PCIe/PXIe-6301 Series

24 bits Temperature Input Module for Resistance Temperature Detector User Manual

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Table of Contents

1. Overview

This chapter presents the information how to use this manual and operate the module if you are already familiar with Microsoft Visual Studio and C# programming language.

1.1 Introduction

JYTEK PCIe/PXIe-6301 is a high-resolution and high-speed temperature measurement module designed for PT100 Resistance Temperature Detector (RTD).

PCIe/PXIe-6301 supports two wiring topologies, “4-wire mode” and “3-wire mode”, which can be selected by software.
“4-wire mode”: each channel can support 2-wire, 3-wire or 4-wire RTD configuration and the module provides 20 channels of analog temperature measurements.
“3-wire mode”: each channel can support 2-wire or 3-wire RTD configuration and the module provides 32 channels of analog temperature measurements.

PCIe/PXIe-6301 can measure resistance up to 400 Ω to cover the full range of PT100 RTD measurements and the maximum sampling rate is up to 800 samples per second.

The PCIe/PXIe-6301 supports digital and software trigger. All trigger signals are routed through PFI or PXI chassis backplane.

PCIe/PXIe-6301 module channel grouping is shown in Table 1.

Wiring topology	ADC	Channels
4-wire mode	ADC 0	Ch0, Ch1, Ch2, Ch3, Ch4
	ADC 1	Ch5, Ch6, Ch7, Ch8, Ch9
	ADC 2	Ch10, Ch11, Ch12, Ch13, Ch14
	ADC 3	Ch15, Ch16, Ch17, Ch18, Ch19
3-wire mode	ADC 0	Ch0, Ch1, Ch2, Ch3, Ch4, Ch5, Ch6, Ch7
	ADC 1	Ch8, Ch9, Ch10, Ch11, Ch12, Ch13, Ch14, Ch15
	ADC 2	Ch16, Ch17, Ch18, Ch19, Ch20, Ch21, Ch22, Ch23
	ADC 3	Ch24, Ch25, Ch26, Ch27, Ch28, Ch29, Ch30, Ch31

Table 1 PCIe/PXIe-6301 Channel Group

1.2 Main Features

- 32 channels (3-wire mode), 20 channels (4-wire mode)
- 24 bits ADC resolution
- -200 °C ~ +850 °C measurement range (using PT100)
- 0 ~ 400 Ω range
- The balance line resistance compensation is provided under the 3-wire RTD measurements
- 128M sample onboard FIFO buffer for analog input
- DMA for analog input
- Provide resistance or temperature measurement value
- Digital/Software Trigger

1.3 Abbreviations

AI: Analog Input

ADC: Analog to Digital Converter

PFI: Programmable Function Interface

RTD: Resistance Temperature Detector

Ex+: Positive terminal of current Excitation

Ex-: Ngative terminal of current Excitation

RDC: Resistance-to-Digital Converter

OS: Operating System

1.4 Learn by Example

JYTEK has added **Learn by Example** in this manual. We provide many sample programs for this device. You can download a JYPEDIA excel file from our web www.jytek.com. Open JYPEDIA and search for JY6301 in the driver sheet, select **JY6301_Examples.zip.** This will lead you to download the sample program for this device. In addition to the download information, JYPEDIA also has a lot of other valuable information, JYTEK highly recommend you use this file to obtain information from JYTEK.

简仪科技 JYTEK	Drivers are often u
Drivers	**Update Date**
JY6301_V3.0.0_Linux.tar	2021/2/5
JY6301_V3.0.0_Win.zip	2021/2/5
JY6301_V3.0.0_Examples.zip	2021/2/5

Figure 1 JYPEDIA Information

In a **Learn by Example** section, the sample program is in bold style such as **Winform AI Continuous MultiChannel**; the property name in the sample program is also in bold style such as **SamplesToAcquire**; the technical names used in the manual is in italic style such as *SampleRate*. You can easily relate the property names in the example program with the manual documentation.

In a **Learn by Example** section, the experiment is set up as follow. A PCIe/PXIe-6301 card is plugged in a desktop computer. The PCIe/PXIe-6301 is connected to a TB- 68 terminal block. A signal source is also connected to the same terminal block as shown in Figure 2.

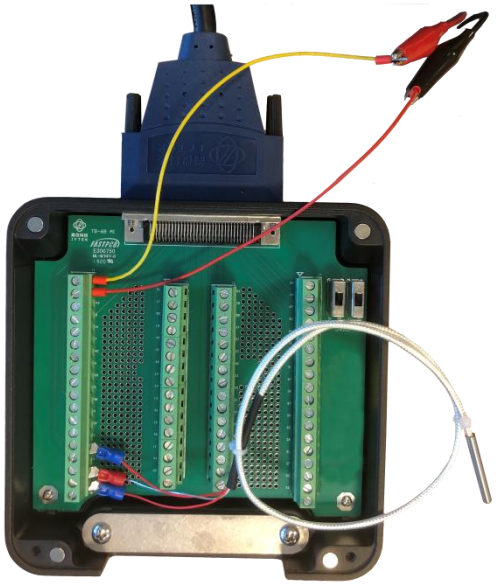

Figure 2 TB- 68 terminal block

2. Hardware

The JYTEK 6301 series are one of the family of temperature measurement module, which can run on PCIe, PXIe, TXI (Thuderbolt) and USB buses (coming soon). JYTEK 6301 series on different buses are shown in Table 2.

6301 Model	PCIe	PXIe	TXI	USB
6301	√	√	√	√

Table 2 6301 on different buses

2.1 Sensor Connection

PCIe/PXIe-6301 can support 2-wire, 3-wire or 4-wire RTD connection at the same time. The wiring configuration used by each channel can be independently configured by software.

2-wire RTD connection

When using a 2-wire RTD configuration, user needs to connect the negative terminal of current excitation (Ex-) to the AI- terminal as shown in Figure 3. Due to the presence of lead wires resistance, this type of connection may introduce large measurement errors, which are related to the material of the lead wire. This type of wiring is not suitable for high precision temperature measurement needs.

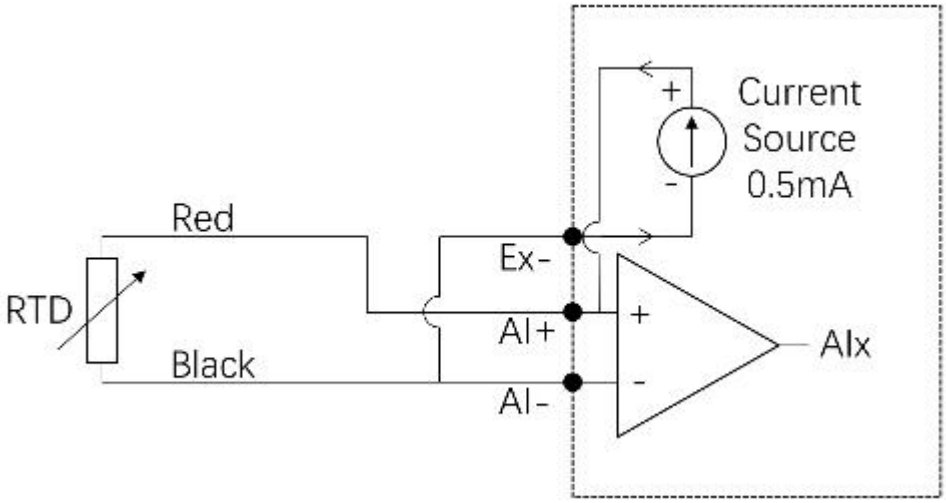

Figure 3 2-wire RTD connection

3-wire RTD connection

In a 3-wire RTD configuration, AI+ terminal will output a precision current excitation, 500 μA to RTD sensor and flow back through the Ex- terminal and AI- terminal as shown in Figure 4 . Since the voltage generated by the RTD connecting the AI+ terminal and the voltage connected to the AI- terminal will cancel each other, this connection can effectively eliminate the influence of the lead wire resistance, but in practical applications, the resistance of the two lead wires is difficult to match completely, so there will still be a certain degree of mismatch error.

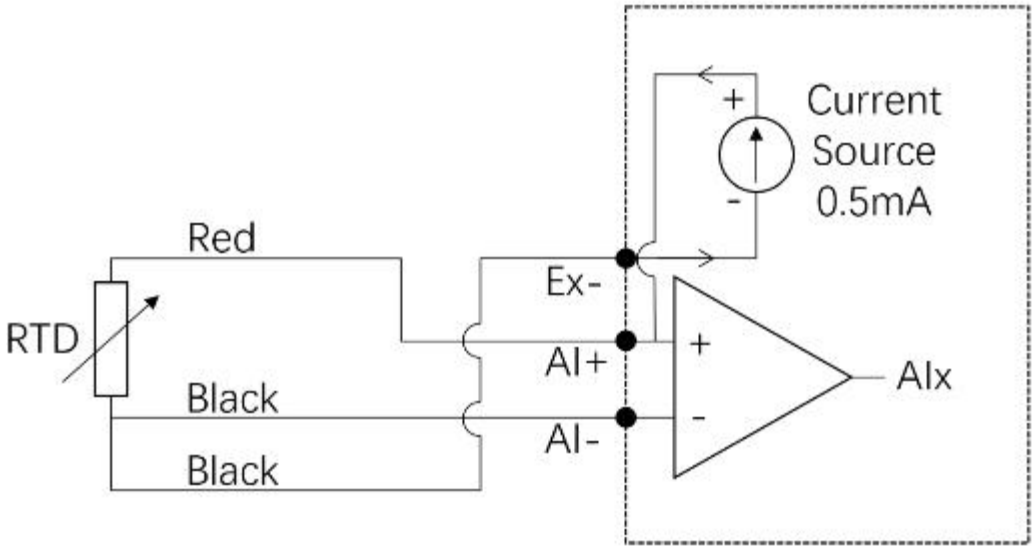

Figure 4 3-wire RTD connection

4-wire RTD connection [1]

In a 4-wire configuration, the Ex+ terminal will output a current excitation, 1000 μA and flows back through the Ex- terminal and AI- terminal as shown in Figure 5. Since the current loop and voltage measuring circuit of the lead wire are independently, so will not introduce errors due to lead wire resistance.

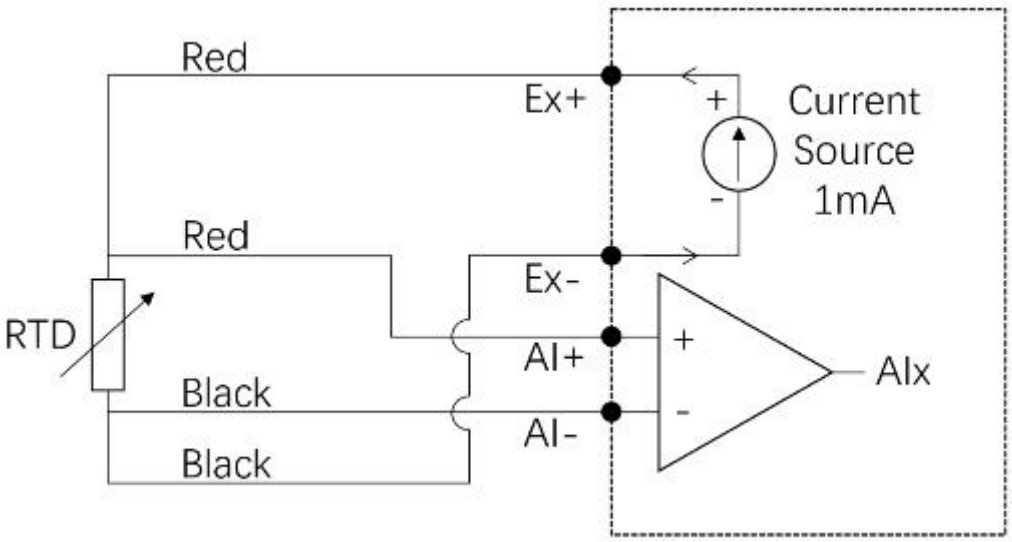

Figure 5 4-wire RTD connection

[1] If you need to use a 4-wire configuration, you must configure the channel topology to a "4-wire mode" when configuring the acquisition task. In this case, the PCIe/PXIe-6301 provides a 20 channels of temperature measurements. If you do not need to use a 4-wire configuration, you can configure the acquisition task to a "3-wire mode", in which case the PCIe/PXIe-6301 provides a 32 channels of temperature measurements.

2.2 Analog Hardware Specifications

Number of channels	32ch (2-wire/3-wire)
	20ch (2-wire/3-wire/4-wire)
Synchronous acquisition	No
Sensor support	RTD PT100
ADC resolution	24 bits
ADC type	Δ-Σ
Input isolation	Yes
Sampling Rate Per Bank (4	800 Sample/s/N (N=1-8)
Banks, 8 Chs/Bank), 4 Banks	160 Sample/s (2-wire/3-wire/4-wire, 20ch fully used)
Use Same Sample Rate	100 Sample/s (2-wire/3-wire, 32ch fully used)
Clock	Onboard (25 MHz) PX I_CLK100 Clock in (PCIe /TX I Only)
Storage depth	128M Samples
Measuring range	0 Ω ~ 400 Ω / -200 °C ~ +850 °C(for PT100)
Terminal type	2-wire/3-wire/4-wire
Excitation current	1000 μA (4-wire)
	500 μA (2-wire/3-wire)
Overvoltage protection	±30 V
Trigger type	Digital/Software
Analog trigger range	0 Ω ~ 400 Ω / -200 °C ~ +850 °C (for PT100)
Trigger mode	StartTrigger，ReferenceTrigger，ReTrigger
Digital trigger sourse	PX I_TRIG <0..7> PX I_STAR PFI<0..7>

Table 3 Analog Input Performance

PCIe/PXIe-6301's 32 channels are grouped by 4 banks, each having 8 channels. The sampling rate per channel must be divided by the sampling rate per bank.

The sample rate parameters are used by PCIe/PXIe-6301 driver software to select the internal ADC Timing Mode which ultimate determines how fast the measurement values are being returned.

ADC Timing Modes	single conversion rate	Single A/D conversion time
Level 0	2.3 Hz	434.7826 ms
Level 1	5.1 H z	196 .0784 ms
Level 2	26.5 Hz	37.7358 ms
Level 3	41 Hz	24.3902 ms
Level 4	410 Hz	2.4390 ms
Level 5	830 Hz	1.1205 ms

Internally, the ADC operates at the single conversion rate per each bank. For multiple channels in the same bank, the sample rates are further reduced. For example, if you chose 800S/s sample rate, the driver software will automatically select level 5 for you. Your measurement accuracy will be determined by Level 5. For accuracies at different levels, please refer to Table 6.

2.3 Resistance Measurement Accuracy

PCIe/PXIe-6301 measures RTD resistance. It has built-in filters to improve the measurement accuracy.

The accuracy is defined by:

Accuracy = Gain Error (% of reading) + Offset Error (mΩ).

The single point resistance measurement accuracy is shown in Table 4. The offset error has included 6 times of noise error for that level. The ADC level is chosen by the driver software, it corresponds to internal ADC conversion rate. This information is important for you if you want to further improve the accuracy by averaging the acquired resistance values. At level 0, ADC already works at 2.3Hz, most system noise is being removed already. Please refer to 2.4.

JY6301 Accuracy = ±(Gain Error % + Offset Error mΩ)

Temperature	ADC Level	Internal ADC Rate (Hz)	2, 3-wires			4-wires			Full Scale Accuracy @ 100Ω (2,3-wires)	Full Scale Accuracy @ 100Ω(4-wires)
Tcal±5 ℃	Level 0	2.3	0.0462	+	25.9	0.0462	+	25.3	30.5 mΩ	30.0 mΩ
Tcal±5 ℃	Level 1	5.1	0.0462	+	26.2	0.0462	+	25.5	30.8 mΩ	30.1 mΩ
Tcal±5 ℃	Level 2	26.5	0.0462	+	26.8	0.0462	+	26.3	31.4 mΩ	30.9 mΩ
Tcal±5 ℃	Level 3	41.0	0.0462	+	26.8	0.0462	+	26.6	31.5 mΩ	31.2 mΩ
Tcal±5 ℃	Level 4	410.0	0.0462	+	31.1	0.0462	+	30.2	35.7 mΩ	34.8 mΩ
Tcal±5 ℃	Level 5	830.0	0.0462	+	56.3	0.0462	+	44.6	60.9 mΩ	49.2 mΩ

Tcal=25℃ typical.
Add 0.0160% to the gain, 20mΩ to the offset for temperatures outside Tcal±5 °C
Offset error contains 3σ,σ is the noise error.

Table 4 Resistance Measurement Accuracy

2.4 Resistance Measurement Noise

Table 5 shows the resistance measurement noises at different ADC levels. 6 times of the noise level are added to the offset error in Section 2.3. You typically do not use this information directly.

Timing mode	single conversion rate	Single A/D conversion time	Noise(2-wire/3-wire)(RMS)	Noise(4-wire) (RMS)
Level 0	2.3 Hz	434.7826 ms	0.35 mΩ	0.18 mΩ
Level 1	5.1 H z	196 .0784 ms	0.45 mΩ	0.24 mΩ
Level 2	26.5 Hz	37.7358 ms	0.65 mΩ	0.5 mΩ
Level 3	41 Hz	24.3902 ms	0.68 mΩ	0.6 mΩ
Level 4	410 Hz	2.4390 ms	2.1 mΩ	1.8 mΩ
Level 5	830 Hz	1.1205 ms	10.5 mΩ	6.6 mΩ

Table 5 Resistance Measurement noise

2.5 Temperature Measurement Accuracy

The temperature measurement is converted from the resistance measurement. The Table 6 lists the temperature measurement accuracies for different wire configurations.

Temperature Accuracy					
Levels	Maximum Total Sample Rate(S/s)	(-200°C,2,3-wires)(°C)	(-200° c,4-wires) (°C)	(850°C,2,3-wires) (°C)	(850°C,4-wires) (°C)
Level 0	2.2	0.06	0.06	0.12	0.12
Level 1	5	0.07	0.06	0.12	0.12
Level 2	25	0.07	0.07	0.13	0.13
Level 3	40	0.07	0.07	0.13	0.13
Level 4	400	0.09	0.08	0.16	0.15
Level 5	800	0.21	0.15	0.33	0.25
Wiring resistance negligible					
Operating temperature =25					

Table 6 6301 Temperature Measurement Accuracy

The typical temperature noises from each wire configuration are listed at Appendix 7.5.

2.6 PFI

The PFIs(Programable Fuction Interface) are digital IO interfaces and are used for general purpose IO, a trigger input/ output, a clock-in and clock out. In 6501, the PFI can only be used for the external digital triggering and cannot be configured as output.

Number of channels	8 (4 of them have hardware pull-ups)
External digital trigger interface	Trigger voltage：5 V TTL
	Trigger edge：Rising /Falling
Initial state	Input*
**6301's PFI is only used for external digital triggering, cannot be configured as output*	

Table 7 PFI Specification

2.7 Trigger

Digital trigger

Trigger source:	PXI_TRIG <0..7>, PXI_STAR, PFI <0..7>
Trigger mode:	Start Trigger, Reference Trigger
Trigger polarity:	Software-selectable

Analog trigger

Trigger source:	AI CH<0..31>
Trigger mode:	Start Trigger, Reference Trigger
Trigger polarity:	Software-selectable

Table 8 Trigger Specification

2.8 Clock

Clock source:	On Board
Clock Destination:	Sample Clock

Table 9 Clock Specification

2.9 Physical and Environment

Bus

PXIe standard:	x4 PXI Express module, specification rev 1.0 compliant
Slot supported:	x1 and x4 PXI Express or PXI Express hybrid slots

Size

External physical size:	3U PXIE
Weight:	190 g

Operating Environment

Ambient temperature range	0 °C to 50 °C
Relative humidity range	20% to 80%, noncondensing

Storage Environment

Ambient temperature range	-20℃ to 80℃
Relative humidity range	10% to 90%, noncondensing

Power

3.3 V:	2.0 A
12 V:	0.04 A

Table 10 Physical and Environment

2.10 Front Panel conections and Pinouts

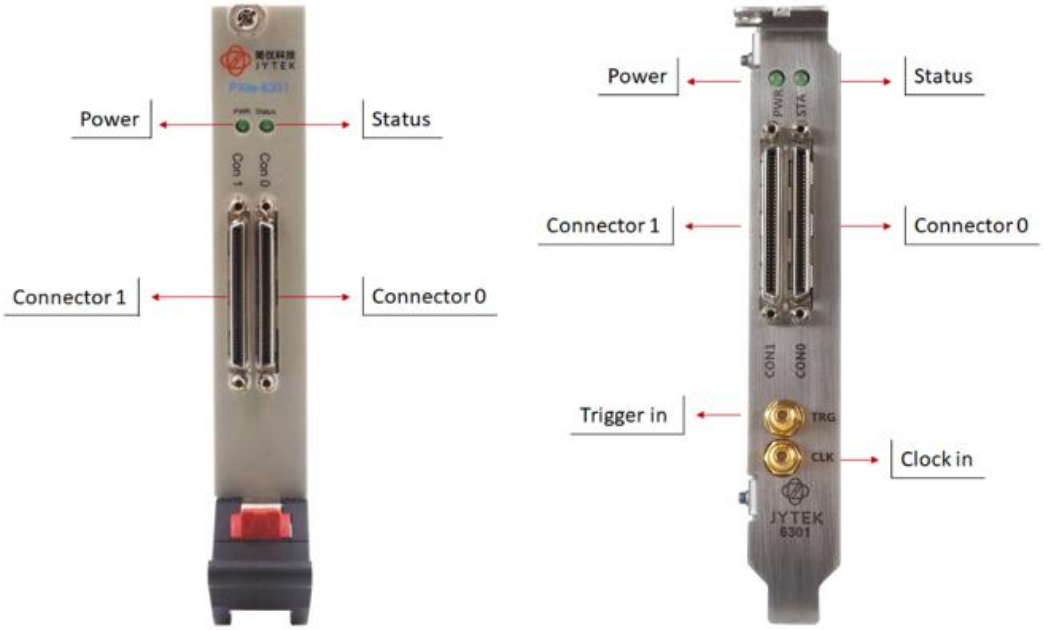

Figure 6 PXIe/PCIe 6301 Front Panel

PCIe/PXIe-6301 supports two wiring topologies, “4-wire mode” and 3-wire mode”. The pinout of the “4-wire mode” is shown in Table 11, the pinout of the “3-wire mode” is shown in Table 12.

Connector 1 (left)		
Channel	**Pin No.**	**Description**
Ch10	P43	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P35	AI+, resistance measurement high side
	P1	AI- , resistance measurement low side
	P36	Ex- , Negative terminal of current exciation
Ch11	P9	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P37	AI+ , resistance measurement high side
	P3	AI- , resistance measurement low side
	P2	Ex- , Negative terminal of current exciation
Ch12	P44	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P38	AI+ , resistance measurement high side
	P4	AI- , resistance measurement low side
	P39	Ex- , Negative terminal of current exciation
Ch13	P10	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P40	AI+ , resistance measurement high side
	P6	AI- , resistance measurement low side
	P5	Ex- , Negative terminal of current exciation
Ch14	P46	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P41	AI+ , resistance measurement high side
	P7	AI- , resistance measurement low side
	P42	Ex- , Negative terminal of current exciation
Ch15	P58	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P49	AI+ , resistance measurement high side
	P15	AI- , resistance measurement low side
	P50	Ex- , Negative terminal of current exciation
Ch16	P24	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P51	AI+, resistance measurement high side
	P17	AI- , resistance measurement low side
	P16	Ex- , Negative terminal of current exciation
Ch17	P59	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P52	AI+, resistance measurement high side
	P18	AI- , resistance measurement low side
	P53	Ex- , Negative terminal of current exciation
Ch18	P25	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P54	AI+, resistance measurement high side
	P20	AI- , resistance measurement low side
	P19	Ex- , Negative terminal of current exciation
Ch19	P61	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P55	AI+ , resistance measurement high side
	P21	AI- , resistance measurement low side
	P57	Ex- , Negative terminal of current exciation
GND	P30	GND
	P31	
	P32	
	P33	
	P34	
PFI	P64	PFI4
	P65	PFI5
	P66	PFI6 (with pull-up resistor)
	P67	PFI7 (with pull-up resistor)
Others	P13	Reserved, NO connect
	P47	
	P28	
	P62	
	P68	

Connector 0 (right)		
Channel	**Pin No.**	**Description**
Ch0	P43	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P35	AI+, resistance measurement high side
	P1	AI- , resistance measurement low side
	P36	Ex- , Negative terminal of current exciation
Ch1	P9	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P37	AI+ , resistance measurement high side
	P3	AI- , resistance measurement low side
	P2	Ex- , Negative terminal of current exciation
Ch2	P44	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P38	AI+ , resistance measurement high side
	P4	AI- , resistance measurement low side
	P39	Ex- , Negative terminal of current exciation
Ch3	P10	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P40	AI+ , resistance measurement high side
	P6	AI- , resistance measurement low side
	P5	Ex- , Negative terminal of current exciation
Ch4	P46	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P41	AI+ , resistance measurement high side
	P7	AI- , resistance measurement low side
	P42	Ex- , Negative terminal of current exciation
Ch5	P58	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P49	AI+ , resistance measurement high side
	P15	AI- , resistance measurement low side
	P50	Ex- , Negative terminal of current exciation
Ch6	P24	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P51	AI+, resistance measurement high side
	P17	AI- , resistance measurement low side
	P16	Ex- , Negative terminal of current exciation
Ch7	P59	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P52	AI+, resistance measurement high side
	P18	AI- , resistance measurement low side
	P53	Ex- , Negative terminal of current exciation
Ch8	P25	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P54	AI+, resistance measurement high side
	P20	AI- , resistance measurement low side
	P19	Ex- , Negative terminal of current exciation
Ch9	P61	Ex+, Positive terminal of current excitation (only for 4-wire mode)
	P55	AI+ , resistance measurement high side
	P21	AI- , resistance measurement low side
	P57	Ex- , Negative terminal of current exciation
GND	P30	GND
	P31	
	P32	
	P33	
	P34	
PFI	P64	PFI0
	P65	PFI1
	P66	PFI2 (with pull-up resistor)
	P67	PFI3 (with pull-up resistor)
Others	P13	Reserved, NO connect
	P47	
	P28	
	P62	
	P68	

Table 11 Pinouts for “4-wire mode” configuration (supports 2-wire, 3-wire or 4-wire RTD)

Connector 1 (left)		
Channel	Port	Port definition
Ch16	P35	AI+ , resistance measurement high side
	P1	AI- , resistance measurement low side
	P36	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch17	P37	AI+ , resistance measurement high side
	P3	AI- , resistance measurement low side
	P2	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch18	P38	AI+ , resistance measurement high side
	P4	AI- , resistance measurement low side
	P39	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch19	P40	AI+ , resistance measurement high side
	P6	AI- , resistance measurement low side
	P5	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch20	P41	AI+ , resistance measurement high side
	P7	AI- , resistance measurement low side
	P42	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch21	P43	AI+ , resistance measurement high side
	P9	AI- , resistance measurement low side
	P8	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch22	P44	AI+ , resistance measurement high side
	P10	AI- , resistance measurement low side
	P45	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch23	P46	AI+ , resistance measurement high side
	P12	AI- , resistance measurement low side
	P11	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch24	P49	AI+ , resistance measurement high side
	P15	AI- , resistance measurement low side
	P50	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch25	P51	AI+ , resistance measurement high side
	P17	AI- , resistance measurement low side
	P16	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch26	P52	AI+ , resistance measurement high side
	P18	AI- , resistance measurement low side
	P53	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch27	P54	AI+ , resistance measurement high side
	P20	AI- , resistance measurement low side
	P19	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch28	P55	AI+ , resistance measurement high side
	P21	AI- , resistance measurement low side
	P57	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch29	P58	AI+ , resistance measurement high side
	P24	AI- , resistance measurement low side
	P23	NEG, short circuit connection to AI- in two-wire mode
Ch30	P59	AI+ , resistance measurement high side
	P25	AI- , resistance measurement low side
	P60	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch31	P61	AI+ , resistance measurement high side
	P27	AI- , resistance measurement low side
	P26	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
GND	P30	GND
	P31	
	P32	
	P33	
	P34	
PFI	P64	PFI4
	P65	PFI5
	P66	PFI6 (with pull-up resistor)
	P67	PFI7 (with pull-up resistor)
Others	P13	Reserved, NO connect
	P47	
	P28	
	P62	
	P68	

Connector 0 (right)		
Channel	Port	Port definition
Ch0	P35	AI+ , resistance measurement high side
	P1	AI- , resistance measurement low side
	P36	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch1	P37	AI+ , resistance measurement high side
	P3	AI- , resistance measurement low side
	P2	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch2	P38	AI+ , resistance measurement high side
	P4	AI- , resistance measurement low side
	P39	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch3	P40	AI+ , resistance measurement high side
	P6	AI- , resistance measurement low side
	P5	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch4	P41	AI+ , resistance measurement high side
	P7	AI- , resistance measurement low side
	P42	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch5	P43	AI+ , resistance measurement high side
	P9	AI- , resistance measurement low side
	P8	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch6	P44	AI+ , resistance measurement high side
	P10	AI- , resistance measurement low side
	P45	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch7	P46	AI+ , resistance measurement high side
	P12	AI- , resistance measurement low side
	P11	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch8	P49	AI+ , resistance measurement high side
	P15	AI- , resistance measurement low side
	P50	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch9	P51	AI+ , resistance measurement high side
	P17	AI- , resistance measurement low side
	P16	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch10	P52	AI+ , resistance measurement high side
	P18	AI- , resistance measurement low side
	P53	NEG, Short circuit connection to AI- in two-wire mode
Ch11	P54	AI+ , resistance measurement high side
	P20	AI- , resistance measurement low side
	P19	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch12	P55	AI+ , resistance measurement high side
	P21	AI- , resistance measurement low side
	P57	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch13	P58	AI+ , resistance measurement high side
	P24	AI- , resistance measurement low side
	P23	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch14	P59	AI+ , resistance measurement high side
	P25	AI- , resistance measurement low side
	P60	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
Ch15	P61	AI+ , resistance measurement high side
	P27	AI- , resistance measurement low side
	P26	Ex- , Negative terminal of current exciation (connet to AI- for 2 wire configuration)
GND	P30	GND
	P31	
	P32	
	P33	
	P34	
PFI	P64	PFI0
	P65	PFI1
	P66	PFI2 (with pull-up resistor)
	P67	PFI3 (with pull-up resistor)
Others	P13	Reserved, NO connect
	P47	
	P28	
	P62	
	P68	

Table 12 Pinouts for “3-wire mode “configuration (supports 2-wire, 3-wire RTD)

RTD Type / 6301 Connection	2-wire	3-wire	4-wire
	Connect AI+/ AI-	Connect AI+/AI-/Ex-	Connect AI+/Ex+/AI-/Ex-
2-wire	Short circuit AI- and Ex-	-	-
3-wire	Short circuit AI- and Ex-	-	-
4-wire	Short circuit AI- and Ex-; Short circuit AI+ and Ex+	Short circuit AI+ and Ex+	-

Table 13 Different RTD wiring methods

3. Software

3.1 System Requirements

PCIe/PXIe-6301 can be used in a Windows or a Linux operating system.

Microsoft Windows: Windows 7 32/64 bit, Windows 10 32/64 bit.

Linux Kernel Versions: There are many Linux versions. It is not possible JYTEK can support and test our devices under all different Linux versions. JYTEK will at the best support the following Linux versions.

Linux Version
Ubuntu LTS
16.04： 4.4.0-21-generic(desktop/server)
16.04.6：4.15.0-45-generic(desktop) 4.4.0-142-generic(server)
18.04： 4.15.0-20-generic(desktop) 4.15.0-91-generic(server)
18.04.4：5.3.0-28-generic (desktop) 4.15.0-91-generic(server)
Localized Chinese Version
中标麒麟桌面操作系统软件（兆芯版）V7.0（Build61）: 3.10.0-862.9.1.nd7.zx.18.x86_64
中标麒麟高级服务器操作系统软件V7.0U6: 3.10.0-957.el7.x86_64

Table 14 Supported Linux Versions

3.2 System Software

When using the PCIe/PXIe-6301 in the Windows enviornment, you need to install the following software from Microsoft website:

Microsoft Visual Studio Version 2015 or above,

.NET Framework version is 4.0 or above.

.NET Framework is coming with Windows 10. For Windows 7, please check .NET Framework version and upgrade to 4.0 or later version.

Given the resouces limitation, JYTEK only tested PCIe/PXIe-6301 module with .NET Framework 4.0 and Microsoft Visual Studio 2015. JYTEK relies on Microsoft to maintain the compatibility for the newer versions.

3.3 C# Programming Language

All JYTEK default programming language is Microsoft Visual Studio C#. This is Microsoft recommended programming language in Microsoft Visual Studio and is particularly suitable for the test and measurement applications. C# is also a cross platform programming language.

3.4 PCIe/PXIe-6301 Hardware Driver

After installing the required application development environment as described above, you need to install the PCIe/PXIe-6301 hardware driver.

JYTEK hardware driver has two parts: the shared Common Kernel Driver (FirmDrive) and the hardware specific driver.

FirmDrive: FirmDrive is the JYTEK's common kernel driver for all hardware of JYTEK instruments. You need to install this kernel driver before using any other JYTEK hardware products. FirmDrive only needs to be installed once. After that, you can only install the hardware specific driver.

Hardware Specific Driver: Each JYTEK hardware has a C# hardware specific driver. This driver provides rich and easy-to-use C# interfaces for users to operate various PCIe/PXIe-6301 functions. JYTEK has standardized the ways JYTEK and other vendor's DAQ cards are used by providing a consistant Application Programming Interface, using the methods, properties and enumerations in the object-oriented programming enviornment. Once you get yourself familiar with how one JYTEK DAQ card works, you shoud be able to know how to use all other DAQ hardware using the same methods.

3.5 Install the SeeSharpTools from JYTEK

To efficiently and effectively use PCIe/PXIe-6301 boards, you need to install a set of free C# utilities from JYTEK SeeSharp Test and Measurement platform. The SeeSharpTools offers versatile user interface functions you will find convenient in developing your applications. They are also needed to run the examples come with PCIe/PXIe-6301 hardware. Please register and download the latest SeeSharpTools from our website www.jytek.com.

3.6 Running C# Programs in Linux

Most C# written programs in Windows OS can be run by MonoDevelop development system in Linux OS. You would develop your C# applications in Windows using Microsoft Visual Stuido. Once it is done, run this application in the MonoDevelop environment. This is JYTEK recommended way to run your C# programs in Linux OS.

If you want to use your own Linux development system other than MonoDevelop, you can do it using our Linux driver. However, JYTEK does not have the capability to support the Linux applications. JYTEK completely relies upon Microsoft to maintain the cross-platform compatibility between Windows and Linux OS using MonoDevelop.

4. Operating PCIe/PXIe-6301 Modules

This chapter provides the operation guides for PCIe/PXIe-6301, including RTD measurement and programmable I/O interface, etc.

JYTEK provides extensive examples, on-line help and documentation to assist you to operate the PCIe/PXIe-6301 board. JYTEK strongly recommends you go through these examples before writing your application. In many cases, an example can also be a good starting point for a user application.

4.1 Quick Start

After you have installed the driver software and the SeeSharpoTols, you are ready to use Microsoft Visual Stuidio and our C# measurement and control platform tools (SeeSharp Platform) to operate the PCIe/PXIe-6301 products.

If you are already familiar with Microsoft Visual Studio C#, the quickest way to use PCIe/PXIe-6301 is to go through our extensive examples. We provide source code of our examples. In many cases, you can modify the source code and start to write your applications.

4.2 AI Operations

When performing AI operations, it will be helpful if you understand the characteristics of the signal to be acquired, then configure PCIe/PXIe-6301 accordingly. Once configured, you can use our tools to read data and save it in the memory or on a disk for your future analysis. Please see the provided software examples for more information.

Learn by Example 4.2

- Connect the PT100's positive pole to AI+ (Pin#35), the negative poles to AI- (Pin#1) and Ex- (Pin#36);
- Open **Winform AI Continuous,** set the following numbers as shown. Choose **ThreeWire** in **RTD Terminal;**

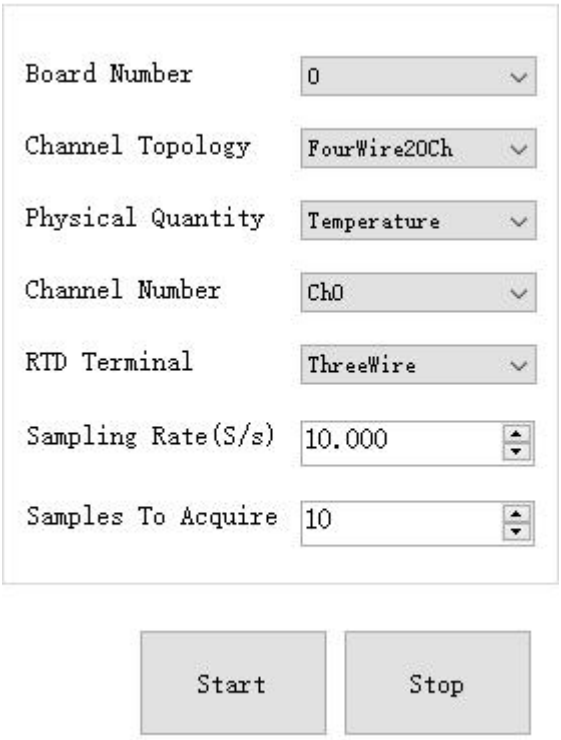

Figure 7 AI Continuous Paraments

■ Click **Start**, the result is shown below.

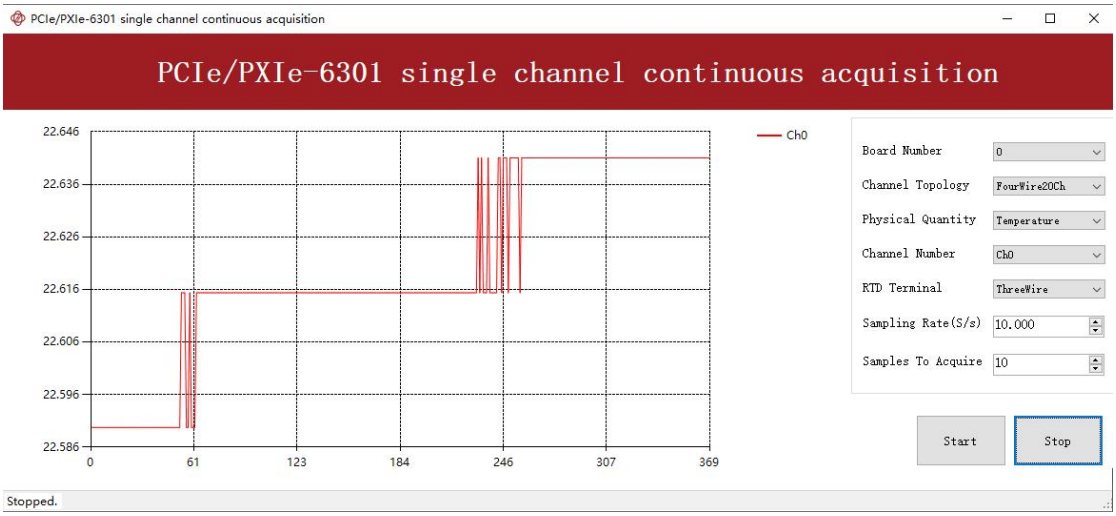

Figure 8 Single Channel Continuous Acquisition

➢ It shows that the temperature measured by channel0 is around 22.6°C.

4.2.1 Channel Scan Sequence

The scanning order of the channels is related to the order in which the user adds channels. When the acquisition task starts, the channels added by the user will be assigned to each ADC according to the group to which they belong. Each ADC will automatically switch channels through the multiplexer to traverse all enabled channels of the ADC for analog to digital conversion.

For a single ADC, the scan order is always consistent with the order in which the channels within the ADC packet range are added. However, since the four ADCs work at the same time, the scanning order of all the channels is not necessarily exactly the same as the order in which the user adds the channels.

Figure 9 shows a typical channel scan sequence. In this case, the user added all channels (Ch 0 ~ Ch 19) in order under the “4-wire mdoe” topology, and these channels were automatically assigned to 4 ADCs. At the beginning of the acquisition task, each ADC will start working at the same time, and then switch the channels in its group.

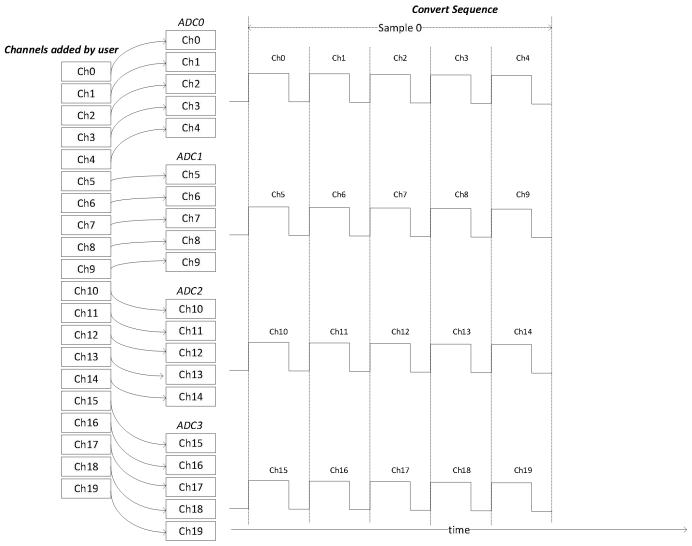

Figure 9 Typical channel scan sequence

Figure 10 shows another typical channel scan sequence, in which case the user added some channels in random order under the “4-wire mdoe” topology.

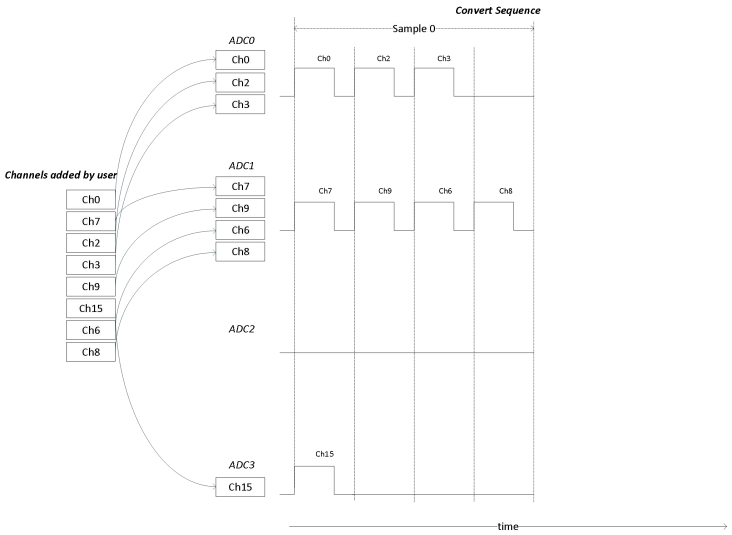

Figure 10 Random channel scan sequence

When using the driver, although the scan order of the channels does not necessarily match the order of adding channels, the data is automatically reordered internally by the driver, so the order of the data of each channel's reading data will always be the same as the order of adding channels.

Learn by Example 4.2.1

- Open the program **Winform AI Continuous MultiChannel;**
- Connect the PT100's positive pole to AI+ (Pin#35), the negative poles to AI- (Pin#1) and Ex- (Pin#36);
- Choose **Ch0** in **Channel Number** for measurement.
- Set other parameters as shown and click **Start.** The result is shown below.

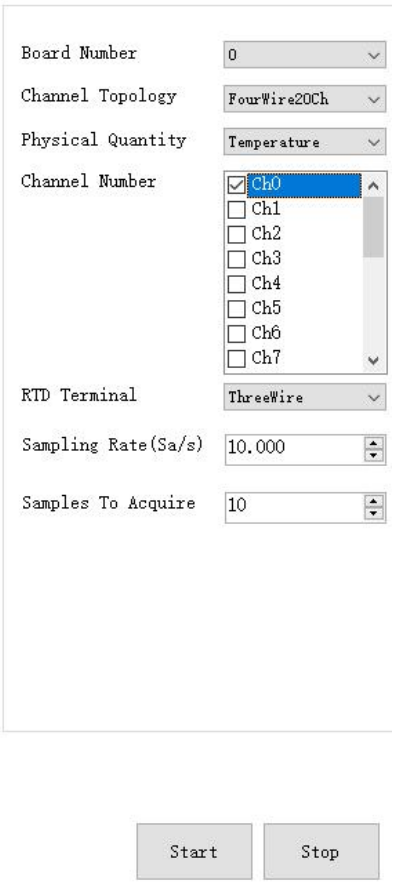

Figure 11 AI MutilChannel Continuouas Paraments

■ Click **Start,** the result is shown below.

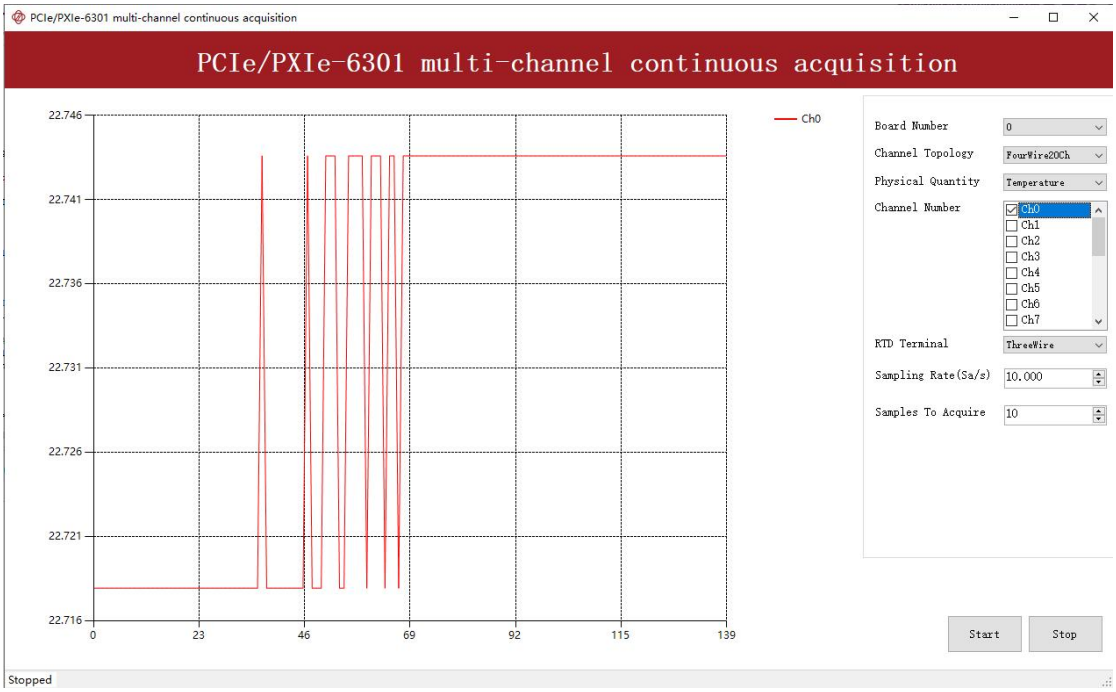

Figure 12 MultiChannel Continuous Acquisition

➢ It shows that the temperature measured by channel0.

4.2.2 ADC Timing Modes

The ADC Timing Mode uses the built-in digital filters to reduce the measurement noise. The ADC Timing mode affects the data output rate and 50 Hz / 60 Hz noise rejection. The lower the ADC conversion rate, the better the noise rejection.

The PCIe/PXIe-6301 driver provides a total of 6 ADC convesrion rates, from Level 0 to Level 5. Level 0 has the slowest conversion rate and best noise rejection. Level 5 has the fastest conversion rate and worst noise suppression performance.

The reciprocal of the ADC conversion rate is the time required for each A/D conversion.

ADC Timing Modes	single conversion rate	Single A/D conversion time
Level 0	2.3 Hz	434.7826 ms
Level 1	5.1 H z	196 .0784 ms
Level 2	26.5 Hz	37.7358 ms
Level 3	41 Hz	24.3902 ms
Level 4	410 Hz	2.4390 ms
Level 5	830 Hz	1.1205 ms

Table 15 A/D conversion time at different speed levels

In the default configuration, the conversion rate level is set to Auto, and the drive will automatically select the lowest possible rate level according to the sampling rate and the number of added channels. If the user explicitly configures the rate level, the driver will automatically limit the highest sampling rate according to the number of added channels and the rate level. If the user-set sampling rate exceeds the limit, the driver will adjust it to nearest rate level. The conversion rate is set to the maximum possible.

For a more detailed description of the relationship between Timing Modes and sampling rates, please refer to Section 4.2.3.

4.2.3 Sampling Rate

When PCIe/PXIe-6301 works, each sample contains the completion of an A/D converter (Convert) on all channels, the principle is as in Figure 13.

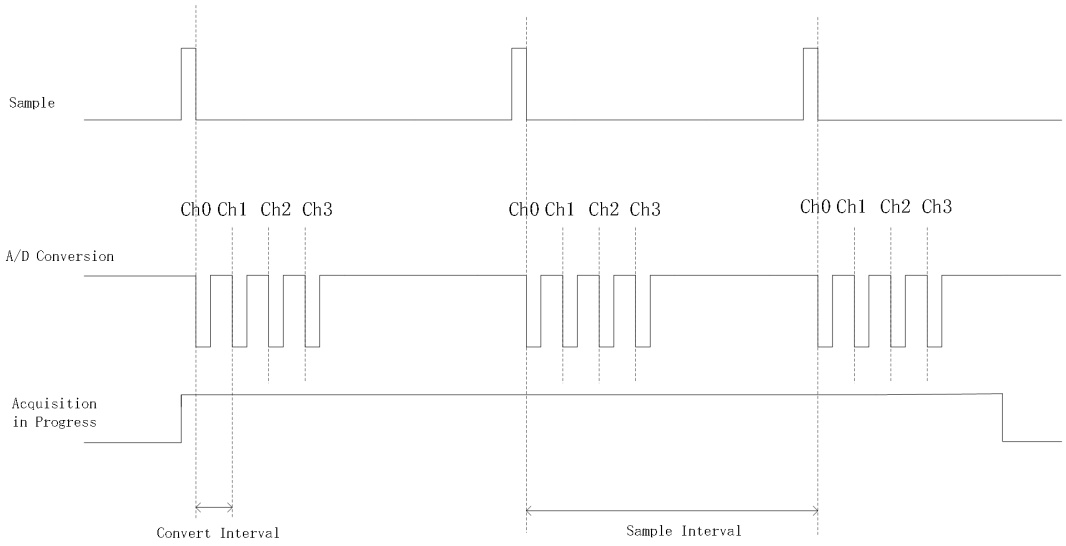

Figure 13 A / D conversion and sampling

The time required for each A/D conversion is controlled by the sampling rate level. The minimum sampling rate of PCIe/PXIe-6301 is 0.275 S/s, and the maximum sampling rate is 800 S/s. The actual maximum sampling rate can be set according to the set rate grade and the number of channels added by each ADC for:

$$Max\ Sample\ Rate = \frac{\text{Max Total Sample Rate}}{\max\ (\text{number of channels on one ADC})}$$

Where:

●$Max\ Sample\ Rate$: The maximum sample rate that can be set

●$\max\ (\text{number of channels on one ADC})$: Maximum number of channels added on a single A DC.

●Max Total Sample Rate: The maximum total sampling rate at the current rate level, as shown in Table 16.

ADC Timing Modes	Maximum total sampling rate
Level 0	2.2 S/s
Level 1	5.0 S/s
Level 2	25.0 S/s
Level 3	40.0 S/s
Level 4	400.0 S/s
Level 5	800.0 S/s

Table 16 ADC Timing Modes and maximum aggregate sampling rate

When the user sets the timing mode to Auto, the driver internally reverses the current actual total sample rate according to the following formula:

$$Total\ Sample\ Rate = \max(\text{number of channels on any one ADC}) * Sample\ Rate$$

Where:

- $Total\ Sample\ Rate$: Current actual total sampling rate

- $\max(\text{number of channels on any one ADC})$: Maximum number of channels added on a single ADC

- $Sample\ Rate$: User-set sampling rate

After the drive internally finds the actual total sampling rate, the lowest timing mode is automatically selected according to the interval divided in above Table 16.

4.3 Conversion of Resistance and Temperature

The PCIe/PXIe-6301 is a temperature measurement module designed for the PT100 RTD with a maximum measurable resistance of 400 Ω. During temperature measurement, PCIe/PXIe-6301 first measures the resistance value, then automatically converts the resistance value (Ω) to the temperature value (°C).

For the conversion of resistance and temperature values, the internal conversion formula of the driver is referenced to the platinum RTD standard DIN/IEC 60751:2008 (Edition 2.0), ie:

When the temperature is between -200 °C and 0 °C:

$$R_t = R_0\left[1 + At + Bt^2 + C(t - 100℃)t^3\right]$$

When the temperature is between 0 °C and 850 °C:

$$R_t = R_0(1 + At + Bt^2)$$

Where:

- R_t: The resistance value (Ω) of PT100 when the temperature is t (°C)
- R_0: The resistance value (Ω) of PT100 when the temperature is 0 °C, ie. 100 Ω
- $A = 3.9083 * 10^{-3}\ ℃^{-1}$
- $B = -5.775 * 10^{-7}\ ℃^{-2}$
- $C = -4.183 * 10^{-12}\ ℃^{-4}$

The complete temperature/resistance index table is shown in

Appendix Table 1.

Get resistance value

The resistance value (Ω) can be read from the PCIe/PXIe-6301 when the ReadRawData method is called.

4.4 Trigger Source

4.4.1 Immediate Trigger

The module will acquire the signal immediately after executing the AI Task without any trigger condition setting by default.

Learn by Example 4.4.1

- Connect the PT100's positive pole to AI+ (Pin#35), the negative poles to AI- (Pin#1) and Ex- (Pin#36);
- Open **Winform AI Continuous;**
- Set parameters as shown and click **Start.**

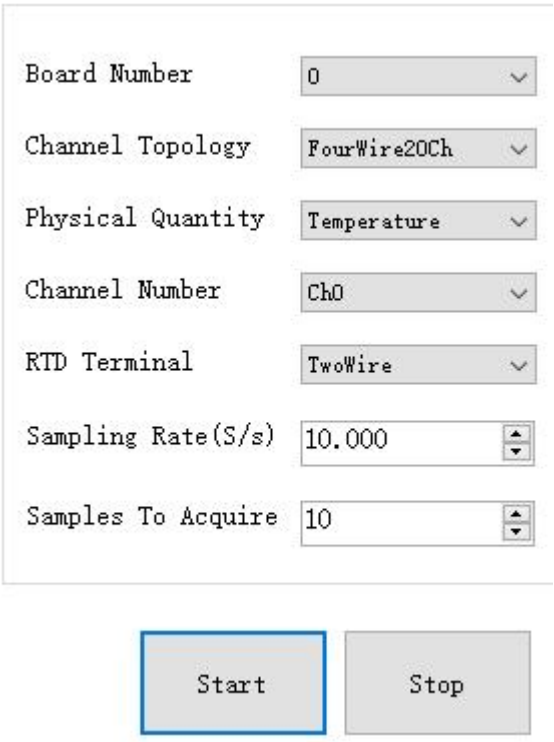

Figure 14 Immediate Trigger Paraments

- With Immediate trigger you can click **Start** to begin the task instead of sending a trigger signal.

4.4.2 Software Trigger

The anglog acquisition task will wait on the software trigger signal in the software trigger mode until receiving a software trigger signal from driver, then AI task will start to acquire the data.

4.4.3 External digital trigger

The module supports different external digital trigger sources from PXI Trigger bus (PXI_TRIG<0..7>), PXI_STAR and connectors of front panel (PFI). The pulse width of digital trigger signal must be longer then 20 ns for effective trigger. Thewill monitor the signal on digital trigger source and wait for the rising edge or falling edge of digital signal which depending on the set trigger condition, then enables the module to acquire the data as shown in Figure 15.

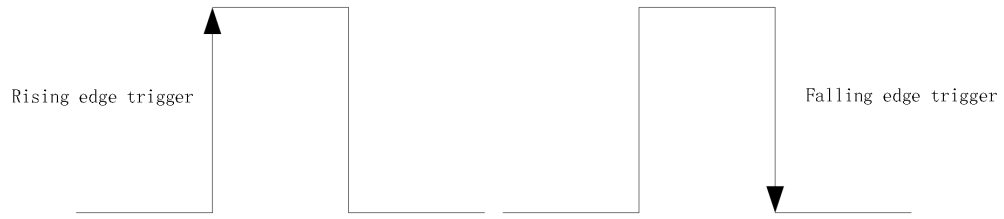

Figure 15 Rising and falling edges of digital signals

Learn by Example 4.4.3

- Connect the PT100's positive pole to AI+ (Pin#35), the negative poles to AI- (Pin#1) and Ex- (Pin#36), then connect the signal source's positive pole and negative pole to PCIe/PXIe-6301 PFI2 (Pin#66) and GND (Pin#30);
- Set the signal source Ch1's output to square wave (f=1Hz, Vpp=5v);
- Choose **Rising** in **Trigger Condition** and choose **PFI_2** in **Trigger Source**;
- Open **Winform AI Continuous Digital Trigger**, set the following parametersas shown and click **Start.**

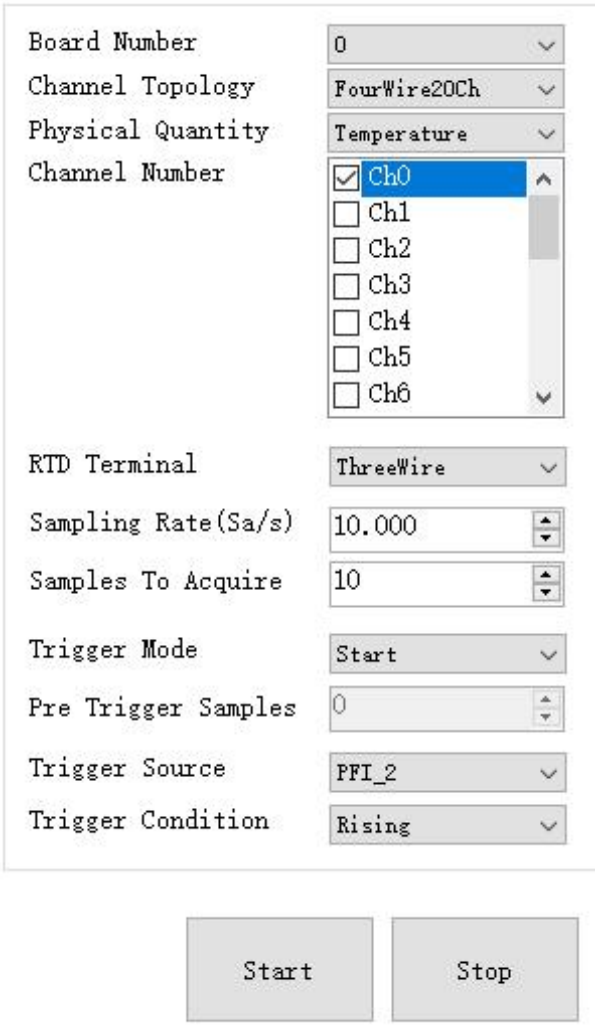

Figure 16 Digital Trigger Paraments

- **Trigger Source** must match the pin on the terminal block.
- There are two **Trigger Conditions**: **Rising** and **Falling**.

■ The result is shown below:

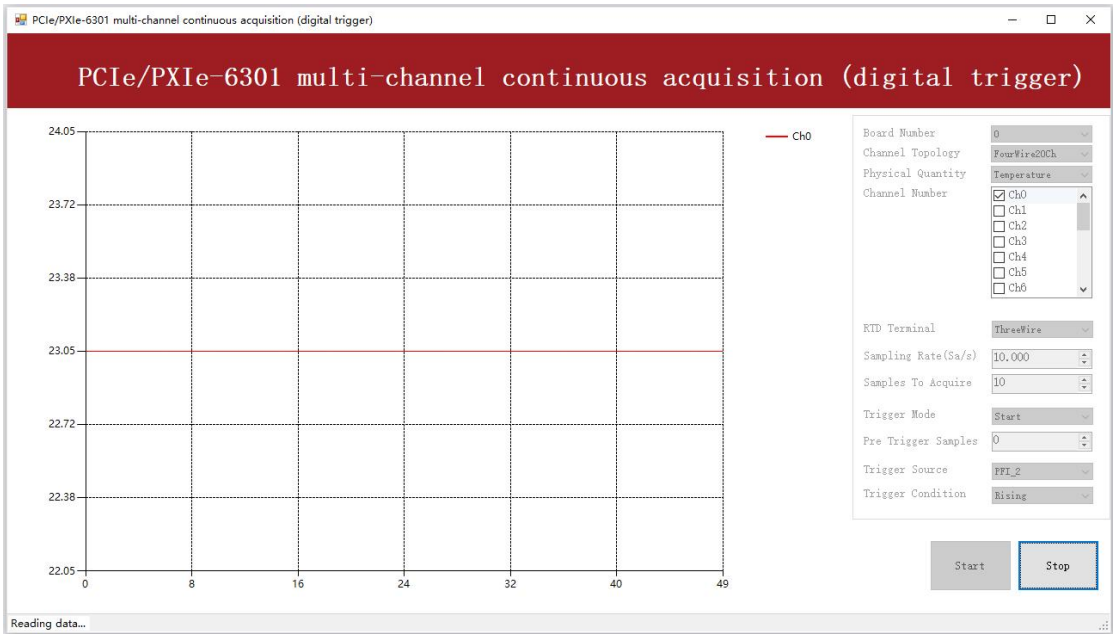

Figure 17 Digial Trigger Acquisition

- Since the squarewave is used for the digital trigger source, when a rising edge of the squarewave occurs, the digital trigger will be activated, and the data acquisition will start.

4.5 Trigger Mode

The analog inputs of the PCIe/PXIe-6301 support several trigger modes: Start Trigger, Reference Trigger and Retrigger.

4.5.1 Start Trigger

In this mode, the analog acquisition task will start to acquire the signal immediately after the trigger asserted as shown in

Figure 18. The Start Trigger mode is suitable for continuousand finite acquisition mode.

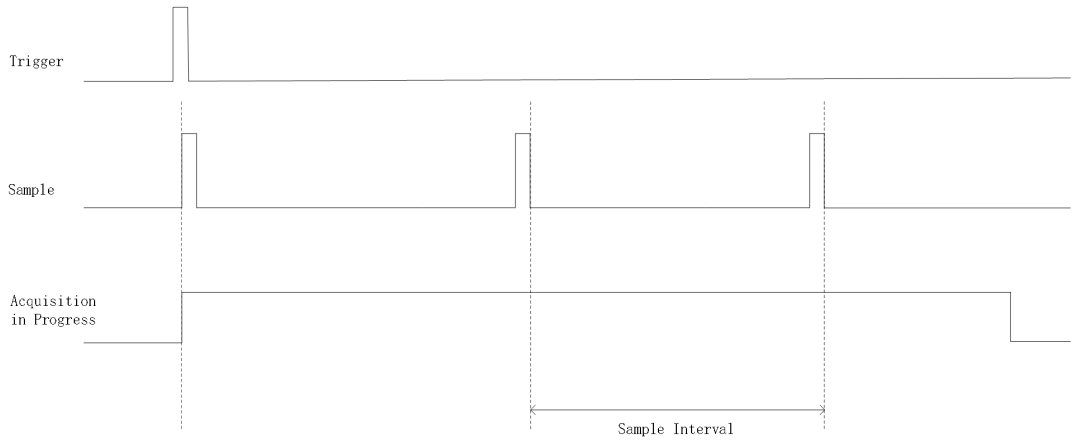

Figure 18 Start Trigger Mode

Learn by Example 4.5.1

- Open **Winform AI Continuous Digital Trigger**, set the following parameters as shown;
- Choose **Start** in **Trigger Mode** to use Start Trigger.

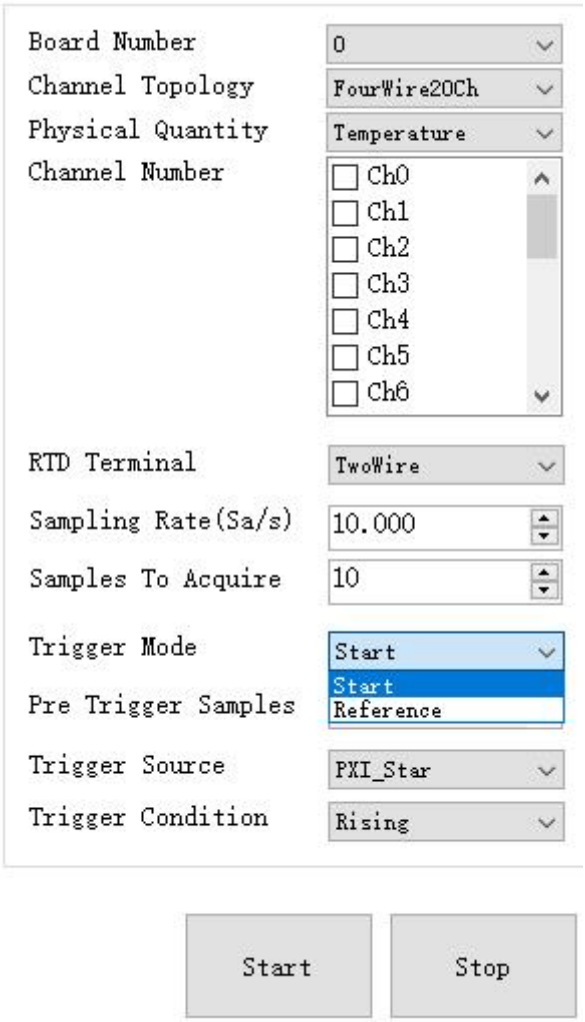

Figure 19 Start Trigger Paraments

- In **Trigger Mode** you can choose **Start** for Start Trigger, **Reference** for Reference Trigger.

4.5.2 Reference Trigger

User can configure a trigger condition and acquire the data between trigger asserted in the Reference Trigger mode. Data acquired before trigger occurred is pretrigger samples. Data acquired after trigger occurred is posttrigger samples. User can configure two parameters, “PretriggerSamples” and “SamplesToAcquire” to capture specified data as shown in Figure 20.

This trigger mode is only suitable for finite acquisition mode. The default number of pretrigger samples is 0.

Example

- SamplesToAcquire: 1000
- PretriggerSamples: 10
- Posttrigger samples: 990 (1000-10)

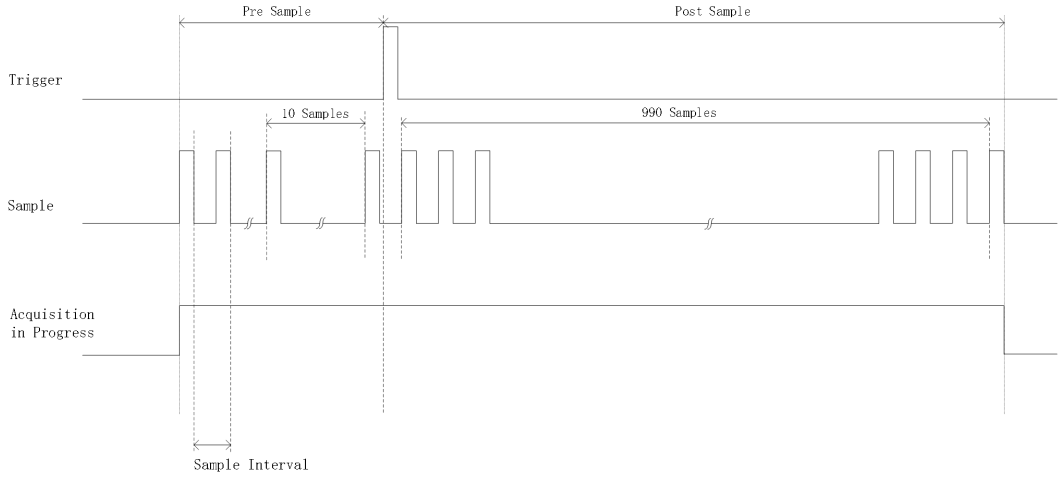

Figure 20 Reference Trigger mode

4.5.3 Retrigger

User can configure a specified trigger condition and repeated trigger times to capture signal. The number of repeated trigger times is set by the parameter “ReTriggerCount”. For example, we set the ReTriggerCount to N and the length of each acquisition to M, therefore the total acquired samples is N * M * channelcounts as shown in Figure 21.

Note, Retrigger mode is only valid in finite acquisition mode.

When theReTriggerCount is set to -1, it will wait on trigger infinitely until aborting the task.

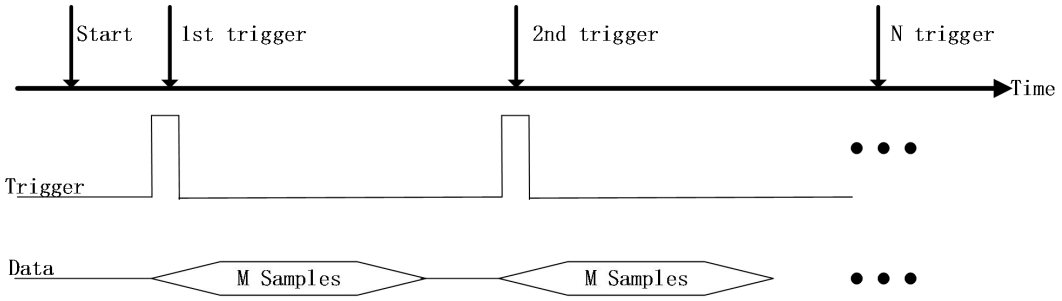

Figure 21 Retrigger mode

Learn by Example 4.5.2 and 4.5.3

- Connect the PT100's positive pole to AI+ (Pin#35), the negative poles to AI- (Pin#1) and Ex- (Pin#36), then connect the signal source's positive pole and negative pole to PCIe/PXIe-6301 PFI2 (Pin#66) and D_GND (Pin#30);
- Set the signal source Ch1's output to square wave (f=1Hz, Vpp=5v);
- Open **Winform AI Finite Digital Trigger**, set the following numbers as shown.

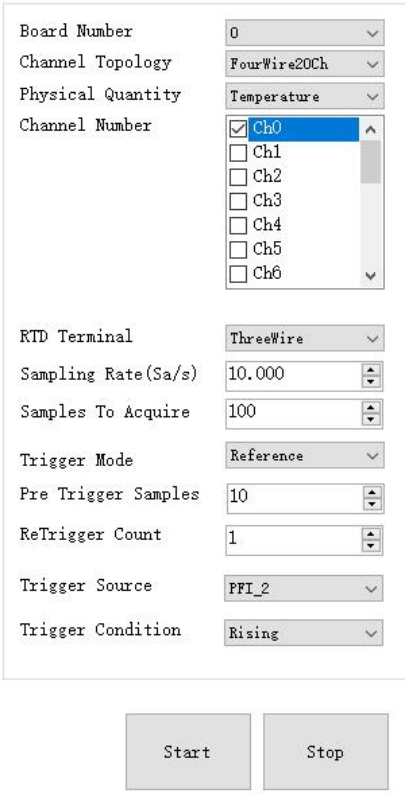

Figure 22 Retrigger Paraments

➢ You can use three different kinds of triggers in this program as mentioned in this chapter. *Start Trigger* and *Reference Trigger* can be set by **Trigger Mode**. For *Re-Trigger* can be used by changing the numbers in **Retrigger Count**.

■ Now the **Trigger Mode** is "**Reference**", and the PreTrigger Samples is 10. Click **Start** to begin the data acquisition, the result is shown below:

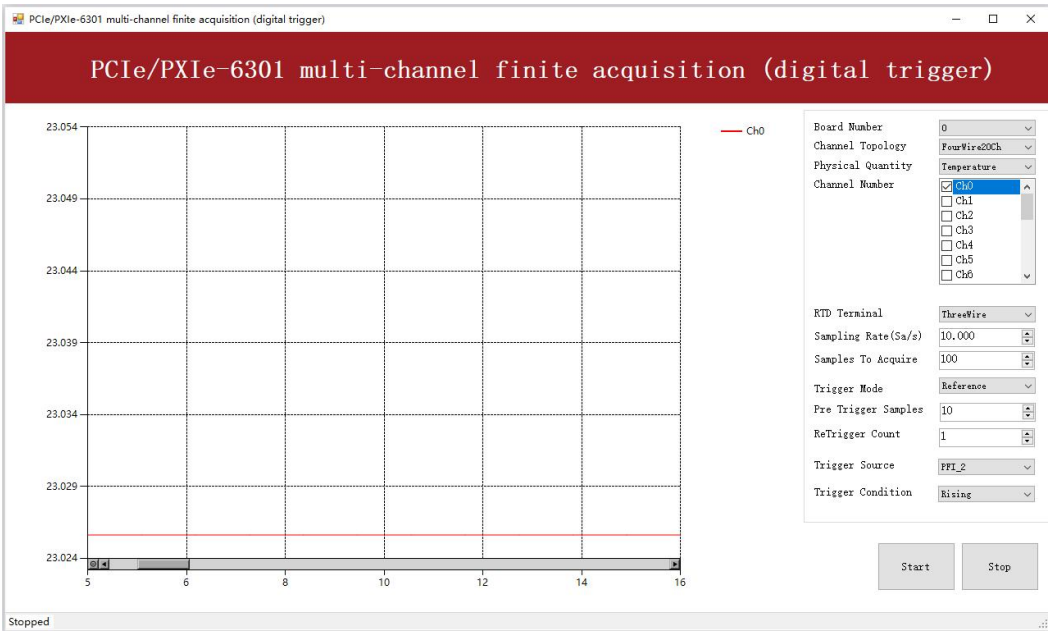

Figure 23 Retrigger in Reference Trigger Mode

➢ Because the measured waveform is a straight line, the effect of reference trigger can not be seen clearly.

■ Now change the mode of trigger to **Retrigger** through giving **Retrigger Count** the number 5 and click **Start**. A message will appear in the lower left corner: "Samples acquired: 400/500".

Figure 24 Retrigger Complete State

➢ It shows the acquisition process through every trigger signal.

4.6 System Synchronization Interface（SSI）for PCIe Modules

The synchronization between PCIe modules are handled differently from the PXIe synchronization, it is implemented by the system synchronization interface (SSI). SSI is designed as a bidirectional bus and it can synchronize up to four PCIe modules. One PCIe module is designated as the master module and the other PCIe modules are designated as the slave modules.

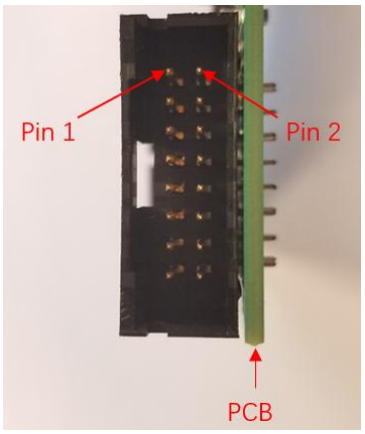

Figure 25 SSI Connector in PCIe-6301

Pin	Signal Name	Signal Name	Pin
1	PXI_TRIG0	GND	2
3	PXI_TRIG1	GND	4
5	PXI_TRIG2	GND	6
7	PXI_TRIG3	GND	8
9	PXI_TRIG4	GND	10
11	PXI_TRIG5	GND	12
13	PXI_TRIG6	GND	14
15	PXI_TRIG7	GND	16

Table 17 SSI Connector Pin Assignment for PCIe-6301

4.7 DIP Switch in PCIe-6301

PCIe-6301 has a DIP switch. The card number can be adjusted manually by changing the DIP switch setting, which is used to identify the boards with different slot position.

For example, if you want to set the card number to 3, you could turn the position 2 and 1 of the DIP switch to the ON position and the orthers to OFF. See below for details.

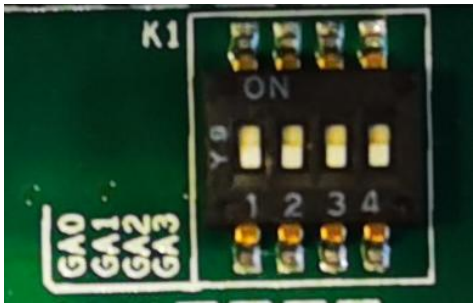

Figure 26 DIP Switch in PCIe-6301

	Position 4 (GA3)	Position 3 (GA2)	Position 2 (GA1)	Position 1 (GA0)
Slot 0	0	0	0	0
Slot 1	0	0	0	1
Slot 2	0	0	1	0
Slot 3	0	0	1	1
Slot 4	0	1	0	0
Slot 5	0	1	0	1
Slot 6	0	1	1	0
Slot 7	0	1	1	1
Slot 8	1	0	0	0
Slot 9	1	0	0	1
Slot 10	1	0	1	0
Slot 11	1	0	1	1
Slot 12	1	1	0	0
Slot 13	1	1	0	1
Slot 14	1	1	1	0
Slot 15	1	1	1	1
Note: OFF=0/ ON=1				

Table 18 Relationship between switch position and card number

5. Calibration

JYTEK PCIe/PXIe-6301 boards are precalibrated before the shipment. We recommend you recalibrate PCIe/PXIe-6301 board periodically to ensure the measurement accuracy. A commonly accepted practice is one year. If you need to recalibrate your board, please contact JYTEK.

6. Using PCIe/PXIe-6301 in Other Software

While JYTEK's default application platform is Visual Studio, the programming language is C#, we recognize there are other platforms that are either becoming very popular or have been widely used in the data acquisition applications. Among them are Python, C++. This chapter explains how you can use PCIe/PXIe-6301 DAQ card using one of this software.

6.1 Python

JYTEK provides and supports a native Python driver for PCIe/PXIe-6301 cards. There are many different versions of Python. JYTEK has only tested in CPython version 3.5. There is no guarantee that JYTEK python drivers will work correctly with other versions of Python.

If you want to be our partner to support different Python platforms, please contact us.

6.2 C++

JYTEK internaly uses our C++ drivers to design the C# drivers. We recommend our customers to use C# drivers because C# platform deliver much better efficiency and performance in most situations. We also make our C++ drivers available. However, due to the limit of our resources, we do not actively support C++ drivers. You can down load our C++ drivers from JYTEK's website. We welcome you report the bugs in our C++ drivers, but will not be able to guarantee that we can fix it within your expectation.

If you want to be our partner to support C++ drivers, please contact us.

7. Appendix

7.1 System Diagram

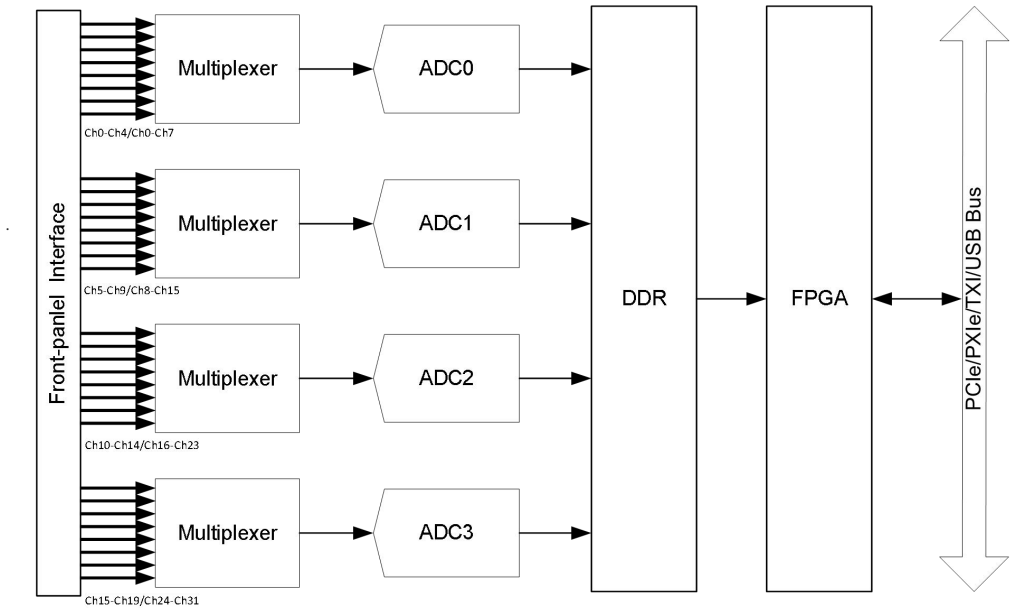

Figure 27 PCIe/PXIe-6301 System Diagram

Figure 27 shows the system diagram of the PCIe/PXIe-6301. The system is mainly composed of ADC, DDR and FPGA control modules. The FPGA-based driver code provides a stable and efficient PCIe / PXIe / USB interface. 6301 has four ADCs, which can work alone or together depending on channel configuration. Each ADC is responsible for the measurement of one group of 5/8 channels (depending on channel topology, i.e. 3-wire or 4-wire) and selects one of the 5/8 channels through the multiplexer at the rising or falling edge of AD conversion clock, as shown in Figure 13.

7.2 PT100 Temperature/Reisitance Table

t(℃)	Resistance at temperature t(Ω)										t(℃)
	0	-1	-2	-3	-4	-5	-6	-7	-8	-9	
-200	18.52										-200
-190	22.83	22.40	21.97	21.54	21.11	20.68	20.25	19.82	19.38	18.95	-190
-180	27.10	26.67	26.24	25.82	25.39	24.97	24.54	24.11	23.68	23.25	-180
-170	31.34	30.91	30.49	30.07	29.64	29.22	28.80	28.37	27.95	27.52	-170
-160	35.54	35.12	34.70	34.28	33.86	33.44	33.02	32.60	32.18	31.76	-160
-150	39.72	39.31	38.89	38.47	38.05	37.64	37.22	36.80	36.38	35.96	-150
-140	43.88	43.46	43.05	42.63	42.22	41.80	41.39	40.97	40.56	40.14	-140
-130	48.00	47.59	47.18	46.77	46.36	45.94	45.53	45.12	44.70	44.29	-130
-120	52.11	51.70	51.29	50.88	50.47	50.06	49.65	49.24	48.83	48.42	-120
-110	56.19	55.79	55.38	54.97	54.56	54.15	53.75	53.34	52.93	52.52	-110
-100	60.26	59.85	59.44	59.04	58.63	58.23	57.82	57.41	57.01	56.60	-100
-90	64.30	63.90	63.49	63.09	62.68	62.28	61.88	61.47	61.07	60.66	-90
-80	68.33	67.92	67.52	67.12	66.72	66.31	65.91	65.51	65.11	64.70	-80
-70	72.33	71.93	71.53	71.13	70.73	70.33	69.93	69.53	69.13	68.73	-70
-60	76.33	75.93	75.53	75.13	74.73	74.33	73.93	73.53	73.13	72.73	-60
-50	80.31	79.91	79.51	79.11	78.72	78.32	77.92	77.52	77.12	76.73	-50
-40	84.27	83.87	83.48	83.08	82.69	82.29	81.89	81.50	81.10	80.70	-40
-30	88.22	87.83	87.43	87.04	86.64	86.25	85.85	85.46	85.06	84.67	-30
-20	92.16	91.77	91.37	90.98	90.59	90.19	89.80	89.40	89.01	88.62	-20
-10	96.09	95.69	95.30	94.91	94.52	94.12	93.73	93.34	92.95	92.55	-10
0	100.00	99.61	99.22	98.83	98.44	98.04	97.65	97.26	96.87	96.48	0
t(℃)	0	1	2	3	4	5	6	7	8	9	t(℃)
0	100.00	100.39	100.78	101.17	101.56	101.95	102.34	102.73	103.12	103.51	0
10	103.90	104.29	104.68	105.07	105.46	105.85	106.24	106.63	107.02	107.40	10
20	107.79	108.18	108.57	108.96	109.35	109.73	110.12	110.51	110.90	111.29	20
30	111.67	112.06	112.45	112.83	113.22	113.61	114.00	114.38	114.77	115.15	30
40	115.54	115.93	116.31	116.70	117.08	117.47	117.86	118.24	118.63	119.01	40
50	119.40	119.78	120.17	120.55	120.94	121.32	121.71	122.09	122.47	122.86	50
60	123.24	123.63	124.01	124.39	124.78	125.16	125.54	125.93	126.31	126.69	60
70	127.08	127.46	127.84	128.22	128.61	128.99	129.37	129.75	130.13	130.52	70
80	130.90	131.28	131.66	132.04	132.42	132.80	133.18	133.57	133.95	134.33	80
90	134.71	135.09	135.47	135.85	136.23	136.61	136.99	137.37	137.75	138.13	90
100	138.51	138.88	139.26	139.64	140.02	140.40	140.78	141.16	141.54	141.91	100
110	142.29	142.67	143.05	143.43	143.80	144.18	144.56	144.94	145.31	145.69	110
120	146.07	146.44	146.82	147.20	147.57	147.95	148.33	148.70	149.08	149.46	120
130	149.83	150.21	150.58	150.96	151.33	151.71	152.08	152.46	152.83	153.21	130
140	153.58	153.96	154.33	154.71	155.08	155.46	155.83	156.20	156.58	156.95	140
150	157.33	157.70	158.07	158.45	158.82	159.19	159.56	159.94	160.31	160.68	150
160	161.05	161.43	161.80	162.17	162.54	162.91	163.29	163.66	164.03	164.40	160
170	164.77	165.14	165.51	165.89	166.26	166.63	167.00	167.37	167.74	168.11	170
180	168.48	168.85	169.22	169.59	169.96	170.33	170.70	171.07	171.43	171.80	180
190	172.17	172.54	172.91	173.28	173.65	174.02	174.38	174.75	175.12	175.49	190
200	175.86	176.22	176.59	176.96	177.33	177.69	178.06	178.43	178.79	179.16	200
210	179.53	179.89	180.26	180.63	180.99	181.36	181.72	182.09	182.46	182.82	210
220	183.19	183.55	183.92	184.28	184.65	185.01	185.38	185.74	186.11	186.47	220
230	186.84	187.20	187.56	187.93	188.29	188.66	189.02	189.38	189.75	190.11	230
240	190.47	190.84	191.20	191.56	191.92	192.29	192.65	193.01	193.37	193.74	240
250	194.10	194.46	194.82	195.18	195.55	195.91	196.27	196.63	196.99	197.35	250
260	197.71	198.07	198.43	198.79	199.15	199.51	199.87	200.23	200.59	200.95	260
270	201.31	201.67	202.03	202.39	202.75	203.11	203.47	203.83	204.19	204.55	270
280	204.90	205.26	205.62	205.98	206.34	206.70	207.05	207.41	207.77	208.13	280
290	208.48	208.84	209.20	209.56	209.91	210.27	210.63	210.98	211.34	211.70	290
300	212.05	212.41	212.76	213.12	213.48	213.83	214.19	214.54	214.90	215.25	300
310	215.61	215.96	216.32	216.67	217.03	217.38	217.74	218.09	218.44	218.80	310
320	219.15	219.51	219.86	220.21	220.57	220.92	221.27	221.63	221.98	222.33	320

Appendix Table 1 PT100 Temperature/Resistance Index Table

t(℃)	Resistance at temperature t(Ω)										t(℃)
	0	1	2	3	4	5	6	7	8	9	
330	222.68	223.04	223.39	223.74	224.09	224.45	224.80	225.15	225.50	225.85	330
340	226.21	226.56	226.91	227.26	227.61	227.96	228.31	228.66	229.02	229.37	340
350	229.72	230.07	230.42	230.77	231.12	231.47	231.82	232.17	232.52	232.87	350
360	233.21	233.56	233.91	234.26	234.61	234.96	235.31	235.66	236.00	236.35	360
370	236.70	237.05	237.40	237.74	238.09	238.44	238.79	239.13	239.48	239.83	370
380	240.18	240.52	240.87	241.22	241.56	241.91	242.26	242.60	242.95	243.29	380
390	243.64	243.99	244.33	244.68	245.02	245.37	245.71	246.06	246.40	246.75	390
400	247.09	247.44	247.78	248.13	248.47	248.81	249.16	249.50	249.85	250.19	400
410	250.53	250.88	251.22	251.56	251.91	252.25	252.59	252.93	253.28	253.62	410
420	253.96	254.30	254.65	254.99	255.33	255.67	256.01	256.35	256.70	257.04	420
430	257.38	257.72	258.06	258.40	258.74	259.08	259.42	259.76	260.10	260.44	430
440	260.78	261.12	261.46	261.80	262.14	262.48	262.82	263.16	263.50	263.84	440
450	264.18	264.52	264.86	265.20	265.53	265.87	266.21	266.55	266.89	267.22	450
460	267.56	267.90	268.24	268.57	268.91	269.25	269.59	269.92	270.26	270.60	460
470	270.93	271.27	271.61	271.94	272.28	272.61	272.95	273.29	273.62	273.96	470
480	274.29	274.63	274.96	275.30	275.63	275.97	276.30	276.64	276.97	277.31	480
490	277.64	277.98	278.31	278.64	278.98	279.31	279.64	279.98	280.31	280.64	490
500	280.98	281.31	281.64	281.98	282.31	282.64	282.97	283.31	283.64	283.97	500
510	284.30	284.63	284.97	285.30	285.63	285.96	286.29	286.62	286.95	287.29	510
520	287.62	287.95	288.28	288.61	288.94	289.27	289.60	289.93	290.26	290.59	520
530	290.92	291.25	291.58	291.91	292.24	292.56	292.89	293.22	293.55	293.88	530
540	294.21	294.54	294.86	295.19	295.52	295.85	296.18	296.50	296.83	297.16	540
550	297.49	297.81	298.14	298.47	298.80	299.12	299.45	299.78	300.10	300.43	550
560	300.75	301.08	301.41	301.73	302.06	302.38	302.71	303.03	303.36	303.69	560
570	304.01	304.34	304.66	304.98	305.31	305.63	305.96	306.28	306.61	306.93	570
580	307.25	307.58	307.90	308.23	308.55	308.87	309.20	309.52	309.84	310.16	580
590	310.49	310.81	311.13	311.45	311.78	312.10	312.42	312.74	313.06	313.39	590
600	313.71	314.03	314.35	314.67	314.99	315.31	315.64	315.96	316.28	316.60	600
610	316.92	317.24	317.56	317.88	318.20	318.52	318.84	319.16	319.48	319.80	610
620	320.12	320.43	320.75	321.07	321.39	321.71	322.03	322.35	322.67	322.98	620
630	323.30	323.62	323.94	324.26	324.57	324.89	325.21	325.53	325.84	326.16	630
640	326.48	326.79	327.11	327.43	327.74	328.06	328.38	328.69	329.01	329.32	640
650	329.64	329.96	330.27	330.59	330.90	331.22	331.53	331.85	332.16	332.48	650
660	332.79	333.11	333.42	333.74	334.05	334.36	334.68	334.99	335.31	335.62	660
670	335.93	336.25	336.56	336.87	337.18	337.50	337.81	338.12	338.44	338.75	670
680	339.06	339.37	339.69	340.00	340.31	340.62	340.93	341.24	341.56	341.87	680
690	342.18	342.49	342.80	343.11	343.42	343.73	344.04	344.35	344.66	344.97	690
700	345.28	345.59	345.90	346.21	346.52	346.83	347.14	347.45	347.76	348.07	700
710	348.38	348.69	348.99	349.30	349.61	349.92	350.23	350.54	350.84	351.15	710
720	351.46	351.77	352.08	352.38	352.69	353.00	353.30	353.61	353.92	354.22	720
730	354.53	354.84	355.14	355.45	355.76	356.06	356.37	356.67	356.98	357.28	730
740	357.59	357.90	358.20	358.51	358.81	359.12	359.42	359.72	360.03	360.33	740
750	360.64	360.94	361.25	361.55	361.85	362.16	362.46	362.76	363.07	363.37	750
760	363.67	363.98	364.28	364.58	364.89	365.19	365.49	365.79	366.10	366.40	760
770	366.70	367.00	367.30	367.60	367.91	368.21	368.51	368.81	369.11	369.41	770
780	369.71	370.01	370.31	370.61	370.91	371.21	371.51	371.81	372.11	372.41	780
790	372.71	373.01	373.31	373.61	373.91	374.21	374.51	374.81	375.11	375.41	790
800	375.70	376.00	376.30	376.60	376.90	377.19	377.49	377.79	378.09	378.39	800
810	378.68	378.98	379.28	379.57	379.87	380.17	380.46	380.76	381.06	381.35	810
820	381.65	381.95	382.24	382.54	382.83	383.13	383.42	383.72	384.01	384.31	820
830	384.60	384.90	385.19	385.49	385.78	386.08	386.37	386.67	386.96	387.25	830
840	387.55	387.84	388.14	388.43	388.72	389.02	389.31	389.60	389.90	390.19	840
850	390.48										850

Appendix Table 2 PT100 Temperature/Resistance Index Table (continued from the previous table)

7.3 Typical Resistance Measurement Noises

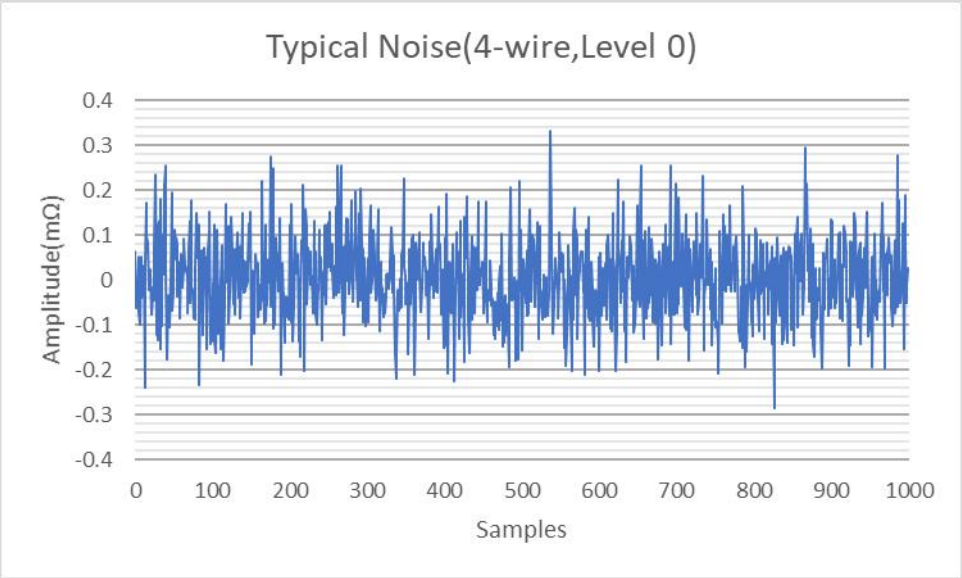

Figure 28 Resistance Measurement noise (4-wire, Level 0)

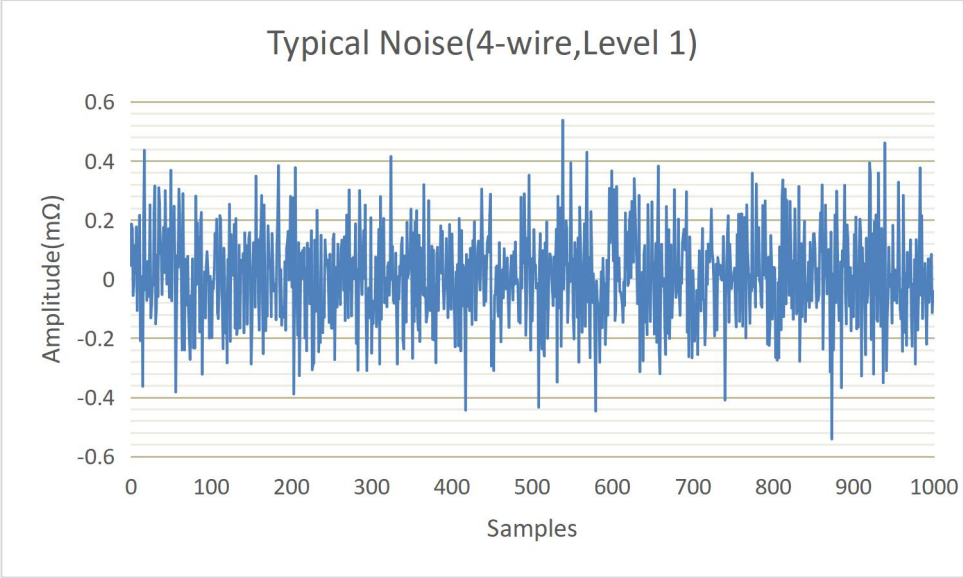

Figure 29 Resistance Measurement noise (4-wire, Level 1)

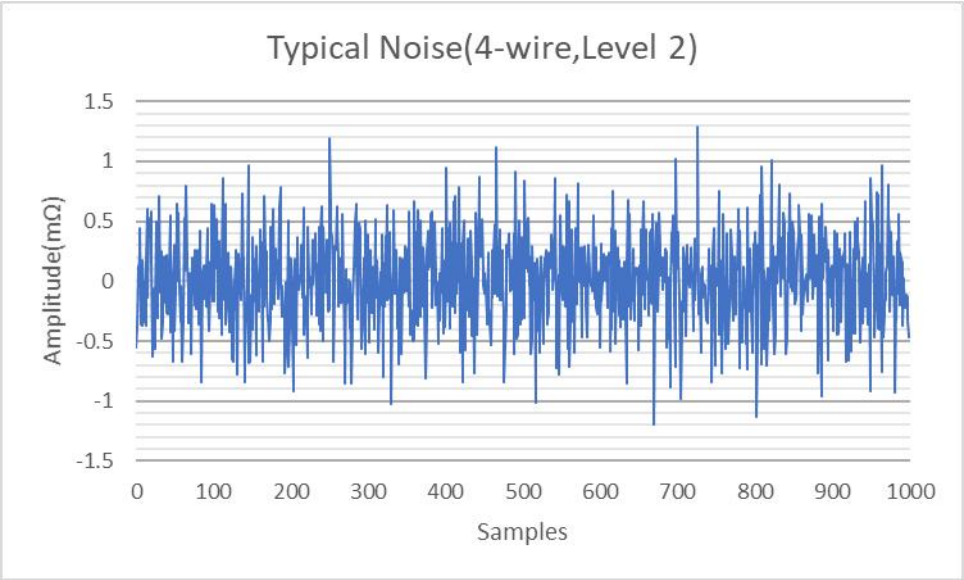

Figure 30 Resistance Measurement noise (4-wire, Level 2)

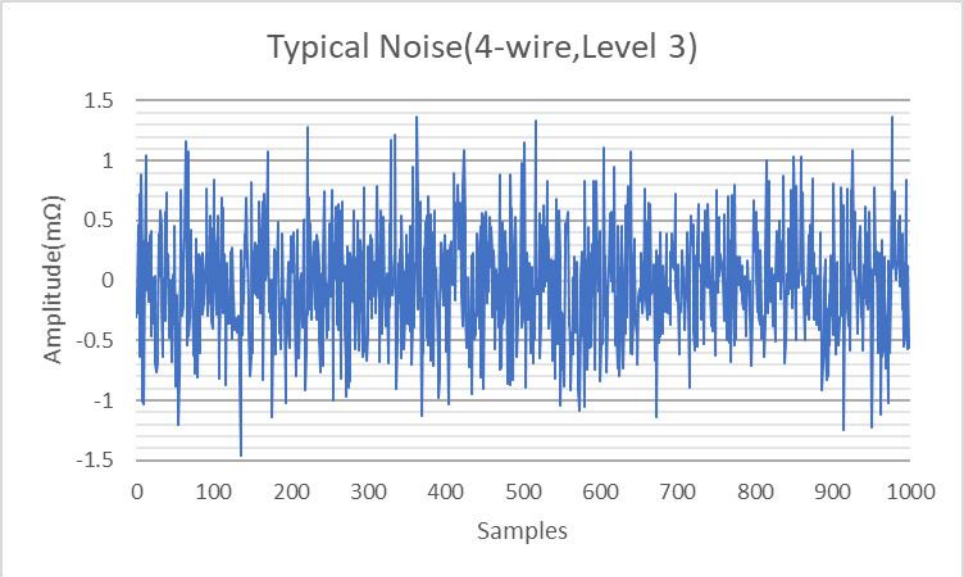

Figure 31 Resistance Measurement noise (4-wire, Level 3)

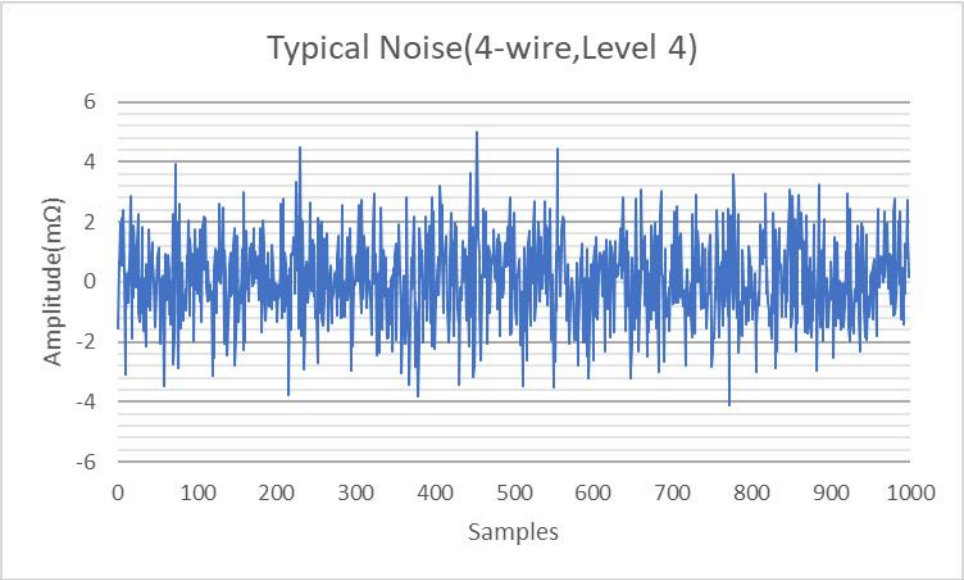

Figure 32 Resistance Measurement noise (4-wire, Level 4)

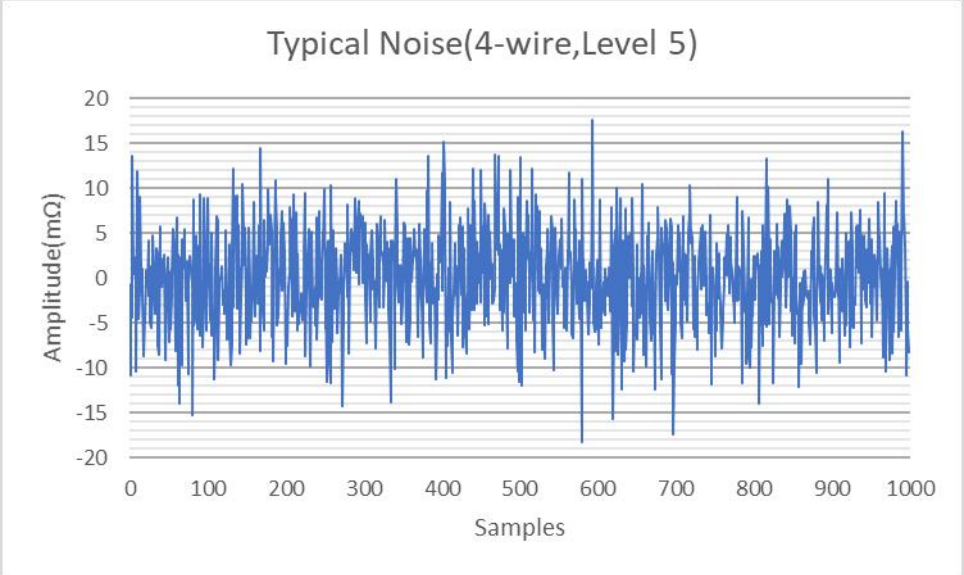

Figure 33 Resistance Measurement noise (4-wire, Level 5)

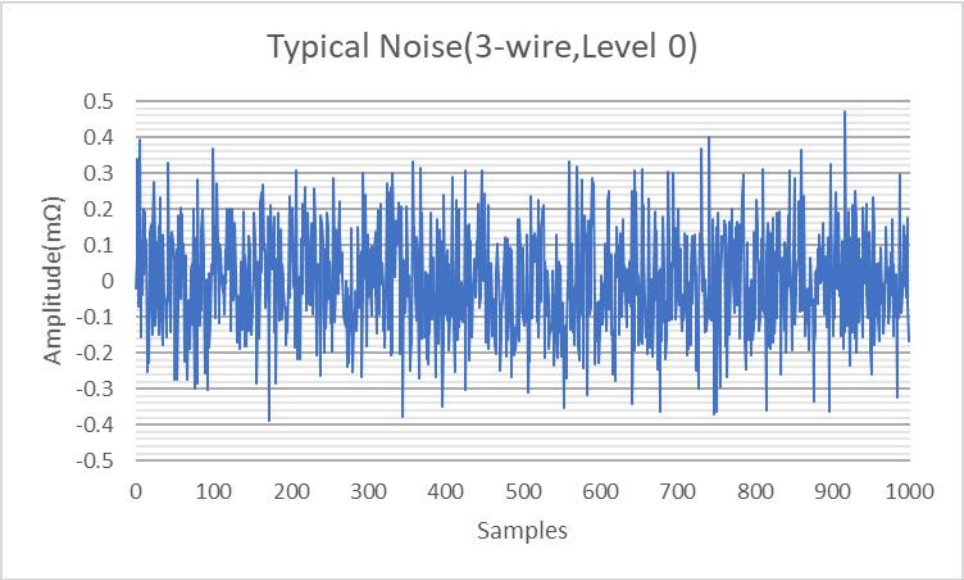

Figure 34 Resistance Measurement noise (3-wire, Level 0)

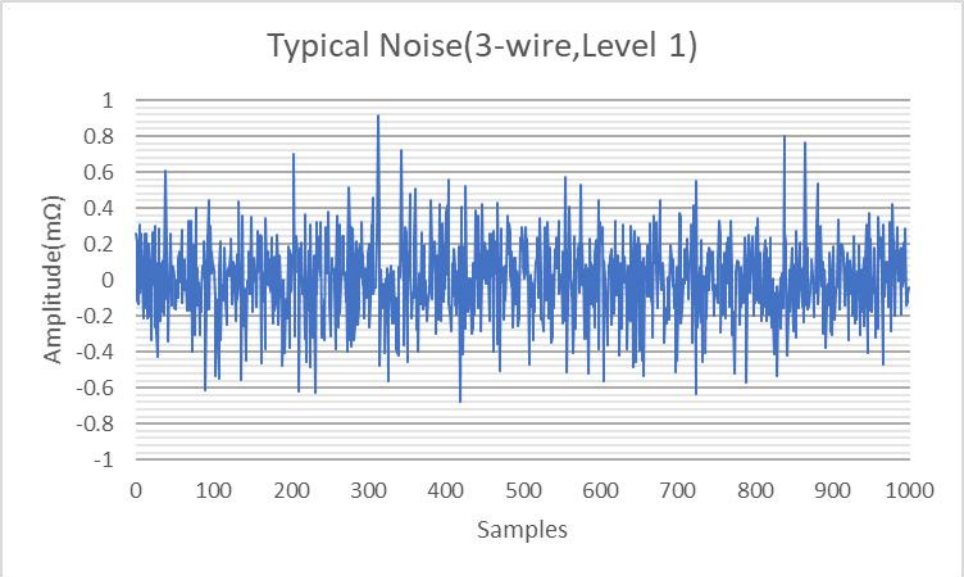

Figure 35 Resistance Measurement noise (3-wire, Level 1)

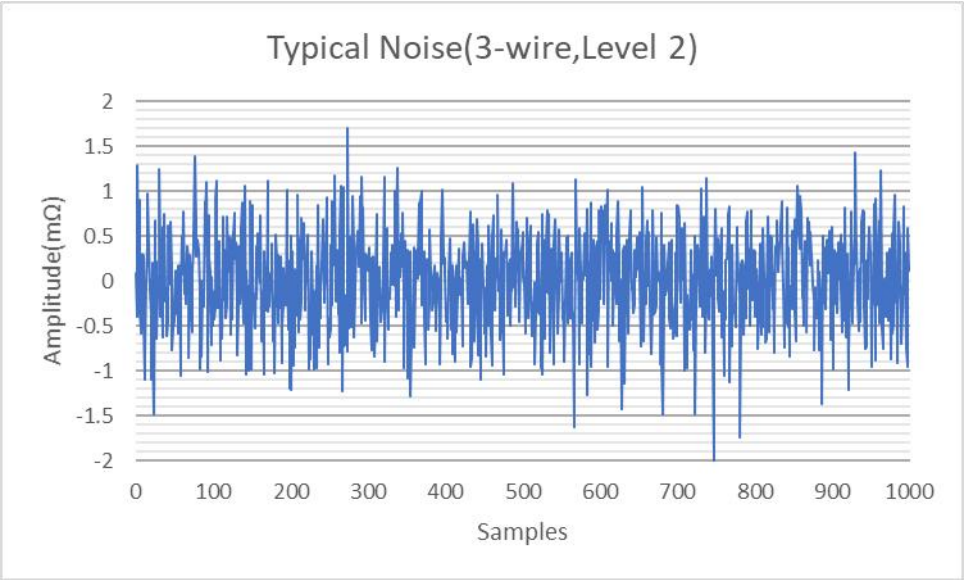

Figure 36 Resistance Measurement noise (3-wire, Level 2)

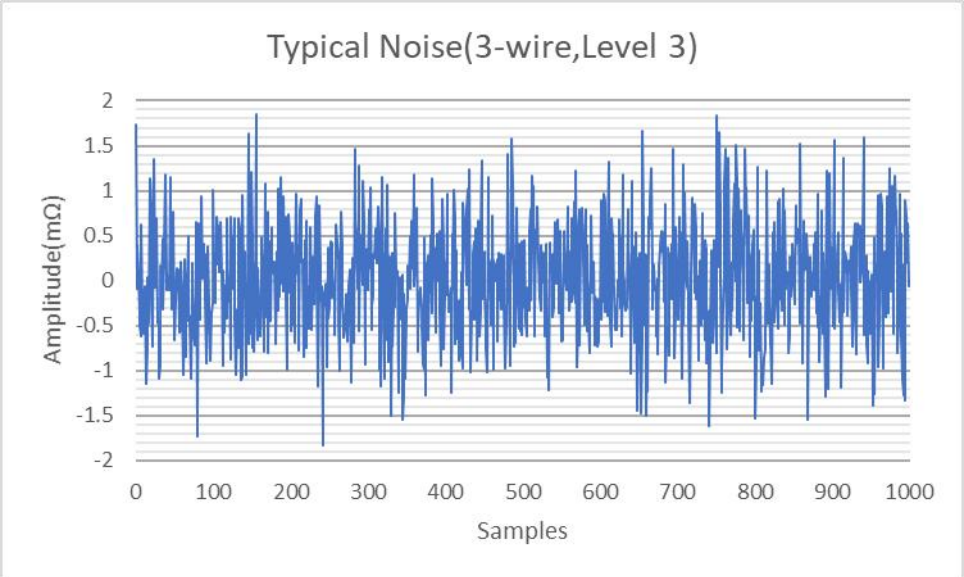

Figure 37 Resistance Measurement noise (3-wire, Level 3)

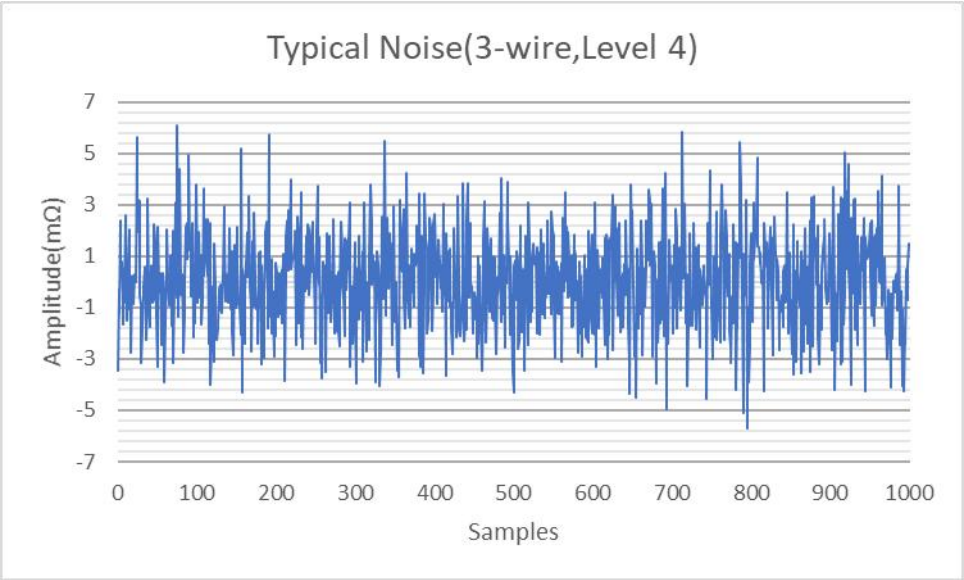

Figure 38 Resistance Measurement noise (3-wire, Level 4)

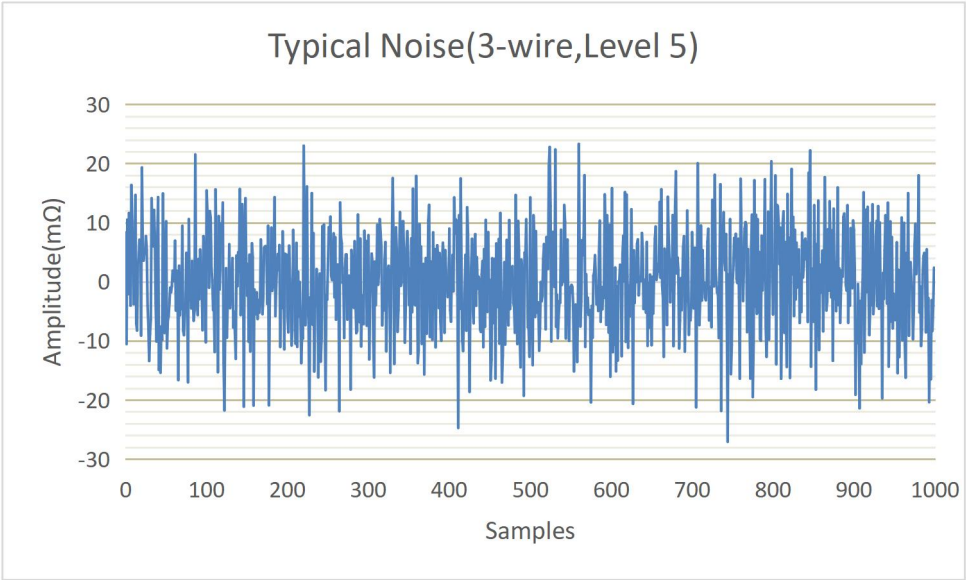

Figure 39 Resistance Measurement noise (3-wire, Level 5)

7.4 Gain and Offset Stability Tests

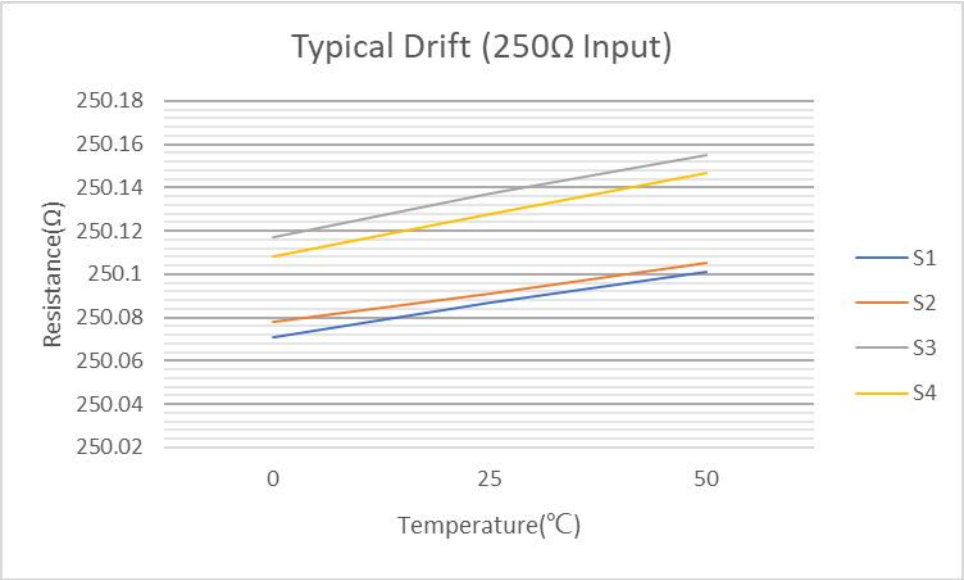

Figure 40 Typical Drift (250 Ω Input)

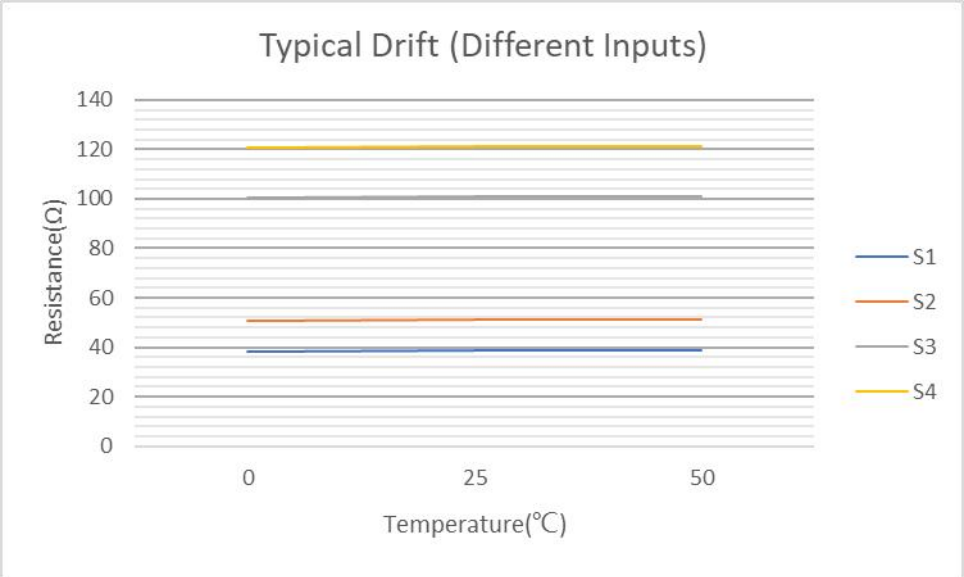

Figure 41 Typical Drift (Different Inputs)

7.5 Reistance Measurement Error

Tests are conducted to measure the resistance measurement errors. The group axis represent each individual test. The order is not important. ???

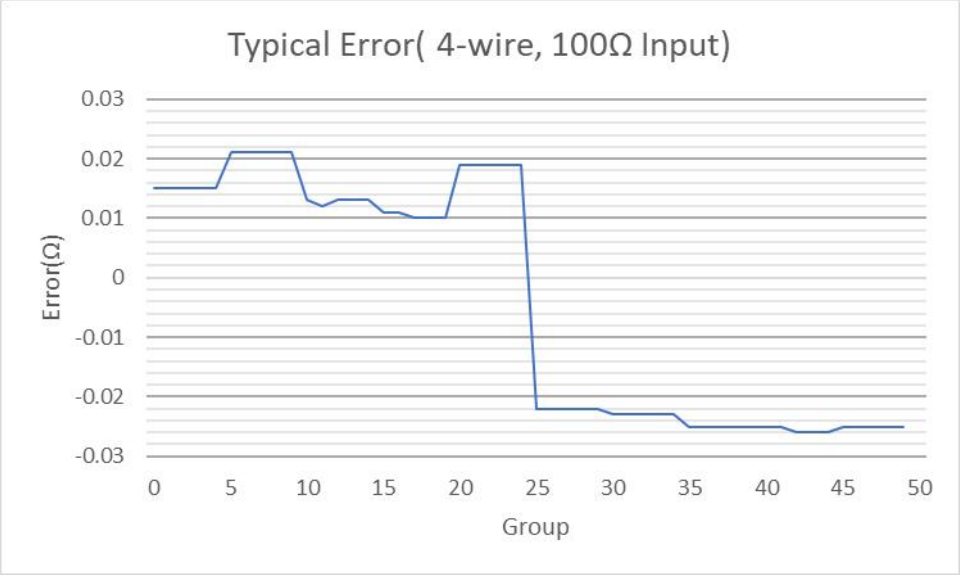

Figure 42 Typical Error (4-wire,100Ω Input)

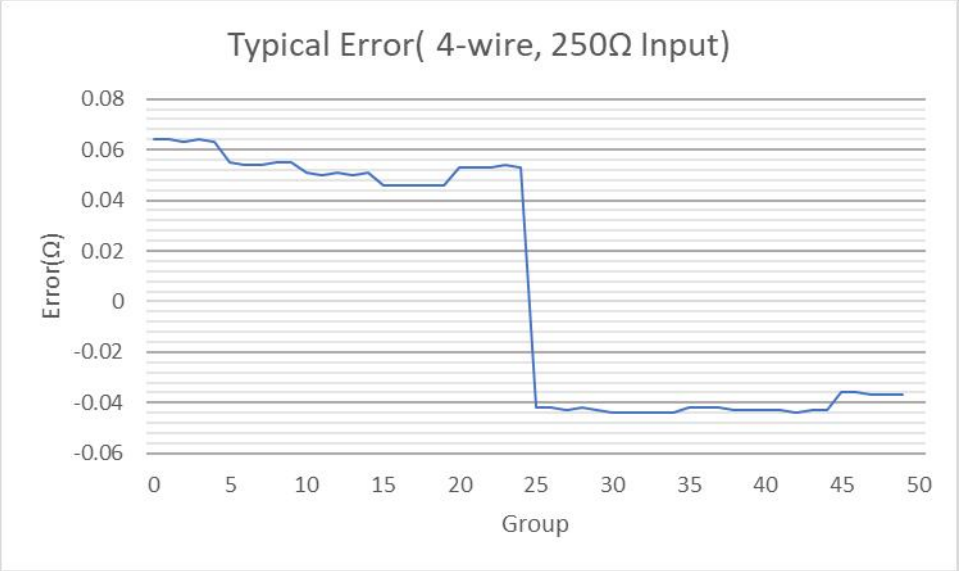

Figure 43 Typical Error (4-wire,250Ω Input)

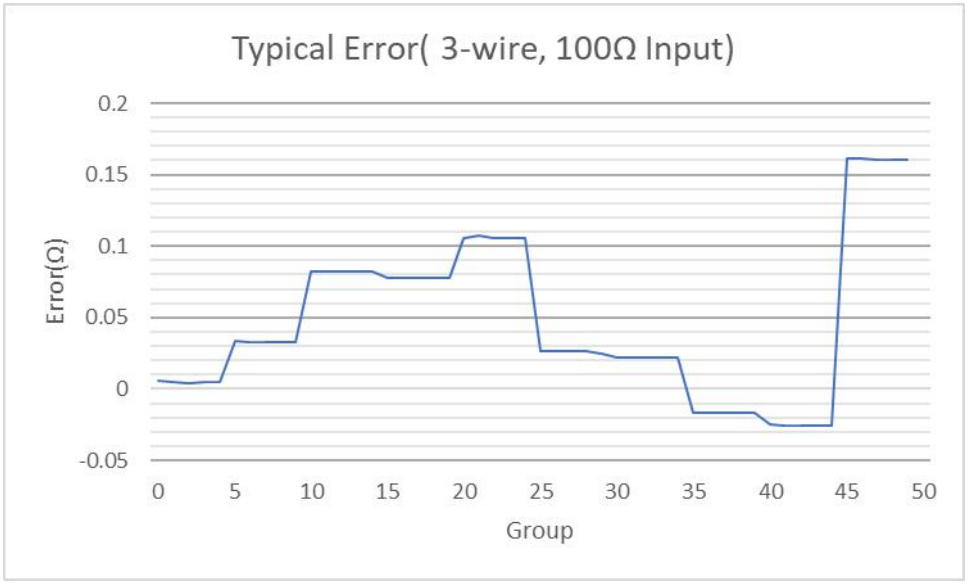

Figure 44 Typical Error (3-wire,100Ω Input)

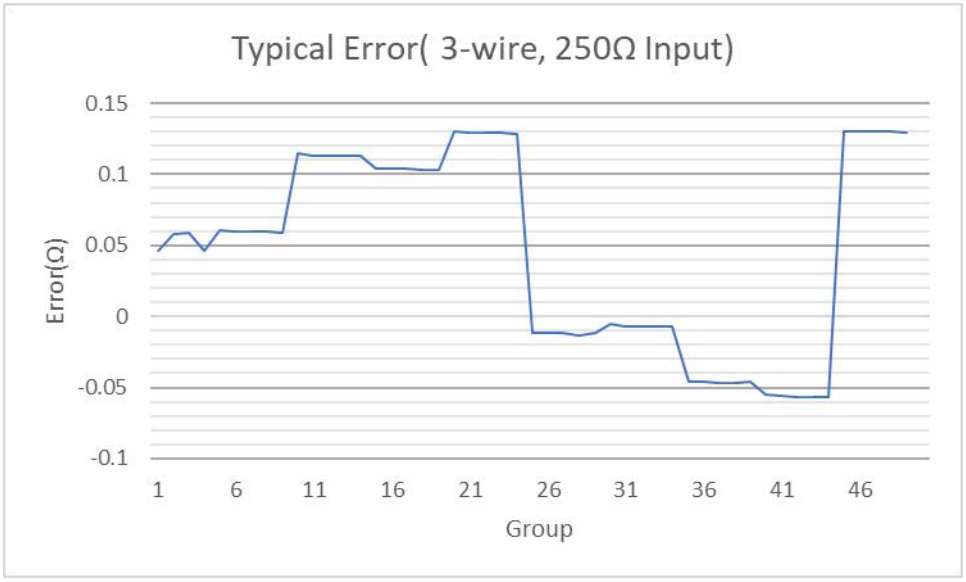

Figure 45 Typical Error (3-wire,250Ω Input)

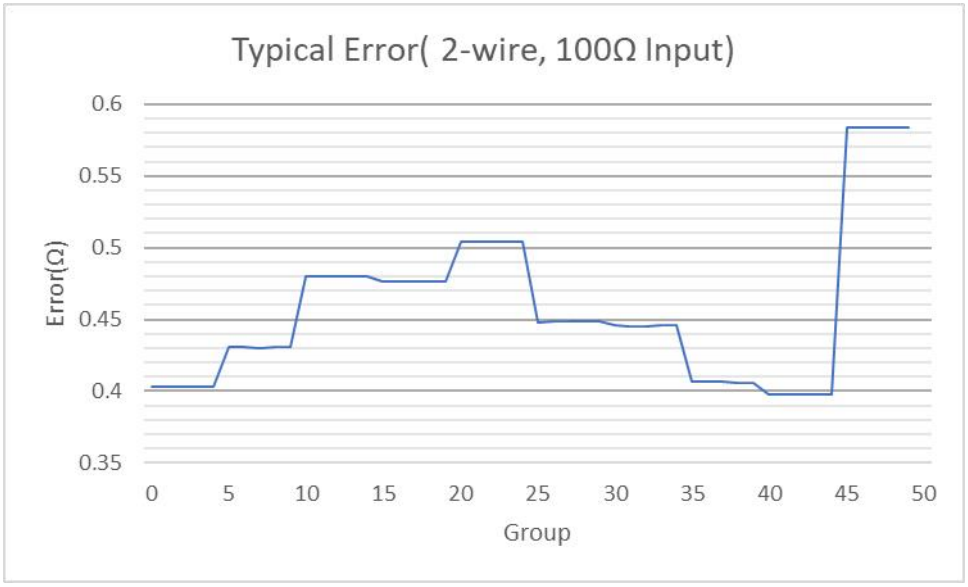

Figure 46 Typical Error (2-wire,100Ω Input)

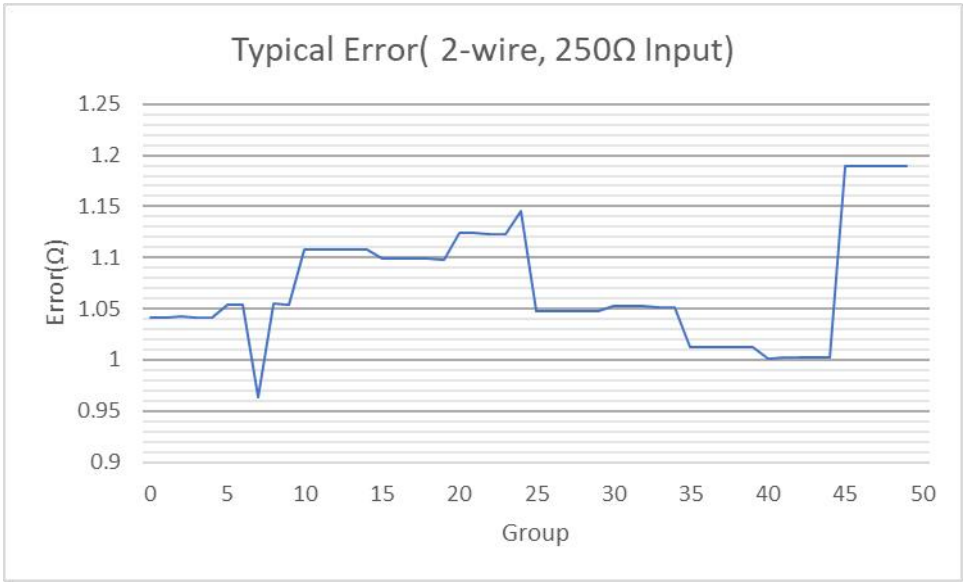

Figure 47 Typical Error (2-wire,250Ω Input)

7.6 Gain and Offset Error Stability

The stability of the resistance measurement is shown in Table 19. These numbers are for information only. The accuracy Table 4 already included the errors due to the gain and offset stability errors. Some typical test data are listed 7.4.

	Typical Value	Max Value
Gain Error Stability	2.72 ppm/℃	3.2 ppm/℃
Offset Error stability	280 μΩ/°C	800 μΩ/°C

Table 19 Resistance Measurement Stability

8. About JYTEK

8.1 JYTEK China

Founded in June, 2016, JYTEK China is a leading Chinese test & measurement company, providing complete software and hardware products for the test and measurement industry. The company is a joint venture between Adlink Technologies and a group of experienced professionals form the industry. JYTEK independenly develop the software and hardware products and is entirely focused on the Chinese market. Our Shanghai headquarters and production service center have regular stocks to ensure timely supply; we have R&D centers in Xi'an and Chongqing to develop new products; we also have highly trained direct technical sales representatives in Shanghai, Beijing, Tianjin, Xi'an, Chengdu, Nanjing, Wuhan, Haerbin, and Changchun. We also have many patners who provide system level support in various cities.

8.2 JYTEK Korea and JYTEK in Other Countries

JYTEK Korea was the first JYTEK enterprise outside China to promote JYTEK products. Together with Adlink Technologies and JYTEK China, JYTEK is expanding to more countries. Each JYTEK location is an independently owned and operated franchise. It shares JYTEK's philosophy and business approach. Together JYTEK entities promote the JYTEK brand, technology, and products.

8.3 JYTEK Hardware Products

According to JYTEK's agreement with our equity partner Adlink Technologies, JYTEK's hardware is manufactured by the state-of-art manufacturing facility located in Shanghai Zhangjiang Hi-Tech Park. Adlink has over 20 years of the world-class low-volumn and high-mix manufacturing expertise with ISO9001-2008, China 3C, UL, ROHS, TL9000, ISO-14001, ISO-13485 certifications. Its 30,000 square meters facilities and three high-speed Panasonic SMT production lines can produce 60,000 pieces boards/month; it also has full supply chain management - planning, sweeping, purchasing, warehousing and distribution. Adlink's manufacturing excellence ensures JYTEK's hardware has word-class manufacturing quality.

One core technical advantage is JYTEK's pursue for the basic and fundamental technology excellence. JYTEK China has developed a unique PCIe, PXIe, USB hardware driver architecture, FirmDrive, upon which many our future hardware will be based.

In addition to our own developed hardware, JYTEK also rebrands Adlink's PXI product lines. In addition, JYTEK has other rebranding agreements to increase our hardware coverage. It is our goal to provide the complete product coverage in PXI and PCI modular instrumentation and data acquisition.

8.4 JYTEK Software Platform

JYTEK has developed a complete software platform, SeeSharp Platform, for the test and measurement applications. We leverage the open sources communities to provide the software tools. Our platform software is also open sourced and is free, thus lowering the cost of tests for our customers. We are the only domestic vendor to offer complete commercial software and hardware tools.

8.5 JYTEK Warranty and SupportServices

With our complete software and hardware products, JYTEK is able to provide technical and sales services to wide range of applications and customers. In most cases, our products are backed by a 1-year warranty. For technical consultation, pre-sale and after-sales support, please contact JYTEK of your country.

9. Statement

The hardware and software products described in this manual are provided by JYTEK China, or JYTEK in short.

This manual provides the product review, quick start, some driver interface explaination for PCIe/PXIe-6301 family of temperature sensor data acquisition cards. The manual is copyrighted by JYTEK.

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While we try to keep this manual up to date, there are factors beyond our control that may affect the accuracy of the manual. Please check the latest manual and product information from our website.

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