Plasma USB Module

DOC No.   **: 16409**
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Date   **: 11, 2003**
Part No.   **: 600-100**

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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 USB HID 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. Also supports up to 4 ACE (Absolute Contacting Encoder) rotaries through a separate daughter board.

- **Filtering Algorithm**
  Features a selectable multipass noise, spike and jitter filtering algorithm for stable output with noisy pots.

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

- **POV HAT Support**
  All POV HAT inputs selectable as digital 8-way or analog 4-way (Thrustmaster type HAT).

- **Button Inputs**
  Up to 32 total button inputs and 64 in HOTAS mode (Active Low) compatible with any kind of switch: toggle, push button, etc.

- **4 Modes of Operation**
  Selectable *SINGLE* or *DUAL* device mode. Enumerates as 8X16B-2HAT device in *SINGLE* mode or two 8X16B-2HAT devices in *DUAL* mode configuration as a USB Composite device.

  Selectable *HOTAS* mode. Enumerates as 8X32B-2HAT device in *SINGLE* mode or two 8X32B-2HAT in *DUAL* mode configuration as a USB Composite device.

Introduction

The Plasma USB adapter is comprised of 4 devices in 1 and entirely 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.
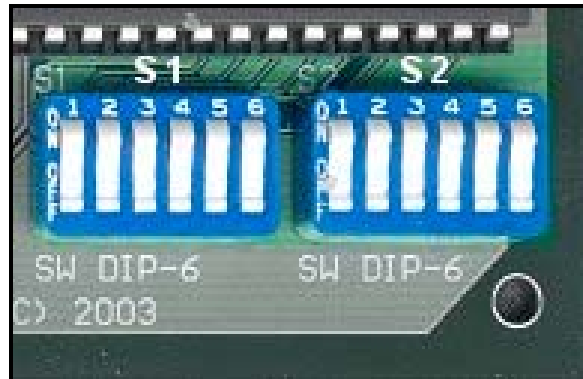

Figure 1

The 4 modes of operation are:

Mode A: ***Plasma - USB Adaptor***
> Device 1 – 8 axis, 16 buttons and 2 POV HATS

Mode B: ***Plasma - Dual USB Adaptor***
> Device 1 – 8 axis, 16 buttons and 2 POV HATS
> Device 2 – 8 axis, 16 buttons and 2 POV HATS

Mode C: ***Plasma HOTAS - USB Adaptor***
> Device 1 – 8 axis, 32 buttons and 2 POV HATS

Mode D: ***Plasma HOTAS - Dual USB Adaptor***
> Device 1 – 8 axis, 32 buttons and 2 POV HATS
> Device 2 – 8 axis, 32 buttons 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 – SW1 & S1 – SW6) are used to set the device in 4 possible modes of operation.
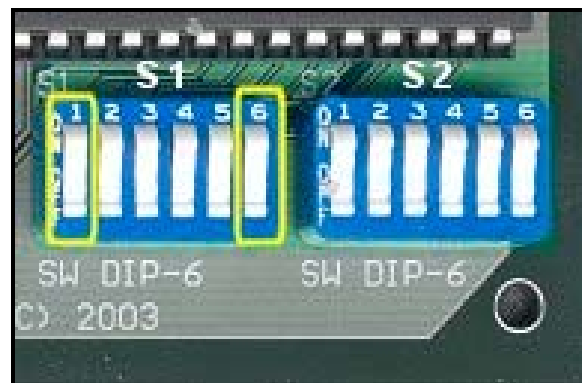

Figure 2

DIP Switch S1:
SW1 – DUAL mode switch
SW6 – HOTAS mode switch

Modes of Operation:
Mode A: *Plasma - USB Adaptor*
S1 – SW1: OFF
S1 – SW6: OFF

Mode B: *Plasma - Dual USB Adaptor*
S1 – SW1: ON
S1 – SW6: OFF

Mode C: *Plasma HOTAS - USB Adaptor*
S1 – SW1: OFF
S1 – SW6: ON

Mode D: *Plasma HOTAS - Dual USB Adaptor*
S1 – SW1: ON
S1 – SW6: ON

Configuration Selection DIP Switches

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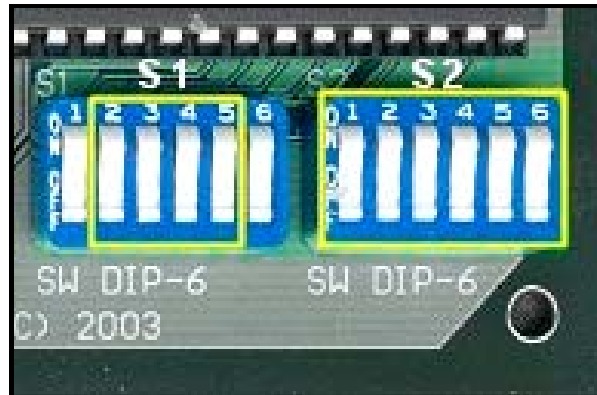

Figure 3

DIP Switch S1:
  SW2 – Analog Axis Filter, Device 1
  SW3 – Analog Axis Filter, Device 2
  SW4 – ACE Rotaries on X-Y Axis, Device 1
  SW5 – ACE Rotaries on X-Y Axis, Device 2

DIP Switch S2:
  SW1 – Digital POV HAT 1, Device 1
  SW2 – Digital POV HAT 2, Device 1
  SW3 – Digital POV HAT 1, Device 2
  SW4 – Digital POV HAT 2, Device 2
  SW5 – Analog Axis Resolution LSB
  SW6 – Analog Axis Resolution MSB

Configuration Options

Analog Axis Filter – To activate filtering on either device, switch to "on" the appropriate switch on S1. Switching on SW2 will activate filtering for device 1 only. Switching on SW3 will activate filtering for device 2 only.

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

Although the filtering algorithm does an excellent job of smoothing the analog output and eliminating jitter, it may not be suitable in all cases where fast control input response is required. General aviation setups can benefit greatly from a clean stable response from control devices, but can be a source of angst for some military fighter control setups where "jinking" is the order of the day.

Jinking is essentially the act of pseudo randomly moving the joystick from side to side in order to avoid enemy fire. This action can in some instances be misinterpreted as "spiking" by the filter and may be inadvertently attenuated.

If you intend to use the Plasma device in a military fighter configuration, it may be preferable in some cases to deactivate filtering for the device connected to the throttle and joystick axes. Filtering can still be activated on the second device in Dual mode if so desired and analog control inputs requiring this filter signal processing can be connected to this secondary device.

In certain instances, the resulting jitter may become intolerable. Reducing the axis resolution will effectively eliminate this undesirable element and still maintain fast control input responsiveness.

ACE Rotaries on X-Y Axis – If you have connected an ACE add-on board to your Plasma unit you can activate them by switching on SW4 and / or SW5. The analog input signals from the X and Y-axis ports will no longer be active and ACE digital data will be used instead.

NOTE: ACE rotary digital data affect only the X & Y-axis of each device. This data cannot be diverted to any other analog axis port.

Digital POV HAT – Each device on the Plasma unit has two POV HATs, which can be configured as either analog or digital. Digital HATs are 8-way POV whereas analog HATs are only 4-way POV and are based on the Thrustmaster standard.

To activate digital HATs, simply toggle to "on" the appropriate switch, SW1 through SW4 on S2. All HAT DIP switches that are in the "off" position default to analog HAT input mode.

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:
> SW5 – Analog Axis Resolution LSB
> SW6 – Analog Axis Resolution MSB

> 32 step resolution:
> > SW5 – off
> > SW6 – off
> 64 step resolution:
> > SW5 – on
> > SW6 – off
> 128 step resolution:
> > SW5 – off
> > SW6 – on
> 256 step resolution:
> > SW5 – on
> > SW6 – on

The higher the step size the more likely the output will suffer from the effects of jitter due to the uncertainties of the conversion process. As such, there is a trade off between resolution and stability of the output signal. The output signal stability is heavily dependent on the use of high quality input devices. Therefore, activation of the 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 "flight mode" 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 the pilot the luxury of keeping his hands on both the throttle and stick and still have access to a plethora of cockpit functions at his fingertips. This avoids the possibly 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 64 virtual buttons are available to the pilot through 24 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.

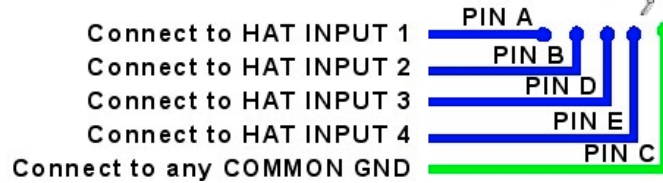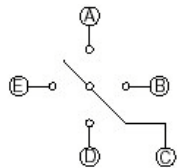Two spare button inputs remain per device (Buttons 31 & 32) and function independently of rockers switches.
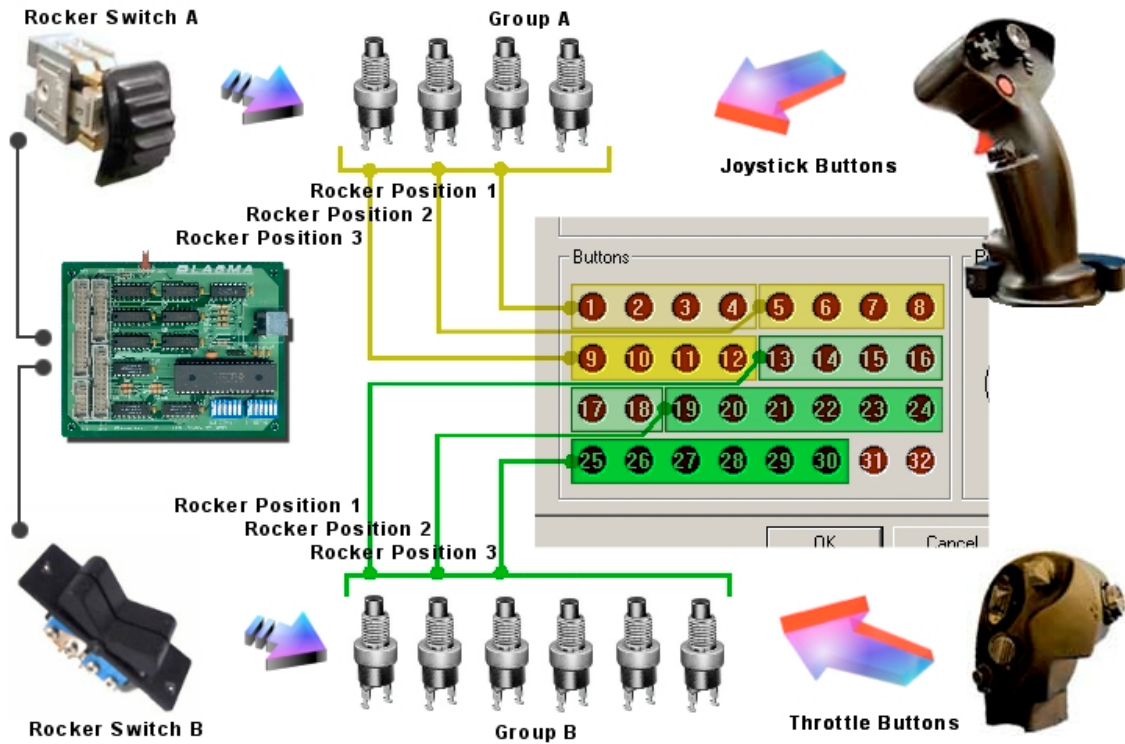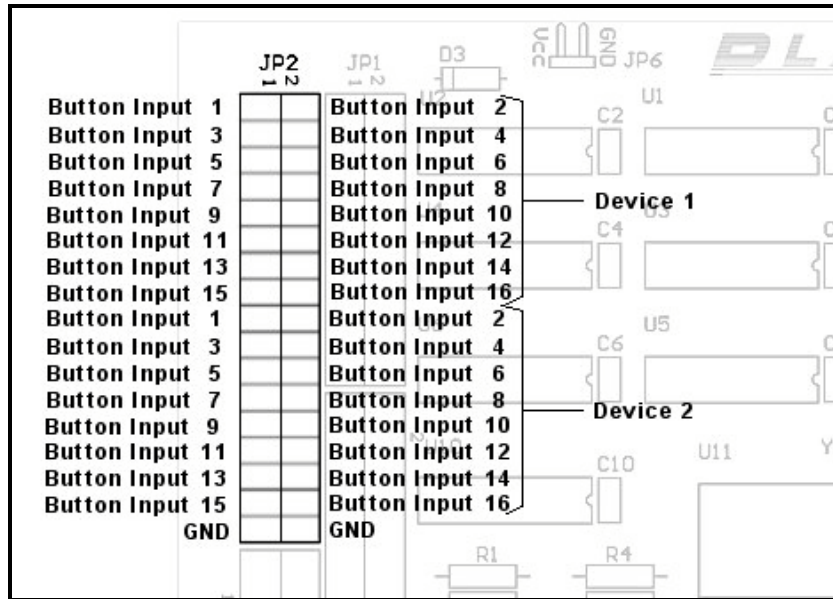
Plasma Pin-Out

Digital POV HAT Inputs
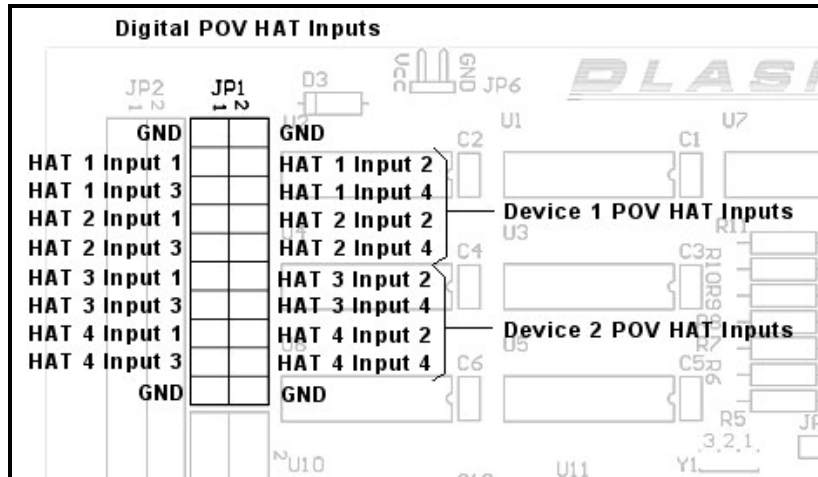
All Digital POV HATS
HAT input 1: POV SWITCH UP
HAT input 2: POV SWITCH RIGHT
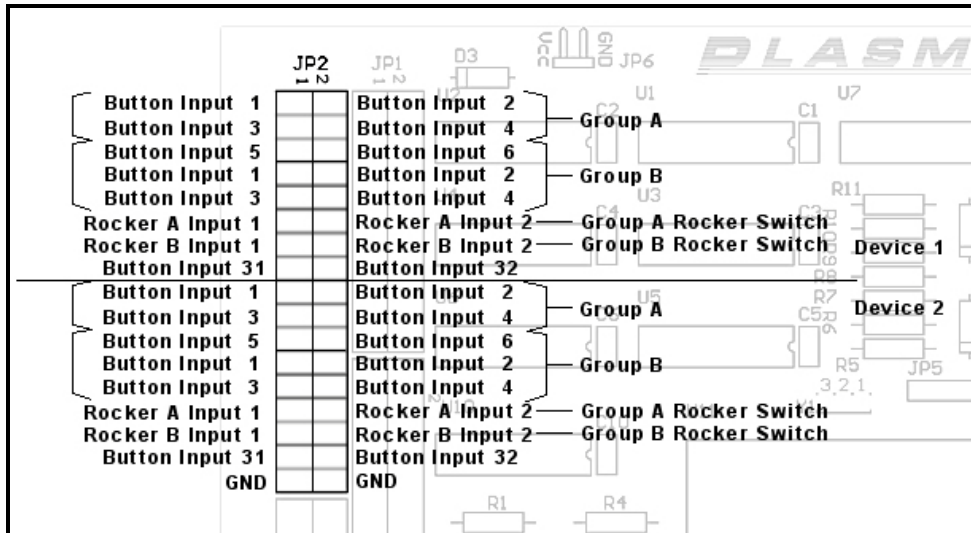HAT input 3: POV SWITCH DOWN
HAT input 4: POV SWITCH LEFT

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.
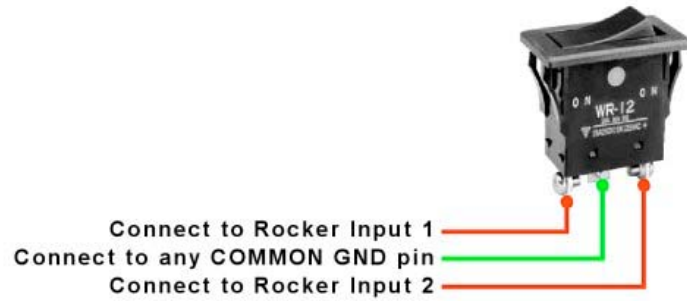
Button Inputs Modes A & B

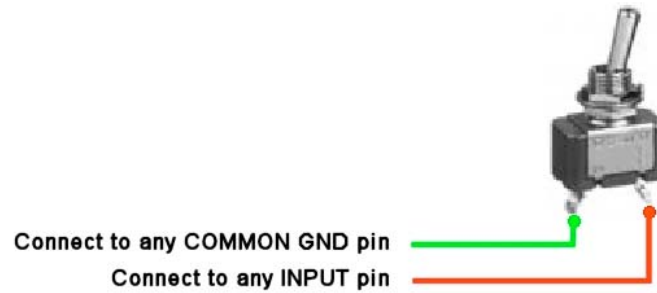
Button Inputs Modes C & D - HOTAS

Connecting Rocker Switch for HOTAS Support

Connect to Rocker Input 1
Connect to any COMMON GND pin
Connect to Rocker Input 2

Connecting Various Switches – All Modes
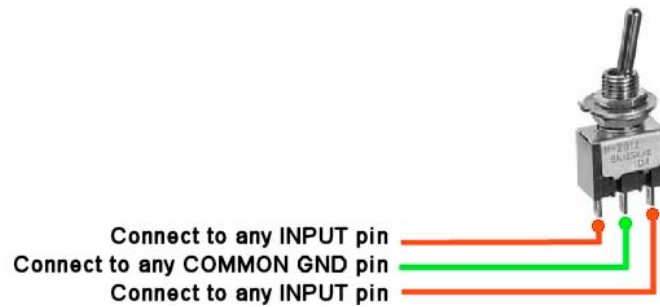
The Plasma module does not use a scan matrix type of input layout. As such diodes are not required since it does not suffer from phantom signals when activating several switch inputs at the same time.
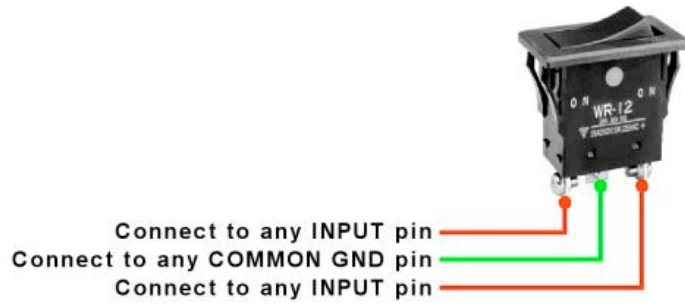
SPST Toggle Switches (On-Off)

Connect to any COMMON GND pin
Connect to any INPUT pin

SPDT Switches (On-On)

Connect to any INPUT pin
Connect to any COMMON GND pin
Connect to any INPUT pin

Rocker Switches (On-Off-On)

Connect to any INPUT pin
Connect to any COMMON GND pin
Connect to any INPUT pin

Push Button Switches

Connect to any COMMON GND pin
Connect to any INPUT pin
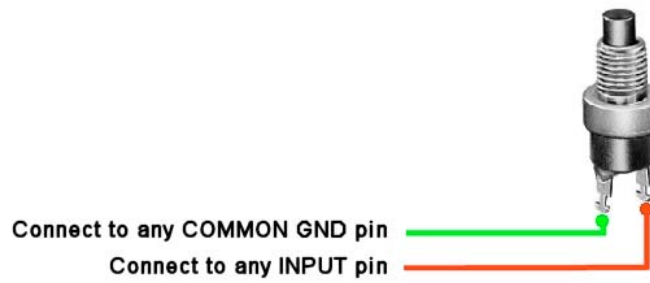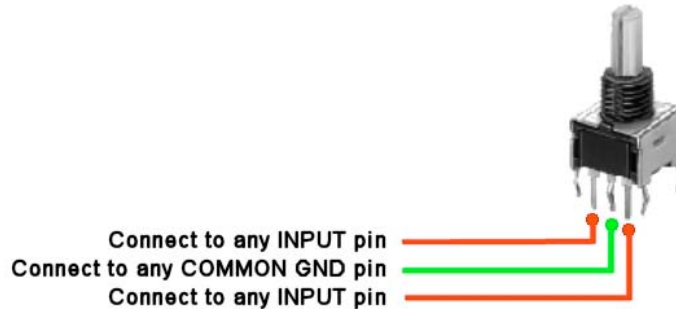
Knitter Rotary Switches

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.

Connect to any INPUT pin
Connect to any COMMON GND pin
Connect to any INPUT pin

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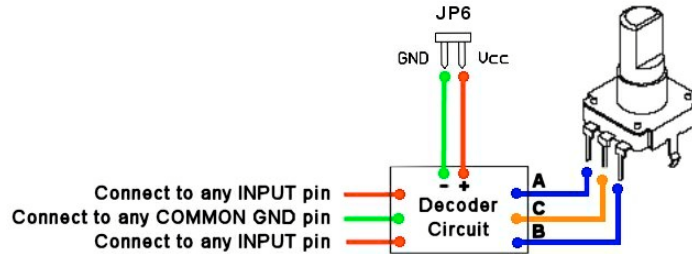
Analog Port Inputs
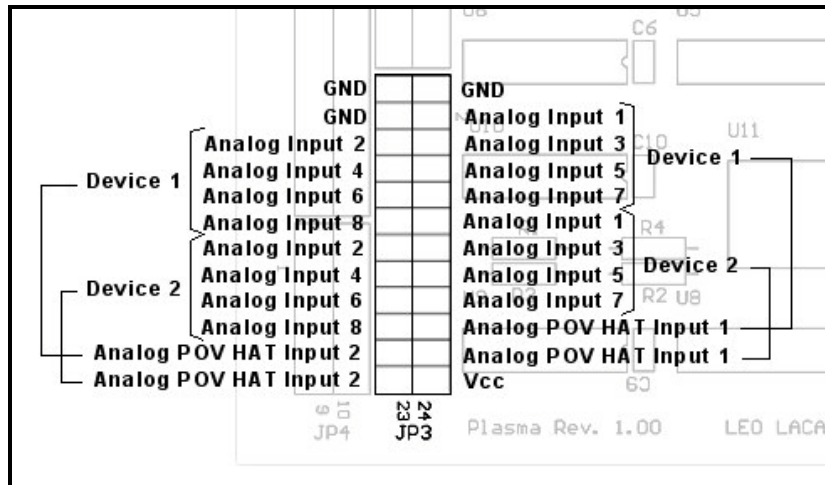
Analog Axis Inputs
Analog Input 1: X-Axis
Analog Input 2: Y-Axis
Analog Input 3: Z-Axis
Analog Input 4: X-Rotation
Analog Input 5: Y-Rotation
Analog Input 6: Z-Rotation
Analog Input 7: Slider 1
Analog Input 8: Slider 2

Connecting Potentiometers to Analog Inputs

Connect to any VCC pin
Connect to any ANALOG INPUT pin
Connect to any COMMON GND pin

Connecting Hall Effect Sensors to Analog Inputs

Connect to any COMMON GND pin — GND pin
Connect to any ANALOG INPUT pin — Output pin
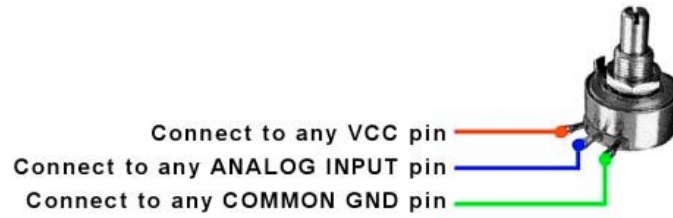Connect to any VCC pin — +Vdd pin
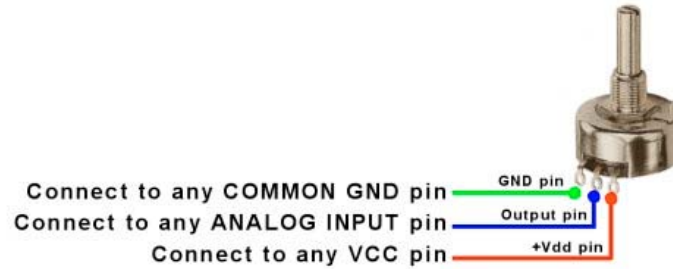
Connecting Linear Transducers to Analog Inputs

Electrical
Connections

Connect to any COMMON GND pin — GND pin
Connect to any ANALOG INPUT pin — Output pin
Connect to any VCC pin — +Vdd pin

Connecting Analog POV HATS (Thrustmaster Standard)

S1 = HAT LEFT
S2 = HAT DOWN
S3 = HAT RIGHT
S4 = HAT UP

S1   S2   S3   S4

80K   240K   80K   26.6K

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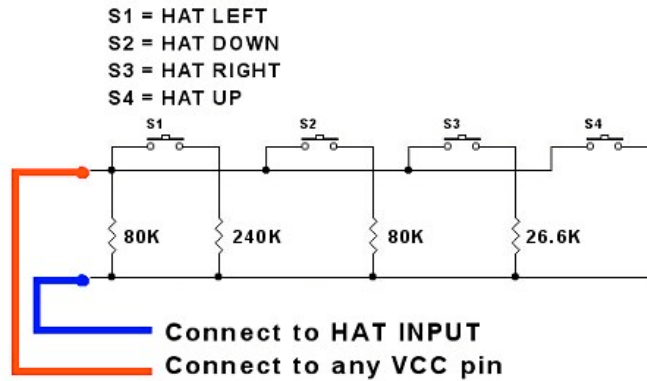
Connecting Analog Joystick Pots
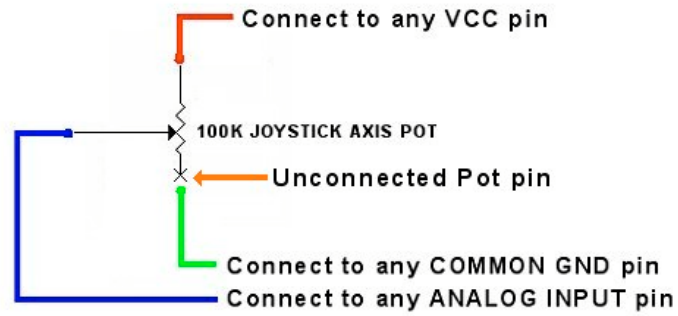
NOTE: Conventional analog Joystick potentiometers have one unconnected pin on axis pots. It is imperative that this pin be grounded in order to properly function when connected to the Plasma analog port inputs.

Hardware Specifications

The firmware runs at a 20 ms iteration rate in Modes A & C and at 40 ms in Modes B & D. As such, any custom interface software should poll this device at least every 20 ms to prevent missing any input. The 20 ms interval time is more than adequate to debounce switch contacts if any are used as inputs. Remember that all inputs are active low, which means you must ground an input in order to register a high "on" signal at the output.

Windows will detect and load the appropriate HID driver for your device and does not require that a custom device driver be installed.

Maximum power consumption is 750mW (150mA) and is USB bus powered. 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.

Mechanical Specifications
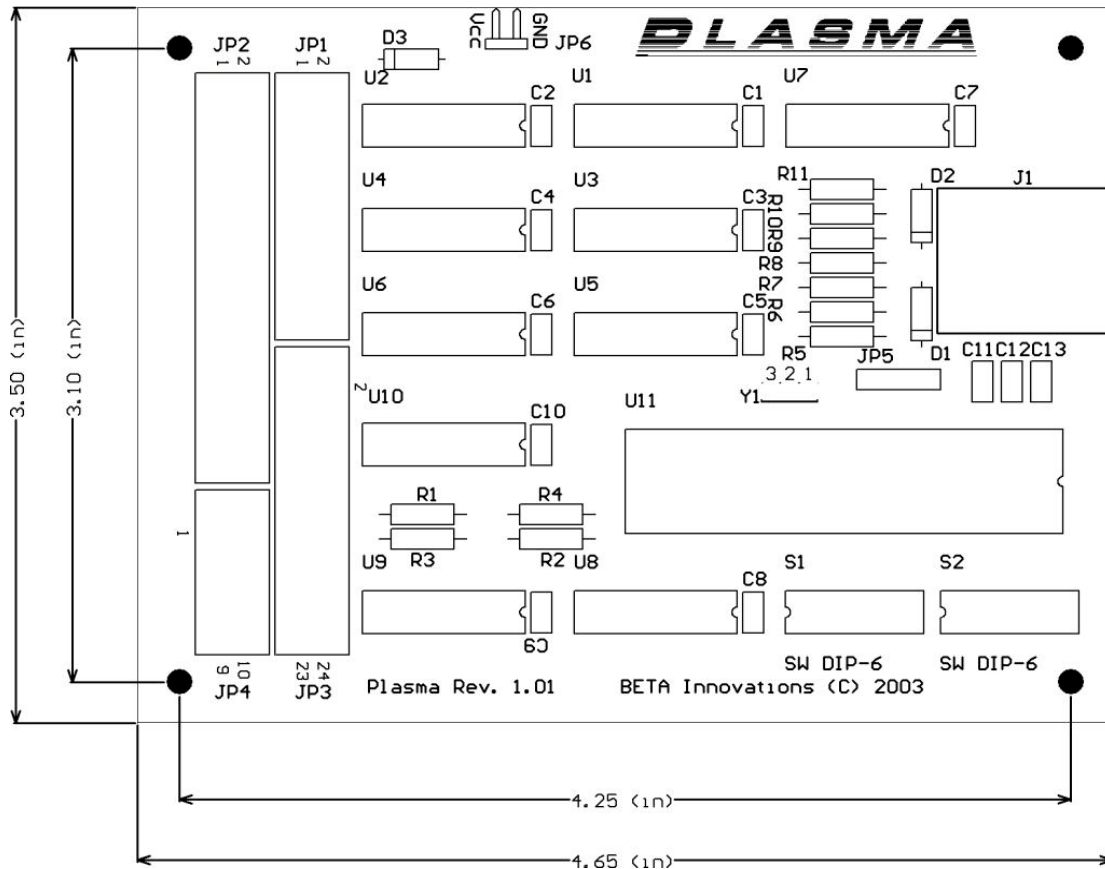
Bill Of Materials

C1   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C2   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C3   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C4   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C5   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C6   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C7   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C8   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C9   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C10   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C11   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C12   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
C13   0.1µF, 20%, 50VDC Ceramic (Digi-Key Part no. BC1127CT-ND)
D3   1N914 Diode
J1   USB Type 'B' Connector (Digi-Key Part No. 787780-1-ND)
JP1   Header, 20-Pin, Dual row
JP2   Header, 34-Pin, Dual row
JP3   Header, 24-Pin, Dual row
JP4   Header, 10-Pin, Dual row
JP5   Header, 4-Pin
JP6   Header, 2-Pin, Right Angle
R1   24K, 10%, 1/4W
R2   24K, 10%, 1/4W
R3   24K, 10%, 1/4W
R4   24K, 10%, 1/4W
R5   1.5K, 1%, 1/4W
R8   10K, 10%, 1/4W
R9   10K, 10%, 1/4W
R10   10K, 10%, 1/4W
R11   10K, 10%, 1/4W
S1   DIP Switch 6
S2   DIP Switch 6
U1   SN74LS251N 1-of-8 Data Selector/Multiplexer with 3-State Outputs
U2   SN74LS251N 1-of-8 Data Selector/Multiplexer with 3-State Outputs
U3   SN74LS251N 1-of-8 Data Selector/Multiplexer with 3-State Outputs
U4   SN74LS251N 1-of-8 Data Selector/Multiplexer with 3-State Outputs
U5   SN74LS251N 1-of-8 Data Selector/Multiplexer with 3-State Outputs
U6   SN74LS251N 1-of-8 Data Selector/Multiplexer with 3-State Outputs
U7   SN74LS138N 3-Line to 8-Line Decoder / Demultiplexer
U8   MC74HC4052AN Dual 4-Channel Analog Multiplexer/Demultiplexer
U9   MC74HC4052AN Dual 4-Channel Analog Multiplexer/Demultiplexer
U10   MC74HC4052AN Dual 4-Channel Analog Multiplexer/Demultiplexer
U11   PIC16C765-I/P EPROM-Based 8-Bit CMOS Microcontroller with A/D Converter
          40 pin DIP socket for U11
Y1   6MHz Ceramic Resonator (Digi-Key Part no. X904-ND)

IMPORTANT: Care must be taken if substituting the analog multiplexer IC's (MC74HC4052AN) in order to minimize analog signal degradation and performance. If the MC74HC4052AN must be substituted, it is imperative that ICs with the lowest "on resistance" are selected.

Please verify the specs of the ceramic resonator before substituting with any other kind. If you have a hard time finding these ceramic resonators, you can order them from Digi-Key.

Installing the headers and the USB 'B' connector is up to you. You can connect all the buttons and USB wires directly to the PCB board but I do not recommend doing this.

Visit www.betainnovations.com for the availability of preprogrammed Microchip micros.