JoyWarrior28

Universal joystick and gamepad controller chips

Code Mercenaries
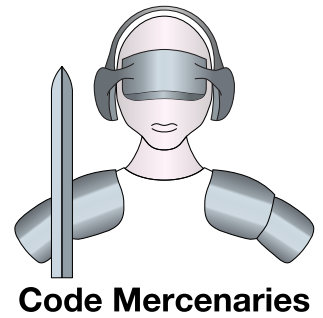
1.0 Features
- Full speed USB interface
- USB V2.0 compliant
- USB HID 1.1 compliant
- Available for analog and digital sticks
- Support for up to 6, 8, 16, or 32 buttons
- Compatible with standard system drivers, no special drivers necessary
- Digital outputs available on some models
- Single +3.3V power supply (5V for some modules)
- Available in QFN28 or as modules

1.1 Variants

JoyWarrior28GP32
- Gamepad style controller, supports 4 switches for directions
- Supports up to 32 buttons, arranged in a 8x4 matrix, or up to 12 buttons connected direct
- Enable output to signal suspend mode to external circuitry
- Mouse emulation mode pin selectable at run time

JoyWarrior28A12L
- Four analog axes with 12 bit resolution each via internal A/D converter
- Supports 8 direct connected buttons or 16 buttons in a 4x4 matrix (pin selectable)
- 4 auxiliary outputs i.e. to control LEDs, supporting flashing modes
- Enable output to signal suspend mode to external circuitry

JoyWarrior28A12-32
- Four analog axes with 12 bit resolution each via internal A/D converter
- Supports up to 32 buttons, arranged in a 8x4 matrix, or up to 12 buttons connected direct
- Enable output to signal suspend mode to external circuitry

JoyWarrior28A12-16
- Eight analog axes with 12 bit resolution each via internal A/D converter
- Supports up to 16 buttons, arranged in a 4x4 matrix, or up to 8 buttons connected direct
- Enable output to signal suspend mode to external circuitry

MouseWarrior28H8L
- Mouse/Joystick hybrid controller
- Runtime switching between mouse and joystick
- Compatible with hall sensors etc.
- 4 analog axes with 8 bit resolution each
- Up to six buttons connected direct
- Autocalibration and autocentering pin selectable
- Dynamic recentering for drift compensation pin selectable
- 4 auxiliary outputs i.e. to control LEDs, supporting flashing modes
- Enable output to signal suspend mode to external circuitry

1.2 Custom variants
Custom adaptions are available on request.

1.3 Obsolete variants
The JoyWarrior24 variants are replaced by JoyWarrior28. Use the following variants to replace legacy products:

JW24GP32	- use JW28GP32
JW24A8-8	- use JW28A12xx
JW24A8-16	- use JW28A12xx
JW24A8L	- use JW28A12xx
JW24A10L	- use JW28A12xx
MW24J8	- use MW28H8L
MW24H8	- use MW28H8L

For details on the earlier discontinued JW20 chips please refer to the old JoyWarrior data sheet.
MouseWarrior24J8 and MouseWarrior24H8 are listed among the JoyWarrior chips since they are based on the same software engine. This was continued with the MouseWarrior28H8L.

2.0 Functional overview
The JoyWarrior family of joystick controllers allows to build USB compatible input devices without the need to acquire much USB know how.
Mostly only electro-mechanical components need to be added to the JoyWarrior chips.
The variety of controller versions covers the requirements for most industrial and game control devices.

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2.1 Product selection matrix

Type	Analog	Digital	A/D	Axes	Bit/Axis	Buttons	Matrix	Outputs	Mouse mode	QFN28	DIL	SO24	Module
JoyWarrior28GP32	-	√	-	2	n.a.	12 or 32	8x4	-	√	√	√	√	√
JoyWarrior28A12L	√	-	internal	4	12	8 or 16	4x4	4	-	√	√	-	√
JoyWarrior28A12-32	√	-	internal	4	12	12 or 32	8x4	-	-	√	√	-	√
JoyWarrior28A12-16	√	-	internal	8	12	8 or 16	4x4	-	-	√	√	-	√
MouseWarrior28H8L	√	-	internal	4	8	6	-	4	√	√	√	-	√

2.2 Package types

The standard package for JoyWarrior28 is a QFN28 SMD package. For simpler handling in small volumes a DIL28 module is available too. JoyWarrior28GP32 is also available as a SOIC24 module to directly replace JoyWarrior24GP32-S.

2.3 DIL28 module

The DIL28 package is intended for easier handling in small volumes. Mechanically it fits on the same footprint as a DIL28 chip package with 300 mil row spacing.

In addition to the JoyWarrior28 chip the module already contains the 100 nF power filter capacitors for the supply power. Aside from that no additional circuitry is on the module. The electrical properties are identical with the QFN28 chips.

The DIL28 module must not be soldered in a reflow process as components may desolder and fall off the module.

2.4 SOIC24 module (JW28GP32 only)

A module that fits on the SOIC24 footprint is available to simplify the transition of designs from the old chips. Due to the functional differences of the other chips this is only possible for the JoyWarrior28GP32.

The JW28GP32-S24 module replicates the function of the JW24GP32-S as close as possible.

A 3.3 V regulator is contained on the module so it can accept 5 V power. No changes to the board should be necessary in most cases.

Differences are as follows:

USB is running at full speed instead of low speed.

The Vreg pin, which drives the USB pull up resistor for JW24GP32, is not connected. JW28GP32 has an internal pull up resistor on the USB and does not need the external resistor. There is no need to remove the resistor on your legacy board.

All pins aside from the /Matrix pin are only 3.3 V tolerant. This should be no issue if all input comes from switches or open drain drivers.

Since the /Matrix pin is 5 V tolerant it may be pulled up to 5 V for direct connected pins.

The Mouse mode of JW28GP32 is not accessible on the SOIC24 module. Neither is the /EN pin.
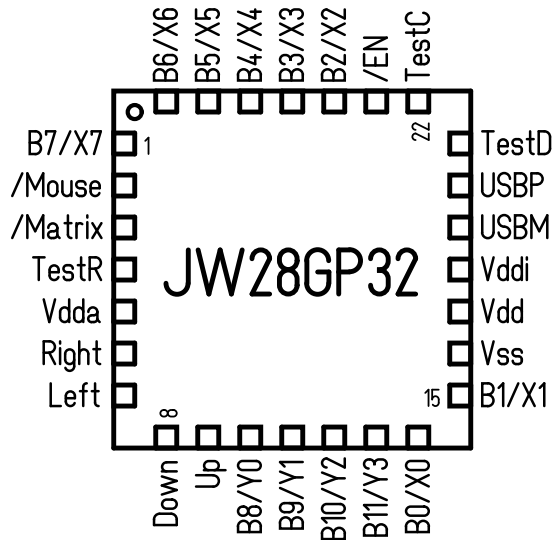
2.5 Ready to use module

To enable applications where a custom PCB design is not feasible all chips are available on ready to use modules.

The modules contain the circuit as shown in the applications in chapter 8. All connections on the PCB are labeled with either the pin number they represent or the signal they represent (i.e. Aref for VDDA, D+ for USB D+ line).
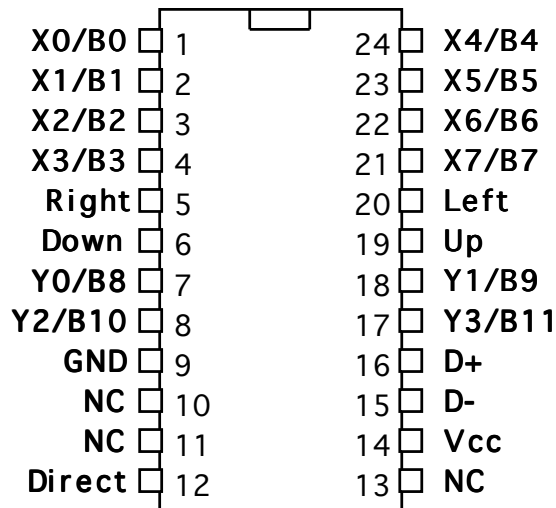
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3.0 Pin Configurations (TOP VIEW!)
JoyWarrior28GP32-Q28
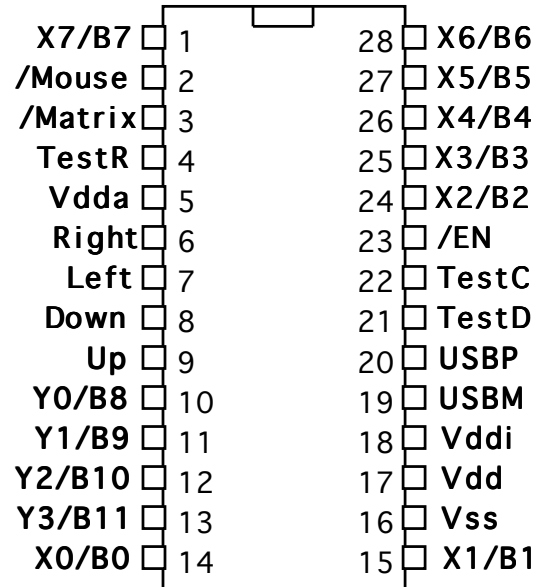**28 Pin QFN**

Top pins (left to right): B6/X6, B5/X5, B4/X4, B3/X3, B2/X2, /EN, TestC

Left pins (top to bottom): B7/X7 (1), /Mouse, /Matrix, TestR, Vdda, Right, Left (8)

Right pins (top to bottom): TestD, USBP, USBM, Vddi, Vdd, Vss, B1/X1 (15)

Bottom pins (left to right): Down, Up, B8/Y0, B9/Y1, B10/Y2, B11/Y3, B0/X0

Center label: JW28GP32 (pin 1 top-left, pin 22 top-right)

JoyWarrior28GP32-DIL28
28 Pin DIL module

Left	Pin	Pin	Right
X7/B7	1	28	X6/B6
/Mouse	2	27	X5/B5
/Matrix	3	26	X4/B4
TestR	4	25	X3/B3
Vdda	5	24	X2/B2
Right	6	23	/EN
Left	7	22	TestC
Down	8	21	TestD
Up	9	20	USBP
Y0/B8	10	19	USBM
Y1/B9	11	18	Vddi
Y2/B10	12	17	Vdd
Y3/B11	13	16	Vss
X0/B0	14	15	X1/B1

All drawings: TOP VIEW!

JoyWarrior28GP32-S24
24 Pin SOIC replacement module

Left	Pin	Pin	Right
X0/B0	1	24	X4/B4
X1/B1	2	23	X5/B5
X2/B2	3	22	X6/B6
X3/B3	4	21	X7/B7
Right	5	20	Left
Down	6	19	Up
Y0/B8	7	18	Y1/B9
Y2/B10	8	17	Y3/B11
GND	9	16	D+
NC	10	15	D-
NC	11	14	Vcc
Direct	12	13	NC

NC pins on JW28GP32-S24 have no internal connection, so it does not matter if they are connected

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JoyWarrior28A12L-Q28
28 Pin QFN

Top pins (left to right): B6/Y2, B5/Y1, B4/Y0, B3/X3, B2/X2, /EN, TestC

Left pins (top to bottom): B7/Y3 (1), NC, /Matrix, TestR, Vdda, CH0, CH1 (8)

Right pins (top to bottom): TestD (22), USBP, USBM, Vddi, Vdd, Vss, B1/X1 (15)

Bottom pins (left to right): CH2, CH3, Aux0, Aux1, Aux2, Aux3, B0/X0

Center: JW28A12L
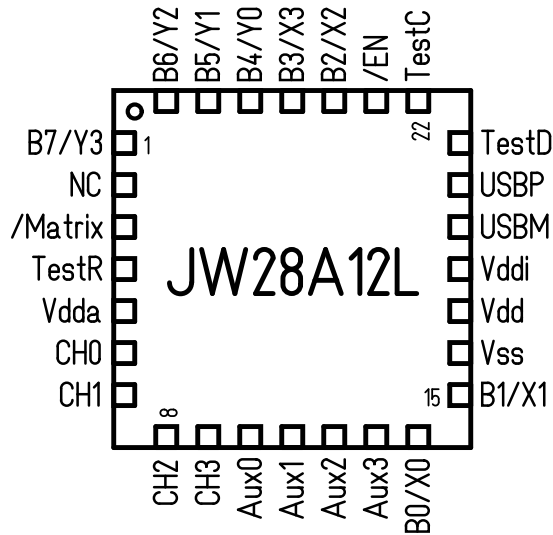
JoyWarrior28A12-32-Q28
28 Pin QFN

Top pins (left to right): X6/B6, X5/B5, X4/B4, X3/B3, X2/B2, /EN, TestC

Left pins (top to bottom): X7/B7 (1), NC, /Matrix, TestR, Vdda, CH0, CH1 (8)

Right pins (top to bottom): TestD (22), USBP, USBM, Vddi, Vdd, Vss, X1/B1 (15)

Bottom pins (left to right): CH2, CH3, Y0/B8, Y1/B9, Y2/B10, Y3/B11, X0/B0

Center: JW28A12-32
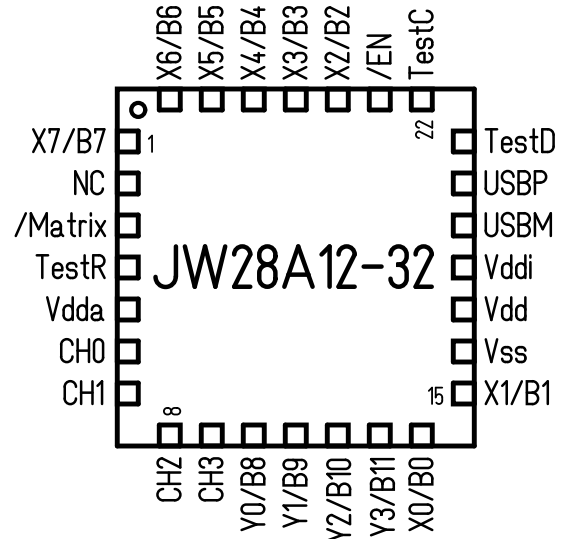
JoyWarrior28A12L-DIL28
28 Pin DIL module

Left			Right
B7/Y3	1	28	B6/Y2
NC	2	27	B5/Y1
/Matrix	3	26	B4/Y0
TestR	4	25	B3/X3
Vdda	5	24	B2/X2
CH0	6	23	/EN
CH1	7	22	TestC
CH2	8	21	TestD
CH3	9	20	USBP
Aux0	10	19	USBM
Aux1	11	18	Vddi
Aux2	12	17	Vdd
Aux3	13	16	Vss
B0/X0	14	15	B1/X1
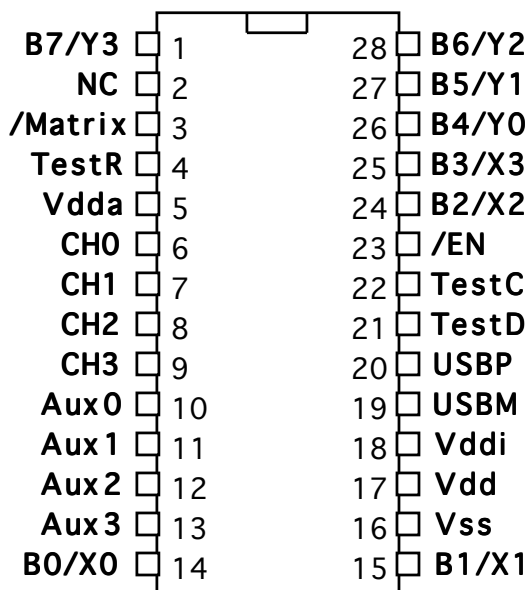
JoyWarrior28A12-32-DIL28
28 Pin DIL module

Left			Right
X7/B7	1	28	X6/B6
NC	2	27	X5/B5
/Matrix	3	26	X4/B4
TestR	4	25	X3/B3
Vdda	5	24	X2/B2
CH0	6	23	/EN
CH1	7	22	TestC
CH2	8	21	TestD
CH3	9	20	USBP
Y0/B8	10	19	USBM
Y1/B9	11	18	Vddi
Y2/B10	12	17	Vdd
Y3/B11	13	16	Vss
X0/B0	14	15	X1/B1
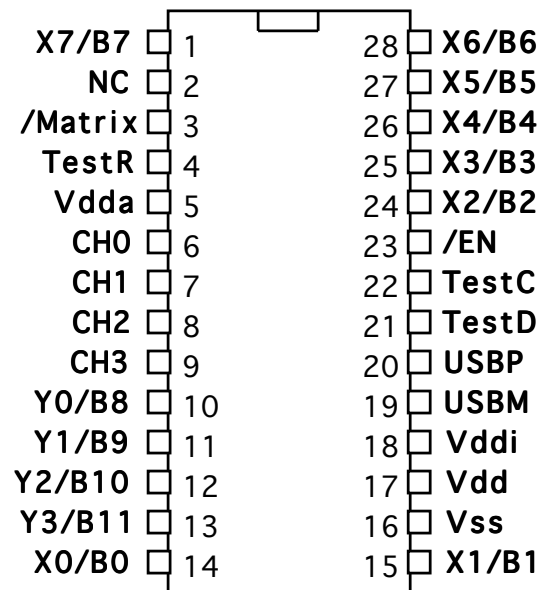
JoyWarrior28A12-16-Q28
28 Pin QFN

Top pins: B6/Y2, B5/Y1, B4/Y0, B3/X3, B2/X2, /EN, TestC

Left pins: B7/Y3 (1), NC, /Matrix, TestR, Vdda, CH0, CH1

Right pins: TestD, USBP, USBM, Vddi, Vdd, Vss, B1/X1 (15)

Bottom pins: CH2, CH3, CH4, CH5, CH6, CH7, B0/X0

Center label: JW28A12-16
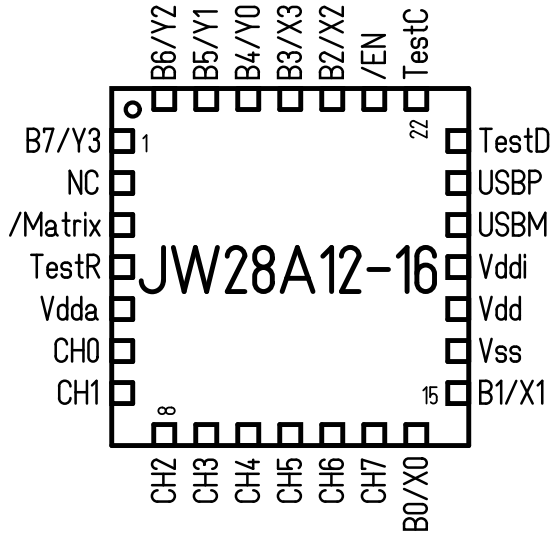
MouseWarrior28H8L-Q28
28 Pin QFN

Top pins: /RAW, B5, B4, B3, B2, /EN, TestC

Left pins: /Joy (1), Center, Range, TestR, Vdda, CH0, CH1

Right pins: TestD, USBP, USBM, Vddi, Vdd, Vss, B1 (15)

Bottom pins: CH2, CH3, Aux0, Aux1, Aux2, Aux3, B0

Center label: MW28H8L
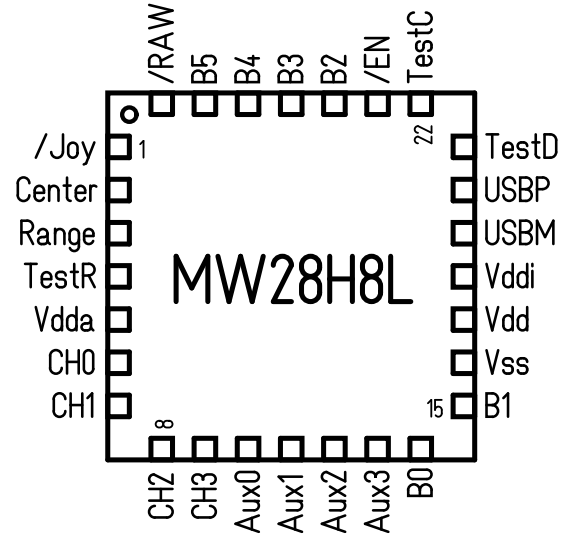
JoyWarrior28A12-16-DIL28
28 Pin DIL module

Left			Right
Y3/B7	1	28	Y2/B6
NC	2	27	Y1/B5
/Matrix	3	26	Y0/B4
TestR	4	25	X3/B3
Vdda	5	24	X2/B2
CH0	6	23	/EN
CH1	7	22	TestC
CH2	8	21	TestD
CH3	9	20	USBP
CH4	10	19	USBM
CH5	11	18	Vddi
CH6	12	17	Vdd
CH7	13	16	Vss
X0/B0	14	15	X1/B1
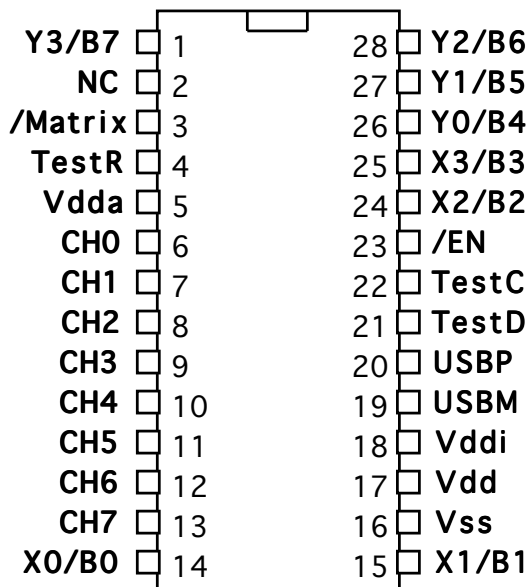
MouseWarrior28H8L-DIL28
28 Pin DIL module

Left			Right
/Joy	1	28	/RAW
Center	2	27	B5
Range	3	26	B4
TestR	4	25	B3
Vdda	5	24	B2
CH0	6	23	/EN
CH1	7	22	TestC
CH2	8	21	TestD
CH3	9	20	USBP
Aux0	10	19	USBM
Aux1	11	18	Vddi
Aux2	12	17	Vdd
Aux3	13	16	Vss
B0	14	15	B1
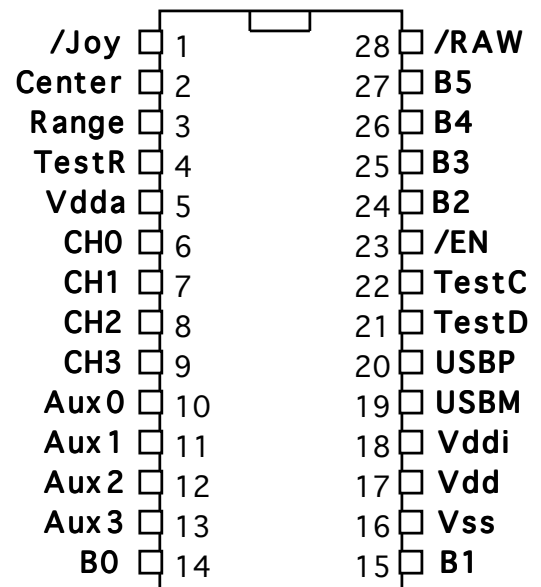
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4.0 Pin Descriptions JoyWarrior28GP32-Q28/-DIL28

Name	I/O	Type	Pins	Description
USBP, USBM	I/O	special	20, 19	USB differential data lines
X0/B0, X1/B1, X2/B2, X3/B3, X4/B4, X5/B5, X6/B6, X7/B7	I	input, internal pull up	14, 15, 24, 25, 26, 27, 28, 1	Button row inputs, active low for matrix mode, direct button inputs 0..7 for direct connection, active low
Y0/B8, Y1/B9, Y2/B10, Y3/B11	I or O	output, open drain, or input, internal pull up	10, 11, 12, 13	Button column outputs, periodically pulled low for matrix mode, direct button inputs 8..11 for direction connection mode, active low
Right	I	input, internal pull up	6	Input for right direction switch, active low
Left	I	input, internal pull up	7	Input for left direction switch, active low
Down	I	input, internal pull up	8	Input for down direction switch, active low
Up	I	input, internal pull up	9	Input for up direction switch, active low
TestR, TestD, TestC		special	4, 21, 22	Used during manufacturing, do not connect
Vss		power supply	16	Ground
Vdd, Vdda, Vddi		power supply	17, 5, 18	Supply voltage, connect to 3.3 V
/EN	O	output, open drain, internal pull up	23	This pin is pulled low when external hardware is allowed to draw power. Supports USB suspend mode
/Matrix	I	input, internal pull down, 5 V tolerant	3	Pull high to enable direct connected buttons
/Mouse	I	input, internal pull up	2	Pull low to enable mouse emulation

4.1 Pin Descriptions JoyWarrior28GP32-S24

Name	I/O	Type	Pins	Description
D+, D-	I/O	special	16, 15	USB differential data lines
X0/B0, X1/B1, X2/B2, X3/B3, X4/B4, X5/B5, X6/B6, X7/B7	I	input, internal pull up	1,2,3,4,24, 23, 22, 21	Button row inputs, active low for matrix mode, direct button inputs 0..7 for direct connection, active low
Y0/B8, Y1/B9, Y2/B10, Y3/B11	I or O	output, open drain, or input, internal pull up	7, 18, 8, 17	Button column outputs, periodically pulled low for matrix mode, direct button inputs 8..11 for direction connection mode, active low
Right	I	input, internal pull up	5	Input for right direction switch, active low
Left	I	input, internal pull up	20	Input for left direction switch, active low
Down	I	input, internal pull up	6	Input for down direction switch, active low
Up	I	input, internal pull up	19	Input for up direction switch, active low
GND		power supply	9	Ground
Vcc		power supply	14	Supply voltage, connect to max. 5 V
Direct	I	input, internal pull down, 5 V tolerant	12	Pull high to enable direct connected buttons
NC	-	no conection	10, 11, 13	No internal connection, don't care

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4.2 Pin Descriptions JoyWarrior28A12L-Q28/-DIL28

Name	I/O	Type	Pins	Description
USBP, USBM	I/O	special	20, 19	USB differential data lines
X0/B0, X1/B1, X2/B2, X3/B3, Y0/B4, Y1/B5, Y2/B6, Y3/B7	I or O	input or output, internal pull up	14, 15, 24, 25, 26, 27, 28, 1	Button inputs, active low for direct connection mode, row and column lines for matrix mode
CH0, CH1, CH2, CH3	I	analog input	6, 7, 8, 9	Analog input, range Vss to Vdda
Aux0, Aux1, Aux2, Aux3	O	output, high and low drive	10, 11, 12, 13	Auxiliary outputs, active low
TestR, TestD, TestC		special	4, 21, 22	Used during manufacturing, do not connect
Vss		power supply	16	Ground
Vdd, Vddi		power supply	17, 18	Supply voltage, connect to 3.3 V
Vdda	I	power supply	5	Supply voltage, connect to 3.3 V, serves as analog input high-reference
/EN	O	output, open drain, internal pull up	23	This pin is pulled low when external hardware is allowed to draw power. Supports USB suspend mode
/Matrix	I	input, internal pull up	3	Pull low to enable 4x4 button matrix

4.3 Pin Descriptions JoyWarrior28A12-32-Q28/-DIL28

Name	I/O	Type	Pins	Description
USBP, USBM	I/O	special	20, 19	USB differential data lines
X0/B0, X1/B1, X2/B2, X3/B3, X4/B4, X5/B5, X6/B6, X7/B7	I	input, internal pull up	14, 15, 24, 25, 26, 27, 28, 1	Button row inputs, active low for matrix mode, direct button inputs 0..7 for direct connection, active low
Y0/B8, Y1/B9, Y2/B10, Y3/B11	I or O	output, open drain, or input, internal pull up	10, 11, 12, 13	Button column outputs, periodically pulled low for matrix mode, direct button inputs 8..11 for direction connection mode, active low
CH0, CH1, CH2, CH3	I	analog input	6, 7, 8, 9	Analog input, range Vss to Vdda
TestR, TestD, TestC		special	4, 21, 22	Used during manufacturing, do not connect
Vss		power supply	16	Ground
Vdd, Vdda, Vddi		power supply	17, 5, 18	Supply voltage, connect to 3.3 V
/EN	O	output, open drain, internal pull up	23	This pin is pulled low when external hardware is allowed to draw power. Supports USB suspend mode
/Matrix	I	input, internal pull down, 5 V tolerant	3	Pull high to enable direct connected buttons
NC	I-	not used	2	

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4.4 Pin Descriptions JoyWarrior28A12-16-Q28/-DIL28

Name	I/O	Type	Pins	Description
USBP, USBM	I/O	special	20, 19	USB differential data lines
X0/B0, X1/B1, X2/B2, X3/B3, Y0/B4, Y1/B5, Y2/B6, Y3/B7	I or O	input or output, internal pull up	14, 15, 24, 25, 26, 27, 28, 1	Button inputs, active low for direct connection mode, row and column lines for matrix mode
CH0, CH1, CH2, CH3, CH4, CH5, CH6, CH7	I	analog input	6, 7, 8, 9, 10, 11, 12, 13	Analog input, range Vss to Vdda
TestR, TestD, TestC		special	4, 21, 22	Used during manufacturing, do not connect
Vss		power supply	16	Ground
Vdd, Vddi		power supply	17, 18	Supply voltage, connect to 3.3 V
Vdda	I	power supply	5	Supply voltage, connect to 3.3 V, serves as analog input high-reference
/EN	O	output, open drain, internal pull up	23	This pin is pulled low when external hardware is allowed to draw power. Supports USB suspend mode
/Matrix	I	input, internal pull up	3	Pull low to enable 4x4 button matrix

4.5 Pin Descriptions MouseWarrior28H8L-Q28/-DIL28

Name	I/O	Type	Pins	Description
USBP, USBM	I/O	special	20, 19	USB differential data lines
B0, B1, B2, B3, B4, B5	I or O	input, internal pull up	14, 15, 24, 25, 26, 27	Button inputs, active low
CH0, CH1, CH2, CH3	I	analog input	6, 7, 8, 9	Analog input, range Vss to Vdda
Aux0, Aux1, Aux2, Aux3	O	output, high and low drive	10, 11, 12, 13	Auxiliary outputs, active low
TestR, TestD, TestC		special	4, 21, 22	Used during manufacturing, do not connect
Vss		power supply	16	Ground
Vdd, Vddi		power supply	17, 18	Supply voltage, connect to 3.3 V
Vdda	I	power supply	5	Supply voltage, connect to 3.3 V, serves as analog input high-reference
/EN	O	output, open drain, internal pull up	23	This pin is pulled low when external hardware is allowed to draw power. Supports USB suspend mode
/Joy	I	input, internal pull up	1	Mode pin, pull low to switch to joystick function
Center	I	input, internal pull up	2	Pull down to disable automatic recentering
Range	I	input, internal pull up	3	Pull down to reduce input value range used for mouse movement, i.e. higher sensitivity
/RAW	I	input, internal pull up	28	Pull low to disable auto calibration and centering

4.5 Pin descriptions

USBP, USBM
Differential data lines of USB. Connect these signals direct to a USB cable. No additional components required. ESD protection may be added.

/EN
Enable output to control the power for external circuitry. To comply with the suspend mode maximum current consumption on the USB it may be necessary to switch off the power to sensors and other external parts.
This pin goes low when power to the sensor should be on. Use whatever circuitry necessary to control the supply power for your sensors.
Open drain output with internal pull up resistor.

X0/B0..X3/B3 (JW28A12L, JW28A12-16)
Matrix row inputs for the buttons. In direct mode these pins work as direct button inputs, active low, use contacts closing to ground.
Internal pull up resistors.

X0/B0..X7/B7 (JW28GP32, JW28A12-32)
Matrix row inputs for the buttons. In direct mode these pins work as direct button inputs, active low, use contacts closing to ground.
Internal pull up resistors.

Y0/B4..Y3/B7 (JW28A12L, JW28A12-16)
Matrix column outputs or button inputs for direct mode. In matrix mode these pins are periodically pulled low to determine the status of the buttons.
In matrix mode all buttons must be decoupled with diodes, see application circuit for details.
In direct mode these pins act as active low inputs, connect contacts closing to ground.
Open drain outputs or inputs with internal pull up resistor.

Y0/B8..Y3/B11 (JW28GP32, JW28A12-32)
Matrix column outputs or button inputs for direct mode. In matrix mode these pins are periodically pulled low to determine the status of the buttons.
In matrix mode all buttons must be decoupled with diodes, see application circuit for details.
In direct mode these pins act as active low inputs, connect contacts closing to ground.
Open drain outputs or inputs with internal pull up resistor.

B0..B5 (MW28H8L)
Inputs for the buttons. Connect contacts closing to ground.
Internal pull up resistors.

CH0..3 (JW28A12L, JW28A12-32, JW28A12-16 MW28H8L)
Analog axis inputs. Input voltage from Vss to Vdda. Input impedance typ. 50 kΩ (before V1.0.1.1 it was 5 kΩ).

CH4..7 (JW28A12-16)
Analog axis inputs. Input voltage from Vss to Vdda. Input impedance typ. 50 kΩ.

Left, Right, Up, Down (JW28GP32)
Inputs for the direction pad. Connect contacts closing to ground.
Internal pull up resistors.

/Matrix (JW8GP32, JW28A12L, JW28A12-32, JW28A12-16)
Pulling this pin low enables the matrix scanning for the buttons, pulling it high enables direct connected buttons.
For backward compatibility the JW28GP32 has a pull down resistor on this pin.
Internal pull down for JW28GP32, internal pull up for JW24A12L

Aux0..Aux3 (JW28A12L, MW28H8L)
Auxiliary outputs, active low.
Push-Pull outputs.

/RANGE (MW28H8L)
Pulling this pin low doubles the sensitivity of the mouse function. i.e. half of the value range of the input signal will be sufficient to get to full cursor speed. This option can be used to compensate reduced voltage swing from the sensor or a circular movement restriction of the sensor. This does not affect the joystick data.
Internal pull up resistor.

CENTER (MW28H8L)
Pulling this pin low disables the automatic recentering. Automatic recentering does adjust the center, or non moving position if the input value is stable on a non center value for a longer time period.
This function compensates drift in the sensor.
Internal pull up resistor.

JoyWarrior28

/RAW (MW28H8L)
Pulling this pin low disables the autocalibration and autocentering function. The chip will then report the raw axis data. This can be useful during design test or for applications that can't accept the autocalibration or autocentering feature.
Internal pull up resistor.

/Joy (MW28H8L)
Pulling this pin low disables the mouse function and enables the joystick function. All axis data is then reported in joystick format. Letting the pin float high does enable the mouse mode in which the X/Y axis position is translated into cursor movements when the axis position is not center.
Allows runtime switching between mouse and joystick function.
Internal pull up resistor.

/Mouse (JW28GP32)
Pulling this pin low enables a mouse emulation mode. The direction inputs are translated into an accelerated mouse cursor movement.
Allows runtime switching between mouse and joystick function.
Internal pull up resistor.

TestC, TestD, TestR
These pins are used during production of the JoyWarrior chips, do not connect.

Vss
Power supply ground.

Vdd, Vddi
Supply voltage. Requires 3.3 V

Vdda
Analog supply voltage to the internal A/D converter, requires 3.3 V. For the analog variants additional filtering may be added to improve signal quality.

Vcc, GND (JW28GP32-S24)
Power supply pins for SOIC24 replacement module. Vcc is 5 V.

5.0 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 Protocol specifics: JoyWarrior28GP32

Even though JoyWarrior28GP32 is a gamepad style device it does report the directional data as a joystick with two axes of 8 bit each. For left and up directions 0 is reported, for neutral 127 and for right and down 255.

This method was chosen since the gamepad data format does cause problems with several older OS variants and some applications.

5.2 Autocalibration and autocentering - MouseWarrior28H8L

The MouseWarrior28H8L chip does have a autocentering and autocalibration function that compensates mechanical tolerances of the joystick. When autocalibration and autocentering is activated (i.e. /RAW pin is unconnected or pulled to Vdd) upon power up the MouseWarrior28H8L will sample axis data for about 200msec and then use the current stick position as center. The chip then assumes that each pot will reach 60% of its total range and will scale all axis data accordingly to cover the value range of 0 to 255. If any axis is moved beyond the assumed range the scaling will be adjusted.

To calibrate a joystick with the autocentering feature activated it is sufficient to place the stick to about center before plugging it in and then move the stick to all maximum positions. The MouseWarrior28H8L will optimize the value scaling for best resolution.

Pulling the /RAW pin low for more than 20msec and then let it go high again triggers a recalibration of the center position and reset of the assumed range to ±60%.

5.3 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.

5.4 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.

Logically the zero, zero position of a USB joystick is upper left corner, like the coordinates on a computer screen.

Higher voltage values at the analog inputs translate to higher axis values.

5.5 Non Joystick Applications

USB does allow a Human Interface Device controller to specify the function of axes and buttons in very much detail. 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, rX (for JW28A12-16 the additional axes identify as rY, rZ, Dial, Slider) and the switch inputs are defined as being just buttons. We can modify the controllers to define axes as other inputs, like gas or rudder pedals or support hat switches etc.

However not all available usages are supported by all operating systems and programs. Windows for instance supports only a small subset of the simulation controls page.

If you have special requirements, please contact us about modifications.

5.6 Auxiliary outputs on JW28A12L/MW28H8L
The JoyWarrior28A12L and MouseWarrior28H8L chips have 4 auxiliary outputs that may be used to drive LED indicators or for other applications. The outputs are active low. This means the outputs are low when active and high when idle.

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 - Heart beat 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 ouput 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 send.

All outputs go to idle when the JoyWarrior enters suspend mode.

JoyWarrior28

6.0 Absolute maximum ratings (chips and modules)

Storage temperature ....-65°C to +150°C
Ambient temperature, operating..-40°C to +85°C
Supply voltage on Vdd, Vdda, Vddi relative to Vss ....-0.3V to +4V
Supply voltage on Vcc relative to Gnd (S24 module) ....-0.3 V to +6.5 V
DC input voltage ....-0.3V to +4V
Maximum current into all ports...80mA
Power dissipation...max. 170mW
Static discharge voltage...>2000V
Latch-up current ....>200mA

6.1 DC characteristics

	Parameter	Min	Max	Units	Remarks
V_{dd}, V_{dda}, V_{ddi}	Operating voltage	2.0	3.6	V	typ. 3.3 V
V_{cc}	Operating voltage	3.6	5.5	V	for S24 module only
I_{cc}	Operating supply current		25	mA	
I_{sb}	Suspend mode current		350	μA	internally active
I_{ol}	Sink current on interface pins		25	mA	max. combined all pins 80 mA
I_{olen}	Sink current on /En pin		25	mA	max. combined all pins 80 mA
V_{ol8}	Output low voltage		0.4	V	I = 8 mA
V_{oh8}	Output high voltage	V_{ddi}-0.4		V	I = 8 mA
V_{ol20}	Output low voltage		1.3	V	I =20 mA
V_{oh20}	Output high voltage	V_{ddi}-1.3		V	I =20 mA
R_{up}	Pull up/down resistors	25	55	kΩ	typ. 40 kΩ
V_{ith}	Input threshold voltage	0.7 x V_{ddi}		V	

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

Partname	Order Code	Description	Package
JoyWarrior28GP32	JW28GP32-Q28	Gamepad controller supports up to 32 buttons, 8x4 matrix	QFN28
JoyWarrior28GP32	JW28GP32-DIL28	Gamepad controller supports up to 32 buttons, 8x4 matrix	DIL28 Mod
JoyWarrior28GP32	JW28GP32-S24	JW24GP32-S replacement	SOIC24 Mod
JoyWarrior28A12L	JW28A12L-Q28	Joystick controller, 4 axis, 12 bit, up to 16 buttons, 4 aux out	QFN28
JoyWarrior28A12L	JW28A12L-DIL28	Joystick controller, 4 axis, 12 bit, up to 16 buttons, 4 aux out	DIL28 Mod
JoyWarrior28A12-32	JW28A12-32-Q28	Joystick controller, 4 axis, 12 bit, up to 32 buttons	QFN28
JoyWarrior28A12-32	JW28A12-32-DIL28	Joystick controller, 4 axis, 12 bit, up to 32 buttons	DIL28 Mod
JoyWarrior28A12-16	JW28A12-16-Q28	Joystick controller, 8 axis, 12 bit, up to 16 buttons	QFN28
JoyWarrior28A12-16	JW28A12-16-DIL28	Joystick controller, 8 axis, 12 bit, up to 16 buttons	DIL28 Mod
MouseWarrior28H8L	MW28H8L-Q28	mouse/joystick hybrid, 4 axis, 8 bit, up to 6 nuttons, 4 aux out	QFN28
MouseWarrior28H8L	MW28H8L-DIL28	mouse/joystick hybrid, 4 axis, 8 bit, up to 6 nuttons, 4 aux out	DIL28 Mod

7.1 Packaging info
QFN28 chips come in trays - TBD
DIP28 modules - TBD
SOIC24 replacement module - TBD

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.

7.3 Product IDs, Versions and Production Status
Following is the current status for all JoyWarrior variants and the Product ID information. ProductIDs are independent of the package type. The MouseWarrior chips listed here are based on the JoyWarrior core.

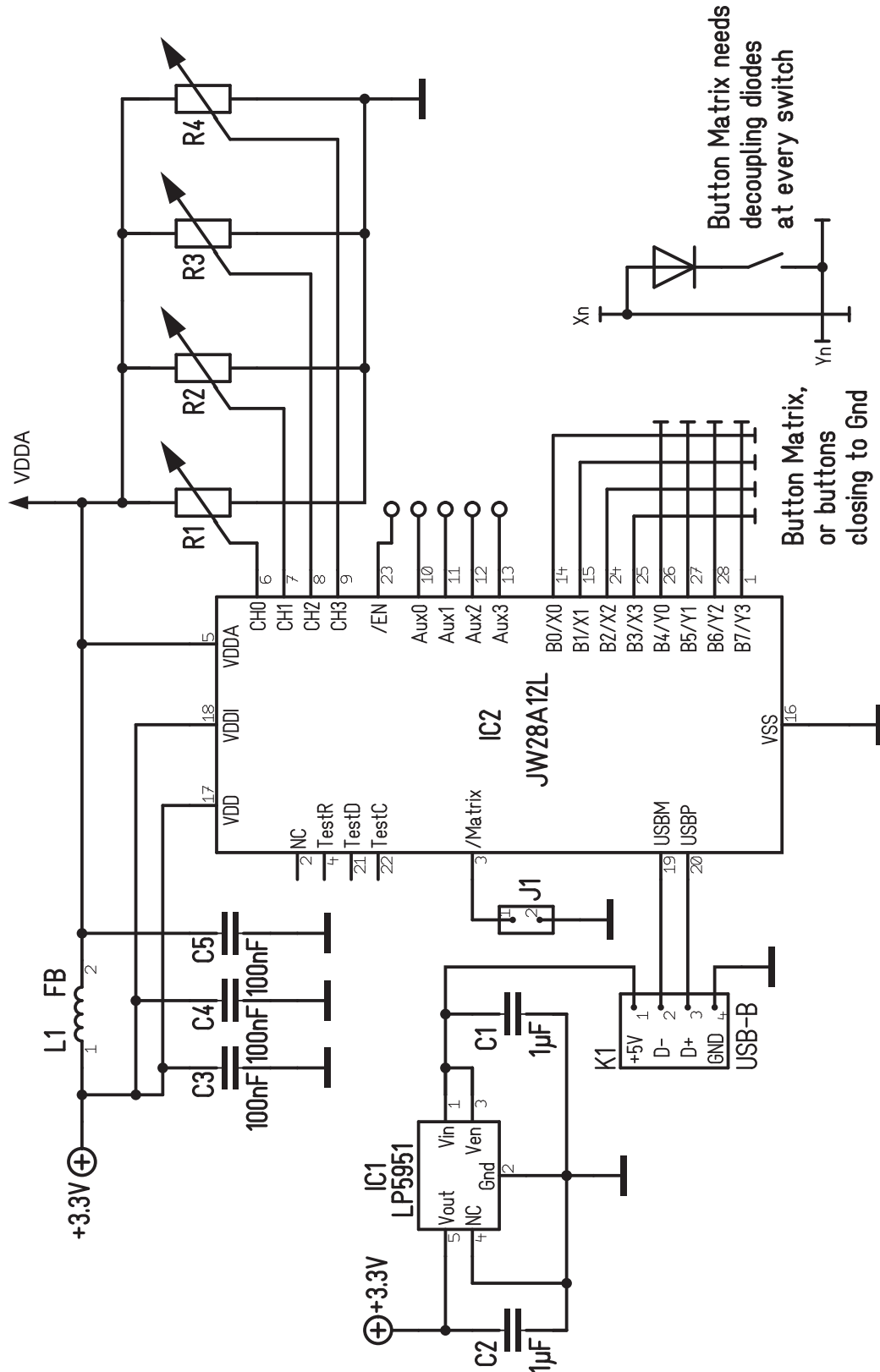| Partname	Product ID	Current Shipping Version	Status
JoyWarrior28GP32	$1180	V1.0.1.6	shipping
JoyWarrior28A12L	$1181	V1.0.1.7	shipping
MouseWarrior28H8L	$1182	V1.0.1.7	shipping
JoyWarrior28A12-32	$1187	V1.0.1.D	shipping
JoyWarrior28A12-16	$1188	V1.0.2.2	shipping
JoyWarrior20 GP 8	$1100	V1.0.3.B	discontinued, available for maintenance only
JoyWarrior24 GP 32	$1101	V1.0.4.7	discontinued, available for maintenance only
JoyWarrior24 A8-8	$1104	V1.0.3.0	discontinued, available for maintenance only
JoyWarrior24 A8-16	$1105	V1.0.3.0	discontinued, available for maintenance only
JoyWarrior20 A10-8	$1108	V1.0.3.B	discontinued, available for maintenance only
JoyWarrior20 A10-16	$1109	V1.0.3.B	discontinued, available for maintenance only
JoyWarrior20 A8-8	$110A	V1.0.3.B	discontinued, available for maintenance only
JoyWarrior20 A8-16	$110B	V1.0.3.B	discontinued, available for maintenance only
JoyWarrior24RC	$1110	V1.0.3.5	discontinued, available for maintenance only
MouseWarrior24J8	$1112	V1.0.3.3	discontinued, available for maintenance only
JoyWarrior24F8	$1113	V1.0.3.8	discontinued, available for maintenance only
MouseWarrior24F8	$1114	V1.0.3.8	discontinued, available for maintenance only
MouseWarrior24H8	$1115	V1.0.3.7	discontinued, available for maintenance only
JoyWarrior24F14	$1116	V1.0.4.0	discontinued, available for maintenance only
JoyWarrior24A8L	$1117	V1.0.4.5	discontinued, available for maintenance only
JoyWarrior24A10L	$1118	V1.0.4.5	discontinued, available for maintenance only

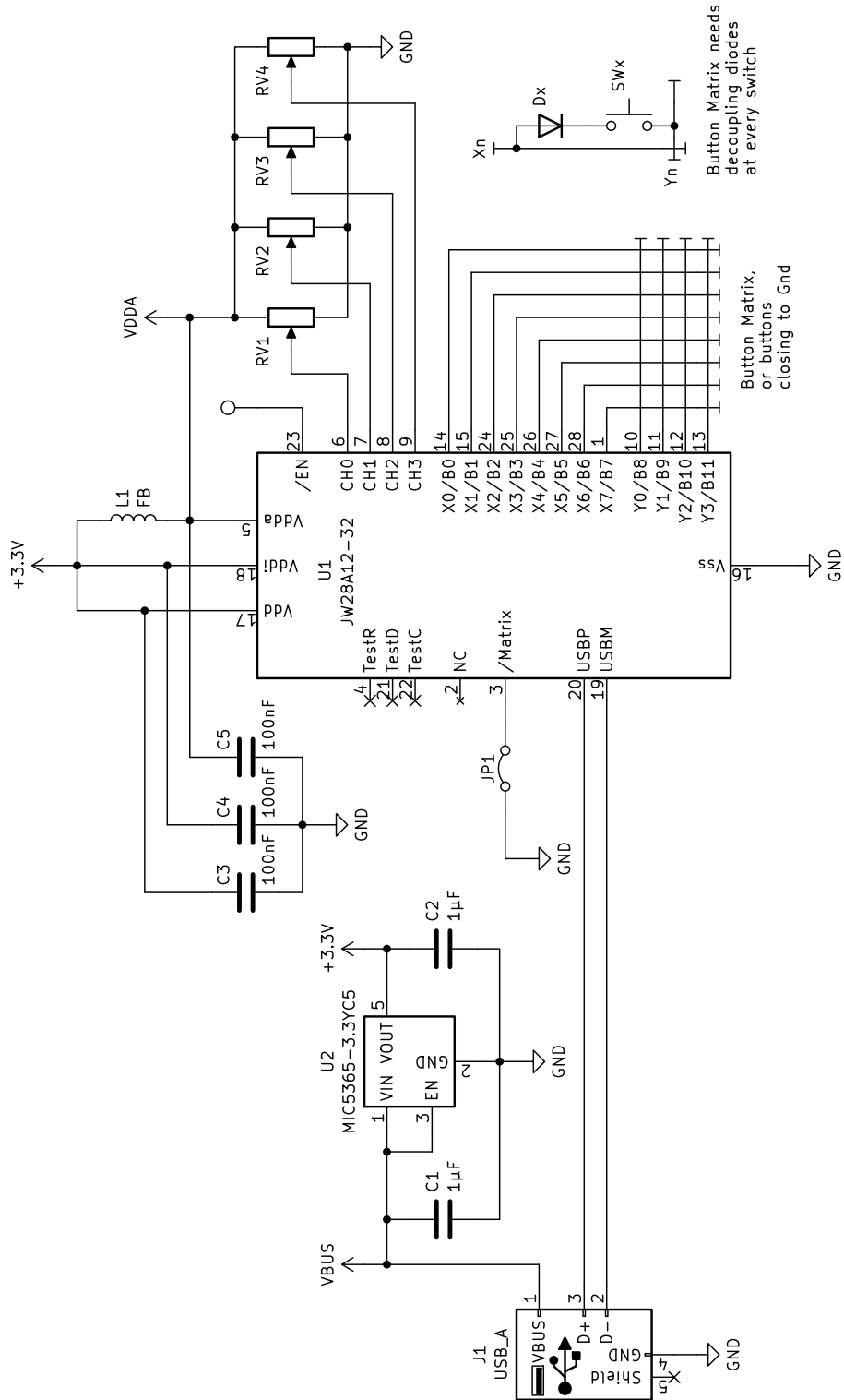## 8. Typical application for JoyWarrior28GP32

Button Matrix needs decoupling diodes at every switch

Button Matrix, or buttons closing to Gnd

IC2
JW28GP32

IC1
LP5951
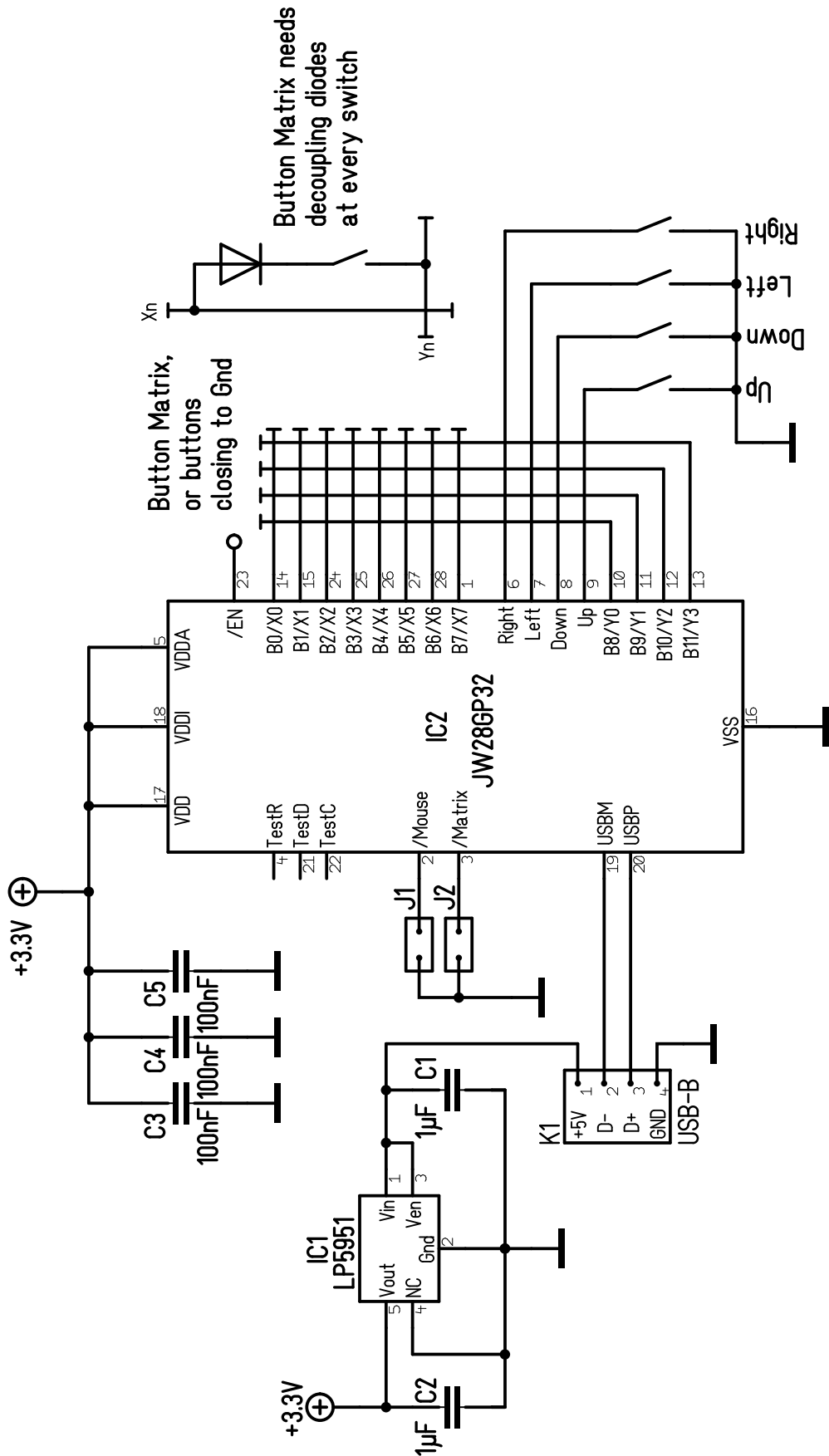
JoyWarrior28

8.1 Typical application for JoyWarrior28A12L

Button Matrix needs decoupling diodes at every switch
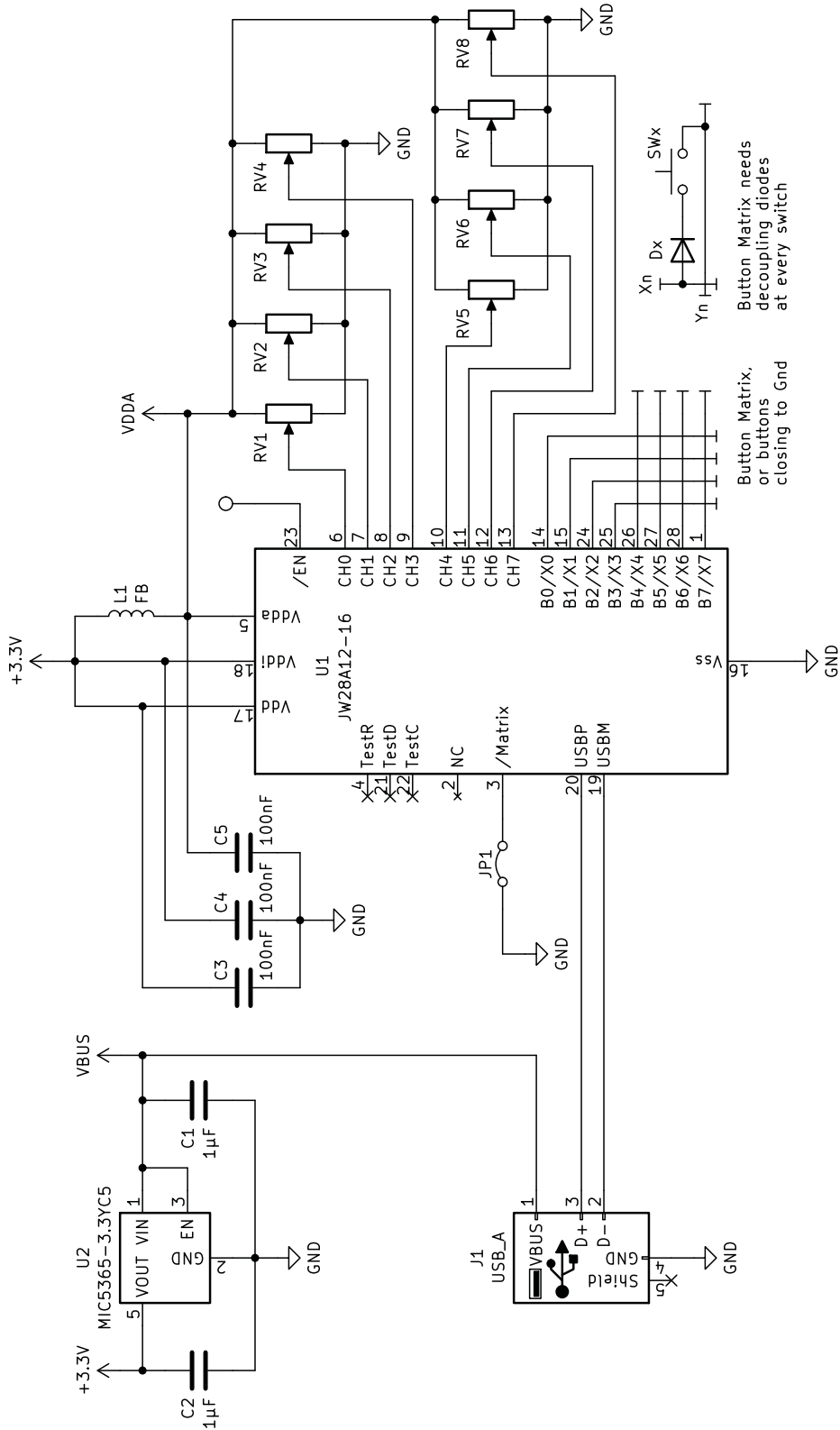
Button Matrix, or buttons closing to Gnd

8.2 Typical application for JoyWarrior28A12-32

JoyWarrior28

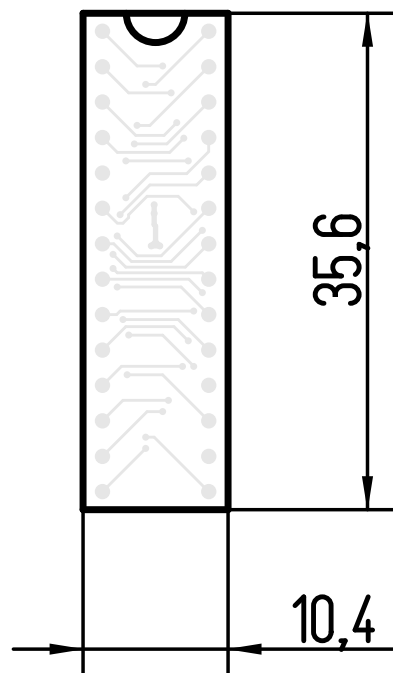**8.3 Typical application for JoyWarrior28A12-16**

8.4 Typical application for MouseWarrior28H8L
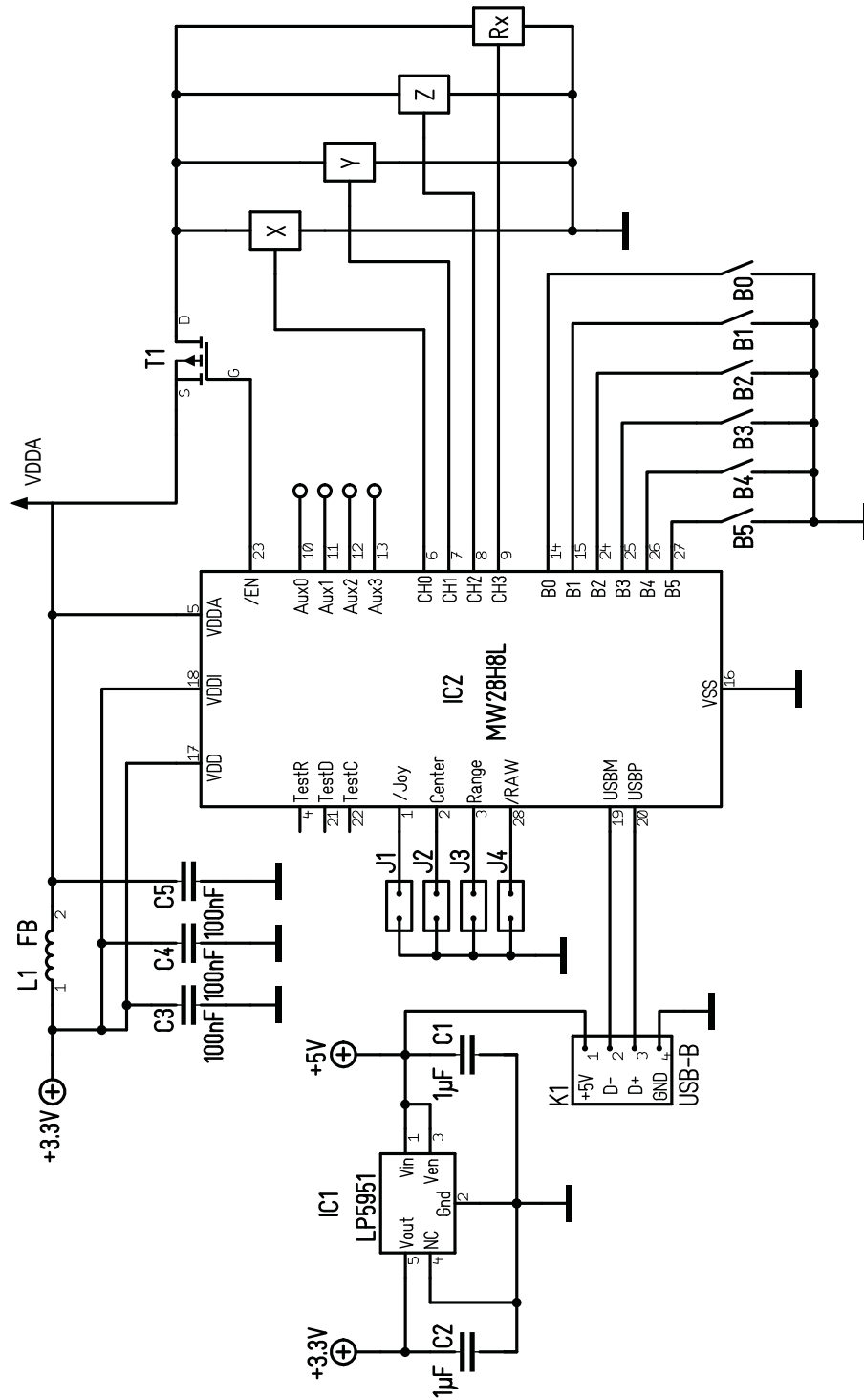
JoyWarrior28

9. Package Dimensions
28 Pin QFN - UQFPN28 - 4x4 mm with 0.5 mm pitch and recommended footprint

Pin #1 identifier — Laser marking area

4,00

4,00

0,25   0,35

0,50   0,40

0,55   0,50

4,30

3,30

0,30

0,50   0,21
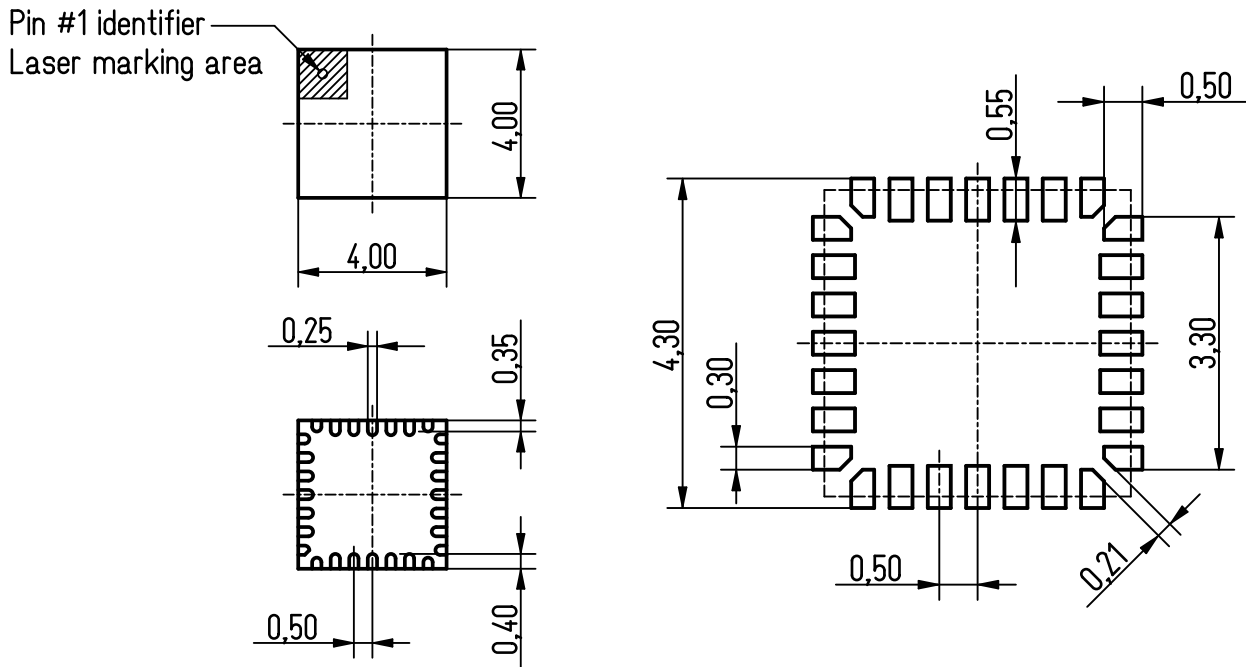
Package thickness: 0.55 mm ±0.05 mm
Outer contour tolerance: ±0.1 mm

28 Pin DIL module

35,6

10,4

All dimensions: mm

JoyWarrior28

24 Pin SO24 Replacement Module (JW28GP32 only)

15,4

10,6
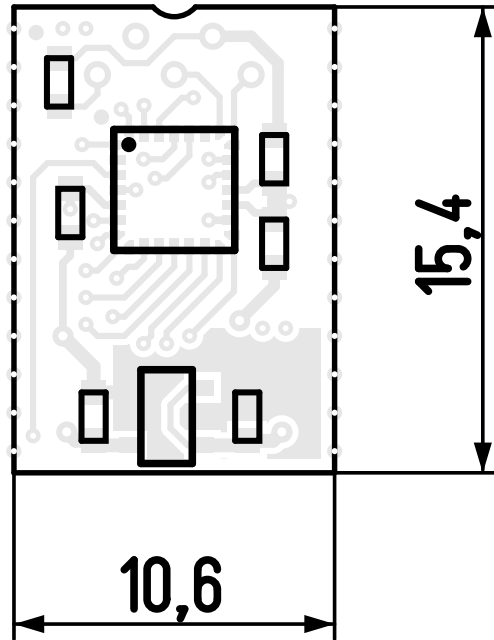
Height at thickest point: max. 2.2 mm

JoyWarrior28

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.

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 capacitors 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.
- Make the matrix lines only as long as absolutely necessary.
- 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.

11. Revision History

For the current shipping versions of the individual variants please refer to chapter 7.3

V1.0.2.2 - Added JW28A12-16.

V1.0.1.D - Added JW28A12-32.

V1.0.1.7 - Fixed a problem with USB that could lead to bidirectional USB interfaces to lock up the In direction. This problem was observed only with JW28A12L under very special timing conditions but the patch was applied to all chips with bidirectional interfaces to avoid this potential problem.

V1.0.1.6 - Fixed a problem with USB that could lead to the device not properly enumerating.

V1.0.1.1 - Improved ADC performance for JW28A12L and MW28H8L. Sampling time was increased, which results in higher input impedance. For JW28A12L a 16x oversampling with low pass decimation filtering was introduced, this reduces signal noise to less than 1 LSB.

No changes in behaviour of JW28GP32, just a parity release.

V1.0.0.3 - Fixed a problem that could cause an error leading to an "unknown device" on Windows system start.

V1.0.0.2 - Fixed a potential problem with the internal handling of the USB endpoint buffers.

V1.0.0.1 - Fixed a potential problem with the internal handling of the USB endpoint buffers.

V1.0.0.0 - Initial release version

11.1 Document Revision History

28.09.2023 - Added application circuit for JW28A12-32 and fixed circuits for JW28A12L and MW28H8L

19.09.2023 - Added JW28A12-32. Fixed shipping versions in 7.3

16.06.2022 - Added version notes for firmware V1.0.1.6 and V1.0.1.7

06.04.2020 - Added version note for firmware V1.0.1.1
Chapter 2: Amended for the ready to use modules.
Chapter 4.4: Added information on input impedance for analog inputs.
Application circuits for JW28A12L and MW28H8L updated.

30.11.2018 - Added details to sections 6.0 and 6.1

12.11.2018 - Added version notes for V1.0.0.2 and V1.0.0.3

02.10.2018 - Added version note for V1.0.0.1

08.08.2018 - fixed pin numbers for Aux-pins in tables 4.2 and 4.3 on page 6
- added package thickness and contour tolerances to QFN package drawing on page 16