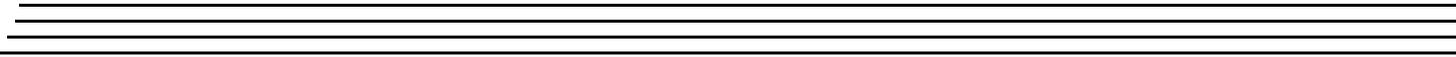
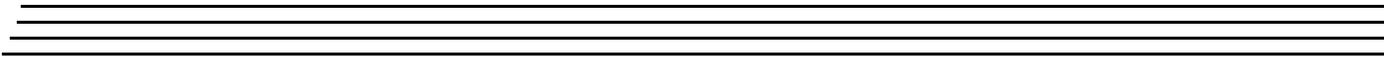




UM-16501-T

DT300 Series User's Manual



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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.

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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.

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About this Manual

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

- DT300 Series software
- DT300 Series board
- STP300 screw terminal panel
- STP68 or STP68-DIN screw terminal panel
- 5B01 or 5B08 signal conditioning backplane
- 7BP16-1, 7BP08-1, or 7BP04 signal conditioning backplane

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 DT300 Series boards, the capabilities of the DT300 Series Device Driver, and how to program the DT300 Series boards using the DT-Open Layers for .NET Class Library™ software. Troubleshooting and calibration information is also provided.

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

Intended Audience

This document is intended for engineers, scientists, technicians, or others responsible for using and/or programming the DT300 Series boards 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. It also provides an overview of the getting started procedure.
- [Chapter 2, "Installing the Board and Loading the Device Driver,"](#) describes how to install the DT300 Series board and load the DT300 Series device driver.
- [Chapter 3, "Attaching and Configuring a Screw Terminal Panel/ Backplane,"](#) describes how to attach and configure the STP300, STP68, or STP68-DIN screw terminal panel, and the 5B and 7B Series signal conditioning backplanes.
- [Chapter 4, "Wiring Signals,"](#) describes how to wire signals to a DT300 Series board.

- [Chapter 5, “Verifying the Operation of a DT300 Series Board,”](#) describes how to verify the operation of a DT300 Series 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 DT300 Series 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 STP300 screw termination 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 DT300 Series 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 DT300 Series 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 boards.
- 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™ Data Acq 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 describes how to use the ActiveX controls provided in DTx-EZ™ to access the capabilities of Data Translation's 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).
- Windows XP, Windows Vista, or Windows 7 documentation.

Where To Get Help

Should you run into problems installing or using a DT300 Series board, our Technical Support Department is available to provide technical assistance. Refer to [Chapter 9](#) starting on [page 125](#) 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

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Features

The DT300 Series is a family of low-cost, multifunction data acquisition boards for the PCI bus. The DT300 Series consists of the following boards: DT301, DT302, DT303, DT304, DT321, and DT322. The different features of these boards are shown in [Table 1](#).

Table 1: Differences Among DT300 Series Boards

Board Type	Analog I/O Resolution	Analog Input Sample Frequency	Analog Input Ranges ^a	Analog Output Channels
DT301	12 bit	225 kHz	±10 V, 0 to 10 V	0
DT302	12 bit	225 kHz	±10 V, 0 to 10 V	2
DT303	12 bit	400 kHz	±10 V, 0 to 10 V	0
DT304	12 bit	400 kHz	±10 V, 0 to 10 V	2
DT321	16 bit	250 kHz	±10 V	0
DT322	16 bit	250 kHz	±10 V	2

a. Assumes a gain of 1. Using these ranges with gains of 2, 4, or 8 yields a number of effective input ranges; refer to [page 75](#) for more information.

All DT300 Series board share the following major features:

- PCI bus mastering capability for analog inputs
- 16 single-ended or pseudo-differential analog input channels, or 8 differential analog input channels
- Signal conditioning through connections to 5B and 7B Series backplanes
- Input gains of 1, 2, 4, and 8
- Continuously-paced and triggered scan capability
- A 1024-location channel-gain 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 in triggered scan mode
- Internal and external clock sources for the analog input subsystem
- Digital TTL triggering for the analog input subsystem
- Software calibration of the analog I/O circuitry
- Two 8-bit digital ports programmable as inputs or outputs on a per-port basis — digital input lines from these lines can be included as part of the analog input channel-gain list to correlate the timing of analog and digital events; digital outputs can drive external solid-state relays
- One 7-bit digital I/O port programmable as a general-purpose (non-clocked) input or output port

- Four user counter/timers programmable for event counting, frequency measurement, rate generation (continuous pulse output), one-shot pulse output, and repetitive one-shot pulse output
- Programmable gate types
- Programmable pulse output polarities (output types) and duty cycles

For a discussion of these features in detail, refer to [Chapter 6 starting on page 71](#).

Supported Software

The following software is available for use with the DT300 Series board and is shipped on the Data Acquisition OMNI CD:

- **DT300 Series 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 DT300 Series board with any of the supported software packages or utilities.
- **The Quick DataAcq application** – This application provides a quick way to get a DT300 Series 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.
- **Calibration Utility** – This utility allows you to calibrate the analog I/O circuitry of the board. Refer to [Chapter 8 starting on page 117](#) 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 the DT300 Series boards 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 the DT300 Series boards 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 DT300 Series boards 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 a DT300 Series board.

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

Accessories

The following optional accessories are available for the DT300 Series board:

- **STP300 screw terminal panel** – Screw terminal panel with two connectors. Connector J1 accommodates the analog and digital I/O signals from the DT300 Series board, and connector J2 allows you to connect 5B and 7B Series signal conditioning backplanes.
- **STP68 screw terminal panel** – A generic, 68-pin screw terminal panel that has one connector to accommodate the signals provided on connector J1 of the DT300 Series boards.
- **STP68-DIN screw terminal panel** – A generic, 68-pin screw terminal panel that is DIN-rail mountable. This screw terminal panel has one connector to accommodate the signals provided on connector J1 of the DT300 Series boards.
- **EP305 cable** – A 2-meter, twisted-pair, shielded cable that connects the 68-pin connector (J1) on the DT300 Series board to the J1 connector on the STP300 screw terminal panel.
- **5B01 or 5B08 backplane and 5B Series modules** – The 5B01 is a 16-channel backplane; the 5B08 is an 8-channel backplane. Both backplanes accept 5B modules for signal conditioning applications, including measuring thermocouples, RTDs, voltage input, current input, strain gage input, and frequency input.

To use the 5B series backplanes and modules with the STP300, you need the following additional accessories available from Data Translation:

- **AC1315 cable** – A 2-foot cable with a 26-pin connector on each end that connects a 5B Series signal conditioning backplane to connector J2 on the STP300 screw terminal panel.
- **PWR-977 power supply** – A 5 V, 3 A power supply for powering the 5B Series backplanes.
- **7BP16-1, 7BP08-1, or 7BP04-1 backplane and 7B Series modules** – The 7BP16-1 is a 16-channel backplane, the 7BP08-1 is an 8-channel backplane, and the 7BP04-1 is a 4-channel backplane. All three backplanes accept 7B modules for signal conditioning applications, including measuring thermocouples, RTDs, voltage input, current input, strain gage input, and frequency input.

To use the 7B series backplanes and modules with the STP300, you need the following additional accessories available from Data Translation:

- **AC1315** – a 2-foot, 26-pin female to 26-pin female cable that connects a 7B Series backplane to the AC1393 cable.
- **AC1393** – a 6-inch, 26-pin male to 25-pin female adapter cable that connects a 7B Series backplane to the AC1315 cable; the AC1315 cable then connects to the STP300 screw terminal panel.
- **HES14-21 power supply** – A linear ac/dc power supply that provides +24 Vdc for powering 7B Series backplanes.
- **DC300 backshell connector kit** – This kit includes a 68-pin mating connector and backshell if you want to build your own cable.

Getting Started Procedure

The flow diagram shown in [Figure 1](#) illustrates the steps needed to get started using a DT300 Series 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.

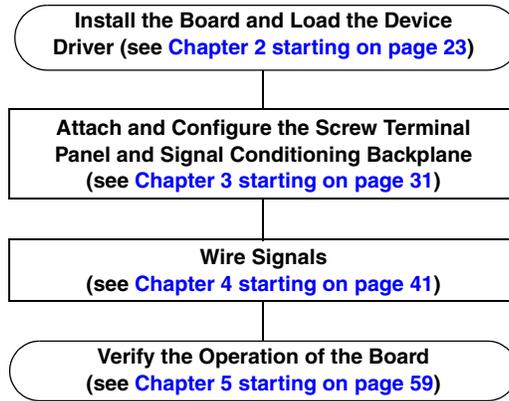


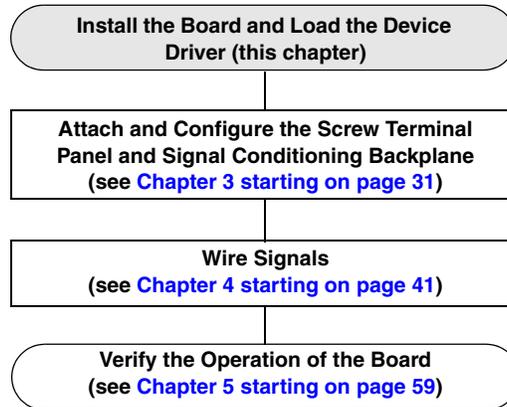
Figure 1: Getting Started Flow Diagram

Part 1: Getting Started



Installing the Board and Loading the Device Driver

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Loading the Device Driver	29



Note: All DT300 Series boards are factory-calibrated and require no further adjustment prior to installation. If you are using the DT300 Series board and decide later to recalibrate it, refer to [Chapter 8 starting on page 117](#) for instructions.

Unpacking

Open the shipping box and remove the wrapped DT300 Series 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:

- DT300 Series 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 manual for instructions.

Setting up an Expansion Slot

Once you have set up the computer, set up an expansion slot by doing the following:

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 plate from the selected expansion slot. Retain the screw that held it in place; you will use it later to install the board.

Inserting the DT300 Series Board into the Computer

Once you have set up an expansion slot, do the following to insert the DT300 Series board into the computer:

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. (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.
4. Position the board so that the cable connectors are facing the rear of the computer, as shown in [Figure 2](#).

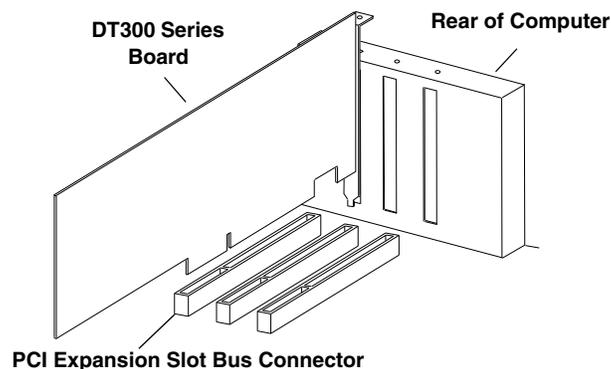


Figure 2: Inserting the DT300 Series Board in the Computer

5. Carefully lower the board into the PCI expansion slot using the card guide to properly align the board in the slot.
6. 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.

7. Secure the board in place at the rear panel of the system unit using the screw removed from the slot cover.
8. Power up the computer.
If you installed the DT300 Series software, the DT300 Series device driver is loaded automatically. If you have not installed the software, do so now.

Loading the Device Driver

To load the DT300 Series device driver in

- Windows XP, follow the steps on [page 29](#).
- Windows Vista, follow the steps on [page 29](#).
- Windows 7, follow the steps on [page 30](#).

Windows XP

Once you have installed the software from the Data Acquisition OMNI CD, installed a DT300 Series 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\DT300.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 DT300 Series 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 DT300 Series board, uncheck this box.
12. When you are finished, click **Close**.

Once the driver is loaded, perform the steps in [Chapter 3 starting on page 31](#) to attach and configure the screw terminal panel and signal conditioning backplane.

Windows Vista

Once you have installed the software from the Data Acquisition OMNI CD, installed a DT300 Series 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 DT300 Series 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 DT300 Series board, uncheck this box.
8. When you are finished, click **Close**.

Once the driver is loaded, perform the steps in [Chapter 3 starting on page 31](#) to attach and configure the screw terminal panel and signal conditioning backplane.

Windows 7

Once you have installed the software from the Data Acquisition OMNI CD, installed a DT300 Series board, and powered up the host computer, the hardware is found automatically. Perform the following steps to configure the device driver.

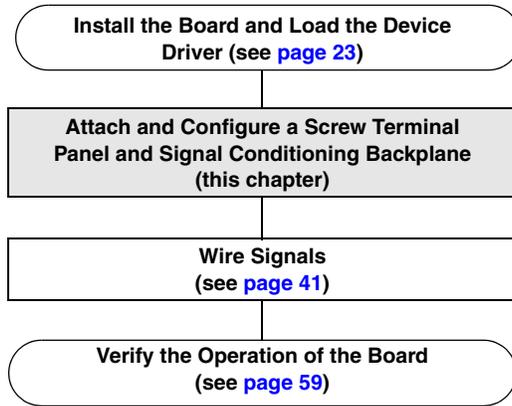
1. Open the Control Panel.
2. Double-click the **Open Layers Control Panel** icon.
3. Select the DT300 Series board to configure, and then click **Advanced**.
By default, the prompt "Handles Overloaded Bus?" is checked.
4. If you are using an Optiplex computer or experience timing problems with your DT300 Series board, uncheck this box.
5. When you are finished, click **Close**.

Once the driver is loaded, perform the steps in [Chapter 3 starting on page 31](#) to attach and configure the screw terminal panel and signal conditioning backplane.



Attaching and Configuring a Screw Terminal Panel/ Backplane

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Using an STP300 Screw Terminal Panel

This section describes how to attach an STP300 screw terminal panel to a DT300 Series board and how to configure a STP300 screw terminal panel for use with a DT300 Series board.

Attaching an STP300 Screw Terminal Panel

To attach an STP300 screw terminal panel to the DT300 Series board, you need the EP305 or equivalent cable. The STP300 screw terminal panel and the EP305 cable are offered by Data Translation as accessories to the DT300 Series boards.

Connector J1 on the STP300 attaches to connector J1 on the DT300 Series board. Connector J2 on the STP300 connects to a 5B or 7B Series signal conditioning backplane.

Figure 3 illustrates how to attach the STP300 screw terminal panel to a DT300 Series board.

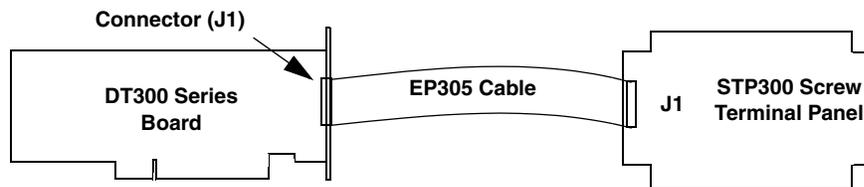


Figure 3: Attaching the STP300 Screw Terminal Panel to a DT300 Series Board

Once you have attached the STP300 screw terminal panel to the board, configure the screw terminal panel, as described in the next section.

Configuring an STP300 Screw Terminal Panel

Figure 4 shows the layout of the STP300 screw terminal panel.

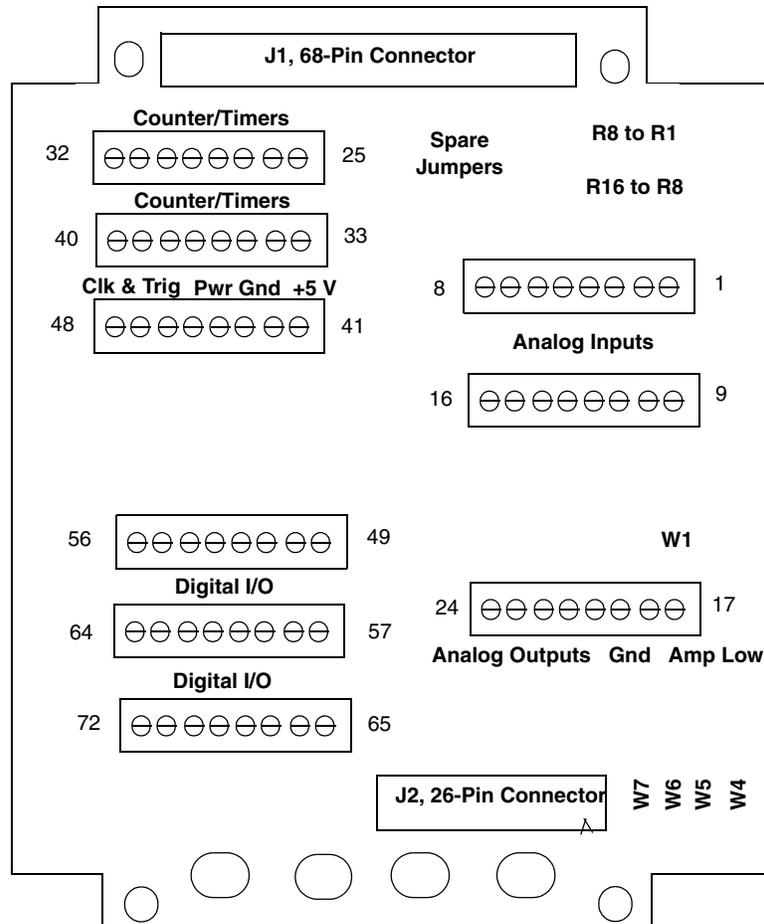


Figure 4: Layout of the STP300 Screw Terminal Panel

Note: The STP300 panel is designed to fit inside a standard 4-inch by 8-inch plastic enclosure.

Configuring Jumpers on the STP300

The STP300 screw terminal panel contains jumper W1, and jumpers W4 to W7. Jumper W1 provides a common ground sense; jumpers W4 to W7 are associated with analog outputs on the 5B01 and 7BP16-1 signal conditioning backplanes. The following subsections describe how to configure these jumpers.

Note: The screw terminal panels are shipped with enough jumper plugs to select every possible configuration. Spare jumper plugs are stored on the panel itself (on the posts marked spare). Save these jumper plugs for future use.

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 DT300 Series 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 16 input channels. Refer to [page 48](#) for an example of removing jumper W1.

Note: If you are using a 5B Series backplane, install jumper W3 on the 5B01 or 5B08 backplane; this connects Amp Low to Analog Ground on the 5B01 or 5B08 backplane to configure pseudo-differential inputs.

Configuring Jumpers W4 to W7 - Analog Outputs on a 5B01 or 7BP16-1 Backplane

Note: You cannot use analog output modules on the 5B08, 7BP08-1, or 7BP04-1 backplane.

Use jumpers W4 to W7 if you are using the STP300 screw terminal panel with analog output modules on the 5B01 or 7BP16-1 signal conditioning backplane.

Install jumpers W4 and W5 to connect DAC0 from the DT300 Series board to channel 14 on the 5B01 or 7BP16-1 backplane. Jumper W4 connects DAC0 to channel 14; jumper W5 connects DAC0's return.

Install jumpers W6 and W7 to connect DAC1 from the DT300 Series board to channel 15 on the 5B01 or 7BP16-1 backplane. Jumper W6 connects DAC1 to channel 15; jumper W7 connects DAC1's return.

Note: If you are using analog output modules on the 5B01 or 7BP16-1 backplane, ensure that you make no connections to the screw terminals corresponding to that signal on the screw terminal panel. For example, if you are using channel 14 on the 5B01 for analog output, do not use screw terminals corresponding to DAC0 on the screw terminal panel. You can read the output of the DACs as inputs.

Configuring Resistors on the STP300

Locations are provided on the STP300 screw terminal panel for installing bias return and current shunt resistors. The following subsections describe how to configure these resistors.

Configuring Resistors R1 to R8 - Bias Return

Resistor locations R1 to R8 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 7, where R1 corresponds to analog input channel 0 and R8 corresponds to analog input channel 7.

The high side of the corresponding analog input channel 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 k Ω to 100 k Ω depending on the application. Refer to [page 49](#) for an example of using bias return resistors with differential inputs.

Configuring Resistors R9 to R16 - Current Shunt

Resistor locations R9 to R16 are typically used to convert current to voltage on channels 0 to 7, where R9 corresponds to analog input channel 0 and R16 corresponds to analog input channel 7.

The resistor location connects the high side of the channel to the low side of the corresponding channel, thereby acting as a shunt. If, for example, you add a 250 Ω resistor to location R9, and then 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 R8 with resistors R9 to R16 for proper operation. Refer to [page 50](#) for an example of using current shunt resistors with current loop inputs.

Using an STP68 or STP68-DIN Screw Terminal Panel

To attach the STP68 or STP68-DIN screw terminal panel to the DT300 Series board, you need the EP305 or equivalent cable. The STP68, STP68-DIN, and the EP305 are offered by Data Translation as accessories to the DT300 Series boards.

Connector J1 on the STP68 and STP68-DIN attaches to connector J1 on the DT300 Series board.

Figure 5 illustrates how to attach the STP68 or STP68-DIN screw terminal panel to a DT300 Series board.

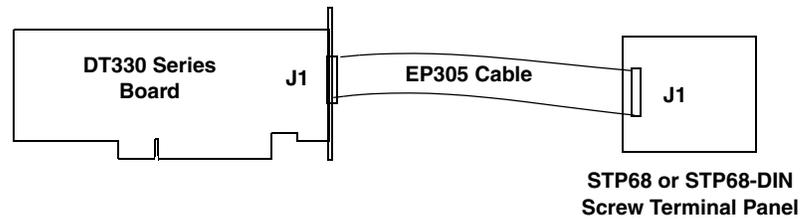


Figure 5: Attaching the STP68 or STP68-DIN Screw Terminal Panel to a DT300 Series Board

The STP68 and STP68-DIN screw terminal panels do not require configuration.

Using 5B and 7B Series Signal Conditioning Backplanes

This section describes how to attach a 5B or 7B Series signal conditioning backplane to an STP300 screw terminal panel and considerations when using signal conditioning accessories with DT300 Series boards.

Attaching a 5B Series Backplane

If you want to condition your analog signals, you can attach a 5B01 or 5B08 signal conditioning backplane to the STP300 using the AC1315 cable. The 5B01 and 5B08 backplanes, 5B Series signal conditioning modules, AC1315 cable, and the PWR-977 power supply are offered by Data Translation as accessories to the DT300 Series boards.

To attach a 5B01 or 5B08 backplane to the STP300 screw terminal panel, do the following:

1. Plug one end of the AC1315 cable into the J2 connector of the STP300 screw terminal panel, as shown in [Figure 6](#).
2. Plug the other end of the AC1315 cable into the 26-pin connector on the 5B01 or 5B08 backplane.
3. Connect power supply PWR-977 to the +5 V and power ground screw terminals on the 5B Series backplane and to the wall outlet.

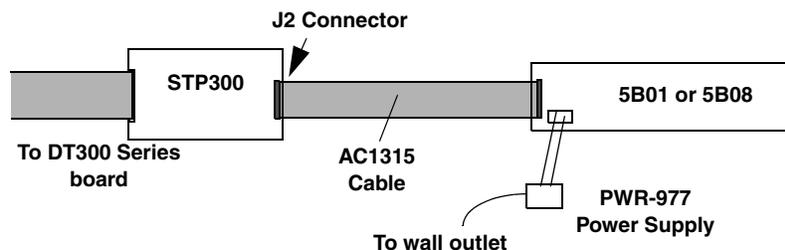


Figure 6: Connecting the 5B01 or 5B08 Backplane to the STP300

Attaching a 7B Series Backplane

To connect a 7B Series signal conditioning backplane to the STP300, do the following while referring to [Figure 7](#):

1. Plug one end of the AC1315 cable into the J2 connector of the STP300 screw terminal panel.
2. Plug the other end of the AC1315 cable into the 26-pin connector of the AC1393 adapter cable; then, attach the 25-pin connector of the AC1393 adapter cable to the 7B Series backplane.
3. Connect power supply HES14-21 to the V+A and COM screw terminals on the 7B Series backplane and to the wall outlet.

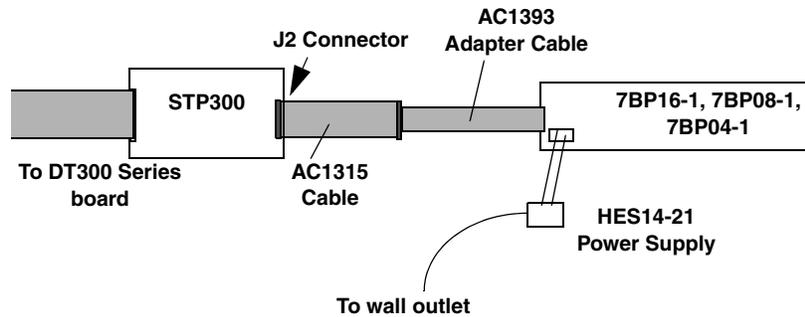


Figure 7: Connecting the 7B Series Backplane to the STP300

Once you have attached the 7B Series signal conditioning backplane to the STP300 screw terminal panel, configure the backplane, as described in the next section.

Considerations When Using 5B or 7B Series Accessories

When using the STP300 screw terminal panel with 5B or 7B Series signal conditioning accessories, keep the following considerations in mind:

- Configure your DT300 Series board to use single-ended mode (pseudo-differential inputs). You must remove jumper W1 on the STP300, as described on [page 35](#). If you are using a 5B Series backplane, you must also install jumper W3 on the 5B Series backplane to connect Amp Low to Analog Ground.
- The 5B08 and 7BP08-1 map to single-ended analog input channels 0 to 7, and the 7BP04-1 maps to single-ended analog input channels 0 to 3. If you are using a signal conditioning module for an analog input channel, ensure that you connect the analog input signal to the module on the signal conditioning backplane. For channels that do not use signal conditioning, connect the analog input signals to the STP300 screw terminal panel.
- By default, the 5B01 and 7BP16-1 backplanes map to single-ended analog input channels 0 to 15. However, by configuring jumpers W4 to W7 on the STP300, as described on [page 35](#), you can use channels 14 and 15 on the 5B01 or 7BP16-1 backplane as analog output channels 0 and 1.

Note: You cannot use analog output modules on the 5B08, 7BP08-1, or 7BP04-1 backplane.

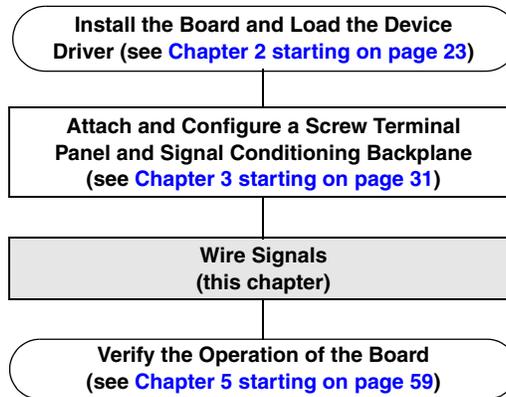
- 5B and 7B thermocouple modules provide their own CJC and return a voltage that already compensates for CJC. Therefore, when using 5B and 7B Series thermocouple modules, you do not have to compensate for offsets.
- The output of many 5B modules is ± 5 V. The output of many 7B modules is 0 to 10 V. Ensure that you select an input range that matches the output of the 5B or 7B modules that you are using. For example, if you are using 5B modules that have an output of ± 5 V, use a bipolar input range and a gain of 2 on the DT300 Series board.

- Connect all unused inputs to analog common. Reading an open channel can cause settling problems on the next valid channel.
- Refer to the user's manuals and data sheets for the 5B and 7B Series for more information.



Wiring Signals

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This chapter describes how to wire signals to the STP300 screw terminal panel. For information on how to wire signals to the 5B or 7B Series module, refer to the 5B and 7B Series data sheets and user's manuals.

Before Wiring

This section describes wiring recommendations and the pin assignments of the STP300 screw terminal panel.

Wiring Recommendations

Keep the following recommendations in mind when wiring signals to the STP300 screw terminal panel:

- Follow standard ESD procedures when wiring signals to the board.
- Use individually shielded twisted-pair wire (size 14 to 26 AWG) when using the DT300 Series board in a highly noisy electrical environment.
- Separate power and signal lines by using physically different wiring paths or conduits.
- To avoid noise, do not locate the STP300 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.
- 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 DT300 Series software.
 - Run the Quick DataAcq application (described in [page 59](#)) 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.

STP300 Screw Terminal Assignments

With the connector held up, the screw terminals on the right side of the STP300 match pins 23 to 34 and pins 57 to 68 of the standard 68-pin connector on the DT300 Series boards; these screw terminals represent the analog I/O signal connections. The remaining screw terminals are located on the left side of the STP300 screw terminal panel and are provided for the digital I/O, counter/timer, and +5 V power signals.

The following subsections describe the screw terminal assignments on the STP300 screw terminal panel by function.

Analog Input Screw Terminals

Table 2 lists the screw terminal (TB) assignments for analog input connections on the STP300 screw terminal panel. The corresponding resistors and their use are also listed.

Table 2: Analog Input Screw Terminal Assignments on the STP300

TB	J1 Pin	Description	Resistor Use	
			Bias Return Resistor	Current Shunt Resistor
1	68	Analog Input 0	–	R9
2	67	Analog Input 8/ Analog Input 0 Return	R1	
3	34	Analog Input 1	–	R10
4	33	Analog Input 9/ Analog Input 1 Return	R2	
5	66	Analog Input 2	–	R11
6	65	Analog Input 10/ Analog Input 2 Return	R3	
7	32	Analog Input 3	–	R12
8	31	Analog Input 11/ Analog Input 3 Return	R4	
9	64	Analog Input 4	–	R13
10	63	Analog Input 12/ Analog Input 4 Return	R5	
11	30	Analog Input 5	–	R14
12	29	Analog Input 13/ Analog Input 5 Return	R6	
13	62	Analog Input 6	–	R15
14	61	Analog Input 14/ Analog Input 6 Return	R7	
15	28	Analog Input 7	–	R16
16	27	Analog Input 15/ Analog Input 7 Return	R8	
17	26	Amp Low	Jumper W1 Connects Amp Low to Analog Ground	
18	25	Analog Ground		

Analog Output and Power Screw Terminals

Table 3 lists the screw terminal (TB) assignments for analog output and power connections on the STP300 screw terminal panel.

Table 3: Analog Output and Power Screw Terminal Assignments on the STP300

TB	J1 Pin	Description
19	58	DAC0 Output
20	57	DAC0 Return
21	60	DAC0 Reference
22	23	DAC1 Return
23	24	DAC1 Output
24	59	DAC1 Reference
41	1	+5 V Output @ 1 A
42	35	Power Ground

Counter/Timer and Digital I/O Screw Terminals

Table 4 lists the screw terminal (TB) assignments for digital I/O connections on the STP300 screw terminal panel.

Table 4: Counter/Timer and Digital I/O Screw Terminal Assignments on the STP300

TB	J1 Pin	Description	TB	J1 Pin	Description
25	42	Digital Ground	50	16	Digital I/O Port A, Line 1
26	41	User Clock Input 0	51	49	Digital I/O Port A, Line 2
27	40	User Counter Output 0	52	15	Digital I/O Port A, Line 3
28	39	External Gate 0	53	48	Digital I/O Port A, Line 4
29	8	Digital Ground	54	14	Digital I/O Port A, Line 5
30	7	User Clock Input 1	55	47	Digital I/O Port A, Line 6
31	6	User Counter Output 1	56	13	Digital I/O Port A, Line 7
32	5	External Gate 1	57	46	Digital I/O Port B, Line 0
33	8	Digital Ground	58	12	Digital I/O Port B, Line 1
34	36	User Clock Input 2	59	45	Digital I/O Port B, Line 2
35	37	User Counter Output 2	60	11	Digital I/O Port B, Line 3
36	38	External Gate 2	61	44	Digital I/O Port B, Line 4

**Table 4: Counter/Timer and Digital I/O
Screw Terminal Assignments on the STP300 (cont.)**

TB	J1 Pin	Description	TB	J1 Pin	Description
37	42	Digital Ground	62	10	Digital I/O Port B, Line 5
38	2	User Clock Input 3	63	43	Digital I/O Port B, Line 6
39	3	User Counter Output 3	64	9	Digital I/O Port B, Line 7
40	4	External Gate 3	65	54	Digital I/O Port C, Line 0
41	1	+5 V Output @ 1A	66	20	Digital I/O Port C, Line 1
42	35	Power Ground	67	53	Digital I/O Port C, Line 2
43, 44, 45	55	Digital Ground	68	19	Digital I/O Port C, Line 3
46	56	External A/D Trigger	69	52	Digital I/O Port C, Line 4
47	21	Digital Ground	70	18	Digital I/O Port C, Line 5
48	22	External A/D Sample Clock Input	71	51	Digital I/O Port C, Line 6
49	50	Digital I/O Port A, Line 0	72	17	Digital Ground

Note: If you are connecting a high-speed clock to the STP300, we recommend that you connect the return to the adjacent ground screw terminal.

Connecting Analog Input Signals

The STP300 screw terminal panel supports both voltage and current loop inputs. You can connect analog input voltage signals to the STP300 in the following configurations:

- **Single-ended** – Choose this configuration when you want to measure high-level signals, when noise is not significant, when the source of the input is close to the STP300 screw terminal panel, and when all the input signals are referred to the same common ground. When you choose the single-ended configuration, all 16 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 STP300 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 16 analog input channels are available.
- **Differential** – Choose this configuration when you want to measure low-level signals (less than 1 V), when you are using an A/D converter with high resolution (> 12 bits), when noise is a significant part of the signal, or when common-mode voltage exists. When you choose the differential configuration, eight 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 STP300 screw terminal panel.

Connecting Single-Ended Voltage Inputs

[Figure 8](#) shows how to connect single-ended voltage inputs (channels 0, 1, and 8, in this case) to the STP300 screw terminal panel.

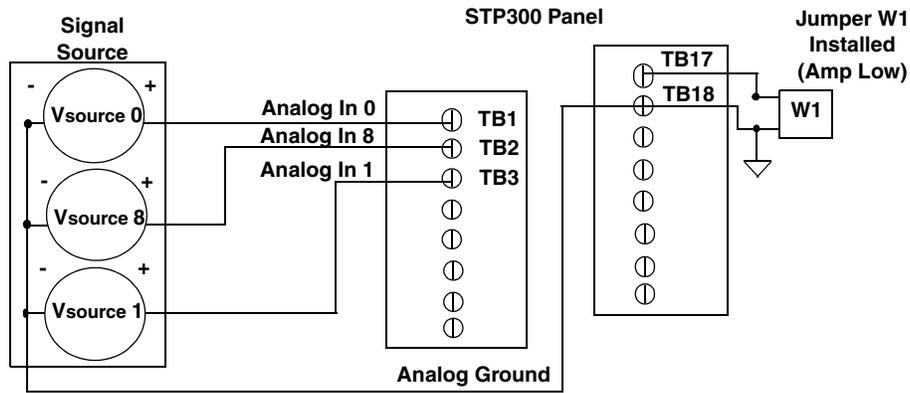


Figure 8: Connecting Single-Ended Voltage Inputs (Shown for Channels 0, 1, and 8)

Connecting Pseudo-Differential Voltage Inputs

Figure 9 shows how to connect pseudo-differential voltage inputs (channels 0, 1, and 8, in this case) to the STP300 screw terminal panel.

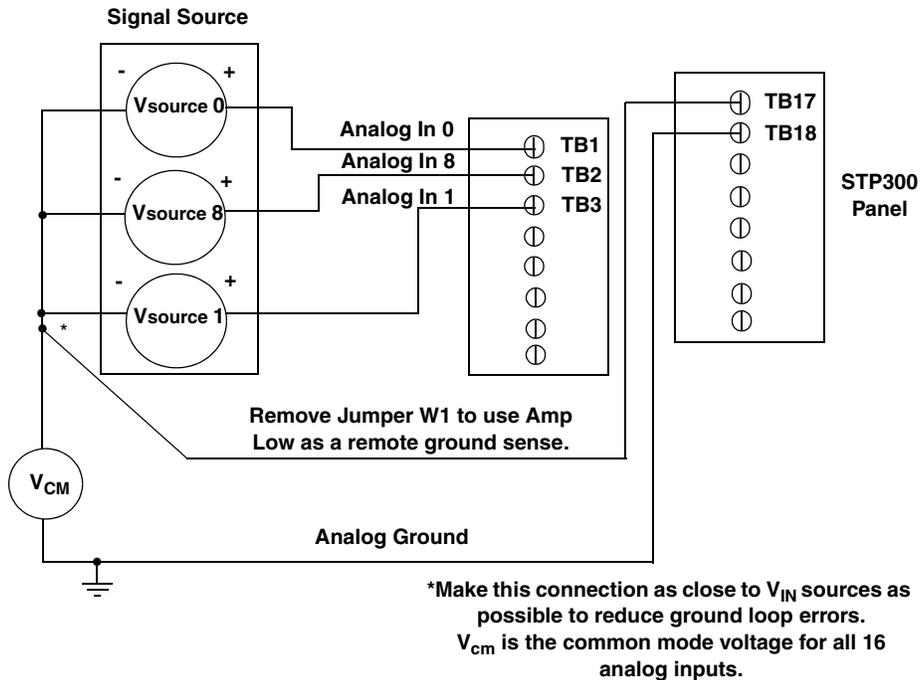


Figure 9: Connecting Pseudo-Differential Voltage Inputs (Shown for Channels 0, 1, and 8)

Connecting Differential Voltage Inputs

Figure 10A illustrates how to connect a floating signal source to the STP300 screw terminal panel using differential inputs. (A floating signal source is a voltage source that has no connection with earth ground.) You need to provide a bias return path by adding resistors R1 to R8 for channels 0 to 7, respectively, for floating signal sources.

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 M Ω . However, when you add noise from external sources to the high impedance, a resistor value of 100 Ω to 100 k Ω is more practical.

In Figure 10B, 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.

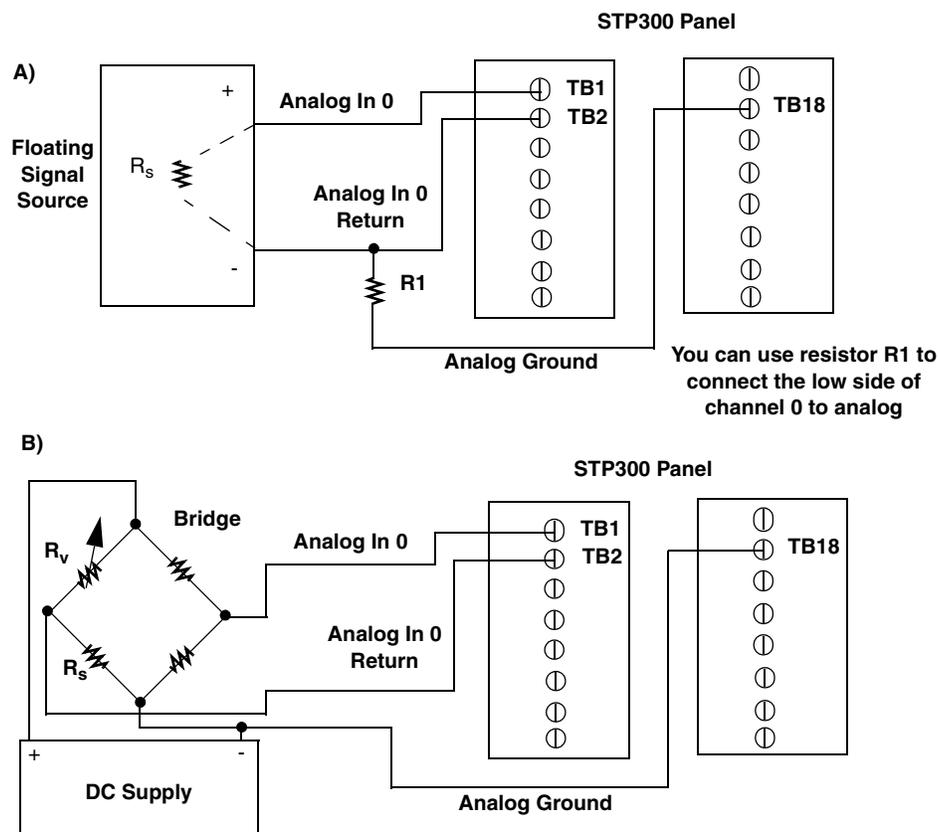
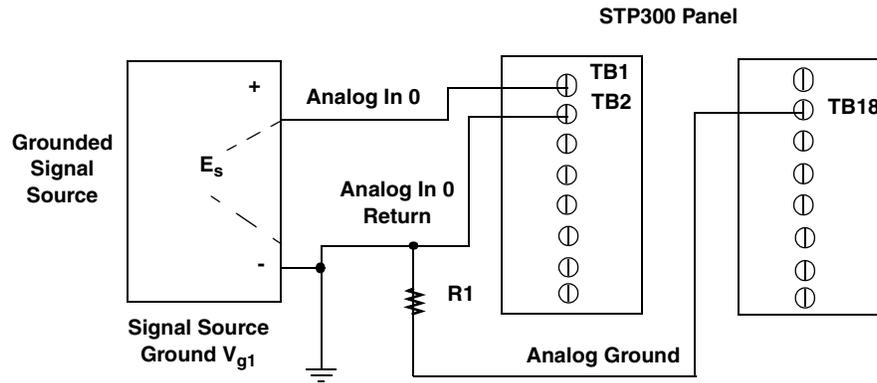


Figure 10: Connecting Differential Voltage Inputs (Shown for Channel 0)

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 STP300 screw terminal panel as shown in Figure 11. In this case, make sure that the low side of the signal (-) is connected to ground at the signal source, not at the STP300 screw terminal panel, and do not tie the two grounds together.

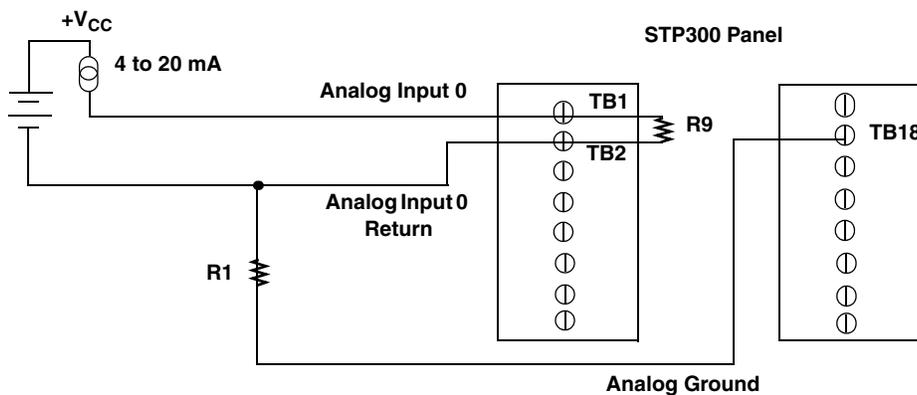


Resistor R1 should be installed for bias return in case the external ground is floating.

Figure 11: Connecting Differential Voltage Inputs from a Grounded Signal Source (Shown for Channel 0)

Connecting Current Loop Inputs

Figure 12 shows how to connect a current loop input (channel 0, in this case) to the STP300 screw terminal panel.



Use current shunt resistor R9 to convert current to voltage; $250\ \Omega$ for 4 to $20\ \text{mA} = 1$ to $5\ \text{V}$. 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 12: Connecting Current Inputs (Shown for Channel 0)

Connecting Analog Output Signals

Figure 13 shows how to connect an analog output voltage signal (channel 0, in this case) to the STP300 screw terminal panel using an external +10 V reference.

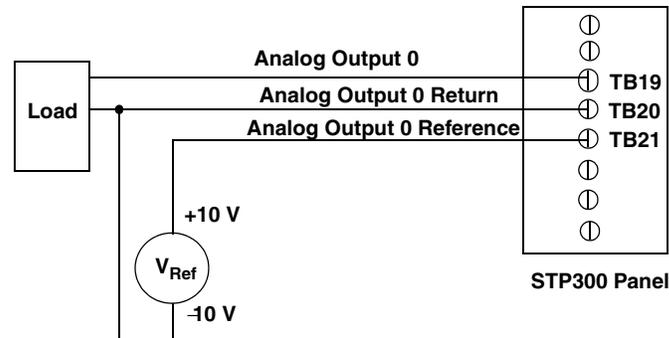


Figure 13: Connecting Analog Output Voltages Using an External +10 V Reference (Shown for Channel 0)

If you do not connect the Analog Output Reference to TB21, the board provides an internal +10 V reference, as shown in Figure 14.

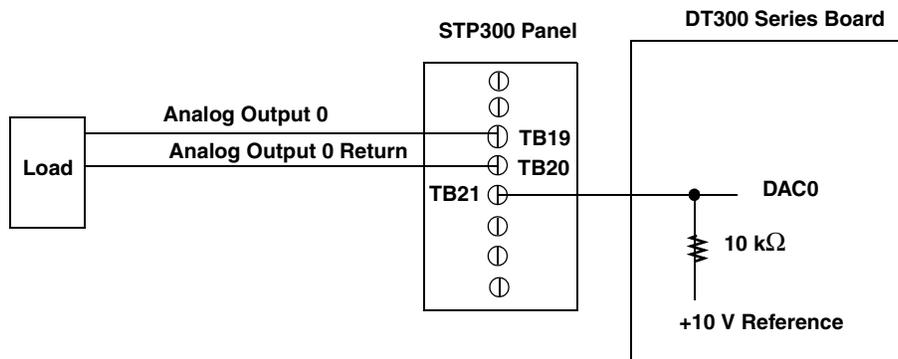


Figure 14: Connecting Analog Output Voltages Using the Board's Internal +10 V Reference (Shown for Channel 0)

Connecting Digital I/O Signals

Figure 15 shows how to connect digital input signals (lines 0 and 1 of digital Port A, in this case) to the STP300 screw terminal panel.

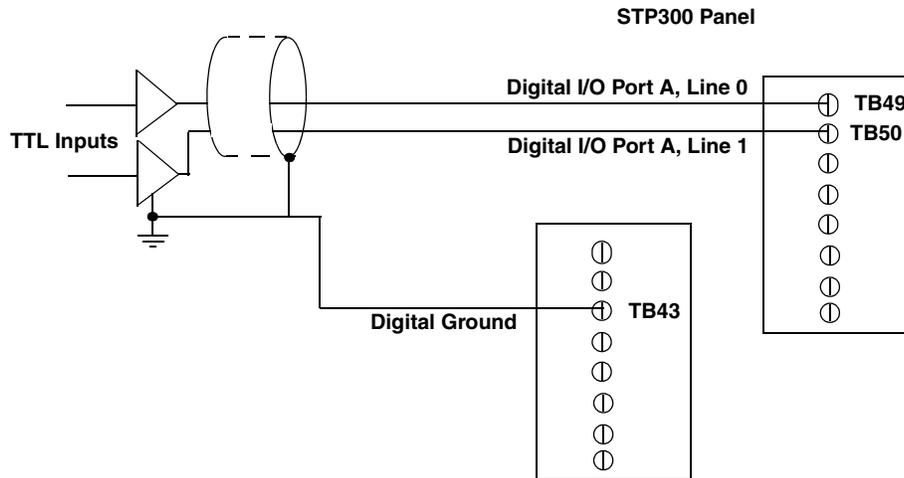


Figure 15: Connecting Digital Inputs (Shown for Channels 0 and 1, Port A)

Figure 16 shows how to connect a digital output signal (line 0 of digital Port B, in this case) to the STP300 screw terminal panel.

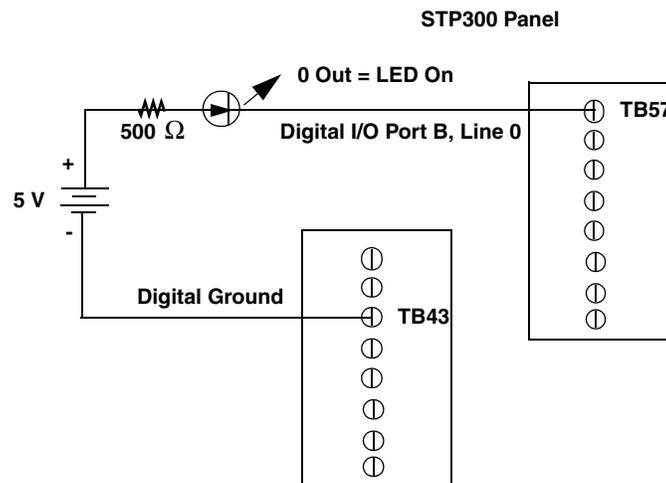


Figure 16: Connecting Digital Outputs (Shown for Channel 0, Port B)

Connecting Counter/Timer Signals

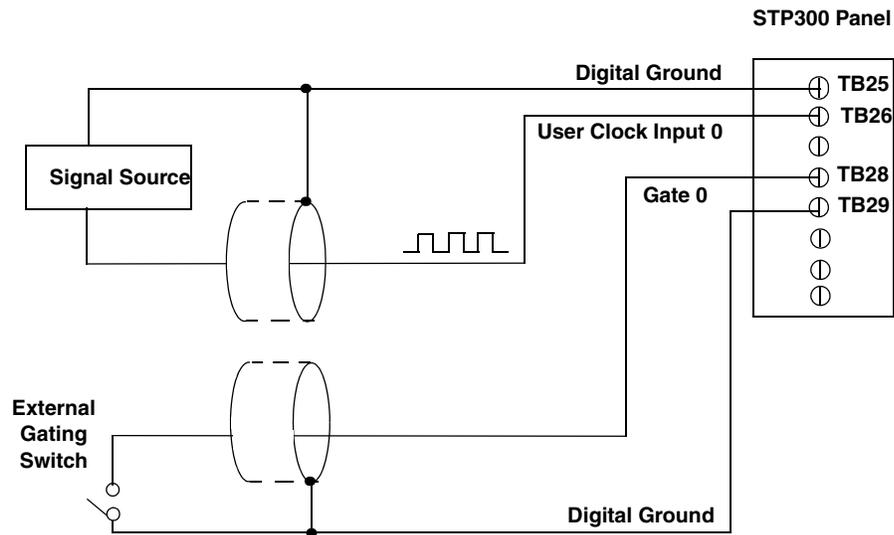
The DT300 Series board and STP300 screw terminal panel provide counter/timer channels that you can use to perform the following operations:

- 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.

Connecting Event Counting Signals

Figure 17 shows one example of connecting event counting signals to the STP300 screw terminal panel using user counter 0. In this example, rising clock edges are counted while the gate is active.



**Figure 17: Connecting Event Counting Signals
(Shown for Clock Input 0 and External Gate 0)**

Figure 18 shows another example of connecting event counting signals to the STP300 screw terminal panel using user counter 0. In this example, a software gate is used to start the event counting operation.

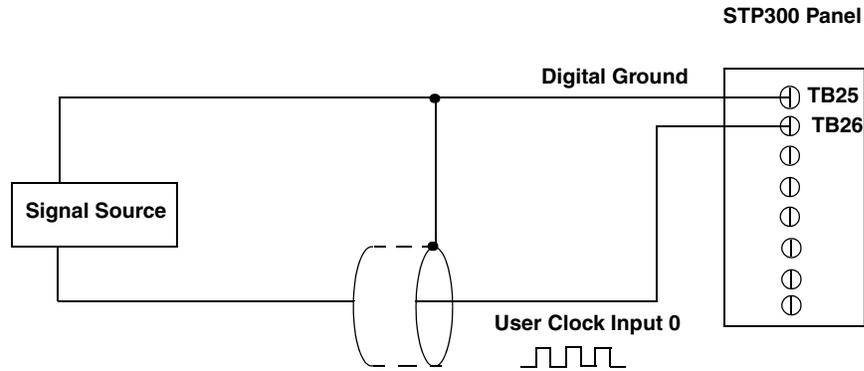
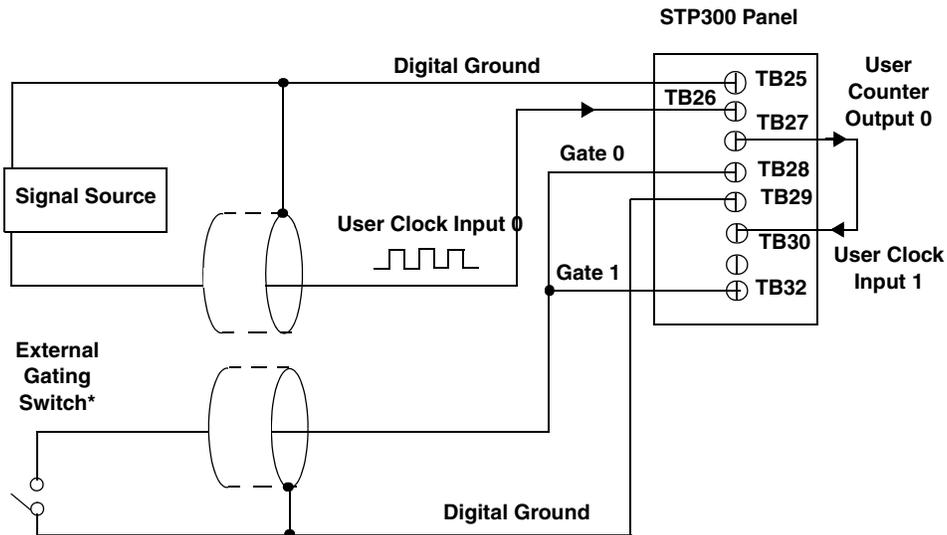


Figure 18: Connecting Event Counting Signals without an External Gate Input (Shown for Clock Input 0)

Figure 19 shows an example of how to cascade two counters externally to perform an event counting operation using user counters 0 and 1. Note that you can also internally cascade counters using software; if you internally cascade the counters, you do not need to make the external cascading connections. Note also that this example shows the use of an external gate; however, this connection is not required.



* *An internal 33 Ω series resistor is used.

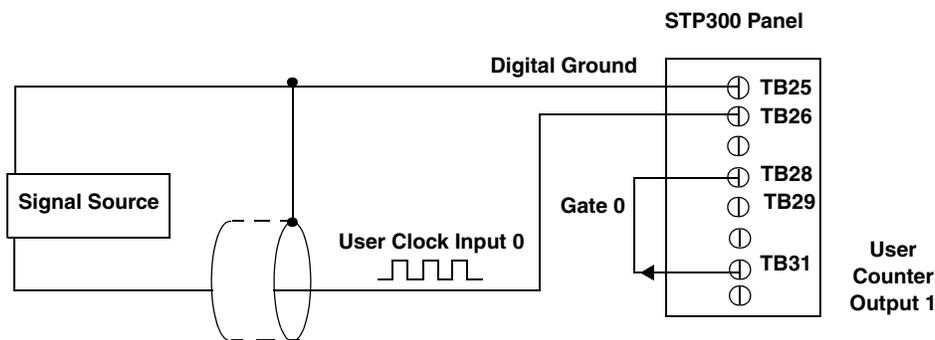
Figure 19: Cascading Counters (Shown for Event Counting Using Counters 0 and 1 and External Gate 0)

Connecting Frequency Measurement Signals

This section describes two examples of how to connect frequency measurement signals to the STP300 screw terminal panel.

The first configuration uses the same wiring as an event counting application that does not use an external gate signal (see [Figure 18](#) on [page 54](#)); the software uses the Windows timer to specify the duration of the frequency measurement. In this configuration, the frequency of the clock input is the number of counts divided by the duration of the Windows timer.

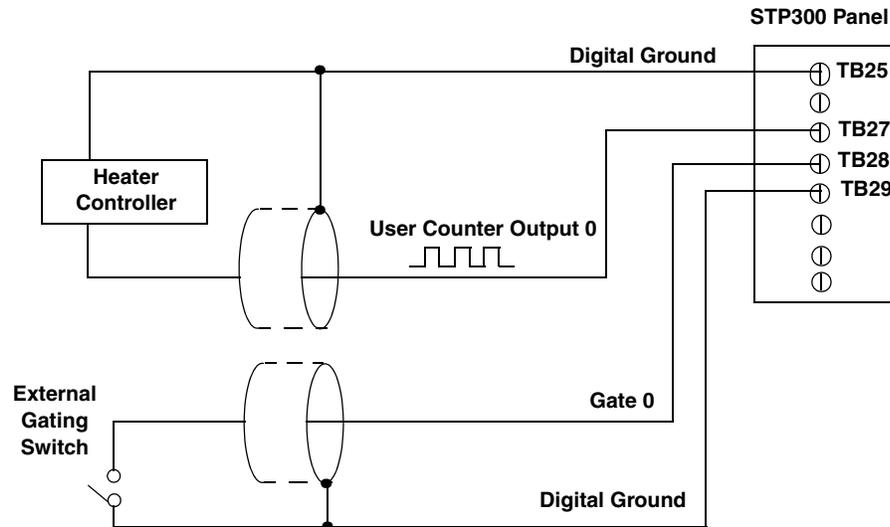
If you need more accuracy than the Windows timer provides, you can connect a pulse of a known duration (such as a one-shot output of another user counter) to the external gate input, as shown in [Figure 20](#). In this configuration, the frequency of the clock input is the number of counts divided by the period of the external gate input.



**Figure 20: Connecting Frequency Measurement Signals
(Shown for Clock Input 0 and External Gate 0)**

Connecting Pulse Output Signals

Figure 21 shows one example of connecting pulse output signals to the STP300 screw terminal panel using user counter 0.



**Figure 21: Connecting Pulse Output Signals
(Shown for Counter Output 0 and Gate 0)**

Figure 22 shows an example of how to externally cascade two counters to perform a rate generation operation using user counters 0 and 1. Note that you can also cascade counters internally using software; if you internally cascade the counters, you do not need to make the external cascading connections. In this example, counter 1 gate is logic high.

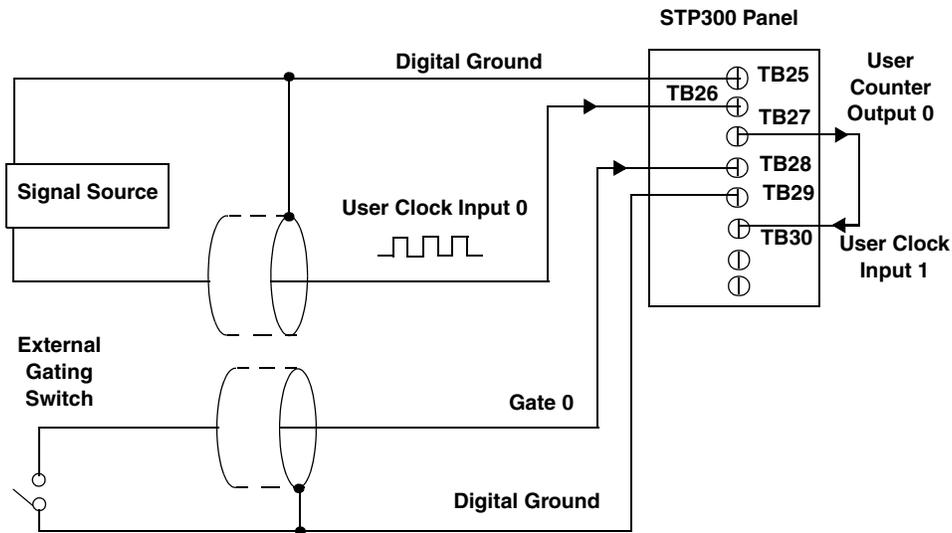


Figure 22: Cascading Counters (Shown for Rate Generation Using Counters 0 and 1 and External Gate 0)

Figure 23 shows an example of how to cascade two counters externally to perform a one-shot operation using user counters 0 and 1. Note that you can also internally cascade counters using software; if you internally cascade the counters, you do not need to make the external cascading connections. In this example, counter 0 gate is logic high.

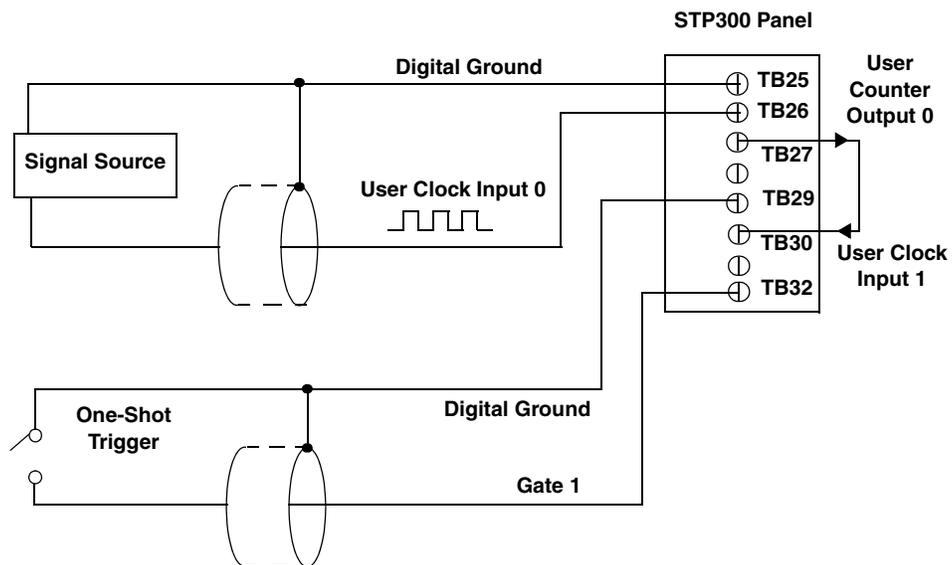
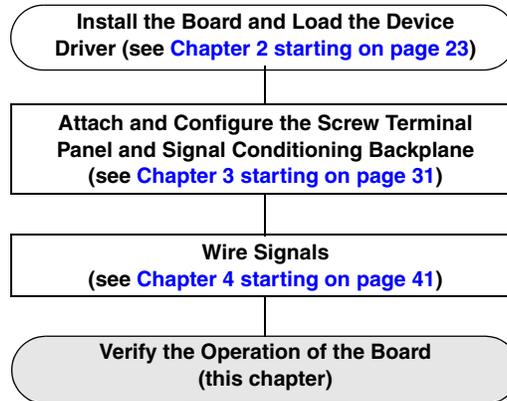


Figure 23: Cascading Counters (Shown for One-Shot Using Counters 0 and 1 and External Gate 1)



Verifying the Operation of a DT300 Series Board

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You can verify the operation of a DT300 Series 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 DT300 Series board. Refer to [page 49](#) 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 DT300 Series 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 51](#) 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 DT300 Series 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 DT300 Series board (using the differential configuration). Refer to [page 49](#) 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 DT300 Series 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. From the **Config** menu, choose **ChannelType**, and then select **Differential**.
7. From the **Config** menu, select **Range**, and then select **Bipolar** or **Unipolar** depending on the configuration of your board.
The default is Bipolar.
8. 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.
9. 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.
10. 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.
11. 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 DT300 Series board. Refer to [page 52](#) 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 DT300 Series 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 DT300 Series board. Refer to [page 52](#) 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 DT300 Series 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 DT300 Series board. Refer to [page 55](#) 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 DT300 Series 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 frequency is displayed 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 DT300 Series board. Refer to [page 56](#) 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 DT300 Series 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



Principles of Operation

Analog Input Features	73
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Counter/Timer Features	94

This chapter describes the analog input, analog output, digital I/O, and counter/timer features of the DT300 Series board. To frame the discussions, refer to the block diagram shown in [Figure 24](#). Note that bold entries indicate signals you can access.

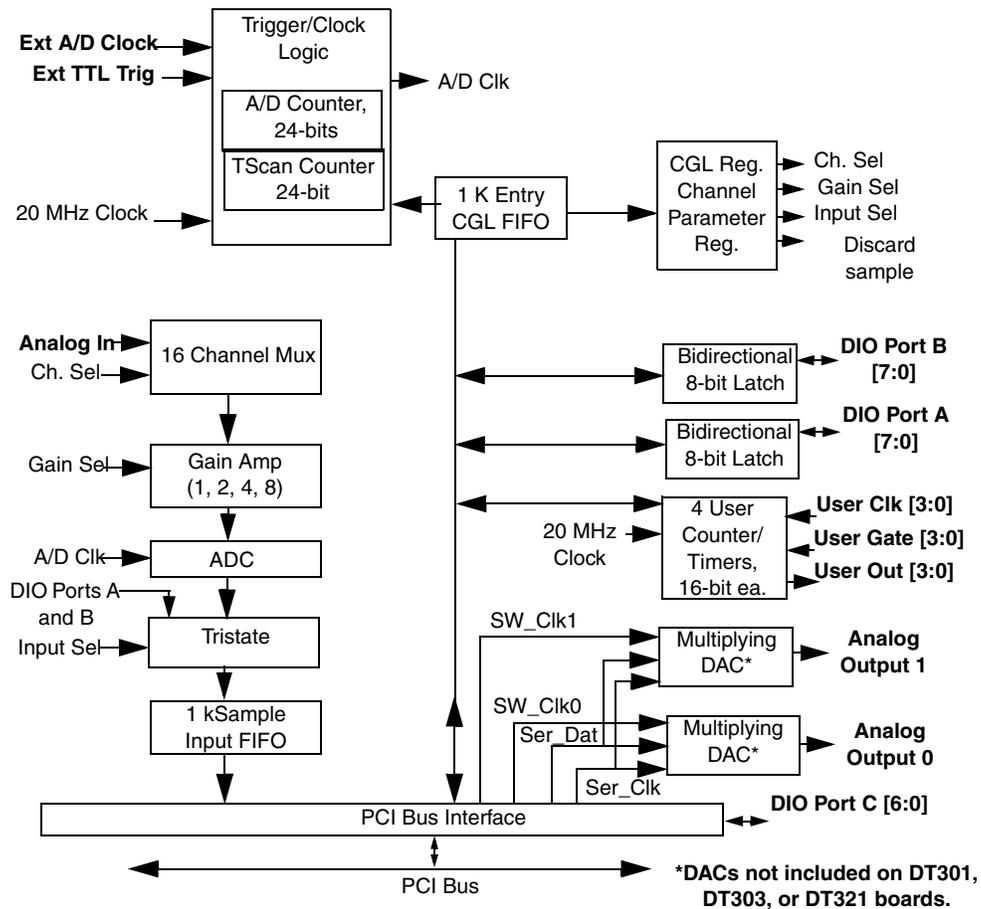


Figure 24: Block Diagram of the DT300 Series Boards

Analog Input Features

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

- 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

Input Resolution

[Table 5](#) lists the input resolutions supported by the DT300 Series boards. The resolution is fixed for each board type; therefore, it cannot be programmed in software.

Table 5: Supported Analog Input Resolutions

Board Type	Supported Resolution
DT301	12 bits
DT302	12 bits
DT303	12 bits
DT304	12 bits
DT321	16 bits
DT322	16 bits

Analog Input Channels

The DT300 Series board supports 16 single-ended or pseudo-differential analog input channels, or 8 differential analog input channels on board. Refer to [Chapter 4 starting on page 41](#) for a description of how to wire these signals. You configure the channel type through software.

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

The DT300 Series board can acquire data from a single analog input channel or from a group of analog input channels. Onboard channels are numbered 0 to 15 for single-ended and pseudo-differential inputs or 0 to 7 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 77](#) for more information on single-value operations.

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

Specifying One or More Channels

On the DT300 Series board, you 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 (first-in, first-out buffer) on the board. You can enter up to 1,024 entries in the channel list. The channels are read in order (using continuous paced mode or triggered scan mode) from the first entry to the last entry in the channel list. You 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 77](#) for more information on the supported conversion modes.

If you wish, you can also use software to inhibit a channel in the 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, the DT300 Series board allows you to read 16 digital I/O lines (Port A, lines 0 to 7 and Port B, lines 0 to 7) 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 physical channel 16 in the analog input channel list. You can enter channel 16 anywhere in the list and can enter it more than once, if desired.

Note: If channel 16 is the only channel in the channel list, the board can read this channel at a rate of 3 MSamples/s.

The digital 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.

Input Ranges and Gains

Each channel on the DT301, DT302, DT303, and DT304 board can measure unipolar and bipolar analog input signals, while each channel on the DT321 and DT322 board can measure bipolar analog input signals only. A unipolar signal is always positive (0 to 10 V on a DT300 Series board), while a bipolar signal extends between the negative and positive peak values (± 10 V on a DT300 Series board).

Through software, specify the range for the subsystem as 0 to 10 V for unipolar signals or -10 V to +10 V for bipolar signals.

DT300 Series boards provide gains of 1, 2, 4, and 8, which are programmable per channel. [Table 6](#) lists the effective ranges supported by the DT300 Series board using these gains.

Table 6: Gains and Effective Ranges

Gain	Unipolar Analog Input Range	Bipolar Analog Input Range ^a
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

a. DT321 and DT322 boards support bipolar analog input ranges only.

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 way you specify gain depends on how you specified the channels, as described in the following subsections.

Specifying the Gain for a Single Channel

The simplest way to specify the gain for a single channel is to specify the gain for a single-value analog input operation using software; refer to [page 77](#) for more information on single-value operations.

Specifying the Gain for One or More Channels

For DT300 Series boards, 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 16 (the 16 digital I/O lines) in the channel list, specify a gain of 1 for the channel entry.

A/D Sample Clock Sources

The DT300 Series board provides 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

You use an A/D sample clock to pace 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 16 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 differs depending on the board type, as shown in [Table 7](#).

Table 7: Maximum Frequency Supported

Board Type	Maximum Frequency
DT301	225 kHz
DT302	225 kHz
DT303	400 kHz

Table 7: Maximum Frequency Supported (cont.)

Board Type	Maximum Frequency
DT304	400 kHz
DT321	250 kHz
DT322	250 kHz

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: If your channel list contains only digital input channel 16, the maximum frequency is 3 MHz (3 MSamples/s).

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 TB48 on the STP300 screw terminal panel (pin 22 on connector J1). Conversions start on the falling edge of the external A/D sample clock input signal.

Using software, specify the clock source as external. For the DT300 Series board, 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

DT300 Series boards support the following conversion modes:

- **Single-value operations** are the simplest to use but offer the least flexibility and efficiency. Using software, you can 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 DT300 Series boards. In a scan, you can specify a channel list, clock source, trigger source, trigger acquisition mode, scan mode, and buffer using software. 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 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 until you stop the operation. Refer to [page 86](#) for more information on buffers.

The conversion rate is determined by the frequency of the A/D sample clock; refer to [page 76](#) 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, continuous pre-trigger, or continuous about-trigger (sometimes called continuous pre-post trigger). The initial trigger source depends on the trigger acquisition mode you use. Refer to [page 80](#) for more information on the supported trigger sources and trigger acquisition modes.

Triggered Scan Mode

DT300 Series 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 DT300 Series board scans the channel list a specified number of times (up to 256), then waits for a software retrigger to occur. When it detects the 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 until you stop the operation; refer to [page 86](#) 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 76](#) 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 on the board; the Triggered Scan Counter is a 24-bit counter with a 20 MHz clock.

Using software, specify the frequency of the software retrigger. The minimum retrigger frequency is 1.2 Hz (1.2 Samples/s). [Table 8](#) lists the maximum retrigger frequency supported by the DT300 Series boards.

Table 8: Maximum Retrigger Frequency

Board	Maximum Retrigger Frequency
DT301/302	155 kHz
DT303/304	219 kHz
DT321/322	165 kHz

The appropriate *retrigger frequency* depends on a number of factors, determined by the following equations:

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

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

For example, if you are using 16 channels in the channel list (CGL), scanning the channel list 256 times every trigger or retrigger, and using an A/D sample clock with a frequency of 100 kHz, set the maximum retrigger frequency to 24.41 Hz, since

$$24.41 \text{ Hz} = \frac{1}{\frac{(16 * 256) + 2 \mu\text{s}}{100 \text{ kHz}}}$$

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

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

The initial trigger source depends on the trigger acquisition mode you use; refer to [page 80](#) for more information on the supported and trigger sources and trigger acquisition modes.

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 a DT300 Series board 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. You can specify any supported post-trigger source as the initial trigger. Specify the external, positive digital (TTL) trigger for the retrigger.

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 until you stop the operation; refer to [page 86](#) 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 76](#) 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 (post-trigger).
- The triggered scan mode as enabled.
- The retrigger source as the external positive digital (TTL) trigger.
- The number of times to scan per trigger or retrigger (also called the multiscan count).

Triggers

A trigger is an event that occurs based on a specified set of conditions. The DT300 Series boards support a number of trigger sources and trigger acquisition modes, described in the following subsections.

Trigger Sources

The DT300 Series board supports a software trigger and an external digital (TTL) trigger.

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

An external digital trigger event occurs when the DT300 Series board detects either a rising (positive) or falling (negative) edge on the External TTL Trigger input signal connected to screw terminal TB46 on the STP300 screw terminal panel (pin 56 of connector J1). The trigger signal is TTL-compatible. Using software, specify the trigger source as a positive external digital trigger or negative external digital trigger.

Trigger Acquisition Modes

DT300 Series 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 (continuous mode) when you want to acquire data when a post-trigger or retrigger, if using triggered scan mode, occurs.

Using software, specify:

- 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 77](#) for more information on the supported conversion modes; refer to [page 80](#) 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 78](#) for more information on triggered scan mode.

[Figure 25](#) 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. When it reaches the end of the channel list, the board wraps to the beginning of the channel list and repeats this process. Data is acquired continuously (continuously-paced scan mode).

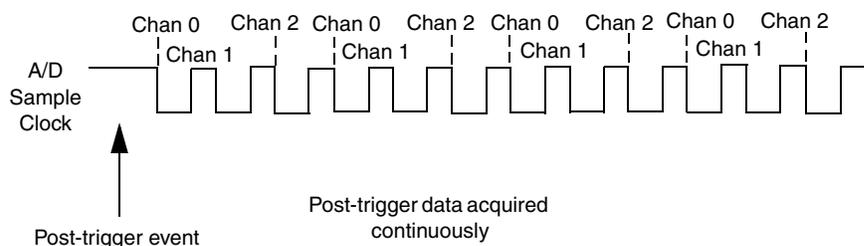


Figure 25: Continuous Post-Trigger Mode without Triggered Scan

Figure 26 illustrates the same example using triggered scan mode (either internally or externally retriggered). 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.

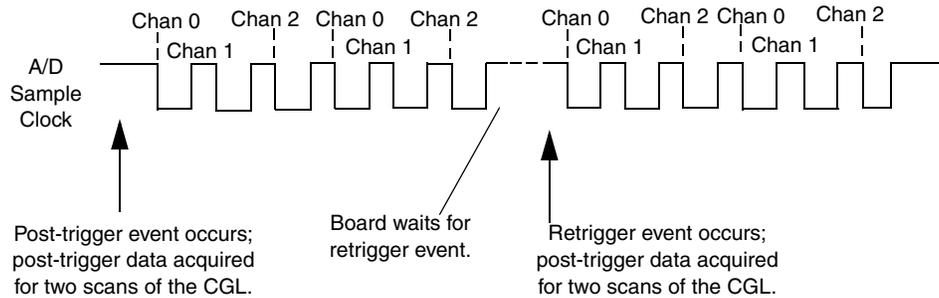


Figure 26: Continuous Post-Trigger Mode with Triggered Scan

Pre-Trigger Acquisition

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

Using software, specify:

- The dataflow as `ContinuousPreTrigger`
- The pre-trigger source as the software trigger
- The post-trigger source as the external, positive, digital (TTL) trigger
- The retrigger mode as the software retrigger if you are using triggered scan mode

Refer to [page 77](#) for more information on the supported conversion modes; refer to [page 80](#) for information on the supported trigger sources.

Note: When using pre-trigger acquisition, you cannot use externally-retriggered scan mode; refer to [page 78](#) 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 software retrigger clock to clock the operation. When the post-trigger event occurs, acquisition stops. Refer to [page 78](#) for more information on software-retriggered scan mode.

[Figure 27](#) 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. When it reaches the end of the channel list, the board wraps to the beginning of the channel list and repeats this process. Data is acquired continuously until the post-trigger event occurs. When the post-trigger event occurs, acquisition stops.

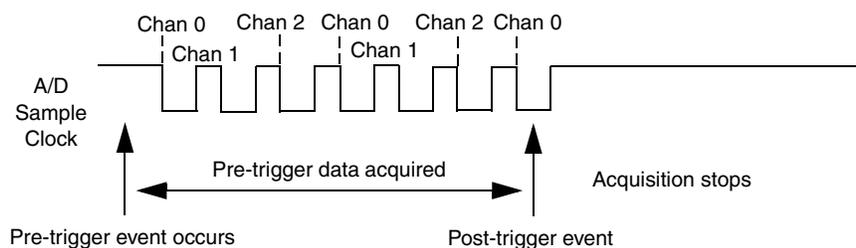


Figure 27: Continuous Pre-Trigger Mode

[Figure 28](#) illustrates the same example using software-retriggered 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. Acquisition stops when the post-trigger event occurs.

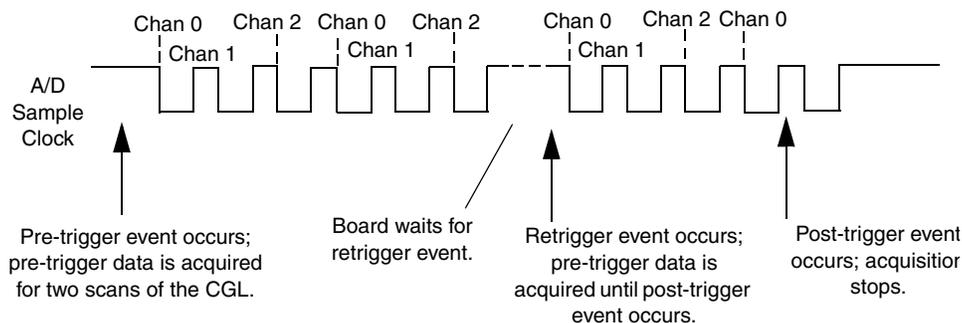


Figure 28: Continuous Pre-Trigger Mode with Triggered Scan

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

Refer to [page 77](#) for more information on the supported conversion modes; refer to [page 80](#) for information on the supported trigger sources.

Note: When using about-trigger acquisition, you cannot use externally-retriggered scan mode; refer to [page 78](#) for more information on triggered scan mode.

The about-trigger acquisition starts when you start the operation. When it 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 software retrigger clock to clock the operation. If, however, the post-trigger event has occurred, the board continues to acquire post-trigger data using the software retrigger clock 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 78](#) for more information on software-retriggered scan mode.

[Figure 29](#) 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 continuously on each clock pulse of the A/D sample clock 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.

Data Format

DT300 Series boards use offset binary data encoding to represent unipolar and bipolar signals. Using software, specify the data encoding as binary.

In software, the analog input value is returned as a code. To convert the code to voltage, use the following formulas:

$$\text{LSB} = \frac{\text{FSR}}{2^N}$$

$$V_{\text{out}} = \text{Code} * \text{LSB} + \text{offset}$$

where,

- *LSB* is the least significant bit.
- *FSR* is the full-scale range. For the DT300 Series, the full-scale range is 10 for the unipolar range or 20 for the bipolar range.

Note: DT321 and DT322 boards support bipolar signals only.

- *N* is the number of bits of the A/D converter. For the DT301, DT302, DT303, and DT304 boards, *N* is 12. For the DT321 and DT322 boards, *N* is 16.
- *V_{out}* is the analog voltage.
- *Code* is the raw count used by the software to represent the voltage.
- *Offset* is the actual minus full-scale value. Theoretically, the minus full-scale value is 0.0 V for the unipolar input range and -10 V for the bipolar input range. However, the actual minus full-scale value may be slightly different than these values, such as 0.01 V and/or -9.99 V. For greatest accuracy, use the actual minus full-scale value when converting codes to voltage.

For example, assume that you are using a DT301 board with a unipolar input range. The actual minus full-scale value is 0.01 V. If the software returns a code of 2010 for the analog input operation, determine the analog input voltage as follows:

$$\text{LSB} = \frac{10}{4096} = 0.002441 \text{ V}$$

$$V_{\text{out}} = 2010 * 0.002441 + 0.01 \text{ V}$$

$$V_{\text{out}} = 4.916 \text{ V}$$

Similarly, assume that you are using a DT322 board with a bipolar input range. The actual minus full-scale value is -9.98 V. If the software returns a code of 2010 for the analog input operation, determine the analog input voltage as follows:

$$\text{LSB} = \frac{20}{65536} = 0.000305 \text{ V}$$

$$V_{out} = 2010 * 0.000305 + -9.98 \text{ V}$$

$$V_{out} = -9.367 \text{ V}$$

For the DT301, DT302, DT303, and DT304 boards, the board outputs FFFh (plus full-scale) for above-range signals and 000h (minus full-scale) for below-range signals. For the 16-bit resolution DT321 and DT322 boards, the board outputs FFFFh (plus full-scale) for above-range signals and 0000h (minus full-scale) for below-range signals.

Data Transfer

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 in the host computer; this buffer is dedicated to the hardware. The board treats each buffer as two consecutive 128 KB blocks of memory.

Note: When you stop an analog input operation, a final block of two samples is transferred even if only one sample is required. The host software ignores the extra sample.

The DT300 Series 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

The DT300 Series board 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. To avoid this error, ensure that you allocated at least three buffers at least as large as the sampling rate; for example, if you are using a sampling rate of 100 kSamples/s (100 kHz), specify a buffer size of 100,000 samples).

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

An analog output (D/A) subsystem is provided on the DT302, DT304, and DT322 boards only. This section describes the following features of the D/A subsystem:

- Output resolution
- Analog output channels
- Output ranges and gains
- Conversion modes
- Data formats and transfer
- Error conditions

Output Resolution

[Table 9](#) lists the output resolutions supported by the DT302, DT304, and DT322 boards. The resolution is fixed for each board type; therefore, it cannot be programmed in software.

Table 9: Supported Analog Output Resolutions

Board Type	Supported Resolution
DT302	12 bits
DT304	12 bits
DT322	16 bits

Analog Output Channels

The DT302, DT304, and DT322 boards support two serial, multiplying, DC-level analog output channels (DAC0 and DAC1). Refer to [Chapter 4 starting on page 41](#) for information on how to wire analog output signals to the board using the screw terminal panel. You configure the channel type as differential through software.

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 $0\text{ V} \pm 10\text{ mV}$. Resetting the board does not clear the values in the DACs.

The DT300 Series board can output data from a single analog output channel only. Specify the channel for a single-value analog output operation using software; refer to [“Conversion Modes,”](#) on this page for more information on single-value operations.

Output Ranges and Gains

For the DT302 and DT304 board, you can specify one of the following ranges for each DAC using software: $\pm 10\text{ V}$, $0\text{ to }10\text{ V}$, $\pm 5\text{ V}$, or $0\text{ to }5\text{ V}$. For the DT322 board, the range is fixed at $\pm 10\text{ V}$.

In software, specify a gain of 1 for analog output operations.

Conversion Modes

DT302, DT304, and DT322 boards can perform single-value operations only. Use software to specify the range, gain, and analog output channel (among other parameters), then output the data from the specified channel. You cannot specify a clock source, trigger source, or buffer.

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

Data Format

Data from the host computer must use offset binary data encoding for analog output signals. Using software, specify the data encoding as binary.

In software, you need to supply a code that corresponds to the analog output value you want the board to output. To convert a voltage to a code, use the following formulas:

$$\text{LSB} = \frac{\text{FSR}}{2^N}$$

$$\text{Code} = \frac{V_{\text{out}} - \text{offset}}{\text{LSB}}$$

where,

- *LSB* is the least significant bit.
- *FSR* is the full-scale range. For the DT300 Series, the full-scale analog output range is 5 for the unipolar range of 0 to 5 V; 10 for the unipolar range of 0 to 10 V or the bipolar output range of ± 5 V; or 20 for the bipolar range or ± 10 V.
- *N* is the number of bits of the D/A converter. For the DT302 and DT304 boards, *N* is 12. For the DT322 board, *N* is 16.
- *Code* is the raw count used by the software to represent the voltage.
- *V_{out}* is the analog voltage.
- *Offset* is the minus full-scale value. The minus full-scale value is 0.0 V for the unipolar range and either -5 V for the ± 5 V range or -10 V for the ± 10 V range.

For example, assume that you are using a DT302 board with a unipolar output range of 0 to 5 V. The minus full-scale value is 0 V. If you want to output a voltage of 4.7 V, determine the code value as follows:

$$\text{LSB} = \frac{5}{4096} = 0.001221 \text{ V}$$

$$\text{Code} = \frac{4.7 \text{ V} - 0 \text{ V}}{0.001221 \text{ V}}$$

$$\text{Code} = 3849 = 0F09\text{h}$$

Similarly, assume that you are using a DT322 board with a bipolar output range of ± 10 V. The minus full-scale value is -10 V. If you want to output a voltage of 4.7 V, determine the code value as follows:

$$\text{LSB} = \frac{20}{65536} = 0.000305 \text{ V}$$

$$\text{Code} = \frac{4.7 \text{ V} - (-10 \text{ V})}{0.000305 \text{ V}}$$

$$\text{Code} = 48196 = \text{BC44h}$$

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

DT300 Series boards support 23 digital I/O lines through the digital input (DIN) and output (DOUT) subsystems; DIN and DOUT subsystems use the same digital I/O lines. These lines are divided into the following ports:

- Port A, lines 0 to 7,
- Port B, lines 0 to 7, and
- Port C, lines 0 to 6.

You can use each port for either input or output; all lines within a port have the same configuration. For example, if you use Port A as an input port, lines 0 to 7 of Port A are configured as inputs. Likewise, if you use Port C as an output port, lines 0 to 6 of Port C are configured as outputs.

For fast, clocked digital input operations, you can enter the digital I/O lines from Ports A and B as a channel in the analog input channel list; refer to [page 74](#) for more information.

By default, the digital I/O lines power up as digital inputs. On power up or reset, no digital data is output from the board.

Digital I/O Resolution

For Ports A and B, you can specify the number of lines to read or write by specifying the resolution in software. If you specify a resolution of 8, element 0 (the first subsystem) corresponds to the Port A, lines 0 to 7; element 1 (the second subsystem) corresponds to Port B, lines 0 to 7; and element 2 (the third subsystem) corresponds to Port C, lines 0 to 6.

If you specify a resolution of 16, element 0 corresponds to Ports A and B, lines 0 to 15; element 1 also corresponds to Ports A and B, lines 0 to 15; and element 2 corresponds to Port C, lines 0 to 6.

Note: When the resolution is 16, digital I/O lines 0 to 7 of Port B are represented as bits 8 to 15 of the digital value; do not use element 0 and element 1 at the same time.

The resolution of Port C is fixed at 7; Port C cannot be combined with Port A or B.

Digital I/O Operation Modes

The DT300 Series board supports the following digital I/O operation modes:

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

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

- **Continuous digital input** takes full advantage of the capabilities of the DT300 Series board. In this mode, enter all 16 digital input lines of Ports A and B as channel 16 of the analog input channel list; program this mode through the A/D subsystem. Using this mode, you can specify a clock source, scan mode, trigger source, and buffer for the digital input operation. Refer to [page 74](#) for more information on specifying digital input lines for a continuous digital input operation.

Counter/Timer Features

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

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

Counter/Timer Channels

The DT300 Series board supports four user 16-bit counter/timer channels (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 31](#).

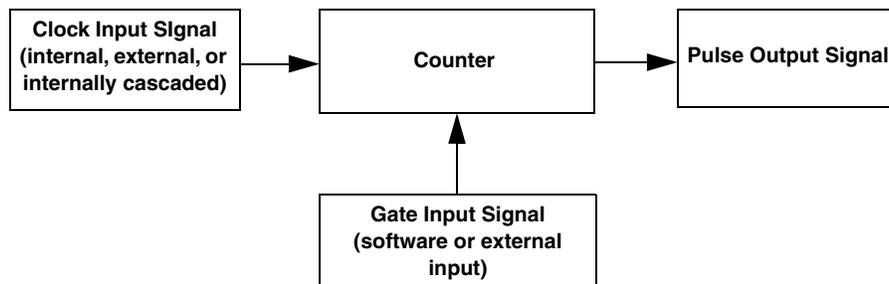


Figure 31: Counter/Timer Channel

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.

Using software, you can 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.

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. For a 16-bit counter, the minimum frequency that you can specify for the clock output signal is 305.17 Hz. 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.

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 65535. 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 source to the board through the STP300 screw terminal panel as follows:

- For Counter 0, connect the external C/T clock signal to screw terminal TB26 (pin 41 of connector J1)
- For Counter 1, connect the external C/T clock signal to screw terminal TB30 (pin 7 of connector J1)
- For Counter 2, connect the external C/T clock signal to screw terminal TB34 (pin 36 of connector J1)
- For Counter 3, connect the external C/T clock signal to screw terminal TB38 (pin 2 of connector J1)

Internally Cascaded Clock

The DT300 Series board supports internal cascading on counters 0 and 1, 1 and 2, and 2 and 3. Cascading counters internally is an effective way to create a 32-bit counter without externally connecting two counters together.

Using software, specify internal cascade mode, then specify the clock input and gate input for the first counter in the cascaded pair. The clock output signal from first counter is the clock input signal of the second counter. For example, if counters 1 and 2 are cascaded, specify the clock input and gate input for counter 1.

The rising edge of the clock input signal is active.

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. The DT300 Series board provides 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 97](#) 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 97](#) for more information on these modes.
- **Falling-edge external gate input** – Triggers 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 97](#) for more information on these modes.
- **Rising-edge external gate input** – Triggers 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 97](#) for more information on these modes.

Specify the gate type in software. Connect an external gate input to the board through the STP300 screw terminal panel as follows:

- For Counter 0, connect the external gate signal to screw terminal TB28 (pin 39 of connector J1)
- For Counter 1, connect the external gate signal to screw terminal TB32 (pin 5 of connector J1)
- For Counter 2, connect the external gate signal to screw terminal TB36 (pin 38 of connector J1)

- For Counter 3, connect the external gate signal to screw terminal TB40 (pin 4 of connector J1)

Pulse Outputs

The DT300 Series boards provide the following C/T pulse output signals:

- For Counter 0, the C/T output signal is screw terminal TB27 (pin 40 of connector J1)
- For Counter 1, the C/T output signal is screw terminal TB31 (pin 6 of connector J1)
- For Counter 2, the C/T output signal is screw terminal TB35 (pin 37 of connector J1)
- For Counter 3, the external C/T output signal is screw terminal TB39 (pin 3 of connector J1)

The DT300 Series board supports 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.

Using software, you can specify the duty cycle of the pulse. 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. [Figure 32](#) illustrates a low-to-high pulse with a duty cycle of approximately 30%.

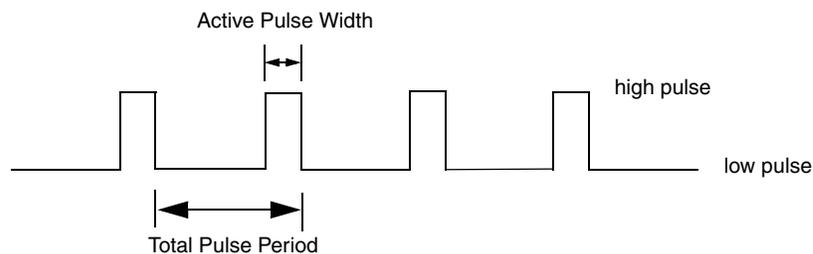


Figure 32: Example of a Low-to-High Pulse Output Type

Counter/Timer Operation Modes

The DT300 Series board supports the following counter/timer operation modes:

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

Refer to the following subsections for more information on these operation modes.

Event Counting

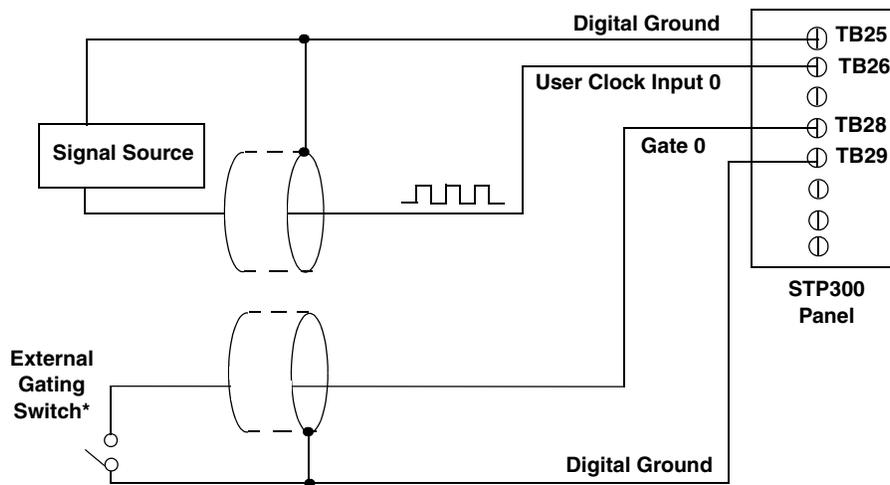
Use event counting mode to count events from the counter's associated clock input source.

If you are using one counter, the board 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, the board 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 95](#) for more information on the external C/T clock source.

Using software, specify the counter/timer mode as event counting (count), the clock source as external, and the gate type that enables the operation. Refer to [page 96](#) for more information on gate types.

Ensure that the signals are wired appropriately. [Figure 33](#) shows one example of connecting an event counting application to the STP300 screw terminal panel using user counter 0. In this example, rising clock edges are counted while the gate is active.



*An internal 33 ohm series resistor is used.

**Figure 33: Connecting Event Counting Signals
(Shown for Clock Input 0 and External Gate 0)**

Figure 34 shows an example of performing an event counting operation. In this example, the gate type is low level.

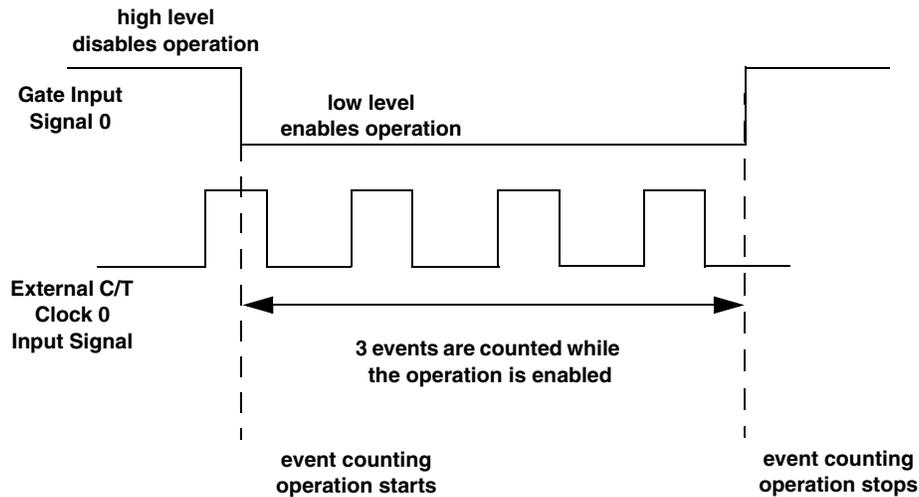


Figure 34: Example of Event Counting

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 95](#) for more information on the external C/T clock source.

One way to perform a frequency measurement is to use the same wiring as an event counting application that does not use an external gate signal, as shown in [Figure 35](#).

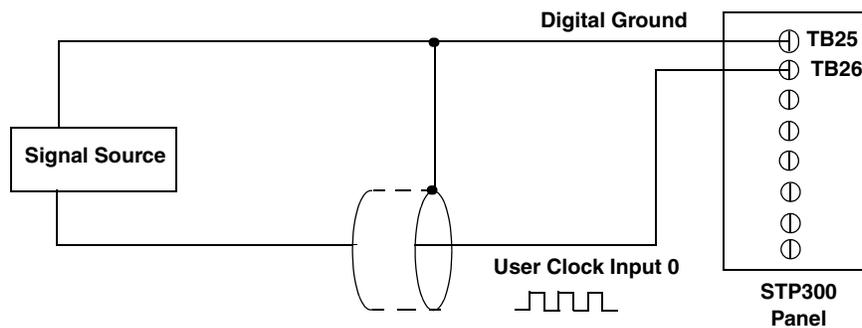


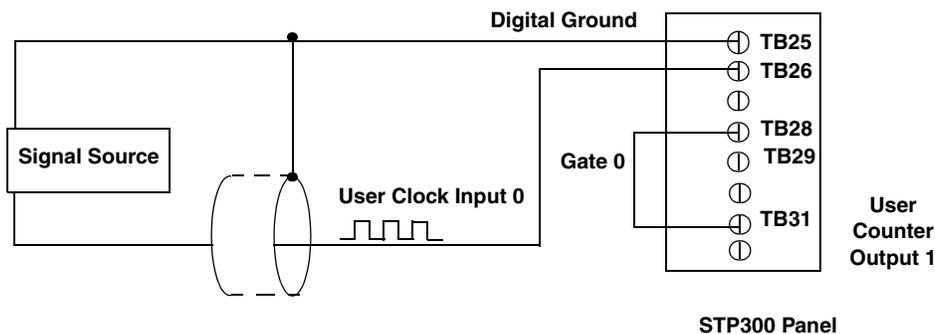
Figure 35: Connecting Frequency Measurement Signals without an External Gate Input (Shown for Clock Input 0)

In this configuration, use software to specify the counter/timer mode as frequency measurement or event counting, and the duration of the Windows timer over which to measure the frequency. (The Windows timer uses a resolution of 1 ms.) In this configuration, frequency is determined using the following equation:

$$\text{Frequency Measurement} = \frac{\text{Number of Events}}{\text{Duration of the Windows Timer}}$$

If you need more accuracy than the Windows timer provides, you can 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 36.



**Figure 36: 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 37 shows an example of performing a frequency measurement operation. In this example, three events are counted during a duration of 300 ms. The frequency, then, is 10 Hz, since $10 \text{ Hz} = 3 / (.3 \text{ s})$.

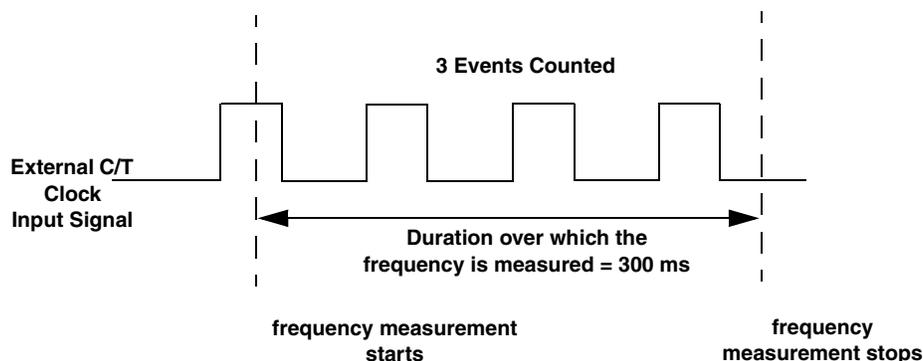


Figure 37: Example of Frequency Measurement

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 or other counter/timer operations.

While the pulse output operation is enabled (determined by the gate input signal), 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 external clock divider. If you are using one counter (not cascaded), you can output pulses using a maximum frequency of 10 MHz. In rate generation mode, either the internal or external C/T clock input source is appropriate depending on your application; refer to [page 95](#) 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 97](#) for more information on the pulse output types; refer to [page 96](#) for more information on gate types.

Ensure that the signals are wired appropriately. [Figure 38](#) shows one example of connecting a pulse output operation to the STP300 screw terminal panel using user counter 0. In this example, a software gate type is used.

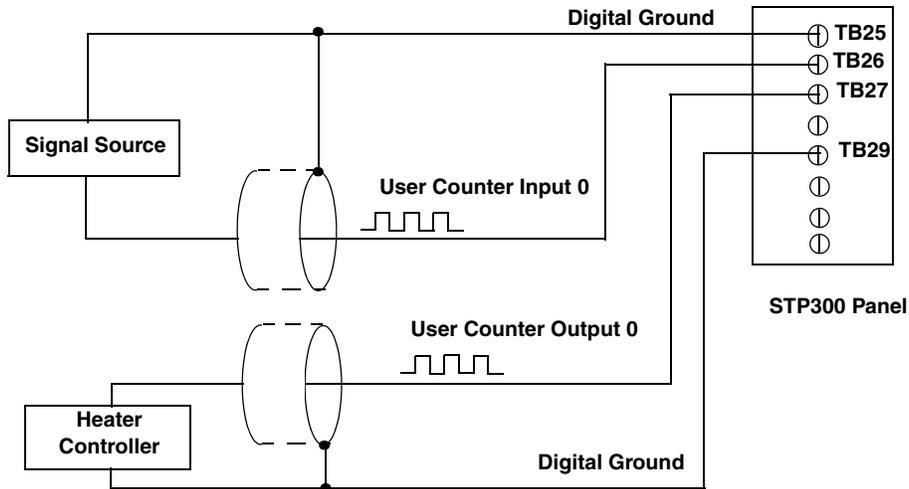


Figure 38: Connecting Rate Generation Signals (Shown for Counter 0; a Software Gate Is Used)

Figure 39 shows an example of performing 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 40 shows the same example using a duty cycle of 25%.

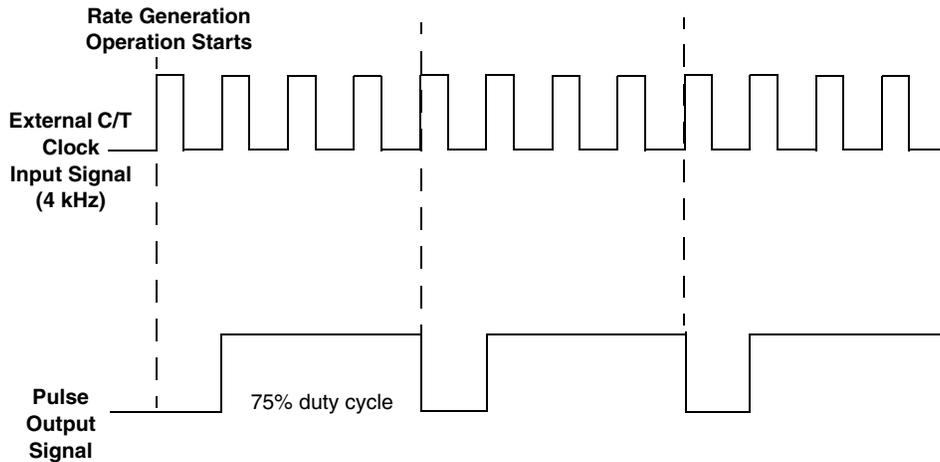


Figure 39: Example of Rate Generation Mode with a 75% Duty Cycle

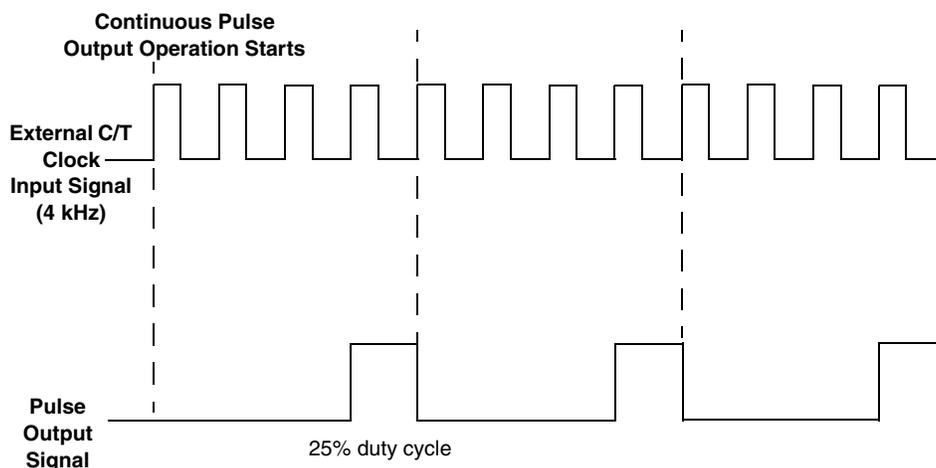


Figure 40: Example of Rate Generation Mode with a 25% Duty Cycle

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 an external instrument.

When the one-shot operation is triggered and 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. Refer to [page 95](#) for more information on the C/T clock sources.

Using software, specify the counter/timer mode as one-shot, the clock source, 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 97](#) for more information on pulse output types. Refer to [page 96](#) for more information on gate types.

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

Ensure that the signals are wired appropriately. [Figure 41](#) shows one example of connecting a pulse output operation to the STP300 screw terminal panel using user counter 0.

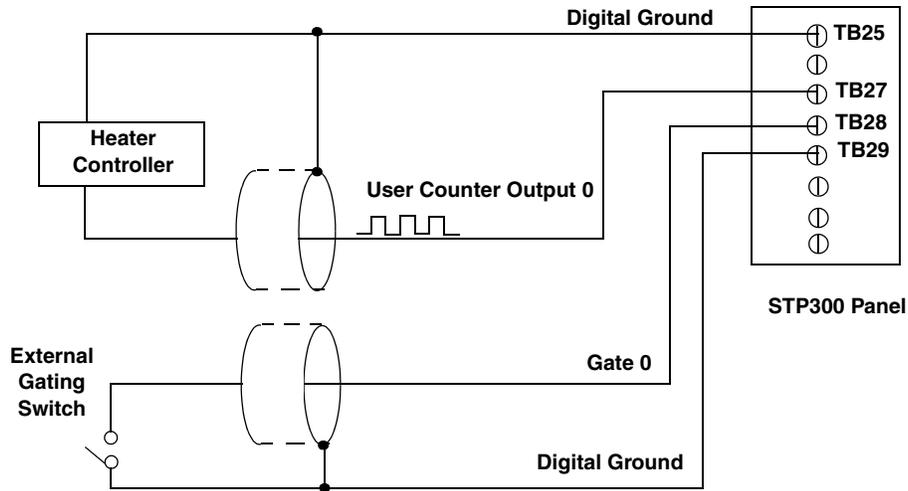


Figure 41: Connecting One-Shot Signals (Shown for Counter Output 0 and Gate 0)

Figure 42 shows an example of performing 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.

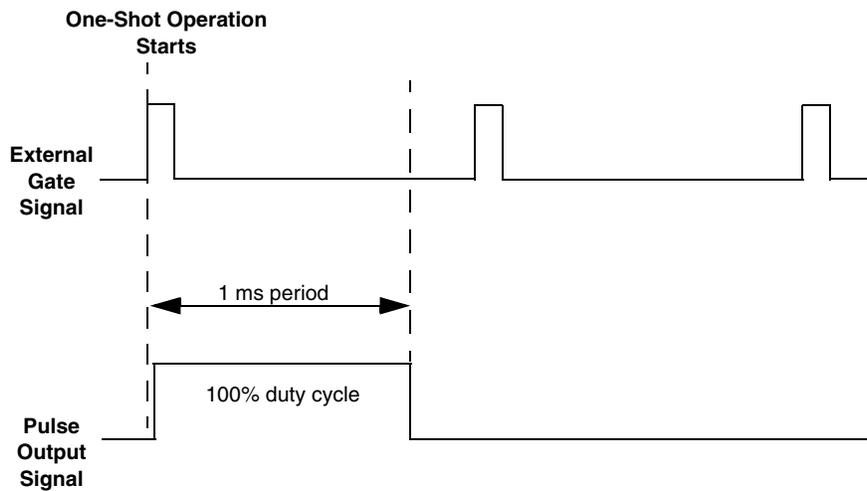


Figure 42: Example of One-Shot Mode

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.

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.

The period of the output pulse is determined by the clock input signal. In repetitive one-shot mode, the internal C/T clock source is more useful than the external C/T clock source; refer to [page 95](#) for more information on the C/T clock sources.

Using software, specify the counter/timer mode as repetitive one-shot, the clock source as internal, the polarity of the output pulses (high-to-low transitions or low-to-high transitions), and the gate type to trigger the operation. Refer to [page 97](#) for more information on pulse output types; refer to [page 96](#) for more information on gate types.

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

Ensure that the signals are wired appropriately. Refer to [Figure 41](#) on [page 104](#) for a wiring example.

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

[Figure 43](#) shows an example of a repetitive one-shot operation using an external gate (rising edge); a clock output frequency of 1 kHz (pulse period of 1 ms), and a low-to-high pulse type.

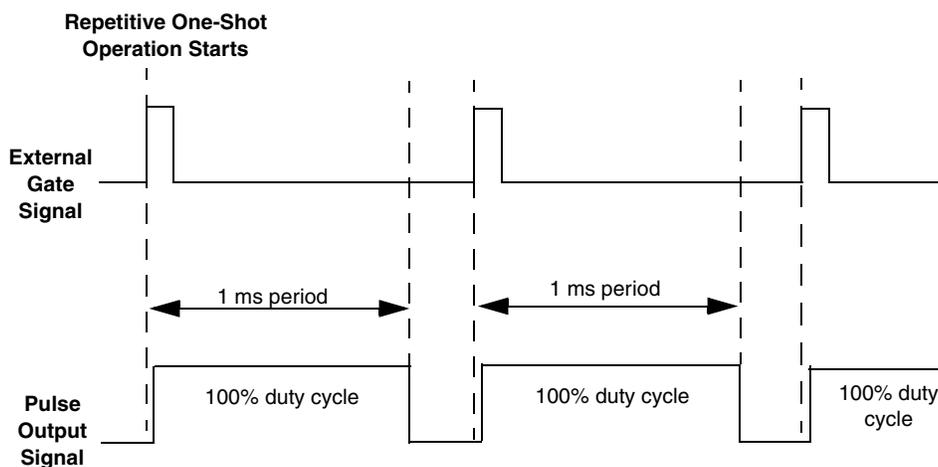


Figure 43: Example of Repetitive One-Shot Mode



Supported Device Driver Capabilities

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The DT300 Series 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.

Table 10: DT300 Series Subsystems

DT300 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Total Subsystems on Board	1	2	3 ^a	3 ^b	4	0

a. The DIN and DOUT subsystems use the same DIO lines.

b. D/A subsystems are supported by the DT302, DT304, and DT322 boards only.

The tables in this chapter summarize the features available for use with the DT-Open Layers for .NET Class Library and the DT300 Series 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 11: DT300 Series Data Flow and Operation Options

DT300 Series	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 ^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						
Supports Programmable Synchronization Modes SupportsSynchronization						
Synchronization Modes SynchronizationMode						
Interrupt Support SupportsInterruptOnChange						
Output FIFO Size FifoSize						
Auto-Calibrate Support SupportsAutoCalibrate						

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

Buffering

Table 12: DT300 Series Buffering Options

DT300 Series	A/D	D/A	DIN	DOU	C/T	QUAD
Buffer Support SupportsBuffering	Yes					
Single Buffer Wrap Mode Support SupportsWrapSingle	Yes					
Inprocess Buffer Flush Support SupportsInProcessFlush	Yes					

Triggered Scan Mode

Table 13: DT300 Series Triggered Scan Mode Options

DT300 Series	A/D	D/A	DIN	DOU	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	155 kHz, 219 kHz, or 165 kHz ^b	0	0	0	0	0
Minimum Retrigger Frequency MinRetriggerFreq	1.2 Hz ^c	0	0	0	0	0

- a. The CGL depth of 1024 entries in conjunction with a multiscan count of 256 provides an effective CGL depth of up to 256K entries.
- b. The maximum retrigger frequency depends on the board type. For DT301 and DT302 boards, the maximum retrigger frequency is 155 kHz. For DT303 and DT304 boards, the maximum retrigger frequency is 219 kHz. For DT321 and DT322 boards, the maximum retrigger frequency is 165 kHz. The maximum retrigger frequency is based on the number of samples per trigger, as follows:
 Min. Retrigger = $\frac{\# \text{ of CGL entries} \times \# \text{ of CGLs per trigger} + 2 \mu\text{s}}{\text{A/D sample clock frequency}}$
 Max. Retrigger = $\frac{1}{\text{Min. Retrigger Period}}$
- c. The value of 1.2 Hz assumes the minimum number of samples is 1.

Data Encoding

Table 14: DT300 Series Data Encoding Options

DT300 Series	A/D	D/A	DIN	DOU	C/T	QUAD
Binary Encoding Support SupportsBinaryEncoding	Yes	Yes	Yes	Yes	Yes	
Twos Complement Support SupportsTwosCompEncoding						
Returns Floating-Point Values ReturnsFloats						

Channels

Table 15: DT300 Series Channel Options

DT300 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Channels NumberOfChannels	17 ^a	2	1	1	1	0
SE Support SupportsSingleEnded	Yes					
SE Channels MaxSingleEndedChannels	16	0	0	0	0	0
DI Support SupportsDifferential	Yes	Yes	Yes	Yes		
DI Channels MaxDifferentialChannels	8	2	1	1	1	0
Maximum Channel-Gain List Depth CGLDepth	1024	1	0 ^b	0 ^b	0	0
Simultaneous Sample-and-Hold Support SupportsSimultaneousSampleHold						
Channel-List Inhibit SupportsChannelListInhibit	Yes					

- a. Channels 0 to 15 are provided for analog input; channel 16 reads all 16 bits from the DIN subsystem (Ports A and B). If the channel-gain list contains channel 16 only, the board can read the digital input channels at a rate of 3 MSamples/s.
- b. All 16 bits of the DIO lines from Ports A and B are assigned to A/D input channel 16. While the DIN subsystem itself is incapable of continuous operation, you can perform a continuous DIN operation by specifying channel 16 in the channel-gain list of the A/D subsystem and starting the A/D subsystem.

Gain

Table 16: DT300 Series Gain Options

DT300 Series	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 17: DT300 Series Range Options

DT300 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Number of Voltage Ranges NumberOfRanges	1 or 2 ^a	4 or 1 ^b	0	0	0	0
Available Ranges SupportedVoltageRanges	±10 V, 0 to 10 V ^a	±10 V, 0 to 10 V, ±5 V, or 0 to 5 V ^b				
Current Output Support SupportsCurrentOutput						

- a. DT301, DT302, DT303, and DT304 boards support two input ranges: ±10 V and 0 to 10 V. DT321 and DT322 boards support one input range: ±10 V.
- b. DT302 and DT304 boards support four output ranges: ±10 V, 0 to 10 V, ±5 V, and 0 to 5 V. DT322 boards support one output range: ±10 V.

Resolution

Table 18: DT300 Series Resolution Options

DT300 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Programmable Resolution SupportsSoftwareResolution			Yes ^a	Yes ^a		
Number of Resolutions NumberOfResolutions	1	1	2 ^a	2 ^a	1	1
Available Resolutions SupportedResolutions	12 or 16 ^b	12 or 16 ^b	8, 16	8, 16		

- a. When configured for 16 bits of resolution, both element 0 and element 1 use DIO bits 15 to 0 (Ports A and B are combined); however, you cannot use both elements at the same time. When configured for 8 bits of resolution, element 0 uses bits 7 to 0 (Port A) and element 1 uses bits 15 to 8 (Port B). Port C (element 2) always uses a fixed resolution of 7 and cannot be combined with Port A and Port B.
- b. The DT301, DT302, DT303, and DT304 boards support 12-bit resolution. The DT321 and DT322 boards support 16-bit resolution.

Thermocouple and RTD Support

Table 19: DT300 Series Thermocouple and RTD Support Options

DT300 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Thermocouple Support SupportsThermocouple						
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 20: DT300 Series IEPE Support Options

DT300 Series	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 21: DT300 Series Trigger Options

DT300 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Software Trigger Support SupportsSoftwareTrigger	Yes	Yes	Yes	Yes	Yes	
External Positive TTL Trigger Support SupportsPosExternalTTLTrigger	Yes				Yes	
External Negative TTL Trigger Support SupportsNegExternalTTLTrigger	Yes					
External Positive TTL Trigger Support for Single-Value Operations SupportsSvPosExternalTTLTrigger						
External Negative TTL Trigger Support for Single-Value Operations SupportsSvNegExternalTTLTrigger						
Positive Threshold Trigger Support SupportsPosThresholdTrigger						
Negative Threshold Trigger Support SupportsNegThresholdTrigger						
Digital Event Trigger Support SupportsDigitalEventTrigger						

Clocks

Table 22: DT300 Series Clock Options

DT300 Series	A/D	D/A	DIN	DOUT	C/T	QUAD
Internal Clock Support SupportsInternalClock	Yes	Yes			Yes	
External Clock Support SupportsExternalClock	Yes				Yes	
Simultaneous Input/Output on a Single Clock Signal SupportsSimultaneousClocking						
Base Clock Frequency BaseClockFrequency	20 MHz	0	0	0	20 MHz	
Maximum Clock Divider MaxExtClockDivider	1.0	1.0	1.0	1.0	65536	
Minimum Clock Divider MinExtClockDivider	1.0	1.0	1.0	1.0	2.0	
Maximum Frequency MaxFrequency	3 MHz ^a	1.0 Hz	0	0	10 MHz ^b	
Minimum Frequency MinFrequency	1.2 Hz	1.0 Hz	0	0	0.005 Hz ^c	

- a. For DT301 and DT302 boards, the maximum throughput for analog input channels is 225 kHz; for DT303 and DT304 boards, the maximum throughput for analog input channels is 400 kHz; for DT321 and DT322 boards, the maximum throughput for analog input channels is 250 kHz. For all boards, if the channel-gain list contains channel 16 only (the digital input channel), the maximum throughput is 3 MHz.
- b. If using cascaded counter/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. If you are not using cascaded counter/timers, this value is approximately 305.18 Hz.

Counter/Timers

Table 23: DT300 Series Counter/Timer Options

DT300 Series	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	
None (internal) Gate Type Support SupportsGateNone					Yes	
High Level Gate Type Support SupportsGateHighLevel					Yes ^a	
Low Level Gate Type Support SupportsGateLowLevel					Yes ^a	
High Edge Gate Type Support SupportsGateHighEdge					Yes ^a	
Low Edge Gate Type Support SupportsGateLowEdge					Yes ^a	
Level Change Gate Type Support SupportsGateLevel						
Clock-Falling Edge Type SupportsClockFalling						
Clock-Rising Edge Type SupportsClockRising						
Gate-Falling Edge Type SupportsGateFalling						
Gate-Rising Edge Type SupportsGateRising						
Interrupt-Driven Operations SupportsInterrupt						

a. High-edge and low-edge gates 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

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The DT300 Series 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 I/O circuitry on the DT300 Series boards every six months.

Note: Ensure that you installed the DT300 Series Device Driver and prior to using the DT300 Series Calibration Utility.

This chapter describes how to run the DT300 Series Calibration Utility and calibrate the analog I/O circuitry of the DT300 Series boards.

Running the Calibration Utility

To start the DT300 Series Calibration Utility, do the following:

1. Click **Start** from the Task Bar.
2. Browse to **Programs | Data Translation, Inc | Calibration | DT300 Calibration Utility**.
The main menu appears.

Once the DT300 Series Calibration Utility is running, you can calibrate the analog I/O circuitry, as described in the following sections.

Calibrating the Analog Input Subsystem

To calibrate the analog input circuitry, you need an external +9.3750 V reference (precision voltage source). Using an external +9.3750 V reference provides an accuracy of approximately ± 3 LSB for the DT321 and DT322 boards and ± 1 LSB for remaining DT300 Series boards.

You can also choose to calibrate the analog input circuitry automatically or manually; auto-calibration is the easiest to use and is the recommended calibration method.

The following sections describe how to configure for calibration using either of the supported references and how to calibrate the analog input circuitry automatically and manually.

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 (TB1) to the positive side of the precision voltage source.
2. Connect Analog In 0 Return (TB2) to the negative side of the precision voltage source.
3. Connect Analog In 0 Return (TB2) to Analog Ground (TB18).
4. Connect Analog In 1 (TB3) to Analog In 1 Return (TB4) and to Analog Ground (TB18).

To calibrate the analog input circuitry automatically, continue on [page 120](#); to calibrate the analog input circuitry manually, continue on [page 121](#).

Using the Auto-Calibration Procedure

To calibrate the analog input subsystem automatically, do the following:

1. From the main menu of the DT300 Series Calibration Utility, click **Configure**, and then **Board**.
2. Select the name of the DT300 Series board to configure from the combo box, and then click **OK**.
3. From the main menu of the DT300 Series Calibration Utility, click **Calibrate**, and then **A/D**.
4. In the Auto Calibration box, click **Go**.
The bipolar (zero and full-scale) and unipolar (zero and full-scale) ranges are automatically calibrated.
5. 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 123](#).

Note: Calibrating the PGH Zero setting in software is no longer required; the hardware calibrates this setting automatically.

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

To calibrate the analog input circuitry manually, do the following:

1. From the main menu of the DT300 Series Calibration Utility, click **Configure**, and then **Board**.
2. Select the name of the DT300 Series board to configure from the combo box, and then click **OK**.
3. From the main menu of the DT300 Series Calibration Utility, click **Calibrate**.
4. Click **A/D**.
5. In the Range box, select **Bipolar**, and then **Zero**.
6. Click the increment or decrement arrows in the Manual Adjustment box until the display reads 0 V (within 0.0001 V for the DT321 and DT322 boards and within 0.0010 V for the remaining DT300 Series boards).
7. In the Range box, select **Bipolar**, and then **FS** (for full-scale).
8. Click the increment or decrement arrows in the Manual Adjustment box until the display reads +9.3750 V with the external reference (within 0.0001 V for the DT321 and DT322 boards and within 0.0010 V for the remaining DT300 Series boards).
9. In the Range box, select **Unipolar**, and then **Zero**.
10. Click the increment or decrement arrows in the Manual Adjustment box until the display reads 0 V (within 0.0001 V for the DT321 and DT322 boards and within 0.0010 V for the remaining DT300 Series boards).
11. In the Range box, select **Unipolar**, and then **FS** (for full-scale).
12. Click the increment or decrement arrows in the Manual Adjustment box until the display reads +9.3750 V with the external reference (within 0.0001 V for the DT321 and DT322 boards and within 0.0010 V for the remaining DT300 Series boards).
13. 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 123](#).

Note: Calibrating the PGH Zero setting in software is no longer required; the hardware calibrates this setting automatically.

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 Analog Output Subsystem

To calibrate the analog output circuitry, use an external precision meter. The following sections describe how to configure for calibration using the supported meters and how to calibrate the analog output circuitry.

Configuring for an External Meter

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

1. Connect Analog Out 0+ (TB19) to the positive side of the precision voltage meter.
2. Connect Analog Out 0 Return (TB20) to the negative side of the precision voltage meter.

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

1. Connect Analog Out 1+ (TB23) to the positive side of the precision voltage meter.
2. Connect Analog Out 1 Return (TB22) to the negative side of the precision voltage meter.

Continue with the next section.

Using the Calibration Procedure

To calibrate the analog output circuitry, do the following:

1. From the main menu of the DT300 Series Calibration Utility, click **Configure**, and then **Board**.
2. Select the name of the DT300 Series board to configure from the combo box, and then click **OK**.
3. From the main menu of the DT300 Series Calibration Utility, click **Calibrate**.
4. Click **D/A**.
5. In the D/A box, select **DAC0**.
6. Click the increment or decrement arrows in the Manual Adjustment box until the display reads 0 V (within 0.0005 V).
7. Select **+FS** and verify that the display reads +9.375 V (within ± 12 mV for the DT322 and within ± 20 mV for the DT302 and DT304 boards.)
8. In the D/A box, select **DAC1**.
9. Click the increment or decrement arrows in the Manual Adjustment box until the display reads 0 V (within 0.0005 V).
10. Select **+FS** and verify that the display reads +9.375 V (within ± 12 mV for the DT322 and within ± 20 mV for the DT302 and DT304 boards.)
11. 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 Calibration Utility, click the close box in the upper, right corner of the window.



Troubleshooting

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General Checklist

Should you experience problems using a DT300 Series 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 loaded 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 24](#) to isolate and solve the problem. If you cannot identify the problem, refer to [page 128](#).

Table 24: 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 DT300 Series 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 128 .
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 137 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 24: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Computer does not boot.	Board is not seated properly.	Check that the slot in which your DT300 Series 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 132 of this manual.
System lockup.	Board is not seated properly.	Check that the slot in which your DT300 Series 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 DT300 Series 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).



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Analog Input Specifications

Table 25 lists the specifications for the A/D subsystem.

Table 25: A/D Subsystem Specifications

Feature	DT301/302 Specifications	DT303/304 Specifications	DT321/322 Specifications
Number of analog inputs Single-ended/ pseudo-differential: Differential:	16 8		
Number of gains	4 (1, 2, 4, 8)		
Resolution	12 bits	12 bits	16 bits
Data encoding	Offset binary		
System accuracy (full-scale) Gain = 1: Gain = 2: Gain = 4: Gain = 8:	0.03% 0.04% 0.05% 0.05%	0.03% 0.04% 0.05% 0.05%	0.01% 0.02% 0.03% 0.03%
Nonlinearity (integral)	±1.0 LSB	±1.0 LSB	±4.0 LSB
Differential linearity	±0.5 LSB (no missing codes)	±0.5 LSB (no missing codes)	±1.2 LSB (no missing codes to 15 bits)
Range (V) Bipolar: Unipolar:	±1.25, 2.5, 5, 10 0 to 1.25, 0 to 2.5, 0 to 5, 0 to 10	±1.25, 2.5, 5, 10 0 to 1.25, 0 to 2.5, 0 to 5, 0 to 10	±1.25, 2.5, 5, 10
Drift Zero: Gain:	±30 μV+ (+20 μV * Gain)/°C ±30 ppm/°C	±30 μV+ (+20 μV * Gain)/°C ±30 ppm/°C	±25 μV+ (+10 μV*Gain)/°C ±20 ppm/°C
Input impedance Off: On:	100 MΩ, 10 pF 100 MΩ, 100 pF		
Input bias current	±20 nA		
Common mode voltage	±11 V maximum (operational)		
Maximum input voltage	±40 V maximum (protection)		
A/D converter noise	0.3 LSB rms		
Amplifier input noise	20 μV rms + (10 μV rms*gain) 200 pA rms (current)	20 μV rms + (10 μV rms*gain) 200 pA rms (current)	15 μV rms + (10 μV rms*gain) 100 pA rms (current)

Table 25: A/D Subsystem Specifications (cont.)

Feature	DT301/302 Specifications	DT303/304 Specifications	DT321/322 Specifications
Channel-to-channel offset	±40.0 µV		
Channel acquisition time	3 µs	1 µs	1 µs
A/D conversion time	4.4 µs	2.5 µs	4 µs
Effective number of bits (ENOB)	11.5 bits	11.5 bits	13.5 bits
Total Harmonic Distortion	−80 dB typical	−80 dB typical	−90 dB typical
Channel crosstalk	−80 dB @ 1 kHz		
Data throughput			
Single analog channel:	225 kSamples/s (0.03% accuracy)	400 kSamples/s (0.03% accuracy)	250 kSamples/s (0.01% accuracy)
Multiple channels (scan):	225 kSamples/s (0.05% accuracy)	400 kSamples/s (0.05% accuracy)	250 kSamples/s (0.03% accuracy)
Single digital channel:	200 kSamples/s (.03% accuracy)	360 kSamples/s (.03% accuracy)	150 kSamples/s (.01% accuracy)
Single digital channel:	3 MSamples/s	3 MSamples/s	3 MSamples/s
External A/D sample clock	Schmitt trigger, falling-edge sensitive		
Input type:	1 HCT14 (TTL)		
Input load:	2.0 V minimum		
High-level input voltage:	0.8 V maximum		
Low-level input voltage:	0.4 V (minimum); 1.5 V (maximum)		
Hysteresis:	1.0 µA		
High-level input current:	−1.0 µA		
Low-level input current:	100 ns (high); 100 ns (low)		
Minimum pulse width:	See Data Throughput spec above		
Maximum frequency:	33 Ω series resistor		
Termination:			
External A/D digital (TTL) trigger	Schmitt trigger, edge sensitive		
Input type:	1 HCT14 (TTL)		
Input load:	2.0 V minimum		
High-level input voltage:	0.8 V maximum		
Low-level input voltage:	0.4 V (minimum); 1.5 V (maximum)		
Hysteresis:	1.0 µA		
High-level input current:	−1.0 µA		
Low-level input current:	100 ns (high); 100 ns (low)		
Minimum pulse width:	33 Ω series resistor		
Termination:			

Analog Output Specifications

Table 26 lists the specifications for the D/A subsystem.

Table 26: D/A Subsystem Specifications

Feature	Specifications
Number of analog output channels (DT302, DT304, and DT322 only)	2
Resolution DT302, DT304: DT322:	12 bits 16 bits
Data encoding (input)	Offset binary
Nonlinearity (integral) DT302, DT304: DT322:	± 1 LSB ± 4 LSB
Differential linearity DT302, DT304: DT322:	± 0.5 LSB (monotonic) ± 1 LSB (monotonic)
Output range DT302, DT304: DT322:	± 10 V, 0 to 10 V, ± 5 V, 0 to 5 V ± 10 V
Zero Error:	Software-adjustable to zero
Gain Error DT302, DT304: DT322:	± 2 LSB + reference ± 6 LSB + reference
Current output	± 5 mA minimum (10 V/ 2 k Ω)
Output impedance	0.3 Ω typical
Capacitive drive capability	0.001 μ F minimum (no oscillations)
Protection	Short circuit to Analog Common
Power-on voltage	0 V ± 10 mV maximum
Settling time to 0.01% of FSR	50 μ s, 20 V step; 10.0 μ s, 100 mV step
Slew rate	2 V/ μ s
Multiplying Zero Error	± 10 mV maximum
External Reference Output	+10 V ± 10 mV
Reference Input Impedance	5 k Ω typical

Digital I/O Specifications

Table 27 lists the specifications for the DIN/DOUT subsystems.

Table 27: DIN/DOUT Subsystem Specifications

Feature	Port A Specifications	Port B Specifications	Port C Specifications
Number of lines	8 (bidirectional)	8 (bidirectional)	7 (bidirectional)
Termination	47 k Ω resistor pullup to +3.3 V; 33 Ω series resistor		
Inputs			
Input type:	Level sensitive	Level sensitive	Level sensitive
Input load:	2 TTL	2 TTL	1 TTL
High-level input voltage:	2.0 V minimum	2.0 V minimum	2.0 V minimum
Low-level input voltage:	0.8 V maximum	0.8 V maximum	0.8 V maximum
High-level input current:	3 μ A	3 μ A	100 μ A
Low-level input current:	-3 μ A	-3 μ A	-100 μ A
Outputs			
Output driver:	TTL	TTL	TTL
Output driver high voltage:	2.4 V minimum (IOH = -15 mA)	2.4 V minimum (IOH = -15 mA)	2.4 V minimum (IOH = 4 mA)
Output driver low voltage:	0.5 V maximum (IOL = 12 mA)	0.5 V maximum (IOL = 12 mA)	0.8 V maximum (IOL = 4 mA)

Counter/Timer Specifications

Table 28 lists the specifications for the C/T subsystems.

Table 28: C/T Subsystem Specifications

Feature	Specifications
Number of counter/timer channels	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 μ A -1.0 μ A 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: 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 μ A -1.0 μ A 100 ns (high); 100 ns (low) 33 Ω series resistor
Counter Outputs Output driver: Output driver high voltage: Output driver low voltage: Termination:	TTL 2.0 V minimum ($I_{OH} = -15$ mA); 2.4 V minimum ($I_{OH} = -3$ mA) 0.5 V maximum ($I_{OL} = 24$ mA); 0.4 V maximum ($I_{OL} = 12$ mA) 33 Ω series resistor

Power, Physical, and Environmental Specifications

Table 29 lists the power, physical, and environmental specifications for the DT300 Series board.

Table 29: Power, Physical, and Environmental Specifications

Feature	Specifications
Power +5 V (± 0.25 V): -5 V: +12 V: -12 V: + 5 V Power Out (J1-1):	1.2 A nominal not used 55 mA maximum; 48 mA nominal 50 mA maximum; 38 mA nominal 1 A maximum (with resettable fuse)
Physical Dimensions: Weight:	Length: 6.875 inches (174.63 mm) Width: 4.2 inches (106.68 mm) 4.38 ounces (124 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 30 lists the connector specifications for the DT300 Series board.

Table 30: Connector Specifications

Feature	Specifications
Connector part number	AMP, 68-pin, 0.05 Subminiature D, #749621-7
Shielded enclosure with jack screws	AMP #750752-1
Recommended shielded cable	Madison, 28 GA, Twisted Pair, #68KDK00029

Screw Terminal Panel Specifications

Table 31 lists the specifications for the STP300 screw terminal panel.

Table 31: STP300 Specifications

Feature	Specifications
Mechanical J1: J2: Terminal block insulator: Screw type: Wire size: Dimensions: Terminal material: Board material: Weight: Mounting:	68-pin connector, SCSI II (AMP/ Tyco 5787170-7) 26-pin connector (3M N2526-50K2RB) Polyamide 6.6 GV M 2.5 x 5, Chrome-plated steel 14 to 28 AWG 4.9 inches (W) x 6.9 inches (L) x 0.90 inches (H) on 0.062 inches G10/FR4 Nickel-plated brass FR4 7 ounces via four, 4-40 screws
Environmental: Storage temperature range: Operational: Relative humidity:	–25° C to 85° C (derated operation) 0° C to 55° C To 95%, noncondensing

Cable Specifications

Table 32 lists the specifications for the cable EP305.

Table 32: EP305 Cable Specifications

Feature	Specifications
Length	2 meters
Conductors	34 twisted pairs, shielded, #28 AWG on 50 mil centers
Connectors	(1) 68-pin, self-locking receptacle (AMP/Tyco 5749621-7)



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Connector J1 on the DT300 Series Board

Table 33 lists the pin assignments of connector J1 on the DT300 Series board.

Table 33: Pin Assignments for Connector J1 on the DT300 Series Boards

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

Table 33: Pin Assignments for Connector J1 on the DT300 Series Boards (cont.)

Pin Number	Signal Description	Pin Number	Signal Description
57	Analog Output 0 Return	58	Analog Output 0
59	DAC1 Reference	60	DAC0 Reference
61	Analog Input 14/6 Return	62	Analog Input 6
63	Analog Input 12/4 Return	64	Analog Input 4
65	Analog Input 10/2 Return	66	Analog Input 2
67	Analog Input 8/0 Return	68	Analog Input 0

Screw Terminal Assignments for Connector J1 on the STP300

Table 34 lists the screw terminal assignments for connector J1 on the STP300 screw terminal panel.

Table 34: Pin Assignments for Connector J1 on the STP300

TB	J1 Pin	Description	TB	J1 Pin	Description
1	68	Analog Input 0	2	67	Analog Input 8/0 Return
3	34	Analog Input 1	4	33	Analog Input 9/1 Return
5	66	Analog Input 2	6	65	Analog Input 10/2 Return
7	32	Analog Input 3	8	31	Analog Input 11/3 Return
9	64	Analog Input 4	10	63	Analog Input 12/4 Return
11	30	Analog Input 5	12	29	Analog Input 13/5 Return
13	62	Analog Input 6	14	61	Analog Input 14/6 Return
15	28	Analog Input 7	16	27	Analog Input 15/7 Return
17	26	Amp Low	18	25	Analog Ground
19	58	DAC0 Output	20	57	DAC0 Return
21	60	DAC0 Reference In and Out	22	23	DAC1 Return
23	24	DAC1 Output	24	59	DAC1 Reference In and Out
25	42	Digital Ground	26	41	User Clock Input 0
27	40	User Counter Output 0	28	39	External Gate 0
29	8	Digital Ground	30	7	User Clock Input 1
31	6	User Counter Output 1	32	5	External Gate 1
33	8	Digital Ground	34	36	User Clock Input 2
35	37	User Counter Output 2	36	38	External Gate 2
37	42	Digital Ground	38	2	User Clock Input 3
39	3	User Counter Output 3	40	4	External Gate 3
41	1	+5 V Output @ 1 A	42	35	Power Ground
43	55	Digital Ground	44	55	Digital Ground
45	55	Digital Ground	46	56	External A/D Trigger
47	21	Digital Ground	48	22	External A/D Sample Clock Input
49	50	Digital I/O Port A, Line 0	50	16	Digital I/O Port A, Line 1
51	49	Digital I/O Port A, Line 2	52	15	Digital I/O Port A, Line 3
53	48	Digital I/O Port A, Line 4	54	14	Digital I/O Port A, Line 5

Table 34: Pin Assignments for Connector J1 on the STP300 (cont.)

TB	J1 Pin	Description	TB	J1 Pin	Description
55	47	Digital I/O Port A, Line 6	56	13	Digital I/O Port A, Line 7
57	46	Digital I/O Port B, Line 0	58	12	Digital I/O Port B, Line 1
59	45	Digital I/O Port B, Line 2	60	11	Digital I/O Port B, Line 3
61	44	Digital I/O Port B, Line 4	62	10	Digital I/O Port B, Line 5
63	43	Digital I/O Port B, Line 6	64	9	Digital I/O Port B, Line 7
65	54	Digital I/O Port C, Line 0	66	20	Digital I/O Port C, Line 1
67	53	Digital I/O Port C, Line 2	68	19	Digital I/O Port C, Line 3
69	52	Digital I/O Port C, Line 4	70	18	Digital I/O Port C, Line 5
71	51	Digital I/O Port C, Line 6	72	17	Digital Ground

Screw Terminal Assignments for Connector J2 on the STP300

Table 35 lists the screw terminal assignments for connector J2 on the STP300 screw terminal panel.

Table 35: Pin Assignments for Connector J2 on the STP300

Pin ^a	Description	Pin	Description
1	Analog Input 0	2	Analog Input 8
3	Analog Ground	4	Analog Input 9
5	Analog Input 1	6	Analog Ground
7	Analog Input 2	8	Analog Input 10
9	Analog Ground	10	Analog Input 11
11	Analog Input 3	12	Analog Ground
13	Analog Input 4	14	Analog Input 12
15	Analog Ground	16	Analog Input 13
17	Analog Input 5	18	Analog Ground
19	Analog Input 6	20	Analog Input 14
21	Analog Ground	22	Analog Input 15
23	Analog Input 7	24	Analog Ground
25	Amp Low	26	Not Connected

a. Signals Analog Input 8 to Analog Input 15 are not available on the 5B08 backplane.

Screw Terminal Assignments for the STP68 and STP68-DIN

Table 36 lists the screw terminal assignments for the STP68 and STP68-DIN screw terminal panel.

Table 36: Screw Terminal Assignments for the STP68 and STP68-DIN Screw Terminal Panel

TB	J1 Pin	Signal Description	TB	J1 Pin	Signal Description
1	1	+5 V Output @ 1 A	2	2	User Clock Input 3
3	3	User Counter Output 3	4	4	External Gate 3
5	5	External Gate 1	6	6	User Counter Output 1
7	7	User Clock Input 1	8	8	Digital Ground
9	9	Digital I/O Port B, Line 7	10	10	Digital I/O Port B, Line 5
11	11	Digital I/O Port B, Line 3	12	12	Digital I/O Port B, Line 1
13	13	Digital I/O Port A, Line 7	14	14	Digital I/O Port A, Line 5
15	15	Digital I/O Port A, Line 3	16	16	Digital I/O Port A, Line 1
17	17	Digital Ground	18	18	Digital I/O Port C, Line 5
19	19	Digital I/O Port C, Line 3	20	20	Digital I/O Port C, Line 1
21	21	Digital Ground	22	22	External A/D Sample Clock In
23	23	Analog Output 1 Return	24	24	Analog Output 1
25	25	Analog Ground	26	26	Amp Low
27	27	Analog Input 15/7 Return	28	28	Analog Input 7
29	29	Analog Input 13/5 Return	30	30	Analog Input 5
31	31	Analog Input 11/3 Return	32	32	Analog Input 3
33	33	Analog Input 9/1 Return	34	34	Analog Input 1
35	35	Power Ground	36	36	User Clock Input 2
37	37	User Counter Output 2	38	38	External Gate 2
39	39	External Gate 0	40	40	User Counter Output 0
41	41	User Clock Input 0	42	42	Digital Ground
43	43	Digital I/O Port B, Line 6	44	44	Digital I/O Port B, Line 4
45	45	Digital I/O Port B, Line 2	46	46	Digital I/O Port B, Line 0
47	47	Digital I/O Port A, Line 6	48	48	Digital I/O Port A, Line 4
49	49	Digital I/O Port A, Line 2	50	50	Digital I/O Port A, Line 0
51	51	Digital I/O Port C, Line 6	52	52	Digital I/O Port C, Line 4

**Table 36: Screw Terminal Assignments for the
STP68 and STP68-DIN Screw Terminal Panel (cont.)**

TB	J1 Pin	Signal Description	TB	J1 Pin	Signal Description
53	53	Digital I/O Port C, Line 2	54	54	Digital I/O Port C, Line 0
55	55	Digital Ground	56	56	External A/D Trigger
57	57	Analog Output 0 Return	58	58	Analog Output 0
59	59	DAC1 Reference	60	60	DAC0 Reference
61	61	Analog Input 14/6 Return	62	62	Analog Input 6
63	63	Analog Input 12/4 Return	64	64	Analog Input 4
65	65	Analog Input 10/2 Return	66	66	Analog Input 2
67	67	Analog Input 8/0 Return	68	68	Analog Input 0



Using Your Own Screw Terminal Panel

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Data acquisition boards can perform only as well as the input connections and signal integrity you provide. If you choose not to use the STP300 screw terminal panel, consideration must be given 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 DT300 Series board. Refer to [Appendix B](#) for connector and cable specifications.

Analog Inputs

DT300 Series 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 is 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 $1,000 \Omega \times (30 \text{ pF} \times 3 \text{ ft}) = 90 \text{ ns}$.

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 k Ω to 100 k Ω from the input low side to analog common. Alternatively, the external common can be returned through a 10 Ω to 100 k Ω resistor to analog common (it cannot be 0 Ω due to ground currents).

Analog Outputs

The analog output channels on DT300 Series boards have a resolution of 12 or 16 bits (even though the accuracy may be less).

Data Translation ensures 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 μ F 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.

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