DATA TRANSLATION®
A MEASUREMENT COMPUTING COMPANY

UM-22359-M

DT3034 User's Manual

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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.

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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

This manual describes how to set up and install the following components:

- DT3034 software
- DT3034 board
- DT3034 Device Driver
- DT740 screw terminal panel

It describes how to wire signals to the board and how to verify the board's operation using the Quick DataAcq application.

This manual also describes the features of the DT3034 board, the capabilities of the DT3034 Device Driver, and how to program the DT3034 board using the DT-Open Layers for .NET Class Library™ software. Troubleshooting and calibration information is also provided.

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

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

Intended Audience

This document is intended for engineers, scientists, technicians, or others responsible for using and/or programming the DT3034 board for data acquisition operations in Microsoft® Windows® XP, Windows Vista®, or Windows 7. 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 board, as well as the supported software and accessories for the board, and provides an overview of the getting started procedure.
- Chapter 2, "Installing the Board and Loading the Device Driver," describes how to install the DT3034 board and load the DT3034 Device Driver.
- Chapter 3, "Attaching and Configuring a Screw Terminal Panel," describes how to attach the DT740 screw terminal panel to a DT3034 board and how to configure the screw terminal panel for use with a DT3034 board.
- Chapter 4, "Wiring Signals," describes how to wire signals to a DT3034 board using the DT740 screw terminal panel.

- Chapter 5, "Verifying the Operation of a DT3034 Board," describes how to verify the operation of a DT3034 board with the Quick DataAcq application
- Chapter 6, "Principles of Operation," describes all of the board's features and how to use them in your application.
- Chapter 7, "Supported Device Driver Capabilities," lists the data acquisition subsystems and the associated features accessible using the DT3034 Device Driver.
- Chapter 8, "Calibration," describes how to calibrate the analog I/O circuitry of the board.
- Chapter 9, "Troubleshooting," provides information that you can use to resolve problems with the board and the device driver, should they occur.
- Appendix A, "Specifications," lists the specifications of the board.
- Appendix B, "Connector Pin Assignments," shows the pin assignments for the connectors on the board and for the DT740 screw terminal panel.
- Appendix C, "Using Your Own Screw Terminal Panel," describes additional considerations to keep in mind when designing your own screw terminal panel for use with a DT3034 board.
- 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 DT3034 board:

- *Measure Foundry Manual* (UM-19298) and online help. These documents describe how to use Measure Foundry™ to build drag-and-drop test and measurement applications for Data Translation® data acquisition devices.
- DT-Open Layers for .NET User's Manual (UM-22161). For programmers who are developing their own application programs using Visual C# or Visual Basic .NET, this manual describes how to use the DT-Open Layers for .NET Class Library to access the capabilities of Data Translation data acquisition devices.
- *DataAcq SDK User's Manual* (UM-18326). For programmers who are developing their own application programs using the Microsoft C compiler, this manual describes how to use the DT-Open Layers DataAcq SDK™ to access the capabilities of Data Translation data acquisition boards. This manual is provided on the Data Acquisition OMNI CD.

- *DTx-EZ Getting Started Manual* (UM-15428). This manual, available from Data Translation, describes how to use the ActiveX controls provided in DTx-EZ™ to access the capabilities of Data Translation data acquisition boards in Microsoft® Visual Basic™ or Visual C++.
- *LV-Link Online Help*. This help file describes how to use LV-Link™ with the LabVIEW™ graphical programming language to access the capabilities of Data Translation data acquisition devices.
- *PCI Specification:* PCI Local Bus Specification, PCI Special Interest Group, Portland, OR. (Revision 2.1, June 1, 1995).
- Microsoft Windows XP, Windows Vista, or Windows 7 documentation.

Where To Get Help

Should you run into problems installing or using a DT3034 board, our Technical Support Department is available to provide prompt, technical assistance. Refer to Chapter 9 starting on page 135 for more information. If you are outside the U.S. or Canada, call your local distributor, whose number is listed on our web site (www.mccdaq.com).

Overview

Features

Table 1 lists the key features of the DT3034 board.

Table 1: Key Features of the DT3034 Board

Feature	Specification
Analog Input Channels	32 single-ended or 16 differential
Analog I/O Resolution	16-bits
A/D Throughput	500 kSamples/s[a]
Analog Output Channels	2
D/A Throughput	200 kSamples/s[b]
Output FIFO	4K
Digital I/O Lines	16
Counter/Timers	4
Connectors	one 50-pin, one 68-pin

a. This throughput is for a single analog input channel.
b. This throughput is for full-scale ranges.

- Programmable bipolar (±10 V) and unipolar (0 to 10 V) input ranges with gains of 1, 2, 4, and 8; fixed output range of ±10 V
- Continuously-paced and triggered scan capability
- A 1024-location channel list that supports sampling analog input channels at the same or different gains in sequential or random order
- Up to 256 scans per trigger for a total of 262,144 samples per trigger
- PCI bus mastering for data transfers
- Pre-, post-, and about-trigger acquisition modes to acquire data relative to an external event using computer memory
- Internal and external clock sources; one external clock input for the analog input subsystem and one external clock input for the analog output subsystem
- Analog threshold triggering using either an external analog input or one of the analog input channels; a separate DAC sets the trigger level (8-bit resolution, fixed hysteresis)
- Digital TTL triggering; one external hardware TTL input for the analog input subsystem and one external hardware TTL input for the analog output subsystem
- Simultaneous analog input and analog output operations running at full speed
- Software calibration of the analog input and output subsystems
- Two 8-bit digital ports programmable as inputs or outputs on a per-port basis; digital inputs can be included as part of the analog input channel list to correlate the timing of analog and digital events; digital outputs can drive external solid-state relays

- Two dynamic, high-speed digital output lines; useful for synchronizing and controlling external equipment, these dynamic digital output lines are programmable as part of the analog input subsystem using the DataAcq SDK
- Programmable gate types
- Programmable pulse output polarities (output types) and duty cycles
- A/D Sample Clock Output and A/D Trigger Output signals, useful for synchronizing and controlling external equipment

For a discussion of these features in detail, refer to Chapter 6 starting on page 69.

Supported Software

The following software is available for use with the DT3034 boards and on the Data Acquisition OMNI CD:

- **DT3034 Device Driver** – The device driver is installed automatically when you install the software from the Data Acquisition OMNI CD. You need the device driver to use the DT3034 board with any of the supported software packages or utilities.
- **The Quick DataAcq application** – This application provides a quick way to get a DT3034 board up and running. Using the Quick DataAcq application, you can verify the features of the board, display data on the screen, and save data to disk.
- **The quickDAQ application –** An evaluation version of this .NET application is included on the Data Acquisition OMNI CD. quickDAQ lets you acquire analog data from all devices supported by DT-Open Layers for .NET software at high speed, plot it during acquisition, analyze it, and/or save it to disk for later analysis.
- **DT3034 Calibration Utility** – The DT3034 Calibration Utility allows you to calibrate the analog input and analog output subsystems of the DT3034 board. Refer to page 123 for more information on this utility.
- **Measure Foundry** – An evaluation version of this software is included on the Data Acquisition OMNI CD. Measure Foundry is drag-and-drop test and measurement application builder designed to give you top performance with ease-of-use development. Order the full development version of this software package to develop your own application using real hardware.
- **DT-Open Layers for .NET Class Library** – Use this class library if you want to use Visual C# or Visual Basic for .NET to develop your own application software for a DT3034 board using Visual Studio 2003 or Visual Studio 2005; the class library complies with the DT-Open Layers standard.
- **DataAcq SDK** – Use the Data Acq SDK if you want to use Visual Studio 6.0 and Microsoft C or C++ to develop your own application software for a DT3034 board using Windows XP, Windows Vista, or Windows 7; the DataAcq SDK complies with the DT-Open Layers standard.
- **DTx-EZ** – DTx-EZ provides ActiveX controls, which allow you to access the capabilities of the DT3034 board using Microsoft Visual Basic or Visual C++; DTx-EZ complies with the DT-Open Layers standard.
- **DAQ Adaptor for MATLAB** – Data Translation's DAQ Adaptor provides an interface between the MATLAB Data Acquisition (DAQ) subsystem from The MathWorks and Data Translation's DT-Open Layers architecture.
- **LV-Link** – An evaluation version of LV-Link is included on the Data Acquisition OMNI CD. Use LV-Link if you want to use the LabVIEW graphical programming language to access the capabilities of the DT3034 boards.

Refer to the Data Translation web site (www.mccdaq.com) for more information on the appropriate software package for your application.

Accessories

The following optional accessories are available for a DT3034 board:

- **DT740 screw terminal panel** – Screw terminal panel with two connectors to accommodate the analog I/O, digital I/O, and counter/timer signals provided by the DT3034 board.
- **EP307 cable** – A 1-meter, twisted-pair, shielded cable that connects the 50-pin analog I/O connector (J1) on the DT3034 board to the J1 connector on the DT740 screw terminal panel.
- **EP308 cable** – A 1-meter, twisted-pair, shielded cable that connects the 68-pin digital I/O connector (J2) on the DT3034 board to the J2 connector on the DT740 screw terminal panel.

Getting Started Procedure

The flow diagram shown in Figure 1 illustrates the steps needed to get started using a DT3034 board. This diagram is repeated in each getting started chapter; the shaded area in the diagram shows you where you are in the getting started procedure.

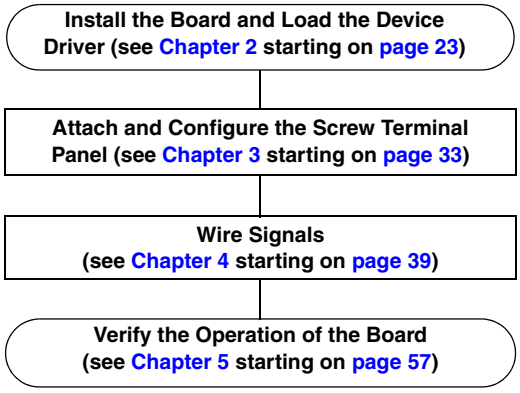
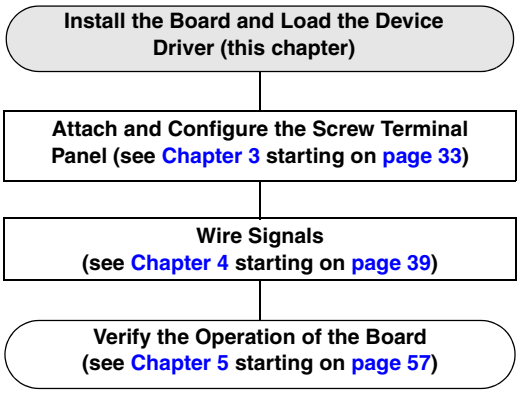


Figure 1: Getting Started Flow Diagram

Part 1: Getting Started

Installing the Board and Loading the Device Driver



Note: All DT3034 boards are factory-calibrated and require no further adjustment prior to installation. If you are using the DT3034 board and decide later to recalibrate it, refer to page 123 for instructions.

Unpacking

Open the shipping box and remove the wrapped DT3034 board.

CAUTION:

Keep the board in its protective antistatic bag until you are ready to install it; this minimizes the likelihood of electrostatic damage.

Verify that the following items are present:

- DT3034 data acquisition board
- Data Acquisition OMNI CD

If an item is missing or damaged, contact Data Translation. If you are in the United States, call the Customer Service Department at (508) 946-5100. An application engineer will guide you through the appropriate steps for replacing missing or damaged items. If you are located outside the United States, call your local distributor, listed on Data Translation's web site (www.mccdaq.com).

Setting up the Computer

CAUTION:

To prevent electrostatic damage that can occur when handling electronic equipment, use a ground strap or similar device when performing this installation procedure.

To set up the computer, do the following:

1. Install the software from the Data Acquisition OMNI CD or Data Translation web site.

Note: If you are using Windows 7, you **must** install the device driver before installing the board in the computer.

2. Turn off the computer.
3. Turn off all peripherals (printer, modem, monitor, and so on) connected to the computer.
4. Unplug the computer and all peripherals.
5. Remove the cover from you computer. Refer to your computer's user's manual for instructions.

Setting up Expansion Slots

Once you have set up the computer, set up the expansion slots as follows:

1. Select a 32-bit or 64-bit PCI expansion slot.

   PCI slots are shorter than ISA or EISA slots and are usually white or ivory. Commonly, three PCI slots (one of which may be a shared ISA/PCI slot) are available. If an ISA board exists in the shared slot, you cannot use the slot for a PCI board; if a PCI board exists in the shared slot, you cannot use the slot for an ISA board.

2. Remove the cover plates from the selected expansion slots. Retain the screws that held them in place; you will use them later to install the board.

Removing the Board for Handling

To remove the board for handling, follow these steps:

1. Discharge any static electricity by holding the wrapped board in one hand while placing your other hand firmly on a metal portion of the computer chassis.
2. Carefully remove the antistatic packing material from the board. (It is recommended that you save the original packing material in the unlikely event that your board requires servicing in the future.)
3. Hold the board by its edges and do not touch any of the components on the board.

Inserting the DT3034 Board into the Computer

Once you have set up the expansion slots, do the following to insert the DT3034 board into the computer:

1. Position the board so that the cable connectors are facing the rear of the computer, as shown in Figure 2.

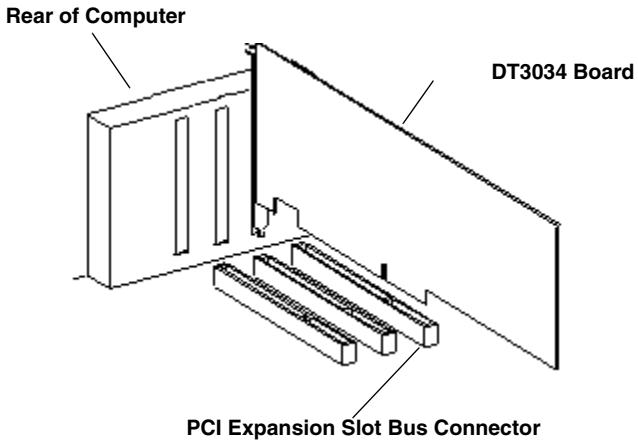


Figure 2: Inserting the DT3034 Board in the Computer

2. Carefully lower the board into the PCI expansion slot using the card guide to properly align the board in the slot.
3. When the bottom of the board contacts the bus connector, gently press down on the board until it clicks into place.

CAUTION:

Do not force the board into place. Moving the board from side to side during installation may damage the bus connector. If you encounter resistance when inserting the board, remove the board and try again.

4. Secure the board in place at the rear panel of the system unit using the screw removed from the slot cover.
5. Reinstall the cover of the computer. Refer to your computer's user's manual for instructions.
6. Power up the computer, and follow the steps in the next section.

Loading the Device Driver

To load the DT3034 device driver in:

- Windows XP, follow the steps on page 30.
- Windows Vista, follow the steps on page 31.
- Windows 7, follow the steps on page 31.

Windows XP

Once you have installed the software from the Data Acquisition OMNI CD, installed a DT3034 board, and powered up the host computer, the New Hardware Found dialog box appears. Do the following to load the device driver in Windows XP:

1. Click **Next**.
2. Click **Search for a suitable driver for my device (recommended)**.
3. Click **Specify a location**, and click **Next**.
4. Browse to Windows\Inf\DT3034.Inf, and then click **Open**.
5. Click **OK**.
6. Click **Next**.
   The files are copied.
7. Click **Finish**.
8. Open the Control Panel.
9. Double-click the **Open Layers Control Panel** icon.
10. Select the DT3034 board to configure, and then click **Advanced**.
    By default, the prompt "Handles Overloaded Bus?" is checked.
11. If you are using an Optiplex computer or experience timing problems with your DT3034 board, uncheck this box.
12. When you are finished, click **Close**.

Once you have finished loading the device driver, perform the steps in Chapter 3 starting on page 33 to attach and configure the screw terminal panel.

Windows Vista

Once you have installed the software from the Data Acquisition OMNI CD, installed a DT3034 board, and powered up the host computer, the New Hardware Found dialog box appears. Do the following to load the device driver in Windows Vista:

1. Click **Locate and install driver software (recommended)**.
   The popup message "Windows needs your permission to continue" appears.
2. Click **Continue**.
   The Windows Security dialog box appears.
3. Click **Install this driver software anyway**.
   The driver files are installed.
4. Open the Control Panel.
5. Double-click the **Open Layers Control Panel** icon.
6. Select the DT3034 board to configure, and then click **Advanced**.
   By default, the prompt "Handles Overloaded Bus?" is checked.
7. If you are using an Optiplex computer or experience timing problems with your DT3034 board, uncheck this box.
8. When you are finished, click **Close**.

Once you have finished loading the device driver, perform the steps in Chapter 3 starting on page 33 to attach and configure the screw terminal panel.

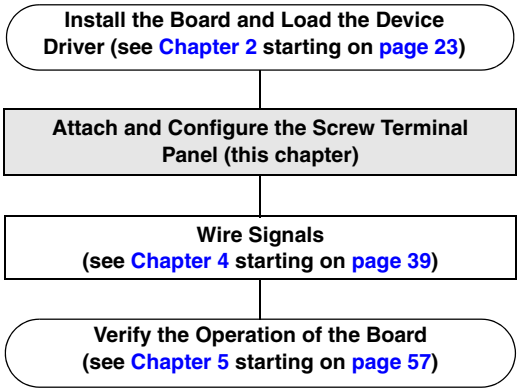
Windows 7

Once you have installed the software from the Data Acquisition OMNI CD, installed a DT3034 board, and powered up the host computer, the hardware is found automatically. Perform the following steps to configure the device driver:

1. Open the Control Panel.
2. Double-click the **Open Layers Control Panel** icon.
3. Select the DT3034 board to configure, and then click **Advanced**.
   By default, the prompt "Handles Overloaded Bus?" is checked.
4. If you are using an Optiplex computer or experience timing problems with your DT3034 board, uncheck this box.
5. When you are finished, click **Close**.

Once you have finished loading the device driver, perform the steps in Chapter 3 starting on page 33 to attach and configure the screw terminal panel.

Attaching and Configuring a Screw Terminal Panel


Install the Board and Load the Device Driver (see Chapter 2 starting on page 23)
Attach and Configure the Screw Terminal Panel (this chapter)
Wire Signals (see Chapter 4 starting on page 39)
Verify the Operation of the Board (see Chapter 5 starting on page 57)

Attaching the DT740 Screw Terminal Panel

If you are using the DT3034 board, you first need to attach the DT740 screw terminal panel to the board before you can wire signals.

Connector J1 on the screw terminal panel brings out all of the analog signals from connector J1 on the board; cable EP307 connects connector J1 on the screw terminal panel to the DT3034 board. Connector J2 on the screw terminal panel brings out all of the digital and counter/timer signals from connector J2 on the board; cable EP308 connects connector J2 on the screw terminal panel to the DT3034 board.

Figure 3 illustrates how to attach the DT740 screw terminal panel to the DT3034 board.

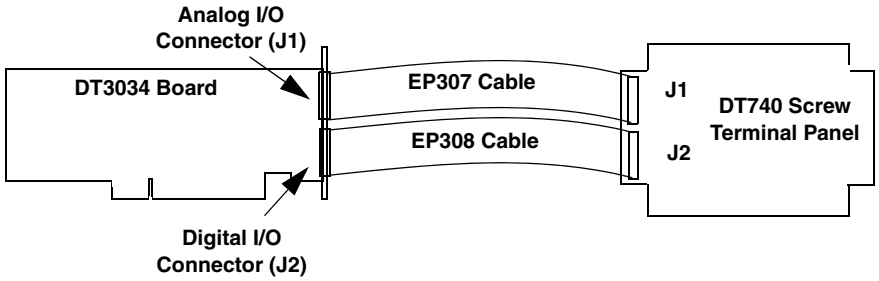


Figure 3: Attaching the DT740 Screw Terminal Panel to the DT3034 Board

Configuring the DT740 Screw Terminal Panel

This section describes how to locate and configure the jumpers and resistors on the DT740 screw terminal panel for use with a DT3034 board.

Figure 4 shows the layout of the DT740 screw terminal panel, and shows the location of the jumper and resistors.

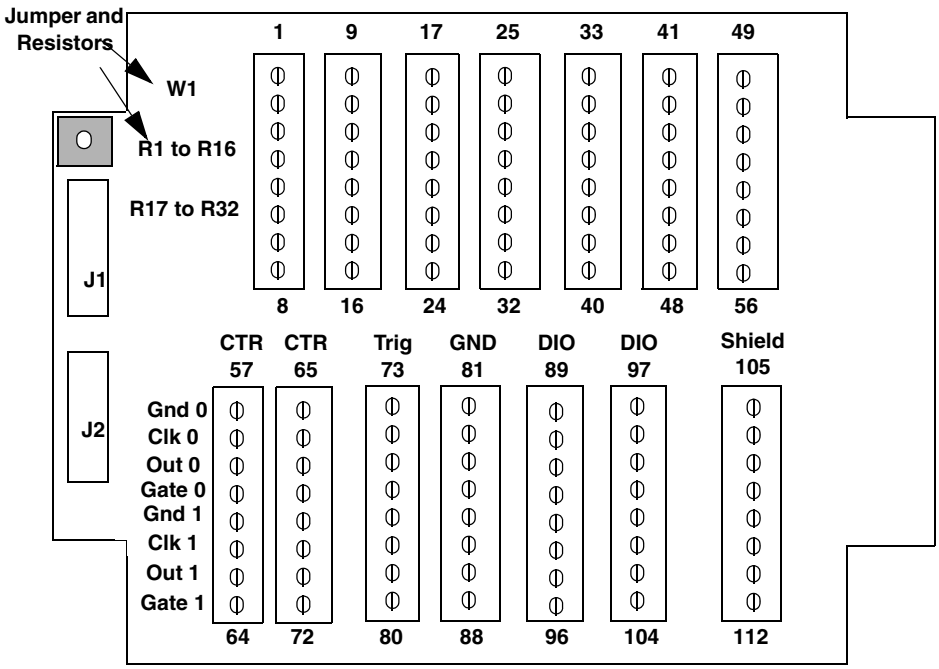


Figure 4: Layout of the DT740 Screw Terminal Panel

Configuring Jumper W1 - Common Ground Sense

When shipped from the factory, jumper W1 connects the low side of the input amplifier (Amp Low) on the DT3034 board to analog ground.

When using pseudo-differential analog inputs, remove jumper W1 and connect Amp Low to a remote common-mode voltage to reject offset voltages common to all 32 input channels. Refer to page 46 for an example of using jumper W1.

Configuring Resistors R1 to R16 - Bias Return

Resistor locations R1 to R16 connect the low side of analog input channels to analog ground. These resistor locations are typically used when connecting differential inputs to analog input channels 0 to 15, where R1 corresponds to analog input channel 0, and R16 corresponds to analog input channel 15.

The high side of the corresponding analog input channels returns the source input impedance through the bias return resistors to the low side of the channels, and then to analog ground. Typical resistor values are 1 kΩ to 100 kΩ depending on the application. Refer to page 46 for an example of using bias return resistors.

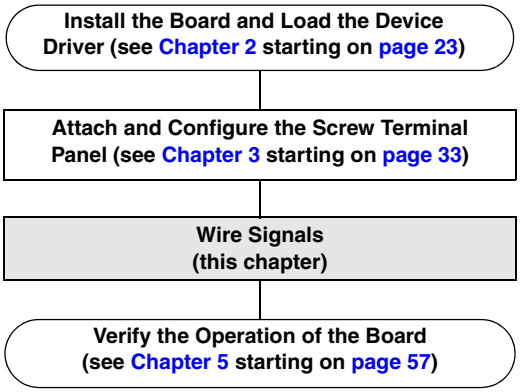
Configuring Resistors R17 to R32 - Current Shunt

Resistor locations R17 to R32 are typically used to convert current to voltage on channels 0 to 15, where R17 corresponds to analog input channel 0, and R32 corresponds to analog input channel 15.

These resistor locations connect the high side to the low side of the corresponding channels, thereby acting as shunts. If, for example, you add a 250 Ω resistor to location R17, and connect a 4 to 20 mA current loop input to channel 0, the input range is converted to 1 to 5 V. Note that, depending on your application, you may need to use resistors R1 to R16 with resistors R17 to R32 for proper operation. Refer to page 49 for an example of using current shunt resistors.

4

Wiring Signals


Install the Board and Load the Device Driver (see Chapter 2 starting on page 23)
Attach and Configure the Screw Terminal Panel (see Chapter 3 starting on page 33)
Wire Signals (this chapter)
Verify the Operation of the Board (see Chapter 5 starting on page 57)

Preparing to Wire to a Screw Terminal Panel

This section describes wiring recommendations when connecting signals to a DT3034 board and screw terminal panel.

Wiring Recommendations

- Follow standard ESD procedures when wiring signals to the board.
- Use individually shielded twisted-pair wire (size 14 to 26 AWG) when using a DT3034 board in highly noisy electrical environments.
- Separate power and signal lines by using physically different wiring paths or conduits.
- To avoid noise, do not locate the screw terminal panel and cabling next to sources that produce high electro-magnetic fields, such as large electric motors, power lines, solenoids, and electric arcs, unless the signals are enclosed in a mumetal shield.
- On the DT740 screw terminal panel, we recommend that you connect the shields as follows:
  - Connect the analog shield to screw terminals TB35 and TB36, and to TB51 through TB56.
  - Connect the digital shield to screw terminals TB105 and TB108.
  - Connect the analog and digital shields to one end only.
- When first installing the board, we recommend that you do the following:
  - Wire a function generator or a known voltage source to analog input channel 0 (use the differential configuration).
  - Wire an oscilloscope or voltage meter to analog output channel 0.
  - Wire a digital input to digital I/O Port A.
  - Wire a external clock or scope to counter/timer channel 0.
  - If you have not done so already, install the DT3034 software.
  - Run the Quick DataAcq application (described in Chapter 5 starting on page 57) to verify that the board is operating properly.
  - Once you have determined that the board is operating properly, wire the signals according to your application's requirements.

Screw Terminal Assignments

Screw terminals TB1 to TB56 on the DT740 screw terminal panel correspond to the analog I/O channels from the DT3034 board. Screw terminals TB57 to TB112 on the DT740 screw terminal panel correspond to the digital I/O signals from the DT3034 board.

Screw terminals TB37 (+15 V) and TB39 (–15 V) on the DT740 screw terminal panel are available for low-current signal conditioning applications. The supply on the DT3034 board is current-limited through a 10 Ω resistor and is specified for a maximum load current of ±3 mA.

Screw terminal TB49 (+5.0 V reference) on the DT740 screw terminal panel is also current-limited through a 10 Ω resistor and is provided for applications that require a reference less than 1 mA.

Screw terminal TB112 (+5 V output) on the DT740 screw terminal panel is current-limited through a series 10 Ω resistor and supports loads up to 100 mA. Note that you must take the drop (current [I] multiplied by resistance [R]) across the series 10 Ω resistor (1 V at 100 mA) into consideration.

To provide maximum signal integrity, screw terminals TB35, TB36, and TB51 to TB56 on the DT740 screw terminal panel have been reserved for external shield connections from the J1 connector. Screw terminals TB105 and TB108 on the DT740 screw terminal panel have been reserved for external shield connections from the J2 connector. In addition, multiple ground connections have been allocated for all the digital and clock signals for proper shielding and current capacity.

Note: If you are connecting a high-speed clock to the DT740, it is recommended that you connect the return to the adjacent ground screw terminal.

Table 2 lists the screw terminal assignments for connector J1 on the DT740 screw terminal panel; Table 3 lists the screw terminal assignments for connector J2 on the DT740 screw terminal panel.

Table 2: Screw Terminal Assignments for Connector J1 on the DT740 Screw Terminal Panel

TB	J1 Pin	Signal Description	TB	J1 Pin	Signal Description
1	25	Analog Input 00	2	50	Analog Input 08/00 Return
3	24	Analog Input 01	4	49	Analog Input 09/01 Return
5	23	Analog Input 02	6	48	Analog Input 10/02 Return
7	22	Analog Input 03	8	47	Analog Input 11/03 Return
9	21	Analog Input 04	10	46	Analog Input 12/04 Return
11	20	Analog Input 05	12	45	Analog Input 13/05 Return
13	19	Analog Input 06	14	44	Analog Input 14/06 Return
15	18	Analog Input 07	16	43	Analog Input 15/07 Return
17	17	Analog Input 16/08	18	42	Analog Input 24/08 Return
19	16	Analog Input 17/09	20	41	Analog Input 25/09 Return
21	15	Analog Input 18/10	22	40	Analog Input 26/10 Return
23	14	Analog Input 19/11	24	39	Analog Input 27/11 Return
25	13	Analog Input 20/12	26	38	Analog Input 28/12 Return
27	12	Analog Input 21/13	28	37	Analog Input 29/13 Return
29	11	Analog Input 22/14	30	36	Analog Input 30/14 Return
31	10	Analog Input 23/15	32	35	Analog Input 31/15 Return
33	9	Amp Low	34	34	Analog Ground
35	8	Analog Shield Ground	36	33	Analog Shield Ground
37	7	+15 V Output	38	32	Power Ground
39	6	−15 V Output	40	31	Reserved
41	5	Analog Output 0+	42	30	Analog Output 0 Return
43	4	Analog Output 1+	44	29	Analog Output 1 Return
45	3	Reserved	46	28	Reserved
47	2	Reserved	48	27	Reserved
49	1	+5 V Reference Out	50	26	Analog Ground
51	-	Analog Shield Ground	52	-	Analog Shield Ground
53	-	Analog Shield Ground	54	-	Analog Shield Ground
55	-	Analog Shield Ground	56	-	Analog Shield Ground

Table 3: Screw Terminal Assignments for Connector J2 on the DT740 Screw Terminal Panel

TB	J2 Pin	Signal Description	TB	J2 Pin	SIgnal Description
57	51, 52	Digital Ground	58	17	User Clock Input 0
59	16	User Counter Output 0	60	50	External Gate 0
61	49	Digital Ground	62	15	User Clock Input 1
63	14	User Counter Output 1	64	48	External Gate 1
65	47	Digital Ground	66	13	User Clock Input 2
67	12	User Counter Output 2	68	46	External Gate 2
69	45	Digital Ground	70	11	User Clock Input 3
71	10	User Counter Output 3	72	44	External Gate 3
73	43	Digital Ground	74	9	External D/A Sample Clock In
75	8	External D/A TTL Trigger	76	7	External A/D Sample Clock In
77	6	External A/D TTL Trigger	78	5	A/D Trigger Out
79	4	A/D Sample Clock Out	80	3	Reserved
81	23, 28, 42	Digital Ground	82	39, 41, 57, 62	Digital Ground
83	18, 38, 40, 63, 64	Digital Ground	84	65	Reserved
85	31	Reserved	86	37	Reserved
87	30	Dynamic Digital Output 0	88	29	Dynamic Digital Output 1
89	27	Digital I/O Bank A 0	90	26	Digital I/O Bank A 1
91	25	Digital I/O Bank A 2	92	24	Digital I/O Bank A 3
93	61	Digital I/O Bank A 4	94	60	Digital I/O Bank A 5
95	59	Digital I/O Bank A 6	96	58	Digital I/O Bank A 7
97	22	Digital I/O Bank B 0	98	21	Digital I/O Bank B 1
99	20	Digital I/O Bank B 2	100	19	Digital I/O Bank B 3
101	56	Digital I/O Bank B 4	102	55	Digital I/O Bank B 5
103	54	Digital I/O Bank B 6	104	53	Digital I/O Bank B 7
105	33	Digital Shield Ground	106	68	Analog Ground
107	34	Analog Trigger	108	67	Digital Shield Ground
109	32	Reserved	110	66	Reserved
111	35, 36	Digital Ground	112	1, 2	+5 V Out

Connecting Analog Input Signals

The DT740 screw terminal panel supports both voltage and current loop inputs. You can connect analog input voltage signals to the screw terminal panels in the following configurations:

- **Single-ended** – Choose this configuration when you want to measure high-level signals, noise is not significant, the source of the input is close to the screw terminal panel, and all the input signals are referred to the same common ground. When you choose the single-ended configuration, all 32 analog input channels are available.
- **Pseudo-Differential –** Choose this configuration when noise or common-mode voltage (the difference between the ground potentials of the signal source and the ground of the screw terminal panel or between the grounds of other signals) exists and the differential configuration is not suitable for your application. This option provides less noise rejection than the differential configuration; however, all 32 analog input channels are available.
- **Differential –** Choose this configuration when you want to measure low-level signals (less than 1 V), you are using an A/D converter with high resolution (greater than 12 bits), noise is a significant part of the signal, or common-mode voltage exists. When you choose the differential configuration, 16 analog input channels are available.

Note: We recommend that you connect all unused analog input channels to analog ground.

This section describes how to connect single-ended, pseudo-differential, and differential voltage inputs, as well as current loop inputs to the screw terminal panels.

Connecting Single-Ended Voltage Inputs

Figure 5 shows how to connect single-ended voltage inputs to the DT740 screw terminal panel.

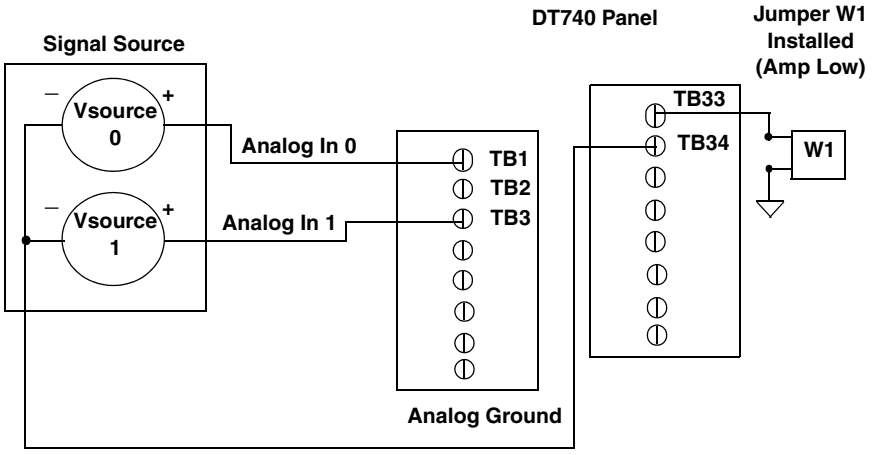


Figure 5: Connecting Single-Ended Voltage Inputs to the DT740 (Shown for Channels 0 and 1)

Connecting Pseudo-Differential Voltage Inputs

Figure 6 shows how to connect pseudo-differential voltage inputs to the DT740 screw terminal panel.

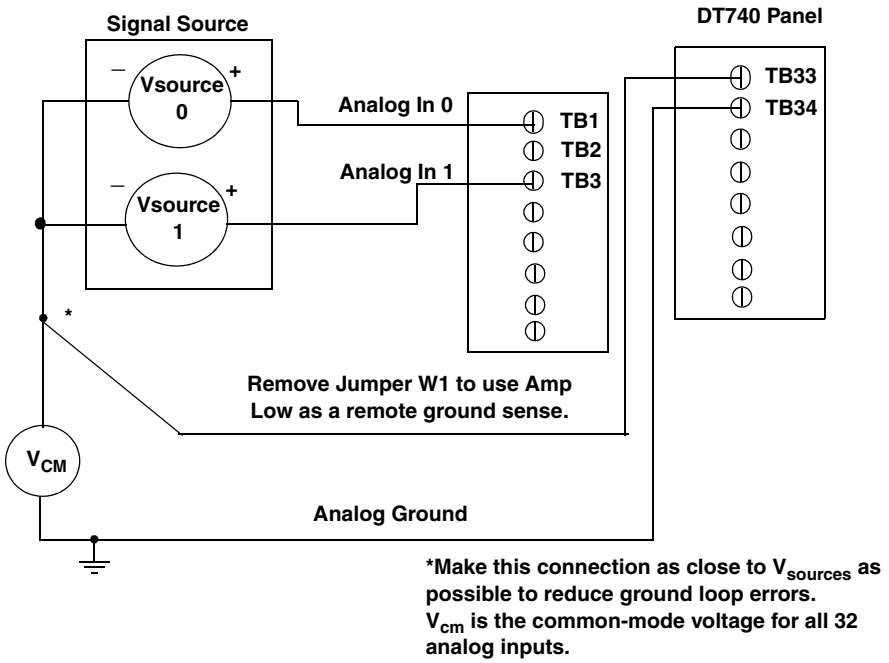


Figure 6: Connecting Pseudo-Differential Voltage Inputs to the DT740 (Shown for Channels 0 and 1)

Connecting Differential Voltage Inputs

Figure 7A illustrates how to connect a floating signal source to the DT740 screw terminal panel using differential inputs. (A floating signal source is a voltage source that has no connection with earth ground.) For floating signal sources, you need to provide a bias return path by adding resistors R1 to R16 for channels 0 to 15, respectively.

If the input signal is +10 V, then the common-mode voltage could be 1 V. Theoretically, the resistor value (R_b) should be 1 V divided by the input bias current (20 nA) or 50 mΩ. However, when you add noise from external sources to the high impedance, a resistor value of 100 Ω to 100 kΩ is more practical.

In Figure 7B, the signal source itself provides the bias return path; therefore, you do not need to use bias return resistors. R_s is the signal source resistance while R_v is the resistance required to balance the bridge. Note that the negative side of the bridge supply must be returned to analog ground.

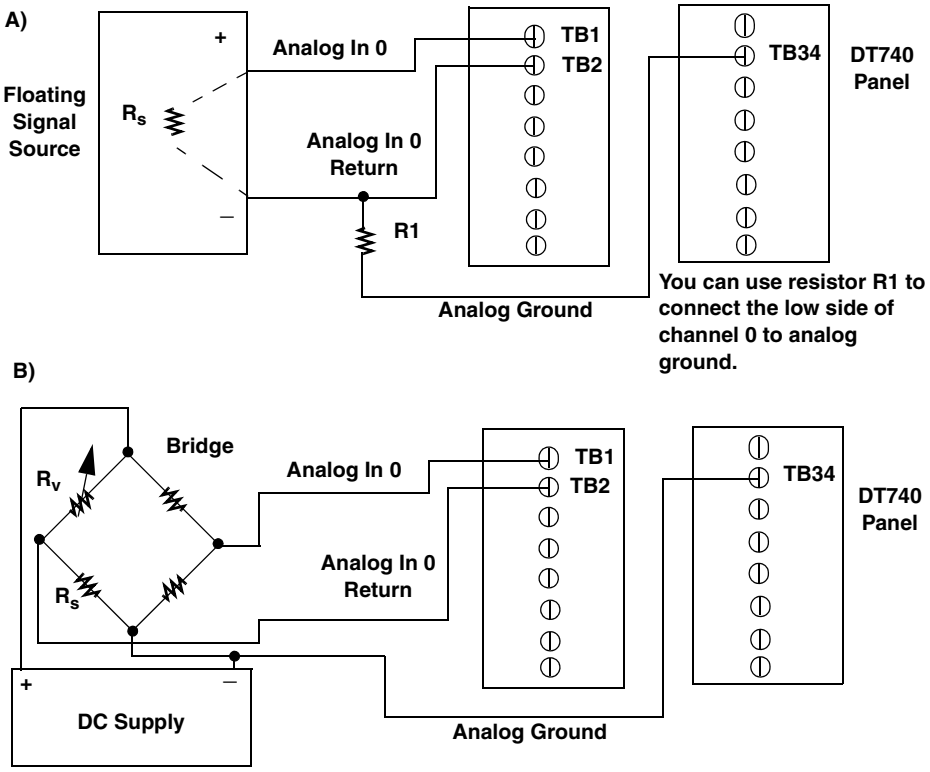


Figure 7: Connecting Differential Voltage Inputs to the DT740 (Shown for Channel 0)

Note that since they measure the difference between the signals at the high (+) and low (–) inputs, differential connections usually cancel any common-mode voltages, leaving only the signal. However, if you are using a grounded signal source and ground loop problems arise, connect the differential signals to the DT740 screw terminal panel as shown in Figure 8.

Make sure that the low side of the signal (–) is connected to ground at the signal source, not at the screw terminal panel, and do not tie the two grounds together.

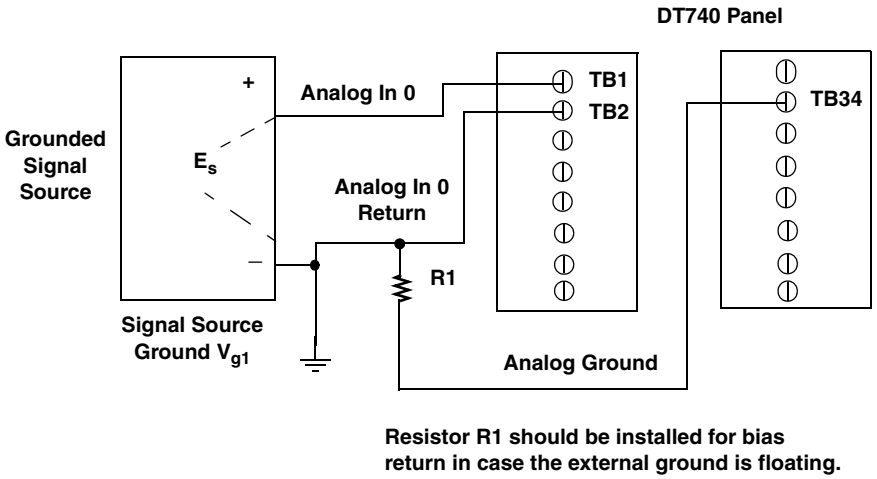
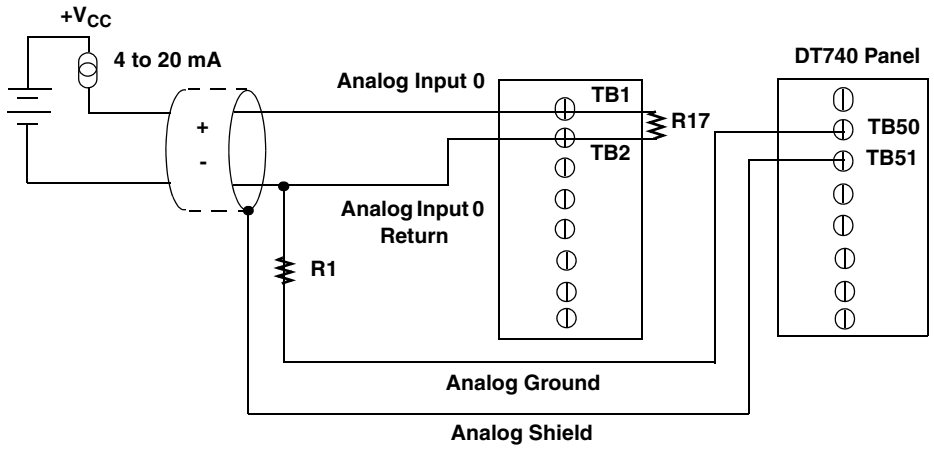


Figure 8: Connecting Differential Voltage Inputs from a Grounded Signal Source to the DT740 (Shown for Channel 0)

Connecting Current Loop Inputs

Figure 9 shows how to connect a current loop input to the DT740 screw terminal panel.



Use current shunt resistor R17 to convert current to voltage; 250 Ω for 4 to 20 mA = 1 to 5 V. The common side of the external loop supply must either connect to analog ground or, if needed, to a bias return resistor (R1 in this case).

Figure 9: Connecting Current Inputs to the DT740 (Shown for Channel 0)

Connecting Analog Output Signals

Figure 10 shows how to connect analog output voltage signals to the DT740 screw terminal panel.

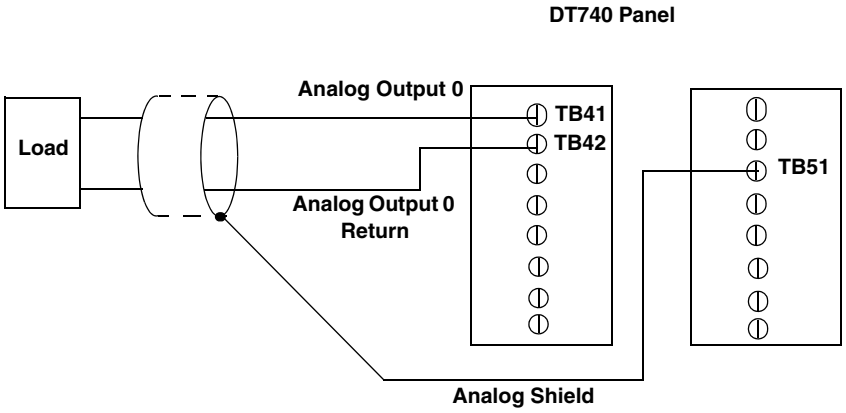


Figure 10: Connecting Analog Output Voltages to the DT740 (Shown for Channel 0)

Connecting Digital I/O Signals

Figure 11 shows how to connect digital input signals to the DT740 screw terminal panel.

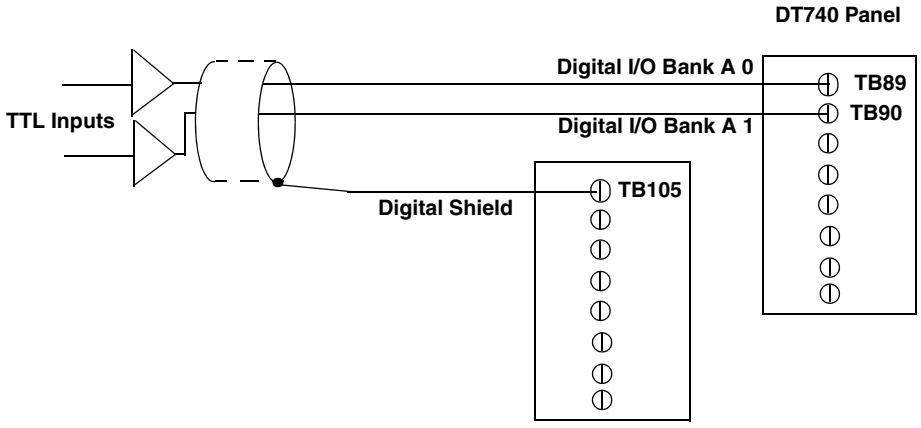


Figure 11: Connecting Digital Inputs to the DT740 (Shown for Lines 0 and 1, Bank A)

Figure 12 shows how to connect a digital output signal to the DT740 screw terminal panel.

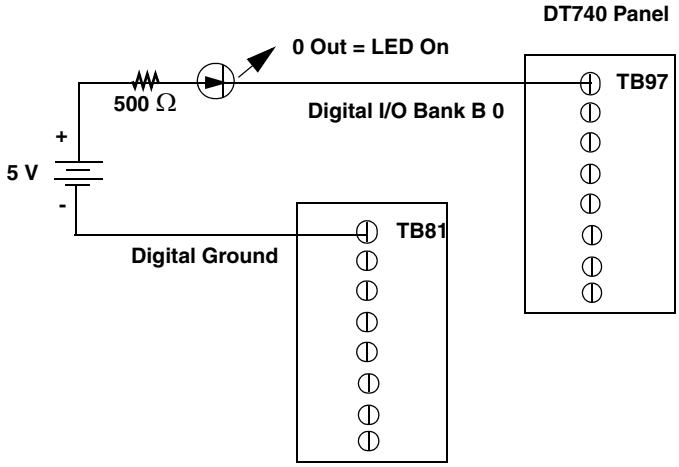


Figure 12: Connecting Digital Outputs to the DT740 (Shown for Line 0, Bank B)

Connecting Counter/Timer Signals

The DT3034 board with the DT740 screw terminal panel provides counter/timers that you can use for the following operations:

- Event counting
- Frequency measurement
- Pulse output (rate generation, one-shot, and repetitive one-shot)

This section describes how to connect counter/timer signals to perform these operations. Refer to page 96 for more information on using the counter/timers.

Connecting Event Counting Signals

Figure 13, Figure 14, and Figure 15 show examples of connecting event counting signals to the DT740 screw terminal panel.

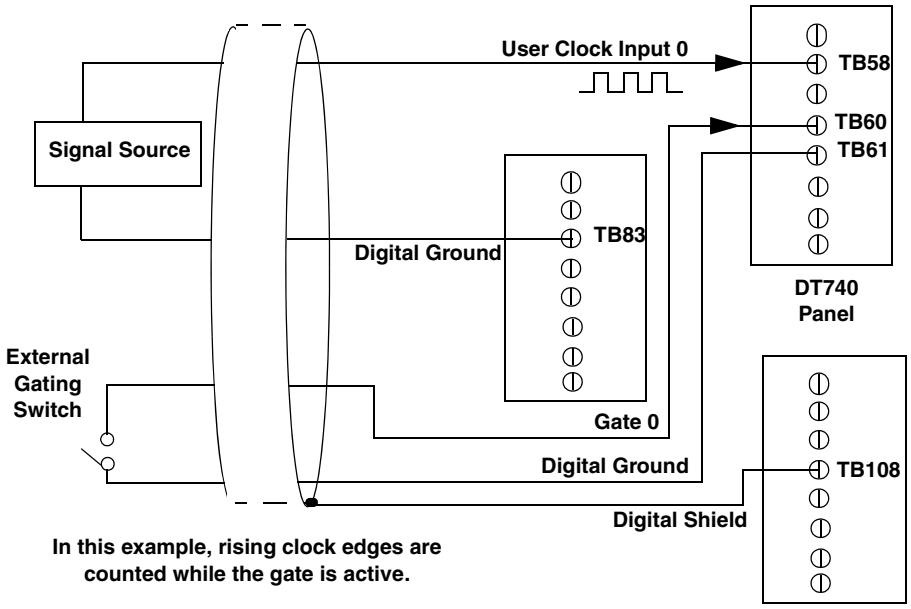


Figure 13: Connecting Event Counting Applications to the DT740 (Shown for Clock Input 0 and an External Gate 0)

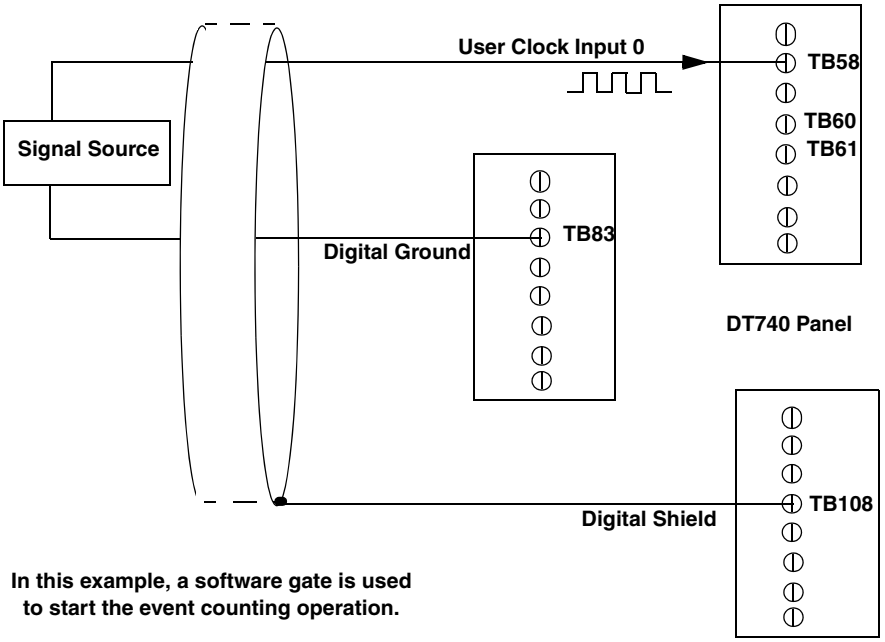


Figure 14: Connecting Event Counting Applications to the DT740 (Shown for Clock Input 0 without an External Gate)

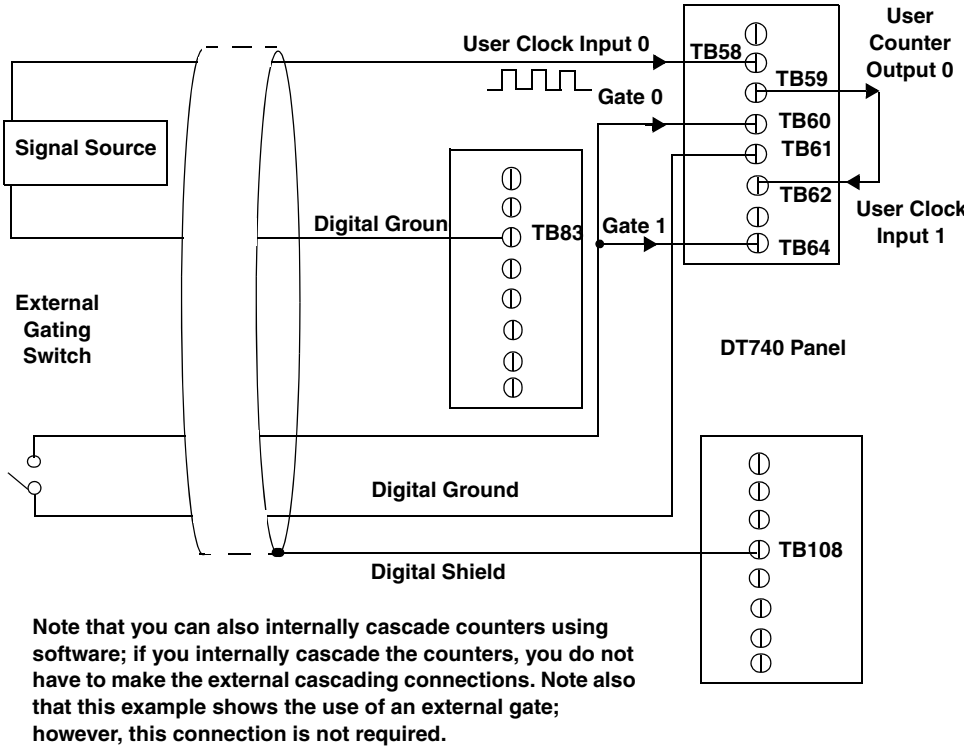


Figure 15: Cascading Counters on a DT740 Screw Terminal Panel (Shown for Event Counting Using Counters 0 and 1 and External Gate 0)

Connecting Frequency Measurement Signals

One way to measure frequency is to connect a pulse of a known duration (such as a one-shot output of another user counter) to the external gate input, as shown in Figure 16. In this configuration, the frequency of the clock input is the number of counts divided by the period of the external gate input.

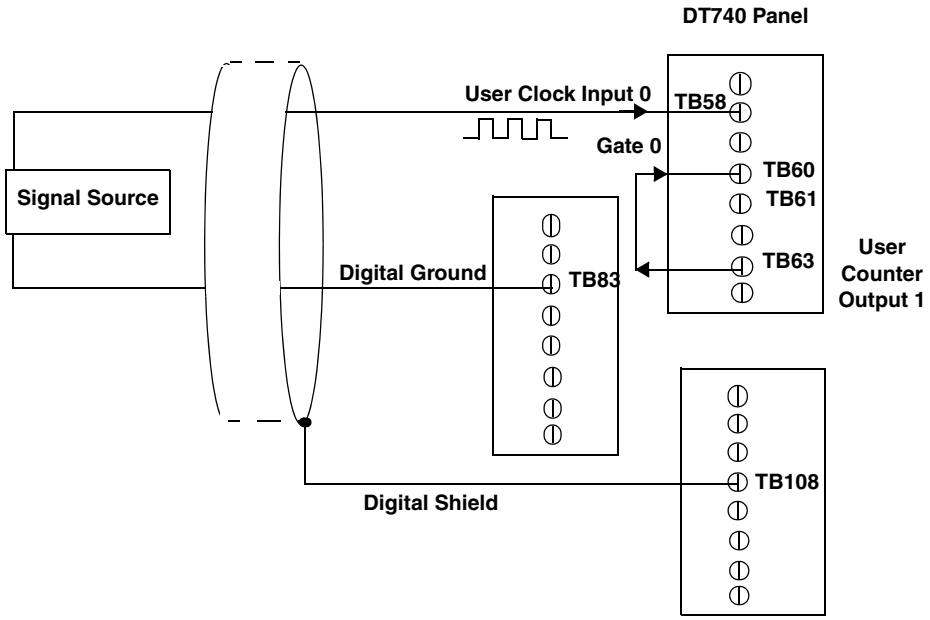


Figure 16: Connecting Frequency Measurement Applications to the DT740 Screw Terminal Panel (Shown for Clock Input 0 and External Gate 0)

Connecting Pulse Output Signals

Figure 17, Figure 18, and Figure 19 show examples of connecting pulse output applications to the DT740 screw terminal panel. Other combinations of signals can be used.

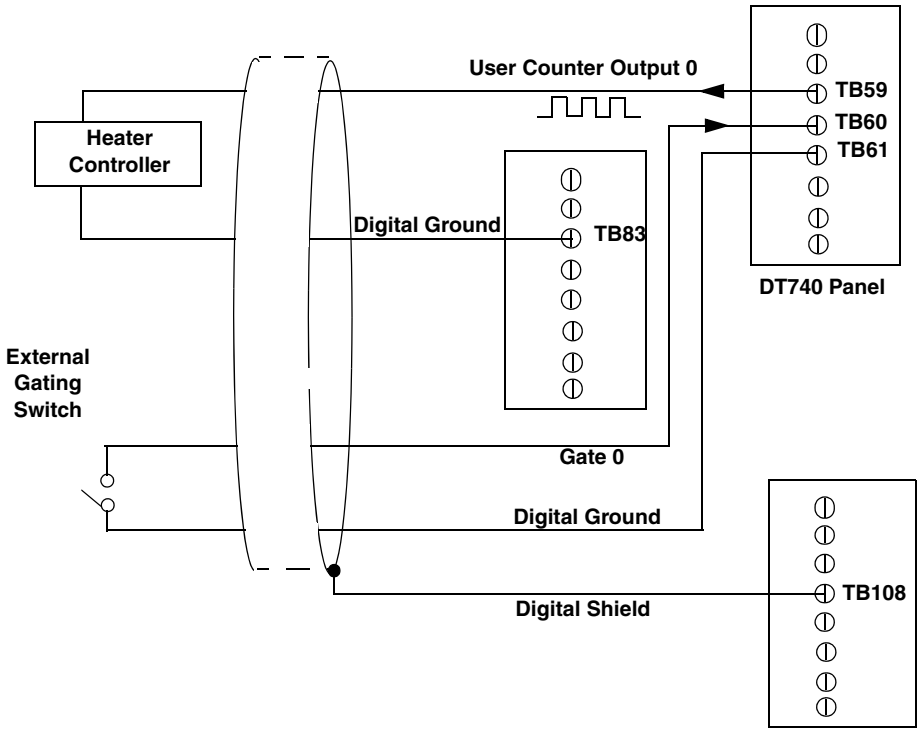


Figure 17: Connecting Pulse Output Applications to the DT740 Screw Terminal Panel (Shown for Counter Output 0 and Gate 0)

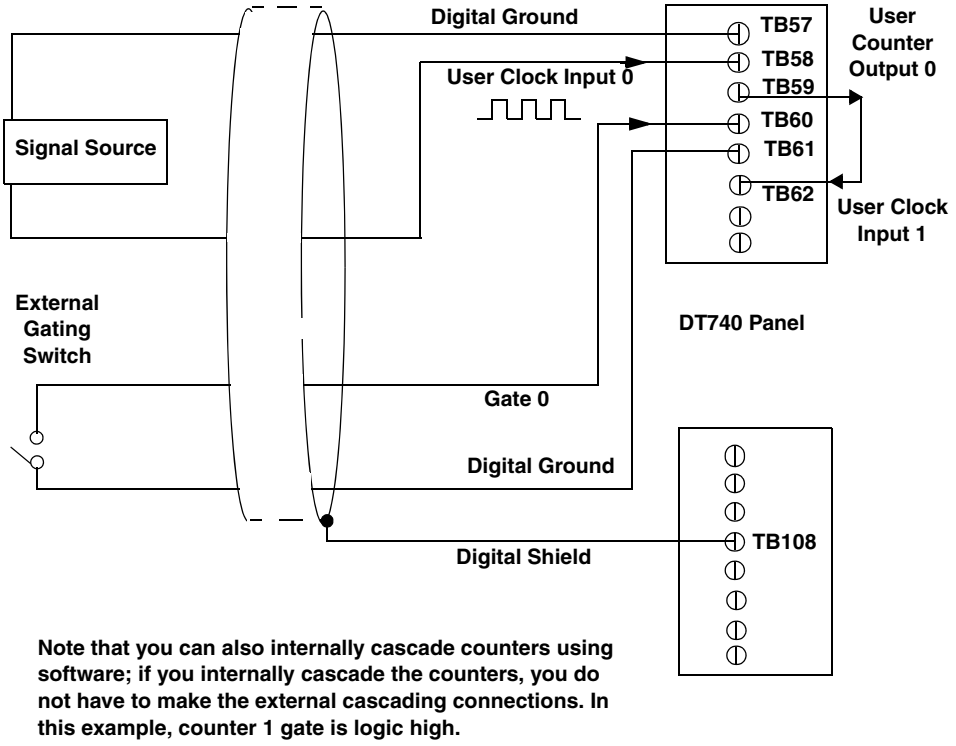


Figure 18: Cascading Counters to the DT740 (Shown for Rate Generation Using Counters 0 and 1 and External Gate 0)

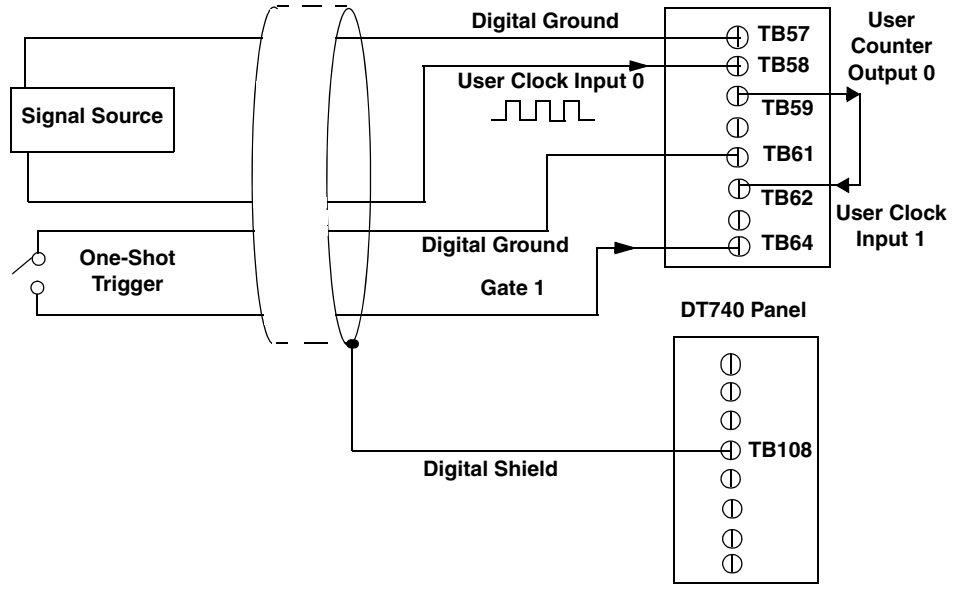
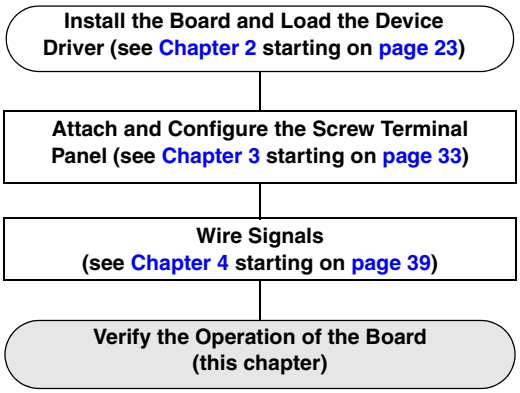


Figure 19: Cascading Counters for the DT740 (Shown for One-Shot Using Counters 0 and 1 and External Gate 1)

5

Verifying the Operation of a DT3034 Board



You can verify the operation of a DT3034 board using the Quick DataAcq application. Quick DataAcq allows you to do the following:

- Acquire data from a single analog input channel or digital input port
- Acquire data continuously from one or more analog input channels using an oscilloscope, strip chart, or Fast Fourier Transform (FFT) view
- Measure the frequency of events
- Output data from a single analog output channel or digital output port
- Output pulses either continuously or as a one-shot
- Save the input data to disk

This chapter describes how to install and run the Quick DataAcq application.

Running the Quick DataAcq Application

The Quick DataAcq application is installed automatically when you install the driver software.

To run the Quick DataAcq application, do the following:

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

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

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

Testing Single-Value Analog Input

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

1. Connect a voltage source, such as a function generator, to analog input channel 0 (differential mode) on the DT3034 board. Refer to page 46 for an example of how to connect a differential analog input.
2. In the Quick DataAcq application, choose **Single Analog Input** from the **Acquisition** menu.
3. Select the appropriate DT3034 board from the Board list box.
4. In the Channel list box, select analog input channel 0.
5. In the Range list box, select the range for the channel.
   The default is ±10 V.
6. Select **Differential**.
7. Click **Get** to acquire a single value from analog input channel 0.
   The application displays the value on the screen in both text and graphical form.

Testing Single-Value Analog Output

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

1. Connect an oscilloscope or voltmeter to DAC0 on the board. Refer to page 50 for an example of how to connect analog output signals.
2. In the Quick DataAcq application, choose **Single Analog Output** from the **Control** menu.
3. Select the appropriate DT3034 board from the Board list box.
4. In the Channel list box, select analog output channel 0.
5. In the Range list box, select the output range of DAC0.
   The default is ±10 V.
6. Enter an output value, or use the slider to select a value to output from DAC0.
7. Click **Send** to output a single value from DAC0.
   The application displays the output value on the screen in both text and graphical form.

Testing Continuous Analog Input

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

1. Connect known voltage sources, such as the outputs of a function generator, to analog input channels 0 and 1 on the DT3034 board (using the differential configuration). Refer to page 46 for an example of how to connect a differential analog input.
2. In the Quick DataAcq application, choose **Scope** from the **Acquisition** menu.
3. Select the appropriate DT3034 board from the Board list box.
4. In the Sec/Div list box, select the number of seconds per division (.1 to .00001) for the display.
5. In the Channels list box, select analog input channel 1, and then click **Add** to add the channel to the channel list.
   Channel 0 is automatically added to the channel list.
6. Click **Config** from the Toolbar.
7. From the Config menu, select **ChannelType**, and then select **Differential**.
8. From the Config menu, select **Range**, and then select **Bipolar** or **Unipolar** depending on the configuration of your board.
   The default is Bipolar.
9. From the Scope view, double-click the input range of the channel to change the input range of the board (±10 V, ±5 V, ±2.5 V, ±1.25 V for bipolar ranges or 0 to 10 V, 0 to 5 V, 0 to 2.5 V or 0 to 1.25 V for unipolar ranges).
   The default is ±10 V. Note that the display changes to reflect the selected range for all the analog input channels on the board.
10. In the Trigger box, select **Auto** to acquire data continuously from the specified channels or **Manual** to acquire a burst of data from the specified channels.
11. Click **Start** from the Toolbar to start the continuous analog input operation.
    The application displays the values acquired from each channel in a unique color on the oscilloscope view.
12. Click **Stop** from the Toolbar to stop the operation.

Testing Single-Value Digital Input

To verify that the board can read a single digital input value, do the following:

1. Connect a digital input to digital input line 0 of port A on the DT3034 board. Refer to page 51 for an example of how to connect a digital input.
2. In the Quick DataAcq application, choose **Digital Input** from the **Acquisition** menu.
3. Select the appropriate DT3034 board from the Board list box.
4. Select digital input port A by clicking **Port A**.
5. Click **Get**.
   The application displays the value of each digital input line in port A on the screen in both text and graphical form.

Testing Single-Value Digital Output

To verify that the board can output a single digital output value, do the following:

1. Connect a digital output to digital output line 0 of port B on the DT3034 board. Refer to page 51 for an example of how to connect a digital output.
2. In the Quick DataAcq application, choose **Digital Output** from the **Control** menu.
3. Select the appropriate DT3034 board from the Board list box.
4. Select digital output port B by clicking **Port B**.
5. Click the appropriate bits to select the digital output lines to write to. If the bit is selected, a high-level signal is output to the digital output line; if the bit is not selected, a low-level signal is output to the digital output line. Optionally, you can enter an output value in the Hex text box.
6. Click **Send**.
   The application displays the value of each digital output line of digital port B on the screen in both text and graphical form.

Testing Frequency Measurement

To verify that the board can perform a frequency measurement operation, do the following:

1. Wire an external clock source to counter/timer 0 on the DT3034 board. Refer to page 54 for an example of how to connect a an external clock for a frequency measurement operation.

   Note: The Quick DataAcq application works only with counter/timer 0.

2. In the Quick DataAcq application, choose **Frequency Counter** from the **Acquisition** menu.
3. Select the appropriate DT3034 board from the Board list box.
4. In the Count Duration text box, enter the number of seconds during which events will be counted.
5. Click **Start** to start the frequency measurement operation.
   The operation automatically stops after the number of seconds you specified has elapsed, and the application displays the frequency on the screen.

If you want to stop the frequency measurement operation when it is in progress, click **Stop**.

Testing Pulse Output

To verify that the board can perform a pulse output operation, do the following:

1. Connect a scope to counter/timer 0 on the DT3034 board. Refer to page 55 for an example of how to connect a scope (a pulse output) to counter/timer 0.

   Note: The Quick DataAcq application works only with counter/timer 0.

2. In the Quick DataAcq application, choose **Pulse Generator** from the **Control** menu.
3. Select the appropriate DT3034 board from the Board list box.
4. Select either **Continuous** to output a continuous pulse stream or **One Shot** to output one pulse.
5. Select either **Low-to-high** to output a rising-edge pulse (the high portion of the total pulse output period is the active portion of the signal) or **High-to-low** to output a falling-edge pulse (the low portion of the total pulse output period is the active portion of the signal).
6. Enter a percentage or use the slider to select a percentage for the pulse width. The pulse width determines the duty cycle of the pulse.
7. Click **Start** to generate the pulse(s).
   The application displays the results both in text and graphical form.
8. Click **Stop** to stop a continuous pulse output operation. One-shot pulse output operations stop automatically.

Part 2: Using Your Board

6

Principles of Operation

This chapter describes the analog input, analog output, digital I/O, counter/timer, and synchronous features of the DT3034 board. To frame the discussions, refer to the block diagram shown in Figure 20. Note that bold entries indicate signals you can access.

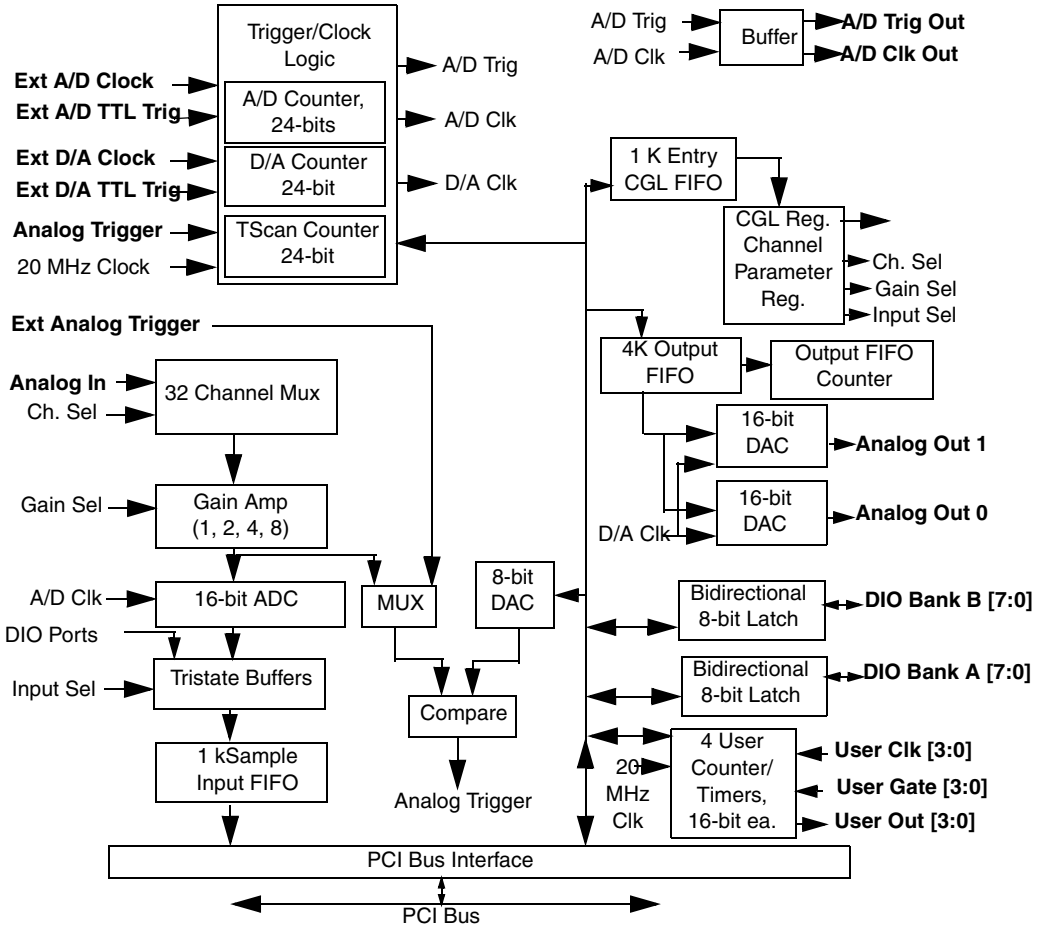


Figure 20: Block Diagram of the DT3034 Board

Analog Input Features

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

- Analog input resolution
- Analog input channels
- Input ranges and gains
- A/D sample clock sources
- Analog input conversion modes
- Trigger sources and trigger acquisition modes
- Data formats and transfer
- Error conditions

Analog Input Resolution

DT3034 boards have a fixed analog input resolution of 16 bits. The analog input resolution cannot be changed in software.

Analog Input Channels

DT3034 boards support 32 single-ended or pseudo-differential analog input channels, or 16 differential analog input channels. Refer to Chapter 4 starting on page 39 for a description of how to wire these signals. Use software to specify the channel type.

Note: For pseudo-differential inputs, specify single-ended in software; in this case, how you wire these signals determines the configuration.

DT3034 boards can acquire data from a single analog input channel or from a group of analog input channels. Channels are numbered 0 to 31 for single-ended and pseudo-differential inputs, and 0 to 15 for differential inputs. The following subsections describe how to specify the channels.

Specifying a Single Channel

The simplest way to acquire data from a single channel is to specify the channel for a single-value analog input operation using software; refer to page 76 for more information on single-value operations.

Specifying One or More Channels

DT3034 boards can read data from one or more analog input channels using an analog input channel list. You can group the channels in the list sequentially (either starting with 0 or with any other analog input channel), or randomly. You can also specify a single channel or the same channel more than once in the list.

Using software, specify the channels in the order you want to sample them. The analog input channel list corresponds to the channel List FIFO on the board. You can enter up to 1,024 entries. The channels are read in order (using continuously- paced scan mode or triggered scan mode) from the first entry to the last entry in the channel list. The board can read the channels in the channel list up to 256 times per trigger (for a total of 262,144 samples per trigger) using triggered scan mode. Refer to page 76 for more information on the supported conversion modes.

Note: If you select an analog input channel as the analog threshold trigger source, the channel used for this trigger source must be the first channel specified in the analog input channel list; refer to page 80 for more information on this trigger source.

If you wish, you can also use software to inhibit data collection from channels in the channel list. This feature is useful if you want to discard acquired values from specific entries in the channel list. You can enable or disable inhibition for each entry in the analog input channel list. If enabled, the value is discarded after the channel is read; if disabled, the value is not discarded after the channel is read.

Specifying Digital Input Lines in the Analog Input Channel List

In addition to the analog input channels, you can read the 16 digital I/O lines (Bank A 0 to 7 and Bank B 0 to 7) of the DT3034 boards using the analog input channel list. This feature is particularly useful when you want to correlate the timing of analog and digital events.

To read these 16 digital I/O lines, specify channel 32 in the analog input channel list. You can enter channel 32 anywhere in the list and can enter it more than once, if desired.

This channel is treated like any other channel in the analog input channel list; therefore, all the clocking, triggering, and conversion modes supported for analog input channels are supported for these digital I/O lines, if you specify them in this manner.

Performing Dynamic Digital Output Operations

Note: This feature is supported in the DataAcq SDK. It is not supported in the DT-Open Layers for .NET Class Library.

Using software, you can enable a synchronous dynamic digital output operation for the A/D subsystem. This feature is particularly useful for synchronizing and controlling external equipment.

Two dynamic digital output lines are provided: 0 and 1. These lines are set to a value of 0 on power up; a reset does not affect the values of the dynamic digital output lines. Note that these lines are provided in addition to the other 16 digital I/O lines; see page 94 for more information on the digital I/O features.

Using software, specify the values to write to the dynamic digital output lines using the analog input channel list. As each entry in the analog input channel list is read, the corresponding value you specified is output to the dynamic digital output lines.

For DT3034 boards, you can specify the following values for the dynamic digital output lines: 0 (00 in binary format), 1 (01 in binary format), 2 (10 in binary format), or 3 (11 in binary format), where a value of 1 means that the line goes high and a value of 0 means that the line goes low. Each bit in binary format corresponds to the value to write to the dynamic digital output line. For example, a value of 1 (01 in binary format) means that a value of 1 is output to dynamic digital output line 0 and value of 0 is output to dynamic output line 1. Similarly, a value of 2 (10 in binary format) means that a value of 0 is output to dynamic digital output line 0 and value of 1 is output to dynamic output line 1.

For example, assume that the analog input channel list contains channels 5, 6, 7, 8; that dynamic digital output operations are enabled; and that the values to write to the dynamic digital output lines are 2, 0, 1, 3. Figure 21 shows this configuration.

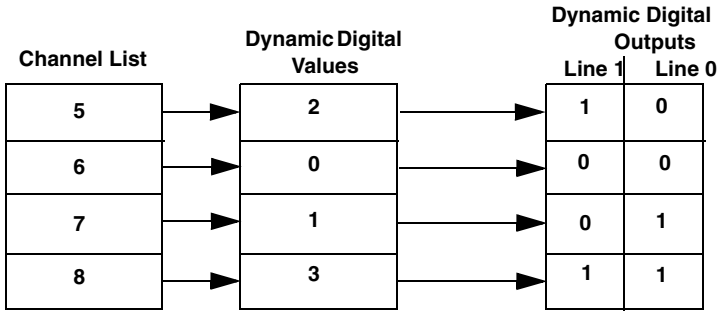


Figure 21: An Example Using Dynamic Digital Outputs

As analog input channel 5 is read, 1 is output to dynamic digital output line 1, and 0 is output to dynamic output line 0 (since 2 in binary format is 10). As analog input channel 6 is read, 0 is output to both dynamic digital output lines. As analog input channel 7 is read, 0 is output to dynamic digital output line 1, and 1 is output to dynamic output line 0 (since 1 in binary format is 01). As analog input channel 8 is read, 1 is written to both dynamic digital output lines.

Input Ranges and Gains

Each channel on the DT3034 board can measure unipolar and bipolar analog input signals. A unipolar signal is always positive (0 to 10 V on DT3034 boards), while a bipolar signal extends between the negative and positive peak values (±10 V on DT3034 boards).

Through software, specify the range as 0 to 10 V for unipolar signals or –10 V to +10 V for bipolar signals. Note that the range applies to the entire analog input subsystem, not to a specific channel.

DT3034 boards also provide gains 1, 2, 4, and 8, which are programmable per channel. Table 4 lists the effective ranges supported by DT3034 boards using these gains.

Table 4: Gains and Effective Ranges

Gain	Unipolar Analog Input Range	Bipolar Analog Input Range
1	0 to 10 V	±10 V
2	0 to 5 V	±5 V
4	0 to 2.5 V	±2.5 V
8	0 to 1.25 V	±1.25 V

For each channel, choose the gain that has the smallest effective range that includes the signal you want to measure. For example, if the range of your analog input signal is ±1.5 V, specify a range of –10 V to +10 V for the board and use a gain of 4 for the channel; the effective input range for this channel is then ±2.5 V, which provides the best sampling accuracy for that channel.

The simplest way to specify gain for a single channel is to specify the gain for a single-value analog input operation using software; refer to page 76 for more information on single-value operations.

If you are using an analog input channel list, you can use software to specify the gain for each analog input channel entry in the analog input channel list.

Note: For analog input channel 32 (the 16 digital I/O channels) in the channel list, specify a gain of 1.

A/D Sample Clock Sources

DT3034 boards provide two clock sources for pacing analog input operations in continuous mode:

- An internal A/D sample clock that uses the 24-bit A/D Counter on the board
- An external A/D sample clock that you can connect to the screw terminal panel

The A/D sample clock paces the acquisition of each channel in the channel list; this clock is also called the A/D pacer clock.

Note: If you enter digital I/O channel 32 in the channel list, the A/D sample clock (internal or external) also paces the acquisition of the 16 digital input lines.

The following subsections describe the internal and external A/D sample clocks in more detail.

Internal A/D Sample Clock

The internal A/D sample clock uses a 20 MHz time base. Conversions start on the falling edge of the counter output; the output pulse is active low.

Using software, specify the clock source as internal and the clock frequency at which to pace the operation. The minimum frequency supported is 1.2 Hz (1.2 Samples/s). The maximum frequency supported is 500 kHz (500 kSamples/s).

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. Doing so avoids an error condition called *aliasing*, in which high frequency input components erroneously appear as lower frequencies after sampling.

Note: You can access the output signal from the A/D sample clock using screw terminal 79 on the DT740 screw terminal panel.

External A/D Sample Clock

The external A/D sample clock is useful when you want to pace acquisitions at rates not available with the internal A/D sample clock or when you want to pace at uneven intervals.

Connect an external A/D sample clock to screw terminal 76 on the DT740 screw terminal panel. Conversions start on the falling edge of the external A/D sample clock input signal.

Using software, specify the clock source as external. The clock frequency is always equal to the frequency of the external A/D sample clock input signal that you connect to the board through the screw terminal panel.

Analog Input Conversion Modes

DT3034 boards support the following conversion modes:

- **Single-value operations** are the simplest to use but offer the least flexibility and efficiency. Use software to specify the range, gain, and analog input channel (among other parameters); acquire the data from that channel; and convert the result. The data is returned immediately. For a single-value operation, you cannot specify a clock source, trigger source, trigger acquisition mode, scan mode, or buffer.

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

- **Scan mode** takes full advantage of the capabilities of the DT3034 board. In a scan, you can specify a channel list, clock source, trigger source, trigger acquisition mode, scan mode, and buffer. Two scan modes are supported: continuously-paced scan mode and triggered scan mode (often called burst mode). These modes are described in the following subsections.

  Using software, you can stop a scan mode operation by performing either an orderly stop or an abrupt stop. In an orderly stop, the board finishes acquiring the specified number of samples, stops all subsequent acquisition, and transfers the acquired data to host memory; all subsequent triggers or retriggers are ignored. In an abrupt stop, the board stops acquiring samples immediately; the acquired data is not transferred to host memory, but all subsequent triggers or retriggers are ignored.

Continuously-Paced Scan Mode

Use continuously-paced scan mode if you want to accurately control the period between conversions of individual channels in a scan.

When it detects an initial trigger, the board cycles through the channel list, acquiring and converting the value for each entry in the channel list; this process is defined as the scan. The board then wraps to the start of the channel list and repeats the process continuously until either the allocated buffers are filled or you stop the operation. Refer to page 85 for more information on buffers.

The conversion rate is determined by the frequency of the A/D sample clock; refer to page 74 for more information on the A/D sample clock. The sample rate, which is the rate at which a single entry in the channel list is sampled, is determined by the frequency of the A/D sample clock divided by the number of entries in the channel list.

To select continuously-paced scan mode, use software to specify the dataflow as Continuous, ContinuousPreTrigger, or Continuous PrePostTrigger; refer to page 81 for more information about these trigger acquisition modes.

The initial trigger source depends on the trigger acquisition mode selected; refer to page 79 for more information on the supported trigger acquisition modes and trigger sources.

Note: An A/D Trigger Out signal is provided for your use. This signal is high when the A/D subsystem is waiting for a trigger and low when a trigger occurs. In continuously-paced scan mode, this signal goes low when the trigger occurs and stays low until you stop the operation.

Triggered Scan Mode

DT3034 boards support two triggered scan modes: software-retriggered and externally-retriggered. These modes are described in the following subsections.

Software-Retriggered Scan Mode

Use software-retriggered scan mode if you want to accurately control both the period between conversions of individual channels in a scan and the period between each scan. This mode is useful when synchronizing or controlling external equipment, or when acquiring a buffer of data on each trigger or retrigger. Using this mode, you can acquire up to 262,144 samples per trigger (256 times per trigger x 1024-location channel list).

When it detects an initial trigger, the board scans the channel list a specified number of times (up to 256), then waits for an software retrigger to occur. When the board detects an software retrigger, the board scans the channel list the specified number of times, then waits for another software retrigger to occur. The process repeats continuously until either the allocated buffers are filled or you stop the operation; refer to page 85 for more information on buffers.

The sample rate is determined by the frequency of the A/D sample clock divided by the number of entries in the channel list; refer to page 74 for more information on the A/D sample clock. The conversion rate of each scan is determined by the frequency of the Triggered Scan Counter, a 24-bit counter with a 20 MHz clock located on the board.

Using software, specify the retrigger frequency. The minimum retrigger frequency is 1.2 Hz. The maximum retrigger frequency is 250 kHz (250 kSamples/s).

Specify the *retrigger frequency* as follows:

$$\text{Min. Retrigger Period} = \frac{\text{\# of CGL entries} \times \text{\# of CGLs per trigger}}{\text{A/D sample clock frequency}} + 2\ \mu s$$

$$\text{Max. Retrigger Frequency} = \frac{1}{\text{Min. Retrigger Period}}$$

For example, if you are using 512 channels in the channel list, scanning the channel list 256 times every trigger or retrigger, and using an A/D sample clock with a frequency of 1 MHz, set the maximum retrigger frequency to 7.62 Hz, since

$$7.62\ \text{Hz} = \frac{1}{\frac{(512 * 256)}{1\ \text{MHz}} + 2\ \mu s}$$

To select software-retriggered scan mode, use software to specify the following parameters:

- The dataflow as Continuous, ContinuousPreTrigger, or ContinuousPrePostTrigger,
- Triggered scan mode usage as enabled.
- The retrigger source as Software.
- The number of times to scan per trigger or retrigger (also called the multiscan count).
- The frequency of the Triggered Scan Counter.

The initial trigger source depends on the trigger acquisition mode selected; refer to page 79 for more information on the supported trigger acquisition modes and trigger sources.

Note: An A/D Trigger Out signal is provided for your use. This signal is high when the A/D subsystem is waiting for a trigger and low when a trigger occurs. In software-retriggered scan mode, this signal stays low until the desired number of samples have been acquired, then goes high until the software retrigger is generated.

Externally-Retriggered Scan Mode

Use externally-retriggered scan mode if you want to accurately control the period between conversions of individual channels and retrigger the scan based on an external event. Like software-retriggered scan mode, this mode allows you to acquire 262,144 samples per trigger (256 times per trigger x 1024-location channel list).

Note: Use externally-retriggered scan mode with continuous post-trigger acquisitions only; refer to page 81 for more information on post-trigger acquisitions.

When it detects an initial trigger (post-trigger source only), the board scans the channel list up to 256 times, then waits for an external retrigger to occur. Specify any supported post-trigger source as the initial trigger. For the retrigger, specify either an external digital (TTL) trigger.

When the retrigger occurs, the board scans the channel list the specified number of times, then waits for another external retrigger to occur. The process repeats continuously until either the allocated buffers are filled or you stop the operation; refer to page 85 for more information on buffers.

The conversion rate of each channel is determined by the frequency of the A/D sample clock; refer to page 74 for more information on the A/D sample clock. The conversion rate of each scan is determined by the period between external retriggers; therefore, it cannot be accurately controlled. The board ignores external triggers that occur while it is acquiring data. Only external retrigger events that occur when the board is waiting for a retrigger are detected and acted on.

To select externally-retriggered scan mode, use software to specify the following parameters:

- The dataflow as Continuous.
- Triggered scan mode as enabled.
- The retrigger source as an external digital (TTL) trigger.
- The number of times to scan per trigger or retrigger (also called the multiscan count).

Note: If you are using an external trigger source as the initial trigger and want to retrigger externally, specify the same trigger source as the retrigger. For example, if you are using an external digital (TTL) trigger as the initial trigger, specify the external digital (TTL) trigger as the retrigger.

An A/D Trigger Out signal is provided for your use. This signal is high when the A/D subsystem is waiting for a trigger and low when a trigger occurs. In externally-retriggered scan mode, this signal stays goes low when the trigger occurs and stays low until the desired number of samples have been acquired, then goes high until the external retrigger is generated.

Triggers

A trigger is an event that occurs based on a specified set of conditions. DT3034 boards support a number of trigger sources and trigger acquisition modes, described in the following subsections.

Trigger Sources

DT3034 boards support the following trigger sources:

- Software trigger
- External digital (TTL) trigger
- Analog threshold trigger

This subsection describes these trigger sources in more detail.

Software Trigger

A software trigger event occurs when you start the analog input operation (the computer issues a write to the board to begin conversions). Specify the software trigger source in software.

External Digital (TTL) Trigger

For analog input operations, an external digital trigger event occurs when the DT3034 board detects either a rising or falling edge on the External A/D TTL Trigger input signal connected to screw terminal 77 on the DT740 screw terminal panel. The trigger signal is TTL-compatible.

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

Analog Threshold Trigger

For analog input operations, an analog trigger event occurs when the DT3034 detects a transition from above a threshold level to below a threshold level (falling edge), or a transition from below a threshold level to above a threshold level (rising edge). The following analog threshold trigger sources are available:

- **External Analog Trigger input signal –** This trigger source is supported by the DataAcq SDK; it is not supported by the DT-Open Layers Class Library.

  Connect an external analog trigger signal to screw terminal 107 on the DT740 screw terminal panel.

  Using software, specify the trigger source as either a rising-edge (OL_TRG_EXTRA+1 for DataAcq SDK users) or falling-edge analog threshold trigger (OL_TRG_EXTRA+2 for DataAcq SDK users).

- **One of the analog input channels** after gain is applied (also called the output of the programmable gain amplifier (PGA)**.** Using software, specify the trigger source as either a positive threshold trigger or negative threshold trigger.
  Using software, specify the analog input channel used as the analog threshold trigger as the first channel in the channel list; refer to page 72 for more information.

On DT3034 boards, the threshold level is set using a dedicated 8-bit DAC (the second D/A subsystem). The hysteresis is fixed at 50 mV. Using software, program the threshold level by writing a voltage value to this DAC; this value can range from –10 V to +10 V.

Note: If you are using an analog threshold trigger to trigger both the A/D and the D/A subsystems, ensure that you use the same analog trigger type for both subsystems (either external or one of the analog input channels). The polarity of the triggers, however, can be different.

Trigger Acquisition Modes

DT3034 boards can acquire data in post-trigger mode, pre-trigger mode, or about-trigger mode. These trigger acquisition modes are described in more detail in the following subsections.

Post-Trigger Acquisition

Use post-trigger acquisition mode when you want to acquire data when a post-trigger or retrigger, if using triggered scan mode, occurs.

Using software, specify the following parameters:

- The dataflow as Continuous.
- The trigger source to start the post-trigger acquisition (the post-trigger source) as any of the supported trigger sources.

Refer to page 76 for more information on the supported conversion modes; refer to page 79 for information on the supported trigger sources.

Post-trigger acquisition starts when the board detects the post-trigger event and stops when the specified number of post-trigger samples has been acquired or when you stop the operation.

If you are using triggered scan mode, the board continues to acquire post-trigger data using the specified retrigger source to clock the operation. Refer to page 77 for more information on triggered scan mode.

Figure 22 illustrates continuous post-trigger mode using a channel list with three entries: channel 0, channel 1, and channel 2. Triggered scan mode is disabled. In this example, post-trigger analog input data is acquired on each clock pulse of the A/D sample clock. The board wraps to the beginning of the channel list and repeats continuously (continuously-paced scan mode).

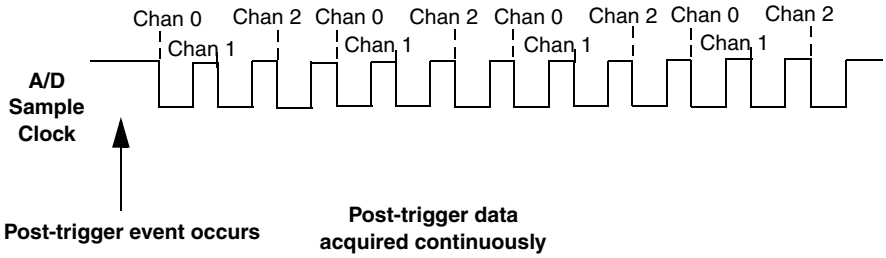


Figure 22: Continuous Post-Trigger Mode without Triggered Scan

Figure 23 illustrates the same example using triggered scan mode (either a software or external retrigger source). The multiscan count is 2 indicating that the channel list will be scanned twice per trigger or retrigger. In this example, post-trigger analog input data is acquired on each clock pulse of the A/D sample clock until the channel list has been scanned twice; then, the board waits for the retrigger event. When the retrigger event occurs, the board scans the channel list twice more, acquiring data on each pulse of the A/D sample clock. The process repeats continuously with every specified retrigger event.

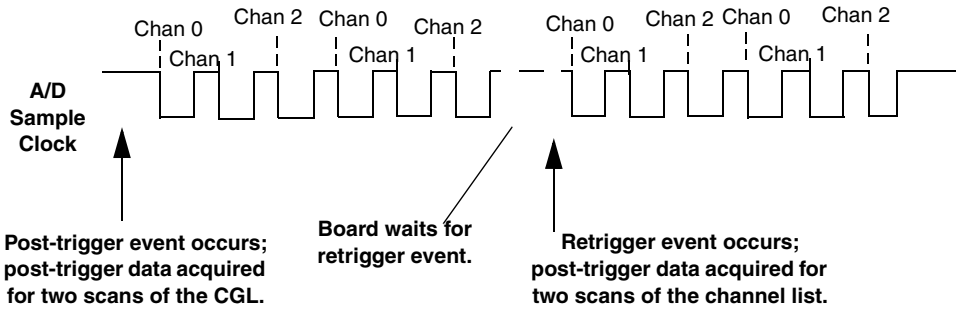


Figure 23: Continuous Post-Trigger Mode with Triggered Scan

Pre-Trigger Acquisition

Use pre-trigger acquisition mode when you want to acquire data before a specific external event occurs.

Using software, specify the following parameters:

- The dataflow as ContinuousPreTrigger.
- The pre-trigger source as Software.
- The post-trigger source as the external digital (TTL) trigger or the external analog threshold trigger.
- If you are using triggered scan mode, the retrigger source as the software retrigger.

Refer to page 76 for more information on the supported conversion modes; refer to page 79 for information on the supported trigger sources.

Note: When using pre-trigger acquisition, you cannot use an external retrigger in triggered scan mode; refer to page 77 for more information on triggered scan mode.

Pre-trigger acquisition starts when you start the operation and stops when the board detects the selected post-trigger source, indicating that the first post-trigger sample was acquired (this sample is ignored).

If you are using software-retriggered scan mode and the post-trigger event has not occurred, the board continues to acquire pre-trigger data using the Triggered Scan Counter to clock the operation. When the post-trigger event occurs, the operation stops. Refer to page 77 for more information on software-retriggered scan mode.

Figure 24 illustrates continuous pre-trigger mode using a channel list of three entries: channel 0, channel 1, and channel 2. In this example, pre-trigger analog input data is acquired on each clock pulse of the A/D sample clock. The board wraps to the beginning of the channel list and the acquisition repeats continuously until the post-trigger event occurs. When the post-trigger event occurs, acquisition stops.

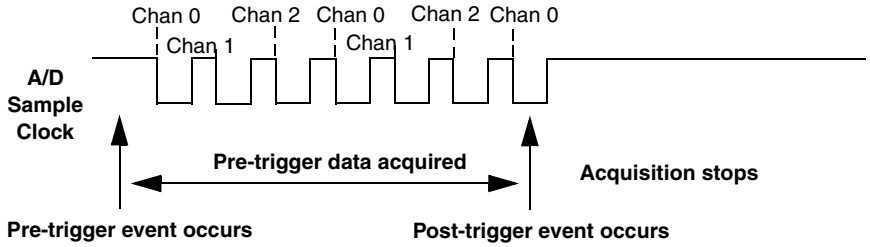


Figure 24: Continuous Pre-Trigger Mode

Figure 25 illustrates the same example using software-retriggered triggered scan mode. The multiscan count is 2 indicating that the channel list will be scanned twice per trigger or retrigger. In this example, pre-trigger analog input data is acquired on each clock pulse of the A/D sample clock until the channel list has been scanned twice; then, the board waits for the software retrigger event. When the software retrigger occurs, the process repeats. The process stops when the post-trigger event occurs.

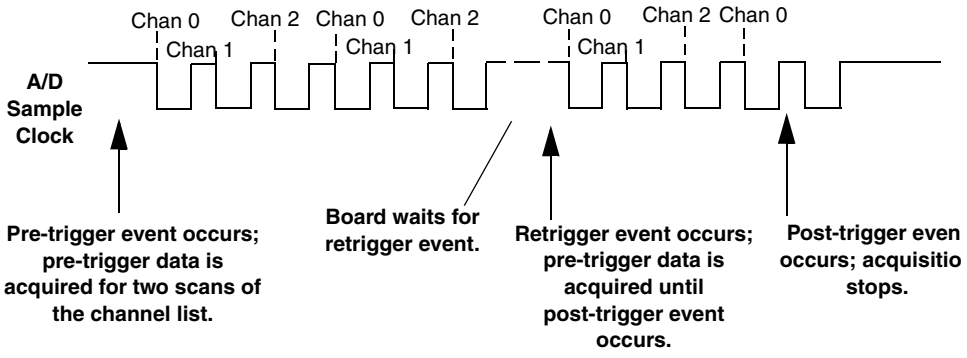


Figure 25: Continuous Pre-Trigger Mode with Triggered Scan

About-Trigger Acquisition

Use about-trigger acquisition mode when you want to acquire data both before and after a specific external event occurs. This operation is equivalent to doing both a pre-trigger and a post-trigger acquisition.

Using software, specify the following parameters:

- The dataflow as ContinuousPrePostTrigger.
- The pre-trigger source as Software.
- The post-trigger source as the external digital (TTL) trigger or the external analog threshold trigger.
- If you are using triggered scan mode, the retrigger source as Software.

Refer to page 76 for more information on the supported conversion modes; refer to page 79 for information on the supported trigger sources.

Note: When using about-trigger acquisition, you cannot use an external retrigger in triggered scan mode; refer to page 77 for more information on triggered scan mode.

The about-trigger acquisition starts when you start the operation. When the board detects the selected post-trigger event, the board stops acquiring pre-trigger data and starts acquiring post-trigger data.

If you are using software-retriggered scan mode and the post-trigger event has not occurred, the board continues to acquire pre-trigger data using the Triggered Scan Counter to clock the operation. If, however, the post-trigger event has occurred, the board continues to acquire post-trigger data using the Triggered Scan Counter to clock the operation.

The about-trigger operation stops when the specified number of post-trigger samples has been acquired or when you stop the operation. Refer to page 77 for more information on software-retriggered scan mode.

Figure 26 illustrates continuous about-trigger mode using a channel list of two entries: channel 0 and channel 1. In this example, pre-trigger analog input data is acquired on each clock pulse of the A/D sample clock, scanning the channel list continuously, until the post-trigger event occurs. When the post-trigger event occurs, post-trigger analog input data is acquired continuously on each clock pulse of the A/D sample clock.

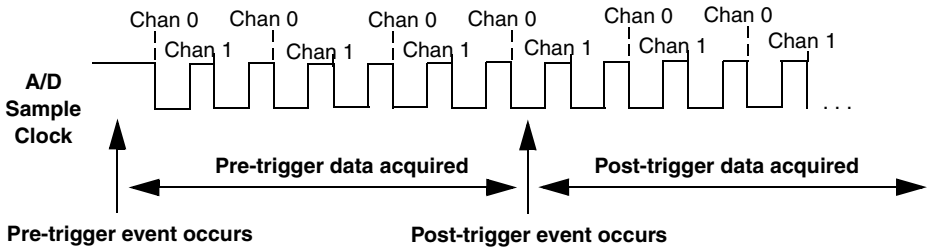


Figure 26: Continuous About-Trigger Mode

Figure 27 illustrates the same example using software-retriggered triggered scan mode. The multiscan count is 2 indicating that the channel list will be scanned twice per trigger or retrigger. In this example, pre-trigger analog input data is acquired on each clock pulse of the A/D sample clock for two scans; then, the board waits for the software retrigger event. When the software retrigger occurs, the board begins acquiring pre-trigger data until the post-trigger event occurs. Then, the board finishes scanning the channel list the specified number of times, but acquires the data as post-trigger samples. On all subsequent software retriggers, post-trigger data is acquired.

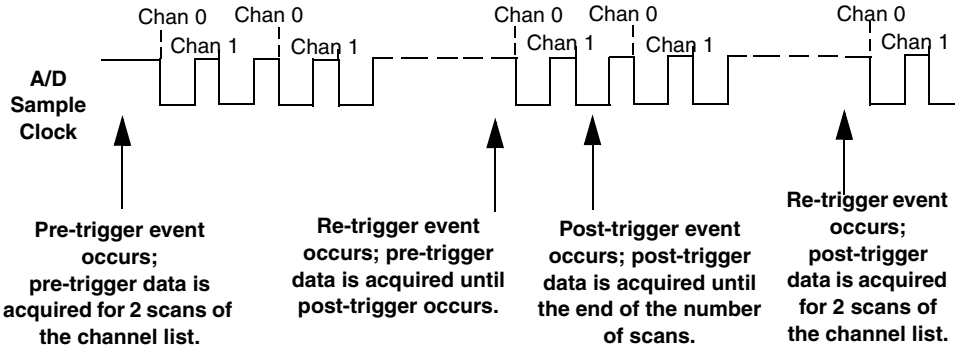


Figure 27: Continuous About-Trigger Mode with Triggered Scan

Data Format and Transfer

To represent unipolar signals, DT3034 boards use straight binary data encoding, such as 0000 to represent 0 V, and FFFFh to represent full-scale. To represent bipolar signals, DT3034 boards use offset binary data encoding, such 0000 to represent negative full-scale, and FFFFh to represent positive full-scale. Use software to specify the data encoding as binary.

The ADC outputs FFFFh for above-range signals, and 0000 for below-range signals.

The board packs two input samples (an even and an odd sample) into each transfer to the host computer. Samples corresponding to entries 0, 2, 4, and so on, in the channel list are considered even samples; samples corresponding to entries 1, 3, 5, and so on, in the channel list are considered odd samples.

Using flags internally, the board determines whether the acquired samples are pre-trigger or post-trigger samples. These flags are not transferred to the host computer. The host computer can read the register on the board to determine where the post-trigger data starts. Note that the host computer cannot read data directly from the board; the data must be transferred to the host computer.

Using PCI bus mastering, the board transfers the analog input data to a 256 KB circular buffer, which is dedicated to the hardware, in the host computer. The board treats this buffer as two consecutive 128 KB blocks of memory.

Note: When you stop an analog input operation, a final block of 32 samples is transferred even if less data is required. The host software ignores the extra samples.

The DT3034 Device Driver accesses the hardware circular buffer to fill user buffers that you allocate in software. It is recommended that you allocate a minimum of two buffers for analog input operations and add them to the subsystem queue using software. Data is written to the queued input buffers continuously; when no more empty buffers are available on the queue, the operation stops. The data is gap-free.

Error Conditions

DT3034 boards can report the following analog input error conditions to the host computer:

- **A/D Over Sample** – Indicates that the A/D sample clock rate is too fast. This error is reported if a new A/D sample clock pulse occurs while the ADC is busy performing a conversion from the previous A/D sample clock pulse. The host computer can clear this error. To avoid this error, use a slower sampling rate.
- **Input FIFO Overflow** – Indicates that the analog input data is not being transferred fast enough from the Input FIFO across the PCI bus to the host computer. This error is reported when the Input FIFO becomes full; the board cannot get access to the PCI bus fast enough. The host computer can clear this error, but the error will continue to be generated if the Input FIFO is still full. To avoid this error, close other applications that may be running while you are acquiring data. If this has no effect, try using a computer with a faster processor or reduce the sampling rate.
- **Host Block Overflow** – Indicates that the host computer is not handling data from the board fast enough. This error is reported if the board completes the transfer of a block of input data to the circular buffer in the host computer before the host computer has finished reading the last block of data. The host computer can clear this error. If you encounter this error, try allocating more buffers or larger buffers.

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

Note: DT-Open Layers reports any of these errors as an overrun message.

Analog Output Features

Two analog output (D/A) subsystems are provided on DT3034 boards. The first D/A subsystem contains the majority of analog output features. The second is dedicated to threshold triggering only (refer to page 89 for more information on analog threshold triggering).

This section describes the following features of the first D/A subsystem:

- Analog output resolution
- Analog output channels
- Output ranges and gains
- Output filters
- D/A output clock sources
- Trigger sources
- Analog output conversion modes
- Data formats and transfer
- Error conditions

Analog Output Resolution

DT3034 boards have a fixed analog output resolution of 16 bits. The analog output resolution cannot be changed in software.

Analog Output Channels

DT3034 boards support two differential analog output channels (DAC0 and DAC1). Use software to specify the channel type. Refer to Chapter 4 starting on page 39 for information on how to wire analog output signals to the board using the screw terminal panel.

Within each DAC, the digital data is double buffered to prevent spurious outputs, then output as an analog signal. Both DACs power up to a value of 0 V ±10 mV. Note that resetting the board does not clear the values in the DACs.

DT3034 boards can output data from a single analog output channel or from two analog output channels. The following subsections describe how to specify the channels.

Specifying a Single Channel

The simplest way to output data to a single analog output channel is to specify the channel for a single-value analog output operation using software; refer to page 90 for more information on single-value operations.

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

Specifying One or More Channels

You can specify one or two analog output channels in the analog output channel list, either starting with DAC 0 or with DAC 1.

Values are output simultaneously to the entries in the channel list.

Output Ranges and Gains

Each DAC on the DT3034 board can output bipolar analog output signals in the range of ±10 V.

Through software, specify the range for the entire analog output subsystem as –10 V to +10 V, and the gain for each DAC as 1.

If you are using a single-value operation, specify a gain of 1; refer to page 90 for more information on single-value operations.

If you are using an analog output channel list, the subsystem defaults to a gain of 1 for each channel; therefore, you do not have to specify the gain.

D/A Output Clock Sources

DT3034 boards provide two clock sources for pacing the output of each channel in the analog output channel list:

- An internal D/A output clock that uses the 24-bit D/A Counter on the board.
- An external D/A output clock that you can connect to the screw terminal panel.

The following subsections describe the internal and external D/A output clocks in more detail.

Internal D/A Output Clock

The internal D/A output clock uses a 20 MHz time base. Conversions start on the falling edge of the counter output; the output pulse is active low.

Through software, specify the clock source as internal and the clock frequency at which to pace the analog output operation.

The minimum frequency supported is 1.2 Hz (1.2 Samples/s). The maximum frequency supported is 500 kHz (500 kSamples/s) with 100 mV steps or 200 kHz (200 kSamples/s) with full-scale steps.

External D/A Output Clock

The external D/A output clock is useful when you want to pace analog output operations at rates not available with the internal D/A output clock, if you want to pace at uneven intervals, or if you want to start pacing when an external event occurs.

Connect an external D/A output clock to screw terminal 74 on the DT740 screw terminal panel. Conversions start on the falling edge of the external D/A output clock signal.

Using software, specify the clock source as external. For DT3034 boards, the clock frequency is always equal to the frequency of the external D/A output clock input signal that you connect to the board through the screw terminal panel.

Trigger Sources

A trigger is an event that occurs based on a specified set of conditions. DT3034 boards support the following trigger sources for analog output operations:

- Software trigger
- External digital (TTL) trigger
- Analog threshold trigger

This subsection describes these trigger sources in more detail.

Software Trigger

A software trigger event occurs when you start the analog output operation (the computer issues a write to the board to begin conversions). Specify the software trigger source in software.

External Digital (TTL) Trigger

For analog output operations, an external digital trigger event occurs when the DT3034 board detects either a rising or falling edge on the External D/A TTL Trigger input signal connected to screw terminal 75 on the DT740 screw terminal panel. The trigger signal is TTL-compatible.

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

Analog Threshold Trigger

For analog output operations, an analog trigger event occurs when the DT3034 board detects a transition from above a threshold level to below a threshold level (falling edge), or a transition from below a threshold level to above a threshold level (rising edge). The following analog threshold trigger sources are available:

- **External Analog Trigger input signal** – This trigger source is supported by the DataAcq SDK; it is not supported by the DT-Open Layers Class Library.

  Connect an external analog signal to screw terminal 107 on the DT740 screw terminal panel. Using software, specify the trigger source as either a rising-edge (OL_TRG_EXTRA+1 for DataAcq SDK users) or falling-edge analog threshold trigger (OL_TRG_EXTRA+2 for DataAcq SDK users).

- **One of the analog input channels** after gain is applied**.** Using software, specify the trigger source as either a positive threshold trigger or a negative threshold trigger.

  Using software, specify the analog input channel used as the analog threshold trigger as the first channel in the analog input channel list; refer to page 72 for more information.

  On DT3034 boards, the threshold level is set using a dedicated 8-bit DAC (the second D/A subsystem); the hysteresis is fixed at 50 mV. Using software, program the threshold level by writing a voltage value to the DAC of the second analog output subsystem; this value can range from –10 V to +10 V.

Note: If you are using an analog threshold trigger to trigger both the A/D and the D/A subsystems, ensure that you use the same analog trigger type for both subsystems (either external or one of the analog input channels). The polarity of the triggers, however, can be different.

Analog Output Conversion Modes

DT3034 boards support the following conversion modes:

- **Single-value operations** are the simplest to use but offer the least flexibility and efficiency. Use software to specify the range, gain, and analog output channel (among other parameters), and output the data from that channel. For a single-value operation, you cannot specify a clock source, trigger source, or buffer.
  Single-value operations stop automatically when finished; you cannot stop a single-value operation.

- **Continuous analog output operations** take full advantage of the capabilities of the DT3034 boards. In this mode, you can specify an analog input channel list, clock source, trigger source, buffer, and buffer wrap mode. Two continuous analog output operations are supported: continuously-paced and waveform generation mode. These modes are described in the following subsections.

  To stop a continuously-paced analog output operation, you can stop sending data to the board, letting the board 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 board finishes outputting the specified number of samples, then stops; all subsequent triggers are ignored. In an abrupt stop, the board stops outputting samples immediately; all subsequent triggers are ignored.

Continuously-Paced Analog Output

Use continuously-paced analog output mode if you want to accurately control the period between conversions of individual analog output channels in the analog output channel list.

The host computer transfers digital values to write to the DACs from allocated circular buffers in computer memory to the output FIFO on the board. The DT3034 board has a 4 kSample output FIFO. Use software to allocate the number of buffers and to specify the values. It is recommended that you allocate a minimum of two buffers.

When it detects a trigger, the board outputs the values in the output FIFO to the DACs at the same time. Even samples (0, 2, 4, and so on) are written to entry 0 in the channel list; odd samples (1, 3, 5, and so on) are written to entry 1 in the channel list. The operation repeats continuously until no more buffers are on the subsystem queue or you stop the operation. Refer to page 92 for more information on buffers.

Ensure that the host computer transfers data to the output FIFO fast enough so that the output FIFO does not empty completely; otherwise, an output FIFO underrun error results. Note that the output FIFO counter increments each time the host loads a value into the output FIFO and decrements each time the DAC reads a value from the output FIFO; the counter is reset to 0 when the output FIFO is reset. To avoid the output FIFO underrun error in continuously-paced mode, the host computer can read the output FIFO counter to determine how many samples remain in the output FIFO, and transfer more data before the output FIFO empties.

The conversion rate is determined by the frequency of the D/A output clock. The maximum throughput rate in this mode is 500 kHz (500 kSamples/s) in 100 mV steps or 200 kHz (200 kSamples/s) in full-scale steps. Note that rate is system-dependent. Refer to page 88 for more information on the D/A output clock.

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

- Set the dataflow as Continuous.
- Set WrapSingleBuffer to False to use multiple buffers. A minimum of two buffers is recommended.
- Set the trigger source as any of the supported trigger sources. Refer to page 89 for more information on the supported trigger sources.

Waveform Generation

Use waveform generation mode if you want to output waveforms repetitively.

Before this process can begin, the host computer must transfer the entire waveform pattern to output to the DACs from a single buffer allocated in computer memory into the output FIFO on the board. Use software to allocate a single buffer and to specify the waveform pattern.

If you are using a single DAC, the waveform pattern can range from 2 to 4,096 samples; if you are using two DACs, the waveform pattern can range from 2 to 2,048 samples. Specify both DACs in the analog output channel list.

When it detects a trigger, the board cycles through the analog output channel list, converting and outputting the specified waveform for the specified DACs. When the output FIFO empties, the board issues a retransmit pulse to the output FIFO. This allows the board to output the same pattern continuously to the DACs without having to reload the output FIFOs. The buffer wrap mode must be single in this mode; refer to page 92 for more information on buffers.

The conversion rate is determined by the frequency of the D/A output clock. The maximum throughput rate in this mode is 500 kHz (500 kSamples/s) in 100 mV steps or 200 kHz (200 kSamples/s) in full-scale steps. Refer to page 88 for more information on the D/A output clock.

To select waveform generation mode, use software to specify the following parameters:

- Set the dataflow to Continuous.
- Set WrapSingleBuffer to True to use a single buffer.
- Set the trigger source to any of the supported trigger sources. Refer to page 89 for more information on the supported trigger sources.

Data Format and Transfer

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

The host computer transfers data as 32-bit words from one or more allocated circular buffers in computer memory to the output FIFO on the board. DT3034 boards act as PCI slaves to the host computer when performing analog output operations.

The host computer must pack two output samples (an even and an odd sample) into each transfer to the DT3034 board. The even sample is written to the output FIFO first, followed by the odd sample. If the analog output channel list contains two DACs, the even samples (0, 2, 4, and so on) are written to channel entry 0 in the analog output channel list; the odd samples (1, 3, 5, and so on) are written to channel entry 1 in the analog output channel list. If the analog output channel list contains one DAC, all the samples are written to the DAC, alternating between even and odd samples.

Note that for continuously-paced analog output operations, the data from the circular buffers in host computer memory can wrap multiple times. Data is output from each of the buffers on the queue; when no more buffers are on the queue, the operation stops.

In waveform generation mode, the data from a single circular buffer is written once to the output FIFO on the board (wrap mode is single); the board then continuously outputs the data. That is, once all the data in the buffer is written to the output FIFO on the board, the host computer is finished transferring data; the board recycles the data in the output FIFO without using the bandwidth of the PCI bus or host processor, and the process repeats continuously until you stop the operation.

Error Conditions

DT3034 boards can report an output FIFO underflow error to the host computer. This error indicates that the analog output data was not being transferred fast enough across the PCI bus from the host computer to the output FIFO on the board.

If the D/A output clock occurs while the output FIFO is empty, an error is not reported since the most likely cause is that the host computer has no more data to output; in this case, the last value received from the host computer is output by the specified DACs continuously until the board is powered down or new data becomes available. If, however, the host does an additional write to the output FIFO (after the D/A output clock occurred while the output FIFO was empty), the data is written to the DACs and the output FIFO Underflow error is reported. This error has no effect on board operation; the host computer can clear this error.

To avoid this error, ensure that the host computer provides data to the output FIFO faster than the DACs are converting the data. You can read the value of the output FIFO counter to determine how many samples are in the output FIFO.

If this error condition occurs, the host computer stops transferring data to the board and the board continues to output the last data transferred to it by the host computer.

Digital I/O Features

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

- Digital I/O lines
- Digital I/O resolution
- Digital I/O operation modes

Digital I/O Lines

DT3034 boards support 16 digital I/O lines through the digital input (DIN) and output (DOUT) subsystems; both subsystems use the same digital I/O lines. These lines are divided into two banks of eight: Bank A, lines 0 to 7; and Bank B, lines 0 to 7. You can use each bank as either an input port or an output port; all eight lines within a bank have the same configuration. For example, if you use Bank A as an input port (port 0), lines 0 to 7 of Bank A are configured as inputs. Likewise, if you use Bank B as an output port (port 1), lines 0 to 7 of Bank B are configured as outputs.

Specify the digital I/O line to read or write in a single-value digital I/O operation; refer to page 94 for more information on single-value operations.

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, no digital data is output from the board.

Digital I/O Resolution

Using software, specify the number of banks to read by specifying the resolution as 8 (for eight lines) or 16 (for 16 lines). If you specify a resolution of 8, two digital I/O subsystems are available. Element 0 (the first subsystem) corresponds to the Bank A, lines 0 to 7. Element 1 (the second subsystem) corresponds to Bank B, lines 0 to 7. If you specify a resolution of 16, one subsystem is available.

Note: When the resolution is 16, digital I/O lines 0 to 7 of Bank B are represented as bits 8 to 15 of the digital value.

Digital I/O Operation Modes

DT3034 boards support the following digital I/O operation modes:

- **Single-value operations** are the simplest to use but offer the least flexibility and efficiency. Use software to specify the digital I/O line, and a gain of 1 (the gain is ignored). Data is then read from or written to the digital I/O line. 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 DT3034 boards. In this mode, you enter all 16 digital input lines as channel 32 of the analog input channel list using software. This mode is programmed through the A/D subsystem. Using this mode, you can specify a clock source, scan mode, trigger source, trigger acquisition mode, and buffer for the digital input operation. Refer to page 72 for more information on specifying digital input lines for a continuous digital input operation.
- **Dynamic digital output** (supported by the DataAcq SDK only) is useful for synchronizing and controlling external equipment and allows you to output data to two dynamic digital output lines each time an analog input value is acquired. This mode is programmed through the A/D subsystem; refer to page 72 for more information.

Counter/Timer Features

The counter/timer circuitry on the board provides the clocking circuitry used by the A/D and D/A subsystems as well as several user counter/timer features. This section describes the following user counter/timer features:

- Units
- C/T clock sources
- Gate types
- Pulse types and duty cycles
- Counter/timer operation modes

Units

DT3034 boards support four user 16-bit counter/timer units (called counters); counters are numbered 0, 1, 2, and 3.

Each counter accepts a clock input signal and gate input signal and outputs a clock output signal (also called a pulse output signal), as shown in Figure 28.

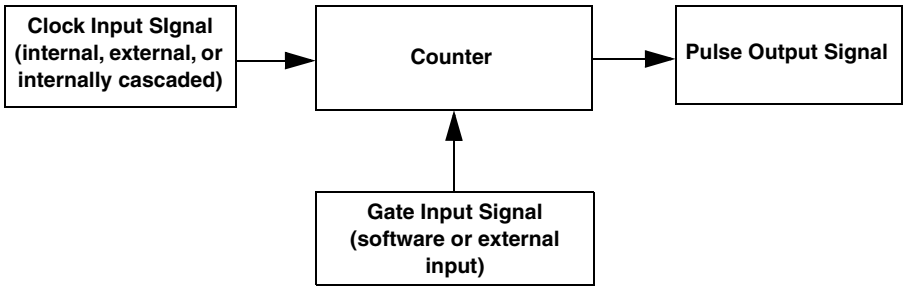


Figure 28: Counter/Timer Channel

Each counter corresponds to a counter/timer (C/T) subsystem. To specify the counter to use in software, specify the appropriate C/T subsystem. For example, counter 0 corresponds to C/T subsystem element 0; counter 3 corresponds to C/T subsystem element 3.

C/T Clock Sources

The following clock sources are available for the user counters:

- Internal C/T clock
- External C/T clock
- Internally cascaded clock

Refer to the following subsections for more information on these clock sources.

Internal C/T Clock

The internal C/T clock uses a 20 MHz time base. Counter/timer operations start on the rising edge of the clock input signal.

Through software, specify the clock source as internal and the frequency at which to pace the counter/timer operation (this is the frequency of the clock output signal). The maximum frequency that you can specify for the clock output signal is 10 MHz. The minimum frequency that you can specify for the clock output signal is 305.18 Hz.

External C/T Clock

The 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 rising edge of the external C/T clock input signal is the active edge.

Using software, specify the clock source as external and the clock divider used to determine the frequency at which to pace the operation (this is the frequency of the clock output signal). The minimum clock divider that you can specify is 2.0; the maximum clock divider that you can specify is 65,536. For example, if you supply an external C/T clock with a frequency of 5 MHz and specify a clock divider of 5, the resulting frequency of the external C/T clock output signal is 1 MHz. The resulting frequency of the external C/T clock output signal must not exceed 2.5 MHz.

Connect the external C/T clock to the board through the DT740 screw terminal panel. Table 5 lists the screw terminals that correspond to the external C/T clock signals of each counter/timer.

Table 5: External C/T Clock Input Signals

Counter/Timer	Screw Terminal on the DT740
0	TB58
1	TB62
2	TB66
3	TB70

Internally Cascaded Clock

You can also internally route the clock output signal from one user counter to the clock input signal of the next user counter to internally cascade the counters. In this way, you can create a 32-bit counter without externally connecting two counters together. DT3034 boards support software cascading on counters 0 and 1, 1 and 2, and 2 and 3.

Specify internal cascade mode in software. The rising edge of the clock input signal is active.

Through software, specify the clock source as internal and the frequency at which to pace the counter/timer operation (this is the frequency of the clock output signal). The maximum frequency that you can specify for the clock output signal is 10 MHz. For a 32-bit cascaded counter, the minimum frequency that you can specify for the clock output signal is 0.00465 Hz, which corresponds to a rate of once every 215 seconds.

Note: In software, specify the clock input and gate input for the first counter in the cascaded pair. For example, if counters 1 and 2 are cascaded, specify the clock input and gate input for counter 1.

Gate Types

The active edge or level of the gate input to the counter enables counter/timer operations. The operation starts when the clock input signal is received. DT3034 boards provide the following gate input types:

- **None** – A software command enables any specified counter/timer operation immediately after execution. This gate type is useful for all counter/timer modes.
- **Logic-low level external gate input** – Enables a counter/timer operation when the external gate signal is low, and disables the counter/timer operation when the external gate signal is high. Note that this gate type is used only for event counting, frequency measurement, and rate generation; refer to page 100 for more information on these modes.
- **Logic-high level external gate input** – Enables a counter/timer operation when the external gate signal is high, and disables a counter/timer operation when the external gate signal is low. Note that this gate type is used only for event counting, frequency measurement, and rate generation; refer to page 100 for more information on these modes.
- **Falling-edge external gate input** – Enables a counter/timer operation on the transition from the high level to the low level (falling edge). In software, this is called a low-edge gate type. Note that this gate type is used only for one-shot and repetitive one-shot mode; refer to page 107 for information on these modes.
- **Rising-edge external gate input** – Enables a counter/timer operation on the transition from the low level to the high level (rising edge). In software, this is called a high-edge gate type. Note that this gate type is used only for one-shot and repetitive one-shot mode; refer to page 107 for information on these modes.

Specify that gate type in software.

Table 6 lists the screw terminals that correspond to the gate input signals of each counter/timer.

Table 6: Gate Input Signals

Counter/Timer	Screw Terminal on the DT740
0	TB60
1	TB64
2	TB68
3	TB72

Pulse Output Types and Duty Cycles

DT3034 boards can output pulses from each counter/timer. Table 7 lists the screw terminals that correspond to the pulse output signals of each counter/timer.

Table 7: Pulse Output Signals

Counter/Timer	Screw Terminal on the DT740
0	TB59
1	TB63
2	TB67
3	TB71

DT3034 boards support the following pulse output types on the clock output signal:

- **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.

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

Figure 29 illustrates a low-to-high pulse with a duty cycle of approximately 30%.

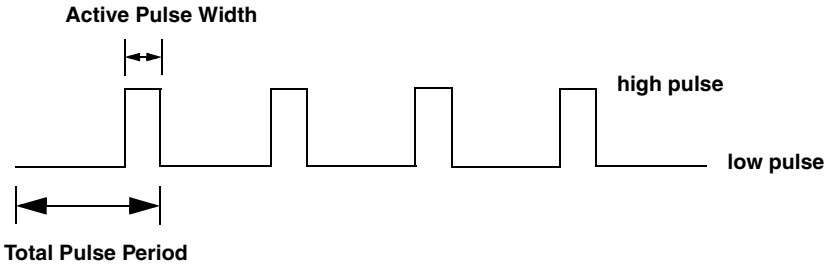


Figure 29: Example of a Low-to-High Pulse Output Type

Counter/Timer Operation Modes

DT3034 boards support the following counter/timer operation modes:

- Event counting
- Frequency measurement
- Rate generation
- One-shot
- Repetitive one-shot

The following subsections describe these modes in more detail.

Event Counting

Use event counting mode to count events from the counter's associated clock input source.

If you are using one counter, you can count a maximum of 65,536 events before the counter rolls over to 0 and starts counting again. If you are using a cascaded 32-bit counter, you can count a maximum of 4,294,967,296 events before the counter rolls over to 0 and starts counting again.

In event counting mode, use an external C/T clock source; refer to page 97 for more information on the external C/T clock source.

Using software, specify the counter/timer mode as event counting (count), the C/T clock source as external, and the gate type that enables the operation. Refer to page 99 for information on gates.

Ensure that the signals are wired appropriately. Figure 30 shows one example of connecting an event counting application. This example uses the DT740 screw terminal panel and user counter 0; rising clock edges are counted while the gate is active.

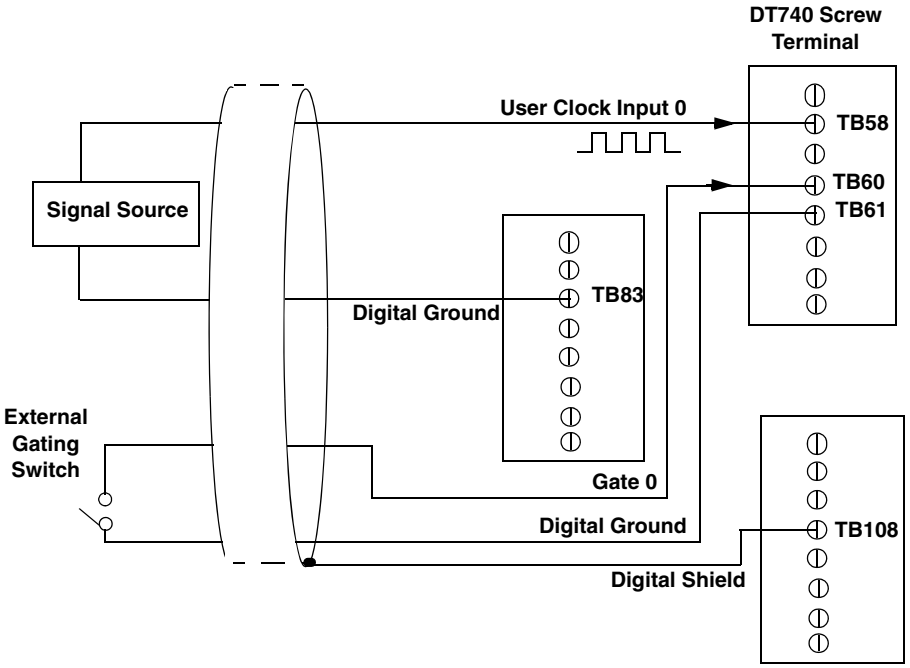


Figure 30: Connecting Event Counting Signals (Shown for Clock Input 0 and External Gate 0)

Figure 31 shows an example of an event counting operation. In this example, the gate type is low level.

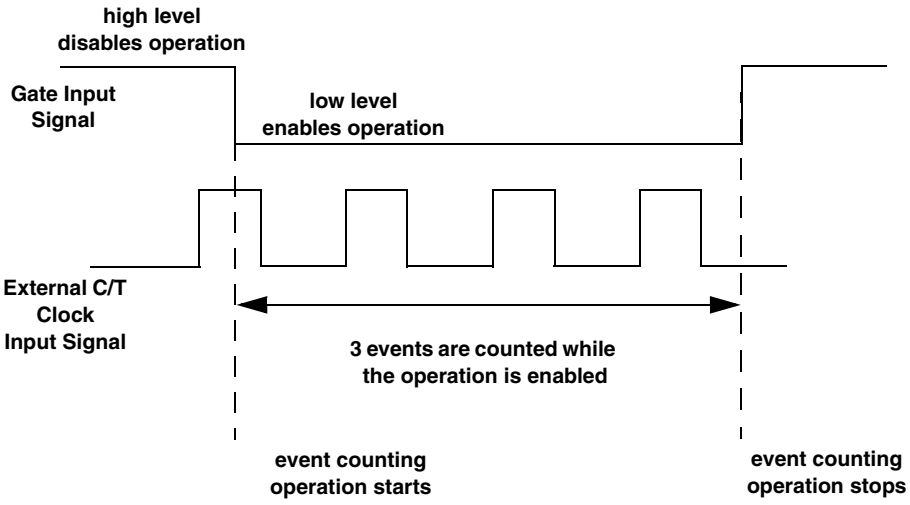


Figure 31: Example of Event Counting

Frequency Measurement

Use frequency measurement mode to measure the frequency of the signal from counter's associated clock input source over a specified duration. In this mode, use an external C/T clock source; refer to page 96 for more information on the external C/T clock source.

Connect a pulse of a known duration (such as a one-shot output of another user counter) to the external gate input, as shown in Figure 32.

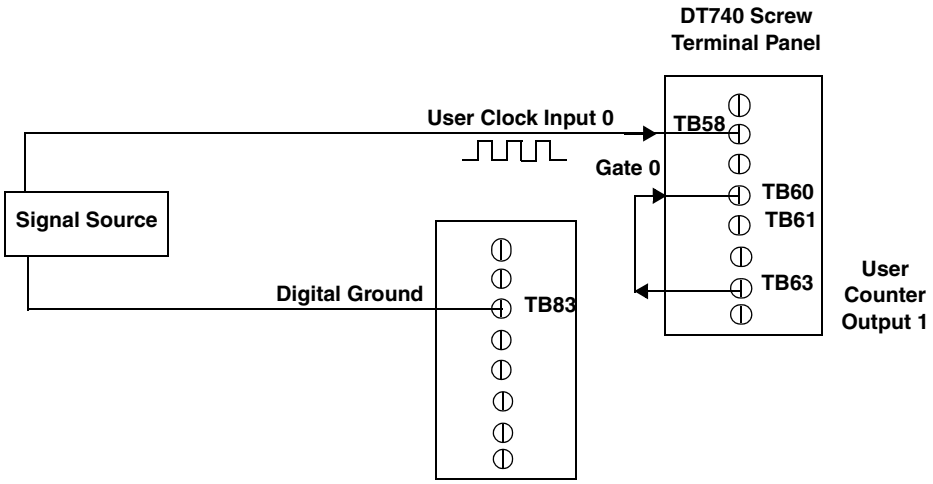


Figure 32: Connecting Frequency Measurement Signals (Shown for Clock Input 0 and External Gate 0)

In this configuration, use software to set up the counter/timers as follows:

1. Set up one of the counter/timers for one-shot mode, specifying the clock source, clock frequency, gate type, and type of output pulse (high or low).
2. Set up the counter/timer that will measure the frequency for event counting mode, specifying the clock source to count, and the gate type (this should match the pulse output type of the counter/timer set up for one-shot mode).
3. Start both counters (events are not counted until the active period of the one-shot pulse is generated).
4. Read the number of events counted. (Allow enough time to ensure that the active period of the one-shot occurred and that events have been counted.)
5. Determine the measurement period using the following equation:

$$\text{Measurement period} = \frac{1}{\text{Clock Frequency}} * \text{Active Pulse Width}$$

6. Determine the frequency of the clock input signal using the following equation:

$$\text{Frequency Measurement} = \frac{\text{Number of Events}}{\text{Measurement Period}}$$

Figure 33 shows an example of a frequency measurement operation. In this example, three events are counted during a duration of 300 ms. The frequency, then, is 10 Hz, since 10 Hz = 3/(.3 s).

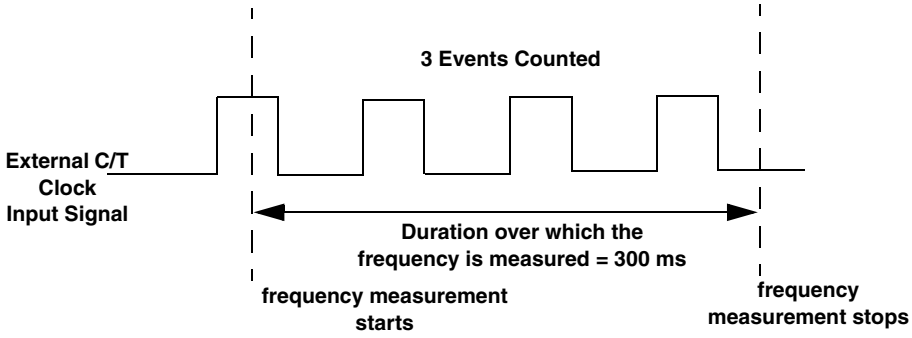


Figure 33: Example of Frequency Measurement

Rate Generation

Use rate generation mode to generate a continuous pulse output signal from the counter; 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.

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 clock input signal and the external clock divider. If you are using one counter (not cascaded), you can output pulses using a maximum frequency of 10 MHz (this is the frequency of the clock output signal). In rate generation mode, either the internal or external C/T clock input source is appropriate depending on your application; refer to page 96 for more information on the C/T clock source.

Using software, specify the counter/timer mode as rate generation (rate), the C/T clock source as either internal or external, the polarity of the output pulses (high-to-low transitions or low-to-high transitions), the duty cycle of the output pulses, and the gate type that enables the operation. Refer to page 99 for more information on pulse output signals and to page 98 for more information on gate types.

Ensure that the signals are wired appropriately. Figure 34 shows one example of connecting a pulse output operation. This example uses the DT740 screw terminal panel, user counter 0, and a software gate type.

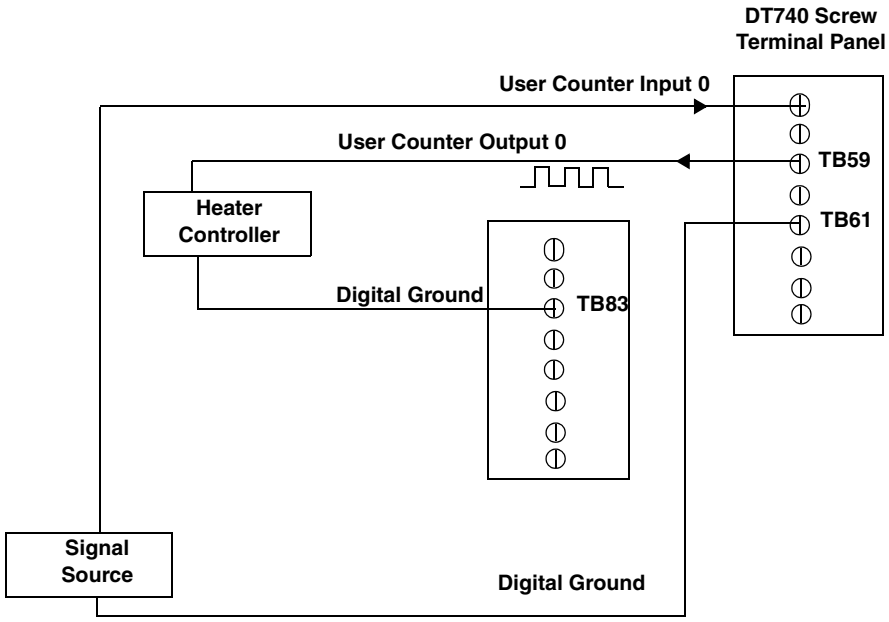


Figure 34: Connecting Rate Generation Signals (Shown for Counter Output 0; a Software Gate is Used)

Figure 35 shows an example of an enabled rate generation operation using an external C/T clock source with an input frequency of 4 kHz, a clock divider of 4, a low-to-high pulse type, and a duty cycle of 75%. (The gate type does not matter for this example.) A 1 kHz square wave is the generated output. Figure 36 shows the same example using a duty cycle of 25%.

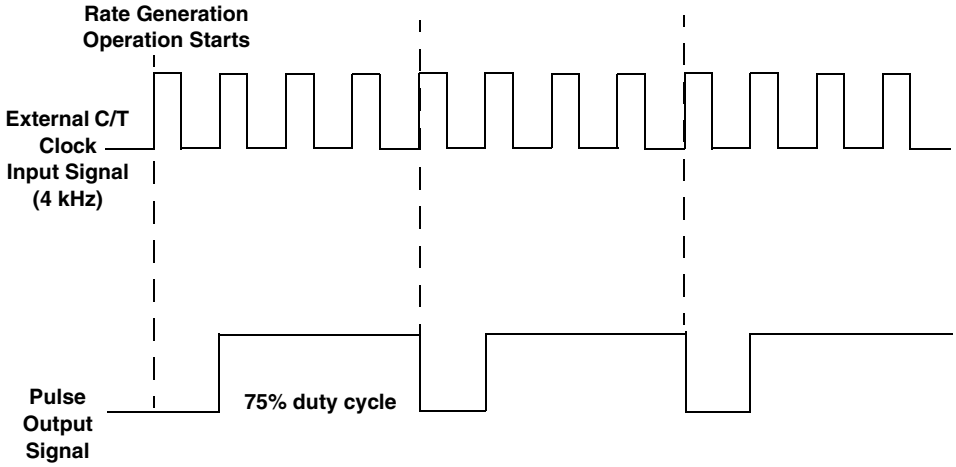


Figure 35: Example of Rate Generation Mode with a 75% Duty Cycle

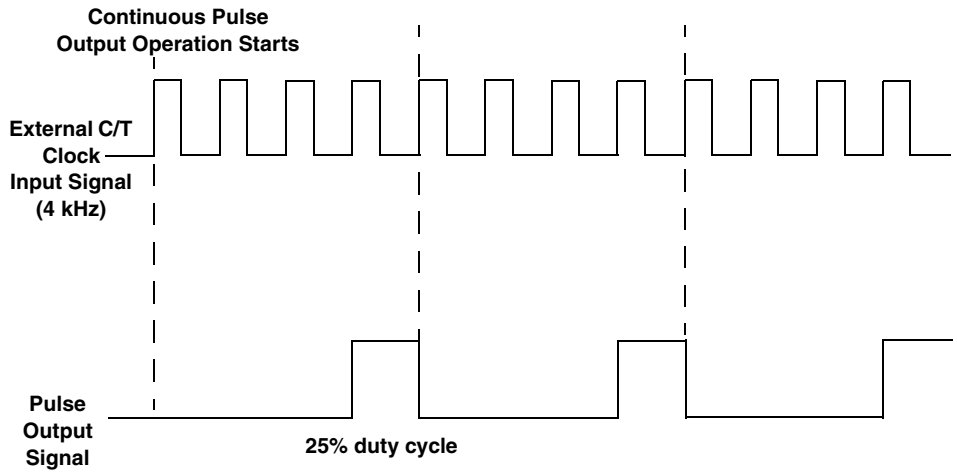


Figure 36: Example of Rate Generation Mode with a 25% Duty Cycle

One-Shot

Use one-shot mode to generate a single pulse output signal from the counter when the operation is triggered (determined by the gate input 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.

When the one-shot operation is triggered, a single pulse is output; then, 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 clock input signal. In one-shot mode, the internal C/T clock source is more useful than an external C/T clock source; refer to page 96 for more information on the internal C/T clock source.

Using software, specify the counter/timer mode as one-shot, the clock source as internal, the polarity of the output pulse (high-to-low transition or low-to-high transition), and the gate type to trigger the operation. Refer to page 99 for more information on pulse output types and to page 98 for more information on gate types.

Note: In the case of a one-shot operation, the pulse width is set to 100% automatically.

Ensure that the signals are wired appropriately. Figure 37 shows one example of connecting a pulse output operation. This example uses the DT740 screw terminal panel and user counter 0.

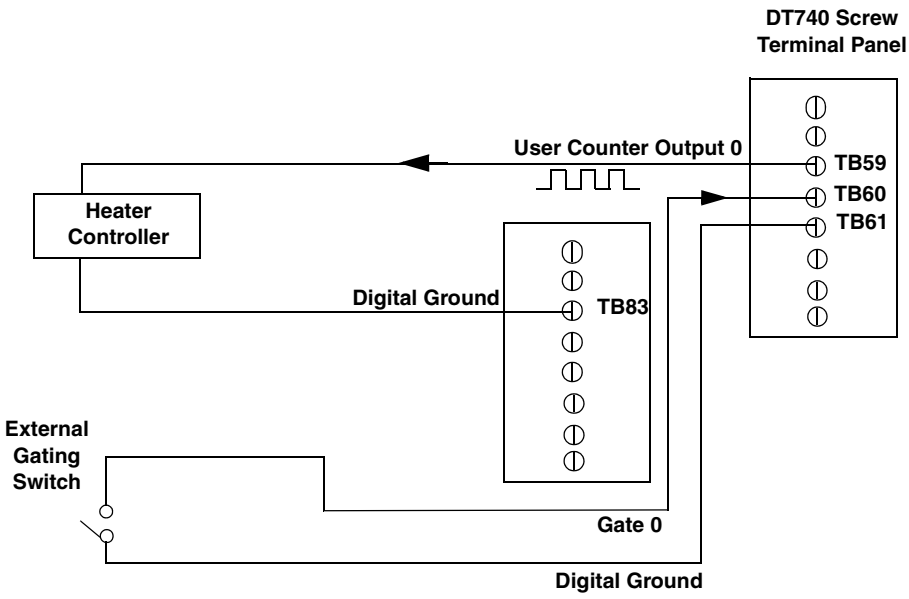


Figure 37: Connecting One-Shot Signals (Shown for Counter Output 0 and Gate 0)

Figure 38 shows an example of a one-shot operation using an external gate input (rising edge), a clock output frequency of 1 kHz (pulse period of 1 ms), and a low-to-high pulse type.

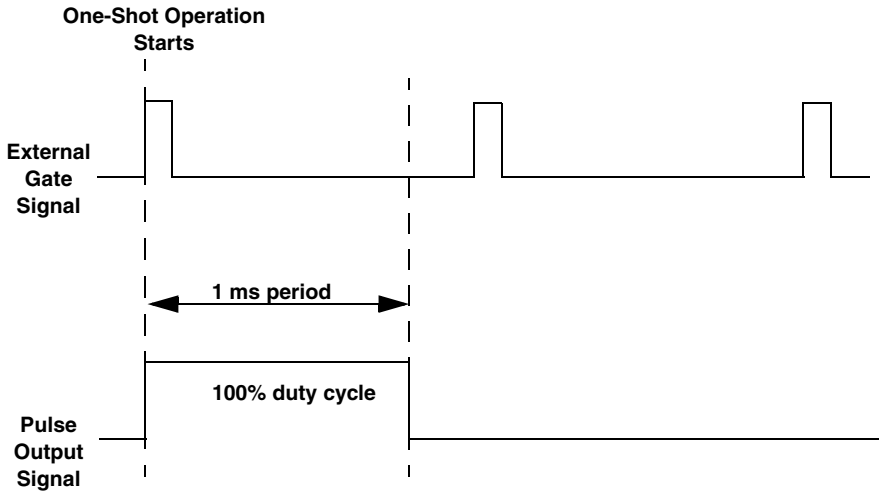


Figure 38: Example of One-Shot Mode

Repetitive One-Shot

Use repetitive one-shot mode to generate a pulse output signal each time the board detects a trigger (determined by the gate input signal). You can use this mode to clean up a poor clock input signal by changing its pulse width, then outputting it.

In repetitive one-shot mode, the internal C/T clock source is more useful than an external C/T clock source; refer to page 96 for more information on the internal C/T clock source.

Use software to specify the counter/timer mode as repetitive one-shot, the polarity of the output pulses (high-to-low transitions or low-to-high transitions), the C/T clock source, and the gate type to trigger the operation. Refer to page 99 for more information on pulse output types and to page 98 for more information on gates.

Note: In the case of a repetitive one-shot operation, the pulse width is set to 100% automatically.

Triggers that occur while the pulse is being output are not detected by the board.

When the one-shot operation is triggered (determined by the gate input signal), a pulse is output. When the board detects the next trigger, another pulse is output. This operation continues until you stop the operation.

Figure 39 shows an example of a repetitive one-shot operation using the DT740 screw terminal panel, an external gate (rising edge), a clock output frequency of 1 kHz (one pulse every 1 ms), and a low-to-high pulse type.

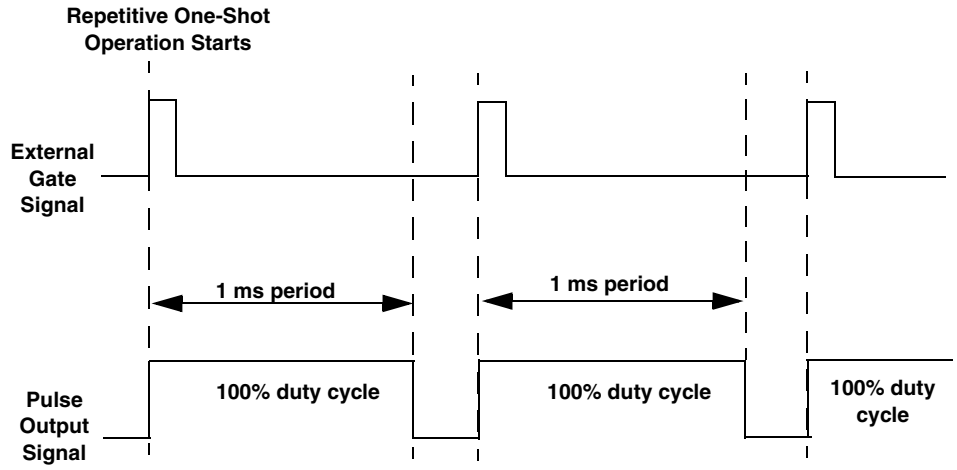


Figure 39: Example of Repetitive One-Shot Mode

Synchronizing A/D and D/A Subsystems

You can synchronize the operation of the A/D and D/A subsystems providing that they are not performing single-value operations. Refer to page 76 and page 90 for more information on single-value operations.

You can synchronize the A/D and D/A subsystems in two ways: by synchronizing the triggers and by synchronizing the clocks. This section describes these two methods.

Synchronizing the Triggers

You can synchronize the triggers of the A/D and D/A subsystems as follows:

- **Software trigger** – Using software, specify the trigger source for the A/D and D/A subsystems as the software trigger. Then, using software, allocate a simultaneous start list, put the A/D and D/A subsystems on the simultaneous start list, prestart the subsystems, and start the subsystems. When started, both subsystems are triggered simultaneously.
- **External digital (TTL) trigger** – Using software, specify the trigger source for the A/D and D/A subsystems as the external digital (TTL) trigger. Then, wire an external digital TTL trigger to both the A/D subsystem and the D/A subsystem. Using software, allocate a simultaneous start list, put the A/D and D/A subsystems on the simultaneous start list, prestart the subsystems, then start the subsystems. When started, both subsystems are triggered simultaneously when the external digital event occurs.
- **External Analog threshold trigger** – This option is supported only when using the DataAcq SDK; it is not supported using the DT-Open Layers for .NET Class Library.

  Using software, specify the trigger source for the A/D and D/A subsystems as the external analog threshold trigger. Then, wire an external analog threshold trigger to the screw terminal panel. Using software, allocate a simultaneous start list, put the A/D and D/A subsystems on the simultaneous start list, prestart the subsystems, then start the subsystems. When started, both subsystems are triggered simultaneously when the external analog event occurs.
- **One of the analog input channels** – Using software, specify the trigger source for the A/D and D/A subsystems as one of the analog input channels. Then, wire an external analog threshold trigger to one of the 32 or 16 analog input channels (depending on the channel type specified). Using software, allocate a simultaneous start list, put the A/D and D/A subsystems on the simultaneous start list, prestart the subsystems, then start the subsystems. When started, both subsystems are triggered simultaneously when the external analog event occurs on the specified analog input channel.

Synchronizing the Clocks

You can synchronize the clocks of the A/D and D/A subsystems as follows:

- **Internal Sample Clocks** – Using software, specify the clock source as the internal A/D sample clock for the A/D subsystem and the internal D/A output clock for the D/A subsystem. Specify the same frequency for both internal clock sources. Then, specify the trigger source for the A/D and D/A subsystems as the software trigger. When started, both subsystems are triggered and clocked simultaneously.
- **External Sample Clocks** – Using software, specify the clock source as the external A/D sample clock for the A/D subsystem and as the external D/A output clock for the D/A subsystem. Then, wire an external sample clock to both the A/D subsystem and the D/A subsystem. Then, specify a synchronous trigger source for the A/D and D/A subsystems (refer to page 108). When started, both subsystems are triggered and clocked simultaneously.

Supported Device Driver Capabilities

The DT3034 Device Driver provides support for the analog input (A/D), analog output (D/A), digital input (DIN), digital output (DOUT), and counter/timer (C/T) subsystems. For information on how to configure the device driver, refer to page 30.

Table 8: DT3034 Subsystems

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Total Subsystems on Board	1	2[a]	2[b]	2[b]	4	0

a. The second D/A subsystem has limited capabilities and is used for threshold triggering only. It has an output range of ±10 V.
b. DIN and DOUT subsystems use the same DIO lines.

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the DT3034 boards. The DT-Open Layers for .NET Class Library provides properties that return support information for specified subsystem capabilities.

The first row in each table lists the subsystem types. The first column in each table lists all possible subsystem capabilities. A description of each capability is followed by the property used to describe that capability in the DT-Open Layers for .NET Class Library.

Note: Blank fields represent unsupported options.

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

Data Flow and Operation Options

Table 9: DT3034 Data Flow and Operation Options

DT3034	A/D	D/A	DIN	DOUT	C/T	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	
Continuous Operation until Trigger **SupportsContinuousPreTrigger**	Yes					
Continuous Operation before & after Trigger **SupportsContinuousPrePostTrigger**	Yes					
Waveform Operations Using FIFO Only **SupportsWaveformModeOnly**						
Simultaneous Start List Support **SupportsSimultaneousStart**	Yes	Yes				
Supports Programmable Synchronization Modes **SupportsSynchronization**						
Synchronization Modes **SynchronizationMode**						
Interrupt Support **SupportsInterruptOnChange**						
Output FIFO Size **FifoSize**		4K				
Auto-Calibrate Support **SupportsAutoCalibrate**						

a. All 16 bits of the DIO lines are assigned to A/D input channel 32. While the DIN subsystem itself is incapable of continuous operation, continuous DIN operation can be performed by specifying channel 32 in the channel-gain list of the A/D subsystem and starting the A/D subsystem.

Buffering

Table 10: DT3034 Buffering Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Buffer Support **SupportsBuffering**	Yes	Yes				
Single Buffer Wrap Mode Support **SupportsWrapSingle**		Yes				
Inprocess Buffer Flush Support **SupportsInProcessFlush**	Yes[a]					

a. The data from the DT3034 board is transferred to the host in 64 byte segments; therefore, the number of valid samples that can be moved is always a multiple of 64. If the application moves data from the buffer before the module has transferred 64 samples to the host, the resulting buffer will contain 0 samples. Your application program must deal with these situations when flushing an inprocess buffer.

Triggered Scan Mode

Table 11: DT3034 Triggered Scan Mode Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Triggered Scan Support **SupportsTriggeredScan**	Yes					
Maximum Number of CGL Scans per Trigger **MaxMultiScanCount**	256[a]	0	0	0	0	0
Maximum Retrigger Frequency **MaxRetriggerFreq**	250 kHz[b]	0	0	0	0	0
Minimum Retrigger Frequency **MinRetriggerFreq**	1.2 Hz[c]	0	0	0	0	0

a. The channel list depth of 1024 entries in conjunction with a multiscan count of 256 provides an effective channel list depth of up to 256K entries.

b. The maximum retrigger frequency is based on the number of samples per trigger as follows:

$$\text{Min. Retrigger Period} = \frac{\text{\# of CGL entries} \times \text{\# of CGLs per trigger}}{\text{A/D sample clock frequency}} + 2\ \mu s$$

$$\text{Max. Retrigger Frequency} = \frac{1}{\text{Min. Retrigger Period}}$$

c. The value of 1.2 Hz assumes the minimum number of samples is 1.

Data Encoding

Table 12: DT3034 Data Encoding Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Binary Encoding Support **SupportsBinaryEncoding**	Yes	Yes	Yes	Yes	Yes	
Twos Complement Support **SupportsTwosCompEncoding**						
Returns Floating-Point Values **ReturnsFloats**						

Channels

Table 13: DT3034 Channel Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Channels **NumberOfChannels**	33[a]	2	1	1	0	0
SE Support **SupportsSingleEnded**	Yes					
SE Channels **MaxSingleEndedChannels**	32	0	0	0	0	0
DI Support **SupportsDifferential**	Yes	Yes	Yes	Yes		
DI Channels **MaxDifferentialChannels**	16	2	1	1	0	0
Maximum Channel-Gain List Depth **CGLDepth**	1024	2	1[b]	1[a]	0	0
Simultaneous Sample-and-Hold Support **SupportsSimultaneousSampleHold**						
Channel-List Inhibit **SupportsChannelListInhibit**	Yes					

a. Channels 0 to 31 are provided for analog input; channel 32 reads all 16 bits from the DIN subsystem.

b. All 16 bits of the DIO lines are assigned to A/D input channel 32. While the DIN subsystem itself is incapable of continuous operation, continuous DIN operation can be performed by specifying channel 32 in the channel list of the A/D subsystem and starting the A/D subsystem.

Gain

Table 14: DT3034 Gain Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Programmable Gain Support **SupportsProgrammableGain**	Yes					
Number of Gains **NumberOfSupportedGains**	4	1	1	1	0	0
Gains Available SupportedGains	1, 2, 4, 8	1	1	1		

Ranges

Table 15: DT3034 Range Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Voltage Ranges **NumberOfRanges**	2	1	0	0	0	0
Available Ranges **SupportedVoltageRanges**	±10 V, 0 to 10 V	±10 V				
Current Output Support **SupportsCurrentOutput**						

Resolution

Table 16: DT3034 Resolution Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Programmable Resolution **SupportsSoftwareResolution**			Yes	Yes		
Number of Resolutions **NumberOfResolutions**	1	1	2[a]	2[a]	1	0
Available Resolutions **SupportedResolutions**	16	16	8, 16[a]	8, 16[a]	16[b]	

a. When configured for 16 bits of resolution, element 0 uses DIO bits 15 to 0 (Banks A and B). When configured for 8 bits of resolution, element 0 uses bits 7 to 0 (Bank A), and element 1 uses bits 15 to 8 (Bank B).

b. You can also internally route the clock output signal from one user counter to the clock input signal of the next user counter to internally cascade the counters. In this way, you can create a 32-bit counter without externally connecting two counters together.

Thermocouple and RTD Support

Table 17: DT3034 Thermocouple and RTD Support Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Thermocouple Support **SupportsThernocouple**						
RTD Support **SupportsRTD**						
Resistance Support **ReturnsOhms**						
Voltage Converted to Temperature in Hardware **SupportsTemperatureDataInStream**						
Supported Thermocouple Types **ThermocoupleType**						
Supported RTD Types **RTDType**						
Supports CJC Source Internally in Hardware **SupportsCjcSourceInternal**						
Supports CJC Channel **SupportsCjcSourceChannel**						
Available CJC Channels **CjcChannel**						
Supports Interleaved CJC Values in Data Stream **SupportsInterleavedCjcTemperaturesInStream**						
Supports Programmable Filters **SupportsTemperatureFilters**						
Programmable Filter Types **TemperatureFilterType**						

IEPE Support

Table 18: DT3034 IEPE Support Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Programmable AC Coupling **SupportsACCoupling**						
Software Programmable DC Coupling **SupportsDCCoupling**						
Software Programmable External Excitation Current Source **SupportsExternalExcitationCurrentSrc**						
Software Programmable Internal Excitation Current Source **SupportsInternalExcitationCurrentSrc**						
Available Excitation Current Source Values **SupportedExcitationCurrentValues**						

Triggers

Table 19: DT3034 Trigger Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Trigger Support **SupportsSoftwareTrigger**	Yes	Yes			Yes	
External Positive TTL Trigger Support **SupportsPosExternalTTLTrigger**	Yes	Yes			Yes	
External Negative TTL Trigger Support **SupportsNegExternalTTLTrigger**	Yes[a]	Yes[a]				
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[b]	Yes[b]				
Negative Threshold Trigger Support **SupportsNegThresholdTrigger**	Yes[b]	Yes[b]				
Digital Event Trigger Support **SupportsDigitalEventTrigger**						

a. For SDK users, specify OL_TRG_EXTRA for the **olDaSetTrigger** function.

b. Threshold triggers are supported for post-trigger acquisition only.
If you are using an analog threshold trigger for both A/D and D/A subsystems, both triggers must by of the same type (that is, either both must be from an analog input channel or external analog threshold). However, the polarities of the two triggers can be different. Refer to page 79 for more information.

Clocks

Table 20: DT3034 Clock Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Internal Clock Support **SupportsInternalClock**	Yes	Yes			Yes	
External Clock Support **SupportsExternalClock**	Yes	Yes			Yes	
Simultaneous Input/Output on a Single Clock Signal **SupportsSimultaneousClocking**						
Base Clock Frequency **BaseClockFrequency**	20 MHz	20 MHz	0	0	20 MHz	0
Maximum Clock Divider **MaxExtClockDivider**	1.0	1.0	1.0	1.0	65536	0
Minimum Clock Divider **MinExtClockDivider**	1.0	1.0	1.0	1.0	2.0	0
Maximum Frequency **MaxFrequency**	500 kHz	500 kHz[a]	0	0	10 MHz[b]	0
Minimum Frequency **MinFrequency**	1.2 Hz	1.2 Hz	0	0	0.005 Hz[c]	0

a. Three conditions are possible:
- 200 kHz per DAC with full-scale steps in continuously-paced or waveform generation mode.
- 500 kHz per DAC with 100 mV steps in waveform generation mode.
- 500 kHz per DAC with 100 mV steps in continuously-paced mode (system-dependent).

b. If using cascaded timers, this value is 5 MHz.

c. Any two adjacent counter/timers, such as (1,2) or (2,3) or (3,4), can be cascaded in software. If not using cascaded timers, this value is approximately 305.18 Hz.

Counter/Timers

Table 21: DT3034 Counter/Timer Options

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Cascading Support **SupportsCascading**					Yes	
Event Count Mode Support **SupportsCount**					Yes	
Generate Rate Mode Support **SupportsRateGenerate**					Yes	
One-Shot Mode Support **SupportsOneShot**					Yes	
Repetitive One-Shot Mode Support **SupportsOneShotRepeat**					Yes	
Up/Down Counting Mode Support **SupportsUpDown**						
Edge-to-Edge Measurement Mode Support **SupportsMeasure**						
Continuous Edge-to-Edge Measurement Mode Support **SupportsContinuousMeasure**						
High to Low Output Pulse Support **SupportsHighToLowPulse**					Yes	
Low to High Output Pulse Support **SupportsLowToHighPulse**					Yes	
Variable Pulse Width Support **SupportsVariablePulseWidth**					Yes[a]	
None (internal) Gate Type Support **SupportsGateNone**					Yes	
High Level Gate Type Support **SupportsGateHighLevel**					Yes[b]	
Low Level Gate Type Support **SupportsGateLowLevel**					Yes[b]	
High Edge Gate Type Support **SupportsGateHighEdge**					Yes[b]	
Low Edge Gate Type Support **SupportsGateLowEdge**					Yes[b]	
Level Change Gate Type Support **SupportsGateLevel**						
Clock-Falling Edge Type **SupportsClockFalling**						
Clock-Rising Edge Type **SupportsClockRising**						
Gate-Falling Edge Type **SupportsGateFalling**						

Table 21: DT3034 Counter/Timer Options (cont.)

DT3034	A/D	D/A	DIN	DOUT	C/T	QUAD
Gate-Rising Edge Type **SupportsGateRising**						
Interrupt-Driven Operations **SupportsInterrupt**						

a. For one-shot and repetitive one-shot operations, the pulse width is set automatically to 100%.
b. 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 and rate generation modes.

Calibration

The DT3034 boards are calibrated at the factory and should not require calibration for initial use. We recommend that you check and, if necessary, readjust the calibration of the analog input and analog output circuitry on the DT3034 boards every six months.

The DT3034 Calibration Utility is provided for calibrating DT3034 boards.

Note: Ensure that you installed the DT3034 Device Driver prior to using the DT3034 Calibration Utility. Refer to page 30 for more information on loading he device driver.

This chapter describes how to calibrate the analog input and output subsystems of DT3034 boards using the DT3034 Calibration Utility.

Calibrating the Analog Input Subsystem

This section describes how to configure the DT740 screw terminal panel for an internal or external reference, and how to use the DT3034 Calibration Utility to calibrate the analog input subsystem of the board.

Choosing a Calibration Reference

To calibrate the analog input circuitry, you can use either of the following references:

- The internal +5 V reference on the DT3034 board.

  Using the +5 V reference on the board allows you to calibrate the analog input circuitry quickly without using external equipment; the accuracy of the calibration is approximately 0.05%.

- An external +9.3750 V reference (precision voltage source).

  Using an external +9.3750 V reference provides an accuracy of approximately ±1 LSB.

This section describes how to configure for an internal or external reference.

Configuring for the Internal Reference

To calibrate the analog input circuitry using the internal +5 V reference, do the following:

1. Connect Analog In 0 to +5 V Reference Out.

Signal	DT740 Screw Terminal
Analog Input 0	TB1
+5 V Reference	TB49

2. Connect Analog In 0 Return to Analog Ground.

Signal	DT740 Screw Terminal
Analog Input 0 Return	TB2
Analog Ground	TB34

3. Connect Analog In 1 to Analog In 1 Return and Analog Ground.

Signal	DT740 Screw Terminal
Analog Input 1	TB2
Analog Input 1 Return	TB4
Analog Ground	TB34

Follow the instructions on page 127.

Configuring for an External Reference

To calibrate the analog input circuitry using an external +9.3750 V reference, do the following:

1. Connect Analog In 0 to the positive side of the precision voltage source.

Signal	DT740 Screw Terminal
Analog Input 0	TB1

2. Connect Analog In 0 Return to the negative side of the precision voltage source.

Signal	DT740 Screw Terminal
Analog Input 0 Return	TB2

3. Connect Analog In 0 Return to Analog Ground.

Signal	DT740 Screw Terminal
Analog Input 0 Return	TB2
Analog Ground	TB34

4. Connect Analog In 1 and Analog In 1 Return to Analog Ground.

Signal	DT740 Screw Terminal
Analog Input 1	TB3
Analog Input 1 Return	TB4
Analog Ground	TB34

5. Follow the instructions on page 127.

Note: If you have a version of the board without the -PBF (lead-free) designator, this potentiometer is labelled R4.

6. Click **Quit** when you are finished.

Once you have finished this procedure, continue with "Calibrating the Analog Output Subsystem" on page 130.

Using the DT3034 Calibration Utility

Note: After switching the power on, allow 15 minutes for the board to warm up before calibrating the analog I/O subsystems.

To start the DT3034 Calibration Utility, do the following:

1. Click **Start** from the Task Bar.
2. Browse to **Programs | Data Translation, Inc | Calibration | DT3034 Calibration Utility**. *The main menu appears.*

Once the DT3034 Calibration Utility is running and you have connected the required calibration signals to the DT740 screw terminal panel, you can calibrate the analog input circuitry of the DT3034 board either automatically or manually; auto-calibration is the easiest to use and is the recommended calibration method.

This section describes these calibration methods.

Using the Auto-Calibration Procedure

Auto-calibration is the easiest to use and is the recommended calibration method.

Note: If you want to manually calibrate the bipolar and unipolar ranges instead of auto-calibrating them, refer to "Using the Manual Calibration Procedure" on page 128.

To calibrate the analog input subsystem, do the following:

1. From the main menu of the DT3034 Calibration Utility, click **Configure**, and then **Board**.
2. Select the name of the DT3034 board to configure from the combo box, and then click **OK**.
3. From the main menu of the DT3034 Calibration Utility, click **Calibrate**, and then **A/D**.

4. In the Reference Source box, select the reference that you are using (**Internal** or **External**; Internal is the default).
5. In the Auto Calibration box, click **Go**.
   The bipolar (zero and full-scale) and unipolar (zero and full-scale) ranges are automatically calibrated, and the calibration values are displayed. The bipolar readings should be within 0.001 V; the unipolar readings should be within 0.0005 V.
6. Click **OK**.
7. In the Range box, select **PGH Zero**.
8. If the displayed value is not 0.0000 V (within 0.001 V), continue with "Calibrating the PGH Zero Setting" on page 129; otherwise, click **Quit** when you are finished calibrating the analog input circuitry.

Once you have finished this procedure, continue with "Calibrating the Analog Output Subsystem" on page 130.

Note: If you are not satisfied with the analog input calibration, you can load the factory default settings stored in the EEPROM by clicking **Restore** in the Factory Settings box.

Using the Manual Calibration Procedure

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

1. From the main menu of the DT3034 Calibration Utility, click **Configure**, and then **Board**.
2. Select the name of the DT3034 board to configure from the combo box, and then click **OK**.
3. From the main menu of the DT3034 Calibration Utility, click **Calibrate.**
4. Click **A/D**.
5. In the Reference Source box, select the reference that you are using (**Internal** or **External**; Internal is the default).
6. In the Range box, select **Bipolar**, and then **Zero**.
7. Click the increment or decrement arrows in the Manual Adjustment box until the display reads 0.0000 V (within 0.001 V).
8. In the Range box, select **Bipolar**, and then **+FS** (for full-scale).
9. Click the increment or decrement arrows in the Manual Adjustment box until the display reads 5 V with the internal reference or +9.3750 V with the external reference (within 0.001 V).
10. In the Range box, select **Unipolar**, and then **+FS** (for full-scale).
11. Click the increment or decrement arrows in the Manual Adjustment box until the display reads 5 V with the internal reference or +9.3750 V with the external reference (within 0.0005 V).
12. In the Range box, select **Unipolar**, and then **Zero**.

13. Click the increment or decrement arrows in the Manual Adjustment box until the display reads just above 0 V, then use the decrement arrow until the first value of 0 V is displayed (within 0.0005 V).
14. In the Range box, select **PGH Zero**.
15. If the displayed value is not 0.0000 V (within 0.001 V), perform the procedure in the next section; otherwise, click **Quit** when you are finished calibrating the analog input circuitry.

Once you have finished this procedure, continue with "Calibrating the Analog Output Subsystem" on page 130.

Note: If you are not satisfied with the analog input calibration, you can load the factory default settings stored in the EEPROM by clicking **Restore** in the Factory Settings box.

Calibrating the PGH Zero Setting

PGH Zero is a factory-calibrated setting and, generally, should not need adjustment. However, if you select **PGH Zero** in the Range box and a value other than 0.0000 V is displayed, do the following to calibrate this setting:

1. In the Range box, select **PGH Zero**.
2. Physically adjust potentiometer R2 (labelled PGZ) on the DT3034 board until the display reads 0.0000 V (0.001 V). Figure 40 shows the location of this potentiometer.

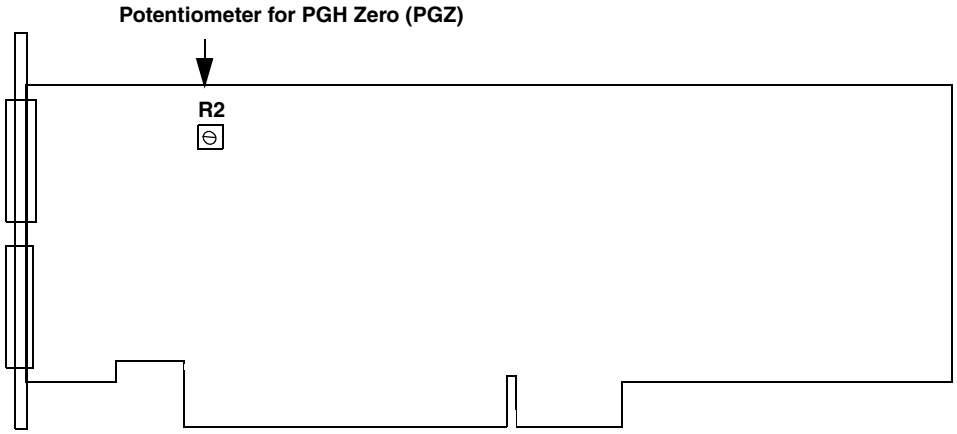


Figure 40: Location of Potentiometer R2 on the DT3034 Board

3. Click **Quit** when you are finished.

Once you have finished this procedure, continue with the next section.

Calibrating the Analog Output Subsystem

This section describes how to configure the DT740 screw terminal panel for an internal or external meter, and how to use the DT3034 Calibration Utility to calibrate the analog output subsystems of the board.

Choosing a Calibration Meter

To calibrate the analog output circuitry, you can use either of the following meters:

- The internal A/D converter (ADC) on the DT3034 board.

  Using the board's ADC as an input to the analog output circuitry allows you to calibrate the analog output circuitry quickly without using external equipment.

- An external precision meter.

The following sections describe how to configure for calibration using either of the supported meters.

Configuring for the Internal ADC

To calibrate DAC0 using the internal ADC, do the following:

1. Connect Analog Out 0+ (TB41) to Analog In 2 (TB5).

Signal	DT740 Screw Terminal
Analog Output 0+	TB41
Analog Input 2	TB5

2. Connect Analog Out Return to Analog In 2 Return.

Signal	DT740 Screw Terminal
Analog Output Return	TB42
Analog Input 2 Return	TB6

To calibrate DAC1 using the internal ADC, do the following:

1. Connect Analog Out 1+ to Analog In 3.

Signal	DT740 Screw Terminal
Analog Output 1+	TB43
Analog Input 3	TB7

2. Connect Analog Out Return to Analog In 3 Return.

Signal	DT740 Screw Terminal
Analog Output 1+ Return	TB44
Analog Input 3 Return	TB8

Follow the instructions on page 132.

Configuring for an External Meter

To calibrate DAC0 using an external voltage meter, do the following:

1. Connect Analog Out 0+ to the positive side of the precision voltage meter.

Signal	DT740 Screw Terminal
Analog Output 0+	TB41

2. Connect Analog Out 0 Return to the negative side of the precision voltage meter.

Signal	DT740 Screw Terminal
Analog Output 0 Return	TB42

To calibrate DAC1 using an external voltage meter, do the following:

1. Connect Analog Out 1+ to the positive side of the precision voltage meter.

Signal	DT740 Screw Terminal
Analog Output 1+	TB43

2. Connect Analog Out 1 Return (TB44) to the negative side of the precision voltage meter.

Signal	DT740 Screw Terminal
Analog Output 1+ Return	TB44

Using the DT3034 Calibration Utility

Once the DT3034 Calibration Utility is running and you have connected the required calibration signals to the DT740 screw terminal panel, do the following to calibrate the analog output subsystem on the DT3034 board:

1. From the main menu of the DT3034 Calibration Utility, click **Configure**, and then **Board**.
2. Select the name of the DT3034 board to configure from the combo box, and then click **OK**.
3. From the main menu of the DT3034 Calibration Utility, click **Calibrate**, and then **D/A**.
4. In the Meter Selection box, select the meter that you are using (**Internal** or **External**; Internal is the default).
5. In the Mode box, select **Calibrate**.
6. In the D/A box, select **DAC 0**.
7. In the Voltages box, select **–9.3750**.
8. Physically adjust potentiometer R15 (labelled 0Z) on the DT3034 board until the display reads –9.3750 V (within 0.001 V). Figure 41 shows the location of this potentiometer.

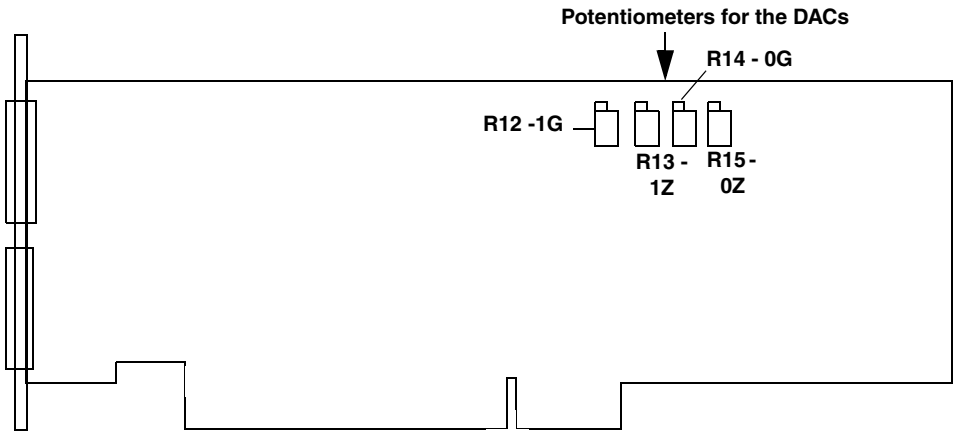


Figure 41: Location of Potentiometers R12 to R15 on the DT3034 Board

9. In the Voltages box, select **+9.3750**.
10. Physically adjust potentiometer R14 (labelled 0G) on the DT3034 board until the display reads +9.3750 V (within 0.001 V). Figure 41 shows the location of this potentiometer.
11. In the D/A box, select **DAC 1**.
12. In the Voltages box, select **–9.3750**.
13. Physically adjust potentiometer R13 (labelled 1Z) on the DT3034 board until the display reads –9.3750 V (within 0.001 V). Figure 41 shows the location of this potentiometer.
14. In the Voltages box, select **+9.3750**.
15. Physically adjust potentiometer R12 (labelled 1G) on the DT3034 board until the display reads +9.3750 V (within 0.001 V). Figure 41 shows the location of this potentiometer.

Note: If you want to check the values for intermediate ranges, select **Display Values** in the Mode box and select any of the available ranges; the range is then displayed. *You cannot calibrate intermediate ranges*.

16. Click **Quit** when you are finished calibrating the analog output circuitry.

Once you have finished this procedure, the analog output circuitry is calibrated. To close the DT3034 Calibration Utility, click the close box in the upper, right corner of the window.

Troubleshooting

General Checklist

Should you experience problems using the DT3034 board, follow these steps:

1. Read all the documentation provided for your product. Make sure that you have added any "Read This First" information to your manual and that you have used this information.
2. Check the OMNI CD for any README files and ensure that you have used the latest installation and configuration information available.
3. Check that your system meets the requirements stated in the README file on the OMNI CD.
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 properly using the instructions in Chapter 2.
6. Search the DT Knowledgebase in the Support section of the Data Translation web site (at www.mccdaq.com) for an answer to your problem.

If you still experience problems, try using the information in Table 22 to isolate and solve the problem. If you cannot identify the problem, refer to page 138.

Table 22: Troubleshooting Problems

Symptom	Possible Cause	Possible Solution
Board does not respond.	The board configuration is incorrect.	Check the configuration of your device driver to ensure that the board name and type are correct.
	The board is incorrectly aligned in a PCI expansion slot.	Check that the slot in which your DT3034 board is located is a PCI slot and that the board is correctly seated in the slot.
	The board is damaged.	Contact Data Translation for technical support; refer to page 138.
Intermittent operation.	Loose connections or vibrations exist.	Check your wiring and tighten any loose connections or cushion vibration sources.
	The board is overheating.	Check environmental and ambient temperature; consult the board's specifications on page 149 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.
Data appears to be invalid.	An open connection exists.	Check your wiring and fix any open connections.
	A transducer is not connected to the channel being read.	Check the transducer connections.
	The board 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.

Table 22: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Computer does not boot.	Board is not seated properly.	Check that the slot in which your DT3034 board is located is a PCI slot, that the board is correctly seated in the slot, and that the board is secured in the slot with a screw.
	The power supply of the computer is too small to handle all the system resources.	Check the power requirements of your system resources and, if needed, get a larger power supply; consult the board's specifications on page 149 of this manual.
System lockup.	Board is not seated properly.	Check that the slot in which your DT3034 board is located is a PCI slot, that the board is correctly seated in the slot, and that the board is secured in the slot with a screw.

Technical Support

If you have difficulty using a DT3034 board, Data Translation's Technical Support Department is available to provide technical assistance.

To request technical support, go to our web site at http://www.mccdaq.com and click on the Support link.

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

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

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

If Your Board Needs Factory Service

Most hardware models can be functionally tested, evaluated for repairs (if needed), and calibrated to factory specifications. An RMA # must be obtained from Application Engineering in advance of sending any product back to Measurement Computing. Customers outside the USA must contact their local distributor for a return procedure. Calibration certificates for most analog models can be obtained for a fee (certificate must be requested at time of RMA # assignment).

Specifications

Analog Input Specifications

Table 23 lists the specifications for the A/D subsystem on the DT3034 board.

Table 23: A/D Subsystem Specifications

Feature	DT3034 Specifications
Number of analog input channels Single-ended/ pseudo-differential: Differential:	 32 16
Number of gains	4 (1, 2, 4, 8)
Resolution	16 bits
Data encoding Bipolar: Unipolar:	 Offset binary Binary
System accuracy (full-scale) Gain = 1: Gain = 2: Gain = 4: Gain = 8:	 0.01% 0.02% 0.02% 0.03%
Nonlinearity (integral)	±2.0 LSB
Differential linearity	±0.75 LSB (no missing codes)
Range Bipolar: Unipolar:	 ±10 V 0 to 10 V
Drift Zero: Gain:	 ±20 μV + (+10 μV * Gain)/°C ±25 ppm/°C
Input impedance[a] Off: On (Differential): On (Single-ended):	 100 MΩ, 10 pF 100 MΩ, 100 pF 100 MΩ, 200 pF
Input bias current	±20 nA
Common mode voltage	±11 V maximum (operational)
Maximum input voltage	±20 V maximum (protection)
A/D converter noise	0.5 LSB rms
Amplifier input noise	15.0 μV rms + (20 μV rms * gain) 20.0 pA rms (current)
Channel-to-channel offset	±30.0 μV
Channel acquisition time, typical	1 μs to 0.01%
A/D conversion time	2.0 μs

Table 23: A/D Subsystem Specifications (cont.)

Feature	DT3034 Specifications
Effective number of bits @ 1 kHz sine wave, 2 channels: 10 kHz sine wave, 2 channels: sine wave, 2 channels:	 14.4 bits typical (at 150 kS/s aggregate rate) 14.2 bits typical (at 150 kS/s aggregate rate) 13.5 bits typical (at 150 kS/s aggregate rate with sine wave of 20 kHz)
Total Harmonic Distortion @ 1 kHz input	–82 dB typical (at 250 kS/s rate)
Channel crosstalk	–80 dB @ 1 kHz
Data throughput Single channel: Multiple channel (scan):	 500 kSamples/s, 0.01% accuracy 450 kSamples/s, 0.01% accuracy
External A/D sample clock Input type: Input load: High-level input voltage: Low-level input voltage: Hysteresis: High-level input current: Low-level input current: Minimum pulse width: Maximum frequency: Termination:	 Schmitt trigger, falling-edge sensitive 1 HCT14 (TTL) 2.0 V minimum 0.8 V maximum 0.4 V (minimum); 1.5 V (maximum) 1.0 μA –1.0 μA 100 ns (high); 150 ns (low) 500 kHz 33 Ω series resistor
External A/D digital (TTL) trigger Input type: Input load: High-level input voltage: Low-level input voltage: Hysteresis: High-level input current: Low-level input current: Minimum pulse width: Termination:	 Schmitt trigger, rising- and falling-edge sensitive 1 HCT14 (TTL) 2.0 V minimum 0.8 V maximum 0.4 V (minimum); 1.5 V (maximum) 1.0 μA –1.0 μA 100 ns (high); 100 ns (low) 33 Ω series resistor
External analog trigger Input type: Threshold voltage: Threshold range: Threshold resolution: Hysteresis: Input impedance: Maximum input voltage: Minimum pulse width:	 Threshold sensitive Programmable –10 V to +10 V (includes TTL) 8 bits/78 mV per LSB 50 mV typical 12 kΩ/20 pF typical ±20 V 100 ns (high); 100 ns (low)

Table 23: A/D Subsystem Specifications (cont.)

Feature	DT3034 Specifications
A/D sample clock output signal	
Output driver:	TTL
Output driver high voltage:	2.0 V minimum (IOH = –15 mA); 2.4 V minimum (IOH = –3 mA)
Output driver low voltage:	0.5 V maximum (IOL = 24 mA); 0.4 V maximum (IOL = 12 mA)
Termination:	33 Ω series resistor
A/D trigger output signal	
Output driver:	TTL
Output driver high voltage:	2.0 V minimum (IOH = –15 mA); 2.4 V minimum (IOH = –3 mA)
Output driver low voltage:	0.5 V maximum (IOL = 24 mA); 0.4 V maximum (IOL = 12 mA)
Termination:	33 Ω series resistor
Dynamic Digital Output Channels	
Number of channels:	2
Output driver:	TTL
Output driver high voltage:	2.0 V minimum (IOH = –15 mA); 2.4 V minimum (IOH = –3 mA)
Output driver low voltage:	0.5 V maximum (IOL = 24 mA); 0.4 V maximum (IOL = 12 mA)
Termination:	33 Ω series resistor

a. The input capacitance is isolated with a 330 Ω resistor to prevent typical amplifiers from oscillating with capacitive loading.

Analog Output Specifications

Table 24 lists the specifications for the D/A subsystem on the DT3034 board.

Table 24: D/A Subsystem Specifications

Feature	DT3034 Specifications
Number of analog output channels	2 (voltage output)
Resolution	16 bits
Data encoding (input)	Offset binary
Nonlinearity (integral)	±4.0 LSB
Differential linearity	±0.75 LSB (monotonic to 15 bits)
Output range	±10 V (bipolar)
Error Zero: Gain:	 Adjustable to 0 Adjustable to 0
Throughput Full scale: 100 mV Step, continuously paced: 100 mV Step, waveform mode:	 200 kSamples/s maximum per channel 500 kSamples/s maximum per channel 500 kSamples/s maximum per channel
Current output	±5 mA maximum load
Output impedance	0.1 Ω maximum
Capacitive drive capability	0.004 μF (no oscillators)
Protection	Short circuit to Analog Common
Power-on voltage	0 V ±10 mV maximum
Settling time to 0.01% of FSR	10 μs, 20 V step; 5.0 μs, 100 mV step
Slew rate	5 V/ μs
External D/A sample clock Input type: Input load: High-level input voltage: Low-level input voltage: Hysteresis: High-level input current: Low-level input current: Minimum pulse width: Maximum frequency: Termination:	 Schmitt trigger, falling-edge sensitive 1 HCT14 (TTL) 2.0 V minimum 0.8 V maximum 0.4 V (minimum); 1.5 V (maximum) 1.0 μA –1.0 μA 200 ns (high); 150 ns (low) 500 kHz 33 Ω series resistor

Table 24: D/A Subsystem Specifications (cont.)

Feature	DT3034 Specifications
External D/A digital (TTL) trigger	
Input type:	Schmitt trigger, edge sensitive
Input load:	1 HCT14 (TTL)
High-level input voltage:	2.0 V minimum
Low-level input voltage:	0.8 V maximum
Hysteresis:	0.4 V (minimum); 1.5 V (maximum)
High-level input current:	1.0 μA
Low-level input current:	–1.0 μA
Minimum pulse width:	100 ns (high); 100 ns (low)
Termination:	33 Ω series resistor

Digital I/O Specifications

Table 25 lists the specifications for the DIN/DOUT subsystems on the DT3034 boards.

Table 25: DIN/DOUT Subsystem Specifications

Feature	Specifications
Number of lines	16 (bidirectional)
Number of ports	2 (8 bits each)
Termination	47 kΩ resistor pullup to +3.3 V; 33 Ω series resistor
Inputs Input type: Input load: High-level input voltage: Low-level input voltage: High-level input current: Low-level input current:	 Level sensitive 1 TTL, 1 TTL 2.0 V minimum 0.8 V maximum 20 μA –0.2 mA
Outputs Output driver: Output driver high voltage: Output driver low voltage:	 TTL 2.0 V minimum (IOH = –15 mA); 2.4 V minimum (IOH = –3 mA) 0.5 V maximum (IOL = 24 mA); 0.4 V maximum (IOL = 12 mA)

Counter/Timer Specifications

Table 26 lists the specifications for the C/T subsystems on the DT3034 boards.

Table 26: C/T Subsystem Specifications

Feature	Specifications
Number of counter/timers	4
Clock Inputs Input type: Input load: High-level input voltage: Low-level input voltage: Hysteresis: High-level input current: Low-level input current: Minimum pulse width: Maximum frequency: Termination:	 Schmitt trigger, rising-edge sensitive 1 HCT14 (TTL) 2.0 V minimum 0.8 V maximum 0.4 V (minimum); 1.5 V (maximum) 1.0 μA –1.0 μA 100 ns (high); 100 ns (low) 5.0 MHz 33 Ω series resistor
Gate Inputs Input type: Input load: High-level input voltage: Low-level input voltage: Hysteresis: High-level input current: Low-level input current: Minimum pulse width: Maximum frequency: Termination:	 Schmitt trigger, level sensitive 1 HCT14 (TTL) 2.0 V minimum 0.8 V maximum 0.4 V (minimum); 1.5 V (maximum) 1.0 μA –1.0 μA 100 ns (high); 100 ns (low) 5.0 MHz 33 Ω series resistor
Counter Outputs Output driver: Output driver high voltage: Output driver low voltage: Termination:	 TTL 2.0 V minimum (IOH = –15 mA); 2.4 V minimum (IOH = –3 mA) 0.5 V maximum (IOL = 24 mA); 0.4 V maximum (IOL = 12 mA) 33 Ω series resistor

Power, Physical, and Environmental Specifications

Table 27 lists the power, physical, and environmental specifications for the DT3034 boards.

Table 27: Power, Physical, and Environmental Specifications

Feature	Specifications
Power +5 V (±0.25 V) – 5 V +12 V –12 V ±15 V Output (J1, pins 6 and 7)	 1.5 A nominal not used 0.12 A nominal 0.1 A nominal ±10 mA nominal
Physical Dimensions: Weight:	 8.5 inches (length) by 4.2 inches (width) 5.95 ounces (170 grams)
Environmental Operating temperature range: Storage temperature range: Relative humidity:	 0°C to 70°C –25°C to 85°C To 95%, noncondensing

Connector Specifications

Table 28 lists the connector specifications for the DT3034 boards and corresponding cables.

Table 28: Connector Specifications for the DT3034 Board

Feature	Specifications
50-Pin Connector Plug for cable: Cable shell kit: Cable wire: Receptacle for board: Latching posts:	 AMP/Tyco 5787131-1 AMP/Tyco 787133-1 AMP/Tyco 57506-1 AMP/Tyco 6658751-1 AMP/Tyco 787003-3 (bag of 200)
68-Pin Connector Plug for cable: Cable shell kit: Cable wire: Receptacle for board: Latching posts:	 AMP/Tyco 5787131-3 AMP/Tyco 787229-1 AMP/Tyco 57508-1 Molex 71430-0101 AMP/Tyco 787003-3 (bag of 200)
EP307	Amp/Tyco 1-636326-1
EP308	Amp/Tyco 1-636327-1

Regulatory Specifications

Table 29 lists the regulatory specifications for the DT3034 boards.

Table 29: Regulatory Specifications

Feature	Specifications
Emissions (EMI)	FCC Part 15, EN55022:1994 + A1:1995 + A2:1997 VCCI, AS/NZS 3548 Class A
Immunity	EN61000-6-1:2001
RoHS (EU Directive 2002/95/EG)	Compliant (as of July 1st, 2006)

Connector Pin Assignments

Connector J1 on the DT3034 Board

Table 30 lists the pin assignments of connector J1 on the DT3034 board.

Table 30: Connector J1 Pin Assignments on the DT3034 Board

Pin	Signal Description	Pin	Signal Description
1	+5 V Ref_Out	2	Reserved
3	Reserved	4	Analog Output 1+
5	Analog Output 0+	6	–15 V output
7	+15 V output	8	Shield Ground
9	Amp Low	10	Analog Input 23/15
11	Analog Input 22/14	12	Analog Input 21/13
13	Analog Input 20/12	14	Analog Input 19/11
15	Analog Input 18/10	16	Analog Input 17/09
17	Analog Input 16/08	18	Analog Input 07
19	Analog Input 06	20	Analog Input 05
21	Analog Input 04	22	Analog Input 03
23	Analog Input 02	24	Analog Input 01
25	Analog Input 00	26	Analog Ground
27	Reserved	28	Reserved
29	Analog Output 1 Return	30	Analog Output 0 Return
31	Reserved	32	Power Ground
33	Shield Ground	34	Analog Ground
35	Analog Input 31/ Analog Input 15 Return	36	Analog Input 30/ Analog Input 14 Return
37	Analog Input 29/ Analog Input 13 Return	38	Analog Input 28/ Analog Input 12 Return
39	Analog Input 27/ Analog Input 11 Return	40	Analog Input 26/ Analog Input 10 Return
41	Analog Input 25/ Analog Input 09 Return	42	Analog Input 24/ Analog Input 08 Return
43	Analog Input 15/ Analog Input 07 Return	44	Analog Input 14/ Analog Input 06 Return

Table 30: Connector J1 Pin Assignments on the DT3034 Board (cont.)

Pin	Signal Description	Pin	Signal Description
45	Analog Input 13/ Analog Input 05 Return	46	Analog Input 12/ Analog Input 04 Return
47	Analog Input 11/ Analog Input 03 Return	48	Analog Input 10/ Analog Input 02 Return
49	Analog Input 09/ Analog Input 01 Return	50	Analog Input 08/ Analog Input 00 Return

Connector J2 on the DT3034 Board

Table 31 lists the pin assignments of connector J2 on the DT3034 boards.

Table 31: Connector J2 Pin Assignments on the DT3034 Board

Pin	Signal Description	Pin	Signal Description
1	+ 5 V Output	2	+ 5 V Output
3	Reserved	4	A/D Sample Clock Output
5	A/D Trigger Output	6	External A/D TTL Trigger
7	External A/D Sample Clock Input	8	External D/A TTL Trigger
9	External D/A Clock Input	10	User Counter Output 3
11	User Clock Input 3	12	User Counter Output 2
13	User Clock Input 2	14	User Counter Output 1
15	User Clock Input 1	16	User Counter Output 0
17	User Clock Input 0	18	Digital Ground
19	Digital I/O Bank B 3	20	Digital I/O Bank B 2
21	Digital I/O Bank B 1	22	Digital I/O Bank B 0
23	Digital Ground	24	Digital I/O Bank A 3
25	Digital I/O Bank A 2	26	Digital I/O Bank A 1
27	Digital I/O Bank A 0	28	Digital Ground
29	Dynamic Digital Output 1	30	Dynamic Digital Output 0
31	Reserved	32	Reserved
33	Shield Ground	34	Analog Trigger
35	Digital Ground	36	Digital Ground
37	Reserved	38	Digital Ground
39	Digital Ground	40	Digital Ground
41	Digital Ground	42	Digital Ground
43	Digital Ground	44	External Gate 3
45	Digital Ground	46	External Gate 2
47	Digital Ground	48	External Gate 1
49	Digital Ground	50	External Gate 0
51	Digital Ground	52	Digital Ground
53	Digital I/O Bank B 7	54	Digital I/O Bank B 6
55	Digital I/O Bank B 5	56	Digital I/O Bank B 4
57	Digital Ground	58	Digital I/O Bank A 7

Table 31: Connector J2 Pin Assignments on the DT3034 Board (cont.)

Pin	Signal Description	Pin	Signal Description
59	Digital I/O Bank A 6	60	Digital I/O Bank A 5
61	Digital I/O Bank A 4	62	Digital Ground
63	Digital Ground	64	Digital Ground
65	Reserved	66	Reserved
67	Shield Ground	68	Analog Trigger Return

Screw Terminal Assignments for the DT740

Table 32 lists the screw terminal assignments for connector J1 on the DT740 screw terminal panel.

Table 32: Pin Assignments for Connector J1 on the DT740

TB	J1 Pin	Signal Description	TB	J1 Pin	Signal Description
1	25	Analog Input 00	2	50	Analog Input 08/00 Return
3	24	Analog Input 01	4	49	Analog Input 09/01 Return
5	23	Analog Input 02	6	48	Analog Input 10/02 Return
7	22	Analog Input 03	8	47	Analog Input 11/03 Return
9	21	Analog Input 04	10	46	Analog Input 12/04 Return
11	20	Analog Input 05	12	45	Analog Input 13/05 Return
13	19	Analog Input 06	14	44	Analog Input 14/06 Return
15	18	Analog Input 07	16	43	Analog Input 15/07 Return
17	17	Analog Input 16/08	18	42	Analog Input 24/08 Return
19	16	Analog Input 17/09	20	41	Analog Input 25/09 Return
21	15	Analog Input 18/10	22	40	Analog Input 26/10 Return
23	14	Analog Input 19/11	24	39	Analog Input 27/11 Return
25	13	Analog Input 20/12	26	38	Analog Input 28/12 Return
27	12	Analog Input 21/13	28	37	Analog Input 29/13 Return
29	11	Analog Input 22/14	30	36	Analog Input 30/14 Return
31	10	Analog Input 23/15	32	35	Analog Input 31/15 Return
33	9	Amp Low	34	34	Analog Ground
35	8	Analog Shield Ground	36	33	Analog Shield Ground
37	7	+15 V Output	38	32	Power Ground
39	6	−15 V Output	40	31	Reserved
41	5	Analog Output 0+	42	30	Analog Output 0 Return
43	4	Analog Output 1+	44	29	Analog Output 1 Return
45	3	Reserved	46	28	Reserved
47	2	Reserved	48	27	Reserved
49	1	+5 V Reference Out	50	26	Analog Ground
51	-	Analog Shield Ground	52	-	Analog Shield Ground
53	-	Analog Shield Ground	54	-	Analog Shield Ground
55	-	Analog Shield Ground	56	-	Analog Shield Ground

Table 33 lists the screw terminal assignments for connector J2 on the DT740 screw terminal panel.

Table 33: Screw Terminal Assignments for Connector J2 on the DT740

TB	J2 Pin	Signal Description	TB	J2 Pin	Signal Description
57	51, 52	Digital Ground	58	17	User Clock Input 0
59	16	User Counter Output 0	60	50	External Gate 0
61	49	Digital Ground	62	15	User Clock Input 1
63	14	User Counter Output 1	64	48	External Gate 1
65	47	Digital Ground	66	13	User Clock Input 2
67	12	User Counter Output 2	68	46	External Gate 2
69	45	Digital Ground	70	11	User Clock Input 3
71	10	User Counter Output 3	72	44	External Gate 3
73	43	Digital Ground	74	9	External D/A Sample Clock In
75	8	External D/A TTL Trigger	76	7	External A/D Sample Clock In
77	6	External A/D TTL Trigger	78	5	A/D Trigger Out
79	4	A/D Sample Clock Out	80	3	Reserved
81	23, 28, 42	Digital Ground	82	39, 41, 57, 62	Digital Ground
83	18, 38, 40, 63, 64	Digital Ground	84	65	Reserved
85	31	Reserved	86	37	Reserved
87	30	Dynamic Digital Output 0	88	29	Dynamic Digital Output 1
89	27	Digital I/O Bank A 0	90	26	Digital I/O Bank A 1
91	25	Digital I/O Bank A 2	92	24	Digital I/O Bank A 3
93	61	Digital I/O Bank A 4	94	60	Digital I/O Bank A 5
95	59	Digital I/O Bank A 6	96	58	Digital I/O Bank A 7
97	22	Digital I/O Bank B 0	98	21	Digital I/O Bank B 1
99	20	Digital I/O Bank B 2	100	19	Digital I/O Bank B 3
101	56	Digital I/O Bank B 4	102	55	Digital I/O Bank B 5
103	54	Digital I/O Bank B 6	104	53	Digital I/O Bank B 7
105	33	Digital Shield Ground	106	68	Analog Ground

Table 33: Screw Terminal Assignments for Connector J2 on the DT740 (cont.)

TB	J2 Pin	Signal Description	TB	J2 Pin	Signal Description
107	34	Analog Trigger	108	67	Digital Shield Ground
109	32	Reserved	110	66	Reserved
111	35, 36	Digital Ground	112	1, 2	+5 V Out

Using Your Own Screw Terminal Panel

Data acquisition boards can perform only as well as the input connections and signal integrity you provide. If you choose not to use the DT740 screw terminal panel, considerations must be given as to how the signals interact in the real world as well as how they interact with each other.

This appendix describes additional considerations to keep in mind when designing your own screw terminal panel for use with a DT3034 board.

Analog Inputs

Typical data acquisition boards have three different types of analog input configurations that you can use:

- Single-ended
- Pseudo-differential
- Differential

Single-Ended Inputs

With single-ended inputs, you have the maximum number of inputs but have the worst-case noise immunity without external signal conditioning.

The major problem with this configuration it that you need a common ground between the external inputs and the data acquisition board. Even with conditioning, consideration must be given to the cable length and how the cable is routed. If the cable is over 3 feet, you must consider the ringing and cross-talk in the cable. A typical cable has 30 pF per foot of capacitance. If the source impedance is 1,000 Ω and the cable is 3 feet, then the cross talk based on the source impedance is 1,000 Ω x (30 pF x 3 ft) = 90 ns.

This seems negligible, but when you consider that it requires nine time constants to settle within 0.01%, the cross-talk becomes almost 10% of the time required to settle when switching channels at 100 kHz.

Coupling must also be considered when adjacent channels have high-speed signals, especially if these signals are TTL-type with high-speed edges.

Pseudo-Differential Inputs

Pseudo-differential inputs allow one common-mode voltage for all single-ended inputs. With this type of connection, the low side of the instrumentation amplifier is used to sense an external common-mode voltage. For example, if you have a signal-conditioning rack, the AMP LOW signal connects to the analog common of the external rack.

The pseudo-differential configuration allows you to use the maximum number of input channels, while placing an impedance between the external ground and the data acquisition ground or analog common. Even if it is 100 Ω, this impedance provides the bias return currents for the inputs and causes only 10 mA of current to flow with a ground potential difference of 1 V. (The input bias current is typically in milliamperes.) This is usually manageable by the common-mode range of the instrumentation amplifier and analog ground system. Consider the problems with 1 Ω of impedance between 1 V of potential difference. The resulting 1 A of current causes many problems in the analog signal integrity.

If it is provided and not used, ensure that you connect AMP LOW to the analog common of the data acquisition board or to ground when running in single-ended mode.

Differential Inputs

Differential inputs offer the maximum noise rejection at the expense of half your total channel count. For the best results, shielded twisted pairs are a must. The shield must connect at one end so that ground currents do not travel over the shield. In low-level voltage applications, differential inputs reduce problems not only due to electrostatic and magnetic noise, but due to cross-talk and thermal errors.

One problem to consider with differential inputs is the bias current error. The differential impedance is usually hundreds of megaohms. With a very small bias current multiplied by this high input impedance, the voltage produced is out of the common-mode input range of the instrumentation amplifier.

An external resistor must be provided to return this bias current to the analog common of the data acquisition board. This resistor is typically in the order of 1 kΩ to 100 kΩ from the input low side to analog common. Alternatively, the external common can be returned through a 10 Ω to 100 kΩ resistor to analog common (it cannot be 0 Ω due to ground currents).

Analog Outputs

Most data acquisition boards have a minimum of two analog output channels, with a resolution of 12 to 16 bits (even though the accuracy may be less).

On all Data Translation boards, we ensure that the analog outputs do not break into a high frequency oscillation with high capacitance loads that may be experienced with long cables. Typically, the analog outputs drive 1,000 pF without degradation and bandwidth-limit with higher capacitive loads.

The grounds of most boards are optimized for analog inputs at the expense of some logic or high-frequency noise on the analog outputs. This is because the analog and digital grounds of the board are connected at the ADC's input.

The analog outputs are brought out as a high and a low signal, but the low side is the analog ground at the DAC's output buffer. To remove the high-frequency noise and smooth the glitch energy on the analog outputs, you can install a 15 kHz RC filter on the output, a 100 Ω resistor in series with the output, and a 0.1 μF capacitor between the output side of the 100 Ω resistor and output low.

Digital Inputs and Counter/Timer Inputs

TTL-type inputs must have current limiting so that circuitry is not damaged when power is removed. On all Data Translation PCI boards, current limiting is used to prevent damage in this fault condition.

On high-speed clock inputs, a ground that is located in the connector next to the clock must be connected as a twisted pair with the high-speed clock input.

Digital Outputs

If you are using the high drive capability of any of the PCI boards, ensure that the load is returned to the digital ground provided in the connector next to the outputs.

If just eight of the digital outputs are switching 16 mA per output, then 128 mA of current flows. To minimize problems with ringing, loading, and EMI, a 33 Ω resistor is used in series with all digital outputs. You must consider this 33 Ω resistor if you are matching cable impedance to the far end.

Cabling Information

If you are building your own screw terminal panel and/or cable, refer to Appendix A for connector specifications.

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