DATA TRANSLATION

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VIBbox User's Manual

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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 9
Intended Audience. 9
How this Manual is Organized 9
Conventions Used in this Manual 10
Related Information 10
Where To Get Help. 10

Chapter 1: Overview 11
Hardware Features 12
Supported Software 15
Supported Accessories. 16
Getting Started Procedure. 17

Chapter 2: Setting Up and Installing the VIBbox 21
Unpacking 23
System Requirements 24
Applying Power to the VIBbox 25
Attaching the VIBbox to the Computer 27
Configuring the VIBbox 29
  Configuring the DT9857 Series Device Driver for each Module 31
  Using the DT Device Collection Manager 33

Chapter 3: Wiring Signals. 35
Preparing to Wire Signals 37
  Wiring Recommendations 37
  Grounding Considerations 37
  Warm-Up Time 39
  Wiring Signals to the VIBbox. 40
Connecting Analog Input Signals 44
Connecting Analog Output Signals 46
Connecting a Tachometer Input Signal 47
Connecting Digital Input Signals. 48
Connecting Digital Output Signals 49
Connecting Counter/Timer Signals 50
  Event Counting 50
  Up/Down Counting. 52
  Period/Pulse Width Measurement. 53
  Edge-to-Edge Measurement 54
  Continuous Edge-to-Edge Measurement 55

Pulse Output 56
Connecting Signals for Measure Counter Operations 57

Chapter 4: Verifying the Operation of a VIBbox 59
Start QuickDAQ 61
Select the Device 62
Select the FFT Analyzer Interface 64
Configure the Channels 65
Configure the Analog Output Settings 65
Configure the Analog Input Channel 67
Configure the Recording Settings 69
Configure the Frequency Settings 71
Configure the Trigger Settings 72
Configure the FFT Windowing Settings 73
Add an FFT Channel to the Channel Plot Display 74
Configure the Appearance of the Channel Plot Display 75
Start the Operation 76

Chapter 5: Principles of Operation 79
Block Diagrams 80
Analog Input Features 84
Analog Input Channels 84
Analog Input Channel Numbers and Names 85
Input Channel Numbers and Names for the VIBbox-64 85
Input Channel Numbers and Names for the VIBbox-48 88
Input Channel Numbers and Names for the VIBbox-32 91
Input Ranges and Gains 92
IEPE Functions 93
Input Resolution 93
Input Clock Source 93
Analog Input Conversion Modes 94
Single-Value Operations 94
Continuous Scan Mode 94
Input Triggers 96
Start Trigger Sources 96
Reference Trigger Sources 97
Data Format and Transfer 98
Error Conditions 98
Analog Output Features 99
Analog Output Channels 99
Analog Output Channel Numbers and Names 99
Output Channel Numbers and Names for the VIBbox-64 100

Output Channel Numbers and Names for the VIBbox-48 101
Output Channel Numbers and Names for the VIBbox-32 102
Output Range and Gain 102
Output Resolution. 102
Output Clocks 102
Output Conversion Modes 103
Single-Value Mode 103
Waveform Generation Mode 103
Continuous Analog Output Operations 104
Output Trigger. 105
Data Format and Transfer 105
Error Conditions 106
Tachometer Input Features 107
General-Purpose Counter/Timer Features. 109
C/T Channels 109
C/T Clock Sources 110
Gate Types 110
Pulse Output Types and Duty Cycles 111
Counter/Timer Operation Modes 111
Event Counting 112
Up/Down Counting 112
Edge-to-Edge Measurement 113
Continuous Edge-to-Edge Measurement 113
Rate Generation 114
One-Shot 114
Repetitive One-Shot 115
Measure Counter Features 116
Digital I/O Features. 120
Digital I/O Lines 120
Operation Modes. 120

Chapter 6: Supported Device Driver Capabilities. 123
Data Flow and Operation Options. 125
Buffering 126
Triggered Scan Mode 126
Data Encoding. 126
Channels 127
Gain 128
Ranges 128
Resolution 128
Current and Resistance Support 129
Thermocouple, RTD, and Thermistor Support 130

IEPE Support 131
Bridge and Strain Gage Support 131
Start Triggers 132
Reference Triggers 133
Clocks 134
Counter/Timers 135
Tachometers 136

Chapter 7: Troubleshooting 137
General Checklist 138
Technical Support 140
If Your VIBbox Needs Factory Service 141

Chapter 8: Calibration 143
Using the Calibration Utility 145
Calibrating the Analog Input Subsystem 146
  Warming up the VIBbox 146
  Connecting a Precision Voltage Source 146
  Using the Auto-Calibration Procedure 146
  Using the Manual Calibration Procedure 147
Calibrating the Analog Output Subsystem 149

Appendix A: Specifications 151
Analog Input Specifications 152
Analog Output Specifications 158
Digital I/O Specifications 160
Tachometer Input Specifications 161
Measure Counter Specifications 162
General-Purpose Counter/Timer Specifications 163
Trigger Specifications 164
Master Oscillator Specifications 165
Power, Physical, and Environmental Specifications 166
Regulatory Specifications 167
Connector Specifications 168
External Power Supply Specifications 169

Appendix B: Connector Pin Assignments and LED Status Indicators 171
Analog Input Connectors 172
Analog Output Connectors 173
External Trigger Connector 174
Digital Connector 175
External USB 3.0 Connector 176
External Power Connector 177

Sync Bus Connectors 178
STP25 Screw Terminal Panel. 180
LED Status Indicators 182

Appendix C: Register-Level Programming 185
Writing to the EEPROM Register 186
Using the Data Acq SDK to Access the Registers 187
Using the Open Layers for .NET Class Library to Access the Registers 188

Appendix D: Synchronizing Multiple VIBboxes 189
Overview 190
Connecting Multiple VIBboxes Together 191
Applying Power to the VIBboxes. 192
Attaching Each VIBbox to the Computer 194
Configuring the DT9857 Series Device Driver for each Module. 197
Collecting all the VIBboxes Using the DT Device Collection Manager 200
Channel Numbering for Multiple VIBboxes 202

Index 203

About this Manual

The first part of this manual describes how to install and set up your VIBbox system and device driver, and verify that your device is working properly.

The second part of this manual describes the features of the VIBbox, the capabilities of the DT9857 Series Device Driver, and how to program the VIBbox using the DT-Open Layers for .NET Class Library™ software. Troubleshooting information is also provided.

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

Intended Audience

This document is intended for engineers, scientists, technicians, or others responsible for using and/or programming a VIBbox 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 VIBbox, as well as the supported software and accessories for the VIBbox.
- Chapter 2, "Setting Up and Installing the VIBbox," describes how to apply power to the VIBbox, connect one or more VIBboxes to a host computer, and configure the VIBbox Device Driver.
- Chapter 3, "Wiring Signals," describes how to wire signals to a VIBbox.
- Chapter 4, "Verifying the Operation of a VIBbox," describes how to verify the operation of a VIBbox using the QuickDAQ application.
- Chapter 5, "Principles of Operation," describes all of the features of the VIBbox.
- Chapter 6, "Supported Device Driver Capabilities," lists the data acquisition subsystems and the associated features accessible using the DT-Open Layers for .NET Class Library with the VIBbox.
- Chapter 7, "Troubleshooting," provides information that you can use to resolve problems with the VIBbox and device driver, should they occur.
- Chapter 8, "Calibration," describes how to calibrate the analog I/O circuitry of the VIBbox.
- Appendix A, "Specifications," lists the specifications of the VIBbox.

- Appendix B, "Connector Pin Assignments and LED Status Indicators," lists the pin assignments of the connectors on the VIBbox, describes the screw terminal assignments of the STP25 screw terminal panel, and describes the LED status indicators on the VIBbox.
- 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 VIBbox:

- *Benefits of the Universal Serial Bus for Data Acquisition.* This white paper describes why USB is an attractive alternative for data acquisition. It is available on the Data Translation web site (www.datatranslation.com).
- *QuickDAQ User's Manual* (UM-24774). This manual describes how to create a QuickDAQ application to acquire and analyze data from a DT-Open Layers data acquisition module.
- *DT-Open Layers for .NET User's Manual* (UM-22161). For programmers who are developing their own application programs using Visual C# or Visual Basic .NET, this manual describes how to use the DT-Open Layers for .NET Class Library to access the capabilities of Data Translation data acquisition devices.
- 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 VIBbox, the Data Translation Technical Support Department is available to provide technical assistance. Refer to Chapter 7 for more information. If you are outside the United States or Canada, call your local distributor, whose number is listed on our web site (www.datatranslation.com).

1

Overview

Hardware Features 12
Supported Software 15
Supported Accessories 16
Getting Started Procedure 17

Hardware Features

The VIBbox, shown in Figure 1, is a high-accuracy, high channel count, dynamic signal analyzer system for sound and vibration applications. Packaged in a rugged, industrial enclosure, the VIBbox provides up to 64 IEPE inputs, up to eight stimulus waveform output channels, up to four tachometers, up to four counter/timers, up to eight measure counters, up to 32 digital inputs, and up to 32 digital outputs.

For high-channel count applications, you can connect up to four VIBboxes together for a maximum of 256 channels.

Figure 1: VIBbox - Front View (VIBbox-64 Shown)

Three versions of the VIBbox are available: the VIBbox-64, VIBbox-48, and VIBbox-32. Table 1 summarizes the number of channels for each VIBbox.

Table 1: Number of Channels for Each VIBbox Model

Model	IEPE Inputs	Analog Outputs	Digital I/O Ports	General-Purpose Counter/Timers	Measure Counters	Tachometers
VIBbox-64	64	8	4 input, 4 output	4	8	4
VIBbox-48	48	6	3 input, 3 output	3	6	3
VIBbox-32	32	4	2 input, 2 output	2	4	2

The key features of the VIBbox are as follows:

- Packages multiple DT9857E-16 modules in a rugged enclosure for field use. The VIBbox-64 contains four DT9857E-16 modules; the VIBbox-48 contains three DT9857E-16 modules, and the VIBbox-32 contains two DT9857E-16 modules.
- Simultaneous analog input and waveform analog output operations.
- Analog input subsystem:
  - 64 analog input channels for the VIBbox-64, 48 analog inputs for the VIBbox-48, or 32 analog inputs for the VIBbox-32.
  - One 24-bit A/D converter per analog input channel.
  - Programmable throughput rate from 195.3125 Samples/s to 105.469 kSamples/s.
  - Input range of ±10 V with software-selectable gains of 1 and 10 for an effective input range of ±10 V and ±1 V.
  - Support for IEPE (Integrated Electronic Piezoelectric) inputs, including use of a 4 mA current source with 24 V compliance voltage for AC or DC coupling.
  - In continuous scan mode, 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, threshold trigger, or Sync Bus). For the threshold trigger, you can program the threshold value from –10 V to +10 V.
  - For the reference trigger, supports a software-programmable trigger source (external digital trigger, threshold trigger, or Sync Bus).
  - Supports the ability to return the value of the tachometers, general-purpose counter/timers, measure counters, and the digital input ports in the analog input data stream, allowing you to measure a variety of signals synchronously with analog input measurements.
- Analog output subsystem:
  - Eight stimulus analog output channels for the VIBbox-64, six analog output channels for the VIBbox-48, and four analog output channels for the VIBbox-32.
  - One 32-bit D/A converter per analog output channel.
  - Single value, waveform, and continuous streaming output.
  - Programmable output rate from 30 kSamples/s to 216 kSamples.
  - Output range of ±10 V.
  - Software-programmable trigger source (software trigger or external digital trigger) to start the analog output operation.
  - Supports the ability to update the digital output port synchronously with the analog output channels.

- Four 8-bit digital input ports and four 8-bit digital output ports for the VIBbox-64, three 8-bit digital input ports and three 8-bit digital output ports for the VIBbox-48, and two 8-bit digital input ports and two 8-bit digital output ports for the VIBbox-32. For synchronous measurements, you can return the value of the digital input ports with your analog input data and/or update the value of the digital output ports with the analog output channels.
- Four tachometer input signals for the VIBbox-64, three tachometer input signals for the VIBbox-48, and two tachometer input signals for the VIBbox-32. The values of each tachometer can be returned in the analog input data stream for synchronous measurements.
- Four general-purpose counter/timers for the VIBbox-64, three general-purpose counter/timers for the VIBbox-48, and two general-purpose counter/timers for the VIBbox-32. You can use the general-purpose counter/timers for performing event counting, up/down counting, edge-to-edge measurement, continuous edge-to-edge measurement, rate generation, and pulse output operations. You can read the value of the counter/timers directly or through the analog input data subsystem, as the counter/timer can be included in the analog input data stream for synchronous measurements.
- Eight measure counters for the VIBbox-64, six measure counters for the VIBbox-48, and four measure counters for the VIBbox-32. You can program the edge that starts the measurement and the edge that stops the measurement. Many edge types are supported. The data from the measure counters can be returned in the analog input data stream for synchronous measurements.
- USB 3.0 connector to attaching to a host computer.
- External +7.5 VDC to +24 VDC power supply.
- Expansion to up to 256 channels by connecting up to four VIBboxes together.

Note: Hereafter, the DT9857E-16 is referred to as the DT9857E module.

Supported Software

The following software is available for use with the VIBbox:

- **DT9857 Series Device Driver –** The DT9857 Device Driver allows you to use the DT9857E modules inside the VIBbox with any of the supported software packages or utilities.
- **DT9857 Calibration Utility –** This utility, described in Chapter 8 starting on page 143, allows you to calibrate the analog input and analog output circuitry of the DT9857E modules in the VIBbox system.
- **QuickDAQ with the Advanced FFT Analysis Option –** The QuickDAQ Advanced FFT Analysis option is a ready-to-measure application package that ships free with VIBbox. This full-featured version of QuickDAQ allows you to acquire data, record data to disk, perform single and two-channel FFT analysis functions, display the results in both a plot and digital display, get statistics about the data, save the data to a variety of file formats, and read a recorded data file. Data can also be exported to other applications like Microsoft Excel® and The Mathworks MATLAB® for more advanced analysis.
- **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 VIBbox system using Visual Studio 2003-2012. The class library complies with the DT-Open Layers standard and supports an aggregation layer for the A/D and D/A subsystems, allowing you combine the channels from all DT9857E modules as one VIBbox system.
- **Signal Processing Component Library for .NET –** Free with VIBbox, use this comprehensive library of object-oriented classes with the DT-Open Layers for .NET Class Library if you want to develop your own signal processing applications. Each class contains properties and methods that can be used to perform single-channel or two-channel FFT operations, and to calculate signal metrics on time domain data.

Note: The DataAcq SDK, DAQ Adaptor for MATLAB, and LV-Link software are supported by the individual DT9857E modules inside the VIBbox, but do not support the aggregation layer which combines the channels from all DT9857E-16 modules into one VIBbox system.

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

Supported Accessories

The following accessories are shipped with the VIBbox system:

- **STP25 screw terminal panel and EP403 cable –** The STP25 screw terminal panel connects to a Digital connector on the VIBbox using the 25-pin, 1.5-meter, EP403 cable.

  The VIBbox-64 ships with four STP25 panels and EP403 cables, the VIBbox-48 ships with three STP25 panels and EP403 cables, and the VIBbox-32 ships with two STP25 cables and two EP403 cables.

  Figure 2 shows the STP25 and EP403 cable.

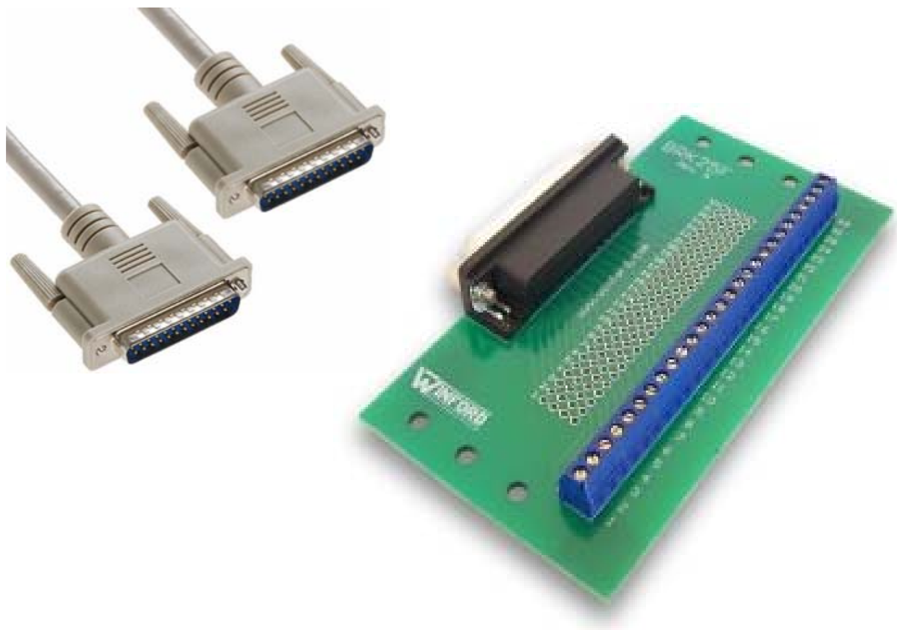


Figure 2: STP25 Screw Terminal Panel and EP403 Cable

- **EP404 Power Supply and cable**. The EP404 is a +12 VDC power supply. Refer to page 169 for the specifications of this power supply.

If you want to connect multiple VIBboxes together, the following optional accessory is also required:

- **EP377 Trigger Bus cable**. The EP377 cable is 25-pin, 0.5 meter cable.

  To connect two VIBboxes together, you need one EP377 cable. To connect three VIBboxes together, you need two EP377 cables. To connect four VIBboxes together, you need three EP377 cables. Refer to page 191 for more information on how to connect multiple VIBboxes using this cable.

Getting Started Procedure

The flow diagram shown in Figure 3 illustrates the steps needed to get started using a VIBbox system. 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.

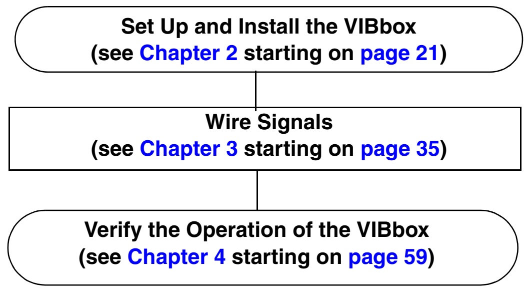


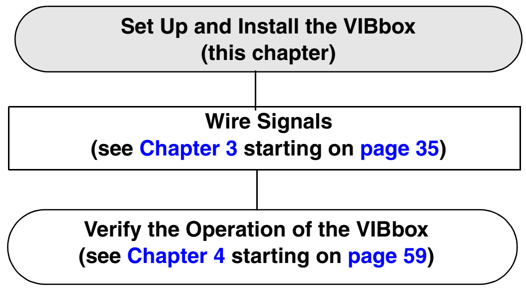
Figure 3: Getting Started Flow Diagram

Part 1: Getting Started

2

Setting Up and Installing the VIBbox

Unpacking 23
System Requirements 24
Applying Power to the VIBbox 25
Attaching the VIBbox to the Computer 27
Configuring the VIBbox 29



Note: This chapter describes how to set up one VIBbox system. If you are using multiple VIBboxes, refer to Appendix D starting on page 189 for instructions on synchronizing multiple VIBboxes.

Unpacking

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

- VIBbox system
- EP404 +12 VDC power supply and cable
- USB cable
- Data Acquisition OMNI CD-ROM
- STP25 screw terminal panels and EP403 cables (one for each Digital connector in the VIBbox system)

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: VIBbox systems are factory-calibrated. If you decide that you want to recalibrate the analog input or analog output circuitry, refer to the instructions in Chapter 8.

System Requirements

For best performance, ensure that your computer meets the following system requirements:

- Processor: Intel Core i7 or equivalent
- RAM: 8 GB minimum
- Screen Resolution: 1024 x 768 pixels
- Operating System: Windows 8, Windows 7, or Windows Vista (32- and 64-bit)
- Solid-state hard drive with read performance of 500 MB/s and write performance of 440 MB/s
- Up to four USB 3.0 ports, one for each VIBbox.

Applying Power to the VIBbox

The VIBbox system works with a +7 VDC to +24 VDC power supply. The EP404 +12 VDC power supply (with cable) is shipped with the VIBbox.

To apply power to the VIBbox, do the following:

1. Ground the chassis of the VIBbox to earth ground by connecting a grounding strap to the grounding stud on the rear panel of the VIBbox, as shown in Figure 4.

Figure 4: Connect a Grounding Strap to the Grounding Stud on the VIBbox System

2. Connect the EP404 power supply to the power connector on the VIBbox, as shown in Figure 5.
3. Plug the power supply into a wall outlet.

Connect the EP404 Power Supply to the VIBbox
and to the Wall Outlet

Figure 5: Attaching an External Power Supply to the VIBbox

Attaching the VIBbox to the Computer

You must install the device driver for the DT9857E modules in your VIBbox before connecting the VIBbox to the host computer. Run the installation program on your Data Acquisition OMNI CD to install the DT9857 Series device driver and other software for the VIBbox.

Notes: You must connect the VIBbox to a USB 3.0 port of your host computer.

You can unplug a VIBbox, 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 VIBbox once it is plugged back in.

To connect a VIBbox to a USB 3.0 port on your computer, do the following:

1. Make sure that you have attached an external power supply to the VIBbox.
2. Attach one end of the USB cable (provided with the system) to the USB 3.0 port on the VIBbox, as shown in Figure 6. The VIBbox supports an optional locking USB cable if desired. You can purchase this cable separately from vendors such as Newnex Technology Corporation (part number UHRB-B00A-U60).

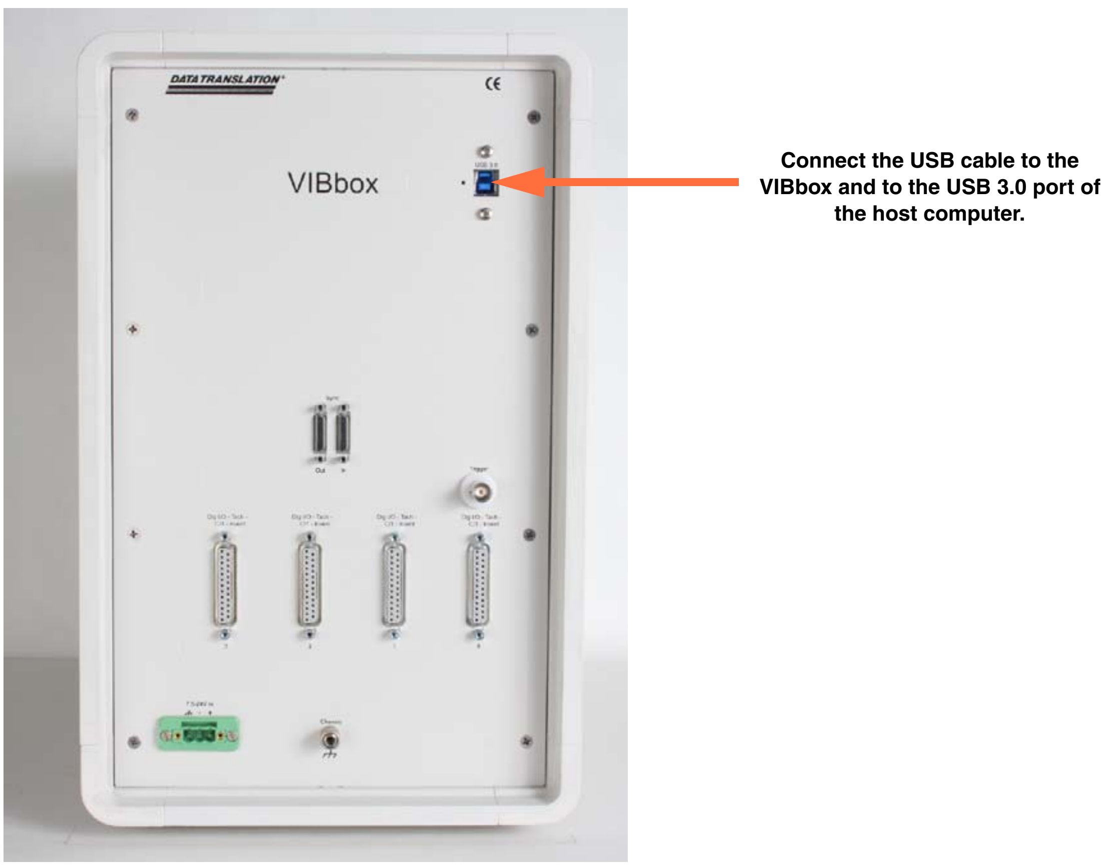


Figure 6: Attaching the USB Cable to the VIBbox

3. Attach the other end of the USB cable to the USB 3.0 port on the host computer.
   The operating system automatically detects the USB device 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.

Note: Once you have applied external power to the VIBbox and connected your VIBbox to the host computer, the Power LED on the VIBbox turns solid green.

Configuring the VIBbox

In software, the DT9857E modules that are in the enclosure are collected together as a VIBbox system. When shipped from the factory, the modules are numbered as follows:

- DT9857E(00) - This is module in the left-most slot, as shown in Figure 7. Analog input channels are numbered 0 to 15. Analog output channels are numbered 0 and 1. See Figure 8 to see how the channels are numbered on each module in the enclosure.
- DT9857E(01) - This is the module in the second slot from the left. Channels 0 to 15. Analog input channels are numbered 0 to 15. Analog output channels are numbered 0 and 1.
- DT9857E(02) - (Included in the VIBbox-48 and VIBbox-64 only.) This is the module in the third slot from the left. Channels 0 to 15. Analog input channels are numbered 0 to 15. Analog output channels are numbered 0 and 1.
- DT9857E(03) - (Included in the VIBbox-64 only.) This is module in the right-most slot. Channels are numbered 0 to 15. Analog input channels are numbered 0 to 15. Analog output channels are numbered 0 and 1.

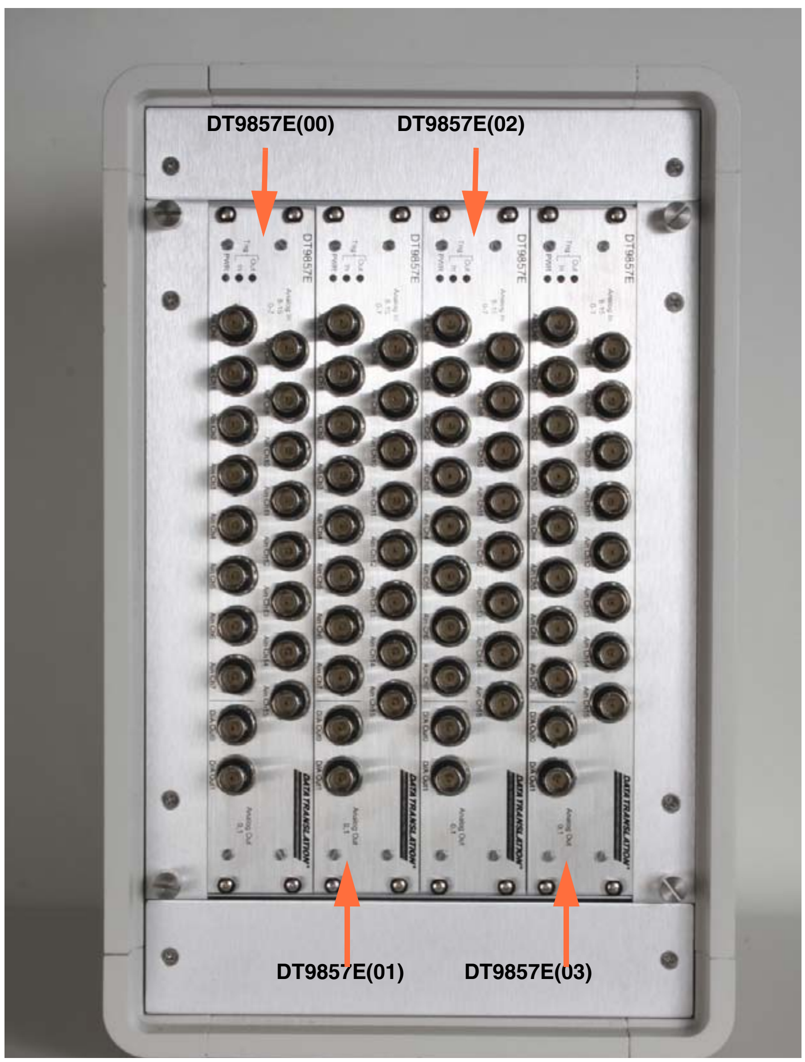


Figure 7: VIBbox Naming

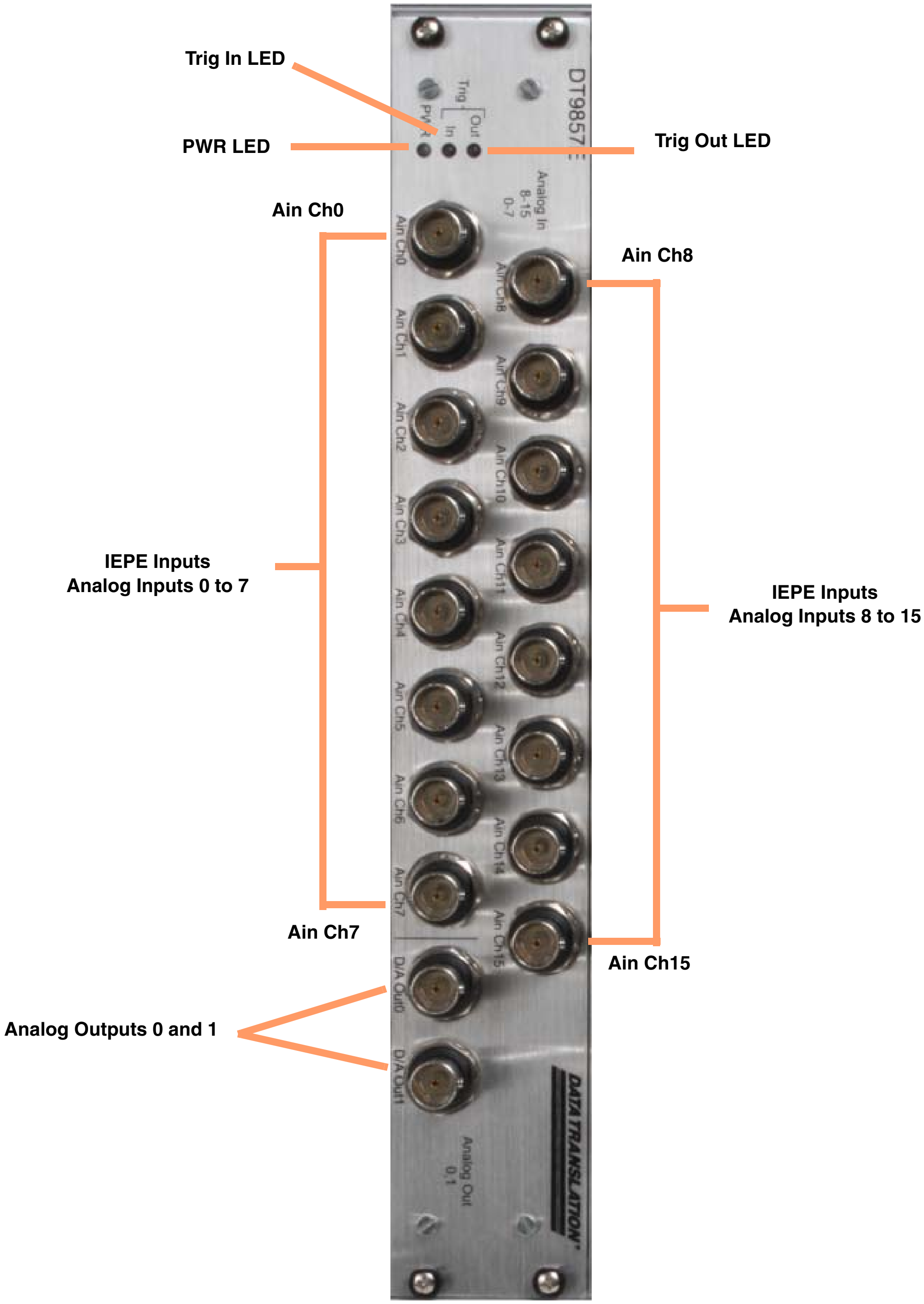


Figure 8: VIBbox Channel Numbering

Configuring the DT9857 Series Device Driver for each Module

Note: In Windows 7, Windows 8, and Windows Vista, you must have administrator privileges to run the Open Layers Control Panel. When you double-click the Open Layers Control Panel icon, you may see the Program Compatibility Assistant. If you do, select **Open the control panel using recommended settings**. You may also see a Windows message asking you if you want to run the Open Layers Control Panel as a "legacy CPL elevated." If you get this message, click **Yes**.

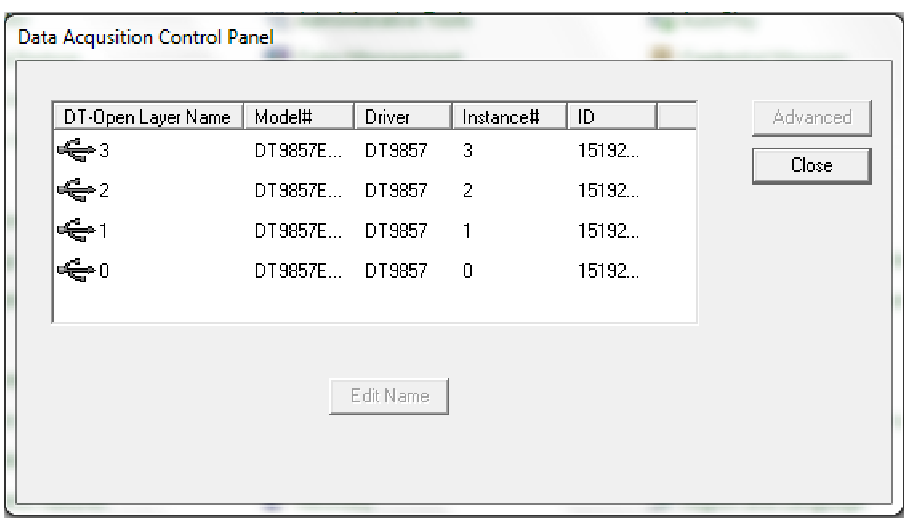
If you do not get this message and have trouble making changes in the Open Layers Control Panel, right click the DTOLCPL.CPL file and select **Run as administrator**. By default, this file is installed in the following location:

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

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

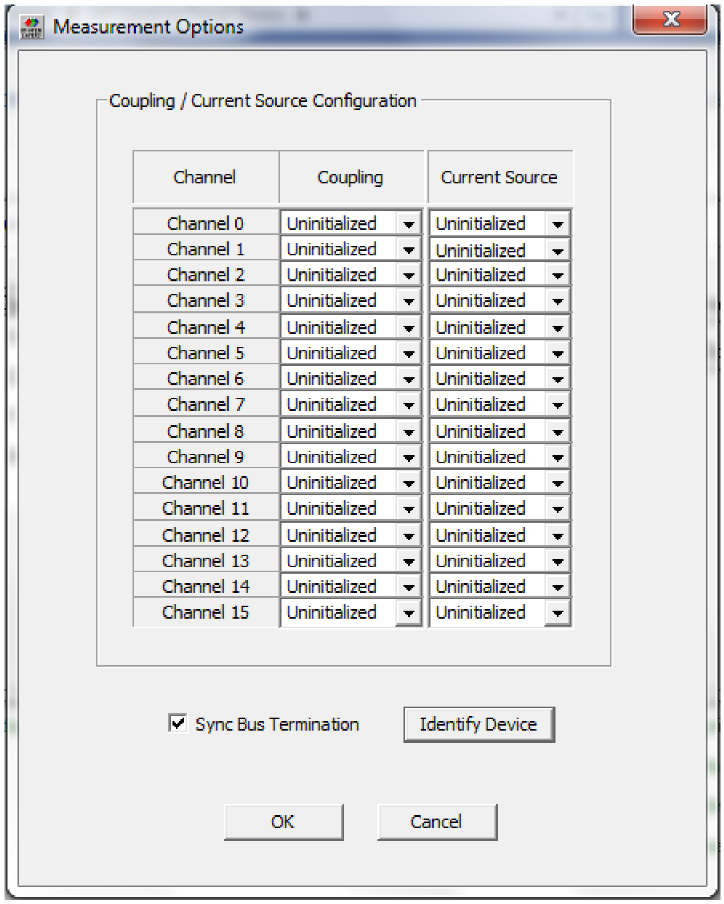
To configure the device driver for each DT9857E module in the VIBbox, perform the following steps:

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 device, click the name of the device that you want to rename, click **Edit Name**, enter a new name for the device, and then click **OK**. The name is used to identify the device in all subsequent applications, including the DT Device Manager Collection application.

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



6. Click the **Identify Device** button to turn the Power LED on the front of the module amber, helping you identify which module you are configuring. Figure 8 on page 30 shows the Power LED on a DT9857E module.
   By default, all settings are uninitialized.

7. For the Coupling type, select **AC** for AC coupling or **DC** for DC coupling for each analog input channel.

8. For the Current Source, select **Enabled** to enable the internal excitation current source or **Disabled** to disable the internal excitation current source for each analog input channel.

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

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9. Leave the termination unchanged. By default, the first and last module in the VIBbox are terminated with a 100 Ω resistor. The DT Device Collection Manager automatically sets the proper termination for the VIBbox system.

10. When you are finished, click **OK** to close the Measurement Options dialog box.

11. Repeat steps 4 to 10 for the other modules that you want to configure.

12. When you are finished configuring the modules, click **Close** to close the Control Panel.

Using the DT Device Collection Manager

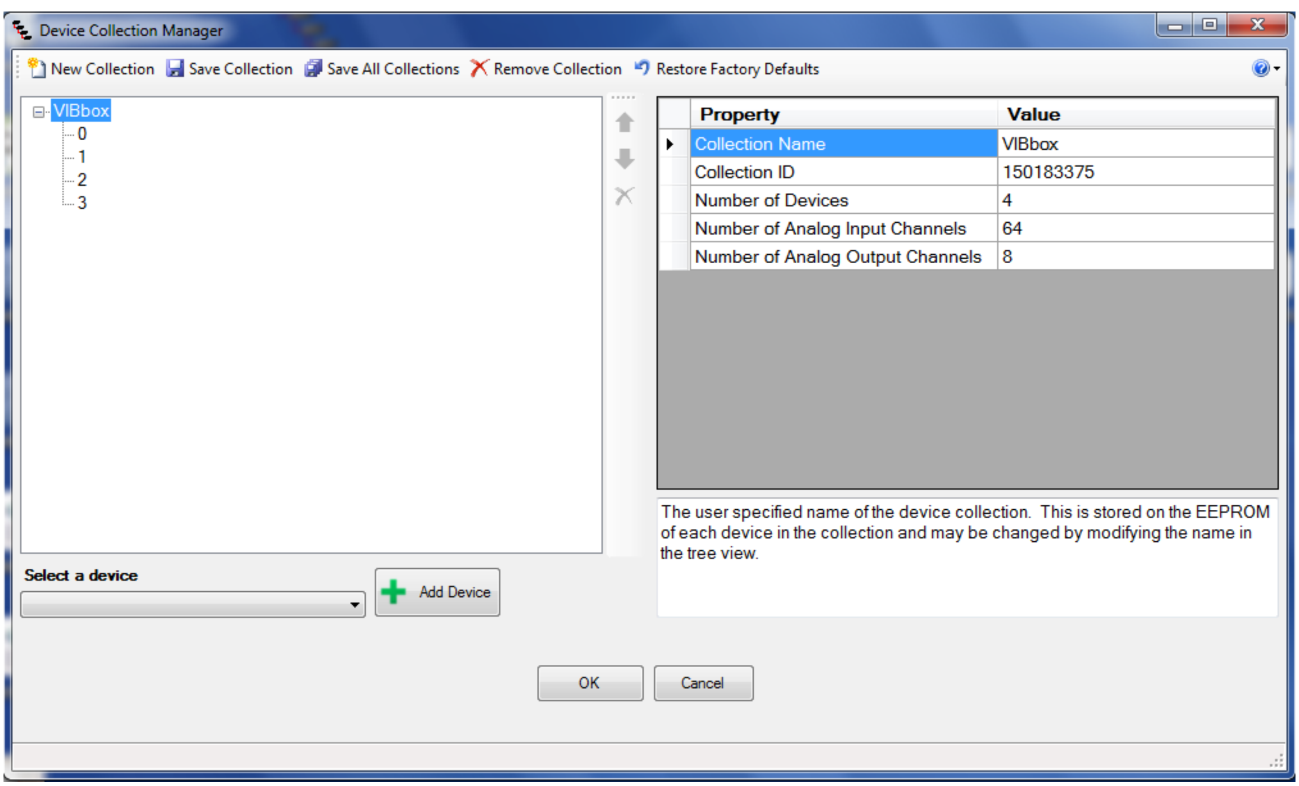
When the VIBbox is shipped from the factory, all the DT9857E modules inside the box are collected in software to aggregate all the analog input channels and all the analog output channels.

You can use the DT Device Collection Manager application to see how the modules are collected.

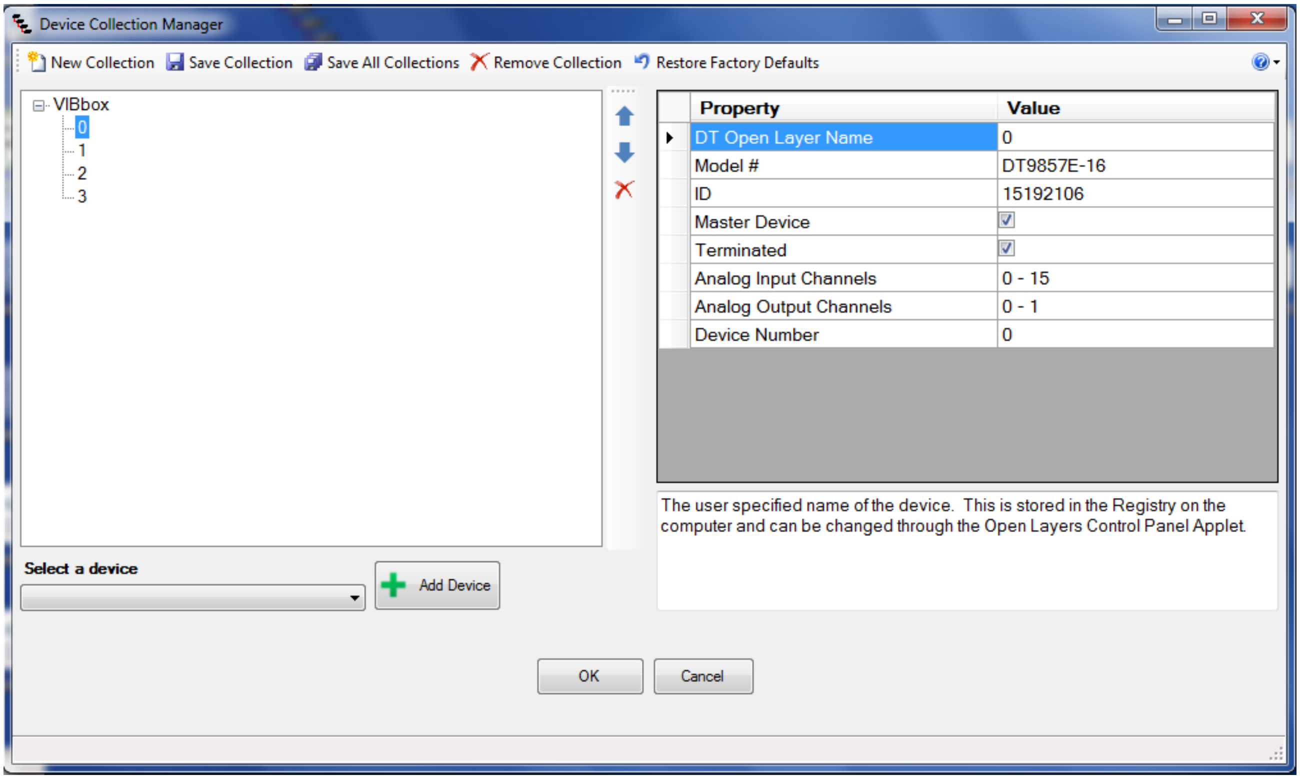
Note: Using this application, you can also change which devices are collected or change their names; however, this is strongly discouraged as you could inadvertently change the configuration of your VIBbox.

To see how the DT9857E modules are aggregated by the DT Device Collection Manager, perform the following steps:

1. From the Windows Start menu, select **Data Translation, Inc**, select the **Utilities** folder, and double click **DT Device Collection Manager.**
   The DT Device Collection Manager application shows the VIBbox collection and the individual DT9857E modules that are included in the collection.



2. To see the configuration of a particular device inside the VIBbox, select the device name in the left pane. For example, the following figure shows the configuration of device 0 in the VIBbox collection:

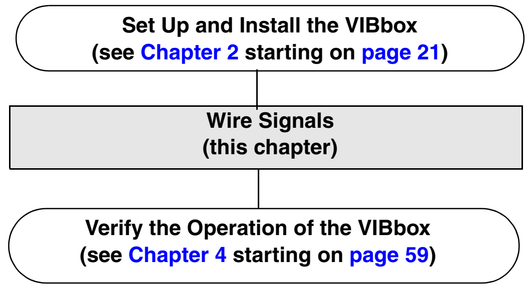


3. Use the online help provided with the application for more information on the DT Device Collection Manager application.

3

Wiring Signals

Preparing to Wire Signals 37
Connecting Analog Input Signals 44
Connecting Analog Output Signals 46
Connecting a Tachometer Input Signal 47
Connecting Digital Input Signals 48
Connecting Digital Output Signals 49
Connecting Counter/Timer Signals 50
Connecting Signals for Measure Counter Operations 50


Set Up and Install the VIBbox
(see Chapter 2 starting on page 21)
Wire Signals
(this chapter)
Verify the Operation of the VIBbox
(see Chapter 4 starting on page 59)

Preparing to Wire Signals

This section provides recommendations and information about wiring signals to a VIBbox system.

Wiring Recommendations

Keep the following recommendations in mind when wiring signals to a VIBbox system

- Follow standard ESD procedures when wiring signals to the VIBbox.
- Separate power and signal lines by using physically different wiring paths or conduits.
- To avoid noise, do not locate the VIBbox 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 VIBbox is operational.
- Connect a 50 Ω or 75 Ω terminator to all unused analog input channels.

Grounding Considerations

Because the VIBbox packages multiple DT9857E modules in one enclosure, up to four different grounds are present. For best performance, it is strongly recommended that if the BNC return must be connected to an external earth or system ground that it be kept in banks of four from each module.

When using the 4 mA IEPE current source, it is recommended that you use an isolated transducer to eliminate the possibility of ground errors. Figure 9 shows the performance of the analog input circuitry with 1 kΩ termination and 6-foot cables.

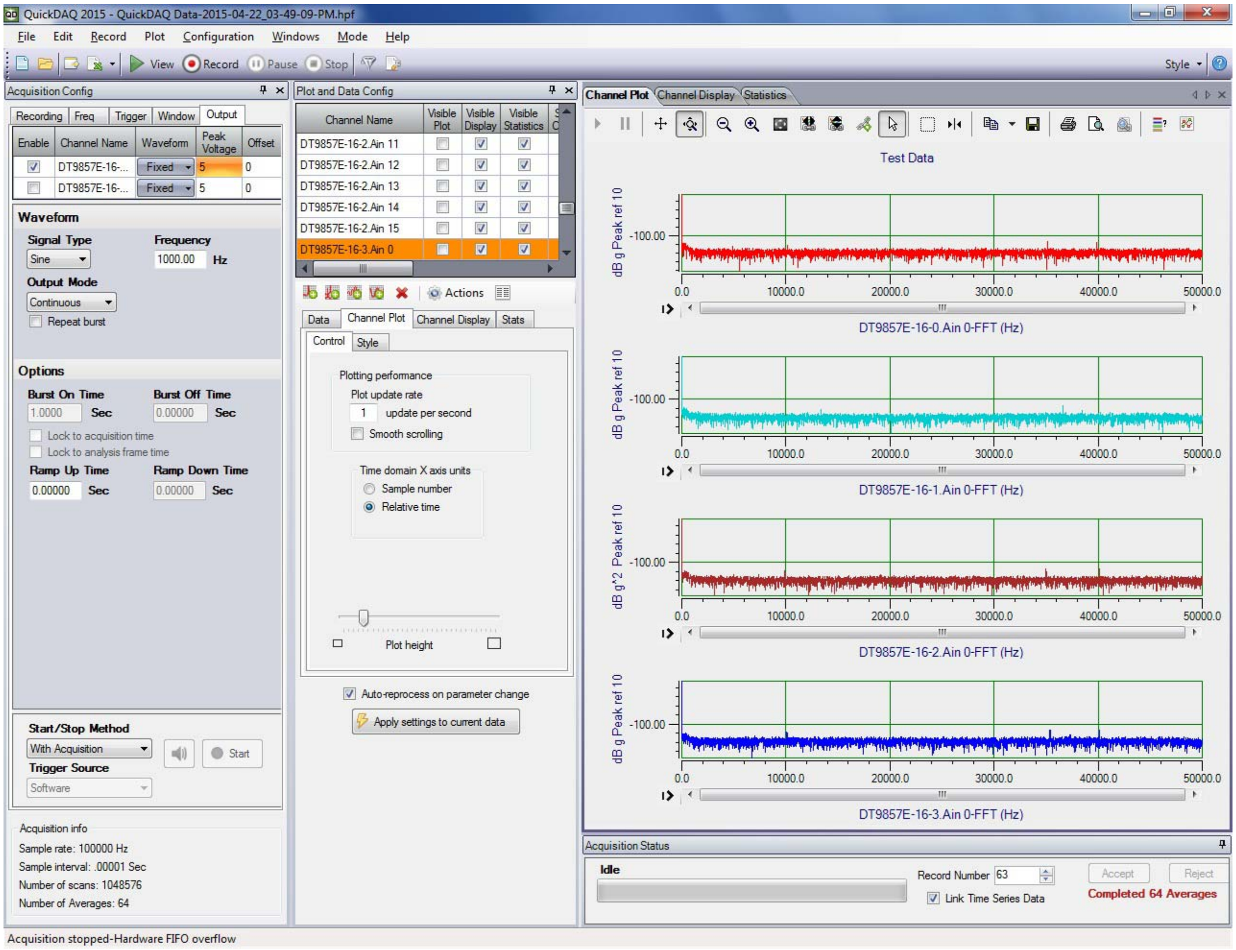


Figure 9: Performance (without Degradation) Using 1 kΩ Termination and Six-Foot Cables

If the analog output signal from a module is used in the grounded signal path, it is best to use the analog output channel associated with the same module. Figure 10 shows approximately 10 dB reduced performance when the analog output channel of module 0 is connected to the first analog input channel of module 1, 2, or 3 in the VIBbox system.

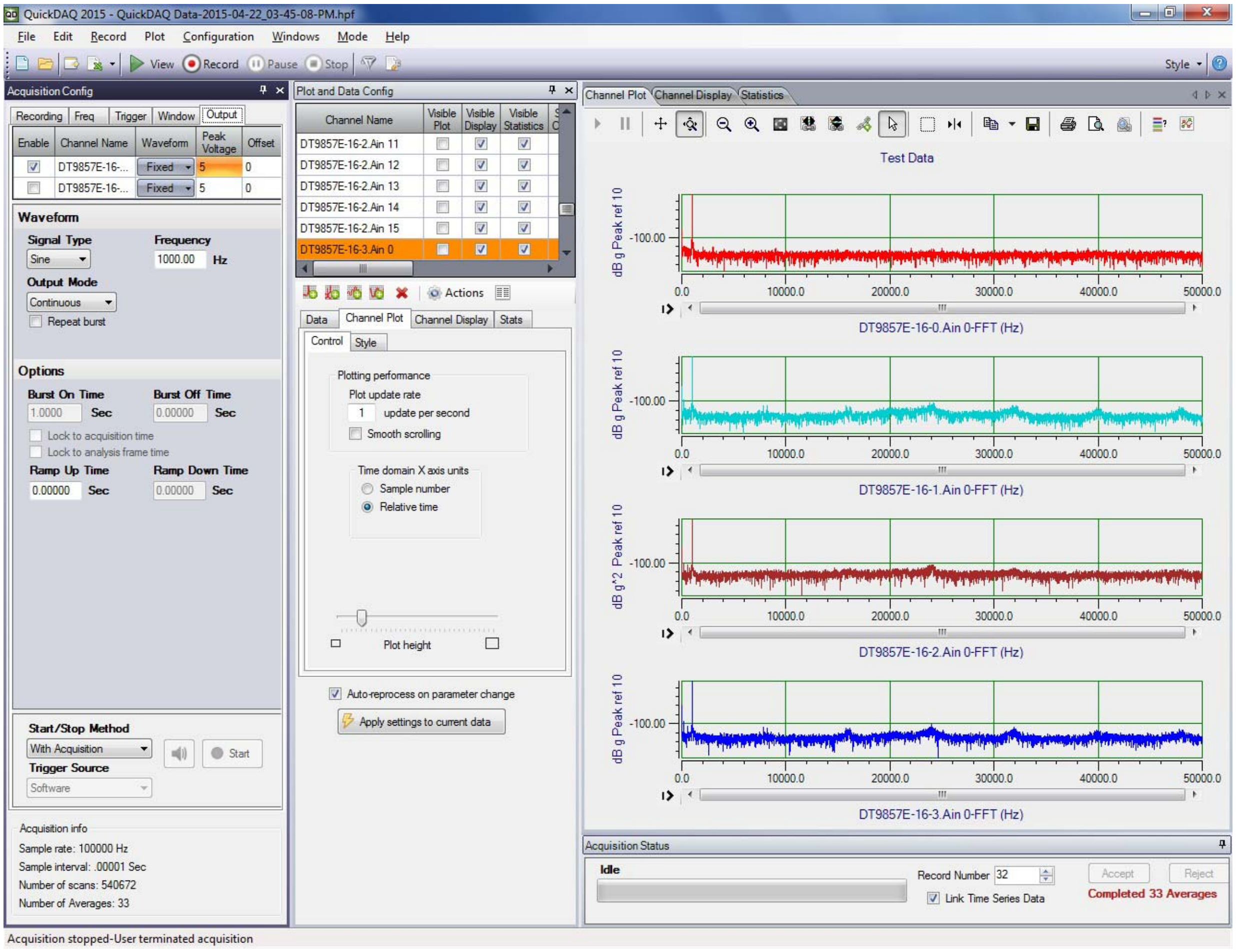


Figure 10: Reduced Performance of 10 dB when the Analog Output is Connected to the Input of a Different Module

Note: This performance reduction is only seen in a common ground system and does not degrade performance with a speaker/microphone connection.

Warm-Up Time

The VIBbox is ideal for acoustic measurements due to its AC coupling and frequency characteristics. It was not designed for DC stability; therefore, ensure that you allow the VIBbox to warm up for 1 hour before use.

Wiring Signals to the VIBbox

Figure 11 shows the connectors on the front panel for each DT9857E module in the VIBbox system, and Figure 12 shows the connectors on the rear panel of the VIBbox.

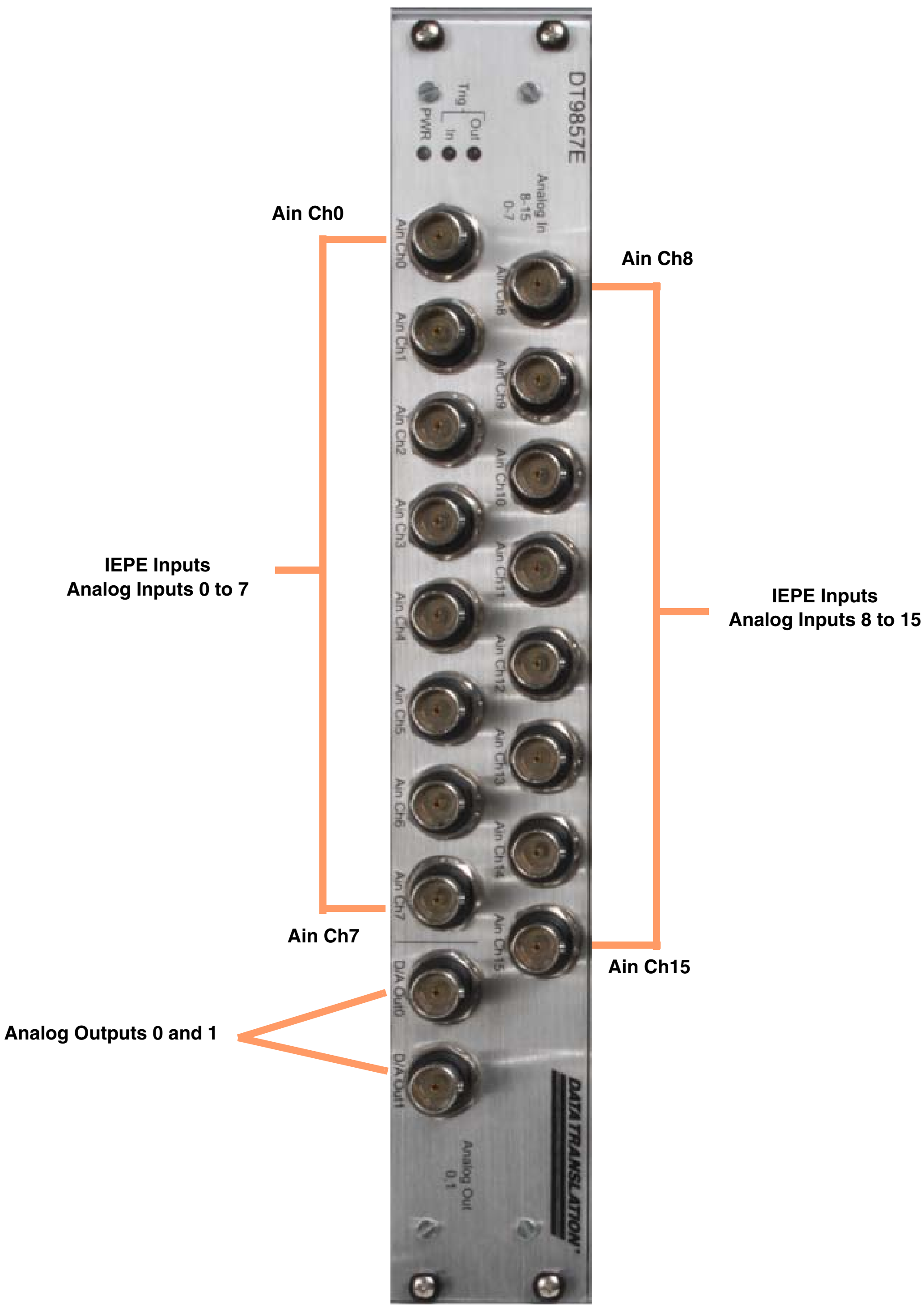


Figure 11: Connectors on the Front Panel for each DT9857E Module in the VIBbox

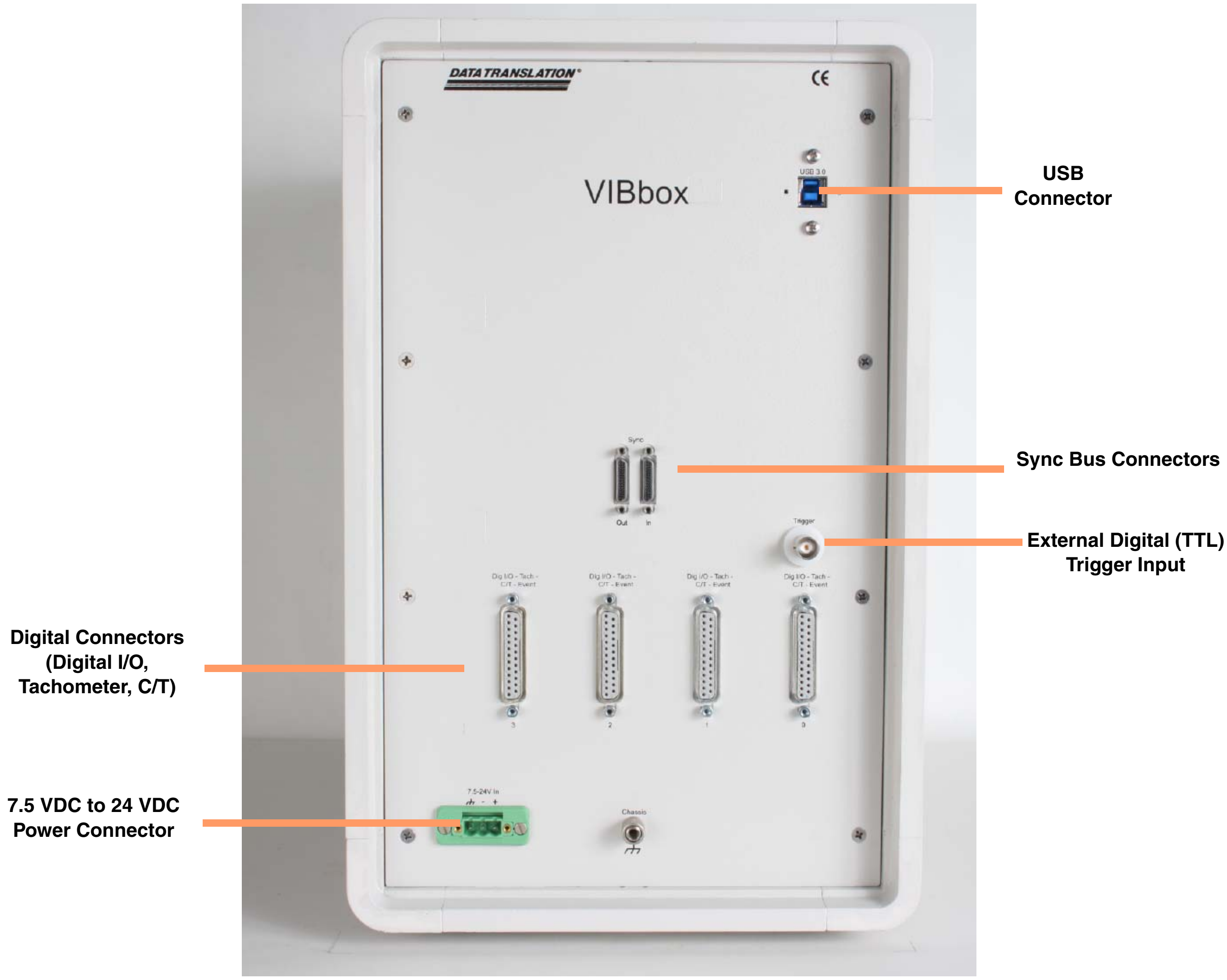


Figure 12: Connectors on the Rear Panel of the VIBbox

A 25-pin Digital connector is provided for attaching digital I/O, external trigger, and counter/timer signals for each DT9857E module in the VIBbox. Figure 13 shows the layout of the 25-pin Digital connectors.

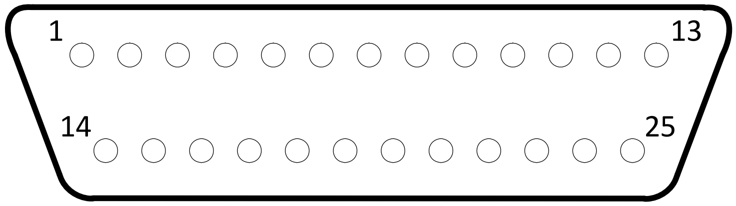


Figure 13: Layout of the Digital Connector

To make wiring easier, you can connect the STP25 screw terminal panel to each Digital connector on the VIBbox as shown in Figure 14.

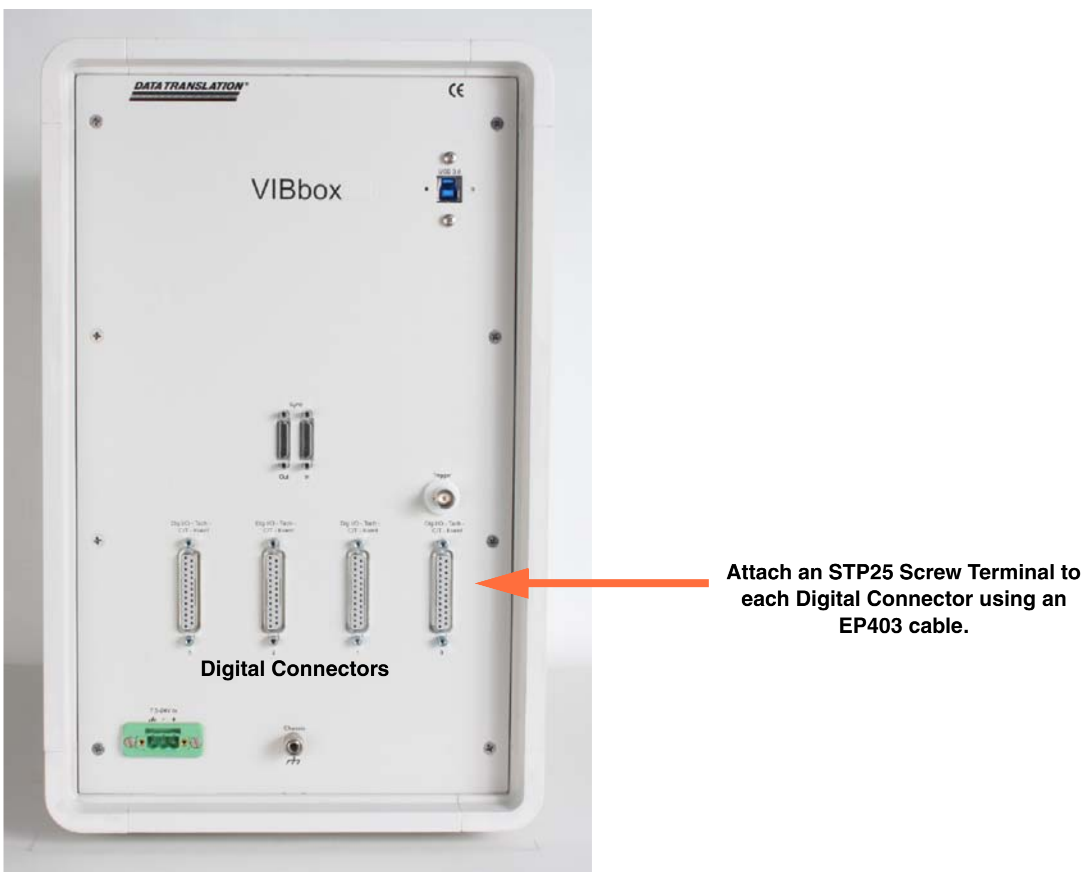
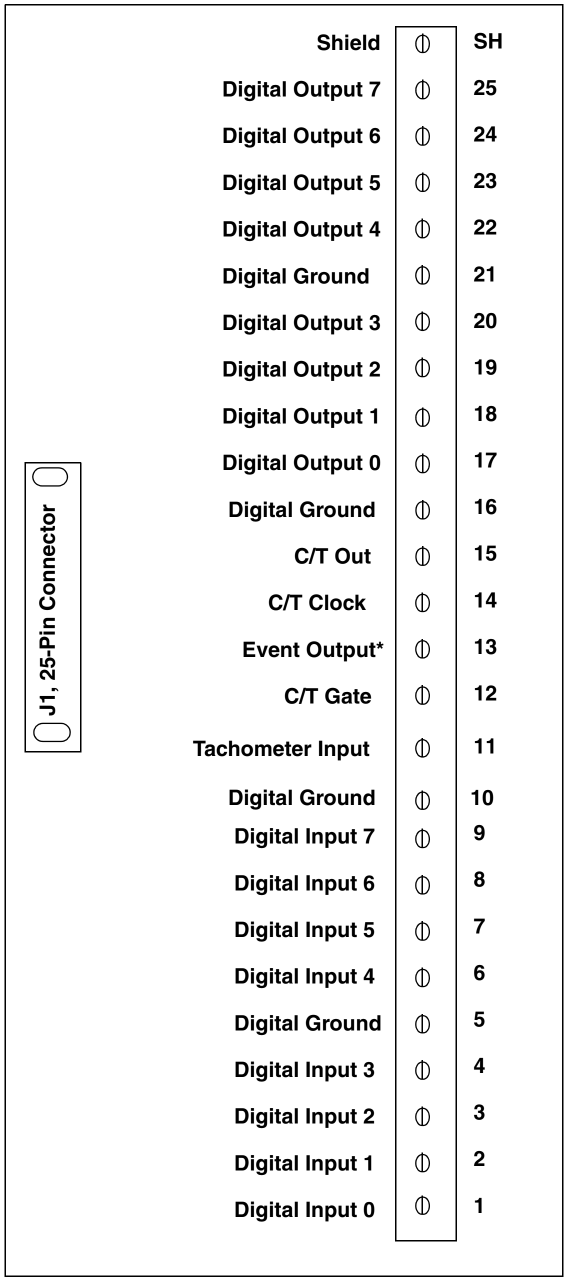


Figure 14: Connecting the STP25 to a Digital Connector on the VIBbox

The STP25 contains one 25-pin connector and a screw terminal block. The 25-pin connector provides access to the signals from the Digital connector on the VIBbox. Figure 15 shows the layout of the STP25 and lists the screw terminal assignments.



***Currently, the event output function is disabled and the output is driven low.**

Figure 15: Layout of the STP25 Screw Terminal Panel

Connecting Analog Input Signals

The VIBbox-64 supports 64 analog input channels, the VIBbox-48 supports 48 analog input channels, and the VIBbox-32 supports 32 analog input channels.

You connect analog input signals (or IEPE sensors) to the BNC connectors on the VIBbox. Internally, these signals are connected in single-ended mode. The VIBbox supports an input signal range of ±10 V (using a gain of 1) or ±1 V (using a gain of 10).

Note: If you enable the use of the internal excitation current source for IEPE inputs, it is recommended that you choose AC coupling. Refer to page 84 for more information on IEPE inputs.

Figure 16 shows how to connect an analog input signal (channel 0, in this case) to one module of the VIBbox.

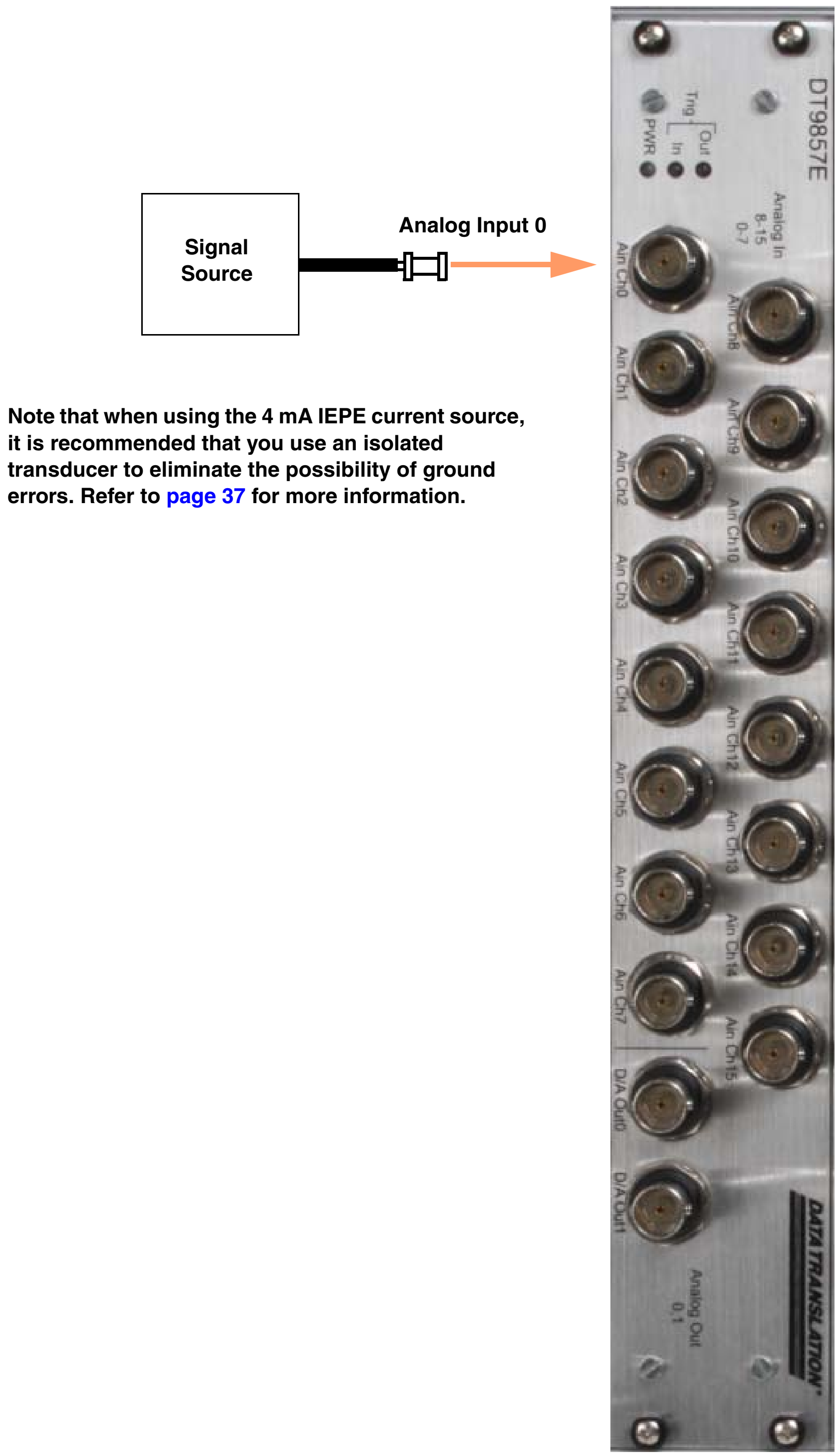
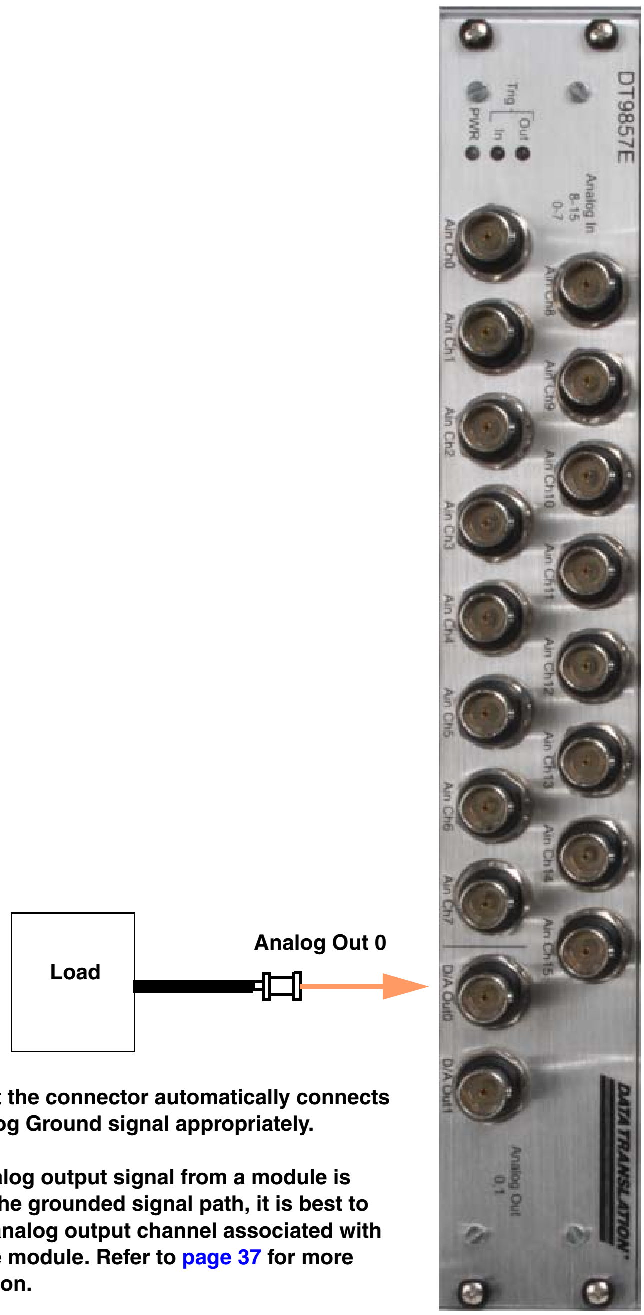


Figure 16: Connecting Analog Input Signals

Connecting Analog Output Signals

The VIBbox-64 supports eight analog output channels, the VIBbox-48 supports six analog output channels, and the VIBbox-32 supports four analog output channels. The output channels have an output range of ±10 V.

Figure 17 shows how to connect an analog output signal (analog output channel 0, in this case) to one module of the VIBbox.



Note that the connector automatically connects the Analog Ground signal appropriately.

If the analog output signal from a module is used in the grounded signal path, it is best to use the analog output channel associated with the same module. Refer to page 37 for more information.

Figure 17: Connecting an Analog Output Signal

Connecting a Tachometer Input Signal

The VIBbox-64 supports four tachometer input signals, the VIBbox-48 supports three tachometer input signals, and the VIBbox-32 supports two tachometer input signals.

You connect the +30 V tachometer input signals to the VIBbox using the Digital connectors (one for each DT9857E module). For each module in the VIBbox, you connect the tachometer input signal to pin 11 of the Digital connector. Figure 18 shows how to connect a tachometer input signal to the STP25 screw terminal panel, which is attached to the Digital connector of a DT9857E module in the VIBbox. Refer to Figure 15 on page 43 for the screw terminal assignments of the STP25 screw terminal panel.

Note: In software, you can read the value of each tachometer in the analog input stream. Refer to page 107 for more information on tachometer measurements.

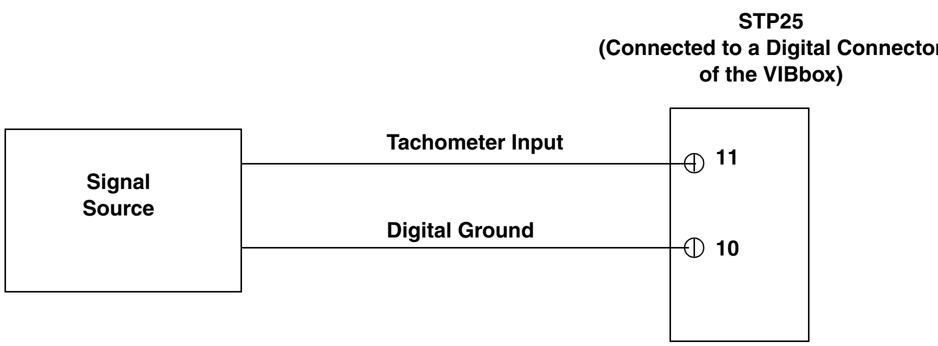


Figure 18: Connecting a Tachometer Input Signal to the VIBbox

Connecting Digital Input Signals

The VIBbox-64 supports 32 digital input signals, the VIBbox-48 supports 24 digital input signals, and the VIBbox-32 supports 16 digital input signals.

You connect the digital input signals to the VIBbox using the Digital connectors (one for each DT9857E module). Figure 19 shows how to connect digital input signals (lines 0 and 1, in this case) to the STP25 screw terminal panel, which is attached to the Digital connector of a DT9857E module in the VIBbox. Refer to Figure 15 on page 43 for the screw terminal assignments of the STP25 screw terminal panel.

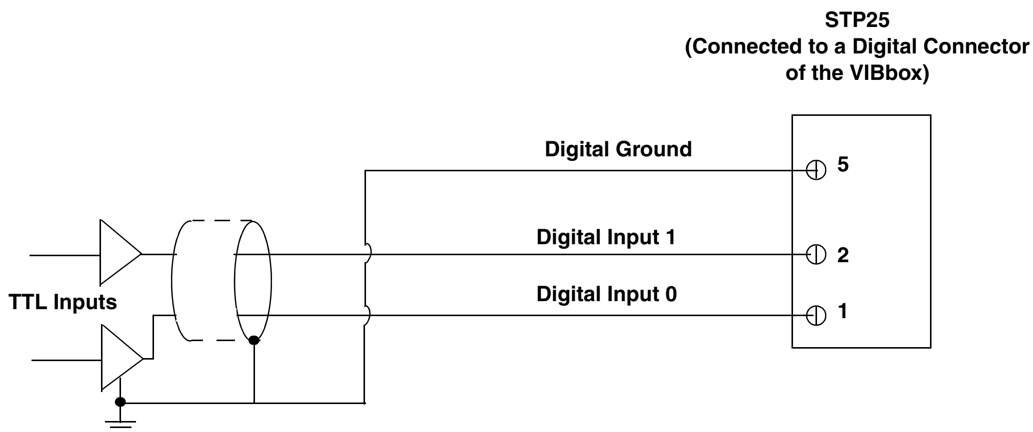
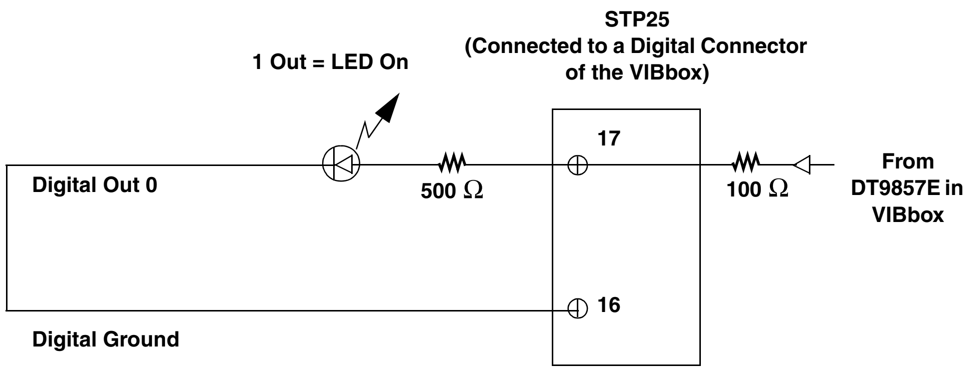


Figure 19: Connecting Digital Inputs

Connecting Digital Output Signals

The VIBbox-64 supports 32 digital output signals, the VIBbox-48 supports 24 digital output signals, and the VIBbox-32 supports 16 digital output signals.

You connect the digital output signals to the VIBbox using the Digital connectors (one for each DT9857E module). Figure 20 shows how to connect a digital output (line 0, in this case) to the STP25 screw terminal panel, which is attached to the Digital connector of a DT9857E module in the VIBbox. Refer to Figure 15 on page 43 for the screw terminal assignments of the STP25 screw terminal panel.



The output current is determined using the following equation:

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

In this example, if the maximum output voltage is 3.3 V, the internal resistor is 100 Ω and the external resistor is 500 Ω, the maximum output current is 5.5 mA. Using the minimum output voltage of 2.4 V with the same resistor values, the minimum current output current is 4.0 mA

Figure 20: Connecting Digital Outputs

Connecting Counter/Timer Signals

The VIBbox-64 supports four general-purpose counter/timers, the VIBbox-48 supports three general-purpose counter/timers, and the VIBbox-32 supports two general-purpose counter/timers.

The general-purpose counter/timers are labelled C/T 0 on each DT9857E module in the VIBbox. The general-purpose counter/timer signals are accessed through the Digital connector on each DT9857E module in the VIBbox. You can use these counter/timers to perform the following operations:

- Event counting
- Up/down counting
- Pulse width/period measurement
- Edge-to-edge measurement
- Continuous edge-to-edge measurement
- Pulse output (continuous, one-shot, and repetitive one-shot)

You can access the counter/timer signals using the STP25 screw terminal panel, described on page 43.

Event Counting

Figure 21 shows how to connect counter/timer signals to the STP25 screw terminal panel to perform an event counting operation on C/T 0 using an external gate. The STP25 is attached to the Digital connector of a DT9857E module in the VIBbox.

The counter counts the number of rising edges that occur on the Counter 0 Clock input when the Counter 0 Gate signal is in the active state (as specified by software). Refer to page 112 for more information on event counting operations.

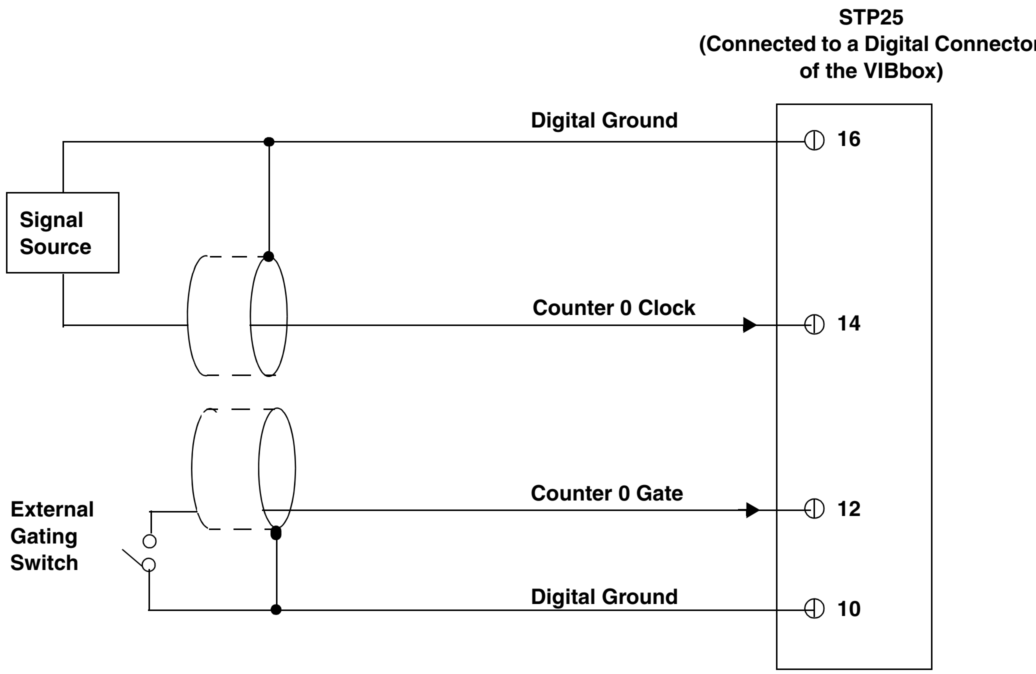


Figure 21: Connecting Counter/Timer Signals for an Event Counting Operation Using an External Gate

Figure 22 shows how to connect counter/timer signals to the STP25 screw terminal panel to perform an event counting operation on C/T 0 without using a gate. The counter counts the number of rising edges that occur on the Counter 0 Clock input.

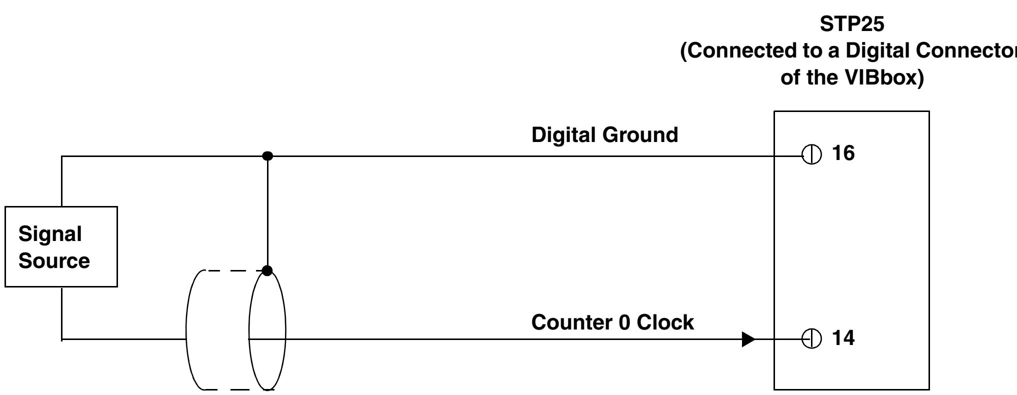


Figure 22: Connecting Counter/Timer Signals for an Event Counting Operation Without Using a Gate

Up/Down Counting

Figure 23 shows how to connect counter/timer signals to an STP25 screw terminal panel to perform an up/down counting operation. The STP25 is attached to the Digital connector of a DT9857E module in the VIBbox.

The counter keeps track of the number of rising edges that occur on the Counter 0 Clock input. The counter increments when the Counter 0 Gate signal is high and decrements when the Counter 0 Gate signal is low. Refer to page 112 for more information about up/down counting operations.

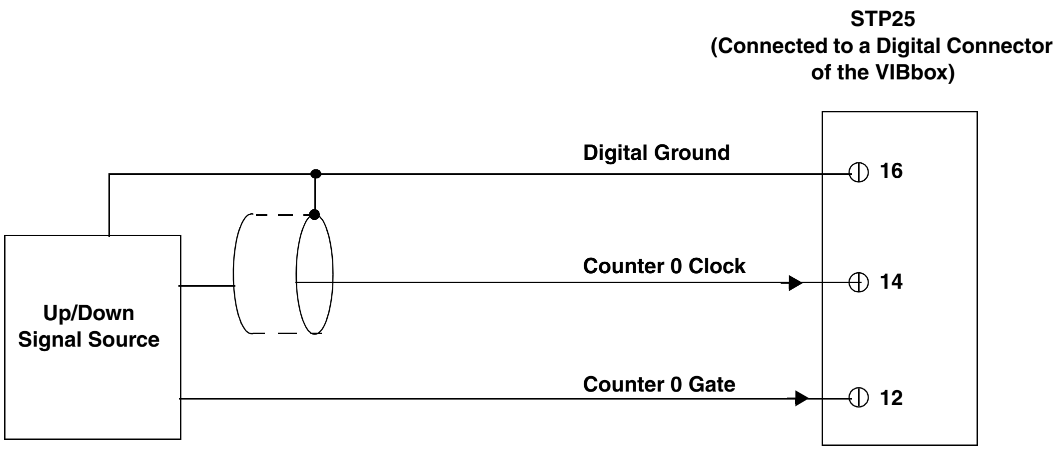


Figure 23: Connecting Counter/Timer Signals for an Up/Down Counting Operation

Period/Pulse Width Measurement

Figure 24 shows how to connect counter/timer signals either to the STP25 screw terminal panel to perform a period/pulse width measurement operation. The STP25 is attached to the Digital connector of a DT9857E module in the VIBbox.

You specify the active pulse (high or low) in software. The pulse width is the percentage of the total pulse period that is active. Refer to page 111 for more information about pulse periods and pulse widths.

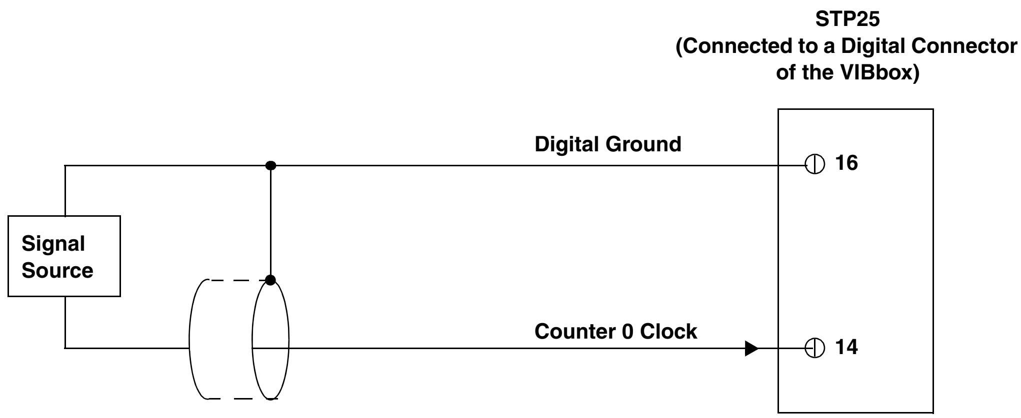


Figure 24: Connecting Counter/Timer Signals for a Period/Pulse Width Measurement Operation

Edge-to-Edge Measurement

Figure 25 shows how to connect counter/timer signals to the STP25 screw terminal panel to perform an edge-to-edge measurement operation using two signal sources. The STP25 is attached to the Digital connector of a DT9857E module in the VIBbox.

The counter measures the number of counts between the start edge (in this case, a rising edge on the Counter 0 Clock signal) and the stop edge (in this case, a falling edge on the Counter 0 Gate signal).

You specify the start edge and the stop edge in software. Refer to page 113 for more information on edge-to-edge measurement mode.

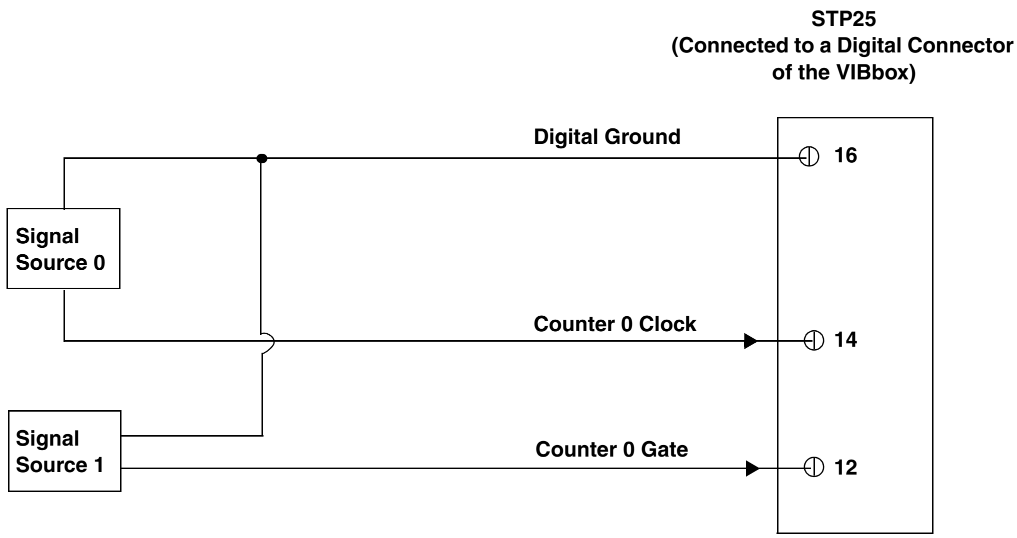


Figure 25: Connecting Counter/Timer Signals for an Edge-to-Edge Measurement Operation

Continuous Edge-to-Edge Measurement

Figure 26 shows how to connect counter/timer signals to the STP25 screw terminal panel to perform a continuous edge-to-edge measurement operation. The STP25 is attached to the Digital connector of a DT9857E module in the VIBbox.

The counter measures the number of counts between two consecutive start edges (in this case, a rising edge on the Counter 0 Clock signal).

You specify the start edge in software. Refer to page 113 for more information on continuous edge-to-edge measurement mode.

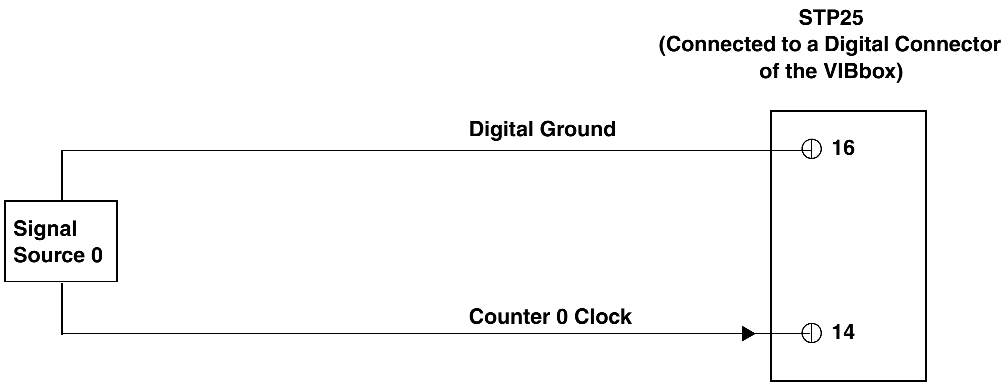


Figure 26: Connecting Counter/Timer Signals for a Continuous Edge-to-Edge Measurement Operation

Pulse Output

Figure 27 shows how to connect counter/timer signals to an STP25 screw terminal panel to perform a pulse output operation. The STP25 is attached to the Digital connector of a DT9857E module in the VIBbox.

In this example, an external gate is used. Refer to page 114 through page 115 for more information about pulse output operations.

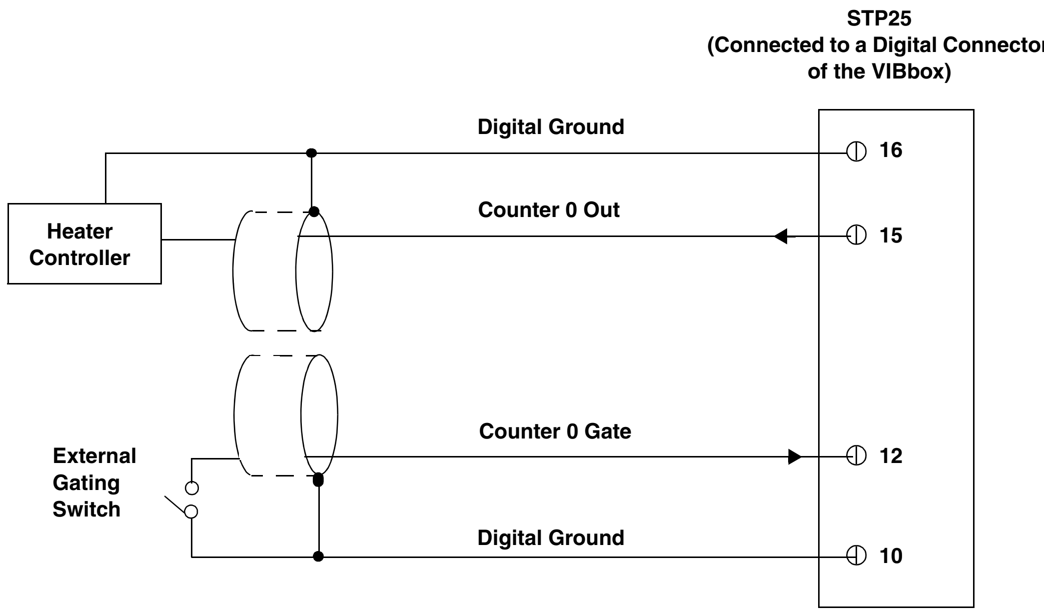


Figure 27: Connecting Counter/Timer Signals for a Pulse Output Operation Using an External Gate

Connecting Signals for Measure Counter Operations

The VIBbox-64 supports eight measure counters, the VIBbox-48 supports six measure counters, and the VIBbox-32 supports four measure counters.

The measure counters are labelled C/T 1 and 2 on each DT9857E module in the VIBbox. You can use the measure counters to measure the frequency, period, or pulse width of a single signal or the time period between two signals and return the value in the analog input stream.

Using software, you must define a signal to start the continuous edge-to-edge measurement operation and a signal to stop the continuous edge-to-edge measurement operation. A variety of signals are supported. How you wire the signals depends on the signals that you want to use. Table 2 lists the possible start and stop signals and the connections that are required for each signal type.

Table 2: Possible Start and Stop Signals

Signal	Connection Required
A/D conversion complete	No connection required
Tachometer input (falling edge or rising edge)	Connect to pin 11 of the Digital Connector
Digital input 0 (falling edge or rising edge)	Connect to Pin 1 of the Digital Connector
Digital input 1 (falling edge or rising edge)	Connect to Pin 2 of the Digital Connector
Digital input 2 (falling edge or rising edge)	Connect to Pin 3 of the Digital Connector
Digital input 3 (falling edge or rising edge)	Connect to Pin 4 of the Digital Connector
Digital input 4 (falling edge or rising edge)	Connect to Pin 6 of the Digital Connector
Digital input 5 (falling edge or rising edge)	Connect to Pin 7 of the Digital Connector
Digital input 6 (falling edge or rising edge)	Connect to Pin 8 of the Digital Connector
Digital input 7 (falling edge or rising edge)	Connect to Pin 9 of the Digital Connector
C/T 0 Clock input (falling edge or rising edge)	Connect to Pin 14 of the Digital Connector
C/T 0 Gate input (falling edge or rising edge)	Connect to Pin 12 of the Digital Connector

Figure 26 shows an example of connecting signals to the STP25 screw terminal panel for a continuous edge-to-edge measurement operation using a measure counter. The STP25 is attached to the Digital connector of a DT9857E module in the VIBbox.

In this example, the signal that starts the measurement is the rising edge of the digital input signal connected to digital input 7. The signal that stops the measurement is the rising edge of the clock input signal connected to C/T 0. (You configure the signals/edges in software).

In this example, measure counter 1 is set up to measure the number of counts between the starting edge (the rising edge of the signal connected to digital input 7) and the stopping edge (the rising edge of the clock input signal connected to C/T 0). By including measure counter 1 in the analog input channel list, you can read the count and determine the time period between the two signals. Refer to page 116 for more information on measure counters.

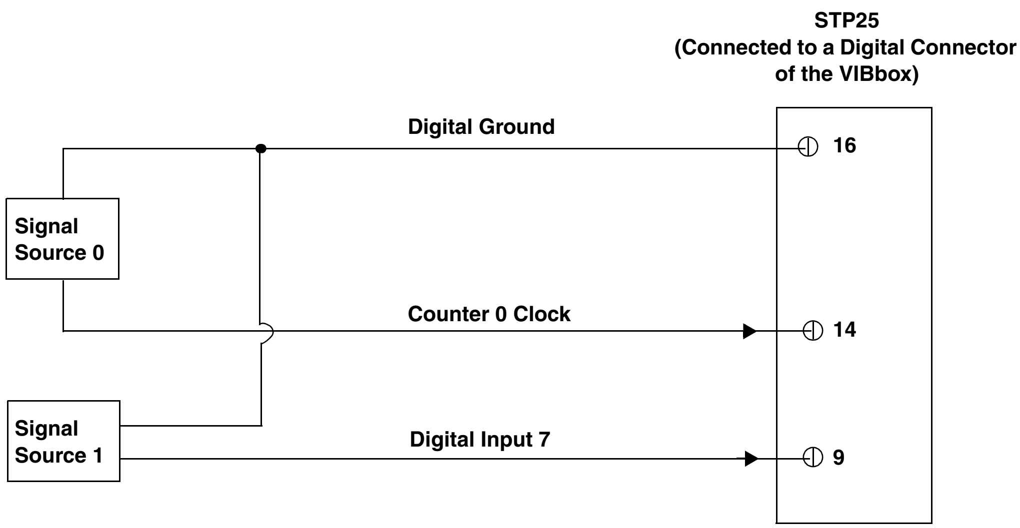
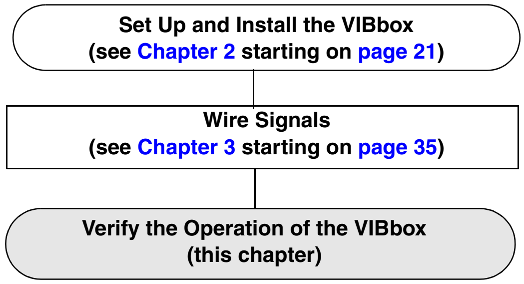


Figure 28: An Example of Connecting Signals for a Continuous Edge-to-Edge Measurement Operation Using a Measure Counter

4

Verifying the Operation of a VIBbox

Start QuickDAQ 61
Select the Device 62
Select the FFT Analyzer Interface 64
Configure the Channels 65
Configure the Recording Settings 69
Configure the Frequency Settings 71
Configure the Trigger Settings 72
Configure the FFT Windowing Settings 73
Add an FFT Channel to the Channel Plot Display 74
Configure the Appearance of the Channel Plot Display 75
Start the Operation 76



You can verify the operation of the VIBbox 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 the VIBbox using the QuickDAQ Advanced FFT version. In this example, the analog output channel outputs a sine wave, which is acquired by analog input channel 0 on the VIBbox. The time domain data and an FFT of the data are displayed and logged to disk.

Start QuickDAQ

A license key for the Advanced FFT Analysis option comes free of charge with the VIBbox product. To use QuickDAQ with the Advanced FFT Analysis option, perform the following steps:

1. Connect the VIBbox to the USB port of your computer, and connect your sensors to the VIBbox.
2. Start the QuickDAQ application.
3. If this is the first time you have used QuickDAQ, the License info dialog appears. Otherwise, click the **Help** menu, and then click **License information**.
   The License info dialog appears:

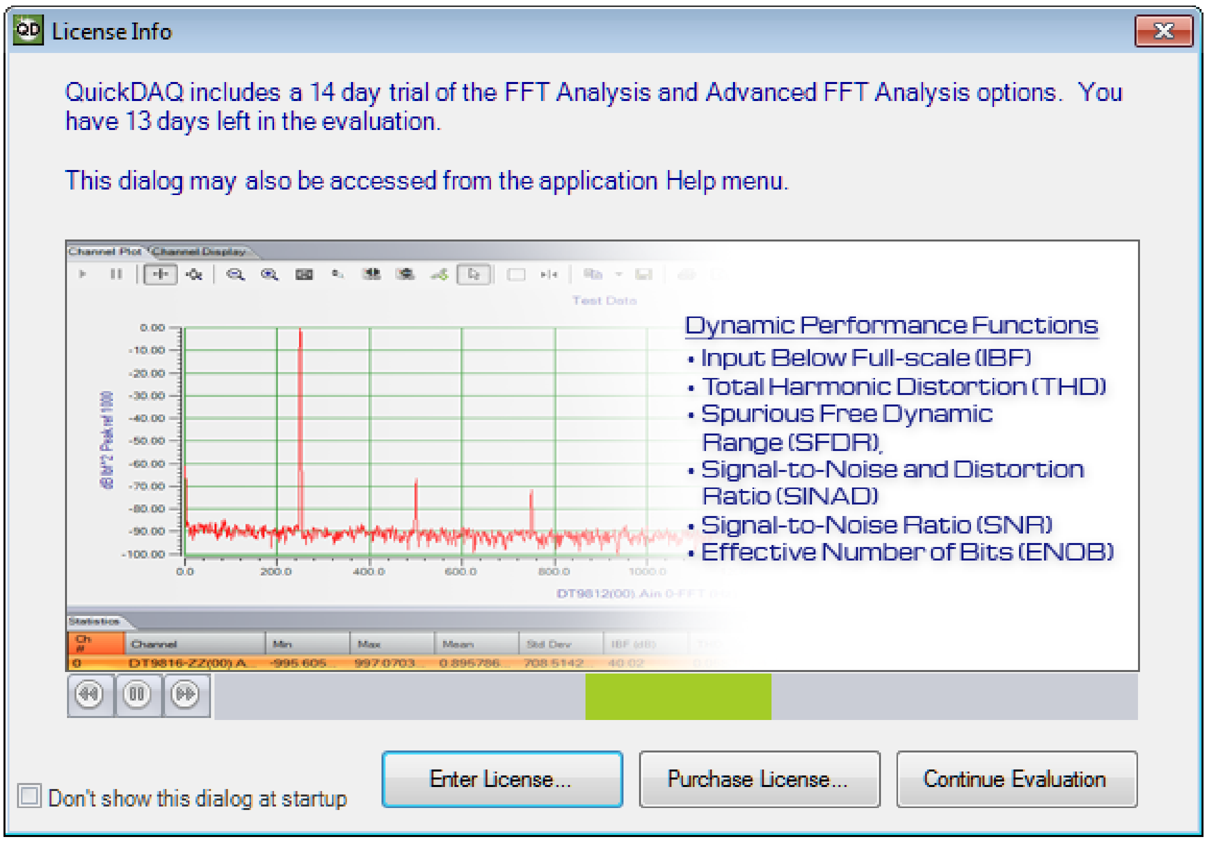


Figure 29: License Info Dialog

4. Click **Enter License** from the License Info dialog.
   The Enter License Key dialog is displayed.
5. Enter the license key or copy and paste the license key from the clipboard using the **Paste from Clipboard** button, and click **Apply License and Continue**.
   The Device Selection dialog appears.

Select the Device

Once you enter the license information, the Device Selection dialog appears as follows:

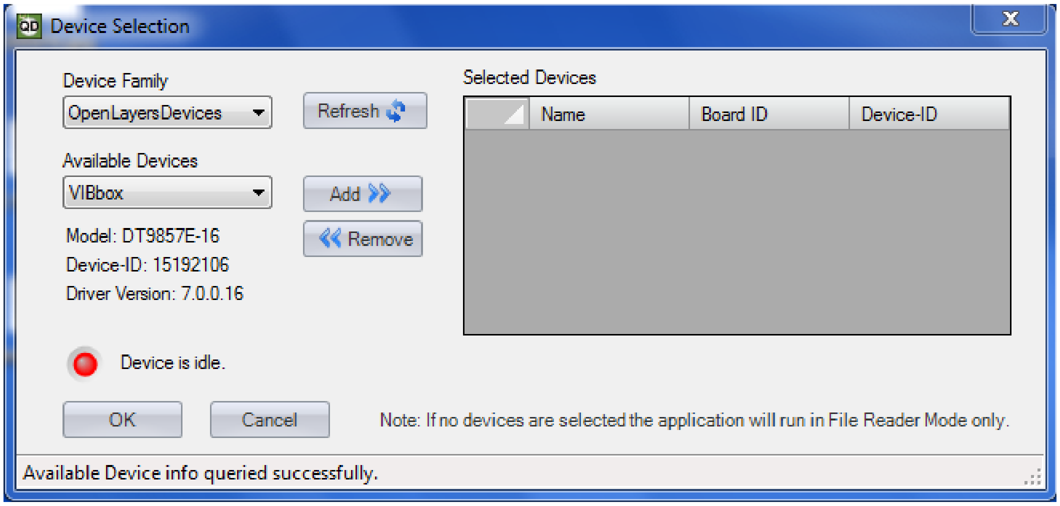
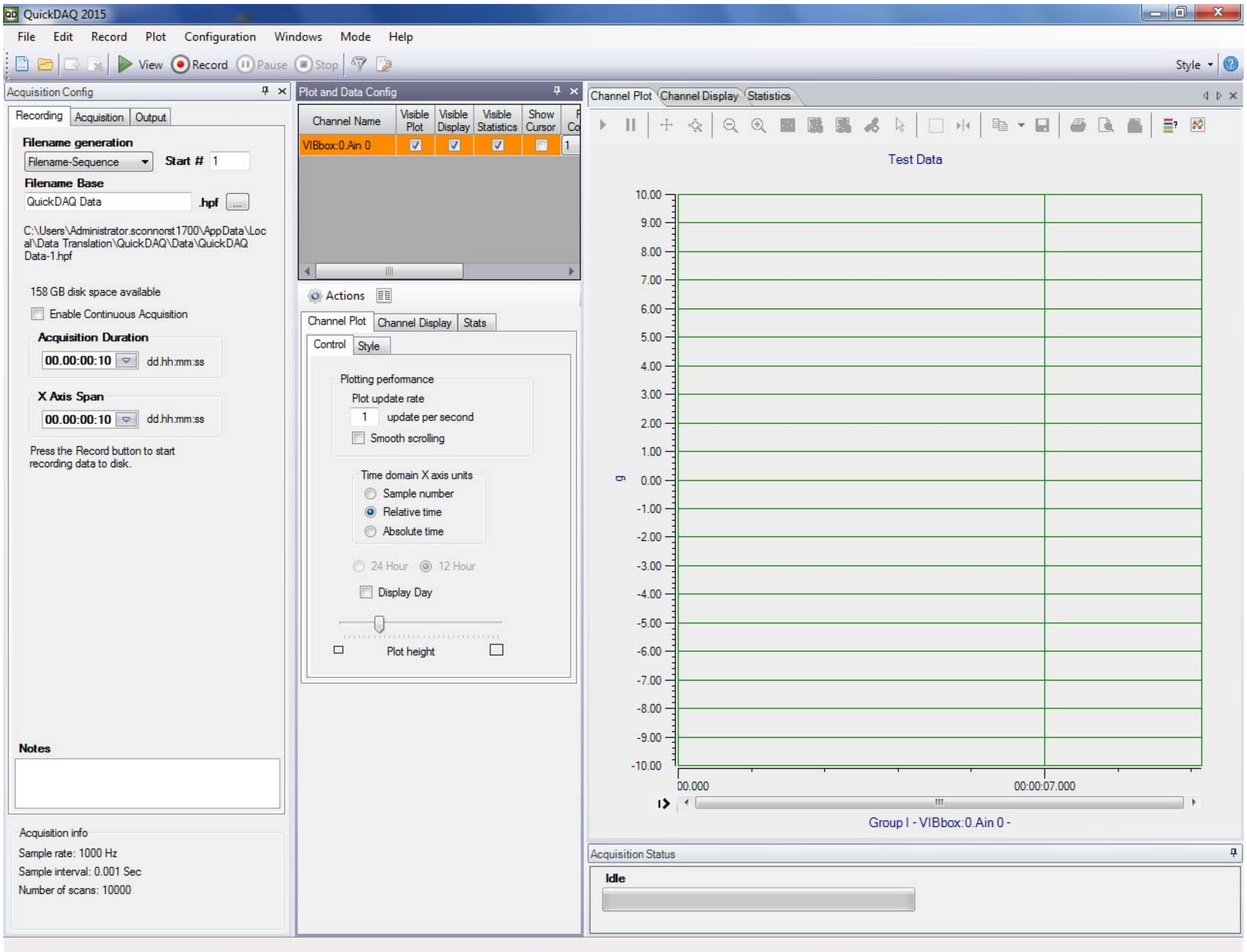


Figure 30: Device Selection Dialog

To use the VIBbox system in QuickDAQ, perform the following steps:

1. From the Device Selection dialog, select **OpenLayersDevices** for the Device Family. By default, the application "discovers" all devices that are available for the specified device family and displays the device name for the VIBbox devices in the drop-down list. If you want to refresh this list to determine if other devices are available, click **Refresh**.
2. Select the name for the VIBbox that you want to use from the list of Available Devices, and click **Add**.
   Information about the first DT9857E device in the VIBbox system (the master device), including the model number, serial number, firmware version, driver version, and scanning status is displayed.
3. (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**.
4. 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 Data Logger interface of the QuickDAQ application is displayed.


QuickDAQ 2015
File Edit Record Plot Configuration Windows Mode Help
View Record Pause Stop
Style
Acquisition Config
Recording Acquisition Output
Filename generation
Filename-Sequence Start # 1
Filename Base
QuickDAQ Data .hpf
C:\Users\Administrator.sconnorst1700\AppData\Local\Data Translation\QuickDAQ\Data\QuickDAQ Data-1.hpf
158 GB disk space available
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: 0.001 Sec
Number of scans: 10000
Plot and Data Config
Channel Name
Visible Plot
Visible Display
Visible Statistics
Show Cursor
VIBbox:0.Ain 0
Actions
Channel Plot Channel Display Stats
Control Style
Plotting performance
Plot update rate
1 update per second
Smooth scrolling
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
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
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-8.00
-9.00
-10.00
g
00.000
00:00:07.000
Group I - VIBbox:0.Ain 0 -
Acquisition Status
Idle

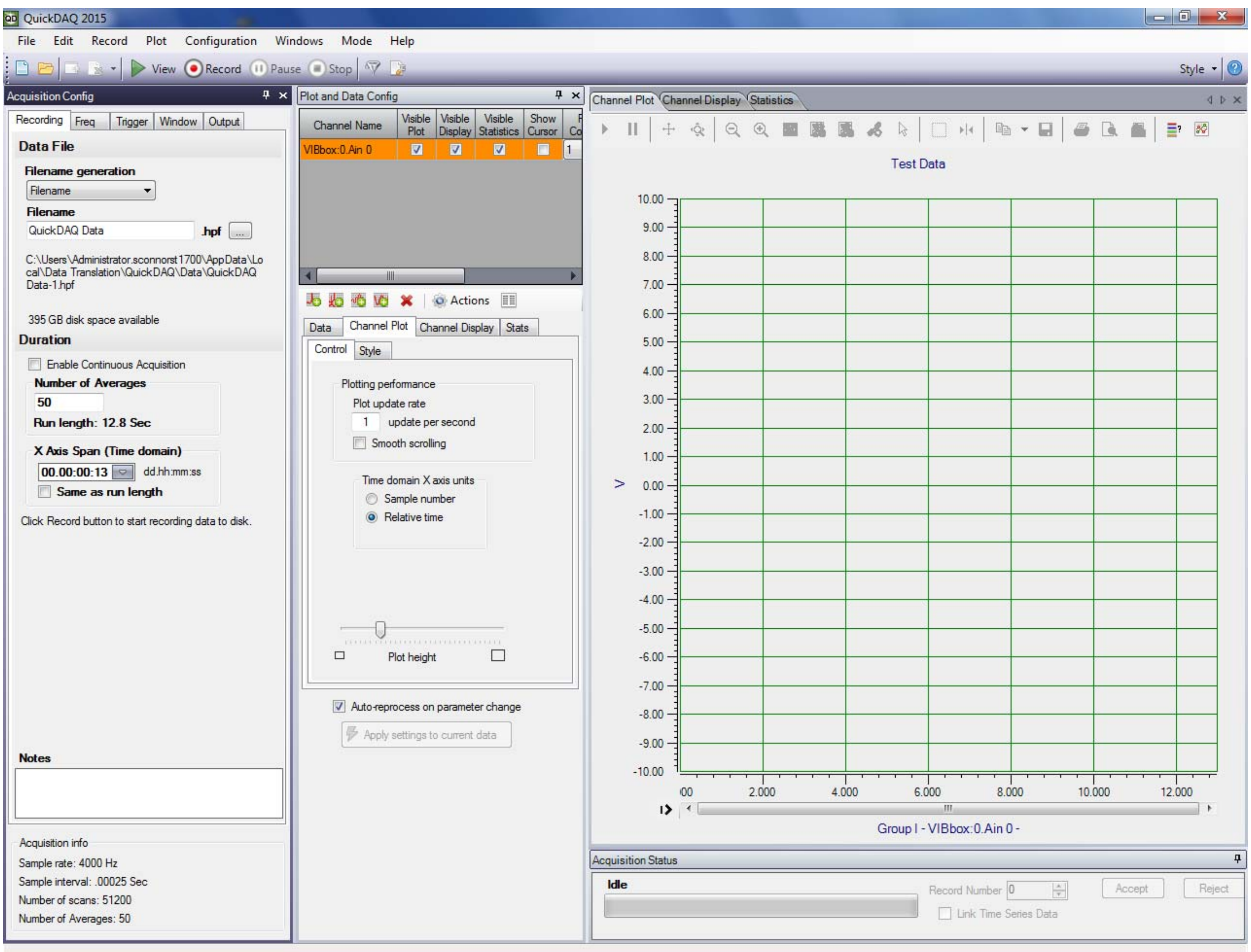
Select the FFT Analyzer Interface

By default, QuickDAQ uses the Data Logger interface provided for the Base version of QuickDAQ.

In this example, we want to output a ±5 V sine wave on analog output 0, acquire the data on analog input 0, and perform and FFT on the acquired data. Therefore, we need to use the FFT Analyzer interface of QuickDAQ.

To use the FFT Analyzer interface for the Advanced FFT Analysis option of QuickDAQ, do the following:

1. Click the **Mode** menu.
2. Click **FFT Analyzer**.
   The FFT Analyzer interface of QuickDAQ is shown.



Configure the Channels

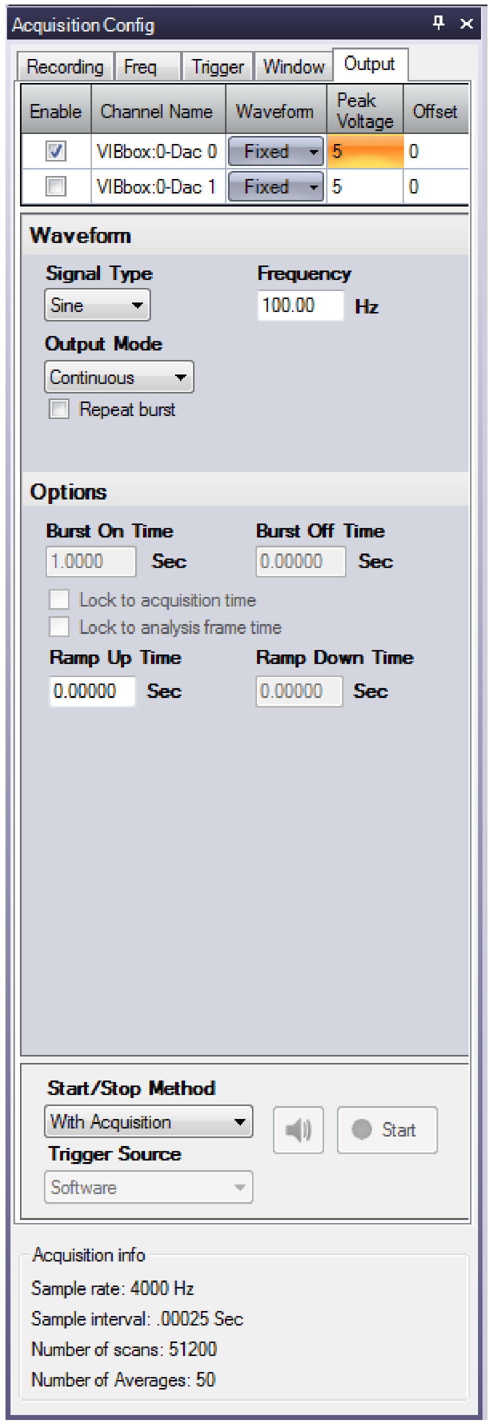
In this example, we want to output a ±5 V sine wave on analog output channel 0 of the VIBbox (DT9857E device 0) and acquired the data on analog input channel 0 of the VIBbox (DT9857E device 0)

This section describes how to configure the analog output and analog input channel settings for this application.

Configure the Analog Output Settings

For this example, configure the analog output channel as follows:

1. Click the **Output** tab of the Acquisition Config window.
2. Select the **Enable** checkbox to enable the analog output channel on the VIBbox.
3. For the **Waveform** type, select **Fixed**.
4. For **Peak Voltage,** enter **5** to output a ±5 V signal.
5. For **Offset**, enter **0**.
6. For **Signal Type**, select **Sine** to output a sine wave.
7. For **Output Mode**, select **Continuous** to output a waveform that repeats continuously.
8. For **Frequency**, select **100 Hz**; this is the frequency of the output waveform.
9. For **Ramp Up Time**, enter **0**.
10. For the **Start/Stop Method**, select **With Acquisition**.
    The analog output operation will start when you start acquisition.

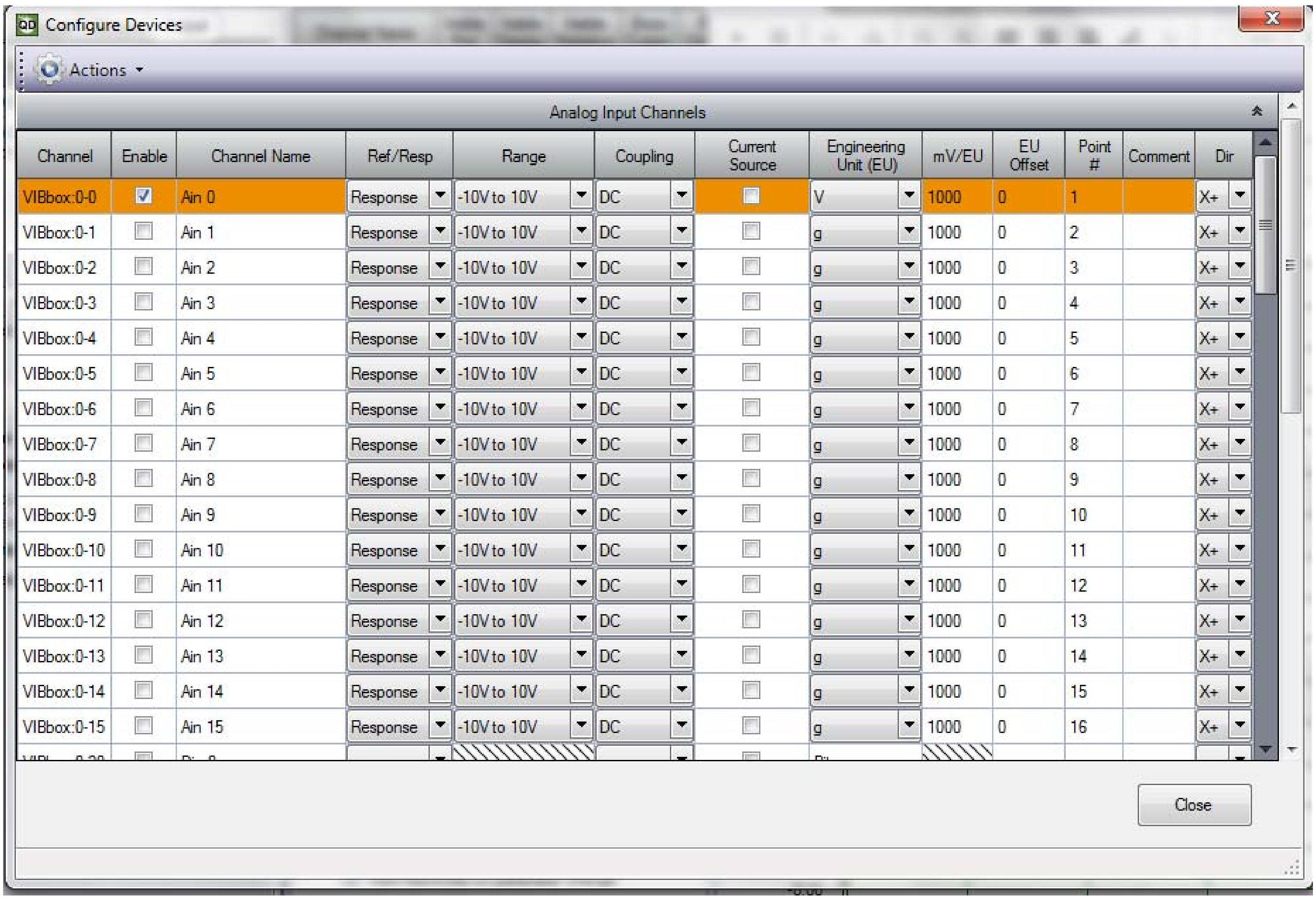


11. If desired, hide the Acquisition Config window by clicking the Auto-Hide pin ( ) in the top, right corner of the window.

Configure the Analog Input Channel

Configure the analog input channel as follows:

1. Ensure that the output from analog output channel 0 is connected to the input of analog input channel 0.
2. Configure the analog input channel by clicking the **Input Channel Configuration** toolbar button ( ) or by clicking the **Configuration** menu and clicking **Input Channel Configuration**.
3. Enable analog input channel 0 by clicking the **Enable** checkbox next to the channel.



Channel	Enable	Channel Name	Ref/Resp	Range	Coupling	Current Source	Engineering Unit (EU)	mV/EU	EU Offset	Point #	Comment	Dir
VIBbox:0-0	☑	Ain 0	Response	-10V to 10V	DC	☐	V	1000	0	1		X+
VIBbox:0-1	☐	Ain 1	Response	-10V to 10V	DC	☐	g	1000	0	2		X+
VIBbox:0-2	☐	Ain 2	Response	-10V to 10V	DC	☐	g	1000	0	3		X+
VIBbox:0-3	☐	Ain 3	Response	-10V to 10V	DC	☐	g	1000	0	4		X+
VIBbox:0-4	☐	Ain 4	Response	-10V to 10V	DC	☐	g	1000	0	5		X+
VIBbox:0-5	☐	Ain 5	Response	-10V to 10V	DC	☐	g	1000	0	6		X+
VIBbox:0-6	☐	Ain 6	Response	-10V to 10V	DC	☐	g	1000	0	7		X+
VIBbox:0-7	☐	Ain 7	Response	-10V to 10V	DC	☐	g	1000	0	8		X+
VIBbox:0-8	☐	Ain 8	Response	-10V to 10V	DC	☐	g	1000	0	9		X+
VIBbox:0-9	☐	Ain 9	Response	-10V to 10V	DC	☐	g	1000	0	10		X+
VIBbox:0-10	☐	Ain 10	Response	-10V to 10V	DC	☐	g	1000	0	11		X+
VIBbox:0-11	☐	Ain 11	Response	-10V to 10V	DC	☐	g	1000	0	12		X+
VIBbox:0-12	☐	Ain 12	Response	-10V to 10V	DC	☐	g	1000	0	13		X+
VIBbox:0-13	☐	Ain 13	Response	-10V to 10V	DC	☐	g	1000	0	14		X+
VIBbox:0-14	☐	Ain 14	Response	-10V to 10V	DC	☐	g	1000	0	15		X+
VIBbox:0-15	☐	Ain 15	Response	-10V to 10V	DC	☐	g	1000	0	16		X+

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

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

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

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

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

12. If desired, enter a test point value for the channel.
    *In this example, **1** is used.*

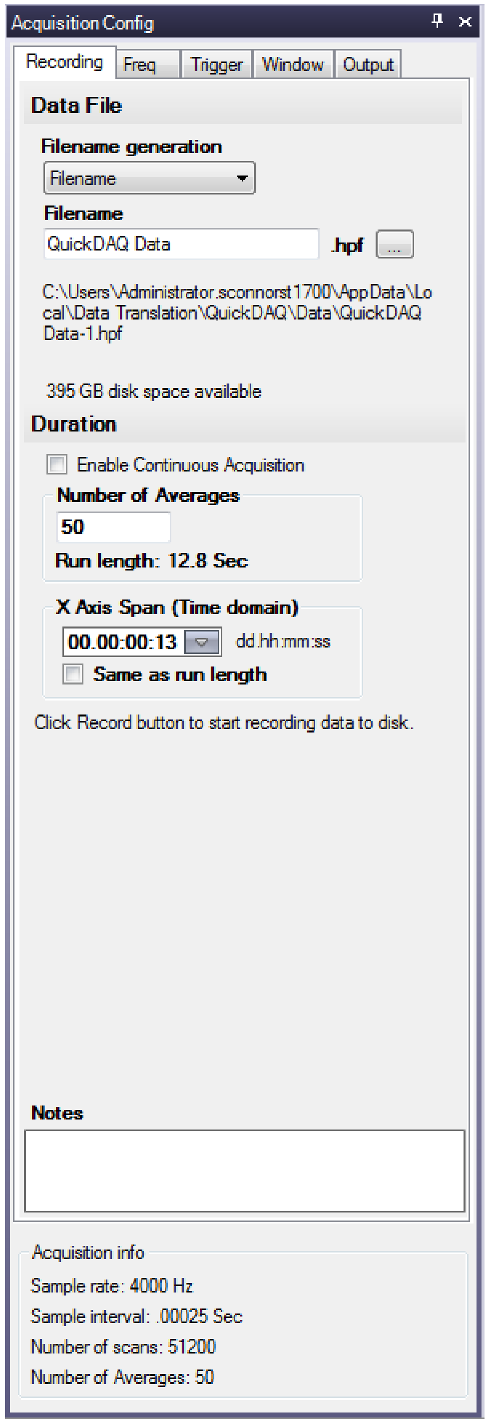
13. If desired, enter a sensor direction for each channel.
    In this example, the default value (X+) is used.

14. 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.

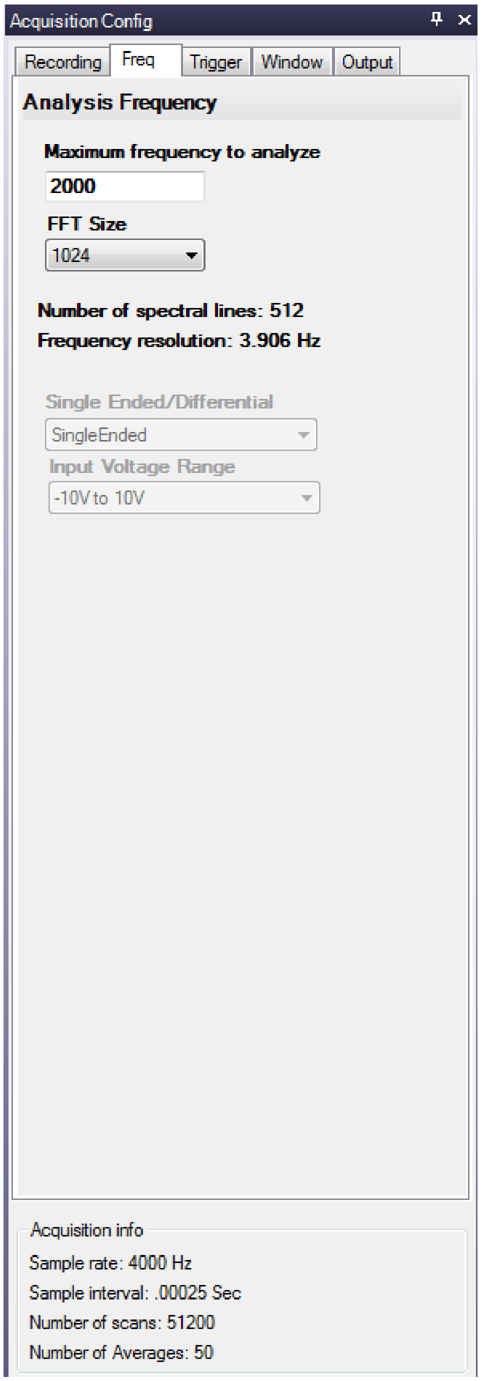


2. For **Filename generation**, use the **Filename** option.
3. For **Filename**, use the default name for the data file.
4. Leave the **Enable Continuous Acquisition** checkbox unchecked.
5. Leave the **Number of Averages** at the default value of **50**.
6. For **X Axis Span**, leave the default value of **13 seconds**.
   The sample rate, sample interval, number of scans, and number of averages are shown.

Configure the Frequency Settings

For this example, configure the frequency settings as follows:

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



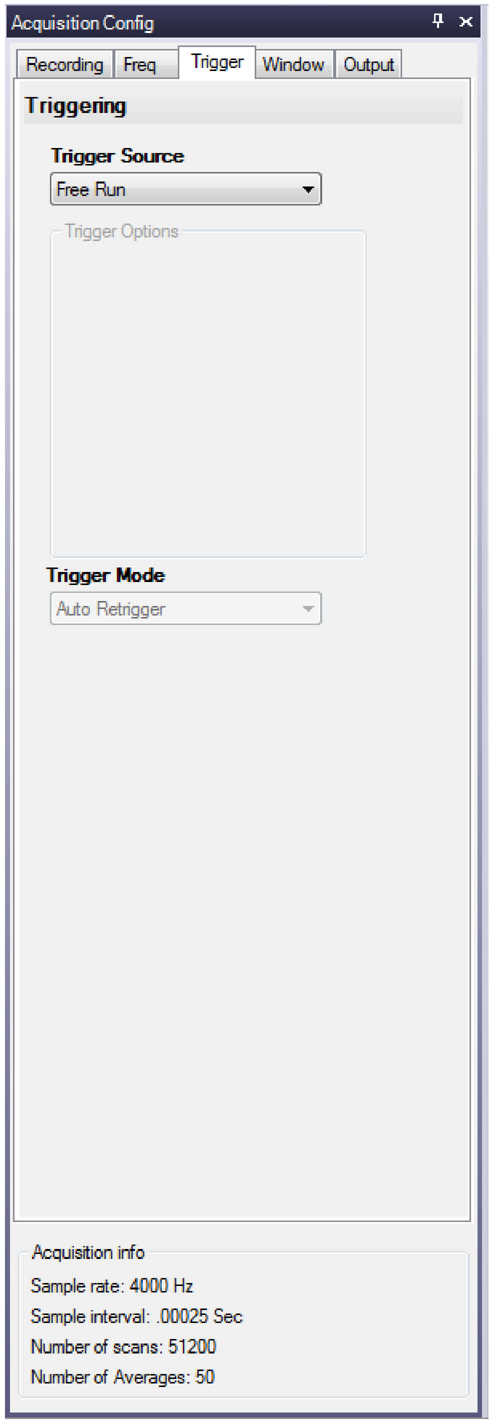
2. For the **Maximum Frequency to Analyze** text box, enter **2000**.
   The sampling rate, sample interval, and number of scans are displayed.

3. For the **FFT size**, select **1024**.
   The number of spectral lines and frequency resolution are shown.

Configure the Trigger Settings

For this example, configure the trigger settings as follows:

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



2. For the **Trigger Source** check box, select **FreeRun** to ensure that the measurement starts as soon as the **Record** button is clicked.

Configure the FFT Windowing Settings

Configure the FFT windowing function that you want to apply to the FFT channel as follows:

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

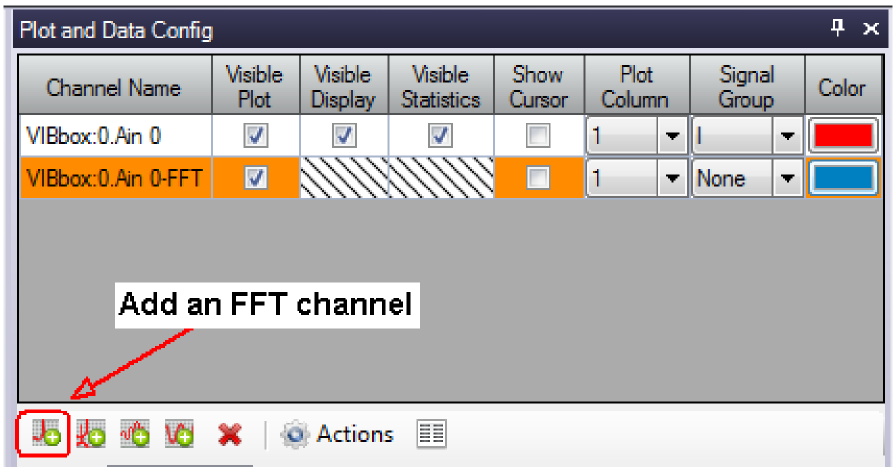
2. For the **Response Window Type**, select the windowing function that you want to apply to the FFT channel. *This examples uses the Hamming window.*

Add an FFT Channel to the Channel Plot Display

In this example, we want to perform an FFT on the acquired data using the windowing function that we selected earlier. To do this, we need to add an FFT channel to the Channel Plot display.

To add a single channel FFT function to Channel Plot display, perform the following steps:

1. Click the **Add single channel FFT function** () button in the Plot and Data Config window.



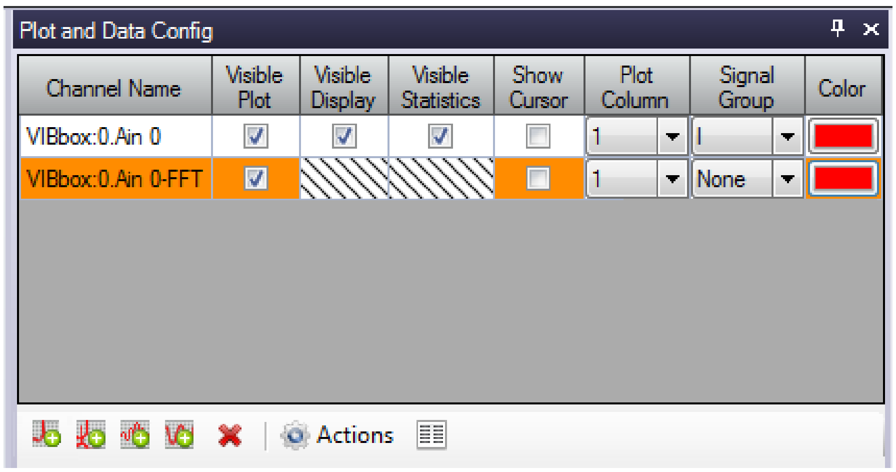
2. Then, choose the analog input channel for which to generate the FFT.
   In this example, channel Ain0 is used.

Configure the Appearance of the Channel Plot Display

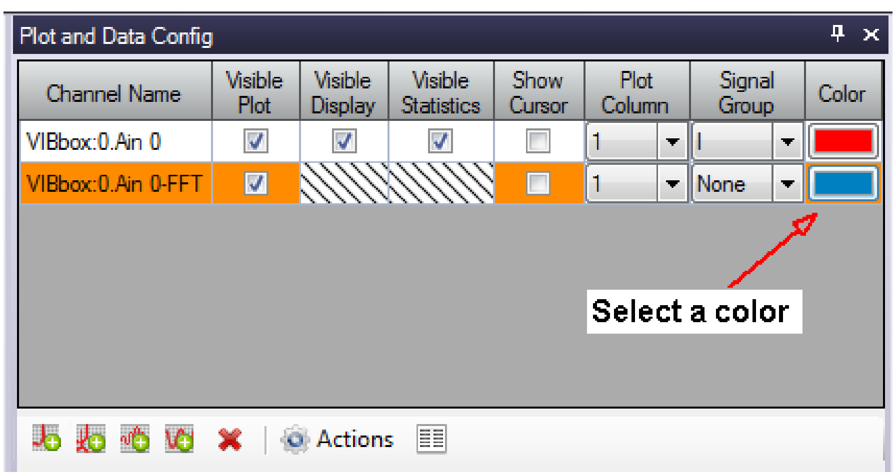
In this example, we want to plot both the time domain data acquired by analog input channel 0 and the FFT of the data.

To ensure that data from both channels is plotted in the Channel Plot display and that each channel shows up in a unique color, configure the appearance of the Channel Plot Display as follows:

1. Under the **Visible Plot** heading, ensure that the checkbox is selected for both the analog input channel (VIBbox:0:Ain 0) and the FFT channel (VIBbox:0.Ain 0-FFT).



2. Leave the settings for the **Visible Display**, **Statistics**, **Show Cursor, Plot Column**, and **Signal Group** columns at their default values.
3. Assign a unique color for each trace.



Start the Operation

Once you have configured the channels and the application parameters, click the **Record** toolbar button (

) or press the **F5** key to start the operation.

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

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 the VIBbox

5

Principles of Operation

Block Diagrams 80
Analog Input Features 84
Analog Output Features 99
Tachometer Input Features 107
General-Purpose Counter/Timer Features 109
Measure Counter Features 116
Digital I/O Features 120

Block Diagrams

Figure 31 shows a block diagram of the VIBbox-64; Figure 32 shows a block diagram of the VIBbox-48, and Figure 33 shows a block diagram of the VIBbox-32.

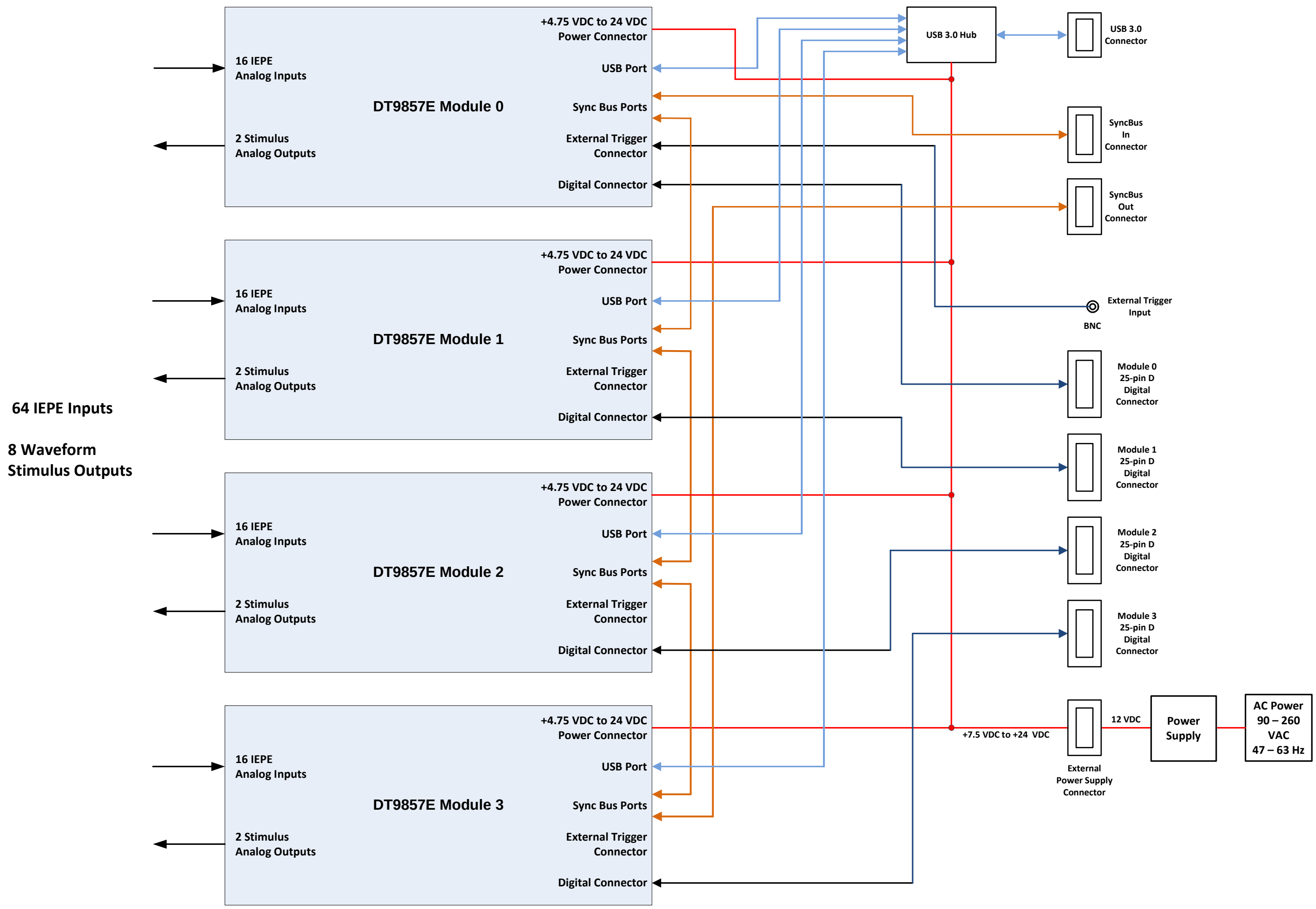


Figure 31: Block Diagram of the VIBbox-64

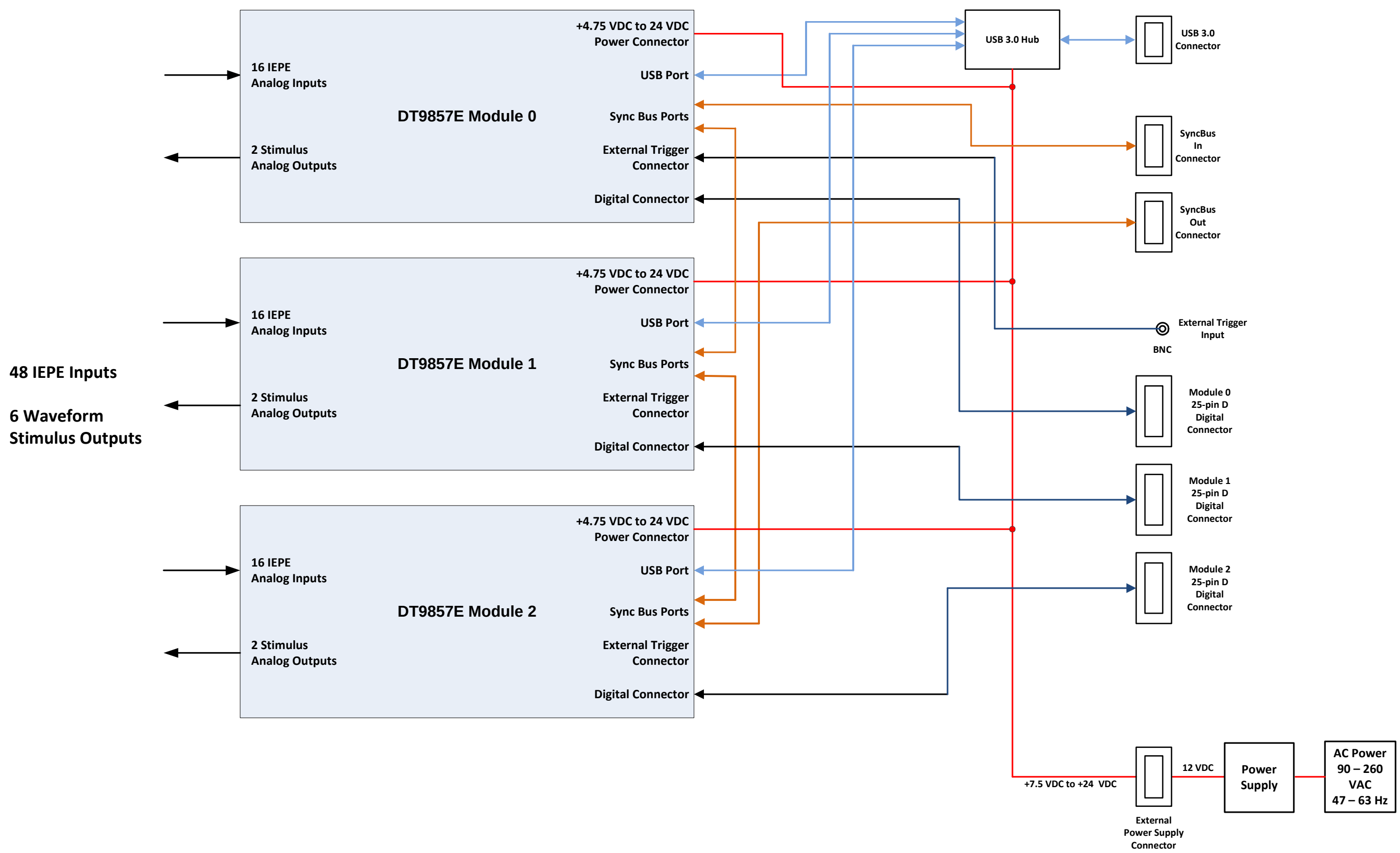


Figure 32: Block Diagram of VIBbox-48

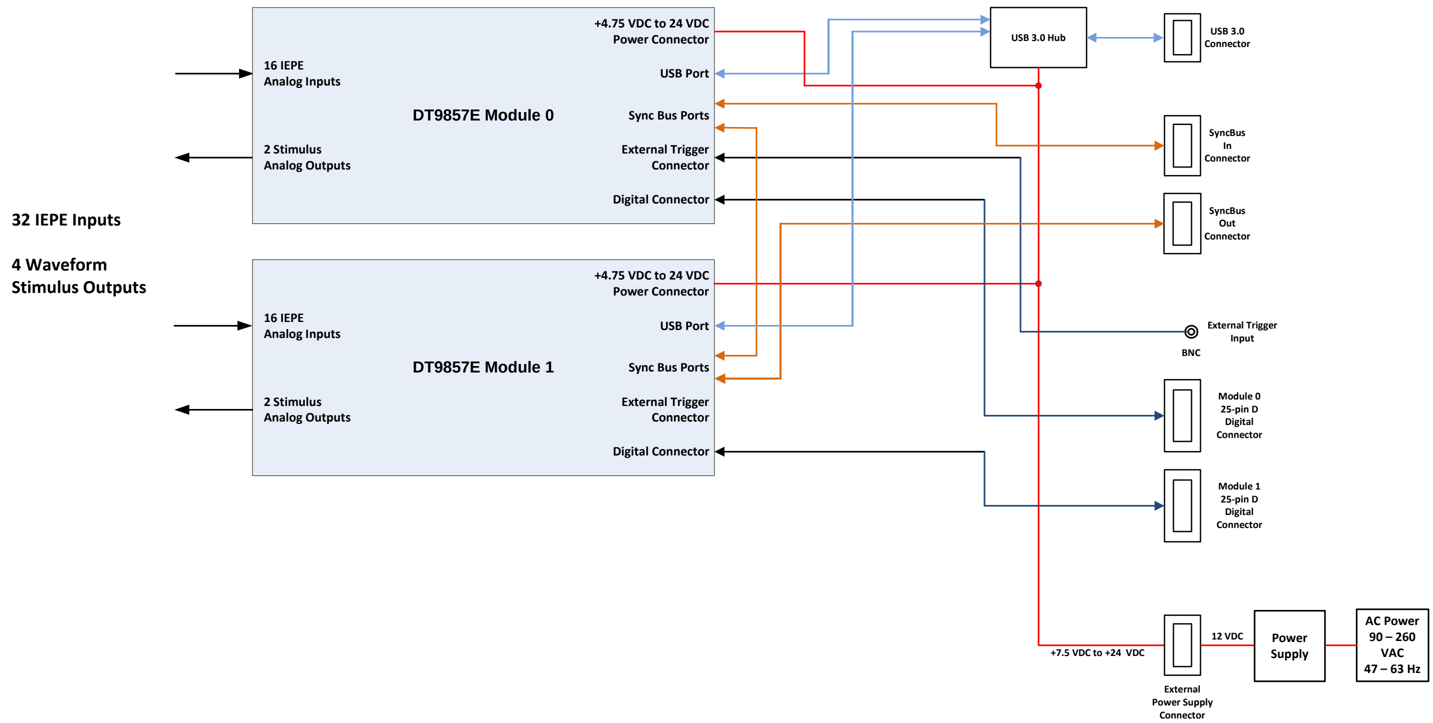


Figure 33: Block Diagram of VIBbox-32

Figure 34 shows the block diagram of each DT9857E module.

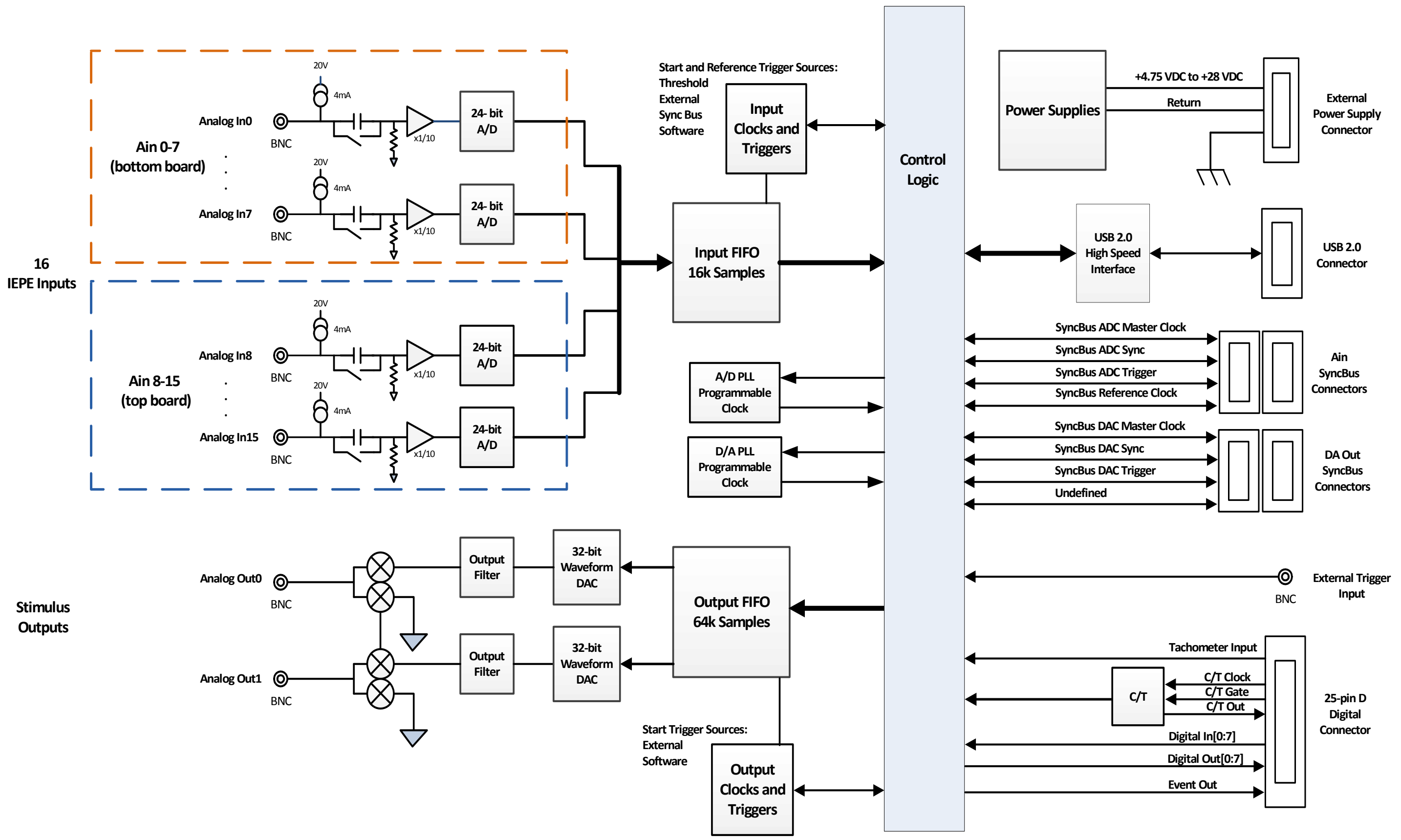


Figure 34: Block Diagram of the DT9857E

Analog Input Features

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

- Analog input channels, described on this page
- Analog input channel numbers and names, described on page 85
- Input ranges and gains, described on page 92
- IEPE functions, described on page 93
- Input resolution, described on page 93
- Input sample clock source, described on page 93
- Analog input conversion modes, described on page 94
- Input triggers, described on page 96
- Data format and transfer, described on page 98
- Error conditions, described on page 98

Analog Input Channels

The VIBbox packages multiple DT9857E modules in an enclosure. Each module (0, 1, 2, and 3) supports 16 analog input channels (labelled 0 to 15) for a total of up to 64 analog inputs in the VIBbox-64, 48 analog inputs in the VIBbox-48, or 32 analog inputs in the VIBbox-32. Refer to page 85 for more on the channel numbers and names.

These are single-ended channels; you can connect IEPE sensors to these inputs, if desired; refer to page 93 for more information on IEPE functions.

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

Each analog input channel uses a Delta Sigma analog-to-digital converter (ADC) that provides anti-aliasing filters based on the clock rate. These filters remove *aliasing*, which is a condition where high frequency input components erroneously appear as lower frequencies after sampling.

Using software, you can acquire a single value from a single analog input channel, a single value from all the analog input channels simultaneously, or multiple values from a one or more analog input channels, the tachometer, measurement counters, general-purpose counter/timers, and/or the digital input ports in the input data stream. Refer to "Analog Input Conversion Modes" on page 94 for more information on specifying and reading data from these channels.

Analog Input Channel Numbers and Names

The VIBbox is a collection of multiple DT9857E modules. In software, you specify the channel number of the VIBbox (not the channel number of the DT9857E) from which to acquire data or, if the software allows, you specify the name of the VIBbox channel.

Channels numbering starts with all the analog input channels for the VIBbox, followed by the extended channels (tachometers, counters, and digital input port) for each module.

The following sections provide the exact channel numbers and names for each channel of your VIBbox system.

Input Channel Numbers and Names for the VIBbox-64

Table 3 lists the channel numbers and the names for each channel that can be included in the input data stream for the VIBbox-64.

Table 3: Analog Input Subsystem Channel Numbers and Channel Names for the VIBbox-64

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
0	Device 0: Ain0	0	Ain 0
1	Device 0: Ain1		Ain 1
2	Device 0: Ain2		Ain 2
3	Device 0: Ain3		Ain 3
4	Device 0: Ain4		Ain 4
5	Device 0: Ain5		Ain 5
6	Device 0: Ain6		Ain 6
7	Device 0: Ain7		Ain 7
8	Device 0: Ain8		Ain 8
9	Device 0: Ain9		Ain 9
10	Device 0: Ain10		Ain 10
11	Device 0: Ain11		Ain 11
12	Device 0: Ain12		Ain 12
13	Device 0: Ain13		Ain 13
14	Device 0: Ain14		Ain 14
15	Device 0: Ain15		Ain 15

Table 3: Analog Input Subsystem Channel Numbers and Channel Names for the VIBbox-64 (cont.)

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
16	Device 1: Ain0	1	Ain 0
17	Device 1: Ain1		Ain 1
18	Device 1: Ain2		Ain 2
19	Device 1: Ain3		Ain 3
20	Device 1: Ain4		Ain 4
21	Device 1: Ain5		Ain 5
22	Device 1: Ain6		Ain 6
23	Device 1: Ain7		Ain 7
24	Device 1: Ain8		Ain 8
25	Device 1: Ain9		Ain 9
26	Device 1: Ain10		Ain 10
27	Device 1: Ain11		Ain 11
28	Device 1: Ain12		Ain 12
29	Device 1: Ain13		Ain 13
30	Device 1: Ain14		Ain 14
31	Device 1: Ain15		Ain 15
32	Device 2: Ain0	2	Ain 0
33	Device 2: Ain1		Ain 1
34	Device 2: Ain2		Ain 2
35	Device 2: Ain3		Ain 3
36	Device 2: Ain4		Ain 4
37	Device 2: Ain5		Ain 5
38	Device 2: Ain6		Ain 6
39	Device 2: Ain7		Ain 7
40	Device 2: Ain8		Ain 8
41	Device 2: Ain9		Ain 9
42	Device 2: Ain10		Ain 10
43	Device 2: Ain11		Ain 11
44	Device 2: Ain12		Ain 12
45	Device 2: Ain13		Ain 13
46	Device 2: Ain14		Ain 14

Table 3: Analog Input Subsystem Channel Numbers and Channel Names for the VIBbox-64 (cont.)

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
47	Device 2: Ain15	2	Ain 15
48	Device 3: Ain0	3	Ain 0
49	Device 3: Ain1		Ain 1
50	Device 3: Ain2		Ain 2
51	Device 3: Ain3		Ain 3
52	Device 3: Ain4		Ain 4
53	Device 3: Ain5		Ain 5
54	Device 3: Ain6		Ain 6
55	Device 3: Ain7		Ain 7
56	Device 3: Ain8		Ain 8
57	Device 3: Ain9		Ain 9
58	Device 3: Ain10		Ain 10
59	Device 3: Ain11		Ain 11
60	Device 3: Ain12		Ain 12
61	Device 3: Ain13		Ain 13
62	Device 3: Ain14		Ain 14
63	Device 3: Ain15		Ain 15
64	Device 0: Tach 0	0	Pin 11 on Digital Connector 0
65	Device 0:CT0		Pins 12, 14, and 15 of Digital Connector 1
66	Device 0:CT1		–[a]
67	Device 0:CT2		–[a]
68	Device 0: Din0		Pins 0 to 4 and 6 to 9 of Digital Connector 0
69	Device 1: Tach 0	1	Pin 11 on Digital Connector 1
70	Device 1:CT0		Pins 12, 14, and 15 of Digital Connector 1
71	Device 1:CT1		–[a]
72	Device 1:CT2		–[a]
73	Device 1: Din0		Pins 0 to 4 and 6 to 9 of Digital Connector 1
74	Device 2: Tach 0	2	Pin 11 on Digital Connector 2
75	Device 2:CT0		Pins 12, 14, and 15 of Digital Connector 2
76	Device 2:CT1		–[a]
77	Device 2:CT2		–[a]

Table 3: Analog Input Subsystem Channel Numbers and Channel Names for the VIBbox-64 (cont.)

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
78	Device 2: Din0	2	Pins 0 to 4 and 6 to 9 of Digital Connector 2
79	Device 3: Tach 0	3	Pin 11 on Digital Connector 3
80	Device 3:CT0		Pins 12, 14, and 15 of Digital Connector 3
81	Device 3:CT1		–[a]
82	Device 3:CT2		–[a]
83	Device 3: Din0		Pins 0 to 4 and 6 to 9 of Digital Connector 3

a. Measure counters.

For example, if you are using a VIBbox-64 and want to acquire data from analog input channel 0 of DT9857E module 0, analog input channel 15 of DT9857E module 1, and the tachometer input of DT9857E module 3, specify VIBbox channel numbers 0, 31, and 79 or, if allowed by the software, the channel names Device 0: Ain 0, Device 1: Ain 15, and Device 3: Tach 0 for the analog input subsystem.

Input Channel Numbers and Names for the VIBbox-48

Table 4 lists the channel numbers and the names for each channel that can be included in the input data stream for the VIBbox-48.

Table 4: Analog Input Subsystem Channel Numbers and Channel Names for the VIBbox-48

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
0	Device 0: Ain0	0	Ain 0
1	Device 0: Ain1		Ain 1
2	Device 0: Ain2		Ain 2
3	Device 0: Ain3		Ain 3
4	Device 0: Ain4		Ain 4
5	Device 0: Ain5		Ain 5
6	Device 0: Ain6		Ain 6
7	Device 0: Ain7		Ain 7
8	Device 0: Ain8		Ain 8
9	Device 0: Ain9		Ain 9
10	Device 0: Ain10		Ain 10
11	Device 0: Ain11		Ain 11

Table 4: Analog Input Subsystem Channel Numbers and Channel Names for the VIBbox-48 (cont.)

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
12	Device 0: Ain12	0	Ain 12
13	Device 0: Ain13		Ain 13
14	Device 0: Ain14		Ain 14
15	Device 0: Ain15		Ain 15
16	Device 1: Ain0	1	Ain 0
17	Device 1: Ain1		Ain 1
18	Device 1: Ain2		Ain 2
19	Device 1: Ain3		Ain 3
20	Device 1: Ain4		Ain 4
21	Device 1: Ain5		Ain 5
22	Device 1: Ain6		Ain 6
23	Device 1: Ain7		Ain 7
24	Device 1: Ain8		Ain 8
25	Device 1: Ain9		Ain 9
26	Device 1: Ain10		Ain 10
27	Device 1: Ain11		Ain 11
28	Device 1: Ain12		Ain 12
29	Device 1: Ain13		Ain 13
30	Device 1: Ain14		Ain 14
31	Device 1: Ain15		Ain 15
32	Device 2: Ain0	2	Ain 0
33	Device 2: Ain1		Ain 1
34	Device 2: Ain2		Ain 2
35	Device 2: Ain3		Ain 3
36	Device 2: Ain4		Ain 4
37	Device 2: Ain5		Ain 5
38	Device 2: Ain6		Ain 6
39	Device 2: Ain7		Ain 7
40	Device 2: Ain8		Ain 8
41	Device 2: Ain9		Ain 9
42	Device 2: Ain10		Ain 10

Table 4: Analog Input Subsystem Channel Numbers and Channel Names for the VIBbox-48 (cont.)

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
43	Device 2: Ain11	2	Ain 11
44	Device 2: Ain12		Ain 12
45	Device 2: Ain13		Ain 13
46	Device 2: Ain14		Ain 14
47	Device 2: Ain15		Ain 15
48	Device 0: Tach 0	0	Pin 11 on Digital Connector 0
49	Device 0:CT0		Pins 12, 14, and 15 of Digital Connector 1
50	Device 0:CT1		–[a]
51	Device 0:CT2		–[a]
52	Device 0: Din0		Pins 0 to 4 and 6 to 9 of Digital Connector 0
53	Device 1: Tach 0	1	Pin 11 on Digital Connector 1
54	Device 1:CT0		Pins 12, 14, and 15 of Digital Connector 1
55	Device 1:CT1		–[a]
56	Device 1:CT2		–[a]
57	Device 1: Din0		Pins 0 to 4 and 6 to 9 of Digital Connector 1
58	Device 2: Tach 0	2	Pin 11 on Digital Connector 2
59	Device 2:CT0		Pins 12, 14, and 15 of Digital Connector 2
60	Device 2:CT1		–[a]
61	Device 2:CT2		–[a]
62	Device 2: Din0		Pins 0 to 4 and 6 to 9 of Digital Connector 2

a. Measure counters.

For example, if you are using a VIBbox-48 and want to acquire data from analog input channel 0 of DT9857E module 0, analog input channel 15 of DT9857E module 1, and the tachometer input of DT9857E module 2, specify VIBbox channel numbers 0, 31, and 58 or, if allowed by the software, the channel names Device 0: Ain 0, Device 1: Ain 15, and Device 2: Tach 0 for the analog input subsystem.

Input Channel Numbers and Names for the VIBbox-32

Table 5 lists the channel numbers and the names for each channel that can be included in the input data stream for the VIBbox-32.

Table 5: Analog Input Subsystem Channel Numbers and Channel Names for the VIBbox-32

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
0	Device 0: Ain0	0	Ain 0
1	Device 0: Ain1		Ain 1
2	Device 0: Ain2		Ain 2
3	Device 0: Ain3		Ain 3
4	Device 0: Ain4		Ain 4
5	Device 0: Ain5		Ain 5
6	Device 0: Ain6		Ain 6
7	Device 0: Ain7		Ain 7
8	Device 0: Ain8		Ain 8
9	Device 0: Ain9		Ain 9
10	Device 0: Ain10		Ain 10
11	Device 0: Ain11		Ain 11
12	Device 0: Ain12		Ain 12
13	Device 0: Ain13		Ain 13
14	Device 0: Ain14		Ain 14
15	Device 0: Ain15		Ain 15
16	Device 1: Ain0	1	Ain 0
17	Device 1: Ain1		Ain 1
18	Device 1: Ain2		Ain 2
19	Device 1: Ain3		Ain 3
20	Device 1: Ain4		Ain 4
21	Device 1: Ain5		Ain 5
22	Device 1: Ain6		Ain 6
23	Device 1: Ain7		Ain 7
24	Device 1: Ain8		Ain 8
25	Device 1: Ain9		Ain 9
26	Device 1: Ain10		Ain 10

Table 5: Analog Input Subsystem Channel Numbers and Channel Names for the VIBbox-32 (cont.)

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
27	Device 1: Ain11	1	Ain 11
28	Device 1: Ain12		Ain 12
29	Device 1: Ain13		Ain 13
30	Device 1: Ain14		Ain 14
31	Device 1: Ain15		Ain 15
32	Device 0: Tach 0	0	Pin 11 on Digital Connector 0
33	Device 0:CT0		Pins 12, 14, and 15 of Digital Connector 1
34	Device 0:CT1		–[a]
35	Device 0:CT2		–[a]
36	Device 0: Din0		Pins 0 to 4 and 6 to 9 of Digital Connector 0
37	Device 1: Tach 0	1	Pin 11 on Digital Connector 1
38	Device 1:CT0		Pins 12, 14, and 15 of Digital Connector 1
39	Device 1:CT1		–[a]
40	Device 1:CT2		–[a]
41	Device 1: Din0		Pins 0 to 4 and 6 to 9 of Digital Connector 1

a. Measure counters.

For example, if you are using a VIBbox-32 and want to acquire data from analog input channel 0 of DT9857E module 0, analog input channel 15 of DT9857E module 1, and the tachometer input of DT9857E module 1, specify VIBbox channel numbers 0, 31, and 37 or, if allowed by the software, the channel names Device 0: Ain 0, Device 1: Ain 15, and Device 1: Tach 0 for the analog input subsystem.

Input Ranges and Gains

Analog input channels in the VIBbox support an input range of ±10 V and software-selectable gains of 1 and 10. This provides effective input ranges of ±10 V (when the gain is 1) and ±1 V (when the gain is 10).

IEPE Functions

Applications that require accelerometer, vibration, noise, or sonar measurements often use IEPE sensors. IEPE conditioning is built-in to the analog input circuitry of the VIBbox. The VIBbox supports the following software-programmable IEPE functions for each analog input channel:

- Excitation current source – The VIBbox provides an internal excitation current source of 4 mA. You can enable or disable the use of a internal excitation current source using software. By default, the excitation current source is disabled.
- Coupling type – You can select whether AC coupling or DC coupling is used. By default, DC coupling is selected for the VIBbox.

The VIBbox provides +24 V of compliance voltage.

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

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

Input Resolution

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

Input Clock Source

The VIBbox supports an internal clock, which is derived from the 48 MHz crystal oscillator.

Use software to specify the internal clock source and the frequency at which to pace the input and output operations and to start the sample clock. The sampling frequency can range from 195.3125 Hz to 105.469 kHz. Note, however, that the maximum throughput rate is system dependent. If you are performing long duration continuous acquisition, it is recommended that you use a maximum sampling frequency of 51.2 kHz (in the FFT mode of QuickDAQ, this is 25599.75 in the Max Frequency to Analyze field).

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.

Once the sample clock is started, the VIBbox requires 39 conversions before the first A/D sample is valid. The valid sample is aligned with the A/D trigger.

Note: The VIBbox has two power modes: low power mode and high power mode. Low power mode is used when you specify a sampling frequency less than 52.734 kHz. High power mode is used when you specify a sampling frequency greater than or equal to 52.734 kHz. If you change the power mode from low to high power or from high power to low power, and then configure the device, the VIBbox is self-calibrated. You may notice that it takes time after the device is configured to complete the calibration process.

Analog Input Conversion Modes

The VIBbox supports single-value and continuous scan mode to acquire and convert analog input data. 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 to 63) and the gain (1 or 10) that you want to use. Refer to page 85 for more information on the channel numbering.

The VIBbox acquires the data from the specified analog input channel and returns the data immediately.

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

Note: Note that internally, the single value operation is performed at the configured sample frequency of the Delta-Sigma converter.

Continuous Scan Mode

In continuous scan mode, you can acquire data from all the entries in the channel-gain list continuously. Using software, you can specify a channel list, clock frequency, start trigger, reference trigger, post-trigger scan count, and buffer using software.

On the VIBbox, you can acquire data from the analog input channels, tachometer, general-purpose counter/timer, measure counters, and digital input port.

Using software, specify the channels that you want to sample in sequential order. Refer to page 85 for information on the channel numbering. When it detects the start trigger, the VIBbox 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 96 for more information about start and reference triggers.

The conversion rate is determined by the frequency of the input sample clock; refer to page 93 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 VIBbox 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 VIBbox 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 channels to acquire in the analog input channel list
- Specify the sampling frequency (refer to page 93)
- Specify the start trigger source (refer to page 96)
- Specify the reference trigger source (refer to page 97)
- Specify the post-trigger scan count (the number of post-trigger samples to acquire after the reference trigger occurs).

Figure 35 illustrates continuous scan mode (using a start and reference trigger) with a channel list of three entries: channel 0 through channel 2. In this example, pre-trigger analog input data is acquired when the start trigger is detected. When the reference trigger occurs, the specified number of post-trigger samples (three, in this example) are acquired.

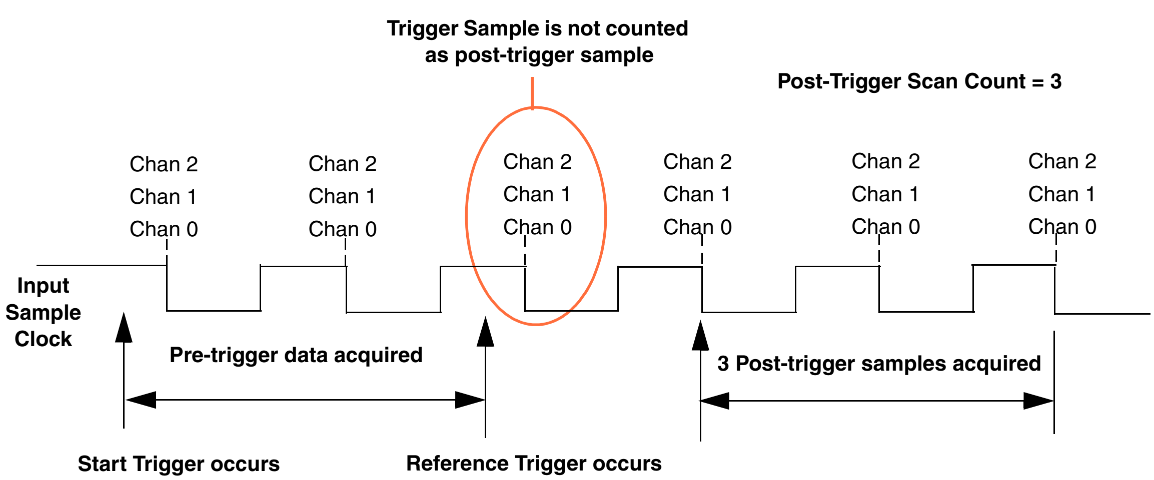


Figure 35: Continuous Scan Mode on the VIBbox Using a Start and Reference Trigger

Note: The Input Trigger LED on the VIBbox, shown on page 182, is amber to indicate an armed condition when the VIBbox is waiting for an external digital trigger, threshold trigger, or Sync Bus trigger (the VIBbox must have been configured for one of these trigger types), green when the VIBbox has been triggered, or off when the VIBbox is idle.

Input Triggers

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

If you are using continuous scan mode, described on page 94, you must specify a start trigger for the VIBbox system that will start acquisition.

If you want to acquire pre-trigger and post-trigger data, you must also specify a reference trigger. In this case, pre-trigger data is acquired when the start trigger occurs. When the reference trigger occurs, pre-trigger acquisition stops and post-trigger acquisition starts. The operation continues until the number of scans that you specify for the post-trigger scan count are acquired; at the point, the operation stops.

Notes: You specify the start trigger and reference trigger for the VIBbox. Internally, each DT9857E module is wired together using the Sync Bus, where the master module is DT9857E module 0 and all the other DT9857E modules are slaves. The trigger source is detected by the master module and is then propagated to each of the slave modules over the Sync Bus.

The following sections describe the start and reference trigger sources that you can configure.

Start Trigger Sources

The VIBbox supports 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 VIBbox 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 VIBbox detects a rising- or falling-edge transition on the Trigger connector.

  Using software, specify the trigger source as an external, positive digital (TTL) trigger for a rising-edge external trigger or an external, negative digital (TTL) trigger for a falling-edge external trigger.
- **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 as the threshold input channel.

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

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

The Input Trigger LED on the VIBbox, shown in page 182, is amber to indicate an armed condition when the VIBbox is waiting for an external digital trigger or threshold trigger (the VIBbox must have been configured for one of these trigger types), green when the VIBbox has been triggered, or off when the VIBbox is idle.

Reference Trigger Sources

The VIBbox supports the following trigger sources for the reference trigger:

- **External digital (TTL) trigger** – An external digital (TTL) trigger event occurs when the VIBbox detects a rising- or falling-edge transition on the External Trigger BNC input of the VIBbox.

  Using software, specify the trigger source as an external, positive digital (TTL) trigger for a rising-edge external trigger or an external, negative digital (TTL) trigger for a falling-edge external trigger.

- **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 as the threshold input channel.

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

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

The Input Trigger LED on the VIBbox, shown in page 182, is amber to indicate an armed condition when the VIBbox is waiting for an external digital trigger or threshold trigger (the VIBbox must have been configured for one of these trigger types), green when the VIBbox has been triggered, or off when the VIBbox is idle.

Data Format and Transfer

The VIBbox uses offset binary data encoding, where 000000 represents negative full-scale, and FFFFFFh represents positive full-scale. Use software to specify the data encoding as binary. The ADC outputs FFFFFFh for above-range signals, and 000000 for below-range signals.

Before you begin acquiring data, you must allocate buffers to hold the data. A Buffer Done event is returned whenever a buffer is filled. This allows you to move and/or process the data as needed.

We recommend that you allocate a minimum of two buffers for continuous analog input operations. Data is written to multiple allocated input buffers continuously; when no more empty buffers are available, the operation stops. The data is gap-free.

Note: Each DT9857E module in the VIBbox system has a 16 kSample input FIFO that is used to store the acquired data before it is sent to the host.

Error Conditions

The VIBbox reports any overrun errors by sending an overrun event to the application program. This event indicates that data buffers are not being sent from the VIBbox 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 VIBbox 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
- Analog output channel numbering and names, described below
- Output ranges and gains, describe on page 102
- Output resolution, described on page 102
- Output clocks, described on page 102
- Output conversion mode, described on page 103
- Output triggers, described on page 105
- Data format and transfer, described on page 105
- Error conditions, described on page 106

Analog Output Channels

The VIBbox packages multiple DT9857E modules in an enclosure. Each module (0, 1, 2, and 3) supports two analog output channels (labelled 0 and 1) for a total of eight analog outputs in the VIBbox-64, six analog outputs in the VIBbox-48, or four analog outputs in the VIBbox-32. Refer to page 99 for more on the channel numbers and names.

Each DT98357E module provides a two-pole, 120 kHz Butterworth filter and quiet start circuitry to prevent noise from interfering with the output signal.

The analog output channels power up to a value of 0 V ±10 mV.

You can update a single analog output channels or multiple analog output channels at once. You can also update the digital output port in the analog output stream. Refer to page 103 for more information.

Analog Output Channel Numbers and Names

For the analog output subsystem, you use software to specify the channel number of the VIBbox (not the channel number of the DT9857E) from which to output data or, if the software allows, you specify the name of the VIBbox channel.

Channels numbering starts with all the analog output channels for the VIBbox, followed by the digital output port for each module.

The following sections provide the exact channel numbers and names for each output channel of your VIBbox system.

Output Channel Numbers and Names for the VIBbox-64

Table 6 lists the channel numbers and the names for each channel that can be included in the output data stream for the VIBbox-64.

Table 6: Analog Output Subsystem Channel Numbers and Channel Names for the VIBbox-64

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
0	Device 0: Aout 0	0	D/A Out 0
1	Device 0: Aout 1		D/A Out 1
2	Device 1: Aout 0	1	D/A Out 0
3	Device 1: Aout 1		D/A Out 1
4	Device 2: Aout 0	2	D/A Out 0
5	Device 2: Aout 1		D/A Out 1
6	Device 3: Aout 0	3	D/A Out 0
7	Device 3: Aout 1		D/A Out 1
8	Device 0: Dout 0	0	Pins 17 to 20 and 22 to 25 of Digital Connector 0
9	Device 1: Dout 0	1	Pins 17 to 20 and 22 to 25 of Digital Connector 1
10	Device 2: Dout 0	2	Pins 17 to 20 and 22 to 25 of Digital Connector 2
11	Device 3: Dout 0	3	Pins 17 to 20 and 22 to 25 of Digital Connector 3

For example, if you are using the VIBbox-64 and you want to output data from analog output channel 0 of DT9857E module 0, analog output channel 1 of DT9857E module 2, and the digital output port of DT9857E module 3, you would specify VIBbox channel numbers 0, 5, and 11 or, if allowed by the software, the channel names Device 0: Aout 0, Device 2: Aout 1, and Device 3: Dout 0 for the analog output subsystem.

Output Channel Numbers and Names for the VIBbox-48

Table 7 lists the channel numbers and the names for each channel that can be included in the output data stream for the VIBbox-48.

Table 7: Analog Output Subsystem Channel Numbers and Channel Names for the VIBbox-48

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
0	Device 0: Aout 0	0	D/A Out 0
1	Device 0: Aout 1		D/A Out 1
2	Device 1: Aout 0	1	D/A Out 0
3	Device 1: Aout 1		D/A Out 1
4	Device 2: Aout 0	2	D/A Out 0
5	Device 2: Aout 1		D/A Out 1
6	Device 0: Dout 0	0	Pins 17 to 20 and 22 to 25 of Digital Connector 0
7	Device 1: Dout 0	1	Pins 17 to 20 and 22 to 25 of Digital Connector 1
8	Device 2: Dout 0	2	Pins 17 to 20 and 22 to 25 of Digital Connector 2

For example, if you are using a VIBbox-48 and you want to output data from analog output channel 0 of DT9857E module 0, analog output channel 1 of DT9857E module 2, and the digital output port of DT9857E module 2, you would specify VIBbox channel numbers 0, 5, and 8 or, if allowed by the software, the channel names Device 0: Aout 0, Device 2: Aout 1, and Device 2: Dout 0 for the analog output subsystem.

Output Channel Numbers and Names for the VIBbox-32

Table 7 lists the channel numbers and the names for each channel that can be included in the output data stream for the VIBbox-32.

Table 8: Analog Output Subsystem Channel Numbers and Channel Names for the VIBbox-32

VIBbox Physical Channel Number	VIBbox Channel Name	DT9857E Module Number	Channel Number or Pin on the DT9857E
0	Device 0: Aout 0	0	D/A Out 0
1	Device 0: Aout 1		D/A Out 1
2	Device 1: Aout 0	1	D/A Out 0
3	Device 1: Aout 1		D/A Out 1
4	Device 0: Dout 0	0	Pins 17 to 20 and 22 to 25 of Digital Connector 0
5	Device 1: Dout 0	1	Pins 17 to 20 and 22 to 25 of Digital Connector 1

For example, if you are using a VIBbox-32 and you want to output data from analog output channel 0 of DT9857E module 0, analog output channel 1 of DT9857E module 1, and the digital output port of DT9857E module 1, you would specify VIBbox channel numbers 0, 3, and 5 or, if allowed by the software, the channel names Device 0: Aout 0, Device 1: Aout 1, and Device 1: Dout 0 for the analog output subsystem.

Output Range and Gain

The VIBbox can output bipolar analog output signals in the range of ±10 V using a gain of 1.

Output Resolution

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

Output Clocks

Using software, you can program the clock frequency for the internal D/A output clock on the VIBbox to a value between 30 kHz and 216 kHz.

The VIBbox requires 36 sample clock periods once the output subsystem has been triggered before the first D/A conversion is completed. The clock is always running.

Output Conversion Modes

The VIBbox supports single-value, waveform, and continuous analog output operations.

Single-Value Mode

Single-value mode is the simplest to use but offers the least flexibility and efficiency. Use software to specify the analog output channel (0 to 7) 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 frequency, trigger source, or buffer. Single-value operations stop automatically when finished; you cannot stop a single-value operation.

Waveform Generation Mode

The VIBbox support the ability to generate a waveform (specified in a single buffer) from the channels specified in the output channel list.

If you want the hardware to output the waveform without USB bus intervention, ensure that the waveform is equal to or less than the size of the output FIFO (64 kSamples) on each DT9857E module. Since there are multiple DT9857E modules in one VIBbox, the buffer size can be 64 kSamples/s x the number of modules in the VIBbox. On each module, the waveform pattern can range from 2 to 64K (65536) samples if you specify one output channel, 2 to 32K (32768) samples for two output channels, or 21.3K (21845) samples for three output channels (two analog output channels and the digital output port) on each DT9857E module.

If your waveform is larger than the size of the output FIFO (64K samples), the driver will manage the buffer for you. However, USB bus intervention is required in this case.

Use software to fill the output buffer with the values that you want to write to the channels in the output channel list.

If the waveform pattern is equal to or less than the size of the output FIFO on the DT9857E module, the host computer transfers the entire waveform pattern to the output FIFO. When it detects a trigger, the module starts writing output values to the output channels, as determined by the output channel list, at the specified clock rate. The channels are updated simultaneously. 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.

If the waveform pattern is greater than the size of the output FIFO, the buffer resides on the host computer. When it detects a software trigger, the DT9857E module starts writing output values to the output channels, as determined by the output channel list, at the specified clock rate using CPU and USB bus intervention. The driver manages the buffer, allowing you to output the same pattern continuously. When it reaches the end of the buffer, the software returns to the first location of the buffer 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 102 for more information about the clock source and frequency.
- Specify the trigger source as any of the supported output trigger sources. Refer to page 105 for more information about the supported output trigger sources.

The hardware supports the ability to mute the output voltage to 0 V. Muting the output does not stop the analog output operation; instead, the analog output voltage is reduced to 0 V over 1020 samples. When desired, you can use unmute the output voltage to its current level. Refer to your software documentation for more information on muting and unmuting the output voltage.

Continuous Analog Output Operations

Use continuously paced analog output mode to output buffered values to the analog output channels and/or the digital output ports continuously at a specified clock frequency. The VIBbox supports the ability to start continuous analog output operations and continuous analog input operations simultaneously.

When the VIBbox detects a trigger, the DT9857E modules start writing the values from the output buffer to the channels specified in the output channel list at the specified clock frequency. The operation repeats continuously until all the data is output from the buffers or you stop the operation.

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

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

- Specify the data flow as Continuous.
- Specify WrapSingleBuffer as False to use multiple buffers.
- Specify the D/A output frequency. Refer to page 102 for more information.
- Specify the trigger source as any of the supported output trigger sources. Refer to page 105 for more information about the supported output trigger sources.

- To start the analog input and analog output operations simultaneously using the DT-Open Layers for .NET Class Library, use the **SimultaneousStart.AddSubsystem, SimultaneousStart.PreStart**, and **SimultaneousStart.Start** methods. Refer to the documentation for the DT-Open Layers for .NET Class Library for more information.

We recommend that you allocate a minimum of two buffers for a continuously paced analog output operation. Data is written from multiple output buffers continuously; when no more buffers of data are available, the operation stops. The data is gap-free.

Note: The Output Trigger LED on the VIBbox, shown in page 182, is amber when the VIBbox is armed and waiting for an external digital (the VIBbox must have been configured for this trigger type), green when the VIBbox has been triggered, or off when the VIBbox is idle.

The hardware supports the ability to mute the output voltage to 0 V. Muting the output does not stop the analog output operation; instead, the analog output voltage is reduced to 0 V over 1020 samples. When desired, you can use unmute the output voltage to its current level. Refer to your software documentation for more information on muting and unmuting the output voltage.

To stop a continuously paced analog output operation, you can stop queuing buffers for the analog output system, letting the VIBbox 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 VIBbox finishes outputting the specified number of samples, and then stops; all subsequent triggers are ignored. In an abrupt stop, the VIBbox stops outputting samples immediately; all subsequent triggers are ignored.

Output Trigger

The VIBbox supports 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 VIBbox to begin conversions). Using software, specify the trigger source for the D/A subsystem as a software trigger.
- **External digital (TTL) trigger** – An external digital (TTL) trigger event occurs when the VIBbox detects a rising- or falling-edge transition on the signal connected to the Trigger connector. Using software, specify the trigger source for the D/A subsystem as an external, positive digital (TTL) trigger for a rising-edge external trigger or an external, negative digital (TTL) trigger for a falling-edge external trigger.

Data Format and Transfer

Data from the host computer must use offset binary data encoding for analog output signals, where 00000000 represents the negative full-scale voltage, and FFFFFFFFh represents the positive full-scale voltage. Using software, specify the data encoding as binary.

Error Conditions

The VIBbox reports 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 VIBbox 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

The VIBbox supports one tachometer on each DT9857E module in the VIBbox system, for a total of four tachometer input signals on the VIBbox-64, three tachometer signals on the VIBbox-48, and two tachometer signals on the VIBbox-32. The tachometer inputs are accessible through pin 11 on the Digital connector. Each tachometer signals has a range of ±30 V, a maximum frequency of 1 MHz, and a minimum pulse width of 0.4 µs. The threshold voltage is fixed at +2 V with 0.5 V of hysteresis.

You can measure the frequency or period of a tachometer input signal 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 a tachometer input signal by including the tachometer channel in the analog input channel list. Refer to page 85 for more information on the channel numbering. The starting edge is programmable (either rising or falling).

Using software commands, you can specify the following parameters for the tachometer input on each DT9857E module:

- The starting edge of the tachometer input signal to use for the measurement (rising 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; at that point, the counter stores and resets the count. The stored count is maintained until it is read as part of the input data stream or until a new count is stored. The next tachometer measurement operation is started automatically.

If the sample rate of the input subsystem is faster than the tachometer input frequency, then the stored count retains the current value when the count is read by the input subsystem. The operation of the Stale flag in this case is described as follows:

- If another input subsystem sample occurs before another measure completes and the Stale flag is enabled, then the Stale flag is set and the stale measure count is written into the input data stream.
- If another input subsystem sample occurs before another measure completes and the Stale flag is disabled, then the Stale flag is not set and the stale measure count is written into the input data stream.

If the input sample rate is slower than the tachometer input frequency, then as each period measurement completes, a new count value is stored. When the input subsystem sample occurs, the most recently stored measure count is written into the input data stream.

A data pipeline is used in the hardware to compensate for the A/D group delay and 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:

Table 9: An Example of Reading the Tachometer Input as Part of the Analog Input Data Stream

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

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

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

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

General-Purpose Counter/Timer Features

This section describes the following features of counter/timer (C/T) operations:

- C/T channels, described below
- C/T clock sources, described on page 110
- Gate types, described on page 110
- Pulse types and duty cycles, described on page 111
- C/T operation modes, described on page 111

C/T Channels

The VIBbox provides one general-purpose counter/timer (C/T 0) on each DT9857E module in the VIBbox system, for a total of 4 general-purpose counter/timers for the VIBbox-64, three general-purpose counter/timers for the VIBbox-48, and two general-purpose counter/timers for the VIBbox-32.

The counter/timer signals are accessible through the Digital connector. Each general-purpose counter/timer accepts a clock input signal and gate input signal and outputs a pulse (pulse output signal), as shown in Figure 36.

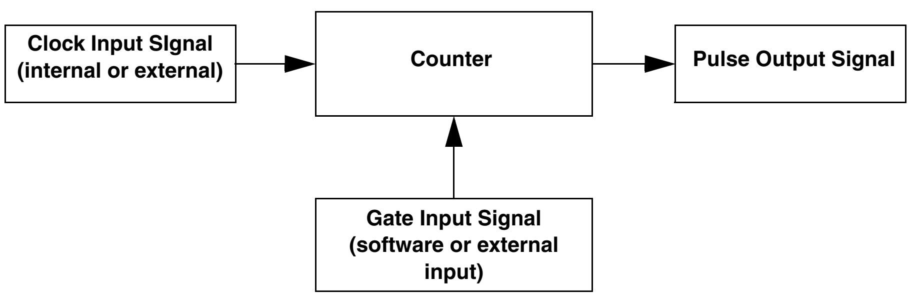


Figure 36: Counter/Timer Channel

Using software, specify C/T subsystem element 0 on each DT9857E module to set up the parameters for the general-purpose counter/timer. To read the counter/timer, specify channel for C/T 0 in the analog input channel list. Refer to page 85 for information on the channel numbering.

C/T Clock Sources

The following clock sources are available for each general-purpose counter/timer:

- **Internal C/T clock** – The internal C/T clock always uses a 48 MHz time base. Through software, specify the clock source as internal, and specify the frequency at which to pace the operation (this is the frequency of the counter's output signal).
- **External C/T clock** – An external C/T clock is useful when you want to pace counter/timer operations at rates not available with the internal C/T clock or if you want to pace at uneven intervals. The frequency of the external C/T clock can range from 0.0112 Hz to 10 MHz.

  Connect the external clock to the C/T 0 clock input signal (pin 14) of the selected Digital connector on the VIBbox. Counter/timer operations start on the rising edge of the clock input signal.

  Using software, specify the clock source as external and specify a clock divider between 2 and 4,924,967,296. Internally, the base frequency of C/T clock, which is 48 MHz, is divided by the specified clock divider to program the frequency of the external C/T clock.

Note: You typically use the external C/T clock (the clock connected to the C/T 0 Clock input signal of the Digital connector) to measure frequency (event counting), or to measure the time interval between edges (measure mode).

If you specify a counter/timer in the analog input channel list, the A/D clock determines how often you want to read the counter value. Refer to page 93 for more information about the A/D clock.

Gate Types

The edge or level of the counter gate signal determines when a counter/timer operation is enabled. The VIBbox provides the following gate types:

- **None** – A software command enables any counter/timer operation immediately after execution.
- **Logic-low level external gate input** – Enables a counter/timer operation when the counter's gate signal is low, and disables the counter/timer operation when the counter's gate signal is high. Note that this gate type is used for event counting and rate generation modes; refer to page 111 for more information about these modes.
- **Logic-high level external gate input** – Enables a counter/timer operation when the counter's gate signal is high, and disables a counter/timer operation when the counter's gate signal is low. Note that this gate type is used for event counting and rate generation modes; refer to page 111 for more information about these modes.
- **Falling-edge external gate input** – Enables a counter/timer operation when a high-to-low transition is detected on the counter's gate signal. In software, this is called a low-edge gate type. Note that this gate type is used for edge-to-edge measurement, one-shot, and repetitive one-shot mode; refer to page 111 for more information about these modes.

- **Rising-edge external gate input –** Enables a counter/timer operation when a low-to-high transition is detected on the counter's gate signal. In software, this is called a high-edge gate type. Note that this gate type is used for edge-to-edge measurement, one-shot, and repetitive one-shot mode; refer to page 111 for more information about these modes.

Specify the gate type in software. If using an external gate, connect the external gate signal to pin 12 of the Digital connector.

Pulse Output Types and Duty Cycles

The VIBbox can output the following types of pulses from each counter/timer:

- **High-to-low transitions –** The low portion of the total pulse output period is the active portion of the counter/timer clock output signal.
- **Low-to-high transitions –** The high portion of the total pulse output period is the active portion of the counter/timer pulse output signal.

You specify the pulse output type in software. Connect the pulse output signal to pin 15 of the Digital connector.

The duty cycle (or pulse width) indicates the percentage of the total pulse output period that is active. For example, a duty cycle of 50 indicates that half of the total pulse output is low and half of the total pulse output is high. You specify the duty cycle in software.

Figure 37 illustrates a low-to-high pulse with a duty cycle of approximately 30%.

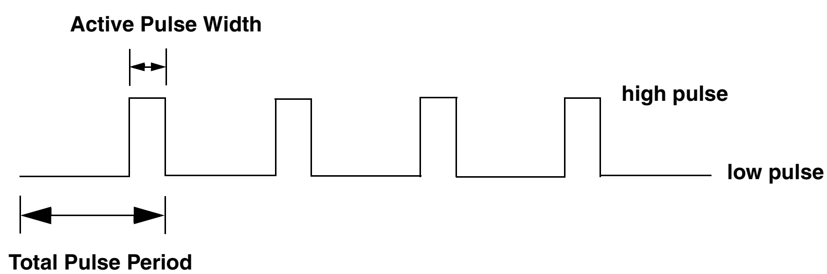


Figure 37: Example of a Low-to-High Pulse Output Type

Counter/Timer Operation Modes

Counters on the VIBbox supports the following counter/timer operation modes:

- Event counting
- Up/down counting
- Edge-to-edge measurement
- Continuous edge-to-edge measurement
- Rate generation

- One-shot
- Repetitive one-shot

Note: The active polarity for each counter/timer operation mode is software-selectable.

The following subsections describe these modes in more detail.

Event Counting

Use event counting mode if you want to count the number of rising edges that occur on the counter's clock input when the counter's gate signal is active (low-level or high-level). Refer to page 110 for information about specifying the active gate type.

You can count a maximum of 4,294,967,296 events before the counter rolls over to 0 and starts counting again.

Using software, specify the counter/timer mode as event counting (count), the C/T clock source as external, and the active gate type as low-level or high-level.

Make sure that the signals are wired appropriately. Refer to page 50 for an example of connecting an event counting application.

Up/Down Counting

Use up/down counting mode if you want to increment or decrement the number of rising edges that occur on the counter's clock input, depending on the level of the counter's gate signal.

If the gate signal is high, the C/T increments; if the gate signal is low, the C/T decrements.

Using software, specify the counter/timer mode as up/down counting (up/down), and the C/T clock source as external. Note that you do not specify the gate type in software.

Make sure that the signals are wired appropriately. Refer to page 52 for an example of connecting an up/down counting application.

Note: Initialize the counter/timer so that the C/T never increments above FFFFFFFFh or decrements below 0.

Edge-to-Edge Measurement

Use edge-to-edge measurement mode if you want to measure the time interval between a specified start edge and a specified stop edge.

The start edge and the stop edge can occur on the rising edge of the counter's gate input, the falling edge of the counter's gate input, the rising edge of the counter's clock input, or the falling edge of the counter's clock input. When the start edge is detected, the counter/timer starts incrementing, and continues incrementing until the stop edge is detected. The C/T then stops incrementing until it is enabled to start another measurement. When the operation is complete, you can read the value of the counter.

You can use edge-to-edge measurement to measure the following:

- Pulse width of a signal pulse (the amount of time that a signal pulse is in a high or a low state, or the amount of time between a rising edge and a falling edge or between a falling edge and a rising edge). You can calculate the pulse width as follows:
  - Pulse width = Number of counts/48 MHz
- Period of a signal pulse (the time between two occurrences of the same edge – rising edge to rising edge or falling edge to falling edge). You can calculate the period as follows:
  - Period = 1/Frequency
  - Period = Number of counts/48 MHz
- Frequency of a signal pulse (the number of periods per second). You can calculate the frequency as follows:
  - Frequency = 48 MHz/Number of Counts

Using software, specify the counter/timer mode as edge-to-edge measurement mode (measure), the C/T clock source as internal, the start edge type, and the stop edge type.

Make sure that the signals are wired appropriately. Refer to page 54 for an example of connecting an edge-to-edge measurement application.

Continuous Edge-to-Edge Measurement

In continuous edge-to-edge measurement mode, the counter starts incrementing when it detects the specified start edge. When it detects the next start edge type, the value of the counter is stored and the next edge-to-edge measurement operation begins automatically.

Every time an edge-to-edge measurement operation completes, the previous measurement is overwritten with the new value. When you read the counter as part of the analog input data stream, the current value (from the last edge-to-edge measurement operation) is returned and the value of the counter is reset to 0. Refer to the previous section for more information on edge-to-edge measurement mode.

Note: If you read the counter before the measurement is complete, 0 is returned.

To select continuous edge-to-edge measurement mode, use software to specify the counter/timer mode as continuous measure, the C/T clock source as internal, and the start edge type.

Rate Generation

Use rate generation mode to generate a continuous pulse output signal from the counter's output line; this mode is sometimes referred to as continuous pulse output or pulse train output. You can use this pulse output signal as an external clock to pace other operations, such as analog input, analog output, or other counter/timer operations.

The pulse output operation is enabled whenever the counter's gate signal is at the specified level. While the pulse output operation is enabled, the counter outputs a pulse of the specified type and frequency continuously. As soon as the operation is disabled, rate generation stops.

The period of the output pulse is determined by the C/T clock source (either internal using a clock divider, or external). You can output pulses using a maximum frequency of 24 MHz (if using the internal C/T clock) or 5 MHz (if using the external C/T clock). Refer to page 110 for more information about the C/T clock sources.

Note: The integrity of the signal degrades at frequencies greater than 10 MHz.

Using software, specify the counter/timer mode as rate generation (rate), the C/T clock source as either internal or external, the clock divider (for an internal clock), the polarity of the output pulses (high-to-low transition or low-to-high transition), the duty cycle of the output pulses, and the active gate type (low-level or high-level). Refer to page 111 for more information about pulse output signals and to page 110 for more information about gate types.

Make sure that the signals are wired appropriately. Refer to page 56 for an example of connecting a rate generation application.

One-Shot

Use one-shot mode to generate a single pulse output signal from the counter's output line when the specified edge is detected on the counter's gate signal. You can use this pulse output signal as an external digital (TTL) trigger to start other operations, such as analog input or analog output operations.

After the single pulse is output, the one-shot operation stops. All subsequent clock input signals and gate input signals are ignored.

The period of the output pulse is determined by the C/T clock source (either internal using a clock divider, or external). Note that in one-shot mode, the internal C/T clock is more useful than an external C/T clock; refer to page 110 for more information about the C/T clock sources.

Using software, specify the counter/timer mode as one-shot, the clock source as internal (recommended), the clock divider, the polarity of the output pulse (high-to-low transition or low-to-high transition), and the active gate type (rising edge or falling edge). Refer to page 111 for more information about pulse output types and to page 110 for more information about gate types.

Note: In the case of a one-shot operation, a duty cycle of 100% is set automatically.

Make sure that the signals are wired appropriately. Refer to page 56 for an example of connecting a one-shot application.

Repetitive One-Shot

Use repetitive one-shot mode to generate a pulse output signal from the counter's output line whenever the specified edge is detected on the counter's gate signal. You can use this mode to clean up a poor clock input signal by changing its pulse width, and then outputting it.

The VIBbox continues to output pulses until you stop the operation. Note that any gate signals that occur while the pulse is being output are not detected by the VIBbox.

The period of the output pulse is determined by the C/T clock source (either internal using a clock divider, or external). Note that in repetitive one-shot mode, the internal C/T clock is more useful than an external clock; refer to page 110 for more information about the C/T clock sources.

Using software, specify the counter/timer mode as repetitive one-shot, the polarity of the output pulses (high-to-low transition or low-to-high transition), the C/T clock source as internal (recommended), the clock divider, and the active gate type (rising edge or falling edge). Refer to page 111 for more information about pulse output types and to page 110 for more information about gates.

Note: In the case of a repetitive one-shot operation, a duty cycle of 100% is set automatically.

Make sure that the signals are wired appropriately. Refer to page 56 for an example of connecting a repetitive one-shot application.

Measure Counter Features

The VIBbox provides two measure counters (C/T 1 and C/T2) on each DT9857E module in the VIBbox system for a total of eight measure counters for the VIBbox-64, six measure counters for the VIBbox-48, and four measure counters for the VIBbox-32.

Using the measure counters, you can measure the frequency, period, or pulse width of a single signal or the time period between two signals and return the value in the analog input stream. This is useful for correlating the analog input data with digital positional data, measuring the frequency of a signal, or as a tachometer. An internal 48 MHz counter is used for the measurement, yielding a resolution of 20 ns (1/48 MHz).

Specify the measure counters (C/T 1 and or C/T2) in the analog input channel list. Refer to page 85 for information on the channel numbering.

Using software commands, you can configure the following parameters for the measure counters on each DT9857E module:

- The operation mode as continuous edge-to-edge measurement mode.
- The signal that starts the measurement. The following signals are supported:
  - A/D conversion complete
  - Tachometer input falling edge
  - Tachometer input rising edge
  - Digital input 0 falling edge
  - Digital input 0 rising edge
  - Digital input 1 falling edge
  - Digital input 1 rising edge
  - Digital input 2 falling edge
  - Digital input 2 rising edge
  - Digital input 3 falling edge
  - Digital input 3 rising edge
  - Digital input 4 falling edge
  - Digital input 4 rising edge
  - Digital input 5 falling edge
  - Digital input 5 rising edge
  - Digital input 6 falling edge
  - Digital input 6 rising edge
  - Digital input 7 falling edge
  - Digital input 7 rising edge
  - C/T 0 Clock input falling edge
  - C/T 0 Clock input rising edge

  - C/T 0 Gate input falling edge
  - C/T 0 Gate input rising edge
- The signal that stops the measurement. The following signals are supported:
  - A/D conversion complete
  - Tachometer input falling edge
  - Tachometer input rising edge
  - Digital input 0 falling edge
  - Digital input 0 rising edge
  - Digital input 1 falling edge
  - Digital input 1 rising edge
  - Digital input 2 falling edge
  - Digital input 2 rising edge
  - Digital input 3 falling edge
  - Digital input 3 rising edge
  - Digital input 4 falling edge
  - Digital input 4 rising edge
  - Digital input 5 falling edge
  - Digital input 5 rising edge
  - Digital input 6 falling edge
  - Digital input 6 rising edge
  - Digital input 7 falling edge
  - Digital input 7 rising edge
  - C/T 0 Clock input falling edge
  - C/T 0 Clock input rising edge
  - C/T 0 Gate input falling edge
  - C/T 0 Gate input rising edge

When the selected start edge is the same as the selected stop edge, the internal 48 MHz counter starts incrementing when it detects the first start edge of the selected input signal and stops incrementing when it detects the selected stop edge (which is the same as the start edge, in this case); at that point, the counter stores and resets the count. The stored count is maintained until it is read as part of the input data stream or until a new count is stored. Since the stop edge is the same as the start edge in this case, the stop edge for the current measurement is the start edge for the next measurement; therefore, no waveform periods are missed.

The value of the measure count depends on the input subsystem sample frequency, described as follows:

- If the input subsystem sample frequency is faster than the selected input frequency, then the stored measure count retains the current value when it is read by the input subsystem.
- If the input subsystem sample frequency is slower than the selected input frequency, then the new measure count value is stored as each period measurement completes. When an input subsystem sample occurs, then the most recently stored measure count is written into the input data stream.

When the selected start edge is not the same as the selected stop edge, the internal 48 MHz counter starts incrementing when it detects the selected start edge and stops incrementing when it detects the next selected stop edge; at that point, the counter stores and resets the count. The stored count is maintained until it is read as part of the input data stream or until a new count is stored. The value of the measure count depends on the input subsystem sample frequency, described as follows:

- If the input subsystem sample rate is faster than the selected measurement period, then the stored count retains the current value when the count is read by the input subsystem.
- If the input subsystem sample rate is slower than the selected measurement period, then a new count value is stored as each period measurement completes. When an input subsystem sample occurs, the most recently stored measure count is written into the input data stream.

A data pipeline is used in the hardware to compensate for the A/D group delay and synchronizes the value of the measure counters with the analog input measurements, so that all measurements are correlated in time. The measure counters are 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 measure counters.

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

Table 10: An Example of Reading a Measure Counter as Part of the Analog Input Data Stream

Time	A/D Value	Measure Counter Values	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 measure counter, you can determine the following:

- Frequency between the start and stop signals/edges. You can calculate the frequency as follows:
  - Frequency = 48 MHz/(Number of counts – 1)
    where 48 MHz is the internal measure counter frequency

    For example, if the count is 201, the measured frequency is 240 kHz (48 MHz/200).
- Period between the start and stop signals/edges. You can calculate the period as follows:
  - Period = 1/Frequency
  - Period = (Number of counts – 1)/48 MHz
    where 48 MHz is the internal measure counter frequency
- Pulse width of the start and stop signal/edges (rising to falling edge or falling edge to rising edge). You can calculate the period as follows:
  - Pulse width = 1/Frequency
  - Pulse width = (Number of counts – 1)/48 MHz
    where 48 MHz is the internal measure counter frequency

Digital I/O Features

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

- Digital I/O lines
- Operation modes

Digital I/O Lines

The VIBbox supports one digital input port and one digital output port for each DT9857E module in the VIBbox system for a total of four digital input and output ports for the VIBbox-64, three digital input and output ports for the VIBbox-48, and two digital input and output ports for the VIBbox-32. You access these signals through the Digital connector on each DT9857E module.

Each digital input port consists of 8 digital input lines (lines 0 to 7) and each digital output port consists of 8 digital output lines (lines 0 to 7). The resolution is fixed at 8 bits.

You can specify the digital I/O line that you want to read or write in a single-value digital I/O operation. Refer to page 120 for more information about single-value operations.

In addition, you can perform a continuous digital input operation by specifying the digital input port in the analog input channel list, or a continuous digital output operation by specifying the digital output port in the analog output channel list.

A digital line is high if its value is 1; a digital line is low if its value is 0. On power up or reset, a low value (0) is output from each of the digital output lines and a high value (1) is read from each of the digital input lines if the lines are not connected.

Operation Modes

The VIBbox supports the following digital I/O operation modes:

- **Single-value operations** are the simplest to use but offer the least flexibility and efficiency. You use software to specify the digital I/O port and a gain of 1 (the gain is ignored). Data is then read from or written to all the digital I/O lines. For a single-value operation, you cannot specify a clock or trigger source.

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

- **Continuous digital input** takes full advantage of the capabilities of the VIBbox. Enter the digital input ports in the analog input channel list. Refer to page 85 for information on the channel numbering.

  You can specify a clock source, scan mode, trigger source, buffer, and buffer wrap mode for the digital input operation. The input sample clock (internal or external) paces the acquisition of data from the digital input ports as well as the analog input channels, tachometer inputs, general-purpose counter/timers, and the measure counters if they are specified in the analog input channel list; refer to page 94 for more information.

- **Continuous digital output** takes full advantage of the capabilities of the VIBbox. Enter the digital output ports in the analog output channel list. Refer to page 99 for information on the channel numbering.

  You can specify a clock source, trigger source, buffer, and buffer wrap mode for the digital output operation. The analog output sample clock paces the analog output and digital output operation. Refer to page 103 for more information.

6

Supported Device Driver Capabilities

Data Flow and Operation Options . . . 125
Buffering . . . 126
Triggered Scan Mode . . . 126
Data Encoding . . . 126
Channels . . . 127
Gain . . . 128
Ranges . . . 128
Resolution . . . 128
Current and Resistance Support . . . 129
Thermocouple, RTD, and Thermistor Support . . . 130
IEPE Support . . . 131
Bridge and Strain Gage Support . . . 131
Start Triggers . . . 132
Reference Triggers . . . 133
Clocks . . . 134
Counter/Timers . . . 135
Tachometers . . . 136

The DT9857 Series Device Driver provides support for the analog input (A/D), analog output (D/A), digital input (DIN), digital output (DOUT), counter/timer (C/T), and tachometer (TACH) subsystems. For information on how to configure the device driver, refer to page 29.

Table 11: VIBbox Subsystems

VIBbox System	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Total Subsystems	1[a]	1[b]	2, 3, or 4[c]	2, 3, or 4[d]	6, 9, or 12[e]	2, 3, or 4[f]	0

a. The VIBbox system aggregates the analog input channels from each DT9857E module through one A/D subsystem.
b. The VIBbox system aggregates the analog output channels from each DT9857E module through one D/A subsystem.
c. Each DT9857E supports one digital input port (port 0) for a total of four digital input ports in the VIBbox-64, three digital input ports in the VIBbox-48, and two digital input ports in the VIBbox-32. These ports are not aggregated in VIBbox; however, they can be accessed through the aggregated A/D subsystem of VIBbox.
d. Each DT9857E supports one digital output port (port 0) for a total of four digital output subsystem for the VIBbox-64, three digital output ports for the VIBbox-48, and two digital output ports for the VIBbox-32. These ports are not aggregated in VIBbox; however, they can be accessed through the aggregated D/A subsystem of VIBbox.
e. Each DT9857E supports three counters for a total of 12 counters for the VIBbox-64, nine counters for the VIBbox-48, and six counters for the VIBbox-32. On each module, C/T element 0 is the general-purpose counter/timer (counter 0), element 1 is measure counter 1, and element 2 and measure counter 2. These counters are not aggregated in VIBbox; however, they can be accessed through the aggregated A/D subsystem of VIBbox.
f. Each DT9857E supports one tachometer input signal for a total of four tachometers in the VIBbox-64, three tachometers in the VIBbox-48, and two tachometers in the VIBbox-32. These tachometers are not aggregated in VIBbox; however, they can be accessed through the aggregated A/D subsystem of VIBbox.

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the VIBbox. 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 12: Data Flow and Operation Options

VIBbox	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Single-Value Operation Support **SupportsSingleValue**	Yes	Yes	Yes	Yes			
Simultaneous Single-Value Output Operations **SupportsSetSingleValues**							
Continuous Operation Support **SupportsContinuous**	Yes	Yes	Yes[a]	Yes[b]	Yes[c]	Yes[d]	
Continuous Operation until Trigger **SupportsContinuousPreTrigger**							
Continuous Operation before & after Trigger **SupportsContinuousPrePostTrigger**							
Waveform Operations Using FIFO Only **SupportsWaveformModeOnly**		Yes[e]					
Simultaneous Start List Support **SupportsSimultaneousStart**	Yes[f]	Yes[f]					
Supports Programmable Synchronization Modes **SupportsSynchronization**	Yes[g]	Yes[h]	Yes[g]		Yes	Yes	
Synchronization Modes **SynchronizationMode**							
Interrupt Support **SupportsInterruptOnChange**							
FIFO Size, in samples **FifoSize**	16 kSamples[i] on each module	64 kSamples on each module					
Muting and Unmuting the Output Voltage **SupportsMute**		Yes					
Auto-Calibrate Support **SupportsAutoCalibrate**							

a. The DIN subsystem supports continuous mode by allowing you to read the digital input port (all 8 digital input lines) using the analog input channel list.
b. The DOUT subsystem supports continuous mode by allowing you to output data from the digital output port (all 8 digital output lines) using the output channel list.
c. The C/T subsystems support continuous mode by allowing you to read the value of the general-purpose counter/timer and/or the measure counters using the analog input channel list.
d. The TACH subsystem supports continuous mode by allowing you to read the value of the tachometer input using the analog input channel list.
e. VIBbox systems support continuous analog output operations in addition to waveform mode.
f. VIBbox systems support the ability to start continuous A/D and continuous D/A operations simultaneously.
g. You can synchronize input data from multiple devices if the A/D subsystem of one VIBbox is configured as a master and the A/D subsystems of the other VIBboxes are configured as slaves. You specify the channels to acquire in the analog input channel list for each device.
h. You can synchronize the output data from multiple devices if the D/A subsystem of one VIBbox is configured as the master and the D/A subsystems of the other VIBboxes are configured as slaves. You specify the output channels to update in the output list for each device.
i. The device driver automatically adjusts the FIFO half-full flag based on the size of the first user buffer on the queue rather than on the size of the A/D FIFO on the VIBbox. This ensures that each sample is transferred from the hardware FIFO to the user buffer without any additional time delay. Therefore, you will always achieve timely buffer complete messages regardless of the sampling rate you choose.

Buffering

Table 13: Buffering Options

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

Triggered Scan Mode

Table 14: Triggered Scan Mode Options

VIBbox	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Triggered Scan Support **SupportsTriggeredScan**							
Maximum Number of CGL Scans per Trigger **MaxMultiScanCount**	1	0	0	0	0		0
Maximum Retrigger Frequency **MaxRetriggerFreq**	0	0	0	0	0		0
Minimum Retrigger Frequency **MinRetriggerFreq**	0	0	0	0	0		0

Data Encoding

Table 15: Data Encoding Options

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

Channels

Table 16: Channel Options

VIBbox	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Number of Channels **NumberOfChannels**	42, 63, 84, up to 336[a]	6, 9,12, up to 48[b]	1[c]	1[d]	3[e]	1[f]	
SE Support **SupportsSingleEnded**	Yes	Yes					
SE Channels **MaxSingleEndedChannels**	32, 48, 64, up to 255[a]	4, 6, 8, up to 32[b]					
DI Support **SupportsDifferential**							
DI Channels **MaxDifferentialChannels**	0	0					
Maximum Channel-Gain List Depth **CGLDepth**	42, 63, 84 up to 336[a]	6, 9, 12, up to 48[b]					
Simultaneous Sample-and-Hold Support **SupportsSimultaneousSampleHold**	Yes						
Channel-List Inhibit **SupportsChannelListInhibit**							
Support MultiSensor Inputs **SupportsMultiSensor**							
Bias Return Termination Resistor Support **SupportsInputTermination**							

a. TheVIBbox aggregates all the input channels through the A/D subsystem.
For the VIBbox-64, the aggregated A/D subsystem supports 64 analog input channels (channels 0 to 63), the tachometer input on each module, the general-purpose counter 0 on each module, measure counters 1 and 2 on each module, and the digital input port on each module.
For the VIBbox-48, the aggregated A/D subsystem supports 48 analog input channels (channels 0 to 47), the tachometer input on each module, the general-purpose counter 0 on each module, measure counters 1 and 2 on each module, and the digital input port on each module.
For the VIBbox-32, the aggregated A/D subsystem supports 32 analog input channels (channels 0 to 31), the tachometer input on each module, the general-purpose counter 0 on each module, measure counters 1 and 2 on each module, and the digital input port on each module. Refer to page 85 for more information on channel numbering.
If you are synchronizing multiple VIBboxes, the A/D subsystem supports all the channels in the input stream from each VIBbox. For example, if you are synchronizing four VIBbox-64 systems, the A/D subsystem supports 256 analog input channels (0 to 255), 16 tachometer inputs, 16 general-purpose counters, 32 measure counters, and 16 digital input ports. Refer to page 202 about channel numbering when synchronizing multiple VIBboxes.

b. The VIBbox-64 supports eight analog output channels (0 to 7), and the digital output port on each module (channels 8 to 11). The VIBbox-48 supports six analog output channels (0 to 5), and the digital output port on each module (channels 6 to 8). The VIBbox-32 supports four analog output channels (0 to 3), and the digital output port on each module (channels 4 and 5). Refer to page 99 for more information on channel numbering.
If you are synchronizing multiple VIBboxes, the D/A subsystem supports all the channels in the output stream from each VIBbox. For example, if you are synchronizing four VIBbox-64 systems, the D/A subsystem supports 32 analog input channels (0 to 31) and 16 digital output ports. Refer to page 202 about channel numbering when synchronizing multiple VIBboxes.

c. One digital input port is supported for each DT9857E module in the VIBbox.

d. One digital output port is supported for each DT9857E module in the VIBbox.

e. Three counters are supported for each DT9857E module in the VIBbox. C/T 0 is the general-purpose counter/timer and C/T 1 and C/T 2 are the measure counters.

f. One tachometer is supported for each DT9857E module in the VIBbox.

Gain

Table 17: Gain Options

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

a. This provides effective input ranges of ±10 V (gain of 1) and ±1 V (gain of 10).

Ranges

Table 18: Range Options

VIBbox	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Number of Voltage Ranges **NumberOfRanges**	1	1	0	0	0	0	
Available Ranges **SupportedVoltageRanges**	±10 V[a]	±10 V					
Current Output Support **SupportsCurrentOutput**							

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

Resolution

Table 19: Resolution Options

VIBbox	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Software Programmable Resolution **SupportsSoftwareResolution**							
Number of Resolutions **NumberOfResolutions**	1	1	1	1			
Available Resolutions **SupportedResolutions**	24	32	8	8	32	31	

Current and Resistance Support

Table 20: Current and Resistance Support Options

VIBbox	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 21: Thermocouple, RTD, and Thermistor Support Options

VIBbox	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Thermocouple Support **SupportsThermocouple**							
RTD Support **SupportsRTD**							
Thermistor Support **SupportsThermistor**							
Voltage Converted to Temperature **SupportsTemperatureDataInStream**							
Supported Thermocouple Types **ThermocoupleType**							
Supports CJC Source Internally in Hardware **SupportsCjcSourceInternal**							
Supports CJC Channel **SupportsCjcSourceChannel**							
Available CJC Channels **CjcChannel**							
Supports Interleaved CJC Values in Data Stream **SupportsInterleavedCjcTemperaturesInStream**							
Supported RTD Types **RTDType**							
RTD R0 Coefficient **RtdR0**							
Supports Data Filters **SupportsTemperatureFilters**							
Temperature Filter Types **TemperatureFilterType**							

IEPE Support

Table 22: IEPE Support Options

VIBbox	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
IEPE Support **SupportsIEPE**	Yes						
Software Programmable AC Coupling **SupportsACCoupling**	Yes						
Software Programmable DC Coupling **SupportsDCCoupling**	Yes						
Software Programmable External Excitation Current Source **SupportsExternalExcitationCurrentSrc**							
Software Programmable Internal Excitation Current Source **SupportsInternalExcitationCurrentSrc**	Yes						
Available Excitation Current Source Values **SupportedExcitationCurrentValues**	.004 A						

Bridge and Strain Gage Support

Table 23: Bridge and Strain Gage Support Options

VIBbox	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 24: Start Trigger Options

VIBbox	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Software Trigger Support **SupportsSoftwareTrigger**	Yes	Yes	Yes[a]	Yes[b]	Yes[c]	Yes[d]	
External Positive TTL Trigger Support **SupportsPosExternalTTLTrigger**	Yes	Yes	Yes[a]	Yes[b]	Yes[c]	Yes[d]	
External Negative TTL Trigger Support **SupportsNegExternalTTLTrigger**	Yes	Yes	Yes[a]	Yes[b]	Yes[c]	Yes[d]	
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[e]		Yes[f]		Yes[g]	Yes[h]	
Negative Threshold Trigger Support **SupportsNegThresholdTrigger**	Yes[e]		Yes[f]		Yes[g]	Yes[h]	
Digital Event Trigger Support **SupportsDigitalEventTrigger**							
Threshold Trigger Channel **SupportedThresholdTriggerChannel**	0 to 63, 0 to 47, 0 to 31, or 0 to up to 255[e]						

a. Supported if the digital input port is included in the analog input channel list.
b. Supported if the digital output port is included in the analog output channel list.
c. Supported if a counter is included in the analog input channel list.
d. Supported if the tachometer is included in the analog input channel list.
e. If you choose a threshold trigger, you can program the threshold level as a value between ±10 V (gain of 1) or ±1 V (gain of 10). You can use any of the analog input channels as the threshold channel (0 to 63 for the VIBbox-64, 0 to 47 for the VIBbox-48, 0 to 31 for the VIBbox-32, or if synchronizing multiple VIBboxes, 0 to up to 255).
f. If the digital input port is included in the analog input channel list, the threshold trigger on the specified analog input channel is supported
g. If the counter is included in the analog input channel list, the threshold trigger on the specified analog input channel is supported.
h. If the tachometer is included in the analog input channel list, the threshold trigger on the specified analog input channel is supported.

Reference Triggers

Table 25: Reference Trigger Options

VIBbox	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
External Positive TTL Trigger Support **SupportsPosExternalTTLTrigger**	Yes		Yes[a]		Yes[b]	Yes[c]	
External Negative TTL Trigger Support **SupportsNegExternalTTLTrigger**	Yes		Yes[a]		Yes[b]	Yes[c]	
Positive Threshold Trigger Support **SupportsPosThresholdTrigger**	Yes[d]						
Negative Threshold Trigger Support **SupportsNegThresholdTrigger**	Yes[d]						
Digital Event Trigger Support **SupportsDigitalEventTrigger**							
Sync Bus Support **SupportsSyncBusTrigger**							
Threshold Trigger Channel **SupportedThresholdTriggerChannel**	0 to 63, 0 to 47, 0 to 31, or 0 to up to 255[d]						
Post-Trigger Scan Count **SupportsPostTriggerScanCount**	Yes[e]						

a. Supported if the digital input port is included in the analog input channel list.
b. Supported if a counter is included in the analog input channel list.
c. Supported if the tachometer is included in the analog input channel list.
d. If you choose a threshold trigger for the reference trigger, you can program the threshold level as a value between ±10 V for a gain of 1 or ±1 V for a gain of 10, and any of the supported analog input channels can be used as the threshold channel (0 to 63 for the VIBbox-64, 0 to 47 for the VIBbox-48, 0 to 31 for the VIBbox-32, or if synchronizing multiple VIBboxes, 0 to up to 255).
If you choose a threshold trigger as both the start trigger and the reference trigger, the threshold channel and threshold level must be the same. The polarity of the trigger (positive or negative going) can be different for each trigger source.
e. 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 26: Clock Options

VIBbox	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Internal Clock Support **SupportsInternalClock**	Yes	Yes			Yes		
External Clock Support **SupportsExternalClock**					Yes[a]	Yes	
Simultaneous Input/Output on a Single Clock Signal **SupportsSimultaneousClocking**	Yes						
Base Clock Frequency **BaseClockFrequency**	27 MHz[b]	27 MHz[b]	0	0	48 MHz	12 MHz	
Maximum Clock Divider **MaxExtClockDivider**	1.0	1.0	1.0	1.0	4,294,967,296	1.0	
Minimum Clock Divider **MinExtClockDivider**	1.0	1.0	1.0	1.0	2	1.0	
Maximum Frequency **MaxFrequency**	105.469 kHz[c]	216 kHz	0	0	24 MHz[d]	1 MHz	
Minimum Frequency **MinFrequency**	195.3125 Hz	30 kHz	0	0	0.0112 Hz	0.00559 Hz	

a. You can connect an external clock to general-purpose counter/timer 0.
b. A 48 MHz reference clock is used to generate the base clock frequency.
c. If you are performing long continuous operations or are synchronizing multiple VIBboxes, a maximum sampling frequency of 51.2 kHz is recommended.
d. The integrity of the signal degrades at frequencies greater than 10 MHz.

Counter/Timers

Table 27: Counter/Timer Options

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

Table 27: Counter/Timer Options (cont.)

VIBbox	A/D	D/A	DIN	DOUT	C/T	TACH	QUAD
Gate-Rising Edge Type **SupportsGateRising**					Yes[a]		
Measure Mode Edge Types **SupportedEdgeTypes**					GateRising[d] GateFalling[d] ClockRising[d] ClockFalling[d] ADCConversionComplete[e] TachometerInputFalling[e] TachometerInputRising[e] DigitalInput0Falling[e] DigitalInput0Rising[e] DigitalInput1Falling[e] DigitalInput1Rising[e] DigitalInput2Falling[e] DigitalInput2Rising[e] DigitalInput3Falling[e] DigitalInput3Rising[e] DigitalInput4Falling[e] DigitalInput4Rising[e] DigitalInput5Falling[e] DigitalInput5Rising[e] DigitalInput6Falling[e] DigitalInput6Rising[e] DigitalInput7Falling[e] DigitalInput7Rising[e] CT0ClockInputFalling[e] CT0ClockInputRising[e] CT0GateInputFalling[e] CT0GateInputRising[e]		
Interrupt-Driven Operations **SupportsInterrupt**							

a. Supported for the general-purpose counter (C/T 0) only.
b. In one-shot mode and repetitive one-shot mode, the duty cycle is set to 100% automatically.
c. High-edge and low-edge are supported for one-shot and repetitive one-shot modes. High-level and low-level are supported for event counting, up/down counting, edge-to-edge measurement, continuous edge-to-edge measurement, and rate generation modes.
d. These edges apply to counter/timer 0 on the specified DT9857E module when in measure or continuous measure mode.
e. These edges apply to measure counters 1 and 2 on the specified DT9857E module.

Tachometers

Table 28: Tachometer Options

VIBbox	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	

7

Troubleshooting

General Checklist 138
Technical Support 140
If Your VIBbox Needs Factory Service 141

General Checklist

Should you experience problems using the VIBbox, 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 VIBbox 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 29 to isolate and solve the problem. If you cannot identify the problem, refer to page 140.

Table 29: Troubleshooting Problems

Symptom	Possible Cause	Possible Solution
VIBbox is not recognized	You plugged the VIBbox 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 the VIBbox to the computer.
VIBbox does not respond	The VIBbox configuration is incorrect.	Check the configuration of your device driver; see the instructions in Chapter 2.
	The VIBbox is damaged.	Contact Data Translation for technical support; refer to page 140.
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 VIBbox is overheating.	Check environmental and ambient temperature; consult the specifications on page 166 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 29: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Device failure error reported	The VIBbox 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 VIBbox was removed while an operation was being performed.	Ensure that the VIBbox 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 VIBbox 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 VIBbox is out of calibration.	VIBbox systems 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 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 3.0, 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 operation. Consult Microsoft for more information.

Technical Support

If you have difficulty using the VIBbox, 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 VIBbox Needs Factory Service

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

1. Record the serial number of the VIBbox, 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 VIBbox as follows:
   – Wrap the VIBbox in an electrically conductive plastic material. Handle with ground protection. A static discharge can destroy components on the VIBbox.
   – Place in a secure shipping container.

3. Return the VIBbox 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

8

Calibration

Using the Calibration Utility 145
Calibrating the Analog Input Subsystem 146
Calibrating the Analog Output Subsystem 149

The VIBbox is 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 of each DT9857E module in the VIBbox system every six months using the DT9857 Calibration Utility.

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

This chapter describes how to calibrate the analog input and output subsystems of the each DT9857E module in the VIBbox using the DT9857 Calibration Utility.

Using the Calibration Utility

Start the DT9857 Calibration Utility as follows:

1. Click **Start** from the Task Bar.
2. Select **Programs | Data Translation, Inc | Calibration | DT9857 Calibration Utility**.
3. Select the DT9857E module that you want to calibrate in the VIBbox system.
   The PWR LED on the front panel of the module that you selected turns amber.

Once the calibration utility is running, you can calibrate the analog input circuitry (either automatically or manually), described on page 146, or the analog output circuitry, described on page 149.

Note: Once you have calibrated both the analog input and analog circuitry for the selected module, close the application, and then run the DT9857 Calibration Utility again, selecting another module in the VIBbox system. Repeat this procedure until all the DT9857E modules in the VIBbox system are calibrated.

Calibrating the Analog Input Subsystem

This section describes how to use the calibration utility to calibrate the analog input subsystem of a DT9857E module.

Warming up the VIBbox

Before calibrating the analog input circuitry, ensure that the VIBbox has been powered on for at least one hour.

Connecting a Precision Voltage Source

To calibrate the analog input circuitry, you need to connect an external +9.3750 V precision voltage source to the selected DT9857E module in the VIBbox system. Connect the precision voltage source to the first channel you want to calibrate; for example, Analog In 0 (AD Ch0).

Using the Auto-Calibration Procedure

Auto-calibration is the easiest to use and is the recommended calibration method. To auto-calibrate the analog input subsystem, do the following:

1. Select the **A/D Calibration** tab of the calibration utility.
2. Under the **Calibration Settings** area of the window, select the sampling frequency, in Hertz, and the gain that you want to use.

Notes: The DT9857E module has two power modes: low power mode and high power mode. Low power mode is calibrated when you specify a sampling frequency less than 52.734 kHz. High power mode is calibrated when you specify a sampling frequency greater than 52.734 kHz. Ensure that you calibrate the board for both high and low power mode if you are using sampling frequencies below and above 52.734 kHz.

By default, this utility uses DC coupling with the current source disabled. This is the recommended setting for most users. While changing these settings is not advised for most users, users with unique applications can change these settings by clicking the **Advanced** button.

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3. Under the Automatic Calibration area of the window, select the channel that you want to calibrate from the **Type of Calibration** drop-down list box, and then click the **Start** button. *A message appears notifying you to verify that 0.0000 V is applied to the channel.*
4. Verify that the supplied voltage to your selected channel is 0.0000 V, and then click **OK**. *The offset value is calibrated. When the offset calibration is complete, a message appears notifying you to set the input voltage of the channel to +9.3750 V.*
5. Check that the supplied voltage to your selected channel is +9.3750 V, and then click **OK**. *The gain value is calibrated and a completion message appears.*
6. Repeat steps 3 to 5 for each analog input channel on the DT9857E module.

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

Using the Manual Calibration Procedure

If you want to manually calibrate the analog input circuitry instead of auto-calibrating it, do the following for each channel:

1. Select the **A/D Calibration** tab of the calibration utility.
2. Under the **Calibration Settings** area of the window, select the sampling frequency, in Hertz, and the gain that you want to use.

Notes: The DT9857E module has two power modes: low power mode and high power mode. Low power mode is calibrated when you specify a sampling frequency less than 52.734 kHz. High power mode is calibrated when you specify a sampling frequency greater than 52.734 kHz. Ensure that you calibrate the board for both high and low power mode if you are using sampling frequencies below and above 52.734 kHz.

By default, this utility uses DC coupling with the current source disabled. This is the recommended setting for most users. While changing these settings is not advised for most users, users with unique applications can change these settings by clicking the **Advanced** button.

---

3. Under the Manual Calibration area of the window, select the channel that you want to calibrate, and then click the **Start** button.
4. Adjust the offset as follows:
   a. Verify that 0.0000 V is applied to the channel that you want to calibrate.
   The current voltage reading for this channel is displayed in the AD Value box.
   b. Adjust the offset by entering values between 0 and 255 in the **Offset** edit box, or by clicking the up/down buttons until the **AD Value** is 0.0000 V.
5. Adjust the gain as follows:
   a. Verify that +9.3750 V is applied to the channel that you want to calibrate.
   The current voltage reading for this channel is displayed in the AD Value box.
   b. Adjust the gain by entering values between 0 and 255 in the **Gain** edit box, or by clicking the up/down buttons until the **AD Value** is 9.3750 V.
6. When you have finished calibrating the channel, click the **Stop** button.
7. Repeat steps 3 to 6 for each analog input channel on the DT9857E module.

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

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

Calibrating the Analog Output Subsystem

To calibrate the analog output circuitry, you need to connect an external precision voltmeter to the analog output channels of the DT9857E module.

Do the following to calibrate the analog output circuitry:

1. Select the **D/A Calibration** tab of the calibration utility.
2. Under the **Calibration Settings** area of the window, select the output frequency, in Hertz.
3. Under the **Channel Selection** area of the window, select the analog output channel to calibrate.
4. Connect an external precision voltmeter to the selected analog output channel.
5. In the **DAC Output Voltage** box, select **0 V**.
6. Under the **Calibration Controls** area of the window, adjust the offset by entering values between 0 and 255 in the **DAC Offset** edit box or by clicking the up/down buttons until the voltmeter reads 0 V.
7. In the **DAC Output Voltage** box, select **9.375 V**.
8. Under the **Calibration Controls** area of the window, adjust the gain by entering values between 0 and 255 in the **DAC Gain** edit box or by clicking the up/down buttons until the voltmeter reads 9.375 V.
9. Repeat steps 2 to 7 for each analog output channel on the DT9857E module.

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

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

A

Specifications

Analog Input Specifications 152
Analog Output Specifications. 158
Digital I/O Specifications 160
Tachometer Input Specifications 161
Measure Counter Specifications. 162
General-Purpose Counter/Timer Specifications 163
Trigger Specifications. 164
Master Oscillator Specifications 165
Power, Physical, and Environmental Specifications 166
Regulatory Specifications 167
Connector Specifications 168
External Power Supply Specifications. 169

Analog Input Specifications

Table 30 lists the specifications for the analog input subsystem on the VIBbox. Unless otherwise noted, specifications are typical at 25° C and are referenced to a sample frequency of 51.2 kHz.

Table 30: Analog Input Subsystem Specifications

Feature	VIBbox Specifications
Number of analog input channels VIBbox-64: VIBbox-48: VIBbox-32:	 64 single-ended 48 single-ended 32 single-ended
Resolution	24 bits
Ranges and gains Gain of 1: Gain of 10:	 ±10 V ±1 V
A/D type	Delta Sigma
Data encoding	Offset binary
Maximum sample rate	105.469 kS/s [a]
Minimum sample rate	195.3125 S/s
ADC master clock range Sampling frequency < 52.734 kHz: 52.734 kHz to 105.469 kHz:	100 kHz to 27 MHz 512 x sample frequency 256 x sample frequency
Group delay	39/sample rate, in seconds
ADC Delta Sigma filter[b] Passband, –3 dB: Passband ripple, ±0.005 dB: Stopband, –100 dB:	 0.49 x sample frequency, Hz 0.453 x sample frequency, Hz 0.547 x sample frequency, Hz
Analog filter[b] Low pass cutoff, –3 dB: High pass cutoff, –3 dB (AC coupling):	 400 kHz 0.1 Hz
Channel-to-channel crosstalk[c] Input Signal =10 kHz:	 > – 110 dB with 50 Ω termination > –105 dB with 1 kΩ termination
Input impedance	1 MΩ ll 20 pF[d]
Coupling	AC/DC (software-selectable per channel)
IEPE current source	4 mA ±0.5%[e]
IEPE compliance voltage	24 V
IEPE current source noise DC to 1 kHz	 5 nARMS

Table 30: Analog Input Subsystem Specifications (cont.)

Feature	VIBbox Specifications	
DC Accuracy		
Offset error[f]	±1 mV	
Offset error temperature coefficient	±(7.2 µV/° C)/ Gain) ± 100 µV/° C	
Gain error Gain of 1: Gain of 10:	 ±0.02% ±0.5%	
Gain error temperature coefficient	50 ppm/° C	
ADC Integral Non-Linearity error, INL	±0.0006% of full-scale range	
ADC Differential Non-Linearity error, DNL	Monotonic to 24 bits	
Dynamic Performance[g]	**Gain of 1**	**Gain of 10**
Effective Number of Bits, ENOB[h] (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	 15.9 bits 16.4 bits	 15.8 bits 16.2 bits
Signal to Noise and Distortion Ratio, SINAD[i] (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	 97 dB 94 dB	 96 dB 93 dB
Signal to Noise Ratio, SNR[j] (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	 98 dB 94 dB	 97 dB 93 dB
Total Harmonic Distortion, THD[k] (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	 –104 dB –110 dB	 –103 dB –109 dB
Spurious Free Dynamic Range, SFDR[l] (1 kHz input, 105.5 kSPS) –1 dBFS input: –6 dBFS input:	 105 dBFS 118 dBFS	 105 dBFS 118 dBFS
Noise Floor (50 Ω input termination, 105.5 kSPS)	 58 µVRMS	 7.5 µVRMS
Overvoltage Protection		
Overvoltage protection Power on: Power off:	 +40 V to –20 V ±40 V	
ESD protection Arc: Contact:	 8 kV 4 kV	

a. When synchronizing multiple VIBboxes, the maximum throughput depends on the total number of channels, as well as the application and system you are using. For example, when using QuickDAQ in Data Logger mode, which saves data as 64-bits/sample for real-time display and processing, the following performance may be achieved (system-dependent): 64 channels at 102.4 kHz, 128 channels at 51.2 kHz, and 256 channels at 25.6 kHz. With an optimized application that writes raw data (32 bit/sample) to the hard disk, the following performance may be achieved (system-dependent): 64 channels at 102.4 kHz, 128 channels at 102.4 kHz, and 256 channels at 51.2 kHz. When acquiring data to system memory, it is possible to achieve 102.kHz per channel for all 256 channels because the hardware and software drivers are designed to get maximum speed to system memory all the time. To achieve high-speed data acquisition, ensure that you use a high-performance computer with an Intel Core i7 processor or equivalent, a high-speed solid-state hard drive, at least 8 GB of RAM, and multiple USB 3.0 ports.
b. The total frequency response is the combined frequency response of the ADC Delta Sigma filter and the analog filter.
c. Channel 0 is the reference channel with a 20 Vpp signal and a maximum sample rate of 105.469 kSamples/s.
d. Cable capacitance of 30 pF per foot (typical) must be added.
e. When using a 4 mA current source, it is recommended that you use an isolated transducer to eliminate the possibility of ground errors. Refer to page 37 for more information.
f. Offset errors are referred to the input.
g. ENOB, SINAD, SNR, THD, and SFDR measurements were made with a 16384 point FFT with a minimum 4-term Blackman Harris window.
h. Effective Number of Bits (ENOB) is calculated from the SINAD value with adjustment for level below full-scale of the input signal.

$$ENOB = \frac{(SINAD - 1.76 + IBFS)}{6.02}$$

where, IBFS is a positive value in dB, representing the ratio of a full-scale signal to the input signal.

i. Signal to Noise and Distortion (SINAD) is the ratio of the RMS value of the input signal to the RMS sum of all other spectral components, excluding DC.
j. Signal to Noise Ratio (SNR) is the ratio of the RMS value of the input signal to the RMS sum of all other spectral components, excluding harmonics and DC.
k. Total Harmonic Distortion (THD) is the ratio of the RMS value of the input signal to the RMS sum of all harmonics.
l. Spurious Free Dynamic Range (SFDR) is the ratio of the RMS full-scale range to the RMS value of the largest peak spurious component, including harmonics.

Figure 38 shows the full system accuracy of each DT9857E module in the VIBbox system as measured by QuickDAQ. In this example, a –1 dB input signal is connected to the DT9857E module and is sampled at 105.469 kHz using a gain of 1. The effective number of bits (ENOB) is 15.85

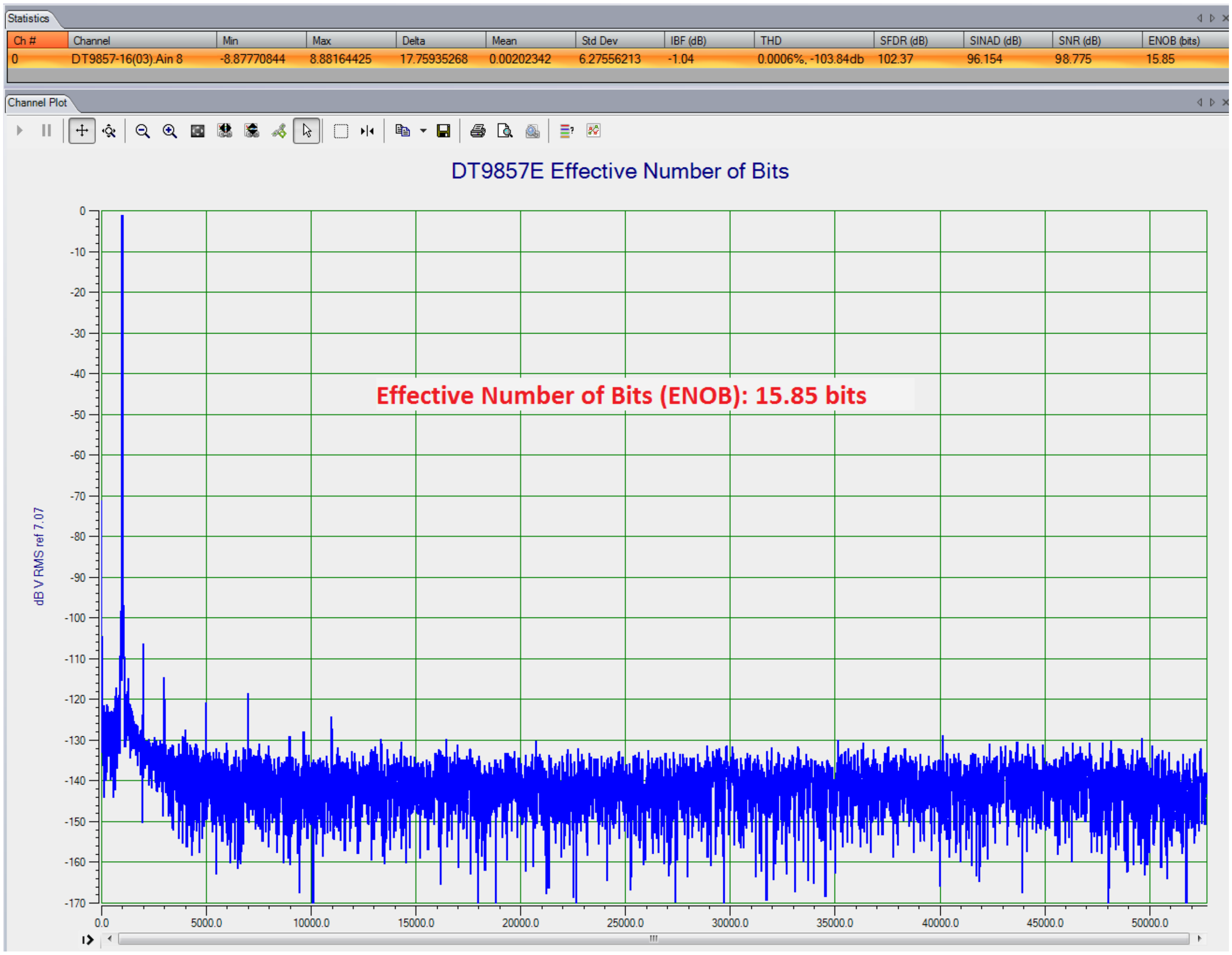


Figure 38: Dynamic Performance of the VIBbox Measured Using QuickDAQ

Figure 39 shows the noise performance of each DT9857E module using QuickDAQ. In this example, the input channel was shorted with 50 Ω and sampled at 105.469 kHz using a gain of 1. The noise is 52 µVRMS.

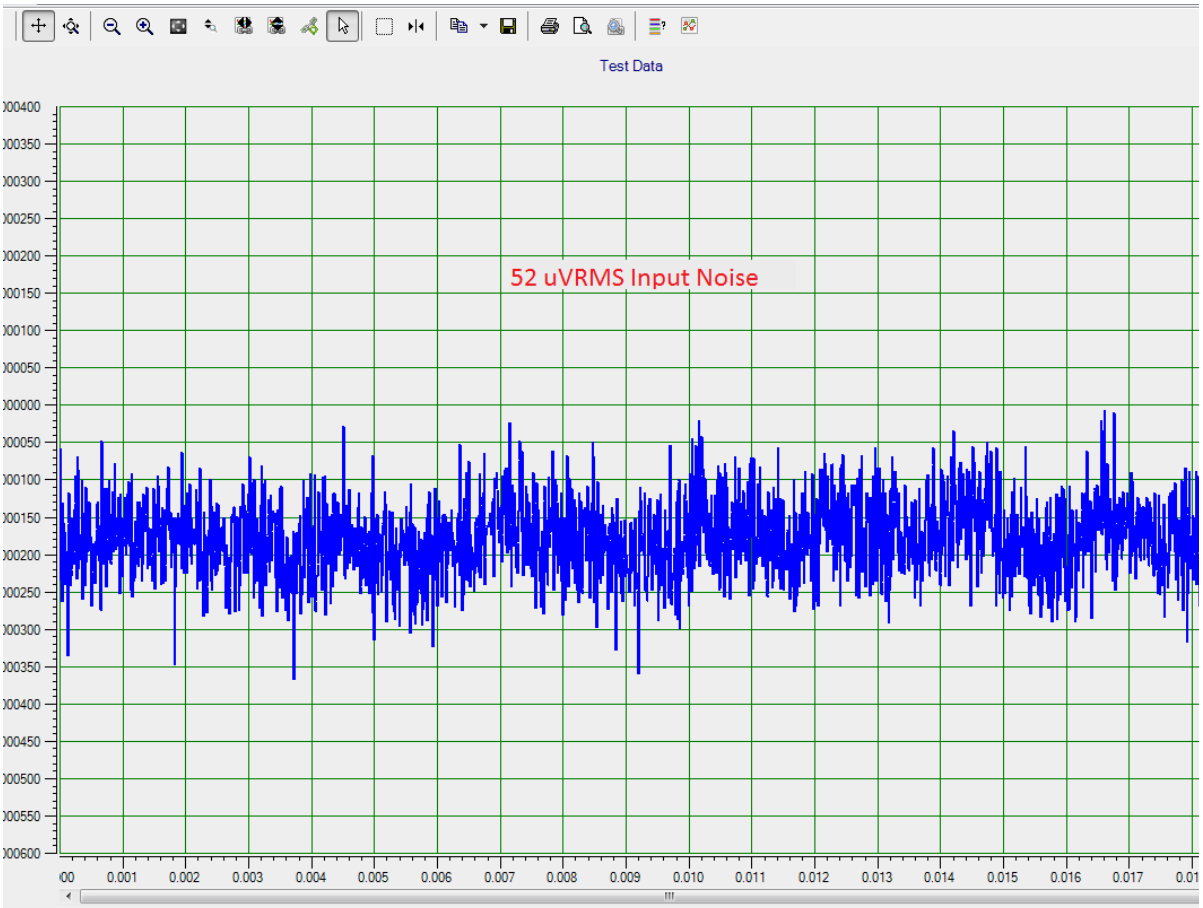


Figure 39: Noise Level of the DT9857E Measured Using QuickDAQ

Verify these numbers Figure 40 shows the analog input passband response of the VIBbox using a sampling rate of 48 kS/s.

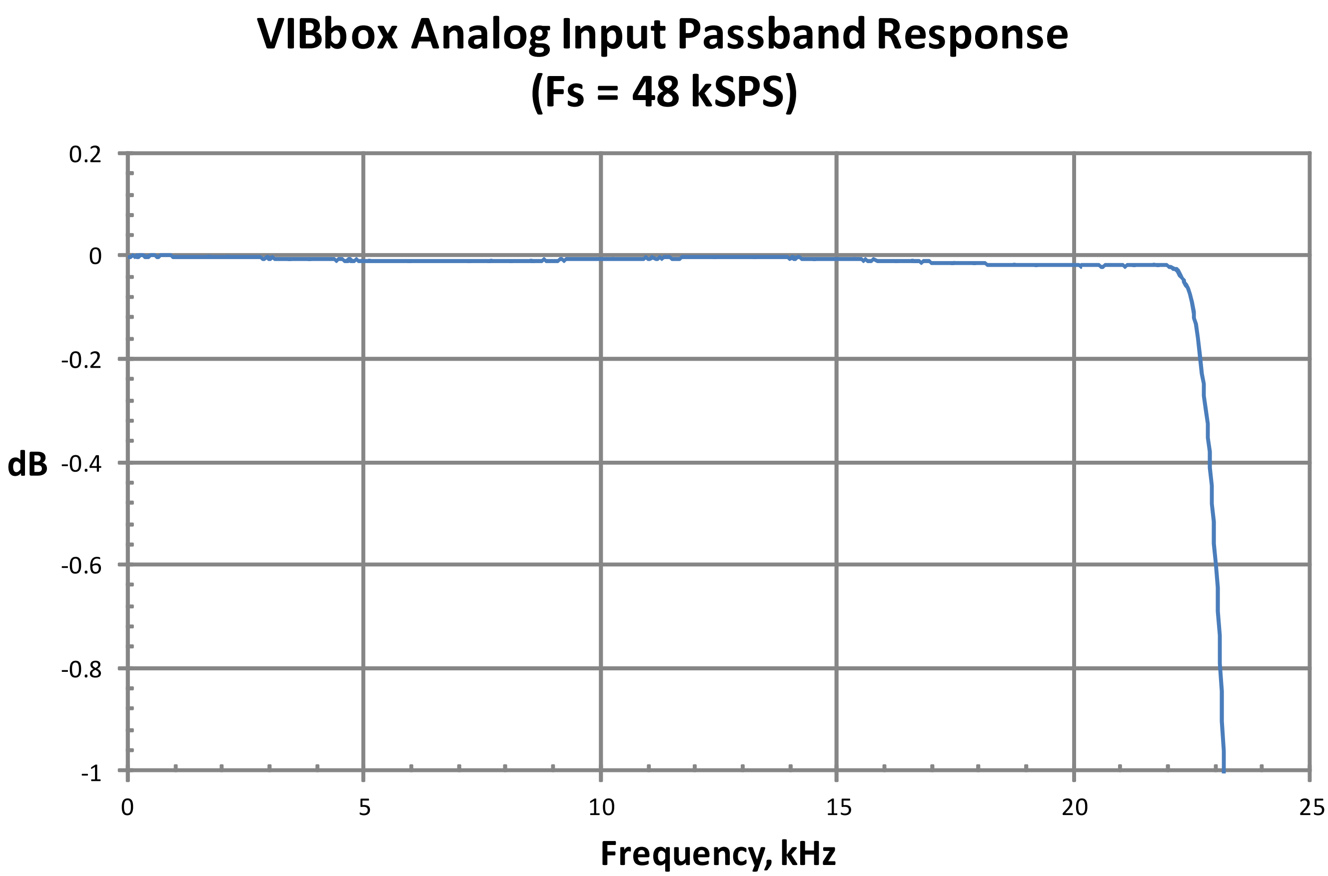


Figure 40: Analog Input Passband Response of the VIBbox

Analog Output Specifications

Table 31 lists the specifications for the analog output subsystem on the VIBbox. Unless otherwise noted, specifications are typical at 25° C.

Table 31: Analog Output Subsystem Specifications

Feature	VIBbox Specifications
Number of analog output channels VIBbox-64: VIBbox-48: VIBbox-32:	 8, single-ended 6, single-ended 4, single-ended
Resolution	32 bits
D/A type	Delta Sigma
Output range	±10 V
Data encoding	Offset binary
Minimum sample frequency	30 kHz
Maximum sample frequency	216 kHz
D/A master clock range Sampling Frequency 30 kHz to 54 kHz: 54 kHz to 108 kHz: 108 kHz to 216 kHz:	13.824 MHz to 27.648 MHz 512 x sample frequency 256 x sample frequency 128 x sample frequency
Group delay (typical)	36/sample rate, in seconds
DAC Delta Sigma filter[a] Passband, –3 dB: Passband ripple, ±0.005 dB: Stopband Stopband attenuation, –100 dB: Stopband attenuation, –95 dB: Stopband attenuation, –90 dB:	 0.49 x sample frequency, Hz 0.454 x sample frequency, Hz 0.546 x sample frequency, Hz Sample frequency ≤ 44.1 kHz Sample frequency ≤ 96 kHz Sample frequency ≤192 kHz
Analog filter[a]	120 kHz, 2-pole, low-pass Butterworth
Output current	±3 mA maximum load (10 V across 3.3 kΩ)
Output FIFO	64 kSamples
Idle channel noise (216 kSPS)	 30 μVRMS
Total Harmonic Distortion, THD[b] (216 kSPS –1 dBFS, 1 kHz output, 3.3 kΩ load: –6 dBFS, 1 kHz output, 3.3 kΩ load:	 –100 dB –110 dB
Spurious Free Dynamic Range, SFDR[b,c] (216 kSPS) –1 dBFS, 1 kHz output, 1 kΩ load: –6 dBFS, 1 kHz output, 1 kΩ load:	 102 dB 118 dB

Table 31: Analog Output Subsystem Specifications (cont.)

Feature	VIBbox Specifications
Offset error	±0.5 mV
Offset error temperature coefficient	130 µV/° C
Gain error	±0.03% of output
Gain error temperature coefficient	55 ppm/° C
Power fault and reset	Goes to 0 V ±0.5 mV if the USB cable is removed, external power fails, USB power is reset, or the system is rebooted
ESD protection Arc: Contact:	 8 kV 4 kV

a. The total frequency response is the combined frequency response of the DAC Delta Sigma filter and the analog filter.

b. THD and SFDR measurements were made with a 16384 point FFT with a minimum 4-term Blackman Harris window.

c. If the analog output signal from a module is used in the grounded signal path, it is best to use the analog output channel associated with the same module. or a 10 dB reduction in performance may result. Refer to page 37 for more information.

Digital I/O Specifications

Table 32 lists the specifications for the digital I/O subsystems on the VIBbox.

Table 32: Digital I/O Specifications

Feature	VIBbox Specifications
Number of digital I/O lines VIBbox-64: VIBbox-48: VIBbox-32:	 32 (8 in, 8 out on each DT9857E module) 24 (8 in, 8 out on each DT9857E module) 16 (8 in, 8 out on each DT9857E module)
Number of ports VIBbox-64: VIBbox-48: VIBbox-32:	 8 (2, 8-bit ports on each DT9857E module) 6 (2, 8-bit ports on each DT9857E module) 4 (2, 8-bit ports on each DT9857E module)
Input voltage range	0 to 3.3 V; 5 V tolerant
Logic sense	Positive true
Inputs Input type: Input logic load: High input voltage: Low input voltage: Low input current: Termination:	 Level-sensitive 1 LVTTL 2.0 V minimum 0.8 V maximum 0.2 mA maximum 22 kΩ pull-up to 3.3 V
Outputs Output type: High output: Low output: High output current: Low output current: Short circuit protected:	 LVTTL 2.4 V minimum 0.4 V maximum –10 mA maximum 4 mA maximum 33 mA
Clocked with sample clock	Yes, if included in the analog input or analog output channel list
Software I/O selectable	No

Tachometer Input Specifications

Table 33 lists the specifications for the tachometer inputs on the VIBbox.

Table 33: Tachometer Input Specifications

Feature	VIBbox Specifications
Number of channels VIBbox-64: VIBbox-48: VIBbox-32:	 4 (one on each DT9857E module) 3 (one on each DT9857E module) 2 (one on each DT9857E module)
Resolution	31 bits per channel
Input voltage range	±30 V
Threshold voltage	+2 V with 0.5 V hysteresis
Input termination	None
Maximum input frequency	1 MHz[a]
Minimum pulse width high/low (minimum amount of time it takes a C/T to recognize an input pulse)	0.4 µs
Clock frequency for tachometer measurements	12 MHz (83 ns resolution)

a. Limited by signal integrity and input signal conditioning.

Measure Counter Specifications

Table 34 lists the specifications for the measure counters (counters 1 and 2) on the VIBbox.

Table 34: Measure Counter Specifications

Feature	VIBbox Specifications
Number of measure counters VIBbox-64: VIBbox-48: VIBbox-32:	 8 (two on each DT9857E module) 6 (two on each DT9857E module) 4 (two on each DT9857E module)
Resolution	31 bits per channel
Clock frequency for measurement counters	48 MHz (20.8 ns resolution)
Maximum input frequency	10 MHz[a]
Minimum pulse width high/low	50 ns (0.4 µs if the tachometer input is used for the starting edge and stopping edge)
Start and stop signals/edges (on each DT9857E module)	A/D conversion complete Tachometer input (falling or rising edge) Digital inputs 0 to 7 (falling or rising edge) C/T 0 Clock input (falling or rising edge) C/T 0 Gate input (falling or rising edge)

a. Limited by signal integrity and input signal conditioning.

General-Purpose Counter/Timer Specifications

Table 33 lists the specifications for the general-purpose counter/timer (C/T 0) on the VIBbox.

Table 35: General Purpose Counter/Timer Specifications

Feature	VIBbox Specifications
Number of general-purpose counter/timers VIBbox-64: VIBbox-48: VIBbox-32:	 4 (one on each DT9857E module) 3 (one on each DT9857E module) 2 (one on each DT9857E module)
Internal reference clock	48 MHz
Resolution	32 bits per channel
Clock divider Minimum: Maximum:	 2 4,294,967,296
Clock output Minimum: Maximum:	 0.0112 Hz 24 MHz
Maximum clock or gate input frequency	24 MHz[a]
Minimum pulse width (minimum amount of time it takes a C/T to recognize an input pulse)	50 ns
Input voltage range	0 to 3.3 V (+5 V tolerance)
Inputs Input logic load: High input voltage: Low input voltage: Low input current: Input termination:	 1 LVTTL 2.0 V minimum 0.8 V maximum –0.2 mA maximum 22 kΩ
Outputs Output type: High output: Low output: High output current: Low output current: Short circuit protected:	 LVTTL 2.4 V minimum 0.4 V maximum –10 mA maximum 4 mA maximum 33 mA

a. The integrity of the signal degrades at frequencies greater than 10 MHz.

Trigger Specifications

Table 36 lists the specifications for the triggers on the VIBbox.

Table 36: Trigger Specifications

Feature	VIBbox Specifications
Trigger sources[a] Internal software trigger: External digital trigger: Threshold trigger:	 Software-initiated Software-selectable Software-selectable
External trigger (digital) Input type: Input termination: Logic family: Input logic load: Lower threshold: Upper threshold: Hysteresis: Input sink current: Minimum pulse width high/low: Maximum input signal:	 Edge-sensitive, rising- or falling-edge trigger (software-selectable) None LVTTL inputs 1 LVTTL 1.1 V 1.3 V 0.2 V 33 µA 250 ns ±30 V
Threshold trigger Type: Threshold level: Hysteresis:	 Rising- or falling-edge threshold trigger on any analog input channel (software-selectable) –10 V to +10 V @ gain of 1; ±1 V @ gain of 10 100 mV
Trigger delay	1 conversion period maximum

a. The trigger sources apply to DT9857E module 0.

Master Oscillator Specifications

Table 37 lists the specifications for the master oscillator on the VIBbox.

Table 37: Master Oscillator Specifications

Feature	VIBbox Specifications
Frequency	48 MHz[a]
Accuracy at 25° C	±30 ppm
Drift over temperature 0 to 70° C (Total)	±50 ppm
Aging (first year)	±5 ppm
Maximum error (first year)	±85 ppm

a. The sample frequencies for the A/D and D/A subsystems are independently programmable and are derived from the same 48 MHz reference clock. Therefore, it is possible to establish a fixed relationship between the A/D and D/A subsystem sample frequencies, including setting them to the same frequency (30 kHz to 105.469 kHz). However, the subsystems are not designed to be synchronous with each other.

Power, Physical, and Environmental Specifications

Table 38 lists the power, physical, and environmental specifications for the VIBbox.

Table 38: Power, Physical, and Environmental Specifications

Feature	VIBbox Specifications
Power	+7.5 VDC to +24 VDC
Warm-up time	1 hour
Physical Dimensions Length: Width: Height: Weight:	 15.57 ±0.06 inches (395.5 ±1.5 mm) 9.40 ±0.06 inches (238.8 ±1.5 mm) 15.98 ±0.06 inches (405.9 ±1.5 mm) 27.9 lbs (12.66 kg)
Environmental Operating temperature range: Storage temperature range: Relative humidity: Altitude:	 0° C to 55° C –25° C to 85° C To 95%, noncondensing To 10,000 feet

Regulatory Specifications

The VIBbox is CE-compliant. Table 39 lists the regulatory specifications for the VIBbox.

Table 39: Regulatory Specifications

Feature	VIBbox 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 40 lists the connector specifications for the VIBbox system.

Table 40: Connector Specifications

Connector	Part Number of Connector	Mating Connector
Analog I/O BNC connectors	TE Connectivity 5227161-9	–
External power supply	Header on VIBbox: Phoenix Contact 1825514	Plug on Power Supply: Phoenix Contact 1805314
Sync Bus connectors (25-pin, Micro D, vertical)	Molex part number 83614-9016[a]	–
USB connector[b]	TE Connectivity 292304-2	–
Digital connector	TE Connectivity 5747846-4	–

a. The Sync Bus connectors attach to the EP377 LXI bus cables (Circuit assembly Corp #U7120044-005 cable)

b. The VIBbox supports an optional locking USB cable. You can purchase a locking USB cable separately from vendors such as Newnex Technology Corporation (part number UHRB-B00A-U60). See http://ntcdistributing.com/products/usb-locking-screws.htm for more information.

External Power Supply Specifications

Table 41 lists the specifications for the +12 V external power supply that is used with the VIBbox.

Table 41: Specifications for the +12 V External Power Supply

Feature	Specifications
Type	Total Power medical power supply (TPMPU101-105)
Input voltage Safety approvals input range: Operate voltage range:	 100 to 240 VAC 90 to 260 VAC
Input frequency	47 to 63 Hz
Input current Low line: High line:	 1.25 A, (Io = Full load, Vin = 100 VAC) 0.5 A (Io = Full load, Vin = 240 VAC)
Inrush current Low line: High line:	 50 A maximum (Io = full load, 25° C, Cool start, Vin = 115 VAC) 100 A maximum (Io = full load, 25° C, Cool start, Vin = 230 VAC)
Output voltage	11 to 13 VDC
Output current	8.33 to 7.70 A
Output wattage	100 W
Noise and ripple	1% maximum peak to peak (Io = Full load, Vin = 90 VAC)
Regulatory specifications	Class I ANSI/AAMI ES 60601-1: 2005 (UL/cUL, 3rd edition) EN 60601-1:2006 (TUV/T-mark 3rd edition)

B

Connector Pin Assignments and LED Status Indicators

Analog Input Connectors 172
Analog Output Connectors 173
External Trigger Connector 174
Digital Connector 175
External USB 3.0 Connector 176
External Power Connector 177
Sync Bus Connectors 178
STP25 Screw Terminal Panel 180
LED Status Indicators 182

Analog Input Connectors

Figure 41 shows the layout of the analog input connectors on the VIBbox.

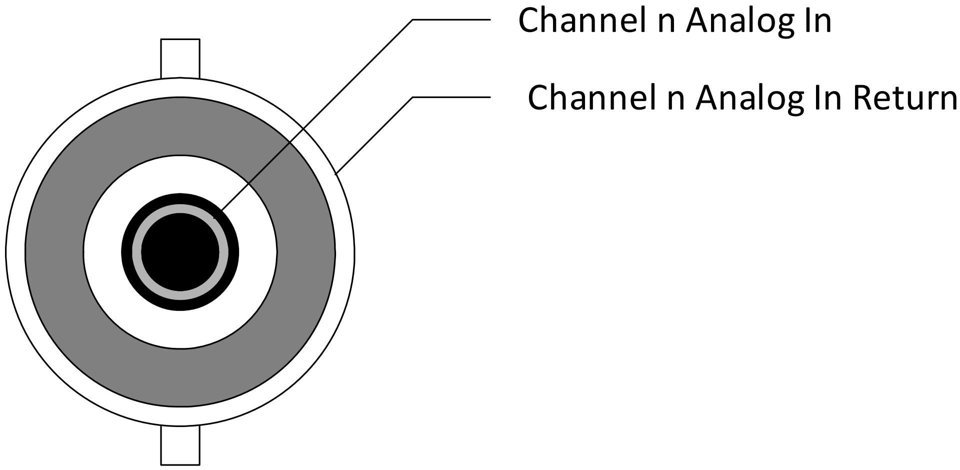


Figure 41: Analog Input Connectors

Analog Output Connectors

Figure 42 shows the layout of the analog output connectors on the VIBbox.

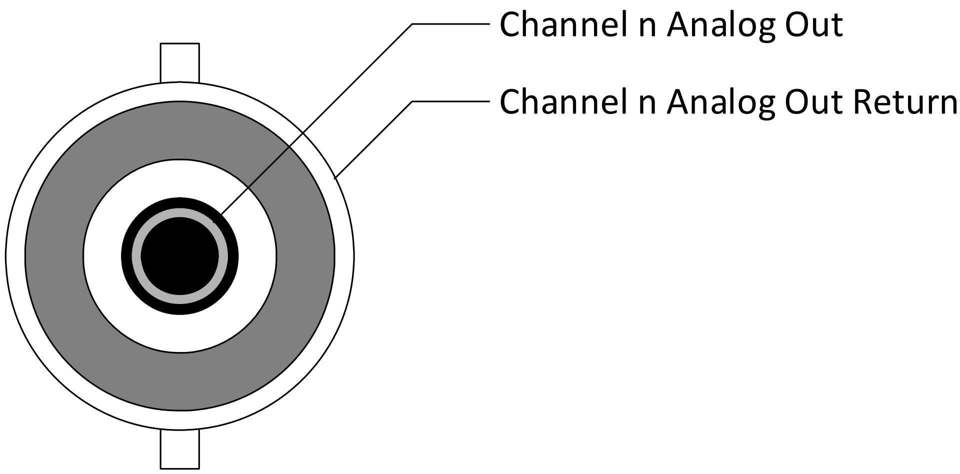


Figure 42: Analog Output Connectors

External Trigger Connector

Figure 43 shows the layout of the external digital (TTL) trigger connector on the VIBbox.

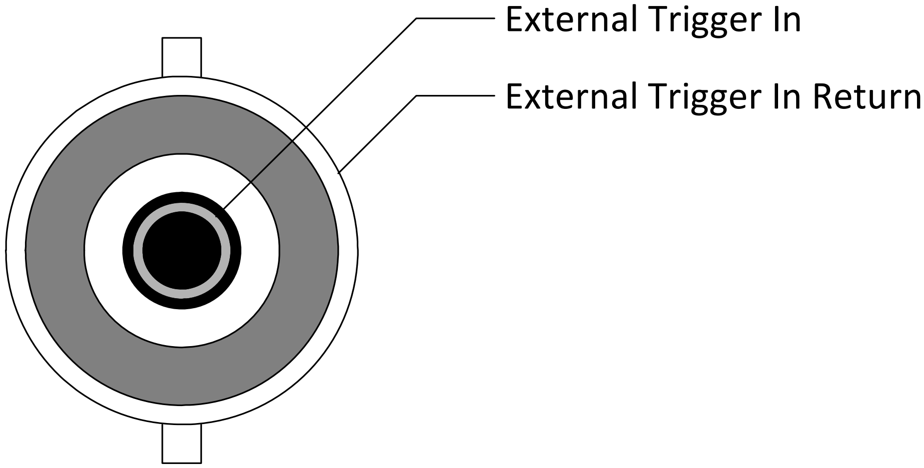


Figure 43: External Trigger Connector

Digital Connector

Figure 44 shows the layout of the 25-pin, D-shell, Digital connectors on the VIBbox.

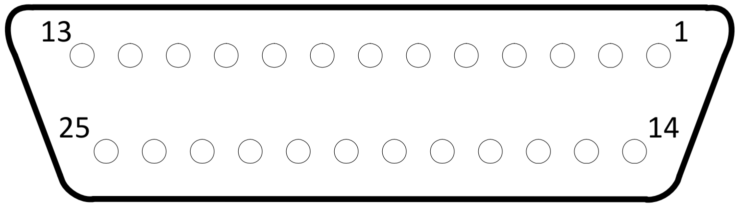


Figure 44: Layout of the Digital Connector

Table 42 lists the pin assignments for the Digital connectors on the VIBbox.

Table 42: Pin Assignments for the Digital Connectors

Connector Pin Number[a]	Signal Description	Connector Pin Number	Signal Description
1	Digital Input 0	14	C/T 0 Clock
2	Digital Input 1	15	C/T 0 Out
3	Digital Input 2	16	Digital Ground
4	Digital Input 3	17	Digital Output 0
5	Digital Ground	18	Digital Output 1
6	Digital Input 4	19	Digital Output 2
7	Digital Input 5	20	Digital Output 3
8	Digital Input 6	21	Digital Ground
9	Digital Input 7	22	Digital Output 4
10	Digital Ground	23	Digital Output 5
11	Tachometer Input	24	Digital Output 6
12	C/T 0 Gate	25	Digital Output 7
13	Event Out[b]		

a. The outer shell of the connector provides cable shield to chassis ground.
b. Currently, the event output function is disabled and the output is driven low.

External USB 3.0 Connector

Figure 45 shows the layout of the external USB 3.0 connector on the VIBbox.

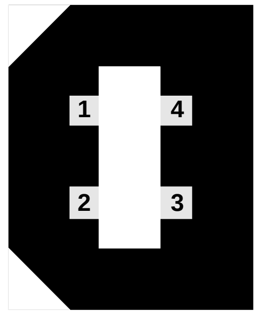


Figure 45: Layout of the USB 3.0 Connector

Table 43 lists the pin assignments for the USB 3.0 connector on the VIBbox.

Table 43: Pin Assignments for the USB 3.0 Connector

Connector Pin Number	Signal Description	Connector Pin Number	Signal Description
1	USB +5 V	3	USB Data +
2	USB Data –	4	USB Ground

External Power Connector

The VIBbox provides a external power supply connector for attaching a +7.5 VDC to +24 VDC external power supply.

Figure 46 shows the layout of the power connector.

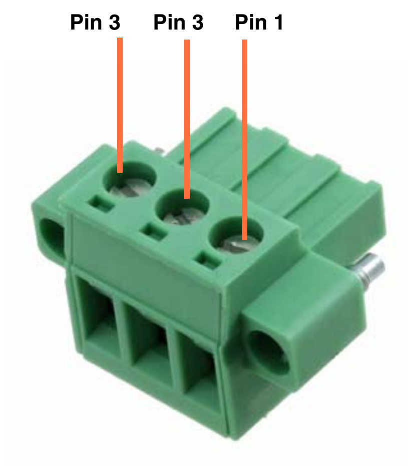


Figure 46: Layout of the Power Connector

Table 44 lists the pin assignments for the external power connector on the VIBbox

Table 44: Pin Assignments for the External Power Connector on the VIBbox

Connector Pin Number	Signal Description
1	+7.5 VDC to +24 VDC
2	Ground
3	Chassis Ground

Sync Bus Connectors

The VIBbox provides two Sync Bus connectors, one for input and one for output, for connecting multiple VIBboxes together. Figure 47 shows the Sync Bus connectors on the VIBbox.

Figure 47: Sync Bus Connectors

Both Sync Bus connectors have the same pin assignments, listed in Table 45.

Table 45: Sync Bus Connector Pin Assignments

Pin	Description
1	No connect
2	No connect
3	SB_DACTRIG_P
4	SB_DACTRIG_P
5	CGND
6	SB_DACMCLK_P
7	SB_DACMCLK_N
8	CGND
9	SB_ADCTRIG_P
10	SB_ADCTRIG_N
11	No connect
12	SB_ADCMCLK_P
13	SB_ADCMCLK_N
14	Reserved
15	Reserved
16	No connect
17	SB_DACSYNC_P

Table 45: Sync Bus Connector Pin Assignments (cont.)

Pin	Description
18	SB_DACSYNC_N
19	CGND
20	SB_REFCLK_P
21	SB_REFCLK_N
22	CGND
23	SB_ADCSYNC_P
24	SB_ADCSYNC_N
25	No connect

STP25 Screw Terminal Panel

The STP25 contains one 25-pin connector and a screw terminal block (TB1). The 25-pin connector provides access to the signals from a Digital connector on the VIBbox.

Figure 48 shows the layout of the STP25 screw terminal panel.

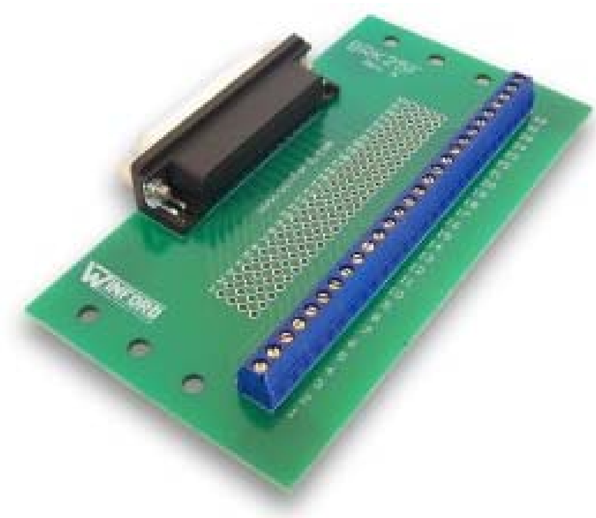


Figure 48: Layout of the STP25 Screw Terminal Panel

Table 46 lists the screw terminal assignments for the STP25 screw terminal panel.

Table 46: Screw Terminal Assignments for the STP25 Screw Terminal Panel

Screw Terminal	Signal Description
SH	Shield
25	Digital Output 7
24	Digital Output 6
23	Digital Output 5
22	Digital Output 4
21	Digital Ground
20	Digital Output 3
19	Digital Output 2
18	Digital Output 1
17	Digital Output 0
16	Digital Ground
15	C/T Out
14	C/T Clock
13	Event Out[a]
12	C/T Gate
11	External Trigger
10	Digital Ground
9	Digital Input 7
8	Digital Input 6
7	Digital Input 5
6	Digital Input 4
5	Digital Ground
4	Digital Input 3
3	Digital Input 2
2	Digital Input 1
1	Digital Input 0

a. Currently, the event output function is disabled and the output is driven low.

LED Status Indicators

The VIBbox has LED indicators on the front panel for each DT9857E module in the system. Figure 49 shows the LEDs on the front panel of each module in the VIBbox system.

Figure 49: LEDs on the Front Panel of Each Module in the VIBbox System

These LEDs are described in Table 47.

Table 47: LED Status Indicators on the VIBbox

LED	Color of the LED	Status Description
Trig In LED	Off	Idle.
	Solid amber	Input subsystem armed; it is waiting for an external digital trigger or threshold trigger (the VIBbox must have been configured for one of these trigger types).
	Solid green	Input subsystem has been triggered.
Trig Out LED	Off	Idle.
	Solid amber	Output subsystem armed; it is waiting for an external digital trigger, threshold trigger, or Sync Bus trigger (the VIBbox must have been configured for one of these trigger types).
	Solid green	Output subsystem has been triggered.
PWR LED	Off	Power off.
	Solid green	Power on (requires both the USB cable and the external power to be plugged in as the VIBbox is held in reset until both conditions are true).
	Amber	Module is identified.

C

Register-Level Programming

Writing to the EEPROM Register 186

Using the Data Acq SDK to Access the Registers 187

Using the Open Layers for .NET Class Library to Access the Registers 188

Writing to the EEPROM Register

If you want to change the default values for the coupling type, current source, and Sync Bus termination that are defined in the Open Layers Control Panel programmatically, you can use the Data Acq SDK function **olDiagWriteReg** or the Open Layers for .NET Class Library method **DiagWriteReg** to write to the EEPROM register of each DT9857E module.

On each DT9857E module, the Open Layers Control Panel has controls for setting the following parameters, which are stored in 8 consecutive bytes of EEPROM:

- Coupling type. The values COUPLING_TYPE_AC or COUPLING_TYPE_DC are stored as constants for these controls.
- Current source. The values EXCITATION_CURRENT_SRC_INTERNAL or EXCITATION_CURRENT_SRC_DISABLED are stored as constants for these controls.
- Sync Bus termination. The value is 0x01.

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

The following code shows the location of these controls in the register map:

```
#define I2C_MEM_BASE     0x00000000
// Coupling storage offsets relative to the base address for the
// analog input channels
#define EEPROM_OFFSET_COUPLING     0x0020
#define EEPROM_OFFSET_COUPLING_END     0x002F
// Current source storage offsets relative to the base address for
// the analog input channels
#define EEPROM_OFFSET_CURRENT_SOURCE     0x0040
#define EEPROM_OFFSET_CURRENT_SOURCE_END     0x004F
//Sync Bus termination offset from the base address
#define EEPROM_OFFSET_SYNC_TERMINATION     0x0C490
```

Using the Data Acq SDK to Access the Registers

The Data Acq SDK provides the **olDiagWriteReg** and **olDiagReadReg** functions for accessing the registers of a device programmatically.

To update the coupling type, use the **olDiagWriteReg** function as follows:

```
OLSTATUS olStatus = olDiagWriteReg(m_hDev, I2C_MEM_BASE +
   EEPROM_OFFSET_COUPLING + channelNumber, couplingType, 1);
```

To read the coupling type, use the **olDiagReadReg** function as follows:

```
OLSTATUS olStatus = olDiagReadReg(m_hDev, I2C_MEM_BASE +
   EEPROM_OFFSET_COUPLING + channelNumber, couplingType, 1);
```

To update the current source, use the **olDiagWriteReg f**unction as follows:

```
OLSTATUS olStatus = olDiagWriteReg(m_hDev, I2C_MEM_BASE +
   EEPROM_OFFSET_CURRENT_SOURCE + channelNumber, currentSource, 1);
```

To read the current source, use the **olDiagReadReg** function as follows:

```
OLSTATUS olStatus = olDiagReadReg(m_hDev, I2C_MEM_BASE +
   EEPROM_OFFSET_CURRENT_SOURCE + channelNumber, currentSource, 1);
```

To update the Sync Bus termination, use the **olDiagWriteReg** function as follows:

```
OLSTATUS olStatus = olDiagWriteReg(m_hDev, I2C_MEM_BASE +
   EEPROM_OFFSET_SYNC_TERMINATION, syncBusTermination, 1);
```

To read the Sync Bus termination, use the **olDiagReadReg** function as follows:

```
OLSTATUS olStatus = olDiagReadReg(m_hDev, I2C_MEM_BASE +
   EEPROM_OFFSET_SYNC_TERMINATION, &syncBusTermination, 1);
```

The parameters of these functions are defined as follows:

- *m_hDev* is the handle to the device that is being opened.
- *channelNumber* is the A/D channel whose EEPROM location is to be updated.
- *couplingType* is either COUPLING_TYPE_AC (for AC coupling) or COUPLING_TYPE_DC (for DC coupling)
- *currentSource* is either EXCITATION_CURRENT_SRC_INTERNAL (to enable the internal excitation source) or EXCITATION_CURRENT_SRC_DISABLED (to disable the excitation current source).
- *syncBusTermination* is 0x01 for enabling termination; if any other value is specified, Sync Bus termination is disabled.

Note: These settings take effect the next time the driver loads (either when the USB plug is removed and plugged back in or the module is powered up).

Using the Open Layers for .NET Class Library to Access the Registers

The Open Layers for .NET Class Library provides the **DiagWriteReg** and **DiagReadReg** methods for accessing the registers of a device programmatically. These methods are provided in the OpenLayers.Base namespace in the Device class.

To update the coupling type, use the **DiagWriteReg** method as follows:

```
Device.DiagWriteReg(I2C_MEM_BASE + EEPROM_OFFSET_COUPLING +
  channelNumber, couplingType, 1);
```

To read the coupling type, use the **DiagReadReg** method as follows:

```
RegValue = Device.DiagReadReg(I2C_MEM_BASE + EEPROM_OFFSET_COUPLING +
  channelNumber, couplingType, 1);
```

To update the current source, use the **DiagWriteReg** method as follows:

```
Device.DiagWriteReg(I2C_MEM_BASE + EEPROM_OFFSET_CURRENT_SOURCE +
  channelNumber, currentSource, 1);
```

To read the current source, use the **DiagReadReg** method as follows:

```
RegValue = Device.DiagReadReg(I2C_MEM_BASE +
  EEPROM_OFFSET_CURRENT_SOURCE + channelNumber, currentSource, 1);
```

To update the Sync Bus termination, use the **DiagWriteReg** method as follows:

```
Device.DiagWriteReg(I2C_MEM_BASE + EEPROM_OFFSET_SYNC_TERMINATION,
syncBusTermination, 1);
```

To read the Sync Bus termination, use the **DiagReadReg** method as follows:

```
RegValue = Device.DiagReadReg(I2C_MEM_BASE +
  EEPROM_OFFSET_SYNC_TERMINATION, &syncBusTermination, 1);
```

The parameters of these methods are defined as follows:

- *channelNumber* is the A/D channel whose EEPROM location is to be updated.
- *couplingType* is either COUPLING_TYPE_AC (for AC coupling) or COUPLING_TYPE_DC (for DC coupling)
- *currentSource* is either EXCITATION_CURRENT_SRC_INTERNAL (to enable the internal excitation source) or EXCITATION_CURRENT_SRC_DISABLED (to disable the excitation current source).
- *syncBusTermination* is 0x01 for enabling termination; if any other value is specified, Sync Bus termination is disabled.

Note: These settings take effect the next time the driver loads (either when the USB plug is removed and plugged back in or the module is powered up).

D

Synchronizing Multiple VIBboxes

Overview 190
Connecting Multiple VIBboxes Together 191
Applying Power to the VIBboxes. 192
Attaching Each VIBbox to the Computer 194
Configuring the DT9857 Series Device Driver for each Module. 197
Collecting all the VIBboxes Using the DT Device Collection Manager 200
Channel Numbering for Multiple VIBboxes 202

Overview

If desired, you can attach up to four VIBboxes together to synchronize up to 256 analog inputs, 8 analog outputs, 16 digital input ports, 16 digital output ports, 16 counter/timers, 32 measure counters, and 16 tachometer inputs.

Note: When synchronizing multiple VIBboxes, the maximum throughput depends on the total number of channels, as well as the application and system you are using.

For example, when using QuickDAQ in Data Logger mode, which saves data as 64-bits/sample for real-time display and processing, the following performance may be achieved (system-dependent): 64 channels at 102.4 kHz, 128 channels at 51.2 kHz, and 256 channels at 25.6 kHz.

With an optimized application that writes raw data (32 bit/sample) to the hard disk, the following performance may be achieved (system-dependent): 64 channels at 102.4 kHz, 128 channels at 102.4 kHz, and 256 channels at 51.2 kHz.

When acquiring data to system memory, it is possible to achieve 102.kHz per channel for all 256 channels because the hardware and software drivers are designed to get maximum speed to system memory all the time.

To achieve high-speed data acquisition, ensure that you use a high-performance computer with an Intel Core i7 processor or equivalent, a high-speed solid-state hard drive, at least 8 GB of RAM, and multiple USB 3.0 ports (one for each VIBbox).

This section describes how to configure multiple VIBboxes.

Connecting Multiple VIBboxes Together

To synchronize multiple VIBbox systems, use the Sync Bus connectors on the rear panel of the VIBbox and optional EP377 LXI cables, as follows:

1. If using two VIBboxes, connect an EP377 cable to the **Sync Bus Out** connector on VIBbox #1 to the **Sync Bus In** connector, of VIBbox #2, as shown in Figure 50.

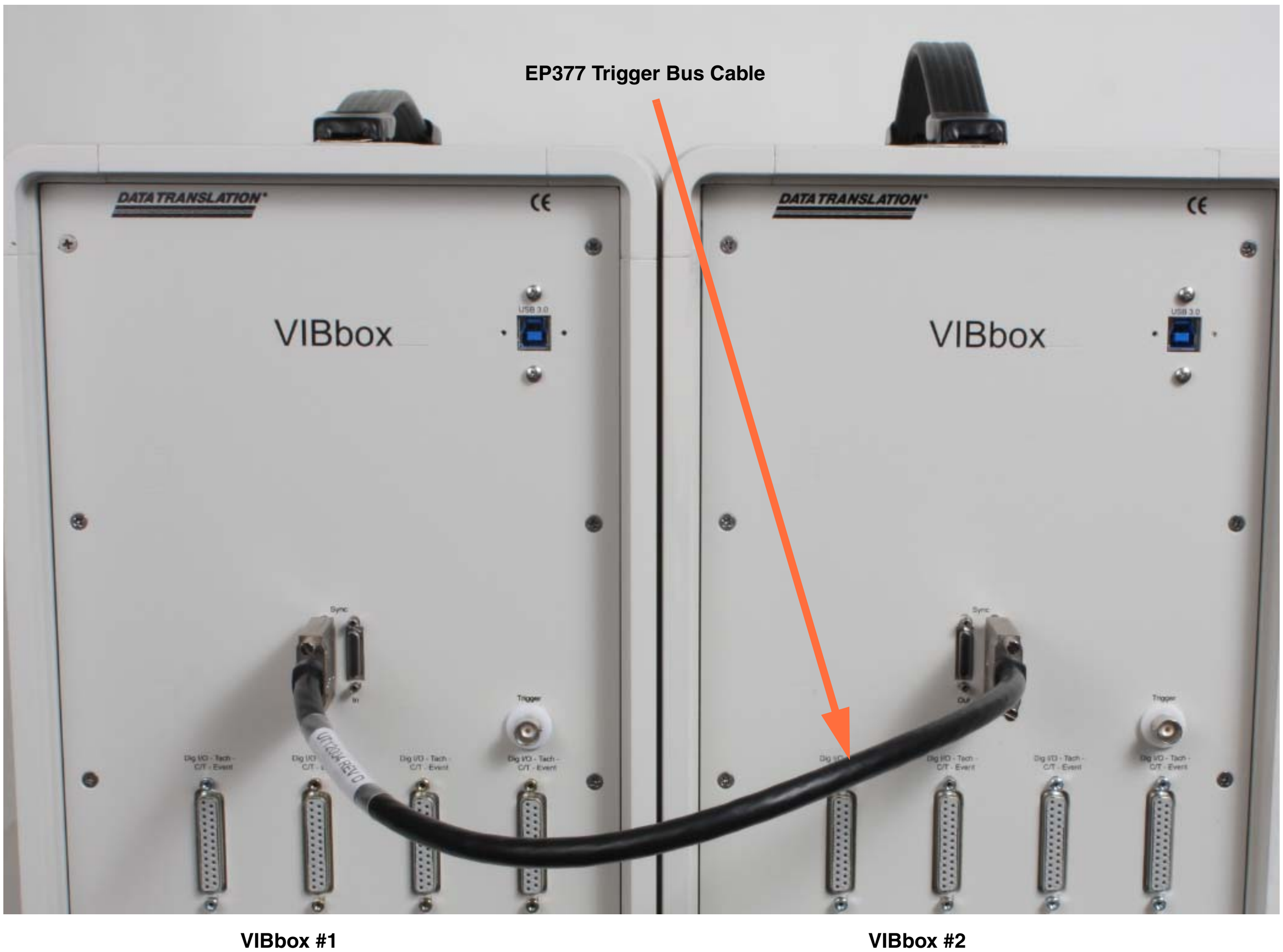


Figure 50: Connect Multiple VIBboxes Together Using the Sync Bus Connectors and EP377 Cables

2. If using three VIBboxes, connect another EP377 cable to the **Sync Bus Out** connector on VIBbox #2 and to the **Sync Bus In** connector on VIBbox #3.
3. If using four VIBboxes, connect another EP377 cable to the **Sync Bus Out** connector on VIBbox #3 and to the **Sync Bus In** connector on VIBbox #4.

Applying Power to the VIBboxes

Apply power to each VIBbox by performing the following steps:

1. Ground the chassis of the VIBbox to earth ground by connecting a grounding strap to the grounding stud on the rear panel of the VIBbox, as shown in Figure 51.

Figure 51: Connect a Grounding Strap to the Grounding Stud on the VIBbox System

2. Connect the EP404 power supply to the power connector on each VIBbox, as shown in Figure 52.

Figure 52: Connect an EP404 Power Supply to Each VIBbox

3. Plug each power supply into a wall outlet.

Attaching Each VIBbox to the Computer

You must install the device driver for each DT9857E module in the VIBbox before connecting the VIBbox to the host computer. If you haven't done so already, run the installation program on your Data Acquisition OMNI CD to install the DT9857 Series device driver and other software for the VIBbox.

Notes: You must connect the VIBbox to a USB 3.0 port of your host computer. USB 3.0 hubs are not supported for connecting multiple VIBboxes to the host computer.

You can unplug a VIBbox, 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 VIBbox once it is plugged back in.

To connect a VIBbox to a USB 3.0 port on your computer, do the following:

1. Make sure that you have attached an external power supply to the VIBbox.
2. For each VIBbox, attach one end of the USB cable (provided with the system) to the USB 3.0 port on the VIBbox, as shown in Figure 53. The VIBbox supports an optional locking USB cable if desired. You can purchase this cable separately from vendors such as Newnex Technology Corporation (part number UHRB-B00A-U60).

Figure 53: Attaching USB Cables to Each VIBbox

3. Attach the other end of each USB cable to the USB 3.0 port on the host computer.
The operating system automatically detects the USB device and starts the Found New Hardware wizard.

4. <u>For Windows Vista:</u>

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.

Once you have applied external power to the VIBboxes and connected the VIBboxes to the host computer, the Power LED on each VIBbox turns solid green. If the Power LED is not solid green, check your cabling.

Configuring the DT9857 Series Device Driver for each Module

Note: In Windows 7, Windows 8, and Windows Vista, you must have administrator privileges to run the Open Layers Control Panel. When you double-click the Open Layers Control Panel icon, you may see the Program Compatibility Assistant. If you do, select **Open the control panel using recommended settings**. You may also see a Windows message asking you if you want to run the Open Layers Control Panel as a "legacy CPL elevated." If you get this message, click **Yes**.

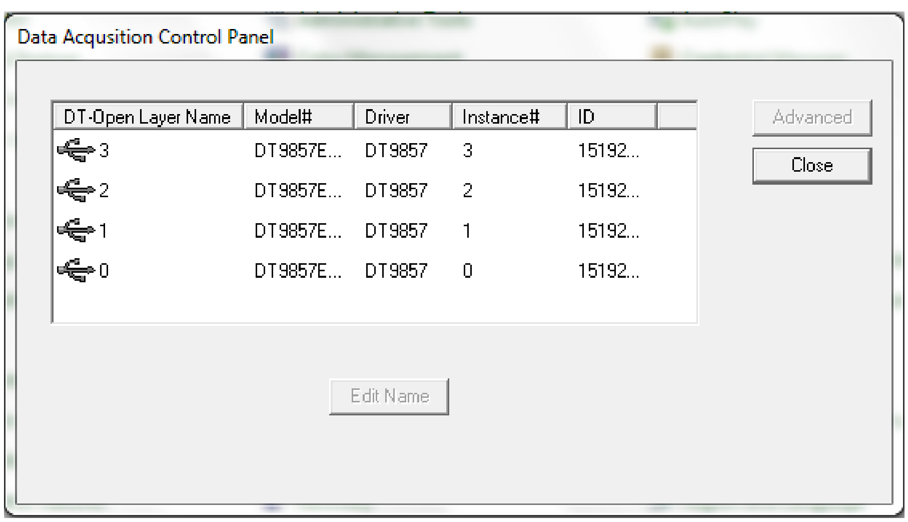
If you do not get this message and have trouble making changes in the Open Layers Control Panel, right click the DTOLCPL.CPL file and select **Run as administrator**. By default, this file is installed in the following location:

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

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

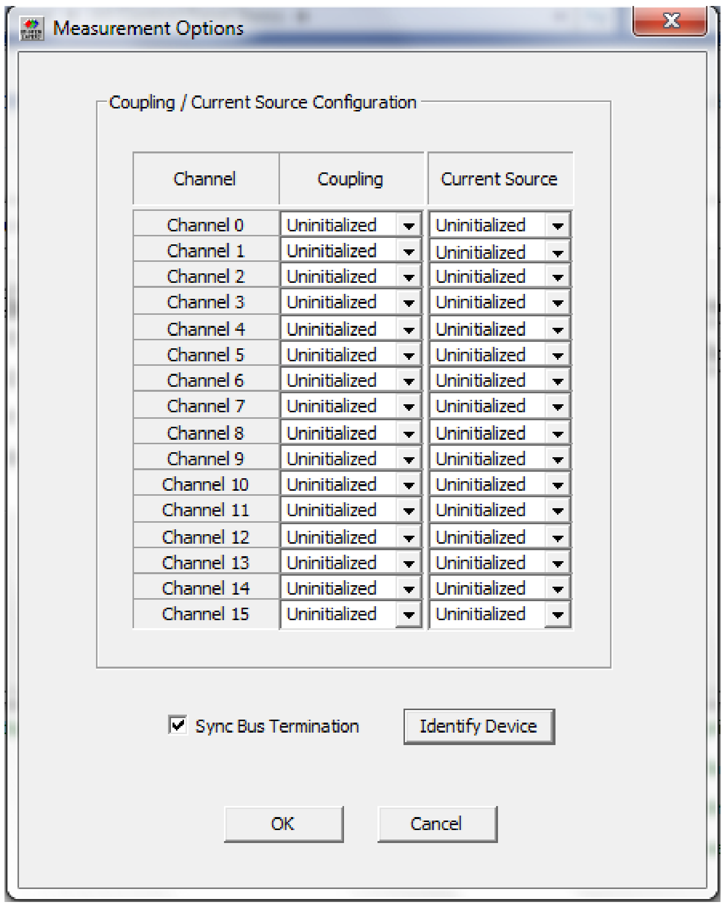
For each VIBbox, configure the device driver for each DT9857E module in the system by performing the following steps:

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 device, click the name of the device that you want to rename, click **Edit Name**, enter a new name for the device, and then click **OK**. The name is used to identify the device in all subsequent applications, including the DT Device Manager Collection application.

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



6. Click the **Identify Device** button to turn the Power LED on the front of the module amber, helping you identify which module you are configuring.
   By default, all settings are uninitialized.

7. For the Coupling type, select **AC** for AC coupling or **DC** for DC coupling for each analog input channel.

8. For the Current Source, select **Enabled** to enable the internal excitation current source or **Disabled** to disable the internal excitation current source for each analog input channel.

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

---

9. Leave the termination unchanged. By default, the first and last module in the VIBbox are terminated with a 100 Ω resistor. The DT Device Collection Manager automatically sets the proper termination for the VIBbox system.
10. When you are finished, click **OK** to close the Measurement Options dialog box.
11. Repeat steps 4 to 10 for the other modules that you want to configure.
12. When you are finished configuring the modules, click **Close** to close the Control Panel.

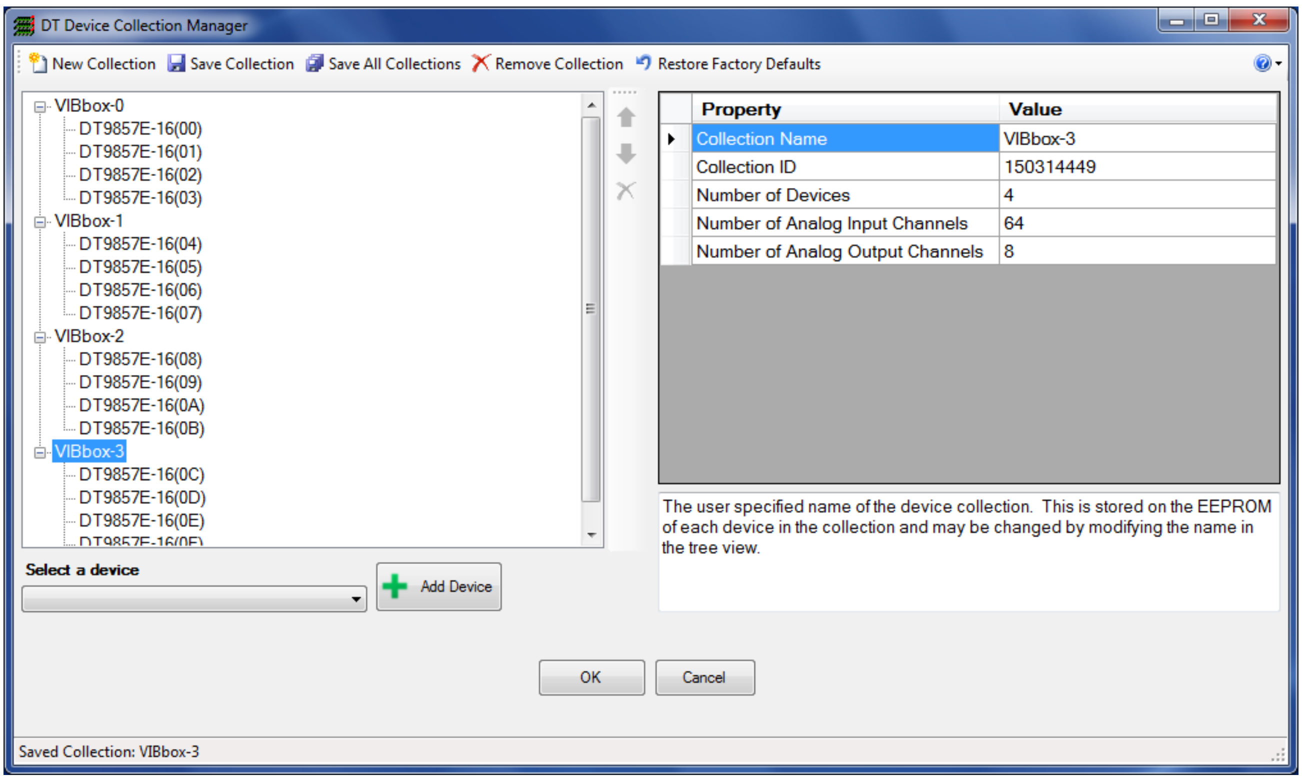
Collecting all the VIBboxes Using the DT Device Collection Manager

When you want to synchronize multiple VIBboxes, use the DT Device Collection Manager to ensure that all VIBboxes are collected as one entity by performing the following steps:

Note: Use the online help provided with the application for more information on using the DT Device Collection Manager application.

---

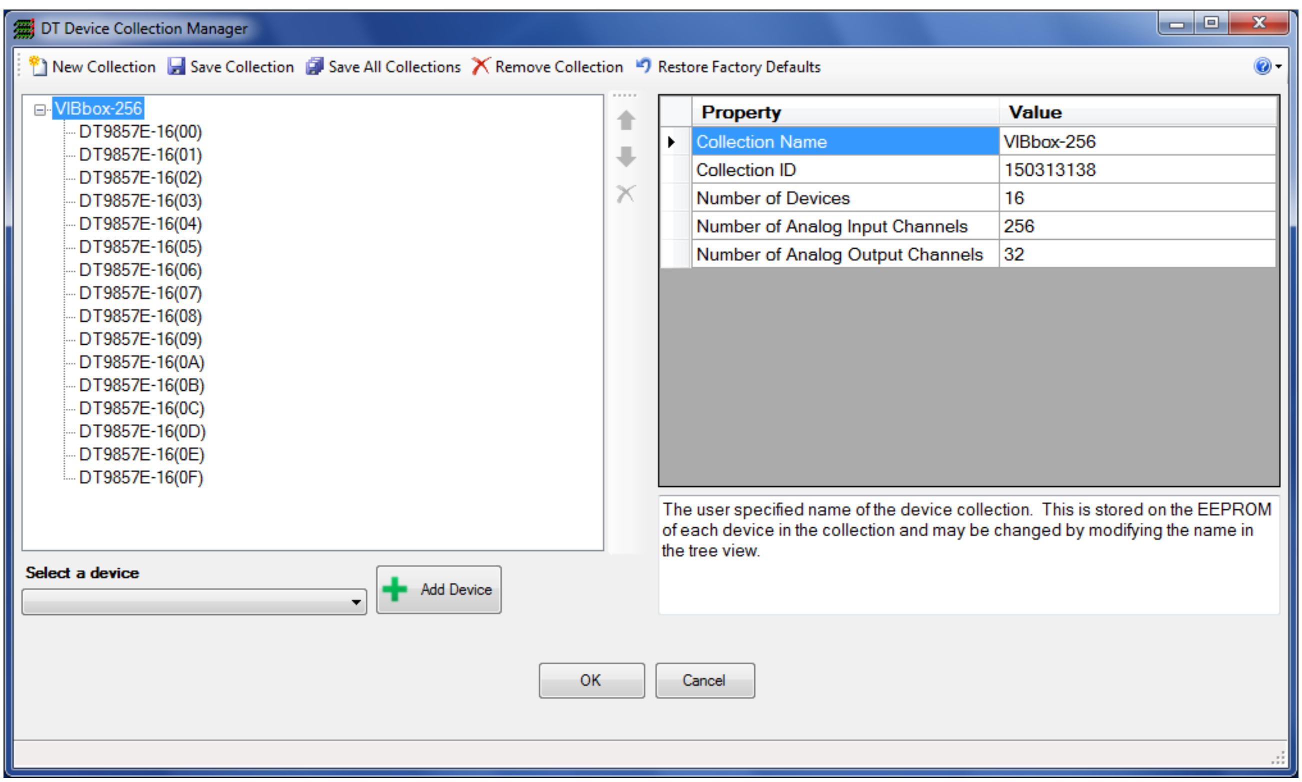
1. From the Windows Start menu, select **Data Translation, Inc**, select the **Utilities** folder, and double click **DT Device Collection Manager.**
   The DT Device Collection Manager application shows the VIBbox collection and the individual DT9857E modules that are included in the collection.



2. If only one VIBbox collection is shown, no further configuration is required; ignore the remaining steps. However, if multiple VIBbox collections are shown (for example, four collections are shown above), remove each of the existing collections by selecting the collection name and clicking the **Remove Collection** button.
   The DT9857E modules will then be available to add to a new collection.

3. Click the **New Collection** button to create a new collection that will contain all the DT9857E devices used by the multiple VIBboxes.

4. Specify a name for the collection.
   In this example, the name is VIBbox-256.
5. From the **Select a device** list box, choose the device that you want to add as the first device in your collection.
   The names of these devices can be changed using the Open Layers Control Panel, if desired. All the devices that are connected to your computer are shown; however, only those of the same model type (product ID) can be added to the collection. Note that the first device that you add will have the lowest channel numbers. In addition, for DT9857E modules, the first device and the last device in the list will be terminated.
6. Click **Add Device**.
   The device is added to your collection. The number of the device as well as the channel numbers for the analog input subsystem and analog output subsystem in the collection are shown on the right side of the screen.
7. Repeat steps 5 and 6 until you have added all the devices to your collection.
8. Once all your devices are added to the collection, use the device tree on the left panel to select the device that you want to be the master. Typically, this is the first device in the list.
9. For the property called **Master Device** in the right panel, select the checkbox in the **Value** field.
10. Save the collection by clicking the **Save Collection** button.
    An example follows:



Channel Numbering for Multiple VIBboxes

Once all devices are combined into one entity using the DT Device Collection Manager, you can use the QuickDAQ application to acquire data from the device. QuickDAQ automatically shows you the channel numbers that correspond to the channels in the input stream. (Refer to Chapter 4 starting on page 59 for more information on QuickDAQ).

However, if you are writing your own application programs using DT-Open Layers for .NET, be mindful of the following channel order and channel numbering when synchronizing multiple VIBboxes:

Input Stream Channel Order

- Analog input channels – The first channels in the list represent the analog input channels from each device, starting with device 0. For example, if you are synchronizing four VIBbox-64 systems, the first channels in the list are analog input channels 0 to 255, where channel 0 corresponds to device 0 analog input channel 0 and channel 255 corresponds to device 15 analog input channel 15.
- Device *n* Other Channels in Input Stream – The next channels in the list are as follows for each sequentially numbered device in the collection: tachometer, general-purpose counter 0, measure counter 0, measure counter 1, digital input port. For example, after all the analog input channels in the input channel list, the channels are ordered as follows: device 0 tachometer, device 0 general-purpose counter 0, device 0 measure counter 0, device 0 measure counter 1, device 0 digital input port, device 1 tachometer, device 1 general-purpose counter 0, device 1 measure counter 0, device 1 measure counter 1, device 1 digital input port, and so on.

Output Stream Channel Order

- Analog output channels – The first channels in the list represent the analog output channels from each device, starting with device 0. For example, if you are synchronizing four VIBbox-64 systems, the first channels in the list are analog output channels 0 to 31, where channel 0 corresponds to device 0 analog output channel 0 and channel 7 corresponds to device 15 analog output channel 1.
- Device *n* Digital Output Port– The next channels in the output channel list are the digital output ports for each sequentially numbered device in the collection. For example, after all the analog output channels in the output channel list, the channels are ordered as follows: device 0 digital output port, device 1 digital output port, and so on.

Index

A

AC coupling 131
accessories
  EP361 26
  EP403 cable 16
  STP25 screw terminal panel 16
administrator privileges 31, 197
aggregating channels 33, 200
aliasing 93
analog input
  calibrating 146
  channels 84
  continuous scan mode 94
  conversion modes 94
  data format and transfer 98
  error conditions 98
  gain 92
  IEPE functions 93
  input range 92
  resolution 93
  sample clock 93
  single-ended configuration 44
  single-value mode 94
  specifications 152
  triggers 96
  wiring 44
analog input connectors 172
analog output
  calibrating 149
  channels 99
  clock sources 102
  continuous operations 104
  conversion modes 103
  data format and transfer 105
  error conditions 106
  gain 102
  ranges 102
  resolution 102
  single-value operations 103
  specifications 158
  waveform generation mode 103
  wiring 46
analog output connectors 173
analog threshold trigger 105
applet, Open Layers Control Panel 139
application wiring
  analog inputs 44
  analog output 46
  continuous edge-to-edge measurement 55
  edge-to-edge measurement 54
  event counting 50
  measure counters 57
  period measurement 53
  pulse output 56
  pulse width measurement 53
  tachometer input 47
  up/down counting 52
applying power 25, 192

B

base clock frequency 134
BaseClockFrequency 134
binary data encoding 126
buffers 126
  inprocess flush 126
  single wrap mode 126

C

C/T, *see* counter/timer 162, 163
cables
  USB 195
calibration
  analog input subsystem 146
  analog output subsystem 149
  running the calibration utility 145
CGLDepth 127
channel numbers and names
  multiple VIBboxes 202
  VIBbox-32 input channels 91
  VIBbox-32 output channels 102
  VIBbox-48 input channels 88
  VIBbox-48 output channels 101
  VIBbox-64 input channels 85
  VIBbox-64 output channels 100
channel type
  differential 127
  single-ended 127
channel-gain list depth 127

channels
analog input 84
analog output 99
counter/timer 109
digital I/O 120
number of 127
chassis grounding stud 25, 192
clock-falling edge type 135
clock-rising edge type 135
clocks
analog input 93
analog output 102
base frequency 134
counter/timer 110
external 134
internal 134
maximum external clock divider 134
maximum throughput 134
minimum external clock divider 134
minimum throughput 134
simultaneous 134
configuring the VIBbox 29
connecting signals
analog inputs 44
analog output 46
continuous edge-to-edge measurement 55
edge-to-edge measurement 54
event counting 50
measure counters 57
period measurement 53
pulse output 56
pulse width measurement 53
tachometer input 47
up/down counting 52
connecting to the host computer 27, 194
connectors
analog input 172
analog output 173
digital 175
external trigger 174
external USB 176
Sync Bus 178
continuous analog input 125
continuous analog output 125
continuous counter/timer 125
continuous digital I/O 125
continuous digital input 120
continuous digital output 121
continuous edge-to-edge measurement mode 113, 135
wiring 55
continuous scan mode 94
Control Panel applet 139
conversion modes
continuous analog input 94
continuous analog output 104
digital I/O 120
single-value analog input 94
single-value analog output 103
waveform generation mode 103
conversion rate 95
counter/timer
channels 109, 127
clock sources 110, 134
clock-falling edge type 135
clock-rising edge type 135
connecting edge-to-edge signals 54, 55
connecting event counting signals 50
connecting period signals 53
connecting pulse output signals 56
connecting pulse width signals 53
connecting up/down counting signals 52
continuous edge-to-edge measurement mode 135
edge-to-edge measurement mode 135
event counting 135
gate types 110
gate-falling edge type 135
gate-rising edge type 136
high-edge gate type 135
high-level gate type 135
high-to-low output pulse 135
internal gate type 135
low-edge gate type 135
low-level gate type 135
low-to-high output pulse 135
measure mode edge types 136
one-shot mode 135
rate generation mode 135
repetitive one-shot mode 135
subsystem specifications 162, 163
up/down counting 135
variable pulse width 135
counting events 112
coupling type 93
current source 93, 131
customer service 141

D

data encoding 98, 105, 126
data flow modes
continuous C/T 125

continuous digital input 125
continuous post-trigger 125
single-value 125
waveform stored in FIFO only 125
data format and transfer
analog input 98
analog output 105
DC coupling 131
device driver 15
device drivers 31, 197
differential channels 127
number of 127
digital connector 175
digital I/O 120
lines 120
operation modes 120
subsystem specifications 160
digital input port 120, 121
digital trigger 96, 97, 105
DIN connector 177
DT Device Collection manager 33, 200
DT9857 Calibration Utility 15
DT-Open Layers for .NET Class Library 15
duty cycle 111

E

edge type
clock falling 135
clock rising 135
gate falling 135
gate rising 136
edge types for measure mode 136
edge-to-edge measurement mode 113, 135
wiring 54
EEPROM register 186
encoding data 98, 105
environmental specifications 166
EP361 power supply 26
EP377 Trigger Bus cable 16, 191
EP403 cable 16
EP404 power supply and cable 16
errors
analog input 98
analog output 106
event counting 112, 135
wiring 50
excitation current source 93
available 131
internal 131
external clock 110, 134
external clock divider
maximum 134
minimum 134
external digital trigger 96, 97, 105
negative TTL 132, 133
positive TTL 132, 133
external trigger connector 174
external USB connector 176

F

factory service 141
features 12
FIFO
input 98
output 103
FifoSize 125
formatting data
analog input 98
analog output 105
frequency
analog input operations 93
base clock 134
external C/T clock 110
internal A/D clock 134
internal A/D sample clock 134
internal C/T clock 110, 134
internal retrigger clock 126
output pulse 113

G

gain 92
actual available 128
analog output 102
number of 128
programmable 128
gate type 110
high-edge 135
high-level 135
internal 135
low-edge 135
low-level 135
gate-falling edge type 135
gate-rising edge type 136
generating pulses 114, 115
grounding considerations 37
group delay 93, 102

H

hardware features 12
high-edge gate type 135
high-level gate type 135
hot-swapping 27, 194

I

IEPE features 93
IEPE support 131
inprocess buffers 126
input
  channels 84
  configuration, single-ended 44
  ranges 92
  resolution 93
input FIFO 98
Input Trigger LED 96, 97
internal
  clock 110
  gate type 135
internal clock 134
internal excitation current source 131
interrupts 125

L

LED
  Input Trigger 96, 97
  Output Trigger 105
  PWR 183
  Trig In 183
  Trig Out 183
LED status indicator 182
legacy CPL elevated 31, 197
lines, digital I/O 120
low-edge gate type 135
low-level gate type 135

M

master and slave synchronization 125
master oscillator, specifications 165
MaxDifferentialChannels 127
MaxExtClockDivider 134
MaxFrequency 134
MaxMultiScanCount 126
MaxRetriggerFreq 126
MaxSingleEndedChannels 127
measure counters
  features 116
  wiring 57
measuring pulses 113
MinExtClockDivider 134
MinFrequency 134
MinRetriggerFreq 126
muting the output voltage 125

N

negative threshold trigger 132, 133
number of
  differential channels 127
  gains 128
  I/O channels 127
  resolutions 128
  scans per trigger 126
  single-ended channels 127
  voltage ranges 128
NumberOfChannels 127
NumberOfRanges 128
NumberOfResolutions 128
NumberOfSupportedGains 128
Nyquist Theorem 93

O

olDiagReadReg 186
olDiagWriteReg 186
one-shot pulse output 114, 135
Open Layers Control panel 31, 197
Open Layers Control Panel applet 139
operation modes
  continuous analog input 94
  continuous digital input 120
  continuous digital output 121
  single-value analog input 94
  single-value analog output 103
  single-value digital I/O 120
  waveform generation 103
oscillator, specifications 165
output
  clock sources 102
  pulses 135
  ranges 102
output FIFO 103
output pulses 56, 114, 115
Output Trigger LED 105

P

period measurement 113
  wiring 53
physical specifications 166
ports, digital I/O 120
positive threshold trigger 132, 133
post-trigger acquisition mode 125
post-trigger scan count 133
power 25, 192
  specifications 166
Power LED 28, 196
power supply 16, 25, 192
preparing to wire signals 37
pulse output
  one-shot 114
  rate generation 114
  repetitive one-shot 115
  types 111
  wiring 56
pulse width 111, 113
  wiring 53
PWR LED 183

Q

QuickDAQ 60
  Advanced FFT Analysis option 15

R

ranges
  analog input 92
  analog output 102
  number of 128
rate generation 114, 135
recommendations for wiring 37
reference trigger 97
  external digital (TTL) trigger 97
  Sync Bus trigger 98
  threshold trigger 97
register-level programming 186
regulatory specifications 167
repetitive one-shot pulse output 115, 135
resolution
  analog input 93
  analog output 102
  available 128
  digital I/O 120
  number of 128
retrigger clock frequency 126
returning boards to the factory 141
RJ45 connector 178
RMA 141

S

sample clock 93
scan count 133
screw terminal panel layout 43
Signal Processing Component Library 15
simultaneous clocking 134
simultaneous sample-and-hold support 127
simultaneous start list 125
single buffer wrap mode 126
single-ended channels 44, 127
  number of 127
single-value mode 94
single-value operations 125
  analog output 103
  digital I/O 120
size, module 166
software trigger 96, 105, 132
specifications 151
  analog input 152
  analog output 158
  connector 168
  counter/timer specifications 162, 163
  digital I/O 160
  environmental 166
  EP361 external power supply 169
  master oscillator 165
  physical 166
  power 166
  regulatory 167
  tachometer input 161
  triggers 164
start trigger
  external digital (TTL) trigger 96, 105
  software 96
  software trigger 105
  Sync Bus 97
  threshold trigger 96, 105
start trigger sources 96
stopping an operation 95, 105
STP25 screw terminal panel 16, 43, 180
  layout 43
SupportedEdgeTypes 136
SupportedExcitationCurrentValues 131
SupportedGains 128
SupportedResolutions 128
SupportedThresholdTriggerChannel 132, 133
SupportedVoltageRanges 128

SupportsACCoupling 131
SupportsBinaryEncoding 126
SupportsBuffering 126
SupportsClockFalling 135
SupportsClockRising 135
SupportsContinuous 125
SupportsContinuousMeasure 135
SupportsCount 135
SupportsDCCoupling 131
SupportsDifferential 127
SupportsExternalClock 134
SupportsFallingEdge 136
SupportsGateFalling 135
SupportsGateHighEdge 135
SupportsGateHighLevel 135
SupportsGateLowEdge 135
SupportsGateLowLevel 135
SupportsGateNone 135
SupportsGateRising 136
SupportsHighToLowPulse 135
SupportsIEPE 131
SupportsInProcessFlush 126
SupportsInternalClock 134
SupportsInternalExcitationCurrentSrc 131
SupportsLowToHighPulse 135
SupportsMeasure 135
SupportsMute 125
SupportsNegExternalTTLTrigger 132, 133
SupportsNegThresholdTrigger 132, 133
SupportsOneShot 135
SupportsOneShotRepeat 135
SupportsPosExternalTTLTrigger 132, 133
SupportsPosThresholdTrigger 132, 133
SupportsPostTriggerScanCount 133
SupportsProgrammableGain 128
SupportsRateGenerate 135
SupportsRisingEdge 136
SupportsSimultaneousClocking 134
SupportsSimultaneousSampleHold 127
SupportsSimultaneousStart 125
SupportsSingleEnded 127
SupportsSingleValue 125
SupportsSoftwareTrigger 132
SupportsStaleDataFlag 136
SupportsSynchronization 125
SupportsUpDown 135
SupportsVariablePulseWidth 135
SupportsWaveformModeOnly 125
SupportsWrapSingle 126
Sync Bus connector 178
Sync Bus trigger 97, 98, 105
synchronizing mulitple VIBboxes
  channel order and numbering 202
synchronizing multiple VIBboxes 189
  aggregating channels 200
  applying power 192
  configuring the device driver 197
  connecting to the host computer 194
  connecting together 191
system requirements 24

T

tachometer input
  falling edges 136
  features 107
  rising edges 136
  specifications 161
  stale data flag 136
  wiring 47
technical support 140
threshold trigger 96, 97, 105
  channel 132, 133
  negative 132, 133
threshold trigger, positive 132, 133
throughput
  maximum 134
  minimum 134
transferring data
  analog input 98
  analog output 105
Trig In LED 183
Trig Out LED 183
triggered scan
  number of scans per trigger 126
  retrigger frequency 126
triggers
  analog input 96
  analog threshold 105
  external 96, 97, 105
  external negative digital 132, 133
  external positive digital 132, 133
  negative threshold 132, 133
  positive threshold 132, 133
  software 96, 105, 132
  specifications 164
  Sync Bus 97, 98, 105
  threshold 96, 97, 105
troubleshooting
  procedure 138
  technical support 140
  troubleshooting table 138

TTL trigger 96, 97, 105

U

units, counter/timer 109
unmuting the output voltage 125
unpacking 23
up/down counting 112, 135
  wiring 52
USB cable 27, 195
USB connector 176

V

variable pulse width 135
VIBbox-32
  input channel numbers and names 91
  output channel numbers and names 102
VIBbox-48
  input channel numbers and names 88
  output channel numbers and names 101
VIBbox-64
  input channel numbers and names 85
  output channel numbers and names 100
Visual Basic for .NET programs 15
Visual C# programs 15
voltage ranges 92, 128
  number of 128

W

warm-up time 39, 146
wiring signals 40
  analog inputs 44
  analog output 46
  continuous edge-to-edge measurement 55
  edge-to-edge measurement 54
  event counting 50
  measure counters 57
  period measurement 53
  preparing 37
  pulse output 56
  pulse width measurement 53
  recommendations 37
  tachometer input 47
  up/down counting 52
writing programs in
  Visual Basic .NET 15
  Visual C# 15