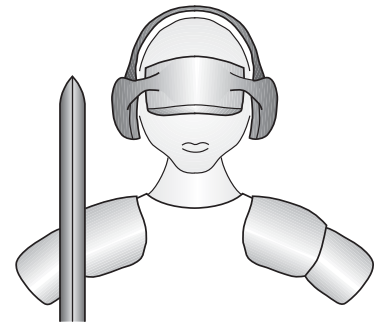# MouseWarrior

MouseWarrior24 Wheel II, MouseWarrior24 EyeIII
Universal mouse controller chips

Code Mercenaries

1. Features
- USB, and PS/2 interfaces
- Auto detects active interface
- Up to six buttons via USB, 5 buttons via PS/2
- Full USB V1.1/2.0 compliance
- Full USB HID 1.1 compliance
- Uses optical quadrature encoder (MouseWarrior24 Wheel II), or optical motion sensor ADNS2051 (MouseWarrior24 EyeIII)
- Supports quadrature encoder wheel or two buttons for scrolling
- Compatible with standard system drivers, no special drivers necessary
- Low external component count
- Single +5V power supply
- Available in DIL24 or SOIC24

1.1 Variants
MouseWarrior is available in a number of variants.

MouseWarrior24 Wheel II
- USB and PS/2 interfaces
- Supports up to six buttons
- Uses any quadrature encoding hardware
- Scrolling by quadrature encoded wheel or two buttons

MouseWarrior24 EyeIII
- USB and PS/2 interfaces
- Supports up to six buttons
- Uses Agilent ADNS2051 optical motion sensor to track movement with no moving parts.
- Scrolling by quadrature encoded wheel or two buttons

MouseWarrior24J8
- USB interface
- Mouse/Joystick hybrid function
- For use with 100 kΩ joystick
See separate data sheet

MouseWarrior24H8
- USB interface
- Mouse/Joystick hybrid function
- Analog input with 8 bit resolution
See separate data sheet

Custom variants
Custom adaptions are available on request.

2. Functional overview
The MouseWarrior family supports multiple pointing technologies. Using MouseWarrior to build a pointing device simplifies the design significantly.
No special drivers are required, MouseWarrior controllers work with the standard mouse drivers of all common operating systems
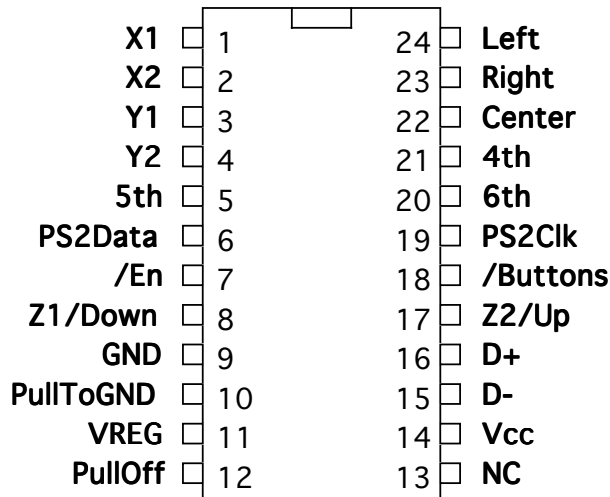
MouseWarrior

2.1 Product selection matrix

Type	Sensor type	Buttons	Wheel	USB	PS/2	DIL24	SOIC24	Module
MouseWarrior24Wheel II	Quadrature	6	√	√	√	√	√	-
MouseWarrior24Eye III	ADNS2051	6	√	√	√	√	√	-
MouseWarrior24J8	resistive joystick	6	3rd axis	√	-	√	√	√
MouseWarrior24H8	8 bit analog	6	3rd axis	√	-	√	√	√

MouseWarrior

3. Pin Configurations

MouseWarrior24 Wheel II-P/S
24 Pin PDIP or 24 Pin SOIC

X1	1		24	Left
X2	2		23	Right
Y1	3		22	Center
Y2	4		21	4th
5th	5		20	6th
PS2Data	6		19	PS2Clk
/En	7		18	/Buttons
Z1/Down	8		17	Z2/Up
GND	9		16	D+
PullToGND	10		15	D-
VREG	11		14	Vcc
PullOff	12		13	NC

MouseWarrior24 EyeIII-P/S
24 Pin PDIP or 24 Pin SOIC

PD	1		24	Left
SDIO	2		23	Right
SCLK	3		22	Center
NC	4		21	4th
5th	5		20	6th
PS2Data	6		19	PS2Clk
/En	7		18	/Buttons
Z1/Down	8		17	Z2/Up
GND	9		16	D+
PullToGND	10		15	D-
VREG	11		14	Vcc
PullOff	12		13	NC
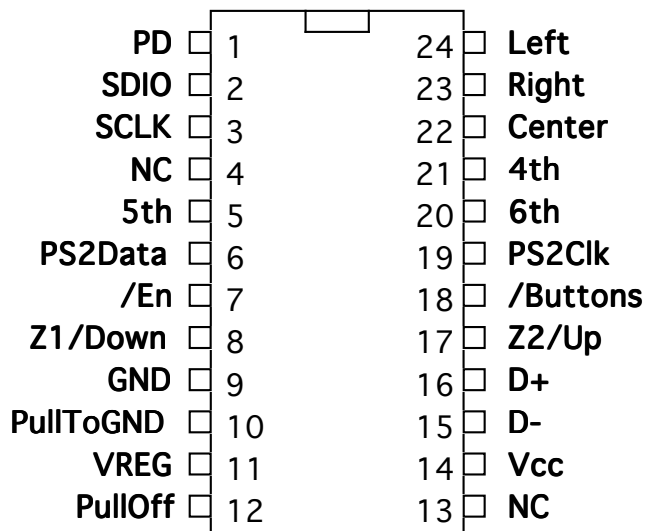
All drawings: TOP VIEW!

MouseWarrior

4. Pin Descriptions MouseWarrior24 Wheel II

Name	I/O	Type	Pins	Description
D+, D-	I/O	special	15,16	USB differential data lines
PS2Clock	I/O	OD, internal Pull Up	19	PS/2 interface clock line
PS2Data	I/O	OD, internal Pull Up	6	PS/2 interface data line
X1	I	input, internal Pull Up	1	Encoder X1 input
X2	I	input, internal Pull Up	2	Encoder X2 input
Y1	I	input, internal Pull Up	3	Encoder Y1 input
Y2	I	input, internal Pull Up	4	Encoder Y2 input
Z1/Down	I	input, internal Pull Up	8	Encoder Z1 input for wheel or scroll down button
Z2/Up	I	input, internal Pull Up	17	Encoder Z2 input for wheel or scroll up button
Left	I	input, internal Pull Up	24	Input for left mouse button
Right	I	input, internal Pull Up	23	Input for right mouse button
Center	I	input, internal Pull Up	22	Input for center mouse button
4th	I	input, internal Pull Up	21	Input for 4th mouse button
5th	I	input, internal Pull Up	5	Input for 5th mouse button
6th	I	input, internal Pull Up	20	Input for 6th mouse button
/Buttons	I	input, internal Pull Up	18	Selects wheel or buttons for scrolling
/En	O	open drain	7	Output to drive the encoder LEDs
VREG	O	sepcial *	11	Supplies power for USB D- pull up resistor
PullToGND	I		10	Used during manufacturing, connect to GND
PullOff	I	input, internal Pull Down	12	Deactivatex pull up resistors on X1, X2, Y1, Y2, Z1, Z2
GND		Power supply	9	Ground
Vcc		Power supply	14	Supply voltage
NC		unused	13	Unused, leave open

* See application circuit for external circuitry.

MouseWarrior

4.1 Pin Descriptions MouseWarrior24 EyeIII

Name	I/O	Type	Pins	Description
D+, D-	I/O	special	15,16	USB differential data lines
PS2Clock	I/O	OD, internal Pull Up	19	PS/2 interface clock line
PS2Data	I/O	OD, internal Pull Up	6	PS/2 interface data line
PD	O	OD, internal Pull Up	1	PowerDown signal to the ADNS2051 sensor
SDIO	I/O	OD, internal Pull Up	2	Serial data to/from ADNS2051
SCLK	O	OD, internal Pull Up	3	Serial clock to ADNS2051
Z1/Down	I	input, internal Pull Up	8	Encoder Z1 input for wheel or scroll down button
Z2/Up	I	input, internal Pull Up	17	Encoder Z2 input for wheel or scroll up button
Left	I	input, internal Pull Up	24	Input for left mouse button
Right	I	input, internal Pull Up	23	Input for right mouse button
Center	I	input, internal Pull Up	22	Input for center mouse button
4th	I	input, internal Pull Up	21	Input for 4th mouse button
5th	I	input, internal Pull Up	5	Input for 5th mouse button
6th	I	input, internal Pull Up	20	Input for 6th mouse button
/Buttons	I	input, internal Pull Up	18	Selects wheel or buttons for scrolling
/En	O	OD, internal Pull Up*	7	Output to supply wheel encoder LED
VREG	O	special *	11	Supplies power for USB D- pull up resistor
PullToGND	I		10	Used during manufacturing, connect to GND
PullOff	I	input, internal Pull Down	12	Deactivatex pull up resistors on X1, X2, Y1, Y2, Z1, Z2
GND		Power supply	9	Ground
Vcc		Power supply	14	Supply voltage
NC		unused	4, 13	Unused, leave open

* See application circuit for external circuitry.

MouseWarrior

4.2 Pin descriptions

D+, D-
Differential data lines of USB. Connect these signals direct to a USB cable or a type B connector.

PS2Clk, PS2Data
These two lines are the PS/2 mouse interface. Connect these lines to the mouse interface of the host computer.
These two pins must be left floating if PS/2 is not used.
Internal pull up resistors.

PD, SDIO, SCLK (MouseWarrior24 EyeIII)
These signals connect direct to the corresponding pins on the ADNS2051 sensor.
Internal pull up resistors.

Z1/Down, Z2/Up
Inputs for quadrature encoded scroll wheel or scroll buttons. The function of these pins is selected by /Buttons pin.
Z1 falling edge leads Z2 falling edge for upward scrolling.
Internal pull up resistors, photo transistors or buttons must pull to ground. Pull up resistors can be disabled via PullOff pin.

/Buttons
This pin is left unconnected when a scroll wheel is used. To use buttons for scrolling pull this pin to ground and connect the scroll buttons to the Z1/Down, Z2/Up pins.
Internal pull up resistor.

/En
Enable signal for the LEDs of the optical quadrature encoder. Open drain output, capable of sinking up to 50mA.
External series resistor may be needed.

Left, Right, Center
Inputs for three mouse buttons. Internal pull up resistors, contacts must close to GND.

4th, 5th, 6th
Input for 4th, 5th, and 6th mouse button. Internal pull up resistor, contact must close to GND.

/Pull to GND
This pin is used during production of the MouseWarrior chips, connect to GND.

PullOff (MouseWarrior24)
The status of this pin at power up determines if the internal pull up resistors on the inputs X1, X2, Y1, Y2 (MW24Wheel II only) and Z1, Z2 are enabled. Pulling this pin high at power up does disable the internal pull up resistors.

VREG
Supplies 3.3V for the USB D- pull up resistor. Don't use this pin to supply power to external circuitry, it does only supply sufficient current for the pull up resistor.

GND
Power supply ground.

Vcc
Supply voltage.

MouseWarrior

5. Device Operation

MouseWarrior does work with very few external components. No jumpers or circuit changes are necessary to use MouseWarrior with either of the interfaces.

MouseWarrior monitors the interface lines to detect which of the interfaces is active. Only one of the interfaces may be connected at any given time, connecting two or more interfaces at the same time will produce unpredictable results.

Once MouseWarrior has been powered up and has detected its active interface it does start checking the mouse sensor and buttons.

5.1 Power Up

Every time the supply voltage is applied MouseWarrior executes an internal reset sequence. All internal pull up resistors are disabled upon power up and will be activated during the internal reset sequence.

After initialisation MouseWarrior waits for any of the interfaces to show activity. If no interface goes active within 5 seconds of power on MouseWarrior will assume it has been hot plugged to a PS/2 port and start working as a PS/2 mouse.

5.2 Protocol details: USB

MouseWarrior works as a HID compliant pointing device using boot protocol. The country code is 0 for not localized hardware. MouseWarrior defines six buttons and a scroll wheel.

5.3 Protocol Details: PS/2

MouseWarrior by default identifies as a PS/2 device type 0. It does report the buttons Left, Right and Center via the standard protocol which is compatible with normal system drivers (i.e. Logitech method).

MouseWarrior is also compatible with the Microsoft Intellimouse Explorer™ protocol on the PS/2 interface. They can be set to work as type 3 devices reporting the scroll wheel and three buttons or to type 4 reporting the 4th and 5th button as well. There is no way to utilze the 6th button via PS/2.

MouseWarrior

6. 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
Power Dissipation...300mW
Static discharge voltage ....>2000V
Latch-up current ....>200mA

6.1 DC Characteristics

	Parameter	Min	Max	Units	Remarks
V_{cc}	Operating Voltage	4.35	5.25	V	
I_{cc}	Operating Supply Current		20	mA	
I_{sb}	Suspend mode current		25	μA	Oscillator off
I_{ol}	Sink current on interface pins		2	mA	Vout = 0.4V
I_{olen}	Sink current on /En pin		50	mA	Vout = 0.8V
R_{up}	Pull-up Resistance	8	24	kΩ	
V_{ith}	Input Threshold Voltage	40%	60%	Vcc	
	USB Interface				
V_{oh}	Static output high	2.8	3.6	V	15kΩ±5% to GND
V_{ol}	Static output low		0.3	V	
V_{di}	Differential Input sensitivity	0.2		V	|(D+)-(D-)|
V_{cm}	Differential Input common Mode Range	0.8	2.5	V	
V_{se}	Single Ended Transceiver Threshold	0.8	2.0	V	
C_{in}	Transceiver capacitance		20	pF	
I_{io}	Hi-Z State Data Line Leakage	-10	10	μA	0V < Vin < 3.3V, Hi-Z State
R_{pu}	Bus Pull-up resistance	1.274	1.326	kΩ	1.3kΩ±2% to Vcc
R_{pd}	Bus Pull-down resistance	14.25	15.75	kΩ	15kΩ±5% to Gnd

MouseWarrior

6.2 AC Characteristics

	Parameter	Min	Max	Units	Remarks
t_{cyc}	input clock cycle time	165.0	168.3	ns	
t_{ch}	Clock high time	0.45tcyc		ns	
t_{cl}	Clock low time	0.45tcyc		ns	
	USB Driver Characteristics				
t_r	Transition rise time	75		ns	CLoad = 50pF
t_r	Transition rise time		300	ns	CLoad = 350pF
t_f	Transition fall time	75		ns	CLoad = 50pF
t_f	Transition fall time		300	ns	CLoad = 350pF
t_{rfm}	Rise/Fall Time matching	80	120	%	
V_{crs}	Output signal crossover voltage	1.3	2.0	V	
	USB Data Timing				
t_{drate}	Low Speed Data Rate	1.4777	1.5225	MBit/s	
t_{djr1}	Receiver data jitter tolerance	-75	75	ns	To next transition
t_{djr2}	Receiver data jitter tolerance	-45	45	ns	For paired transitions
t_{deop}	Differential to EOP transition skew	-40	100	ns	
t_{eopr1}	EOP width at receiver	165		ns	Rejects as EOP
t_{eopr2}	EOP width at reeiver	675		ns	Accepts as EOP
t_{eopt}	Source EOP width	1.25	1.50	μs	
t_{udj1}	Differential driver jitter	-95	95	ns	To next transition
t_{udj2}	Differential driver jitter	-150	150	ns	To paired transition

MouseWarrior

7. Ordering information

Partname	Order Code	Description	Package
MouseWarrior24Wheel II	MW24Wheel II-P	Mouse controller for optical encoders with scroll support, 6 buttons	PDIP24
MouseWarrior24Wheel II	MW24Wheel II-S	Mouse controller for optical encoders with scroll support, 6 buttons	SOIC24
MouseWarrior24EyeIII	MW24EyeIII-P	Mouse controller for optical motion sensor and scrolling, 6 buttons	PDIP24
MouseWarrior24EyeIII	MW24EyeIII-S	Mouse controller for optical motion sensor and scrolling, 6 buttons	SOIC24

The chips listed here are standard products. Customized chips are available on request.

7.1 Packaging info
PDIP24 chips come in tubes of 16 each.
SOIC24 chips come in tubes with 31 chips each.
To assure best handling and shipping safety please order the chips in full tubes if possible.

7.2 USB VendorID and ProductID
By default all MouseWarrior chips are shipped with the USB VendorID of Code Mercenaries ($7C0 or decimal 1984) and a fixed ProductID.
On request chips can be equipped with the customers VendorID and ProductID. VendorIDs can be obtained from the USB Implementers Forum <www.usb.org>
Customized chips may be subject to minimum order quantities, contact <sales@codemercs.com> for details.

Following are the ProductIDs for the MouseWarrior controllers:
MouseWarrior20 O $0001
MouseWarrior20 V $0002
MouseWarrior24 Wheel II $000A
MouseWarrior24 EyeIII $0009

ProductIDs are independent of the package type.

MouseWarrior20O and MouseWarrior20V are obsolete and are listed for information purposes only.

MouseWarrior

8. Typical application for MouseWarrior24 Wheel II

Circuit: MouseWarrior Wheel II
Version: 1.1
Date: May 22nd 2007
Drawn by:
Function:
Page:

Close JP1 for
Button scrolling

Close JP2 to disable
internal pull ups on Z1/Z2

MouseWarrior

8.1 Typical application for MouseWarrior24EyeIII
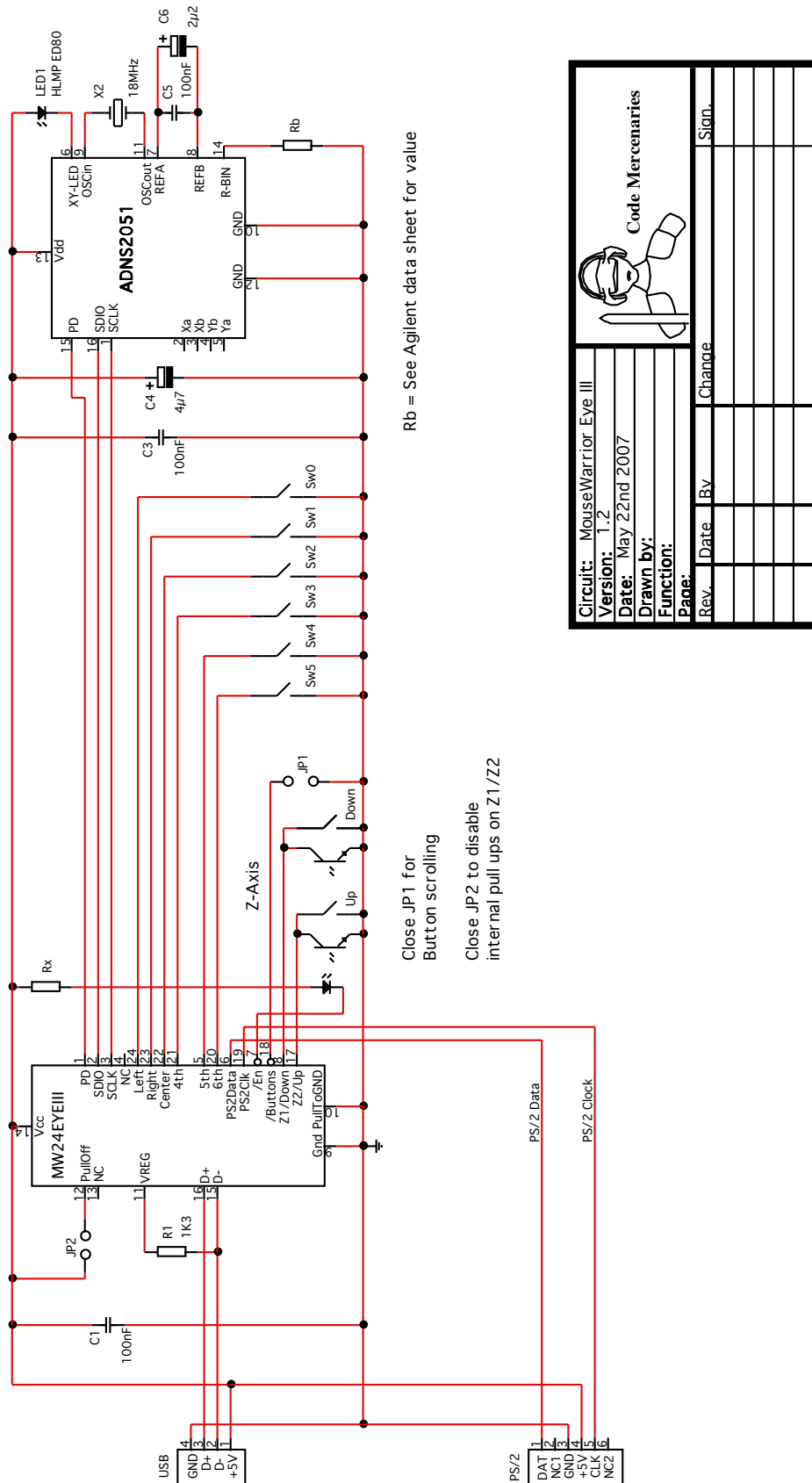
Rb = See Agilent data sheet for value

Z-Axis

Close JP1 for
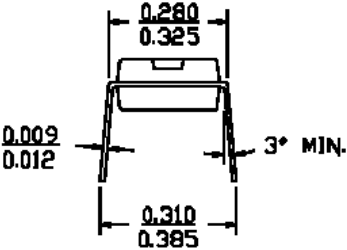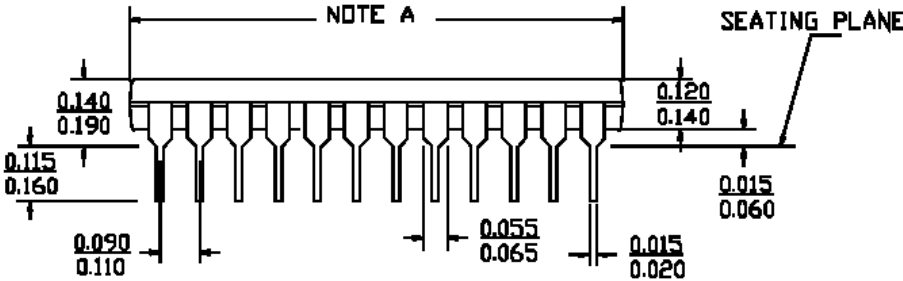Button scrolling

Close JP2 to disable
internal pull ups on Z1/Z2

Code Mercenaries

Circuit:	MouseWarrior Eye III			
Version:	1.2			
Date:	May 22nd 2007			
Drawn by:				
Function:				
Page:				
Rev.	Date	By	Change	Sign.

9. Package Dimensions
24 Pin DIL

DIMENSIONS IN INCHES MIN.
MAX.
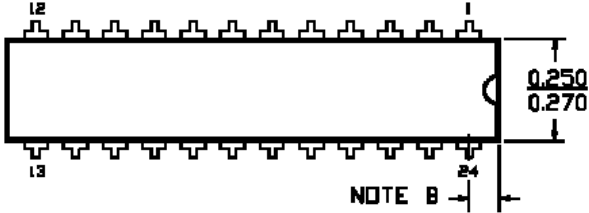
	P 13	P 13A
NOTE A	1.170 1.200	1.230 1.260
NOTE B	0.030 0.050	0.060 0.080

24 Pin SOIC
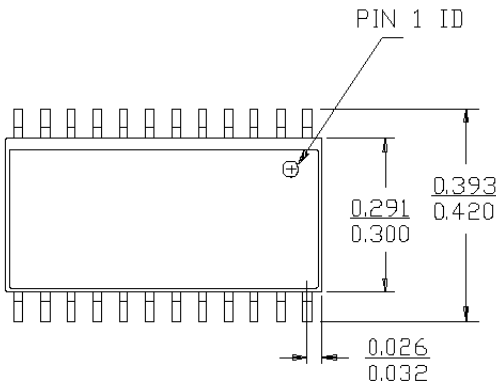
DIMENSIONS IN INCHES MIN.
MAX.
LEAD COPLANARITY 0.004 MAX.
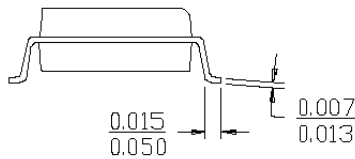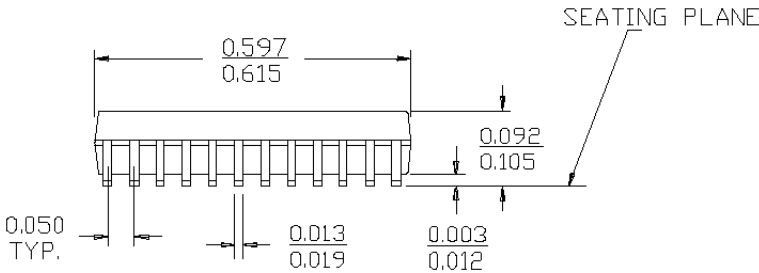
MouseWarrior

10. Revision history

Changes made to the MouseWarrior chips since V1.0.0:

V1.0.6.3
- Discontinued MouseWarrior24EyeII and replaced it by MouseWarrior24EyeIII.
- Discontinued MouseWarrior24Wheel and replaced it by MouseWarrior24Wheel II.

V1.0.6.2 (was not generally released)
- Added various custom versions.
- PS/2 interfaces does now send BAT OK on power up. This assures that the mouse is detected as hot plugged and gets initialized by the host. Newer BIOS versions show better results with this approach.

V1.0.6.1
- Discontinued MouseWarrior24Eye and replaced it by MouseWarrior24EyeII.

V1.0.6.0 (was not generally released)
- Added various custom versions.
- Changed PS/2 timing so clock low and high phase are symmetrical.
- Switched to four part version numbers.

V1.0.5 (was not generally released)
- Optimized USB stack
- Improved encoder scanning speed of MW20O and MW24Wheel by moving send routines to interrupt.
- Made Report Protocol default as specified in HID 1.1 for USB.

V1.0.4
- Added MouseWarrior24Eye variant.
- Modified MouseWarrior24Wheel to also work as a type 4 PS/2 device, enabling it to report the 4th button.
- Added some delay between receiving a PS/2 command and answering on it. This fixes problems with some badly designed host controllers.
- Fixed an interrupt related problem in the PS/2 protocol that could under certain timing conditions cause the return of a wrong reply to a command. The correct data byte to be send was overwritten, returning a random reply. This lead to the mouse not being recognized or not properly configured on some hosts.

V1.0.3
- Finished MouseWarrior24 Wheel.
- SetScaling command on PS/2 of MouseWarrior20 O and MouseWarrior24 Wheel does now activate a ballistic scaling of the mouse movement.

V1.0.2
- Added MouseWarrior24 Wheel variant. Still preliminary, subject to changes.
- Reversed position of USB Class and Endpoint descriptor to be HID Draft 4 compliant.
- Fine tuned axis handling of MouseWarrior20 V to match KeyWarrior Combo V.
- Optimized Wakeup interrupt to minimize on time during USB suspend state when checking for activity.
- Changed MouseWarrior20 O speed on USB, ADB and serial to maximum.

V1.0.1
- Modified MouseWarrior20 V to use the stronger direction of an axis instead of the difference between the directions. This eliminates the Z-axis force from X and Y.
- Fixed a bug in USB suspend that caused the controller to crash when going to suspend with remote wakeup enabled.

11. ESD Considerations

MouseWarrior has an internal ESD protection to withstand discharges of more than 2000V without permanent damage. However ESD may disrupt normal operation of the chip and cause it to exhibit erratic behaviour.

For the typical office environment the 2000V protection is normally sufficient. Though for industrial use additional measures may be necessary.

When adding ESD protection to the signals special care must be taken on the USB signal lines. The USB has very low tolerance for additional resistance or capacitance introduced on the USB differential signals.

The PS/2 lines are less critical. Series resistors of 27Ω and signal to ground capacitors of 27pF may be used alone or in addition to some kind of suppressor device.

11.1 EMC Considerations

MouseWarrior uses relatively low power levels and so it causes few EMC problems if a few precautions are taken.

To avoid any EMC problems the following rules should followed:

- Put a 100nF ceramic capacitor right next to the power supply pins and make sure the PCB traces between the chips power pins and the capacitor are as short as possible.
- Run the power supply lines first to the capacitor, then to the chip.

Adding a ferrite bead to the +5V power supply lines is advisable.