

PCM-3780

**2-ch Counter/Timer with
24-channel TTL DIO Module**

User Manual

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Advantech warrants to you, 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 which have been repaired or altered by persons other than repair personnel authorized by Advantech, or which 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.

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2. Call your dealer and describe the problem. Please have your manual, product, and any helpful information readily available.
3. If your product is diagnosed as defective, obtain an RMA (return merchandise authorization) number from your dealer. This allows us to process your return more quickly.
4. Carefully pack the defective product, a fully completed Repair and Replacement Order Card and a photocopy proof of purchase date (such as your sales receipt) in a shippable container. A product returned without proof of the purchase date is not eligible for warranty service.
5. Write the RMA number visibly on the outside of the package and ship it prepaid to your dealer.

CE Notification

The PCM-3780, developed by Advantech Co., Ltd., has passed the CE test for environmental specifications when shielded cables are used for external wiring. We recommend the use of shielded cables. This kind of cable is available from Advantech. Please contact your local supplier for ordering information.

FCC Class A

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Technical Support and Assistance

1. Visit the Advantech web site at **www.advantech.com/support** where you can find the latest information about the product.
2. Contact your distributor, sales representative, or Advantech's customer service center for technical support if you need additional assistance. Please have the following information ready before you call:
 - 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 and in good condition. If any item does not accord with the table, please contact your dealer immediately.

The package should contain the following items:

- 1 x PCM-3780 DA&C card
- 1 x PCM-3780 User Manual
- 1 x Advantech DLL Drivers CD-ROM

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Introduction

This chapter provides an introduction to the PCM-3780.

Sections include:

- Introduction
- Features
- Applications
- Installation Guide
- Accessories

Chapter 1 Introduction

Thank you for buying the Advantech PCM-3780. The PCM-3780 is a general purpose multiple channel counter/timer card for the PC/104 bus. It targets the AM9513 to implement the counter/timer function by CPLD. It provides two 16-bit counter channels and 24-ch digital TTL I/O.

The I/O bits are divided into three 8-bit I/O ports: A0, B0 and C0. You can configure each port as either input or output via software. The powerful Advantech-designed counter functions fulfill your industrial or laboratory application needs.

The following sections of this chapter will provide further information about features of the multifunction cards, a quick startup guide for installation, together with some brief information on software for the PCM-3780 card.

1.1 Features

The Advantech PCM-3780 offers the following main features:

- 2 independent 16-bit counters
- 2 programmable clock sources
- 24-ch digital TTL I/O
- Up to 20 MHz input frequency
- Multiple counter clock source selectable
- Counter output programmable
- Counter gate function
- Flexible interrupt source select

Counter Modes

Table 1.1: PCM-3780 Counter Mode

Counter Mode	A	B	C	D	E	F	G	H	I	J	K	L
Special Gate (CM6)	0	0	0	0	0	0	0	0	0	0	0	0
Reload Source (CM5)	0	0	0	0	0	0	1	1	1	1	1	1
Repetition (CM4)	0	0	0	1	1	1	0	0	0	1	1	1
Gate Control (CM15~CM12)	N	L	E	N	L	E	N	L	E	N	L	E
Count to TC once, then disarm	Y	Y	Y									
Count to TC twice, then disarm							Y	Y	Y			
Count to TC repeatedly without disarming				Y	Y	Y				Y	Y	Y
Gate input dose not gate counter input	Y			Y			Y			Y		
Count only during active gate level		Y			Y			Y			Y	
Start count on active gate edge and stop count on next TC			Y			Y						
Start count on active gate edge and stop count on second TC									Y			Y
Start count on active gate edge and stop count on inactive gate edge												
Reload counter from Load Register on TC	Y	Y	Y	Y	Y	Y						
Reload counter on each TC, alternating reload source between Load and Hold Registers							Y	Y	Y	Y	Y	Y

(N: No gate control, L: Level gate control, E: Edge gate control)

Table 1.2: PCM-3780 Counter Mode

Counter Mode	M	N	O	P	Q	R	S	T	U	V	W	X
Special Gate (CM6)	0	0	0	0	0	0	0	0	0	0	0	0
Reload Source (CM5)	0	0	0	0	0	0	1	1	1	1	1	1
Repetition (CM4)	0	0	0	1	1	1	0	0	0	1	1	1
Gate Control (CM15~CM12)	N	L	E	N	L	E	N	L	E	N	L	E
Count to TC once, then disarm	Y	Y	Y									
Count to TC twice, then disarm							Y	Y	Y			
Count to TC repeatedly without disarming				Y	Y	Y				Y	Y	Y
Gate input dose not gate counter input	Y			Y			Y			Y		
Count only during active gate level		Y			Y			Y			Y	
Start count on active gate edge and stop count on next TC			Y			Y						
Start count on active gate edge and stop count on second TC									Y			Y
Start count on active gate edge and stop count on inactive gate edge												
Reload counter from Load Register on TC	Y	Y	Y	Y	Y	Y						
Reload counter on each TC, alternating reload source between Load and Hold Registers							Y	Y	Y	Y	Y	Y

Note: For detailed **specifications** of the PCM-3780, please refer to **Appendix A Specifications**.

1.2 Applications

- Event counting
- One shot output
- Programmable frequency output
- Frequency measurement
- Pulse width measurement
- PWM output
- Periodic interrupt generation
- Time-delay generation

1.3 Installation Guide

Before you install your PCM-3780 card, please make sure you have the following necessary components:

- PCM-3780 DA&C card
- PCM-3780 User Manual
- **Driver software** Advantech DLL drivers (included in the companion CD-ROM)
- **Wiring cable:** PCL-10120 & PCL-10150
- **Wiring board:** ADAM-3920 (Option)
ADAM-3950 (Option)
- **Computer** Personal computer or workstation with a PC/104 slot (running Windows 2000/XP)

Some other optional components are also available for enhanced operation:

- **Application software** ActiveDAQ, GeniDAQ or other third-party software packages

After you get the necessary components and maybe some of the accessories for enhanced operation of your Multifunction card, you can then begin the Installation procedures. Figure 1-1 on the next page provides a concise flow chart to give users a broad picture of the software and hardware installation procedures:

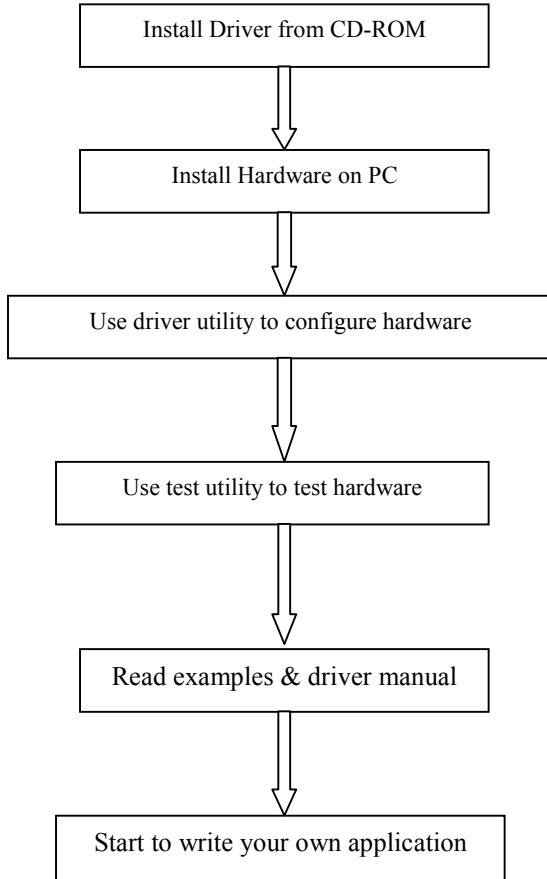


Figure 1.1: Installation Flow Chart

1.4 Software Overview

Advantech offers a rich set of DLL drivers, third-party driver support and application software to help fully utilize the functions of your PCM-3780 card:

1.4.1 Device Drivers (on the companion CD-ROM)

- LabVIEW driver
- Advantech ActiveDAQ
- Advantech GeniDAQ

Programming choices for DA&C cards: You may use Advantech application software such as Advantech Device Drivers. On the other hand, advanced users can use another option for register-level programming, although it is not recommended due to its laborious and time-consuming nature.

1.4.2 Device Drivers

The Advantech Device Drivers software is included on the companion CD-ROM at no extra charge. It also comes with all Advantech DA&C cards. Advantech's device drivers feature a complete I/O function library to help boost your application performance. The Advantech

Device Drivers for Windows 2000/XP works seamlessly with development tools such as Visual C++, Visual Basic, Inprise C++ Builder and Inprise Delphi.

1.4.3 Register-level Programming

Register-level programming is reserved for experienced programmers who find it necessary to write code directly at the level of device registers. Since register-level programming requires much effort and time, we recommend that you use the Advantech Device Drivers instead. However, if register-level programming is necessary, you should refer to the relevant information in Appendix C, Register Structure and Format, or to the example codes included on the companion CD-ROM.

1.5 Device Drivers Programming Roadmap

This section will provide a roadmap to demonstrate how to build an application from scratch using Advantech Device Drivers with your favorite development tools such as Visual C++, Visual Basic, Delphi and C++ Builder. The step-by-step instructions on how to build your own applications using each development tool will be given in the *Device Drivers Manual*. Moreover, a rich set of example source code is also given for your reference.

1.5.1 Programming Tools

Programmers can develop application programs with the following tools:

- Visual C++
- Visual Basic
- Delphi
- C++ Builder

For instructions on how to begin programming works in each development tool, Advantech offers a *Tutorial Chapter* in the *Device Drivers Manual* for your reference. Please refer to the corresponding sections in this chapter of the *Device Drivers Manual* to begin your programming efforts. You can also look at the example source code provided for each programming tool, since they can get you very well oriented.

The *Device Drivers Manual* can be found on the companion CD-ROM. Or if you have already installed the Device Drivers on your system, The *Device Drivers Manual* can be readily accessed through the *Start* button:

*Start/Programs/Advantech Automation/Device Manager
/Device Driver's Manual*

The example source codes could be found under the corresponding installation folder such as the default installation path:

\Program Files\Advantech\ADSAPI\Examples

For information about using other function groups or other development tools, please refer to the *Creating Windows 2000/XP Application with Device Drivers* chapter and the *Function Overview* chapter on the *Device Drivers Manual*.

1.5.2 Programming with Device Drivers Function Library

Advantech Device Drivers offers a rich function library to be utilized in various application programs. This function library consists of numerous APIs that support many development tools, such as Visual C++, Visual Basic, Delphi and C++ Builder.

According to their specific functions or services, those APIs can be categorized into several function groups:

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

For the usage and parameters of each function, please refer to the *Function Overview* chapter in the *Device Drivers Manual*.

1.5.3 Troubleshooting Device Drivers Error

Driver functions will return a status code when they are called to perform a certain task for the application. When a function returns a code that is not zero, it means the function has failed to perform its designated function. To troubleshoot the Device Drivers error, you can pass the error code to **DRV_GetErrorMessage** function to return the error message. Or you can refer to the *Device Drivers Error Codes Appendix* in the *Device Drivers Manual* for a detailed listing of the Error Code, Error ID and the Error Message.

1.6 Accessories

Advantech offers a complete set of accessory products to support the PCM-3780 card. These accessories include:

1.6.1 Wiring Cables

- **PCL-10120**

PCL-10120 cable is a 20-pin flat cable for PCM-3780 cards.

- **PCL-10150**

PCL-10150 cable is a 50-pin flat cable for PCM-3780 cards.

1.6.2 Wiring Boards

The ADAM-3900 series consists of universal screw terminal modules designed for field signal wiring in industrial applications. They can be connected to the analog and digital ports of Advantech products such as the PCI, PCM and PCL series.

- **ADAM-3920**

ADAM-3920 is a 20-Pin Flat Cable Wiring Terminal.

- **ADAM-3950**

ADAM-3950 is a 50-Pin Flat Cable Wiring Terminal.

CHAPTER 2

Hardware Installation

This chapter provides a packaged items checklist, proper instructions about unpacking and step-by-step procedures for card hardware installation.

Chapter 2 Hardware Installation

2.1 Unpacking

After receiving your PCM-3780 package, please inspect its contents first. The package should contain the following items:

- PCM-3780 card
- Companion CD-ROM (DLL driver included)
- User Manual

The PCM-3780 card has electronic components vulnerable to *electrostatic discharge* (ESD). ESD could easily damage the integrated circuits and certain components if preventive measures are not carefully paid attention to. Before removing the card from the antistatic plastic bag, you should take following precautions to ward off possible ESD damage:

- Touch the metal part of your computer chassis with your hand to discharge static electricity accumulated on your body. Or use a grounding strap.
- Touch the anti-static bag to a metal part of your computer chassis before opening the bag.
- Take hold of the card only by the metal bracket when removing it from the bag.

After taking out the card you should first inspect the card for any possible signs of external damage (loose or damaged components, etc.). If the card is visibly damaged, please notify Advantech's service department or the local sales representative immediately. Avoid installing a damaged card into your system. Also, pay extra caution to the following aspects to ensure proper installation:

- Avoid physical contact with materials that could hold static electricity such as plastic, vinyl and Styrofoam.
- Whenever you handle the card, hold it only by its edges. **DO NOT TOUCH** the exposed metal pins of the connector or the electronic components.

Note *Keep the anti-static bag for future use. You might need the original bag to store the card if you have to remove the card from the PC or transport it elsewhere.*

2.2 Driver Installation

We recommend you to install the driver before you install the PCM-3780 card into your system, since this will guarantee a smooth installation process.

The Advantech Device Drivers Setup program for the PCM-3780 card is included on the companion CD-ROM that is shipped with your DA&C card package. Please follow the steps below to install the driver software:

Step 1: Insert the companion CD-ROM into your CD-ROM drive.

Step 2: The Setup program will be launched automatically if you have the autoplay function enabled on your system. When the Setup Program is launched, you'll see the following Setup Screen.

Note: If the autoplay function is not enabled on your computer, use Windows Explorer or the Windows Run command to execute SETUP.EXE on the companion CD-ROM.



Figure 2.1: The Setup Screen of Advantech Automation Software

Step 3: Select the Individual Drivers option.

Step 4: Select the specific device then just follow the installation instructions step by step to complete your device driver setup.

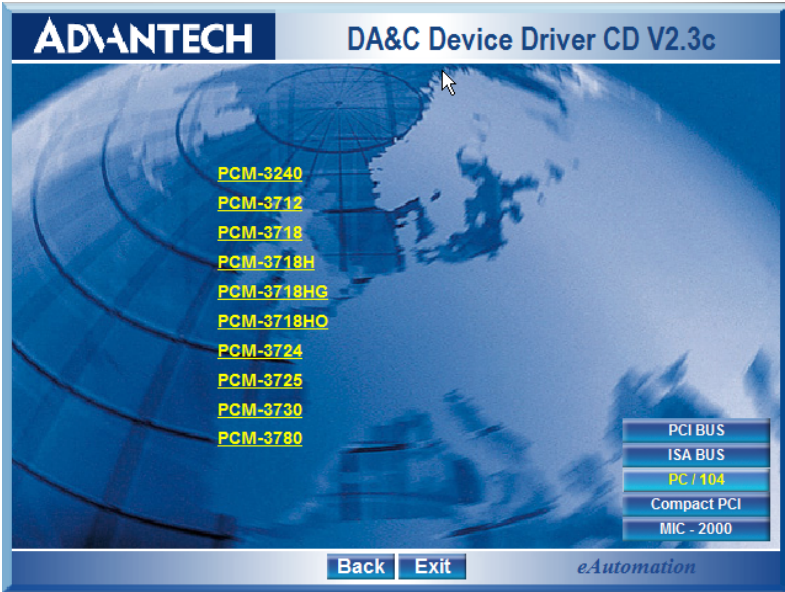


Figure 2.2: Different Options for Driver Setup

For further information on driver-related issues, an online version of Device Drivers Manual is available by accessing the following path:

*Start/Programs/Advantech Automation/Device Manager
/Device Driver's Manual*

2.3 Hardware Installation

Note: Make sure you have installed the driver before you install the card. We strongly recommend that you install the software driver before you install the hardware into your system, since this will guarantee a smooth and trouble-free installation process.

For more information about the driver installation, configuration and removal procedures for Windows 2000 and Windows XP, please see the corresponding help file:

After the DLL driver installation is completed, you can go on to install the PCM-3780 card in one of the PC/104 I slots on your computer. It is suggested that you refer to the computer user's manual or related documentation if you have any doubts. Please follow the steps below to install the card on your system.

2.3.1 Installing the Module

1. Turn the PC's power off. Turn off the power of any peripheral devices such as printers and monitors.
2. Disconnect the power cord and any other cables from the back of the computer.
3. Remove the system unit cover (see the user's guide for your chassis if necessary).
4. Remove the CPU card from the chassis (if necessary) to gain access to the card's PC/104 connector.
5. Connect connector J1 of the PCM-3780 card to the PC/104 connector. Carefully align the pins with the PC/104 connector. Slide the module into the connector. The module pins may not slide all the way into the connector; do not force the pins into place, as the module may be damaged.
6. Fasten the module to the CPU card by using the included brass screw. Screw the brass spacer into the threaded hole on the CPU card. Do not tighten too much, or the threads may be damaged.
7. Attach any accessories to the PCM-3780 card using 20 pin cables.
8. Reinstall the CPU card and replace the system unit cover. Reconnect the cables you removed in step 2. Plug in and turn on the power.

Pin Assignments & Jumper Settings

This chapter provides useful information about how to connect input and output signals to the PCM-3780 via the I/O connector.

Sections include:

- Overview
- Signal Connections
- Switch & Jumper Settings
- Connectors Pin Assignment
- Period Measurement
- Frequency Measurement

Chapter 3 Pin Assignments & Jumper Settings

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 PCM-3780 via the I/O connector.

3.2 Signal Connections

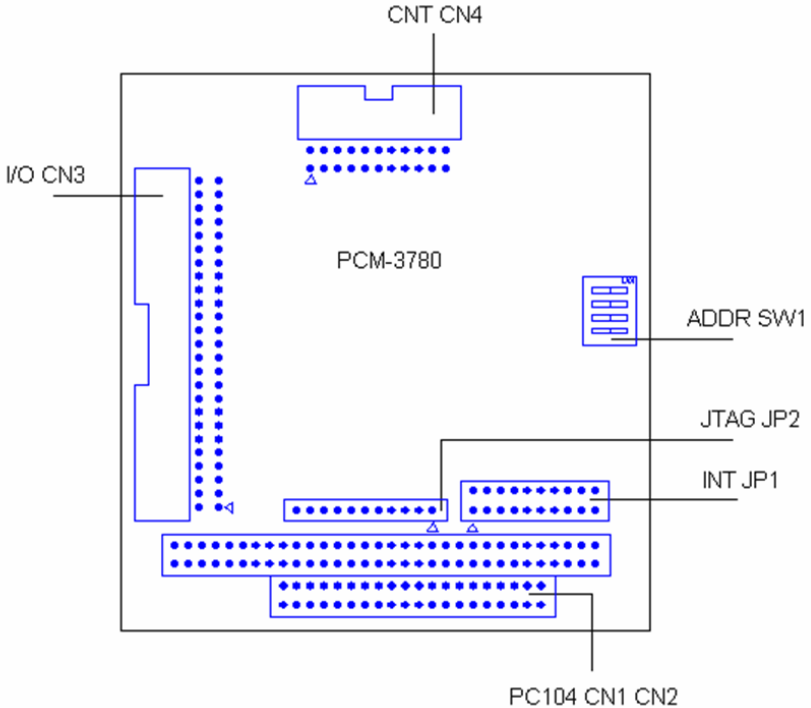


Figure 3.1: Connectors Locations

Table 3.1: Connectors Table

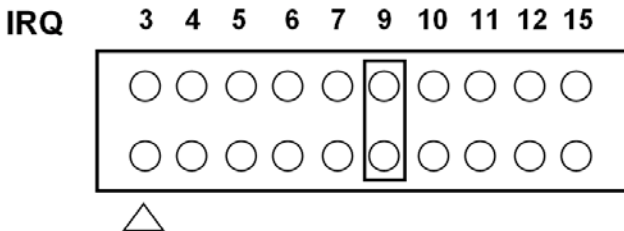
Label	Function
CN1	PC/104 Slot
CN2	PC/104 Slot
CN3	I/O Port Connector
CN4	Counter Interface Connector
JP1	Interrupt Jumper
JP2	JTAG Connector
SW1	Base Address Configuration Switch

3.3 Switch and Jumper Settings

We designed PCM-3780 with ease-of-use in mind. It has one address switch and one interrupt jumper setting. The following section describes how to configure the card.

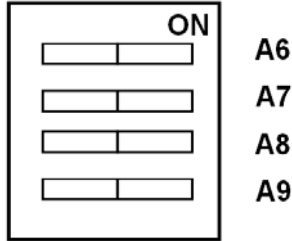
Interrupt Level (IRQ) Setting (JP1)

Select an IRQ which is not already in use by another card in the system. If you are installing more than one PCM-3780, set them to different IRQ numbers. Jumper bank JP1 controls the card IRQ. Simply place the jumper on the required interrupt level as shown in the following figure.



Base Address Setting (SW1)

Select an address which is not already in use by another card in the system. If you are installing more than one PCM-3780 card in your system, set the cards to different base addresses. The base address configuration switch SW1 controls each card's base address, as shown below.



Switch ON: Address Line Value = 0

Switch OFF: Address Line Value = 1

Table 3.2: Base Address Setting

Base Address	A6	A7	A8	A9
100H — 13FH	0	0	1	0
140H — 17FH	1	0	1	0
.....				
3C0H — 3FFH	1	1	1	1

For example:

Base Address 140H:

A6 OFF A7 ON A8 OFF A9 ON

*Default Setting = 300H

The following example shows how to set the base address to 140H.

The switch SW1 sum is set to 140H:

$$40H(A6=1) + 0(A7=0) + 100H(A8=1) + 0(A9=0) = 140$$

Address Line	A6	A7	A8	A9
HEX Value	40H	80H	100H	200H

3.4 Connectors Pin Assignment

CN3: I/O Port Connector

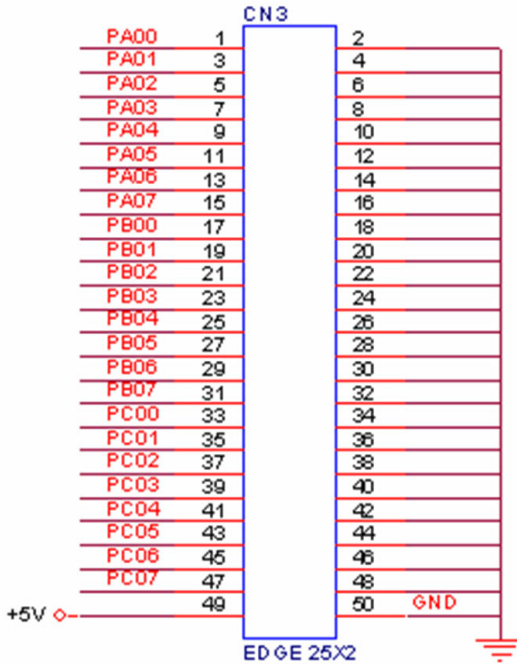


Figure 3.2: I/O Port Connector

CN4: Counter Interface Connector

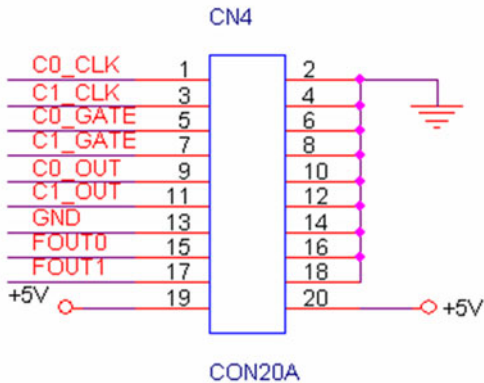


Figure 3.3: Counter Interface Connector

I/O Connector Signal Description

Table 3.3: I/O Connector Signal Descriptions

Signal Name	Reference	Direction	Description
GND	-	-	DC ground
+5V	GND	Output	+5 VDC source
FOUT<0..1>	GND	Output	Frequency output channels
C_OUT<0..1>	GND	Output	Counter output channels
C_CLK<0..1>	GND	Input	Clock external input channels
C_GATE<0..1>	GND	Input	Gate control channels
PA(/B/C)<0..7>	GND	I/O	Digital I/O channels

3.5 Period Measurement

3.5.1 Using Advantech 32-bit DLL Driver

This approach is for a **low** frequency signal.

We recommend you to perform period measurement through our 32-bit DLL driver because it is the simplest way for both programming and wiring. Just connect the unknown single to **Gate** and the duty cycle will be measured by the software.

3.5.2 Using Direct I/O

This approach is for a **low** frequency signal.

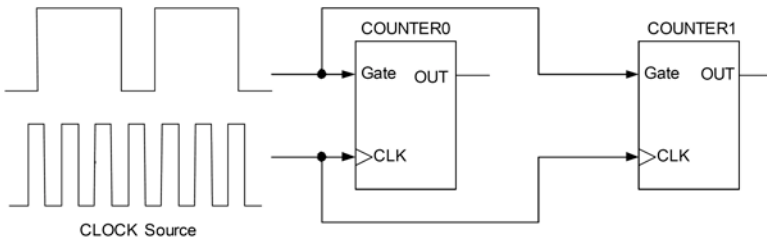


Figure 3.4: Period Measurement

Implementing this measurement needs two counters, one for the up cycle period and another for the down cycle period. These added together gives the total period. The duty cycle can also be calculated by dividing the up period with the total period. Connect the unknown signal to each counter's gate.

Apply a standard clock pulse to each counter. **Counter 0** counts the up cycle, while **Counter 1** counts the down cycle. In PCM-3780, wiring is simple. Just connect the unknown signal to **Counter 0**, and use the register to select the gate source. **Counter 0** selects "**Gate N**". **Counter 1** selects "**Gate N-1**".

Apply the standard clock to both counters with the clock source selection register. It can change the clock for different measurement ranges.

Counter 0 set as "**Mode 0**" will make gate polarity positive. **Counter 1** set as "**Mode 0**" will make gate polarity negative.

3.6 Frequency Measurement

3.6.1 Using Advantech 32-bit DLL Driver

This approach is for a **high** frequency signal.

Measuring pulse frequency is simple by using the Advantech 32-bit DLL driver. Just connect the unknown single to **Gate** and the pulse frequency will be measured by the software.

3.6.2 Using Direct I/O

This approach is for a **high** frequency signal.

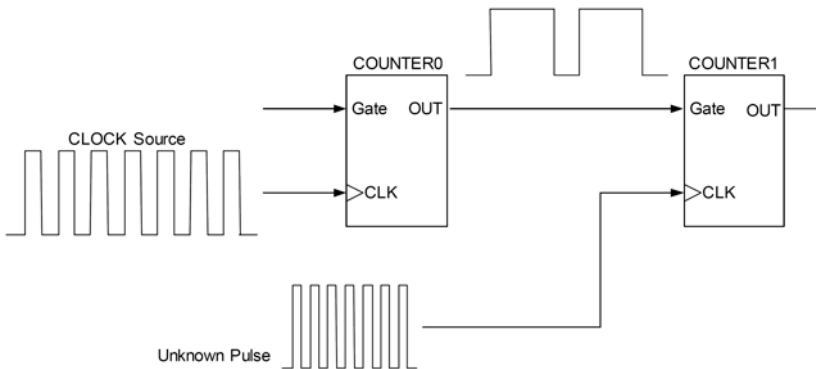


Figure 3.5: Frequency Measurement

It also takes two counters for frequency measurement. **Counter 0** counts the number of incoming standard source clock, while **Counter 1** counts the number of incoming unknown signal clock pulses.

Connect the standard clock source to **Gate** of **Counter 0** and set **Counter 0** to “**Mode D**”. The total time period can be measured by **Counter 0** through the standard source clock (Multiply the number of incoming pulses by their frequency). Also connect the unknown signal to **CLK** of **Counter 1** and set **Counter 1** to “**Mode B**”, and the frequency of the unknown signal can be calculated by dividing the number of pulses by the total time period.

APPENDIX A

Specifications

This appendix provides detailed specifications for PCM-3780.

Appendix A Specifications

A.1 Programmable Counter

Channels	2	
Resolution	16-bit	
Compatibility	TTL level	
Max. Input Frequency	20 MHz	
Clock Input	Low	0.8 V max.
	High	2.0 V min.
Gate Input	Low	0.8 V max.
	High	2.0 V min.
Counter Output	Low	0.4 V max.@ +8.0mA (sink)
	High	2.4 V min.@ -0.4mA(source)

A.2 Digital Input/Output

Channels	24 (8255Mode 0)	
Input Voltage	Low	0.4V max.
	High	2.4 V min.
Input Load	Low	0.4 V max.@ -0.2mA
	High	2.7 V min.@20 μ A
Output Voltage	Low	0.5 V max.@+24 mA
	High	2.4 V min.@-15 mA

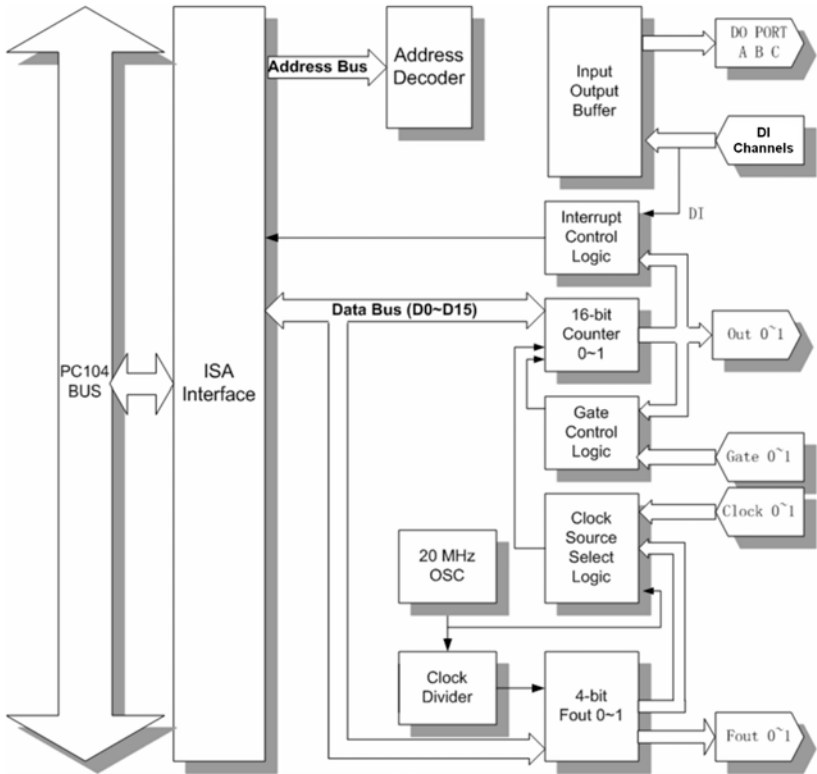
A.3 General

I/O Connector Type	One 50 pin and one 20 pin box header	
Dimensions	90 x 96 mm (3.6" x 3.8")	
Power Consumption	Typical	+5 V @ 300mA
	Max.	+5 V @ 0.8A
Temperature	Operating	0~+60° C (32~158° F) (refer to IEC 68-2-1,2)
	Storage	-20~+70° C(-4~158° F)
Relative Humidity	Operating	5~85 % RH non-condensing (refer to IEC 68-1,-2,-3)
	Storage	5~95 % RH non-condensing (refer to IEC 68-1,-2,-3)
Certifications	CE certified	

Block Diagram

This chapter provides information on the block diagram for PCM-3780.

Appendix B Block Diagram



APPENDIX C

Register Structure & Format

This chapter provides information on the register structure and format for PCM-3780.

Appendix C Register Structure & Format

C.1 Overview

PCM-3780 is delivered with an easy-to-use 32-bit DLL driver for user programming under the Windows 2000/XP operating system. We advise users to program the PCM-3780 using the 32-bit DLL driver provided by Advantech to avoid the complexity of low-level programming by register.

The most important consideration in programming the PCM-3780 at register level is to understand the function of the card's registers. The information in the following sections is provided only for users who would like to do their own low-level programming.

C.2 I/O Port Address Map

The PCM-3780 requires 64 consecutive addresses in the PC's I/O space. The address of each register is specified as an offset from the card's base address. For example, BASE+0 is the card's base address and BASE+6 is the base address plus six bytes.

Table C-1 shows the function of each register of the PCM-3780 or driver and its address relative to the card's base address.

C.2.1 Register Format

Table C.1: Register Offset Address Table

Base		PCM-3780 Register Format															
Address + HEX		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
00h	W	Counter 0 Mode Register															
		CM	CM	CM1	CM1	CM1	CM1	CM	CM	CM	CM	CM	CM	CM	CM	CM	CM
	R	15	14	3	2	1	0	9	8	7	6	5	4	3	2	1	0
02h	W	Counter 0 Load Register															
		CL	CL1	CL13	CL12	CL11	CL10	CL9	CL8	CL	CL	CL	CL	CL	CL	CL	CL
	R	15	14						7	6	5	4	3	2	1	0	
04h	W	Counter 0 Hold Register															
		CH	CH1	CH1	CH1	CH1	CH1	CH	CH	CH	CH	CH	CH	CH	CH	CH	CH
	R	15	14	3	2	1	0	9	8	7	6	5	4	3	2	1	0
06h	W	Counter 0 Command Register															
	R														C2	C1	C0
08h	W	Counter 1 Mode Register															
		CM	CM	CM1	CM1	CM1	CM1	CM	CM	CM	CM	CM	CM	CM	CM	CM	CM
	R	15	14	3	2	1	0	9	8	7	6	5	4	3	2	1	0
A0h	W	Counter 1 Load Register															
		CL	CL1	CL13	CL12	CL11	CL10	CL9	CL8	CL	CL	CL	CL	CL	CL	CL	CL
	R	15	14						7	6	5	4	3	2	1	0	
C0h	W	Counter 1 Hold Register															
		CH	CH1	CH1	CH1	CH1	CH1	CH	CH	CH	CH	CH	CH	CH	CH	CH	CH
	R	15	14	3	2	1	0	9	8	7	6	5	4	3	2	1	0
E0h	W	Counter 1 Command Register															
	R														C2	C1	C0
20h	W	Counter Command Enable Register															
	R															CE	CE
																1	0

Table C.1: Register Offset Address Table

22h	W	Counter Command Enable Register																CE	CE			
																		1	0			
	R	Interrupt Status Register																				
																		DI	DIB	DIA	C1	C0
24h	W	Interrupt Clear																				
	R	N/A																				
2Ch	W	I/O Direction Control Register																PA	PC			
																			H		PB	PC
	R	N/A																				
2Eh	W	N/A																				
	R	Port A Interrupt Status Register																				
30h	W	N/A																				
	R	Port B Interrupt Status Register																				
32h	W	N/A																				
	R	Port C Interrupt Status Register																				
38h	W	FOUT0 Register																				
					FOE		FS2	FS1	FS0													
	R	N/A																DV	DV			
3Ah	W	FOUT1 Register																				
					FOE		FS2	FS1	FS0													
	R	Port C Interrupt Status Register																DV	DV			

C.3 Counter 0/1 Mode Register

Base Address + HEX		PCM-3780 Register Format															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0h	W	Counter 0 Mode Register															
		CM15	CM14	CM13	CM12	CM11	CM10	C9	C8	C7	C6	C5	CM4	CM3	CM2	CM1	CM0
	R	Counter 0 Mode Register															
		CM15	CM14	CM13	CM12	CM11	CM10	C9	C8	C7	C6	C5	CM4	CM3	CM2	CM1	CM0
8h	W	Counter 1 Mode Register															
		CM15	CM14	CM13	CM12	CM11	CM10	C9	C8	C7	C6	C5	CM4	CM3	CM2	CM1	CM0
	R	Counter 1 Mode Register															
		CM15	CM14	CM13	CM12	CM11	CM10	C9	C8	C7	C6	C5	CM4	CM3	CM2	CM1	CM0

1. CM1 to CM0: Output Control

00 = Active High Terminal Count Pulse

01 = Active Low Terminal Count Pulse

10 = TC Toggled from low

11 = TC Toggled from high

2. CM2: Output Enable Control

0 = Disable Output (High impedance)

1 = Enable Output

3. CM6 to CM3: Count Control

CM6:

0 = Disable edge disarm in edge gate mode

1 = Enable edge disarm in edge gate mode

CM5:

0 = Reload from Load

1 = Reload from Load or Hold

CM4:

0 = Count Once

1 = Count Repetitively

CM3:

0 = Count Down

1 = Count Up

4. CM7: Count Source Edge

0 = Count on Rising Edge

1 = Count on Falling Edge

5. CM11 to CM8: Count Source Selection

0000 = Internal Clock (20MHz)

0001 = OUT N-1

0010 = CLK N

0011 = CLK N-1

0100 = FOUT0

0101 = FOUT1

0111 = GATE N-1

6. CM13 to CM12: Gate Source Selection

00 = No Gating

01 = OUT N-1

10 = GATE N

11 = GATE N-1

7. CM14: Gating Polarity Selection

0 = High Level for Level Active, Rising Edge for Edge Active

1 = Low Level for Level Active, Falling Edge for Edge Active

8. CM15: Gate Active Edge or Level

0 = Level Active

1 = Edge Active

C.4 Counter 0/1 Load Register:

Base Address + HEX		PCM-3780 Register Format															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
2h	W	Counter 0 Load Register															
		CL15	CL14	CL13	CL12	CL11	CL10	CL9	CL8	CL7	CL6	CL5	CL4	CL3	CL2	CL1	CL0
	R	Counter 0 Load Register															
Ah	W	Counter 1 Load Register															
		CL15	CL14	CL13	CL12	CL11	CL10	CL9	CL8	CL7	CL6	CL5	CL4	CL3	CL2	CL1	CL0
	R	Counter 1 Load Register															

1. CL15 to CL0: Counter load data

C.5 Counter 0/1 Hold Register

Base Address + HEX		PCM-3780 Register Format															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
4h	W	Counter 0 Hold Register															
		CH15	CH14	CH13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0
	R	Counter 0 Hold Register															
Ch	W	Counter 1 Hold Register															
		CH15	CH14	CH13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0
	R	Counter 1 Hold Register															

1. CH15 to CH0: Counter hold data

C.6 Counter 0/1 Command Register

Base Address + HEX		PCM-3780 Register Format															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
6h	W	Counter 0 Command Register															
	R															C2	C1
Eh	W	Counter 1 Command Register															
	R															C2	C1

1. C2 to C0 : Command Code

000 = Disarm counter

001 = Load counter from LOAD

010 = Disarm and Save counter

100 = Arm counter

101 = Load and Arm counter

110 = Save counter to HOLD

111 = Reset counter

C.7 Counter Command Enable Register

Base Address + HEX		PCM-3780 Register Format															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
20h	W	Counter Command Enable Register															
	R																CE1

1. CE1 to CE0: Counter Command Enable Bit

0 = Not Select this counter

1 = Select this counter

C.8 Interrupt Control Register

Base Address + HEX		PCM-3780 Register Format																	
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
22h	W	Interrupt Control Register																	
	R														DIC	DIB	DIA	C1	C0

1. C1 to C0: Counter Interrupt enable Bit

0 = Not enable interrupt for this counter

1 = Enable interrupt for this counter

2. DIA, DIB and DIC: DI Interrupt enable Bit

0 = Not enable interrupt for DI

1 = Enable interrupt for DI

C.9 Interrupt Status Register

Base Address + HEX		PCM-3780 Register Format																	
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
22h	W																		
	R	Interrupt Status Register																	
																DIC	DIB	DIA	C1

1. C1 to C0: Counter Interrupt Status Bit

0 = No interrupt occur

1 = Interrupt occur

2. DIA, DIB and DIC: Interrupt Status Bit

0 = No interrupt occurred

1 = Interrupt occurred

C.10 Interrupt Clear Register

Write any data to these two bytes to clear the interrupt.

Base Address + HEX	PCM-3780 Register Format																
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
24h	W	Interrupt Clear															
	R																

C.11 I/O Direction Control Register

Base Address + HEX	PCM-3780 Register Format																
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
2Ch	W	I/O Direction Control Register															
	R											PA	PCH		PB	PCL	

1. I/O Direction Control Bit:

0 = Output

1 = Input

C.12 Port A/B/C Interrupt Status Register

Base Address + HEX	PCM-3780 Register Format																
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
2Eh	W	Port A Interrupt Status Register															
	R	N/A															
30h	W	Port B Interrupt Status Register															
	R									Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
32h	W	Port C Interrupt Status Register															
	R									Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

1. Bit7 to Bit0: Port A/B/C Interrupt Status Register

0 = No interrupt occurred

1 = Interrupt occurred

C.13 FOUT Register

Base Address + HEX		PCM-3780 Register Format															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
38h	W	FOUT0 Register															
	R				FOE		FS2	FS1	FS0					DV3	DV2	DV1	DV0
3Ah	W	FOUT1 Register															
	R				FOE		FS2	FS1	FS0					DV3	DV2	DV1	DV0

1. DV3 to DV0: FOUT Divider (Divide by 1 to 16)

0000 = Divide by 1

0001 = Divide by 2

0010 = Divide by 3

0011 = Divide by 4

0100 = Divide by 5

0101 = Divide by 6

0110 = Divide by 7

0111 = Divide by 8

1000 = Divide by 9

1001 = Divide by 10

1010 = Divide by 11

1011 = Divide by 12

1100 = Divide by 13

1101 = Divide by 14

1110 = Divide by 15

1111 = Divide by 16

2. FS2 to FS0: FOUT Source

001 = CLK N

010 = FOUT N-1

011 = 10 MHz clock

100 = 1 MHz clock

101 = 100 KHz clock

110 = 10 KHz clock

111 = 1KHz clock

3. FOE: FOUT Output Enable

0 = Disable Output

1 = Enable Output

Waveform of Each Mode

The PCM-3780 offers 16 powerful counter functions for your industrial or laboratory applications. This chapter will describe each mode in detail with waveform diagrams.

Appendix D Waveform of Each Mode

D.1 Counter Mode Descriptions

Counter Mode register bits CM15-CM12 and CM6-CM4 select the operating mode for each counter (see Table D-1). To simplify references to a particular mode, each mode is assigned a letter from **A** through **X**. Representative waveforms for the counter modes are illustrated in Figure **A** through **X** (because the letter suffix in the figure number is keyed to the mode, Figures **M**, **N**, **P**, **Q**, **V**, and **W** do not exist).

The figures assume counting on rising source edges. These modes (which automatically disarm the counter) (CM4 = 0) are shown with the WR pulse entering the required ARM command. For modes that count repetitively (CM4 = 1) the ARM command is omitted. Both a TC output waveform and a TC Toggled output waveform are shown for each mode.

The symbols **L** and **H** are used to represent count values equal to the **Load** and **Hold** register contents, respectively. The symbols **K** and **N** represent arbitrary count values. For each mode, the required bit pattern in the Counter Mode register is shown; "don't care" bits are marked "X". These figures are designed to clarify the mode descriptions.

To keep the following mode descriptions concise and to the point, the phrase "source edges" is used to refer to active-going source edges only, not to inactive-going edges. Similarly, the phrase "gate edges" refers only to active-going gate edges. Also, again to avoid verbosity and euphuism, the descriptions of some modes state that a counter is stopped or disarmed "on a TC, inhibiting further counting."

As is fully explained in the TC section of the document, for these modes the counter is actually stopped or disarmed following the active-going source edge, which drives the counter out of TC. In other words, since a counter in the TC state always counts, irrespective of its gating of arming status, the stopping or disarming of the count sequence is delayed until TC is terminated.

Table D.1: PCM-3780 Counter Mode

Counter Mode	A	B	C	D	E	F	G	H	I	J	K	L
Special Gate (CM6)	0	0	0	0	0	0	0	0	0	0	0	0
Reload Source (CM5)	0	0	0	0	0	0	1	1	1	1	1	1
Repetition (CM4)	0	0	0	1	1	1	0	0	0	1	1	1
Gate Control (CM15~CM12)	N	L	E	N	L	E	N	L	E	N	L	E
Count to TC once, then disarm	Y	Y	Y									
Count to TC twice, then disarm							Y	Y	Y			
Count to TC repeatedly without disarming				Y	Y	Y				Y	Y	Y
Gate input dose not gate counter input	Y			Y			Y			Y		
Count only during active gate level		Y			Y			Y			Y	
Start count on active gate edge and stop count on next TC			Y			Y						
Start count on active gate edge and stop count on second TC									Y			Y
Start count on active gate edge and stop count on inactive gate edge												
Reload counter from Load Register on TC	Y	Y	Y	Y	Y	Y						
Reload counter on each TC, alternating reload source between Load and Hold Registers							Y	Y	Y	Y	Y	Y

(N: No gate control, L: Level gate control, E: Edge gate control)

Table D.2: PCM-3780 Counter Mode

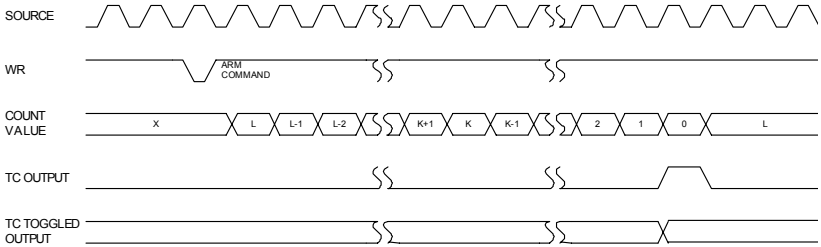
Counter Mode	M	N	O	P	Q	R	S	T	U	V	W	X
Special Gate (CM6)	0	0	0	0	0	0	0	0	0	0	0	0
Reload Source (CM5)	0	0	0	0	0	0	1	1	1	1	1	1
Repetition (CM4)	0	0	0	1	1	1	0	0	0	1	1	1
Gate Control (CM15~CM12)	N	L	E	N	L	E	N	L	E	N	L	E
Count to TC once, then disarm	Y	Y	Y									
Count to TC twice, then disarm							Y	Y	Y			
Count to TC repeatedly without disarming				Y	Y	Y				Y	Y	Y
Gate input dose not gate counter input	Y			Y			Y			Y		
Count only during active gate level		Y			Y			Y			Y	
Start count on active gate edge and stop count on next TC			Y			Y						
Start count on active gate edge and stop count on second TC									Y			Y
Start count on active gate edge and stop count on inactive gate edge												
Reload counter from Load Register on TC	Y	Y	Y	Y	Y	Y						
Reload counter on each TC, alternating reload source between Load and Hold Registers							Y	Y	Y	Y	Y	Y

Note: Counter modes **M, N, P, Q, S, T, V, W** are identical to **A, B, D, E, G, H, J, K**.

D.2 Mode A Waveforms

Software-Triggered Strobe with No Hardware Gating

Mode A is one of the simplest operating modes. The counter will be available for counting source edges when it is issued an ARM command. On each TC the counter will reload from the Load register and automatically disarm itself, inhibiting further counting. Counting will resume when a new ARM command is issued.



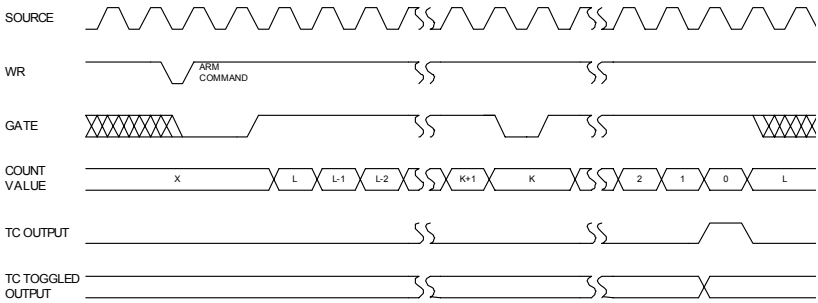
Mode A Waveforms

D.3 Mode B Waveforms

Software-Triggered Strobe with Level Gating

Mode B is identical to Mode A except that source edges are counted only when the assigned gate is active. The counter must be armed before counting can occur. Once armed, the counter will count all source edges that occur while the gate is active and disregard those edges that occur while the gate is inactive.

This permits the gate to turn the counting process on and off. On each TC the counter will reload from the **Load** register and automatically disarm itself, inhibiting further counting until a new ARM command is issued.



Mode B Waveforms

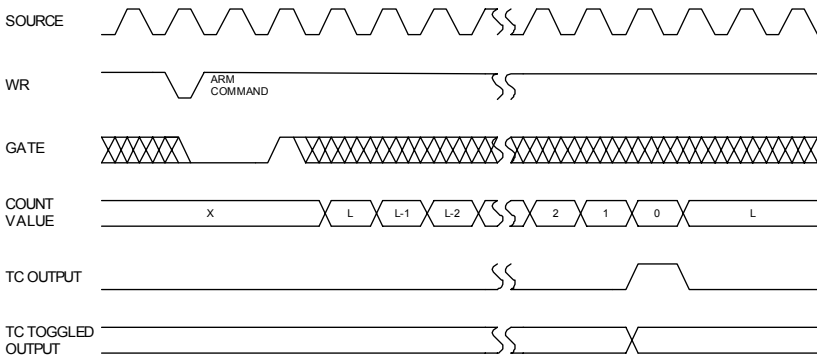
D.4 Mode C Waveforms

Hardware-Triggered Strobe

Mode C is identical to Mode A, except that counting will not begin until a gate edge is applied to the armed counter. The counter must be armed before application of the triggering gate edge, while gate edges applied to a disarmed counter are disregarded.

The counter will start counting on the first source edge after the triggering gate edge and will continue counting until TC. At TC, the counter will reload from the **Load** register and automatically disarm itself. Counting will then remain inhibited until a new ARM command and a new gate edge are applied in that order.

Note that after application of a triggering gate edge, the gate input will be disregarded for the remainder of the count cycle. This differs from Mode B, where the gate can be modulated throughout the count cycle to stop and start the counter.

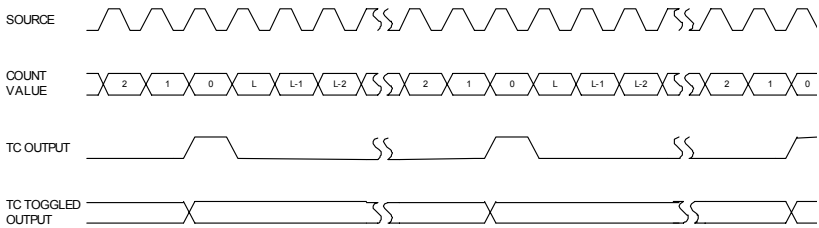


Mode C Waveforms

D.5 Mode D Waveforms

Rate Generator with No Hardware Gating

Mode D is typically used in frequency generation applications. In this mode, the gate input does not affect counter operation. Once armed, the counter will count to TC repetitively. On each TC the counter will reload itself from the Load register; hence the Load register value determines the time between TCs. A square wave rate generator may be obtained by specifying the TC Toggled output mode in the Counter Mode register.

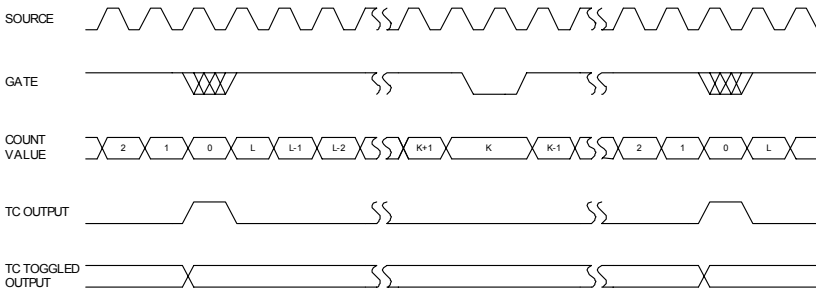


Mode D Waveforms

D.6 Mode E Waveforms

Rate Generator with Level Gating

Mode E is identical to Mode D, except the counter will only count those source edges that occur while the gate input is active. This feature allows the counting process to be enabled and disabled under hardware control. A square wave rate generator may be obtained by specifying the TC toggled output mode.



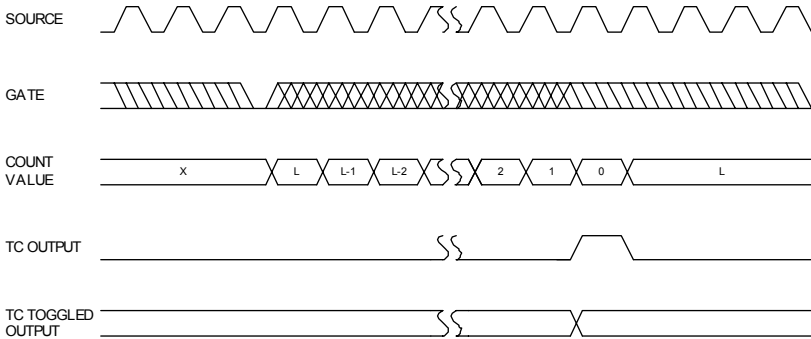
Mode E Waveforms

D.7 Mode F Waveforms

Non-Retriggerable One-Shot

Mode F provides a non-retriggerable, one-shot, timing function. The counter must be armed before it will function. Application of a gate edge to the armed counter will enable counting. When the counter reaches TC, it will reload itself from the Load register. The counter will then stop counting, awaiting a new gate edge.

Note that unlike Mode C, a new ARM command is not needed after TC, only a new gate edge. After application of a triggering gate edge, the gate input is disregarded until TC.



Mode F Waveforms

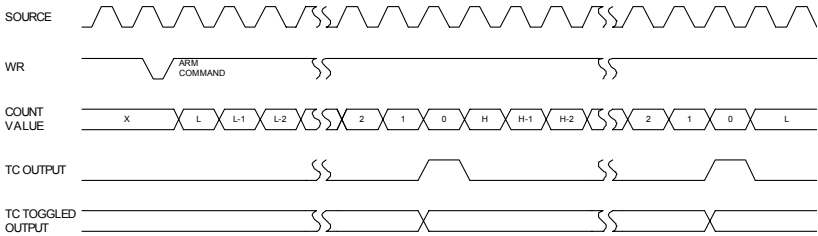
D.8 Mode G Waveforms

Software-Triggerred Delayed Pulse One-Shot

In Mode G, the gate does not affect the counter's operation. Once armed, the counter will count to TC twice and then automatically disarm itself. For most applications, the counter will initially be loaded from the **Load** register either by a LOAD command or by the last TC of an earlier timing cycle.

Upon counting to the first TC, the counter will reload itself from the **Hold** register. Counting will proceed until the second TC, when the counter will reload itself from the **Load** register and automatically disarm itself, inhibiting further counting. Counting can be resumed by issuing a new ARM command.

Specifying the TC Toggled output mode in the Counter Mode register may generate a software-triggerred delayed pulse one-shot. The initial counter contends control of the delay from the ARM command until the output pulse starts. The **Hold** register contents control the pulse duration.



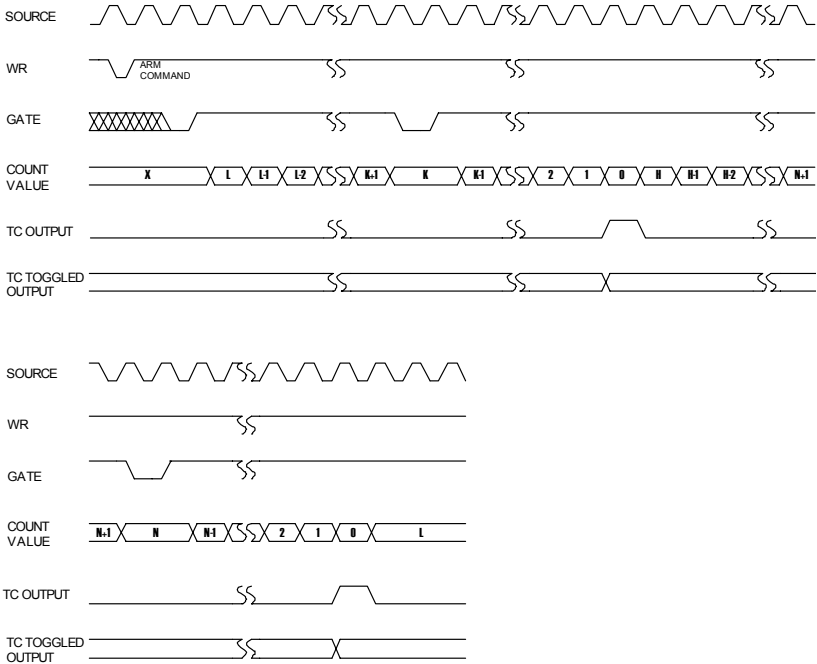
Mode G Waveforms

D.9 Mode H Waveforms

Software-Triggered Delayed Pulse One-Shot with Hardware Gating

Mode H is identical to Mode G except that the gate input is used to qualify which source edges are to be counted. The counter must be armed for counting to occur. Once armed, the counter will count all source edges that occur while the gate is active and disregard those source edges that occur while the gate is inactive. This permits the gate to turn the count process on and off.

As with Mode G, the counter will be reloaded from the Hold register on the first TC and reloaded from the Load register and disarmed on the second TC. This mode allows the Gate to control the extension of both the initial output delay time and the pulse width.



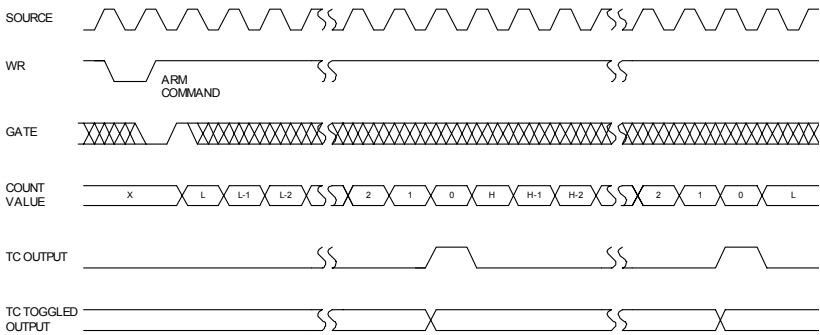
Mode H
Waveforms

D.10 Mode I Waveforms

Hardware-Triggered Delayed Pulse Strobe

Mode I is identical to Mode G, except that counting will not begin until a gate edge is applied to an armed counter. The counter must be armed before application of the triggering gate edge. Gate edges applied to a disarmed counter are disregarded. An armed counter will start counting on the first source edge after the triggering gate edge. Counting will then proceed in the same manner as in Mode G. After the second TC, the counter will disarm itself. An ARM command and gate edge must be issued in this order to restart counting.

Note that after application of a triggering gate edge, the gate input will be disregarded until the second TC. This differs from Mode H, where the gate can be modulated throughout the count cycle to stop and start the counter.



Mode I Waveforms

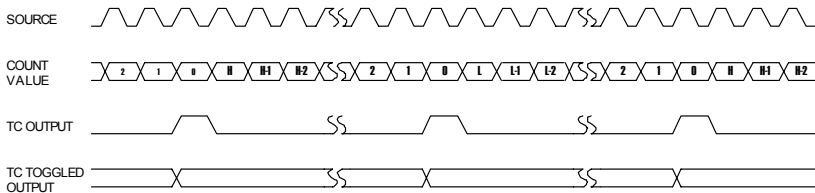
D.11 Mode J Waveforms

Variable Duty Cycle Rate Generator with No Hardware Gating

Mode J will find the greatest usage in frequency generation applications with variable duty cycle requirements. Once armed, the counter will count continuously until it is issued a DISARM command.

On the first TC, the counter will be reloaded from the Hold register. Counting will then proceed until the second TC at which time the counter will be reloaded from the Load register. Counting will continue, with the reload source alternating on each TC, until a DISARM command is issued to the counter. (The third TC reloads from the Hold register, the fourth TC reloads from the Load register, etc.)

Specifying the TC Toggled output in the Counter Mode register can generate a variable duty cycle output. The Load and Hold values then directly control the output duty cycle, with high resolution available when relatively high count values are used.



Mode J
Waveforms

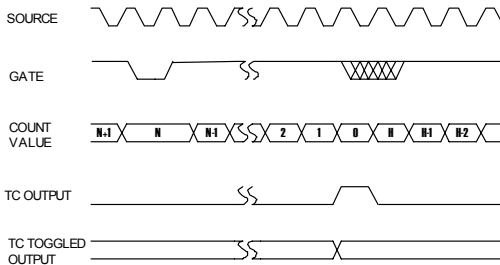
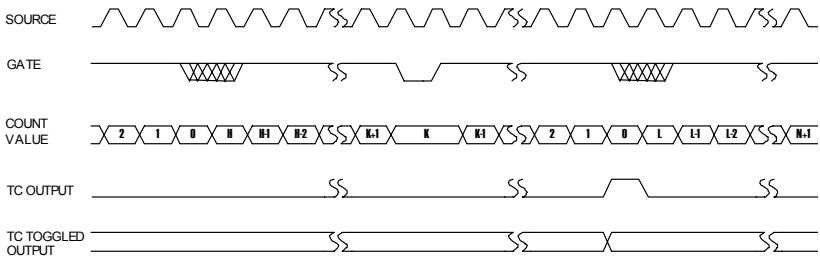
D.12 Mode K Waveforms

Variable Duty Cycle Rate Generator with Level Gating

Mode K is identical to Mode J except that source edges are only counted when the Gate is active. The counter must be armed for counting to occur.

Once armed, the counter will count all source edges that occur while the gate is active and disregard those source edges that occur while the gate is inactive. This permits the gate to turn the count process on and off.

As with Mode J, the reload source used will alternate on each TC, starting with the Hold register on the first TC. After the gate modulate the duty cycle of the output waveform. It can affect both the high and low portions of the output waveform.



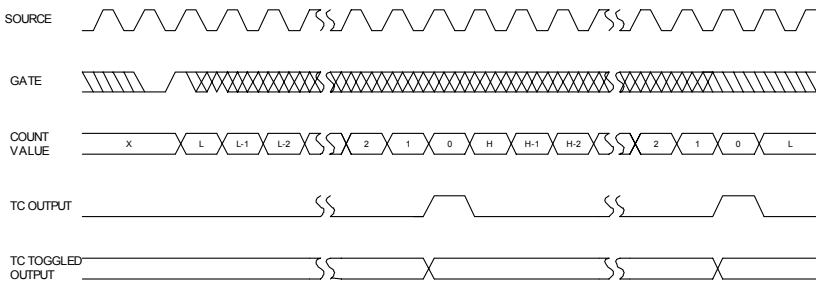
Mode K
Waveforms

D.13 Mode L Waveforms

Hardware-Triggered Delayed Pulse One-Shot

Mode L is similar to Mode J except that counting will not begin before a gate edge is applied to an armed counter. The counter must be armed before application of the triggering gate edge; gate edges applied to a disarmed counter are disregarded. The counter will start counting source edges and counting will proceed until the second TC.

Note that after application of a triggering gate edge, the gate input will be disregarded for the remainder of the count cycle. This differs from Mode K, where the gate can be modulated throughout the count cycle to stop and start the counter. On the first TC after application of the triggering gate edge, the counter will be reloaded from the Hold register. On the second TC, the counter will be reloaded from the Load register and counting will stop until a new edge is issued to the counter. Note that unlike Mode K, new gate edges must be altered every second TC to continue counting.

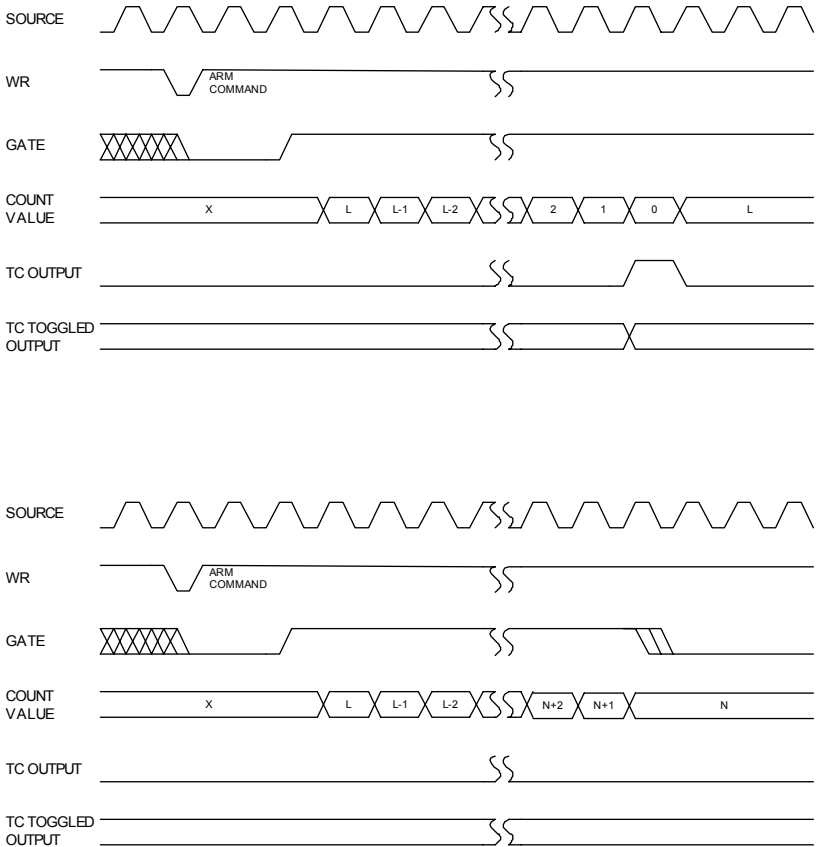


Mode L Waveforms

D.14 Mode O Waveforms

Hardware-Triggered Strobe with Edge Disarm

Mode O, shown in Figure O, is identical to Mode C except that the counter will be disarmed while an inactive-going gate edge is applied to the counter. And the counter will hold the count value until it is issued a LOAD command or REST command.

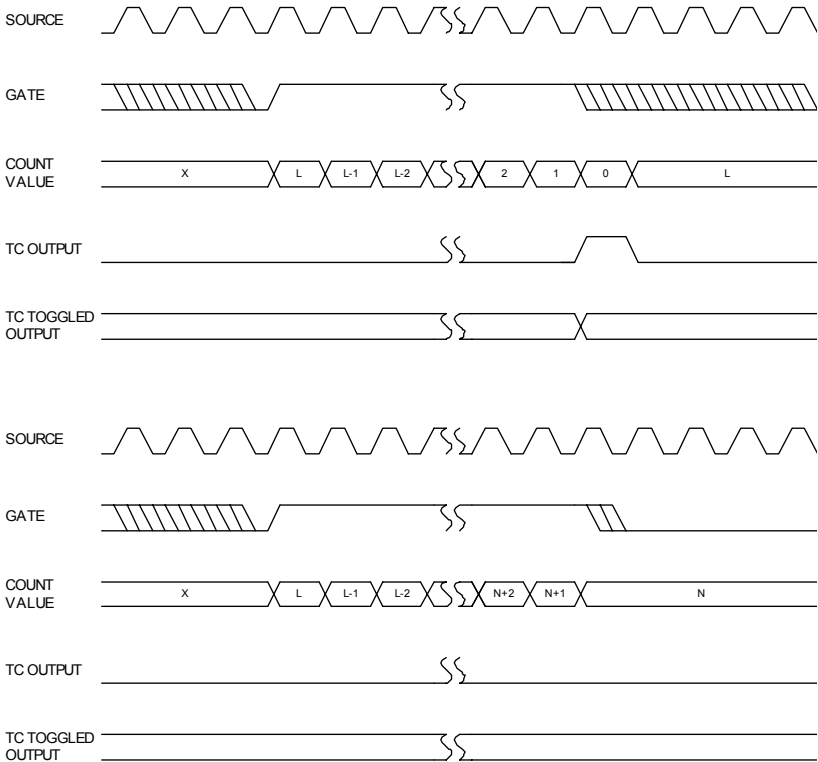


Mode O Waveforms

D.15 Mode R Waveforms

Non-Retriggerable One-Shot with Edge Disarm

Mode R is identical to Mode F except that the counter will be disarmed while an inactive-going gate edge is applied to the counter. The counter will hold the count value until it is issued a LOAD command or REST command.

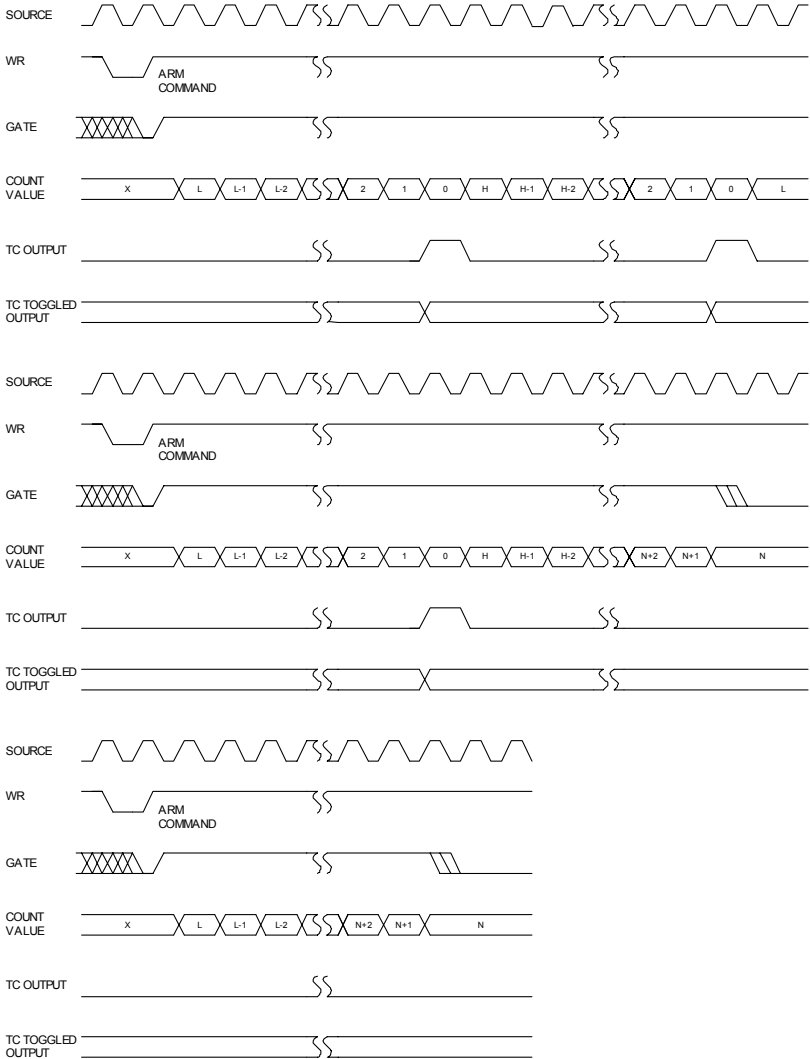


Mode R Waveforms

D.16 Mode U Waveforms

Hardware-Triggered Delayed Pulse Strobe with Edge Disarm

Mode U is identical to Mode I except that the counter will be disarmed while the gate and inactive-going gate edge is applied to the counter. The counter will hold the count value until it is issued a LOAD command or REST command.

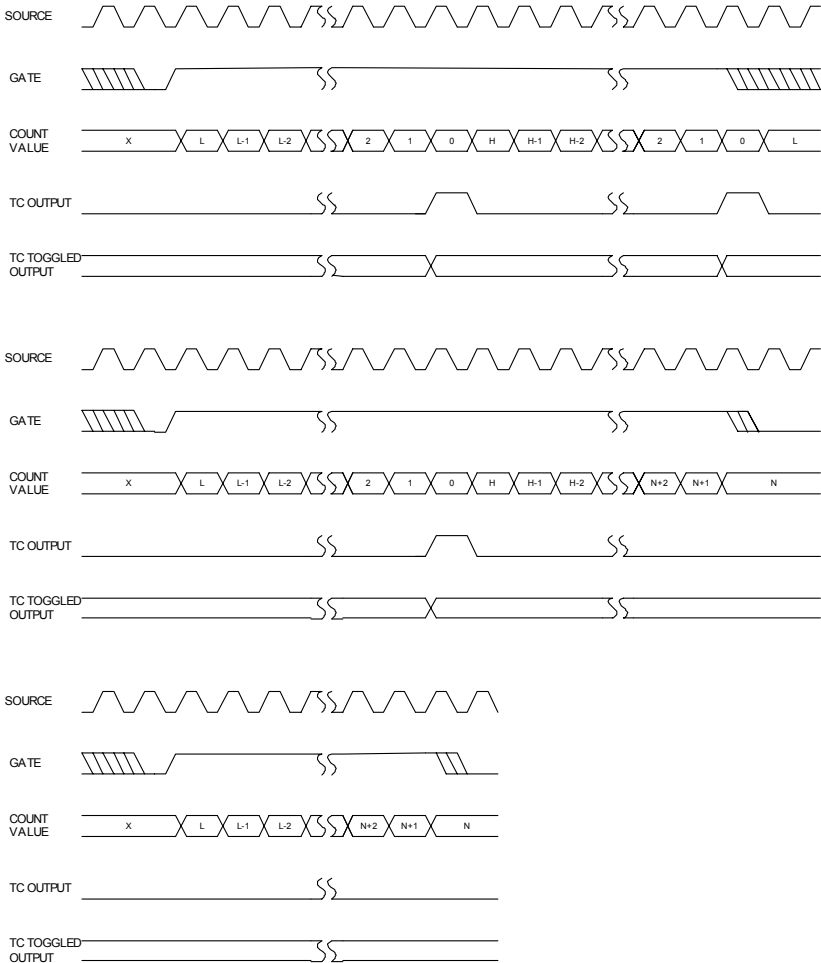


Mode U Waveforms

D.17 Mode X Waveforms

Hardware-Triggered Delayed Pulse One-Shot with Edge Disarm

Mode X is identical to Mode L except that the counter will be disarmed while an inactive-going gate edge is applied to the counter. The counter will hold the count value until it is issued a LOAD command or REST command.



Mode X Waveforms