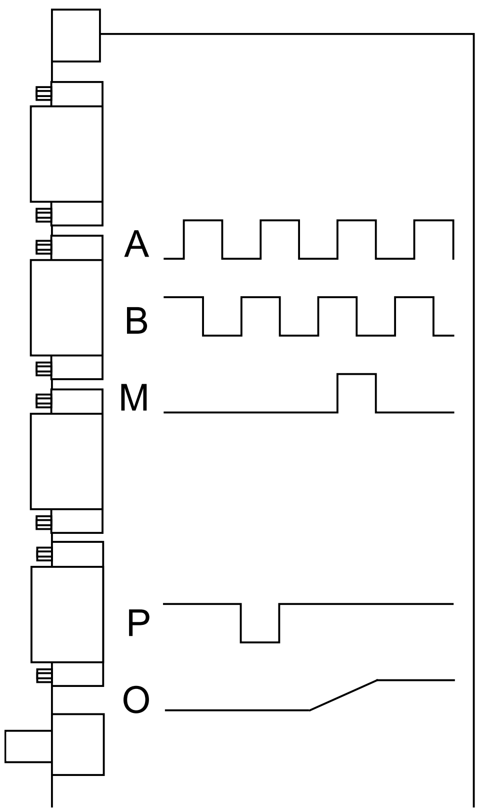
DEVA037 USB encoder interface card with optical edge detection

User's Manual



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1 Overview

1.1 Product Features

The DEVA037 3 axis incremental encoder interface cards have been designed to enable simultaneous reading of 3 encoders using a PC based system. They can be used for a wide range of measurement applications, such as optical projectors and co-ordinate measuring machines.

The range includes support for PCIe, PCI and ISA bus interfaces. All three types share many common features; however the PCI / PCIe variants have several additional facilities.

1.1.1 Features

- Three encoder inputs for differential or single - ended input
- 32 bit counters for each encoder channel
- Marker input (freeze / capture) for each encoder channel
- +5v and +12v Power supply pass through on encoder connectors
- Digital filters on all channels
- Timer / Event driven interrupt logic
- Touch probe input
- Optical edge input

1.2 Support software

A variety of software drivers and libraries are provided with the interface card to enable software development to be performed within a number of operating systems and applications. Software support is an ongoing activity, if support for a particular application or operating system is not currently provided, please call the Deva office to determine its availability.

1.2.1 Windows 8/7/Vista/XP 32/64

The Deva037 is supported in Windows 8/7/Vista/XP 32/64 by a Windows driver model driver (WDM). The driver supports a standard programming interface. Please refer to section 3 ‘Device Driver Usage’ for more details.

1.2.2 Digital Readout

A powerful digital readout is supplied which is capable of exercising all the common facilities of the DEVA037. This is useful to allow users to quickly verify that the DEVA037 is installed correctly and to make checks of their system without having to write their own software.

The DRO will handle up to four cards (12 axes) and displays both absolute and incremental positions. The DRO also displays the Marker register, Probe register and allows control of the Probe and Footswitch options.

To allow the user to read meaningful values each axis of the DRO may be independently scaled to display real units.

For the incremental card all facilities such as Marker, Probe and Optical edge detect may be toggled on and off. If a Probe is activated the probed values are shown in the Probe register, if a Marker is activated the value is shown in the Marker register an if the Optical edge is activated the values are shown in the Optical register.

1.3 Accessories

The DEVA037 incremental encoder interface is supplied with three high density 15 way 'D' type connectors, one 9 way ‘D’ type connector and matching shells.

2 Installation and configuration

2.1 Software support CDROM

The DEVA037 3-axis encoder interface card is supplied with a software support CDROM containing support for all DEVA037 encoder interfaces along with support and information for many of Deva's other products. The CDROM includes the following items:

- Windows 8/7/Vista/XP 32/64 bit device drivers, providing coherent encoder interface card hardware management.
- Windows 8/7/Vista/XP 32/64 bit DLL and import library, containing the driver access functions.
- 'C' language library routines and header files, which create a simple interface to device driver functions.
- Example 'C' programs, illustrating card read/write using device driver functions.
- Visual Basic 6 Module, which provides constant and function definitions to allow simple DLL access.
- Example Visual Basic 6 programs, illustrating card read/write using device driver functions.
- .Net 2.0 Assembly, which provides a complete interface to the standard DLL.
- Example C# programs, illustrating card read/write using device driver functions.
- Demonstration Digital Readout Program for Windows 8/7/Vista/XP 32 and 64 bit.

2.2 USB Plug and Play cards

2.2.1 System requirements

The device driver library functions and the demonstration software require a PC computer with one spare USB connector and Windows 8/7/Vista or XP 32/64 bit operating systems. Both 32 and 64 bit operating systems are fully supported.

2.2.2 Device driver installation

2.2.2.1 Windows 8 / 7 / Vista / XP installation

When the card is connected windows will indicate that a new device has been found and will start the standard driver installation procedure. If this does not occur it is possible to initiate this process manually via the ‘add new hardware’ icon in the control panel or via the windows device manager.

Follow the instructions and when requested select ‘have disk’ and then browse to the directory on the installation CDROM containing the Deva037.inf file.

For example :

\PC interface products\Deva037\Issue1.x\Drivers\

Click ok and follow instructions to complete the installation.

The installation may be tested using the supplied DRO program which may be found on the CD in the utils\Win32 or utils\Win64 directories.

3 Device Driver Usage

3.1 Device driver functions

The supplied Windows 8/7/Vista/XP 32/64 bit device drivers provide a simple method of accessing card functions and remove the need for direct register programming. Use of the device driver ensures that the user's application software is compatible with other Deva products and is protected from any future changes in the card hardware or register layout. The device driver determines the total number of axes and I/O available from all the cards in a system. This section describes the functions provided by the device driver whilst the compatibility chart in section 3.2 details the functions available from particular cards.

3.1.1 System information

Command & equate		Channel	Rd/Wr	Operation
0	VECTOR	Not used	Rd	Provides a vector to the device driver command handler.
1	NUM_AXES	Not used	Rd	Returns the total number of axis channels available from the installed cards.
2	NUM_TIMERS	Not used	Rd	Returns the total number of timers available from the installed cards.
3	NUM_INPUTS	Not used	Rd	Returns the total number of digital inputs available from the installed cards.
4.	NUM_DACS	Not used	Rd	Returns the total number of digital to analog converters available from the installed cards.
5.	NUM_OUTPUTS	Not used	Rd	Returns the total number of digital outputs available from the installed cards.
7.	NUM_BOARDS	Not used	Rd	Returns the number of encoder cards present in the system.
8.	CARD_TYPE	Not used	Rd	Returns the card type identifier.
9.	VERSION_NUM	Not used	Rd	Returns the device driver version number multiplied by 100.

3.1.2 Channel information

Command & equate		Channel	Rd/Wr	Operation
10	CNT_16	Axis no.	Rd/Wr	Allows direct 16 bit read/write of the counter chip registers.

11 MODE	Axis no.	Rd/Wr	Allows access to the mode registers of the incremental encoder counter chip or the SSI mode register.

INC_MODE — Incremental mode number formed from a variety of bit fields.

Bit	Function
0-3	Count mode: 5=QUADx4AB, quadrature AB decode (default) 8=CNTAx2DIRB, count rising and falling edges of A, B selects count up/down direction 9=CNTADIRB, count rising edges of A, B selects count up/down direction
4	Invert quadrature signal A
5	Invert quadrature signal B
6	Invert marker signal M
7	Invert zero signal Z
8	Disable marker synchronisation with signals A & B
9	Count inhibit

SSI_MODE — SSI mode number formed from a variety of bit fields.

Bit	Function
0-2 (ISA)	Frequency 0=2.50Mhz, 1=1.25Mhz, 2=625kHz, 3=313kHz, 4=156kHz, 5-7=78.1kHz
0-2 (PCI)	Frequency 0=2.78Mhz, 1=1.39Mhz, 2=694kHz, 3=347kHz, 4=174kHz, 5-7=86.8kHz
3-7	Reserved
8-11	Offset 0 to 15 bits
12-13	Extra bit, 0=None, 1=Power fail, 2=Even Parity, 3=Odd parity
14	0=Binary, 1=Gray
15	Output control, 0=Off, 1=On
16-18	Acquisition mode, 0=One Shot, 1=Timer, 2-3=Continuous, 4=Channel Digital Input 0
18-22	Reserved
23	Read Complete Interrupt Enable, 0=Off (Default), 1=On
24-29	Data length 1 to 32
30-31	Reserved

12 AXIS_SIZE	Axis no.	Rd	Returns the number of 16 bit registers allocated to an input channel.
13 ENCODER_TYPE	Axis no.	Rd	0 = Incremental, 1 = SSI
14 AXIS_INPUTS	Axis no.	Rd	Returns the status of the axis (post filter & inverter) inputs. The bit fields indicate 0 or 1 depending on the state of the axis inputs.

INC_INPUTS — Incremental inputs register formed from a variety of bit fields.

Bit	Status
0	Quadrature input A
1	Quadrature input B
2	Marker input M
3	Zero input Z
4	Limit input 0
5	Limit input 1

SSI_INPUTS — SSI inputs register formed from a variety of bit fields.

Bit	Status
0	Raw SSI data input

15 AXIS_STATUS — Axis no. — Rd — Returns the axis status register. The bit fields indicate 0 or 1 depending on the status bit.

INC_STATUS — Incremental status register formed from a variety of bit fields.

Bit	Status
0	Power supply failure
1	Quadrature error

SSI_STATUS — SSI status register formed from a variety of bit fields.

Bit	Status
0	Power supply failure
1	Parity failure
2	Read complete occur

16 AXIS_OUT_EN — Axis no. — Rd — Enables the axis digital outputs. Specifying 1/0 in each bit field enables/disables the equivalent digital output.

INC_OUT_EN — N/A

SSI_OUT_EN — SSI axis digital output enable register formed from a variety of bit fields.

Bit	Status
0	SSI Read Trigger
1	SSI Read Complete

3.1.3 Marker information

Command & equate	Channel	Rd/Wr	Operation
20 MARK_16	Axis no.	Rd	Returns the value of a 16-bit counter register latched by the last marker function (or any other function the marker latch source is set to). See commands 23 and 26.
21 MARK_INPUT	Axis no.	Rd	Returns either 0 or 1 depending on the state of the marker input.
22 MARK_INT	Axis no.	Rd/Wr	Allows access to the card interrupt controller mask. Writing a value of 1/0 enables/disables an interrupt from the marker input. This function is for special applications only.

23 MARK_FUNC	Axis no.	Rd/Wr	Writing a value of 1/0 enables/disables the channel marker function.
24 MARK_INT_VECT	Axis no.	Rd/Wr	Allows access to the interrupt vector or interrupt call-back executed by a marker input interrupt.
25 MARK_INT_OCCUR	Axis no.	Rd	Returns a value of 1 every time a marker input interrupt has occurred.
26 MARK_LATCH_SEL	Axis no.	Rd/Wr	Controls the source event of the 'Marker' associated latch of each axis.

Value	Source
0	Marker Occur
1	Zero Occur
2	Pulse Generator 0 Sync Occur
3	User Event 0 Occur
4	Channel Digital Input 0 Occur
5	Axis Compare 0 Sync Occur
6	Axis Compare 1 Sync Occur
7	N/A (Axis Compare 0 Enable)

27 MARK_OUT_EN	Axis no.	Rd/Wr	Writing a value of 1/0 enables/disables the marker digital output.

3.1.4 Zero information

Command & equate	Channel	Rd/Wr	Operation
30 ZERO_INPUT	Axis no.	Rd	Returns either 0 or 1 depending on the state of the zero input.
31 ZERO_INT	Axis no.	Rd/Wr	Allows access to the card interrupt controller mask. Writing a value of 1/0 enables/disables an interrupt from the zero input. This function is for special applications only.
32 ZERO_FUNC	Axis no.	Rd/Wr	Writing a value of 1/0 enables/disables the channel zero function.
33 ZERO_INT_VECT	Axis no.	Rd/Wr	Allows access to the interrupt vector or interrupt call-back executed by a zero input interrupt.
34 ZERO_INT_OCCUR	Axis no.	Rd	Returns a value of 1 every time an encoder zero interrupt has occurred.

3.1.5 Extended axes

Command & equate	Channel	Rd/Wr	Operation
40 AXIS_32	Axis no.	Rd/Wr	Allows access to the 32-bit counter register values or to pseudo-incremental 32-bit position for absolute SSI encoders.

41 MARK_32	Axis no.	Rd	Returns the value of a 32-bit counter register latched by the last marker function (or any other function the marker latch source is set to). See commands 23 and 26.
42 VEL_INST	Axis no.	Rd	Returns the counter velocity per interrupt time.
43 VEL_FILT	Axis no.	Rd	Returns 10 times the counter velocity per interrupt period filtered over 10 samples.
44 ACCEL_INST	Axis no.	Rd	Returns the counter acceleration per interrupt time.
45 ACCEL_FILT	Axis no.	Rd	Returns 10^2 times the counter acceleration per interrupt $period^2$ filtered over 10 samples.
46 PROBE_32	Axis no.	Rd	Returns the value of a 32-bit counter register latched by the last probe function (or any other function the probe latch source is set to). See commands 93 and 100.
47 ABSOLUTE_32	Axis no.	Rd	Returns the 32-bit absolute position latched by the last read of an absolute SSI encoder.
48 TIMER_32	Axis no.	Rd	Returns the value of a 32-bit counter value latched by the last timer 1 function (or any other function the timer latch source is set to). See commands 65 and 64.
49 OPTICAL_32	Axis no.	Rd	Returns the 32 bit latched encoder value of the last optical trigger.

3.1.6 Input status

Command & equate	Channel	Rd/Wr	Operation
50 INPUT	Input no.	Rd	Returns either 0 or 1 depending on the state of the input.

3.1.7 Timer information

Command & equate	Channel	Rd/Wr	Operation
60 TIMER	Timer no.	Rd/Wr	This command allows access to the interval values of the on-board user timers. The timer intervals are programmed in units of 0.1 ms.
61 TIMER_INT	Timer no.	Rd/Wr	Writing a value of 1/0 enables/disables the user timer interrupt.
62 TIMER_INT_VECT	Timer no.	Rd/Wr	Allows access to the interrupt vector or interrupt call-back executed by the user timer interrupt.
63 TIMER_INT_OCCUR	Timer no.	Rd	Returns a value of 1 every time a user timer interrupt has occurred.
64 TIMER_LATCH_SEL	Axis no.	Rd/Wr	Controls the source event of the timer latch of each axis.

Value	Source
0	Timer 1 Sync Occur
1	N/A (Read Counter)
2	Pulse Generator 0 Sync Occur
3	User Event 0 Occur

65 TIMER1_FUNC	Axis no.	Rd/Wr	Writing a value of 1/0 enables/disables the user timer function for the specific axis. This allows for position readings latched on every timer 1 interval of the equivalent board.
66 TIMER_OUT_EN	Timer no.	Rd/Wr	Enables the timer digital outputs. Specifying 1/0 in each bit field enables/disables the equivalent digital output.

Bit	Status	Pulse Width
0	Timer Occur	Occur to serviced
1	Timer Terminal Count	1us

3.1.8 DAC Control

Command & equate	Channel	Rd/Wr	Operation
70 DAC_MV	Axis no.	Rd/Wr	Allows access to the analog output channel for each axis in a system. The value is in units of mV.
71 DAC_UV	Axis no.	Rd/Wr	Allows access to the analog output channel for each axis in a system. The value is in units of uV.

3.1.9 Output control

Command & equate	Channel	Rd/Wr	Operation
80 OUTPUT	Output no.	Rd/Wr	Allows access to the system digital outputs. The output is energised with a logical 1.
81 SERVO_ENABLE	Axis no.	Rd/Wr	Allows access to the system servo enable outputs for each axis. The output is energised with a logical 1.

3.1.10 Probe information

Command & equate	Channel	Rd/Wr	Operation
90 PROBE_16	Axis no.	Rd	Returns the value of a 16-bit counter register latched by the last probe function (or any other function the probe latch source is set to). See commands 93 and 100.
91 PROBE_INPUT	Board no.	Rd	Returns either 0 or 1 depending on the state of the probe input.

92	PROBE_INT	Board no.	Rd/Wr	Allows access to the card interrupt controller mask. Writing a value of 1/0 enables/disables the probe input interrupt. This function is for special applications only.
93	PROBE_FUNC	Board no.	Rd/Wr	Writing a value of 1/0 enables/disables the channel probe function. The probe function is level triggered by the probe input and the function reset automatically after execution of the function.
94	PROBE_INT_VECT	Board no.	Rd/Wr	Allows access to the interrupt vector or interrupt call-back executed by a probe input interrupt.
95	PROBE_INT_OCCUR	Board no.	Rd	Returns a value of 1 every time a probe input interrupt has occurred.
96	PROBE_SENSE	Board no.	Rd/Wr	Allows access to the probe sense control. Writing a value of 0/1 sets probe operation to active high/low.
97	PROBE_LED	Board no.	Rd/Wr	0 = Off, 1 =On, 2 = Auto
98	PROBE_SOUND	Board no.	Rd/Wr	0 = Off, 1 =On, n = time in ms
99	PROBE_FOOTSWITCH	Board no.	Rd/Wr	0 = Off, 1 = Auto, 2 = Auto (Inverted)

3.1.11 Probe information extended

Command & equate		Channel	Rd/Wr	Operation
100	PROBE_LATCH_SEL	Axis no.	Rd/Wr	Controls the source event of the ‘Probe’ associated latch of each axis.

Value	Source
0	Probe Occur
1	N/A (Read Counter)
2	Pulse Generator 0 Sync Occur
3	User Event 0 Occur
4	Channel Digital Input 0 Occur
5	Axis Compare 0 Sync Occur
6	Axis Compare 1 Sync Occur
7	N/A (Axis Compare 1 Enable)

101	PROBE_OUT_EN	Board no.	Rd/Wr	Enables the probe digital outputs. Specifying 1/0 in each bit field enables/disables the equivalent digital output.

Bit	Status	Pulse Width
0	Probe Occur	Occur to serviced
1	Footswitch Occur	Occur to serviced

3.1.12 Time-stamper information

Command & equate	Channel	Rd/Wr	Operation

110 TIMESTAMP_NOW	Board no.	Rd/Wr	Allows access to the current value of the 32-bit time-stamper register in units of 1μs.
111 TIMESTAMP_EVENT	Board no.	Rd	Allows access to the latched value of the 32-bit time-stamper register in units of 1μs.
112 TIMESTAMP_SEL	Board no.	Rd/Wr	Controls the source event of the Time-stamper latch.

Value	Source
0	Probe Occur
1	Timer 1 Sync Occur
2	User Event 0 Occur
3	Board Digital Input 0 Occur
4	Pulse Generator 0 Sync Occur
5	Axis Compare 0 Sync Occur
6	Axis Compare 1 Sync Occur
7	Reserved

3.1.13 Pulse generator information

Command & equate	Channel	Rd/Wr	Operation
120 PULSEGEN0	Axis no.	Rd/Wr	Allows access to the 16-bit pulse generator register in units of 1 quadrature count.
121 PULSEGEN0_MODE	Axis no.	Rd/Wr	Controls the mode of operation of the pulse generator.

Bit	Function
0	Direction when in Uni-directional mode (1/0 = +/-)
1	Bi-directional operation (1/0 = Bi-directional / Uni-directional)
2	Hardware Start/Stop by Axis Comparators (1/0 = On/Off)
3	Deglitch - Do not repeat the same pulse sequentially (1/0 = On/Off)

122 PULSEGEN0_EN	Axis no.	Rd/Wr	Writing a value of 1/0 enables/disables the pulse generator function.
123 PULSEGEN0_OCCUR	Axis no.	Rd	Returns a value of 1 every time a pulse generator interrupt has occurred.
124 PULSEGEN0_OUT_EN	Axis no.	Rd/Wr	Enables the pulse generator 0 digital outputs. Specifying 1/0 in each bit field enables/disables the equivalent digital output.

Bit	Status	Pulse Width
0	Pulse Generator 0 Occur	Occur to serviced
1	Pulse Generator 0 Terminal Count	Quadrature count width

125 PULSEGEN0_INT_VECT	Axis no.	Rd/Wr	Allows access to the interrupt vector or interrupt call-back executed by a pulse generator 0 interrupt.

3.1.14 Axis compare information

Command & equate	Channel	Rd/Wr	Operation
130 COMPARE0	Axis no.	Rd/Wr	Allows access to the 32-bit axis compare 0 register.
131 COMPARE0_FUNC	Axis no.	Rd/Wr	Writing a value of 1/0 enables/disables the axis compare 0 function.
132 COMPARE0_OCCUR	Axis no.	Rd	Returns a value of 1 every time an axis position compare 0 has occurred.
133 COMPARE0_OUT_EN	Axis no.	Rd/Wr	Writing a value of 1/0 enables/disables the axis compare 0 digital output.
134 COMPARE0_INT_VECT	Axis no.	Rd/Wr	Allows access to the interrupt vector or interrupt call-back executed by an axis compare 0 interrupt.
135 COMPARE1	Axis no.	Rd/Wr	Allows access to the 32-bit axis compare 1 register.
136 COMPARE1_FUNC	Axis no.	Rd/Wr	Writing a value of 1/0 enables/disables the axis compare 1 function.
137 COMPARE1_OCCUR	Axis no.	Rd	Returns a value of 1 every time an axis position compare 1 has occurred.
139 COMPARE1_INT_VECT	Axis no.	Rd/Wr	Allows access to the interrupt vector or interrupt call-back executed by an axis compare 1 interrupt.

3.1.15 User event information

Command & equate	Channel	Rd/Wr	Operation
140 USEREVENT0_OCCUR	Board no.	Rd/Wr	Returns a value of 1 every time a board user event 0 has been triggered and acknowledged. Writing any value triggers the board user event.
141 USEREVENT0_OUT_EN	I/O no.	Rd/Wr	Writing a value of 1/0 enables/disables the user event 0 digital output at the specified I/O bit, provided such mapping is possible.

3.1.16 Input event information

Command & equate	Channel	Rd/Wr	Operation
150 BOARD_INPUT_EN	Board no.	Rd/Wr	Writing a value of 1/0 enables/disables the equivalent board digital input positive edge detector.
151 BOARD_INPUT_OCCUR	Board no.	Rd	Returns a value of 1 every time a board digital input interrupt has occurred.
152 BOARD_INPUT_INT_VECT	Board no.	Rd/Wr	Allows access to the interrupt vector or interrupt call-back executed by an board digital input interrupt.

155	AXIS_INPUT_EN	Axis no.	Rd/Wr	Writing a value of 1/0 enables/disables the equivalent axis digital input positive edge detector.
156	AXIS_INPUT_OCCUR	Axis no.	Rd	Returns a value of 1 every time an axis digital input positive edge has occurred.
157	AXIS_INPUT_INT_VECT	Axis no.	Rd/Wr	Allows access to the interrupt vector or interrupt call-back executed by an axis digital input interrupt.

3.1.17 Digital I/O information

Command & equate	Channel	Rd/Wr	Operation
160 IO	I/O no.	Rd/Wr	Allows access to individual digital I/O register bits.
161 IO_DIR	I/O no.	Rd/Wr	Allows access to the direction of individual digital I/Os. This function only affects I/Os that can be individually configured. For further hardware details please refer to section **Error! Reference source not found.** '**Error! Reference source not found.**' of this manual.
165 IO_32	Reg no.	Rd/Wr	Allows access to 32 digital I/O register bits.
166 IO_32_DIR	Reg no.	Rd/Wr	Allows access to the direction of 32 digital I/Os. For I/Os whose direction can only be configured in groups, all bits of the group need to be set to the same direction. For further hardware details please refer to section **Error! Reference source not found.** '**Error! Reference source not found.**' of this manual.
169 NUM_IOS	N/A	Rd	Returns the total number of digital I/O available.

3.1.18 FIFO buffer information

The following tables list a number of tasks to be carried out when setting up and using a FIFO buffer.

Set up task	**Related Function(s)**
Configure buffer *clock* (which event triggers a data capture operation)	BUF_CLK_CHANNEL BUF_CLK_TYPE BUF_CLK_DIV
Configure buffer *data block* (how many and which *data elements* to be captured per buffer clock pulse)	BUF_NUM_DATA BUF_DATA_INDEX BUF_DATA_CHANNEL BUF_DATA_TYPE
Set buffer *size*	BUF_SIZE
Set buffer *mode*	BUF_MODE

Usage task	**Related Function**
Enable buffer	BUF_EN
Monitor amount of buffer contents	BUF_STATUS
Read buffer contents	BUF_READ

Command & equate	Channel	Rd/Wr	Operation
170 BUF_CLK_CHANNEL	Buffer no.	Rd/Wr	Controls the channel (timer / board / axis) of the event that triggers a buffer data capture.
171 BUF_CLK_TYPE	Buffer no.	Rd/Wr	Controls the type of event that triggers a buffer data capture.

Value	Timer Event
0	Timer 1 Occur
Value	**Board Event**
1	Probe Occur
2	Board Digital Input 0 Occur
3	User Event 0 Occur
Value	**Axis Event**
16	Marker Occur
17	Zero Occur
18	Pulse Generator 0 Occur
19	Axis Compare 0 Occur
20	Axis Compare 1 Occur
21	Channel Digital Input 0 Occur
22	SSI Read Complete Interrupt Occur

172 BUF_CLK_DIV Buffer no. Rd/Wr Controls the buffer clock divider.

173 BUF_NUM_DATA Buffer no. Rd/Wr Specifies the number of data elements to be captured in a FIFO buffer block, on each clock pulse.

174 BUF_DATA_INDEX Buffer no. Rd/Wr Selects which data element of a FIFO buffer block is accessed by data element functions BUF_DATA_CHANNEL and BUF_DATA_TYPE.

175 BUF_DATA_CHANNEL Buffer no. Rd/Wr Controls the channel (buffer / board / axis) of the data to be captured.

176 BUF_DATA_TYPE Buffer no. Rd/Wr Controls the type of data to be captured.

Value	Buffer Data	Note
0	Buffer clock counter	Resets on a buffer Enable, Flush or Configuration
Value	**Board Data**	
1	Time Stamp Now	See command 110 TIMESTAMP_NOW
2	Time Stamp Event	See command 111 TIMESTAMP_EVENT
3	Digital I/O	See command 165 IO_32
Value	**Axis Data**	
16	Timer Latch / SSI Latch	See command 48 TIMER_32 / 47 ABSOLUTE_32
17	Marker Latch	See command 41 MARK_32
18	Probe Latch	See command 46 PROBE_32
19	Incremental Position	See command 40 AXIS_32

180 BUF_SIZE Buffer no. Rd/Wr Allows the user to detect or specify the FIFO buffer size in data elements. Writing to this function disables and initialises data in the buffer. Buffer memory allocation succeeds if a non-zero value is returned.

181 BUF_MODE Buffer no. Rd/Wr Controls the mode of operation of the FIFO buffer.

Bit	Mode
0	Logging mode (1/0 = Discard old data when full / Discard new data when full)

182 BUF_EN	Buffer no.	Rd/Wr	Writing a value of 1/0 enables/disables FIFO buffer logging.
183 BUF_FLUSH	Buffer no.	Wr	Writing to this function clears the contents of the FIFO buffer. The value parameter passed to this command is ignored.
184 BUF_STATUS	Buffer no.	Rd	Allows access to the status register of the FIFO buffer.

Value	Status
-1	Overflow
0	Empty
+ve	Number of data elements currently in buffer

185 BUF_READ	Buffer no.	Rd	Returns a single data element from the FIFO buffer.
187 BUF_MEMFREE	Not used	Rd	Returns the total amount of free memory available to FIFO buffers in units of data elements.
188 BUF_MAXDATA	Not used	Rd	Returns the maximum number of data elements that can be captured by a FIFO buffer on each clock pulse.
189 NUM_BUFFERS	Not used	Rd	Returns the total number of FIFO buffers available to the system.

3.1.19 Software call-back information

Command & equate	Channel	Rd/Wr	Operation
200 NUM_LOSTCALLBACKS	Not used	Rd	Returns the number of lost software call-backs since this function was last read.

3.1.20 Optical edge detector

Command & equate	Channel	Rd/Wr	Operation
210 OPTICAL_LIGHT_LEVEL	Board no.	Rd	Returns the current light level in lowest 15 bits.
211 OPTICAL_INPUT	Board no.	Rd	Returns either 0 or 1 depending on the state of the probe input.
213 OPTICAL _FUNC	Board no.	Rd/Wr	Writing a value of 1/0 enables/disables the channel optical function. The optical function is level triggered by the optical input and the function reset automatically after execution of the function.
215 OPTICAL _INT_OCCUR	Board no.	Rd	Returns a value of 1 or 2 every time a optical input interrupt has occurred. 1=pos, 2=neg.
220 OPTICAL_TRIGGER_LEVEL	Board no.	Rd/Wr	Trigger level
221 OPTICAL_HYSTERESIS_LEVEL	Board no.	Rd/Wr	Hysteresis level.

222	OPTICAL_GAIN	Board no.	Rd/Wr	Sets the gain of the system / PGA for the optical light level. 1 to 256 (almost), scaled by 128 so use 128 to 32767.
223	OPTICAL_REF_LEVEL	Board no.	Rd	Returns the current reference light level.
224	OPTICAL_REF_GAIN	Board no.	Rd/Wr	Sets the gain of the system / PGA for the optical reference level. 1 to 256 (almost), scaled by 128 so use 128 to 32767.
225	OPTICAL_REF_NOM_LEVEL	Board no.	Rd/Wr	Sets the nominal reference level. A non zero value enables compensation of the signal input with respect to this reference level. Suggested value 80% of range 26214.

3.2 Function compatibility

No.	Equate	DEVA001 issue 3.x	DEVA001 issue 4.1	DEVA001 issue 4.2+, 5.0+	Deva037 issue 1.x
0	VECTOR	Yes	No	No	No
1	NUM_AXES	3, channel 0..2	3, channel 0..2	3, channel 0..2	3, channel 0..2
2	NUM_TIMERS	2, timer 1 for user only	2, timer 1 for user only	2, timer 1 for user only	No
3	NUM_INPUTS	6, input 0..5	0	0	0
4	NUM_DACS	0	0	0	0
5	NUM_OUTPUTS	0	0	0	0
7	NUM_BOARDS	0	0	Number of cards	Number of cards
8	CARD_TYPE	Yes	Yes	Yes	Yes
9	VERSION_NUM	Yes	Yes	Yes	Yes
10	CNT_16	Yes	Yes	Yes	Yes
11	MODE	Mode 5 or SSI_CMR	Mode 5 or SSI_CMR	INC or SSI mode	Mode 5
12	AXIS_SIZE	2 x 16 bits	2 x 16 bits	2 x 16 bits	2 x 16bits
13	ENCODER_TYPE	Yes	Yes	Yes	Yes
14	AXIS_INPUTS	No	No	Yes	Yes
15	AXIS_STATUS	No	No	Yes	Yes
16	AXIS_OUT_EN	No	No	Yes	No
19	NUM_CHANNELS_PER_BOARD				3
20	MARK_16	Yes	Yes	Yes	Yes
21	MARK_INPUT	Yes	Yes	Yes	Yes
22	MARK_INT	Yes	No	Yes	
23	MARK_FUNC	Yes	Yes	Yes	Yes
24	MARK_INT_VECT	Yes	Yes	Yes	No
25	MARK_INT_OCCUR	Yes	Yes	Yes	Yes
26	MARK_LATCH_SEL	Defaults to marker	Defaults to marker	Yes	No
27	MARK_OUT_EN	No	No	Yes	No
28	MARK_????	No	No	No	Yes
30	ZERO_INPUT	Yes, channel 0 shared with probe input	No	Yes	No
31	ZERO_INT	Yes	No	Yes	No
32	ZERO_FUNC	Zero function performed in software	No	Zero function performed in software	No
33	ZERO_INT_VECT	Yes	No	Yes	No
34	ZERO_INT_OCCUR	Yes	No	Yes	No
40	AXIS_32	32 bit hardware counter	32 bit hardware counter	32 bit hardware counter	Yes
41	MARK_32	32 bit hardware latch value	32 bit hardware latch value	32 bit hardware latch value	Yes
42	VEL_INST	Software generated using timer 1 interrupt system	Yes based on software timer	Yes	Yes
43	VEL_FILT	Software generated using timer 1 interrupt system	Yes based on software timer	Yes	Yes
44	ACCEL_INST	Software generated using timer 1 interrupt system	Yes based on software timer	Yes	Yes
45	ACCEL_FILT	Software generated using timer 1 interrupt system	Yes based on software timer	Yes	Yes
46	PROBE_32	32 bit hardware latch value	32 bit hardware latch value	32 bit hardware latch value	Yes
47	ABSOLUTE_32	Yes	Yes	Yes	No
48	TIMER_32	No	No	32 bit hardware latch value	No
49	OPTICAL_32	No	No	No	Yes

No.	Equate	DEVA001 issue 3.x .	DEVA001 issue 4.1	DEVA001 issue 4.2+, 5.0+	Deva037 issue 1.x
50	INPUT	Yes	No	No	No
60	TIMER	Timer 1 value x 0.1ms	Timer 1 value x 0.1ms *	Timer 1 value x 0.1ms	No
61	TIMER_INT	Timer 1	No	Yes	No
62	TIMER_INT_VECT	Timer 1	No	Yes	No
63	TIMER_INT_OCCUR	Timer 1	No	Yes	No
64	TIMER_LATCH_SEL	No	No	Yes	No
65	TIMER1_FUNC	No	No	Yes	No
66	TIMER_OUT_EN	No	No	Yes	No
70	DAC_MV	No	No	No	No
71	DAC_UV	No	No	No	No
80	OUTPUT	No	No	No	No
81	SERVO_ENABLE	No	No	No	No
90	PROBE_16	Yes	Yes	Yes	Yes
91	PROBE_INPUT	ZX / Renishaw option	Renishaw option	Renishaw option	Yes
92	PROBE_INT	Yes	No	Yes	Yes
93	PROBE_FUNC	Yes	Yes	Yes	Yes
94	PROBE_INT_VECT	Yes	Yes	Yes	Yes
95	PROBE_INT_OCCUR	Yes	Yes	Yes	Yes
96	PROBE_SENSE	Yes	No	No	Yes
97	PROBE_LED_MODE	Yes	Auto	Auto	Yes
98	PROBE_SOUND	Yes	Yes	Yes	Yes
99	PROBE_FOOTSWITCH	Yes	Yes	Yes	Yes
100	PROBE_LATCH_SEL	Defaults to probe	Defaults to probe	Yes	No
101	PROBE_OUT_EN	No	No	Yes	No
110	TIMESTAMP_NOW	No	No	Yes	No
111	TIMESTAMP_EVENT	No	No	Yes	No
112	TIMESTAMP_SEL	No	No	Yes	No
120	PULSEGEN0	No	No	Yes	No
121	PULSEGEN0_MODE	No	No	Yes	No
122	PULSEGEN0_EN	No	No	Yes	No
123	PULSEGEN0_OCCUR	No	No	Yes	No
124	PULSEGEN0_OUT_EN	No	No	Yes	No
125	PULSEGEN0_INT_VECT	No	No	Yes	No
130	COMPARE0	No	No	Yes	No
131	COMPARE0_FUNC	No	No	Yes	No
132	COMPARE0_OCCUR	No	No	Yes	No
133	COMPARE0_OUT_EN	No	No	Yes	No
134	COMPARE0_INT_VECT	No	No	Yes	No
135	COMPARE1	No	No	Yes	No
136	COMPARE1_FUNC	No	No	Yes	No
137	COMPARE1_OCCUR	No	No	Yes	No
139	COMPARE1_INT_VECT	No	No	Yes	No
140	USEREVENT0_OCCUR	No	No	Yes	No
141	USEREVENT0_OUT_EN	No	No	Yes	No

* 1ms granularity

No.	Equate	DEVA001 issue 3.x .	DEVA001 issue 4.1	DEVA001 issue 4.2+, 5.0+	Deva037 issue 1.x
150	BOARD_INPUT_EN	No	No	Yes	No
151	BOARD_INPUT_OCCUR	No	No	Yes	No
152	BOARD_INPUT_INT_OCCUR	No	No	Yes	No
155	AXIS_INPUT_EN	No	No	Yes	No
156	AXIS_INPUT_OCCUR	No	No	Yes	No
157	AXIS_INPUT_INT_VECT	No	No	Yes	No
160	IO	No	No	Yes	No
161	IO_DIR	No	No	No	No
165	IO_32	No	No	Yes	No
166	IO_32_DIR	No	No	Yes	No
169	NUM_IOS	No	No	Yes	No
170	BUF_CLK_CH	No	No	Yes	No
171	BUF_CLK_TYPE	No	No	Yes	No
172	BUF_CLK_DIV	No	No	Yes	No
173	BUF_NUM_DATA	No	No	Yes	No
174	BUF_DATA_INDEX	No	No	Yes	No
175	BUF_DATA_CH	No	No	Yes	No
176	BUF_DATA_TYPE	No	No	Yes	No
180	BUF_SIZE	No	No	Yes	No
181	BUF_MODE	No	No	Yes	No
182	BUF_EN	No	No	Yes	No
183	BUF_FLUSH	No	No	Yes	No
184	BUF_STAT	No	No	Yes	No
185	BUF_READ	No	No	Yes	No
187	BUF_MEMFREE	No	No	Yes	No
188	BUF_MAXDATA	No	No	Yes	No
189	NUM_BUFFERS	No	No	Yes	No
200	NUM_LOSTCALLBACKS	No	Yes	Yes	No
210	OPTICAL_LIGHT_LEVEL	No	No	No	Yes
211	OPTICAL_INPUT	No	No	No	Yes
213	OPTICAL_FUNC	No	No	No	Yes
215	OPTICAL_INT_OCCUR	No	No	No	Yes
220	OPTICAL_TRIGGER_LEVEL	No	No	No	Yes
221	OPTICAL_HYSTERESIS_LEVEL	No	No	No	Yes
222	OPTICAL_GAIN	No	No	No	Yes
223	OPTICAL_REF_LEVEL	No	No	No	Yes
224	OPTICAL_REF_GAIN	No	No	No	Yes
225	OPTICAL_REF_NOM_LEVEL	No	No	No	Yes

3.3 Device driver programming from 'C'

In order to simplify the user software required to access the Windows 8/7/Vista/XP device drivers, a selection of functions are supplied on the distribution CDROM. The functions are prototyped in the 'C' header file *enclib.h*. This section describes the 'C' functions provided for device driver access:

3.3.1 short open_encoder (void)

Opens the device driver and provides access to the functions provided.

Entry	:	none	
Exit	:	returns	0 if no error
		returns	-1 if error

3.3.2 void close_encoder (void)

Closes the device driver.

Entry	:	none	
Exit	:	returns	0 if no error
		returns	-1 if error

3.3.3 long read_encoder (short command, short channel)

Returns in a 32 bit integer the result of reading the device driver. See section 3.1 for a description of the command and channel parameters.

Entry	:	command	16 bit command
		channel	16 bit channel
Exit	:	returns	32 bit value

3.3.4 void write_encoder (short command, short channel, long value)

Writes a 32 bit integer to the device driver. See section 3.1 for a description of the command and channel parameters

Entry	:	command	16 bit command
		channel	16 bit channel
		value	32 bit value
Exit	:	none	

3.3.5 short enclib_callback (short receive, long priority);

Enables software call-backs. A user level function can be defined as call-back function by setting the function address (function pointer) as the interrupt vector value, using the appropriate *_INT_VECT function of section 3.1. Please note that this function is required only for Microsoft Windows operating systems. Call-backs are currently available only to a single software application / process.

Entry	:	receive	16 bit flag (1 to enable, 0 to disable)
		priority	32 bit call-back thread priority (defined in ‘winbase.h’) • For high speed operations: THREAD_PRIORITY_TIME_CRITICAL THREAD_PRIORITY_HIGHEST THREAD_PRIORITY_ABOVE_NORMAL THREAD_PRIORITY_NORMAL • For not real-time notifications: THREAD_PRIORITY_BELOW_NORMAL THREAD_PRIORITY_LOWEST THREAD_PRIORITY_IDLE
Exit	:	returns	0 if no error
		returns	1 if already enabled for this process
		returns	2 if a resource allocation error occurs

3.3.6 Example 'C' programming

```
/*---------------------------------------------------------------------------
     Example program to demonstrate device driver access
---------------------------------------------------------------------------*/
#include <stdlib.h>
#include <conio.h>
#include <stdio.h>
#include "enclib.h"
void main(void)
{
     long axis_position[12];       /* up to 4 cards x 3 axes */
     short num_channels;
     short i;
//   open device driver, exit if error
     if (open_encoder()==-1)
           exit(1);
//   read number of installed encoder channels
     num_channels=read_encoder(NUM_AXES,0L);

//   loop while not key pressed
     while(!kbhit())
           {
//         display axis positions
           for (i=0;i<num_channels;i++)
                         {
                         axis_position[i]=read_encoder(AXIS_32,i);
                         printf("%1u:%08lx ",i,axis_position[i]);
                         }
           printf("\r");
           }
//   close device driver
     close_encoder();
}
```

3.4 Device driver programming from Visual Basic

In order to simplify the user software required to access the Windows 8/7/Vista/XP 32/64 bit device drivers, a selection of Visual Basic functions is supplied on the distribution disk. The functions are declared in the *enclib.bas* module. This section describes the Visual Basic functions provided for device driver access:

3.4.1 Function open_encoder () As Integer

Opens the device driver and provides access to the functions provided.

Entry	:	none	
Exit	:	returns	0 if no error
		returns	-1 if error

3.4.2 Function close_encoder () As Integer

Closes the device driver.

Entry	:	none	
Exit	:	returns	0 if no error
		returns	-1 if error

3.4.3 Function read_encoder (ByVal com As Integer, ByVal chan As Integer) As Long

Returns in a 32 bit integer the result of reading the device driver. See section 3.1 for a description of the command and channel parameters

Entry	:	command	16 bit command
	:	channel	16 bit channel
Exit	:	returns	32 bit value

3.4.4 Function write_encoder (ByVal com As Integer, ByVal chan As Integer, ByVal value As Long) As Integer

Writes a 32 bit integer to the device driver. See section 3.1 for a description of the command and channel parameters

Entry	:	command	16 bit command
	:	channel	16 bit channel
	:	value	32 bit value
Exit	:	none	

3.4.5 Example Visual Basic programming

```
'---------------------------------------------------------------------------
'    Encoder card MSVB example
'---------------------------------------------------------------------------
Option Explicit
Dim Axes_name(1 To 12) As String
Dim Version_string As String
Dim Channel As Integer
Dim temp As Integer
Private Sub Form_Load()
    If (open_encoder() <> 0) Then
        Call MsgBox("Unable to load Driver Info", vbExclamation, "Digital
Read Out")
        End
    End If
    Call write_encoder(TIMER, 1, 10)
    Call write_encoder(TIMER_INT, 1, 1)

   For Channel = 1 To 3
        Call write_encoder(MARK_FUNC, Channel - 1, 1)
        Load LabelName(Channel)
        With LabelName(Channel)
            .Top = .Top + .Height * Channel
            .Visible = True
        End With
        Load LabelPosition(Channel)
        With LabelPosition(Channel)
            .Top = .Top + .Height * Channel
            .Visible = True
        End With
        Load LabelMark(Channel)
        With LabelMark(Channel)
            .Top = .Top + .Height * Channel
            .Visible = True
        End With
        Load LabelVelocity(Channel)
```

```
        With LabelVelocity(Channel)
            .Top = .Top + .Height * Channel
            .Visible = True
        End With
        Load LabelAccel(Channel)
        With LabelAccel(Channel)
            .Top = .Top + .Height * Channel
            .Enabled = True
            .Visible = True
        End With
    Next Channel
End Sub
Private Sub Form_Unload(Cancel As Integer)
    Call close_encoder
End Sub
Private Sub TimerUpdate_Timer()
    LabelName(1).Caption = "x"
    LabelName(2).Caption = "y"
    LabelName(3).Caption = "z"
    For Channel = 1 To 3
        LabelPosition(Channel).Caption = read_encoder(AXIS_32, Channel - 1)
        LabelMark(Channel).Caption = read_encoder(MARK_32, Channel - 1)
        LabelVelocity(Channel).Caption = read_encoder(VEL_INST, Channel - 1)
        LabelAccel(Channel).Caption = read_encoder(ACCEL_INST, Channel - 1)
    Next Channel
End Sub
```

3.5 Device driver programming from C# .Net

In order to simplify the user software required to access the Windows 8/7/Vista/XP 32/64 bit device drivers, a selection of .Net functions are supplied on the distribution disk as the enclibNet.dll. This section describes the .Net functions provided for device driver access.

The DEVA001 .Net assembly consists of a single namespace: “Deva”. In which is a single static class “Enclib”. Within Enclib, all necessary methods and types commonly found in the ‘C’ header file.

3.5.1 public static short open_encoder()

Opens the device driver and provides access to the functions provided.

Entry	:	none	
Exit	:	returns	0 if no error
		returns	-1 if error

3.5.2 public static void close_encoder()

Closes the device driver.

Entry	:	none	
Exit	:	returns	0 if no error
		returns	-1 if error

3.5.3 public static int read_encoder(short command, short channel)

Returns a 32bit integer, which contains the result from the device driver. See section 3.1 for a description of the command and channel parameters.

Entry	:	command	16 bit command
	:	channel	16 bit channel
Exit	:	returns	32 bit value

3.5.4 public static void write_encoder(short command, short channel, int value)

Writes a 32bit integer to the device driver. See section 3.1 for a description of the command and channel parameters

Entry	:	command	16 bit command
	:	channel	16 bit channel
	:	value	32 bit value
Exit	:	none	

3.5.5 Example C# programming

```
/*------------------------------------------------------------------------------
 *    Encoder card MSCS example
 * -----------------------------------------------------------------------------*/

using System;
using Deva;

namespace Deva_mscsExample
{
  class Program
  {
    static void Main()
    {
      Console.WriteLine("DEVA001 MSC# Example");

      int num_channels = 12;  /* up to 4 cards x 3 axes */
      int[] axis_position = new int[num_channels];

      //open device driver, exit if error
      if (Enclib.open_encoder() == -1)
        return;

      //read number of installed encoder channels
      num_channels = Enclib.read_encoder((short)Enclib.COMMANDS.NUM_AXES, 0);

      //loop while key not pressed
      while(!Console.KeyAvailable)
      {
        //display axis positions
        for (short index = 0; index < num_channels; index++)
        {
          axis_position[index] = Enclib.read_encoder((short)Enclib.COMMANDS.AXIS_32, index);
          Console.WriteLine("Axis:" + index.ToString() + "\tPosition: " +
axis_position[index]);
        }
        Console.SetCursorPosition(0, 1);
      }

      //close device driver
      Enclib.close_encoder();
    }
  }
}
```

4 USB incremental encoder interface hardware

4.1 Functional description

The DEVA037 is designed to interface up to three incremental encoders or linear scales to the USB bus. The following sections describe the various functions of the interface.

4.1.1 Quadrature input

Each encoder channel has four differential / single ended input circuits designated A, B, Z and M. The A and B inputs accept the quadrature signals from the encoder and drive an up/down counter via a x4 directional discriminator circuit. The counter has 32bit resolution and may be read at any time. The maximum count rate is in excess of 10MHz.

4.1.2 Marker input

The M input circuit designated marker is a positive edge triggered input which can synchronously latch the counter value. To gain the most accurate result the input conditioning circuit latches the counter when both A and B inputs are at a logic one level. The user must therefore phase the A and B signals carefully to meet this criteria. Should this not be achievable circuit operation is still possible although the latched value will not be accurate to a single count. Correct phasing may also be achieved by using the input invertors on signals A, B & M.

To use the marker input the marker circuit must be enabled. Once a positive edge has occurred on the marker input the counter is latched when both A and B are at logic one. The marker latch register may now be read while the counter continues to maintain position. To enable the maker latch to capture a further marker event the marker function should be disabled and then re-enabled. Marker synchronisation with signals A & B can optionally be disabled.

4.1.3 Zero input

The Z input circuit designated zero is a positive edge triggered input which can asynchronously latch the counter value. It has been provided to maintain compatibility with previous issues and offer more flexibility when connecting encoders. The marker function which accurately latches the counter value is equally suited to performing a zero type operation by using the latched value as an offset which is subsequently subtracted from the counter reading.

4.1.4 Touch Probe Interface

The DEVA037 incorporates a touch probe input. This input provides the correct signal conditioning to allow a volt-free contact type touch probe to be used. The probe function works like the marker function but latches all three axis counters simultaneously. Unlike the marker function it operates asynchronously and hence does not require that the A and B signals are at a logic one level. The probe function has its own enable bit.

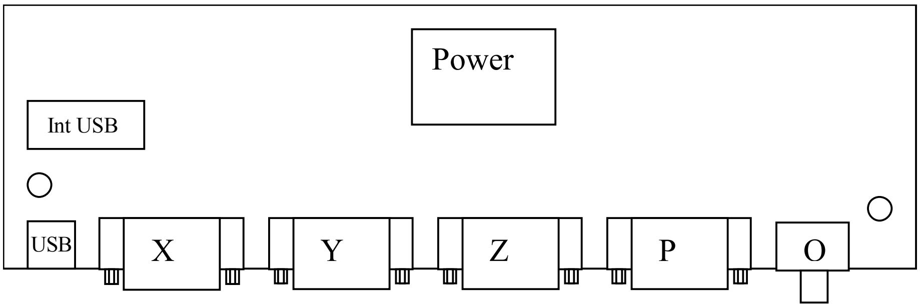
The card also incorporates an output to drive the probe led, an output to drive an audible sounder and a further input to allow the probe to be controlled via a footswitch.

4.2 Optical edge detector input.

The Deva037 incorporates a dual input optical edge detector system. Encoder positions can be latched when the optical level present at the signal input crosses a pre-programmed threshold. Furthermore the reference input can be used improve the signal quality by receiving light from the illumination source and cancelling out any disturbances present in the light signal.

4.3 Connection details

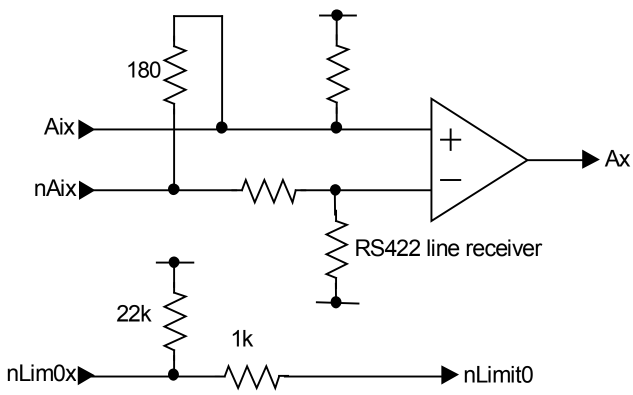
The layout of the DEVA037 is shown below.



4.3.1 Encoder input connections

Each encoder is connected via a 15 way female HD-type connector in accordance with the following pin-out table and simplified input circuit.

Pin Number	Signal	Function
1	Ai	A phase input
2	Bi	B phase input
3	Zi	Zero input
4	Mi	Marker input
5	nLim0	nLimit 0
6	nAi	nA phase input
7	nBi	nB phase input
8	nZi	nZero input
9	nMi	NMarker input
10	nLim1	nLimit 1
11	+12V	+12 volts supply
12	+5V	+5 volt supply
13	0V	0 volt common
14		
15		



Note: Do not connect the 15 way HD-type plug from a VGA monitor into one of the encoder input channels, as damage may result.

4.3.1.1 Input signal descriptions

The Ai & nAi, Bi & nBi inputs are differential pairs for connection to the A-phase and B-phase quadrature outputs of an incremental encoder.

The Mi & nMi inputs are differential inputs for the channel marker signal. This function will latch the counter reading for the relevant channel, allowing an accurate reading of the position of a moving encoder to be made at a specific instant. The marker function does not stop the counter itself, which is able to continue reading the encoder position and so it will not cause the card to lose track of the system's datum position.

The Zi & nZi may be used as an alternative to the Mi & nMi inputs. In this case the driver will zero the counter readings in software.

The inputs nLim0 and nLim1 are digital inputs intended to be used to connect normally closed overtravel inputs.

The differential inputs use RS422 levels which accept OV for logic low, and from +5V to +12V for logic high. Because they are differential inputs, one input should be low when the other is high. For Example, to trigger the marker function, set Mi input to high, and set nMi input to low. To turn the marker function off, reverse these voltages.

An internal resistor network is provided which allows connection of single ended signals to the non-inverting inputs.

The +/- 12V and +5V power supply pins may be used to supply the dc power requirements for the encoders and are derived from the external power connector.

4.3.2 Touch probe input connections

A touch probe, footswitch and sounder may be connected via a 9 way female 'D' connector with reference to the following pin-out table.

Pin Number	Signal	Function
1	Led C	Led cathode
2	0v	(0v)
3	Led A	Led anode
4	Probe +	Probe
5	Probe -	(0v)
6	Sounder +	Siren +5v
7	Sounder -	(0v)
8	FootSw +	Footswitch input
9	FootSw -	(0v)

4.3.3 USB connection

USB connection will be via a B connector.

The internal USB connection will be via a 4-pin header.

Pin Number	Signal
1	+5v
2	Data0-
3	Data0+
4	0v

4.3.4 Internal Encoder Power

The internal encoder power will be via a 4-pin right angle male molex 8981 connector. The +5v and +12v from this connector are routed via 1amp resettable fuses to the encoder connections.

Pin Number	Signal
1	+12v
2	0v
3	0v
4	+5v

4.3.5 Optical

Optical connections will be via a Fibre-SMA connector. The optical signal connector is at the bottom of the stack and the reference connector is at the top of the stack.

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