PCI 766 Series

PCI PnP Analog Board
User's Manual
PCI766-8, PCI766-16, PCI766-24

Eagle Technology – Cape Town, South Africa
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Analog Output Boards
Data Acquisition and Process Control

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- The warranty will not apply to conditions where the **ETDAQD** has been operated in a manner exceeding its specifications.

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1. Introduction

The PCI766 series are 32-bit PCI bus architecture data acquisition boards. They are available in three models, the 8, 16 and 24 analog output channels. The PCI766 contains digital input and counter-timers. The PCI766 is used in waveform generation and power control applications.

Features

The PCI766 contains the following features.

- 32-bit PCI bus Revision 2.2 compliant at 33MHz.
- PCI Bus 3.3V compatible.
- PCI Bus Master DMA.
- Fully programmable analog output system.
- Waveform generation.
- Overvoltage protected digital inputs.

Feature	PCI 766-8	PCI 766-16	PCI 766-24
Number of analog output channels	8	16	24
DAC output resolution	16-bit	16-bit	16-bit
Maximum update rate	100 KHz	100 KHz	100 KHz
Voltage Range	±10V	±10V	±10v
FIFO Depth	64K	64K	64K
Waveform generation capability	YES	YES	YES
Triggering capability	External, Internal Clock	External, Internal Clock	External, Internal Clock
Counters	2	2	2
Counter resolution	24-bit	24-bit	24-bit
Number of digital/multi-function input lines	6	6	6

Table 1-1 PCI766 Versions

Applications

The PCI766 can be used in the following applications:

- Laser control applications.
- 3D positioning.
- Signal phased control applications.
- Automation and test equipment.
- Signal generation.
- Laboratory training.

Key Specifications

- 16-bit analog output @ 100 KHz.
- Waveform generation support.
- Individually programmable banks.
- 64K FIFO for waveform generation data.

Software Support

The PCI766 is supported by EDR Enhanced and comes with an extensive range of examples. The software will help you to get your hardware going very quickly. It also makes it easy to develop complicated control applications quickly. All operating system drivers, utility and test software are supplied on the Eagle Technology CD-Rom. The latest drivers can also be downloaded from the Eagle Technology website. For further support information see the Contact Details section.

Contact Details

Below are the contact details of Eagle Technology.

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2. Installation

This chapter describes how to install and configure the PCI766 for the first time. Minimal configuration is necessary; almost all settings are done through software. The PCI BIOS or operating system will take care of all resource assignments.

Package

PCI766 package will contain the following:

- PCI766 PCI board
- Software CD-Rom

Operating System Support

PCI766 support the following operating systems

Board Type	Revision	Operating Systems	Driver Type
PCI766-8	Revision 2	Windows NT/2000/98/ME/XP	NT Sys, WDM PnP
PCI766-16	Revision 2	Windows NT/2000/98/ME/XP	NT Sys, WDM PnP
PCI766-24	Revision 2	Windows NT/2000/98/ME/XP	NT Sys, WDM PnP

Table 2-1 Operating System Support

Hardware Installation

This section will describe how to install your PCI board into your computer.

- Switch off the computer and disconnect from power socket.

> ⚠ **CAUTION**
>
> **Failure to disconnect all power cables can result in hazardous conditions, as there may be dangerous voltage levels present in externally connected cables.**

- Remove the cover of the PC.
- Choose any open PCI slot and insert PCI board
- Insert bracket screw and ensure that the board sits firmly in the PCI socket.
- Replace the cover of the PC.
- Reconnect all power cables and switch the power on.
- The hardware installation is now completed.

Software Installation

Windows 98/2000/ME

Installing the Windows 98/2000 device driver is a very straightforward task. Because it is plug and play Windows will auto detect the PCI board as soon as it is installed. No setup is necessary. You simply have to supply Windows with a device driver.

Wait until Windows detects the new hardware
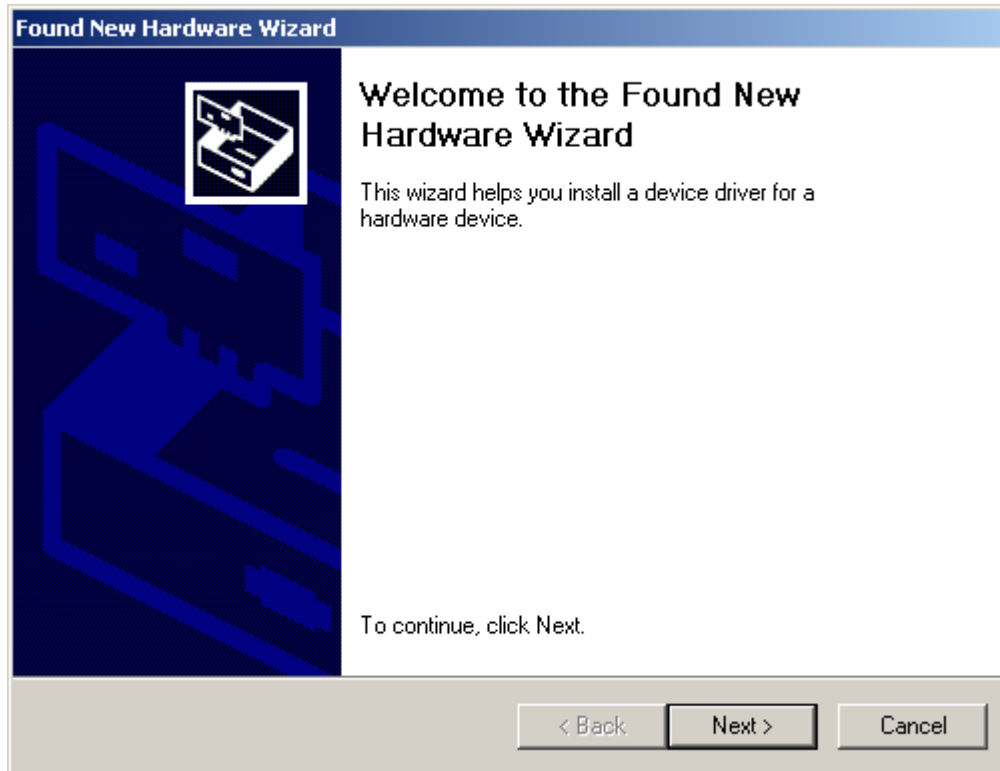
Select Next

Select "Search for a suitable driver for my device…" and select next
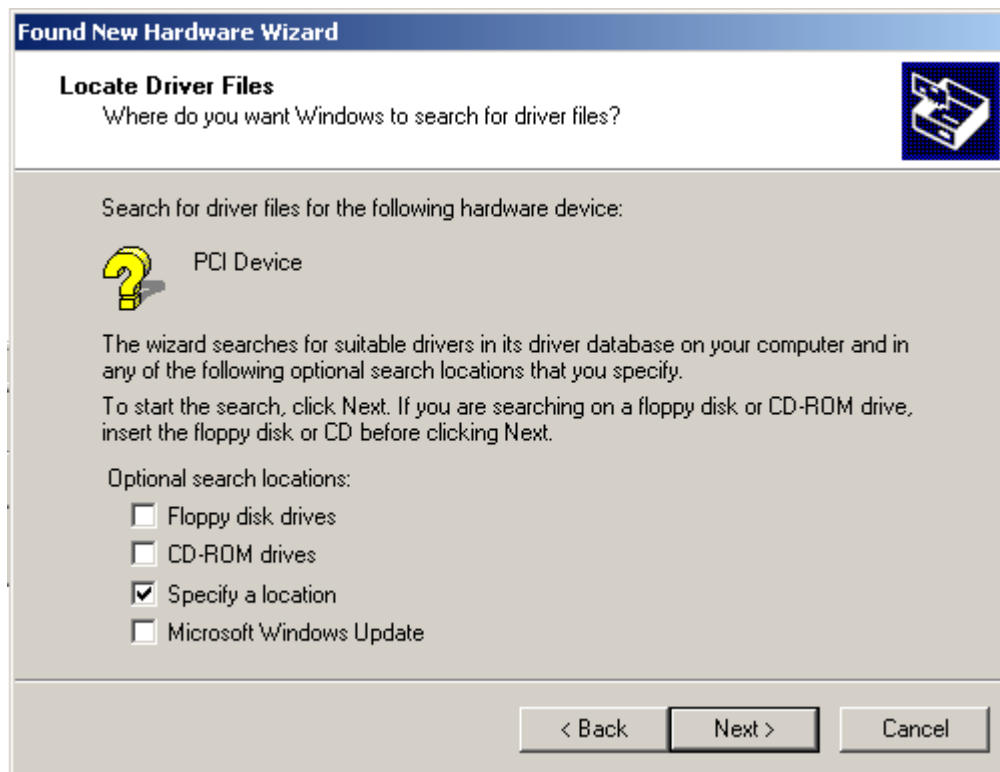
Make sure only "Specify a location" is selected and select next
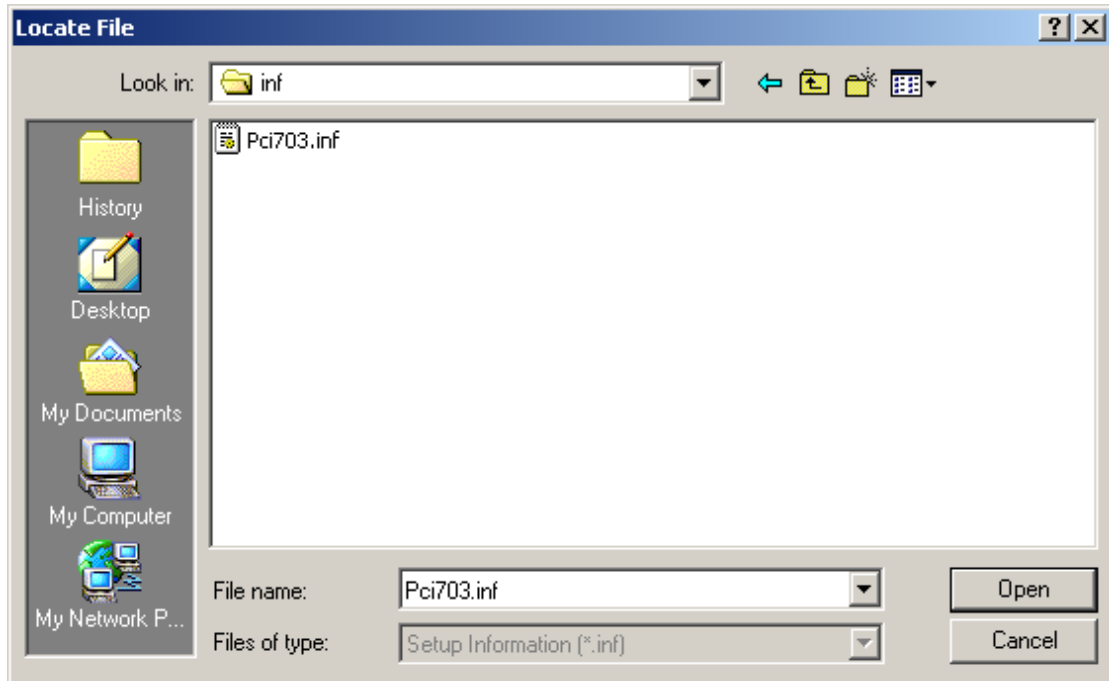
Select the browse button and search for the PCI766.inf file on the Eagle CD-Rom.
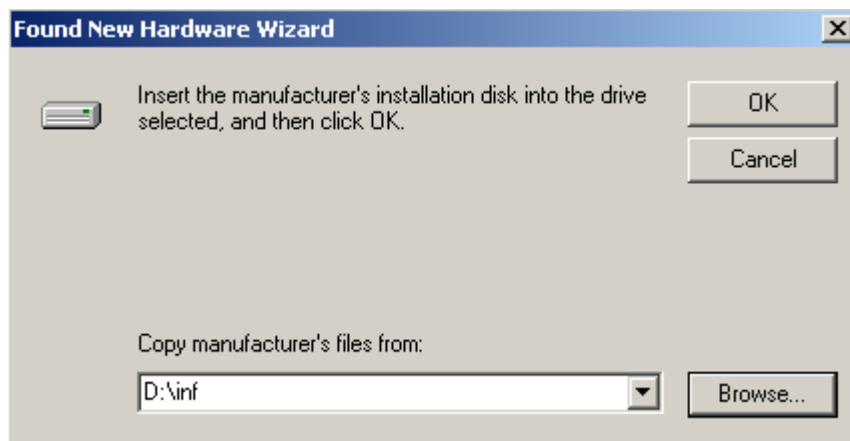
The driver is normally located in the <CDROM>:\EDRE\DRIVERS\WDM\PCI766 directory.

Select next when found.

Found New Hardware Wizard

Driver Files Search Results
The wizard has finished searching for driver files for your hardware device.

The wizard found a driver for the following device:

PCI Device

Windows found a driver for this device. To install the driver Windows found, click Next.

d:\inf\pci703.inf

< Back   Next >   Cancel

Select next again.

Found New Hardware Wizard

Completing the Found New Hardware Wizard

Pci703 A/D Board

Windows has finished installing the software for this device.

To close this wizard, click Finish.

< Back   Finish   Cancel

When done you might have to restart your computer.

Post installation

When done with the driver installation the device manager can be open to make sure the installation was a success.

- First make sure that the driver is working properly by opening the *Device Manager*.
- Check under the Eagle Data Acquisition list if your board is listed and working properly. See picture below.
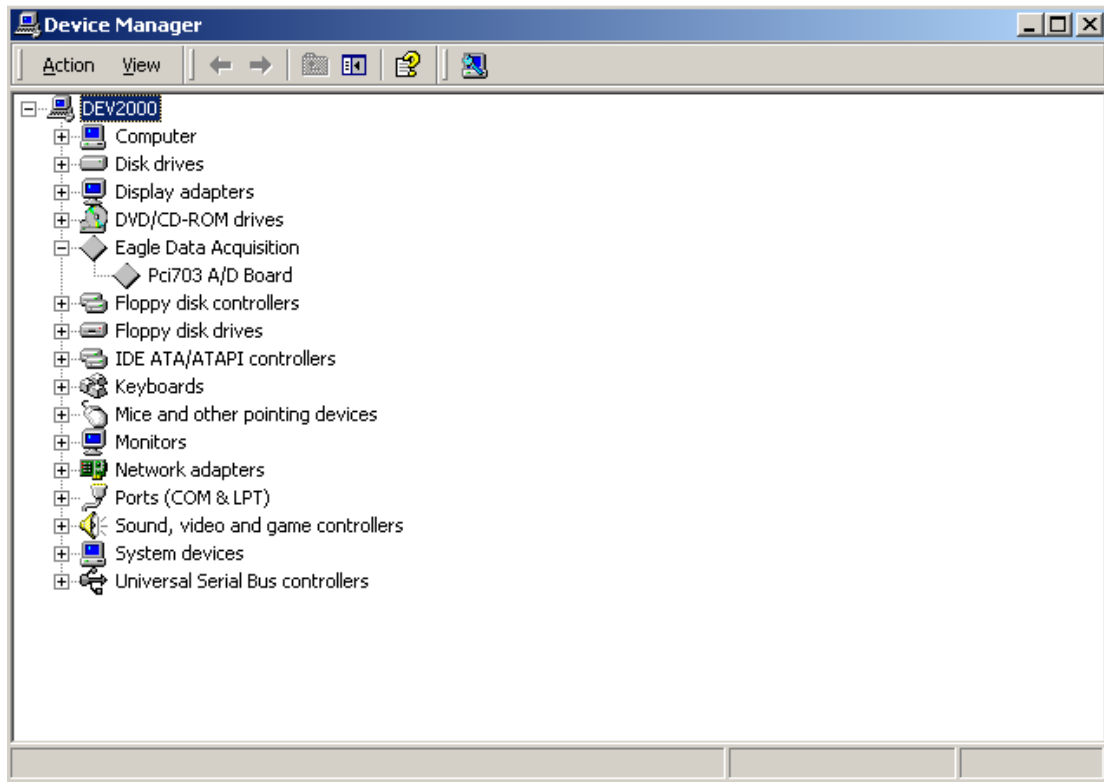
- Clearly you can see that the PCI device is listed and working properly.
- Further open the control panel and then the *EagleDAQ* folder. This dialog should list all installed hardware. Verify your board's properties on this dialog. See picture below

Now the first part of your installation has been completed and ready to install the EDR Enhanced Software Development Kit.

- Run *edreapi.exe* found on the Eagle CD-Rom and follow the on screen instructions

Windows NT

Windows NT does not require any special setup procedure. The Windows NT driver does not support plug and play. If Windows 2000 detects a new device simply install a default driver, or so called placeholder. This will disable the device in the plug and play manager.

To install the Windows NT drivers simply run *edrewinnt.exe* on the Eagle CD-Rom. This will automatically install the device drivers. Restart your computer when done. Open the *EagleDAQ* folder in the control panel to check if your installation was successful.

Accessories

The PCI703 has got a wide variety of accessories that it can be connected too. See the Eagle Technology catalog for more information.

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3. Interconnections

The PCI766 has got one external connector that includes connections for analog-output, digital input and power. All connections are made through this connector situated on the card's bracket.

Accessories are available to help to connect to the card easier. This includes cable and screw terminal boards.

External Connectors

The PCI766 contains one SCSI D-Sub 68 way male connector.

Pin Assignments

PCI766-8/16/24

Pin	Name	Pin	Name	Pin	Name	Pin	Name
1	AGND	18	AREF13	35	AGND	52	AOCH13
2	AREF0	19	AREF14	36	AOCH0	53	AOCH14
3	AREF1	20	AREF15	37	AOCH1	54	AOCH15
4	AREF2	21	AGND	38	AOCH2	55	AGND
5	AREF3	22	AREF16	39	AOCH3	56	AOCH16
6	AGND	23	AREF17	40	AGND	57	AOCH17
7	AREF4	24	AREF18	41	AOCH4	58	AOCH18
8	AREF5	25	AREF19	42	AOCH5	59	AOCH19
9	AREF6	26	AGND	43	AOCH6	60	AGND
10	AREF7	27	AREF20	44	AOCH7	61	AOCH20
11	AGND	28	AREF21	45	AGND	62	AOCH21
12	AREF8	29	AREF22	46	AOCH8	63	AOCH22
13	AREF9	30	AREF23	47	AOCH9	64	AOCH23
14	AREF10	31	DI4	48	AOCH10	65	DI5
15	AREF11	32	DI2	49	AOCH11	66	DI3
16	AGND	33	DI0/EXT_GATE	50	AGND	67	DI1/EXT_CLK
17	AREF12	34	+5V_FUSED	51	AOCH12	68	DGND

Table 3-1 Pinouts for PCI7766-8/16/24 (External Connector – SCSI 68) Revision 1

Signal Definitions

This sections deal with all the signals abbreviations.

Signal	Description
AOCH0-23	Analog output channels
AREF0-23	Analog output references
AGND	Analog ground
DI0-5	Digital inputs
DGND	Digital ground

Table 3-2 Signal definitions

Pin Descriptions

Analog Output Channels (AOCH0-23)
These are the analog output channels. In waveform generation mode they are allocated in blocks of 4.

Analog Output References (AREF0-23)
This is the reference for each channel. They are normally used in applications where the point of connections is very far from the card. This measures the voltage at the point of connection.

Analog Ground (AGND)
This is the analog reference used by the analog output channels.

Digital Input (DI0-7)
The DI0-5 pins are the pins for the digital inputs.

Digital Ground (DGND)
All digital ground signals should be connected to this pin.

Power Output (+5V_FUSED)
This pin is a +5 volt supply line.

External Clock (EXT_CLK)
This is the input for an external clock line.

External Gate (EXT_GATE)
This is the external gate pin.

4. Programming Guide

The PCI766 is supplied with a complete software development kit. EDR Enhanced (EDRE SDK) comes with drivers for many operating systems and a common application program interface (API). The API also serves as a hardware abstraction layer (HAL) between the control application and the hardware. The EDRE API makes it possible to write an application that can be used on all hardware with common sub-systems.

The PCI766 can also be programmed at register level, but it is not recommended. A detailed knowledge of the PCI766 is needed and some knowledge about programming Plug and Play PCI devices. We recommend that you only make use of the software provided by Eagle Technology.

EDR Enhanced API

The EDR Enhanced SDK comes with both ActiveX controls and a Windows DLL API. Examples are provided in many different languages and serve as tutorials. EDRE is also supplied with a software manual and user's guide.

The EDRE API hides the complexity of the hardware and makes it really easy to program the PCI703. It has got functions for each basic sub-system and is real easy to learn.
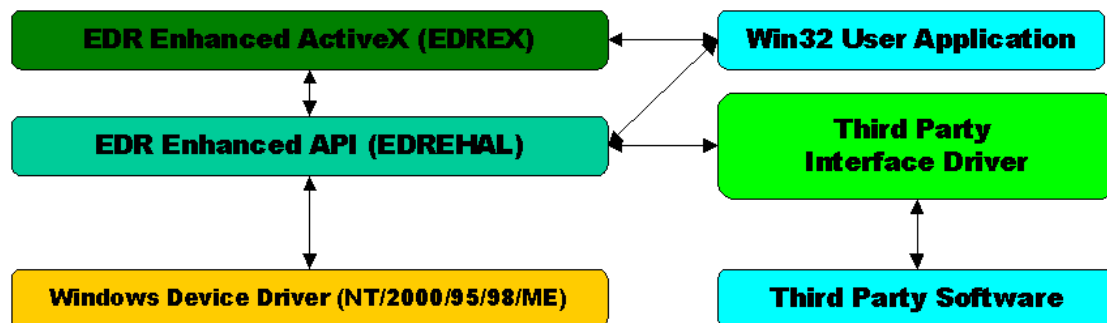
Figure 4-A EDR Enhanced Design

Digital Inputs

The PCI766 has 6 digital input lines. All have protection (see specifications) and can only be used as inputs. They are also used to control the counter-timers externally.

Reading the Digital Inputs

A single call is necessary to read a digital I/O port.

Long EDREDioX.Read(long Port)

Parameter	Type	Description
Port	Long	The port to be read. 0-5 is valid.
Return	Long	Equal and larger than 0 indicates port was read successfully. Smaller than 0 indicates error.

Counters

The counter sub-system is supported by functions to Read, Write, Configure and controlling the gate. There are 2 counters timers of which the first is assigned to waveform generation. Both counters have a 24-bit resolution. The counter-timers are compatible with the industry standard 8255.

Writing the initial counter value

A single call is necessary to write a counter's initial load value.
Long EDRECTX.Write(long ct, long value)

Parameter	Description
Ct	Counter Number:
	0 : Counter 0
	1 : Counter 1
Value	24-bit value to be written to the counter
Return	Error Code

Reading the current count value

A single call is necessary to read a counter.
Long EDRECTX.Write(long ct)

Parameter	Description
Ct	Counter Number:
	0 : Counter 0
	1 : Counter 1
Return	If the returned value is positive, it is the value read from the counter. If the value is negative it means an error occurred.

Configuring a counter

A single call is necessary to configure a counter.

Long EDRECTX.Configure(long ct, long mode, long type, long source, long gate)
The counter-number, mode, type, clock source and gate source is needed to specify a counter's configuration. A return code will indicate if any errors occurred.

Only the counter mode, clock source and type parameters are used by the PCI703. The table below shows the options for each parameter.

Parameter	Description
Ct	Counter Number:
	0 : Counter 0
	1 : Counter 1
Mode	0 : 8254 Mode 0
	1 : 8254 Mode 1
	2 : 8254 Mode 2
	3 : 8254 Mode 3
	4 : 8254 Mode 4
	5 : 8254 Mode 5
	See appendix for more details on counter-timer modes.
Type	Not Used
Source	0 : Internal Clock – 20 MHz
	1 : External clock via digital input 1.
Gate	0: Gate Disabled
	1: Gate Enabled
	2: External Gate via Digital Input 0

Controlling the counter gate

A single call is necessary to setup/control a counter's gate.

Long EDRECTX.SoftGate(long Ct, long Gate)

Parameter	Description
Ct	Counter Number:
	0 : Counter 0

Gate	1 : Counter 1
	0: Gate Disabled
	1: Gate Enabled
	2: External Gate via Digital Input 0

Analog Output

The PCI766 has from 8 to 24 channels of D/A channels. Channels are grouped in banks of four each. Channels can also only operate in banks of four. This meaning that when any channel in a bank is assigned to polled I/O or waveform generation the remaining channels in that bank can only serve the same function. Channels assigned to waveform generation do not have to include all channels in a bank.

Writing to a DAC channel

A single call is necessary to set a voltage on a DAC channel.

Long EDREDAX.Write (long Channel, long uVoltage)

Parameter	Type	Description
Channel	Unsigned long	Channel 0 – 23
uVoltage	Long	Micro voltage to be written to the specific channel. Call will fail if the channel is assigned to waveform generation. The voltage must be in a ±10 000 000 uV range
Return	Long	Error Code

Generating a Waveform

Generation a waveform involves first configuring the system, supplying an initial list of data and then starting the process. Depending on the mode, either continuous or normal, data must be supplied when necessary. A query can be run to determine the number of available samples for the board to be used. With this it can be determined when to add data to the driver buffer.

*Long EDRDAX.Configure (long Channel, long Frequency, long ClkSrc, long GateSrc, long Continuous, long Length, long *uVoltage)*

Parameter	Type	Description
Channel	Long	This parameter is used to enable the different channel banks.
		<table><tr><td>Bit 5</td><td>Bit 4</td><td>Bit 3</td><td>Bit 2</td><td>Bit 1</td><td>Bit 0</td></tr><tr><td>Bank5</td><td>Bank4</td><td>Bank3</td><td>Bank2</td><td>Bank1</td><td>Bank0</td></tr><tr><td>Ch20-23</td><td>Ch16-19</td><td>Ch12-15</td><td>Ch8-11</td><td>Ch4-7</td><td>Ch0-3</td></tr></table>
Frequency	Long	Divider Value This is the actual value written to the counter.
ClkSrc	Long	Clock Source and Load Source <table><tr><td>Bits</td><td>Description</td><td>Values</td></tr><tr><td>0-7</td><td>Clock Source</td><td>0: Internal Clock 1: Digital Input 1</td></tr><tr><td>8-15</td><td>Load Source</td><td>0: TC Timer 0 1: Digital Input 1</td></tr></table>
GateSrc	Long	Timer Gate Source 0: Disable 1: Enabled 2: External – Digital Input 0
Continuous	Long	FIFO or Looped Mode 0: FIFO mode is used to stream data from software to hardware or when data is less than the hardware buffer and needs to be streamed once. 1: Loop through hardware buffer. Samples cannot be more that the size of the hardware buffer.
Length	Long	Number of samples in buffer
uVoltage	Pointer to a long buffer	Buffer filled with micro voltages
Return	Long	Error Code

Long EDREDAX.Control (long Channel, long Command)

The hardware can also be controlled via software. The Control method is used to start, stop and pause the process.

Parameter	Type	Description
Channel	Long	Specify the start channel. 0: Channel 0 1: Channel 4 2: Channel 8 3: Channel 12 4: Channel 16 5: Channel 20

Command	Long	Command Code 0: NULL 1: Start process 2: Stop process 3: Pause process 4: Continue process
Return	Long	Error Code

*Long EDREDAX.UpdateData (long Channel, long Length, long *uVoltage)*

UpdateData is used to update data while streaming data from a user application.

Parameter	Type	Description
Channel	Long	Not used.
Length	Long	Size of buffer in number of samples.
uVoltage	Pointer to a long buffer	Buffer filled with micro voltages
Return	Long	Error Code

Query Examples

1. Query for available space in the driver buffer when doing streaming:
   SPACE = EDREUTLX.Query(DABUFSPACE,0)
   Where DABUFSPACE = 205

2. Query for a buffer underrun:
   STATUS = EDREUTLX.Query(DABUFUNDER,0)
   Where DABUFSPACE = 206
   If STATUS = 0, Buffer OK.
   If STATUS = 1, Buffer under run occurred.

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5. Calibration

The calibration software can be found on the Eagle CD-Rom
(*<EAGLECD>\EDRE\APPS\PCI700CAL\PCI700CalibrationSoftware.EXE*). Make sure that
the latest copy of EDR Enhanced API is installed. The reference offsets of the PCI766 needs
to be calibrated. Use a high accuracy multimeter to measure these offsets.

1. Calibrate coarse setting of the +10 volt offset. Measure at test point +10V with
   reference to analog ground.
2. Calibrate fine setting of the +10 volt offset. Measure at test point +10V with reference
   to analog ground.
3. Calibrate coarse setting of the -10 volt offset. Measure at test point -10V with
   reference to analog ground.
4. Calibrate fine setting of the -10 volt offset. Measure at test point -10V with reference
   to analog ground.
5. When compete save values and restart application.

A
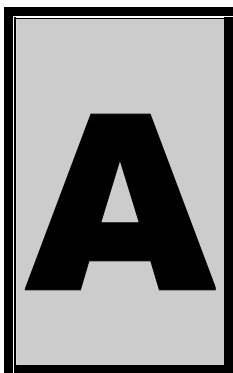
A.Specifications

Analog Output Characteristics

Output Characteristics

Resolution	16 bits
Maximum Update Rate	100 KHz to 0.03% full scale
FIFO Buffer Size	64K x 16 Maximum
Data Transfer	Programmed I/O, Interrupts, BM DMA
Update Mode	Channel list synchronous mode

Voltage Output Characteristics

Range	$\pm$ 10 Volt
Output Settling Time	10 us to 0.03% full scale
Noise	$\pm$ 2 LSB
Output Coupling	DC
Output Impedance	0.2 Ω
Output Drive	$\pm$ 5 mA
Power-on State	0V

Digital Input Characteristics

Number of Channels	6
Compatibility	TTL
I/O Characteristics	

Item (Relative to DGND)	Value
Minimum input voltage to register as a logic '1'	+2.5V
Maximum input voltage to register as a logic '0'	+1.0V
Maximum continuous input voltage	$\pm$32V
Maximum input voltage spike < 100ms	$\pm$80V
Maximum timer frequency as counter	8 MHz
Maximum timer frequency as DAC clock	100 KHz
Minimum positive pulse width	120 ns
Minimum low between positive pulses	120 ns

Counter-Timer Characteristics

Number of Channels	2
Resolution	24-bit
Clock Source	Internal 20MHz, 100 KHz external max

      Compatibility   TTL

Other

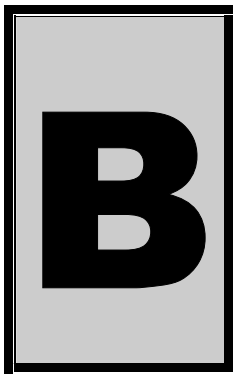   **Bus Interface**   PCI 2.2 Compatible
                                                    Master & Slave
                                                    3.3V or 5V
   **Power Requirements**   +5V ($\pm$5%) @ 600mA – 1.4A

B

B. Configuration Constants

Query Codes

| Name	Value	Description
APIMAJOR	1	Query EDRE API major version number.
APIMINOR	2	Query EDRE API minor version number.
APIBUILD	3	Query EDRE API build version number.
APIOS	4	Query EDRE API OS type.
APINUMDEV	5	Query number of devices installed.
BRDTYPE	10	Query a board's type.
BRDREV	11	Query a board's revision.
BRDYEAR	12	Query a board's manufactured year.
BRDMONTH	13	Query a board's manufactured month.
BRDDAY	14	Query a board's manufactured day.
BRDSERIALNO	15	Query a board's serial number.
DRVMAJOR	20	Query a driver's major version number.
DRVMINOR	21	Query a driver's minor version number.
DRVBUILD	22	Query a driver's build version number.
ADNUMCHAN	100	Query number of ADC channel.
ADNUMSH	101	Query number of samples-and-hold channels.
ADMAXFREQ	102	Query maximum sampling frequency.
ADBUSY	103	Check if ADC system is busy.
ADFIFOSIZE	104	Get ADC hardware FIFO size.
ADFIFOOVER	105	Check for FIFO overrun condition.
ADBUFFSIZE	106	Check software buffer size.
ADBUFFOVER	107	Check for circular buffer overrun.
ADBUFFALLOC	108	Check if software buffer is allocated.
ADUNREAD	109	Get number of samples available.
ADEXTCLK	110	Get status of external clock line – PCI30FG.
ADEXTTRIG	111	Get status of external trigger line – PCI30FG.
ADBURST	112	Check if burst mode is enabled.
ADRANGE	113	Get ADC range.
DANUMCHAN	200	Query number of DAC channels.
DAMAXFREQ	201	Query maximum DAC output frequency.
DABUSY	202	Check if DAC system is busy.
DAFIFOSZ	203	Get DAC FIFO size.
DABUFSZ	204	Get DAC driver buffer size
DABUFSPACE	205	Get space available in buffer when streaming
DABUFUNDER	206	Check for a buffer under run
CTNUM	300	Query number of counter-timer channels.
CTBUSY	301	Check if counter-timer system is busy.
DIONUMPORT	400	Query number of digital I/O ports.
DIOQRYPORT	401	Query a specific port for capabilities.
DIOPORTWIDTH	402	Get a specific port's width.
INTNUMSRC	500	Query number of interrupts sources.
INTSTATUS	501	Queries interrupt system's status.
INTBUSCONNECT	502	Connect interrupt system to bus.
INTISAVAILABLE	503	Check if an interrupt is available.
INTNUMTRIG	504	Check number times interrupted

Error Codes

Name	Value	Description
EDRE_OK	0	Function successfully.
EDRE_FAIL	-1	Function call failed.
EDRE_BAD_FN	-2	Invalid function call.
EDRE_BAD_SN	-3	Invalid serial number.
EDRE_BAD_DEVICE	-4	Invalid device.
EDRE_BAD_OS	-5	Function not supported by operating system.
EDRE_EVENT_FAILED	-6	Wait on event failed.
EDRE_EVENT_TIMEOUT	-7	Event timed out.
EDRE_INT_SET	-8	Interrupt in use.
EDRE_DA_BAD_RANGE	-9	DAC value out of range.
EDRE_AD_BAD_CHANLIST	-10	Channel list size out of range.
EDRE_BAD_FREQUECY	-11	Frequency out of range.
EDRE_BAD_BUFFER_SIZE	-12	Data passed by buffer incorrectly sized
EDRE_BAD_PORT	-13	Port value out of range.
EDRE_BAD_PARAMETER	-14	Invalid parameter value specified.
EDRE_BUSY	-15	System busy.
EDRE_IO_FAIL	-16	IO call failed.
EDRE_BAD_ADGAIN	-17	ADC-gain out of range.
EDRE_BAD_QUERY	-18	Query value not supported.
EDRE_BAD_CHAN	-19	Channel number out of range.
EDRE_BAD_VALUE	-20	Configuration value specified out of range.
EDRE_BAD_CT	-21	Counter-timer channel out of range.
EDRE_BAD_CHANLIST	-22	Channel list invalid.
EDRE_BAD_CONFIG	-23	Configuration invalid.
EDRE_BAD_MODE	-24	Mode not valid.
EDRE_HW_ERROR	-25	Hardware error occurred.
EDRE_HW_BUSY	-26	Hardware busy.
EDRE_BAD_BUFFER	-27	Buffer invalid.
EDRE_REG_ERROR	-28	Registry error occurred.
EDRE_OUT_RES	-29	Out of resources.
EDRE_IO_PENDING	-30	Waiting on I/O completion

Digital I/O Codes

Name	Value	Description
DIOOUT	0	Port is an output.
DIOIN	1	Port is an input.
DIOINOROUT	2	Port can be configured as in or out.
DIOINANDOUT	3	Port is an input and an output.

C

C.Layout Diagram

D
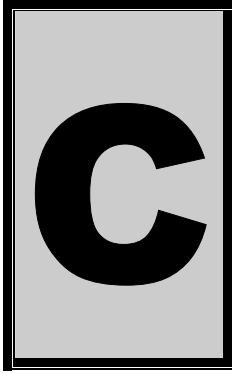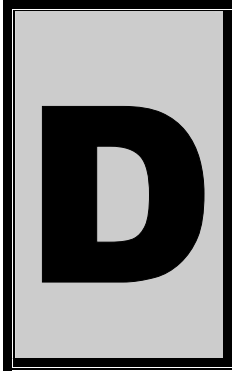
D.Ordering Information

For ordering information please contact Eagle Technology directly or visit our website www.eagle.co.za. They can also be emailed at eagle@eagle.co.za.

Board	Description
PCI 766-8	8 Channel analog output board.
PCI 766-16	16 Channel analog output board.
PCI 766-24	24 Channel analog output board.

Please visit our website to have a look at our wide variety of data acquisition products and accessories.

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