DATA TRANSLATION

UM-24985-G

DT9839 User's Manual

Eighth Edition
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Data Translation, Inc.
100 Locke Drive
Marlboro, MA 01752-1192
(508) 481-3700
www.datatranslation.com
Fax: (508) 481-8620
E-mail: info@datx.com

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 first part of this manual describes how to install and set up your DT9839 module and DT9839 Series device driver, and verify that your module is working properly.

The second part of this manual describes the features of the DT9839 module, the capabilities of the DT9839 Series Device Driver, and how to program the DT9839 module using the DT-Open Layers for .NET Class Library™ software. Troubleshooting information is also provided.

Note: For information on checking system requirements, installing the software, and viewing the documentation, refer to the README file on the OMNI CD.

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 DT9839 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 DT9839 module, as well as the supported software and accessories for the module.
- Chapter 2, "Setting Up and Installing the Module," describes how to install a DT9839 module and how to configure the DT9839 Series Device Driver.
- Chapter 3, "Wiring Signals," describes how to wire signals to a DT9839 module.
- Chapter 4, "Verifying the Operation of a Module," describes how to verify the operation of the DT9839 module with the QuickDAQ application.
- Chapter 5, "Principles of Operation," describes all of the features of the DT9839 module and how to access them in your application.
- Chapter 6, "Supported Device Driver Capabilities," lists the data acquisition subsystems and the associated features accessible using the DT9839 Series Device Driver.
- Chapter 7, "Troubleshooting," provides information that you can use to resolve problems with the DT9839 module and DT9839 Series Device Driver, should they occur.
- Chapter 8, "Calibration," describes how to calibrate the analog I/O circuitry of the DT9839 module.

- Appendix A, "Specifications," lists the specifications of the DT9839 module.
- Appendix B, "Connector Pin Assignments and LED Status Indicator," lists the pin assignments for the screw terminal blocks on the DT9839 module. It also describes the LED status indicator on the 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 DT9839 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).
- *QuickDAQ User's Manual* (UM-24774). This manual describes how to create a QuickDAQ application to acquire and analyze measurement data.
- *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 DT9839 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).

Overview

Hardware Features

The DT9839 module, shown in Figure 1, is a low-cost, portable, USB-based data acquisition module intended for sound, vibration, and general-purpose acquisition of signals from DC through the audio range. The DT9839 module supports USB 1.1, USB 2.0, and USB 3.0.

Figure 1: DT9839 Module

The key hardware features of the DT9839 module are as follows:

- Simultaneous analog input and analog output operations (continuous or waveform mode)
- Analog input subsystem:
  - A four-channel, 16-bit Delta-Sigma A/D provides four simultaneous analog input channels
  - Throughput rate from 195.3 Samples/s to 52.734 kSamples/s per channel
  - Input range of ±2.5 V (nominal)
  - Support for IEPE (Integrated Electronic Piezoelectric) inputs, including use of a 4 mA current source with 15 V compliance voltage, and AC or DC input 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 threshold trigger on any analog input channel). You can program the analog input threshold value from –2.4 V to +2.4 V.
  - For the reference trigger, supports an external digital trigger or a threshold trigger on any analog input channel. You can program the threshold value from –2.4 V to +2.4 V.
- Analog output subsystem:
  - One 24-bit D/A converter to provide stimulus for vibration measurements
  - Single value, waveform, and continuous streaming output
  - Programmable output rate from 10 kSamples/s to 96 kSamples/s
  - Output range of ±2.5 V
  - Software-programmable trigger source (software trigger or external digital trigger) to start the analog output operation.
- Internal clock source (shared between the analog input and analog output subsystems)
- Operates on USB power

Supported Software

The following software is available for use with the DT9839 module and is included on the Data Acquisition OMNI CD:

- **DT9839 Series Device Driver** – The DT9839 Series Device Driver allows you to use a DT9839 module with any of the supported software packages or utilities.
- **DT9839 Calibration Utility** – This utility, described in Chapter 8 starting on page 91, allows you to calibrate the analog input and analog output circuitry of a DT9839 module.
- **QuickDAQ Base Version** – The base version of QuickDAQ is free-of-charge and allows you to acquire and analyze data from all Data Translation USB and Ethernet devices, except the DT9841 Series, DT9817, DT9835, and DT9853/54. Using the base version of QuickDAQ, you can perform the following functions:
  - Discover and select your devices.
  - Configure all input channel settings for the attached sensors.
  - Load/save multiple hardware configurations.
  - Generate output stimuli (fixed waveforms, swept sine waves, or noise signals).
  - On each supported data acquisition device, acquire data from all channels supported in the input channel list.
  - Choose to acquire data continuously or for a specified duration.
  - Choose software or triggered acquisition.
  - Log acquired data to disk in an .hpf file.
  - Display acquired data during acquisition in either a digital display using the Channel Display window or as a waveform in the Channel Plot window.
  - Choose linear or logarithmic scaling for the horizontal and vertical axes.
  - View statistics about the acquired data, including the minimum, maximum, and mean values and the standard deviation in the Statistics window.
  - Export time data to a .csv or .txt file; you can open the recorded data in Microsoft Excel® for further analysis.
  - Read a previously recorded .hpf data file.
  - Customize many aspects of the acquisition, display, and recording functions to suit your needs, including the acquisition duration, sampling frequency, trigger settings, filter type, and temperature units to use.
- **QuickDAQ FFT Analysis Option** – When enabled with a purchased license key, the QuickDAQ FFT Analysis option includes all the features of the QuickDAQ Base version plus basic FFT analysis features, including the following:
  - The ability to switch between the Data Logger time-based interface and the FFT Analyzer block/average-based interface.
  - Supports software, freerun, or triggered acquisition with accept and reject controls for impact testing applications.

  - Allows you to perform single-channel FFT (Fast Fourier Transform) operations, including AutoSpectrum, Spectrum, and Power Spectral Density, on the acquired analog input data. You can configure a number of parameters for the FFT, including the FFT size, windowing type, averaging type, integration type, and so on.
  - Allows you to display frequency-domain data as amplitude or phase.
  - Supports dB or linear scaling with RMS (root mean squared), peak, and peak-to-peak scaling options
  - Supports linear or exponential averaging with RMS, vector, and peak hold averaging options.
  - Supports windowed time channels.
  - Supports the following response window types: Hanning, Hamming, Bartlett, Blackman, Blackman Harris, and Flat top.
  - Supports the ability to lock the waveform output to the analysis frame time.
  - Allows you to configure and view dynamic performance statistics, including the input below full-scale (IBF), total harmonic distortion (THD), spurious free dynamic range (SFDR), signal-to-noise and distortion ratio (SINAD), signal-to-noise ratio (SNR), and the effective number of bits (ENOB), for selected time-domain channels in the Statistics window.
  - Supports digital IIR (infinite impulse response) filters.

- **QuickDAQ Advanced FFT Analysis Option** – When enabled with a purchased software license, the QuickDAQ Advanced FFT Analysis option includes all the features of the QuickDAQ Base version with the FFT Analysis option plus advanced FFT analysis features, including the following:
  - Allows you to designate a channel as a Reference or Response channel.
  - Allows you to perform two-channel FFT analysis functions, including Frequency Response Functions (Inertance, Mobility, Compliance, Apparent Mass, Impedance, Dynamic Stiffness, or custom FRF) with H1, H2, or H3 estimator types, Cross-Spectrum, Cross Power Spectral Density, Coherence, and Coherent Output Power.
  - Supports the Exponential response window type.
  - Supports the following reference window types: Hanning, Hamming, Bartlett, Blackman, Blackman Harris, FlatTop, Exponential, Force, and Cosine Taper windows.
  - Supports real, imaginary, and Nyquist display functions.
  - Allows you to save data in the .uff file format.
- **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 DT9839 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 DT9839 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 DT9839 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 2 illustrates the steps needed to get started using a DT9839 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.

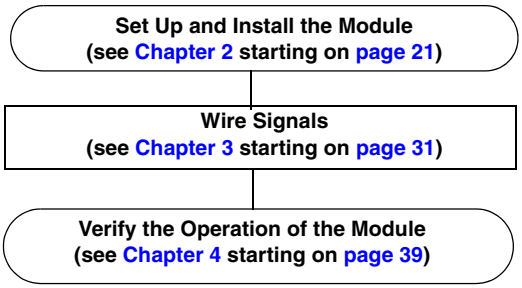
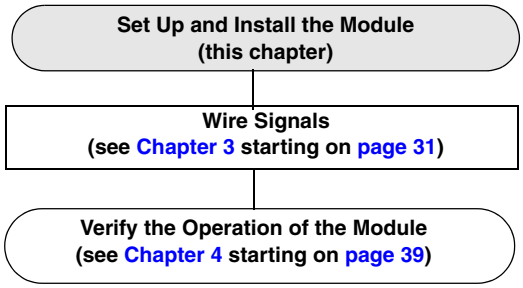


Figure 2: Getting Started Flow Diagram

Part 1: Getting Started

Setting Up and Installing the Module


Set Up and Install the Module
(this chapter)
Wire Signals
(see Chapter 3 starting on page 31)
Verify the Operation of the Module
(see Chapter 4 starting on page 39)

Unpacking

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

- DT9839 module
- EP365 USB cable
- Screw driver
- 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 DT9839 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 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, or Windows Vista (32- and 64-bit)
- Disk Space: 4 GB

Attaching Modules to the Computer

This section describes how to attach a DT9839 module to the host computer.

Note: Most computers have several USB ports that allow direct connection to USB devices. If your application requires more DT9839 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 27.

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.

DT9839 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 DT9839 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 3.
   The operating system automatically detects the USB module and starts the Found New Hardware wizard.

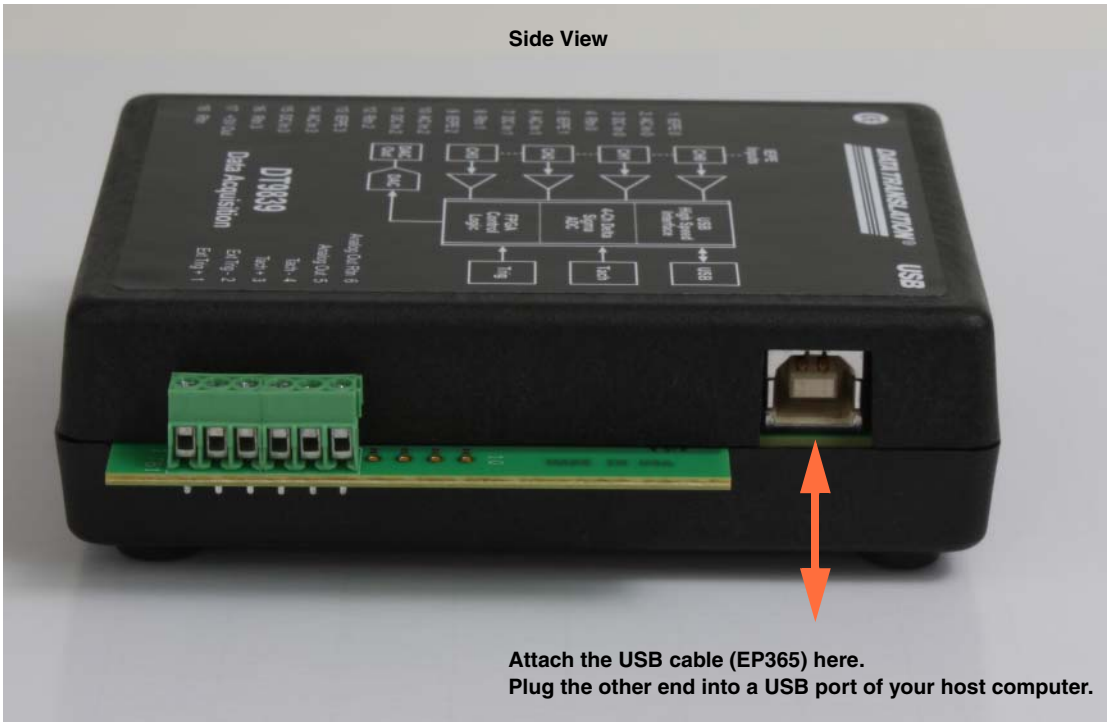


Figure 3: Attaching the Module to the Host Computer

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 DT9839 module to the host computer, if desired.

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, shown in Figure 4, 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.

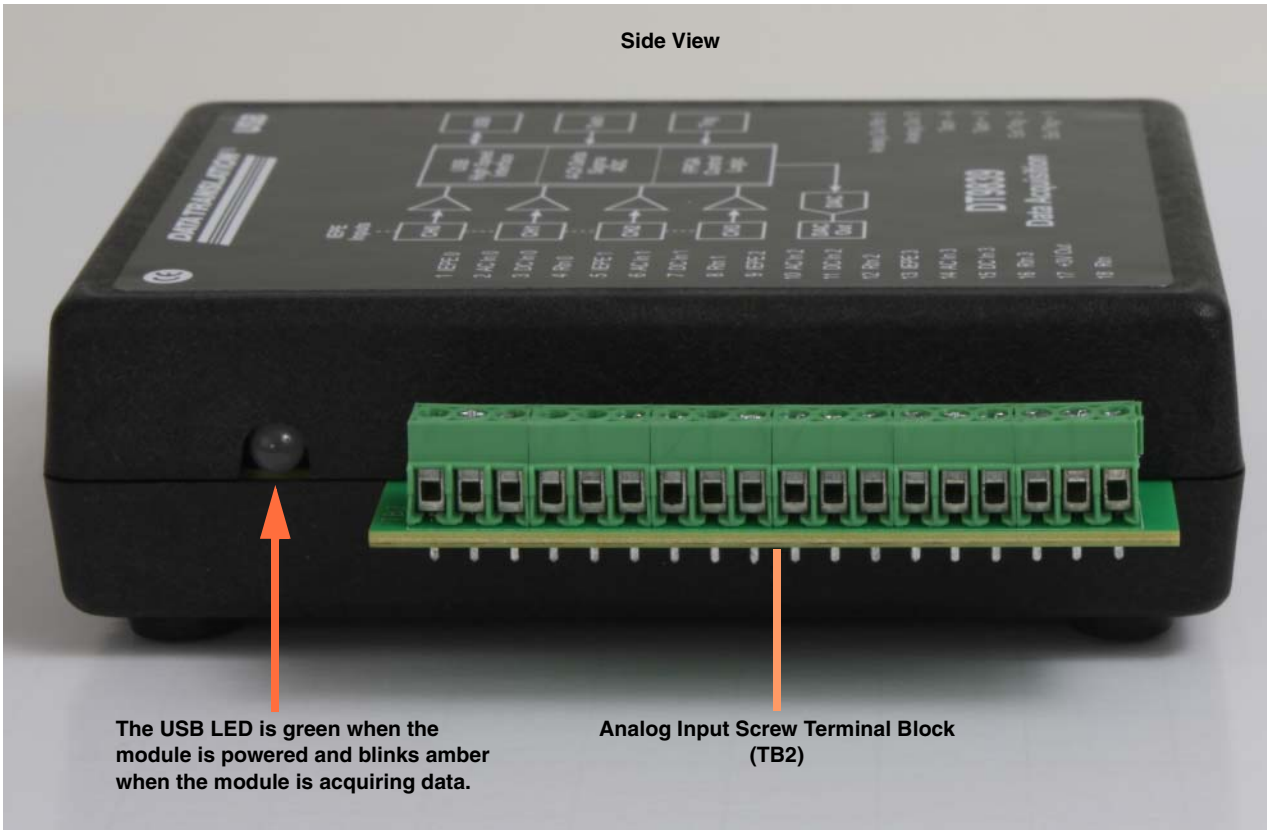


Figure 4: USB LED on the Module

Connecting to an Expansion Hub

Expansion hubs are powered by their own external power supply. The practical number of DT9839 modules that you can connect to a single USB port depends on the throughput you want to achieve.

To connect multiple DT9839 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.

5. Repeat these steps until you have attached the number of expansion hubs and modules that you require. Refer to Figure 5.
   The operating system automatically detects the USB devices as they are installed.

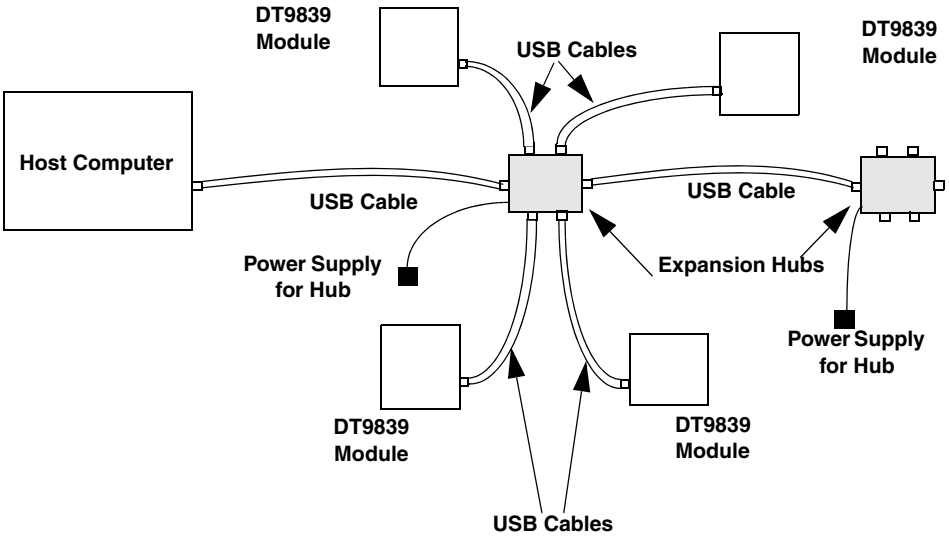


Figure 5: Attaching Multiple Modules Using Expansion Hubs

Note: Once you have connected your module to the host computer, power is turned on to the DT9839 module when your application program opens the module. The LED on the module, shown in Figure 4, 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 DT9839 Series Device Driver

Note: In Windows 7, Vista, and Windows 8, 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:

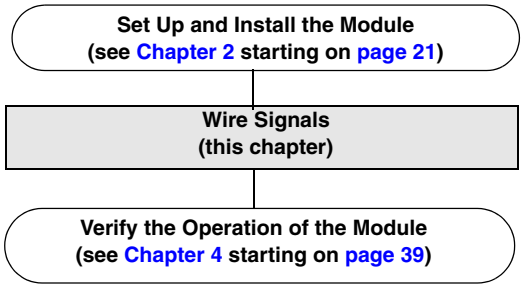
Windows 7, Vista, and Windows 8 (32-bit)
C:\Windows\System32\Dtolcpl.cpl

Windows 7, Vista, and Windows 8 (64-bit)
C:\Windows\SysWOW64\Dtolcpl.cpl

To configure the device driver for a DT9839 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. Repeat steps 4 for the other modules that you want to configure.
6. When you are finished configuring the modules, click **Close** to close the Control Panel.

Wiring Signals


Set Up and Install the Module
(see Chapter 2 starting on page 21)
Wire Signals
(this chapter)
Verify the Operation of the Module
(see Chapter 4 starting on page 39)

Preparing to Wire Signals

This section provides recommendations and information about wiring signals to a DT9839 module.

Wiring Recommendations

Keep the following recommendations in mind when wiring signals to a DT9839 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 DT9839 module contains screw terminals, shown in Figure 6, for connecting signals to the module.

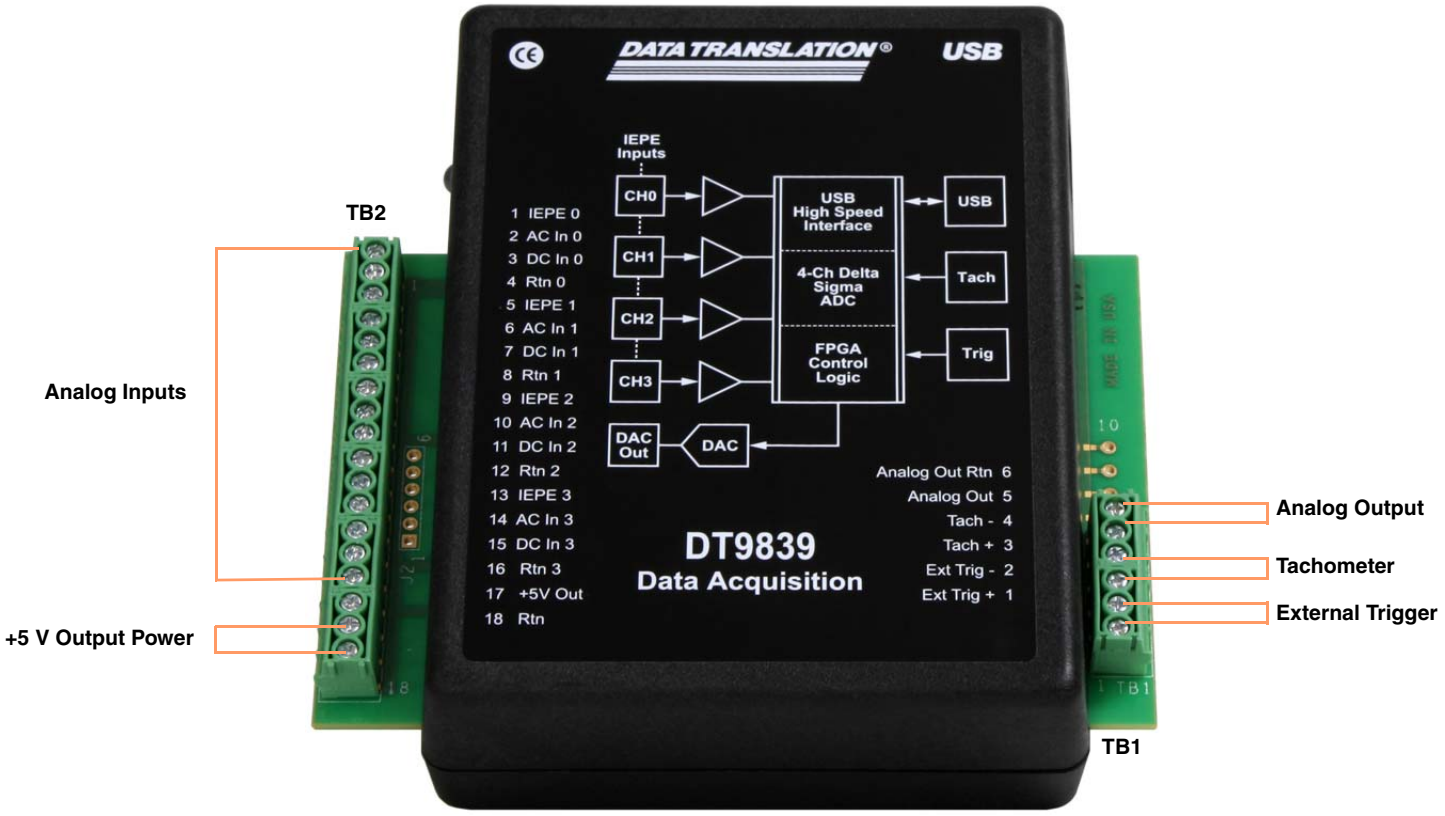


Figure 6: Screw Terminals on the DT9839 Module

Connecting Analog Input Signals

You can connect up to four analog input signals (or IEPE sensors) to the screw terminals on the DT9839 module, shown in Figure 6. Internally, these signals are connected in single-ended mode. The DT9839 module supports an input signal range of –2.5 V (±1 m V) to +2.5 V (±1 mV) with a gain of 1.

Connecting an IEPE Sensor

Figure 7 shows how to connect an IEPE sensor to an analog input channel of a DT9839 module. In this example, analog input channel 0 is shown.

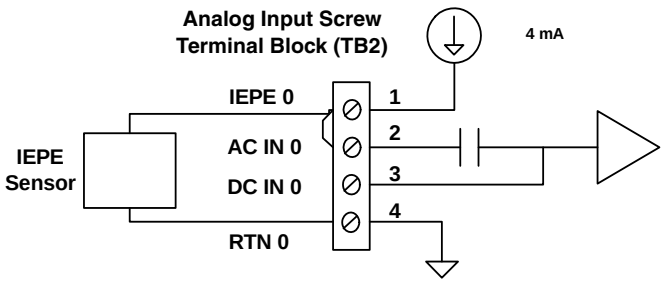


Figure 7: Connecting an IEPE Sensor to an Analog Input Channel (Channel 0 Shown)

Connecting an AC-Coupled Voltage Source

Figure 8 shows how to connect an AC-coupled voltage source to an analog input channel of a DT9839 module. In this example, analog input channel 0 is shown.

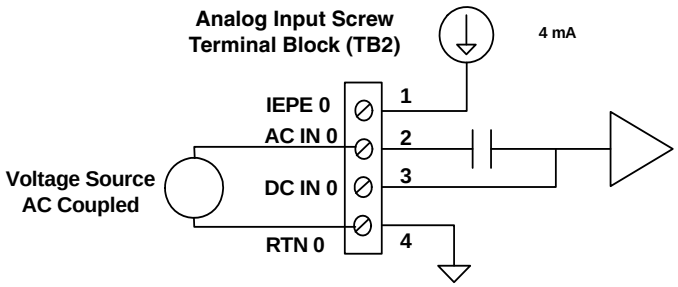


Figure 8: Connecting an AC-Coupled Voltage Source to an Analog Input Channel (Channel 0 Shown)

Note: It is recommended that you configure the input for AC coupling when using an IEPE sensor.

Connecting a DC-Coupled Voltage Source

Figure 9 shows how to connect a DC-coupled voltage source to an analog input channel of a DT9839 module. In this example, analog input channel 0 is shown.

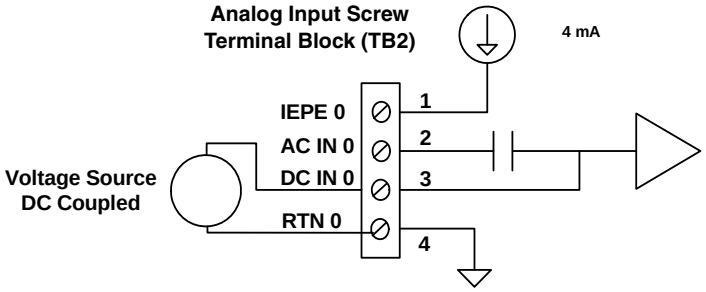


Figure 9: Connecting a DC-Coupled Voltage Source to an Analog Input Channel (Channel 0 Shown)

Connecting an Analog Output Signal

The DT9839 module provides one analog output channel with an output range of ±2.5 V. You connect the analog output signal to the screw terminals on the DT9839 module, shown in Figure 6.

Figure 10 shows how to connect an analog output signal to a DT9839 module.

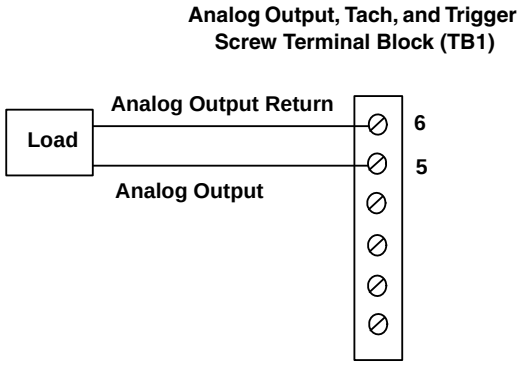


Figure 10: Connecting an Analog Output Signal to a DT9839 Module

Connecting a Tachometer Input Signal

You can connect a tachometer input signal of up to ±30 V to the screw terminals of a DT9839 module, shown in Figure 6.

Note: In software, you can read tachometer measurements as part of the analog input channel list. Refer to page 67 for more information on tachometer measurements.

Figure 11 shows how to connect a tachometer input to a DT9839 module.

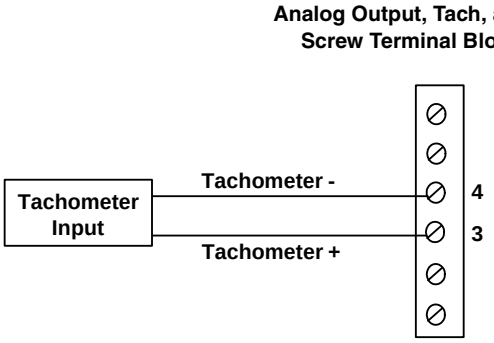


Figure 11: Connecting a Tachometer Input Signal to a DT9839 Module

Connecting an External Trigger Signal

You can connect an external digital trigger signal to the screw terminals of a DT9839 module, shown in Figure 6.

Figure 12 shows how to connect an external trigger to a DT9839 module.

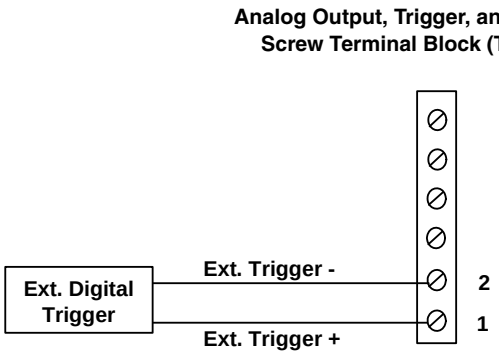
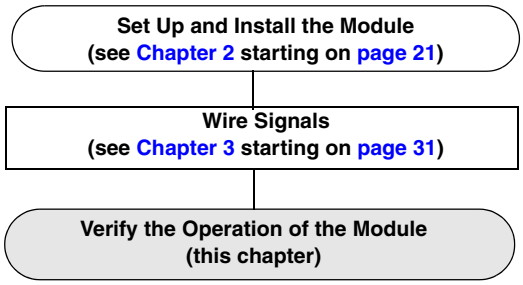


Figure 12: Connecting an External Digital Trigger Signal to a DT9839 Module

Note: If you want to use the threshold trigger, use software to select the threshold trigger and to specify the threshold voltage, and then monitor the voltage of the specified analog input channel.

Verifying the Operation of a Module



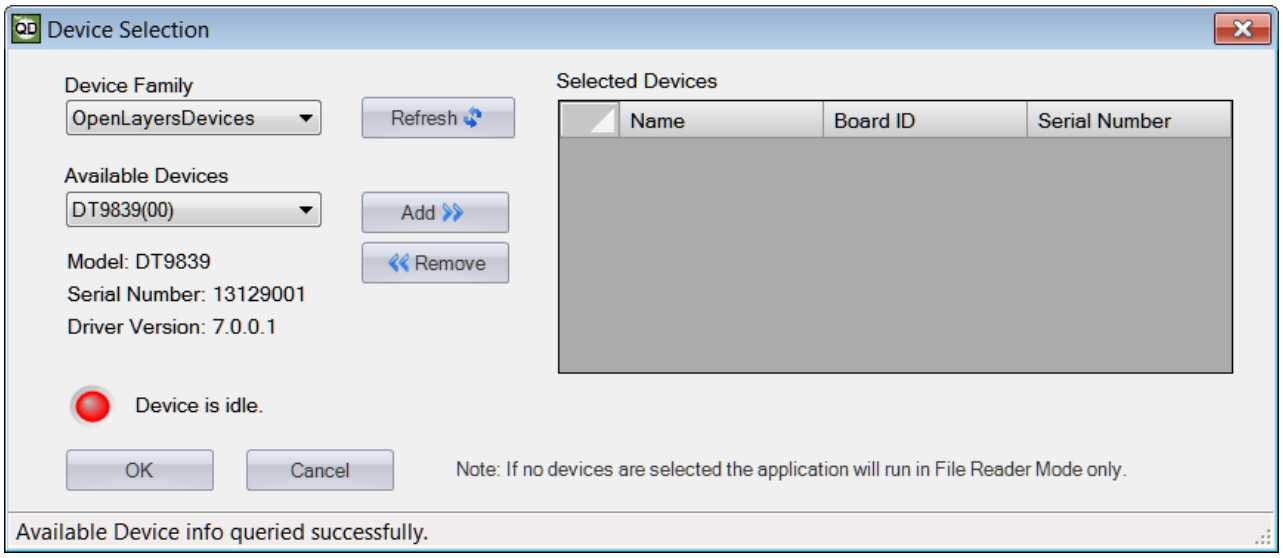
You can verify the operation of a DT9839 module using the QuickDAQ application.

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 DT9839 module using the QuickDAQ base version.

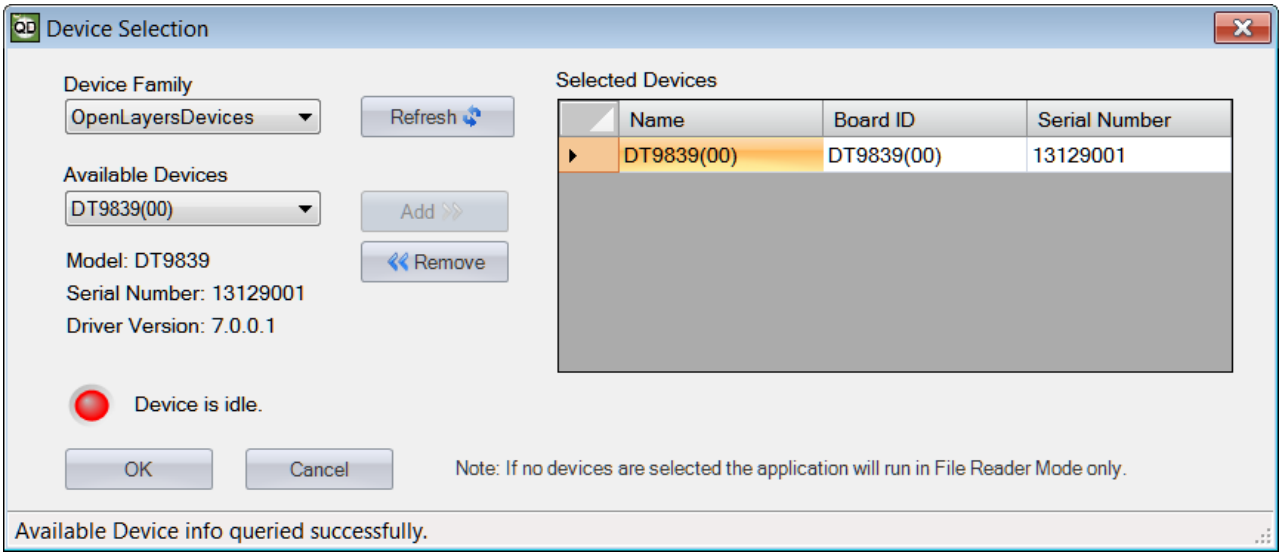
Select the Device

To get started with your DT9839 module and QuickDAQ, follow these steps:

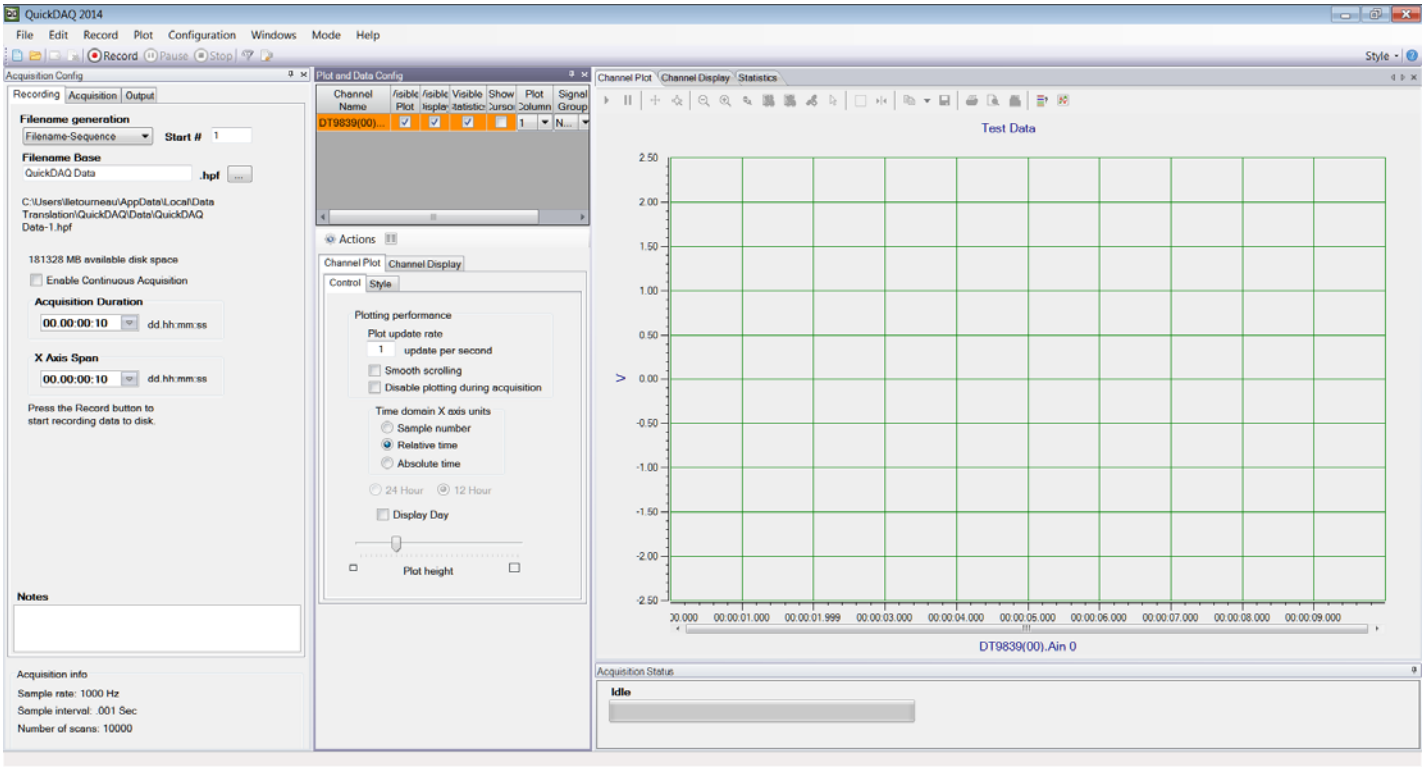
1. Connect the DT9839 module to the USB port of your computer, and connect your sensors to the module.
2. Start the QuickDAQ application.
   The Device Selection window appears.



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 DT9839 module that you want to use from the list of Available Devices, and click **Add**.
   Information about the device, including the model number, serial number, firmware version, driver version, and scanning status is displayed.



5. (Optional) If you want to rename your device, do the following:
   a. Click the Row Selector button for the device.
   b. Click the IP address or module name in the **Name** column to highlight it and enter a meaningful name to represent each available device.
6. (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, and the interface of the QuickDAQ application is displayed.*


QuickDAQ 2014
File Edit Record Plot Configuration Windows Mode Help
Record Pause Stop
Style
Acquisition Config
Recording Acquisition Output
Filename generation
Filename-Sequence
Start #
Filename Base
QuickDAQ Data
.hpf
C:\Users\lletourneau\AppData\Local\Data Translation\QuickDAQ\Data\QuickDAQ Data-1.hpf
181328 MB available disk space
Enable Continuous Acquisition
Acquisition Duration
00:00:00:10
dd:hh:mm:ss
X Axis Span
00:00:00:10
dd:hh:mm:ss
Press the Record button to start recording data to disk.
Notes
Acquisition info
Sample rate: 1000 Hz
Sample interval: .001 Sec
Number of scans: 10000
Plot and Data Config
Channel Name
Plot Column
Signal Group
DT9839(00)...
Actions
Channel Plot
Channel Display
Control
Style
Plotting performance
Plot update rate
update per second
Smooth scrolling
Disable plotting during acquisition
Time domain X axis units
Sample number
Relative time
Absolute time
24 Hour
12 Hour
Display Day
Plot height
Channel Plot
Channel Display
Statistics
Test Data
V
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
00:00:01.000
00:00:01.999
00:00:03.000
00:00:04.000
00:00:05.000
00:00:06.000
00:00:07.000
00:00:08.000
00:00:09.000
DT9839(00).Ain 0
Acquisition Status
Idle

Perform an Acceleration Measurement

The following steps describe how to use the QuickDAQ application to configure an acceleration measurement.

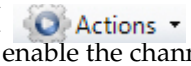
This example uses a triaxial MEMS accelerometer (ADXL335) connected to analog input channels 0, 1, and 2 of a DT9839 module to measure gravity when the accelerometer is moved.

In this example, the accelerometer is wired to the module as follows:

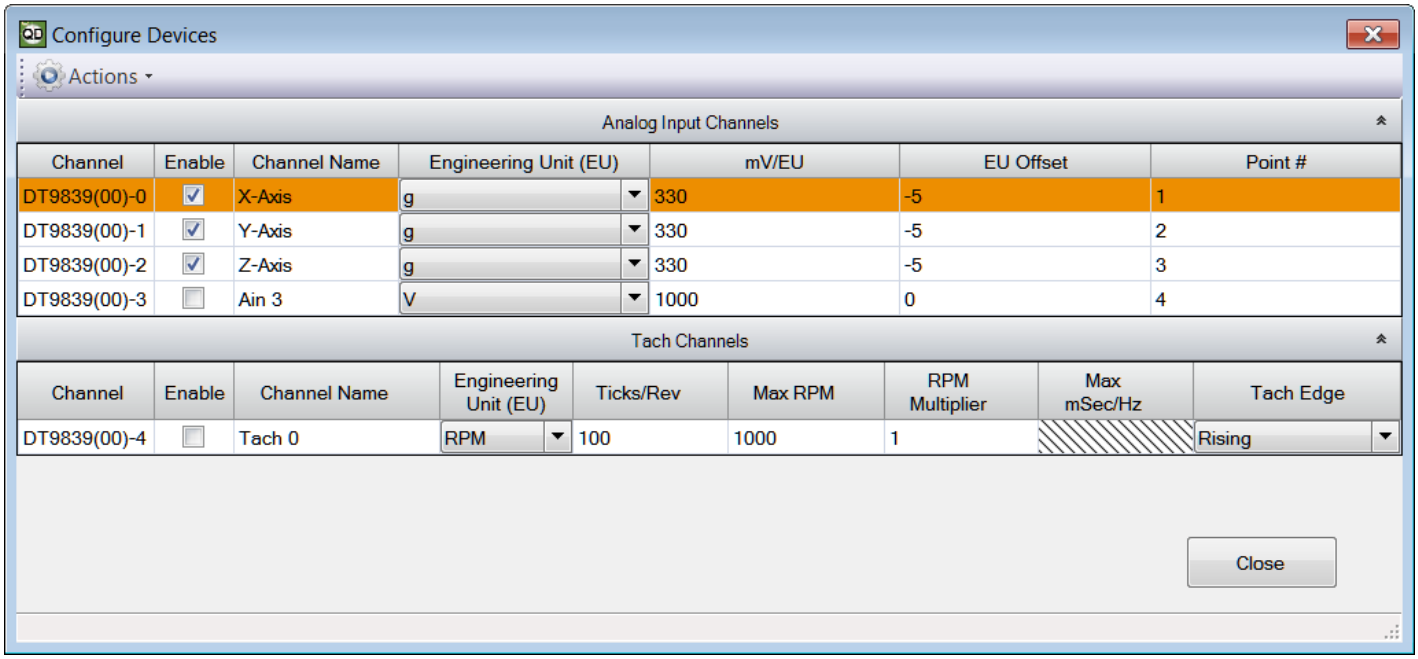
- The x-axis for the accelerometer is wired to TB2, screw 3 (DC IN 0) on the module.
- The y-axis for the accelerometer is wired to TB2, screw 7 (DC IN 1) on the module.
- The z-axis for the accelerometer is wired to TB2, screw 11 (DC IN 2) on the module.
- Power (Vcc) for the accelerometer is connected to TB2, screw 17 (+5 V OUT) on the module.
- Ground (GND) for the accelerometer is connected to TB2, screw 18 on the module (+5 V RTN).

Configure the Channels

Configure the channels as follows:

1. Ensure that the accelerometer is connected to your data acquisition device. For a triaxial accelerometer, each axis should be connected to a unique analog input channel.
   In this example, the x-axis connector is attached to analog input channel 0, the y-axis connector is attached to analog input channel 1, and the z-axis connector is attached to analog input channel 2 of a DT9839 module.
2. Configure each 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 channels 0, 1, and 2 at once by highlighting these analog input channels, clicking the **multi-channel Actions** button (

 ), and clicking **Enable all Selected Channels**. Alternatively, you can enable the channels by clicking the **Enable** checkbox for each of these channels.
   In this example, analog input channels 0, 1, and 2 are enabled.



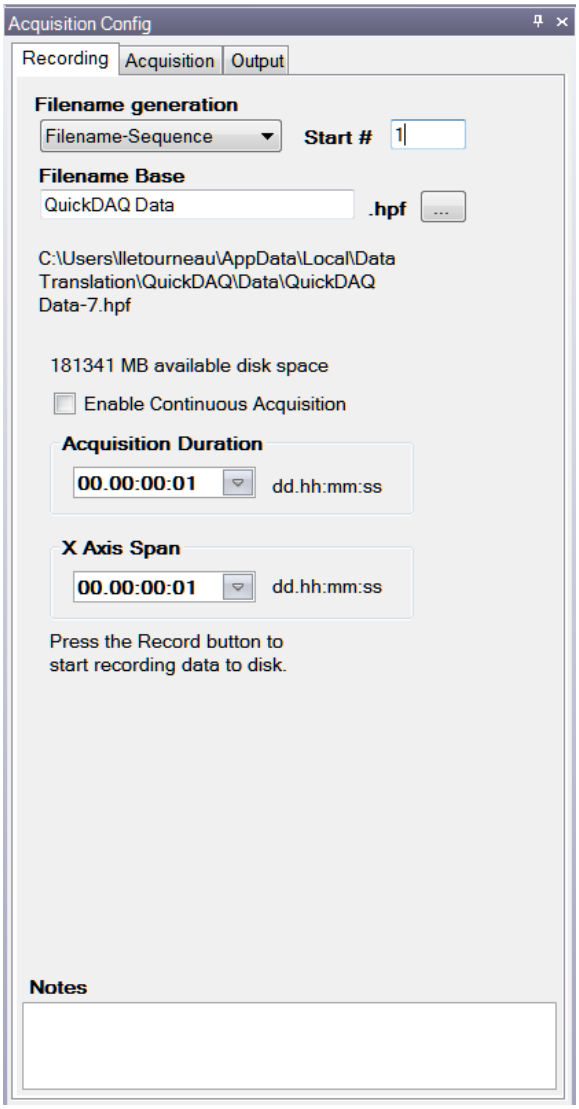
4. Under the **Channel Name** column, enter the following names for the analog input channels:
   - For analog input channel 0, enter **X-Axis**.
   - For analog input channel 1, enter **Y-Axis**.
   - For analog input channel 2, enter **Z-Axis**.
5. Under the **Engineering Units** column, select the engineering units for the accelerometer.
   *In this example, **g** is used.*
6. Enter the calibrated sensitivity for the axis that is connected to the selected analog input channel in the **mV/EU** field.
   In this example, an ADXL335 accelerometer is used, which has a sensitivity of 330 mV/EU.
7. Enter an offset for the accelerometer in the **EU Offset** field, if desired.
   In this example, -5 is used so that the ADXL335 accelerometer displays 0 g for the X- and Y-axes and 1 g for the Z-axis when the accelerometer is lying flat on the table. To determine the offset value, you need to equate the accelerometer's output of 1.65 V (the output of the accelerometer when it is lying flat on the table) to 0 g by dividing 1.65 V by the sensitivity of the accelerometer, 0.33 V/g; this yields 5 g. To subtract this offset value from the final measurement, specify the offset value as -5 g. For more precise zeroing, you can measure the output of the X-, Y-, and Z-axes with the accelerometer lying flat on the table, and adjust the EU offset value as desired. For example, if your configuration produces 1.7 V for the X-axis, set the offset value to -5.15 g (1.7 V divided by 0.33 V/g).

8. If desired, enter a test point value for each channel. In this example, the following values are used:
   - Analog input channel 0 (X-Axis) = 1
   - Analog input channel 1 (Y-Axis) = 2
   - Analog input channel 2 (Z-Axis) = 3
9. 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.

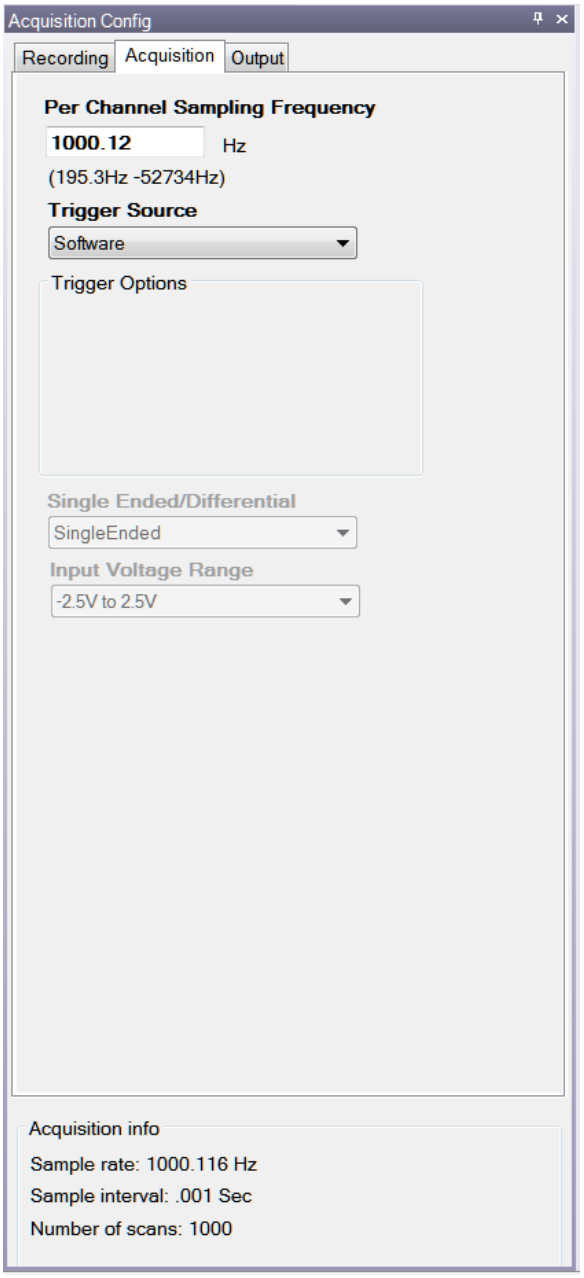


2. For **Filename generation**, use the default **Filename** option.
3. For **Filename**, use the default name for the data file.
4. Leave the **Enable Continuous Acquisition** checkbox unchecked.
5. For **Acquisition Duration**, select **1 second**.
   The number of seconds for the total run and the 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:

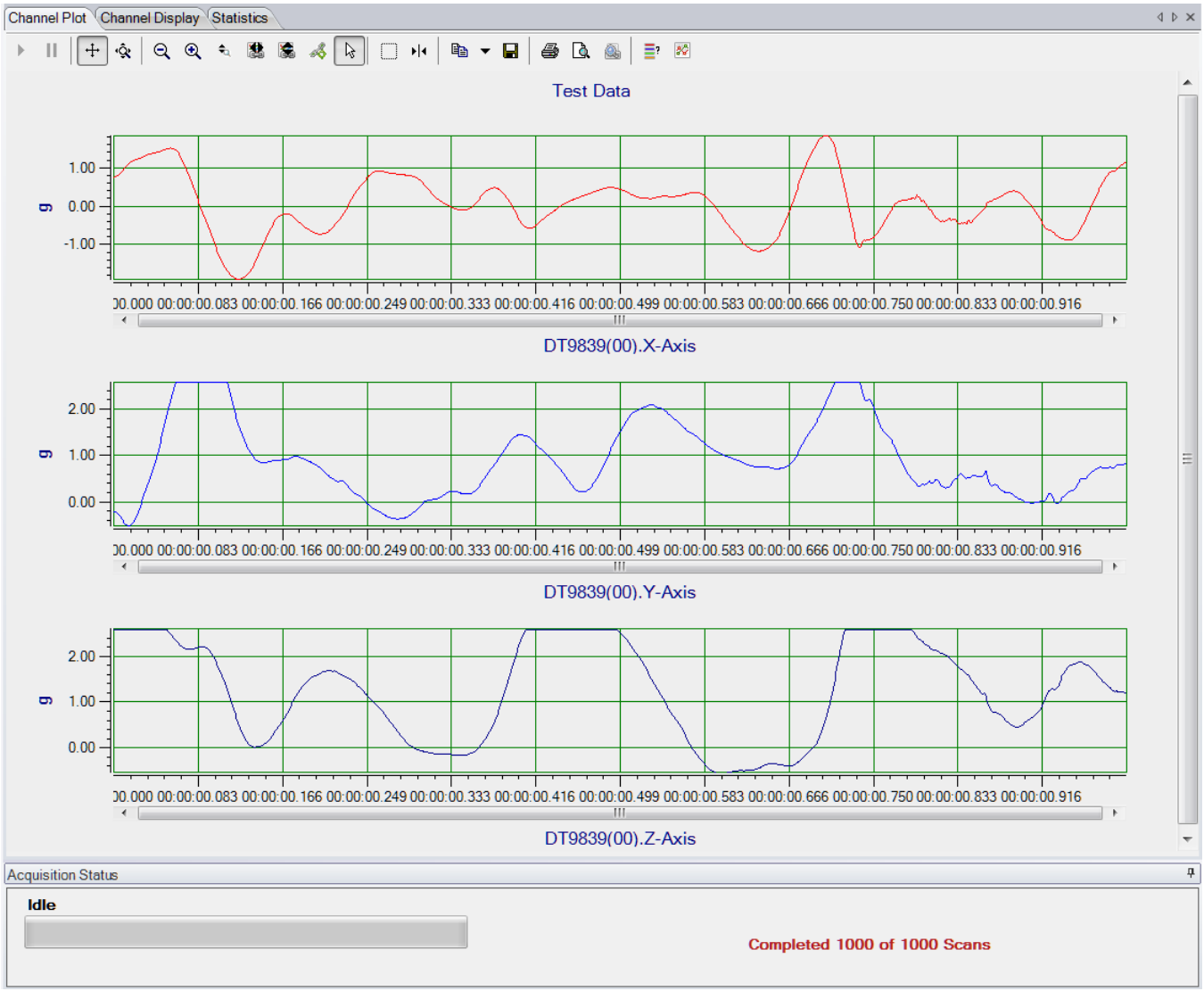
1. Click the **Acquisition** tab of the Acquisition Config window.



2. For the **Per Channel Sampling Frequency** text box, enter **1000**.
   The application snaps to the closest value. 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 Acceleration Measurement

Once you have configured the channels and the parameters for the Channel Plot window, start acquisition and log data to disk by clicking the **Record** toolbar button (Record).
Results similar to the following are displayed in the Channel Plot window.



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

Part 2: Using Your Module

Principles of Operation

Figure 13 shows a block diagram of the DT9839 module.

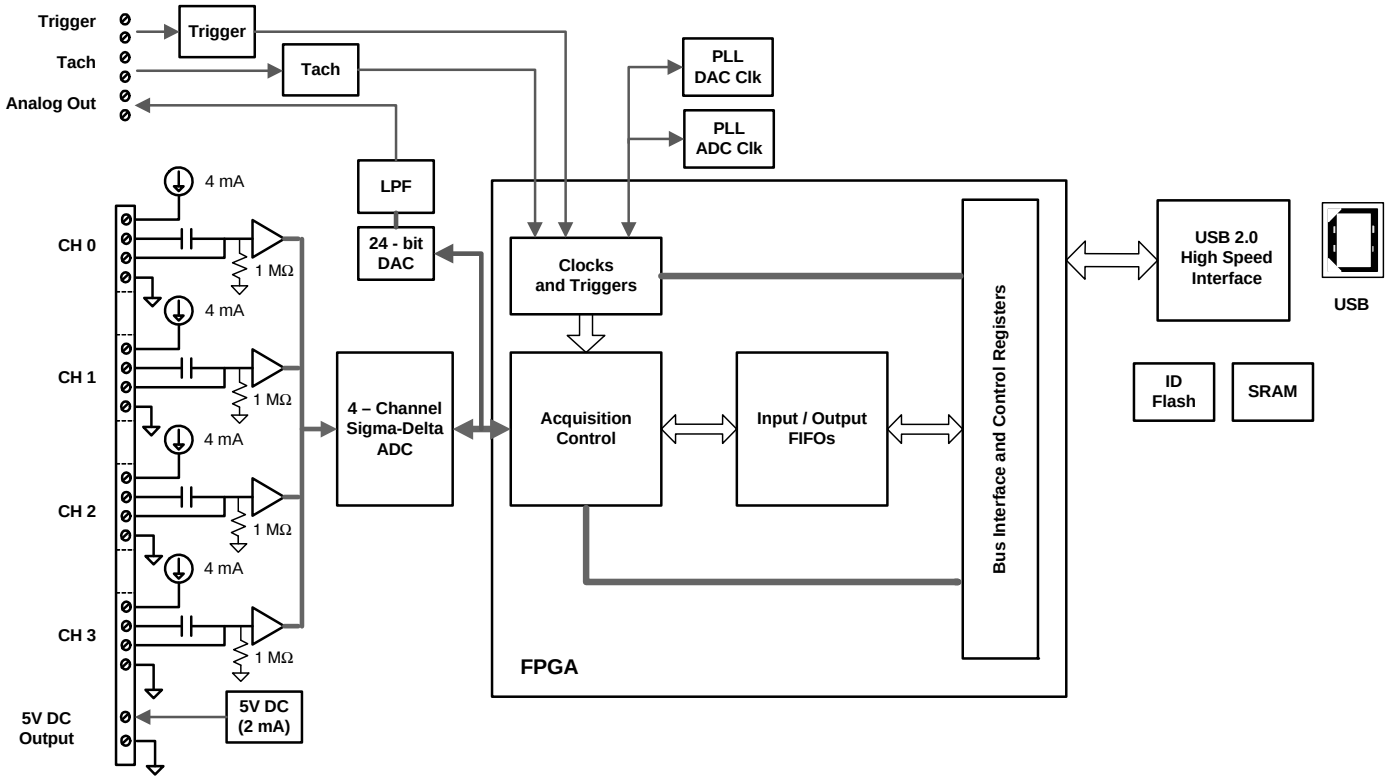


Figure 13: Block Diagram of the DT9839 Module

Analog Input Features

This section describes the following features of analog input (A/D) subsystem on the DT9839 module:

- Analog input channels, described on this page
- IEPE functions, described on page 56
- Input resolution, described on page 56
- Input ranges and gains, described on page 56
- Input sample clock sources, described on page 56
- Analog input conversion modes, described on page 57
- Input triggers, described on page 60
- Data format and transfer, described on page 61
- Error conditions, described on page 62

Analog Input Channels

The DT9839 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 56 for more information on IEPE functions.

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

The DT9839 module uses a four-channel simultaneous sampling 16-bit Delta-Sigma analog-to-digital converter (ADC) that provides anti-aliasing filters based on the clock rate. This filter removes *aliasing*, which is a condition where high frequency input components erroneously appear as lower frequencies after sampling.

DT9839 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 tachometer channel through the analog input channel list., as described below.

Specifying the Tachometer Channel in the Analog Input Channel List

You can read the value of the 32-bit tachometer input on the DT9839 module using the analog input channel list.

You need two channel list entries to read one 32-bit value. Specify channel 4 in the analog input channel list to read the lower 16-bit word; specify channel 5 in the analog input channel list to read the upper 16-bit word. You must specify both channel list entries if you include the tachometer channel.

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

Refer to "Continuous Scan Mode" on page 58 for more information on specifying and reading data from the tachometer channel.

Input Ranges and Gains

The DT9839 module provides a nominal input range of ±2.5 V with a gain of 1. The specified range is from –2.5 V (±1 m V) to +2.5 V (±1 mV).

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 DT9839 module. The module supports the following IEPE functions for each of the four analog inputs:

- Excitation current source – You configure whether a 4 mA internal excitation current source is used by how the IEPE input is wired. See page 34 for wiring information.
- Coupling type – You configure whether AC coupling or DC coupling is used by how the input is wired. See page 34 for wiring information.

Note: It is recommended that you configure the input for AC coupling when using an IEPE sensor.

Input Resolution

The resolution of the analog input channels is fixed at 16 bits; you cannot specify the resolution in software.

Input Clock Source

DT9839 modules support an internal clock, which is derived from a 48 MHz reference clock.

Use software to specify the internal clock source and the frequency at which to pace the input operations and to start the sample clock. The sampling frequency ranges from 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 modules support a –3 dB bandwidth of 0.49 x sampling frequency for a maximum bandwidth of 25.8 kHz.

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

DT9839 modules use a Delta-Sigma ADC, which operates from a clock frequency of 512 times the output sample rate. 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.

The Delta-Sigma ADC has a group delay of 38 conversions, which means that there is a time delay of 38 sample periods from the analog input signal to the output data. The group delay of the ADC is accounted for internally so that the sampled data is aligned with the selected trigger signal. The internal filters of the ADC have a settling time of 76 samples. Therefore, when a step change is applied to one of the inputs, the output data is guaranteed to be fully settled by 76 sample periods.

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

DT9839 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) that you want to use and the corresponding gain for each channel (1 for the DT9839 module). The module acquires the data from the specified channel and returns the data immediately.

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

Note: You cannot read the value of tachometer counter 0 (described on page 67) using a standard single-value operation. To read this value, specify the channel as part of the analog input channel list using continuous scan mode, described on page 58.

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: A single values operation returns values from analog input channels 0 to 3. Use continuous scan mode, described next, to read valid data from the tachometer counter.

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 DT9839 module. You can specify a channel list, clock source, start trigger, reference trigger, post-trigger scan count, and buffer using software.

You can enter up to six entries in the channel list, including four analog input channels (A/D channels 0 through 3), and the tachometer counter 0 (A/D channel 4 and 5), as described on page 55. 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 60 for more information about triggers.

The conversion rate is determined by the frequency of the input sample clock; refer to page 56 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 56)
- Specify the start trigger (refer to page 60)
- Specify the reference trigger (refer to page 61).
- Specify the post-trigger scan count (the number of post-trigger samples to acquire after the reference trigger occurs).

Figure 14 illustrates continuous scan mode (using a start and reference trigger) with a channel list of three entries: channel 0 through channel 2. In this example, pre-trigger 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.

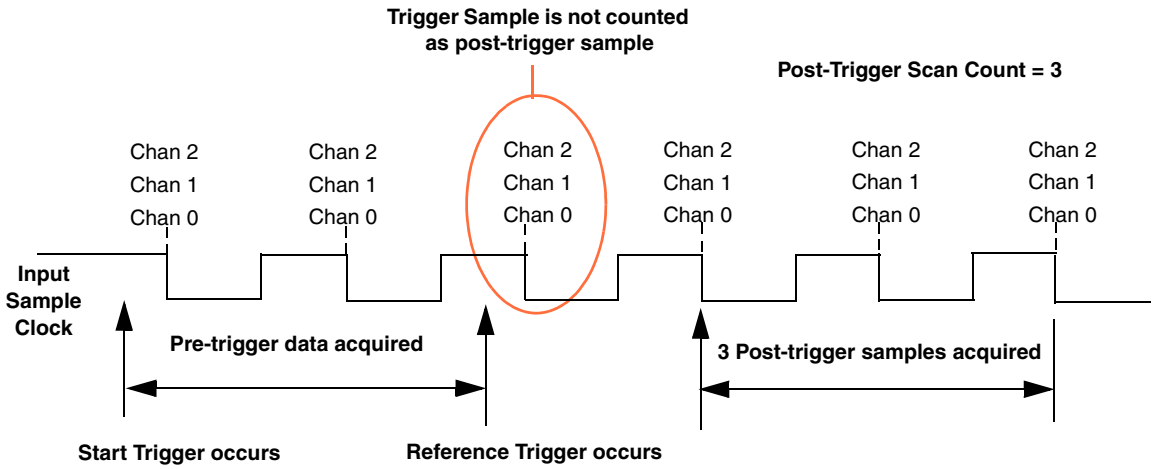


Figure 14: Continuous Scan Mode on a DT9839 Module Using a Start and Reference Trigger

Input Triggers

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

On the DT9839 module, you can specify a start trigger source and a reference trigger source. Pre-trigger data acquisition starts when the start trigger event occurs. When the reference trigger event occurs, pre-trigger data acquisition stops and post-trigger acquisition starts. Post-trigger acquisition stops when the number of samples you specify for the post-trigger scan count has been reached. Refer to page 58 for more information.

Start Trigger Sources

DT9839 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 transition on the signal connected to the Ext Trig screw terminal on the module. Using software, you can specify whether the rising-edge or falling-edge is used as the active edge. The threshold is fixed at 1.25 V.
- **Threshold trigger** – The start trigger event occurs when the signal attached to a specified analog input channel in the channel list rises above or falls below a user-specified threshold value. Using software, specify the following parameters:
  - Start trigger source – Specify a positive (low-to-high transition) threshold trigger if you want to trigger when the signal rises above a threshold level, or a negative (high-to-low transition) threshold trigger if you want to trigger when the signal falls below a threshold level.
  - Threshold channel – Specify any one of the analog input channels that are included in the channel list as the threshold input channel.
  - Threshold level – Specify a value between ±2.4 V as the threshold level.

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

Reference Trigger Sources

DT9839 modules support the following trigger sources for the reference trigger:

- **External digital (TTL) trigger** – An external digital (TTL) trigger event occurs when the module detects a transition on the signal connected to the Ext Trig screw terminal on the module. Using software, you can specify whether the rising-edge or falling-edge is used as the active edge. The threshold is fixed at 1.25 V.
- **Threshold trigger** – The reference trigger event occurs when the signal attached to a specified analog input channel in the channel list rises above or falls below a user-specified threshold value. Using software, specify the following parameters:
  - Reference trigger source – Specify a positive (low-to-high transition) threshold trigger if you want to trigger when the signal rises above a threshold level, or a negative (high-to-low transition) threshold trigger if you want to trigger when the signal falls below a threshold level.
  - Threshold channel – Specify any one of the analog input channels that are included in the channel list as the threshold input channel.
  - Threshold level – Specify a value between ±2.4 V as the threshold level.

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

Data Format and Transfer

DT9839 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

DT9839 modules report any overrun errors by sending an overrun event to the application program. This event indicates that data buffers are not being sent from the module to the host fast enough, and the A/D converter ran out of buffers. To avoid this error, try one or more of the following:

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

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

Analog Output Features

This section describes the following features of analog output operations:

- Analog output channels, described below
- Output ranges and gains, described below
- Output resolution, described on page 63
- Output conversion mode, described on page 64
- Output clocks, described on page 63
- Output triggers, described on page 66
- Data format and transfer, described on page 66
- Error conditions, described on page 66

Analog Output Channels

DT9839 modules support one analog output channel through analog output subsystem 0.

The DT9839 module uses a two-pole, low-pass, 75 kHz Butterworth filter to filter the DAC output and provide a flat frequency response.

The analog output channel powers up to a value of 0 ±10 mV.

Output Ranges and Gains

DT9839 modules output bipolar analog output signals in the range of ±2.5 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 (DAC sampling clock) on the DT9839 module is derived from a 48 MHz clock.

You can program the clock frequency to a value between 10 kHz and 96 kHz. Use software to specify an internal clock source and to specify the clock frequency for the analog output subsystem.

Due to the group delay of the Delta-Sigma D/A converter, the DT9839 module requires 29 sample periods once the analog output sample clock is started before the first D/A conversion is completed.

Output Conversion Modes

DT9839 modules support single-value, continuous, and waveform analog output operations. This section describes each of these conversion modes.

Single-Value Mode

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

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

Waveform Generation Mode

In waveform generation mode, a waveform, which is specified in a single buffer, is output repetitively. You can allocate a buffer of any size, and then fill the buffer with the waveform that you want to output.

Note: The output FIFO on the DT9839 module can hold up to 8192 samples at a time. The driver manages how the data from the user buffer is written to the output FIFO.

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 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 63 for more information about the clock source and frequency.
- Specify a software trigger source, described in the next section

The hardware on the DT9839 module supports the ability to mute the output voltage to 0 V. Muting the output does not stop the analog output operation; instead, the analog output voltage is reduced to 0 V over 1020 samples. Similarly, you can restore the output signal to its unattenuated level over a time period of 1020 samples by unmuting the output. Refer to your software documentation for more information on muting and unmuting the output voltage.

Continuous Analog Output Operations

Use continuously paced analog output mode to continuously output buffered values to the analog output channel at a specified clock frequency. You can start continuous analog output operations and continuous analog input operations simultaneously.

Use software to fill multiple output buffers with the values that you want to write to the analog output channel. When it detects the specified trigger, the module starts writing the values from the output buffer to the analog output channel at the specified clock frequency. The operation repeats continuously until either all the data is output from the buffers or you stop the operation.

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

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

- Specify the data flow as Continuous
- Specify WrapSingleBuffer as False to use multiple buffers
- Specify the clock source as internal and specify the clock frequency. Refer to page 63 for more information about the clock source and frequency.
- Specify the trigger source as any of the supported trigger sources. Refer to page 66 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 hardware on the DT9839 module supports the ability to mute the output voltage to 0 V. Muting the output does not stop the analog output operation; instead, the analog output voltage is reduced to 0 V over 1020 samples. Similarly, you can restore the output signal to its unattenuated level over a time period of 1020 samples by unmuting the output. Refer to your software documentation for more information on muting and unmuting the output voltage.

To stop a continuously paced analog output operation, you can stop queuing buffers for the analog output system, letting the module stop when it runs out of data, or you can perform either an orderly stop or an abrupt stop using software. In an orderly stop, the module finishes outputting the specified number of samples, and then stops; all subsequent triggers are ignored. In an abrupt stop, the module stops outputting samples immediately; all subsequent triggers are ignored.

Output Trigger

DT9839 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** – An external digital (TTL) trigger event occurs when the module detects a transition on the signal connected to the Ext Trig screw terminal on the module. Using software, you can specify whether the rising-edge or falling-edge is used as the active edge. The threshold is fixed at 1.25 V.

Data Format and Transfer

Data from the host computer must use offset binary data encoding for analog output signals, where 000000 represents –2.5 V, and FFFFFFh represents +2.5 V. Using software, specify the data encoding as binary.

Error Conditions

DT9839 modules report any underrun errors by sending an underrun event to the application. This event indicates that the data buffers are not being sent from the host to the module fast enough, and the D/A converter ran out of data. To avoid this error, try one or more of the following:

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

Tachometer Input Features

You can connect a tachometer signal with a range of ±30 V to the DT9839 module. This signal has 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 measure the frequency or period of the tachometer input signal using tachometer counter 0. You can use frequency or period measurements to calculate the rotation speed for high-level (±30 V) tachometer input signals. An internal 12 MHz counter is used for the measurement, yielding a resolution of 83 ns (1/12 MHz).

You can read the number of counts between two consecutive starting edges of the tachometer input signal by including channels 4 and 5 in the analog input channel list. Refer to page 55 for more information about specifying channels.

You can specify the following parameters for the tachometer using software:

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

When the operation is started, the internal 12 MHz counter starts incrementing when it detects the first starting edge of the tachometer input and stops incrementing when it detects the next starting edge of the tachometer input. When the measurement is complete, the counter/timer remains idle until it is 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.

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 1: 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 41, the measured frequency is 300 kHz (12 MHz/40).
- 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

Triggering Acquisition on Multiple Modules

The internal clock on the DT9839 module 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 15. 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.

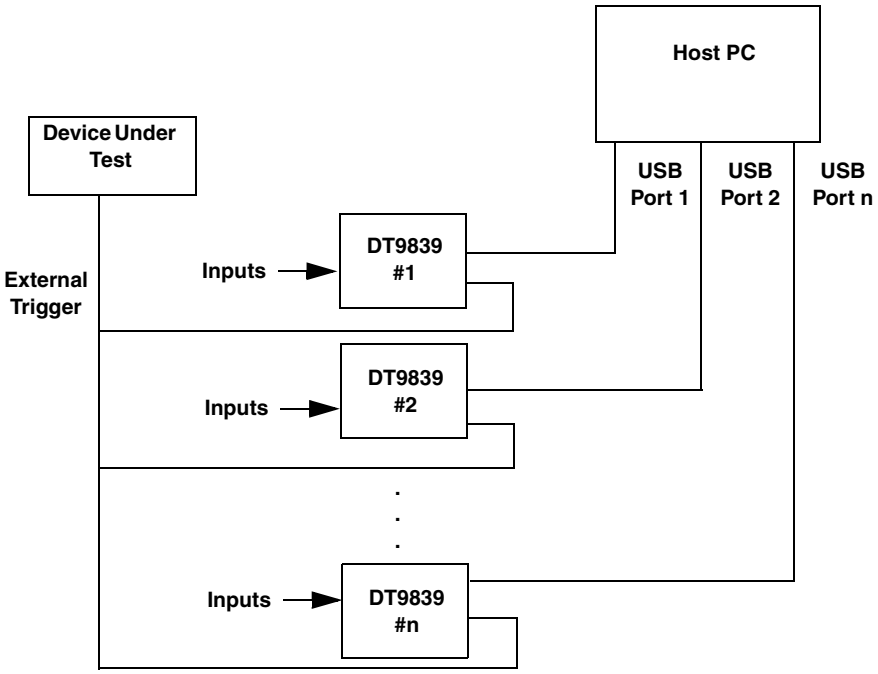


Figure 15: Triggering Multiple Modules Using an External Trigger Source

Supported Device Driver Capabilities

The DT9839 Series Device Driver provides support for the analog input (A/D) and analog output (D/A) subsystems. For information on how to configure the device drivers, refer to page 29.

Table 2: Subsystems on the DT9839

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Total Subsystems on Module	1	1	0	0	0	1	0

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the DT9839 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: The following tables include the capabilities that can be queried. However, some capabilities may not be supported by your device. Blank fields represent unsupported options.

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

Data Flow and Operation Options

Table 3: Data Flow and Operation Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Single-Value Operation Support **SupportsSingleValue**	Yes	Yes					
Simultaneous Single-Value Output Operations **SupportsSetSingleValues**							
Continuous Operation Support **SupportsContinuous**	Yes	Yes					
Continuous Operation until Trigger **SupportsContinuousPreTrigger**							
Continuous Operation before & after Trigger **SupportsContinuousPrePostTrigger**							
Waveform Operations Using FIFO Only **SupportsWaveformModeOnly**		Yes					
Simultaneous Start List Support **SupportsSimultaneousStart**	Yes	Yes					
Supports Programmable Synchronization Modes **SupportsSynchronization**							
Synchronization Modes **SynchronizationMode**							
Interrupt Support **SupportsInterruptOnChange**							
FIFO Size, in Samples **FifoSize**	2048	8192					
Muting and Unmuting the Output Voltage **SupportsMute**		Yes					
Auto-Calibrate Support **SupportsAutoCalibrate**							

Buffering

Table 4: Buffering Options

DT9839	A/D	D/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						

Triggered Scan Mode

Table 5: Triggered Scan Mode Options

DT9839	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	
Maximum Retrigger Frequency **MaxRetriggerFreq**	0	0				0	
Minimum Retrigger Frequency **MinRetriggerFreq**	0	0				0	

Data Encoding

Table 6: Data Encoding Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Binary Encoding Support **SupportsBinaryEncoding**	Yes	Yes					
Twos Complement Support **SupportsTwosCompEncoding**							
Returns Floating-Point Values **ReturnsFloats**							

Channels

Table 7: Channel Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Number of Channels **NumberOfChannels**	6[a]	1				1	
SE Support **SupportsSingleEnded**	Yes	Yes					
SE Channels **MaxSingleEndedChannels**	4	1				1	
DI Support **SupportsDifferential**							
DI Channels **MaxDifferentialChannels**	0	0				0	
Maximum Channel-Gain List Depth **CGLDepth**	6[a]	1				0	
Simultaneous Sample-and-Hold Support **SupportsSimultaneousSampleHold**	Yes						
Channel-List Inhibit **SupportsChannelListInhibit**							
Support MultiSensor Inputs **SupportsMultiSensor**							
Bias Return Termination Resistor Support **SupportsInputTermination**							

a. Channels 0 to 3 correspond to the analog input channels, channel 4 corresponds to the lower 16-bit word of tachometer counter 0, and channel 5 corresponds to the upper 16-bit word of tachometer counter 0.

Gain

Table 8: Gain Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Programmable Gain Support **SupportsProgrammableGain**	Yes						
Number of Gains **NumberOfSupportedGains**	1	1				0	
Gains Available **SupportedGains**	1	1					

Ranges

Table 9: Range Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Number of Voltage Ranges **NumberOfRanges**	1	1				0	
Available Ranges **SupportedVoltageRanges**	±2.5 V [a]	±2.5V					

a. The nominal range is ±2.5 V. The specified range is from –2.5 V (±1 m V) to +2.5 V (±1 mV).

Resolution

Table 10: Resolution Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Software Programmable Resolution **SupportsSoftwareResolution**							
Number of Resolutions **NumberOfResolutions**	1	1				0	
Available Resolutions **SupportedResolutions**	16	24				0	

Current and Resistance Support

Table 11: Current and Resistance Support Options

DT9838	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Current Support **SupportsCurrent**							
Current Output Support **SupportsCurrentOutput**							
Resistance Support **SupportsResistance**							
Software Programmable External Excitation Current Source for Resistance **SupportsExternalExcitationCurrentSrc**							
Software Programmable Internal Excitation Current Source **SupportsInternalExcitationCurrentSrc**							
Available Excitation Current Source Values **SupportedExcitationCurrentValues**							

Thermocouple, RTD, and Thermistor Support

Table 12: Thermocouple, RTD, and Thermistor Support Options

DT9839	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 13: IEPE Support Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
IEPE Support **SupportsIEPE**	Yes						
Software Programmable AC Coupling **SupportsACCoupling**							
Software Programmable DC Coupling **SupportsDCCoupling**	Yes[a]						
Software Programmable External Excitation Current Source **SupportsExternalExcitationCurrentSrc**							
Software Programmable Internal Excitation Current Source **SupportsInternalExcitationCurrentSrc**							
Available Excitation Current Source Values **SupportedExcitationCurrentValues**							

a. DT9839 modules do not support AC coupling and DC coupling through software. Instead, AC or DC coupling type on these modules is determined by how the input signal is wired. Refer to page 34 for more information.

Bridge and Strain Gage Support

Table 14: Strain Gage Support Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Bridge Support **SupportsBridge**							
Supported Bridge Configurations **BridgeConfiguration**							
Strain Gage Support **SupportsStrainGage**							
Supported Strain Gage Bridge Configurations **StrainGageBridgeConfiguration**							
External Excitation Voltage **SupportsExternalExcitationVoltage**							
Internal Excitation Voltage **SupportsInternalExcitationVoltage**							
Shunt Calibration **SupportsShuntCalibration**							
Voltage Excitation Per Channel **SupportedPerChannelVoltageExcitation**							
Minimum Excitation Voltage **MinExcitationVoltage**							
Maximum Excitation Voltage **MaxExcitationVoltage**							

Start Triggers

Table 15: Start Trigger Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Software Trigger Support **SupportsSoftwareTrigger**	Yes[a]	Yes					
External Positive TTL Trigger Support **SupportsPosExternalTTLTrigger**	Yes[a]	Yes					
External Negative TTL Trigger Support **SupportsNegExternalTTLTrigger**	Yes[a]	Yes					
External Positive TTL Trigger Support for Single-Value Operations **SupportsSvPosExternalTTLTrigger**							
External Negative TTL Trigger Support for Single-Value Operations **SupportsSvNegExternalTTLTrigger**							
Positive Threshold Trigger Support **SupportsPosThresholdTrigger**	Yes[a,b]						
Negative Threshold Trigger Support **SupportsNegThresholdTrigger**	Yes[a,b]						
Digital Event Trigger Support **SupportsDigitalEventTrigger**							
Threshold Trigger Channel **SupportedThresholdTriggerChannel**	0, 1, 2, or 3						

a. The start trigger is also used for the tachometer input channel if the tachometer channel (channel 4) is included in the analog input channel list.

b. If you choose a threshold trigger for the start trigger, you can program the threshold level as a value between ±2.4 V, and any of the supported analog input channels can be used as the threshold channel.

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

Reference Triggers

Table 16: Reference Trigger Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
External Positive TTL Trigger Support **SupportsPosExternalTTLTrigger**	Yes[a]						
External Negative TTL Trigger Support **SupportsNegExternalTTLTrigger**	Yes[a]						
Positive Threshold Trigger Support **SupportsPosThresholdTrigger**	Yes[a,b]						
Negative Threshold Trigger Support **SupportsNegThresholdTrigger**	Yes[a,b]						
Digital Event Trigger Support **SupportsDigitalEventTrigger**							
Sync Bus Support **SupportsSyncBusTrigger**							
Analog Input Channels Supported for the Threshold Trigger **SupportedThresholdTriggerChannels**	0, 1, 2, 3						
Post-Trigger Scan Count Support **SupportsPostTriggerScanCount**	Yes[c]						

a. The reference trigger is also used for the tachometer input channel if the tachometer channel (channel 4) is included in the analog input channel list.

b. if you choose a threshold trigger as a reference trigger, you can program the threshold level as a value between ±2.4 V, and any of the supported analog input channels can be used as the threshold channel.

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

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

Clocks

Table 17: Clock Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Internal Clock Support **SupportsInternalClock**	Yes	Yes					
External Clock Support **SupportsExternalClock**							
Simultaneous Input/Output on a Single Clock Signal **SupportsSimultaneousClocking**	Yes						
Base Clock Frequency **BaseClockFrequency**	27 MHz[a]	48 MHz				12 MHz	
Maximum Clock Divider **MaxExtClockDivider**	1.0	1.0					
Minimum Clock Divider **MinExtClockDivider**	1.0	1.0					
Maximum Frequency **MaxFrequency**	52.734 kHz	96 kHz				380 kHz	
Minimum Frequency **MinFrequency**	195.3 Hz	10 kHz					

a. DT9839 modules support an internal clock, which is derived from a 48 MHz reference clock.

DT9839 modules use a Delta-Sigma ADC, which operates from a clock frequency of 512 times the output sample rate. 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.

Counter/Timers

Table 18: Counter/Timer Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Cascading Support **SupportsCascading**							
Event Count Mode Support **SupportsCount**							
Generate Rate Mode Support **SupportsRateGenerate**							
One-Shot Mode Support **SupportsOneShot**							
Repetitive One-Shot Mode Support **SupportsOneShotRepeat**							
Up/Down Counting Mode Support **SupportsUpDown**							
Edge-to-Edge Measurement Mode Support **SupportsMeasure**							
Continuous Edge-to-Edge Measurement Mode Support **SupportsContinuousMeasure**							
High to Low Output Pulse Support **SupportsHighToLowPulse**							
Low to High Output Pulse Support **SupportsLowToHighPulse**							
Variable Pulse Width Support **SupportsVariablePulseWidth**							
None (internal) Gate Type Support **SupportsGateNone**							
High Level Gate Type Support **SupportsGateHighLevel**							
Low Level Gate Type Support **SupportsGateLowLevel**							
High Edge Gate Type Support **SupportsGateHighEdge**							
Low Edge Gate Type Support **SupportsGateLowEdge**							
Level Change Gate Type Support **SupportsGateLevel**							
Clock-Falling Edge Type **SupportsClockFalling**							
Clock-Rising Edge Type **SupportsClockRising**							
Gate-Falling Edge Type **SupportsGateFalling**							
Gate-Rising Edge Type **SupportsGateRising**							
Interrupt-Driven Operations **SupportsInterrupt**							

Tachometers

Table 19: Tachometer Options

DT9839	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Tachometer Falling Edges **SupportsFallingEdge**						Yes	
Tachometer Rising Edges **SupportsRisingEdge**						Yes	
Tachometer Stale Data Flag **SupportsStaleDataFlag**						Yes	

Troubleshooting

General Checklist

Should you experience problems using a DT9839 module, do the following:

1. Read all the documentation provided for your product, including any "Read This First" information.
2. Check the OMNI CD for any README files and ensure that you have used the latest installation and configuration information available.
3. Check that your system meets the requirements stated on page 24.
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 20 to isolate and solve the problem. If you cannot identify the problem, refer to page 88.

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 2.
	The module is damaged.	Contact Data Translation for technical support; refer to page 88.
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 105 of this manual and the documentation provided by your computer manufacturer for more information.
	Electrical noise exists.	Check your wiring and either provide better shielding or reroute unshielded wiring; see the instructions in Chapter 3.

Table 20: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Device failure error reported	The DT9839 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 DT9839 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.	DT9839 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 DT9839 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

Calibration

Using the Calibration Utility

DT9839 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 DT9839 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.

To start the DT9839 Calibration Utility, do the following:

1. Click **Start** from the Task Bar.
2. Select **Programs | Data Translation, Inc | Calibration | DT9839 Calibration Utility.** *The main window of the DT9839 Calibration Utility appears.*
3. Select the module to calibrate, and then click **OK**.

Once the calibration utility is running, you can calibrate the analog input circuitry (either automatically or manually), described on page 93, or the analog output circuitry of the module, described on page 95.

Calibrating the Analog Input Subsystem

This section describes how to use the calibration utility to calibrate the analog input subsystem of a DT9839 module.

Connecting a Precision Voltage Source

To calibrate the analog input circuitry, you need to connect an external precision voltage source to the DT9839 module. Connect the precision voltage source to the DC input of the first channel that you want to calibrate, as shown in Figure 16.

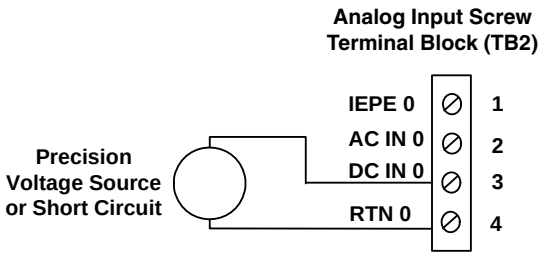


Figure 16: Connecting a Precision Voltage Source to Calibrate the Analog Input Circuitry (Shown for Channel 0)

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, that you want to use with the module. Valid sampling frequencies range from 195.3 Hz to 52734 Hz.
3. Under the **Automatic Offset Calibration** area of the window, select the channel whose offset 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. The DC input may also be shorted to RTN signal for the channel to create a 0.000 V input.
4. Verify that the supplied voltage to your selected channel is 0.000 V, and then click **OK**.
   The offset value is calibrated for the selected channel.
5. Repeat steps 3 and 4 for each analog input channel on the module.
6. Under the **Automatic Reference Calibration** area of the window, select all the channels that you want to calibrate, and then click the **Start** button.
   A message appears notifying you to verify that 2.4 V is applied to each of the selected channel.
7. Verify that the supplied voltage to your selected channels is 2.400 V, and then click **OK**.
   The average voltage values for all the selected channels is used to calibrate the reference value.

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, that you want to use with the module. Valid sampling frequencies range from 195.3 Hz to 52734 Hz.
3. Under the **Manual Calibration** area of the window, select the channel that you want to calibrate.
4. Short the DC input to the RTN signal of the channel that you want to calibrate, and click the **Start** button.
   The current voltage reading for this channel is displayed in the AD Value box.
5. Adjust the offset by entering values in the **Offset** edit box or by clicking the up/down buttons until the **AD Value** is 0.0000 V or the closest value to 0.0000 V.
6. Repeat steps 4 and 5 for each analog input channel on the module.
7. Verify that 2.400 V is applied to the selected analog input channel.
   The current voltage reading for this channel is displayed in the AD Value box.
8. Adjust the reference by entering values in the **A/D0-3 Ref** edit box, or by clicking the up/down buttons until the **AD Value** is 2.400 V or the closest value to 2.400 V.

   Note: The value of the **A/D0-3 Ref** edit box precisely calibrates the gain only for the selected analog input channel. The other channels are assured of a gain calibration within 0.1%. As an alternative, the auto-calibration procedure minimizes the average gain error of all selected channels.

9. Click the **Stop** button.

Note: At any time, you can click **Restore Factory Settings** to reset the A/D calibration values to their original factory settings. This process will undo any auto or manual calibration settings.

Once you have finished this procedure, continue with "Calibrating the Analog Output Subsystem."

Calibrating the Analog Output Subsystem

To calibrate the analog output circuitry, connect an external precision voltmeter to analog output channel 0 of the DT9839 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 DT9839 module.
3. In the DAC Output Voltage box, select **0 V**.
4. Adjust the offset by entering values in the **Offset** edit box or by clicking the up/down buttons until the voltmeter reads 0 V ±500 µV.
5. In the DAC Output Voltage box, select **2.4 V**.
6. Adjust the gain by entering values in the **Gain** edit box or by clicking the up/down buttons until the voltmeter reads 2.4 V ±0.001 V.
7. Recheck the offset value of the DAC by selecting **0 V** in the DAC Output Voltage box.
8. If the reading on the voltmeter is within ±500 µV, calibration is complete. If reading on the voltmeter is not within ±500 µV, repeat steps 4 through 8 until the offset is within ±500 µV.

Note: At any time, you can click **Restore Factory Settings** to reset the D/A calibration values to their original factory settings. This process will undo any D/A calibration settings.

Once you have finished this procedure, the analog output circuitry is calibrated. To close the calibration utility, click the close box in the upper right corner of the window.

Specifications

Analog Input Specifications

Table 21 lists the specifications for the analog input subsystem on the DT9839 module.

Table 21: Analog Input Subsystem Specifications

Feature	DT9839 Specifications[a]
Number of analog input channels	4, single-ended
Resolution	16 bits
ADC type	Delta-Sigma, simultaneous sampling
Input range	±2.5 V nominal –2.5 V (±1 m V) to +2.5 V (±1 mV)
Maximum sample rate, per channel	52734 Samples/s
Minimum sample rate, per channel	195.3 Samples/s
Offset error after calibration	±1 LSB (±76 µV)
Gain error after calibration	±0.1%
Group delay	38/sample rate, in s
Settling time	76/sample rate, in s
ADC Sigma Delta 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
Analog Filter[b] Low pass cutoff, –3 dB: High pass cutoff, –3 dB (AC coupling):	 300 kHz 1 Hz
Noise (50 Ω input termination)	1 LSBpp (76 µVpp)
Signal-to-noise and distortion ratio (SINAD) –3 dB FS, 1 kHz sine wave, f_s = 26367 Samples/s[c]:	 91 dB
Effective number of bits (ENOB) –3 dB FS, 1 kHz sine wave, f_s = 26367 Samples/s[c]:	 15.3 bits
Total harmonic distortion (THD) –3 dB FS, 1 kHz sine wave, f_s = 26367 Samples/s[c]:	 –95 dB (0.0018%)
Spurious free dynamic range (SFDR) –3 dB FS, 1 kHz sine wave, f_s = 26367 Samples/s[c]:	 100 dB
Data encoding	Offset binary
Maximum input voltage (without damage)	±20 V
Input impedance DC input to Return AC input to Return	 1 MΩ ‖ 10 pF 0.15 µF in series with DC impedance
IEPE current source	4 mA ±0.1 mA
IEPE compliance voltage	15 V

Table 21: Analog Input Subsystem Specifications (cont.)

Feature	DT9839 Specifications[a]
IEPE current noise density @1 kHz	200 pA / √Hz
5 VDC output	5 VDC ±10% with 1 mA load
5 VDC output current	2 mA maximum
ESD protection Arc: Contact:	 8 kV 4 kV

a. Unless otherwise noted, specifications are typical at 25 ° C.
b. The total frequency response is the combined frequency response of the ADC Sigma Delta filter and the analog filter.
c. f_s = sample frequency.

Typical Performance Characteristics of the DT9839

Figure 17 shows the typical performance characteristics of the DT9839 module using the QuickDAQ application. In this case, data was taken on one analog input channel using a 1 kHz (–3 dB) sine wave input and a sample rate of 52734 Samples/s. As you can see, the total harmonic distortion (THD) is less than 0.002% (–95.45 dB) and the effective number of bits (ENOB) is 15.46 bits with no spurious signals present in the spectrum. The low noise characteristics of the DT9839 allow you to measure very low levels of vibration accurately.

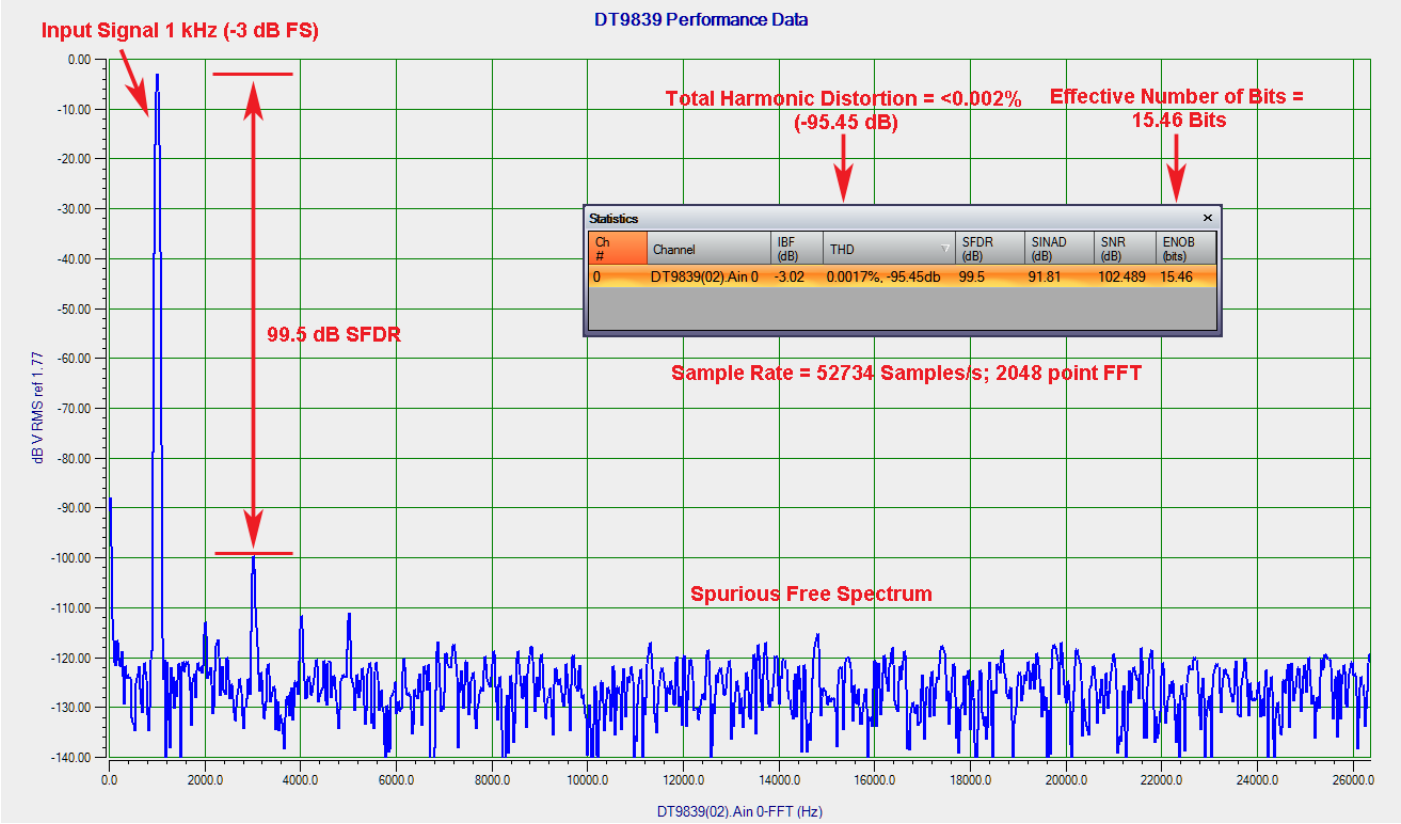


Figure 17: Typical Performance Characteristics of the DT9839 Module

Analog Output Specifications

Table 22 lists the specifications for the analog output subsystem on the DT9839 module.

Table 22: Analog Output Subsystem Specifications

Feature	DT9839 Specifications[a]
Number of analog output channels	1
Resolution	24 bits
Output range	±2.5 Vpk
Output coupling	DC
Data encoding	Offset binary
Output current	±2.5 mA (1 kΩ maximum working load)
Output impedance	10 Ω
Output short circuit	Continuous
FIFO	8192 Samples, total
DC offset after calibration	500 µV
DC gain error after calibration	±0.1%
DAC time delay	29/sample rate, in s
Power fault and reset	Goes to 0 V ±10 mV if the USB cable is removed or the power fails
Total harmonic distortion (THD) (–1 dB FS, 1 kHz, sine wave, f_s = 96 kHz)[b]:	 0.0015% (–96 dB)
Internal clock	sample frequency x 512, Hz
Minimum sample frequency	10 kHz
Maximum sample frequency	96 kHz
DAC Sigma Delta Filter[c] Passband, –3 dB: Passband ripple, ±0.002 dB: Stopband, –82 dB:	 0.49 x sample frequency, Hz 0.454 x sample frequency, Hz 0.567 x sample frequency, Hz
Analog Filter[c] Type: Output filter response 20 kHz: 48 kHz:	 2-pole, 75 kHz, low-pass Butterworth –0.1 dB –0.5 dB
ESD protection Arc: Contact:	 8 kV 4 kV

a. Unless otherwise noted, specifications are typical at 25 ° C.
b. f_s = sample frequency.
c. The total frequency response is the combined frequency response of the DAC Sigma Delta filter and the analog filter.

Tachometer Input Specifications

Table 23 lists the specifications for the tachometer input on the DT9839 module.

Table 23: Tachometer Input Specifications

Feature	DT9839 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 (83 ns resolution)

Trigger Specifications

Table 24 lists the specifications for the triggers on the DT9839 module.

Table 24: Trigger Specifications

Feature	DT9839 Specifications
Trigger sources	
Internal software trigger:	Software-initiated
External digital trigger:	Software-selectable
Threshold trigger:	Software-selectable
External digital trigger	
Input type:	Edge-sensitive, positive or negative trigger
Logic family:	LVTTL-compatible inputs
Input logic load:	1 LVTTL
Lower threshold:	1.1 V
Upper threshold:	1.3 V
Hysteresis:	0.2 V
Input sink current:	33 µA
Minimum pulse width high/low:	1.3 µs
Maximum input signal:	±30 V
Input configuration:	Pulled high with 100 kΩ resistor
Analog threshold trigger	
Type:	Positive or negative threshold trigger on any analog input channel
Threshold level range:	–2.4 V to +2.4 V
Hysteresis:	100 mV
Trigger delay	1 ADC conversion period maximum

Master Oscillator Specifications

Table 25 lists the specifications for the master oscillator on the DT9839 module.

Table 25: Master Oscillator Specifications

Feature	DT9839 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 26 lists the power, physical, and environmental specifications for the DT9839 module.

Table 26: Power, Physical, and Environmental Specifications

Feature	DT9839 Specifications
Power, +5 V	400 mA maximum
Physical Dimensions of enclosure: Dimensions of PCB only: Weight: PCB assembly with enclosure: PCB assembly:	 Width = 3.27 inches (83.06 mm) Length = 4.27 inches (108.46 mm) Height = 1.32 inches (33.53 mm) Width: 4.137 inches (105.08 mm) Length: 3.937 inches (100 mm) Thickness: 0.062 inches (1.57 mm) 4.72 oz (133.8 g) 2.07 oz (58.6 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

Table 27 lists the regulatory specifications for the DT9839 module.

Table 27: Regulatory Specifications

Feature	DT9839 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 28 lists the connector specifications for the DT9839 module.

Table 28: Connector Specifications

Feature	DT9839 Specifications
Analog Input Screw Terminal Block (TB2)	18-Position Header: Phoenix Contact 170556
Analog Output, Trigger, and Tach Screw Terminal Block (TB1)	6-Position Header: Phoenix Contact 1984659
USB Connector	TE Connectivity 292304-2

B

Connector Pin Assignments and LED Status Indicator

Analog Input Screw Terminal Block

An 18-position screw terminal block (TB2) is provided for connecting up to four analog input channels. Table 29 lists the screw terminal assignments for the analog input screw terminal block on the DT9839 module.

Table 29: Analog Input Screw Terminal Block (TB2)

Screw Terminal Block	Description
1	IEPE 0
2	AC IN 0
3	DC IN 0
4	RTN 0
5	IEPE 1
6	AC IN 1
7	DC IN 1
8	RTN 1
9	IEPE 2
10	AC IN 2
11	DC IN 2
12	RTN 2
13	IEPE 3
14	AC IN 3
15	DC IN 3
16	RTN 3
17	+5 V OUT
18	+5 V RTN

Analog Output, Tach, and Trigger Screw Terminal Block

A 6-position screw terminal block(TB1) is provided for connecting an analog output channel, tachometer, and external digital trigger signal. Table 30 lists the screw terminal assignments for the analog output, tach, and trigger screw terminal block on the DT9839 module.

Table 30: Analog Output, Trigger, and Tach Screw Terminal Block (TB1)

Screw Terminal Block	Description
6	Analog Output Return
5	Analog Output
4	Tach –
3	Tach +
2	External Trigger –
1	External Trigger +

LED Status Indicator

The DT9839 module has a single bi-color LED that indicates the status of the module, as described in Table 31.

Table 31: LED Status Indicators on the DT9839 Module

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

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