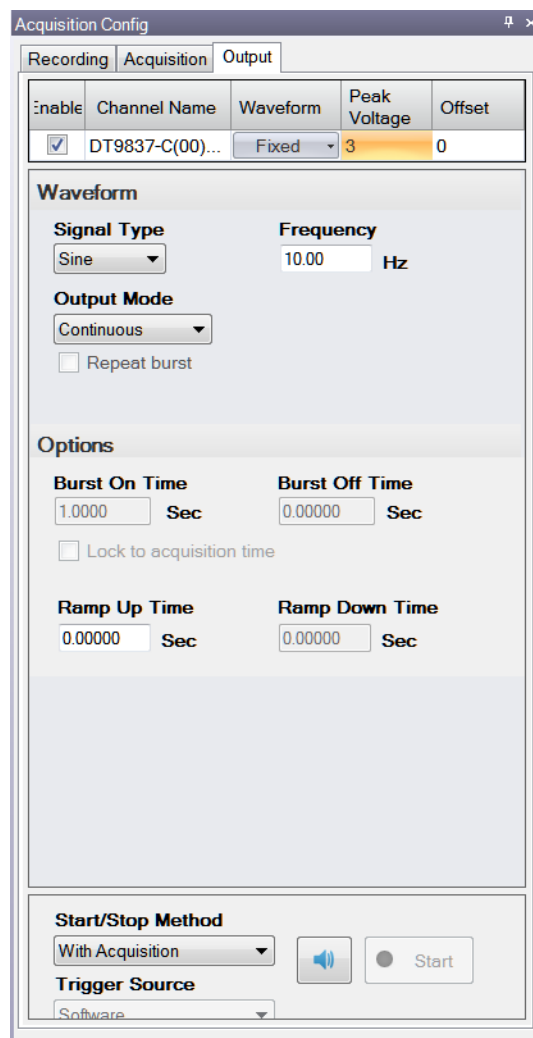
In this example, a 3 V sine wave is output on analog output channel 0 of a DT9837C module. The analog output channel is connected to analog input channel 0 on the DT9837C module.


Note: If you are using a DT9837B module, attach a voltage source of ± 10 V to analog input channel 0, and skip the next section on configuring the analog output settings.

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.

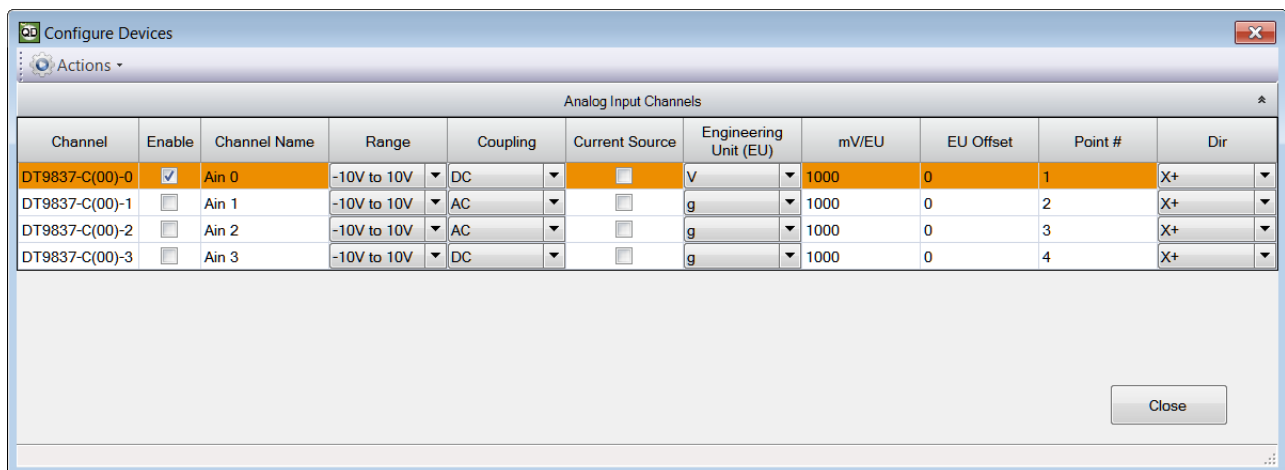


2. Select the **Enable** checkbox to enable the analog output channel on the module.
3. For the **Waveform** type, select **Fixed**.
4. For **Peak Voltage**, enter 3 to output a ± 3 V signal.
5. For **Offset**, enter 0.
6. For **Signal Type**, select **Sine** to output a sine wave.
7. For **Output Mode**, 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.



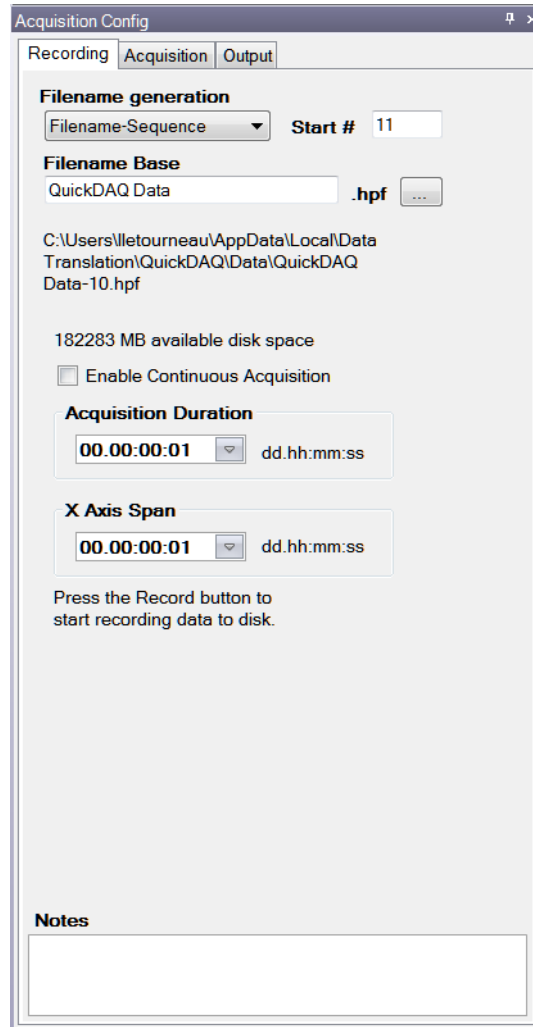
4. Under the **Channel Name** column, leave the default channel name as Ain 0.
5. Under the **Range** column, select the input range for analog input channel.
In this example, ± 10 V is used.

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 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, **1** is used.*
12. If desired, enter a sensor direction for each channel.
*In this example, the default value of **X+** 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.

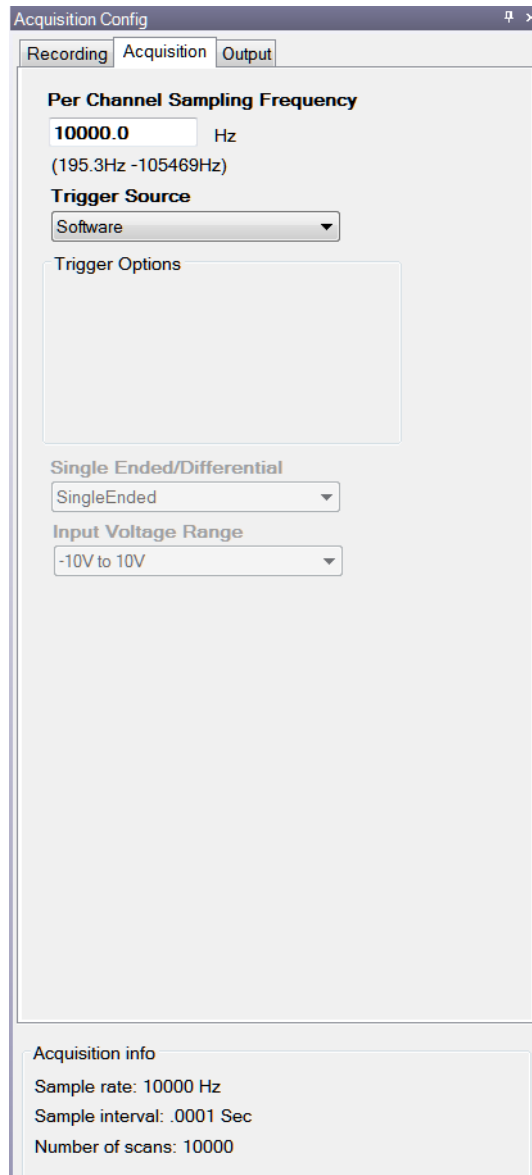


2. For **Filename generation**, use the default **Filename** option.
3. For **Filename**, use the default name for the data file.
4. Leave the **Enable Continuous Acquisition** checkbox unchecked.
5. For **Acquisition Duration**, select **1 second**.
The number of seconds for the total run and the amount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

Configure the Acquisition Settings

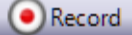
For this example, configure the acquisition settings as follows:

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

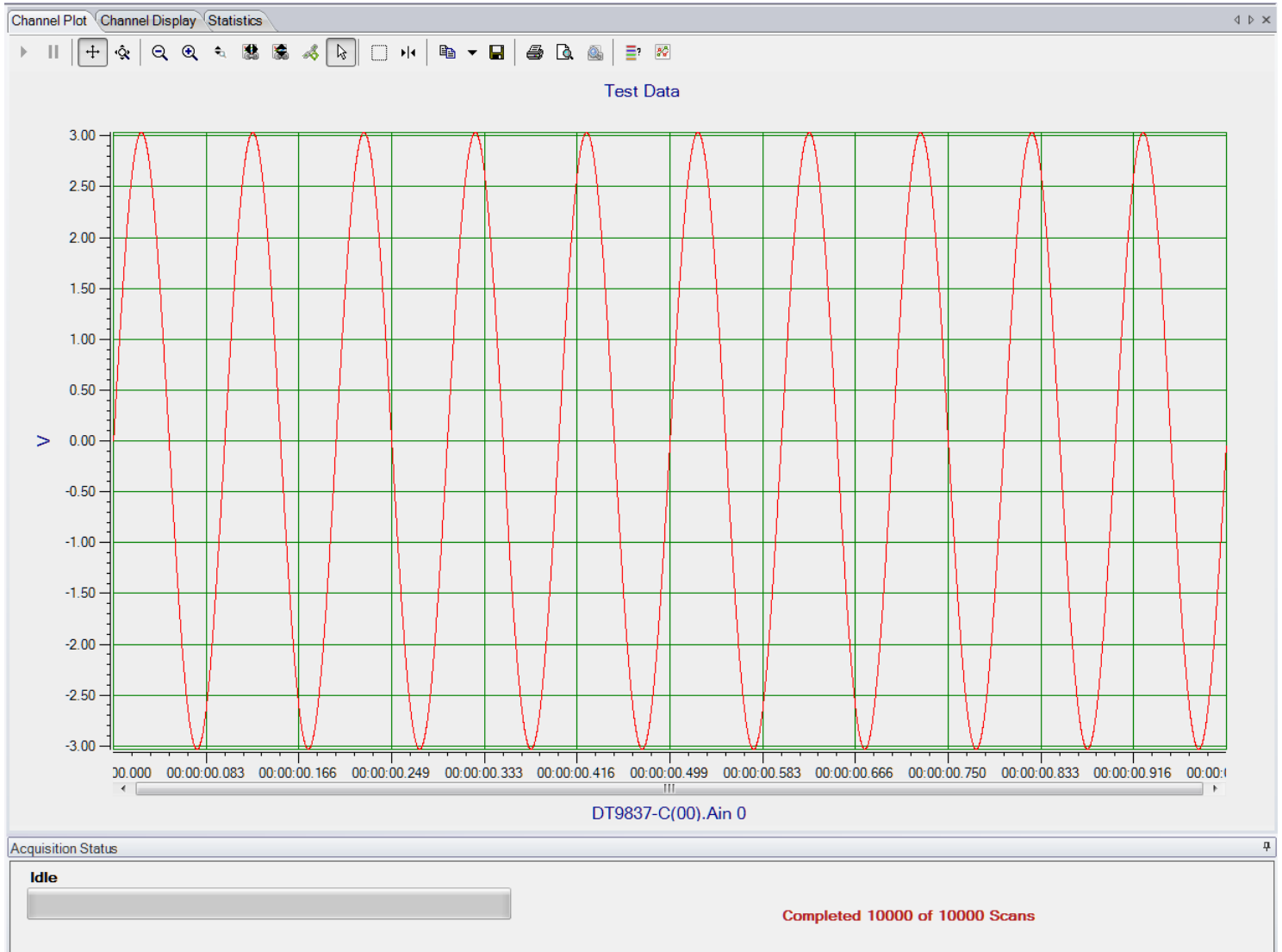


2. For the **Per Channel Sampling Frequency** text box, enter **10000**.
The sampling rate, sample interval, and number of scans are displayed.
3. For the **Trigger Source** check box, select **Software** to ensure that the measurement starts as soon as the **Record** button is clicked.

Start the Operation

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

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



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

Part 2: Using Your Module



Principles of Operation

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Block Diagrams

Figure 19 shows a block diagram of the DT9837 module.

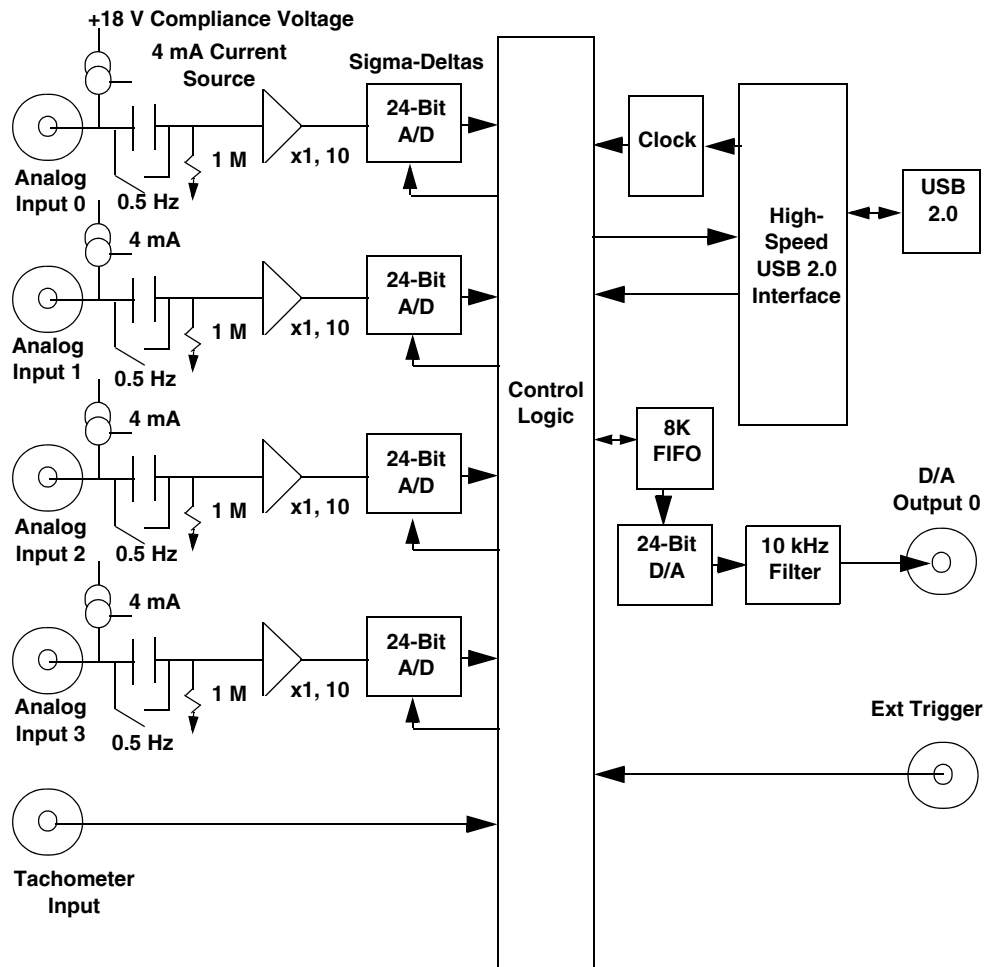


Figure 19: Block Diagram of the DT9837 Module

Figure 20 shows a block diagram of the DT9837A module.

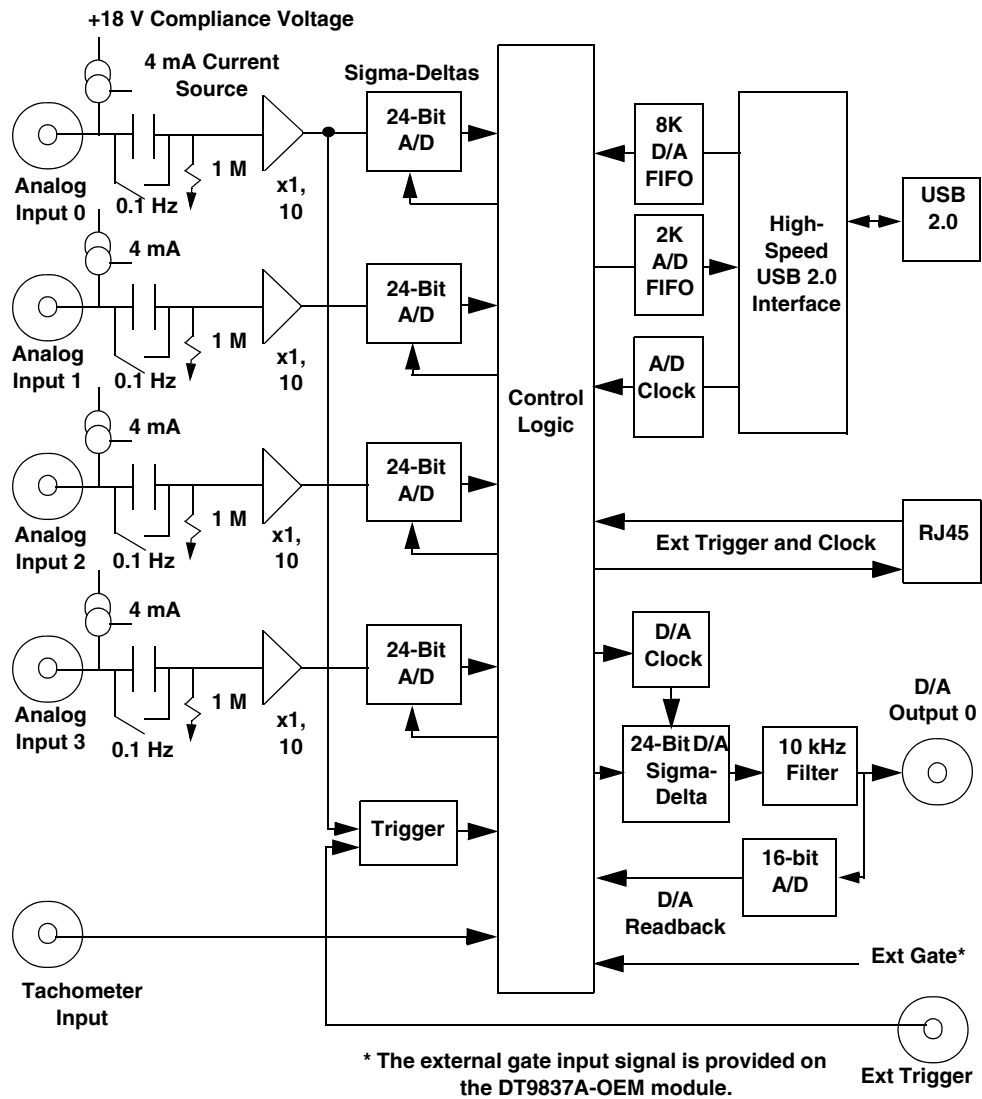


Figure 20: Block Diagram of the DT9837A Module

Figure 21 shows a block diagram of the DT9837B module.

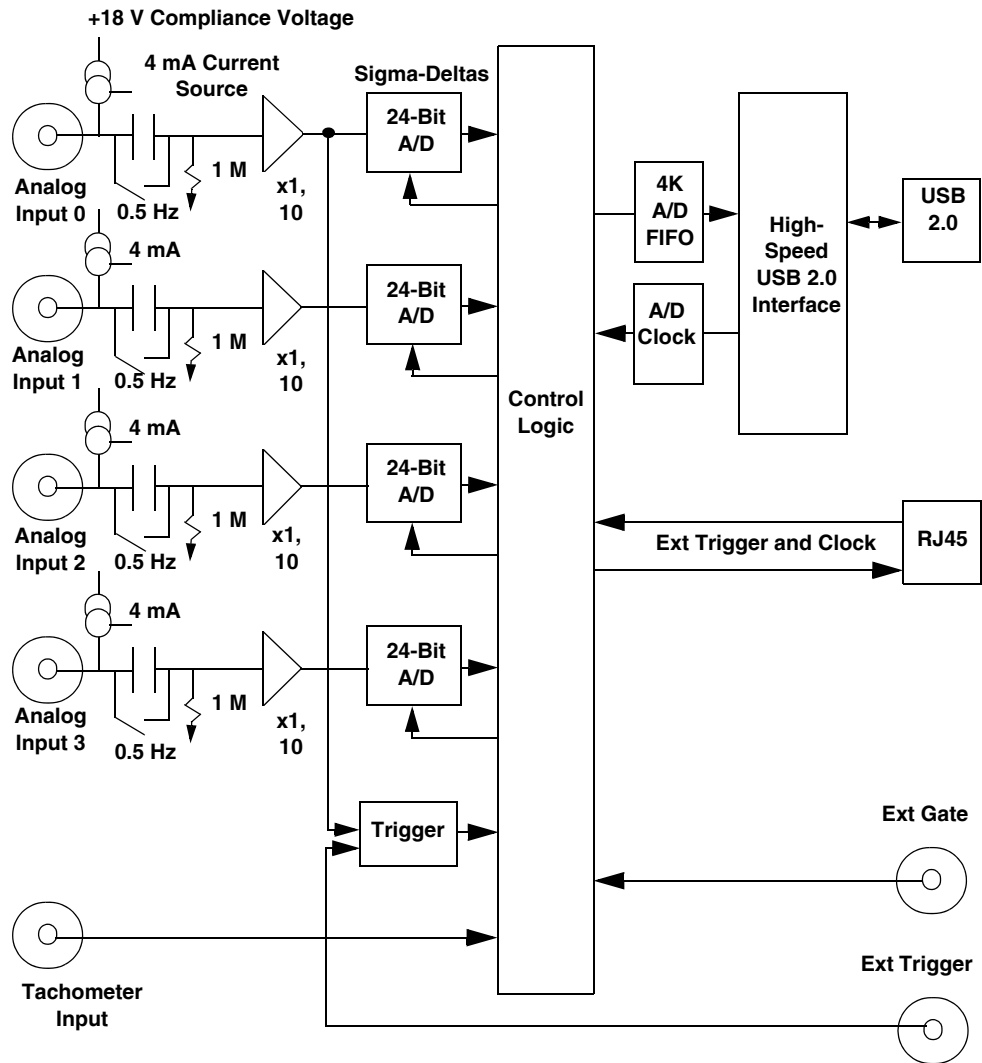


Figure 21: Block Diagram of the DT9837B Module

Figure 22 shows a block diagram of the DT9837C module.

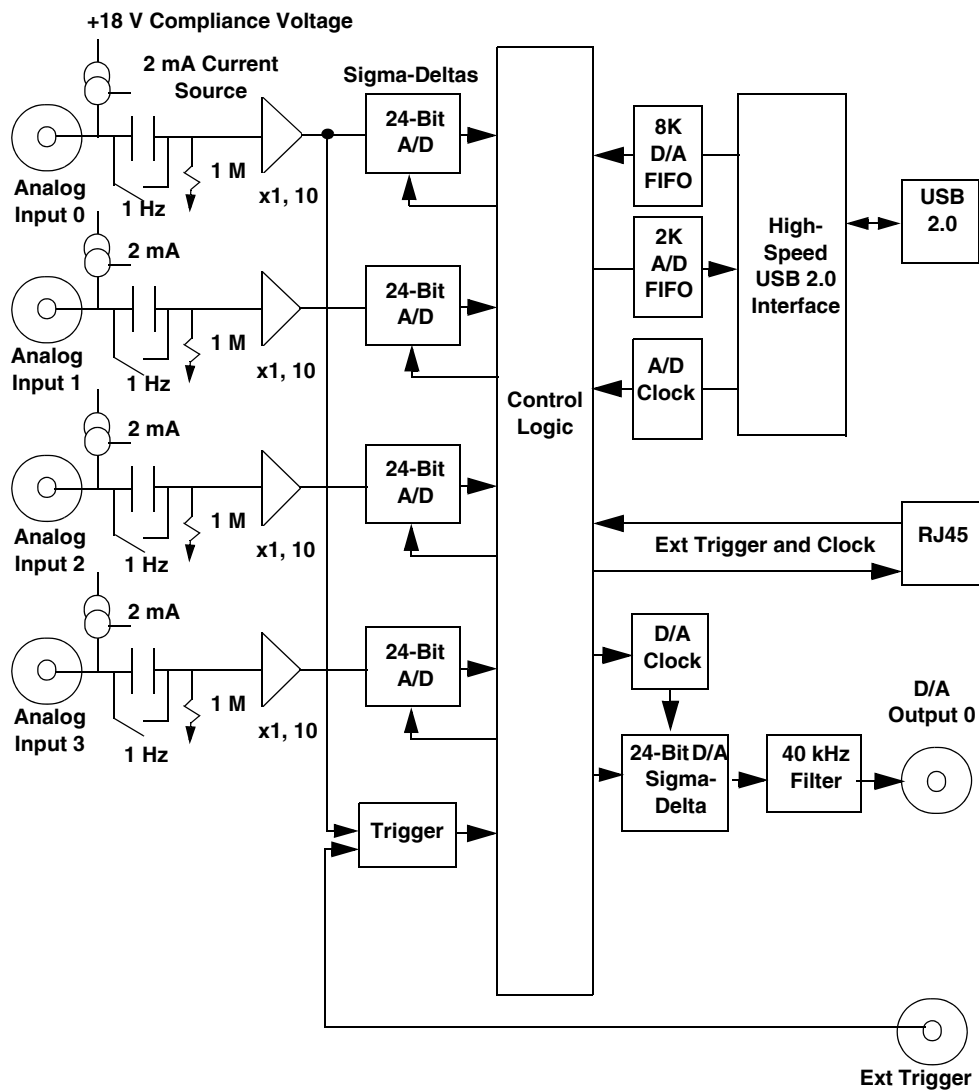


Figure 22: Block Diagram of the DT9837C Module

Analog Input Features

This section describes the following features of analog input (A/D) subsystem on the DT9837 Series modules:

- Analog input channels, described on this page
- IEPE functions, described on [page 69](#)
- Input resolution, described on [page 69](#)
- Input ranges and gains, described on [page 68](#)
- Input sample clock sources, described on [page 69](#)
- Analog input conversion modes, described on [page 70](#)
- Input triggers, described on [page 73](#)
- Data format and transfer, described on [page 74](#)
- Error conditions, described on [page 75](#)

Analog Input Channels

The DT9837 Series modules support four, single-ended analog input channels (numbered 0 to 3). All analog input channels are simultaneously clocked. If desired, you can connect IEPE sensors to these inputs; refer to [page 69](#) for more information on IEPE functions.

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

The DT9837 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.

Input Ranges and Gains

The DT9837 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 DT9837 Series modules. The modules support the following software-programmable IEPE functions for each of the four analog inputs:

- Excitation current source – The DT9837, DT9837A, and DT9837B modules provide an internal excitation current source of 4 mA. The DT9837C module provides an internal excitation current source of 2 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.

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

The DT9837C also provides a 1 Hz high-pass filter.

If you are using Windows, you can change the IEPE settings using the Open Layers Control Panel applet, described on [page 36](#), or by writing to the registers of the module, as described on [Appendix C](#) starting on [page 135](#). You can also use the Control Panel to keep the module's high-power circuitry always turned on to minimize any settling time errors related to the IEPE current source. Refer to [page 36](#) for more information.

If you are using Linux or macOS, refer to [page 147](#) for information on programming the IEPE settings.

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 DT9837 Series modules support an internal clock, which is derived from the USB clock.

Use software to specify the internal clock source and the frequency at which to pace the input and output operations and to start the sample clock. For the DT9837 and DT9837A, the sampling frequency ranges from 195.3 Hz to 52.734 kHz. For the DT9837B and DT9837C, the sampling frequency ranges from 195.3 Hz to 105.469 kHz.

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

The modules support a wide pass band to eliminate aliasing, allowing you to measure low frequency signals accurately at the Nyquist sampling rate.

The actual frequency that the module can achieve may be slightly different than the frequency you specified due to the accuracy of the clock. You can determine the actual clock frequency using software.

Internally, the value that you specify for the internal clock frequency is multiplied by 512 (for frequencies of 52.734 kHz or less) or 256 (for frequencies greater than 52.734 kHz) to set the oscillator on the module. For example, if you specify an internal clock frequency of 50 kHz, the module sets the internal oscillator for the A/D converters to 25.6 MHz. The maximum timebase is 27 MHz.

Once the sample clock is started, the module requires 39 clock pulses before the first A/D conversion is completed (39/sample rate) due to the group delay of the converters. The software automatically adjusts for the group delay to provide only valid data in each buffer.

The tachometer data (which does not have the 39 sample group delay) is synchronized with the analog data stream. This is done through the firmware and device driver by caching the tachometer data and aligning it in time with the analog data in the user's data buffers.

Analog Input Conversion Modes (Windows Only)

Note: This section applies to DT-Open Layers in Windows. If you are using Linux or macOS, refer to the online help for UL for Linux (see <https://github.com/mccdaq/uldaq>) for more information on supported modes of operation.

In Windows, DT9837 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 (0, 1, 2, or 3) and the gain that you want to use. 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.

Note: You cannot read the value of tachometer counter 0 (described on [page 82](#)), tachometer counter 1 (described on [page 84](#)), gate counter 2 (described on [page 85](#)), or the analog output readback channel (described on [page 80](#)) using a standard single-value operation. To read these values, specify the channels as part of the analog input channel list using continuous scan mode, described on [page 71](#).

Single-Values Operations

If you prefer to read a single value from all the analog input channels simultaneously using one software call, use 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.

Note: For the DT9837, a single values operation also returns a valid value from tachometer counter 0 (analog input channel 4), described on [page 82](#).

For the DT9837A and DT9837B, a single values operation returns values from the analog input channels as well as from tachometer counter 0 (described on [page 82](#)), tachometer counter 1 (described on [page 84](#)), gate counter 2 (described on [page 85](#)), and the analog output readback channel (for the DT9837A; described on [page 80](#)), but only the data from analog input channels 0 through 3 is valid. Use continuous scan mode, described next, to read valid data from the tachometer counters, gate counter, and analog output readback channel.

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 DT9837 Series modules. You can specify a channel list, clock source, start trigger, reference trigger, post-trigger scan count, and buffer using software.

On the DT9837 module, you can enter up to 5 entries in the channel list, including four analog input channels (A/D channel 0 to 3) and tachometer counter 0 (A/D channel 4), described on [page 82](#).

On the DT9837A module, you can enter up to 8 entries in the channel list, including four analog input channels (A/D channels 0 to 3), tachometer counter 0 (A/D channel 4), described on [page 82](#), tachometer counter 1 (A/D channel 5), described on [page 84](#), gate counter 2 (A/D channel 6), described on [page 85](#), and the analog output readback value (A/D channel 7), described on [page 80](#). Using software, specify the channels you want to sample in sequential order.

On the DT9837B module, you can enter up to 7 entries in the channel list, including four analog input channels (A/D channels 0 to 3), tachometer counter 0 (A/D channel 4), described on [page 82](#), tachometer counter 1 (A/D channel 5), described on [page 84](#), and gate counter 2 (A/D channel 6), described on [page 85](#). Using software, specify the channels you want to sample in sequential order.

On the DT9837C module, you can enter up to 4 entries in the channel list (analog input 0 to 3). 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 73](#) for more information about triggers.

The conversion rate is determined by the frequency of the input sample clock; refer to [page 69](#) 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 69](#))
- Specify the start trigger (refer to [page 74](#))
- Specify the reference trigger (refer to [page 74](#))
- Specify the post-trigger scan count (the number of post-trigger samples to acquire after the reference trigger occurs)

[Figure 23](#) illustrates continuous scan mode (using a start and reference trigger) with a channel list of four entries: channel 0 through channel 3. 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.

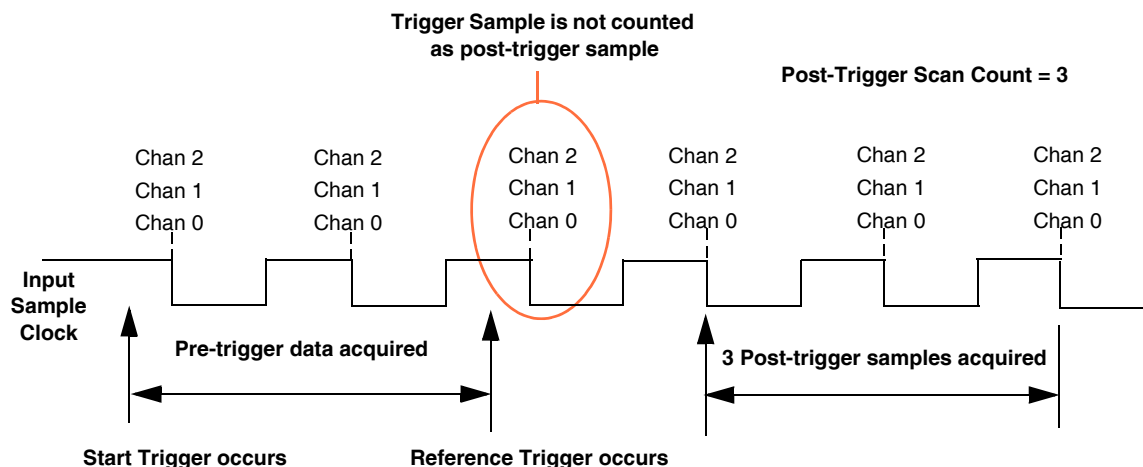


Figure 23: Continuous Scan Mode on the DT9837 Series Modules Using a Start and Reference Trigger

Input Triggers

A trigger is an event that occurs based on a specified set of conditions. The DT9837 Series modules support the following input triggers:

- **Software trigger** – A software trigger occurs when you start the analog input operation in software (the computer issues a write to the module to begin conversions).
- **External digital (TTL) trigger** – An external digital (TTL) trigger occurs when the module detects a rising-edge transition on the signal connected to the Ext Trig connector on the module.
- **Analog threshold trigger** – For the DT9837 module, the analog threshold trigger occurs when the signal attached to analog input channel 0 rises above 1.0 V (the fixed threshold level).

For the DT9837A and DT9837B modules, the analog threshold trigger occurs when the signal attached to analog input channel 0 rises above a user-specified threshold value. The threshold level can be a value between 0.2 V and 9.8 V.

For the DT9837C module, the analog threshold trigger occurs when the signal attached to one of the selected analog input channels rises above or falls below a user-specified threshold value. Threshold level can be a value between ± 10 V for a gain of 1 or ± 1 V for a gain of 10.

Specifying Input Triggers in Windows

When using DT-Open Layers in Windows, you can specify a start trigger source and a reference trigger source when performing continuous scan operations.

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 (see [page 71](#) for more information).

You can specify any of the supported input trigger sources for the start trigger.

For the reference trigger, you can specify an analog threshold trigger only.

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.

Specifying Input Triggers in Linux or macOS

Reference triggers are not used in UL for Linux. Acquisition starts when the input trigger occurs.

Users can monitor the data as it is being acquired to determine if a particular event (threshold crossing) has occurred.

Refer to [Appendix D](#) starting on [page 145](#) for more information on UL for Linux.

Data Format and Transfer (Windows Only)

Note: This section applies to DT-Open Layers in Windows. If you are using Linux or macOS, refer to the online help for UL for Linux (see <https://github.com/mccdaq/uldaq>) for more information.

DT9837 Series modules use offset binary data encoding, where 000000 represents negative full-scale, and FFFFFFFh represents positive full-scale. When using DT-Open Layers in Windows, 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: The DT9837A and DT9837 C modules have an input FIFO of 2 kSamples; the DT9837B has an input FIFO of 4 kSamples and the DT9837 does not use an input FIFO.

Error Conditions (Windows Only)

Note: This section applies to DT-Open Layers in Windows. If you are using Linux or macOS, refer to the online help for UL for Linux (see <https://github.com/mccdaq/uldaq>) for more information.

DT9837 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 on [page 76](#)
- Output conversion mode, described on [page 77](#)
- Output clocks, described on [page 76](#)
- Output triggers, described on [page 80](#)
- Data format and transfer, described on [page 80](#)
- Error conditions, described on [page 81](#)

Analog Output Channels

The DT9837, DT9837A, and DT9837C modules support one analog output channel through analog output subsystem 0. Note that on the DT9837A module, you can read back the value of the analog output channel using software; refer to [page 80](#) for more information.

The DT9837 and DT9837A modules provide a two-pole, 10 kHz Butterworth filter and the DT9837C provides a 40 kHz smoothing filter to prevent noise from interfering with the output signal.

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

Output Ranges and Gains

The DT9837 and DT9837A modules can output bipolar analog output signals in the range of $\pm 10\text{ V}$, with a gain of 1.

The DT9837C module can output bipolar analog output signals in the range of $\pm 3\text{ V}$, with a gain of 1.

Output Resolution

The resolution of the analog output channel is fixed at 24-bits; you cannot specify the resolution in software.

Output Clocks

The output clock on the DT9837, DT9837A, and DT9837C modules is derived from the USB clock to produce the output clock frequency.

On the DT9837 module, the clock frequency is fixed at 46.875 kHz. On the DT9837A module, you can program the clock frequency to value between 10 kHz and 52.734 kHz. On the DT9837C module, you can program the clock frequency to value between 10 kHz and 96.0 kHz. Use software to specify an internal clock source and to specify the clock frequency for the analog output subsystem.

Internally, the value that you specify for the analog output clock frequency is multiplied by 512 to set the oscillator on the module. The maximum timebase for the DT9837 is 24 MHz; the maximum timebase for the DT9837A and DT9837C is 27 MHz.

Due to the group delay of the Delta-Sigma D/A converter, the DT9837 requires 34 clock pulses, while the DT9837A and DT9837C modules require 29 clock pulses once the analog output sample clock is started before the first D/A conversion is completed.

Output Conversion Modes (Windows Only)

Note: This section applies to DT-Open Layers in Windows. If you are using Linux or macOS, refer to the online help for UL for Linux (see <https://github.com/mccdaq/uldaq>) for more information on supported operation modes.

Using DT-Open Layers in Windows, the DT9837, DT9837A, and DT9837C modules support single-value and waveform analog output operations. The DT9837A and DT9837C modules also support continuous analog output operations. This section describes each of these conversion modes.

Note: The DT9837A also provides the ability to read the value of the analog output channel in the analog input data stream. Refer to [page 80](#) for more information.

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.

Note: On the DT9837 module, ensure that no analog input operations are running before performing an analog output operation or an error will be reported.

Waveform Generation Mode

Waveform generation mode is supported on the DT9837, DT9837A, and DT9837C modules. In this mode, a waveform, which is specified in a single buffer, is output repetitively.

On the DT9837, allocate a buffer less than or equal to 8192 samples, and then fill the buffer with the waveform that you want to output. On the DT9837A and DT9837C modules, you can allocate a buffer of any size, and then fill the buffer with the waveform that you want to output.

When it detects a software trigger, the host computer transfers the entire waveform pattern to the 8 kSample output FIFO on the module, and the module starts writing output values to the analog output channel 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 76](#) for more information about the clock source and frequency.
- Specify a software trigger source, described in the next section

Note: On the DT9837, an error will be reported if you specify a buffer with greater than 8192 samples (the size of the output FIFO on the module).

If you want to output data from the analog output channel on the DT9837 module while acquiring analog input data, ensure that you set up and start the analog output operation before starting the analog input operation, or an error will be reported.

The DT9837, DT9837A, and DT9837C modules support 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 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

Continuous analog output operations are supported on the DT9837A and DT9837C modules only. Use continuously paced analog output mode to continuously output buffered values to the analog output channel at a specified clock frequency. The DT9837A and DT9837C support the ability to start continuous analog output operations and continuous analog input operations simultaneously.

Use software to fill multiple output buffers with the values that you want to write to the analog output channel. When it detects the specified trigger, the module starts writing the values from the output buffer to the analog output channel at the specified clock frequency. The operation repeats continuously until either 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 76](#) for more information about the clock source and frequency.
- Specify the trigger source as any of the supported trigger sources. Refer to [page 80](#) 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.

The DT9837, DT9837A, and DT9837C modules support 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.

Reading Back the Analog Output Value (DT9837A Only)

On the DT9837A module only, you can read back the value of the analog output channel in the analog input stream.

If you are using DT-Open Layers in Windows, specify channel 7 in the analog input channel list to read back the value of the analog output channel. When the analog input operation is started, the value of the analog output channel is returned in the analog input data stream. The software automatically synchronizes the value of the analog output channel with the analog input measurements, so that all measurements are correlated in time.

If you are using UL for Linux, refer to [page 152](#) for more information on reading the analog output value.

Output Trigger

The DT9837, DT9837A, and DT9837C 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.
- **External digital (TTL) trigger** – This trigger source is supported on the DT9837A and DT9837C modules. An external digital (TTL) trigger event occurs when the module detects a rising-edge transition on the signal connected to the Ext Trig connector on the module.
- **Analog threshold trigger** – This trigger source is supported on the DT9837A and DT9837C modules.

For the DT9837A module, an analog threshold trigger event occurs when the signal attached to analog input channel 0 rises above a user-specified threshold value. Using software, specify the trigger source as a positive threshold trigger, the threshold trigger channel as analog input channel 0, and the threshold level as a value between 0.2 V and 9.8 V.

For the DT9837C module, the analog threshold trigger event occurs when the signal attached to a specified analog input channel rises above a user-specified threshold value. The threshold level can be a value between ± 10 V for a gain of 1 or ± 1 V for a gain of 10.

Data Format and Transfer (Windows Only)

Data from the host computer must use offset binary data encoding for analog output signals, where 000000 represents -10 V, and FFFFFFFh represents $+10$ V.

When using DT-Open Layers in Windows, specify the data encoding as binary.

Error Conditions (Windows Only)

The DT9837, DT9837A, and DT9837C 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
- For the DT9837, ensure that you allocate a single buffer with 8192 or fewer samples
- Close any other applications that are running
- Run the program on a faster computer

Tachometer Input Features

You can connect a tachometer signal with a range of ± 30 V to the DT9837, DT9837A, and DT9837B modules. (The DT9837C does not support a tachometer input.) On the DT9837, this signal has a maximum frequency of 380 kHz and a minimum pulse width of 1.3 μ s. On the DT9837A and DT9837B modules, this signal has a maximum frequency of 1 MHz and a minimum pulse width of 0.4 μ s. The threshold voltage is fixed at +2 V with 0.5 V of hysteresis.

You can measure the frequency or period of the tachometer input signal using tachometer counter 0. On the DT9837A and DT9837B modules, you can also measure the phase of the tachometer input signal in relation to the A/D sample using tachometer counter 1. These measurements are described in more detail in the following subsections.

Frequency or Period Measurements – Tachometer Counter 0

Use frequency or period measurements to calculate the rotation speed for high-level (± 30 V) tachometer input signals. An internal 12 MHz counter (tachometer counter 0) is used for the measurement, yielding a resolution of 83 ns (1/12 MHz).

You can read the number of counts between two consecutive starting edges of the tachometer input signal. On the DT9837A and DT9837B, you can specify the following parameters for tachometer counter 0 using software:

- The starting edge of the tachometer input signal to use for the measurement: rising edge or falling edge. On the DT9837 module, the starting edge is always the rising edge.
- The value read between measurements: either zero or the previous measurement value. On the DT9837 module, this value is always the previous measurement value.
- A flag (called Stale) indicating whether or not the data is new. If the Stale flag is set as Used, the most significant bit (MSB) of the value is set to 0 to indicate new data; reading the value before the measurement is complete returns an MSB of 1. If the Stale flag is set to Not Used, the MSB is always set to 0.

On the DT9837 module, the MSB is always 0 (Not Used).

When the operation is started, the internal 12 MHz counter starts incrementing when it detects the first starting edge of the tachometer input and stops incrementing when it detects the next starting edge of the tachometer input. When the measurement is complete, the counter/timer remains idle until it is read. On the next read, either 0 or the current value of the tachometer input (from the previous measurement operation) is returned depending on the module and its settings, described above, and the next operation is started automatically.

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

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

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

Reading Tachometer Counter 0 Using Windows

In Windows, you can read tachometer counter 0 by specifying channel 4 in the analog input channel list. You can specify the parameters for tachometer counter 0 by using the Open Layers Control Panel applet, described on [page 36](#), by using software commands, or by writing to the registers of the module, as described in [Appendix C](#) starting on [page 135](#).

The software automatically synchronizes the value of the tachometer input with the analog input measurements, so that all measurements are correlated in time.

The tachometer input is treated like any other channel in the analog input channel list; therefore, all the triggering and conversion modes supported for analog input channels are supported for the tachometer input.

When you read the value of the tachometer input as part of the analog input data stream, you might see results similar to the following (note that this assumes that the previous measurement value is returned between new measurement values):

Table 2: An Example of Reading the Tachometer Input as Part of the Analog Input Data Stream

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

Reading Tachometer 0 Using in Linux or macOS

If you are using UL for Linux, you can read and configure tachometer counter 0 through the counter subsystem. Refer to [page 147](#) for more information on reading and configuring tachometer counter 0.

Phase Measurements – Tachometer Counter 1

On the DT9837A and DT9837B modules, you can measure the phase of the tachometer input in relation to the A/D sample by reading tachometer counter 1.

An internal 48 MHz clock (with 21 ns resolution) is used to calculate the measurement, which allows you to precisely correlate tachometer measurements with the analog input data.

Using software, you can specify the following parameters for tachometer counter 1:

- The signal that starts the measurement: A/D sample, rising edge of the tachometer input signal, or falling edge of the tachometer input signal
- The signal that stops the measurement: A/D sample, rising edge of the tachometer input signal, or falling edge of the tachometer input signal

Note: Note that if you choose to start the measurement using the A/D sample, choose a tachometer edge to stop the measurement. Likewise, if you choose to stop the measurement using the A/D sample, choose a tachometer edge to start the measurement.

- The value of the Self-Clear flag, which determines the value that is read between measurements (either 0 or the previous measurement value)

If you are using DT-Open Layers in Windows, specify channel 5 in the analog input channel list to read the value of tachometer counter 1. You can specify the parameters for tachometer counter 1 using the Open Layers Control Panel applet, described on [page 36](#), or by writing to the registers of the module, as described in [Appendix C](#) starting on [page 135](#):

If you are using UL for Linux, refer to [page 150](#) for more information on specifying tachometer counter 1 and its parameters.

Gate Input Features

The DT9837A-OEM module provides a 4-pin gate input connector for connecting a TTL gate input signal; see [page 133](#) for connector pin assignments. The DT9837B module provides a BNC connector for connecting a gate input signal.

You can read the value of gate counter 2 to measure the phase between the following signals:

- Completion of the A/D sample to the rising or falling edge of the gate input signal
- Rising or falling edge of the gate input signal to the completion of the A/D sample

You can also determine the pulse width of the gate signal by measuring between the Rising or falling edge of the gate input signal to the next rising or falling edge of the gate input signal.

An internal 48 MHz clock (with 21 ns resolution) is used to calculate the measurements, which allows you to precisely correlate analog input data with measurements from the gate input signal.

You can specify the following parameters for gate counter 2 using software:

- The signal that starts the measurement: A/D sample, gate rising edge, or gate falling edge
- The signal that stops the measurement: A/D sample, gate rising edge, or gate falling edge

Note: Note that if you choose to start the measurement using the A/D sample, choose a gate input edge to stop the measurement. Likewise, if you choose to stop the measurement using the A/D sample, choose a gate input edge to start the measurement.

If you choose the start and stop the measurement using the same gate edge, be aware that the stopping edge does not restart the measurement; the next starting edge will start the next measurement.

- The value of the Self-Clear flag, which determines the value that is read between measurements (either 0 or the previous measurement value)

If you are using DT-Open Layers in Windows, specify channel 6 in the analog input channel list to read the value of gate counter 2. You can specify the parameters for gate counter 2 using the Open Layers Control Panel applet, described on [page 36](#), or by writing to the registers of the module, as described in [Appendix C](#) starting on [page 135](#):

If you are using UL for Linux, refer to [page 151](#) for more information on specifying gate counter 2 and its parameters.

Triggering Acquisition on Multiple Modules

Note: For DT9837A, DT9837B, and DT9837C modules, you can synchronize acquisition on multiple modules using the RJ45 (LVDS) synchronization connector, described on [page 87](#).

The internal clock on the DT9837, DT9837A, and DT9837C modules when the synchronization mode is none (see [page 87](#)), 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 24](#). 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.

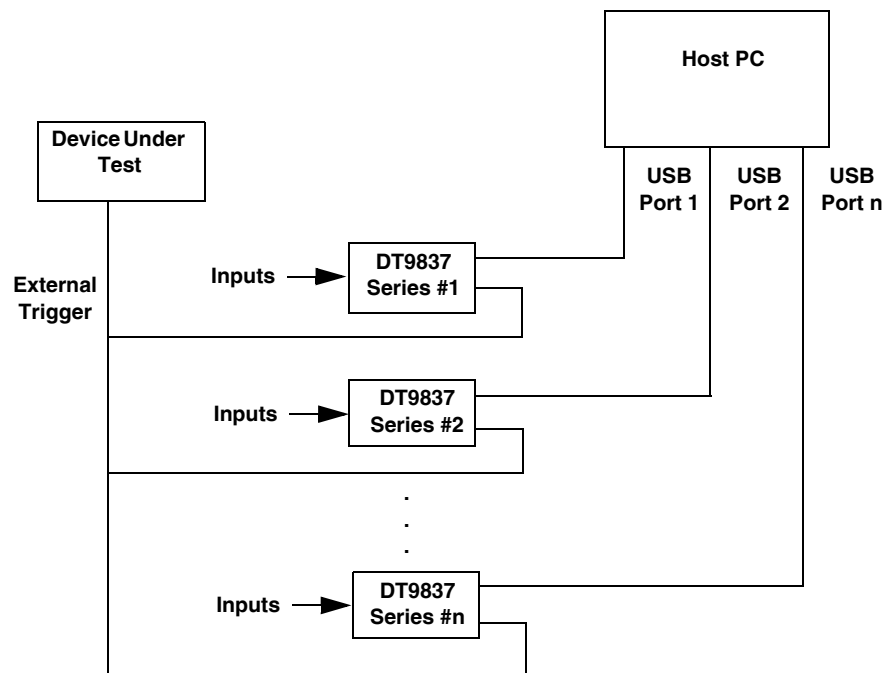


Figure 24: Triggering Multiple Modules Using an External Trigger Source

Synchronizing Acquisition on Multiple DT9837A, DT9837B, or DT9837C Modules

DT9837A, DT9837B, and DT9837C modules provide an RJ45 (LVDS) synchronization connector that you can use to connect and synchronize multiple DT9837A, DT9837B, or DT9837C modules. In this scheme, one module is the master and the other modules are the slaves.

Notes: When using the master/slave configuration, you can use DT9837A and DT9837B modules together, however, the maximum sampling rate is limited by the slowest module (52.7 kHz, in this case). If you are using DT9837C modules in a master/slave configuration, it is recommended that you do not connect any other module type except the DT9837C.

You cannot use the Ext Trig connector on slave modules.

For the DT9837A and DT9837B modules, you cannot use an analog threshold trigger for the slave modules.

For DT9837C modules, if you are using an analog threshold trigger for the master DT9837C module, you must configure slave DT9837C modules to use an analog threshold trigger as well.

In Windows, you specify the synchronization mode of the RJ45 connector as master, slave, or none. When configured as a master, the RJ45 synchronization connector outputs trigger and clock signals. When configured as a slave, the RJ45 connector accepts trigger and clock signals from the master. When synchronization is none, the DT9837A, DT9837B, or DT9837C module uses the USB clock instead of the RJ45 synchronization connector. The synchronization mode remains set until changed or until the application exits.

If you are using Linux or macOS, refer to [page 153](#) for information on specifying the synchronization mode.

You can connect multiple modules in one of two ways. [Figure 25](#) shows how to connect a maximum of two DT9837A, DT9837B, or DT9837C modules by daisy chaining them together through the RJ45 connector. [Figure 26](#) shows how to connect a maximum of four DT9837A, DT9837B, or DT9837C modules by using an RJ45 distribution panel, such as the EP386, where the panel contains four RJ45 connectors that are wired in parallel.

Note: You must have revision H or later of the DT9837A module or revision F or later of the DT9837A-OEM module to be able to attach four modules together. You can identify the revision of your module by looking at the serial number label on your module.

If you have revision G or earlier of the DT9837A or revision E or earlier of the DT9837A-OEM, you can attach a maximum of two modules together.

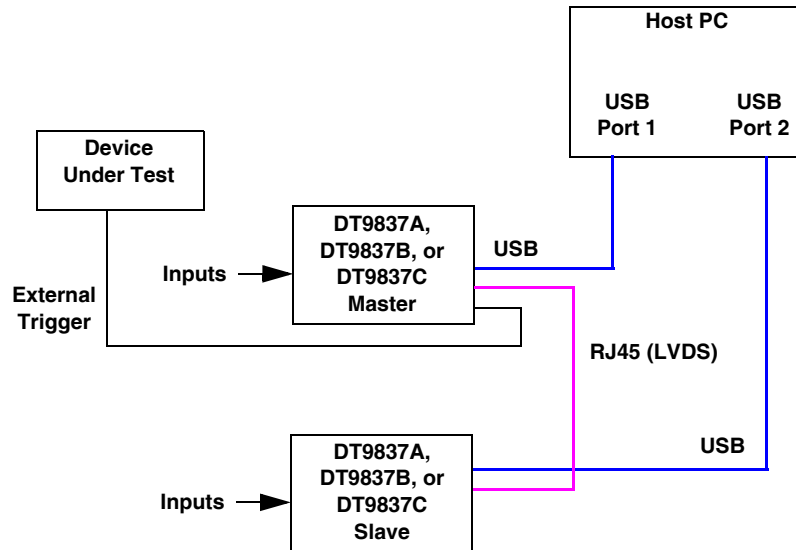
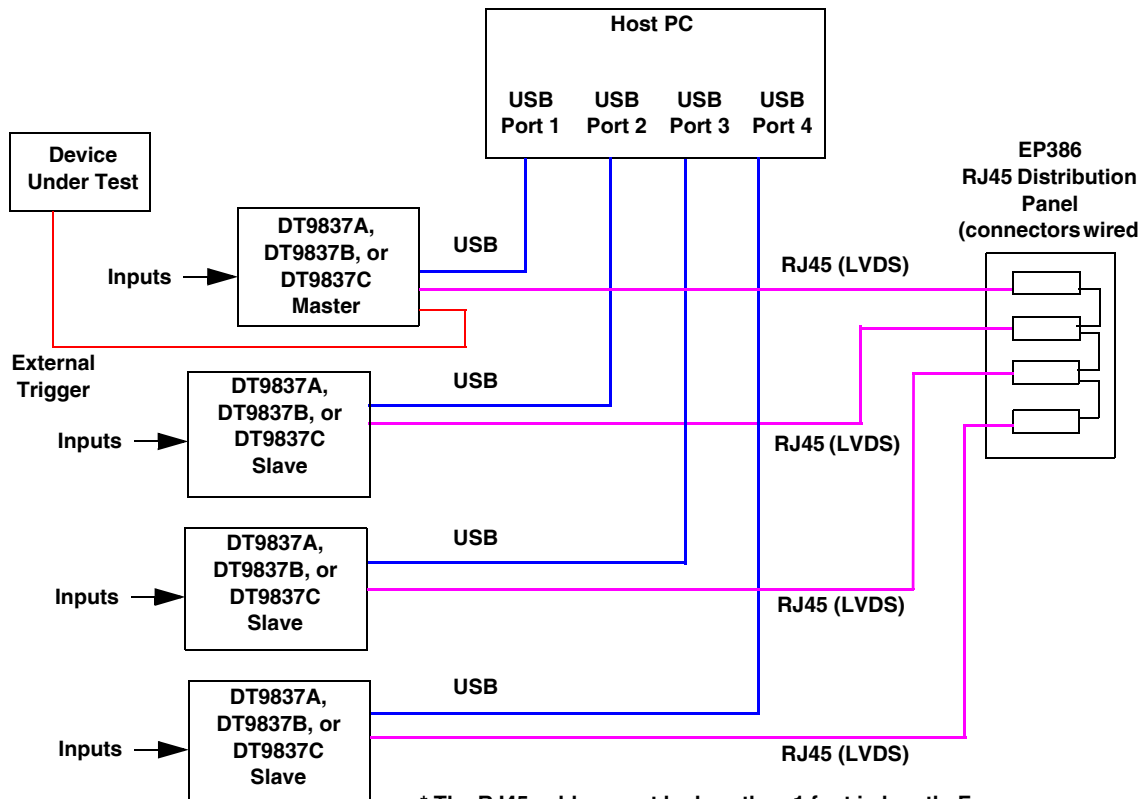


Figure 25: Synchronizing Two DT9837A, DT9837BB, or DT9837C Modules by Daisy Chaining the RJ45 Connectors (Shown Using an External Trigger)



* 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 26: Synchronizing Four DT9837A, DT9837B, or DT9837C Modules Using the EP386 RJ45 Distribution Panel (Shown Using an External Trigger)

For Windows only, when synchronizing multiple modules, you must start the slave modules before starting the master module. When the master module is triggered (using any of the supported trigger sources), 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: (Windows only) 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 DT9837A, DT9837B, or DT9837C modules before disconnecting the cable from the RJ45 connectors.



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Note: This chapter applies to programming in DT-Open Layers in Windows. For information on programming in Linux, refer to [Appendix D](#) starting on [page 145](#).

Windows DT9837 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 3: DT9837 Series Subsystems

DT9837 Series Modules	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Total Subsystems on Module	1	1 ^a or 2 ^b	0	0	0	0 ^c	0

- The DT9837 supports D/A subsystem 0 to access the capabilities of the analog output subsystem. The DT9837B supports D/A subsystem 0 to program the threshold value for the analog threshold trigger, but the threshold level can also be programmed directly through the analog input subsystem using software.
- The DT9837A supports two D/A subsystem (0 and 1). Use D/A subsystem 0 to access the capabilities of the analog output subsystem. D/A subsystem 1 is available to program the threshold value for the analog threshold trigger, but the threshold level can also be programmed directly through the analog input subsystem using software.
- The DT9837 supports one tachometer input for measuring frequency or period. The DT9837A and DT9837B support one tachometer input for measuring frequency or period and a gate input for measuring phase. The DT9837C does not support a tachometer input.

You cannot use the DT-Open Layers for .NET Class Library to configure the tachometer or gate input on the DT9837 Series modules. Instead, use the Open Layers Control Panel applet, described on [page 36](#), or write to the registers of the module, described on [page 135](#), to configure the tachometer and/or gate input parameters.

You read the value of the tachometer and gate input signals through the A/D subsystem.

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the DT9837 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 4: Data Flow and Operation Options

DT9837 Series Modules	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Single-Value Operation Support SupportsSingleValue	Yes	Yes ^b					
Simultaneous Single-Value Output Operations SupportsSetSingleValues							
Continuous Operation Support SupportsContinuous	Yes	Yes ^c					
Continuous Operation until Trigger SupportsContinuousPreTrigger							
Continuous Operation before & after Trigger SupportsContinuousPrePostTrigger							
Waveform Operations Using FIFO Only SupportsWaveformModeOnly		Yes ^d					
Simultaneous Start List Support SupportsSimultaneousStart	Yes ^e	Yes ^e					
Supports Programmable Synchronization Modes SupportsSynchronization	Yes						
Synchronization Modes SynchronizationMode	None, Master, Slave						
Interrupt Support SupportsInterruptOnChange							
FIFO Size, in samples FifoSize	2 kSamples or 4 kSamples ^f	8 kSamples ^g					
Muting and Unmuting the Output Voltage SupportsMute		Yes					
Auto-Calibrate Support SupportsAutoCalibrate							

- The D/A subsystem is not supported by the DT9837B module.
- To perform a single value analog output operation, ensure that no analog input operations are running or an error will be reported.
- For the DT9837, if you want to output data from the analog output channel while acquiring analog input data, ensure that you set up and start the analog output operation before starting the analog input operation, or an error will be reported.
- The DT9837A and DT9837C modules support continuous analog output operations in addition to waveform mode.
- The DT9837A and DT9837C modules support the ability to start continuous A/D and continuous D/A operations simultaneously.
- The DT9837A and DT9837 C modules have an input FIFO of 2 kSamples; the DT9837B has an input FIFO of 4 kSamples; and the DT9837 does not use an input FIFO.
- The DT9837B does not have an output FIFO. The output FIFO on the DT9837, DT9837A, and DT9837C is 8 kSamples.

Buffering

Table 5: Buffering Options

DT9837 Series Modules	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Buffer Support SupportsBuffering	Yes	Yes					
Single Buffer Wrap Mode Support SupportsWrapSingle		Yes					
Inprocess Buffer Flush Support SupportsInProcessFlush	Yes						

a. The D/A subsystem is not supported by the DT9837B module.

Triggered Scan Mode

Table 6: Triggered Scan Mode Options

DT9837 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 7: Data Encoding Options

DT9837 Series Modules	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Binary Encoding Support SupportsBinaryEncoding	Yes	Yes					
Twos Complement Support SupportsTwosCompEncoding							
Returns Floating-Point Values ReturnsFloats							

a. The D/A subsystem is not supported by the DT9837B module.

Channels

Table 8: Channel Options

DT9837 Series Modules	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Number of Channels NumberOfChannels	4 ^b , 5 ^c , 7 ^d , or 8 ^e	1	0	0	0		0
SE Support SupportsSingleEnded	Yes	Yes					
SE Channels MaxSingleEndedChannels	4	1	0	0			0
DI Support SupportsDifferential							
DI Channels MaxDifferentialChannels	0	0	0	0	0		0
Maximum Channel-Gain List Depth CGLDepth	4 ^b , 5 ^c , 7 ^d , or 8 ^e	1	0	0	0		0
Simultaneous Sample-and-Hold Support SupportsSimultaneousSampleHold	Yes						
Channel-List Inhibit SupportsChannelListInhibit							
Support MultiSensor Inputs SupportsMultiSensor							
Bias Return Termination Resistor Support SupportsInputTermination							

- The D/A subsystem is not supported by the DT9837B module.
- On the DT9837C, channels 0 to 3 correspond to the analog input channels.
- On the DT9837, channels 0 to 3 correspond to the analog input channels; channel 4 corresponds to tachometer counter 0.
- On the DT9837B, channels 0 to 3 correspond to the analog input channels; channel 4 corresponds to tachometer counter 0; channel 5 corresponds to tachometer counter 1, and channel 6 corresponds to gate counter 2.
- On the DT9837A, channels 0 to 3 correspond to the analog input channels; channel 4 corresponds to tachometer counter 0; channel 5 corresponds to tachometer counter 1, channel 6 corresponds to gate counter 2 on the DT9837A-OEM module, and channel 7 corresponds to the analog output readback channel.

Gain

Table 9: Gain Options

DT9837 Series Modules	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Programmable Gain Support SupportsProgrammableGain	Yes						
Number of Gains NumberOfSupportedGains	2	1	0	0	0		0
Gains Available SupportedGains	1 and 10	1					

- The D/A subsystem is not supported by the DT9837B module.

Ranges

Table 10: Range Options

DT9837 Series Modules	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Number of Voltage Ranges NumberOfRanges	1	1	0	0	0		0
Available Ranges SupportedVoltageRanges	± 10 V ^b	± 10 V or ± 3 V ^c					

- The D/A subsystem is not supported by the DT9837B module.
- By applying a gain of 1, the effective input range is ± 10 V. By applying a gain of 10, the effective input range is ± 1 V.
- The DT9837 and DT9837A support an output voltage range of ± 10 V; the DT9837C supports an output voltage range of ± 3 V.

Resolution

Table 11: Resolution Options

DT9837 Series Modules	A/D	D/A ^a	DIN	DOUT	C/T	TACH	QUAD
Software Programmable Resolution SupportsSoftwareResolution							
Number of Resolutions NumberOfResolutions	1	1	0	0	0		0
Available Resolutions SupportedResolutions	24	24	0	0	0		0

- The D/A subsystem is not supported by the DT9837B module.

Current and Resistance Support

Table 12: Current and Resistance Support Options

DT9837 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 13: Thermocouple, RTD, and Thermistor Support Options

DT9837 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 14: IEPE Support Options

DT9837 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 or .002 A ^a						

- a. The DT9837, DT9837A, and DT9837B support an internal excitation current of 4 mA, while the DT9837C supports an internal excitation current source of 2 mA.

Bridge and Strain Gage Support

Table 15: Bridge and Strain Gage Support Options

DT9837 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 16: Start Trigger Options

DT9837 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Software Trigger Support SupportsSoftwareTrigger	Yes	Yes ^a					
External Positive TTL Trigger Support SupportsPosExternalTTLTrigger	Yes	Yes ^b					
External Negative TTL Trigger Support SupportsNegExternalTTLTrigger							
External Positive TTL Trigger Support for Single-Value Operations SupportsSvPosExternalTTLTrigger							
External Negative TTL Trigger Support for Single-Value Operations SupportsSvNegExternalTTLTrigger							
Positive Threshold Trigger Support SupportsPosThresholdTrigger	Yes ^c	Yes ^d					
Negative Threshold Trigger Support SupportsNegThresholdTrigger	Yes ^e						
Digital Event Trigger Support SupportsDigitalEventTrigger							
Threshold Trigger Channel SupportedThresholdTriggerChannel	0 or 0 to 3 ^c	0 or 0 to 3 ^f					

- a. This trigger is option is not supported for the DT9837B module.
- b. On the DT9837A and DT9837C, you can use the external trigger to trigger D/A subsystem 0.
- c. If you choose a threshold trigger for the start trigger on the DT9837, the threshold level is fixed at 1.0 V and the threshold channel is analog input channel 0.

If you choose a threshold trigger for the start trigger on the DT9837A or DT9837B, you can program the threshold level from 0.2 V to 9.8 V and the threshold channel is analog input channel 0.

If you choose a threshold trigger for the start trigger on the DT9837C 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.

- d. On the DT9837A and DT9837C, you can use the analog threshold trigger to trigger D/A subsystem 0.
- e. The DT9837C supports a negative threshold trigger.
- f. On the DT9837A, you can use analog input channel 0 as the analog threshold trigger channel to start analog output operations. On the DT9837C, you can use any of the analog input channels as the threshold trigger channel to start analog output operations.

Reference Triggers

Table 17: Reference Trigger Options

DT9837 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
External Positive TTL Trigger Support SupportsPosExternalTTLTrigger							
External Negative TTL Trigger Support SupportsNegExternalTTLTrigger							
Positive Threshold Trigger Support SupportsPosThresholdTrigger	Yes ^a						
Negative Threshold Trigger Support SupportsNegThresholdTrigger	Yes ^a						
Digital Event Trigger Support SupportsDigitalEventTrigger							
Sync Bus Support SupportsSyncBusTrigger							
Analog Input Channels Supported for the Threshold Trigger SupportedThresholdTriggerChannels	0 to 3						
Post-Trigger Scan Count Support SupportsPostTriggerScanCount	Yes ^b						

- a. If you choose a threshold trigger as a reference trigger on any of the DT9837 Series modules, 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. If you use a reference trigger, 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 18: Clock Options

DT9837 Series	A/D	D/A ^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	27 MHz	24 MHz or 27 MHz ^b	0	0			
Maximum Clock Divider MaxExtClockDivider	1.0	1.0	1	1	1		1
Minimum Clock Divider MinExtClockDivider	1.0	1.0	1	1	1		1
Maximum Frequency MaxFrequency	52.734 kHz, 105.469 kHz ^c	46.875 kHz, 52.734 kHz, or 96 kHz ^d	0	0	0		0
Minimum Frequency MinFrequency	195.3 Hz	46.875 kHz or 10 kHz ^d	0	0	0		0

- The D/A subsystem is not supported by the DT9837B module.
- The base clock for the D/A subsystem on the DT9837 is fixed at 24 MHz; the base clock for the D/A subsystem on the DT9837A and DT9837C has a maximum frequency of 27 MHz.
- The DT9837 and DT9837A support a maximum sampling frequency of 52.734 kHz; the DT9837B and DT9837C support a maximum sampling frequency of 105.469 kHz.
- The DT9837 supports a fixed clock frequency of 46.875 kHz for D/A subsystem 0; the DT9837A supports programmable clock frequencies from 10 kHz to 52.734 kHz for D/A subsystem 0; and the DT9837C supports programmable clock frequencies from 10 kHz to 96 kHz for D/A subsystem 0

Counter/Timers

Table 19: Counter/Timer Options

DT9837 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							

Tachometer

Table 20: Tachometer Options

DT9837 Series	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Tachometer Falling Edges SupportsFallingEdge						Yes ^a	
Tachometer Rising Edges SupportsRisingEdge						Yes ^a	
Tachometer Stale Data Flag SupportsStaleDataFlag						Yes ^b	

- a. On the DT9837 module, the starting edge is always rising; on the DT9837A and DT9837B modules, the starting edge is programmable (either rising or falling). For the DT9837A and DT9837B, you specify the edge using the Open Layers Control Panel applet, described on [page 36](#), or by writing to the registers of the module, described on [page 135](#); you cannot use the DT-Open Layers for .NET Class Library to configure these settings.
- b. The Stale Data flag can be 0 or 1 on the DT9837A and DT9837B; the Stale Data flag is always 0 on the DT9837. For the DT9837A and DT9837B, you specify whether to use the Stale Data Flag using the Open Layers Control Panel applet, described on [page 36](#), or by writing to the registers of the module, described on [page 135](#); you cannot use the DT-Open Layers for .NET Class Library to configure these settings.



Troubleshooting

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General Checklist

Should you experience problems using a DT9837 Series module, do the following:

1. Read all the documentation provided for your product, including any “Read This First” information to your manual.
2. Check that your system meets the requirements stated on [page 32](#).
3. Check that you have installed your hardware properly using the instructions in [Chapter 2](#).
4. If you are using Windows, check that you have installed and configured the device driver for your module using the instructions in [Chapter 2](#).
5. Check that you have wired your signals properly using the instructions in [Chapter 3](#).
6. 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 21](#) to isolate and solve the problem. If you cannot identify the problem, refer to [page 108](#).

Table 21: Troubleshooting Problems

Symptom	Possible Cause	Possible Solution
Module is not recognized	You plugged the module into your computer before installing the device driver.	In Windows, go to Control Panel > System > Hardware > Device Manager, uninstall any unknown devices (showing a yellow question mark). Then, run the setup program on your OMNI CD to install the USB device drivers, and reconnect your USB module to the computer. In Linux or macOS, install UL for Linux (see Appendix D), reconnect your USB module to the computer, and run your application.
Module does not respond	The module configuration is incorrect.	In Windows, check the configuration of your device driver; see the instructions in Chapter 2 . In Linux or macOS, check the settings in your program. Refer to Appendix D for more information.
	The module is damaged.	Contact Data Translation for technical support; refer to page 108 .

Table 21: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
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 127 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 .
Device failure error reported	The DT9837 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 DT9837 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.	DT9837 Series modules are calibrated at the factory. If you want to readjust the calibration of the analog input or analog output circuitry using Windows, refer to Chapter 8 .
USB 2.0 is not recognized	Your operating system does not have the appropriate Service Pack installed.	If using Windows, 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 DT9837 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 CD or UL for Linux 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 (Windows Only)

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Overview

Note: The DT9837 Series Calibration Utility is provided for Windows only. Before using the calibration utility, ensure that you installed the device driver for your module using the Data Acquisition OMNI CD.

DT9837 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 DT9837 Series Calibration Utility.

This chapter describes how to calibrate the analog input and output subsystems of a DT9837 Series module using the calibration utility.

Using the Calibration Utility

Start the DT9837 Series Calibration Utility as follows:

1. Click **Start** from the Task Bar.
2. For the DT9837 module, select **Programs | Data Translation, Inc | Calibration | DT9837 Series Calibration Utility**.
The main window of the DT9837 Series Calibration Utility appears.
3. Select the module to calibrate, and then click **OK**.

Once the calibration utility is running, you can calibrate the analog input circuitry (either automatically or manually), described on [page 114](#), or the analog output circuitry of the module, described on [page 116](#).

Calibrating the Analog Input Subsystem

This section describes how to use the calibration utility to calibrate the analog input subsystem of a DT9837 Series module.

DT9837 Series modules have separate calibration for each A/D input channel.

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 DT9837 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. 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

This section describes how to use the calibration utility to calibrate the analog output subsystem of a DT9837, DT9837A, or DT9837C module.

To calibrate the analog output circuitry, you need to connect an external precision voltmeter to analog output channel 0 of the DT9837, DT9837A, or DT9837C module.

Do the following to calibrate the analog output circuitry:

1. Select the **D/A Calibration** tab of the calibration utility.
2. Connect an external precision voltmeter to Analog Output 0 (DAC Ch0) of the DT9837 Series module.
3. In the DAC Output Voltage box, select **-9.375 V** for the DT9837 and DT9837A, or **-2.75 V** for the DT9837C.
4. Adjust the offset by entering values between 0 and 255 in the **DAC 0 Offset** edit box or by clicking the up/down buttons until the voltmeter reads -9.375 V for the DT9837 and DT9837A, or -2.75 V for the DT9837C.
5. In the DAC Output Voltage box, select **9.375 V** for the DT9837 and DT9837A, or **2.75 V** for the DT9837C.
6. Adjust the gain by entering values between 0 and 255 in the **DAC 0 Gain** edit box or by clicking the up/down buttons until the voltmeter reads 9.375 V for the DT9837 and DT9837A, or 2.75 V for the DT9837C.

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 22 lists the specifications for the analog input subsystem on the DT9837 Series modules. Unless otherwise noted, specifications are typical at 25° C.

Table 22: Analog Input Subsystem Specifications

Feature	DT9837 Specifications	DT9837A Specifications	DT9837B Specifications	DT9837C Specifications
Number of analog input channels	4, single-ended, simultaneous	4, single-ended, simultaneous	4, single-ended, simultaneous	4, single-ended, simultaneous
Resolution	24 bits	24 bits	24 bits	24 bits
Ranges and gains Gain of 1: Gain of 10:	±10 V ±1 V	±10 V ±1 V	±10 V ±1 V	±10 V ±1 V
A/D type	Delta Sigma	Delta Sigma	Delta Sigma	Delta Sigma
Data encoding	Offset binary	Offset binary	Offset binary	Offset binary
Maximum sample rate	52.734 kHz ^a	52.734 kHz ^a	105.469 kHz ^a	105.469 kHz ^a
Minimum sample rate	195.3 Hz	195.3 Hz	195.3 Hz	195.3 Hz
Group delay	39/data rate, in seconds	39/data rate, in seconds	39/data rate, in seconds	39/data rate, in seconds
ADC Delta Sigma filter ^b Passband, -3 dB:	0.49 x sample frequency, Hz	0.49 x sample frequency, Hz	0.49 x sample frequency, Hz	0.49 x sample frequency, Hz
Passband ripple, ±0.005 dB:	0.453 x sample frequency, Hz	0.453 x sample frequency, Hz	0.453 x sample frequency, Hz	0.453 x sample frequency, Hz
Stopband, -100 dB:	0.547 x sample frequency, Hz	0.547 x sample frequency, Hz	0.547 x sample frequency, Hz	0.547 x sample frequency, Hz
Analog filter ^b Low pass cutoff, -3 dB: High pass cutoff, -3 dB (AC coupling):	400 kHz 0.5 Hz	400 kHz 0.1 Hz	400 kHz 0.5 Hz	400 kHz 1 Hz
Channel-to-channel crosstalk ^c Input Signal = 10 kHz:	> -110 dB with 50 Ω termination > -105 dB with 1 kΩ termination	> -110 dB with 50 Ω termination > -105 dB with 1 kΩ termination	> -110 dB with 50 Ω termination > -105 dB with 1 kΩ termination	> -110 dB with 50 Ω termination > -105 dB with 1 kΩ termination
Input impedance	1 MΩ, 20 pF ^d	1 MΩ, 20 pF ^d	1 MΩ, 20 pF ^d	1 MΩ, 20 pF ^d
Coupling	AC/DC (software-selectable per channel)	AC/DC (software-selectable per channel)	AC/DC (software-selectable per channel)	AC/DC (software-selectable per channel)
IEPE current source	4 mA ±0.5%	4 mA ±0.5%	4 mA ±0.5%	2 mA ±0.5%
IEPE compliance voltage	18 V	18 V	18 V	18 V

Table 22: Analog Input Subsystem Specifications (cont.)

Feature	DT9837 Specifications	DT9837A Specifications	DT9837B Specifications	DT9837C Specifications
IEPE current source noise DC to 1 kHz	5 nARMS	5 nARMS	5 nARMS	5 nARMS
DC Accuracy				
Offset error ^e	1.5 mV	1.5 mV	1.5 mV	1.5 mV
Offset error temperature coefficient	(10 $\mu\text{V}/^\circ\text{C}$ x Gain) + 100 μV	(10 $\mu\text{V}/^\circ\text{C}$ x Gain) + 100 μV	(10 $\mu\text{V}/^\circ\text{C}$ x Gain) + 100 μV	(10 $\mu\text{V}/^\circ\text{C}$ x Gain) + 100 μV
Gain error Gain of 1: Gain of 10:	$\pm 0.02\%$ $\pm 0.5\%$	$\pm 0.02\%$ $\pm 0.5\%$	$\pm 0.02\%$ $\pm 0.5\%$	$\pm 0.02\%$ $\pm 0.5\%$
Gain error temperature coefficient	25 ppm/ $^\circ\text{C}$	25 ppm/ $^\circ\text{C}$	25 ppm/ $^\circ\text{C}$	25 ppm/ $^\circ\text{C}$
ADC Integral Non-Linearity error, INL	$\pm 0.0006\%$ of full-scale range	$\pm 0.0006\%$ of full-scale range	$\pm 0.0006\%$ of full-scale range	$\pm 0.0006\%$ of full-scale range
ADC Differential Non-Linearity error, DNL	Monotonic to 24 bits	Monotonic to 24 bits	Monotonic to 24 bits	Monotonic to 24 bits
D/A Readback in A/D Stream A/D resolution: Zero error: Full-scale error: Clock on input A/D Done	– – – –	16 bits ± 15 mV +0, –2% 42 ns to 83 ns	– – – –	– – – –
Dynamic Performance^f	See Table 23 on page 120.			
Maximum input voltage (without damage) Power on: Power off:	± 30 V ± 20 V	± 40 V ± 40 V	± 40 V ± 40 V	± 40 V ± 40 V
Overvoltage Protection				
Overvoltage protection (power on/off)	± 40 V	± 40 V	± 40 V	± 40 V
ESD protection Arc: Contact:	8 kV 4 kV	8 kV 4 kV	8 kV 4 kV	8 kV 4 kV

a. For frequencies of 52.734 kHz or less, Conversion Rate = Sample Rate * 512.

For frequencies greater than 52.734 kHz, Conversion Rate = Sample rate * 256.

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

c. Channel 0 is the reference channel with a 20 V PP signal and a maximum sample rate of 52.734 kSamples/s.

d. Cable capacitance of typically 30 pF per foot must be added.

e. Offset errors are referred to the input.

f. ENOB, SINAD, SNR, THD, and SFDR measurements were made with a 16384 point FFT with a minimum 4-term Blackman Harris window.

Table 23: Dynamic Performance Specifications

Dynamic Performance ^a	DT9837 Specifications		DT9837A Specifications		DT9837B and DT9837C Specifications	
	Gain of 1	Gain of 10	Gain of 1	Gain of 10	Gain of 1	Gain of 10
Effective Number of Bits, ENOB ^b (1 kHz input, 52.734 kSPS) –1 dBFS input: –6 dBFS input:	15.2 bits 15.8 bits	14.6 bits 15.3 bits	15.3 bits 16.3 bits	14.7 bits 15.6 bits	14.8 bits 16.0 bits	14.3 bits 15.4 bits
Signal to Noise and Distortion Ratio, SINAD ^c (1 kHz input) –1 dBFS input: –6 dBFS input:	92 dB 91 dB	88 dB 88 dB	93 dB 94 dB	89 dB 90 dB	90 dB 92 dB	87 dB 88 dB
Signal to Noise Ratio, SNR ^d (1 kHz input) –1 dBFS input: –6 dBFS input:	95 dB 91 dB	94 dB 91 dB	98 dB 95 dB	96 dB 94 dB	97 dB 93 dB	95 dB 92 dB
Total Harmonic Distortion, THD ^e (1 kHz input) –1 dBFS input: –6 dBFS input:	–96 dB –104 dB	–90 dB –91 dB	–95 dB –102 dB	–90 dB –92 dB	–91 dB –99 dB	–88 dB –91 dB
Spurious Free Dynamic Range, SFDR ^f (1 kHz input) –1 dBFS input: –6 dBFS input:	100 dBFS 110 dBFS	93 dBFS 101 dBFS	98 dBFS 108 dBFS	93 dBFS 100 dBFS	94 dBFS 107 dBFS	91 dBFS 100 dBFS
Noise Floor (50 Ω input termination)	100 μVRMS	10 μVRMS	60 μVRMS	10 μVRMS	80 μVRMS	9 μVRMS

a. ENOB, SINAD, SNR, THD, and SFDR measurements were made with a 16384 point FFT using a minimum 4-term Blackman Harris window at the maximum sampling rate.

b. 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.

c. 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.

d. 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.

e. Total Harmonic Distortion (THD) is the ratio of the RMS value of the input signal to the RMS sum of all harmonics.

f. 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.

Analog Output Specifications

Table 24 lists the specifications for the analog output subsystem on the DT9837, DT9837A, and DT9837C modules. Unless otherwise noted, specifications are typical at 25° C.

Table 24: Analog Output Subsystem Specifications

Feature	DT9837 Specifications	DT9837A Specifications	DT9837C Specifications
Number of analog output channels	1	1	1
Resolution	24 bits	24 bits	24 bits
D/A type	Delta Sigma	Delta Sigma	Delta Sigma
Output range	±10 V	±10 V	±3 V
Data encoding	Offset binary	Offset binary	Offset binary
Minimum sample frequency	46.875 kHz	10 kHz	10 kHz
Maximum sample frequency	46.875 kHz	52.734 kHz	96.0 kHz
Group delay (typical)	34/sample rate, in s	29/sample rate, in s	29/sample rate, in s
D/A master clock range	output frequency x 256	output frequency x 512	output frequency x 512
DAC Delta Sigma filter ^a Passband, -3 dB: Passband ripple, ±0.002 dB: Stopband, -82 dB:	0.49 x sample frequency, Hz 0.454 x sample frequency, Hz 0.546 x sample frequency, Hz	0.49 x sample frequency, Hz 0.454 x sample frequency, Hz 0.5646 x sample frequency, Hz	0.49 x sample frequency, Hz 0.454 x sample frequency, Hz 0.5646 x sample frequency, Hz
Analog filter ^a	10 kHz, 2-pole, low-pass Butterworth	10 kHz, 2-pole, low-pass Butterworth	40 kHz smoothing filter
Output current	±1 mA maximum load (10 V across 10 K)	±3 mA maximum load (10 V across 3.3 K)	±2 mA maximum load (3 V across 1.5 K)
Output FIFO	8192 Samples, total	8192 Samples, total	8192 Samples, total
Idle channel noise (216 kSPS)	600 μVRMS	100 μVRMS	30 μVRMS
Total Harmonic Distortion, THD ^b -1 dBFS, 1 kHz output, 10 kΩ load: -6 dBFS, 1 kHz output, 10 kΩ load:	-80 dB -80 dB	-78 dB -78 dB	-97 dB -100 dB
Spurious Free Dynamic Range, SFDR ^b -1 dBFS, 1 kHz output, 10 kΩ load: -6 dBFS, 1 kHz output, 10 kΩ load:	84 dBFS 86 dBFS	88 dBFS 88 dBFS	100 dBFS 109 dBFS
Offset error	±1.5 mV	±1.5 mV	±1.5 mV
Offset error temperature coefficient	200 μV/° C	200 μV/° C	200 μV/° C
Gain error	±3.0%	±0.03%	±0.03%

Table 24: Analog Output Subsystem Specifications (cont.)

Feature	DT9837 Specifications	DT9837A Specifications	DT9837C Specifications
Gain error temperature coefficient	50 ppm/° C	50 ppm/° C	50 ppm/° C
Power fault and reset	Goes to 0 V ±10 mV if the USB cable is removed or the power fails		
ESD protection Arc: Contact:	8 kV 4 kV	8 kV 4 kV	8 kV 4 kV

- a. The total frequency response is the combined frequency response of the DAC Sigma Delta filter and the analog filter.
- b. THD and SFDR measurements were made with a 16384 point FFT using a minimum 4-term Blackman Harris window at the maximum sample rate.

Tachometer Input Specifications

Table 25 lists the specifications for the tachometer input on the DT9837, DT9837A, and DT9837B modules. The tachometer is not supported by the DT9837C module.

Table 25: Tachometer Input Specifications

Feature	DT9837 Specifications	DT9837A Specifications	DT9837B Specifications
Number of channels	1	1	1
Resolution	31 bits per channel	31 bits per channel	31 bits per channel
Input voltage range	±30 V	±30 V	±30 V
Threshold voltage	+2 V with 0.5 V hysteresis	+2 V with 0.5 V hysteresis	+2 V with 0.5 V hysteresis
Maximum input frequency	380 kHz	1 MHz	1 MHz
Minimum pulse width high/low (minimum amount of time it takes a C/T to recognize an input pulse)	1.3 μs	0.4 μs	0.4 μs
Clock frequency for tachometer counter 0 measurements	12 MHz (83 ns resolution)	12 MHz (83 ns resolution)	12 MHz (83 ns resolution)
Clock frequency for tachometer counter 1 measurements	–	48 MHz (21 ns resolution)	48 MHz (21 ns resolution)

Gate Input Specifications

Table 26 lists the specifications for the gate input on the DT9837A-OEM and DT9837B modules.

Table 26: Gate Input Specifications

Feature	DT9837A-OEM and DT9837B Specifications
Signal type	LVTTTL
Input voltage range for gate input signal	0 to 5 V
Threshold voltage	± 2 V with 0.5 V hysteresis
Maximum input frequency	1 MHz
Minimum pulse width (high/low)	0.4 μ s
Counter resolution	32 bits
Clock frequency for gate counter 2 measurements	48 MHz (21 ns resolution)

Trigger Specifications

Table 27 lists the specifications for the trigger on the DT9837 Series modules.

Table 27: Trigger Specifications

Feature	DT9837 Specifications	DT9837A and DT9837B Specifications	DT9837C 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, positive trigger LVTTTL inputs 1 LVTTTL 1.1 V 1.3 V 0.2 V 33 μ A 1.3 μ A \pm 30 V	
Analog threshold trigger Type: Threshold level: Hysteresis:	Positive threshold trigger on analog input channel 0 1.0 V 100 mV	Positive threshold trigger on analog input channel 0 +0.2 to +9.8 V 100 mV	Positive or negative threshold trigger on any analog input channel \pm 10 V for a gain of 1; \pm 1 V for a gain of 10 100 mV
Trigger delay	1 conversion period maximum	1 conversion period maximum	1 conversion period maximum

Master Oscillator Specifications

Table 28 lists the specifications for the master oscillator on the DT9837A, DT9837B, and DT9837C modules.

Table 28: Master Oscillator Specifications

Feature	DT9837A, DT9837B, and DT9837C Specifications
Frequency	48 MHz
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

Power, Physical, and Environmental Specifications

Table 29 lists the power, physical, and environmental specifications for the DT9837 Series modules.

Table 29: Power, Physical, and Environmental Specifications

Feature	DT9837 Specifications	DT9837A Specifications	DT9837B Specifications	DT9837C Specifications
Power, +5 V	±0.5 V @ 0.5 A	±0.30 V @ 0.5 A	±0.30 V @ 425 mA	±0.30 V @ 0.5 A
Physical Dimensions of enclosure: Dimensions of PCB only: Weight: PCB assembly with enclosure: PCB assembly:	Width = 105.9 mm Length = 189 mm Height = 40 mm Width: 100 mm Length: 146.6 mm Thickness: 1.6 mm 490.7 g 153.1 g			
Environmental Operating temperature range: Storage temperature range: Relative humidity: Altitude:	0° C to 55° C -25° C to 85° C to 95%, noncondensing up to 10,000 feet			

Regulatory Specifications

The DT9837 Series is CE-compliant. [Table 30](#) lists the regulatory specifications for the DT9837 Series modules.

Table 30: Regulatory Specifications

Feature	DT9837 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 31 lists the connector specifications for the DT9837A, DT9837A-OEM, DT9837B, and DT9837C modules.

Table 31: Connector Specifications

Feature	Specifications
RJ45 (LVDS) Connector	Molex part number 44661-0001
Gate Input Connector ^a	AMP/Tyco part number 5-146282-4
BNC Connectors (DT9837, DT9837A, DT9837B, and DT9837C-BNC)	Amphenol 31-5540
Mini-XLR connectors (DT9837C-XLR)	Switchcraft TRAPC3MX

a. This connector is available on the DT9837A-OEM module only.



Connector Pin Assignments and LED Status Indicators

RJ45 (LVDS) Connector	132
Gate Input Connector	133
LED Status Indicators	134

RJ45 (LVDS) Connector

Figure 27 shows the RJ45 (LVDS) synchronization connector.

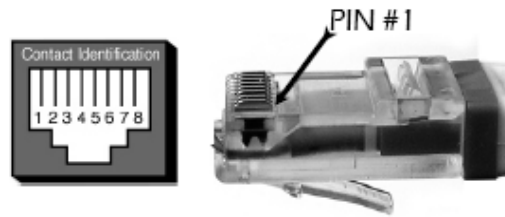


Figure 27: RJ45 (LVDS) Synchronization Connector

Table 32 lists the pin assignments for the RJ45 (LVDS) synchronization connector on the DT9837A, DT9837A-OEM, DT9837B, and DT9837C modules.

Table 32: RJ45 (LVDS) Synchronization Connector Pin Assignments

Pin	Description
1	Clock + (An LVDS signal for synchronizing data collection between two modules.)
2	Clock –
3	Trigger + (An LVTTTL signal that is asserted low for triggering between modules.)
4	Sync + (An LVTTTL signal that is asserted low for synchronizing all the analog input signals between modules for simultaneous sample-and-hold applications.)
5	Sync – (Connected to digital ground through a 100 Ω resistor.)
6	Trigger – (Connected to digital ground through a 100 Ω resistor.)
7	No Connect
8	No Connect

Gate Input Connector

The 4-pin Gate Input connector is available on the DT9837A-OEM module only. (The DT9837B module uses a BNC for the gate input signal). [Figure 28](#) shows the orientation of the Gate Input connector on the DT9837A-OEM module.

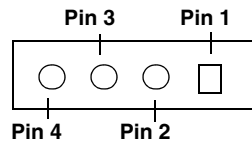


Figure 28: Gate Input Connector

[Table 33](#) lists the pin assignments for the Gate Input connector on the DT9837A-OEM module.

Table 33: Gate Input Connector Pin Assignments

Pin	Description
1	Gate Input
2	No Connect
3	Digital Ground
4	No Connect

LED Status Indicators

The DT9837 Series has a single bi-color LED that indicates the status of the module, as described in [Table 34](#).

Table 34: LED Status Indicators on the DT9828 Module

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



Register-Level Programming

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DT9837 Register-Level Programming

If you need to change the settings of the Open Layers Control Panel for the DT9837 programmatically, you can write to the following registers of the DT9837 module:

- General Control Register 2 – Write to this memory location to change the tachometer settings.
- EEPROM – Write to this memory location to change the coupling type, current source, or high power mode settings.

If you are using Windows, you can use the Data Acq SDK function `oldiagWriteReg` to write to these registers.

The following subsections describe writing to these memory locations in more detail.

Writing to the General Control Register 2

[Table 35](#) describes the bits of General Control Register 2 on the DT9837 module that relate to the programmable settings in the Open Layers Control Panel, described on [page 36](#).

Table 35: DT9837 General Control Register 2

Bits	Type	Name	Description
[7]	RW	Tach Counter 0 Start Select	Select the starting edge for the period measurement on Tach Counter 0: 0 – Tach Input Rising Edge 1 – Tach Input Falling Edge
[5]	RW	Tach Counter 0 Mode Select	Select the value read in between measured values on Tach Counter 0: 0 – Previous measurement 1 – Zeros
[4]	RW	Tach Counter 0 Flag Select	Select whether or not to use the Stale Data flag: 0 – Stale Data flag not used 1 – Stale Data flag used

The following Windows example shows how to update the bits of General Control Register 2 on the DT9837 module using the value specified in the `RegValueToWrite` variable:

```
#define LOCAL_BUS_BASE 0x200000
#define GENERAL_CNTRL_REG2 (LOCAL_BUS_BASE | 0x4102)
oldiagWriteReg (m_hDev, GENERAL_CONTROL_REG2, RegValueToWrite,2);
General Control Register 2 (ControlReg2) Offset: 0x2
```

Note: The contents of the registers are reset once the application exits.

Writing to EEPROM to Change the Coupling Type and Current Source

The Open Layers Control Panel has controls for setting the coupling type and current source for analog input channels 0, 1, 2, and 3, and for keeping the high power mode always on or off. You can change these settings programmatically by writing to the EEPROM on the DT9837 module.

The EEPROM_OFFSET_SETTINGS control (15) is used to store the coupling type and current source values for the DT9837. [Table 36](#) describes the bit values in the EEPROM_OFFSET_SETTINGS control that are used to store the coupling type and current source values on the DT9837 module.

**Table 36: DT9837 EEPROM Byte (EEPROM_OFFSET_SETTINGS)
for the Coupling Type and Current Source**

Bits	Type	Default	Name	Description
[0]	RW	1	ADC 0 Coupling	Select the coupling type for analog input channel 0: 0 – AC 1 – DC
[1]	RW	1	ADC 1 Coupling	Select the coupling type for analog input channel 1: 0 – AC 1 – DC
[2]	RW	1	ADC 2 Coupling	Select the coupling type for analog input channel 2: 0 – AC 1 – DC
[3]	RW	1	ADC 3 Coupling	Select the coupling type for analog input channel 3: 0 – AC 1 – DC
[4]	RW	1	ADC 0 Current Source	Select whether or not to use the 4 mA current source for analog input channel 0: 0 – Enabled 1 – Disabled
[5]	RW	1	ADC 1 Current Source	Select whether or not to use the 4 mA current source for analog input channel 1: 0 – Enabled 1 – Disabled
[6]	RW	1	ADC 2 Current Source	Select whether or not to use the 4 mA current source for analog input channel 2: 0 – Enabled 1 – Disabled
[7]	RW	1	ADC 3 Current Source	Select whether or not to use the 4 mA current source for analog input channel 3: 0 – Enabled 1 – Disabled

In Windows, you can read this EEPROM location programmatically using the **oldDiagReadReg()** function, and write to the EEPROM location programmatically using the **oldDiagWriteReg()** function. To change a single bit requires a read/modify/write operation.

The following constants define the location of the registers in EEPROM:

```
#define EEPROM_MEM_BASE 0x100000
const ULONG EEPROM_OFFSET_SETTINGS = 15;
```

This Windows example shows how to read the current source and coupling type from the EEPROM:

```
ULONG olddata;
OLSTATUS olStatus = oldDiagReadReg(m_hDev, EEPROM_MEM_BASE +
    EEPROM_OFFSET_SETTINGS, &olddata, 1);
```

This Windows example shows how to write values to EEPROM to change the current source and coupling type:

```
ULONG newdata;
OLSTATUS olStatus = oldDiagWriteReg(m_hDev, EEPROM_MEM_BASE +
    EEPROM_OFFSET_SETTINGS, newdata, 1);
```

Note: The data must be read and written as a 32-bit value, but only the lower 8-bits of this value is actually transferred.

Writing to EEPROM to Change the High Power Mode

For the high power mode setting, you can keep high power mode always turned on or turn off high power mode (the default setting) by writing to the **EEPROM_OFFSET_POWER_OVERRIDE_REG** (0x000E) control in the EEPROM.

Turning off the high-power circuitry (writing a value of 0 to this control) helps to conserve power, which may be useful when the module is used with a laptop. However, to ensure that the module is warmed up and that any settling time errors of the IEPE current source are minimized, it is recommended that you keep the module's high-power circuitry always turned on by writing a value of 1 to this control.

In Windows, you can read the EEPROM location programmatically using the **oldDiagReadReg()** function, and write to the EEPROM location programmatically using the **oldDiagWriteReg()** function. To change a single bit requires a read/modify/write operation.

The following constants define the location of the registers in EEPROM:

```
#define EEPROM_MEM_BASE 0x100000
#define EEPROM_OFFSET_POWER_OVERRIDE_REG 0x000E
```

This Windows example shows how to read the high power mode value from the EEPROM:

```
ULONG alwaysOn = 1;
UINT numberOfBytes = 1;
OLSTATUS olStatus = oldiagReadReg(m_hDev, EEPROM_MEM_BASE +
    EEPROM_OFFSET_POWER_OVERRIDE_REG, &alwaysOn, numberOfBytes);
```

This Windows example shows how to write to this EEPROM location to keep high power mode always on:

```
// To keep the high power mode always on, use the following code:
UINT alwaysOn = 1;
UINT numberOfBytes = 1;
OLSTATUS olStatus = oldiagWriteReg(m_hDev, EEPROM_MEM_BASE +
    EEPROM_OFFSET_POWER_OVERRIDE_REG, alwaysOn, numberOfBytes);
```

Note: Currently, only one bit of this control is used; therefore, there is no need to mask any other bits in this control.

DT9837A, DT9837B, and DT9837C Register-Level Programming

If you need to change the settings of the Open Layers Control Panel for the DT9837A, DT9837B, or DT9837C programmatically, you can write to the following registers of the DT9837A, DT9837B, or DT9837C module:

- General Control Register 4 – Write to this memory location to change the tachometer and gate settings. The DT9837C module does not support this register.
- EEPROM – Write to this memory location to change the coupling, current source, and high power mode settings.

In Windows, you can write to these registers using the Data Acq SDK function `oldiagWriteReg`.

If you are using Linux or macOS, refer to [page 147](#) for more information on writing to these registers.

The following subsections describe writing to these memory locations in more detail.

Writing to the General Control Register 4

[Table 37](#) describes the bits of General Control Register 4 on the DT9837A and DT9837B, modules that relate to the tachometer and gate settings in the Open Layers Control Panel, described on [page 36](#).

Table 37: DT9837A and DT9837B General Control Register 4

Bits	Type	Name	Description
[15:14]	RW	Tach Counter 1 Start Select	Select the starting edge for the Tach Counter 1 measurement function: 00 – A/D Ready Falling Edge 01 – Reserved 10 – Tach Input Falling Edge 11 – Tach Input Rising Edge
[13:12]	RW	Gate Counter 2 Start Select	Select the starting edge for the Gate Counter 2 measurement function: 00 – A/D Ready Falling Edge 01 – Reserved 10 – Gate Falling Edge 11 – Gate Rising Edge
[11:10]	RW	Gate Counter 2 Stop Select	Select the stopping edge for the Gate Counter 2 measurement function: 00 – A/D Ready Falling Edge 01 – Reserved 10 – Gate Falling Edge 11 – Gate Rising Edge

Table 37: DT9837A and DT9837B General Control Register 4 (cont.)

Bits	Type	Name	Description
[8]	RW	Gate Counter 2 Self Clear	Select the value read in between measured values on Gate Counter 2: 0 – Keep the last value 1 – Clear to 0 on write to Input FIFO
[7:6]	RW	Tach Counter 1 Stop Select	Select the stopping edge for the Tach Counter 1 measurement function: 00 – A/D Ready Falling Edge 01 – Reserved 10 – Tach Input Falling Edge 11 – Tach Input Rising Edge
[4]	RW	Tach Counter 1 Self Clear	Select the value read in between measured values on Tach Counter 1: 0 – Keep the last value 1 – Clear to 0 on write to Input FIFO
[3]	RW	Tach Counter 0 Start Select	Select the starting edge for the period measurement on Tach Counter 0: 0 – Tach Input Rising Edge 1 – Tach Input Falling Edge
[1]	RW	Tach Counter 0 Mode Select	Select the value read in between measured values on Tach Counter 0: 0 – Previous measurement 1 – Zeros
[0]	RW	Tach Counter 0 Flag Select	Select whether or not to use the Stale Data flag: 0 – Stale Data flag not used 1 – Stale Data flag used

The following Windows example shows how to update the bits of General Control Register 4 on the DT9837A and DT9837B modules using the value specified in the *RegValueToWrite* variable:

```
#define LOCAL_BUS_BASE 0x400000
#define GENERAL_CNTRL_REG4 (LOCAL_BUS_BASE | 0x8)
oldiagWriteReg (m_hDev, GENERAL_CONTROL_REG4, RegValueToWrite, 2);
General Control Register 4 (ControlReg4) Offset: 0x8
```

Note: The contents of the registers are reset once the application exits.

Writing to EEPROM

On the DT9837A, DT9837B, and DT9837C 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, 2 and 3 Coupling type. The values AC or DC are stored as constants for these controls.
- Channel 0, 1, 2 and 3 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)
- High power mode. You can keep high power mode always turned on or turn off high power mode (the default setting). Turning off the high-power circuitry helps to conserve power, which may be useful when the module is used with a laptop. However, to ensure that the module is warmed up and that any settling time errors of the IEPE current source are minimized, it is recommended that you keep the module's high-power circuitry always turned on.

To keep high power mode always on, set the value of this control to True. To turn off high power mode, set the value of this control to False.

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

If you are using Linux or macOS, these settings are programmed using software commands; refer to [page 147](#) for more information.

In Windows, you can access the storage locations programmatically using 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
// four analog input channels
const EEPROM_OFFSET_COUPLING_0 = 0x0020;
const EEPROM_OFFSET_COUPLING_1 = 0x0021;
const EEPROM_OFFSET_COUPLING_2 = 0x0022;
const EEPROM_OFFSET_COUPLING_3 = 0x0023;

// Current source storage offsets relative to the base address for
// the four analog input channels
const EEPROM_OFFSET_CURRENT_SOURCE_0 = 0x0024;
const EEPROM_OFFSET_CURRENT_SOURCE_1 = 0x0025;
const EEPROM_OFFSET_CURRENT_SOURCE_2 = 0x0026;
const EEPROM_OFFSET_CURRENT_SOURCE_3 = 0x0027;
// High power mode offset relative to the base address
const EEPROM_OFFSET_POWER_OVERRIDE_REG = 0x0040;
```

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

```
// 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);

// 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);

// To keep the high power mode always on, use the following code:
BOOL alwaysOn = True;
UNIT numberOfBytes = 1;
OLSTATUS olStatus = olDiagWriteReg(m_hDev, EEPROM_MEM_BASE +
    EEPROM_OFFSET_POWER_OVERRIDE_REG, alwaysOn, numberOfBytes);
```




Programming in Linux or macOS

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Overview

If you want to program a Data Translation DT9837A, DT9837B, or DT9837C module in Linux or macOS rather than in Windows, use the Universal Library (UL) for Linux from Measurement Computing Corporation instead of DT-Open Layers.

Note: UL for Linux does not support the DT9837 module. Also note that user calibration is supported only in Windows using the DT9837 Series Calibration Utility.

Installing UL for Linux

Follow the instructions from github at <https://github.com/mccdaq/uldaq> to build and install UL for Linux.

Using UL for Linux

Refer to the examples and online help provided with UL for Linux for information on how to develop applications for data acquisition devices using C or Python on the Linux or macOS operating system.

Listed below are particular notes to be aware of when using UL for Linux with the DT9837A, DT9837B, or DT9837C modules.

Channel Numbering in UL for Linux

When using UL for Linux with Data Translation devices, you must specify the channels differently for scans than in DT-Open Layers.

In DT-Open Layers scanned data is accessed through the analog input subsystem, and each channel number in the channel list specifies the analog or counter channel to be scanned. In UL for Linux, scanned data is accessed through the corresponding subsystem type, and channel numbers for each subsystem type start at 0.

For example, to get scan data on the DT9837B using UL for Linux, keep the following in mind:

- To get analog input data only, use **ulAInScan** and specify the analog input channels to sample (0 to 3).
- To get data from tachometer channel 0 only, use **ulCInScan** and specify channel 0.
- To get data from tachometer channel 1 only, use **ulCInScan** and specify channel 1.
- To get data from gate counter 2 only, use **ulCInScan** and specify channel 2.
- To get data from all these channels at once, use **ulDaqInScan**, and specify the channel number (starting at 0) and the channel type (such as analog or counter) in the *DaqInChanDescriptor* structure.

IEPE Settings for Analog Inputs

In Windows, you can use the Open Layers Control panel to configure the IEPE settings that are used at power up.

In UL for Linux, IEPE is always off at power up. The current source is disabled and DC coupling is used for the analog input channels by default.

To configure the current source in UL for Linux, use the function **ulAISetConfig** with the *configItem* `AI_CFG_CHAN_IEPE_MODE`. Specify `IEPE_DISABLED` or `IEPE_ENABLED` for the *configValue*.

To configure the coupling mode (DC or AC) in UL for Linux, use the function **ulAISetConfig** with the *configItem* `AI_CFG_CHAN_COUPLING_MODE`. Specify `CM_DC` or `CM_AC` for the *configValue*.

To set the sensor sensitivity of your IEPE input in UL for Linux, use the function **ulAISetConfigDbf** with the *configItem* `AI_CFG_CHAN_SENSOR_SENSITIVITY`. For *configValue*, specify a floating point number for the sensitivity.

Note: The values that are set using **ulAISetConfig** and **ulAISetConfigDbf** are not retained in EEPROM; therefore, they are not used a power up. It is recommended that your program initialize these values when your program runs.

Tachometer Measurements

In Windows, you can use the Open Layers Control panel to configure the settings that are used at power up for the tachometer (tachometer counter 0 and tachometer counter 1).

In UL for Linux, the DT9837A and DT9837B always power up with the values for the tachometer that were set through the Open Layers Control Panel. (The DT9837C does not support tachometer inputs.)

Frequency and Period Measurement - Tachometer Counter 0

In UL for Linux, you can read the number of counts between two consecutive starting edges of the tachometer input signal by using **ulCInScan** function and specifying channel 0 or by using the **ulDaqInScan** function and specifying channel number 0 and the counter channel type in the *DaqInChanDescriptor* structure.

You can configure the settings for the measurement using the **ulCtrSetConfig** function with the *configItem* `CTR_CFG_REG`. This *configItem* is used to write to General Control Register 4, described in [Table 38 on page 148](#).

Table 38: General Control Register 4

MSB	14	13	12	11	10	9	8	7	6	5	4	3	2	1	LSB
T1 ST		G2 ST		G2 STP		X	G2 CLR	T1 STP		X	T1 CLR	T0 ST	X	T0 MD	T0 FLG
Gate Counter 2 Self Clear Select value read between measured values on Gate Counter 2								Tach Counter 0 Flag Select Select whether or not to use the Stale Data flag							
G2 CLR	0	Keep the last value						T0 FLG	0	Stale Data flag not used					
	1	Clear to 0 on write to Input FIFO							1	Stale Data flag used					
Gate Counter 2 Stop Select Select stopping edge for Gate Counter 2 measurement function								Tach Counter 0 Mode Select Select value read between measured values on Tach Counter 0							
G2 STP	00	A/D Ready Falling Edge						T0 MD	0	Previous measurement					
	01	Reserved							1	Zeros					
	10	Gate Input Falling Edge													
	11	Gate Input Rising Edge						Tach Counter 0 Start Select Select starting edge for Tach Counter 0 measurement function							
Gate Counter 2 Start Select Select starting edge for Gate Counter 2 measurement function								T0 ST	0	Tach Input Falling Edge					
									1	Tach Input Rising Edge					
G2 ST	00	A/D Ready Falling Edge						Tach Counter 1 Self Clear Select value read between measured values on Tach Counter 1							
	01	Reserved						T1 CLR	0	Keep the last value					
	10	Gate Input Falling Edge							1	Clear to 0 on write to Input FIFO					
	11	Gate Input Rising Edge													
Tach Counter 1 Start Select Select starting edge for Tach Counter 1 measurement function								Tach Counter 1 Stop Select Select stopping edge for Tach Counter 1 measurement function							
T1 ST	00	A/D Ready Falling Edge						T1 STP	00	A/D Ready Falling Edge					
	01	Reserved							01	Reserved					
	10	Tach Input Rising Edge							10	Tach Input Rising Edge					
	11	Tach Input Falling Edge							11	Tach Input Falling Edge					

Specify the appropriate bitmask value for the register using the *configValue* argument of the `ulCtrSetConfig` function. (You can first read the value of the register using the `ulCtrGetConfig` function with the `configItem CTR_CFG_REG` to make this easier.)

Note: The values that are set using `ulCtrSetConfig` are not retained in EEPROM; therefore, they are not used at power up. It is recommended that your program initialize these values when your program runs.

The following settings are configurable for tachometer counter 0 using `configItem` `CTR_CFG_REG` and the `ulCtrSetConfig` function:

- Tach Counter 0 Start Select (T0 ST, bit 3 of General Control Register 4) – Set bit 3 to a value of 1 (Tach Input Falling Edge) to start the measurement on the falling edge of the tachometer input signal, or to a value of 0 (Tach Input Rising Edge) to start the measurement on the rising edge of the tachometer input signal.
- Tach Counter 0 Mode Select (T0 MD, bit 1 of General Control Register 4) – Set bit 1 to a value of 1 (Zeros) to read a value of 0 between measurements, or to a value of 0 (Previous measurement) if you want to read the previous measurement value if the new measurement value is not yet complete.
- Tach Counter 0 Flag Select (T0 FLG, bit 0 of General Control Register 4) – Set bit 0 to a value of 1 (Stale Data flag used) if you want to indicate whether or not the measurement value is new, or to a value of 0 (Stale Data flag not used) if you do not want to indicate whether the measurement value is new.

If the Stale Data flag is used, the most significant bit (MSB) of the measurement value is set to 0 to indicate new data; reading the value before the measurement is complete returns an MSB of 1.

If the Stale Data flag is not used, the MSB of the measurement value is always set to 0.

Using the count that is returned from channel 0 of the `ulCInScan` (or channel 0 of the counter subsystem of the `ulDaqInScan` function), you can determine the following:

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

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

Phase Measurements – Tachometer Counter 1

On the DT9837A and DT9837B modules, you can measure the phase of the tachometer input in relation to the A/D sample by using the **ulCInScan** function and specifying channel 1 or by using the **ulDaqInScan** function and specifying channel number 1 and the counter channel type in the *DaqInChanDescriptor* structure.

You can configure the settings for the measurement using the **ulCtrSetConfig** function with the *configItem* CTR_CFG_REG. This *configItem* is used to write to General Control Register 4, described in [Table 38 on page 148](#). Specify the appropriate bitmask value for the register using the *configValue* argument of the **ulCtrSetConfig** function. (You can first read the value of the register using the **ulCtrGetConfig** function with the *configItem* CTR_CFG_REG to make this easier.)

Note: The values that are set using **ulCtrSetConfig** are not retained in EEPROM; therefore, they are not used at power up. It is recommended that your program initialize these values when your program runs.

The following settings are configurable for tachometer counter 1 using *configItem* CTR_CFG_REG and the **ulCtrSetConfig** function:

- Tach Counter 1 Start Select (T1 ST, bit 15 and 14 of General Control Register 4) – To start the measurement on the rising edge of the tachometer input signal, set bits 15 and 14 to a value of 1 (Tach Input Rising Edge).

To start the measurement on the falling edge of the tachometer input signal, set bit 15 to a value of 1 and bit 14 to a value of 0 (Tach Input Falling Edge).

To start the measurement on the falling edge of the A/D ready signal, set bits 15 and 14 to a value of 0 (A/D Ready Falling Edge).

- Tach Counter 1 Stop Select (T1 STP, bit 7 and 6 of General Control Register 4) – To stop the measurement on the rising edge of the tachometer input signal, set bits 7 and 6 to a value of 1 (Tach Input Rising Edge).

To stop the measurement on the falling edge of the tachometer input signal, set bit 7 to a value of 1 and bit 6 to a value of 0 (Tach Input Falling Edge).

To stop the measurement on the falling edge of the A/D ready signal, set bits 7 and 6 to a value of 0 (A/D Ready Falling Edge).

Note: If you choose to start the measurement using the A/D sample, choose a tachometer edge to stop the measurement. Likewise, if you choose to stop the measurement using the A/D sample, choose a tachometer edge to start the measurement.

- Tach Counter 1 Self Clear (T1 CLR, bit 4 of General Control Register 4) – Set bit 4 to a value of 1 (Clear to 0 on write to Input FIFO) if you want to return a value of 0 between measurements. Set bit 4 to a value of 0 (Keep the last value) if you want to return the previous measurement value between readings.

Gate Measurements

In Windows, you can use the Open Layers Control panel to configure the settings that are used at power up for the gate input signal (gate counter 2) on the DT9837A-OEM and DT9837B modules. In UL for Linux, the DT9837A-OEM and DT9837B modules always power up with the values for the gate input signal that were set through the Open Layers Control Panel.

You can measure the phase of the gate input in relation to the A/D sample by using the **ulCInScan** function and specifying channel 2 or by using the **ulDaqInScan** function and specifying channel number 2 and the counter channel type in the *DaqInChanDescriptor* structure.

You can configure the settings for the measurement using the **ulCtrSetConfig** function with the *configItem* CTR_CFG_REG. This *configItem* is used to write to General Control Register 4, described in [Table 38 on page 148](#). Specify the appropriate bitmask value for the register using the *configValue* argument of the **ulCtrSetConfig** function. (You can first read the value of the register using the **ulCtrGetConfig** function with the *configItem* CTR_CFG_REG to make this easier.)

Note: The values that are set using **ulCtrSetConfig** are not retained in EEPROM; therefore, they are not used at power up. It is recommended that your program initialize these values when your program runs.

The following settings are configurable for Gate Counter 2 using *configItem* CTR_CFG_REG and the **ulCtrSetConfig** function:

- Gate Counter 2 Start Select (G2 ST, bit 13 and 12 of General Control Register 4) – To start the measurement on the rising edge of the gate input signal, set bits 13 and 12 to a value of 1 (Gate Input Rising Edge).

To start the measurement on the falling edge of the gate input signal, set bit 13 to a value of 1 and bit 12 to a value of 0 (Gate Input Falling Edge).

To start the measurement on the falling edge of the A/D ready signal, set bits 13 and 12 to a value of 0 (A/D Ready Falling Edge).

- Gate Counter 2 Stop Select (G2 STP, bit 11 and 10 of General Control Register 4) – To stop the measurement on the rising edge of the gate input signal, set bits 11 and 10 to a value of 1 (Gate Input Rising Edge).

To stop the measurement on the falling edge of the gate input signal, set bit 11 to a value of 1 and bit 10 to a value of 0 (Gate Input Falling Edge).

To stop the measurement on the falling edge of the A/D ready signal, set bits 11 and 10 to a value of 0 (A/D Ready Falling Edge).

Note: If you choose to start the measurement using the A/D sample, choose a gate input edge to stop the measurement. Likewise, if you choose to stop the measurement using the A/D sample, choose a gate input edge to start the measurement.

If you choose the start and stop the measurement using the same gate edge, you will measure the pulse width of the gate signal; be aware that the stopping edge does not restart the measurement; the next starting edge will start the next measurement.

- Gate Counter 2 Self Clear (G2 CLR, bit 8 of General Control Register 4) – Set bit 8 to a value of 1 (Clear to 0 on write to Input FIFO) if you want to return a value of 0 between measurements.

Set bit 8 to a value of 0 (Keep the last value) if you want to return the previous measurement value between readings.

Power Mode Setting

In Windows, the power mode setting is configured using the Open Layers Control Panel.

In UL for Linux, the DT9837A, DT9837B, or DT9837C module always powers up in low power mode, which helps to conserve power when the module is used with a laptop.

Once you run a UL for Linux program for the module, high power mode is turned on automatically to ensure that the module is warmed up and that any settling time errors of the IEPE current source are minimized. This setting is not configurable in UL for Linux.

Input Triggers

When using UL for Linux, acquisition starts when the input trigger occurs. Unlike DT-Open Layers, a reference trigger is not used.

Users can monitor the data as it is being acquired to determine if a particular event (threshold crossing) has occurred.

Reading Back the Value of the Analog Output Channel

For the DT9837A only, you can read back the value of the analog output channel in the input stream by using the `ulDaqInScan` function and specifying `DAQI_DAC` in the `DaqInChanDescriptor` structure.

Synchronizing Acquisition on Multiple Modules

DT9837A, DT9837B, and DT9837C modules provide an RJ45 (LVDS) synchronization connector that you can use to connect and synchronize multiple DT9837A, DT9837B, or DT9837C modules. In this scheme, one module is the master and the other modules are the slaves.

Notes: By default, no synchronization is used in UL for Linux. In this configuration, the DT9837A, DT9837B, or DT9837C module uses the USB clock instead of the RJ45 synchronization connector to provide the timebase for the clock.

When using the master/slave configuration, you can use DT9837A and DT9837B modules together, however, the maximum sampling rate is limited by the slowest module (52.7 kHz, in this case). If you are using DT9837C modules in a master/slave configuration, it is recommended that you do not connect any other module type except the DT9837C.

To synchronize multiple modules using UL for Linux, do the following:

- For the master device, set the *options* argument of the scan function that you want to use (**ulAInScan**, **ulDaqInScan**, or **ulCInScan**) to `SO_TIMEBASEOUT`. In this configuration, the master outputs the clock signal (timebase) to the slave devices.
- For the slave devices, set the *options* argument of the scan function (**ulAInScan**, **ulDaqInScan**, or **ulCInScan**) to `SO_EXTTIMEBASE`. In this configuration, the slave devices accept the clock signal (timebase) from the master.

When the subsystem on the master is triggered, the subsystems on the master and the slave devices start acquiring data at the same time (within one A/D conversion of the clock). You can set the scan rate to be the same or different on each module.

Notes: If you are using multiple DT9837C modules and want to trigger the master module with an analog threshold trigger, you must set the master and the slave devices to use the analog threshold trigger for proper operation (no physical trigger connection to the slave is required).

When you are finished acquiring data, be sure to stop the subsystems on the master and all connected slave modules before disconnecting the cable from the RJ45 connectors.

The synchronization settings remain set until changed or until the application exits.

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