DATA TRANSLATION

DT9837 Series
User's Manual

Radio and Television Interference

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

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

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

Canadian Department of Communications Statement

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

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

Table of Contents

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, the capabilities of the DT9837 Series Device Drivers, and how to program the DT9837 Series modules using the DT-Open Layers for .NET Class Library™ software. Troubleshooting information is also provided.

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

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 in the Microsoft® Windows Vista®, Windows 7, or Windows 8 operating system. It is assumed that you have some familiarity with data acquisition principles and that you understand your application.

How this Manual is Organized

This manual is organized as follows:

- Chapter 1, "Overview," describes the major features of the 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.

- Chapter 3, "Wiring Signals," describes how to wire signals to a DT9837 Series module.

- Chapter 4, "Verifying the Operation of a Module," describes how to verify the operation of a DT9837 Series module with the Quick DataAcq application.

- 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," lists the data acquisition subsystems and the associated features accessible using the DT9837 Series Device Drivers.

- 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," describes how to calibrate the analog I/O circuitry of the DT9837 Series modules.

- 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.

- 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:

- *Benefits of the Universal Serial Bus for Data Acquisition.* This white paper describes why USB is an attractive alternative for data acquisition. It is available on the Data Translation web site (www.datatranslation.com).

- *QuickDAQ User's Manual* (UM-24774). This manual describes how to create a QuickDAQ application to acquire and analyze data from a DT-Open Layers data acquisition module.

- *DT-Open Layers for .NET User's Manual* (UM-22161). For programmers who are developing their own application programs using Visual C# or Visual Basic .NET, this manual describes how to use the DT-Open Layers for .NET Class Library to access the capabilities of Data Translation data acquisition devices.

- *DataAcq SDK User's Manual* (UM-18326). For programmers who are developing their own application programs using the Microsoft C compiler, this manual describes how to use the DT-Open Layers DataAcq SDK™ to access the capabilities of Data Translation data acquisition devices.

- *LV-Link Online Help*. This help file describes how to use LV-Link™ with the LabVIEW™ graphical programming language to access the capabilities of Data Translation data acquisition devices.

- Microsoft Windows Vista, Windows 7, or Windows 8 documentation.

- USB web site (http://www.usb.org).

Where To Get Help

Should you run into problems installing or using a DT9837 Series module, the Data Translation 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.datatranslation.com).

1

Overview

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.
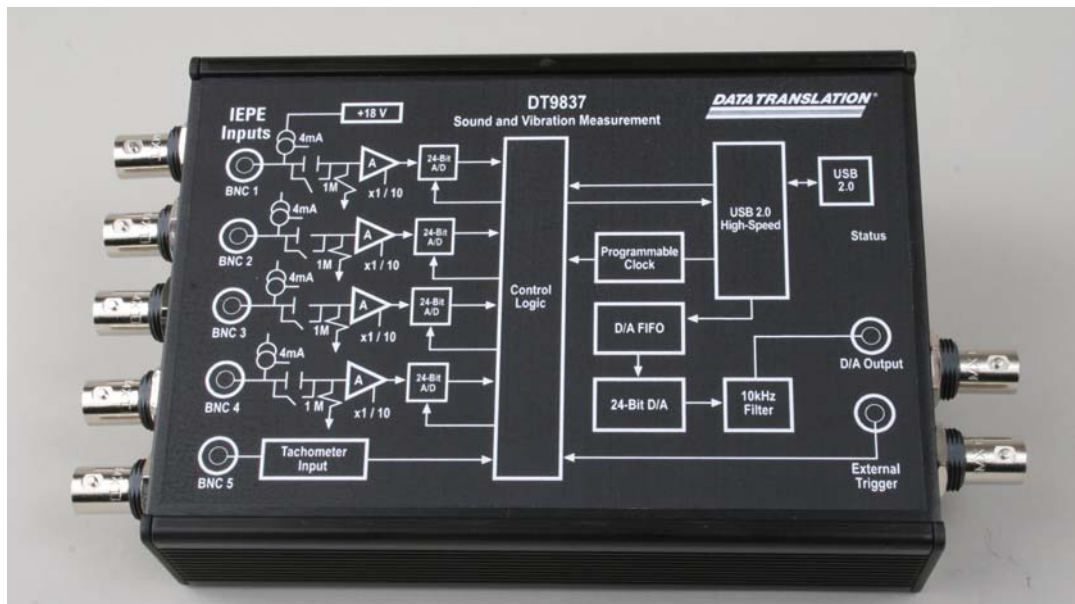
Figure 1: DT9837 Module

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 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 ±10 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.
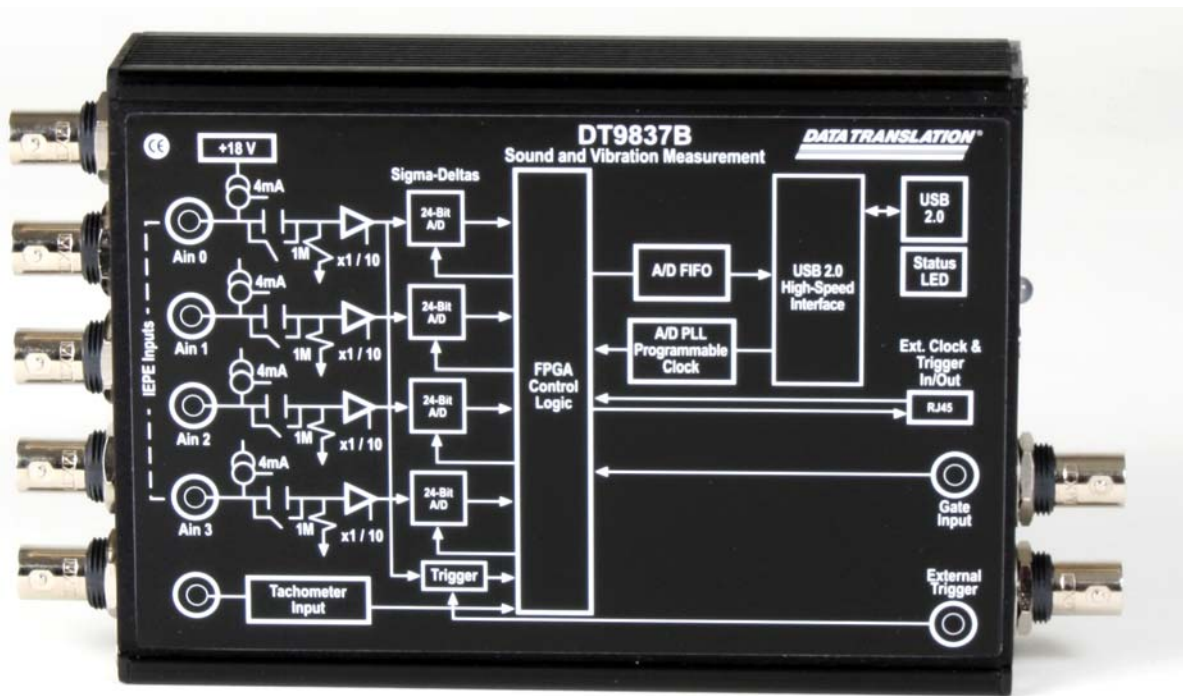
Figure 3: DT9837B Module

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.
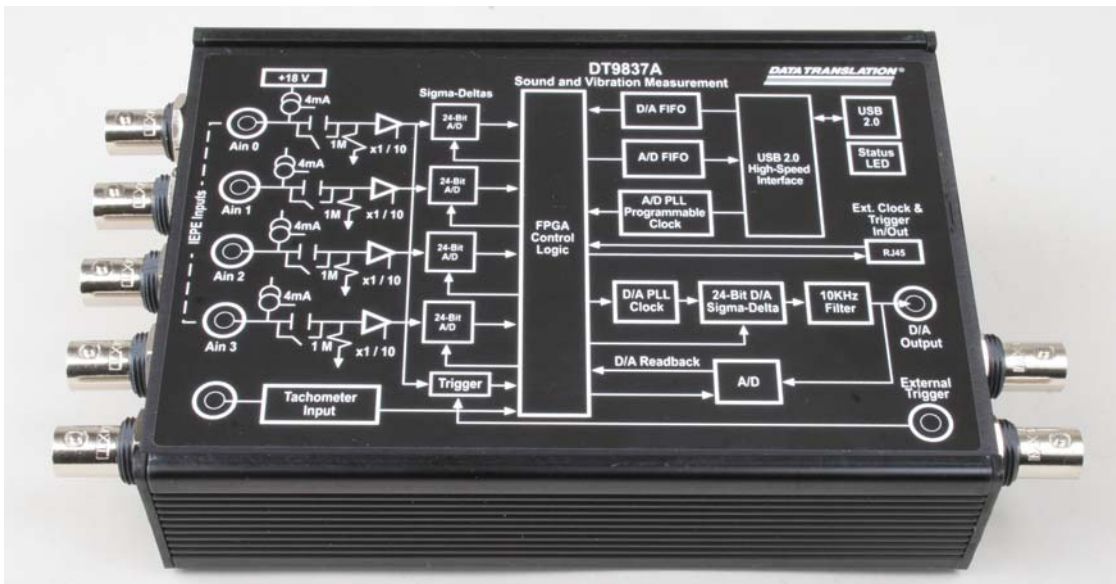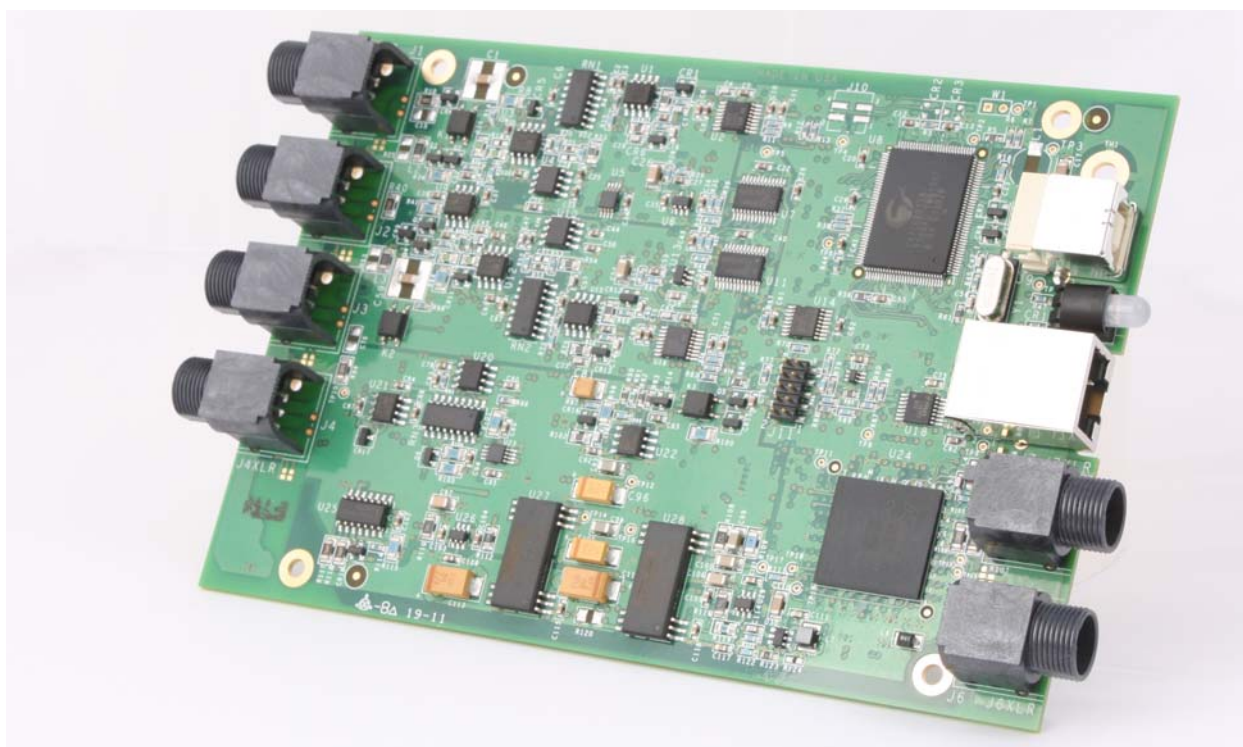

Figure 4: DT9837C Module

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

The following software is available for use with the DT9837 Series modules 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 Data Translation web site (www.datatranslation.com) for information about selecting the right software package for your needs.

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.

Set Up and Install the Module
(see Chapter 2 starting on page 29)

Wire Signals
(see Chapter 3 starting on page 39)

Verify the Operation of the Module
(see Chapter 4 starting on page 49)
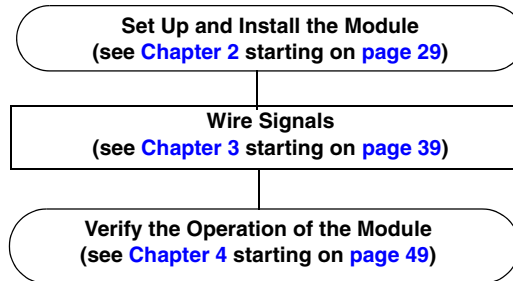
Figure 6: Getting Started Flow Diagram

Part 1: Getting Started

2

Setting Up and Installing the Module

Set Up and Install the Module
(this chapter)

Wire Signals
(see Chapter 3 starting on page 39)

Verify the Operation of the Module
(see Chapter 4 starting on page 49)

Unpacking

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

- DT9837, DT9837A, or DT9837B module

- EP365 USB cable

- Data Acquisition OMNI CD-ROM

If an item is missing or damaged, contact Data Translation. If you are in the United States, call the Customer Service Department at (508) 481-3700, ext. 1323. An application engineer will guide you through the appropriate steps for replacing missing or damaged items. If you are located outside the United States, call your local distributor, listed on Data Translation's web site (www.datatranslation.com).

Note: The DT9837 Series modules are factory-calibrated. If you decide that you want to recalibrate the analog input or analog output circuitry, refer to the instructions in Chapter 8.

System Requirements

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

- Processor: Pentium 4/M or equivalent

- RAM: 1 GB

- Screen Resolution: 1024 x 768 pixels

- Operating System: Windows 8, Windows 7, Windows Vista (32- and 64-bit)

- Disk Space: 4 GB

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 .

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. Run the installation program on your Data Acquisition OMNI CD to install the device driver and other software for the module.

Connecting Directly to the USB Ports

To connect a 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 and starts the Found New Hardware wizard.
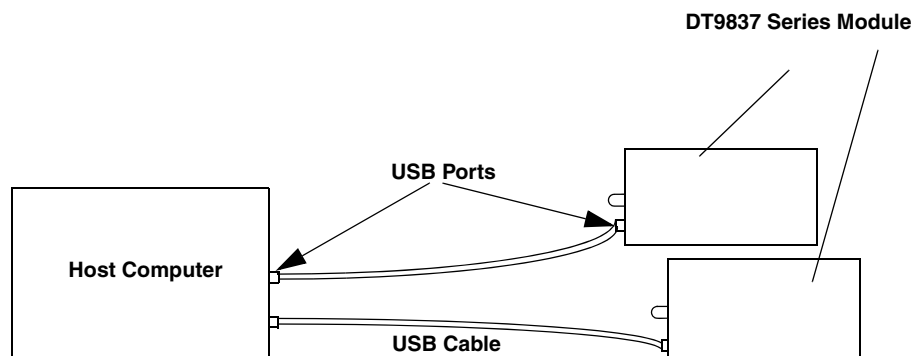
Figure 7: Attaching the Module to the Host Computer

3. *For Windows Vista:*

    a. Click **Locate and install driver software (recommended**).
        The popup message "Windows needs your permission to continue" appears.

    b. Click **Continue**.
        The Windows Security dialog box appears.

    c. Click **Install this driver software anyway**.

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

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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 and starts the Found New Hardware wizard.

4. *For Windows Vista:*

    a. Click **Locate and install driver software (recommended**).
        The popup message "Windows needs your permission to continue" appears.

    b. Click **Continue**.
        The Windows Security dialog box appears.

    c. Click **Install this driver software anyway**.

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

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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.
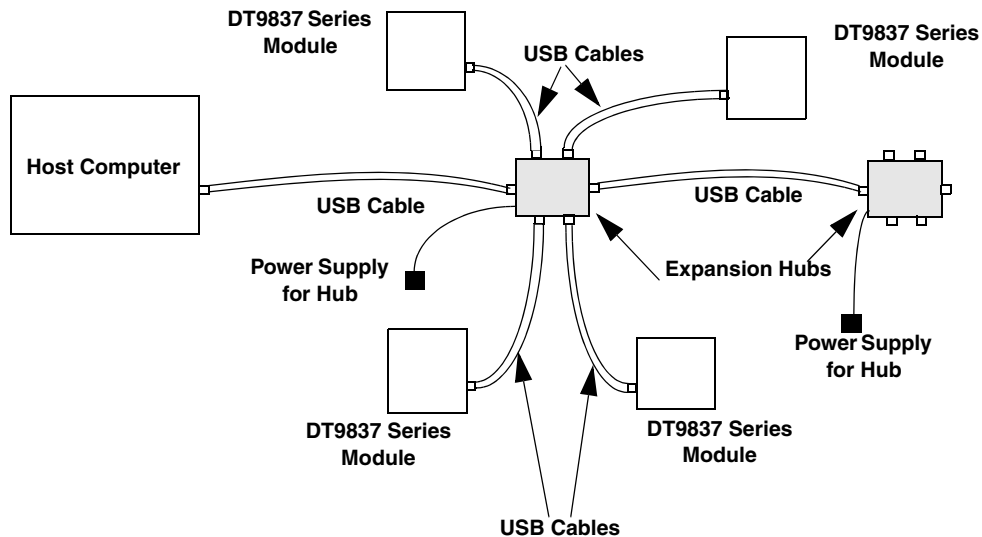
Figure 8: Attaching Multiple Modules Using Expansion Hubs

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

> **Note:** In Windows 7, Windows 8, and Vista, you must have administrator privileges to run the Open Layers Control Panel. When you double-click the Open Layers Control Panel icon, you may see the Program Compatibility Assistant. If you do, select **Open the control panel using recommended settings**. You may also see a Windows message asking you if you want to run the Open Layers Control Panel as a "legacy CPL elevated." If you get this message, click **Yes**.
>
> If you do not get this message and have trouble making changes in the Open Layers Control Panel, right click the DTOLCPL.CPL file and select **Run as administrator**. By default, this file is installed in the following location:
>
> Windows 7, Windows 8, and Vista (32-bit)
> C:\Windows\System32\Dtolcpl.cpl
>
> Windows 7, Windows 8, and Vista (64-bit)
> C:\Windows\SysWOW64\Dtolcpl.cpl

To configure the device driver for a DT9837 Series module, do the following:

1. If you have not already done so, power up the host computer and all peripherals.

2. From the Windows Start menu, select **Settings|Control Panel**.

3. From the Control Panel, double-click **Open Layers Control Panel**.
   The Data Acquisition Control Panel dialog box appears.

4. If you want to rename the module, click the name of the module that you want to rename, click **Edit Name**, enter a new name for the module, and then click **OK**. The name is used to identify the module in all subsequent applications.

5. Select the module that you want to configure, and then click **Advanced**.
   The Measurement Options dialog box appears.

6. 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 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** (the default) 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** (the default value) if you want to indicate whether or not the measurement value if 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 time from the stopping edge of the tachometer input signal to the A/D sample or from the A/D sample to the stopping edge of the tachometer input signal by specifying channel 5 (tachometer counter 1) in the analog input channel list; see 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** (the default value) 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 time between the A/D sample to the specified edge of the gate input signal, the time between two gate input signals, or the time between the specified edge of the gate input signal 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.

   c. From the **Self Clear** combo box, select **Clear to zero** (the default value) 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. Refer to Appendix C starting on page 135 for more information.

3

Wiring Signals

Set Up and Install the Module
(see **Chapter 2** starting on **page 29**)

Wire Signals
(this chapter)

Verify the Operation of the Module
(see **Chapter 4** starting on **page 49**)

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.
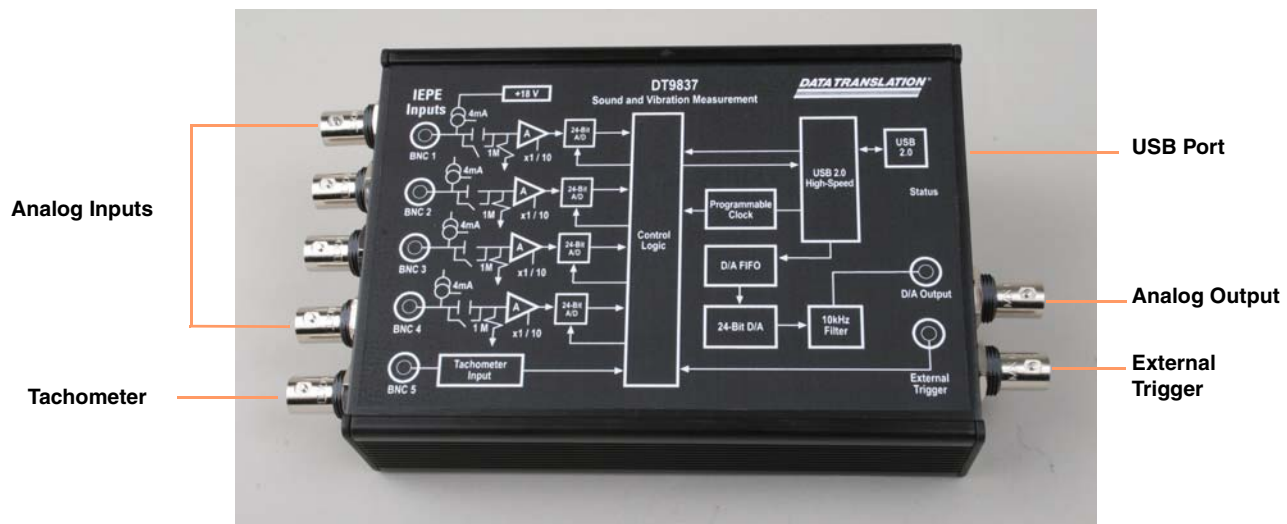
Figure 9: Connectors on the DT9837 Module

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.
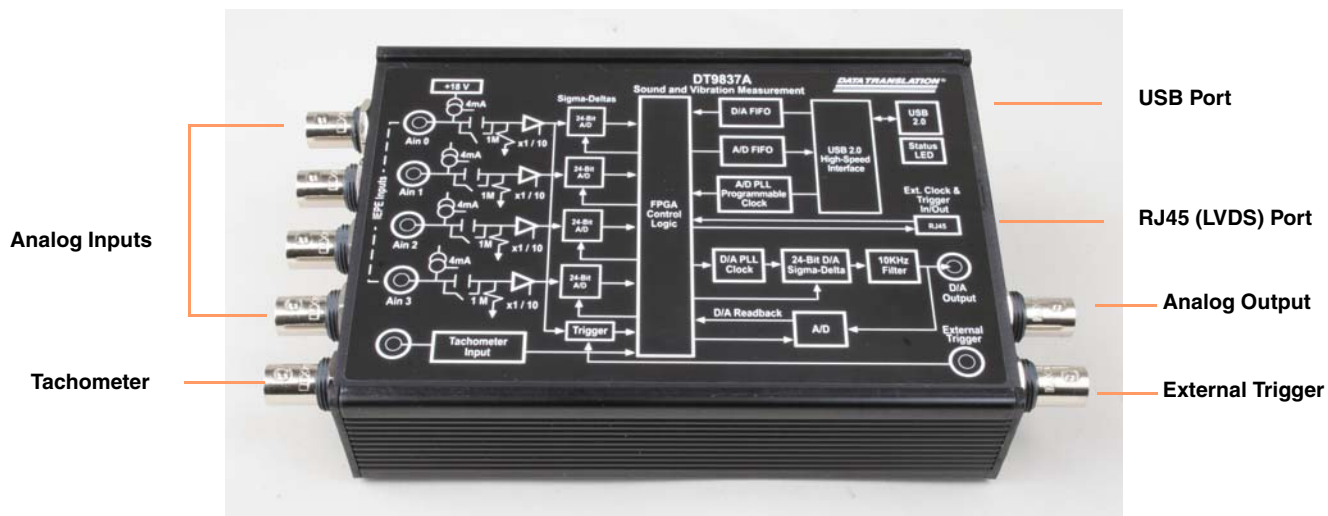
Figure 10: Connectors on the DT9837A Module (OEM Version Shown)

Figure 11 shows the connectors on the DT9837B module.
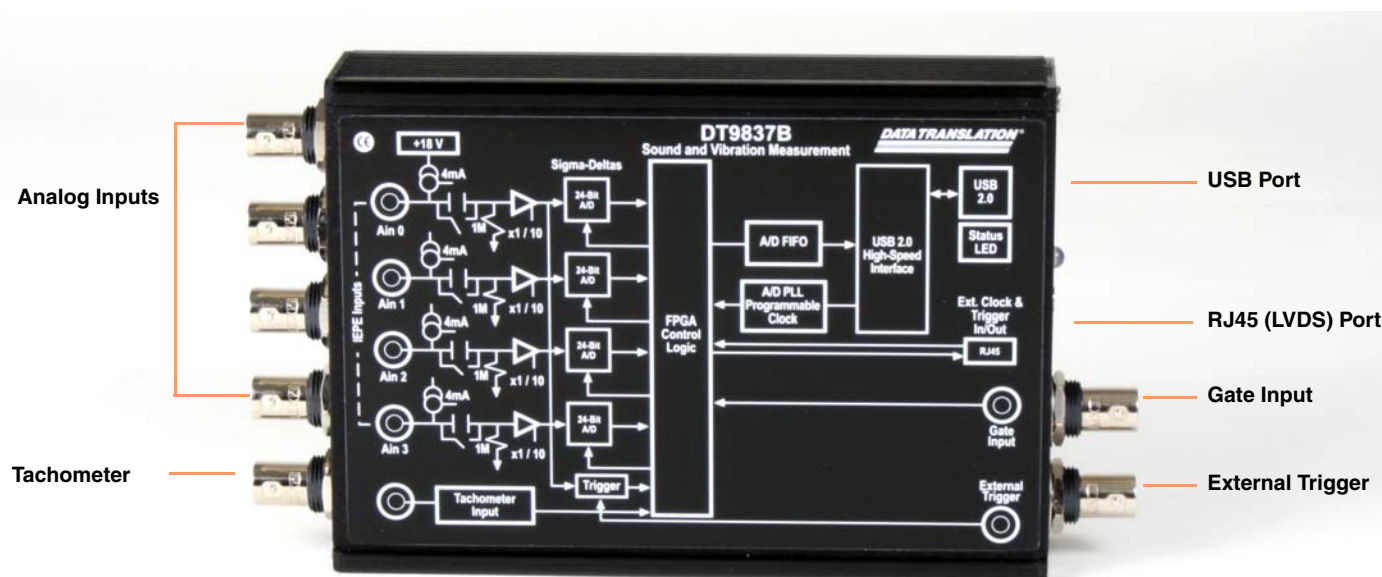
Figure 11: Connectors on the DT9837B Module

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

USB Port

RJ45 (LVDS) Port

Analog Output

External Trigger

Analog Inputs

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).

USB Port

RJ45 (LVDS) Port

Analog Output

External Trigger
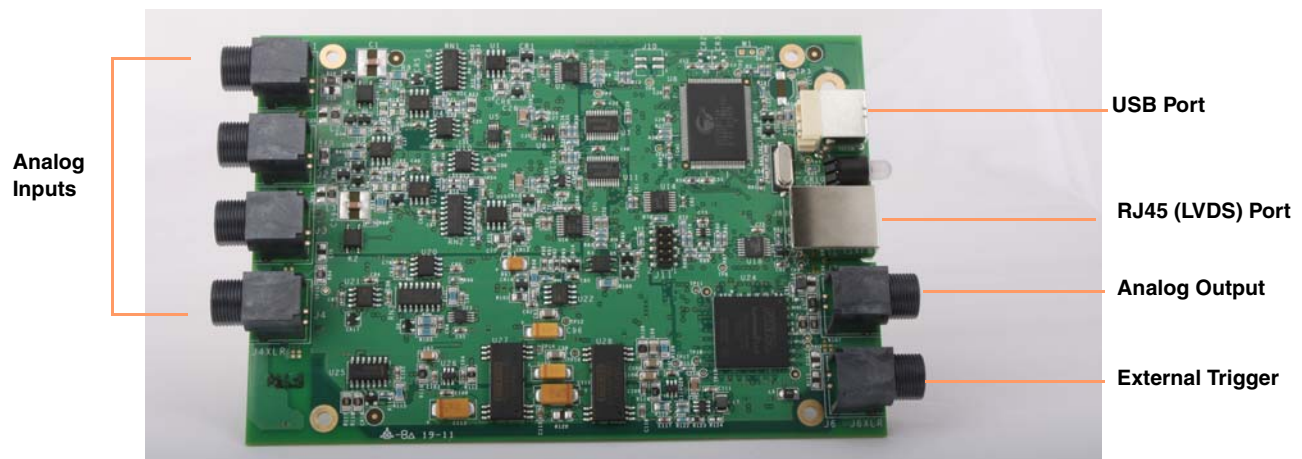
Analog Inputs

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.
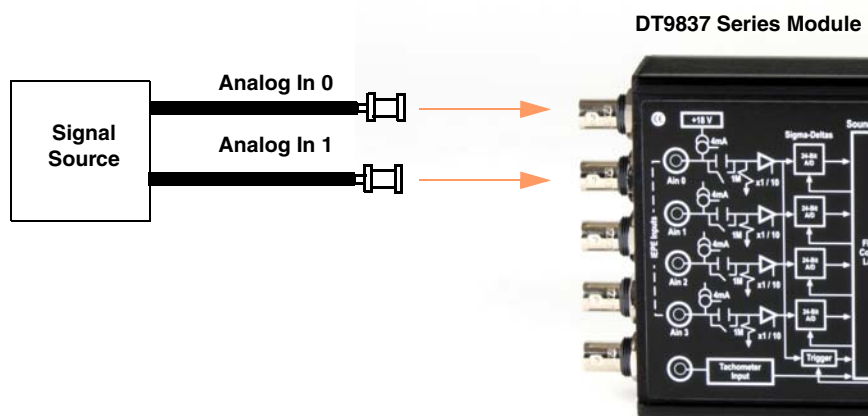
Figure 14: Connecting Analog Inputs to a DT9837 Series Module

Connecting an Analog Output Signal

The DT9837, DT9837A, and DT9837C modules provide one analog output channel with an output range of ±10 V. Figure 15 shows how to connect an analog output signal to the DT9837, DT9837A, or DT9837C module.
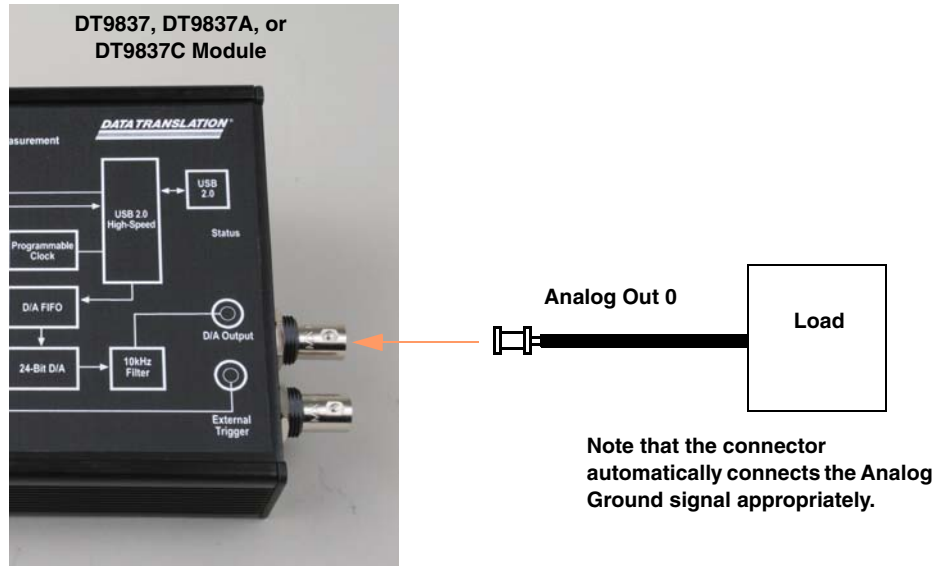
**Figure 15: Connecting an Analog Output Signal to a
DT9837, DT9837A, or DT9837C Module**

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.

Note: In software, you can read tachometer measurements as part of the analog input channel list. Refer to page 82 for more information on tachometer measurements.
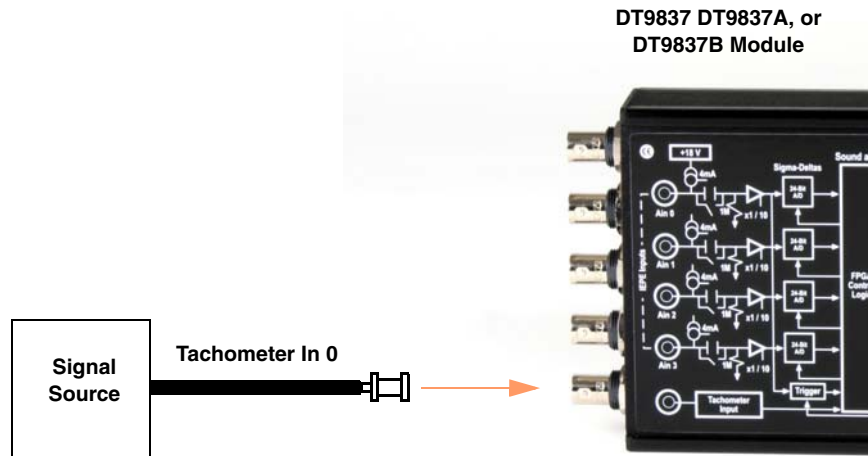
Figure 16: Connecting a Tachometer Input Signal to a DT9837, DT9837A, or DT9837B Module

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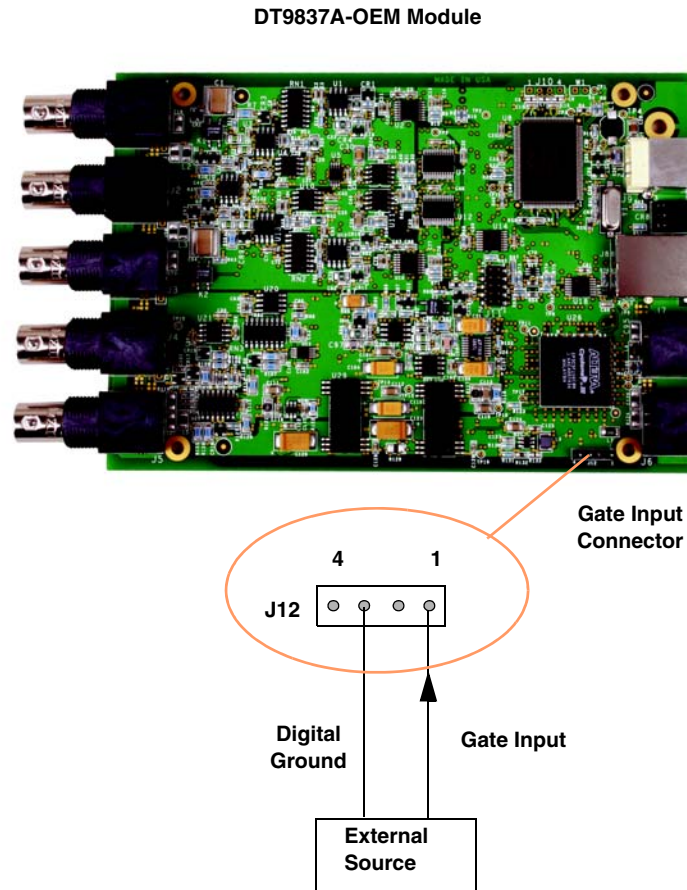
Figure 17: Connecting a Gate Input Signal to the DT9837A-OEM Module

Figure 18 shows how to attach a TTL gate input signal to a DT9837B module.
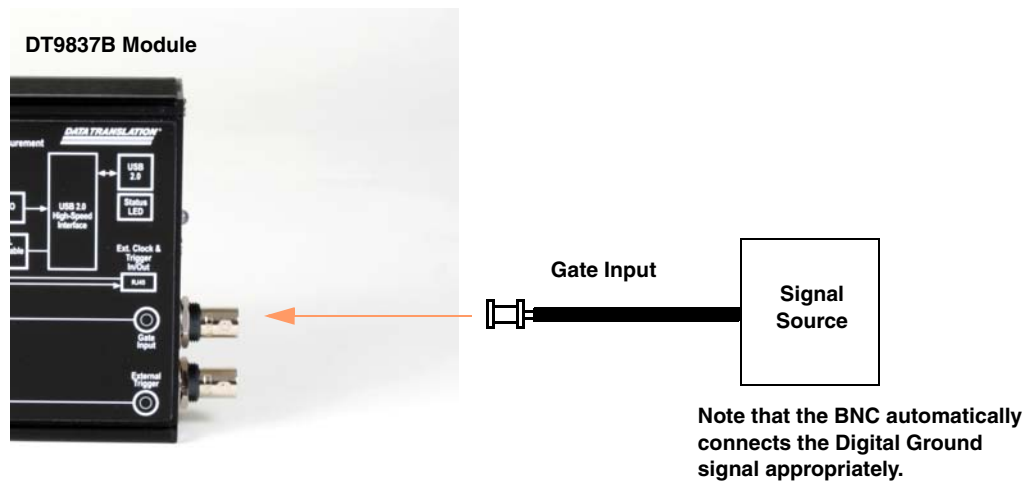
Figure 18: Connecting a Gate Input Signal to a DT9837B Module

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Note: In software, you can read the gate measurements as part of the analog input channel list. Refer to page 85 for more information on gate input measurements.

4

Verifying the Operation of a Module

```
┌─────────────────────────────────────┐
│      Set Up and Install the Module   │
│   (see Chapter 2 starting on page 29)│
└─────────────────────────────────────┘
                  │
┌─────────────────────────────────────┐
│            Wire Signals              │
│  (see Chapter 3 starting on page 39) │
└─────────────────────────────────────┘
                  │
┌─────────────────────────────────────┐
│    Verify the Operation of the Module│
│            (this chapter)            │
└─────────────────────────────────────┘
```
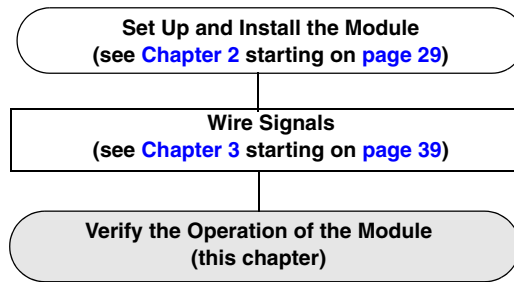
You can verify the operation of a DT9837 Series module using the QuickDAQ application.

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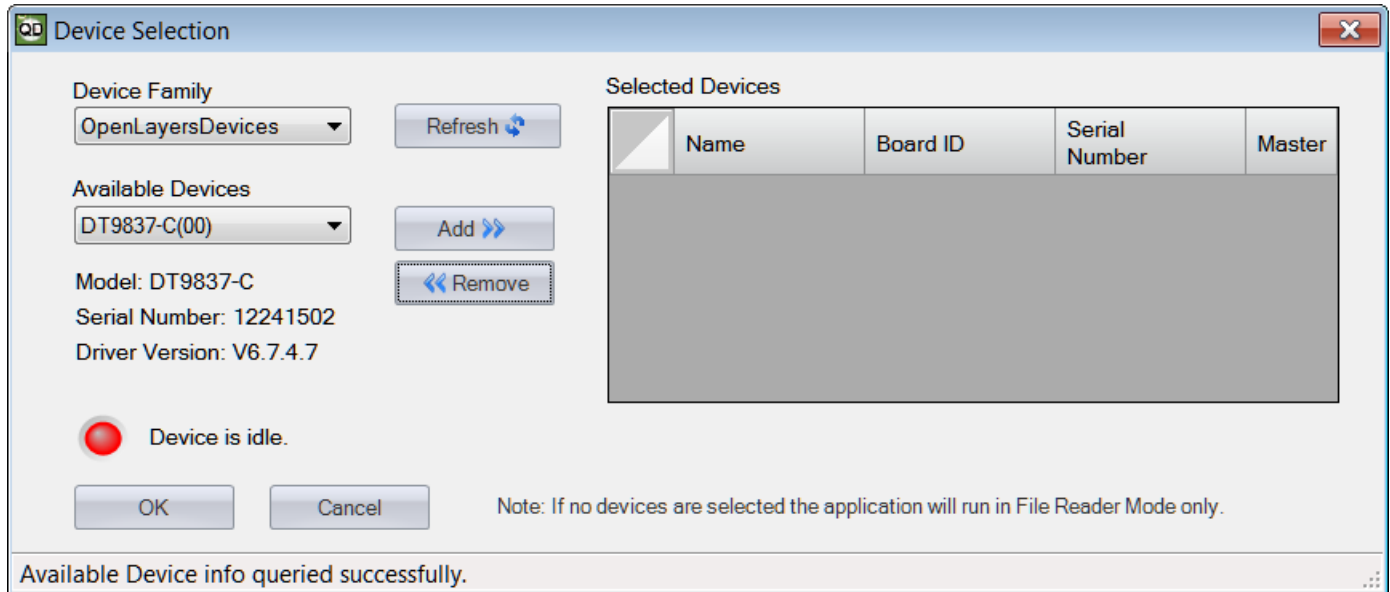
3. For the Device Family selection, select **OpenLayersDevices**.
   By default, the application "discovers" all devices that are available for the specified device family and displays the module name for the USB devices in the drop-down list. If you want to refresh this list to determine if other devices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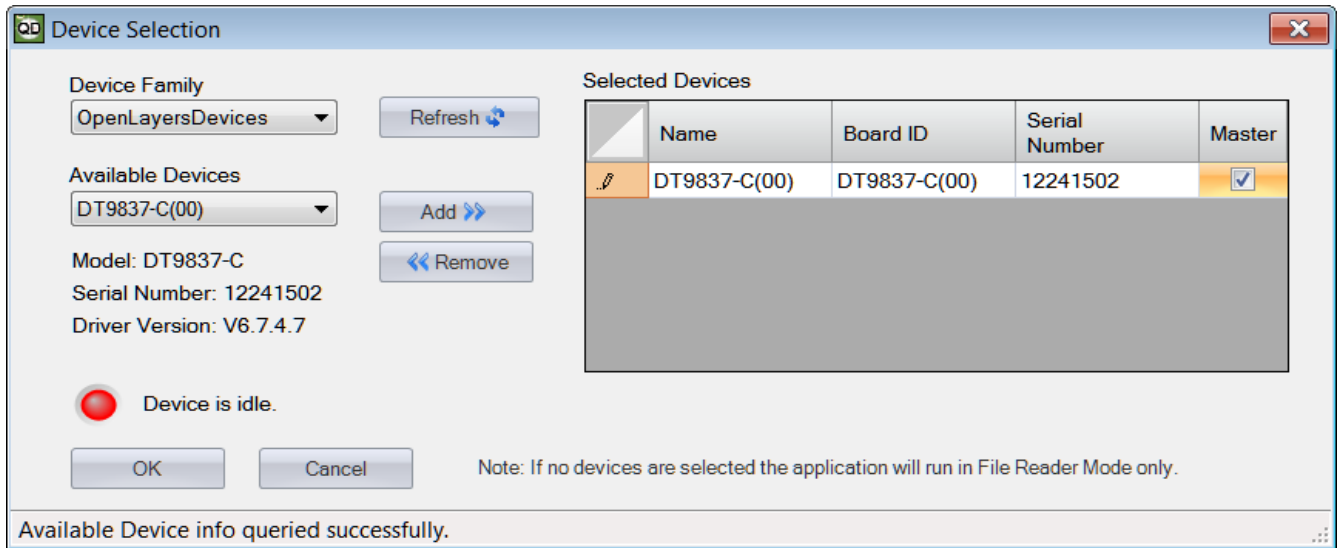
If you want to rename your device, do the following:

    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.*
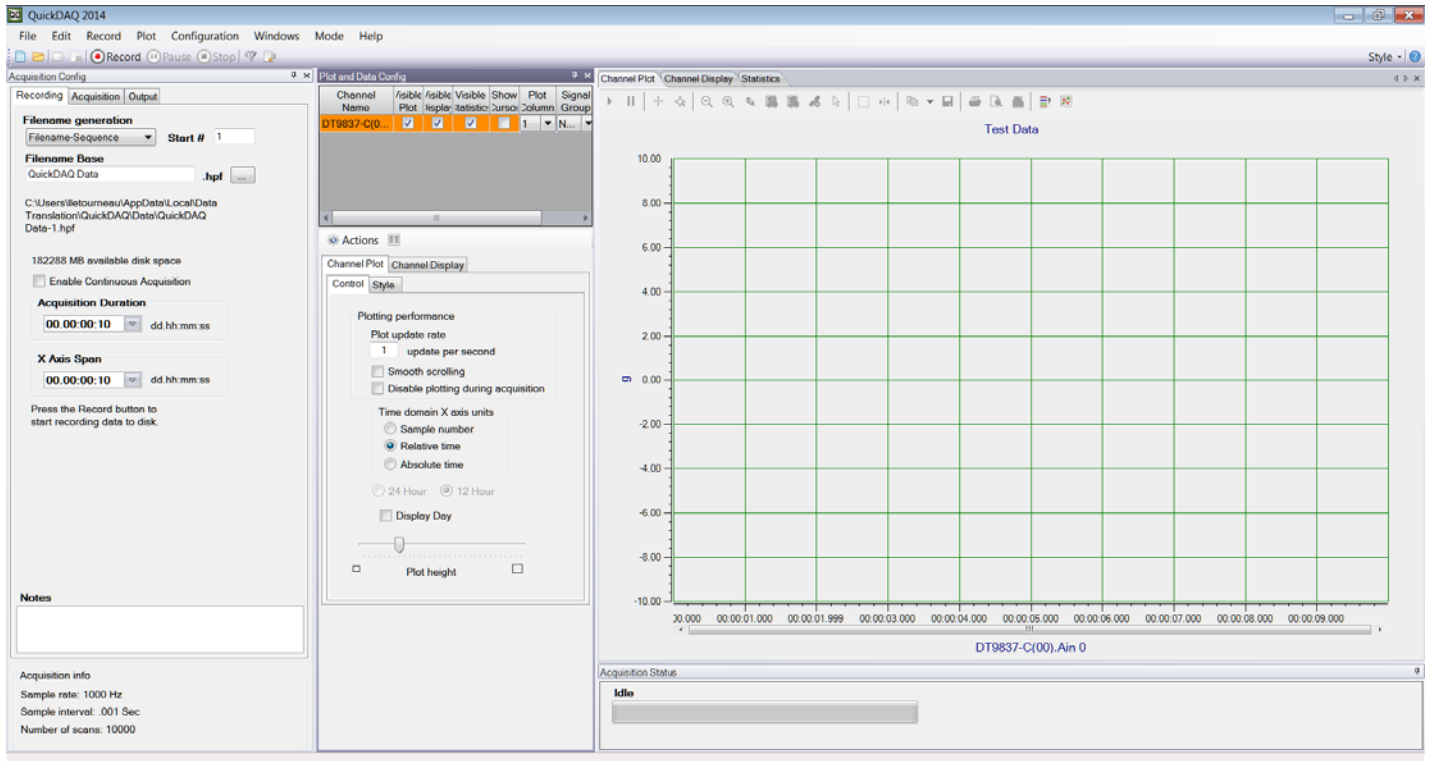
Acquire Data from an Analog Output Channel

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 10 V sine wave is output on analog output channel 0 of a DT9837-C module. The analog output channel is connected to analog input channel 0 on the DT9837-C module.

> **Note:** If you are using a DT9837-B 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.

Channel	Enable	Channel Name	Range	Coupling	Current Source	Engineering Unit (EU)	mV/EU	EU Offset	Point #	Dir
DT9837-C(00)-0	☑	Ain 0	-10V to 10V ▼	DC ▼	☐	V ▼	1000	0	1	X+ ▼
DT9837-C(00)-1	☐	Ain 1	-10V to 10V ▼	AC ▼	☐	g ▼	1000	0	2	X+ ▼
DT9837-C(00)-2	☐	Ain 2	-10V to 10V ▼	AC ▼	☐	g ▼	1000	0	3	X+ ▼
DT9837-C(00)-3	☐	Ain 3	-10V to 10V ▼	DC ▼	☐	g ▼	1000	0	4	X+ ▼
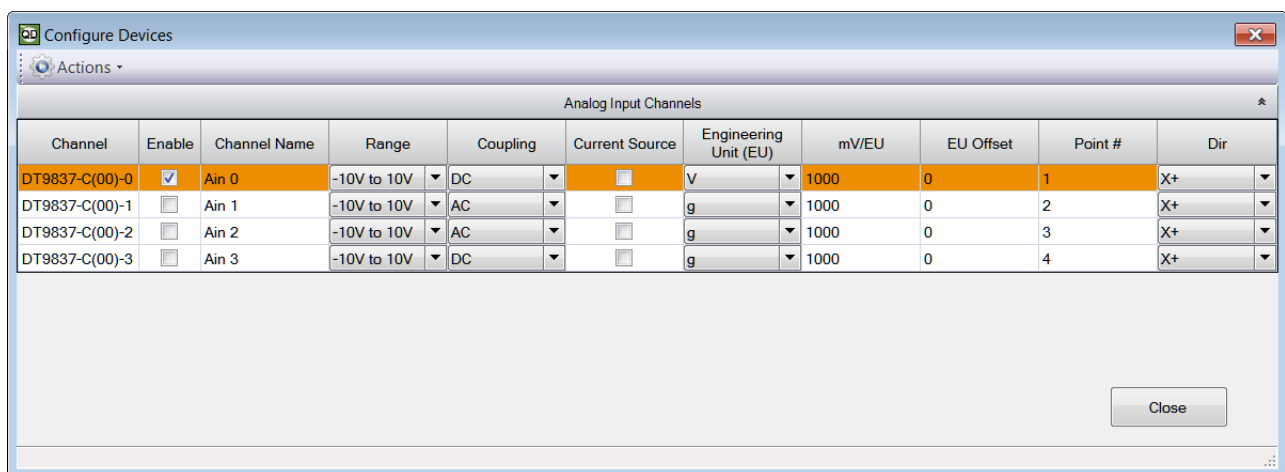
4. Under the **Channel Name** column, leave the default channel name as Ain 0.

5. Under the **Range** column, select the input range for analog input channel.
   In this example, ±10 V is used.

6. Under the **Coupling** column, select the coupling type (AC or DC) for your sensor.
    *Since this example is monitoring a voltage input, **DC** is used.*

7. Under the **Current Source** column, select whether to enable or disable use of the 4 mA current source on the data acquisition device.
    *Since this example is monitoring a voltage input, the **Current Source** checkbox is not checked (disabled) for the analog input channel.*

8. Under the **Engineering Units** column, select the engineering units for the input.
    *In this example, **V** is used.*

9. Enter the number of mV per engineering unit in the **mV/EU** field.
    *In this example, **1000** is used.*

10. If an offset is specified for the input, enter the value in the **EU Offset** field.
    *In this example, no offset (**0**) is specified.*

11. If desired, enter a test point value for the channel.
    *In this example, **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.
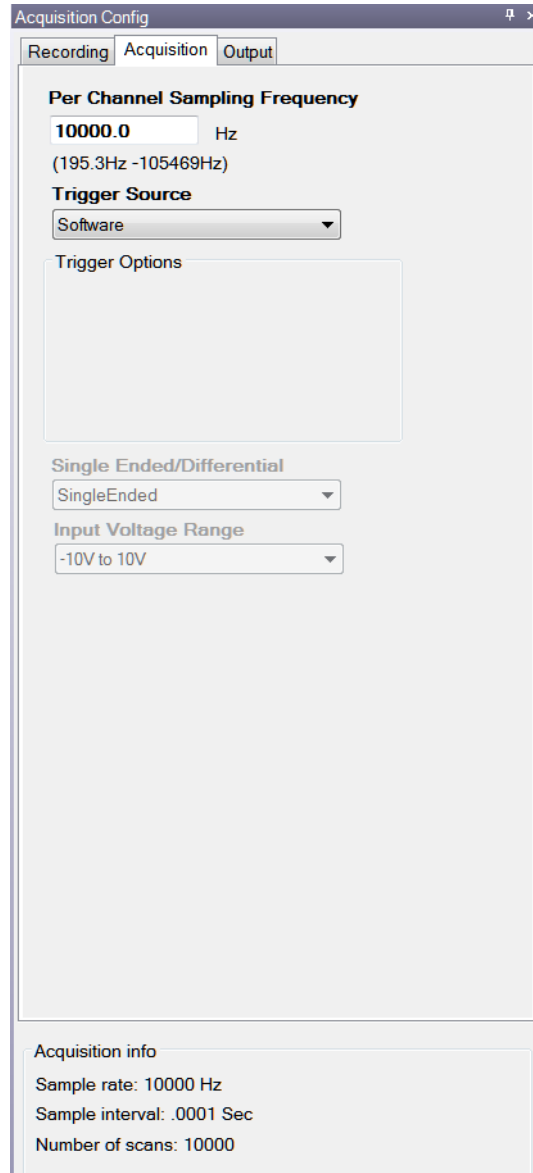
4. Leave the **Enable Continuous Acquisition** checkbox unchecked.

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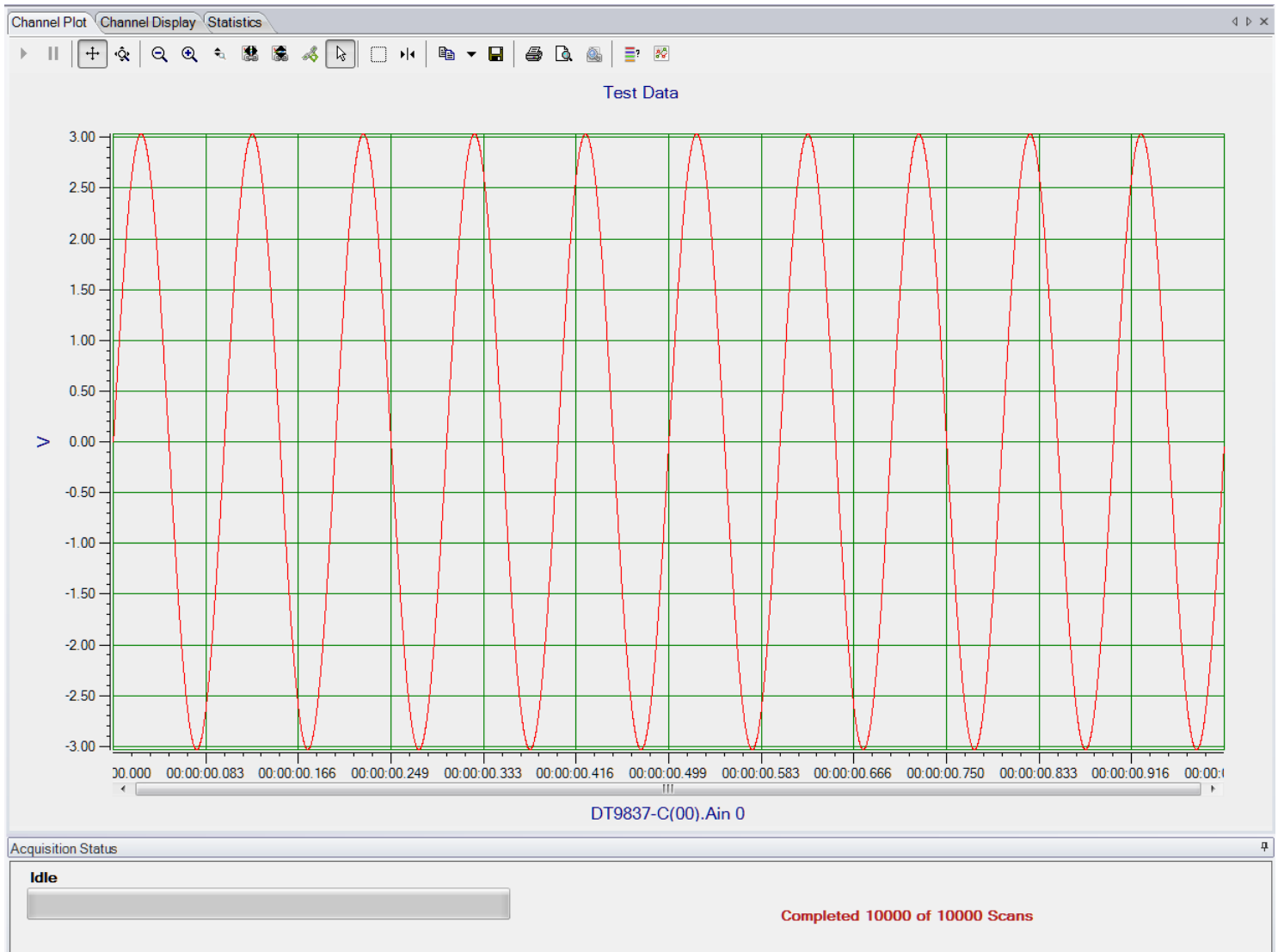
Note: Many additional options are provided in QuickDAQ for measuring and analyzing the data. Refer to the *QuickDAQ User's Manual* for detailed information.

Part 2: Using Your Module

5

Principles of Operation

Figure 19 shows a block diagram of the DT9837 module.
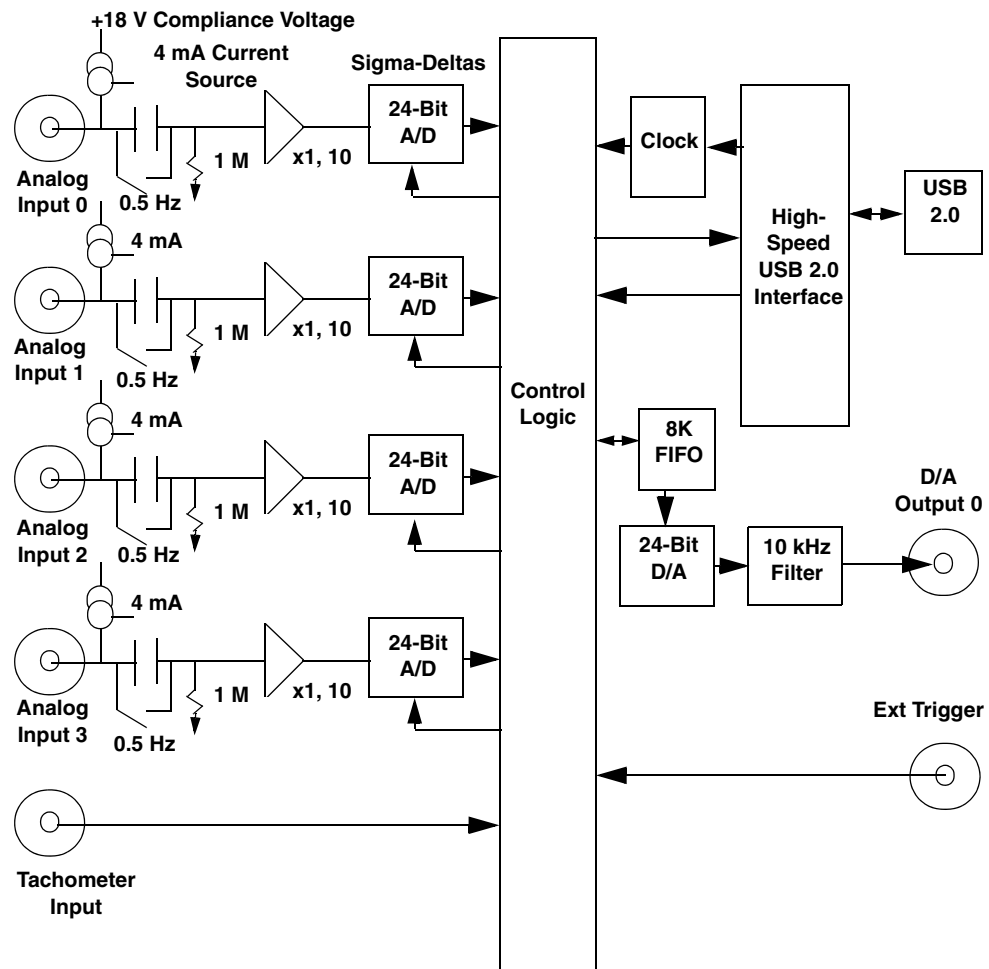
Figure 19: Block Diagram of the DT9837 Module

Figure 20 shows a block diagram of the DT9837A module.
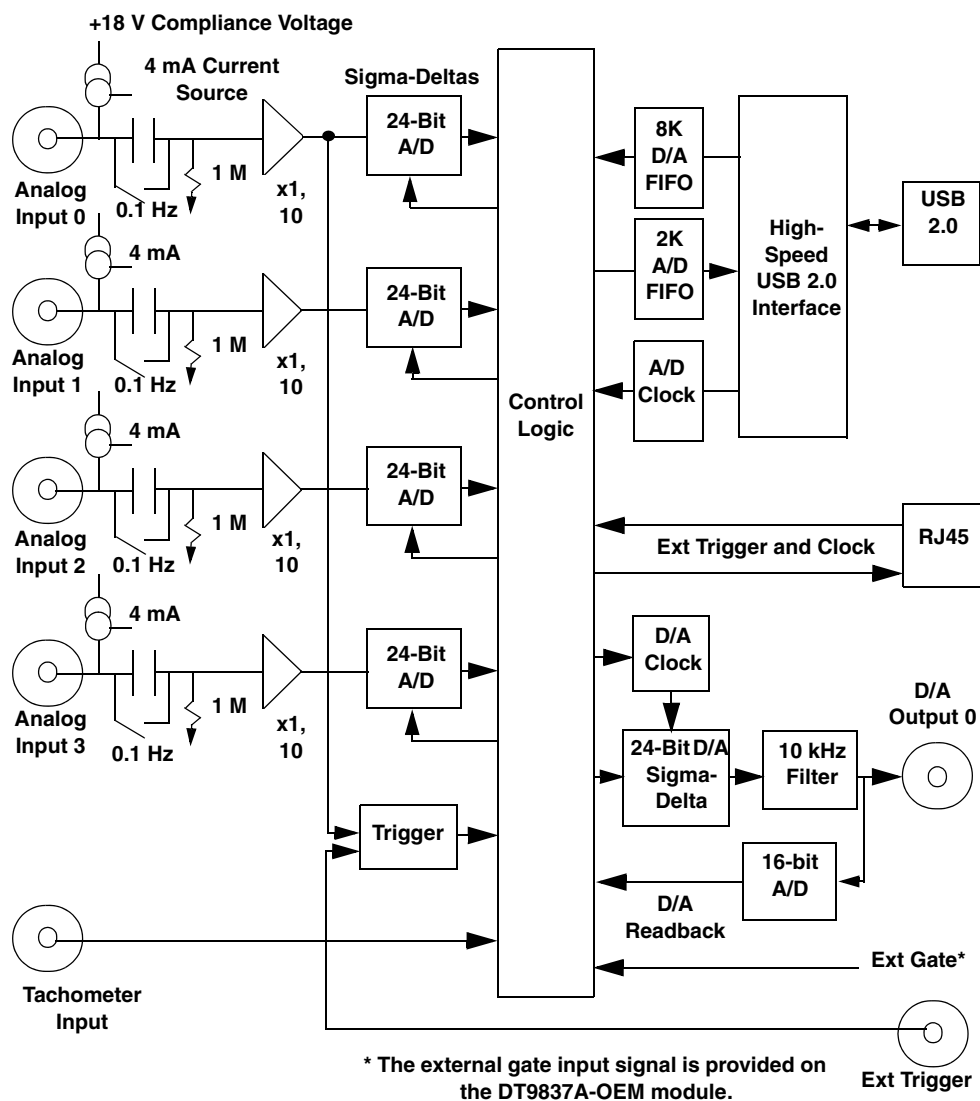
Figure 20: Block Diagram of the DT9837A Module

Figure 21 shows a block diagram of the DT9837B module.
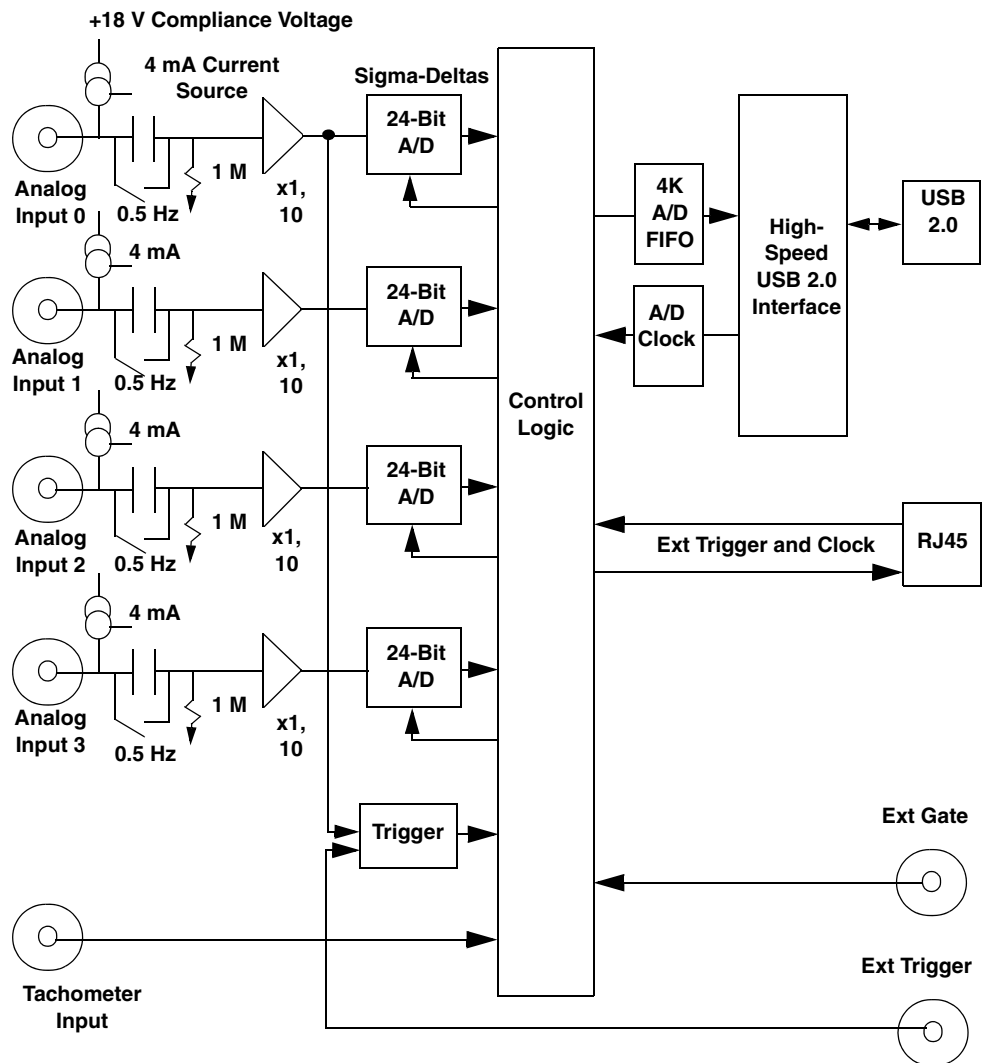
Figure 21: Block Diagram of the DT9837B Module

Figure 22 shows a block diagram of the DT9837C module.
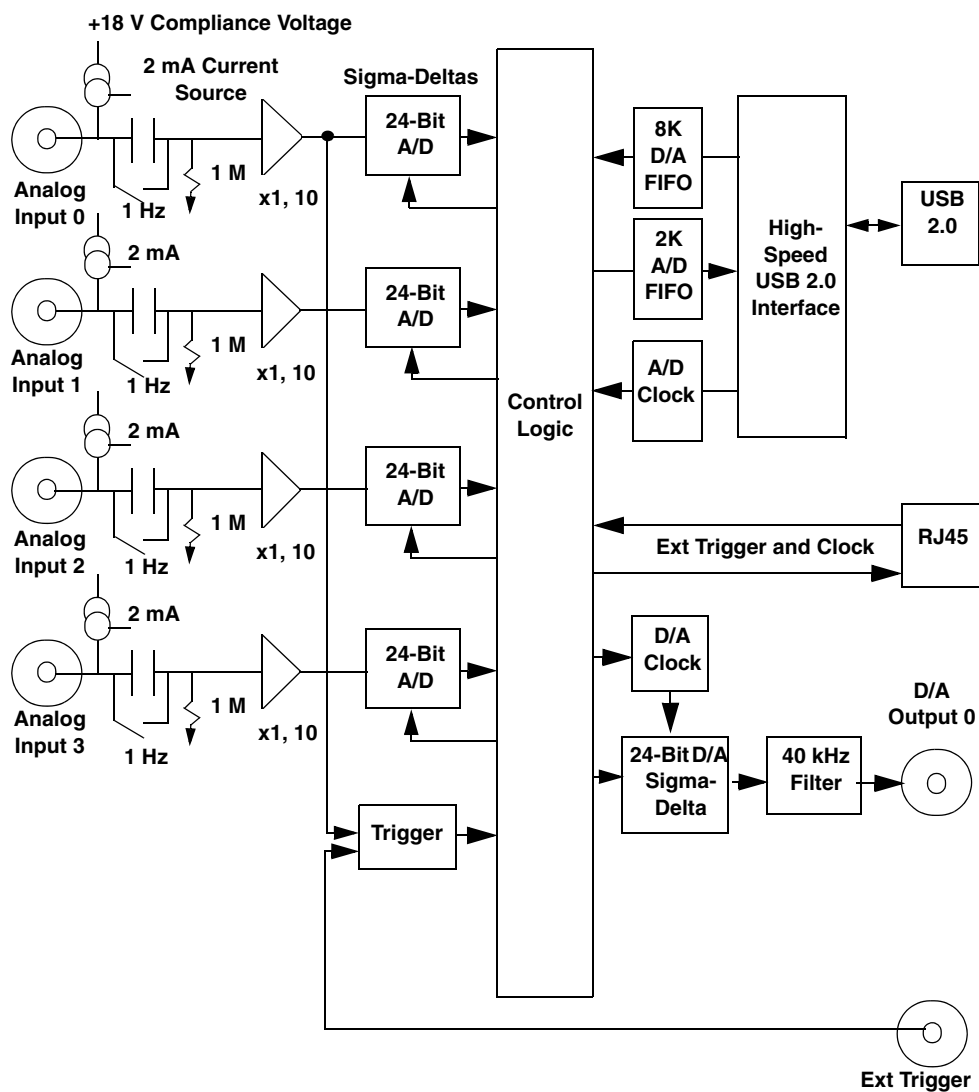
Figure 22: Block Diagram of the DT9837C Module

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 69

- 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 75

- 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.

DT9837 Series modules can acquire a single value from a single analog input channel, a single value from all the analog input channels simultaneously, or multiple values from a group of analog input channels. You can also read data from the following channels if supported by your module:

- Tachometer counter 0 – Supported on the DT9837, DT9837A, DT9837A-OEM, and DT9837B modules

- Tachometer counter 1 – Supported on the DT9837A, DT9837A-OEM, and DT9837B modules

- Gate counter 2 – Supported on the DT9837A-OEM and DT9837B modules

- Analog output readback channel – Supported on the DT9837A module

Refer to "Analog Input Conversion Modes" on page 70 for more information on specifying and reading data from these channels.

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. By default, DC coupling is selected for the DT9837, DT9837A, and DT9837C modules, and AC coupling is selected for the DT9837B module.

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.

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. For information on wiring IEPE inputs, refer to page 44.

For the DT9837A, 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.

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 of 0.5 Hz (0.1 Hz for the DT9837A) to 25.8 kHz (0.49 x sampling frequency) 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

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), tachometer counter 1 (described on), gate counter 2 (described on), or the analog output readback channel (described on) 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 .

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 79), 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 79. 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 73)

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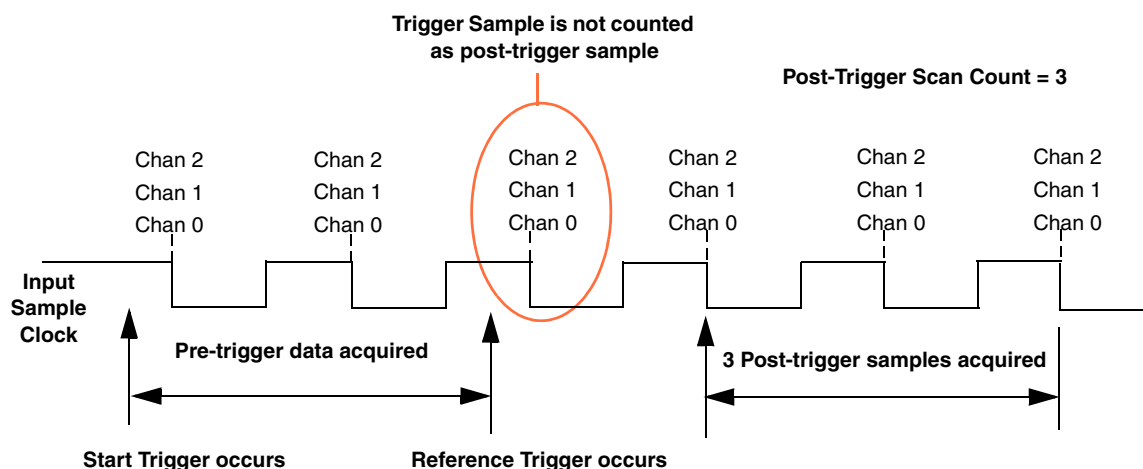
Figure 23: Continuous Scan Mode on the DT9837 Series Modules Using a Start and Reference Trigger

Input Triggers

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

On the DT9837 Series modules, you can specify a start trigger source and a reference trigger source. Pre-trigger data acquisition starts when the start trigger event occurs. When the reference trigger event occurs, pre-trigger data acquisition stops and post-trigger acquisition starts. Post-trigger acquisition stops when the number of samples you specify for the post-trigger scan count has been reached. Refer to for more information.

Start Trigger Sources

The DT9837 Series modules support the following sources for the start trigger:

- **Software trigger** – A software trigger event occurs when you start the analog input operation (the computer issues a write to the module to begin conversions). Using software, specify the start trigger source as a software trigger.

- **External digital (TTL) trigger** – An external digital (TTL) trigger event occurs when the module detects a rising-edge transition on the signal connected to the Ext Trig connector on the module. Using software, specify the start trigger source as an external, positive digital (TTL) trigger.

Note: On the DT9837A, DT9837B, and DT9837C modules, if you configure the synchronization mode as slave, the RJ45 connector accepts trigger and clock signals from the master; you cannot use the Ext Trig connector on the slave module. Refer to for more information.

- **Analog threshold trigger** – For the DT9837 module, the start trigger event occurs when the signal attached to analog input channel 0 rises above 1.0 V (the fixed threshold level). Using software, specify the start trigger source as a positive threshold trigger, and the threshold trigger channel as channel 0.

  For the DT9837A and DT9837B modules, the start trigger event occurs when the signal attached to analog input channel 0 rises above a user-specified threshold value. Using software, specify the start trigger source as a positive threshold trigger, the threshold trigger channel as channel 0, and the threshold level as a value between 0.2 V and 9.8 V.

  For the DT9837C module, the start trigger event occurs when the signal attached to a specified analog input channel in the channel list rises above or falls below a user-specified threshold value. Using software, specify the following parameters:

  – Start trigger source – Specify a positive (low-to-high transition) threshold trigger if you want to trigger when the signal rises above a threshold level, or a negative (high-to-low transition) threshold trigger if you want to trigger when the signal falls below a threshold level.

  – Threshold channel – Specify any one of the analog input channels that are included in the channel list as the threshold input channel.

  – Threshold level – Specify a value between ±10 V for a gain of 1 or ±1 V for a gain of 10 as the threshold level.

Note: On the DT9837A, DT9837B, and DT9837C modules, if you configure the synchronization mode as slave, the RJ45 connector accepts trigger and clock signals from the master; you cannot use the analog threshold trigger on the slave module. Refer to for more information.

Reference Trigger Sources

DT9837 Series modules support an analog threshold trigger for the reference trigger.

The reference trigger event occurs when the signal attached to a specified analog input channel in the channel list rises above or falls below a user-specified threshold value. Using software, specify the following parameters:

- Reference trigger source – Specify a positive (low-to-high transition) threshold trigger if you want to trigger when the signal rises above a threshold level, or a negative (high-to-low transition) threshold trigger if you want to trigger when the signal falls below a threshold level.

- Threshold channel – Specify any one of the analog input channels that are included in the channel list as the threshold input channel.

- Threshold level – Specify a value between ±10 V for a gain of 1 or ±1 V for a gain of 10 as the threshold level.

Data Format and Transfer

DT9837 Series modules use offset binary data encoding, where 000000 represents negative full-scale, and FFFFFFh represents positive full-scale. Use software to specify the data encoding as binary. The ADC outputs FFFFFFh 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 kBytes; the DT9837B has an input FIFO of 4 kBtyes; and the DT9837 does not use an input FIFO.

Error Conditions

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
- Output conversion mode, described on
- Output clocks, described on
- Output triggers, described on
- Data format and transfer, described on
- Error conditions, described on

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 through the analog input channel list; refer to 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 V ±10 mV.

Output Ranges and Gains

The DT9837 and DT9837A modules can output bipolar analog output signals in the range of ±10 V, with a gain of 1.

The DT9837C module can output bipolar analog output signals in the range of ±3 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

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 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 kByte 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 module 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 for more information about the clock source and frequency.

- Specify the trigger source as any of the supported trigger sources. Refer to 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 the Analog Output Value in the Analog Input Data Stream (DT9837A Only)

On the DT9837A module, you can read back the value of the analog output channel in the analog input data stream. 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. (An analog value is returned.) The software automatically synchronizes the value of the analog output channel with the analog input measurements, so that all measurements are correlated in time.

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, specify the trigger source for D/A subsystem 0 as a software trigger.

- **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. Using software, specify the trigger source for D/A subsystem 0 as an external, positive digital (TTL) trigger.

- **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 in the channel list rises above or falls below a user-specified threshold value. Using software, specify the following parameters:

  – Start trigger source – Specify a positive (low-to-high transition) threshold trigger if you want to trigger when the signal rises above a threshold level, or a negative (high-to-low transition) threshold trigger if you want to trigger when the signal falls below a threshold level.

  – Threshold channel – Specify any one of the analog input channels that are included in the channel list as the threshold input channel.

  – Threshold level – Specify a value between ±10 V for a gain of 1 or ±1 V for a gain of 10 as the threshold level.

Note: If you configure the synchronization mode as slave, the RJ45 connector accepts trigger and clock signals from the master; you cannot use the Ext Trig connector on the slave module. Refer to for more information.

Data Format and Transfer

Data from the host computer must use offset binary data encoding for analog output signals, where 000000 represents –10 V, and FFFFFFh represents +10 V. Using software, specify the data encoding as binary.

Error Conditions

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 µs. On the DT9837A and DT9837B modules, this signal has a maximum frequency of 1 MHz and a minimum pulse width of 0.4 µs. 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 by including channel 4 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).

You can specify the following parameters for tachometer counter 0 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 starting edge of the tachometer input signal to use for the measurement (rising or falling edge). On the DT9837 module, the starting edge is always the rising edge.

- The value read between measurements (either zero, the default value, 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 default value), the most significant bit (MSB) of the value is set to 0 to indicate new data; reading the value before the measurement is complete returns an MSB of 1. If the Stale flag is set to Not Used, the MSB is always set to 0.

  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 the Control Panel settings, described above, and the next operation is started automatically.

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

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:

  – Frequency = 12 MHz/(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:

  – Period = 1/Frequency

  – Period = (Number of counts – 1)/12 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 reading tachometer counter 1. To read the value of this counter, specify channel 5 in the analog input channel list.

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.

You can specify the following 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:

- 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)

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 time 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 rising or falling edge of the gate input signal, which you can use to determine the pulse width of the gate signal

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

For these measurements, specify channel 6 in the analog input channel list. An internal 48 MHz clock (with 21 ns resolution) is used for 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 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:

- 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

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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)

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 .

The internal clock on the DT9837, DT9837A, and DT9837C modules when the synchronization mode is none (see), 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.
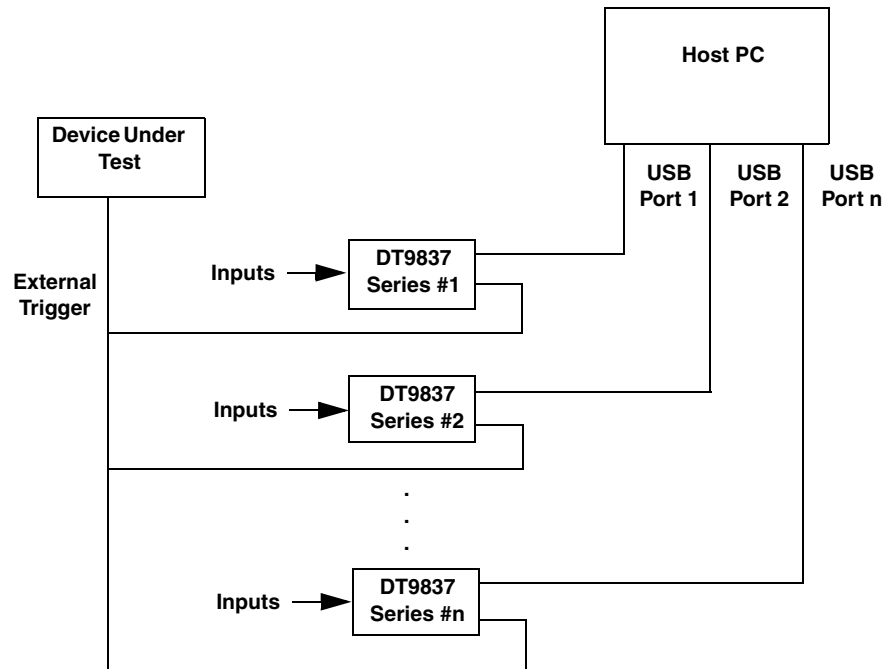
Figure 24: Triggering Multiple Modules Using an External Trigger Source

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 slave. You specify the synchronization mode (master, slave, or none) of the RJ45 connector using software.

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; you cannot use the Ext Trig connector or the analog threshold trigger on the slave module in this configuration. When configured as none (the default mode), 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.

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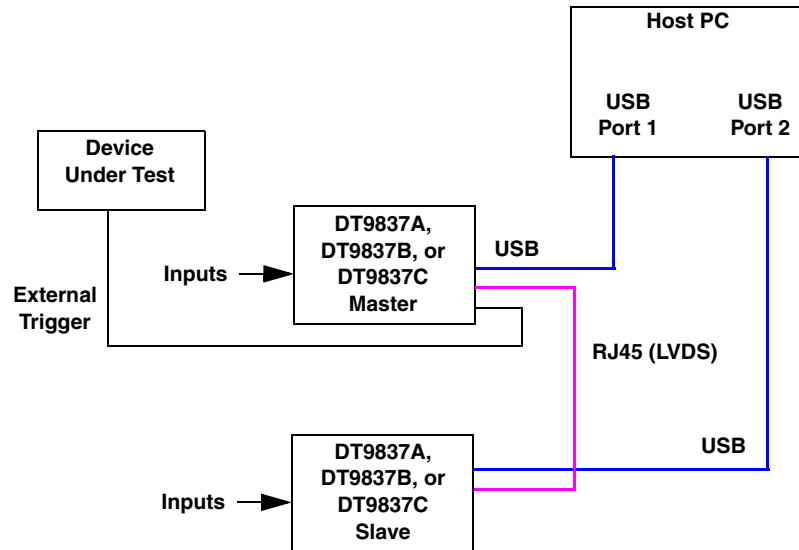
Figure 25: Synchronizing Two DT9837A, DT9837BB, or DT9837C Modules by Daisy Chaining the RJ45 Connectors (Shown Using an External Trigger)

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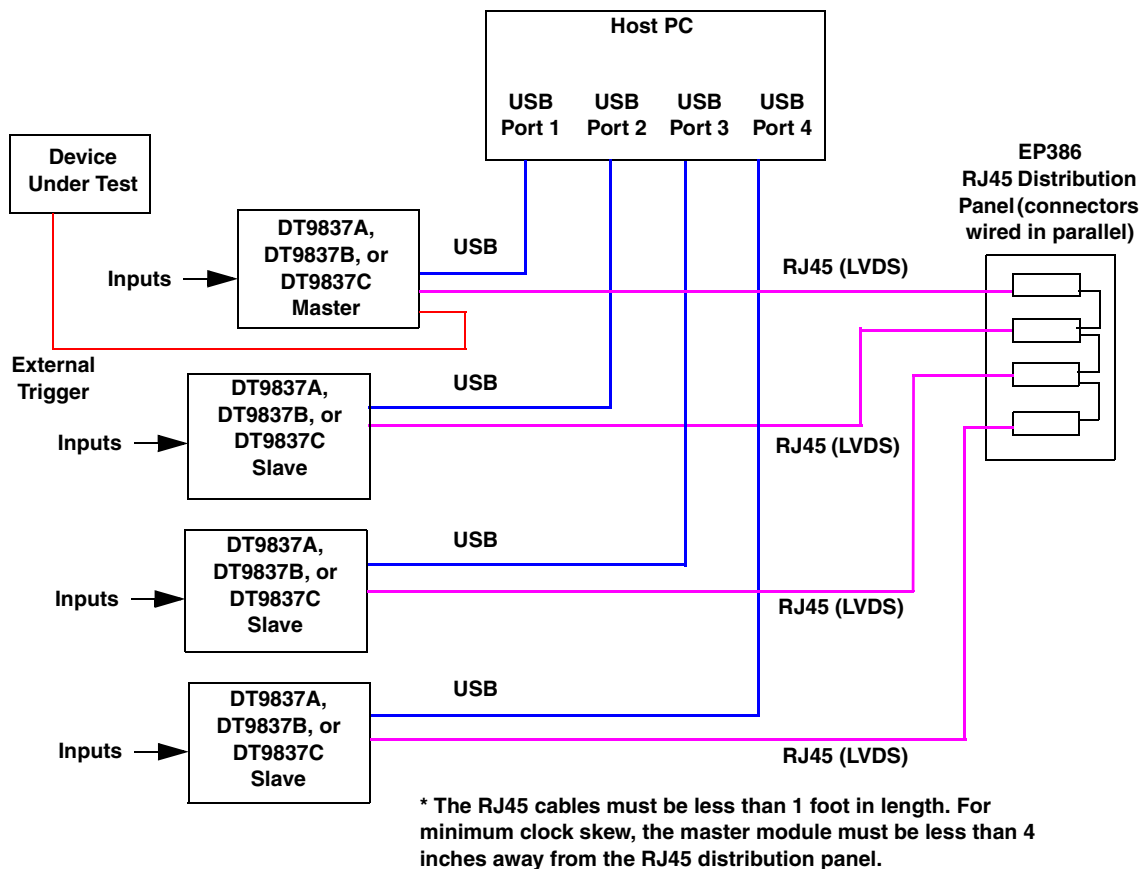
Figure 26: Synchronizing Four DT9837A, DT9837B, or DT9837C Modules Using the EP386 RJ45 Distribution Panel (Shown Using an External Trigger)

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

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

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

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.

6

Supported Device Driver Capabilities

The 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 .

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

a. 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.

b. 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.

c. 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 , or write to the registers of the module, described on , 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**							

a. The D/A subsystem is not supported by the DT9837B module.
b. To perform a single value analog output operation, ensure that no analog input operations are running or an error will be reported.
c. 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.
d. The DT9837A and DT9837C modules support continuous analog output operations in addition to waveform mode.
e. The DT9837A and DT9837C modules support the ability to start continuous A/D and continuous D/A operations simultaneously.
f. 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.
g. 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**							

a. The D/A subsystem is not supported by the DT9837B module.
b. On the DT9837C, channels 0 to 3 correspond to the analog input channels.
c. On the DT9837, channels 0 to 3 correspond to the analog input channels; channel 4 corresponds to tachometer counter 0.
d. 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.
e. 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					

a. 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]					

a. The D/A subsystem is not supported by the DT9837B module.
b. By applying a gain of 1, the effective input range is ±10 V. By applying a gain of 10, the effective input range is ±1 V.
c. The DT9837and DT9837 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

a. 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 **SupportsThernocouple**							
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]	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

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

b. 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.

c. 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.

d. 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.

7

Troubleshooting

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 the OMNI CD for any README files and ensure that you have used the latest installation and configuration information available.

3. Check that your system meets the requirements stated on page 32.

4. Check that you have installed your hardware properly using the instructions in Chapter 2.

5. Check that you have installed and configured the device driver for your module using the instructions in Chapter 2.

6. Check that you have wired your signals properly using the instructions in Chapter 3.

7. Search the DT Knowledgebase in the Support section of the Data Translation web site (at www.datatranslation.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.	From the Control Panel > System > Hardware > Device Manager, uninstall any unknown devices (showing a yellow question mark). Then, run the setup program on your OMNI CD to install the USB device drivers, and reconnect your USB module to the computer.
Module does not respond	The module configuration is incorrect.	Check the configuration of your device driver; see the instructions in Chapter 2.
	The module is damaged.	Contact Data Translation for technical support; refer to page 108.
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.

Table 21: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
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, refer to Chapter 8.
USB 2.0 is not recognized	Your operating system does not have the appropriate Service Pack installed.	Ensure that you load the appropriate Windows Service Pack. If you are unsure of whether you are using USB 2.0 or USB 1.1, run the Open Layers Control Panel applet, described in Chapter 2.
	Standby mode is enabled on your PC.	For some PCs, you may need to disable standby mode on your system for proper USB 2.0 operation. Consult Microsoft for more information.

Technical Support

If you have difficulty using a 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.datatranslation.com and click on the Support link.

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

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

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

If Your Module Needs Factory Service

If your module must be returned to Data Translation, do the following:

1. Record the module's serial number, and then contact the Customer Service Department at (508) 481-3700, ext. 1323 (if you are in the USA) and obtain a Return Material Authorization (RMA).

   If you are located outside the USA, call your local distributor for authorization and shipping instructions; see our web site (www.datatranslation.com) for the name and telephone number of your nearest distributor. All return shipments to Data Translation must be marked with the correct RMA number to ensure proper processing.

2. Using the original packing materials, if available, package the module as follows:

   – Wrap the module in an electrically conductive plastic material. Handle with ground protection. A static discharge can destroy components on the module.

   – Place in a secure shipping container.

3. Return the module to the following address, making sure the RMA number is visible on the outside of the box.

   Customer Service Dept.
   Data Translation, Inc.
   100 Locke Drive
   Marlboro, MA 01752-1192

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Calibration

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.

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

This chapter describes how to calibrate the analog input and output subsystems of a 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 , or the analog output circuitry of the module, described on .

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.

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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.

A

Specifications

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: Passband ripple, ±0.005 dB: Stopband, –100 dB:	0.49 x sample frequency, Hz 0.453 x sample frequency, Hz 0.547 x sample frequency, Hz	0.49 x sample frequency, Hz 0.453 x sample frequency, Hz 0.547 x sample frequency, Hz	0.49 x sample frequency, Hz 0.453 x sample frequency, Hz 0.547 x sample frequency, Hz	0.49 x sample frequency, Hz 0.453 x sample frequency, Hz 0.547 x sample frequency, Hz
Analog filter[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 µV/° C x Gain) + 100 µV	(10 µV/° C x Gain) + 100 µV	(10 µV/° C x Gain) + 100 µV	(10 µV/° C x Gain) + 100 µV

Gain error
  Gain of 1:
  Gain of 10:
	±0.02%
	±0.5%
		±0.02%
		±0.5%
			±0.02%
			±0.5%
				±0.02%
				±0.5%

Gain error temperature coefficient	25 ppm//° C	25 ppm//° C	25 ppm//° C	25 ppm//° C
ADC Integral Non-Linearity error, INL	±0.0006% of full-scale range	±0.0006% of full-scale range	±0.0006% of full-scale range	±0.0006% of full-scale range
ADC Differential Non-Linearity error, DNL	Monotonic to 24 bits	Monotonic to 24 bits	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. The conversion rate = Sample rate * 512.

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	LVTTL
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 µs
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, DT9837B, and 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
	LVTTL inputs
	1 LVTTL
	1.1 V
	1.3 V
	0.2 V
	33 µA
	1.3 µA
	±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

Trigger delay	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 EMC Requirements 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.

B

Connector Pin Assignments and LED Status Indicators

RJ45 (LVDS) Connector

Figure 27 shows the RJ45 (LVDS) synchronization connector.
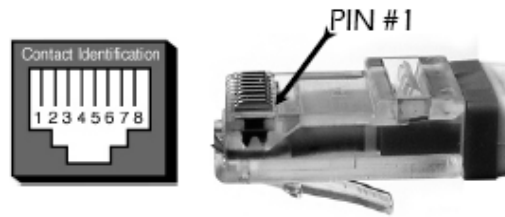
Figure 27: RJ45 (LVDS) Synchronization Connector

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 LVTTL signal that is asserted low for triggering between modules.)
4	Sync + (An LVTTL 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.

Pin 3   **Pin 1**

Pin 4   **Pin 2**
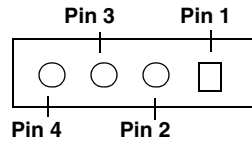
Figure 28: Gate Input Connector

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

DT9837 Register-Level Programming

If you need to change the settings of the Open Layers Control Panel for the DT9837 programmatically, you can use the Data Acq SDK function **olDiagWriteReg** to 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.

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

Writing to the General Control Register 2

The following 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 0x400000
#define GENERAL_CNTRL_REG2 (LOCAL_BUS_BASE | 0x2)
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.

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	Default	Name	Description
[7]	RW	0	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	0	Tach Counter 0 Mode Select	Select the value read in between measured values on Tach Counter 0: 0 – Previous measurement 1 – Zeros
[4]	RW	0	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

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

Programmatically, you can read this EEPROM location using the **olDiagReadReg()** function, and write to the EEPROM location using the **olDiagWriteReg()** 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 example shows how to read the current source and coupling type from the EEPROM:

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

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

```
ULONG newdata;
OLSTATUS  olStatus = olDiagWriteReg(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.

Programmatically, you can read the EEPROM location using the **olDiagReadReg()** function, and write to the EEPROM location using the **olDiagWriteReg()** 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 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 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: Current, 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 use the Data Acq SDK function **olDiagWriteReg** to 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.

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

Writing to the General Control Register 4

The following 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.

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	Default	Name	Description
[15:14]	RW	0	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	0	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

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

Bits	Type	Default	Name	Description
[11:10]	RW	0	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
[8]	RW	0	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	0	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	0	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	0	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	0	Tach Counter 0 Mode Select	Select the value read in between measured values on Tach Counter 0: 0 – Previous measurement 1 – Zeros
[0]	RW	0	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

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.

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

```
#define EEPROM_MEM_BASE             0x100000
// Coupling storage offsets relative to the base address for the
// 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);
```

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