# PCI-QUAD04

Four-channel Quadrature encoder input
Two 24-bit LS726 interface chips

# User's Guide



**MEASUREMENT COMPUTING**™
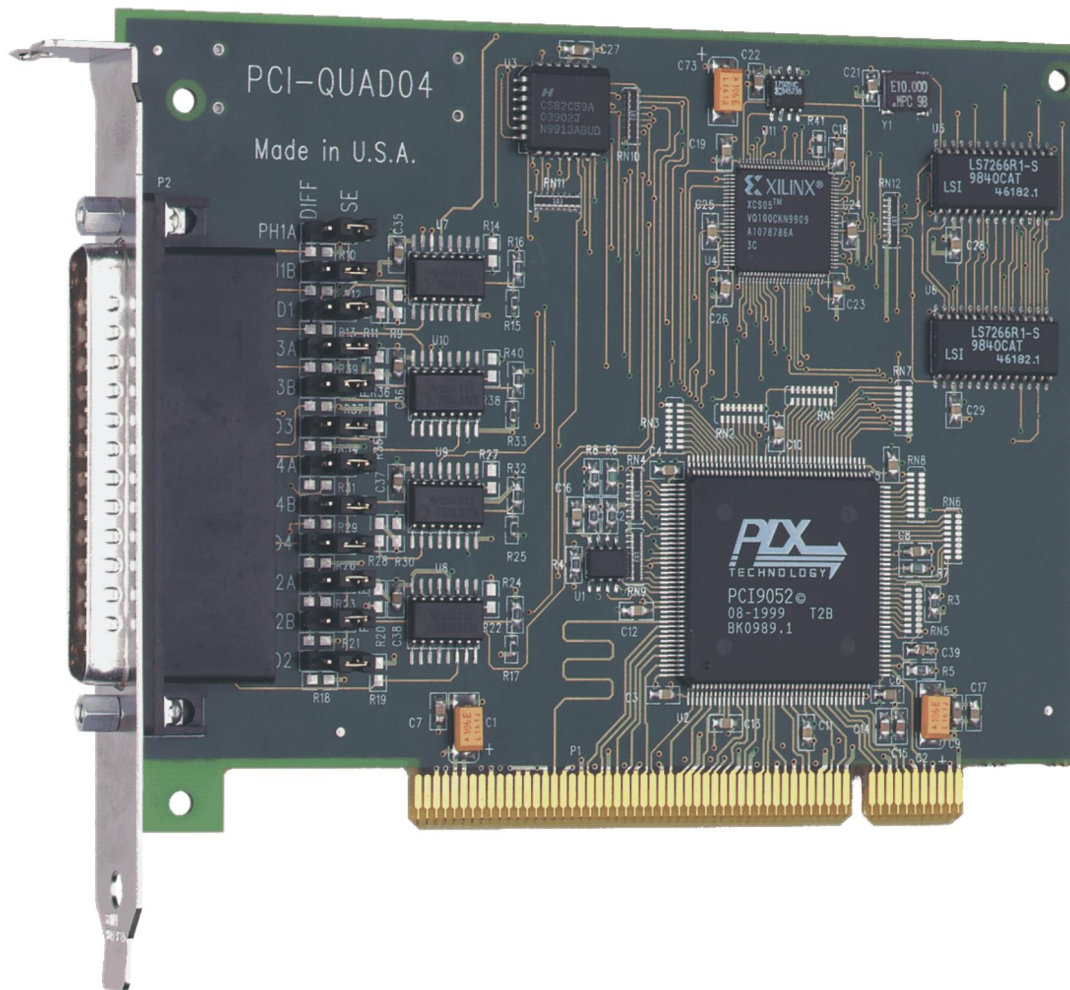
# PCI-QUAD04

## Four-Channel Quadrature Encoder Input Board

## User's Guide

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# Table of Contents

# About this User's Guide

## What you will learn from this user's guide

This user's guide explains how to install, configure and use the PCI-QUAD04 quadrature encoder board.

This user's guide also refers you to related documents available on our web site and to technical support resources.

## Conventions in this user's guide

> **For more information on …**
> Text presented in a box signifies additional information and helpful hints related to the subject matter you are reading.

**Caution!**  Shaded caution statements present information to help you avoid injuring yourself and others, damaging your hardware, or losing your data.

<#:#>    Angle brackets that enclose numbers separated by a colon signify a range of numbers, such as those assigned to registers, bit settings, etc.

**bold** text    **Bold** text is used for the names of objects on the screen, such as buttons, text boxes, and check boxes. For example:
1.  Insert the disk or CD and click the **OK** button.

*italic* text    *Italic* text is used for the names of manuals and help topic titles, and to emphasize a word or phrase. For example:
The *Insta*Cal installation procedure is explained in the *Quick Start Guide*.
*Never* touch the exposed pins or circuit connections on the board.

## Where to find more information

For additional information relevant to the operation of your hardware, refer to the *Documents* subdirectory where you installed the MCC DAQ software (C:\Program Files\Measurement Computing\DAQ by default), or search for your device on our website at www.mccdaq.com.

If you need to program at the register level in your application, refer to the *Register Map for the PCI-QUAD04*. This document is available on our web site at www.mccdaq.com/registermaps/RegMapPCI-QUAD04.pdf.

# Introducing the PCI-QUAD04

## Overview: PCI-QUAD04 features

The PCI-QUAD04 is a PCI plug-in board that provides inputs and decoding for up to four incremental quadrature encoders. The PCI-QUAD04 can also be used as a high speed pulse counter for general counting applications.

Incremental quadrature encoders are used to provide feedback signals from motors, that is, to count rotations and convert the physical movement into a series of electrical signals. These signals are sent to the computer which then decides whether or not to trigger signals that control the motor's movement and what those control signals should be. The PCI-QUAD04 is the link between up to four incremental quadrature encoders and the computer.

The PCI-QUAD04 is a plug-in board for PC/XT/AT computers; it uses one PCI slot and a 37 pin D-type connector for up to four channels. Each incremental quadrature encoder connects to an input channel on the board through a DB37 female connector on the board's rear panel. Channels 1 through 4 connect to the DB37 connector on the rear panel bracket.

For each channel, the signals provided at the DB37 connectors are:

- Phase A+, A-
- Phase B+, B-
- Index ±
- +5VDC and GND (optional power for +5V encoders)

Pin out diagrams are shown on page 12.

The PCI-QUAD04 provides inputs for three basic signals, Phase A, Phase B, and Index. Phase A and Phase B are generated at a 90° phase shift with respect to each other. Using these signals, a computer can determine system position (counts), velocity, (counts per second), and direction of rotation.

The Index signal is used to establish an absolute reference position within one count of the encoder rotation (360°). Therefore, the Index signal is often used to reset or preset the position counter, particularly upon system startup when the incremental encoder cannot determine the starting position of the motor. The Index signal can also be used to generate an interrupt signal to the computer.

The Phase A, Phase B, and Index inputs are jumper-selectable for differential or single-ended input mode. These signals, after being routed through differential receivers, offer various paths to the LS7266 inputs through the FPGA. The inputs are register-programmable for the following:

- Individual incremental encoder inputs to allow up to four channels
- Cascadable counters to allow non-quadrature counting up to 96-bits
- Routing the Index input to either the Load Counter/Load Latch input or the Reset Counter/Gate input with quarter cycle and half cycle signals
- Routing the Compare or Carry/Borrow output signals to the 8259 Interrupt controller

The heart of the PCI-QUAD04 is the LSI Computer Systems, Inc., LS7266R1 24-bit Dual-Axis Quadrature Counter IC. This component contains:

- Two 24-bit counters with associated 24-bit preset and 24-bit output latch registers
- Integrated digital filtering with 8-bit counter prescalers
- Programmable index functionality and programmable count modes including non-quadrature modes

The PCI-QUAD04 can operate as a high-speed pulse and general purpose counter, cascadable to 96-bits. The 24-bit counters can count either in binary or BCD through register programming.

The PCI-QUAD04 also includes an 82C59 Programmable Interrupt Controller which accepts the four Index inputs directly and the Carry/Borrow outputs from the LS7266 (counter overflow/underflow or count value match) to generate interrupts to the PC bus. The interrupt controller operates in Polled Mode and allows for masking and priority setting of the interrupt inputs.

## PCI-QUAD04 block diagram

PCI-QUAD04 functions are illustrated in the block diagram shown here.
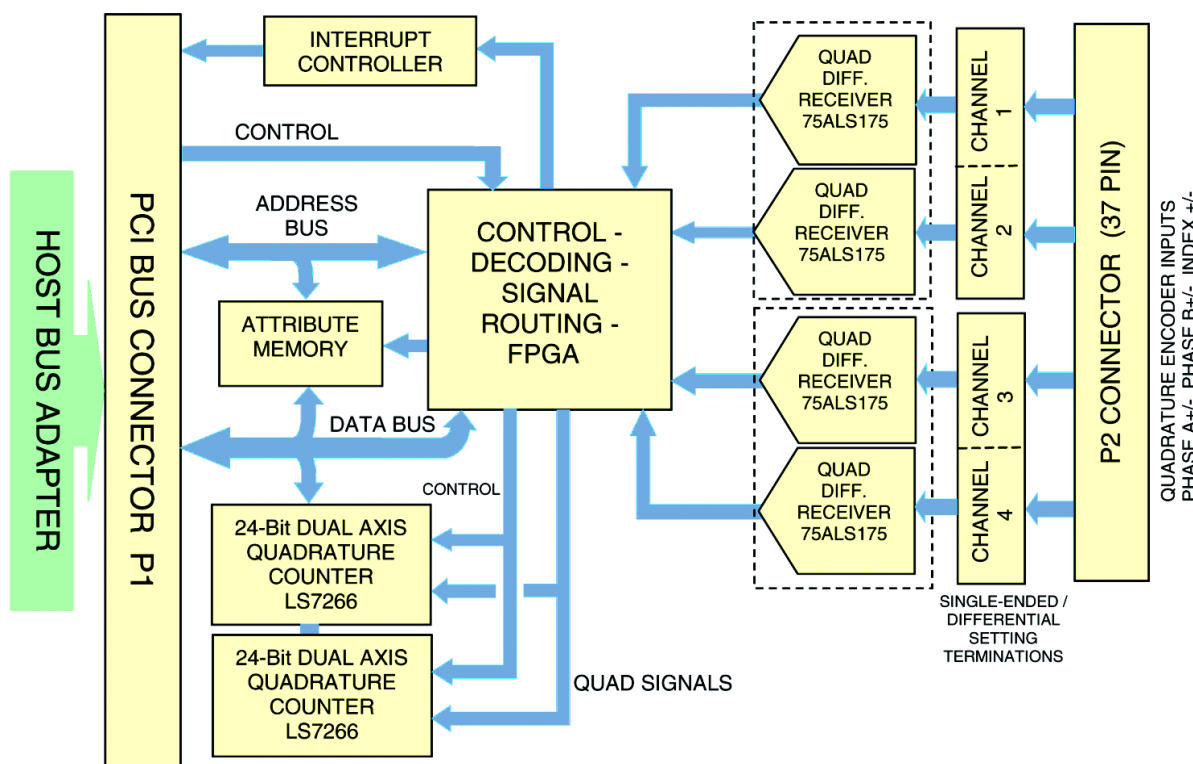


Figure 1. PCI-QUAD04 functional block diagram

## Software features

For information on the features of *Insta*Cal and the other software included with your PCI-QUAD04, refer to the *Quick Start Guide* that shipped with your device. The *Quick Start Guide* is also available in PDF at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf.

Check http://www.mccdaq.com/download.htm for the latest software version or versions of the software supported under less commonly used operating systems.

# Installing the PCI-QUAD04

## What comes with your PCI-QUAD04 shipment?

As you unpack your board, make sure each of the items shown below is included.

### Hardware

- PCI-QUAD04 board
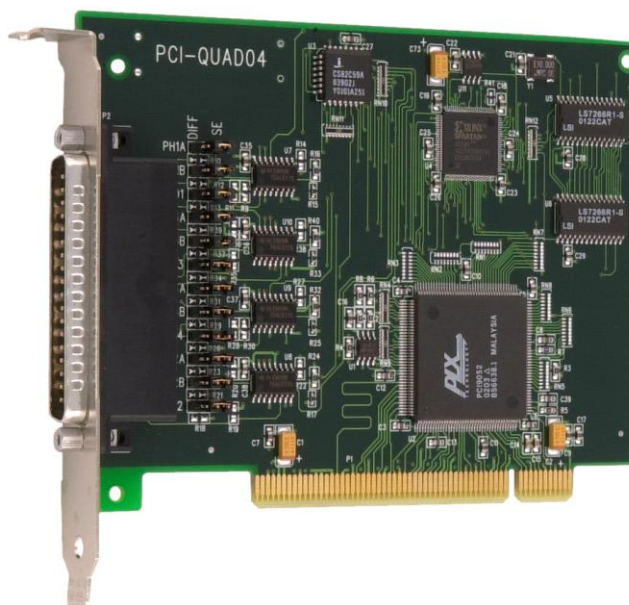


- C37F-4X9F-1M — One meter DB37F to 4 x DB9F cable



### Additional documentation

In addition to this hardware user's guide, you should also receive the *Quick Start Guide* (available in PDF at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf). This booklet supplies a brief description of the software you received with your PCI-QUAD04 and information regarding installation of that software. Please read this booklet completely before installing any software or hardware.

## Unpacking the PCI-QUAD04

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the PCI-QUAD04 from its packaging, ground yourself using a wrist strap or by simply touching the computer chassis or other grounded object to eliminate any stored static charge.

If any components are missing or damaged, notify Measurement Computing Corporation immediately by phone, fax, or e-mail:

- Phone: 508-946-5100 and follow the instructions for reaching Tech Support.
- Fax: 508-946-9500 to the attention of Tech Support
- Email: techsupport@mccdaq.com

## Installing the software

Refer to the *Quick Start Guide* for instructions on installing the software on the *Measurement Computing Data Acquisition Software CD*. This booklet is available in PDF at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf.

## Configuring the PCI-QUAD04

Before installing the board, configure the channel input mode for either single-ended or differential. You set the channel configuration with a set of jumper blocks on the board. Each jumper is labeled for its functionality. By default, the board is shipped with the channels configured for single-ended operation, with no termination resistors installed.

### Channel input mode

To configure for single-ended operation, place a jumper between pin 2 and pin 3 (labeled **SE**). To configure for differential operation, place a jumper between pin 1 (labeled **DIFF**) and pin 2. A single-ended configuration is shown in Figure 2.
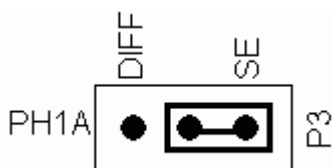


Figure 2. Channel input mode configured for SE operation

Input mode jumper settings are listed in the table below.

Channel input mode jumper settings

| Input | Input channel | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Phase A | P3 | P8 | P14 | P11 |
| Phase B | P4 | P7 | P13 | P10 |
| Index | P5 | P6 | P12 | P9 |

### Termination resistors

Although termination resistors typically are not required, SMT pads on the PCI-QUAD04 are open and labeled to allow you to install terminating resistors from the various inputs to ground.

Termination resistor settings

| Input | Channel | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| Phase A+ | R9 | R22 | R38 | R30 |
| Phase A- | R10 | R23 | R39 | R31 |
| Phase B+ | R11 | R20 | R36 | R28 |
| Phase B- | R12 | R21 | R37 | R29 |
| Index+ | R14 | R19 | R35 | R27 |
| Index- | R13 | R18 | R34 | R26 |

# Installing the PCI-QUAD04

After configuring the PCI-QUAD04, install the board in your computer. Follow the steps below.

---
**Install the MCC DAQ software before you install your board**

The driver needed to run your board is installed with the MCC DAQ software. Therefore, you need to install the MCC DAQ software before you install your board. Refer to the *Quick Start Guide* for instructions on installing the software.

---

1. Turn your computer off and open it up.

2. Close your computer and turn it on.

   If you are using an operating system with support for plug-and-play (such as Windows 2000 or Windows XP), a dialog box opens as the system loads, indicating that new hardware has been detected. If the information file for this board is not already loaded onto your PC, you are prompted for the disk containing this file. The *Measurement Computing Data Acquisition Software* CD supplied with your board contains this file. If required, insert the disk or CD and click **OK**.

3. To test your installation and configure your board, run the *Insta*Cal utility installed in the previous section. Refer to the *Quick Start Guide* that came with your board for information on how to initially set up and load *Insta*Cal.

# Connecting the board for I/O operations

### Connectors, cables – main I/O connector

The table below lists the board connectors, compatible cable, and compatible accessory products for the PCI-QUAD04.

Board connectors, cables, and accessory equipment

| I/O connector type | 37-pin connector |
|---|---|
| Compatible cable | C37F-4X9F-1M |

## Pin out – main I/O connector

Pin assignments of the 37-pin connector **P2** are shown in Figure 3.

**Important**
Be sure to correctly phase the encoder according to the manufacturer's instructions.

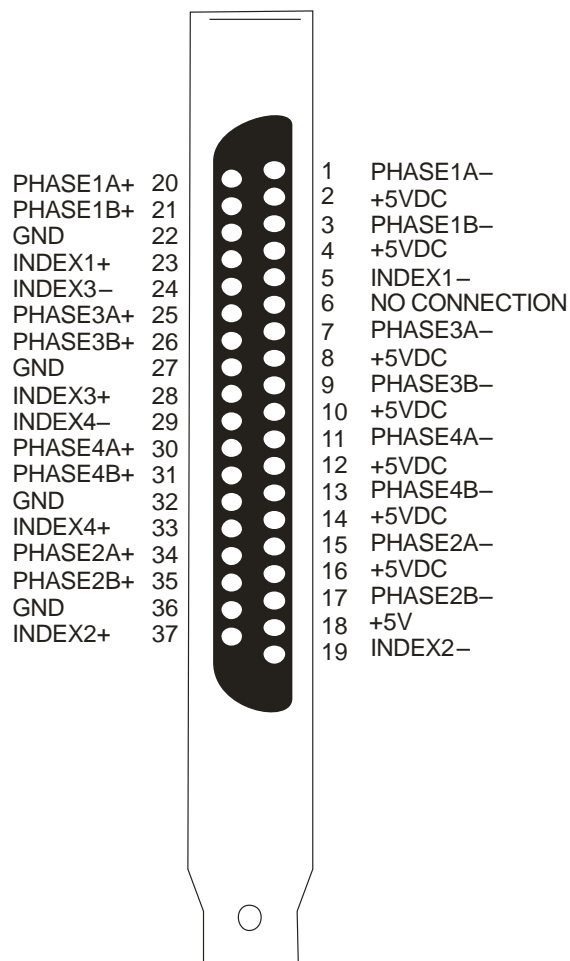| | | | | |
|---|---|---|---|---|
| PHASE1A+ | 20 | | 1 | PHASE1A− |
| PHASE1B+ | 21 | | 2 | +5VDC |
| GND | 22 | | 3 | PHASE1B− |
| INDEX1+ | 23 | | 4 | +5VDC |
| INDEX3− | 24 | | 5 | INDEX1− |
| PHASE3A+ | 25 | | 6 | NO CONNECTION |
| PHASE3B+ | 26 | | 7 | PHASE3A− |
| GND | 27 | | 8 | +5VDC |
| INDEX3+ | 28 | | 9 | PHASE3B− |
| INDEX4− | 29 | | 10 | +5VDC |
| PHASE4A+ | 30 | | 11 | PHASE4A− |
| PHASE4B+ | 31 | | 12 | +5VDC |
| GND | 32 | | 13 | PHASE4B− |
| INDEX4+ | 33 | | 14 | +5VDC |
| PHASE2A+ | 34 | | 15 | PHASE2A− |
| PHASE2B+ | 35 | | 16 | +5VDC |
| GND | 36 | | 17 | PHASE2B− |
| INDEX2+ | 37 | | 18 | +5V |
| | | | 19 | INDEX2− |

Figure 3. Connector pin out

## Board connector-to-C37F-4X9F-1M cable pin out

Connections from the board connector to the C37F-4X9F-1M cable are shown in
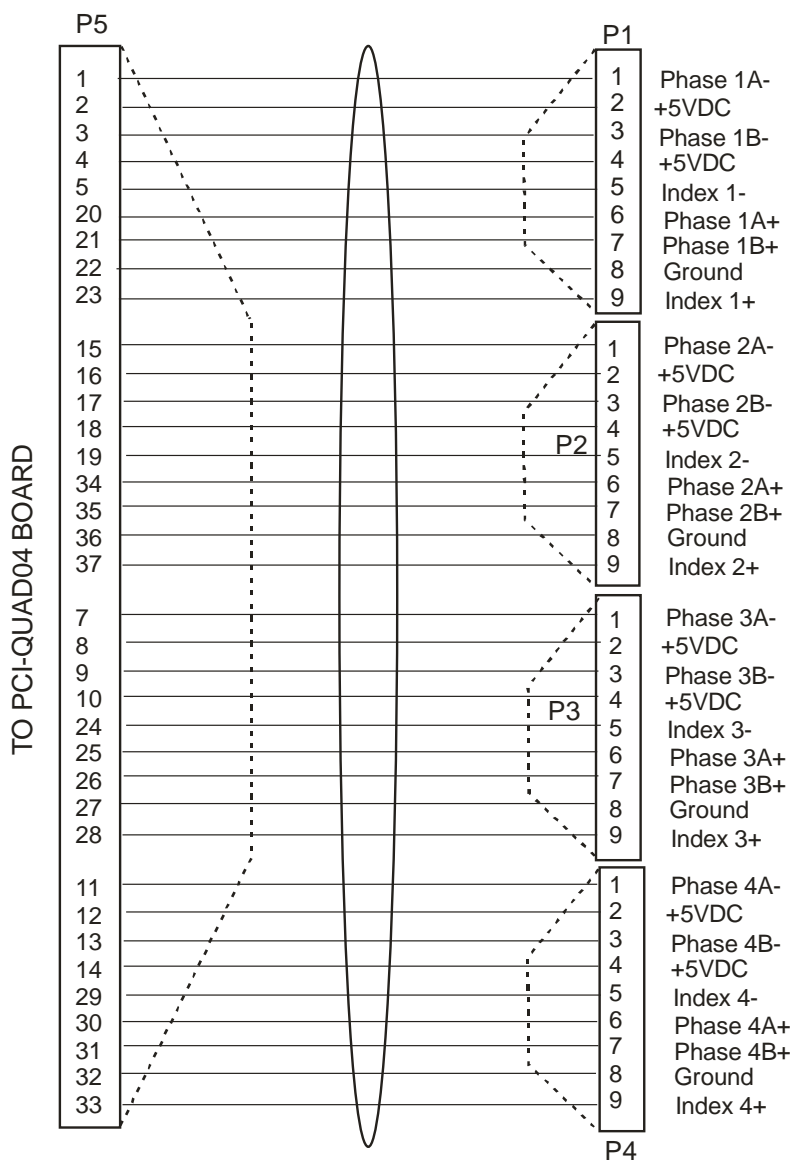
Figure 4.



Figure 4. Board connector-to-cable C37F-4X9F-1M pin out

Details on the C37F-4X9F-1M cable are available on our web site at
www.mccdaq.com/products/accessories.aspx.

# Specifications

**Typical for 25 °C unless otherwise specified.**

**Specifications in *italic text* are guaranteed by design.**

## Power consumption

Table 1. Power consumption specifications

| Not supplying power to external encoders: | |
|---|---|
| +5 V | 325 mA typical, 460 mA max. |
| Typical supplying 1 Dynamics Research Incremental Optical Rotary Encoder part number M21AAFOBB2E-2500: | |
| +5 V | 1058 mA typical, 1479 mA max. |

## Input

Table 2. Input specifications

| Receiver type | SN75ALS175 quad differential receiver |
|---|---|
| Configuration | Each channel consists of PhaseA input, PhaseB input and Index input; each input switch / jumper selectable as single-ended or differential |
| Differential | ■ PhaseA, PhaseB and Index (+) inputs at user connector routed to (+) inputs of differential receiver.<br>■ PhaseA, PhaseB and Index (-) inputs at user connector routed to (-) inputs of differential receiver. |
| Single - ended | ■ PhaseA, PhaseB and Index (+) inputs at user connector routed to (+) inputs of differential receiver.<br>■ PhaseA, PhaseB and Index (-) inputs at user connector routed to ground. (-) inputs of differential receiver routed to +3 V reference. |
| Number of channels | 4 |
| Common mode input voltage range | ±12 V max. |
| Differential input voltage range | ±12 V max. |
| Input sensitivity | ±200 mV |
| Input hysteresis | 50 mV typ. |
| Input impedance | 12 kΩ min. |
| Propagation delay | 27 ns max. (tpLH, tpHL) |
| Absolute maximum input voltage: | |
| Differential | ±14 V max. |
| Miscellaneous | ■ Meets or exceeds ANSI EIA/TIA-422-B, EIA/TIA-423-B, RS-485.<br>■ Meets ITU recommendations V.10, V.11, X.26, X.27.<br>■ Designed for multipoint busses on long lines and in noisy environments. |

# Counter

Table 3. Counter specifications

| Counter type | LS7266R1 24-bit Dual-axis Quadrature Counter |
|---|---|
| Quadrature mode: | |
| Clock frequency | 1.2 MHz max. |
| Separation | 100 ns min. |
| Clock pulse width | 400 ns min. |
| Index pulse width | 300ns min. |
| Count mode: | |
| Clock frequency | 30 MHz max, (25 MHz max Mod-N mode) |
| Clock A - high pulse width | 14 ns min. |
| Clock A - low pulse width | 14 ns min. |
| Filter clock (FCK) | 10 MHz |
| Digital filter rate | 10 MHz, software selectable divider (1 to 256 in single steps) |
| Crystal oscillator (FCK source): | |
| Frequency | 10 MHz |
| Frequency accuracy | 100 ppm |

# Interrupt controller

Table 4. Interrupt controller specifications

| Controller type | 8259 Programmable Interrupt Controller |
|---|---|
| Configuration | Polled mode only |
| Interrupts | 2, 3, 5, 7, 10, 11, 12 and 15 |
| Interrupt enable | Programmable |
| Interrupt sources | All Carry/Borrow outputs from LS7266R1, all Index inputs |

# Environmental

Table 5. Environmental specifications

| Operating temperature range | 0 to 70 °C |
|---|---|
| Storage temperature range | -40 to 100 °C |
| Humidity | 0 to 90% non-condensing |

# $CE$ Declaration of Conformity

| | |
|---|---|
| Manufacturer: | Measurement Computing Corporation |
| Address: | 10 Commerce Way |
| | Suite 1008 |
| | Norton, MA  02766 |
| | USA |
| Category: | Electrical equipment for measurement, control and laboratory use. |

Measurement Computing Corporation declares under sole responsibility that the product

## PCI-QUAD04

to which this declaration relates is in conformity with the relevant provisions of the following standards or other documents:

EC EMC Directive 2004/108/EC: General Requirements, EN 61326-1:2006 (IEC 61326-1:2005).

Emissions:

- EN 55011 (2007) / CISPR 11(2003): Radiated emissions: Group 1, Class A
- EN 55011 (2007) / CISPR 11(2003): Conducted emissions: Group 1, Class A

Immunity:  EN 61326-1:2006, Table 3.

- IEC 61000-4-2 (2001): Electrostatic Discharge immunity.
- IEC 61000-4-3 (2002): Radiated Electromagnetic Field immunity.
- IEC 61000-4-4 (2004): Electric Fast Transient Burst Immunity.
- IEC 61000-4-5 (2001): Surge Immunity.
- IEC 61000-4-6 (2003): Radio Frequency Common Mode Immunity.
- IEC 61000-4-11 (2004): Voltage Interrupts.

To maintain compliance to the standards of this declaration, the following conditions must be met.

- The host computer, peripheral equipment, power sources, and expansion hardware must be CE compliant.
- All I/O cables must be shielded, with the shields connected to ground.
- I/O cables must be less than 3 meters (9.75 feet) in length.
- The host computer must be properly grounded.
- Equipment must be operated in a controlled electromagnetic environment as defined by Standards EN 61326-1:2006, or IEC 61326-1:2005.

Declaration of Conformity based on tests conducted by Chomerics Test Services, Woburn, MA 01801, USA in March, 2009. Test records are outlined in Chomerics Test Report #EMI5299.09.

We hereby declare that the equipment specified conforms to the above Directives and Standards.

Carl Haapaoja, Director of Quality Assurance