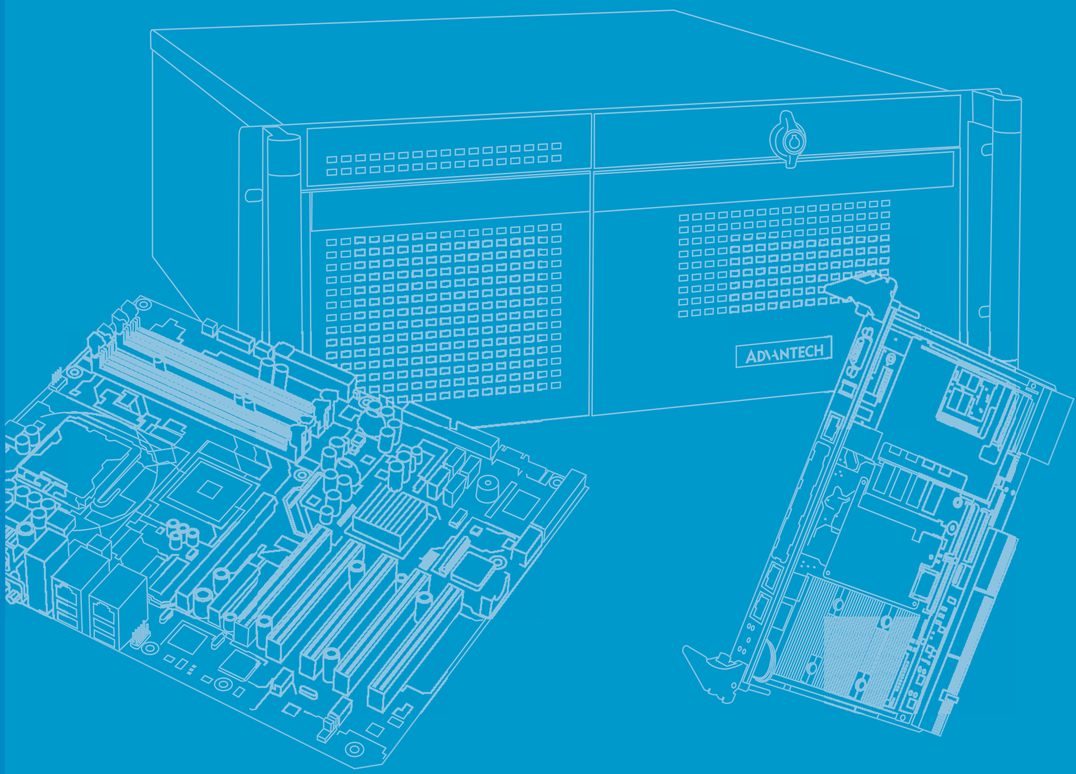

User Manual

PCIE-1884

32-Bit, 4-Channel Encoder Counter with Preloaded Position Comparison FIFO PCI Express Card

ADVANTECH

Enabling an Intelligent Planet

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Product Warranty (2 years)

Advantech warrants the original purchaser that each of its products will be free from defects in materials and workmanship for two years from the date of purchase.

This warranty does not apply to any products that have been repaired or altered by persons other than repair personnel authorized by Advantech, or products that have been subject to misuse, abuse, accident, or improper installation. Advantech assumes no liability under the terms of this warranty as a consequence of such events.

Because of Advantech's high quality control standards and rigorous testing, most customers never need to use our repair service. However, if an Advantech product is defective, it will be repaired or replaced free of charge during the warranty period. For out-of-warranty repairs, customers are billed according to the cost of replacement materials, service time, and freight. Consult your dealer for more details.

If you believe that your product is defective, follow the steps outlined below.

1. Collect all the information about the problem encountered. (For example, CPU speed, Advantech products used, other hardware and software used, etc.) Note anything abnormal and list any onscreen messages displayed when the problem occurs.
2. Call your dealer and describe the problem. Have your manual, product, and any relevant information readily available.
3. If your product is diagnosed as defective, obtain a return merchandize authorization (RMA) number from your dealer. This allows us to process your return more quickly.
4. Carefully pack the defective product, a completed Repair and Replacement Order Card, and a proof of purchase date (such as a photocopy of your sales receipt) into a shippable container. Products returned without a proof of purchase date are not eligible for warranty service.
5. Write the RMA number visibly on the outside of the package and ship the package prepaid to your dealer.

Part No. 2001188400 Edition 1

December 2018

CE

This product has passed the CE test for environmental specifications when shielded cables are used for external wiring. We recommend the use of shielded cables. This type of cable is available from Advantech. Please contact your local supplier for ordering information.

Technical Support and Assistance

1. Visit the Advantech website at **http://support.advantech.com.tw/** to obtain the latest product information.
2. Contact your distributor, sales representative, or Advantech's customer service center for technical support if you need additional assistance. Have the following information ready before calling:
   - Product name and serial number
   - Description of your peripheral attachments
   - Description of your software (operating system, version, application software, etc.)
   - A complete description of the problem
   - The exact wording of any error messages

Packing List

Before setting up the system, check that the items listed below are included with your product and in good condition. If any item is missing or damaged, contact your dealer immediately.

- 1 x PCIE-1884 encoder card
- 1 x PCIE-1884 startup/user manual

Safety Precautions - Static Electricity

Follow these simple precautions to protect yourself from harm and the products from damage.

1. To avoid electrical shock, always disconnect the power from the PC chassis before manual handling. Do not touch any components on the CPU card or other cards while the PC is powered on.
2. Disconnect the power before implementing any configuration changes. The sudden rush of power after connecting a jumper or installing a card may damage sensitive electronic components.

Contents

Chapter 1 Introduction 1

1.1 Key Features 2
1.2 Applications 3
1.3 Packing List 3
1.4 Software Overview 4
1.5 DAQNavi Device Driver Programming 4
1.6 Accessories 5

Chapter 2 Installation 7

2.1 Unpacking Instructions 8
2.2 Driver Installation 8
2.3 Hardware Installation 9
2.4 Device Setup and Configuration 10
Figure 2.1 PCIE-1884 Device Settings 10
Figure 2.2 Device Settings Page 11
Figure 2.3 PCIE-1884 Device Testing 11

Chapter 3 Signal Connections 13

3.1 Overview 14
3.2 Switch and Jumper Settings 14
Figure 3.1 Connector and Switch Locations 14
3.2.1 Board ID (SW1) 15
Table 3.1: Board ID Setting (SW1) 15
3.2.2 Power On Configuration (JP1) 15
Table 3.2: Power on Configuration after Hot Reset (JP1) 15
3.3 Signal Connections 16
Figure 3.2 The 37-Pin I/O Connector Pin Assignments 16
3.3.1 I/O Connector Signal Description 17
3.4 Field Wiring Considerations 19

Appendix A Specifications 21

A.1 Function Block 22
A.2 Digital Input 22
A.3 Digital Output 22
A.4 Counter/Timer 23
A.5 General 23

Appendix B Operation Theory 25

B.1 Digital Input/Output Operation 26
B.2 Counter Input and PWM Input/Output 26

Chapter 1

Introduction

This chapter provides a brief introduction to the PCIE-1884 card and its typical applications.

- Features
- Applications
- Packing List
- Software Overview
- Roadmap
- Accessories

PCIE-1884 is a PCI Express card that features four 32-bit encoder counters with programmable trigger output (preloaded FIFO) for position comparisons. Ideal for motor control and position monitoring applications, PCIE-1884 also provides general counter functions, such as frequency measurement, pulse width measurement, pulse output, and PWM output. All channels are protected by 2,500 V_{DC} isolation circuits.

1.1 Key Features

- 4 x 32-bit programmable encoder counters
- Quadrature (X1, X2, X4), dual pulse (CW/CCW), and signed pulse (OUT/DIR) modes
- Programmable trigger output (preloaded FIFO) for position comparisons
- Supports single-ended and differential inputs
- 2,500 V_{DC} isolation protection for all channels
- Digital filter with selectable values

Onboard Programmable Encoder (or General Purpose) Counters

The PCIE-1884 card features four 32-bit encoder (or general purpose) counters that provide encoder input, encoder-compare output, one-shot output, PWM output, periodic interrupt output, and time-delay output, as well as measurements of frequency and pulse width.

Encoder Interface

Each channel includes a decoding circuit for incremental quadrature encoding. Inputs accept either single-ended or differential signals. Quadrature input works with or without an index, allowing linear or rotary encoder feedback.

Counters

For the four independent 32-bit counters, the maximum quadrature input rate is 40 MHz and the maximum input rate in counter mode is 10 MHz. Each counter can be individually configured for quadrature decoding, pulse/direction counting or up/down counting.

Onboard FIFO for Position Comparisons

PCIE-1884 is also equipped with a 1k-byte FIFO for enabling high-speed position comparisons and trigger pulse output.

Digital Input and Interrupts

PCIE-1884 features four digital input channels. Each channel accepts digital input as either index input for a rotary encoder or as home sensor input for a linear encoder. The card can initiate repeated system interrupts based on a digital input signal, counter comparison, or programmed time interval. These interrupts facilitate precise monitoring of the control system speed.

Flexible Digital Output Function

PCIE-1884 also features four digital output channels. Each channel accepts digital output either as normal TTL output for a rotary encoder or as indicated output with pulse/level mode for a linear encoder. The PCIE-1884 can generate an indicated output based on a signal from compare of its counters. The pulse width of an indicated output depends on the counter clock or clear interrupt.

BoardID Switch

The PCIE-1884 card is equipped with a built-in DIP switch for defining each card's ID when multiple cards are installed on the same PC chassis. The BoardID setting function is very useful when building a system with multiple PCIE-1884 cards. With the correct BoardID settings, users can easily identify and access each card during hardware configuration and software programming operations.

Note! *For more detailed specifications and operational instructions regarding the PCIE-1884 card, please refer to Appendices A and B of this manual.*

1.2 Applications

- Motion control
- Position sensing, monitoring, and measuring
- Coordinate measurement machines
- X-Y table monitors
- Robotics
- Machine control

1.3 Packing List

Before installing the PCIE-1884 card, please ensure that you have the following necessary components:

- PCIE-1884 encoder card
- PCIE-1884 startup manual
- Advantech DAQNavi driver software (available for download from the Advantech website)
- Personal computer or workstation with a PCI Express interface (running Windows 10, 8, or 7)
- PCL-10137H shielded cable (optional)
- ADAM-3937 wiring board (optional)

The following optional accessories are also available for enhanced operation:

- DAQNavi, LabView, and other third-party software

After all the necessary components and optional accessories for enhanced operation have been acquired, users can begin the encoder installation procedures.

1.4 Software Overview

Advantech offers a comprehensive bundle of DLL drivers, third-party drivers, and application software to assist users with leveraging the full benefits of the PCIE-1884 card.

- Device drivers
- LabVIEW driver
- Advantech DAQNavi software
- Datalogger

Programming Choices for Encoder Cards

Advantech's application software, such as Advantech Device Drivers, can be used for programming. Additionally, advanced users can perform register-level programming. However, this is not recommended because of its laborious and time-consuming nature.

DAQNavi Software

Advantech DAQNavi software includes device drivers and an SDK, which features a complete I/O function library to enhance application performance. This software comes with all Advantech encoder cards and can be downloaded from the Advantech website free of charge. The Advantech DAQNavi software for Windows 10/8/7 (desktop mode) works seamlessly with a range of development tools such as Visual Studio .NET, Visual C++, Visual Basic, and Borland Delphi.

1.5 DAQNavi Device Driver Programming

This section provides a roadmap for building unique applications using the Advantech DAQNavi device driver combined with popular development tools, such as Visual Studio .NET, Visual C++, Visual Basic, Delphi, and C++ Builder. Moreover, a comprehensive set of example source codes is also provided for easy reference.

Programming Tools

Programmers can develop application programs using a variety of development tools, as listed below.

- Visual Studio .NET
- Visual C++ and Visual Basic
- Delphi
- C++ Builder

The DAQNavi SDK manual features a tutorial chapter that provides instructions on how to begin programming using each development tool. Users should refer to this information when programming. Additionally, users can reference the example source codes provided for each programming tool. These examples can help jump-start a project.

The DAQNavi SDK manual can be retrieved from the accompanying DVD-ROM. Alternatively, if the DAQNavi device driver has already been installed, the DAQNavi SDK manual can be accessed via the Start menu. The file path is as follows:

Start/Programs/Advantech Automation/DAQNavi/DAQNavi Manuals/DAQNavi SDK Manual

Example source codes can be found under the folder for the specific programming tool. The default installation path is as follows:

\Advantech\DAQNavi\Examples

For information about using other function groups or development tools, refer to the chapter titled “Using DAQNavi SDK” in the DAQNavi SDK manual or the video tutorials presented in the Advantech Navigator utility environment.

Programming with the DAQNavi Function Library

Advantech’s DAQNavi device drivers software features a comprehensive function library that can be adopted for diverse application programs. The function library contains numerous APIs that support a variety of development tools such as Visual Studio .NET, Visual C++, Visual Basic, Delphi, and C++ Builder.

These APIs can be categorized into the following function groups according to their functions:

- Counter Function Group
- Port Function Group (direct I/O)
- Event Function Group
- Digital Input/Output Function Group

For information regarding the usage and parameters of each function, refer to the chapter titled “Using DAQNavi SDK” in the DAQNavi SDK manual.

Troubleshooting DAQNavi Device Driver Errors

Driver functions will return a status code when they are called to perform a certain task for the application. When a code that is not zero is returned, this means the function has failed to perform its designated function. To troubleshoot the driver error, check the error code and description against the error control information provided in the DAQNavi SDK manual.

1.6 Accessories

Advantech offers a wide range of accessories for the PCIE-1884 card, as listed below.

Wiring Cables

- **PCL-10137H-1E** DB-37 high-speed shielded cable, 1 m
- **PCL-10137H-3E** DB-37 high-speed shielded cable, 3 m

Wiring Boards

- **ADAM-3937-BE** DB-37 wiring terminal with DIN-rail mount support

Chapter 2

Installation

This chapter provides detailed step-by-step instructions for driver and card installation.

- Unpacking Instructions
- Driver Installation
- Hardware Installation
- Device Setup and Configuration

2.1 Unpacking Instructions

After receiving the PCIE-1884 product shipment, inspect the package to ensure that you have received the following:

- 1 x PCIE-1884 card
- 1 x PCIE-1884 startup manual

The PCIE-1884 card contains certain electronic components that are vulnerable to electrostatic discharge (ESD). ESD can easily damage the integrated circuits and components if preventive measures are ignored.

Before removing the card from the anti-static plastic bag, take the precautions outlined below to prevent potential damage from ESD.

- Touch the metal part of the computer chassis to discharge any static electricity accumulated in your body. Alternatively, use a grounding strap.
- Touch the anti-static bag to a metal part of the computer chassis before opening the bag.
- Hold the card by the metal bracket only when removing it from the anti-static bag.

After taking out the card

- Inspect the card for any external signs of damage (loose or damaged components, etc.). If the card is visibly damaged, notify Advantech's service department or your local sales representative immediately. Do not install a damaged card in your system.

To ensure proper installation, take care to

- Avoid physical contact with materials that may hold static electricity such as plastic, vinyl, and styrofoam.
- When physically handling the card, hold the card only by its edges. Do not touch the exposed metal pins of the connector or any electronic components.

Note! *Retain the anti-static bag for future use. The original bag may be needed to store the card after a card replacement or when transporting the computer system.*

2.2 Driver Installation

We recommend installing the driver *before* installing the PCIE-1884 card to ensure smooth operation.

The Advantech DAQNavi Setup program for the PCIE-1884 card can be downloaded from the Advantech website.

2.3 Hardware Installation

After the device driver has been installed, the PCIE-1884 card can be installed in the computer. The steps for installing the card are outlined below. Please refer to the computer's user manual or related documentation for additional installation advice.

1. Turn off the computer and unplug the power cord and cables before installing or removing any components from the computer.
2. Remove the cover of your computer.
3. Remove the slot cover on the rear panel of your computer.
4. Touch any metal surface of the computer to neutralize any static electricity that might be on your body.
5. Insert the PCIE-1884 card into the PCI Express interface. Hold the card only by its edges and carefully align the card with the slot. Insert the card into the slot carefully. Using excessive force may damage the card.
6. Connect any additional accessories (for example, a 37-pin DB shielded cable or wiring terminals) to the card.
7. Replace the cover of the computer chassis. Re-connect the cables that were disconnected in Step 1.
8. Plug in the power cord and turn on the computer.

After the PCIE-1884 card is installed in the computer, the Advantech Navigator Program can be used to configure the system. Comprehensive device installation procedures should include device setup, configuration, and testing. The following sections of this chapter provide information on how to set up, configure, and test your device.

2.4 Device Setup and Configuration

The Advantech Navigator program is a utility for setting up, configuring, and testing devices. The configuration settings are stored on the system registry and used when any device driver API is accessed.

Setting Up a Device

1. To install the I/O device for your card, run the Advantech Navigator program (by accessing Start/Programs/Advantech Automation/Navigator for DN4).
2. The device(s) already installed on the system (if any) will be shown in the Installed Devices list. If the PCIE-1884 card hardware and software has been successfully installed, the PCIE-1884 card should be in the Installed Devices list.

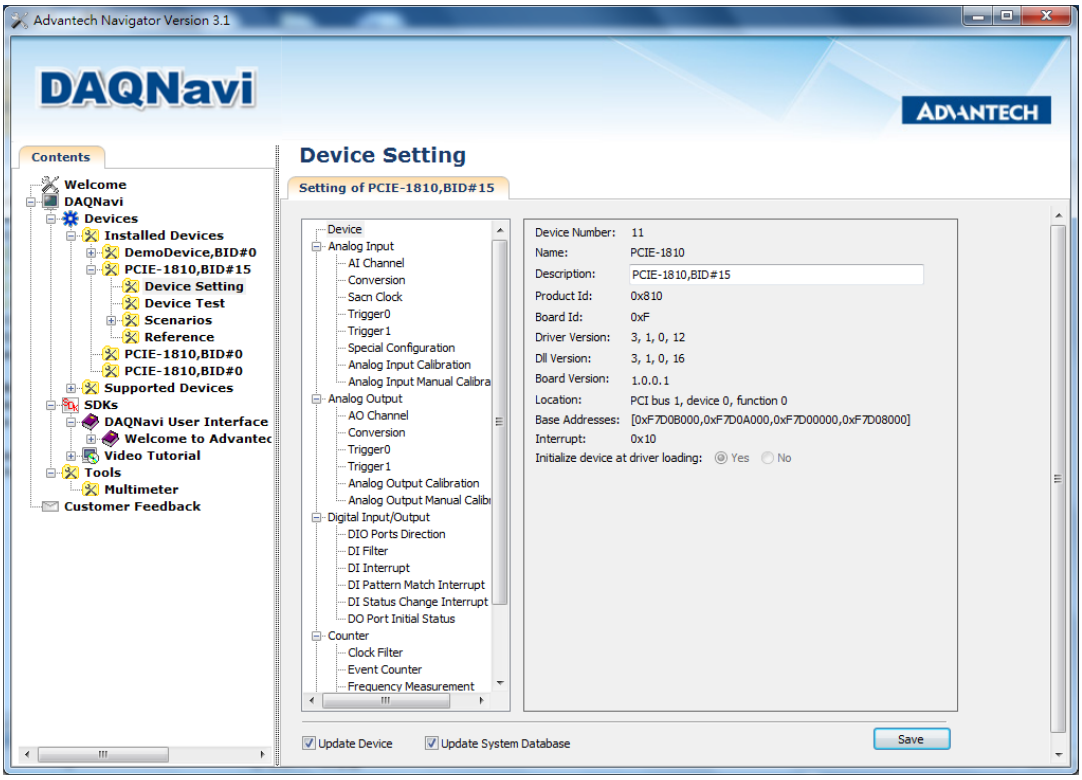


Figure 2.1 PCIE-1884 Device Settings

Configuring the Device

3. Navigate to the Device Settings page to configure the PCIE-1884 card. Users can configure not only the counter/PWM output, but also the Digital Input/Output.

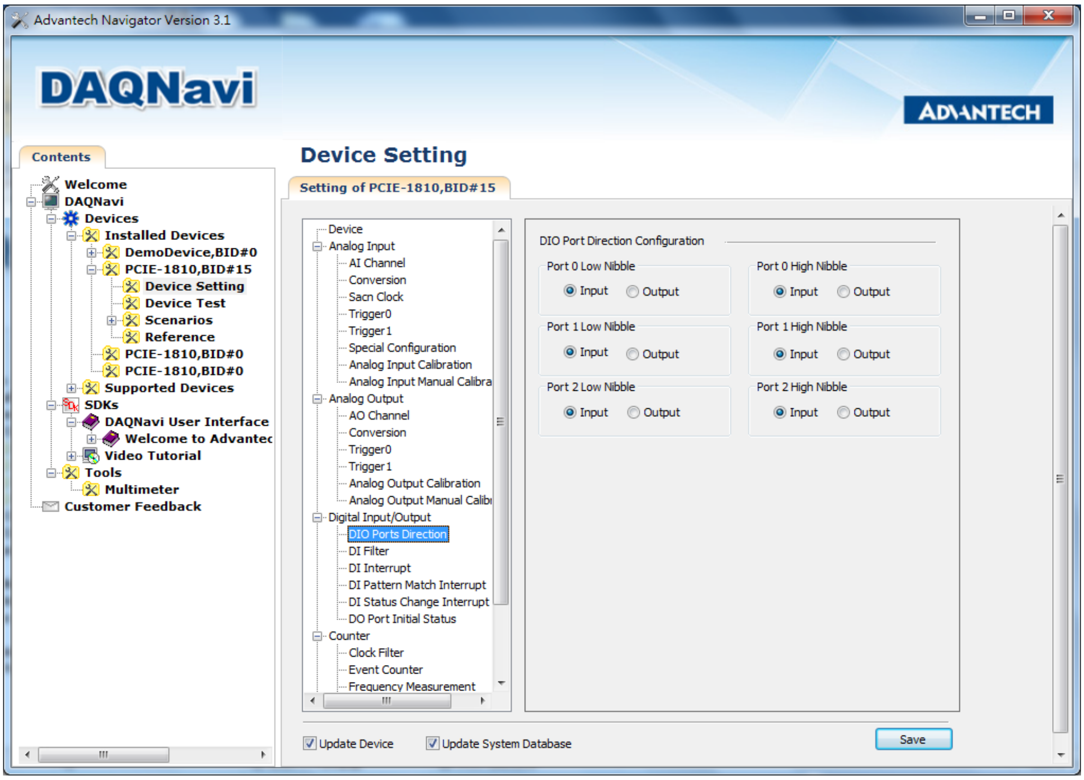


Figure 2.2 Device Settings Page

4. After the card is installed and configured, navigate to the Device Test page to test the hardware using the testing utility supplied.

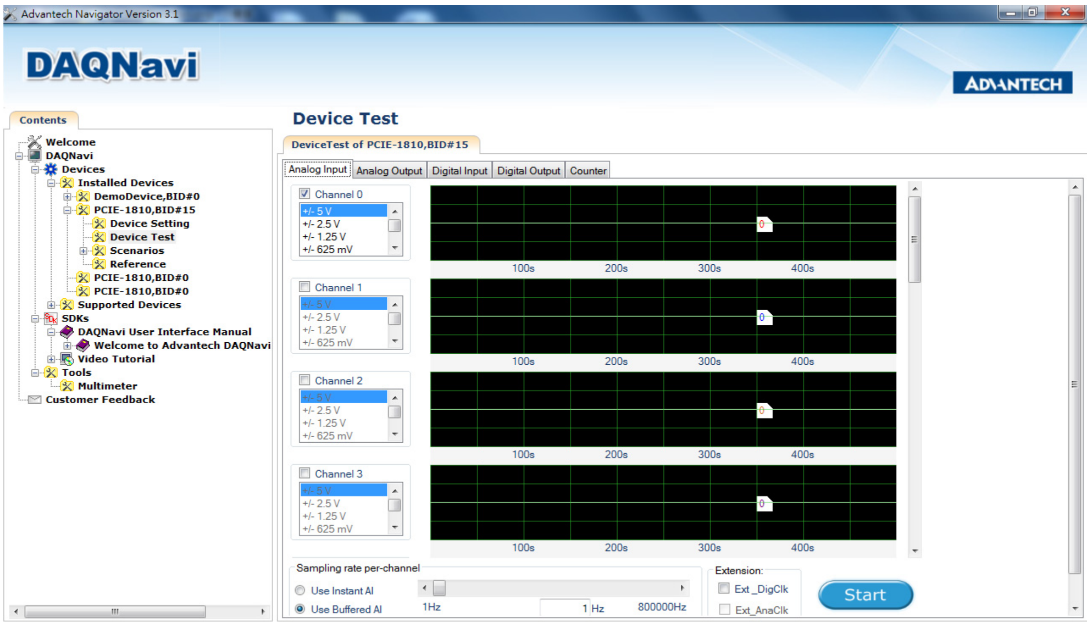


Figure 2.3 PCIE-1884 Device Testing

For more detailed information, please refer to the DAQNavi SDK manual or user interface manual in Advantech Navigator.

Chapter 3

Signal Connections

This chapter explains how to connect input and output signals to the PCIE-1884 card via the I/O connector.

- Overview
- Board ID Settings
- Signal Connections
- Field Wiring Considerations

3.1 Overview

Maintaining signal connections is one of the most important factors in ensuring that your application system is sending and receiving data correctly. A good signal connection can avoid unnecessary and costly damage to your PC and other hardware devices. This chapter provides useful information about how to connect input and output signals to the PCIE-1884 card via the I/O connector.

3.2 Switch and Jumper Settings

The location of jumpers and switches on the PCIE-1884 card is shown in Figure 3.1.

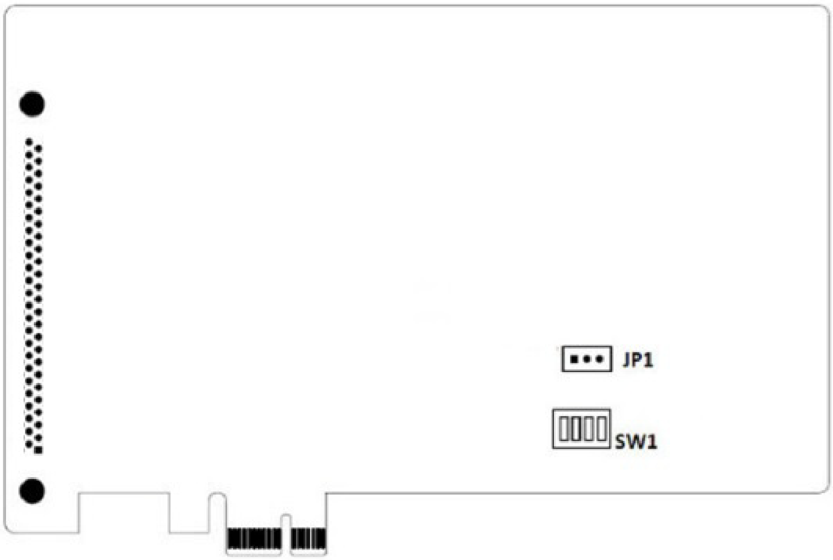


Figure 3.1 Connector and Switch Locations

3.2.1 Board ID (SW1)

The PCIE-1884 card features a built-in DIP switch (SW1) that is used to define each card's board ID. When multiple cards are installed on the same chassis, the board ID switch is used to set each card's device number.

After setting the card numbers, each card in the system can be identified using their device number. The default board ID value is 0. To adjust this value (SW1), please reference the data shown in Table 3.1.

Table 3.1: Board ID Setting (SW1)

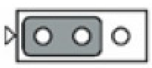
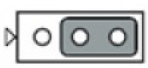
SW1	Position 1	Position 2	Position 3	Position 4
BoardID	Bit 3	Bit 2	Bit 1	Bit 0
0	ON	ON	ON	ON
1	ON	ON	ON	OFF
2	ON	ON	OFF	ON
3	ON	ON	OFF	OFF
4	ON	OFF	ON	ON
5	ON	OFF	ON	OFF
6	ON	OFF	OFF	ON
7	ON	OFF	OFF	OFF
8	OFF	ON	ON	ON
9	OFF	ON	ON	OFF
10	OFF	ON	OFF	ON
11	OFF	ON	OFF	OFF
12	OFF	OFF	ON	ON
13	OFF	OFF	ON	OFF
14	OFF	OFF	OFF	ON
15	OFF	OFF	OFF	OFF

Default setting is 0

3.2.2 Power On Configuration (JP1)

The default configuration after a system power on or reset is to set all analog input and analog output channels to open (output voltage equals zero). This protects external devices from damage during system power on or reset. When the system is hot reset, the status of the isolated digital output channels is set by jumper JP1. Table 3.2 shows the possible configurations of jumper JP1.

Table 3.2: Power on Configuration after Hot Reset (JP1)

JP1	Power on configuration after hot reset
1 	Retain the same status as before reset
1 	Default configuration (DO status low)

3.3 Signal Connections

Pin Assignments

The I/O connector on the PCIE-1884 card is a 37-pin connector that enables users to integrate additional accessories via the PCL-10137H shielded cable.

The pin assignments for the 37-pin I/O connector on the PCIE-1884 card are shown in Figure 3.2. The I/O connector signal description is presented in Table 3.3.

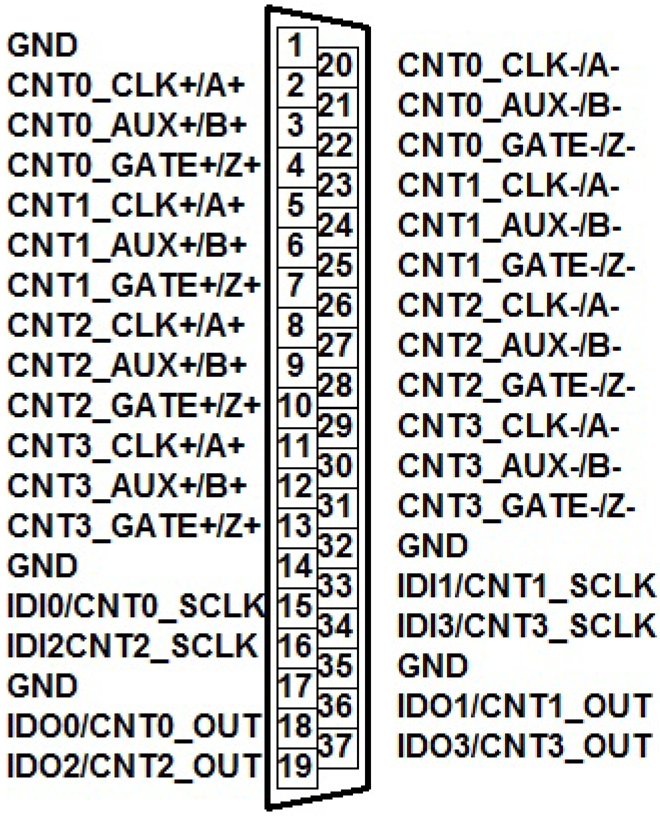


Figure 3.2 The 37-Pin I/O Connector Pin Assignments

3.3.1 I/O Connector Signal Description

Pin Name	Type	Pin#	Description
			Counter
CNT0_CLK+/A+	I	2	Positive input of the clock input (general purpose counter) or signal A input (encoder counter) of counter channel 0
CNT0_CLK-/A-	I	20	Negative input of the clock input (general purpose counter) or signal A input (encoder counter) of counter channel 0
CNT1_CLK+/A+	I	5	Positive input of the clock input (general purpose counter) or signal A input (encoder counter) of counter channel 1
CNT1_CLK-/A-	I	23	Negative input of the clock input (general purpose counter) or signal A input (encoder counter) of counter channel 1
CNT2_CLK+/A+	I	8	Positive input of the clock input (general purpose counter) or signal A input (encoder counter) of counter channel 2
CNT2_CLK-/A-	I	26	Negative input of the clock input (general purpose counter) or signal A input (encoder counter) of counter channel 2
CNT3_CLK+/A+	I	11	Positive input of the clock input (general purpose counter) or signal A input (encoder counter) of counter channel 3
CNT3_CLK-/A-	I	29	Negative input of the clock input (general purpose counter) or signal A input (encoder counter) of counter channel 3
CNT0_AUX+/B+	I	3	Positive input of signal B input (encoder counter) of counter channel 0
CNT0_AUX-/B-	I	21	Negative input of signal B input (encoder counter) of counter channel 0
CNT1_AUX+/B+	I	6	Positive input of signal B input (encoder counter) of counter channel 1
CNT1_AUX-/B-	I	24	Negative input of signal B input (encoder counter) of counter channel 1
CNT2_AUX+/B+	I	9	Positive input of signal B input (encoder counter) of counter channel 2
CNT2_AUX-/B-	I	27	Negative input of signal B input (encoder counter) of counter channel 2
CNT3_AUX+/B+	I	12	Positive input of signal B input (encoder counter) of counter channel 3
CNT3_AUX-/B-	I	30	Negative input of signal B input (encoder counter) of counter channel 3
CNT0_GATE+/Z+	I	4	Positive input of gate input (general purpose counter) or signal Z input (encoder counter) of counter channel 0
CNT0_GATE-/Z-	I	22	Negative input of gate input (general purpose counter) or signal Z input (encoder counter) of counter channel 0
CNT1_GATE+/Z+	I	7	Positive input of gate input (general purpose counter) or signal Z input (encoder counter) of counter channel 1

CNT1_GATE-/Z-	I	25	Negative input of gate input (general purpose counter) or signal Z input (encoder counter) of counter channel 1
CNT2_GATE+/Z+	I	10	Positive input of gate input (general purpose counter) or signal Z input (encoder counter) of counter channel 2
CNT2_GATE-/Z-	I	28	Negative input of gate input (general purpose counter) or signal Z input (encoder counter) of counter channel 2
CNT3_GATE+/Z+	I	13	Positive input of gate input (general purpose counter) or signal Z input (encoder counter) of counter channel 3
CNT3_GATE-/Z-	I	31	Negative input of gate input (general purpose counter) or signal Z input (encoder counter) of counter channel 3
IDI0/CNT0_SCLK	I	15	Isolated digital input channel 0 or sample clock input (general purpose counter) or (encoder counter) of counter channel 0
IDI1/CNT1_SCLK	I	33	Isolated digital input channel 1 or sample clock input (general purpose counter) or (encoder counter) of counter channel 1
IDI2/CNT2_SCLK	I	16	Isolated digital input channel 2 or sample clock input (general purpose counter) or (encoder counter) of counter channel 2
IDI3/CNT3_SCLK	I	34	Isolated digital input channel 3 or sample clock input (general purpose counter) or (encoder counter) of counter channel 3
IDO0/CNT1_OUT	O	18	Isolated digital output channel 0 of output of counter channel 0
IDO1/CNT1_OUT	O	36	Isolated digital output channel 1 of output of counter channel 1
IDO2/CNT2_OUT	O	19	Isolated digital output channel 2 of output of counter channel 2
IDO3/CNT3_OUT	O	37	Isolated digital output channel 3 of output of counter channel 3
Power and Ground			
GND	-	1, 14, 17, 32, 35	Reference ground for all signals

3.4 Field Wiring Considerations

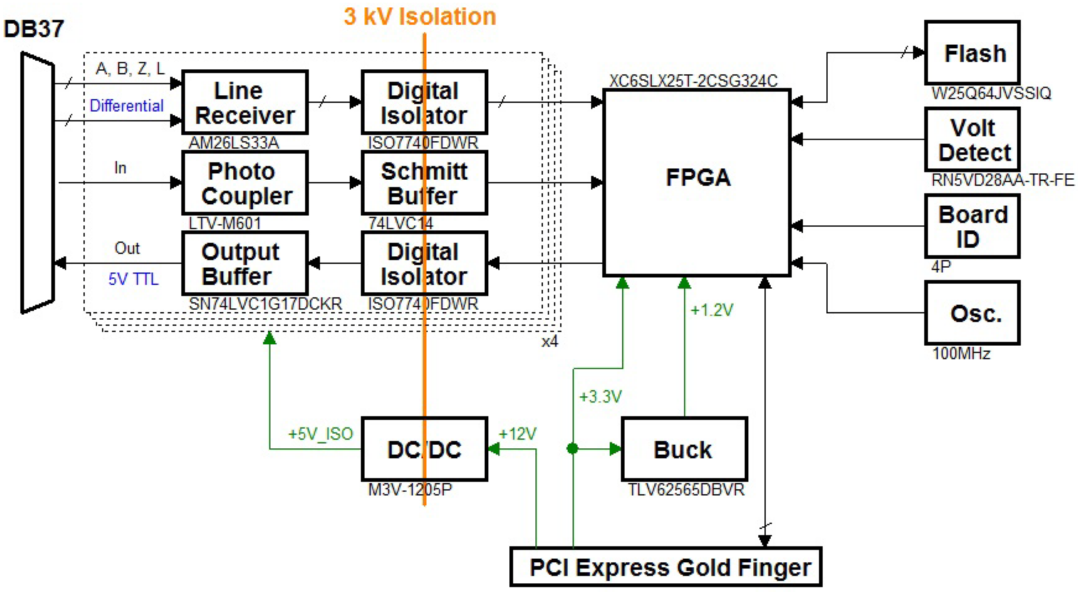
When using PCIE-1884 cards to acquire data in an outdoor environment, general environmental noise can significantly affect the accuracy of measurements if due cautions are not taken. The following measures can reduce possible interference to signal wires running between signal sources and the PCIE-1884 card.

- Signal cables should be kept away from strong electromagnetic sources such as power lines, large electric motors, circuit breakers, and welding machines because they may cause strong electromagnetic interference. Keep analog signal cables away from all video monitors because they can significantly affect data acquisition systems.
- If the cable travels through an area with significant electromagnetic interference, individually shielded twisted-pair wires should be used as the analog input cable. This type of cable has signal wires that are twisted together and shielded with a metal mesh. The metal mesh should only be connected to one point at the signal source ground.
- Avoid running the signal cables through any conduit that may also have power lines.
- If the signal cable must be placed parallel to a power line that has a high voltage or high current running through it, try to maintain a safe distance between the cable and power line. Alternatively, the signal cable can be placed at a right angle to the power line to minimize interference.
- The signals transmitted via the cable are directly affected by the quality of the cable. To ensure superior signal quality, we recommend using a PCL-10137H shielded cable.

Appendix A

Specifications

A.1 Function Block



A.2 Digital Input

Channels	4 (shared with CNTn_SCLK/L pins)	
Optical Isolation	2500 V_{DC}	
Opto-Isolator Response Time	100ns	
Input Voltage	VIH (max.)	50 VDC
	VIH (min.)	5 VDC
	VIL (max.)	2 VDC

A.3 Digital Output

Channels	4 (shared with CNTn_OUT pins)
Optical Isolation	2500 V_{DC}
Response Time	100 ns
Supply Voltage	5V/TTL level
Sink/Source Current	24 mA max./channel

A.4 Counter/Timer

Channels	4 channels (independent)	
Resolution	32 bit	
Digital Input Filter	1.28 us, 10.24 us, 163.84 us, or 1.31 ms (each channel can be individually enabled/disabled)	
Counter Measurements	Event counting, frequency measurement, pulse width measurement	
Position Measurements	Quadrature encoding (X1, X2, and X4; Channel Z reload), two-pulse encoding, signed pulse encoding	
Output Applications	One shot, timer/pulse, pulse width modulation, position comparison	
Compatibility	TTL level	
Base Clock	Internal 20 MHz or external clock (10 MHz max.). Selected via software	
Output Frequency	Max. 10 MHz	
Input Voltage Single-ended	Low	0.8 V max.
	High	2.8 V min.
Input Voltage Differential	Low	-0.5 V max.
	High	0.5 V min.
Counter Output	Low	0.8V max. @ +24mA
	High	2V min. @ -24mA
Error in Advanced Functions	Frequency Measurement	0.1% when input signal frequency ≥ 20 KHz
	Pulse Width Measurement	0.1% when input signal frequency ≥ 20 KHz
	Pulse Output	within 2% when output frequency > 20 Hz
	PWM Output	within 2% when output frequency > 20 Hz

Note! *When performing advanced functions, such as frequency measurements and pulse output, there will be errors. The error rate will vary depending on the parameter settings and OS performance.*

A.5 General

I/O Connector Type	37-pin D-sub female	
Dimensions	167 x 100 mm (6.57 x 3.93 in)	
Power Consumption	Typical	3.3 V @ 290 mA, 12 V @ 90 mA
	Max.	3.3 V @ 360 mA, 12 V @ 245 mA
Temperature	Operating	0 ~ 60 °C (32 ~ 140 °F)
	Storage	-40 ~ 70 °C (-40 ~ 158 °F)
Relative Humidity	Operating	5 ~ 85% RH non-condensing
	Storage	5 ~ 95% RH non-condensing
Certifications	CE/FCC	

Appendix B

Operation Theory

B.1 Digital Input/Output Operation

The PCIE-1884 card supports 32 digital I/O channels. Each byte can be used as either an input port or an output port by configuring the corresponding parameter. All four channels of the byte have the same configuration.

The clock source or trigger source does not need to be specified. To output data, simply write the data to the digital output channel directly. Similarly, data can be read via the digital input channel. The default configuration after a system reset sets all the digital I/O channels to a low logic level to avoid damaging external devices during system start up or reset.

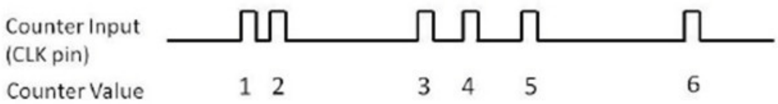
B.2 Counter Input and PWM Input/Output

PCIE-1884 offers four 32-bit counter inputs that be used for event counting, frequency measurement, pulse width measurement, and encoder counter with comparison output.

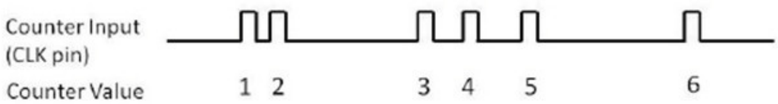
The counters on PCIE-1884 have a counter value match interrupt function. When this interrupt function is enabled, an interrupt signal is generated if the counter value reaches a pre-set counter match value. The counter will continue to count until an overflow occurs, then it will return to the reset value of zero and continue the counting process. Users can set individual counter channels to count either falling edge (high-to-low) or rising edge (low-to-high) signals.

Additionally, counter input channels can be combined with PWM output channels to generate single pulse, pulse train, or PWM (pulse-width modulated) output signals. Pulse-width modulated waveforms are created when the High and Low periods of a periodic rectangular signal are varied. Using PCIE-1884, user can individually set each PWM channel's High and Low periods for 2 to (2^{32} -1) 1 units (1 unit = 50 ns) according to their requirements.

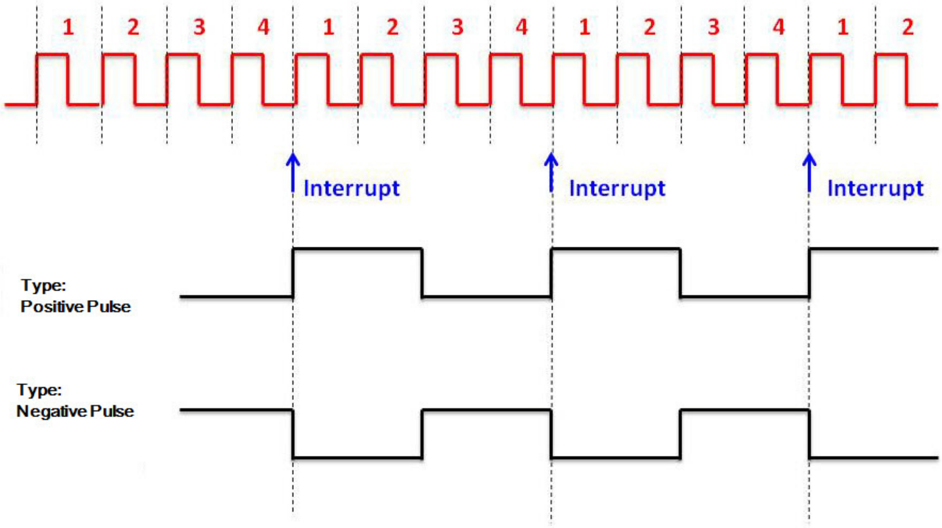
1. **Event Counter Connection**
   The PCIE-1884's built-in counter can calculate how many pulses are sent to the input channels.



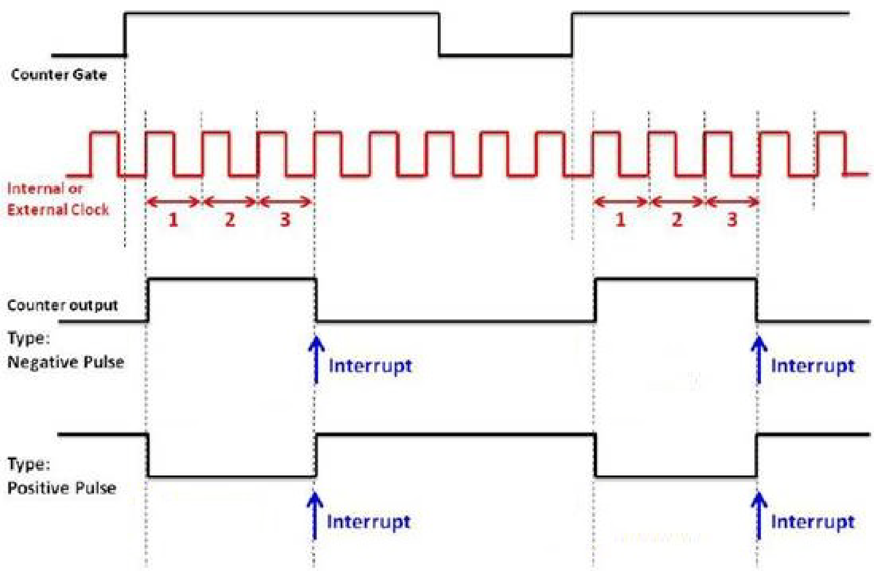
2. **Frequency Measurement Connection**
   The PCIE-1884's built-in counter can measure the frequency value of the signal connected to the counter input.



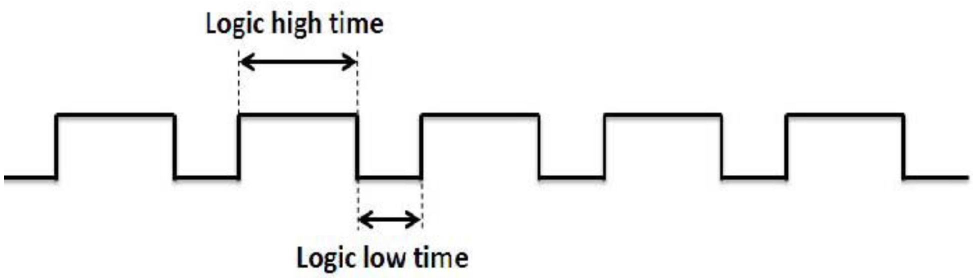
3. **Pulse Width Measurement Connection**
The PCIE-1884's built-in counter can measure the pulse width value of the signal connected to the counter input. The measurable range is 50 ns to 107 seconds. Both the logic high time and logic low time can be measured within the measurable range.
4. **Pulse Output with Timer Interrupt**
The PCIE-1884 counter features an internal clock that can be used to produce periodic output signals with interrupt signals simultaneously. The PCIE-1884 counter uses the internal clock as a time base to deliver the desired frequency. In the example provided in the figure below, the desired frequency is 5 MHz. The internal clock is 20 MHz, thus, the PCIE-1884 car will periodically generate output signals and interrupt signals for every 4 pulses of the internal clock. (20 MHz/5 MHz = 4). The available output frequency range is 0.005 Hz ~ 5 MHz.



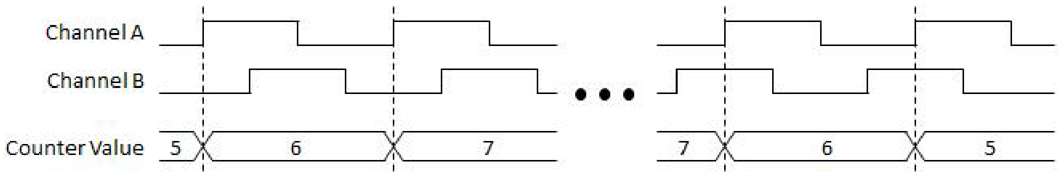
5. **Delay Pulse Generation**
Using the PCIE-1884's internal clock, users can change the logic level within a specific period, starting from a trigger signal connecting to a counter gate input. For example, if the count is defined as equal to 3 (as shown in the example below), a counter output will change its status after 3 pulses of the internal clock, after a trigger signal from the counter gate becomes high.



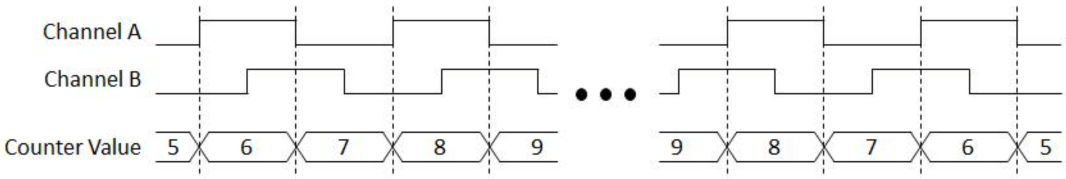
6. **PWM Output**
PCIE-1884 can generate PWM (pulse width modulation) signals. Users can configure the logic high time and logic low time as shown in the figure below. The available period for logic high time and logic low time is 100 ns ~ 214 seconds.



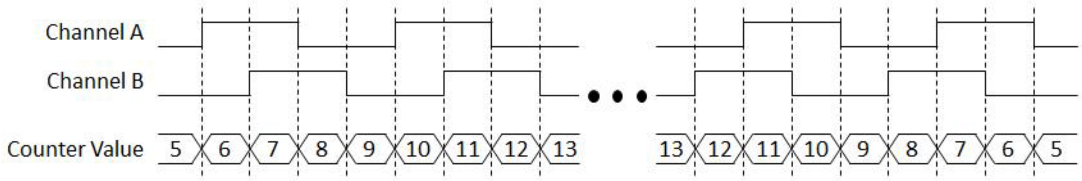
7. **Measurements Using Quadrature Encoders**
The counters can perform measurements of quadrature encoders that use X1, X2, or X4 encoding. A quadrature encoder can have up to three channels: channels A (Source), B (Aux), and Z (Gate).
   – X1 Encoding: When channel A leads channel B in a quadrature cycle, the counter increments. When channel B leads channel A in a quadrature cycle, the counter decrements. The amount of increments and decrements per cycle depends on the type of encoding (X1, X2, or X4).
   The figure below shows a quadrature cycle and the resulting increments and decrements for X1 encoding. When channel A leads channel B, the increment occurs on the rising edge of channel A. When channel B leads channel A, the decrement occurs on the rising edge of channel A.



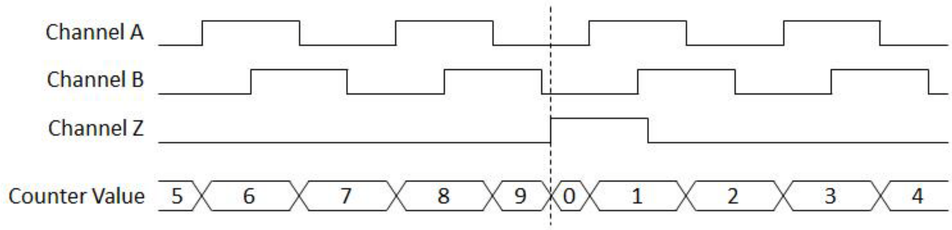
   – X2 Encoding: The same behavior is true for X2 encoding, except for the counter increments or decrements on each edge of channel A (depending on which channel leads the other). Each cycle results in two increments or decrements, as shown in the figure below.



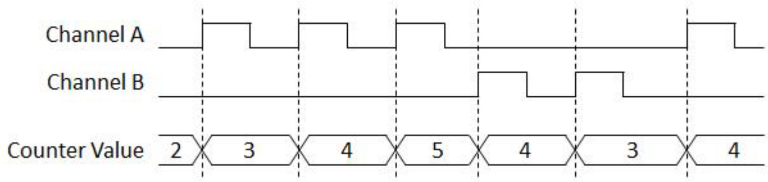
– X4 Encoding: Similarly, counter increments or decrements occur on each edge of channel A and B for X4 encoding. Whether the counter increments or decrements depends on which channel leads the other. Each cycle results in four increments or decrements, as shown in the figure below.



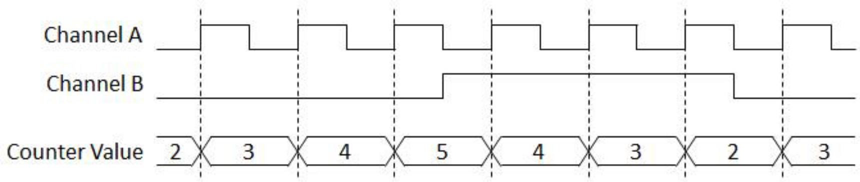
Some quadrature encoders have a third channel, channel Z, which is also referred to as the index channel. According to the configuration, a rising or falling edge of channel Z causes the counter to be reloaded with a specified value. After the reload occurs, the counter continues to count as before. The figure below illustrates a channel Z rising edge reload with X2 encoding.



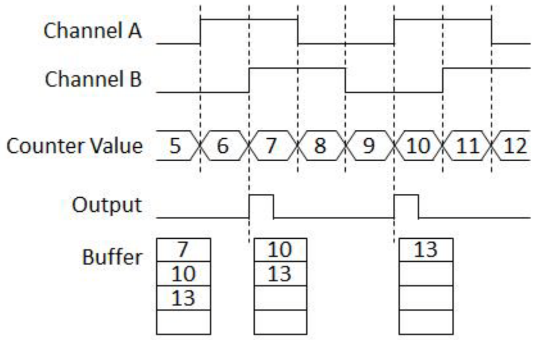
8. **Measurements Using Two Pulse Encoders**
The counter supports two pulse encoders that have two channels: channels A (Source) and B (Aux).
The counter increments on each active edge of channel A. The counter decrements on each active edge of channel B, as shown in below.



9. **Measurements Using Signed Pulse Encoders**
The counter supports signed pulse encoders that have two channels: channels A (Source) and B (Aux).
The counter increments on each active edge of channel A when channel B is low, and decrements on each active edge of channel A when channel B is high, as shown in the figure below.



10. **Position Comparison**
This function compares the counter value to a predetermined value. A pulse is generated at the Counter Output signal when the counter value becomes equal to the predetermined value. Users can define multiple values for comparison and storage in the FIFO. When the counter value becomes equal to the first value in the FIFO, a pulse is generated. Moreover, the second value in the FIFO becomes the value to be compared next time.
Users can program the width of the generated pulse. The range of the pulse width is from 10 ns to 42.94967295 seconds in step of 10 ns.
An example position comparison using quadrature X4 encoding is shown in the figure below.



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Please verify specifications before quoting. This guide is intended for reference purposes only.

All product specifications are subject to change without notice.