Orangutan X2 Robot Controller

Quick-Start Guide

Introduction

The Orangutan X2 is the third release in Pololu's line of Orangutan robot controllers. Like the original Orangutan and subsequent Baby Orangutan, the Orangutan X2 is designed to be a compact, high-performance control center for robotics and automation projects. The Orangutan X2's two-board design allows the unit to maintain the compactness characteristic of the Orangutan line while offering substantially more electrical and computational power: the X2 can deliver up to a horsepower across two motor channels, and the twin-microcontroller architecture allows maximum access to the primary microcontroller, an Atmel ATmega1284P with 64 KB of program space and 4 KB of RAM. A battery, motors, and sensors can be connected directly to the module for quick creation of advanced robots.

Contacting Pololu

Check the Orangutan X2 product pages at `http://www.pololu.com/orangutanx2` for additional information and resources, including more detailed documentation, file downloads, application examples, and troubleshooting tips.

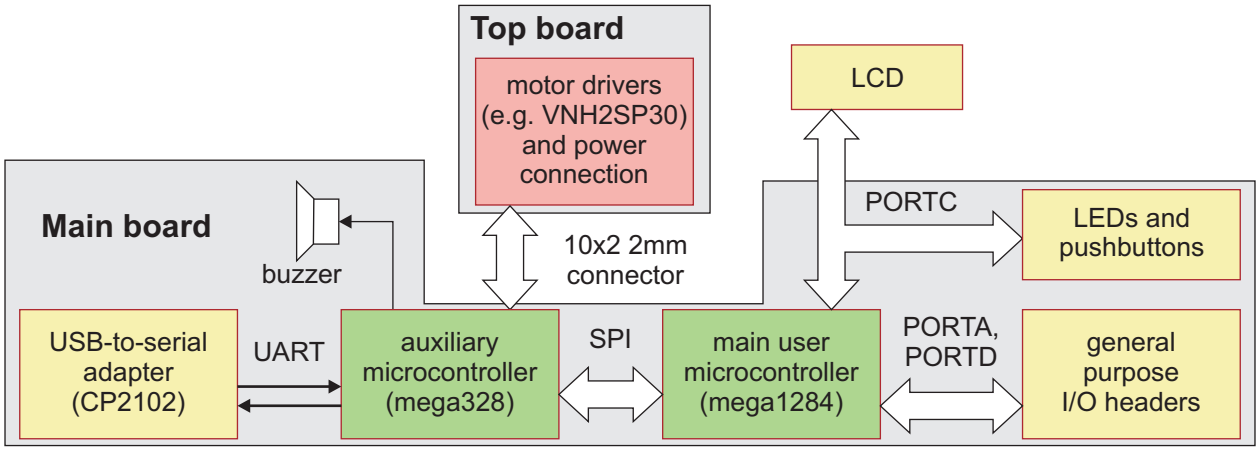
We would be delighted to hear from you about your project and about your experience with the Orangutan X2. You can contact us through our online feedback form or by email at `support@pololu.com`. Tell us what we did well, what we could improve, what you would like to see in the future, or anything else you would like to say!

Hardware Overview

Two circuit boards. A block diagram of the Orangutan X2 is shown below. The Orangutan X2 consists of two printed circuit boards connected by a 20-pin connector. The top board holds the high-power motor drivers and power terminals; the rest of the electronics, including the microcontrollers, is on the bottom board. The connections on the top board are symmetric, so until the connectors are soldered on, the board can be mounted in either orientation. The Orangutan is available with two motor driver options: the VNH3SP30 costs less, but has slightly lower performance; the VNH2SP30 can deliver more current and adds current sensing. Battery and motor leads (or leads to your favorite connector style) can be soldered directly to the top board, or the supplied terminal blocks can be used for quick convenient motor or power supply changes.

Two microcontrollers. The Orangutan X2 has two microcontrollers: an Atmel ATmega1284P for the main application, and an auxiliary ATmega328P that interfaces to most of the dedicated hardware on the X2 and serves as a programmer for the main processor. The two-microcontroller design simplifies multitasking by relieving the main processor of common tasks such as motor control and melody generation, and the approach also leaves the mega1284 completely unencumbered, allowing the mega1284 hardware, such as timers and interrupts, to be used for your higher-level design.

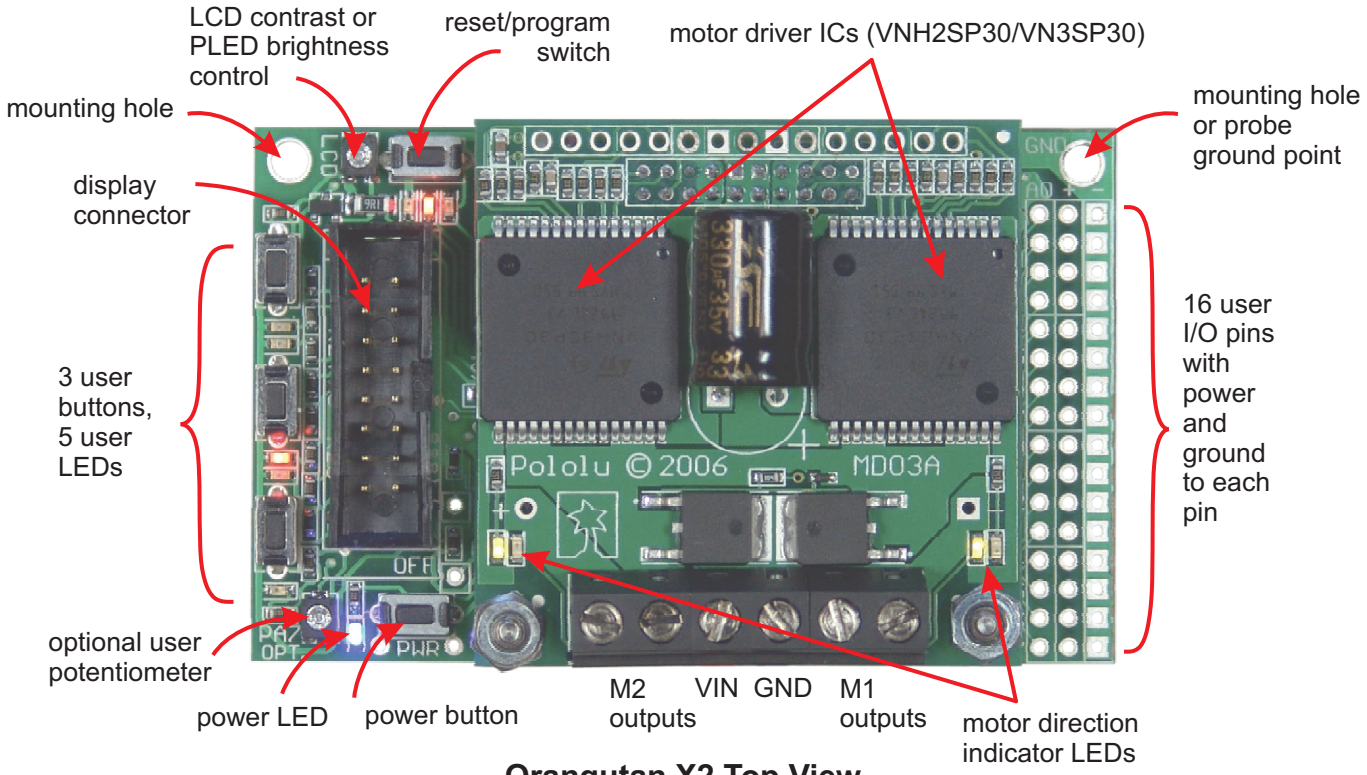
For more details, please check the complete schematic included at the end of this document.



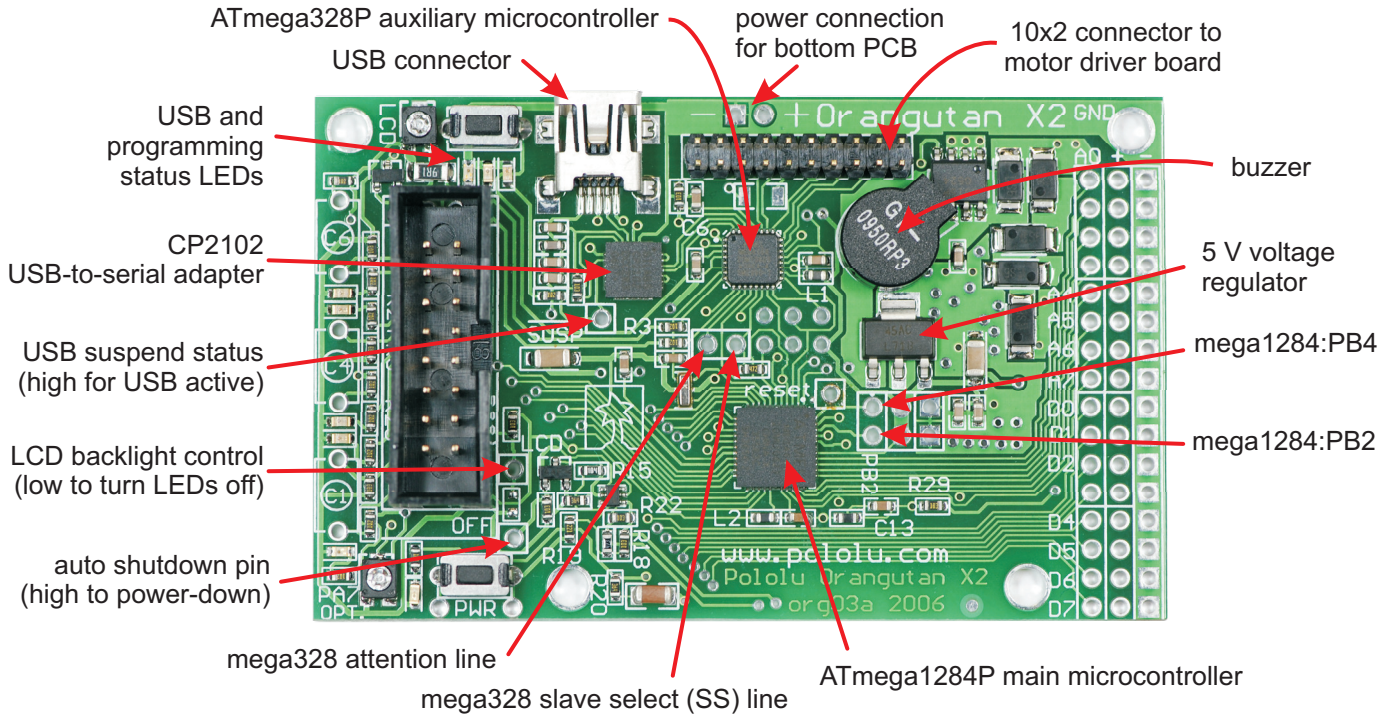
Orangutan X2 Block Diagram

Module Layout

The main features of the Orangutan X2 are indicated below. Most of the mega1284 I/O lines come out to the 0.1″ header along the right side, but the two uncommitted port B pins and the optional mega328 handshaking lines are in the middle of the board. The motor driver board has a few power supply capacitor options; the picture below shows a single capacitor bent over for a low-profile installation.



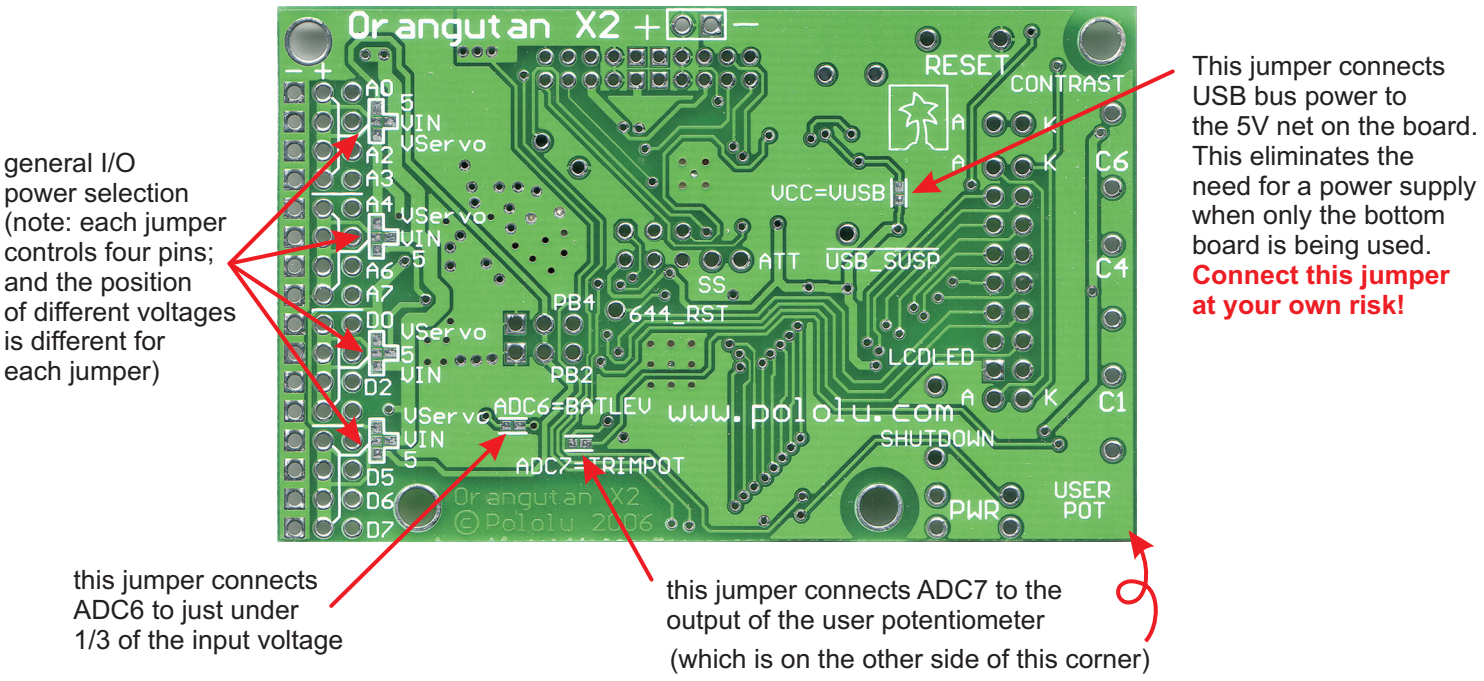
Orangutan X2 Top View



Orangutan X2 Main Board, Component Side

Module Layout (continued)

Some hardware options on the Orangutan X2 are accessed by making or breaking solder bridges across surface-mount pads on the bottom side of the main printed circuit board; the pads are indicated below.



Orangutan X2 Bottom View

Power Connections and Limits

The Orangutan X2 power input is on the two lower, middle pins of the upper board. The operating range is **6-16V**. When using large motors, make sure the power supply and wiring can handle the current; you might also consider putting a fuse in line with the main power. The motor drivers are capable of delivering surges of up to 30 A, and continuous current will depend on the environment. The VNH3 is generally good for up to about 9 A continuous, and the VNH2 is good for up to about 14 A. Heat sinks can improve the motor driver performance.

The power to the main PCB is delivered through four pairs of pins on the 2mm connector, which limits the total power to the bottom board to approximately 6 A. The onboard linear 5 V regulator is good for up to 500 mA, but since the practical limit comes from power dissipation, the usable current will depend on the input voltage and the ambient temperature. The Vservo line is about 2V below the input voltage, and it can be used to power servos when the main supply is just a bit too high for servos, as with 6- or 7-cell NiMH battery packs. The limit for this supply is about 3A, but as with most power issues, it depends on how much heat the rest of the board is dissipating.

The Orangutan X2 is intended to be used as a single unit with both boards connected together. However, it may sometimes be convenient to work with just the lower board, without motors or a large power supply connected. In such cases, the two power input pins above the 20-pin connector can be used. In cases where very little power needs to be supplied outside the board, the USB port can also be used as a power source. **In this case, the power switch will not work, and your computer will be exposed to any voltage fluctuations on your Vcc line, so do so at your own risk**.

Power Button

The Orangutan X2 power is controlled by a pushbutton; push it to toggle the unit on and off. Because the power switch is operated by a pushbutton, many buttons can be used in parallel, allowing for external power buttons in cases where the main unit is difficult to access. Only power for the main board is switched; the motor driver board power is not switched.

The power consumption in the off state depends on the input voltage, but it is typically under 100 uA, most of which comes from the motor driver quiescent current and power supply capacitor leakage current. **Note: the power switch does not actually disconnect the power supply from the board, so even if the board is turned off, it is possible to do things like accidentally short-circuit the power supply!**

Connecting the Orangutan to a Computer

The mega328 microcontroller is the programmer for the main mega1284 MCU. The mega328 performs this function by emulating an AVRISP programmer, which connects to a computer serial (COM) port and programs AVR microcontrollers via the SPI (serial peripheral interface) port. Instead of a standard serial port, the Orangutan X2 uses a USB-to-serial bridge that allows a USB connection to look like a COM port. Before connecting the Orangutan X2 to a computer, the driver must be installed to allow the computer's operating system to treat the USB connection as an old-fashioned serial connection. The driver and installation instructions are available on the Orangutan X2 web page.

Once the USB-to-serial driver is installed and the Orangutan X2 is connected, the mega328 can communicate with the computer through its serial port, and the green LED next to the USB connector will be lit. When programming the mega1284, the Orangutan X2 will look like an AVRISP programmer; during normal operation, the mega328 can send and receive data to or from the computer (e.g. using a terminal program) for debugging or other purposes.

Programming the Orangutan X2

The Orangutan X2 can be programmed using any platform for which there is a USB driver and for which there is AVRISP-compatible programmer software. We recommend using Atmel's AVR Studio, an integrated development environment (IDE) that works with the free GCC C compiler and includes a simulator and other useful tools, including AVRISP support. A development software bundle is available for download from resources tab of the Orangutan X2 product pages.

To enter programming mode, hold down the reset/programming button (next to the USB connector) for more than half a second. The buzzer will beep, and the yellow LED will turn on, indicating that you have entered programming mode. The mega328 will no longer respond to commands from the mega1284, and it will wait for programming commands from the computer via the USB connection. When programming is in progress, the red LED will be lit. When programming completes, the mega1284 is allowed to execute, but the mega328 will remain in programming mode until the reset button is pressed.

It is also possible to set the mega328 to always look out for programming commands. In that state, normal serial port use is unavailable, and any incoming serial data is treated as coming from the computer programming software. When programming is requested, the mega328 will program the mega1284 and then reset itself and the mega1284, allowing full operation to resume immediately upon completion of programming.

When programming the mega1284, access to some fuse settings is not available. The most important setting is the clock source setting since the mega1284 must be set for an external resonator, and the mega1284 provides a 20 MHz clock to the mega328. In general, the fuses should only be changed rarely and with great care since the Orangutan X2 could become unresponsive.

Running the Orangutan X2

Using the Orangutan X2 is generally identical to using any other mega1284-based project, and most of the mega1284's resources are available to the user. The exceptions are the reset system and the SPI port, which are connected to the mega328.

Reset

Because the mega328 and mega1284 need to stay synchronized, it is not desirable to reset the mega1284 independently. The reset button does not connect directly to either processor's hardware reset line. Instead, the mega328 monitors the reset button and determines when to reset itself or the mega1284. Typically, the mega328 will reset both processors, keep the mega1284 reset while it initializes, and then finally allow the mega1284 to begin execution. The reset button will not work during programming.

SPI Port

The SPI port is the main connection between the two MCUs. During programming, the mega328 becomes the master; during normal operation, the mega1284 is the master and sends the mega328 commands via the SPI interface. The default setup of the Orangutan X2 assumes no other use of the SPI lines (the mega328's slave-select line is pulled down by a resistor). The SS line can instead be connected to one of the mega1284 I/O lines, and the mega1284 can then control multiple slave devices on the same SPI lines. It can also be desirable to use the SS line even without additional SPI devices since the SS line provides added robustness to the protocol.

The mega1284 to mega328 SPI interface is detailed in a separate document; please see the Orangutan X2 web page for more details.

Orangutan X2 Robot Controller Schematic Diagram