DATA TRANSLATION

UM-22416-A

DT9837
User's Manual

First Edition
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Radio and Television Interference

This equipment has been tested and found to comply with CISPR EN55022 Class A, and EN50082-1 (CE) 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 first part of this manual describes how to install and set up your DT9837 module and device driver, and verify that your module is working properly.

The second part of this manual describes the features of the DT9837 module, the capabilities of the DT9837 Device Driver, and how to program the DT9837module 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 the DT9837 modules for data acquisition operations in the Microsoft® Windows® 2000 or Windows XP 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 module, as well as the supported software and accessories for the modules.
- Chapter 2, "Preparing to Use a Module," describes how to unpack the DT9837 package, check the system requirements, install the DT9837 software under Windows 2000 or Windows XP, and view the DT9837 documentation online.
- Chapter 3, "Setting Up and Installing the Module," describes how to install a DT9837 module, how to apply power to the module, and how to configure the device driver.
- Chapter 4, "Wiring Signals," describes how to wire signals to a DT9837 module.
- Chapter 5, "Verifying the Operation of a Module," describes how to verify the operation of the DT9837 module with the Quick DataAcq application.
- Chapter 6, "Principles of Operation," describes all of the features of the DT9837 module and how to use them in your application.
- Chapter 7, "Supported Device Driver Capabilities," lists the data acquisition subsystems and the associated features accessible using the DT9837 Device Driver.
- Chapter 8, "Troubleshooting," provides information that you can use to resolve problems with the DT9837 module and device driver, should they occur.
- Chapter 9, "Calibration," describes how to calibrate the analog I/O circuitry of the DT9837 module.
- Appendix A, "Specifications," lists the specifications of the DT9837 module.
- 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 module:

- *Benefits of the Universal Serial Bus for Data Acquisition*. This white paper describes why USB is an attractive alternative for data acquisition. It is available on the Data Translation web site (www.datatranslation.com).
- *Measure Foundry Getting Started Manual* (UM-19298) and online help. These documents describe how to use Measure Foundry™ to build drag-and-drop test and measurement applications for Data Translation data acquisition devices without programming.
- *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 or Data Translation data acquisition devices.

- *DataAcq SDK User's Manual* (UM-18326). For programmers who are developing their own application programs using the Microsoft C compiler, this manual describes how to use the DT-Open Layers DataAcq SDK™ to access the capabilities of Data Translation data acquisition devices.
- *DTx-EZ Getting Started Manual* (UM-15428). This manual describes how to use the ActiveX controls provided in DTx-EZ™ to access the capabilities of Data Translation data acquisition devices in Microsoft Visual Basic® or Visual C++®.
- *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 2000 or Windows XP documentation.
- USB web site (http://www.usb.org).

Where To Get Help

Should you run into problems installing or using a DT9837 module, the Data Translation Technical Support Department is available to provide technical assistance. Refer to Chapter 8 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

DT9837 Hardware Features

The DT9837 is a high-performance, multifunction data acquisition modules for the USB (Ver. 2.0 or Ver. 1.1) bus. The key hardware 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
  - Support for a tachometer input in the analog input data stream for synchronous measurements
  - Software-programmable trigger type (software, external digital trigger, or analog threshold trigger) to start the analog input operation
- Analog output subsystem:
  - One 24-bit D / A converter
  - Waveform capability of up to 8,192 samples
  - Output rate fixed at 46.875 kSamples / s
  - Output range of ±10 V.
  - Software trigger starts the waveform operation
- Internal clock source (shared between the analog input and analog output subsystems).

Supported Software

The following software is available for use with the DT9837 module and is on the Data Acquisition OMNI CD:

- **DT9837 Device Driver** – The device driver allows you to use a DT9837 module with any of the supported software packages or utilities.
- **Quick DataAcq application** – The Quick DataAcq application provides a quick way to get up and running using a DT9837 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.)
- **The quickDAQ application –** An evaluation version of this .NET application is included on the Data Acquisition OMNI CD. quickDAQ lets you acquire analog data from all devices supported by DT-Open Layers for .NET software at high speed, plot it during acquisition, analyze it, and / or save it to disk for later analysis.
- **Measure Foundry** – An evaluation version of this software is included or provided via a link on the Data Acquisition OMNI CD. Measure Foundry is a drag-and-drop test and measurement application builder designed to give you top performance with ease-of-use development. Order the full development version of this software package to develop your own application using real hardware.
- **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 module using Visual Studio 2003 or Visual Studio 2005; 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 module using Windows 2000 or Windows XP; 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** – An evaluation version of 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 module.

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

Getting Started Procedure

The flow diagram shown in Figure 1 illustrates the steps needed to get started using the DT9837 module. This diagram is repeated in each Getting Started chapter; the shaded area in the diagram shows you where you are in the getting started procedure.

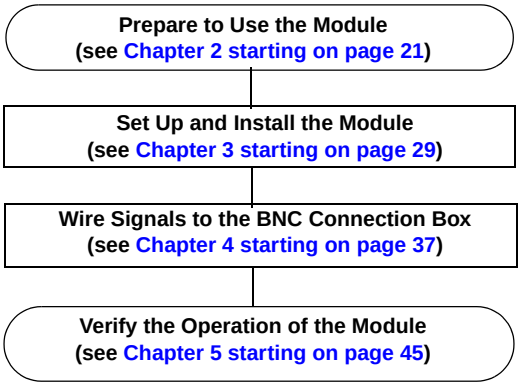
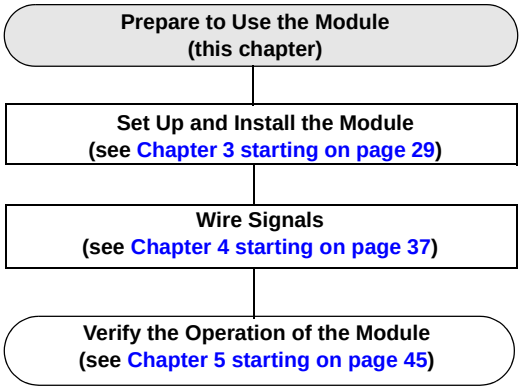


Figure 1: Getting Started Flow Diagram

Part 1:
Getting Started

2

Preparing to Use a Module


Prepare to Use the Module
(this chapter)
Set Up and Install the Module
(see Chapter 3 starting on page 29)
Wire Signals
(see Chapter 4 starting on page 37)
Verify the Operation of the Module
(see Chapter 5 starting on page 45)

Unpacking

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

- DT9837 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. 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).

Once you have unpacked your module, check the system requirements, as described in the next section.

Checking the System Requirements

For reliable operation, your DT9837 module requires the following:

- PC with Pentium 233 MHz (or higher) processor
- Windows 2000 or Windows XP (Professional Edition) operating system

  For USB Ver. 2.0 support, make sure that you install Service Pack 2 (for Windows XP) or Service Pack 4 (for Windows 2000). In addition, for some systems, you may have to disable standby mode. If you are not sure whether you are using USB Ver. 1.1 or Ver. 2.0, run the Open Layers Control Panel applet, described on page 35.
- One or more USB ports (Ver. 2.0 or Ver. 1.1). USB Ver. 2.0 is strongly recommended; USB Ver. 1.1 will severely degrade performance
- 64 MB (or more) of RAM; 128 MB (or more) recommended
- One or more CD-ROM drives
- Super VGA (800 x 600 or higher resolution) display monitor

Once you have verified that your system meets the system requirements, install the software, as described in the next section.

Installing the Software

To install the software, perform the following steps:

1. Insert the Data Acquisition OMNI CD into your CD-ROM or DVD drive.
   The installation program should automatically start, and the InstallShield Wizard should appear.
2. If the installation program does not automatically start, double-click **Setup.exe** from the CD.
   The InstallShield Wizard appears.
3. Click **Install Drivers**.
   The installation screen appears.
4. Click **Install now!**
   The InstallShield Wizard appears.
5. If your system does not have the Microsoft .NET Framework 1.1 software installed, the following prompt appears:
   DT-Open Layers optionally uses the Microsoft .NET 1.1 Framework. Would you like to install it now?
   a. Click **Yes**; the Framework is required.
      The Framework installation begins and the license agreement is displayed.
   b. Read the license agreement, click the radio button next to "I agree," and then click **Install**.
   c. After the components have been installed, click **OK** to configure them.
   d. Without removing your Data Acquisition OMNI CD, click **Restart** to restart your system.
      When the system restarts, the Windows Installer dialog box appears, followed by the DT-Open Layers InstallShield Wizard.
6. Click **Next**.
   The license agreement appears.

7. Read the license agreement, click the radio button next to "I accept the terms in the license agreement," and then click **Next**.
   The Destination Folder dialog box appears.
8. Change the default destination folder path, if you wish, by clicking **Change**, and then click **Next**.
9. Click **Install**.
   The files are copied to the specified destination folder.
10. Click **Finish** to complete the installation process.

Viewing the Documentation

Note: To view the documentation, you must have Adobe Acrobat Reader 5.0 or greater installed on your system. Acrobat Reader is provided on the Data Acquisition OMNI CD. If you install Acrobat Reader from this CD, make sure that you open Acrobat Reader and accept the license agreement before viewing the documentation.

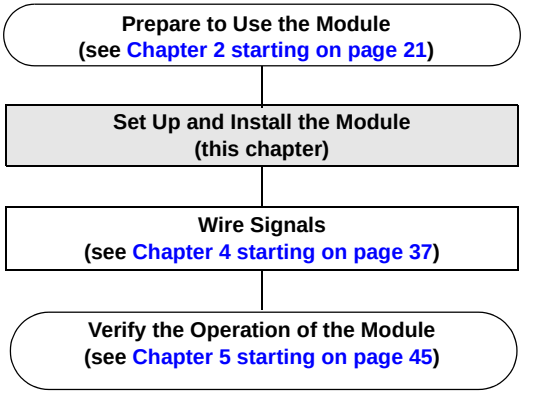
You can access the DT9837 documentation from the Hardware Documentation program group. From the Windows Start menu, click **Programs | Data Translation, Inc | Hardware Documentation**, and then select the appropriate document to view.

The following may be helpful when using Adobe Acrobat Reader:

- To navigate to a specific section of the document, click a heading from the table of contents on the left side of the document.
- Within the document, click the text shown in blue to jump to the appropriate reference (the pointer changes from a hand to an index finger).
- To go back to the page from which the jump was made, click the right mouse button and **Go Back,** or from the main menu, click **Document**, and then **Go Back.**
- To increase or decrease the size of the displayed document, from the main menu, click **View**, and then **Zoom**.
- By default, Acrobat Reader smooths text and monochrome images, sometimes resulting in blurry images. If you wish, you can turn smoothing off by clicking **File**, and then **Preferences/General**, and unchecking **Smooth Text and Images**.

3

Setting Up and Installing the Module



Note: The DT9837 module is factory-calibrated. If you decide that you want to recalibrate the analog input or analog output circuitry, refer to the instructions in Chapter 9.

Attaching Modules to the Computer

This section describes how to attach a DT9837 module to the host computer.

Notes: Most computers have several USB ports that allow direct connection to USB devices. If your application requires more DT9837 modules than you have USB ports for, you can expand the number of USB devices attached to a single USB port by using expansion hubs. For more information, refer to page 33.

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 module uses less than 500 mA; therefore, it does not require external power supply.

You must install the device driver before connecting your DT9837 module(s) to the host computer. See “Installing the Software” on page 25.

Connecting Directly to the USB Ports

To connect a DT9837 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 2.
   The operating system automatically detects the USB module and starts the Found New Hardware wizard.

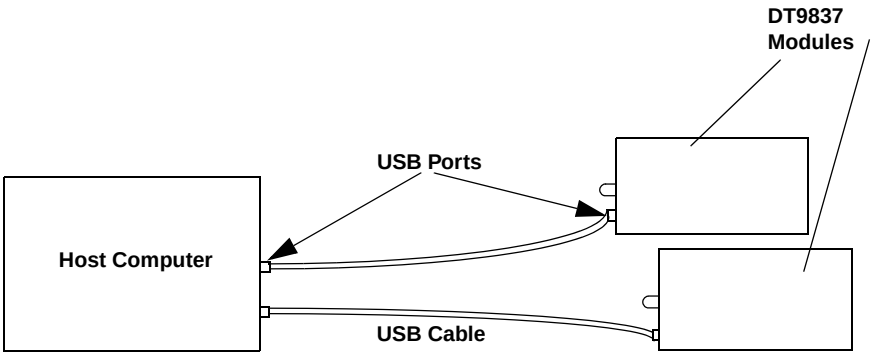


Figure 2: Attaching the Module to the Host Computer

3. Click **Next** and / or **Finish** as required in the wizard. Once the firmware is loaded, the wizard restarts to initiate the firmware to accept commands. Click **Next** and / or **Finish** again.
4. Repeat the steps to attach another DT9837 module to the host computer, if desired.

Note: Once you have connected your module to the host computer, power is turned on to the DT9837 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 DT9837 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. Theoretically, you can connect up to five expansion hubs to a USB port on the host computer. However, the practical number of DT9837 modules that you can connect to a single USB port depends on the throughput you want to achieve. Each of the hubs supports up to four modules.

To connect multiple DT9837 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. Click **Next** and/or **Finish** as required in the wizard. Once the firmware is loaded, the wizard restarts to initiate the firmware to accept commands. Click **Next** and/or **Finish** again.
5. Repeat these steps until you have attached the number of expansion hubs (up to five) and modules (up to four per hub)

that you require. Refer to Figure 3.
The operating system automatically detects the USB devices as they are installed.

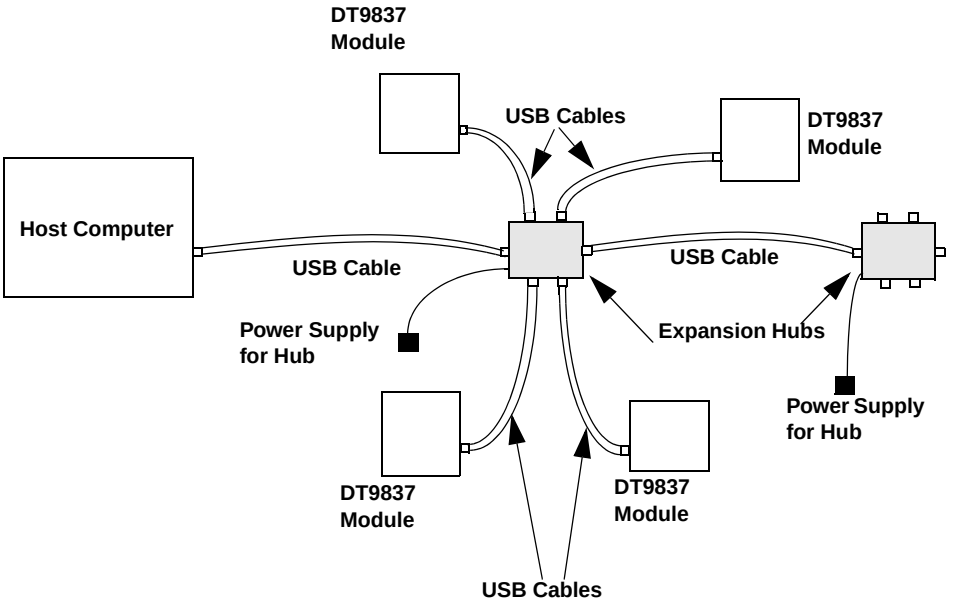


Figure 3: Attaching Multiple Modules Using Expansion Hubs

Note: Once you have connected your module to the host computer, power is turned on to the DT9837 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 DT9837 module when your application program terminates its connection to the module.

Configuring the DT9837 Device Driver

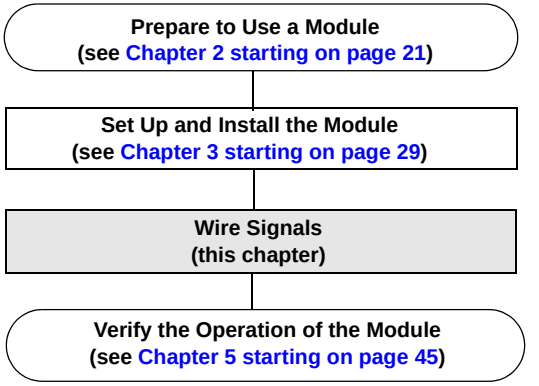
To configure the device driver for the DT9837 module, do the following:

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. Click the DT9837 module that you want to configure, and then click **Advanced**.
   The Configurable Board Options dialog box appears.
5. If you want to rename the module, 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.
6. Repeat steps 4 to 5 for the other modules that you want to configure.
7. When you are finished configuring the modules, click **Close**.

Continue with the instructions on wiring in Chapter 4 starting on page 37.

4

Wiring Signals


Prepare to Use a Module
(see Chapter 2 starting on page 21)
Set Up and Install the Module
(see Chapter 3 starting on page 29)
Wire Signals
(this chapter)
Verify the Operation of the Module
(see Chapter 5 starting on page 45)

Preparing to Wire Signals

CAUTION:

To avoid electrostatic sensitivity, unplug your module from the computer before wiring signals.

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

Wiring Recommendations

Keep the following recommendations in mind when wiring signals to a DT9837 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 DT9837 module is operational.
- Connect all unused analog input channels to analog ground.

Wiring Signals to the DT9837 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 4.

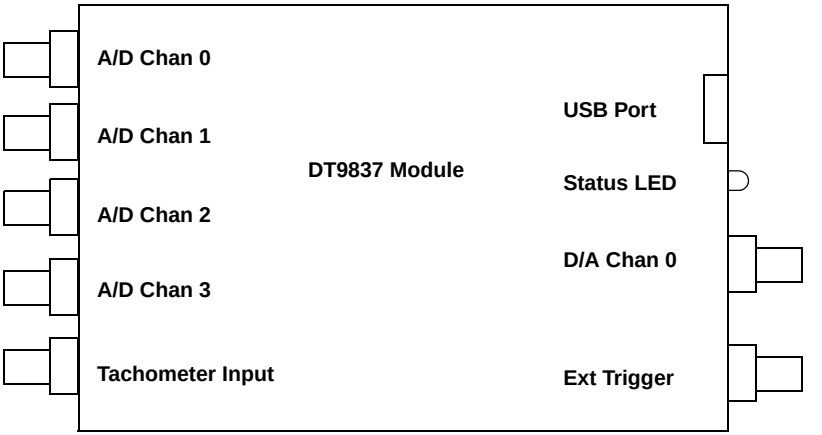


Figure 4: Connectors of the DT9837 Module

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 the DT9837 module. Internally, these signals are connected in single-ended mode. The DT9837 supports an input signal range of ±10 V (using a gain of 1) or ±1 V (using a gain of 10).

Figure 5 shows how to connect analog inputs (channels 0 and 1, in this case) to the BNC connectors on the DT9837 module.

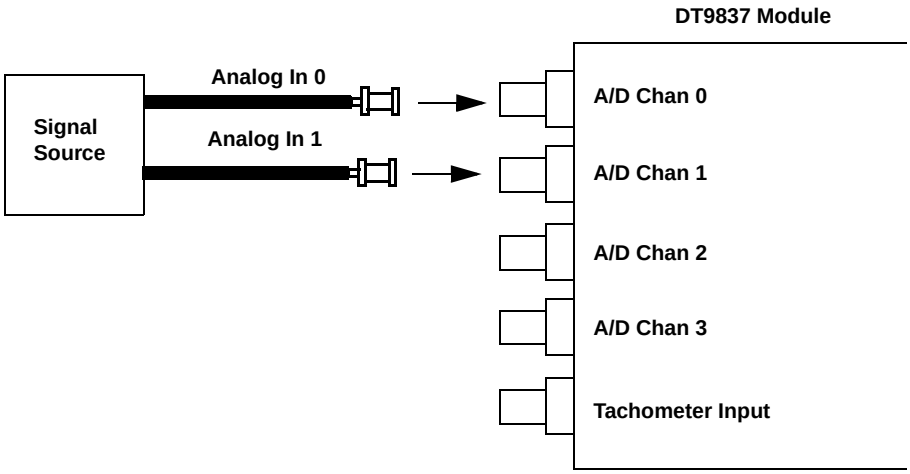


Figure 5: Connecting Analog Inputs to the DT9837 Module

Connecting an Analog Output Signal

The DT9837 module provides one analog output channel with an output range of ±10 V. Figure 6 shows how to connect an analog output signal to the DT9837 module.

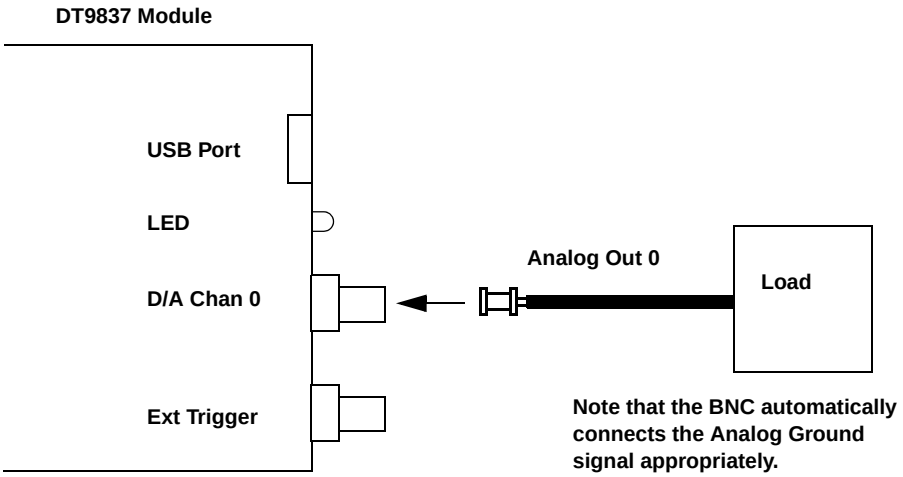


Figure 6: Connecting an Analog Output Signal to the DT9837

Connecting a Tachometer Input

You can connect a ±30 V, 31-bit tachometer input signal with a maximum frequency of 380 kHz and a minimum pulse width of 1.3 µs to the tachometer input BNC on the DT9837 module, as shown in Figure 5.

Note: In software, you can read the tachometer input as part of the analog input channel list. Refer to Chapter 6 for more information.

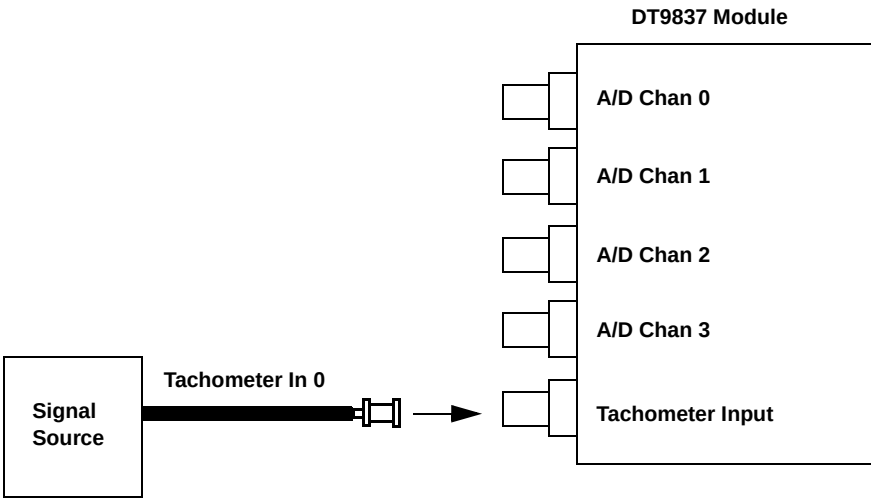


Figure 7: Connecting a Tachometer Input Signal to the DT9837

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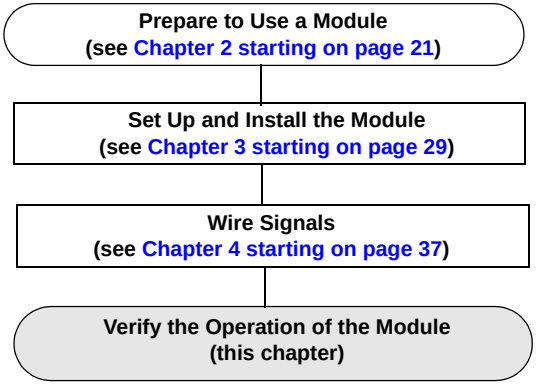
Verifying the Operation of a Module



You can verify the operation of a DT9837 module using the Quick DataAcq application. Quick DataAcq lets you do the following:

- Acquire data from a single analog input channel
- Acquire data continuously from one or more analog input channels using an oscilloscope, strip chart, or Fast Fourier Transform (FFT) view
- Output a single value from the analog output channel
- Output a waveform from the analog output channel
- Save the input data to disk

Note: This application does not support configuring AC/DC coupling or the excitation current source for IEPE inputs.

Installing the Quick DataAcq Application

The Quick DataAcq application is installed automatically when you install the driver software. See “Installing the Software” on page 25.

Running the Quick DataAcq Application

To run the Quick DataAcq application, do the following:

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

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

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

Testing Single-Value Analog Input

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

1. Connect a voltage source, such as a function generator, to analog input channel 0 on the DT9837 module. Refer to page 41 for an example of how to connect an analog input.
2. In the Quick DataAcq application, choose **Single Analog Input** from the **Acquisition** menu.
3. Select the appropriate DT9837 module from the **Board** list box.
4. In the **Channel** list box, select analog input channel 0.
5. In the **Range** list box, select the range for the channel. The default is ±10 V.
6. Select **Single-Ended**.
7. Click **Get** to acquire a single value from analog input channel 0. *The application displays the value on the screen in both text and graphical form*.

Testing Continuous Analog Input

To verify that the module can perform a continuous analog input operation, do the following:

1. Connect known voltage sources, such as the outputs of a function generator, to analog input channels 0 and 1 on the DT9837 module.
2. In the Quick DataAcq application, choose **Scope** from the **Acquisition** menu.
3. Select the DT9837 module from the **Board** list box.
4. In the **Sec/Div** list box, select the number of seconds per division (.1 to .00001) for the display.
5. In the **Channel** list box, select analog input channel 1, and then click **Add** to add the channel to the channel list. Note that, by default, channel 0 is included in the channel list.
6. Click **Config** from the Toolbar.
7. In the **Config** dialog, select **ChannelType**, and then select **Single-Ended**.
8. In the **Config** dialog, select **Range,** and then select **Bipolar**.
9. Click **OK** to close the dialog box
10. From the Scope view, double-click the input range of the channel to see the input range of the module. The default is ±10 V.
    The display reflects the selected range for all the analog input channels on the module.
11. In the **Trigger** box, select **Auto** to acquire data continuously from the specified channels or **Manual** to acquire a burst of data from the specified channels.

12. Click **Start** from the Toolbar to start the continuous analog input operation.
    The application displays the values acquired from each channel in a unique color on the oscilloscope view.
13. Click **Stop** from the Toolbar to stop the operation.

Testing Single-Value Analog Output

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

1. Connect an oscilloscope or voltmeter to analog output channel 0 on the module. Refer to page 42 for an example of how to connect analog output signals.
2. In the Quick DataAcq application, choose **Single Analog Output** from the **Control** menu.
3. Select the appropriate DT9837 module from the **Board** list box.
4. In the **Channel** list box, select analog output channel 0.
5. In the **Range** list box, select the output range of DAC0. The default is ±10 V.
6. Enter an output value or use the slider to select a value to output from DAC0.
7. Click **Send** to output a single value from analog output channel 0.
   The application displays the output value both on the slider and in the text box.

Testing Continuous Analog Output

To verify that the module can output a continuous waveform from the analog channel, do the following:

1. Connect an oscilloscope or voltmeter to analog output channel 0 on the module. Refer to page 42 for an example of how to connect analog output signals.
2. In the Quick DataAcq application, choose **Wave Generator** from the **Control** menu.
3. Select the appropriate DT9837 module from the **Board** list box.
4. In the **Waveform** area, select **Sine**.
5. Change the **Peak Voltage** and **Wave Frequency** values, if desired.
6. Click **Start** to output a waveform from analog output channel 0. *The application displays the waveform in the Wave Generator window, and on the attached oscilloscope or voltmeter.*

Part 2:
Using Your Module

6

Principles of Operation

Figure 8 shows a block diagram of the DT9837 module.

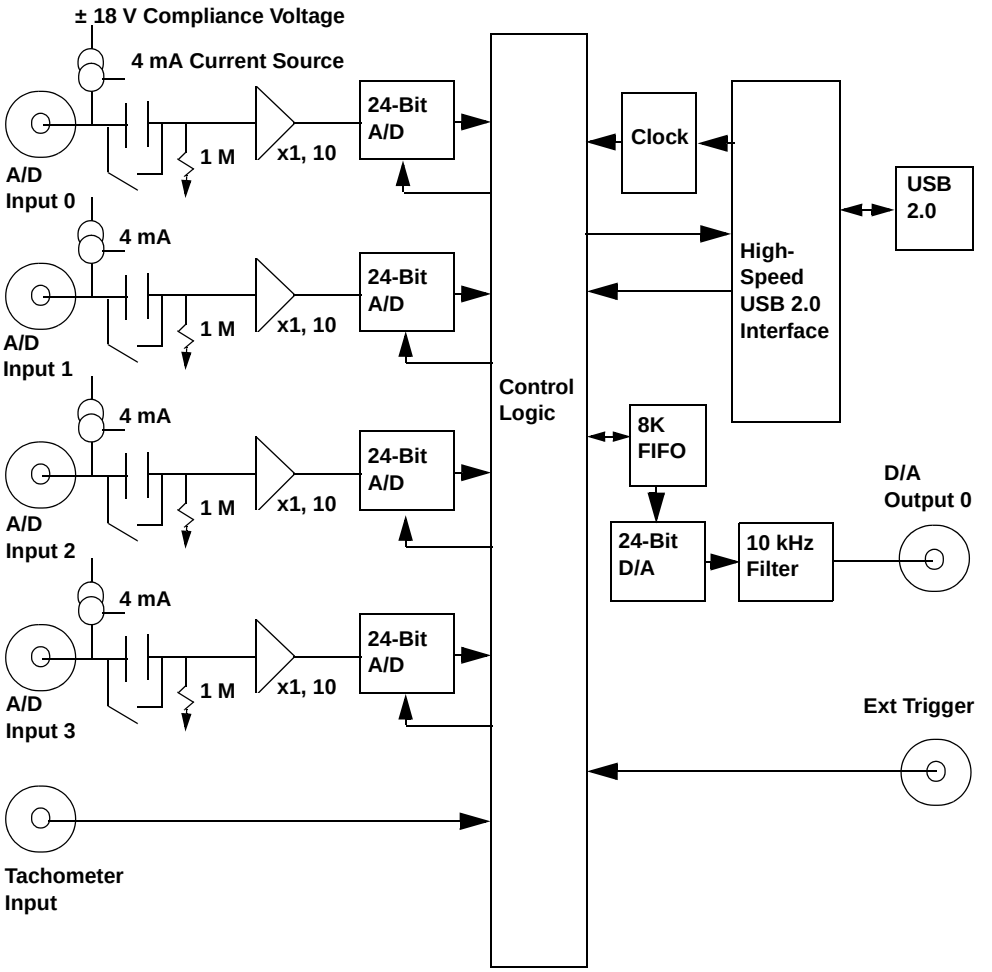


Figure 8: Block Diagram of the DT9837 Module

Analog Input Features

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

- Analog input channels, described below
- IEPE functions, described on page 61
- Input resolution, described on page 61
- Input ranges and gains, described on page 61
- Input sample clock sources, described on page 62
- Analog input conversion modes, described on page 63
- Input triggers, described on page 65
- Data format and transfer, described on page 66
- Error conditions, described on page 67

Analog Input Channels

The DT9837 module supports 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 61 for more information on IEPE functions.

The DT9837 module uses 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.

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

DT9837 modules can acquire data from a single analog input channel or from a group of analog input channels. In addition, the DT9837 module can acquire data from a tachometer input that is specified as part of the analog input channel list.

The following subsections describe how to specify these channels.

Specifying a Single Analog Input Channel

The simplest way to acquire data from a single analog input channel is to specify the channel for a single-value analog input operation using software; refer to page 63 for more information about single-value operations.

You can also specify a single channel using the analog input channel list, described in the next section.

Specifying One or More Analog Input Channels

You can read data from one or more analog input channels using an analog input channel list. Using software, specify the channels you want to sample in sequential order. You can enter up to 5 entries in the channel list, including four analog input channels and the tachometer input; see the next section for more information about including the tachometer input in the analog input channel list. Refer to page 63 for more information about the supported conversion modes.

Specifying a Tachometer Input in the Analog Input Channel List

The DT9837 module accepts one ±30 V, 31-bit tachometer input signal with a maximum frequency of 380 kHz and a minimum pulse width of 1.3 µs. The threshold voltage is fixed at ±2 V with 0.5 V of hysteresis.

You can read the number of counts between two consecutive rising on the tachometer input by including channel 4 in the analog input channel list. 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 the operation is started, an internal counter / timer on the DT9837 module starts incrementing when it detects a rising edge on the tachometer input and stops incrementing when it detects the next rising edge on the tachometer input.When the measurement is complete, the counter / timer remains idle until it is next read. On the next read, the current value of the tachometer input (from the previous measurement operation) is returned and the next operation is started automatically.

Note: If you read the value of the tachometer input before the measurement is complete, the previous value of the tachometer input returned.

If the 31-bit counter rolls over, indicating that you are reading the value of the tachometer input very slowly, a value of 0 is returned.

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

Table 5: 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

Input Ranges and Gains

The DT9837 module provides 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. The DT9837 module supports the following following software-programmable IEPE functions for each of the four analog inputs:

- Excitation current source – You can enable or disable the use of a 4 mA, internal excitation current source. 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.

Input Resolution

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

Clock Source

The DT9837 module supports 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. The sampling frequency ranges from 195.3 Hz to 52.734 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 DT9837 supports a wide pass band of 0.5 Hz 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.

The value that you specify for the internal clock frequency is multiplied by 512 internally 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 DT9837 module requires 38 clock pulses before the first A / D conversion is completed (38 / 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 38 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 modules support single-value and continuous scan conversion modes. This section describes each of these conversion mode.

Single-Value Operations

Single-value operations are the simplest to use. Using software, you specify the analog input channel and the gain that you want to use. The module acquires the data from the specified channel and returns the data immediately. For a single-value operation, you cannot specify a clock source, trigger source, scan mode, or buffer.

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

Note: You can also read a single value from the tachometer input by specifying analog input channel 4 and a gain of 1 for a single-value operation.

Continuous Scan Mode

Continuous scan mode takes full advantage of the capabilities of the DT9837 module. You can specify a channel list, clock source, trigger source, and buffer using software.

When it detects an initial trigger, the module simultaneously samples all of the input channels, including the tachometer input, if it is included in the channel list, and converts the analog input data. The sampled data is placed in the allocated buffer(s) and the operation continues until the allocated buffers are filled or until you stop the operation. Refer to page 66 for more information about buffers.

The conversion rate is determined by the frequency of the input sample clock; refer to page 62 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 trigger source as any of the supported trigger sources (refer to page 65)

Figure 9 illustrates continuous scan mode using a channel list with five entries: channel 0, 1, 2, 3, and 4. In this example, data is acquired simultaneously on all channels on each clock pulse of the input sample clock. Data is acquired continuously until all the queued buffers have been filled or you stop the operation.

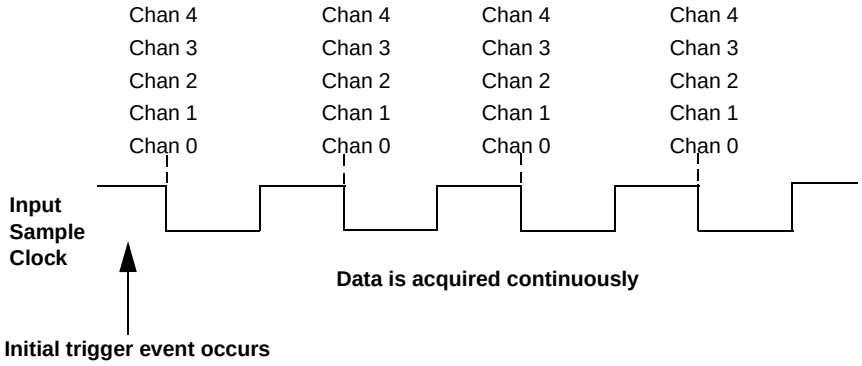


Figure 9: Continuous Scan Mode

Input Triggers

A trigger is an event that occurs based on a specified set of conditions. Acquisition starts when the module detects the initial trigger event and stops when either all the buffers that have been queued to the subsystem have been filled or you stop the operation.

The DT9837 module supports the following trigger sources:

- **Software trigger** – A software trigger event occurs when you start the analog input operation (the computer issues a write to the module to begin conversions). Using software, specify the trigger source as a software trigger.
- **External digital (TTL) trigger** – An external digital (TTL) trigger event occurs when the DT9837 module detects a rising-edge transition on the signal connected to the Ext Trig BNC connector on the module. Using software, specify the trigger source as an external, positive digital (TTL) trigger.

- **Analog threshold trigger** – An analog threshold 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 trigger source as a positive threshold trigger.

Note: Channel 0 does not have to be included in the channel list for the trigger to work.

Data Format and Transfer

DT9837 modules use offset binary data encoding, where 0000 represents negative full-scale, and FFFFh represents positive full-scale. Use software to specify the data encoding as binary. The ADC outputs FFFFh for above-range signals, and 0000 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.

Error Conditions

The DT9837 module reports any overrun errors by sending an overrun event to the application program. This event indicates that data buffers are not being sent from the host to the module fast enough, and so the A / D converter ran out of buffers. To avoid this error, try one or more of the following:

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

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

Analog Output Features

This section describes the following features of analog output operations:

- Analog output channels, described below
- Output ranges and gains, described below
- Output resolution, described on page 68
- Output conversion mode, described on page 69
- Output clocks, described on page 69
- Output triggers, described on page 71
- Data format and transfer, described on page 71
- Error conditions, described on page 71

Analog Output Channels

The DT9837 module supports one analog output channel through analog output subsystem 0.

A two-pole, 10 kHz Butterworth filter is applied 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 module can output bipolar analog output signals in the range of ±10 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 DT9837 module uses a fixed 12 MHz internal clock, which is derived from the USB clock, to produce an effective sampling frequency of 46.875 kHz.

Use software to specify an internal clock source for the analog output subsystem with a clock frequency of 46.875kHz.

Once the sample clock is started, the DT9837 module requires 34 clock pulses before the first D/A conversion is completed (34/46.875 kHz) due to the group delay of the converter.

Output Conversion Modes

The DT9837 module supports the following analog output conversion modes:

- **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: To perform a single value analog output operation, ensure that no analog input operations are running or an error will be reported.

- **Waveform generation mode** takes full advantage of the capabilities of the DT9837 module. In this mode, a waveform, which is specified in a single buffer, is output repetitively.

  You must allocate a buffer less than or equal to 8192 samples, 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 FIFO on the module, and the module starts writing output values to the analog output channel. 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 a software trigger source, described below

Notes: Since the waveform is downloaded to the FIFO on the module, an error will be reported if you specify a buffer with greater than 8192 samples (the size of the FIFO on the module).

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.

Output Trigger

The DT9837 module supports a software trigger only. A software trigger occurs when you issue a command to start the analog output operation. Specify the trigger type in software.

Data Format and Transfer

Data from the host computer must use offset binary data encoding for analog output signals, where 0000 represents –10 V, and FFFFh represents +10 V. Using software, specify the data encoding as binary.

Error Conditions

The DT9837 module reports any underrun errors by sending an underrun event to the application. This event indicates that data buffers are not being sent from the host to the module fast enough, and so 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
- 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

Synchronizing Acquisition on Multiple Modules

The internal clock on the DT9837 module, which is derived from the USB clock, provides the timing for both the analog input and analog output subsystems on the module.

You can synchronize the start of acquisition on multiple modules by connecting all modules to a shared external trigger input, as shown in Figure 10. When triggered, the modules remain locked to the same clock. Note that due to the logic delays, you may see a delay of one A/D conversion between modules.

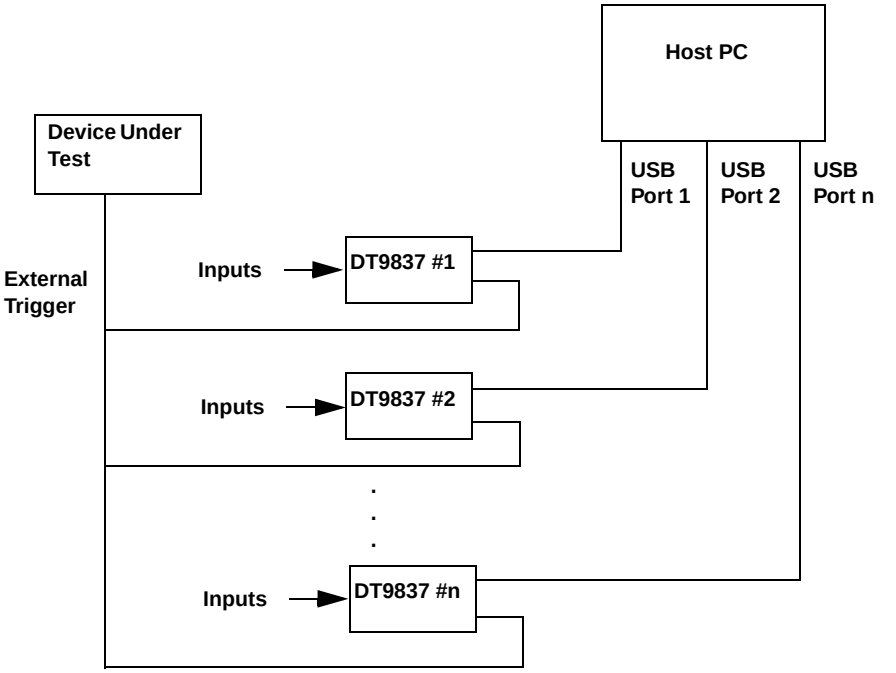


Figure 10: Synchronizing Multiple Modules Using an External Trigger

7

Supported Device Driver Capabilities

The DT9837 Device Driver provides support for the analog input (A / D), analog output (D / A), and counter / timer (C / T) subsystems. For information on how to configure the device driver, refer to Chapter 3.

Table 6: DT9837 Subsystems

DT9837	A/D	D/A	DIN	DOUT	C/T	QUAD
Total Subsystems on Module	1	1	0	0	0	0

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the DT9837 module. 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: 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 7: DT9837 Data Flow and Operation Options

DT9837	A/D	D/A	DIN	DOUT	C/T	QUAD
Single-Value Operation Support **SupportsSingleValue**	Yes	Yes[a]				
Continuous Operation Support **SupportsContinuous**	Yes	Yes[b]				
Continuous Operation until Trigger **SupportsContinuousPreTrigger**						
Continuous Operation before & after Trigger **SupportsContinuousPrePostTrigger**						
Waveform Operations Using FIFO Only **SupportsWaveformModeOnly**		Yes				
Simultaneous Start List Support **SupportsSimultaneousStart**						
Interrupt Support **SupportsInterruptOnChange**						
Output FIFO Size **FifoSize**		8K				

a. To perform a single value analog output operation, ensure that no analog input operations are running or an error will be reported.

b. 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.

Buffering

Table 8: DT9837 Buffering Options

DT9837	A/D	D/A	DIN	DOUT	C/T	QUAD
Buffer Support **SupportsBuffering**	Yes	Yes				
Single Buffer Wrap Mode Support **SupportsWrapSingle**		Yes				
Inprocess Buffer Flush Support **SupportsInProcessFlush**	Yes					

Triggered Scan Mode

Table 9: DT9837 Triggered Scan Mode Options

DT9837	A/D	D/A	DIN	DOUT	C/T	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 10: DT9837 Data Encoding Options

DT9837	A/D	D/A	DIN	DOUT	C/T	QUAD
Binary Encoding Support **SupportsBinaryEncoding**	Yes	Yes				
Twos Complement Support **SupportsTwosCompEncoding**						

Channels

Table 11: DT9837 Channel Options

DT9837	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Channels **NumberOfChannels**	5[a]	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**	5	1	0	0	0	0
Simultaneous Sample-and-Hold Support **SupportsSimultaneousSampleHold**	Yes					
Channel-List Inhibit **SupportsChannelListInhibit**						

a. Channels 0 to 3 read the analog input channels; channel 4 reads the tachometer input.

Gain

Table 12: DT9837 Gain Options

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

Ranges

Table 13: DT9837 Range Options

DT9837	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Voltage Ranges **NumberOfRanges**	1	1	0	0	0	0
Available Ranges **SupportedVoltageRanges**	±10 V[a]	±10 V				

a. By applying a gain of 1, the effective input range is ±10 V. By applying a gain of 10, the effective input range is ±1 V.

Resolution

Table 14: DT9837 Resolution Options

DT9837	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Programmable Resolution **SupportsSoftwareResolution**						
Number of Resolutions **NumberOfResolutions**	1	1	0	0	0	0
Available Resolutions **SupportedResolutions**	24	24	0	0	0	0

Thermocouple Support

Table 15: DT9837 Thermocouple Support Options

DT9837	A/D	D/A	DIN	DOUT	C/T	QUAD
Thermocouple Support **SupportsThernocouple**						
Voltage Converted to Temperature in Hardware **SupportsTemperatureDataInStream**						
Supported Thermocouple Types **ThermocoupleType**						
Supports CJC Source Internally in Hardware **SupportsCJCSourceInternal**						
Supports CJC Channel **SupportsCJCSourceChannel**						
Available CJC Channels **SupportedCJCChannels**						

IEPE Support

Table 16: DT9837 IEPE Support Options

DT9837	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Programmable AC Coupling **SupportsACCoupling**	Yes					
Software Programmable DC Coupling **SupportsDCCoupling**	Yes					
Software Programmable External ExcitationCurrent Source **SupportsExternalExcitationCurrent Src**						
Software Programmable Internal Excitation Current Source **SupportsInternalExcitationCurrentSrc**	Yes					
Available Excitation Current Source Values **SupportedExcitationCurrentValues**	.004 A					

Triggers

Table 17: DT9837 Trigger Options

DT9837	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Trigger Support **SupportsSoftwareTrigger**	Yes	Yes				
External Positive TTL Trigger Support **SupportsPosExternalTTLTrigger**	Yes					
External Negative TTL Trigger Support **SupportsNegExternalTTLTrigger**	Yes					
Positive Threshold Trigger Support **SupportsPosThresholdTrigger**	Yes[a]					
Negative Threshold Trigger Support **SupportsNegThresholdTrigger**						
Digital Event Trigger Support **SupportsDigitalEventTrigger**						

a. The threshold level is fixed at 1.0 V.

Clocks

Table 18: DT9837 Clock Options

DT9837	A/D	D/A	DIN	DOUT	C/T	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	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	46.875 kHz	0	0	0	0
Minimum Frequency **MinFrequency**	195.3 Hz	46.875 kHz	0	0	0	0

Counter/Timers

Table 19: DT9837 Counter/Timer Options

DT9837	A/D	D/A	DIN	DOUT	C/T	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**						

Table 19: DT9837 Counter/Timer Options (cont.)

DT9837	A/D	D/A	DIN	DOUT	C/T	QUAD
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**						

8

Troubleshooting

General Checklist

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

1. Read all the documentation provided for your product. Make sure that you have added any "Read This First" information to your manual and that you have used this information.
2. Check the Data Acquisition OMNI CD for any README files and ensure that you have used the latest installation and configuration information available.
3. Check that your system meets the requirements stated in Chapter 2.
4. Check that you have installed your hardware properly using the instructions in Chapter 3.
5. Check that you have installed and configured the device driver properly using the instructions in Chapter 3.
6. Check that you have wired your signals properly using the instructions in Chapter 4.
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 20 to isolate and solve the problem. If you cannot identify the problem, refer to page 90.

Table 20: Troubleshooting Problems

Symptom	Possible Cause	Possible Solution
Module is not recognized	You plugged the module into your computer before installing the device driver.	From the Control Panel > System > Hardware > Device Manager, uninstall any unknown devices (showing a yellow question mark). Then, run the 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 3.
	The module is damaged.	Contact Data Translation for technical support; refer to page 90.
Intermittent operation.	Loose connections or vibrations exist.	Check your wiring and tighten any loose connections or cushion vibration sources; see the instructions in Chapter 4.
	The module is overheating.	Check environmental and ambient temperature; consult the module's specifications on page 107 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 4.

Table 20: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Device failure error reported.	The DT9837 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 4.
	The DT9837 module was removed while an operation was being performed.	Ensure that your DT9837 module is properly connected; see the instructions in Chapter 3.
Data appears to be invalid.	An open connection exists.	Check your wiring and fix any open connections; see the instructions in Chapter 4.
	A transducer is not connected to the channel being read.	Check the transducer connections; see the instructions in Chapter 4.
	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 4.

Table 20: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Data appears to be invalid (cont.)	The DT9837 module is out of calibration.	DT9837 modules are calibrated at the factory. If you want to readjust the calibration of the analog input or analog output circuitry, refer to Chapter 9 starting on page 93.
USB 2.0 is not recognized.	Your operating system does not have the appropriate Service Pack installed.	Ensure that you load the appropriate Windows Service Pack (version 2 for Windows XP or version 4 for Windows 2000). 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 3.
	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 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 modules are calibrated at the factory and should not require calibration for initial use. We recommend that you check and, if necessary, readjust the calibration of the analog input and analog output circuitry on the DT9837 modules every six months using the DT9837 Calibration Utility.

Note: Ensure that you installed the DT9837 Device Driver prior to using the DT9837 Calibration Utility. Refer to Chapter 2 for more information on installing the device driver.

This chapter describes how to calibrate the analog input and output subsystems of DT9837 modules using the DT9837 Calibration Utility.

Using the Calibration Utility

Start the DT9837 Calibration Utility as follows:

1. Ensure that you installed the software using the instructions in Chapter 2.
2. Click **Start** from the Task Bar, and then select **Programs | Data Translation, Inc | Calibration | DT9837 Calibration Utility.**
   The main menu of the DT987 Calibration Utility appears.
3. Select the module to calibrate, and then click **OK**.

Once the DT9837 Calibration Utility is running, you can calibrate the analog input circuitry (either automatically or manually), described on page 96, or the analog output circuitry of the DT9837 module, described on page 99.

Calibrating the Analog Input Subsystem

This section describes how to use the DT9837 Calibration Utility to calibrate the analog input subsystem of a DT9837 module.

The DT9837 module has separate calibration for each A/D input channel. You can choose to calibrate either an individual channel or all channels on the module.

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 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 DT9837 Calibration Utility.
2. Choose either a single channel or all channels from the **Type of Calibration** drop-down list box in the **Automatic Calibration** area.
3. Set the voltage supply on your selected channel to 0.000V.
4. Click the Auto Calibration **Start** button.
   A message appears notifying you to verify that 0.000 V is applied to the channel.
5. 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.

6. 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.

7. If you chose to calibrate all channels, then the proceeding four steps repeat for all other A / D channels on the board the calibration utility prompts you to attach the precision voltage source to the next channel). Follow the on-screen prompts to proceed through the rest of the channels.

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 (substitute the appropriate channel number as you go):

1. Adjust the offset as follows:

   a. Verify that 0.000 V is applied to AD Ch0, and that A / D Channel Select is set to Channel 0.
   The current voltage reading for this channel is displayed in the A/D Value window.

   b. Adjust the offset by entering values between 0 and 255 in the Offset edit box, or by clicking the up / down buttons until the A / D Value is 0.000 V.

2. Adjust the gain as follows:

   a. Verify that +9.375 V is applied to AD Ch0, and that A / D Channel Select is set to Channel 0.
   The current voltage reading for this channel is displayed in the A/D Value window.

b. Adjust the gain by entering values between 0 and 255 in the Gain edit box, or by clicking the up / down buttons until the A / D Value is 9.3750 V.

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 DT9837 Calibration Utility to calibrate the analog output subsystem of a DT9837 module.

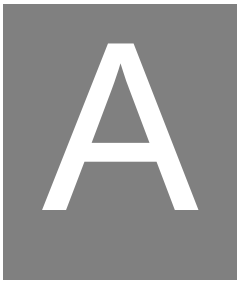
To calibrate the analog output circuitry, you need to connect an external precision voltmeter to analog output channel 0 of the DT9837 module.

Do the following to calibrate the analog output circuitry:

1. Select the **D/A Calibration** tab of the DT9837 Calibration Utility.
2. Connect an external precision voltmeter to Analog Output 0 (DAC Ch0) of the DT9837 module.
3. In the DAC Output Voltage box, select **–9.375 V**.
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.
5. In the DAC Output Voltage box, select **9.375 V**.
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.

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 DT9837 Calibration Utility, click the close box in the upper right corner of the window.



Specifications

Analog Input Specifications

Table 3 lists the specifications for the analog input subsystem on the DT9837 module.

Table 3: Analog Input Subsystem Specifications

Feature	Specifications
Number of analog input channels	4, single-ended, simultaneous
Resolution	24 bits
Ranges and gains	±10 V (gain of 1), ±1 V (gain of 10)
Gain error Gain of 1: Gain of 10:	 ±0.02% ±0.5%
A/D type	Delta-Sigma
Maximum sample rate	52.734 kHz[a]
Minimum sample rate	195.3 Hz
Group delay	38/Sample Frequency
Pass band at –3 dB: at –100 dB:	 0.49 x Sample Frequency 0.55 x Sample Frequency
Pass band ripple	±0.005 dB
Signal/noise (typical)	106 dB
Total harmonic distortion (–0.5 dB) using 1 kHz sine wave, sampled at 50 kHz	 –90 db typical

A

Table 3: Analog Input Subsystem Specifications (cont.)

Feature	Specifications
Spurious free dynamic range (SFDR) using a 1 kHz sine wave, sampled at 50 kHz 10 V full-scale signal (–0.5 dB): 1 V signal (–20 dB): 100 mV signal (–40 dB): 0 V signal:	 –90 dB typical –105 dB typical –115 dB typical –115 dB typical
Data encoding	Offset binary
Maximum input voltage (without damage) Power on: Power off:	 ±30 V ±20 V
Input impedance	1 MΩ, 20 pF[b]
Overvoltage protection (power on/off)	±40 V
ESD protection Arc: Contact:	 8 kV 4 kV
Current source	4 mA
Compliance voltage	18 V[c]
Current noise @ 1 kHz bandwidth	5 nA rms
Current source accuracy	±1.0%
DC offset	1.5 mV
AC coupling at –3 dB	0.5 Hz

a. The conversion rate = Sample rate * 512.
b. Cable capacitance of typically 30 pF per foot must be added.
c. Options are available for accessing the 18 V output signal on the DT9837-OEM version of the module. Contact Data Translation for details.

Analog Output Specifications

Table 4 lists the specifications for the analog output subsystem on the DT9837 module.

Table 4: Analog Output Subsystem Specifications

Feature	Specifications
Number of analog output channels	1
Resolution	24 bits
Output range	±10 V
Data encoding	Offset binary
Output current	±1 mA maximum load (10 V across 10 K)
FIFO	8192 Samples, total
ESD protection Arc: Contact:	 8 kV 4 kV
DC offset	±1.5 mV
Gain error	±3.0%
2-pole, low-pass Butterworth filter	10 kHz
Time delay (typical)	34/output frequency
Power fault and reset	Goes to 0 V ±10 mV if the USB cable is removed or the power fails
Total harmonic distortion (typical at 1 kHz)	0.0015%
Internal clock	output frequency x 256
Sample frequency	46.875 kHz

Table 4: Analog Output Subsystem Specifications (cont.)

Feature	Specifications
Pass band ripple (typical ±0.002 dB)	0.454 x output frequency
Pass band (typical)	0.454 x output frequency
Stop band (typical)	0.546 x output frequency

Tachometer Input Specifications

Table 5 lists the specifications for the tachometer input on the DT9837 module.

Table 5: Tachometer Input Specifications

Feature	Specifications
Number of channels	1
Resolution	31 bits per channel
Input voltage range	±30 V
Threshold voltage	±2 V with 0.5 V hysteresis
Maximum input frequency	380 kHz
Minimum pulse width high/low (minimum amount of time it takes a C/T to recognize an input pulse)	1.3 µs
Measurement clock frequency	12 MHz

Power, Physical, and Environmental Specifications

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Table 6 lists the power, physical, and environmental specifications for the DT9837 modules.

Table 6: Power, Physical, and Environmental Specifications

Feature	Specifications
Power, +5 V	±0.5 V@ 0.5 A
Physical	
Dimensions of enclosure:	Width = 100 mm Length = 188.98 mm Height = 17.29 mm
Dimensions of PCB only:	Width: 100 mm Length: 146.56mm Thickness: 1.57 mm
Weight:	
PCB assembly with enclosure:	490.74 g
PCB assembly:	153.09 g
Environmental	
Operating temperature range:	0° C to 55° C
Storage temperature range:	–25° C to 85° C
Relative humidity:	to 95%, noncondensing
Altitude:	up to 10,000 feet

Regulatory Specifications

Table 7 lists the regulatory specifications for the DT9837 module.

Table 7: Regulatory Specifications

Feature	Specifications
EMI	FCC part 15, class A EN 55022:1994 (based on CISPR-22:1993)
EN 50082-1:1998 IEC 801-2:1984: IEC 801-3: IEC 801-4: VCCI (Japan version of CISPR-22) Safety:	 8 KV air/4 KV contact 3 V/m from 27 to 500 MHz 1 KV coupled to AC lines 0.5 KV coupled to I/O lines UL, CSA
RoHS (EU Directive 2002/95/EG)	Compliant (as of July 1st, 2006)

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