

## USB JOYSTICK INTERFACE

The Apem Components USB Joystick Interface is designed to connect a Joystick with up-to 3 analogue axes, 16 buttons and 4 LEDs to a USB port on a PC or Mac®.

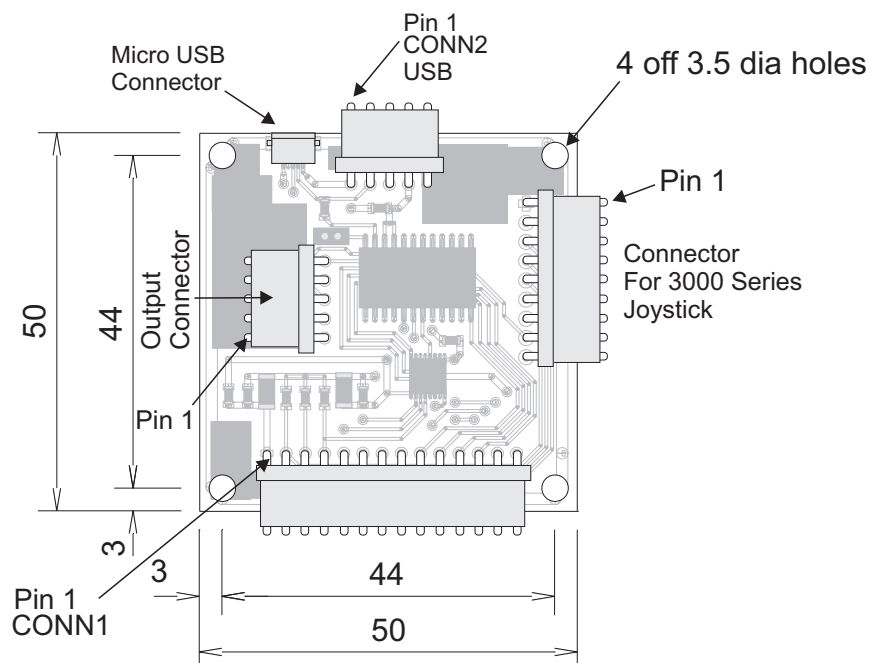
We have utilised a 'JoyWarrior' controller chip from Code Mercenaries® for controlling the USB interface.

The interface is fully USB V1.1/2.0 and HID 1.1 compliant. It is compatible with standard system drivers, so no special drivers are required.

There are 3 analogue inputs for X, Y and Z axes with 10 bit resolution and connections for up-to 8 directly connected pushbuttons or 16 in a matrix. There are 4 outputs for driving auxillary functions. The most common application would be for driving LED indicators.

Apem manufacture a huge range of LED indicators, (Apem Q Series) and switch products. Please refer to [www.apem.com](http://www.apem.com) for full details.

The interface board measurements and mounting points are shown below:



USB connection is made via either a 5 way 2.54mm pitch Molex® KK style header or a Micro USB type B socket on the board. A suitable USB cable (1.5m long) is included.

The joystick connects to Conn1, a 14 way 2.54mm pitch Molex KK style header.

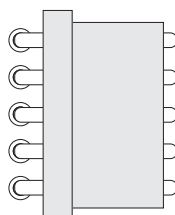
A separate 9 way connector is fitted to allow direct connection of a 3000 Series Joystick having a standard connector.

4 open drain outputs are also available on a 5 way Molex KK style header to enable you to drive LEDs.

Please refer to the pin-outs below:

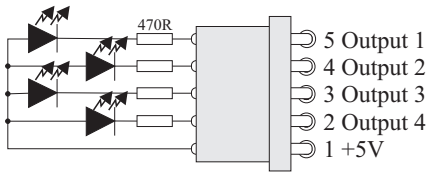
Conn 2 (USB) :

Pin 1 +5V  
Pin 2 D-  
Pin 3 D+  
Pin 4 0V  
Pin 5 Screen



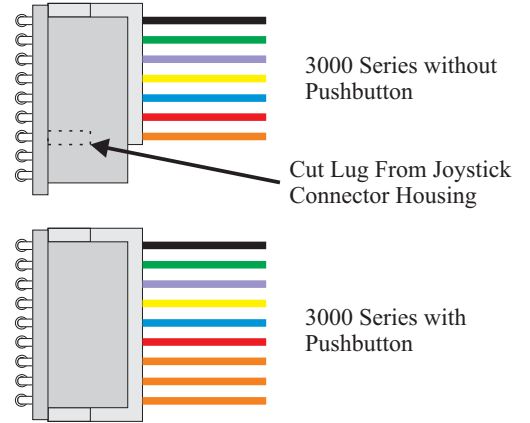
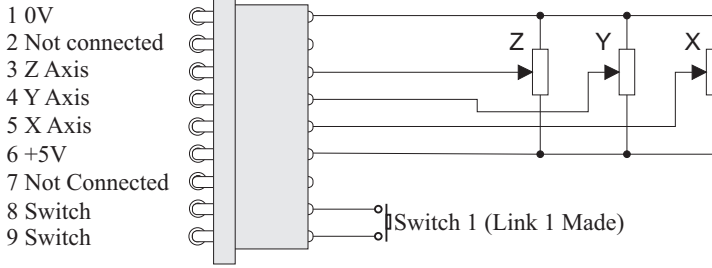
Note: The 4 external mounting holes are connected to the USB cable screen

## Output Connections:



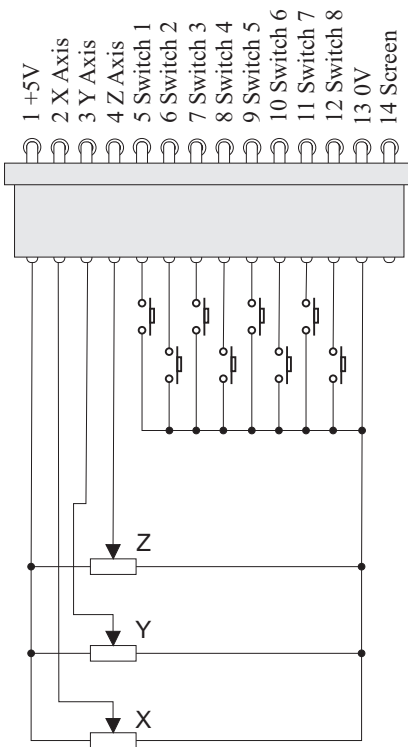
Each Output is capable of driving 50mA  
(up to a total of 70mA for all 4 outputs)

## 3000 Series Joystick Connector:

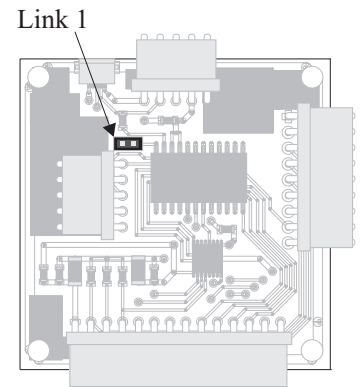
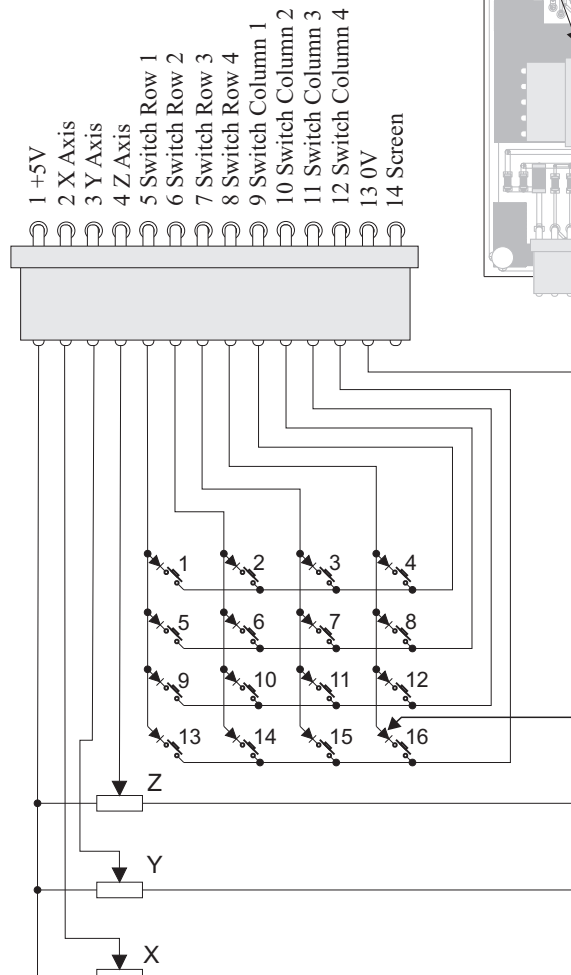


## Conn 1 Joystick:

Direct  
Switch  
Connection  
for 8 switches  
(Link 1 Made)



Matrix  
Switch  
Connection  
for 16 switches  
(Link 1 Not Made)



A diode is needed in series with each switch on matrix.

### **DATA FOR THE 'JOYWARRIOR®' CHIPSET**

#### **Device Operation**

By following the USB HID specifications JoyWarrior chips are able to work with most operating systems without the need to supply special drivers. Any operating system with support for USB HID game controllers will have the necessary drivers already in place.

#### **Operation with Windows®**

Any Windows® versions 98 and newer & 2000 and newer will work with JoyWarrior. Older versions of Windows® do not support USB.

Upon connecting a JoyWarrior based device for the first time you will be asked to perform the standard driver install. The same happens if you connect the device to a different USB port on the same computer.

After the driver installation has completed you should be able to see the device in the "Game Controllers" control panel and be able to access it via DirectInput.

#### **Operation with MacOS®**

MacOS 9.0 and up and MacOS X do support JoyWarrior direct. Some versions of MacOS 8.x do support USB as well, though their use is not recommended.

On MacOS X access is available via the HIDManager.

There will be no warnings or dialogs when a properly functioning JoyWarrior based device is connected under MacOS, it will simply start to work.

#### **Joystick axis orientation**

USB specifies the axis orientation as follows:

For the X axis values should increase for left to right movement, Y axis values increase for far to near movements (i.e. pulling the stick gets you larger values), Z axis values should increase for high to low movement.

#### **Non Joystick Applications**

USB does allow a Human Interface Device controller to very detailed specify the function of axes and buttons. This gives a game controller device the option to specify a certain axis to be a throttle or break or something else.

The standard JoyWarrior chips are for general use, so the analog axes variants just specify X, Y, Z and the switch inputs are defined as being just buttons.

#### **Remote Wakeup**

All JoyWarrior chips support the remote wakeup feature. They are able to wake the host computer from sleep state if the host operating system does enable this feature.

Remote wakeup is initiated by JoyWarrior if any button is pressed or if any switch of the direction pad closes. Changes on the analog axes are not detected.

#### **Auxiliary outputs on JW24A10L**

The JoyWarrior24A10L

chip has four auxiliary outputs that may be used to drive LED indicators or for other applications. Due to the significant current sinking capability of the outputs they are defined as being active low. Setting the outputs is done by sending a four byte feature report to the joystick device. In most cases this can be done via standard file I/O functions.

The outputs are set by one byte each, the first byte sets Aux0, second Aux1 etc.

The bits in the bytes do have the following meaning:

- 7 - reserved, write 0
- 6 - reserved, write 0
- 5 - reserved, write 0
- 4 - reserved, write 0
- 3 - Invert blink mode
- 2 - reserved, write 0
- 1 - Mode MSB
- 0 - Mode LSB

The mode bits determine the behaviour of the output. Following are the combinations (MSB/LSB):

- 00 - Output idle (high)
- 01 - Output static on (low)
- 02 - Fast blink mode (1/8th second on/off)
- 03 - Heartbeat blink mode
- 0A - Inverted fast blink mode
- 0B - Inverted heartbeat blink mode

Heart beat mode switches the output low for 1/16th second, then high for 1/16th, again low for 1/16th and then idles high for 13/16th seconds.

The invert bit reverts the output status for the blink modes (no effect on static on/off), this allows to have two indicators blink in an exactly alternating pattern.

The output status and blinking is maintained by the JoyWarrior without further host interaction until a new configuration is sent. All outputs go to idle when the JoyWarrior enters suspend mode.

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### Absolute Maximum Ratings

Storage Temperature .....	-65°C to +150°C
Ambient Temperature with power applied.....	-0°C to +70°C
Supply voltage on Vcc relative to Gnd .....	-0.5V to +7V
DC input voltage.....	-0.5V to Vcc+0.5V
Maximum current into all ports.....	70mA
Power Dissipation.....	300mW
Static discharge voltage.....	>2000V
Latch-up current .....	>200mA

### DC Characteristics

	Parameter	Min	Max	Units	Remarks
V <sub>cc</sub>	Operating Voltage	4.35	5.25	V	
I <sub>cc</sub>	Operating Supply Current		20	mA	
I <sub>sb</sub>	Suspend mode current		25	μA	Oscillator off
I <sub>ol</sub>	Sink current on output pins		2	mA	V <sub>out</sub> = 0.4V
R <sub>up</sub>	Pull-up Resistance	8	24	kΩ	
I <sub>olaux</sub>	Sink current into Aux pins		50	mA	V <sub>out</sub> = 0.8V
I <sub>ohaux</sub>	Source current from Aux pins		2	mA	V <sub>out</sub> > V <sub>cc</sub> -2V
I <sub>snk</sub>	Combined sink current to all pins		70	mA	Cumulative across all ports
V <sub>ith</sub>	Input Threshold Voltage	40%	60%	V <sub>cc</sub>	
	<b>USB Interface</b>				
V <sub>oh</sub>	Static output high	2.8	3.6	V	15kΩ +/- 5% to Gnd
V <sub>ol</sub>	Static output low		0.3	V	
V <sub>di</sub>	Differential Input sensitivity	0.2		V	(D+)-(D-)
V <sub>cm</sub>	Differential Input common Mode Range	0.8	2.5	V	
V <sub>se</sub>	Single Ended Transceiver Threshold	0.8	2.0	V	
C <sub>in</sub>	Transceiver capacitance		20	pF	
I <sub>io</sub>	Hi-Z State Data Line Leakage	-10	10	μA	0V < V <sub>in</sub> < 3.3V, Hi-Z State
R <sub>pu</sub>	Bus Pull-up resistance	1.274	1.324	kΩ	
R <sub>pd</sub>	Bus Pull-down resistance	14.25	15.75	kΩ	15kΩ +/- 5%

### AC Characteristics

	Parameter	Min	Max	Units	Remarks
	<b>USB Driver Characteristics</b>				
t <sub>r</sub>	Transition rise time	75		ns	C <sub>Load</sub> = 200pF
t <sub>r</sub>	Transition rise time		300	ns	C <sub>Load</sub> = 600pF
t <sub>f</sub>	Transition fall time	75		ns	C <sub>Load</sub> = 200pF
t <sub>f</sub>	Transition fall time		300	ns	C <sub>Load</sub> = 600pF
t <sub>r/m</sub>	Rise/Fall Time matching	80	125	%	
V <sub>crs</sub>	Output signal crossover voltage	1.3	2.0	V	
	<b>USB Data Timing</b>				
t <sub>drate</sub>	Low Speed Data Rate	1.4777	1.5225	MBit/s	
t <sub>djr1</sub>	Receiver data jitter tolerance	-75	75	ns	To next transition
t <sub>djr2</sub>	Receiver data jitter tolerance	-45	45	ns	For paired transitions
t <sub>deop</sub>	Differential to EOP transition skew	-40	100	ns	
t <sub>eopr2</sub>	EOP width at receiver	670		ns	Accepts as EOP
t <sub>eopt</sub>	Source EOP width	1.25	1.50	Os	
t <sub>udj1</sub>	Differential driver jitter	-95	95	ns	To next transition
t <sub>udi2</sub>	Differential driver jitter	-150	150	ns	To paired transition

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### USB VendorID and ProductID

By default all JoyWarrior chips are shipped with the USB VendorID of Code Mercenaries (\$7C0 or decimal 1984) and a fixed ProductID.

Following is the ProductID for the JoyWarrior controller:

JoyWarrior24A10L	\$1118
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## USB JOYSTICK INTERFACE

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### **Using the Joystick to Control the Mouse Pointer and Defining the Function of the Buttons**

There are software utilities available to download from the internet that allow the user to define the function of the buttons as well as allowing the joystick to control the mouse pointer.

#### **Joystick to mouse conversion.....**

'Joystick To Mouse'

<http://www.imgpresents.com/joy2mse/j2m.htm>

'Joystick 2 Mouse V3'

<http://www.tucows.com/preview/292788>

'Jmouse 1.0'

<http://www.newfreedownloads.com/Desktop-Utilities/Miscellaneous/jmouse.html>

#### **Joystick Configuration & Keyboard mapping.....**

'Total Game Control'

<http://www.newfreedownloads.com/Games/Tools-and-Editors/Total-Game-Control.html>

'Pinnacle Game Profiler'

<http://www.pinnaclegameprofiler.com>

'AutoHotKey' (Assigns macros to mouse keyboard and joystick)

<http://www.newfreedownloads.com/Windows-Utilities/Automation/AutoHotkey.html>

#### **Program for testing the interface and the four outputs.....**

'SimpleHIDWrite'

<http://www.lvr.com/files/SimpleHIDWrite3.zip>

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