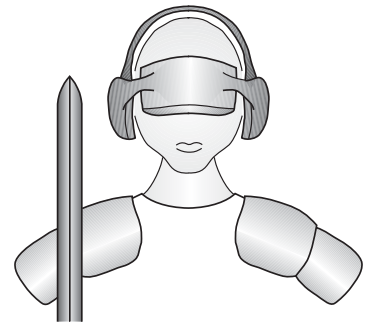


JW24RC

**Model RC to USB joystick converter chip
Supplement to the JoyWarrior data sheet**



Code Mercenaries

1. Features

- USB interface
- Full USB V1.1/2.0 compliance
- Full USB HID 1.1 compliance
- Accepts input signals from most teacher/student interfaces on popular model RCs
- Auto detection of signal polarity
- Support for 1 to 12 channels, auto detection of number of channels
- Channels 1 to 5 are reported as 8 bit joystick axes
- Channels 6 and up are reported as buttons with two threshold levels per axis
- Compatible with standard system drivers, no special drivers necessary
- Channels 6 to 12 are available in 8 bit analog format with optional software
- Jumper options for inverting channels 1 to 5 and switching channel positions
- USB override of jumper options with optional software
- Single +5V power supply
- Available in 24 pin DIL, or 24 pin SOIC

1.1 Variants

JoyWarrior24RC is available in one variant only.

1.2 Custom variants

Custom adaptations are available on request.

Production of chips with different product names is available for volumes of 100 or more.

2. Functional overview

JoyWarrior24RC adapts the teacher/student interface of a model Remote Control to the USB and provides the data to the system as a joystick. This allows to use model RCs to control most simulators and games.

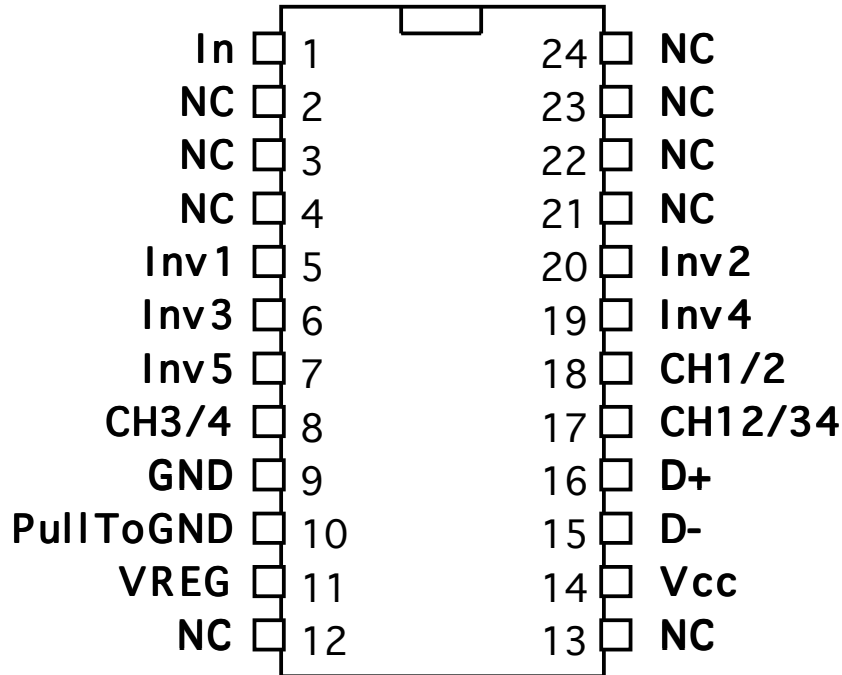
JW24RC requires only minimal external circuitry and offers a number of options to allow using almost all available RCs.

The channels 1 to 5 are assigned to joystick axes, any additional channels are converted to buttons. Jumpers allow to modify which channel get assigned to which axis. The jumper settings can be overridden by data sent via USB which can be done by optional software. This allows to control most simulators with a model RC.

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3.0 Pin Configurations

JoyWarrior24RC-P/S 24 Pin PDIP or 24 Pin SOIC



Drawing: TOP VIEW!

4.0 Pin Descriptions JoyWarrior24RC

Name	I/O	Type	Pins	Description
D+, D-	I/O	special	16,15	USB differential data lines
In	I	input, internal Pull Up	1	Input for the PPM signal, polarity independent
Inv1, Inv 2, Inv3, Inv4, Inv5	I	input, internal Pull Up	5, 20, 6, 19, 7	Option inputs, pulling one of these to Gnd inverts the corresponding channel data
CH1/2	I	input, internal Pull Up	18	Option input, pulling this pin to ground switches the positions of channels 1 and 2
CH3/4	I	input, internal Pull Up	8	Option input, pulling this pin to ground switches the positions of channels 3 and 4
CH12/34	I	input, internal Pull Up	17	Option input, pulling this pin to ground switches the positions of channels 1 and 2 with channels 3 and 4
VREG	O	special *	11	Power for USB D- pull up resistor
PullToGND	I		10	Used during manufacturing, connect to GND
GND		Power supply	9	Ground
Vcc		Power supply	14	Supply voltage
NC		Unused pins	2, 3, 4, 12, 13, 21, 22, 23, 24	Do not connect these pins

*) See application circuit for details

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4.4 Pin descriptions

D+, D-

Differential data lines of USB. Connect these signals direct to a USB cable. D- requires a pull up resistor, see application circuits for details.

In

Input pin for the PPM signal from a teacher/student plug on a model RC.

Depending on environmental conditions additional input circuitry may be required to suppress signal noise or level adjust the input signal. Refer to the application circuit for our recommended input circuit that works under most conditions. Signal polarity does not need to be preserved by the input circuit as JW24RC does accept either polarity.

Inv1, Inv2, Inv3, Inv4, Inv5

Option inputs that allow to individually invert the data of the channels 1 to 5. This is required if the direction of a channel runs backwards.

Pulling one of these pins to low does invert the corresponding channel.

The settings of these pins can be overridden by a USB command.

CH1/2

Option input to exchange the position of the channels 1 and 2.

If this pin is left open channel 1 will map to the X axis and channel 2 to Y. Pulling this pin to ground reverts the channel positions. This channel switching happens after the inversion options.

The setting of this pin can be overridden by a USB command.

CH3/4

Option input to exchange the position of the channels 3 and 4.

If this pin is left open channel 3 will map to the Z axis and channel 4 to rX (rotational X). Pulling this pin to ground reverts the channel positions. This channel switching happens after the inversion options.

The setting of this pin can be overridden by a USB command.

CH12/34

Option input to exchange the position of the channels 1 and 2 with that of channels 3 and 4.

Pulling this pin to ground reverts the channel positions, essentially swapping the left/right position of the sticks on a typical RC. This channel switching happens after the inversion options and after the channel 1/2 and 3/4 switching options.

The setting of this pin can be overridden by a USB command.

/Pull to GND

This pin is used during production of the JoyWarrior chips, connect it to GND for normal operation.

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.

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5. 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.

5.1 Operation with Windows

Any Windows versions 98 and newer and 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 may 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.

5.2 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.

With MacOS 9.x you will be able to use JoyWarrior based devices via InputSprocket or with 3rd party software like USB Overdrive.

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.

5.3 Mapping of the channels

The mapping of the channels to axes can be influenced by setting the option jumpers or by sending a command via USB.

By default the channels are mapped as follows:

Ch1 - X

Ch2 - Y

Ch3 - Z

Ch4 - rX

Ch5 - rY

Channels 6 to 12 are also used to generate joystick buttons. If the value of a channel is below 30% or above 70% of maximum a button will be reported as being activated. Each channel does control two buttons, i.e. by default channel 6 does set the button 1 as active if it is below 30% value and button 2 if it is above 70%.

The channels which generate buttons can be changed by sending a USB command. It is possible to set the first channel to be converted to buttons between 3 and 12.

The conversion of channels to buttons is done after the inversion and position switching options have been accounted for.

5.4 Additional functions via USB

JW24RC has a second interface (an interface is a logical device in a USB device) that identifies as a generic HID class device. Interface 0 is the joystick function that will be controlled by a system driver. Interface 1 identifies as a generic HID function and can be controlled from application level on most operating systems.

Via this interface JW24RC provides the raw data of the channels 6 to 12 and some status bits. It can also receive option data overriding the jumper settings of the option pins.

The input data from interface 1 has the following format:

0	1	2	3	4	5	6	7
Flags	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12

The first byte contains status flags and the information how many channels are detected in the input signal:

7 - Valid PPM signal, 1 = valid

6 - Signal polarity

5 - unused, zero

4 - unused, zero

3 - channel count MSB

2 - channel count

1 - channel count

0 - channel count LSB

The other bytes contain the data for one channel each.

Output data to interface 1 is two bytes long:

0	1
Options	Buttons

The first byte contains the option flags that have the same function as the option pins. Setting any of the bits to 1 is equivalent to pulling the corresponding option pin low. If the JW24RC receives an output report to interface 1 it will not use the option pins any longer but instead use the flags it has received in the report.

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Sending a new report will immediately override the older options flags.

Following are the option flags:

- 7 - CH12/34
- 6 - CH3/4
- 5 - CH1/2
- 4 - Inv5
- 3 - Inv4
- 2 - Inv3
- 1 - Inv2
- 0 - Inv1

The second byte contains the channel number from which on up the channels should be converted to buttons. Values 3 to 12 are valid, so the first channel that can be converted to buttons is channel 3 and channel 12 will be converted to buttons in any case. Values outside this range will be automatically adjusted to legal values.

5.5 Remote Wakeup

JoyWarrior24RC does not support Remote Wakeup of a sleeping host.

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6. 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 output pins		70	mA	V _{out} = 0.4V
R _{up}	Pull-up Resistance	8	24	kΩ	
V _{ith}	Input Threshold Voltage	40%	60%	V _{cc}	
	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 < V _{in} < 3.3V, Hi-Z State
R _{pu}	Bus Pull-up resistance	1.274	1.326	kΩ	1.3kΩ±2% to V _{reg}
R _{pd}	Bus Pull-down resistance	14.25	15.75	kΩ	15kΩ±5%

6.1 AC Characteristics

	Parameter	Min	Max	Units	Remarks
F _{iclk2}	Internal clock frequency	5.91	6.09	MHz	Clock synchronized to USB
	USB Driver Characteristics				
t _r	Transition rise time	75		ns	C _{Load} = 50pF
t _r	Transition rise time		300	ns	C _{Load} = 350pF
t _f	Transition fall time	75		ns	C _{Load} = 50pF
t _f	Transition fall time		300	ns	C _{Load} = 350pF
t _{rfm}	Rise/Fall Time matching	80	125	%	
V _{crs}	Output signal crossover voltage	1.3	2.0	V	
	USB Data Timing				
t _{drate}	Low Speed Data Rate	1.4775	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 receiver	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

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7. Ordering information

Partname	Order Code	Description	Package
JoyWarrior24 RC	JW24RC-P	RC to USB adapter	PDIP24
JoyWarrior24 RC	JW24RC-S	RC to USB adapter	SOIC24

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

7.1 Packaging info

PDIP24 chips come in tubes with 16 chips each. SOIC24 chips come in tubes with 31 chips each. To assure best handling and shipping safety please order the chips in full tubes. Custom chips are produced in multiples of full tubes only.

7.2 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.

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 are subject to minimum order quantities, contact <sales@codemercs.com> for details.

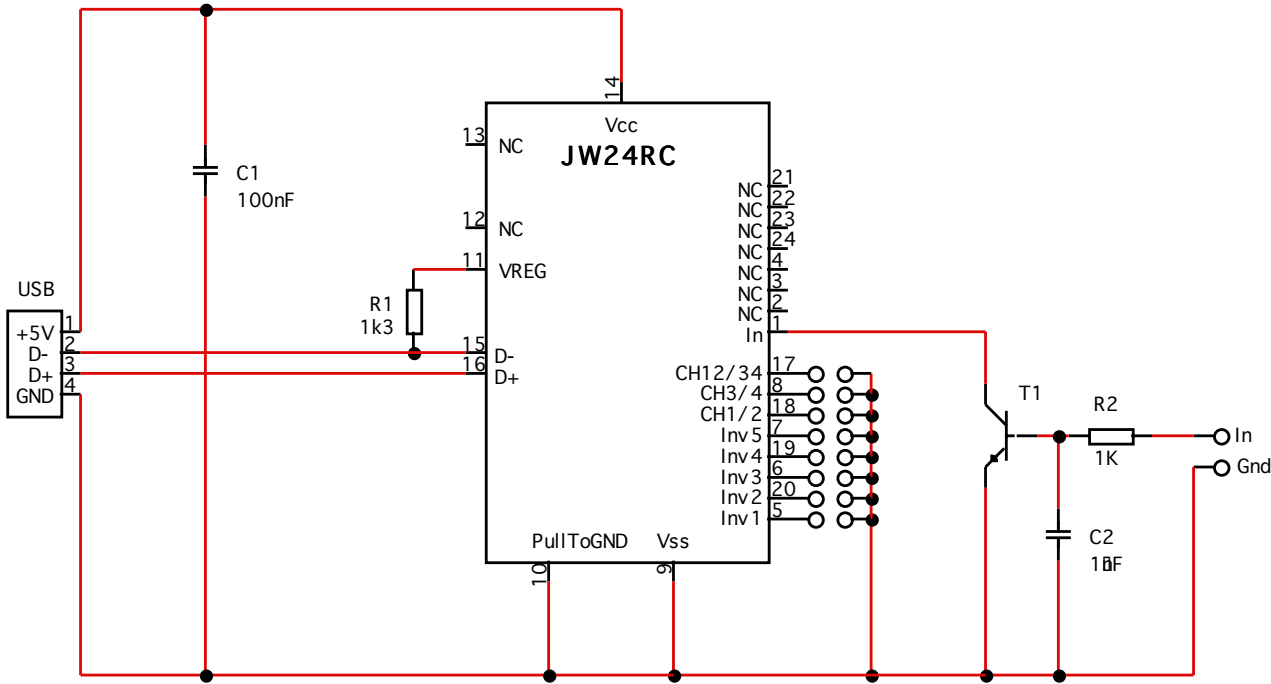
Following are the ProductIDs for the JoyWarrior controllers:


JoyWarrior24 RC \$1110

ProductIDs are independent of the package type.

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8. Typical application for JoyWarrior24 RC



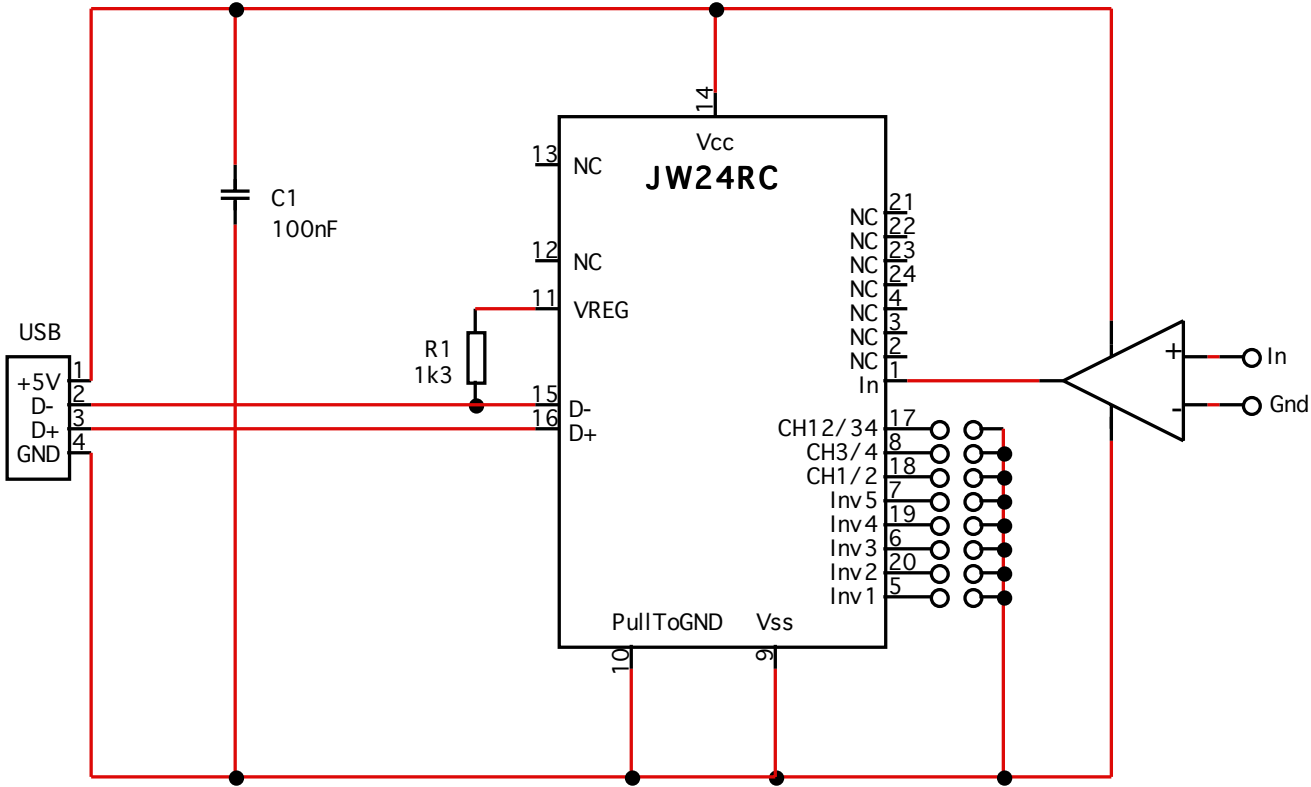
Circuit: JoyWarrior 24RC					 Code Mercenaries
Version: V1.0					
Date: 6.5.2004					
Drawn by:					
Function:					
Page:					
Rev.	Date	By	Change	Sign.	

T1 can be either NPN or PNP, any small signal switching transistor will be OK.

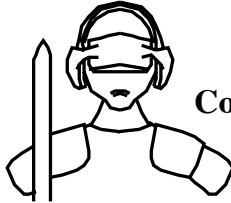
R2/C2 are low pass filtering the signal to get rid of RF noise. Depending on the environment it may be necessary to modify the filter characteristic or use shielded cable for the signal. If the RC does not deactivate the RF transmitter in student/teacher mode the RF signal is going to generate a significant noise level that may interfere with proper operation of JoyWarrior24 RC.

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8.1 Typical application for JoyWarrior24 RC when used with DSC jack on Graupner transmitters



IC2 - use a low power comparator, i.e. TLC339 or similar

Circuit: JoyWarrior 24RC w. DSC					 Code Mercenaries
Version: V1.0					
Date: 28.9.2004					
Drawn by:					
Function:					
Page:					
Rev.	Date	By	Change	Sign.	

The DSC connector as found on newer Graupner transmitters has a signal level different from the usual teacher/student connectors. The signal is only about 1.5Vpp and it is AC coupled. The easiest way to use this signal for the JW24RC is by passing it through a comparator. Since the signal is AC coupled it can be treated as a differential signal, so it does not matter to which input of the comparator the lines from the DSC connector go. Do not use an opamp for this purpose as the output levels may be inappropriate at 5V supply.

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10. ESD Considerations

JoyWarrior 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.

Series resistors of 27Ω may be used alone or in addition to some kind of suppressor device. In any case the USB 2.0 specification chapter 6 and 7 should be read for detailed specification of the electrical properties.

10.1 EMC Considerations

JoyWarrior uses relatively low power levels and so it causes few EMC problems.

To avoid any EMC problems the following rules should followed:

- Put the 100nF ceramic capacitor right next to the power supply pins of the chip 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.
- Keep the two USB signal lines close to each other, route no other signal between them. USB uses differential signalling so the best signal quality with lowest RF emission is achieved by putting these lines very close to each other.
- Adding a ferrite bead to the +5V power supply line is advisable.

11. Revision History

Please refer to the JoyWarrior main data sheet for the revision history.

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