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NI SC Express

NI PXIe-4353 User Manual

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1 Getting Started

The NI PXIe-4353 is a high-accuracy thermocouple input module that supports up to 32 thermocouple inputs and has 8 cold junction compensation (CJC) channels for improved CJC accuracy. The CJC sensors are located on the terminal block in close proximity to the screw terminals. The module multiplexes its inputs to three separate 24-bit delta-sigma ADCs at speeds of up to 90 S/s for all channels.

The module supports open thermocouple detection for all channels, which you can disable programmatically for improved accuracy. The NI PXIe-4353 is bank isolated to 300 V in order to allow flexibility in where you install the thermocouples and to minimize crosstalk with other devices in the system.

Installation

Refer first to the *NI SC Express Installation Requirements* and then to the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* documents for step-by-step software and hardware installation instructions.

Module and Terminal Block Specifications

Refer to the *NI PXIe-4353 Specifications* document for module specifications. Refer to the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* document for the terminal block specifications.

Module Accessories and Cables

Refer to the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* document for information about supported accessories and cables.

Calibration

You can obtain the calibration certificate and information about calibration services for the NI PXIe-4353 at `ni.com/calibration`.

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2

Using the NI PXIe-4353

This chapter explains how to connect signals to the NI PXIe-4353 and measure temperature with thermocouples. It also includes overviews of the features available on the NI PXIe-4353.

Connecting Signals

This section briefly explains how to connect signals to the NI PXIe-4353. It also contains shielding and grounding considerations, the module pinout, and an explanation of the signals to connect to the NI PXIe-4353. For additional signal connection information for the terminal block, refer to the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* document.

Connect the positive lead of the thermocouple to the TC+ terminal and the negative lead of the thermocouple to the TC– terminal. If you are unsure which of the thermocouple leads is positive and which is negative, check the thermocouple documentation or the thermocouple wire spool. The NI PXIe-4353 also has common terminals, COM, that are internally connected to the isolated ground reference of the module.

Grounding and Shielding Considerations

The NI PXIe-4353 is bank-isolated from chassis (earth) ground, which allows for the connection of floating thermocouples and thermocouples with a common-mode voltage of up to 300 V relative to chassis ground. However, regardless of the channel-to-ground voltage, the maximum allowable channel-to-channel voltage is ±10 V.

In addition to the chassis ground lugs, the module provides access to its isolated ground through the COM terminal. In most applications, connection to COM is not necessary. Specifically, COM should be left unconnected in the following application configurations:

- All thermocouples are floating.
- All thermocouples are referenced to the same common-mode voltage.
- One thermocouple is referenced to a common-mode voltage and all others are floating.

However, in the configuration in which two or more thermocouples are referenced to *different* common-mode voltages, common-mode rejection performance will be improved by connecting COM according to the following guidelines. If the common-mode voltages are smaller than ±10 V, COM should be connected to chassis ground. Otherwise, COM must be connected to the same common-mode voltage as one of the input channels so as to not violate

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the module's channel-to-COM limit of ±10 V. The module accuracy can be impacted if any input channel is more than 10 V from COM. Refer to the *Common-Mode Over-Range Detection* section for more details about detecting if channels are outside the ±10 V common-mode range.

If you are using a shielded thermocouple, connect the shield to the chassis ground, using the ground lugs on the terminal block. Refer to the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* document for details about the location of these lugs. Figure 2-1 illustrates a typical shielding configuration.

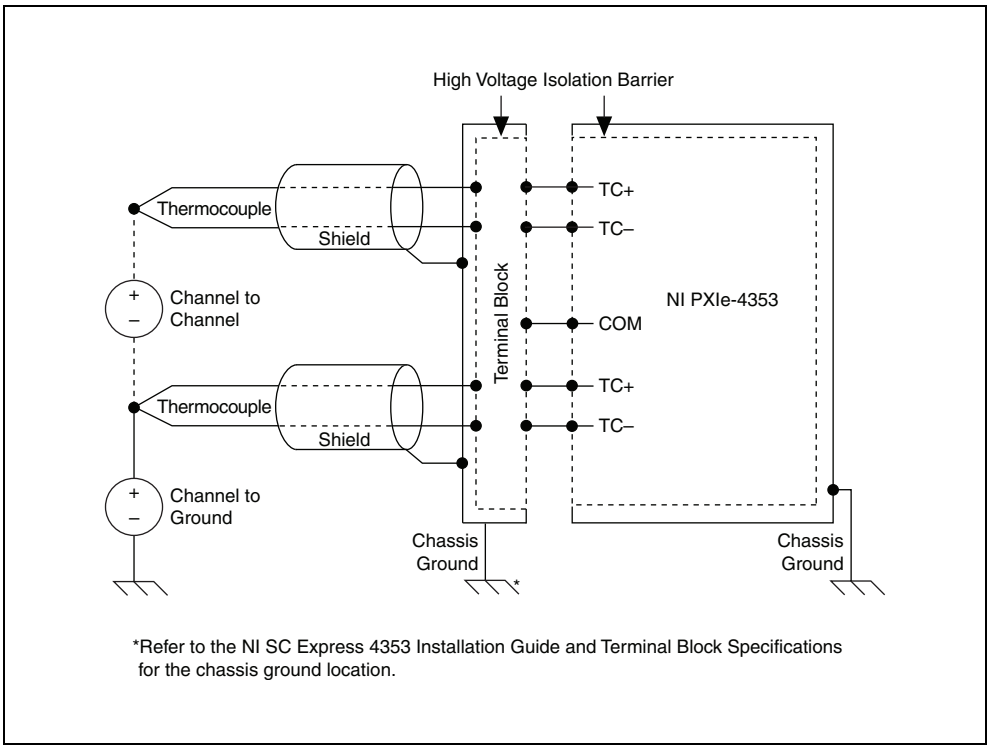


Figure 2-1. Connecting a Shielded Thermocouple to the NI PXIe-4353

Note For proper electromagnetic compatibility (EMC) performance, use shielded wire and connect the shield to the chassis ground.

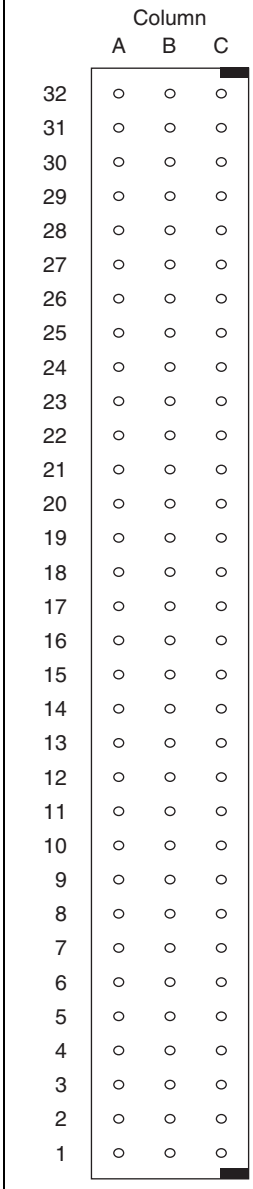
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Module Pinout

Table 2-1illustrates the pinout of the front connector on the NI PXIe-4353. Refer to the *Signal Descriptions* section for definitions of each signal. Refer to the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* document for signal locations on the terminal block.

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Table 2-1. Front Connector Pin Assignments

Front Connector Diagram	Pin Number	Column A	Column B	Column C
	32	COM	TC0+	TC1+
	31	TC2+	TC0–	TC1–
	30	TC2–	TC3–	TC3+
	29	COM	TC4+	TC5+
	28	CJC0+	TC4–	TC5–
	27	CJC0–	TC6–	TC6+
	26	COM	TC7+	TC8+
	25	CJC1+	TC7–	TC8–
	24	CJC1–	TC9–	TC9+
	23	COM	TC10+	TC11+
	22	CJC2+	TC10–	TC11–
	21	CJC2–	TC12–	TC12+
	20	COM	TC13+	TC14+
	19	CJC3+	TC13–	TC14–
	18	CJC3–	TC15–	TC15+
	17	COM	TC16+	TC17+
	16	CJC4+	TC16–	TC17–
	15	CJC4–	TC18–	TC18+
	14	COM	TC19+	TC20+
	13	CJC5+	TC19–	TC20–
	12	CJC5–	TC21–	TC21+
	11	COM	TC22+	TC23+
	10	CJC6+	TC22–	TC23–
	9	CJC6–	TC24–	TC24+
	8	COM	TC25+	TC26+
	7	CJC7+	TC25–	TC26–
	6	CJC7–	TC27–	TC27+
	5	COM	TC28+	TC29+
	4	TC30+	TC28–	TC29–
	3	TC30–	TC31–	TC31+
	2	RSVD	RSVD	RSVD
	1	RSVD	RSVD	RSVD

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Signal Descriptions

Table 2-2 describes the signals found on the I/O connectors along with the internal signals.

Table 2-2. I/O Connector Signal Descriptions

I/O Connector Signal	NI-DAQmx Signal Name	Description
TC<0..31>+, TC<0..31>–	AI <0..31>	Thermocouple input channels 0 to 31. TC+ is the positive thermocouple input terminal, and TC– is the negative thermocouple input terminal.
CJC<0..7>+, CJC<0..7>–	_cjtemp<0..7>	Cold-junction compensation (CJC) channels 0 to 7. These terminals are used to measure the CJC thermistors on the terminal block. The CJC channels are sampled during a thermocouple acquisition for the associated thermocouple channel in order to compensate for the thermocouple cold junction. Refer to the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* document for details regarding the association of each CJC channel to the thermocouple input channels. Also refer to the *CJC Channels* section for more information.
COM	—	These terminals are connected to the isolated ground reference for all of the thermocouple channels. Refer to the *Grounding and Shielding Considerations* section for more information about using this terminal.
RSVD	—	These pins are reserved for communication with the accessory.
—	_aignd_vs_aignd <0..1>	Internal autozero channels that compensate for offset errors. _aignd_vs_aignd0 (autozero channel 0) compensates for offset errors on the even thermocouple channels, and _aignd_vs_aignd1 (autozero channel 1) compensates for offset errors on the odd thermocouple channels. Refer to the *Using the Autozero Channels* section for more information.

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Measuring Temperature with Thermocouples

This section explains how to take a thermocouple temperature measurement using the NI PXIe-4353 and National Instruments software. For an introduction to thermocouples and temperature measurements, refer to `ni.com/info` and enter `rdtttm`.

To measure temperature with a thermocouple, you use the NI-DAQmx driver software and its functions and VIs that are packaged with your NI PXIe-4353. With NI-DAQmx, you can configure your temperature measurement interactively with the DAQ Assistant—a graphical interface for configuring measurement tasks, channels, and scales—or programmatically with your application development environment such as LabVIEW, LabWindows™/CVI™, or Measurement Studio.

To find out more about using NI-DAQmx, refer to the *NI-DAQmx Help*, which is installed at **Start»All Programs»National Instruments»NI-DAQ** by default.

Measuring Temperature with the DAQ Assistant

Note The following procedure assumes you have already installed NI-DAQmx and connected the thermocouple to your device. Refer to the *Connecting Signals* section as well as the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* document for pinouts and additional signal connection content.

To measure temperature using the DAQ Assistant, do the following:

1. In MAX, right-click **Data Neighborhood**, and select **Create New** from the shortcut menu. Select **NI-DAQmx Task** in the Create New window, and click **Next**.

Note Within LabVIEW, LabWindows/CVI, Measurement Studio, or LabVIEW Signal Express, you can also access the DAQ Assistant. Refer to the *NI-DAQmx Help*, which is installed by default at **Start»All Programs»National Instruments»NI-DAQ**, for additional information.

2. Select **Acquire Signals»Analog Input»Temperature»Thermocouple**.
3. Select a physical channel for the NI PXIe-4353 and click **Next**. The physical channel is the terminal at which you measure an analog signal.
4. Enter a name, such as `myTemperatureTask`, and click **Finish**.
5. In the configuration tab, specify the input range, thermocouple type, and CJC source.
6. Click **Save**.

You have now created a task.

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A task is a software entity that encapsulates the physical channels—the terminals at which you measure an analog signal—along with other channel-specific information such as the range, terminal configuration, and custom scaling. A task also includes timing and triggering.

7. To start the measurement, click **Run**.

Measuring Temperature with LabVIEW or LabWindows/CVI

The following procedure assumes you have already installed NI-DAQmx and connected the thermocouple to your device. Refer to the *Connecting Signals* section as well as the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* document for pinouts and additional signal connection content.

To measure temperature using LabVIEW or LabWindows/CVI, do the following:

1. Call the AI Temp TC instance of the DAQmx Create Virtual Channel VI in LabVIEW (`DAQmxCreateTask` and `DAQmxCreateAIThrmcplChan` functions in LabWindows/CVI).
2. Specify the physical channel for the device connected to the thermocouple signal. The physical channel is the terminal at which you measure an analog signal.
3. Specify a name, such as `myThermocoupleChannel`, to assign.
4. Select the appropriate values for the thermocouple type and range inputs.

You have now created a task.

A task is a software entity that encapsulates the physical channels—the terminals at which you measure an analog signal—along with other channel-specific information such as the range, terminal configuration, and custom scaling. A task also includes timing and triggering.

5. Call the DAQmx Start Task VI (`DAQmxStartTask` in LabWindows/CVI).
6. Call the Analog 1D DBL 1Chan NSamp instance of DAQmx Read VI, select the number of samples to acquire (`DAQmxReadAnalogF64` in LabWindows/CVI).
7. Call the DAQmx Stop Task VI (`DAQmxStopTask` function in LabWindows/CVI) after the desired number of samples have been acquired.
8. Call the DAQmx Clear Task VI (`DAQmxClearTask` function in LabWindows/CVI).

Temperature Accuracy Considerations

Temperature measurement errors depend on the thermocouple type, the accuracy of the thermocouple wire, the temperature being measured, the accuracy of the measurement module, and the cold-junction temperature. Refer to the *Temperature Measurement Accuracy* section in the *NI PXIe-4353 Specifications* document for the accuracy of each thermocouple type when connected to the NI PXIe-4353.

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Cold-Junction Temperature Measurement Accuracy

Cold-junction compensation is the process of measuring the temperature of the screw terminal junction for the thermocouple and applying a representative compensating voltage to the voltage measured by the thermocouple input channel. The accuracy of the cold-junction temperature measurement is a key part of the accuracy of the overall thermocouple temperature measurement. The NI PXIe-4353 is carefully designed to ensure high-accuracy cold-junction temperature measurements under a variety of conditions; however, care must be taken to ensure the best possible accuracy. Refer to the *Minimizing Thermal Gradients* section in the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* document for guidelines to minimize thermal gradients that could impact the CJC accuracy. Refer to the *NI PXIe-4353 Specifications* document for the CJC accuracy specifications.

NI PXIe-4353 Features

For increased performance, the NI PXIe-4353 shares its thermocouple and CJC inputs across three different ADCs and supports multiple timing modes in order to balance the trade-offs among speed, accuracy, and noise rejection.

The NI PXIe-4353 multiplexes 32 thermocouple input channels, 8 cold-junction compensation (CJC) channels, and 2 autozero channels to 3 different ADCs. All even thermocouple input channels and autozero channel 0 are multiplexed to the first ADC, all odd thermocouple input channels and autozero channel 1 are multiplexed to the second ADC, and 8 CJC input channels are multiplexed to the last ADC.

Each thermocouple input channel of the NI PXIe-4353 passes through a differential filter and then is multiplexed and sampled by a 24-bit delta-sigma ADC. All channels also have a programmable open thermocouple detection (OTD) circuit that is selectable on a per-module basis, which consists of a current source between the TC+ and TC– terminals.

The NI PXIe-4353 is bank isolated from the PXI Express chassis and from other modules in the system.

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NI PXIe-4353 Measurement Circuitry

Figure 2-2 shows the measurement circuitry on the NI PXIe-4353.

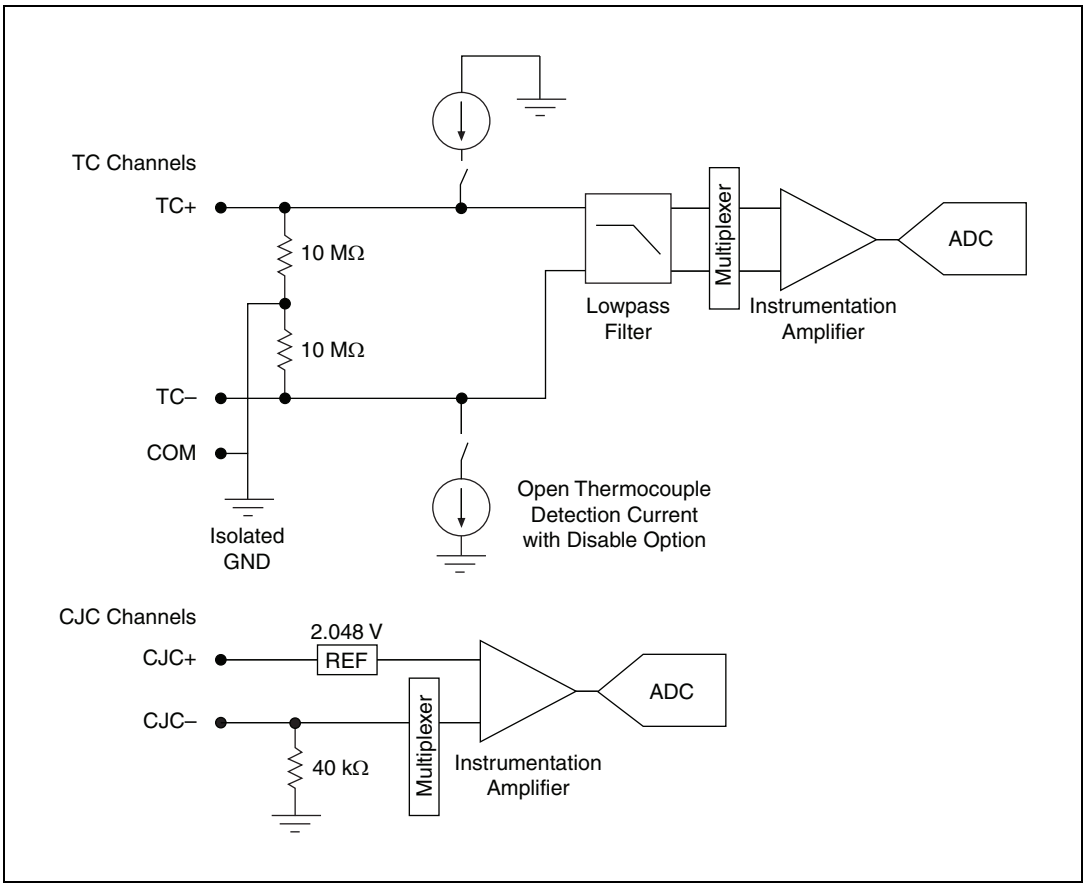


Figure 2-2. NI PXIe-4353 Measurement Circuitry Diagram

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NI PXIe-4353 Block Diagram

Figure 2-3 shows the NI PXIe-4353 block diagram.

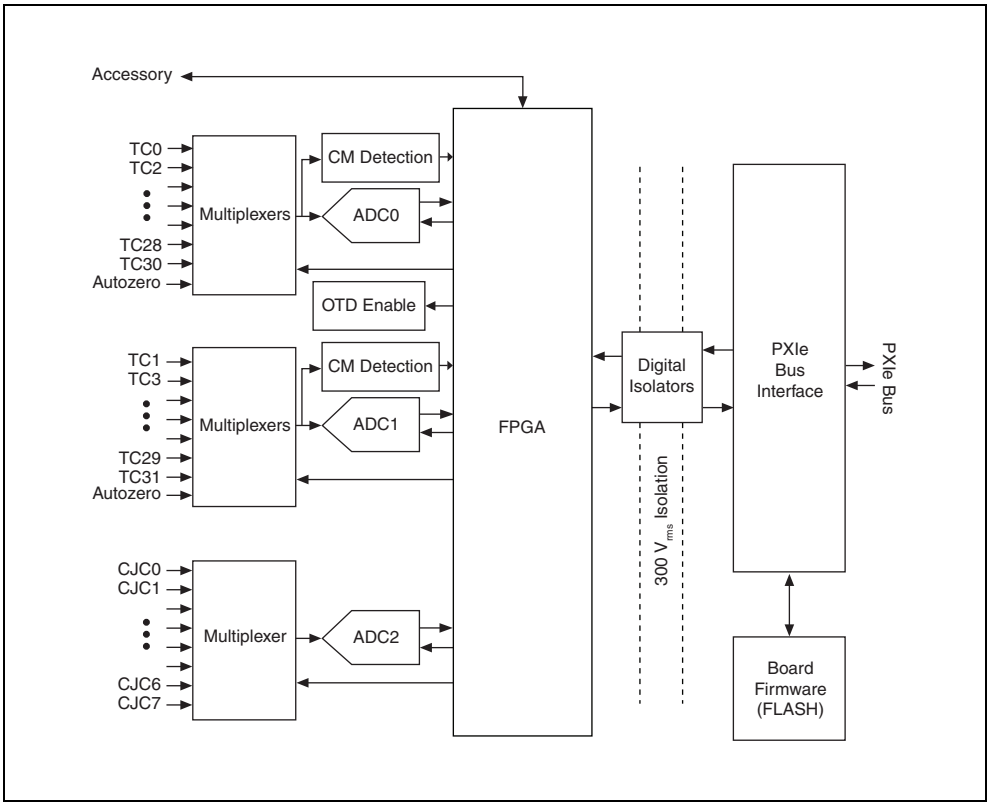


Figure 2-3. NI PXIe-4353 Block Diagram[1]

[1] For more information on CM detection, refer to the *Common-Mode Over-Range Detection* section. For more information on OTD enable, refer to the *Open Thermocouple Detection (OTD)* section.

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Sample Rates

This section explains timing on the NI PXIe-4353.

Hardware and Software Timing

You can use software timing or hardware timing to control when a signal is acquired. With hardware timing, a digital signal, such as the sample clock on the NI PXIe-4353, controls the acquisition rate. With software timing, the acquisition rate is determined by the software and operating system instead of by the measurement device. A hardware clock can run faster than a software loop. A hardware clock can sample data with less jitter in the data rate than a software loop.

In NI-DAQmx, enable hardware timing with the Sample Clock instance of the DAQmx Timing function or VI or by setting the **Sample Timing Type** property to Sample Clock. If you do neither of these things, or you set the **Sample Timing Type** attribute/property to On Demand, you are selecting software timing.

ADC Timing Modes

Although the timing engine on the NI PXIe-4353 supports sampling the channels at nearly any sample rate requested up to 90 S/s, the three internal ADCs are capable of acquiring data at only seven different discrete rates that are defined by timing modes 1 to 7 in NI-DAQmx. Timing mode 1 (high resolution) samples signals at the slowest rate but has the lowest noise and highest accuracy. It is the only mode with 50/60 Hz noise rejection. By default, if you are using on-demand (or software) timing, timing mode 1 is enabled regardless of the channel count. Timing mode 7 (high speed) samples signals at the fastest rate but has the highest level of noise and lowest accuracy. The noise and accuracy change incrementally for each intermediate timing mode. Refer to the *NI PXIe-4353 Specifications* document for details about accuracy.

When the **ADC Timing Mode** property is not explicitly set, NI-DAQmx automatically selects the lowest possible ADC timing mode for the selected sample rate and number of channels, which results in the best accuracy. Table 2-3 shows the ADC timing mode NI-DAQmx uses for best accuracy, depending on sample rate and number of channels.

Since the NI PXIe-4353 has a multiplexed architecture, there is a timing skew between channels in a scanlist. A scanlist is an ordered list of channels to be sampled. The skew between channels is based on how long it takes the ADC to convert signals. Timing mode 7 has the least amount of skew between channels.

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You can choose to select an ADC timing mode independent of the requested sample rate using the **ADC Timing Mode** property. This can allow for sampling all channels at a faster rate within a shorter window after the sample clock. Refer to Table 2-3 for a quick reference about the ADC timing mode that NI-DAQmx selects based on the number of channels per ADC and the selected sample rate. Refer to the *Computing Aggregate Sample Rates* section for more detailed information on determining sample rates.

Table 2-3. ADC Timing Mode Quick Reference Chart

Maximum Channels per ADC \ Sample Rate (S/s)	1	10	20	30	40	50	60	70	80	90
1	1	1	2	2	3	3	3	4	4	4
3	1	2	3	4	4	5	5	5	5	5
5	1	3	4	5	5	5	6	6	6	6
7	1	4	5	5	6	6	6	6	7	7
9	1	4	5	5	6	6	6	7	7	7
11	1	4	5	6	6	7	7	7	7	7
13	1	4	5	6	6	7	7	7	7	7
15	1	5	6	6	7	7	7	7	7	7
17	1	5	6	6	7	7	7	7	7	7

1 = High-Resolution Mode, 7 = High-Speed Mode

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Channel Ordering

When using the thermocouple task in NI-DAQmx, the CJC channels in the task are added automatically based on the associated thermocouple input (TC) channels on the terminal block. The CJC channels are added to the end of the scanlist in the same order as the first associated TC channel in the original scanlist. This association is terminal block specific, so you should reference the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* document for details. In this example, the TB-4353 is the assumed terminal block. If autozero is enabled and one or more thermocouple channels on the same ADC are in the scanlist, the autozero channels will automatically be added to the end of the scanlist after all CJC channels. Refer to Figure 2-4 for an example showing channels in a measurement task and the resulting channels that are sampled.

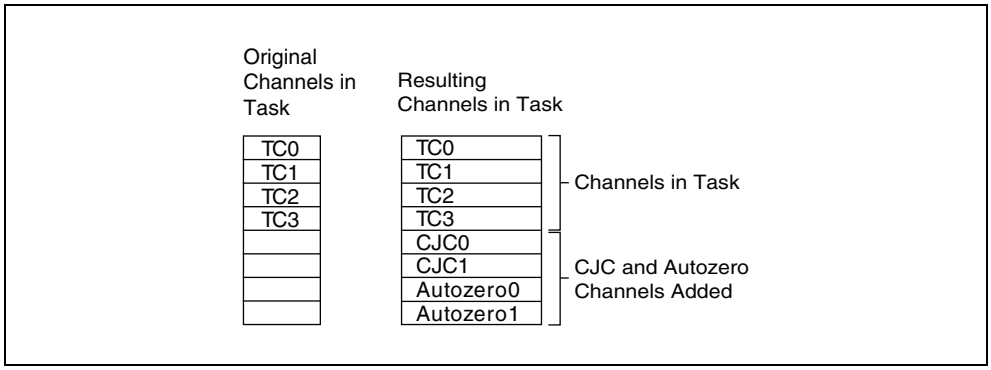


Figure 2-4. Task with Autozero Enabled

To achieve the fastest possible sample rate, it is important to distribute the channels in use evenly across both even and odd thermocouple ADCs as well as within banks that utilize a minimal number of CJCs.

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The module samples the channels in the order NI-DAQmx requests and are dependent on the ADC to which the channel belongs. Inside the module, the requested channels in the task are divided into three ADC-dependent scanlists in order to optimize the sample rate. These scanlists are sampled in parallel. As a result, a channel listed later in the original task may be sampled before another channel that is earlier in the task. Figure 2-5 shows a sample conversion sequence.

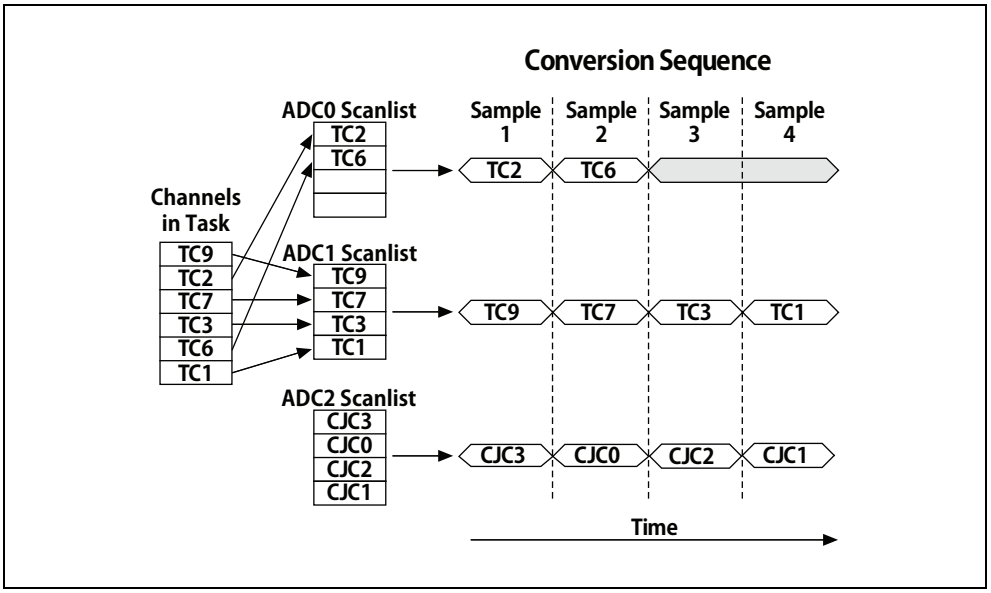


Figure 2-5. Channel Conversion Sequence

Computing Aggregate Sample Rates

The sample rate is dependent on the number of channels on each ADC. Refer to Figure 2-3, *NI PXIe-4353 Block Diagram*, to determine how each channel is connected. For a given ADC conversion rate or timing mode, you can calculate the maximum sample rate using the following equation:

$$Max\ Samp\ Rate = min\left[\left(\frac{ADC\ Conversion\ Rate}{max(\#Even\ TCs + AZ, \#Odd\ TCs + AZ, \#CJCs)}\right), 90\ \text{S/s}\right]$$

where *#Even TCs* is the number of even thermocouple channels
#Odd TCs is the number of odd thermocouple channels
#CJCs is the number of CJC channels
AZ is 0 if autozero is sampled none or once, or 1 if autozero is sampled every sample.

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Use the following equation to determine the ADC conversion rate and timing mode based on a given sample rate:

$$ADC\ Conv\ Rate = Samp\ Rate \times [max(\#Even\ TCs + AZ, \#Odd\ TCs + AZ, \#CJCs)]$$

where *#Even TCs* is the number of even thermocouple channels
#Odd TCs is the number of odd thermocouple channels
#CJCs is the number of CJC channels
AZ is 0 if autozero is sampled none or once, or 1 if autozero is sampled every sample.

You can determine the ADC timing mode by coercing the ADC conversion rate to the next largest rate using the values in the following table:

ADC Timing Modes	ADC Conversion Rate
1 (High Resolution)*	17 Hz
2	34 Hz
3	68 Hz
4	136 Hz
5	272 Hz
6	544 Hz
7 (High Speed)	1530 Hz

* ADC timing mode 1 is the default setting for the On-Demand timing mode when the **ADC Timing Mode** property is not explicitly selected.

Using the Autozero Channels

The NI PXIe-4353 has two internal autozero channels that compensate for the offset error. The first autozero channel compensates for the offset error on even thermocouple input channels (TC0, TC2, TC4 … TC30), and the second autozero channel compensates for the offset error on odd thermocouple input channels (TC1, TC3, TC5 … TC31).

When autozero is enabled, the NI PXIe-4353 measures the autozero channel and subtracts that measurement from the measurement of each corresponding thermocouple channel. The autozero channels are enabled by default for each channel. These channels can be accessed directly in NI-DAQmx, using the channel names, _aignd_vs_aignd<0,1>. You can also specify how often to sample autozero using the DAQmx channel property **AI Autozero Mode**.

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For best measurement accuracy and stability, NI recommends that you enable the autozero channels for every sample. This will provide the best performance in most applications but is particularly important when operating over a varying ambient temperature range. However, applications seeking to meet a particular speed or noise requirement may benefit from alternate settings. You can choose to configure the autozero channel to only sample once at the beginning of a task or not sample the autozero channel at all.

CJC Channels

The NI PXIe-4353 includes 8 input channels for measuring CJC thermistors from the connected terminal block. These channels are measured using a dedicated ADC on the NI PXIe-4353, so they are scanned in parallel with the rest of the thermocouple channels in your task.

When using a thermocouple task in NI-DAQmx, the correct CJC channel is automatically added to the task based on the selected thermocouple channels, and the CJC measurement is applied to the thermocouple measurement automatically. You must select **Built-in** in NI-DAQmx for the CJC channel when you configure your thermocouple task in order for the CJC channels to be scanned and applied to the measurement automatically. The CJC channels can be accessed directly in NI-DAQmx using the channel name _cjtemp<0..7>.You can configure tasks in the DAQ Assistant or in your application development environment. To learn more about using software to configure thermocouple measurements, refer to the *Measuring Temperature with Thermocouples* section. This section also links to a tutorial that details how CJC works.

Refer to the *NI SC Express 4353 Installation Guide and Terminal Block Specifications* document for details about how CJC channels are associated with thermocouple input channels and for details about CJC accuracy and methods for improving accuracy.

Open Thermocouple Detection (OTD)

OTD allows you to find channels that do not have a thermocouple connected to the module. The NI PXIe-4353 has an OTD circuit per channel and has a single control to enable or disable all channels programmatically. OTD can be enabled or disabled using the **Open Thermocouple Detection Enable** DAQmx channel property.

To determine if a thermocouple is disconnected or becomes open, you can use the **Open Thermocouple Channels Exist** and **Open Thermocouple Channels** properties, which are DAQmx Read properties. **Open Thermocouple Channels Exist** returns a Boolean of true if one or more channels were disconnected since the last time the property was queried, and **Open Thermocouple Channels** returns the names of the virtual channels that were disconnected.

When OTD is enabled, each thermocouple channel has a current source connected to the TC+ and TC– input terminals that force full-scale voltage. Figure 2-2, *NI PXIe-4353 Measurement Circuitry Diagram*, illustrates the input circuitry for one thermocouple channel on the NI PXIe-4353. The errors resulting from this current flowing through the lead-wire resistance of connected thermocouples are negligible for most applications. However, applications using

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long thermocouple wires can introduce more significant errors. The OTD circuit can be disabled in NI-DAQmx to reduce errors due to thermocouples with higher lead-wire resistances. Refer to the *NI PXIe-4353 Specifications* document for more information about errors resulting from lead-wire resistance.

Common-Mode Over-Range Detection

All input channels share a common ground, COM, that is isolated from other modules in the system. The NI PXIe-4353 common-mode range is the maximum voltage between any channel and COM. The NI PXIe-4353 measures the common-mode voltage level of each channel, and its over-range status can be monitored in NI-DAQmx.

To determine if a common-mode over-range detection has occurred, use the **Common Mode Range Error Channels Exist** and **Common Mode Range Error Channels** properties within the DAQmx Read property node. **Common Mode Range Error Channels Exist** returns a Boolean of true if one or more channels exceed the common-mode input range since the last time the property was queried, and **Common Mode Range Error Channels** returns the names of the virtual channels that exceed the common-mode input range.

If a common-mode voltage out of range is detected, the accuracy of the data on any channel in the task may be impacted. If a thermocouple is connected to the NI PXIe-4353, but is not in the task, make sure the channel does not exceed the common-mode voltage range. A floating thermocouple, or a channel that is left unconnected, will not exceed the common-mode voltage range.

Refer to the *NI PXIe-4353 Specifications* document for more information about the common-mode voltage range.

Accessory Auto-Detection

NI SC Express modules automatically detect compatible accessories or terminal blocks. The RSVD pins on the I/O connector provide power to the accessories as well as digital communication lines. This allows software to detect when accessories are inserted or removed. In addition, software can automatically identify the specific terminal block as well as access any calibration or scaling information associated with the terminal block.

Measurement & Automation Explorer (MAX) allows you to see the accessories connected to your device. In MAX, expand Devices and Interfaces and locate your device. If a terminal block is connected to your device, it will be displayed beneath the device. Unsupported terminal blocks appear in MAX with an “X” next to them.

NI-DAQmx property nodes can be used to programmatically access information about connected accessories in your application. Refer to the *NI-DAQmx Help* for documentation on programmatically accessing accessory status. Select **Start»All Programs»National Instruments»NI-DAQ»NI-DAQmx Help**.

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3

PXI Express Considerations

This chapter details the clock and trigger functionality available through the PXI Express chassis for the NI PXIe-4353.

NI SC Express Clock and Trigger Signals

PXIe_CLK100

PXIe_CLK100 is a common low-skew 100 MHz reference clock for synchronization of multiple modules in a PXI Express measurement or control system. The PXIe backplane is responsible for generating PXIe_CLK100 independently to each peripheral slot in a PXI Express chassis. For more information, refer to the *PXI Express Specification* at `www.pxisa.org`.

PXIe_SYNC100

PXIe_SYNC100 is a common low-skew 10 MHz reference clock with a 10% duty cycle for synchronization of multiple modules in a PXI Express measurement or control system. This signal is used to accurately synchronize modules using PXIe_CLK100 along with those using PXI_CLK10. The PXI Express backplane is responsible for generating PXIe_SYNC100 independently to each peripheral slot in a PXI Express chassis. For more information, refer to the *PXI Express Specification* at `www.pxisa.org`.

PXI_CLK10

PXI_CLK10 is a common low-skew 10 MHz reference clock for synchronization of multiple modules in a PXI measurement or control system. The PXI backplane is responsible for generating PXI_CLK10 independently to each peripheral slot in a PXI chassis.

Note PXI_CLK10 cannot be used as a reference clock for SC Express modules.

PXI Triggers

A PXI chassis provides eight bused trigger lines to each module in a system. Triggers may be passed from one module to another, allowing precisely timed responses to asynchronous external events that are being monitored or controlled. Triggers can be used to synchronize the operation of several different PXI peripheral modules.

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On SC Express modules, the eight PXI trigger signals are synonymous with RTSI <0..7>.

Notice that in a PXI chassis with more than eight slots, the PXI trigger lines may be divided into multiple independent buses. Refer to the documentation for your chassis for details.

PXI_STAR Trigger

In a PXI Express system, the Star Trigger bus implements a dedicated trigger line between the system timing slot and the other peripheral slots. The Star Trigger can be used to synchronize multiple devices or to share a common trigger signal among devices.

A system timing controller can be installed in this system timing slot to provide trigger signals to other peripheral modules. Systems that do not require this functionality can install any standard peripheral module in this system timing slot.

An SC Express module receives the Star Trigger signal (PXI_STAR) from a system timing controller. PXI_STAR can be used as an external source for many AI, AO, and counter signals.

An SC Express module is not a system timing controller. An SC Express module can be used in the system timing slot of a PXI system, but the system will not be able to use the Star Trigger feature.

PXIe_DSTAR<A..C>

PXI Express devices can provide high-quality and high-frequency point-to-point connections between each slot and a system timing slot. These connections come in the form of three low-voltage differential star triggers that create point-to-point, high-frequency connections between a PXI Express system timing controller and a peripheral device. Using multiple connections enable you to create more applications because of the increased routing capabilities.

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Table 3-1 describes the three differential star (DSTAR) lines and how they are used.

Table 3-1. PXIe-DSTAR Line Descriptions

Trigger Line	Purpose
PXIe_DSTARA	Distributes high-speed, high-quality clock signals from the system timing slot to the peripherals (input).
PXIe_DSTARB	Distributes high-speed, high-quality trigger signals from the system timing slot to the peripherals (input).
PXIe_DSTARC	Sends high-speed, high-quality trigger or clock signals from the peripherals to the system timing slot (output).

The DSTAR lines are only available for PXI Express devices when used with a PXI Express system timing module. For more information, refer to the *PXI Express Specification* at `www.pxisa.org`.

Trigger Filters

You can enable a programmable debouncing filter on each PXI_Trig, PXIe_DSTAR, or PXI_STAR signal. When the filters are enabled, your module samples the input on each rising edge of a filter clock. This filter clock is generated using the onboard oscillator.

The following example explains how the filter works for low-to-high transitions of the input signal. High-to-low transitions work similarly.

Assume that an input terminal has been low for a long time. The input terminal then changes from low to high, but glitches several times. When the filter clock has sampled the signal high on N consecutive edges, the low-to-high transition is propagated to the rest of the circuit. The value of N depends on the filter setting. Refer to Table 3-2.

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Table 3-2. Trigger Debouncing Filters

Filter Setting	Filter Clock	N (Filter Clocks Needed to Pass Signal)	Pulse Width Guaranteed to Pass Filter	Pulse Width Guaranteed to Not Pass Filter
None	—	—	—	—
90 ns (short)	100 MHz	9	90 ns	80 ns
5.12 µs (medium)	100 MHz	512	5.12 µs	5.11 µs
2.56 ms (high)	100 kHz	256	2.56 ms	2.55 ms
Custom	User Configurable	N	N/timebase	(N – 2)/timebase

The filter setting for each input can be configured independently. At power on, the filters are disabled.

Enabling filters introduces jitter on the input signal. The maximum jitter is one period of the timebase.

These filters work by rejecting any pulse shorter than the specified filter setting. For example, a 5.12 µs filter will reject any pulses shorter than 5.12 µs. The trigger filters can be used to prevent false triggers from occurring in cases where the trigger signal is noisy or glitchy.

Data Transfer Methods

The primary ways to transfer data across the PXI Express bus are as follows:

- Direct Memory Access (DMA)—DMA is a method to transfer data between the device and computer memory without the involvement of the CPU. This method makes DMA the fastest available data transfer method. NI uses DMA hardware and software technology to achieve high throughput rates and increase system utilization. DMA is the default method of data transfer for PXI Express devices.
- Programmed I/O—Programmed I/O is a data transfer mechanism where the user's program is responsible for transferring data. Each read or write call in the program initiates the transfer of data. Programmed I/O is typically used in software-timed (on-demand) operations.

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A

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