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PCIP-CNTR

USER'S GUIDE

PCIP-CNTR User's Guide

Revision C - October 1996
Part Number: 74190

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Preface

This manual is designed for users responsible for setting up, installing, and using the PCIP-CNTR board.

The information in this manual assumes that you are familiar with your computer and its operation and that you are familiar with data acquisition principles.

This manual is organized as follows:

- Chapter 1 provides an introduction to the features of the PCIP-CNTR board, supported software, and accessories.
- Chapter 2 describes how to unpack and inspect the board, set the base address, install the board, and connect signals to the board.
- Chapter 3 provides a functional description of the board.
- Chapter 4 describes how to calibrate the board.
- Chapter 5 describes how to troubleshoot the board and how to return the board should it be necessary.
- Chapter 6 describes the register map for the board.
- Appendix A lists the specifications for the board.
- Appendix B describes the built-in transfer functions and resolutions available on the board.
- An index completes this manual.

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1

Introduction

The PCIP-CNTR is a two channel, 8-digit, universal counter board that plugs directly into any I/O slot of an IBM® PC/XT™ or PC AT®compatible computer. The PCIP-CNTR is available in two versions:

- The standard PCIP-CNTR provides .01% (100 PPM) accuracy and is targeted towards low to middle accuracy applications.
- The PCIP-CNTR/TCXO is available for users who require 1 PPM accuracy.

Unless a feature applies to a particular board, the name PCIP-CNTR is used to refer to both the standard PCIP-CNTR and PCIP-CNTR/TCXO boards.

This chapter describes the following aspects of the board:

- Major features
- Supported software
- Available accessories

Features

The major features of the PCIP-CNTR board are as follows:

- Operates up to 80 MHz on each channel
- Measures frequency on Channel A, Channel B, or the ratio of Channels A and B
- Measures the average period on Channel A, Channel B, or the ratio of Channels A and B

- Measures a single period on Channel A or Channel B
- Measures the pulse width on Channel A
- Measures counts on Channel A, on Channel A gated by Channel B, or on Channel A started and stopped by Channel B
- Plugs directly into any IBM PC/XT, IBM AT, or compatible computer; no IEEE-488 or GPIB interface is required
- Supports a wide variety of input configurations
- Operates in two modes:
  - As a standard bench instrument - In this mode, the board functions like a standard bench-top instrument, except that the readings are displayed on the computer screen, not on LEDs or LCDs, and the operating mode, channel selected, trigger level, and so on, are selected using the keyboard or mouse.
  - Under program control - This mode allows you to write programs that control the board directly, which is useful when using the board in automated tests or experiments.
- Provides BNC plugs for all connections to Channels A and B on the board.
- Provides a 9-pin "D" connector to connect all other signals, such as an external clock.

Supported Software

The PCIP-CNTR OCX software provided for the PCIP-CNTR board is a 32-bit ActiveX custom control for developing Windows™ 95 and Windows NT applications. The PCIP-CNTR OCX supports application development in C/C++, Visual Basic™, and Delphi. This software package is described in a separate manual, shipped with the software.

Note: For those users who have purchased previous versions of the PCIP-CNTR board, this revision of the board contains all the features of the previous versions of the board while providing a greater operating range for Channel B (0 MHz to 80 MHz). DOS software provided with previous versions will work with the new revision of the PCIP-CNTR board. However, to take advantage of the new features, you must use the PCIP-CNTR OCX software.

Accessories

The following accessories are optional for the PCIP-CNTR board:

- **C-BMM-5** cable - 5-foot BNC-to-BNC cable.
- **C-BMM-15** cable - 15-foot BNC-to-BNC cable.
- **SMC-9** connector - 9-pin, male solder cup connector.

2

Setup and Installation

This chapter describes how to set up and install the PCIP-CNTR board. The following procedures are provided:

- Unpacking and inspecting
- Setting the base address
- Installing the board
- Connecting signals

Unpacking and Inspecting the Board

After you remove the wrapped board from its outer shipping carton, proceed as follows:

1. Your board is packaged at the factory in an anti-static wrapper that must not be removed until you have discharged any static electricity by either of the following methods:
   - If you are equipped with a grounded wrist strap, you discharge static electricity as soon as you hold the wrapped board.
   - If you are not equipped with a grounded wrist strap, discharge static electricity by holding the wrapped board in one hand while placing your other hand firmly on a metal portion of the computer chassis (your computer must be turned off but grounded).
2. Carefully unwrap your board from its anti-static wrapping material. (You may wish to store the wrapping material for future use.)
3. Inspect the board for signs of damage. If damage is apparent, arrange to return the board to the factory (see page 5-5).

4. Check the remaining contents of your package against the packing list to be sure your order is complete. Report any missing items, immediately.
5. When you are satisfied with the inspection, proceed with setting the base address.

Note: The PCIP-CNTR board is factory calibrated; it requires no further adjustment prior to installation. If at a later time you decide to recalibrate the board, refer to page 4-1 for instructions.

Setting the Base Address

The PCIP-CNTR uses a block of 16 non-overlapping I/O addresses. A DIP switch on the board selects where in the computer's I/O space the board resides.

The PCIP-CNTR has a default base address setting of 320h; this address is typically free in most computers. However, no two boards can use the same I/O addresses or base address. If you are using more than one instrument, you must assign each a unique base address. Base addresses range from 100h to 3FFh (512 to 1023 decimal).

The base address switch is a six-position, DIP switch located in the lower right-hand corner of the board. To specify a base address, move the individual switches to the ON or OFF position. Figure 2-1 shows the address values corresponding to each of the six switches.

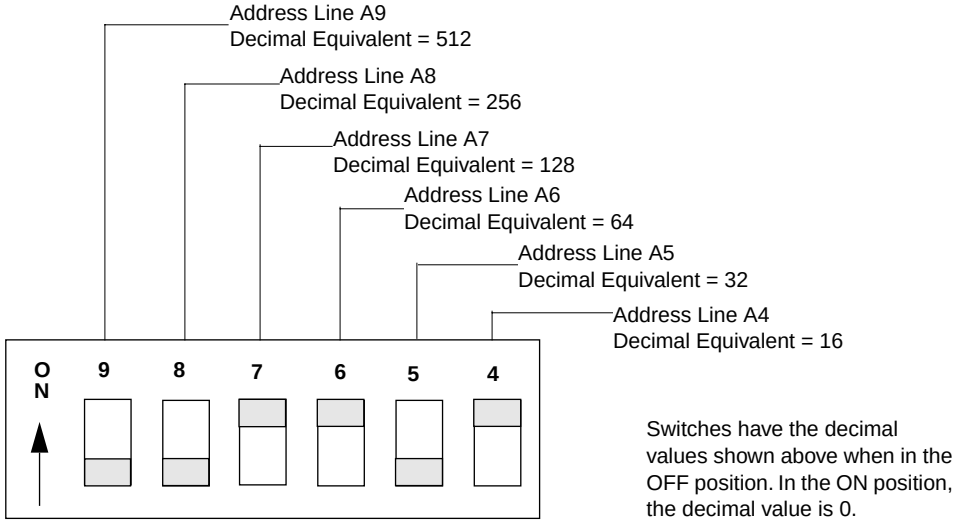


Figure 2-1. The Base Address Switch (Default Base Address of 320h Shown)

Installing the Board

This section provides general instructions for installing the PCIP-CNTR board. For more detailed information on installing peripheral boards, consult the documentation provided with your computer.

Caution: Do not insert or remove any peripheral board with the computer power on. This could cause damage to your computer.

Use the following steps to install the PCIP-CNTR board in an accessory slot of your computer:

1. Turn off power to the computer and all attached equipment.
2. Remove the computer chassis cover.
3. Select an unoccupied accessory slot, and remove the corresponding blank plate from the I/O connector panel.
4. Make sure the setting of the base address switch is correct for your board.
5. Insert and secure the board in the selected slot.
6. Replace the computer cover.
7. Turn on power to the computer.

You are now ready to connect signals to the board, as described in the following section.

Connecting Signals

BNC plugs are provided to connect signals to Channels A and B on the PCIP-CNTR board. A 9-pin "D" connector provides connections for all other signals (such as an external clock). Figure 2-2 shows the location of the BNC and 9-pin connectors. Figure 2-3 shows the pin assignments of the 9-pin connector.

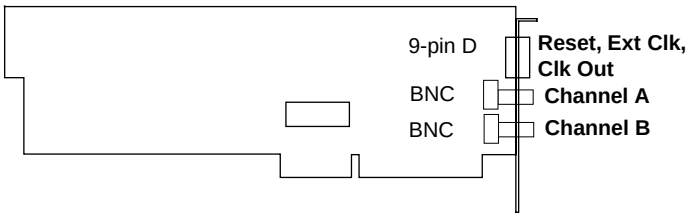


Figure 2-2. The Board I/O Connectors

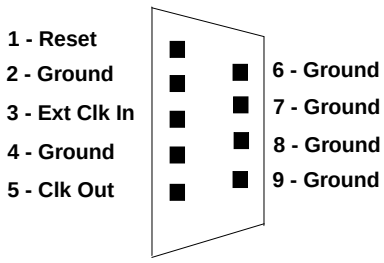


Figure 2-3. Pin Assignments of the 9-Pin "D" Connector

3

Functional Description

This chapter describes the functionality of the PCIP-CNTR board. Many users of the PCIP-CNTR will not need to refer to this chapter. However, in certain circumstances it may be important to know the technical details of the board's operation. This chapter describes the following:

- Summary of operating modes
- Configurable channel settings
- Frequency measurements
- Average period measurements
- Single period measurements
- Pulse width measurements
- Event counting measurements

Summary of Operating Modes

Table 3-1 summarizes the operating modes supported by the PCIP-CNTR board.

Table 3-1. Operating Mode Summary

Operating Mode	Range	Method	Timebase Range
Frequency A	0.1 Hz to 80 MHz	Synchronized input, multiple period, averaging	13 ms to 107 s
Frequency B	0.1 Hz to 80 MHz	Synchronized input, multiple period, averaging	13 ms to 107 s
Frequency A/B	Freq A = Freq B = 0 to 80 MHz	Frequency A as input with Frequency B as system clock	13 ms to 107 s
Frequency Test	–	The frequency test mode loops the 10 MHz reference oscillator back into an input channel to test overall board operation.	–
Average Period A	20 ns to 400 s	Reciprocal frequency measurement	13 ms to 107 s
Average Period B	100 ns to 400 s	Reciprocal frequency measurement	13 ms to 107 s
Average Period A/B	Period A = Period B = 100 ns to 400 s	Period A as input with Period B as system clock	13 ms to 107 s
Single Period A	400 ns to 400 s	Single period count of 100 ns system clock	–
Single Period B	400 ns to 400 s	Single period count of 100 ns system clock	–
Pulse Width A	100 ns to 400 s	Count of 100 ns system clock	–
Count A	1 to 999,999,999	Manual: Started and stopped by Start button/ command. Counting accumulates until a Reset occurs. External: Controlled by input B, either gated during the duration of the B pulse, or started and stopped by separate B pulses. Single count or accumulating count is also selectable.	Minimum pulse width: 250 ns Minimum time between pulses: 250 ns

Configurable Channel Settings

Independent of the operating mode selected, you can specify the following channel settings for the PCIP-CNTR board:

- **Coupling** - AC or DC coupling is provided for each channel.
- **Attenuation** - A divide-by-ten attenuator is provided. Installing the divide-by-ten attenuator changes the input range from a standard 300 mV to 5 V peak-to-peak range to a 3 V to 50 V peak-to-peak range.
- **Analog Input Filter** - For lower frequency applications, you can add a 50 kHz low pass filter to the analog front-end.
- **External or Internal Clock** - For most applications, the 10 MHz internal clock provided on the PCIP-CNTR board is acceptable. However, if you want to synchronize the PCIP-CNTR board to an external clock or use a more accurate external clock source than that provided, you can use an external clock with the PCIP-CNTR board.

Note: All PCIP-CNTR software assumes a 10 MHz system clock. If the external clock used does not use a 10 MHz timebase, then all frequency, period, and pulse width data must be scaled accordingly. However, the frequency ratio of A/B operation provides a pure ratio and works correctly without scaling.

Frequency Measurements

Four frequency measurements are supported by the PCIP-CNTR board:

- Frequency of Channel A
- Frequency of Channel B
- Board test
- Frequency Ratio of A/B

The PCIP-CNTR performs frequency measurement according to the following formula:

Frequency = (Number of cycles) / Time

Using software, you select the desired timebase for the frequency measurement according to the resolution required for the result. Note that the timebase selects the minimum time to sample. The counter always waits for the completion of the last cycle before calculating the frequency measurement (number of cycles per second).

Figure 3-1 shows the technique that is used for frequency as well as period measurements (described in the following section). The counting is gated by the input signal so that only completed input cycles are counted. This avoids a ±1 input cycle count error. The 10 MHz system clock is also counted during the gate time. The counting is continued until the end of an input cycle. This technique results in a measurement error of ±1 clock pulse (100 ns); the resolution of the measurement depends only on the measuring time. For example, the resolution for a 1 second measuring time is 0.1 PPM (100 ns/1 s) and is independent of frequency.

The frequency ratio A/B measurement is done in a similar manner. The difference is that Channel B is substituted for the 10 MHz system clock; the result is obtained by dividing the count from Channel A by the count from Channel B.

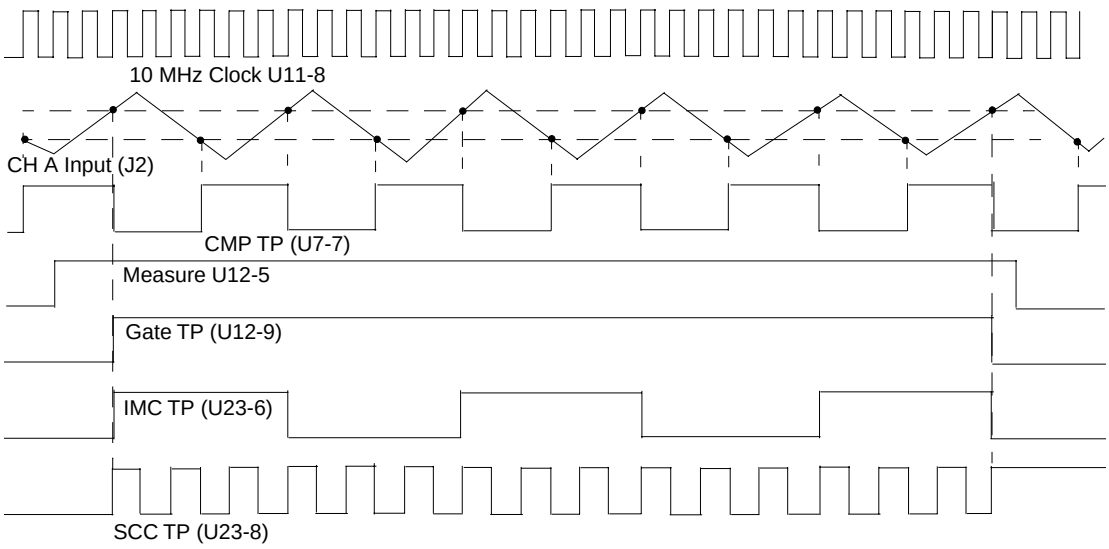


Figure 3-1. Frequency Measurement Timing Diagram

Average Period Measurements

The average period measurement provides the reciprocal of a frequency measurement. Thus, the PCIP-CNTR performs average period measurements according to this formula:

Period = Time / (Number of cycles)

The following average period measurements are supported:

- Period of Channel A
- Period of Channel B
- Board test

Refer to Figure 3-1 for more information.

Single Period Measurements

A single period measurement determines the period of a single cycle of the incoming waveform from either Channel A or Channel B. The PCIP-CNTR board can measure a single period having a minimum duration of 400 ns by counting 100 ns cycles of the system clock.

You can set the trigger polarity for a single period measurement as positive or negative. When the trigger polarity is positive, the period is measured between two consecutive rising edges. When the trigger polarity is negative, the period is measured between two consecutive falling edges.

Pulse Width Measurement

The PCIP-CNTR board can measure the pulse width of an incoming waveform from Channel A only. The pulse widths can be as long as 400 s, determined by counting 100 ns cycles of the system clock.

You can set the trigger polarity for a single period measurement as positive or negative. When the trigger polarity is positive, the pulse width is measured from rising edge to falling edge. When the trigger polarity is negative, the pulse width is measured from falling edge to rising edge.

Note: A pulse width measurement is different than single period measurement in that it measures the time between a rising and falling (or vice versa) edge. A single period measurement, in contrast, measures the time between consecutive rising or consecutive falling edges.

Event Counting Measurements

You can use the PCIP-CNTR board to count either single or accumulated events on Channel A, described as follows:

- **Single count operations** - The counter is reset at the start of each event. Each time the counter is triggered (by a trigger from Channel B or software control), the count is reset to zero.
- **Accumulated count operations** - The counter is not reset; each new count is added to the total count. The only way to reset the counter in accumulated count mode is by issuing a reset command.

You can perform event counting in the following configurations:

- **No external gating or triggering** - A software command enables the counter; the counts are accumulated until a stop or reset command is issued.
- **Channel A gated by Channel B** - This mode (sometimes called level triggering) allows the input of Channel A to be gated by the level of the input at Channel B. When the trigger polarity of the input at Channel B is positive, the counter is enabled when the input at Channel B is high and disabled when the input at Channel B is low. When the trigger polarity of the input at Channel B is negative, the counter is enabled when the input at Channel B is low and enabled when the input at Channel B is high.

Note: When controlling the gate with logic level signals, it is recommended that you use the following input configuration for Channel B: DC-coupled, x1 Attenuation, Filter Out, and 1.4 V trigger level.

- **Channel A started and stopped by Channel B** - This mode (sometimes called edge triggering) allows counting to be started by an edge from the input at Channel B. Counting is stopped by the next valid edge of the input at Channel B. Rising edges are counted when the trigger polarity of the input at Channel B is set to positive; falling edges are counted when the trigger polarity of the input at Channel B is set to negative.

4

Calibration

The standard PCIP-CNTR board requires no periodic calibration and contains no potentiometers. The accuracy of the board depends on the output frequency of the crystal oscillator.

The PCIP-CNTR/TXCO board can be calibrated. To perform this calibration, perform the following steps:

1. Input a known frequency from a high quality frequency standard.
2. Adjust the screw on the PCIP-CNTR/TXCO board for the correct frequency reading.

5

Troubleshooting

If your PCIP-CNTR board is not operating properly, use the information in this chapter to isolate the problem. If the problem appears serious enough to warrant technical support, refer to page 5-5 for information on how to contact an applications engineer.

Problem Isolation

If you encounter a problem with a PCIP-CNTR board, use the instructions in this section to isolate the cause of the problem before calling for technical support.

Identifying Symptoms and Possible Causes

Use the troubleshooting information in Table 5-1 to try to isolate the problem. Table 5-1 lists general symptoms and possible solutions for problems with PCIP-CNTR boards.

Table 5-1. Troubleshooting Information

Symptom	Possible Cause	Possible Solution
Board does not respond	Base address is incorrect or not consistent with what the software is addressing.	Check the base address switch setting on the board. If the base address is set correctly, make sure no other computer device is using any 16 of the I/O locations beginning at the specified base address. If necessary, reconfigure the base address. Refer to page 2-2 for instructions on setting the base address.
	The board is incorrectly aligned in the accessory slot.	Check the board for proper seating.
	The board is damaged.	Contact Keithley MetraByte for technical support; see page 5-5.
Intermittent operation	The most common cause of this problem is that the I/O bus speed is in excess of 8 MHz.	Reduce I/O bus speed to a maximum of 8 MHz (to change the I/O bus speed, run BIOS setup). See your computer documentation for instructions on running BIOS setup.
	Vibrations or loose connections exist.	Cushion source of vibration and tighten connections.
	The board is overheating.	Check environmental and ambient temperature. See the documentation for your computer.
	Electrical noise exists.	Provide better shielding or reroute unshielded wiring.
Data appears to be invalid	The most common cause of this problem is that the I/O bus speed is in excess of 8 MHz.	Reduce I/O bus speed to a maximum of 8 MHz (to change the I/O bus speed, run BIOS setup). See the documentation for your computer for instructions on running BIOS setup.
	An open connection exists.	Check wiring.
	Another system resource is using the specified base address.	Reconfigure the base address of the PCIP-CNTR board; refer to page 2-2 for more information. Check the I/O assignments of other system resources and reconfigure, if necessary.

Table 5-1. Troubleshooting Information (cont.)

Symptom	Possible Cause	Possible Solution
Computer does not boot.	Board not seated properly.	Check the installation of the board.
	The base address setting of the PCIP-CNTR board conflicts with that of another system resource.	Check the base address settings of your system resources; each address must be unique.
	The power supply of the host computer is too small to handle all the system resources.	Check the needs of all system resources and obtain a larger power supply.
System lockup	A timing error occurred.	Press **Ctrl + Break**.

If your board is not operating properly after using the information in Table 5-1, continue with the next two sections to further isolate the problem.

Testing the Board and Host Computer

To isolate the problem to the PCIP-CNTR board or to the host computer, use the following steps:

Caution: Removing a board with the power ON can cause damage to your board and/or computer.

---

1. Turn the power to the host computer off, and remove power connections to the computer.
2. While keeping connections to accessories intact, unplug the cables to the PCIP-CNTR board.
3. Remove the board from the computer and visually check for damage. If a board is obviously damaged, refer to page 5-5 for information on returning the board.
4. With the PCIP-CNTR board out of the computer, check the computer for proper operation. Power up the computer and perform any necessary diagnostics.

At this point, if you have another PCIP-CNTR board that you know is functional, you can test the slot and I/O connections using the instructions in the next section. If you do not have another board, refer to the instructions on page 5-5 before calling Keithley MetraByte for technical support.

Testing the Accessory Slot and I/O Connections

When you are sure that the computer is operating properly, test the computer accessory slot and I/O connections using another PCIP-CNTR board that you know is functional. To test the computer accessory slot and the I/O connections, follow these steps:

1. Remove computer power again and install a PCIP-CNTR board that you know is functional. Do not make any I/O connections.
2. Turn computer power on and check operation with the functional board in place. This test checks the computer accessory slot. If you were using more than one board when the problem occurred, use the functional board to test the other slot, as well.
3. If the accessory slots are functional, use the functional board to check the I/O connections. Reconnect and check the operation of the I/O connections, one at a time.
4. If operation fails for an I/O connection, check the individual inputs one at a time for shorts and opens.
5. If operation remains normal to this point, the problem is in the PCIP-CNTR board(s) originally in the computer. If you were using more than one board, try each board one at a time in the computer to determine which is faulty.
6. If you cannot isolate the problem, refer to the next section for instructions on obtaining assistance.

Technical Support

Before returning any equipment for repair, call Keithley MetraByte for technical support at:

(508) 880-3000

Monday - Friday, 8:00 A.M. - 6:00 P.M., Eastern Time

An applications engineer will help you diagnose and resolve your problem over the telephone. Please make sure that you have the following information available before you call:

PCIP-CNTR Board Configuration	Model	_____
	Serial #	_____
	Revision code	_____
	Base address setting	_____
Computer	Manufacturer	_____
	CPU type	_____
	Clock speed (MHz)	_____
	KB of RAM	_____
	Video system	_____
	BIOS type	_____
Operating System	DOS version	_____
	Windows version	_____
Software Package	Name	_____
	Serial #	_____
	Version	_____
	Invoice/Order #	_____

Compiler (if applicable)	Language	_____
	Manufacturer	_____
	Version	_____
		___
Accessories	Type	_____
	Type	_____
	Type	_____
	Type	_____
		____

If a telephone resolution is not possible, the applications engineer will issue you a Return Material Authorization (RMA) number and ask you to return the equipment. Include the RMA number with any documentation regarding the equipment.

When returning equipment for repair, include the following information:

- Your name, address, and telephone number.
- The invoice or order number and date of equipment purchase.
- A description of the problem or its symptoms.
- The RMA number on the **outside** of the package.

Repackage the equipment, using the original anti-static wrapping, if possible, and handling it with ground protection. Ship the equipment to:

ATTN: RMA #_____
Repair Department
Keithley MetraByte
440 Myles Standish Boulevard
Taunton, Massachusetts 02780

Telephone (508) 880-3000
FAX 508/824-5517

Notes: If you are submitting your equipment for repair under warranty, you must include the invoice number and date of purchase.

To enable Keithley MetraByte to respond as quickly as possible, you must include the RMA number on the outside of the package.

6

Register Map

For those who require more specific control over the PCIP-CNTR than their software provides, this chapter describes the register map of the PCIP-CNTR board. The sections of this chapter are as follows:

- Register map summary
- Measurement Count Out register
- Time Count Out register
- Mode Selection register
- Input Configuration register
- Channel A: DC-Coupled Trigger Level register
- Channel B: DC-Coupled Trigger Level register
- Timer Control register
- Status register
- Channel B Divide register

Register Map Summary

Table 6-1 summarizes the register map of the PCIP-CNTR board.

Table 6-1. Register Summary

Location	Register	Read/Write Type
Base Address + 0	Measurement Count Out - Byte 0 (LSB)	Read
Base Address + 1	Measurement Count Out - Byte 1	Read
Base Address + 2	Measurement Count Out - Byte 2	Read
Base Address+ 3	Measurement Count Out - Byte 3 (MSB)	Read
Base Address + 4	Time Count Out - Byte 0 (LSB)	Read
Base Address + 5	Time Count Out - Byte 1	Read
Base Address + 6	Time Count Out - Byte 2	Read
Base Address + 7	Time Count Out - Byte 3 (MSB)	Read
Base Address + 8	Mode Selection	Write
Base Address + 9	Input Configuration	Write
Base Address + 10	Channel A: DC-Coupled Trigger Level	Write
Base Address + 11	Channel B: DC-Coupled Trigger Level	Write
Base Address + 12	Timer Control	Write
Base Address + 13	Status	Read
Base Address + 14	Channel B Divide	Write

Measurement Count Out Register (Read Only)

Base Addresses +0 through +3 correspond to the Measurement Count Out register. This register contains the number of cycles of the input that was counted during the synchronized gate period.

Byte 0 (Base Address +0) contains the eight lowest-order bits of the 28-bit (8-digit) output. Reading this byte causes both the measurement count and the time count to be latched into their respective output registers. Therefore, this byte must be the first byte read.

Byte 1 (Base Address +1) contains the second eight low-order bits of the 28-bit (8-digit) output.

Byte 2 (Base Address +2) contains the third eight bits of the 28-bit (8-digit) output.

Byte 3 (Base Address +3) contains the four highest-order bits of the 28-bit (8-digit) output. The four bits are right justified and zero-filled.

Time Count Out Register (Read Only)

Base Addresses +4 through +7 correspond to the Time Count Out register. The Time Count Out register contains the number of cycles of one of the following signals, depending on the configuration:

- the 10 MHz system clock that was counted during the synchronized gate period
- the external clock if set in external mode, or
- Channel B if set in A:B mode.

Byte 0 (Base Address +4) contains the eight lowest-order bits of the 31-bit output.

Byte 1 (Base Address +5) contains the second eight low-order bits of the 31-bit output.

Byte 2 (Base Address +6) contains the third eight bits of the 31-bit output.

Byte 3 (Base Address +7) contains the seven highest-order bits of the 31-bit output. The leading bit is 0 because the result must be positive.

Mode Selection Register (Write Only)

Base Address +8 corresponds to the Mode Selection register. The values of bits 0 to 6 of this 8-bit register are described in Table 6-2.

Table 6-2. Bits 0 to 6 of the Mode Selection Register (Base Address +8)

Bit Values	Description
0001010	Frequency: Channel A or B
0101010	Frequency: Channel A/B
0001010	Period: Channel A or B[1]
0001001	Pulse Width: Channel A or B[2]
0001100	Count: Channel A or B
0000100	Count: A gated by B - Single
1000100	Count: A gated by B - Accumulating
0010100	Count: A started and stopped by B - Single
1010100	Count: A started and stopped by B - Accumulating

Notes

[1] For a single period measurement, a measurement count output not equal to 2 indicates an input pulse width of less than 400 ns, which is the minimum resolution of the PCIP-CNTR.

[2] For a repetitive signal, a measurement count output not equal to 2 indicates an input pulse width of less than 100 ns, which is the minimum resolution of the PCIP-CNTR.

The values for bit 7 of this register are defined as follows:

- 0 = Internal
- 1 = External

Input Configuration Register (Write Only)

Base Address +9 corresponds to the input configuration register. Bits 0 to 7 of this 8-bit register are defined in Table 6-3.

Table 6-3. Bits 0 to 7 of the Input Configuration Register (Base Address +9)

Bit	Description	Values
0	Input Coupling - Channel A	0 = DC 1 = AC
1	Input Attenuation - Channel A	0 = x1 1 = x10
2	50 kHz Input Filter - Channel A	0 = Out 1 = In
3	Polarity - Channel A or B (depending on mode selection)	0 = Negative 1 = Positive
4	Input Coupling - Channel B	0 = DC 1 = AC
5	Input Attenuation - Channel B	0 = x1 1 = x10
6	50 kHz Input Filter - Channel B	0 = Out 1 = In
7	Polarity - Channel B (when used as a gate for counting)	0 = Negative 1 = Positive

Channel A: DC-Coupled Trigger Level Register (Write Only)

Base Address +10 corresponds to the Channel A: DC-Coupled Trigger Level register. This register loads the 8-bit DAC data for the Channel A, DC-coupled trigger level. The DAC provides a 256-step trim resolution covering –2.5 V to +2.5 V.

Channel B: DC-Coupled Trigger Level Register (Write Only)

Base Address +11 corresponds to the Channel B: DC-Coupled Trigger Level register. This register loads the 8-bit DAC data for the Channel B, DC-coupled trigger level. The DAC provides a 256-step trim resolution covering –2.5 V to +2.5 V.

Timer Control Register (Write Only Register)

Base Address +12 corresponds to the Timer Control register. The bits of this register are defined in Table 6-4.

Table 6-4. Bits 0 to 7 the Timer Control Register (Base Address +12)

Bits	Description	Values
0 to 1	Use of 10 MHz clock	00 = 10 MHz test mode 01 = Channel A divided by 1 (up to 10 MHz) 10 = Channel A divided by 8 (10 MHz to 80 MHz) 11 = Channel B[1]
2 to 6	Timer data for frequency and period measurements	Interval = $2^{n-1}/10^7$, where n = 2 to 31 For example, bits 10010 = 0.0131072 s interval bits 10101 = 0.1048576 s interval bits 11001 = 1.6777216 s interval bits 11100 = 13.4217728 s interval
7	Start/stop measurement	1 = Start; set by the computer's bus to start a measurement 0 = Stop; reset by the board when the measurement is done; additionally, can be reset through the computer's bus to stop a measurement in progress[2]

Notes

[1] The 1-bit Channel B Divide register (Base Address + 14) determines whether Channel B is divided by 1 (the power-up default) or divided by 8.

[2] If a previous measurement is already in progress (bit 1 of the Status register is 0), you must stop that measurement (set bit 7 to 0) before a new measurement can be started (set bit 7 to 1).

Status Register (Read Only)

Base Address +13 corresponds to the Status register. The values of this register are described in Table 6-5.

Table 6-5. Bits 0 to 7 of the Status Register (Base Address +13)

Bit	Description	Values
0	Measurement in Progress	This bit is set to 1 by the board when the measurement is started and reset to 0 by the board when the measurement is completed.
1	Measurement Completed	This bit is set to 1 by the board once the measurement is completed and reset to 0 by the board at the start of a new measurement cycle.
2	Input Measurement Counter Overflow	This bit is set to 1 by the board if the 32-bit counter overflows and is reset to 0 by the board at the start of a new measurement cycle.
3	System Clock Counter Overflow	This bit is set to 1 by the board if the 32-bit counter overflows and is reset to 0 by the board at the start of a new measurement cycle.
4	Gate Status (Channel B)	This bit reflects the level of Channel B when in the "Count A gated by B" mode. When B is at a TTL high, a "1" indicates that A is gated "On."
5	Reset Request	This bit is set to 1 by the board when the –RESET input is low. The reset is particularly useful for clearing a Count.
6	Triggering	This bit is set to 1 when you have properly set the trigger level.
7	Trigger Level	This bit is set to 1 when the trigger level is set too high. This bit is valid when bit 6 is reset.

Channel B Divide Register (Write Only)

Base Address +14 corresponds to the Channel B Divide register. Only the least significant bit of this register is used. At power-up, this bit is cleared and the input to Channel B is used directly for all operations (divided by 1); the input frequency ranges from 0 to 10 MHz.

Setting the least significant bit causes the input frequency of Channel B to be divided by 8 (10 MHz to 80 MHz range).

A

Specifications

This appendix lists the specifications for the PCIP-CNTR board.

Table A-1. PCIP-CNTR Specifications

Feature	Specification
Number of Channels	2
Input Modes	Frequency of Channel A Frequency of Channel B Frequency Ratio of Channels A/B Period of Channel A Period of Channel B Average Period of Channel A Average Period of Channel B Pulse Width of Channel A Totalizer/Event Counter: Channel A, Channel B, Channel A started/stopped by Channel B, Channel A gated by Channel B
Counter Digits	8
Frequency Range of each Channel	0 to 80 MHz
Pulse Width Range	100 ns to 400 s
Maximum Event Counting Frequency	2 MHz
Input Impedance	1 MΩ/18 pF
Inputs	AC or DC
Triggering	+ or – Edge
Sensitivity (Channel A)	AC coupled: 160 mV_{rms} (450 mV_{pp}) sine wave (50 Hz to 80 MHz) DC coupled: 160 mV_{rms} (450 mV_{pp}) sine wave (0 Hz to 80 MHz)

Table A-1. PCIP-CNTR Specifications (cont.)

Feature	Specification
Sensitivity (Channel B)	AC coupled: 160 mV_{rms} (450 mV_{pp}) sine wave (50 Hz to 80 MHz) DC coupled: 160 mV_{rms} (450 mV_{pp}) sine wave (0 Hz to 80 MHz)
Input Range	450 mV_{pp} to 5 V_{pp} 4.5 V_{pp} to 50 V_{pp}
Attenuator	x10
Trigger Thresholds	AC coupled: 100 mV Hysteresis DC coupled: ±2.5 V set with an 8-bit DAC ±25 V set with an 8-bit DAC
Accuracy	Standard PCIP-CNTR board: 0.01% (100 PPM), 0 to 70°C PCIP-CNTR/TCXO board: 1.0 PPM, 0 to 70°C, (1 PPM/year after 30 days)
Clock Selection	Internal or External
Noise Filter	Switchable 50 kHz low-pass filter on Channels A and B
Maximum Input Voltage	Channel A and Channel B: 100 Vdc Reset: –10 Vdc to +15 Vdc Clock In: 25 V_{rms}
External Clock Input	Frequency: 10 MHz Sensitivity: 500 mV_{rms} Input Impedance: Approximately 2 kΩ Coupling: AC
Reset Input	Input Levels: TTL Reset Active: Less than 0.8 V (internal 10 kΩ pull-up disables Reset when not connected) Minimum Pulse: 100 ns
Clock Output	Frequency: 10 MHz Output Level: TTL Output Impedance: 150 Ω Coupling: DC Protection: Short-circuit proof
Power Requirement	+5 V Supply: 420 mA typical –12 V Supply: 42 mA typical
I/O Connections	BNC: Channel A, Channel B 9-Pin D connector: Reset, Clock Output, External Clock Input

B

Built-in Transfer Functions and Available Resolutions

This appendix describes the built-in transfer functions used by and resolutions available with the PCIP-CNTR board.

Transfer Functions

The following transfer function is used by the PCIP-CNTR for frequency measurements:

Frequency = (Measurement Count –1) / ((Time Count –1) x 10^7 s)

The following transfer function is used by the PCIP-CNTR for period measurements:

Period = ((Time Count –1) x 10^7 s) / (Measurement Count – 1)

The following transfer function is used by the PCIP-CNTR for pulse width measurements:

Pulse Width = (Time Count –1) x 10^7 s

Available Resolutions

Table B-1 demonstrates the resolution that can be obtained with various combinations of prescaler and interval selections for frequency and period measurements.

Table B-1. Scaling Selections for Frequency and Period Measurements

Maximum Input Frequency	Prescale Divider	Interval (s)	Resolution (Digits)
12 MHz	None	0.0131072	6
		0.2097152	7
		1.6777216	8
80 MHz	8	0.0131072	6
		0.2097152	7
		1.6777216	8

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