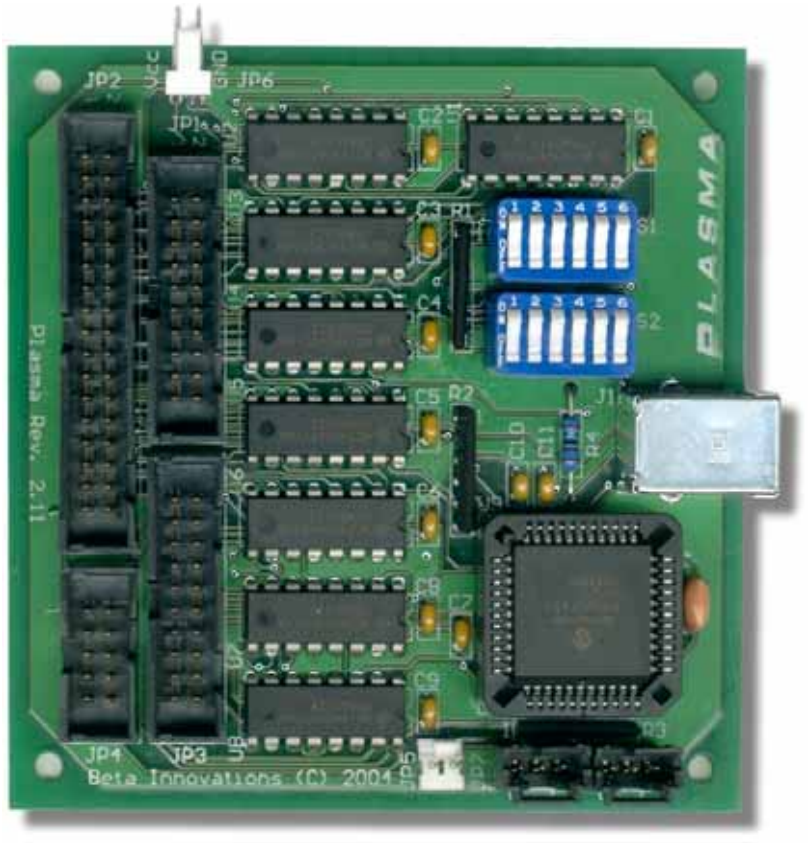
Plasma V2 USB Module



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Rev. : **A7-211**
Date : **5, 2004**
Firmware Rev. : **600-210**

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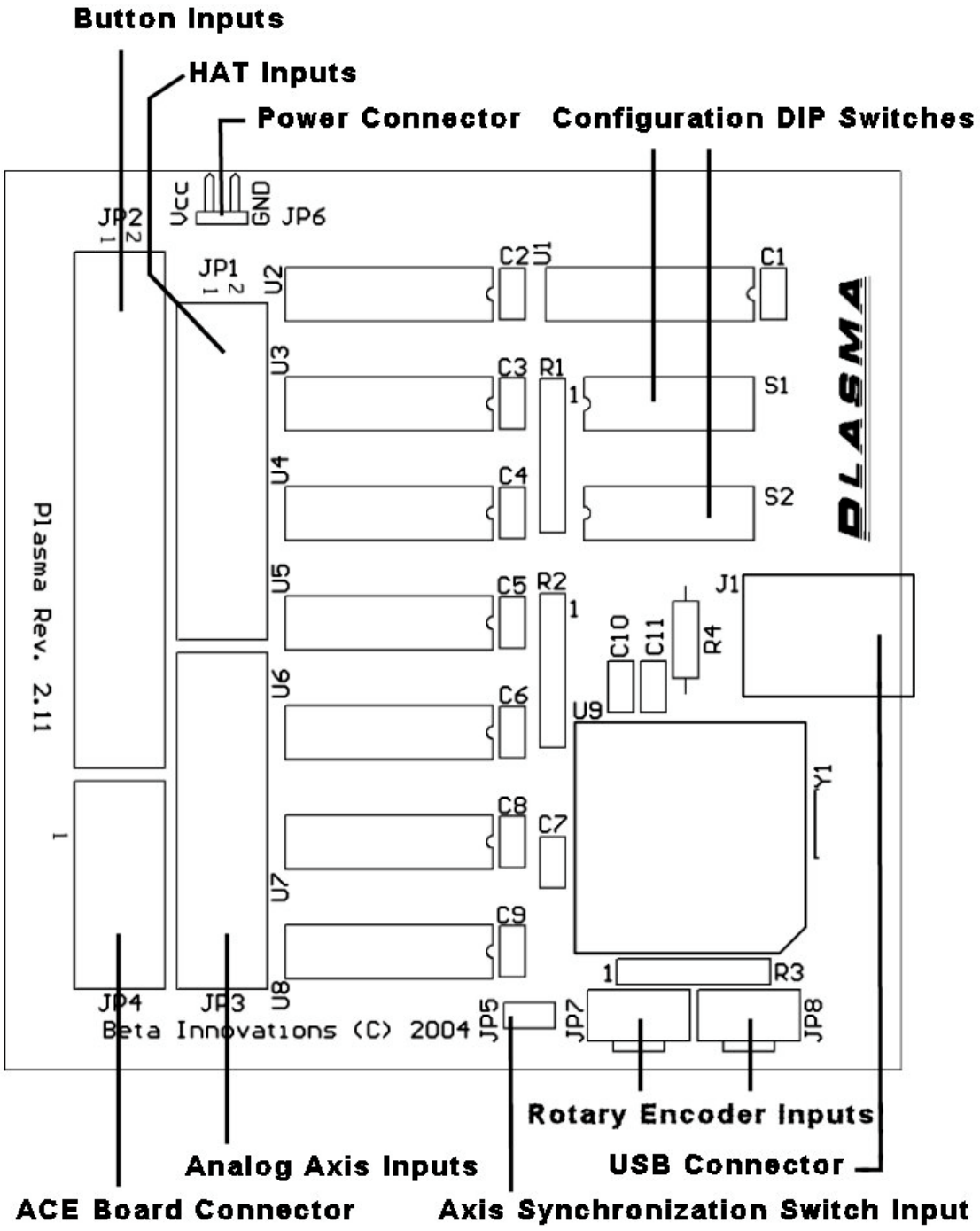
Plasma USB Module



Main Features

- **Easy installation**
  The Plasma device is a Low Speed USB HID compliant device, which uses default drivers and powered by the USB Bus.

- **Analog Axis Input**
  Supports a variety of input devices including, Potentiometers, Hall Effect sensors, and pressure transducers or force sensors for precise control.

- **Digital Axis Input**
  Supports up to 4 ACE (Absolute Contacting Encoder) rotaries through a separate daughter board.

- **Filtering Algorithm**
  Features a proprietary selectable 2 level *Recursive Moving Delta Sigma* filtering algorithm virtually eliminating noise, spike and jitter for stable output.

- **Axis Resolutions**
  Selectable analog axis resolution from 32 to 256 steps (128 steps max for ACE rotaries).

- **POV HAT Support**
  Up to 4 Digital 8-way POV HAT inputs.

- **Button Inputs**
  Up to 32 button inputs in NON-HOTAS mode and 60 in HOTAS mode (Active Low) compatible with any kind of switch: toggle, push button, etc.

- **Trim Switch / Rapid Fire Inputs**
  Up to 4 rapid fire inputs producing 10 pulses per second which can be used for trim switch functions.

- **Buffered Rotary Encoder Support**
  Dedicated channels for up to 2 rotary encoders (2 bit gray code). Buffered outputs prevent lost inputs when rotaries are turned rapidly.

- **Analog Axis Synchronization**
  Up to 4 analog axis inputs can be synchronized to eliminate asymmetric thrust on multi-lever throttles due to linearity differences between potentiometers or any other input devices.

- **4 Modes of Operation**
  Selectable *SINGLE* or *DUAL* device mode. Enumerates as 8X16B1R2H (8 axis, 16 buttons, 1 rotary, 2 HATs) device in *SINGLE* mode or two 8X16B1R2H devices in *DUAL* mode configuration as a USB Composite device.

  Selectable *HOTAS* mode. Enumerates as 8X30B1R2H device in *SINGLE* mode or two 8X30B1R2H in *DUAL* mode configuration as a USB Composite device.

Introduction

The Plasma USB adapter is comprised of 4 devices in 1 and configurable through mode selection switches (Figure 1). In each mode, the Plasma unit will enumerate as a new and unique USB device in the configuration manager and in the Gaming Options Applet on MS Windows systems.

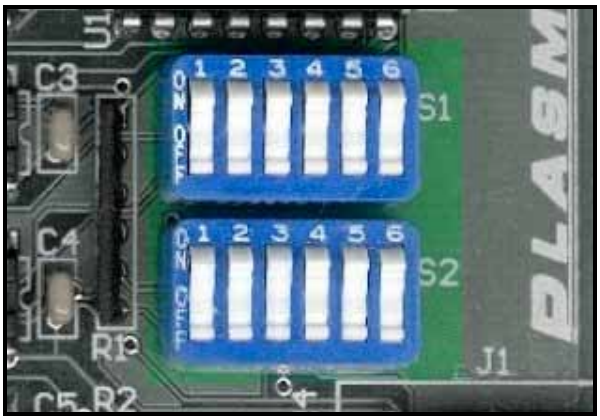


Figure 1

The 4 modes of operation are:

Mode A: ***Plasma - USB Adaptor***
Device 1 – 8 axis, 14 buttons, 2 Rapid Fire inputs, 1 Rotary Encoder and 2 POV HATS

Mode B: ***Plasma - Dual USB Adaptor***
Device 1 – 8 axis, 14 buttons, 2 Rapid Fire inputs, 1 Rotary Encoder and 2 POV HATS
Device 2 – 8 axis, 14 buttons, 2 Rapid Fire inputs, 1 Rotary Encoder and 2 POV HATS

Mode C: ***Plasma HOTAS - USB Adaptor***
Device 1 – 8 axis, 30 buttons, 1 Rotary Encoder and 2 POV HATS

Mode D: ***Plasma HOTAS - Dual USB Adaptor***
Device 1 – 8 axis, 30 buttons, 1 Rotary Encoder and 2 POV HATS
Device 2 – 8 axis, 30 buttons, 1 Rotary Encoder and 2 POV HATS

The various modes can be selected without having to disconnect the device from the USB bus. The OS will automatically detect the new configuration and install the appropriate drivers.

Plasma Configuration

The Plasma module has several user adjustable DIP switches that allow the configuration of various onboard systems, features and device modes.

Mode Selection DIP Switches

Mode selection DIP switches (Figure 2: S1 – switch 1 & switch 2) are used to set the device in one of four possible modes of operation.

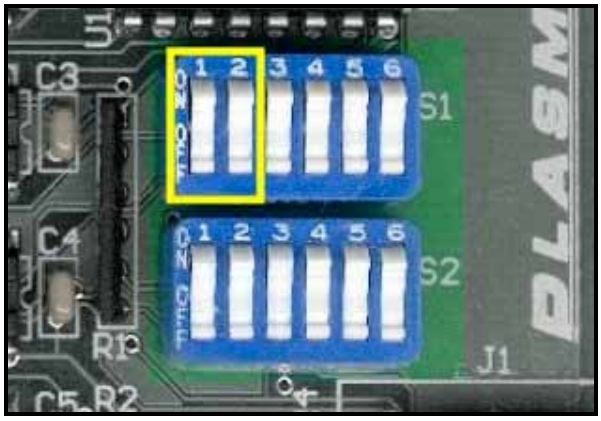


Figure 2

DIP Switch S1:

Switch 1 – DUAL mode switch
Switch 2 – HOTAS mode switch

Modes of Operation:

Mode A: *Plasma - USB Adaptor*
- S1 – Switch 1: OFF
- S1 – Switch 2: OFF

Mode B: *Plasma - Dual USB Adaptor*
- S1 – Switch 1: ON
- S1 – Switch 2: OFF

Mode C: *Plasma HOTAS - USB Adaptor*
- S1 – Switch 1: OFF
- S1 – Switch 2: ON

Mode D: *Plasma HOTAS - Dual USB Adaptor*
- S1 – Switch 1: ON
- S1 – Switch 2: ON

Configuration Selection DIP Switches

Configuration selection DIP switches (Figure 3) can be used to activate additional features and affect all modes of operation.

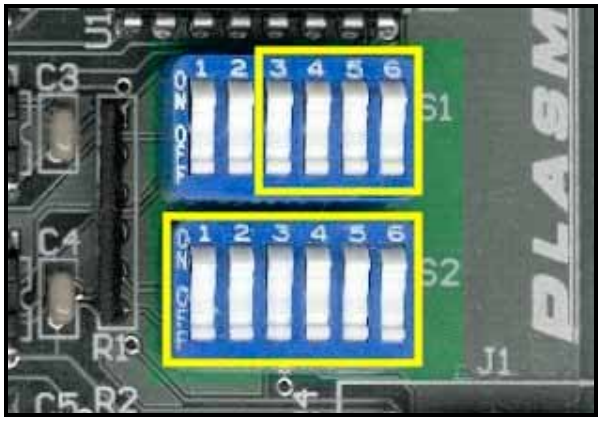


Figure 3

DIP Switch S1:

Switch 3 – **Level 1 Analog Axis Filter**, Device 1
Switch 4 – **Level 2 Analog Axis Filter**, Device 1 (Level 1 must be active)
Switch 5 – **Level 1 Analog Axis Filter**, Device 2
Switch 6 – **Level 2 Analog Axis Filter**, Device 2 (Level 1 must be active)

DIP Switch S2:

Switch 1 – **ACE Rotaries on X & Y Axis**, Device 1
Switch 2 – **ACE Rotaries on Z & Rx Axis**, Device 1
Switch 3 – **Axis Synchronization**, Device 1
Switch 4 – **2 / 4 Axis Synchronization**, Device 1
Switch 5 – **Analog Axis Resolution** LSB (Least Significant Bit)
Switch 6 – **Analog Axis Resolution** MSB (Most Significant Bit)

Configuration Options

Level 1 Analog Axis Filter: is adequate for eliminating a substantial amount of jitter (noise), but has poor attenuation properties on spikes and extreme cases of line noise. This level of filtering has no noticeable effect on input sensitivity.

Level 2 Analog Axis Filter: virtually eliminates most forms of spiking and line noise but may adversely affect input sensitivity. As a result, level 2 filtering should only be activated when absolutely necessary. Level 2 filtering will only work in conjunction with level 1 filtering therefore level 1 filtering *must be turned ON*.

NOTE: ACE rotaries are not filtered due to their digital nature.

To activate filtering on either device, toggle ON the appropriate dip switch on S1.

A substantial improvement was made over the filtering algorithm used in the previous version of Plasma with the addition of a user selectable level of filtering for jitter (noise) and spikes, the two most common drawbacks associated with potentiometers.

In certain instances where raw input data is preferred, reducing the axis resolution can be sufficient to effectively eliminate these undesired elements.

ACE Rotaries – If you have connected an ACE add-on board to your Plasma unit you can activate the unit by toggling ON switch 1 and/or 2 on S2.

ACE Rotaries on X & Y Axis – Toggling ON switch 1 on S2, ACE rotary digital data will be used for the X & Y axis inputs. The X and Y analog axis ports on Device 1 will no longer be active and ACE digital data will be used instead.

ACE Rotaries on Z & Rx Axis – Toggling ON switch 2 on S2, ACE rotary digital data will be used for the Z & Rx axis inputs. The Z and Rx analog axis ports on Device 1 will no longer be active and ACE digital data will be used instead.

NOTE: ACE axis data cannot be diverted to any other analog axis ports. ACE's are only available on device 1 of the Plasma unit in all modes of operation and are ideally suited for throttle levers.

Axis Synchronization – Device 1 is equipped with an analog axis synchronization feature. Switch 3 will activate this feature and can be toggled ON/OFF through a momentary push button switch connected to JP5.

2 / 4 Axis Synchronization – If switch 4 is set to OFF, only the X & Y axis on device 1 will be synchronized. When switch 4 is set to ON, X, Y, Z and Rx axis will be synchronized. Synchronization can be toggled ON/OFF through a momentary push button switch connected to JP5.

Analog Axis Resolution – All analog axes have 4 pre-settable axis resolutions. One setting affects all analog inputs on the Plasma unit. The step number represents the maximum number of possible discrete positions on the output.

DIP Switch S2:
Switch 5 – Analog Axis Resolution LSB
Switch 6 – Analog Axis Resolution MSB

32 step resolution:
Switch 5 – off
Switch 6 – off
64 step resolution:
Switch 5 – on
Switch 6 – off
128 step resolution:
Switch 5 – off
Switch 6 – on
256 step resolution:
Switch 5 – on
Switch 6 – on

The higher the step size the more likely the output will suffer from the effects of jitter due to the LSB uncertainty in the ADC conversion process. As such, there is a trade off between resolution and stability of the output signal. The output signal stability is also heavily dependent on the use of high quality input devices (i.e Hall Sensors, Potentiometers, etc.). Therefore, activation of the digital filter is recommended if a clean stable signal is required at the output while maintaining a high degree of step size and resolution.

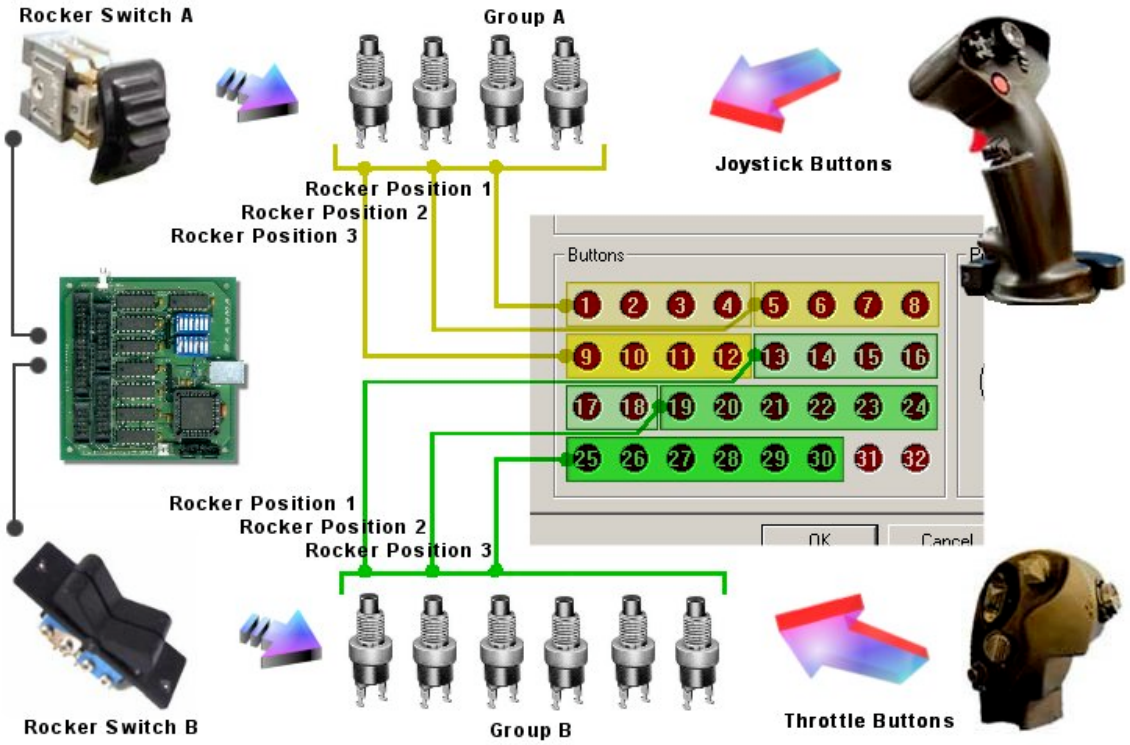
Plasma HOTAS Modes C & D

Plasma HOTAS (Hands On Throttle And Stick) mode is nothing more than system of generating 3 different functions per switch when pressed, based on the position of a master rocker switch. Incorporating this added functionality onto a stick and throttle effectively triples the number of physical switch inputs.

In the Plasma HOTAS system, 10 physical switches can have 30 different functions thus allowing pilots the luxury of keeping their hands on both the throttle and stick and still have access to a plethora of cockpit functions at their fingertips. This avoids the possible deadly distraction of looking down at an avionics panel to toggle that all too important switch during an intense dogfight.

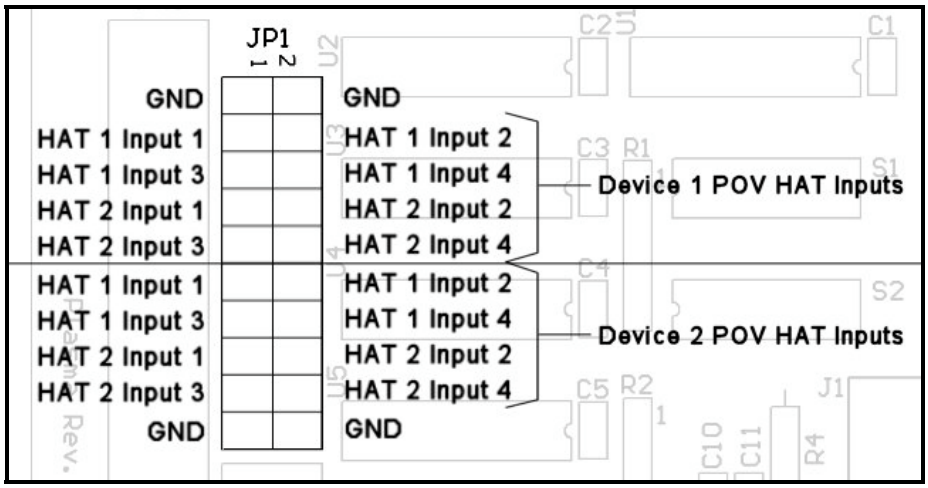
By combining both Plasma HOTAS devices into a single set of controls, a total of 60 virtual buttons are available to the pilot through 20 physical buttons and 4 separate rocker switches each controlling a group of buttons. Button groupings are defined as 4 and 6 for each Plasma device and controlled by 2 separate rocker switches.

Two spare button inputs remain per device (Buttons 31 & 32) which are used by the rotary encoder inputs and function independently of rockers switches.



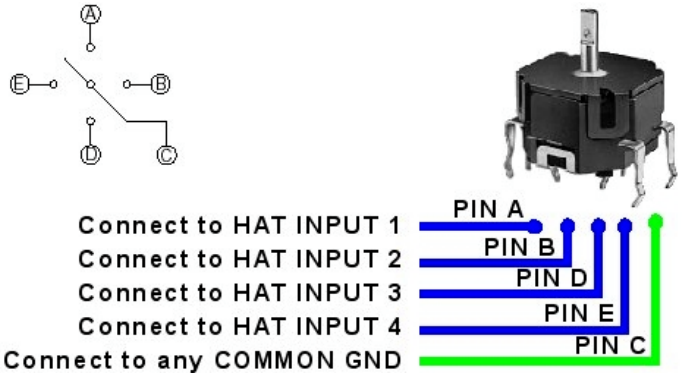
Plasma Pin-Out

Digital POV HAT Inputs



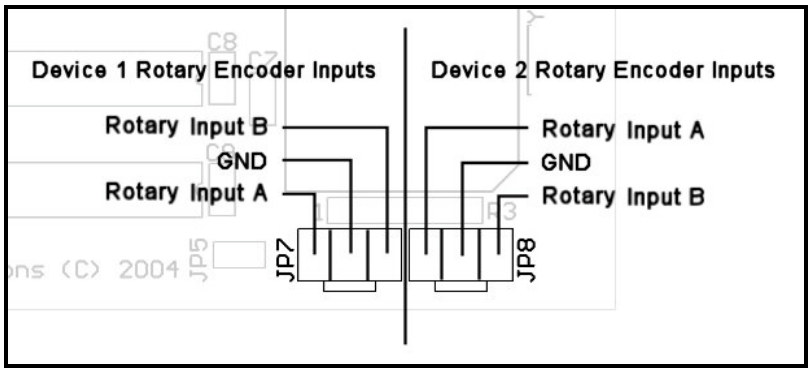
Connecting Digital POV HATS

HAT input 1: POV SWITCH UP
HAT input 2: POV SWITCH RIGHT
HAT input 3: POV SWITCH DOWN
HAT input 4: POV SWITCH LEFT



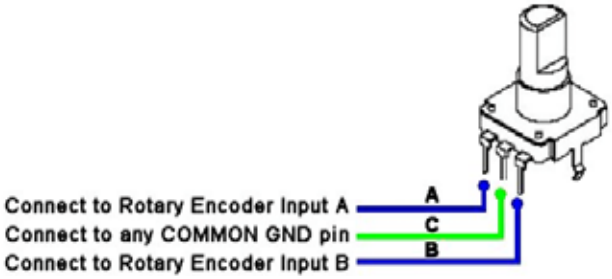
The POV HAT switch common pin must be connected to one of the ground pins. All other HAT switch pins must be connected to the appropriate input pins as describe above.

Mechanical Rotary Encoder Inputs



The mechanical rotary encoder inputs convert 2-bit gray code type encoders only. These inputs are buffered to prevent lost inputs with a maximum output rate limited to 12 PPS (Pulses Per Second). The pulse output is comprised of a 40 ms ON pulse followed by a 40 ms OFF pulse.

Connecting Rotary Encoders



Rotary outputs are located on button inputs 17 & 18 in MODES A & B (figure 4) and button inputs 31 & 32 in HOTAS MODES C & D (figure 5).

Figure 4 – Rotary output MODES A & B

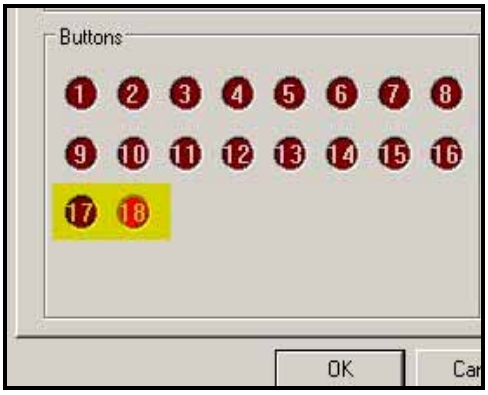
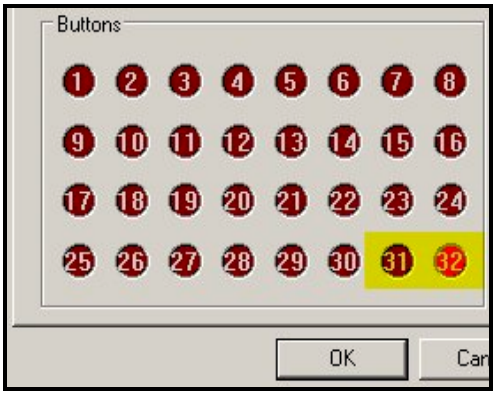
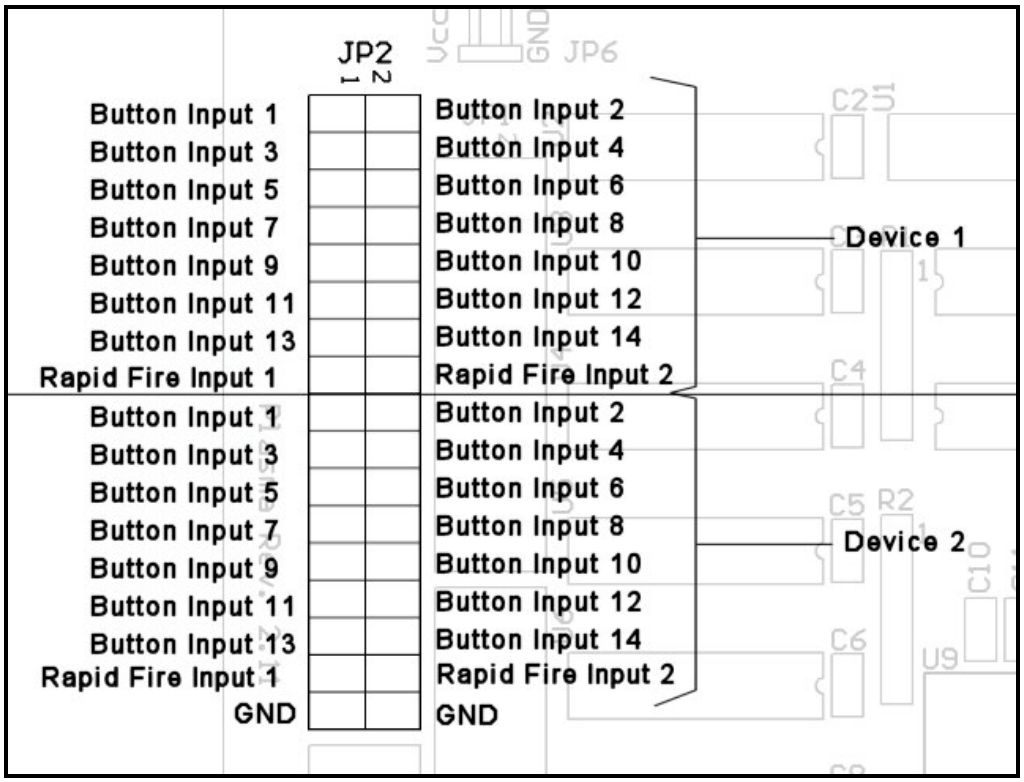


Figure 5 – Rotary output MODES C & D



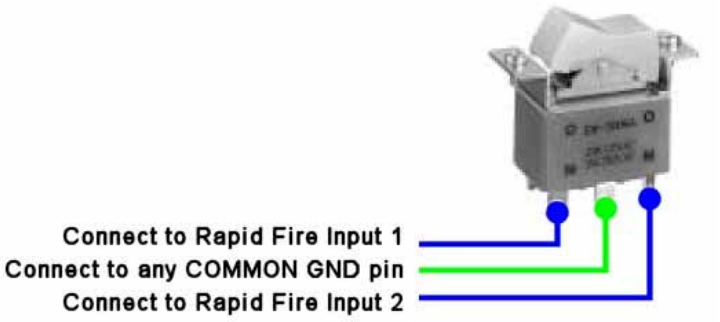
NOTE: Any software reading device inputs less than 25 Hz (25 times per second) will invariably drop inputs.

Button Inputs Modes A & B



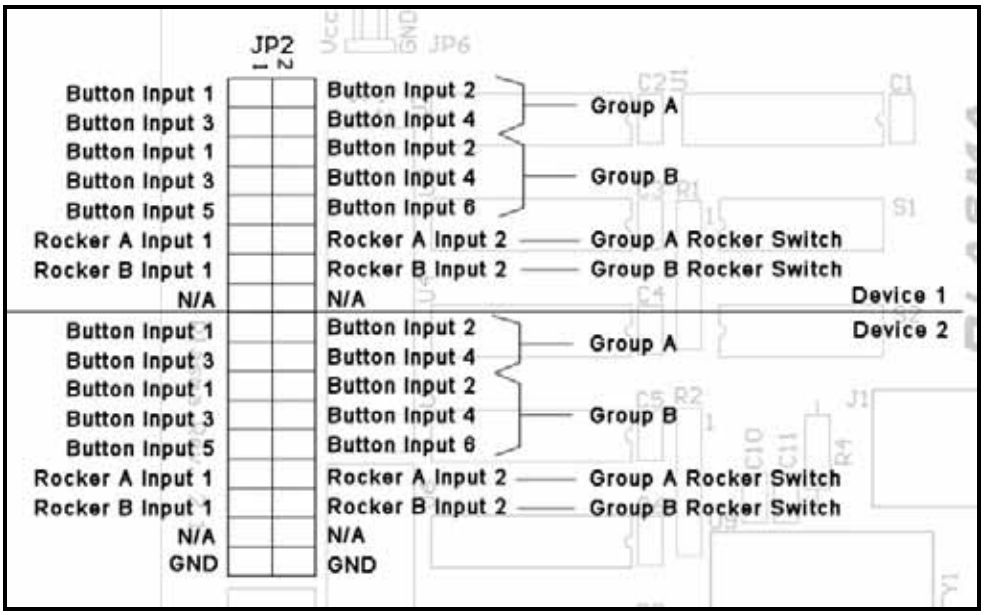
Unlike the standard button inputs, *Rapid Fire Inputs* send a pulse stream instead of a continuous ON signal. The pulse rate has been preset to 10 PPS (Pulses Per Second).

Connecting Rocker Switch for Trim Support

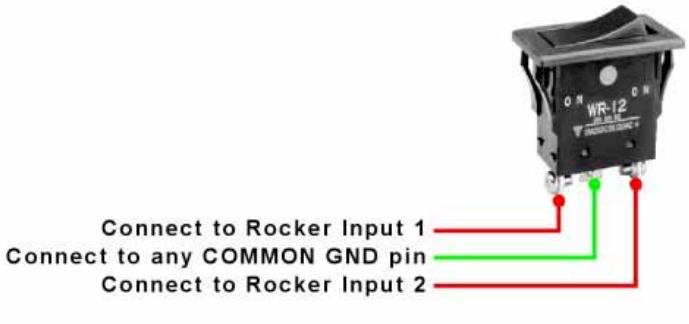


Inputs 1 & 2 can be wired to a momentary rocker switch (MOM-OFF-MOM) for use as a digital trim switch.

Button Inputs Modes C & D - HOTAS



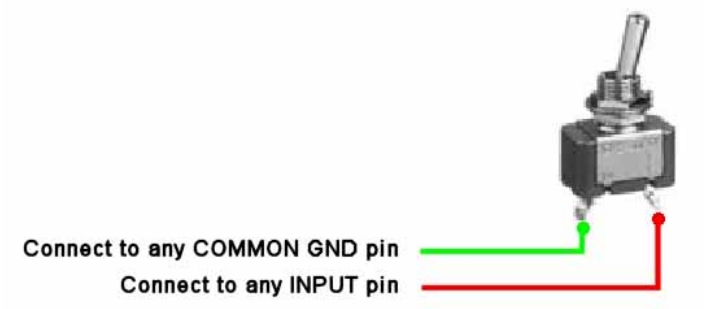
Connecting Rocker Switch for HOTAS Support



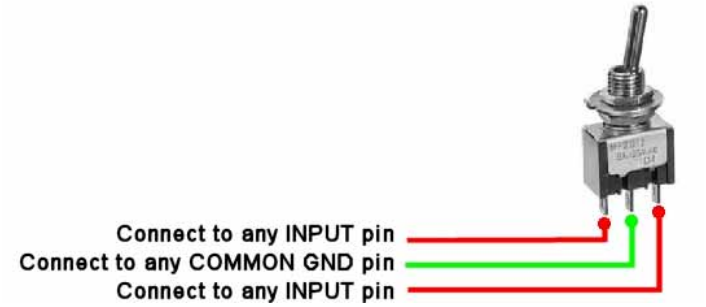
Connecting Various Switches – All Modes

The Plasma module does not use a scan matrix type of input layout. As such, diodes are not required since it does not suffer from phantom signals when activating several switch inputs at the same time.

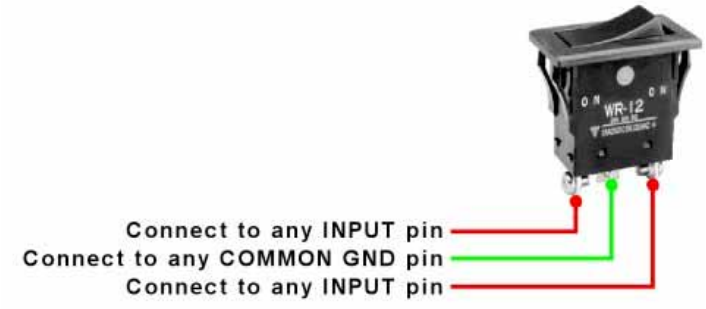
SPST Toggle Switches (On-Off)



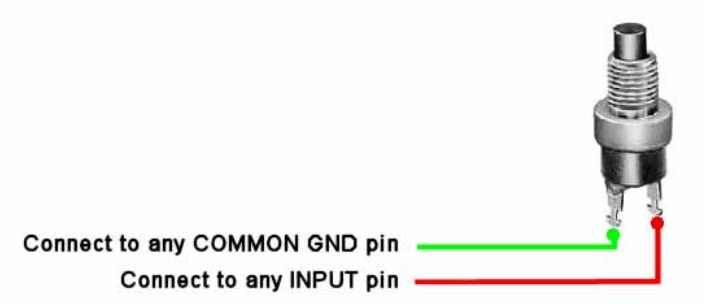
SPDT Switches (On-On)



Rocker Switches (On-Off-On)

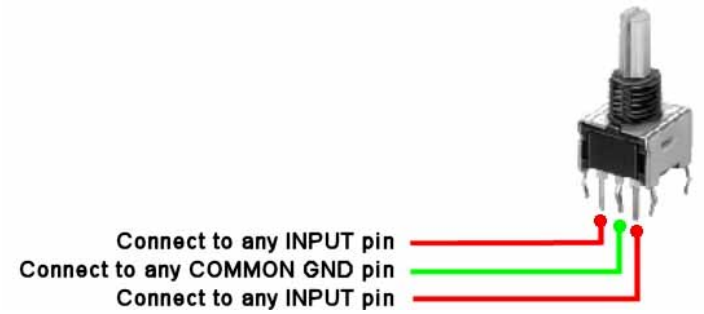


Push Button Switches



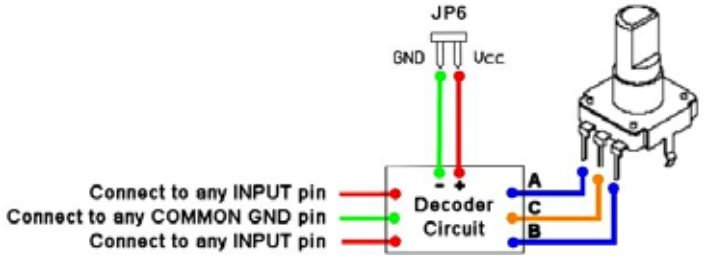
Rotary Switches

These are special rotary type switches that do not require a decoder circuit in order to be used with the Plasma button inputs. Typical rotary encoders require a decoder circuit in order to convert the output signals into a form usable by this USB module.



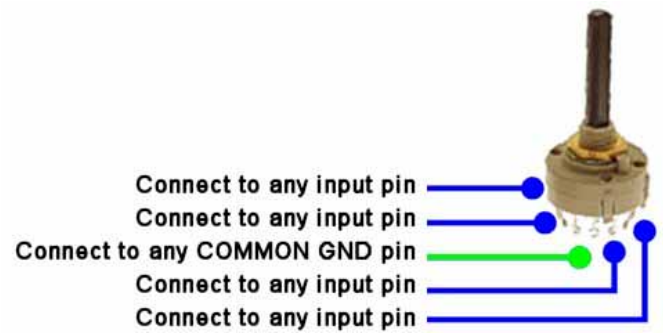
Mechanical / Optical Rotary Encoders

These types of rotary encoders require a decoder circuit in order to convert the output signals into a form usable by this USB module. Rotary output signals can be 2-bit gray code or 2-bit quadrature code.

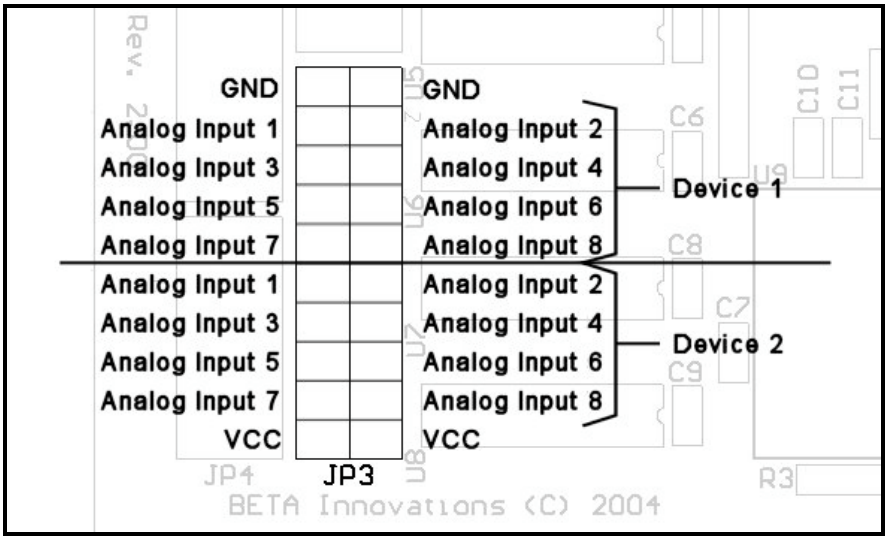


Multi-Position Rotary Switches

Multi-Position Rotary Switches come in many configurations, but the most important thing to note is that they all share one or several common pins. These common pins must to be connected to any one of the common GND pins found on the Plasma unit. All other pins can be connected to any one of the inputs as required.



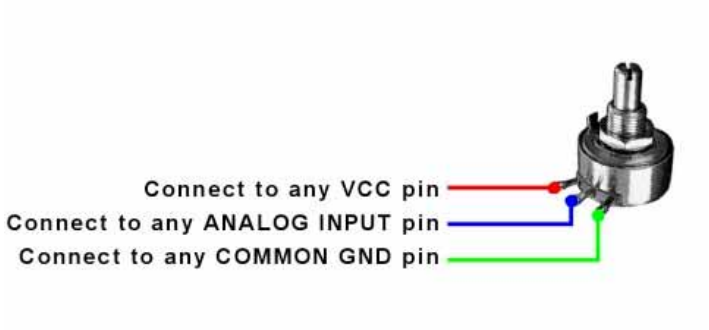
Analog Port Inputs



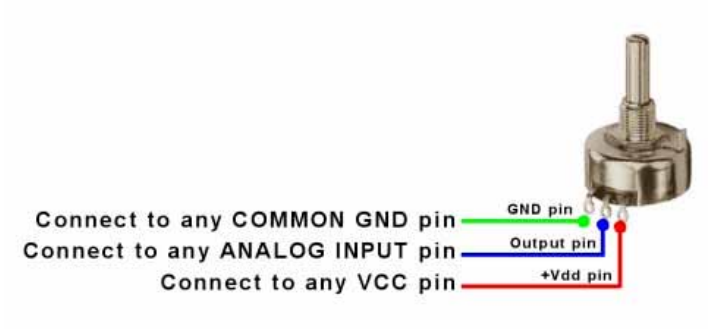
Analog Axis Inputs
Analog Input 1: X-Axis
Analog Input 2: Y-Axis
Analog Input 3: Z-Axis
Analog Input 4: X-Rotation
Analog Input 5: Y-Rotation
Analog Input 6: Z-Rotation
Analog Input 7: Slider 1
Analog Input 8: Slider 2

NOTE: Some operating system's default USB drivers may not support 8 axis. MS Windows 98 (USB Upgrade) / ME / 2000 / XP support up to 8 axis per device.

Connecting Potentiometers to Analog Inputs

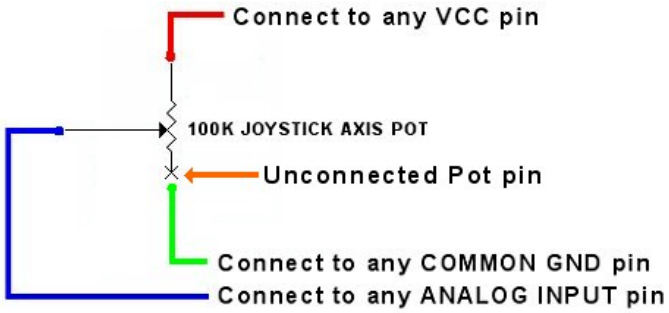


Connecting Hall Effect Sensors to Analog Inputs



Connecting Linear Transducers to Analog Inputs

Connecting Analog Joystick Pots



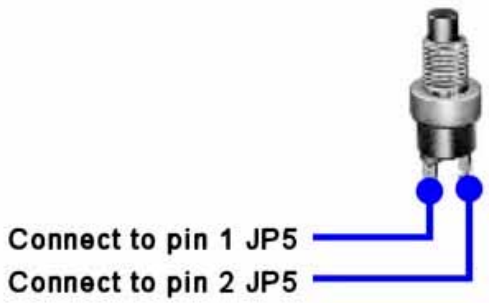
NOTE: Conventional analog Joystick potentiometers have one unconnected pin on axis pots. It is imperative that this pin be grounded in order to properly function when connected to the Plasma analog port inputs.

Axis Synchronization

With the inherent linearity errors of potentiometers, analog input values can differ by as much as 20% under worst case conditions. This can cause undesired effects when precision between multiple analog input is required on 2 or 4 engine throttle quadrants.

Although more expensive solutions exist (i.e. ACE's, Hall Sensors, etc.) which do not suffer from these linearity differences, a simple solution is employed on select analog ports by averaging the inputs and eliminating these linear variations. This synchronization can be quickly activated when needed by pressing a momentary push button connected to JP5.

Connecting Axis Synchronization Switch



NOTE: Although axis synchronization can be used in conjunction with ACE rotaries, it should be noted that it is not required due to their high degree of linearity.

Hardware Specifications

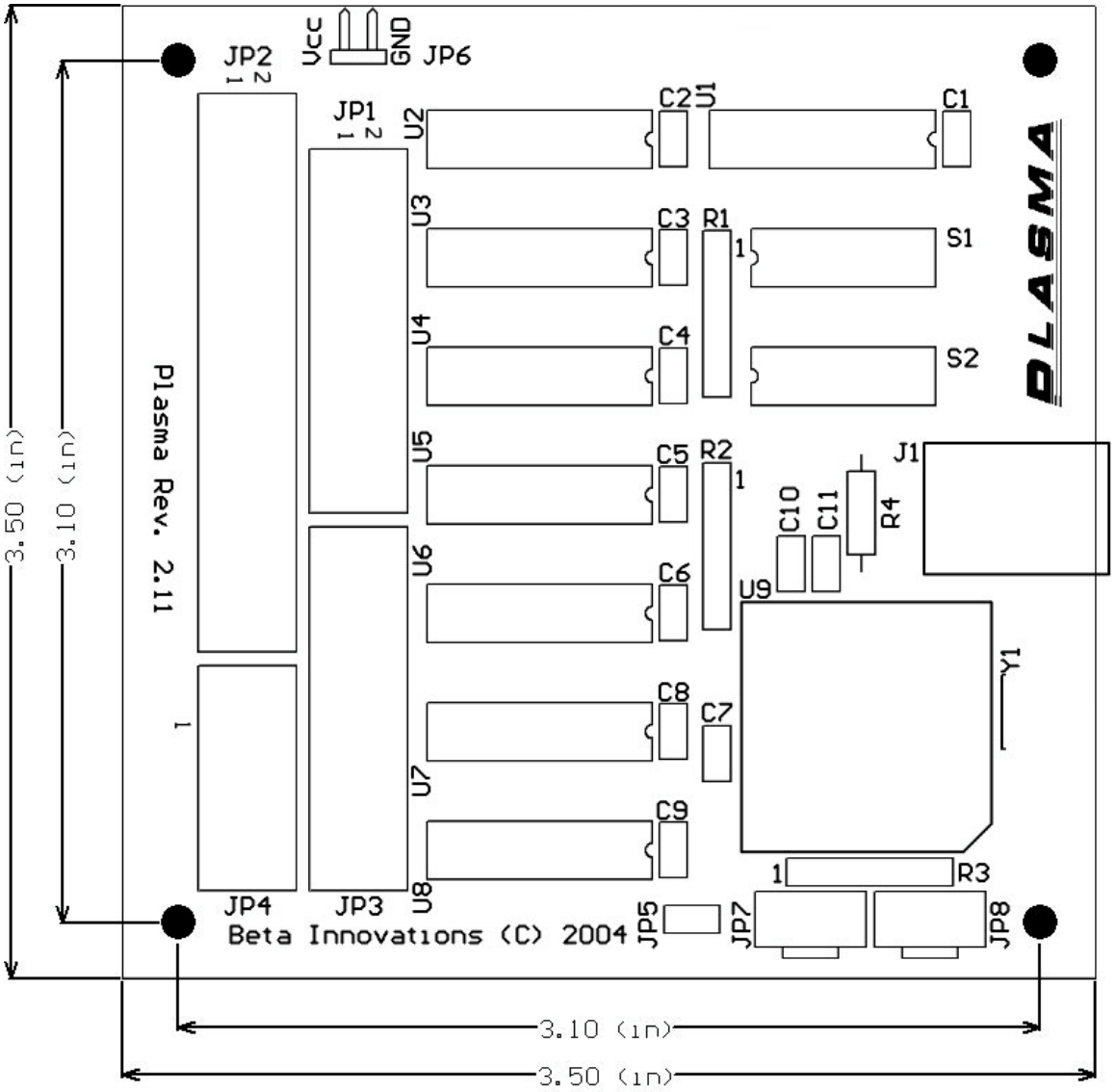
The firmware runs at 40 ms iteration rate in all Modes of operation. As such, any custom interface software should poll this device at least every 40 ms to prevent lost inputs. The 40 ms interval time is more than adequate to debounce switch contacts if any are used as inputs. Note that all inputs are active low, which means you must ground an input in order to register a high “ON” signal at the output.

Most operating systems will detect and load the appropriate HID driver for your device and do not require that a custom device driver be installed. On some operating systems, these default drivers may not support all features of the Plasma module.

Maximum power consumption is 500mW (100mA) and is powered by the USB bus. You do not need to use an external power supply for this device, even when connecting (and powering) several rotary decoder modules to the onboard power pins specifically added for this purpose.

NOTE: **DO NOT CONNECT any of the Plasma Vcc pins to external power supplies or voltage sources.** Although common grounds can be safely connected to external grounds, it is not recommended and should be avoid whenever possible. Doing so may adversely affect performance, possibly causing strange or erratic behavior under certain conditions.

Mechanical Specifications



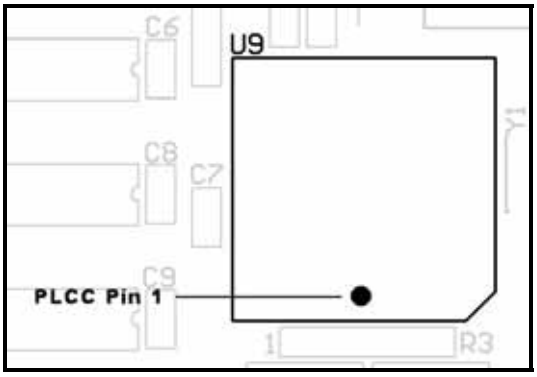
Bill Of Materials

C1	0.1µF, 20%, 50VDC Ceramic
C2	0.1µF, 20%, 50VDC Ceramic
C3	0.1µF, 20%, 50VDC Ceramic
C4	0.1µF, 20%, 50VDC Ceramic
C5	0.1µF, 20%, 50VDC Ceramic
C6	0.1µF, 20%, 50VDC Ceramic
C7	0.1µF, 20%, 50VDC Ceramic
C8	0.1µF, 20%, 50VDC Ceramic
C9	0.1µF, 20%, 50VDC Ceramic
C10	0.1µF, 20%, 50VDC Ceramic
C11	0.1µF, 20%, 50VDC Ceramic
J1	USB Type 'B' Connector
JP1	Header, 20-Pin .100, Dual row
JP2	Header, 34-Pin .100, Dual row
JP3	Header, 20-Pin .100, Dual row
JP4	Header, 10-Pin .100, Dual row
JP5	Header, 2-Pin .100, Straight
JP6	Header, 2-Pin .100, Right Angle
JP7	Connector receptacle, 3-Pin .100
JP8	Connector receptacle, 3-Pin .100
R1	EXB-F6E822G 8.2K, 10%, 1/4W, 5 Resistor pack with common pin
R2	EXB-F6E822G 8.2K, 10%, 1/4W, 5 Resistor pack with common pin
R3	EXB-F6E822G 8.2K, 10%, 1/4W, 5 Resistor pack with common pin
R4	1.5K, 1%, 1/4W
S1	AMP 435640-4 DIP Switch, 6 toggle switches
S2	AMP 435640-4 DIP Switch, 6 toggle switches
U1	MC74HC4051AN 8-Channel Analog Multiplexer/Demultiplexer
U2	MC74HC4051AN 8-Channel Analog Multiplexer/Demultiplexer
U3	MC74HC4051AN 8-Channel Analog Multiplexer/Demultiplexer
U4	MC74HC4051AN 8-Channel Analog Multiplexer/Demultiplexer
U5	MC74HC4051AN 8-Channel Analog Multiplexer/Demultiplexer
U6	MC74HC4051AN 8-Channel Analog Multiplexer/Demultiplexer
U7	MC74HC4051AN 8-Channel Analog Multiplexer/Demultiplexer
U8	MC74HC4051AN 8-Channel Analog Multiplexer/Demultiplexer
U9	PIC16C765-I/L EPROM-Based 8-Bit CMOS Microcontroller with A/D Converter 44 pin PLCC socket for U9
Y1	6MHz Ceramic Resonator with integrated 22 pf capacitors

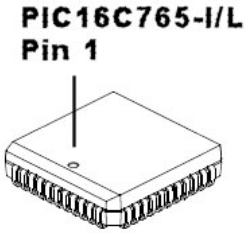
IMPORTANT: Care must be taken if substituting the analog multiplexer IC's (MC74HC4051AN) in order to minimize analog signal degradation and performance. If the MC74HC4051AN must be substituted, it is imperative that ICs with the lowest “on resistance” are selected.

Clearly identify all PIN 1 positions prior to component placement. Particular attention must be paid to the orientation of the following critical components:

PIC16C765-I/L Microcontroller

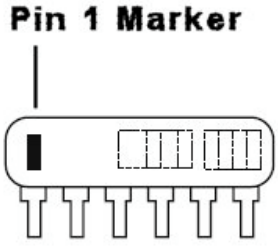


PLCC Socket Pin 1 Location

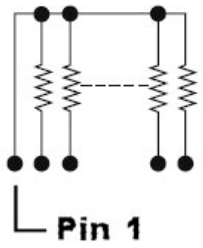


PIC16C765-I/L Pin 1 Location

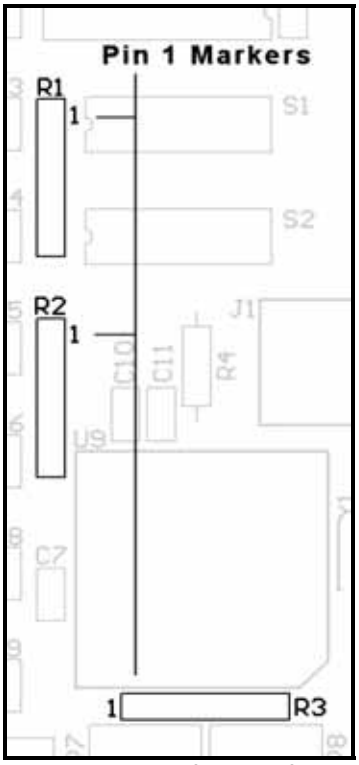
EXB-F6E822G - 8.2K, 5 Resistor Pack



Resistor Network Pack Pin 1 Location



Common Terminal Resistor Network



R1, R2 & R3 Pin 1 Markers

Visit www.betainnovations.com for the availability of kits, fully assembled modules and accessories.