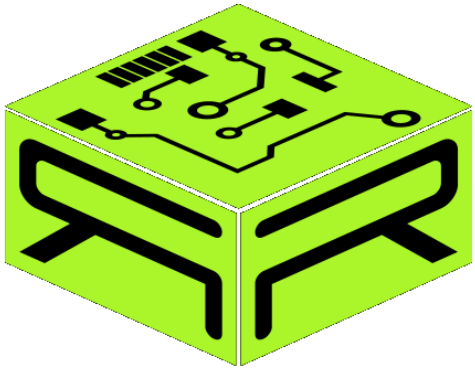

REPRAPELECTRO

RAMBo 1.1B User Manual

by **RepRap Electro**

RAMBo board designed by **UltiMachine**

USER MANUAL CHANGELOG

Date	Author	Version	Changes
02/09/2014	Kakaroto	1.0	Initial release

CREDITS

Johnny Russell for the design of the RAMBo.

Thomas Sanladerer for providing us with images (the ones that look good) for the manual.

anethema (IRC) for reviewing and correcting the manual.

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DISCLAIMER

Handle with care. Static sensitive device.

Reversing input power polarity can damage electronics and cause fire hazard!

Test all electronics thoroughly before placing into service.

Do not leave power supplied to electronics unattended, or run machines unattended due to risk of fire or malfunction.

This is NOT a toy and it contains small and sharp parts. Children can choke or suffocate by swallowing small objects. Keep all parts away from children and never leave printer/parts unattended.

LICENSING INFORMATION AND CREDITS

The RAMBo was designed by J*ohnny Russell* for **UltiMachine**. UltiMachine (Johnny, Britt, Dorothy, Lee, Bruce) holds the Copyright and Intellectual Property of the design of the RAMBo. Based on work by the Arduino Team and the RepRap project.

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This User Manual was written by *Youness Alaoui* for **RepRap Electro** with some images provided by *Thomas Sanladerer*. The user manual is released under the GNU Free Documentation License v1.3. Permission is granted to copy, distribute and/or modify this document.

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INTRODUCTION

The RAMBo (RepRap Arduino-Mega Board) Controller Board for 3D printers is an all-in-one electronics board for all your 3D printing needs. It is the successor of the popular RAMPS (RepRap Arduino-Mega Pololu Shield) shield used to control most RepRap 3D printers.

Other than the all-in-one advantage, the RAMBo adds many improvements over the RAMPS by the addition of new easy to use connectors for motors, endstops, thermistors, heaters and power connectors. These connectors will insert easily and will clip into place and can be released by pressing the connector's side before removing them. RAMBo has three separate connectors for power and it allows you to power the motors, mosfets and heat-bed separately. It also has replaceable fuses that protect the board from over-current and allows you to replace them without any soldering required. The design of the RAMBo also allows it to act as a heat dissipater for the stepper motor drivers, which means that there is no need to install a heatsink on the stepper driver chips as was often the case with the RAMPS.

The RAMBo supports an input power voltage of 12V or 24V, and it has 6 mosfets for controlling 2 heaters, one heat-bed and up to 3 fans. It supports 6 motors with 5 integrated stepper drivers and digital potentiometer, one connector each for the X axis, Y axis, first and second extruders and two duplicated connectors for the Z axis. It also has connectors for up to 4 thermistors and 6 endstops. While the logic circuit of the board can be powered by USB, a jumper can be set on the board to power the logic directly from the power supply, allowing for untethered printing. Plenty of headers are available for expansion, allowing you to connect an SD card reader, Smart LCD displays, I2C device, extra motors, etc..

On top of all these improvements over other RepRap electronic boards, the RAMBo also includes a digital potentiometer which can be used to calibrate your stepper motor's current. There is no more need to turning tiny knobs on your steppers to calibrate the current to the motors, you can now set the current directly in your firmware. You can also change the current dynamically by sending commands to your printer through Pronterface for example. This will allow for fine-tuning of the current and minimize the motor noise, motor heat and the risk of missing steps.

SOFTWARE SETUP

Before using the RAMBo, you must first upload a firmware to it. RAMBo boards come pre-loaded with a default Marlin firmware, but you will almost certainly want to upload a firmware configured for your specific printer.

Since RAMBo is based on Arduino, we will use the Arduino IDE (Integrated Development Environment) to upload the firmware to it. The Arduino IDE will require modifications to take advantage of the full capabilities of the RAMBo, so we will copy some files to the Arduino installation directory to set it up for use with the RAMBo. This step is however optional but it will help unlock the full potential of the board.

Once the Arduino IDE is correctly set up, we will upload to it a compatible firmware set-up for your 3D printer and configured to use RAMBo.

INSTALLING RAMBO DRIVERS

If you are using Linux or Mac OS X, then you do not need to install drivers as they will use the USB CDC interface which has hardware drivers built in the operating system.

If you are using a Windows Operating System, then you will need to install drivers for your RAMBo. When you first connect the board to your computer, it will not be recognized by the system.

To install the driver, simply download it from the following URL : http://reprapelectro.com/wp-content/uploads/2014/07/RAMBo-Driver.zip

Extract the contents of the RAMBo-Driver.zip file, you will find it contains two files, rambo.cat and rambo.inf :

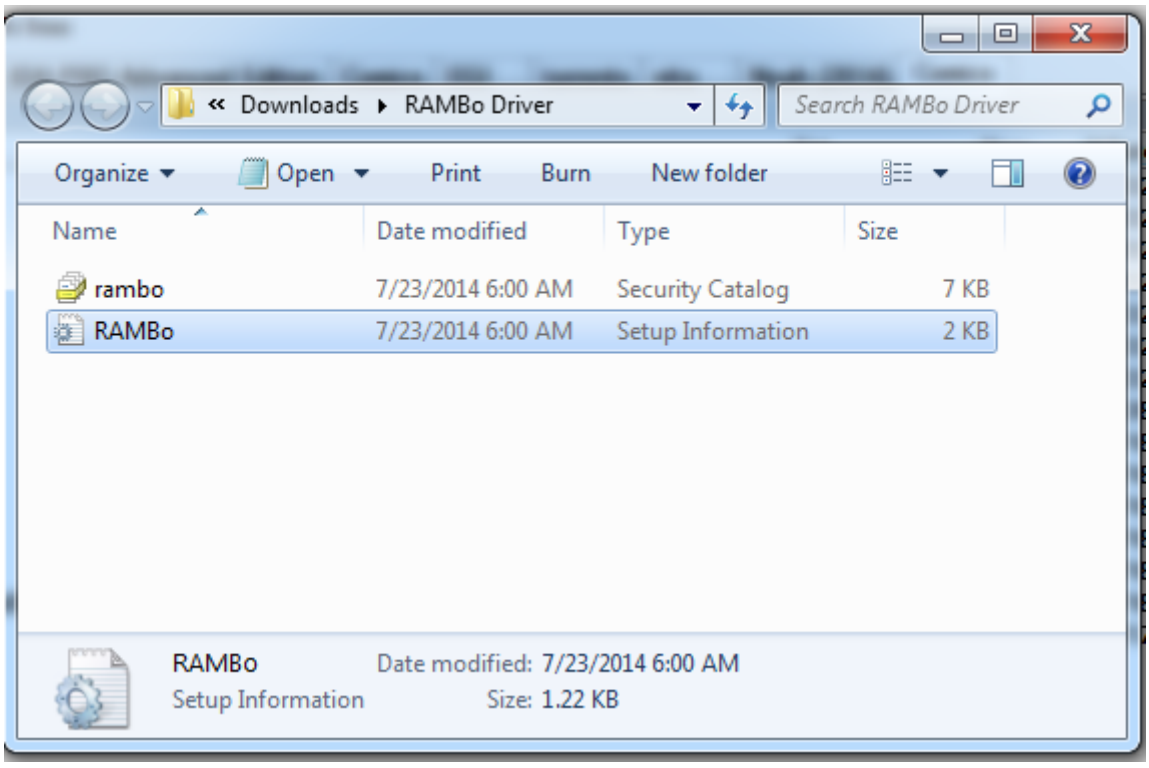


Figure 1 - Driver files

Simply right click on the **RAMBo.inf** file (if your system does not show file extensions, it's the file with type "Setup Information" and an icon with a gear as seen in the picture below) and select the "**Install**" option :

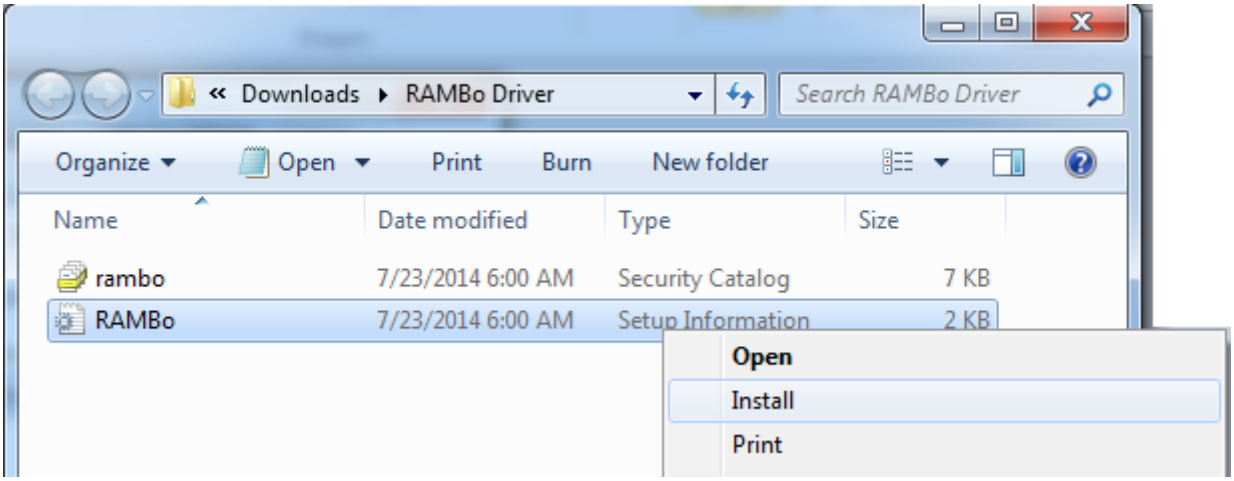


Figure 2 - Driver Install contextual menu

Once you click on the **Install** option, Windows should prompt a security warning asking you to approve the installation of the driver :

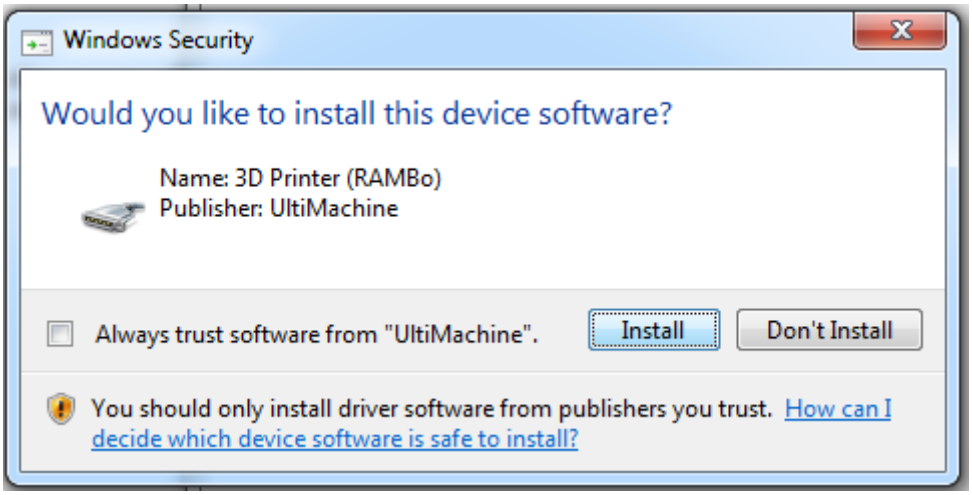


Figure 3 - Driver install Windows Security warning

Simply click **Install** to finish the installation of the driver for the RAMBo.

Once installed, remove the USB connector from the RAMBo and reconnect it. Windows should then display the successful detection and identification of your RAMBo.

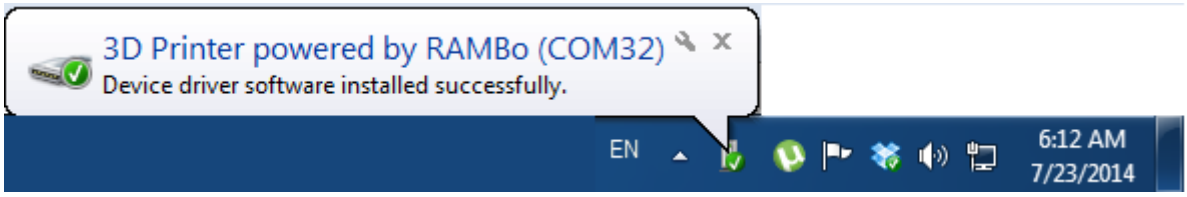


Figure 4 - Driver installation successful

You have successfully installed your RAMBo drivers and you can now use it. Note the "**COM32**" as your board's COM port, it will be useful later in order to connect to it.

ARDUINO IDE SETUP

We will first download the Arduino IDE from Arduino's website available at the following address : http://arduino.cc/en/Main/Software.

At the time of writing this manual, the latest version of the Arduino IDE is version 1.0.5.

The Arduino IDE has configuration files for various Arduino products. When you open the Arduino IDE, you can select the type of board you will use. In the case of the RAMBo, selecting the "Arduino Mega 2560 or Mega ADK", as seen below, will work. However, this will not allow you to use extended features of your board, such as the LCD display.

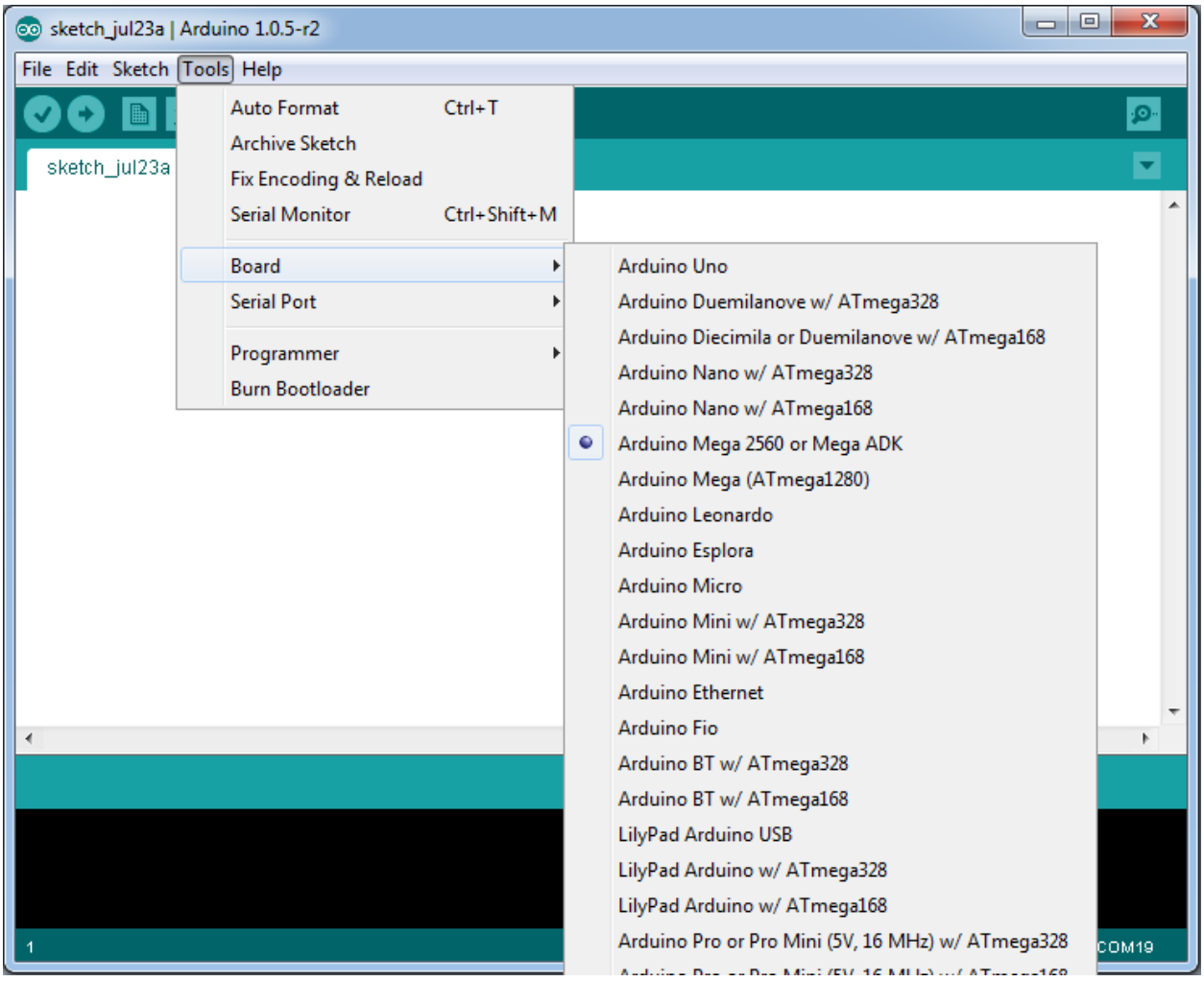


Figure 5 - Atmega2560 board selection in Arduino IDE

In order to use the LCD and take advantage of the full capabilities of the RAMBo, we will install an Arduino Addon for RAMbo by downloading it from the following URL :

http://reprapelectro.com/wp-content/uploads/2014/07/Arduino_1.x.x.zip

Once you extract the zip file of the Arduino Addon, you will find in it a directory named **rambo**, you will need to copy that directory to the **hardware** directory of the Arduino installation.

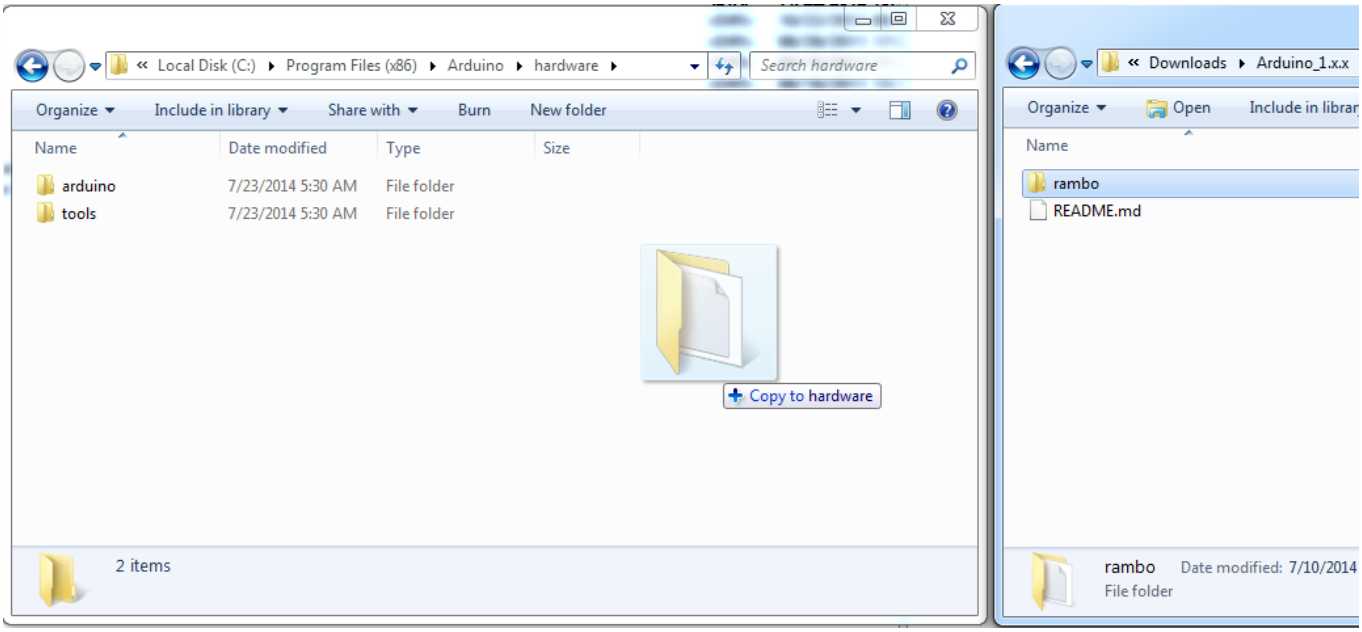


Figure 6 - Copy Arduino Addons rambo directory to Arduino/hardware directory

Notice on the left of the above image, the full path of the directory in which we copied the **rambo** directory from the **Arduino_1.x.x.** On your system, the path may be different, but it will often be :

C:\Program Files (x86)\Arduino\hardware

Once the **rambo** directory is copied, you can close the Arduino IDE and re-open it. You can now select **RAMBo** as a choice of board from the Tools menu.

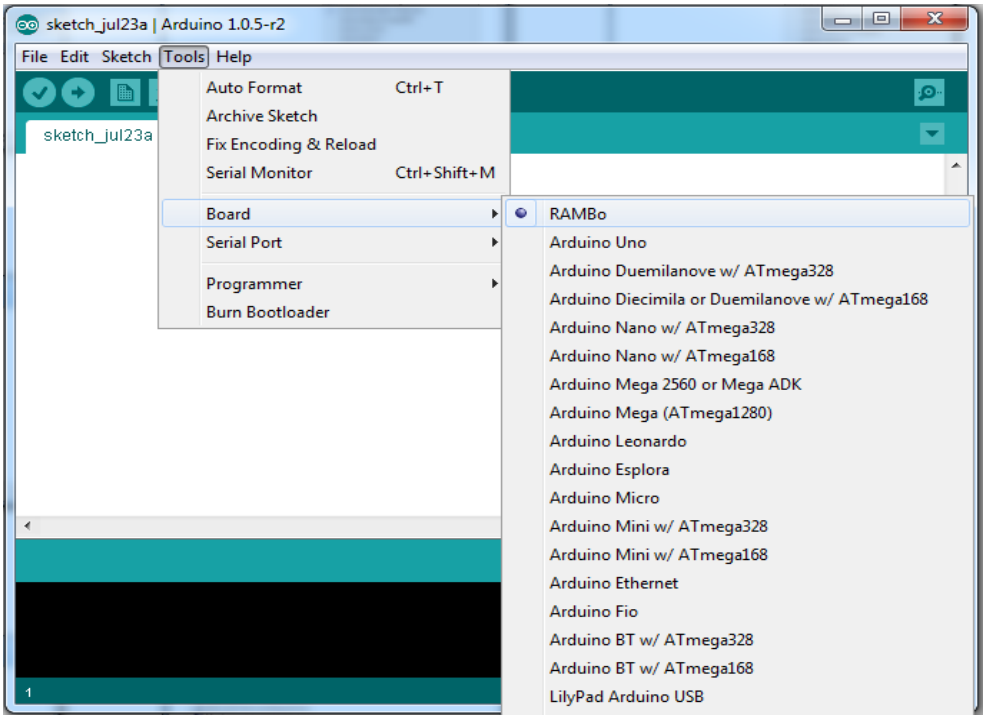


Figure 7 - RAMBo board selection in Arduino IDE

At this point, the Arduino IDE has been set-up to work with the RAMBo. You only need to select the Serial Port the RAMBo appears on.

FIRMWARE SETUP - MARLIN

The next step is to setup your firmware. RAMBo is compatible with the Marlin firmware, as well as Repetier Firmware, however, we will show you here how to configure Marlin for use with the RAMBo.

You will also need to configure Marlin for your specific printer, such as print area, steps per mm for each axis, etc.. Those configuration options are outside the scope of this manual however, and we will only concentrate on the RAMBo specific parts of the Marlin configuration.

It is very easy to configure Marlin to use with the RAMBo. Once you open the Marlin.ino file in the Arduino IDE, select the Configuration.h tab, and scroll down until you see the configuration option for the motherboard. In order to configure Marlin for RAMBo, simply set the motherboard configuration to '301' with the following line :

#define MOTHERBOARD 301

This is how it should look like :

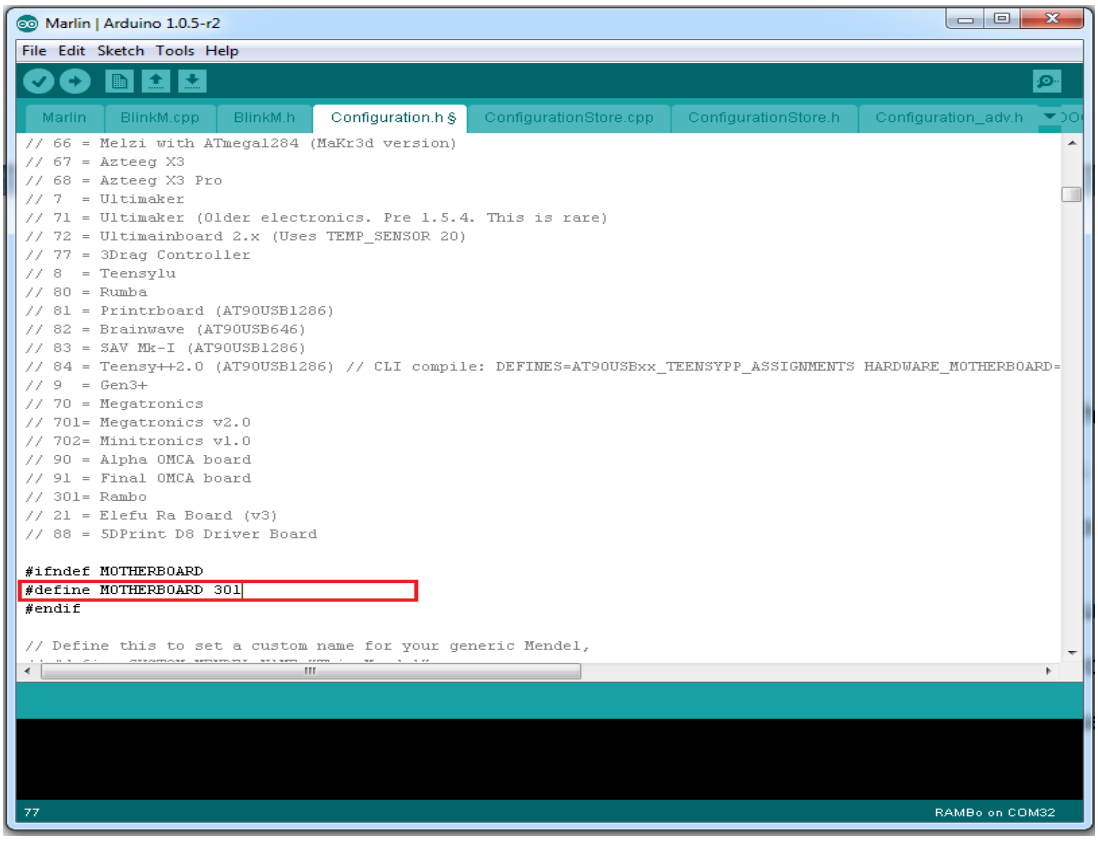


Figure 8 - Motherboard selection in Marlin

Once you've set the Motherboard to 301 and configured your firmware for your 3D printer, you can click the **Upload** button, or select **Upload** from the **File** menu.

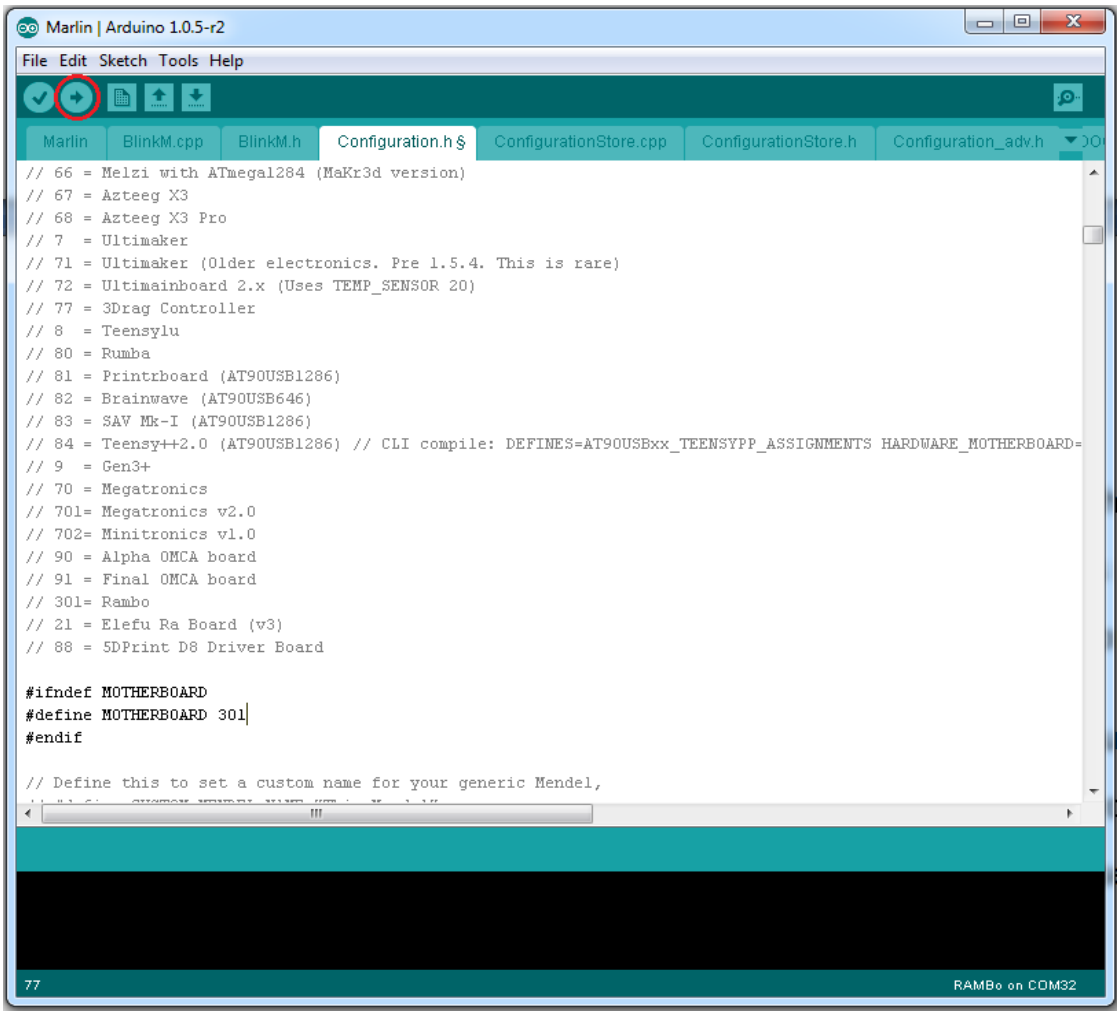


Figure 9 - Upload button in toolbar

This will *compile* the firmware and upload it to the RAMBo.

If you need to add support for an LCD display, such as the RepRapDiscount Smart LCD Controller, you will need to have your board type set to RAMBo and Arduino IDE configured correctly as explained in the previous section, then you will need to update some files from the Marlin firmware.

If you are using the latest git version or any version from August 4th 2013 and later, then you don't need to modify the Marlin firmware for using the LCD, if you use however an older version of the Marlin firmware and do not wish to update to a more recent one, or if you are simply unsure, then you will need to overwrite the **fastio.h** and **pins.h** files from the Marlin directory with the latest version of those files available from github :

https://raw.githubusercontent.com/ErikZalm/Marlin/Marlin_v1/Marlin/pins.h

https://raw.githubusercontent.com/ErikZalm/Marlin/Marlin_v1/Marlin/fastio.h

Simply download those two files and copy them to the Marlin directory, overwriting the previous files.

You can now configure the Marlin firmware to use the LCD controller that you have and it will work with the RAMBo as long as it is wired correctly (See the relevant section of this manual for instructions on how to wire the LCD controller to the RAMBo).

Don't forget to install the *U8glib* library to the Arduino IDE installation directory if you use the Full Graphics Smart LCD Controller, as instructed in Marlin's Configuration.h file. To do so, copy the **U8glib** directory which you can find in the Marlin directory under the Marlin/ArduinoAddons/Arduino_1.x.x/libraries/ subdirectory into the Arduino's **libraries** directory (C:\Program Files (x86)\Arduino\libraries).

HARDWARE SETUP

Connecting the RAMBo to your 3d printer is relatively straightforward. You may need to prepare some of the wires with the provided housings prior to connecting them to the RAMBo. All of RAMBo's connectors are easy to use with a clipping system preventing the cables from falling and allowing you to remove them without effort by pressing lightly on the connector.

The accessories bag that comes with the RAMBo has a set of connector housings and female crimp pins that you can use to create RAMBo compatible wires for your motors, a set of wires for your thermistors and a set of endstops and a wire harness that are pre-crimped and ready to use. The accessories bag also contains 2-pin pluggable and 6-pin pluggable connectors for the mosfets and power input respectively as well as a USB cable. Depending on your source, it may also come with the SmartLCD Adapter.

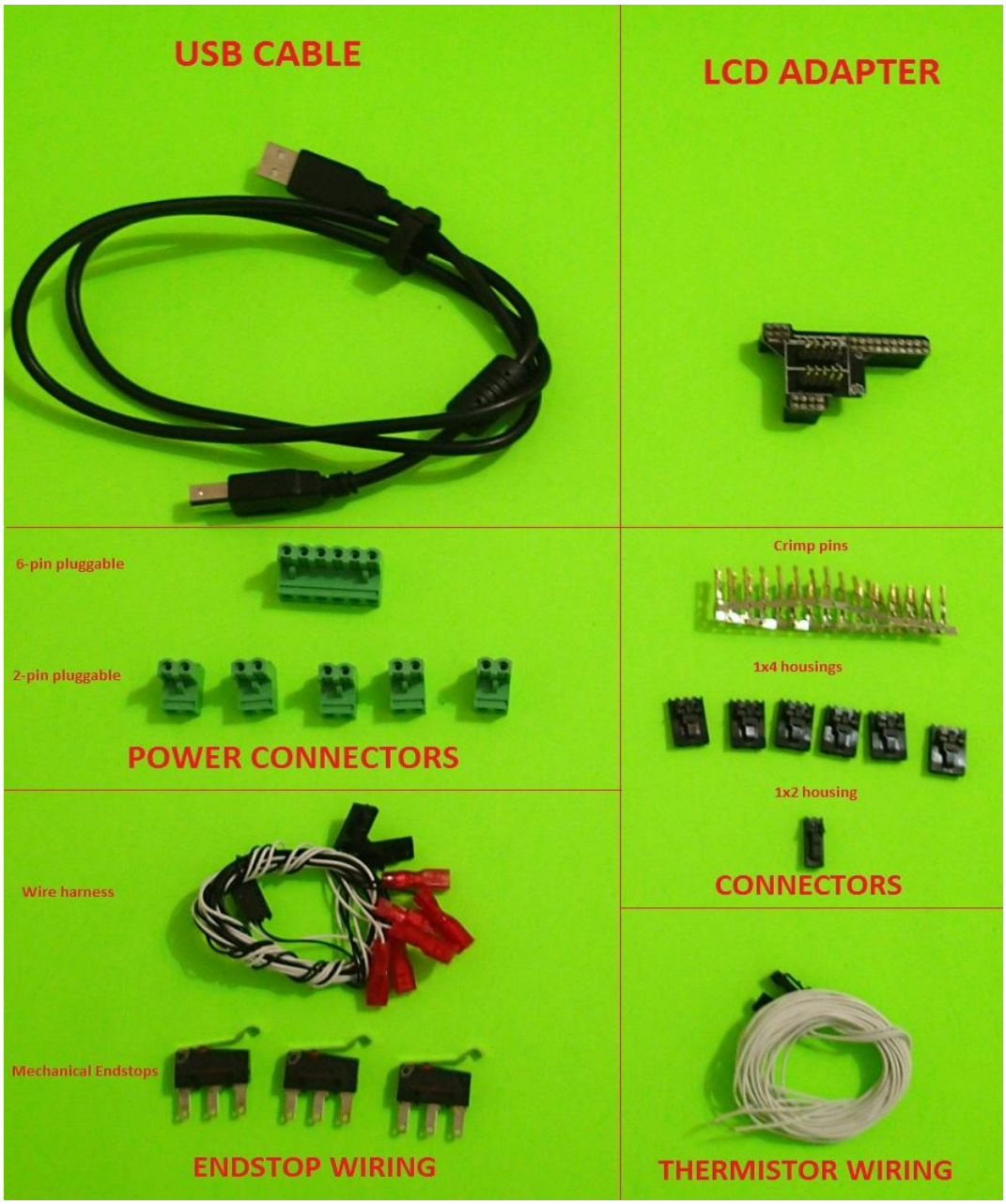


Figure 10 - Labeled accessories of RAMBo

CABLE PREPARATION

MOTORS

Your stepper motors use four wires and will usually come with a 4 pin connector. It is possible that the 4 pin connector of your motors will fit in the RAMBo connectors, in which case you can choose to leave it as is or change the connector to the RAMBo supplied ones. It is also possible that the 4 pin connector of your motors will simply not fit in the RAMBo connectors, in which case you will need to change the connector of the motor's wires. Note however that if you leave the motor wire with its original connector, that the insertion and removal of the connector will not be as easy as if you used the RAMBo connectors.

Here are some examples of compatible and non-compatible stock motor connectors with a RAMBo connector for comparison.

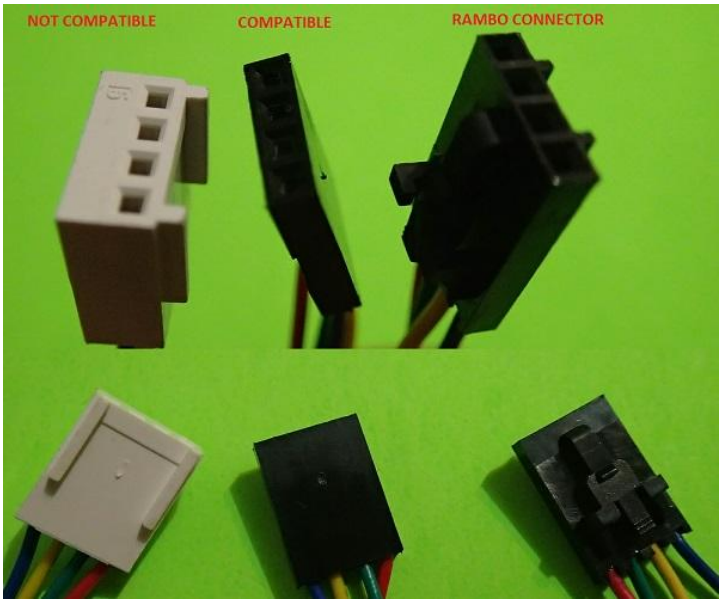


Figure 11 - Motor wire connectors - RAMBo Compatible, non-compatible, and RAMBo connector

The crimp pins come in a pack. In order to detach one, you can simply bend it a couple of times until it comes loose.

Figure 12 - Crimp pins

First, you need to detach a crimp pin from the supplied pack and inspect it, you should see two pairs of tabs at one end of the crimp pin, one pair slightly larger than the other. The tabs at the end of the pin are called *insulation crimp* and are used for stress relief by holding the insulation of the wire, while the larger tabs are called conductor crimp and are used for making contact with the wire itself. There will also be a *locking tang* that will hold the crimp in place inside the connector housing. Please familiarize yourself with the crimp pin before reading further.

Figure 13 - Crimp pin details

You can now cut the motor's wire just before the existing connector if there is one. Use a wire stripper to strip the end of the insulation and reveal the copper wires beneath. You should only strip about 3mm (1/8") off the end of the wire. Use one of the female crimp pins as reference for the length required, knowing that the wire shouldn't go much beyond the conductor crimp of the pin, and the insulation should fit on the insulation crimp.

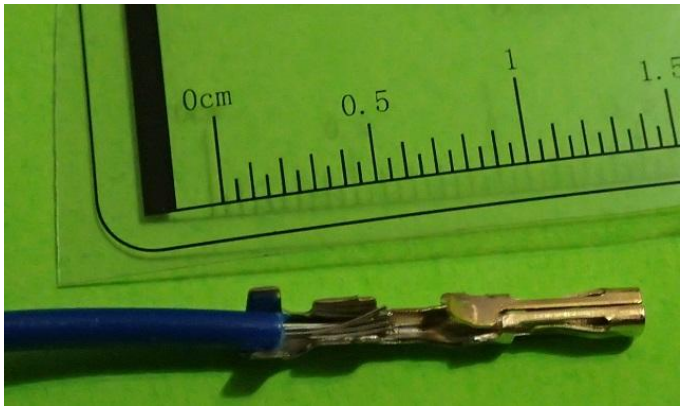


Figure 14 - Stripped wire positioned on crimp pin

You will need a good crimp tool in order to crimp the wire to the pin, you can get one from Pololu's store, for example : http://www.pololu.com/product/1928

In the above link, you can also find instructions and links to two useful tutorial videos on how to crimp a wire with the tool. We would strongly suggest you read the instructions and watch those two videos in order to get familiar with the process : https://www.youtube.com/watch?v=K7Qb3DzIX3s and https://www.youtube.com/watch?v=GkbOJSvhCgU#t=280

If you do not have a crimp tool and do not want to buy one, you can simply use needle-nose pliers, although the process will be slightly slower, more complicated and will not yield as good as a result as if you used a proper crimp tool. Use this video as a reference on how to crimp the pins with needle-nose pliers : http://www.youtube.com/watch?v=jz_8w2XHKL8

Insert your stripped wire into the crimp pin, making sure the insulation crimps are aligned with the insulation and the wire sits between the conductor crimps, then either use the crimp tool as explained in the above links, or, if you're using needle-nose pliers, push down on each tab individually until you crimp the wire into the pin.

Figure 15 - Result of crimped wire with needle-nose pliers

Make sure the wire is crimped securely to the pin and that it won't easily fall off.

After crimping all four wires of the motor to the pins, you will then insert each pin in its appropriate position on a 4x1 housing connector. Make sure the locking tang on the pin is aligned with the hole on the connector :

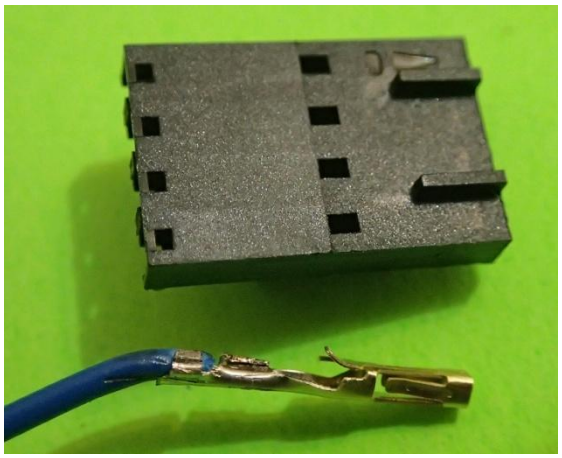


Figure 16 - Crimp pin with connector housing

The motor wires are color coded and must be inserted in the following order : blue - yellow - green - red. The blue wire goes into the slot of the housing where the circuit identifier is located (the little triangle on the top right of the housing in the above picture).

Use the following picture as a reference on which wire goes into which slot of the housing. Note the circuit identifier on the housing is where the blue wire is located. Make sure the wires are inserted in the right order as the connector is keyed and can only be inserted in one direction on the RAMBo.

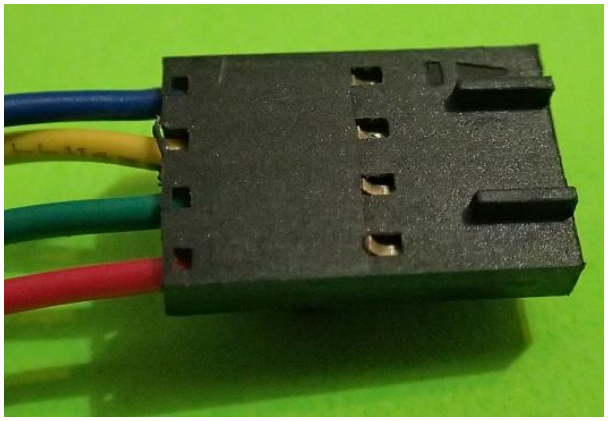


Figure 17 - Connector housing with all crimp pins inserted in the correct order

This was the most complicated part of the hardware preparation. Once you're done, take a break and look at your masterpiece.

POWER INPUT

The RAMBo can be powered by a 12V or a 24V power supply.

The power input connector is the 6 pin pluggable green (or black, depending on your source) connector.

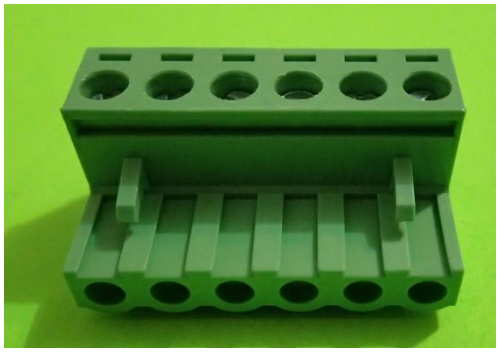


Figure 18 - 6-pin pluggable green connector

You must strip your power supply's wires then open the screws on top of the connector. When opening the screws, a metal plate will be lowered allowing you to insert the wire between the metal plate and the top part of the hole. Once you tighten the screw, the wire will be clamped to the metal plate.

The following picture shows the right most hole of the connector with the metal plate lowered.

Figure 19 - Lowered metal plate for wire insertion

Once you insert the wire into the hole, tighten the screw to keep the wire in place.

Figure 20 - Wire inserted in the appropriate gap of connector before tightening of the screw

Make sure the wire is secured and no strands of the wire are floating around as it can cause shorts.

The connector takes 3 pairs of V+ and V- wires. Make sure not to invert the wires and use the following picture as reference for where each wire goes :

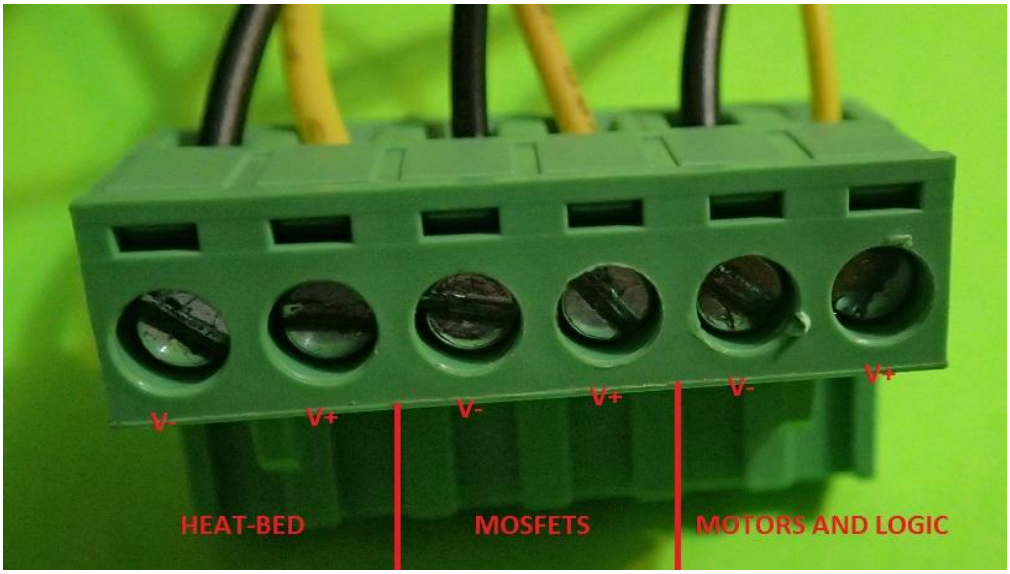


Figure 21 - Labeled power connector with polarities

You should double check your wire connections and make sure the polarities are not inverted by inserting the un-powered connector into the RAMBo and verifying the wires' polarities are aligned with the board's polarities :

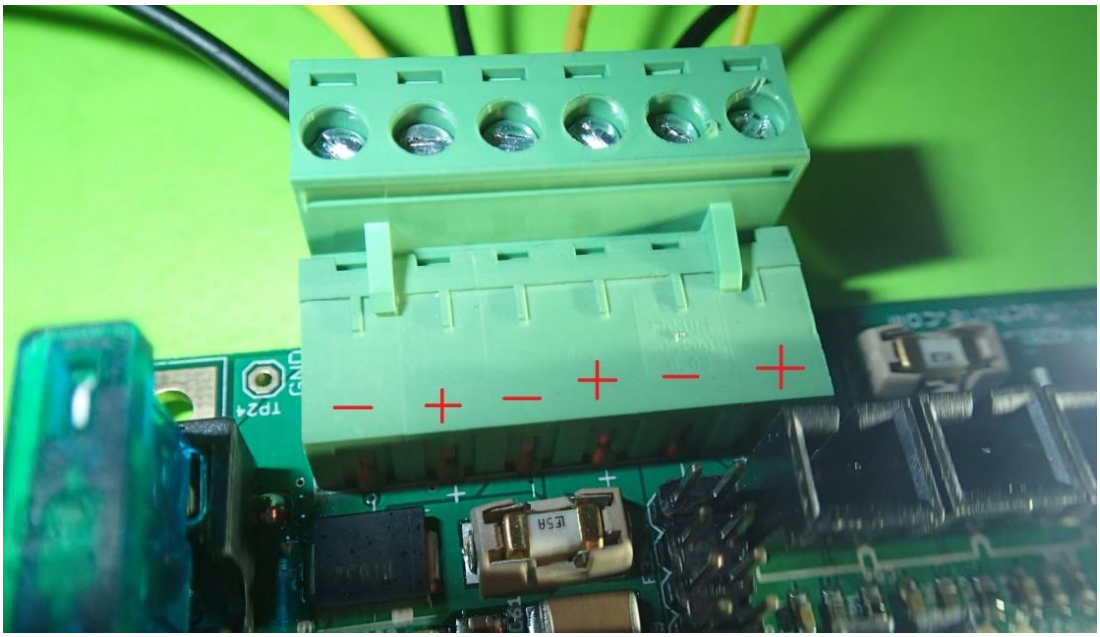


Figure 22 - Inserted power connector with polarities

You can now connect your wires to the power supply, making sure that the polarities are not inverted.

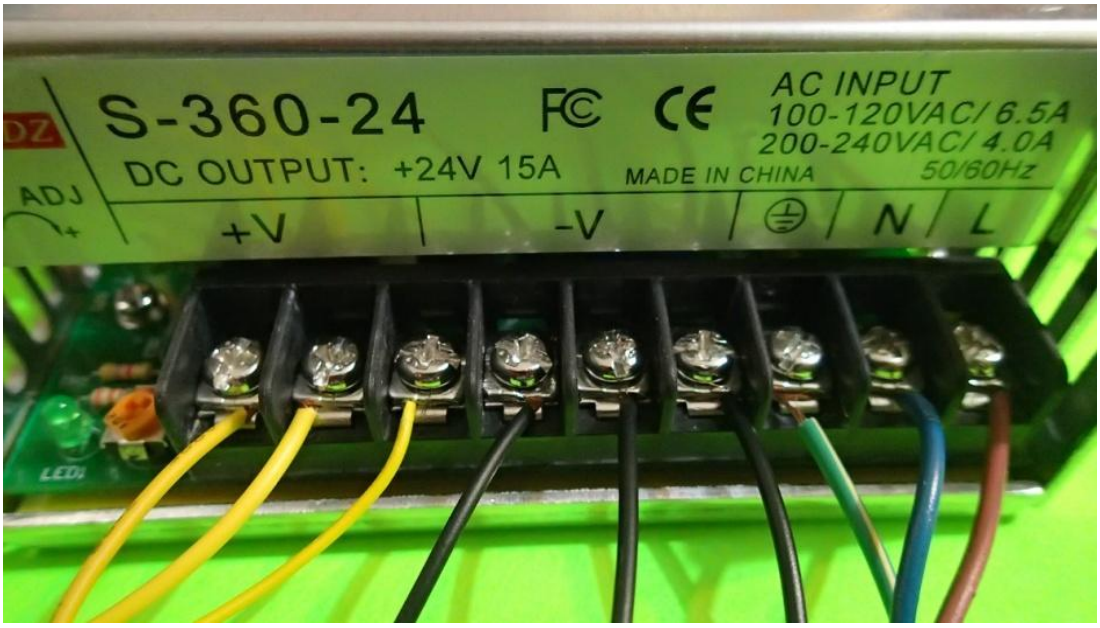


Figure 23 - Wired power supply

MOSFETS (HEATERS, FANS AND HEAT-BED)

The mosfet connectors are the 2 pin pluggable green connectors.

Figure 24 - 2-pin pluggable green connector

Follow the same instructions for installing the wires on these connectors as for the power input connector, but pay close attention to the polarity on these connections :

Figure 25 - Connector with wires and polarity labels

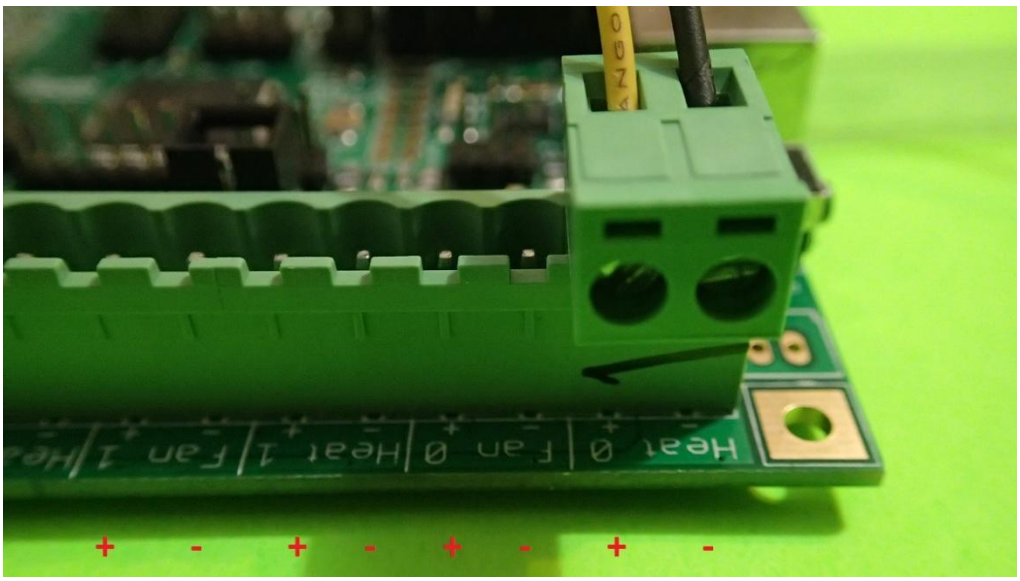


Figure 26 - Inserted connector with board polarities

THERMISTORS

The RAMBo comes with a pre-crimped wire harness for thermistors.

Figure 27 - Thermistor wire set

You can skip this step and connect the existing thermistor connector directly to the RAMBo if your thermistors are already soldered to a wire with a connector which fits into the RAMBo, note however than the insertion and removal of the connector will not be as easy as if you used the RAMBo connectors.

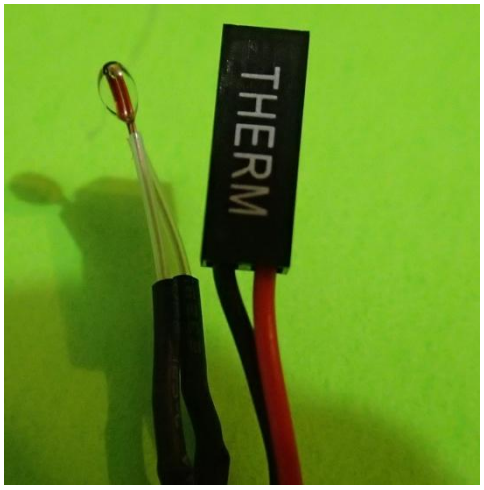


Figure 28 - Standard pre-wired thermistor

To use the RAMBo connectors, simply solder the wires to the thermistor to prepare it for the RAMBo. *Colin Farrer* from *Makerfarm* has a great video tutorial on how to wire a thermistor available here : http://www.youtube.com/watch?v=Su7-okPLH50

ENDSTOPS

The RAMBo comes with a pre-crimped wire harness for endstops.

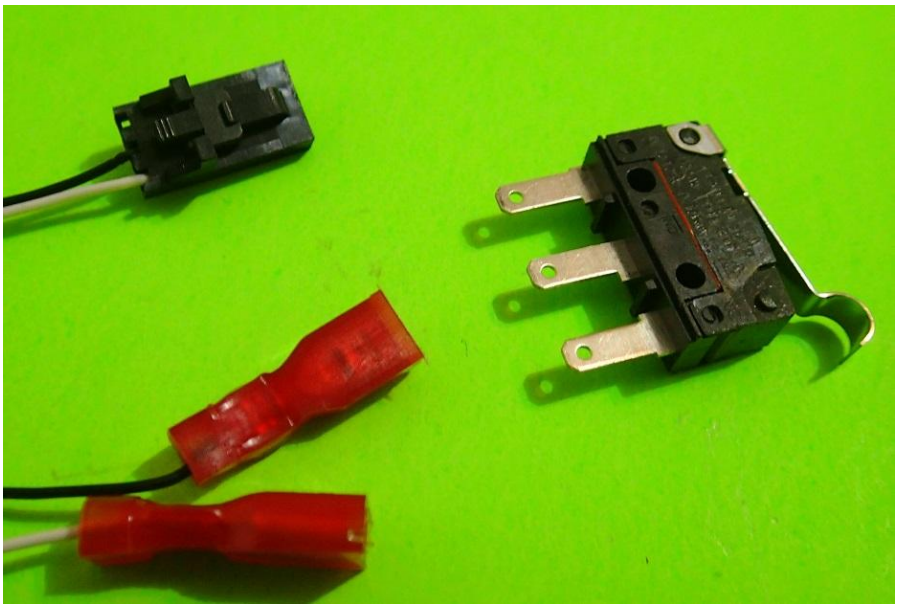


Figure 29 - Endstop and wire harness

On one end of the wires, a RAMBo connector is available while the other end has a connector for the endstops.

You must connect the endstops to the wire harness. Note that there are two possible ways to connect the endstops to the wire harness. Both are valid, but the configuration of the firmware will vary depending on how you connected them.

The first configuration is when using the connectors on each side of the endstop, as shown in this picture :

Figure 30 - Wired endstop - No inverting

In this configuration, the **ENDSTOP_INVERTING** option in the Marlin firmware must be set to ***false*** :

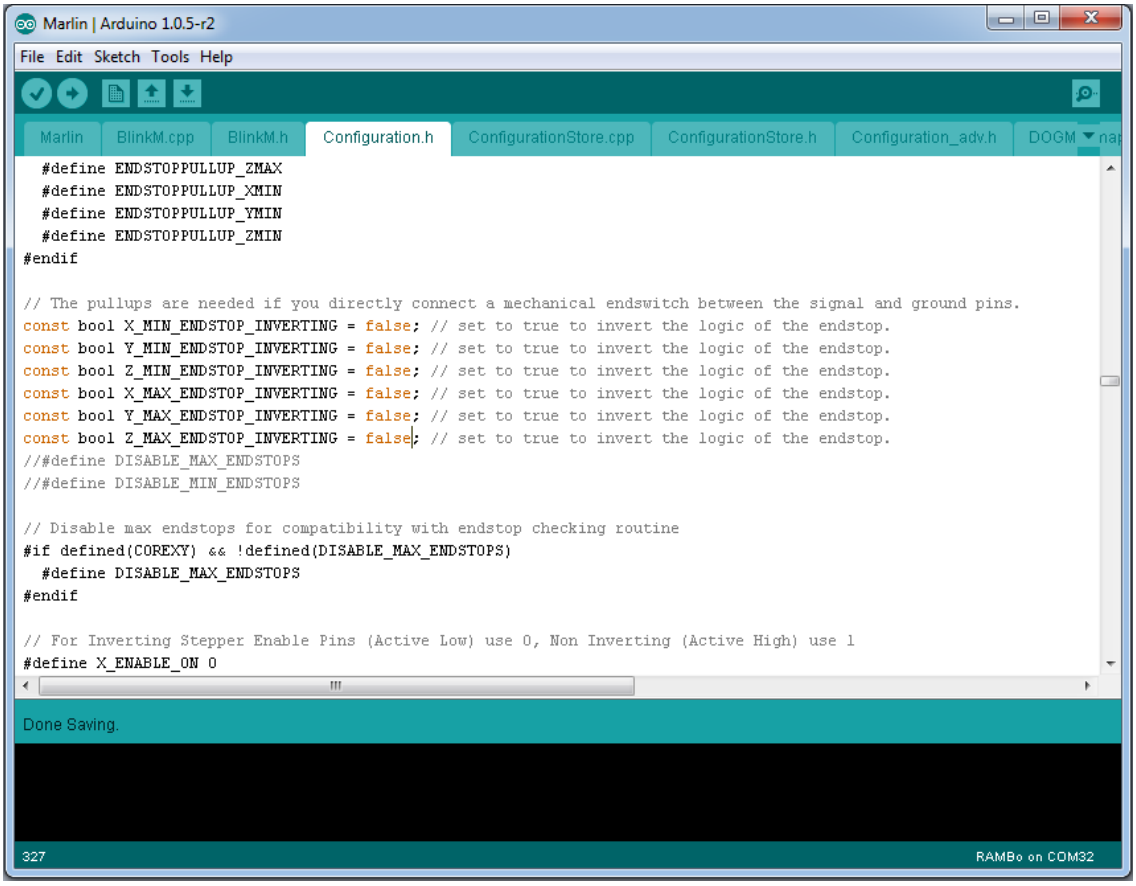


Figure 31 - Marlin endstop inverting options - False

The second configuration of the endstops is when using the middle connector with the connector below the trigger button of the switch, as shown in this picture :

Figure 32 - Wired endstop - Inverting

In this case, the **ENDSTOP_INVERTING** option in the Marlin firmware must be set to ***true*** :

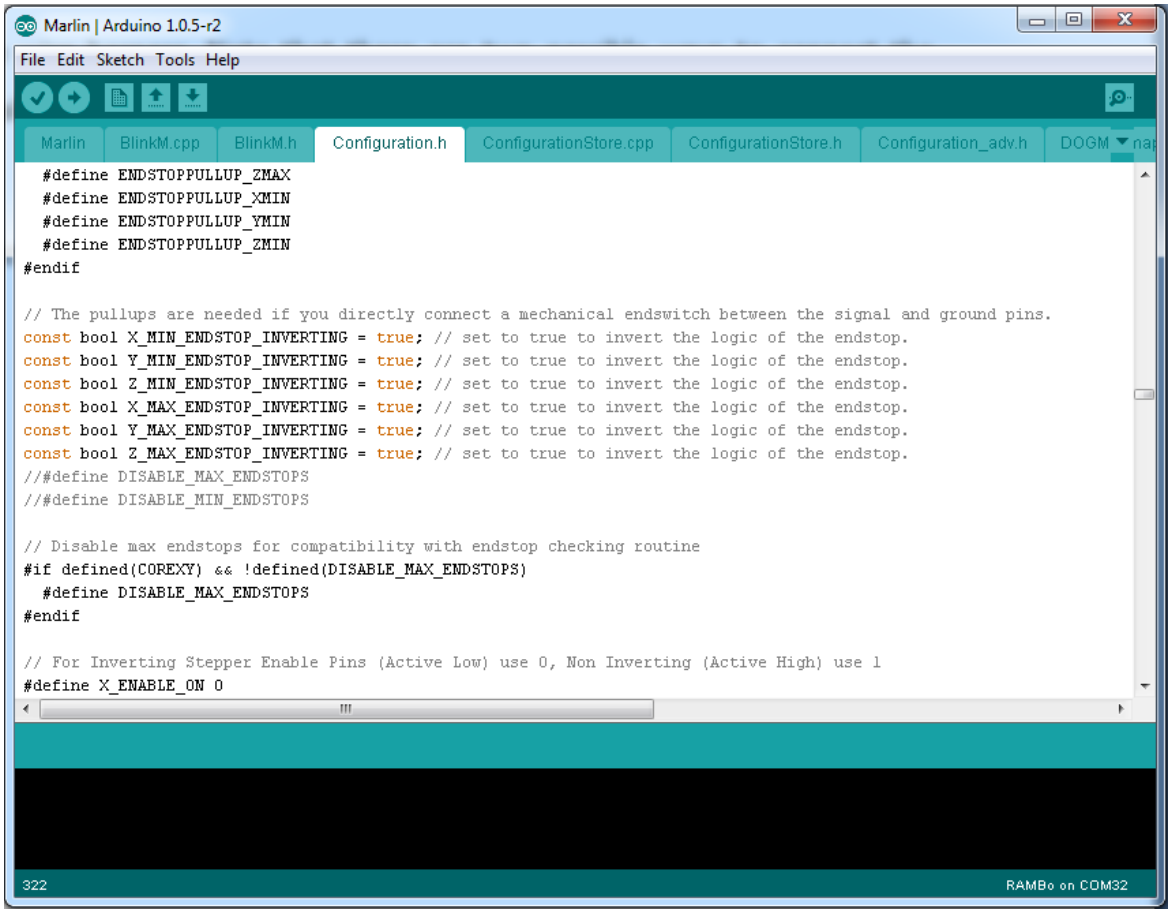


Figure 33 - Marlin endstop inverting options - True

CONNECTING THE RAMBO

Now that all your wires are prepared, connecting everything to the RAMBo will be easy and straightforward. Here is an overview of all of the connectors available on the RAMBo.

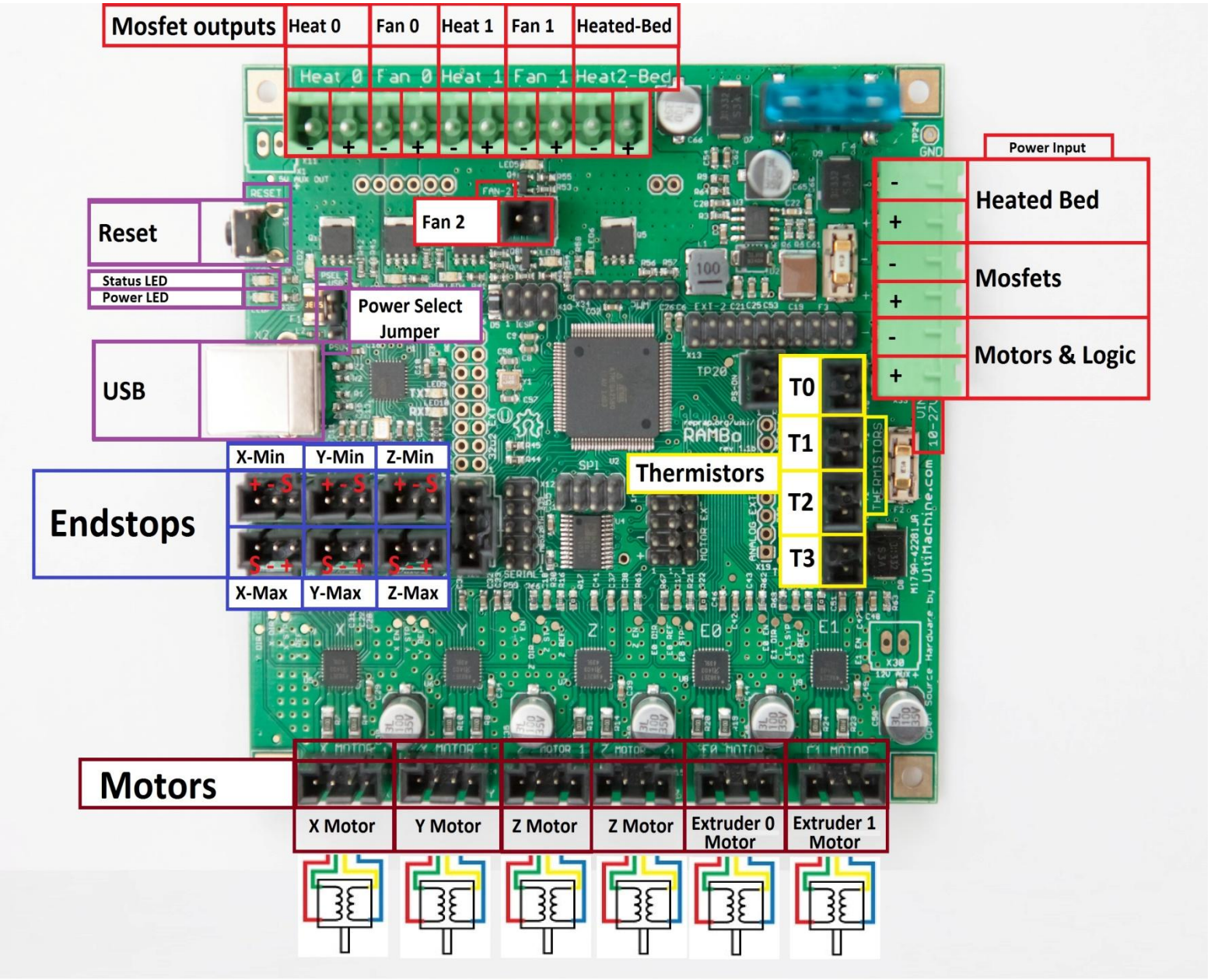


Figure 34 - RAMBo main connectors

Original image by Thomas Sanladerer

POWER INPUT

The RAMBo can be powered by a 12V or a 24V power supply.

The power connector is the green (or black) 6-pin connector on the right-hand side of the board marked with "**VIN 10-27V**" and with **-** and **+** polarities marked on the PCB :

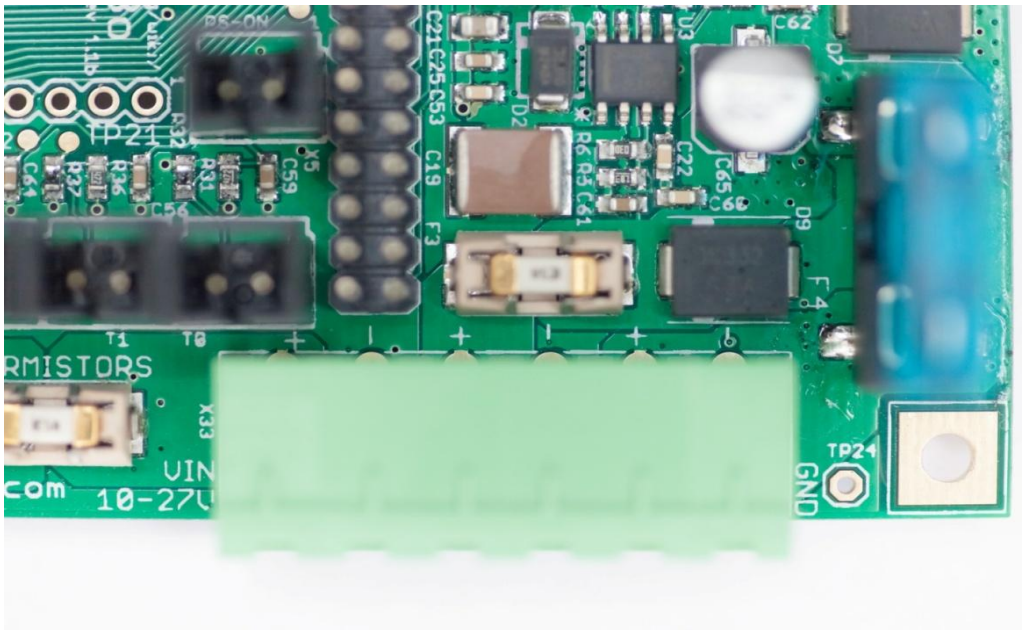


Figure 35 - Power input connector

Image by Thomas Sanladerer

To connect power to the RAMBo, simply insert the 6-pin pluggable into the Power Input socket. As shown previously, make sure the polarity is not inverted.

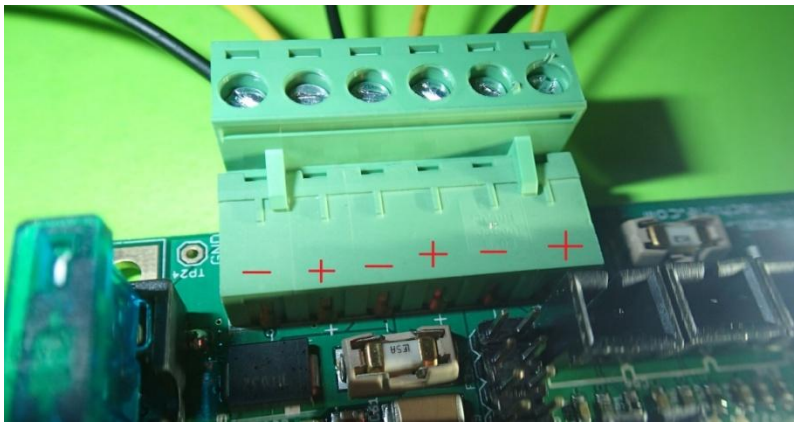


Figure 36 - Power input connector with insert connectors

MOSFETS

To connect the heater, fans and heat-bed, insert the 2-pin pluggable in the appropriate mosfet connectors on the board. There is also a FAN-2 standard connector below the row of mosfet connectors which can be used to control a second fan.

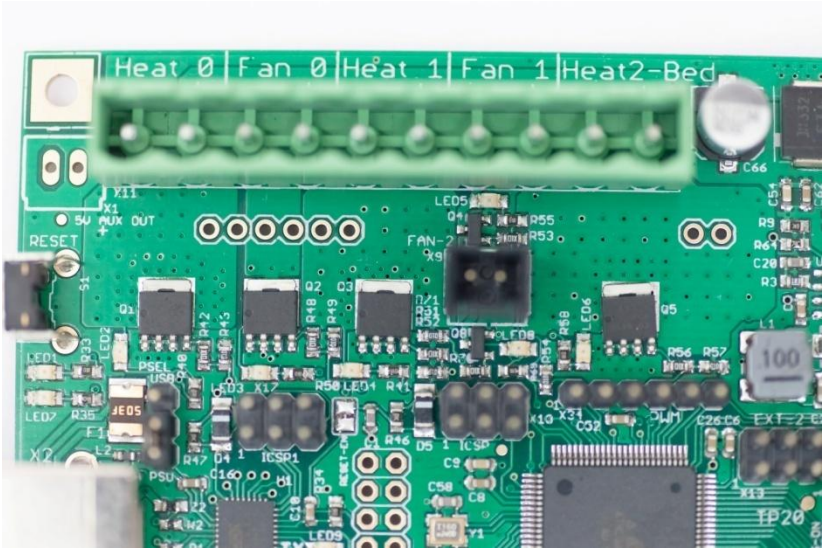


Figure 37 - Mosfets

Image by Thomas Sanladerer

Note that the Heat-0, Fan-0, Heat-1 and Heat2-Bed connectors use high capacity mosfets and are suitable for powering heaters, however, the Fan-1 and Fan-2 connectors use low capacity mosfets which are more suited for powering fans rather than heaters. It is not recommended to connect any electronics that drains more than 2A of current into the Fan-1 and Fan-2 connectors.

MOTORS

Connect the motors to the motor connectors on the bottom of the board. The blue wire must be towards the right of the board (where the orientation of the board is with the 15A fuse holder on top and the USB connector to the left) :

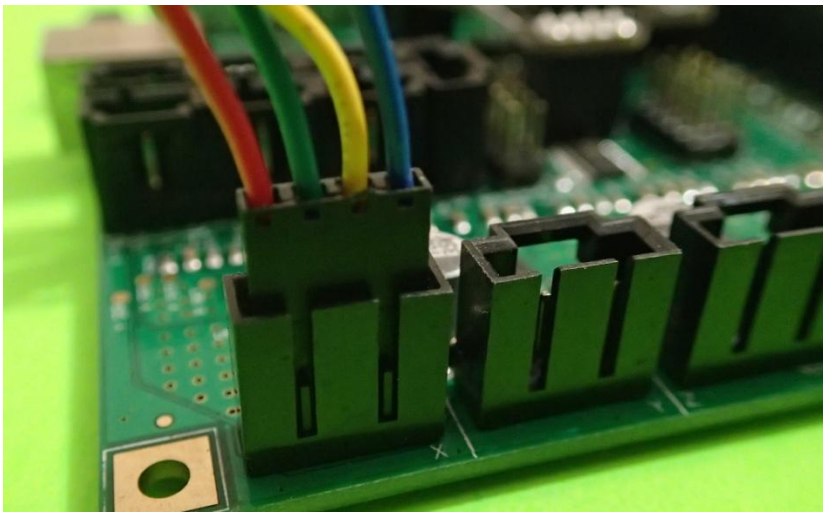


Figure 38 - Inserted motor connector

The motor connectors are marked with X, Y, Z, Z, E0 and E1 for the X, Y, Z (twice), first extruder and second extruder respectively. The Z motor has a duplicated connector for connecting two motors to be controlled by the same stepper driver.

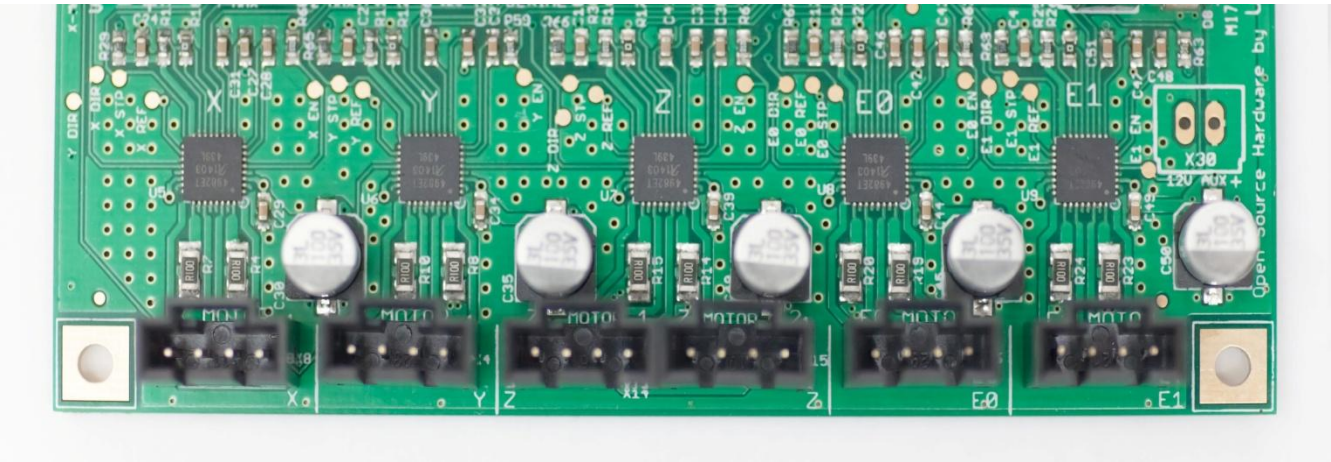


Figure 39 - Motor connectors on the board

Image by Thomas Sanladerer

If the motor is turning in the wrong direction, you can change it in software by changing the value of the **INVERT_X_DIR, INVERT_Y_DIR, INVERT_Z_DIR, INVERT_E0_DIR** or **INVERT_E1_DIR** from *false* to *true* or from *true* to *false*, depending on which motor's direction is wrong.

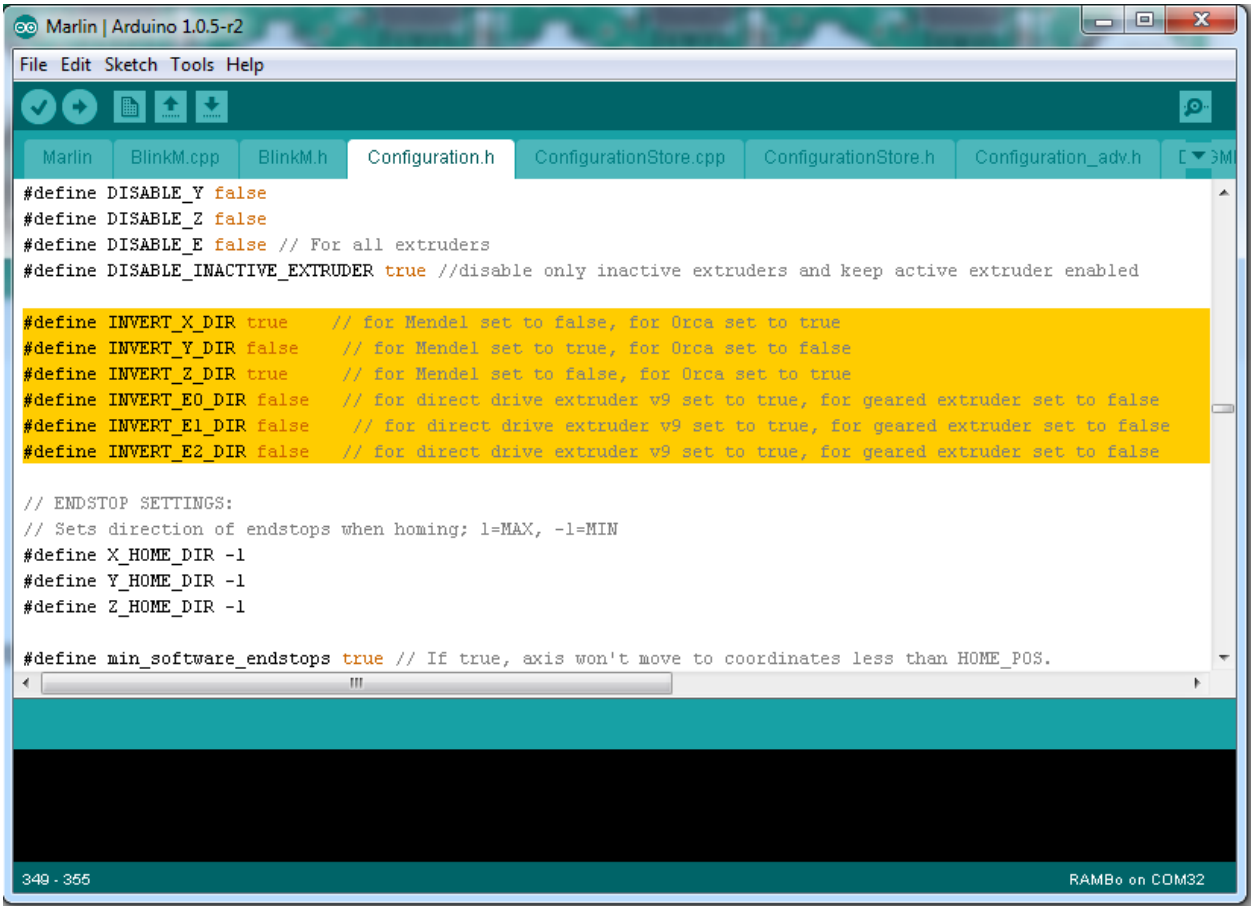


Figure 40 - Invert motor direction in software

ENDSTOPS

Connect your endstops to the endstops connectors on the RAMBo board (below the USB connector). The top row is for the Min endstops while the bottom row is for the Max endstops. They are ordered from the left for the X, Y and Z endstops :

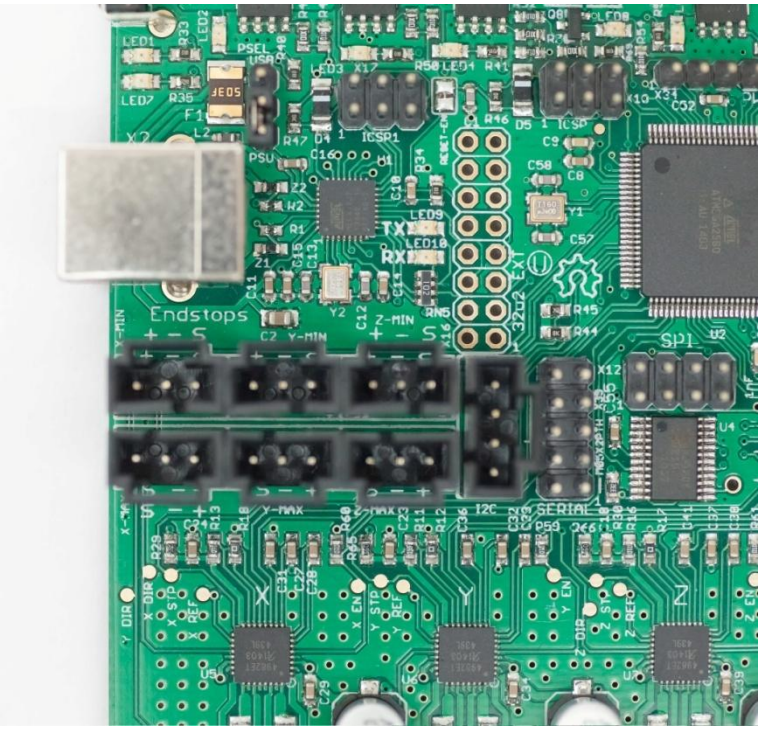


Figure 41 - Endstop connectors on the board

Image by Thomas Sanladerer

The mechanical endstops need to be connected to the **S** and **-** pins of the connector. If you use an opto-endstop, then you will need to connect the **S, -** and **+** pins to the opto-endstop.

Warning: If you do not use the include endstop wire harness, you must make sure not to connect the mechanical endstop to the **+** and **-** pins of the board, as it will short-circuit the board.

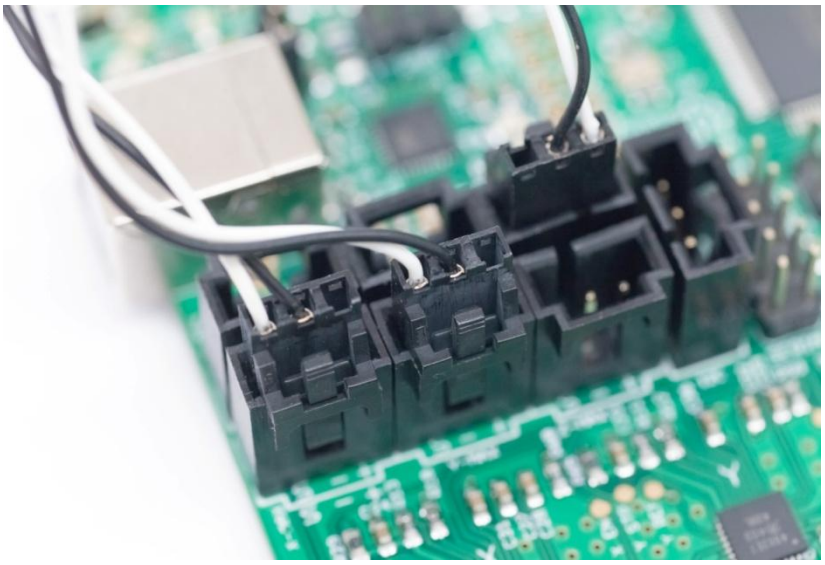


Figure 42 - Connected mechanical endstops to Z-Min, X-Max, Y-Max. Black=Ground, White=S

Image by Thomas Sanladerer

THERMISTORS

Your thermistor row is on the right of the board, next to the power input connector. Each thermistor connector is marked as either T0, T1, T2 or T3.

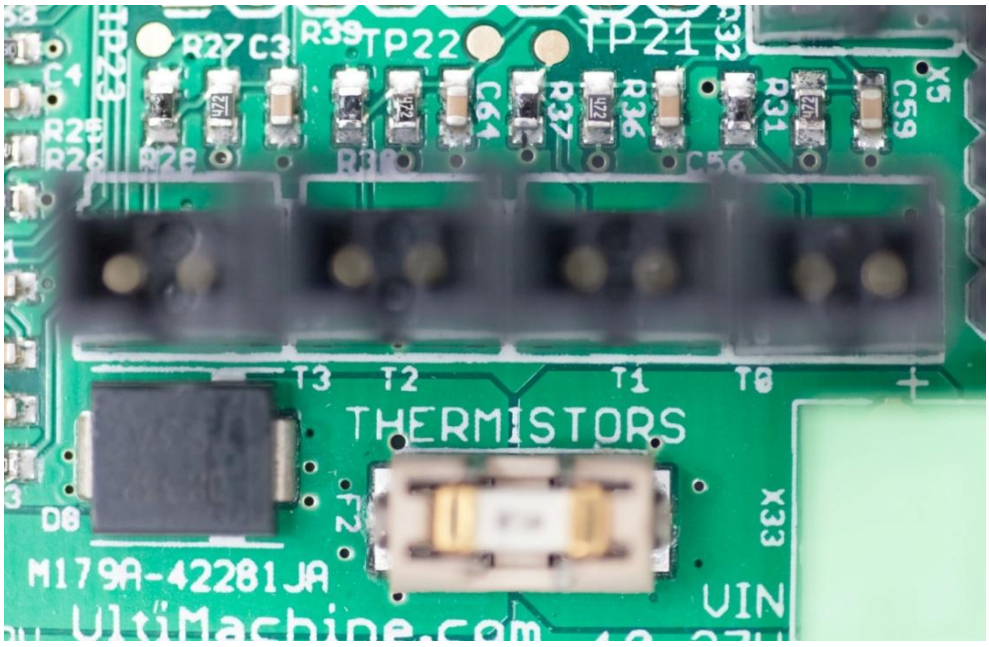


Figure 43 - Thermistor connectors on the board

Image by Thomas Sanladerer

By default, in the Marlin firmware, T0 is the thermistor for the first extruder, T1 is the thermistor for the second extruder and T2 is the thermistor for the heat-bed while T3 is left unused.

Simply connect the thermistor to the appropriate connector.

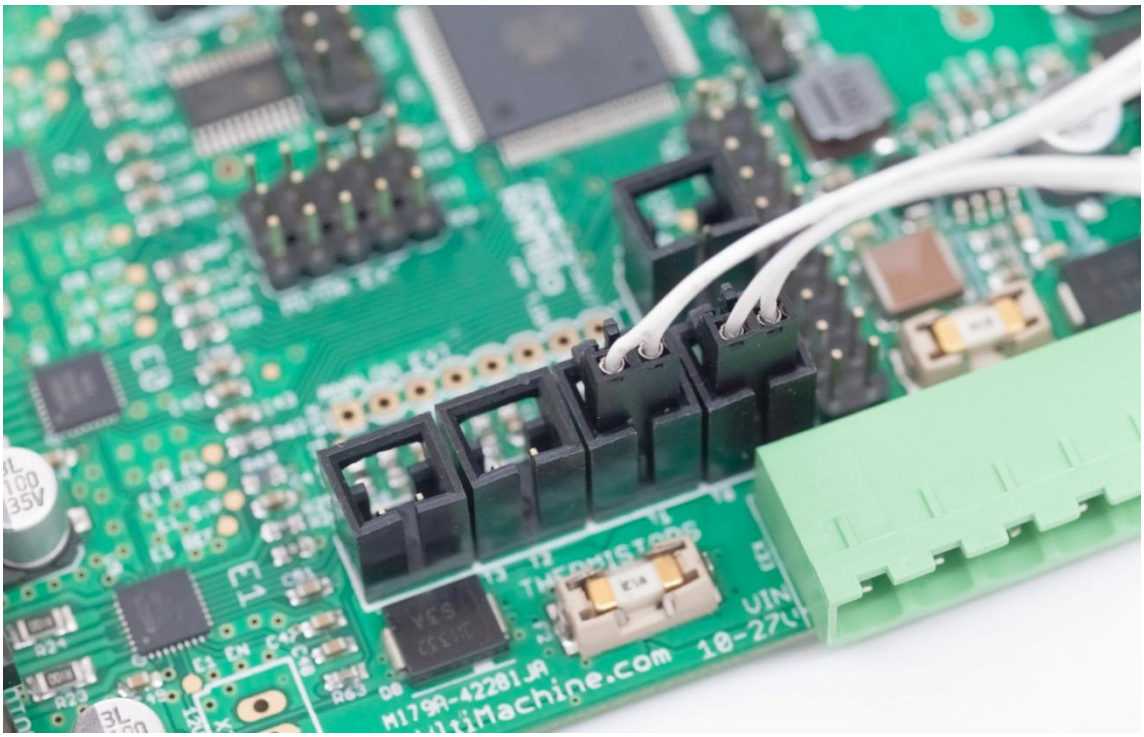


Figure 44 - Thermistors connected to T0 and T1 connectors

Image by Thomas Sanladerer

USB CABLE

Once everything has been connected, you can then connect the USB cable to the board. The provided USB cable is a *USB printer cable* (USB-A to USB-B male-male).

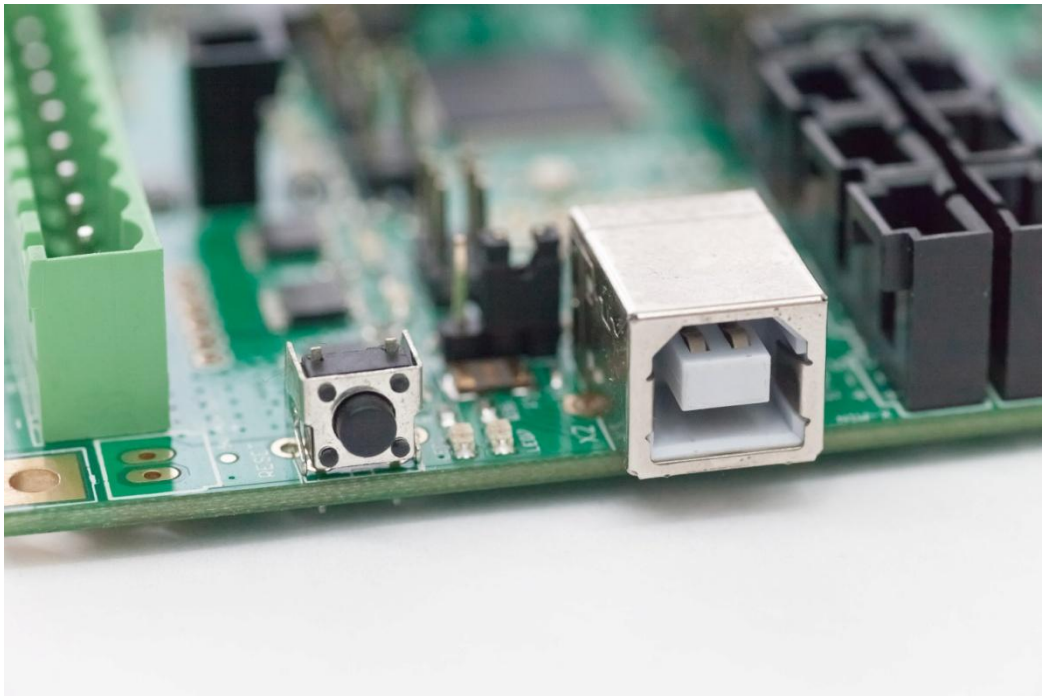


Figure 45 - USB connector and Reset button

Image by Thomas Sanladerer

Note the two LEDs next to the USB connectors representing the Power LED and Status LED, as well as the Reset button to cause the firmware to reset.

SMART LCD CONTROLLER

If you have the Smart LCD Adapter, either as part of your accessories kit or bought separately, you can easily connect the SmartLCD to the RAMBo. First insert the LCD Adapter into the RAMBo by connecting it to the EXT-2, ICSP 2560 and SD/SPI connectors so the adapter is sitting above the Atmega2560 chip.

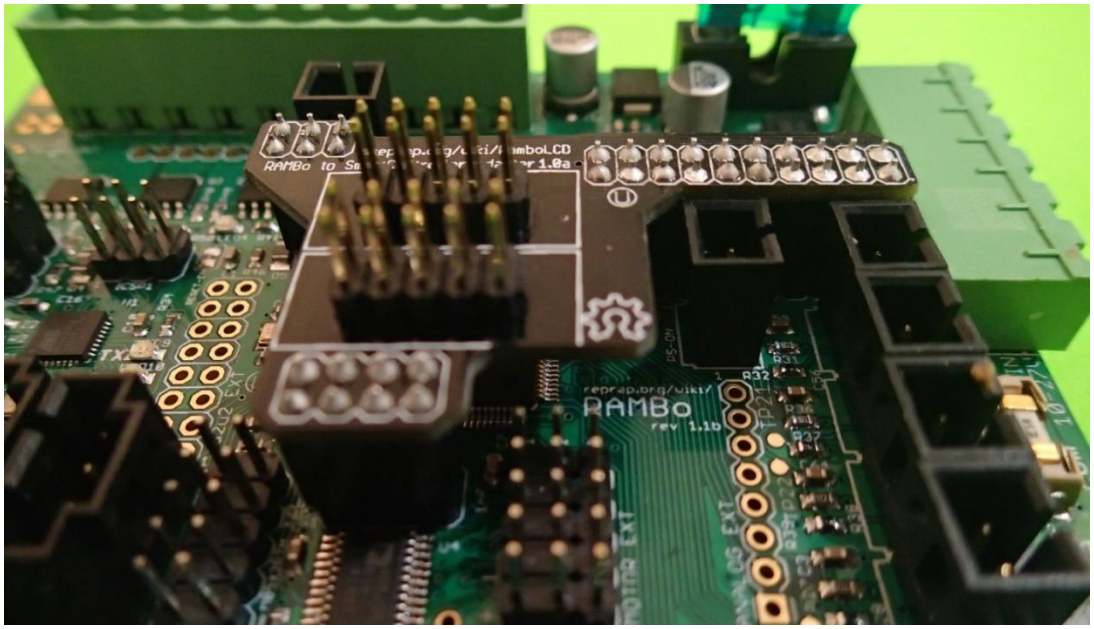


Figure 46 - Smart LCD Adapter inserted on RAMBo

You can then connect the ribbon cables (which should be provided with the LCD controller) to the **EXP1** and **EXP2** connectors on the Smart LCD Controller :

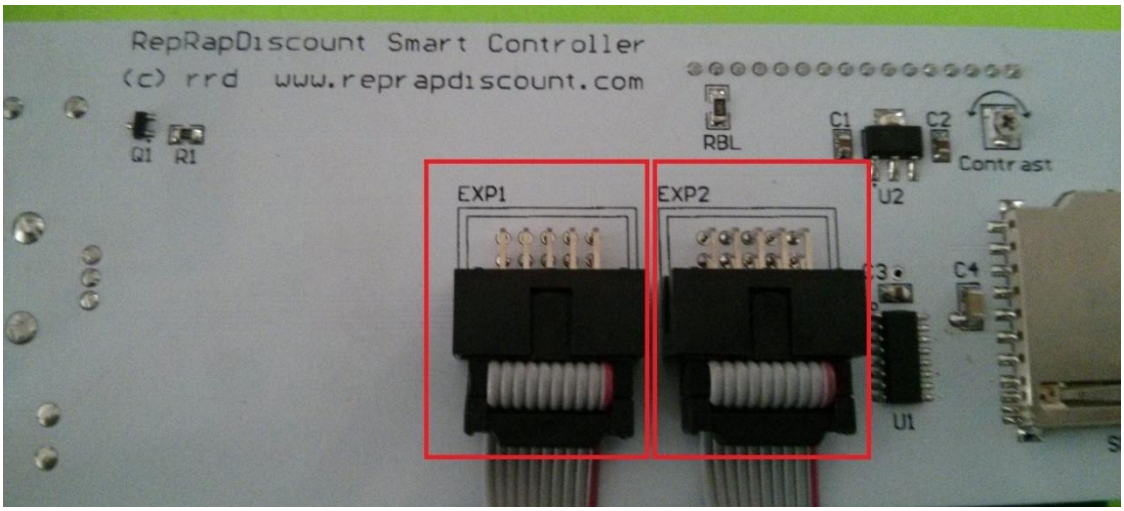


Figure 47 - EXP1 and EXP2 connectors on Smart LCD Controller

Or on the Full Graphics LCD Controller :

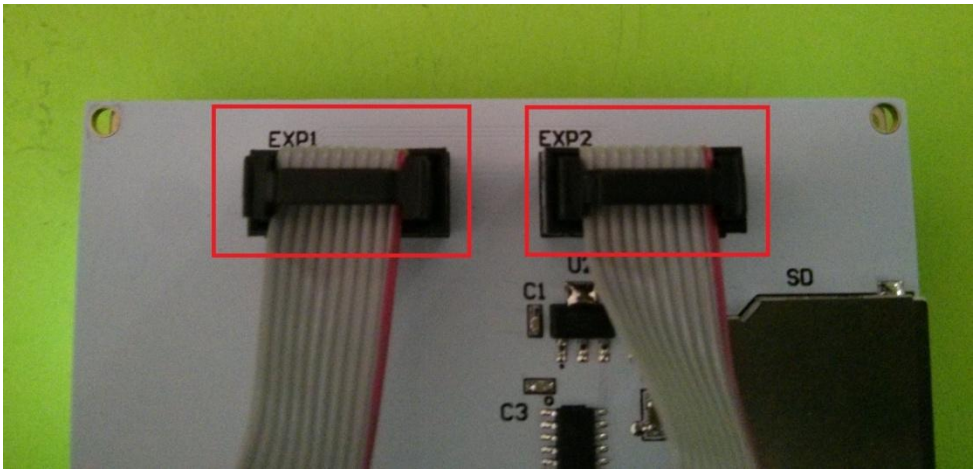


Figure 48 - EXP1 and EXP2 connectors on Full Graphics Smart LCD Controller

You can then connect the ribbon cables to the Smart LCD Controller on the RAMBo :

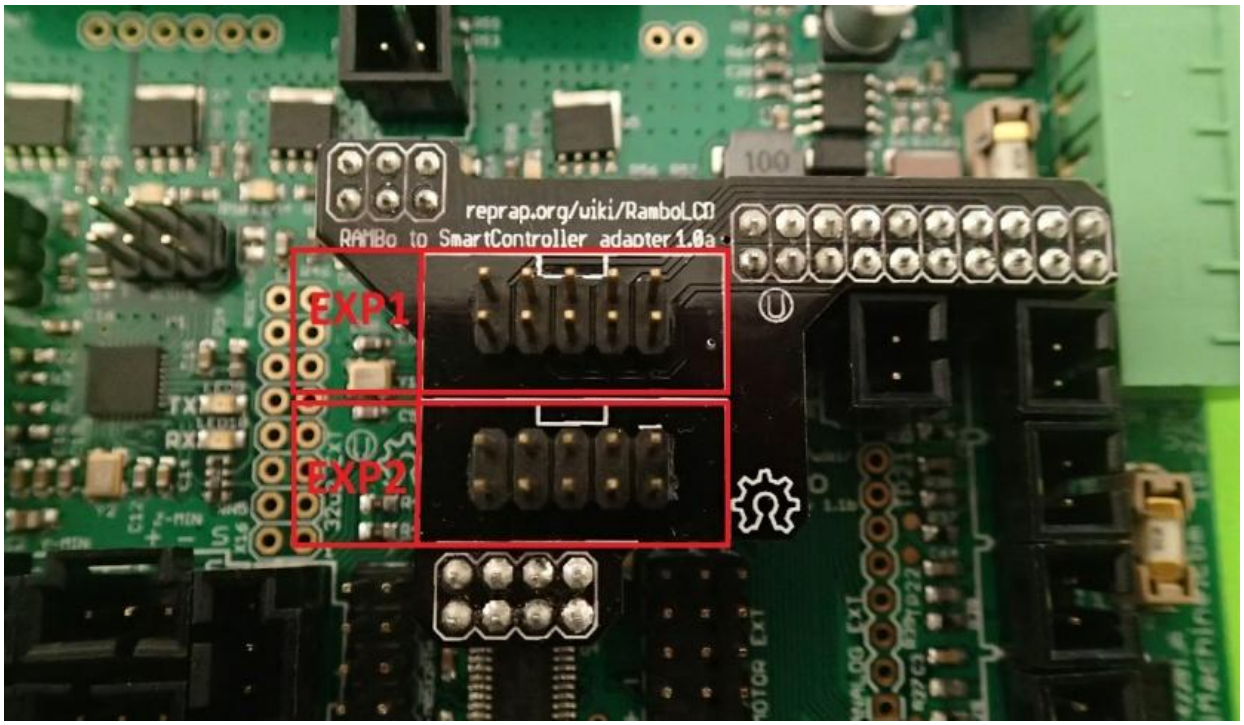


Figure 49 - Labeled positions for EXP1 and EXP2 on Smart LCD Adapter

Note the position of the ribbon cable's connector's key (the notch). It must align with the smaller white square on the adapter.

Once you connect the cables to the appropriate positions, the LCD adapter should then work once your firmware is configured properly. Note the red wire's position :

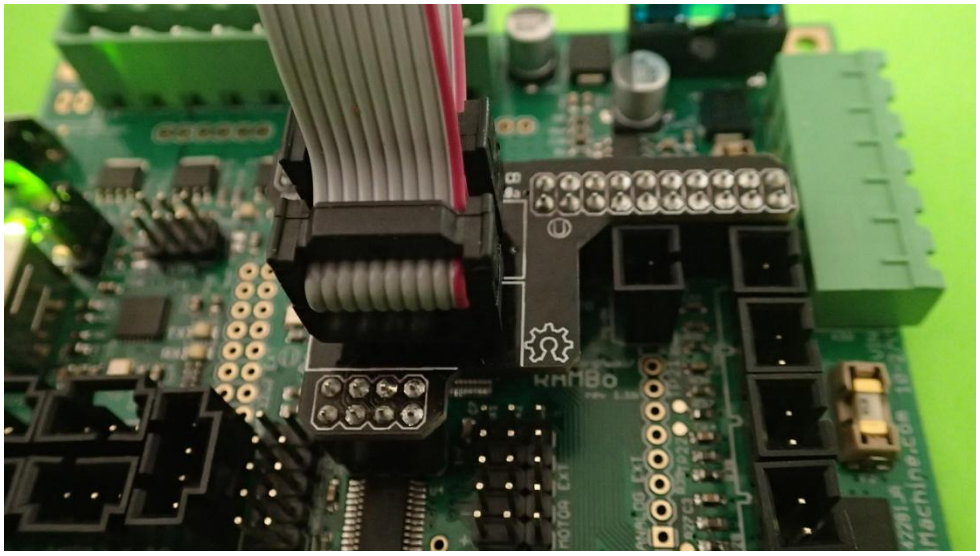


Figure 50 - Connected ribbon cable on Smart LCD Adapter

If you do not have a Smart LCD Adapter, you can create your own wiring by following the tutorial available in the RepRap wiki : http://reprap.org/wiki/RamboLCD

AUXILIARY CONNECTORS

Here is an image showing all the connectors on the RAMBo. The auxiliary connectors available on the board are the I2C, Serial, SD/SPI, Motor-Ext, Analog-Ext, PWM-Ext and EXT2 connectors. There are also additional extension pins such as the 32u2-Ext and ICSP pins for the Atmega32u2 and Atmega2560 as well as a 5V and a 12-24V (depending on power input for Motors & Logic) Auxiliary power output connectors :

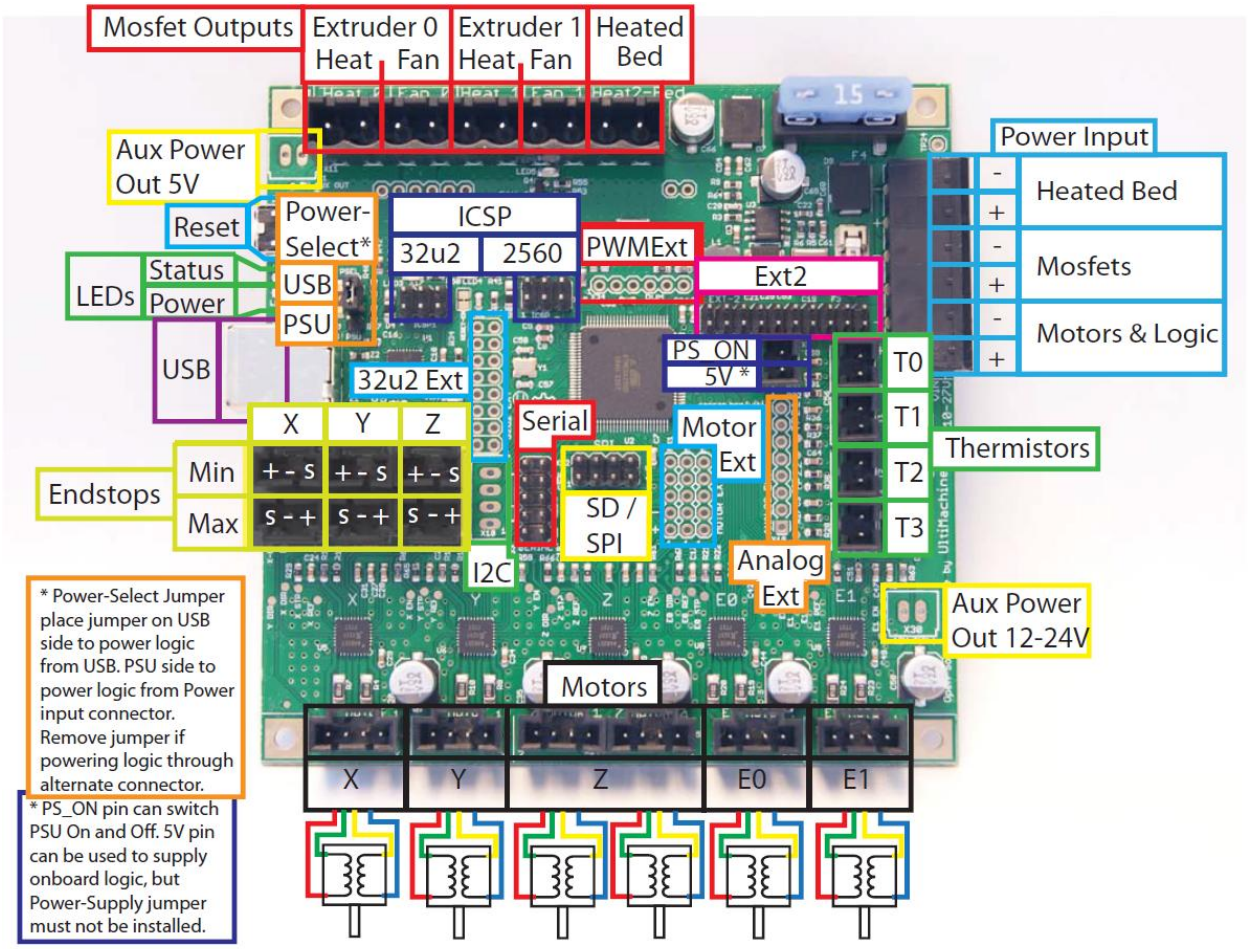


Figure 51 - Main and Auxiliary connectors

Image by Ultimachine

You can refer to Annex A and Annex B for the board's schematic and pin mapping or to the appropriate sub-sections below for understanding how to use the extension headers.

Here are more detailed views of the main auxiliary connectors :

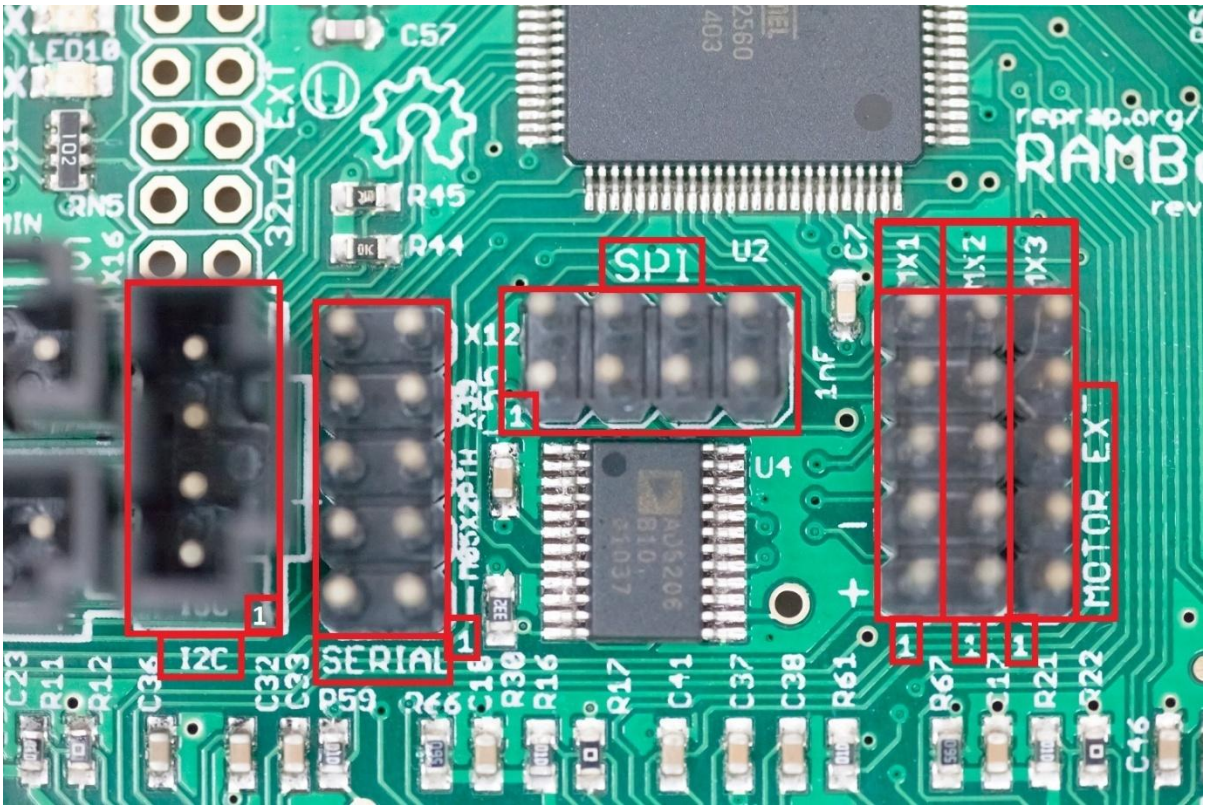


Figure 52 - I2C, Serial, SD/SPI, Motor-Ext pins

Image by Thomas Sanladerer

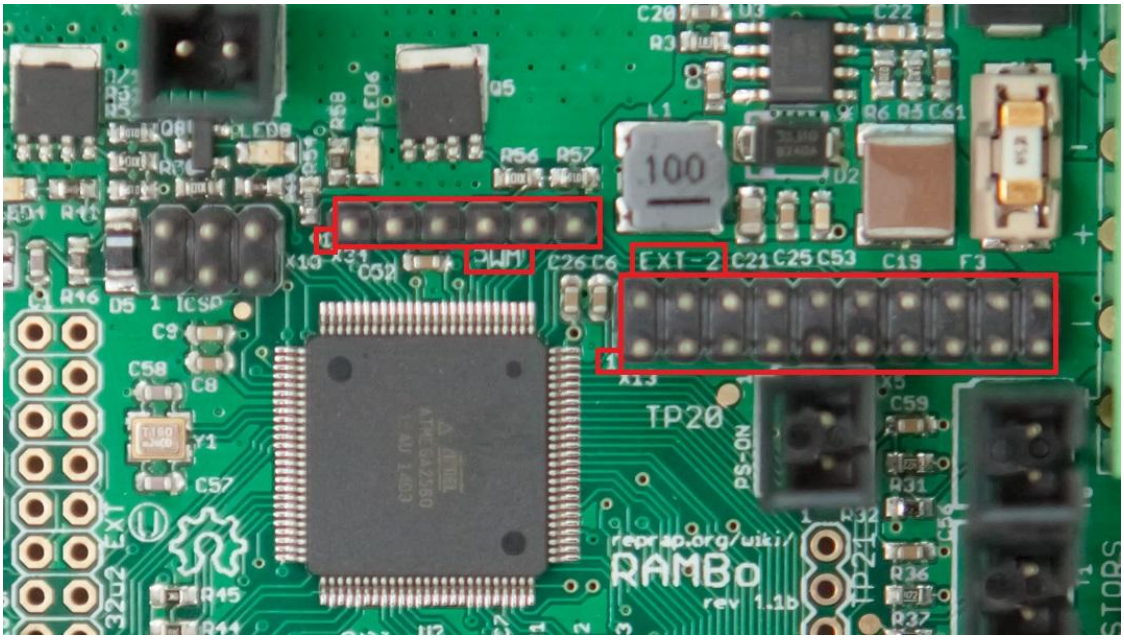


Figure 53 - PWM and EXT-2 pins

Image by Thomas Sanladerer

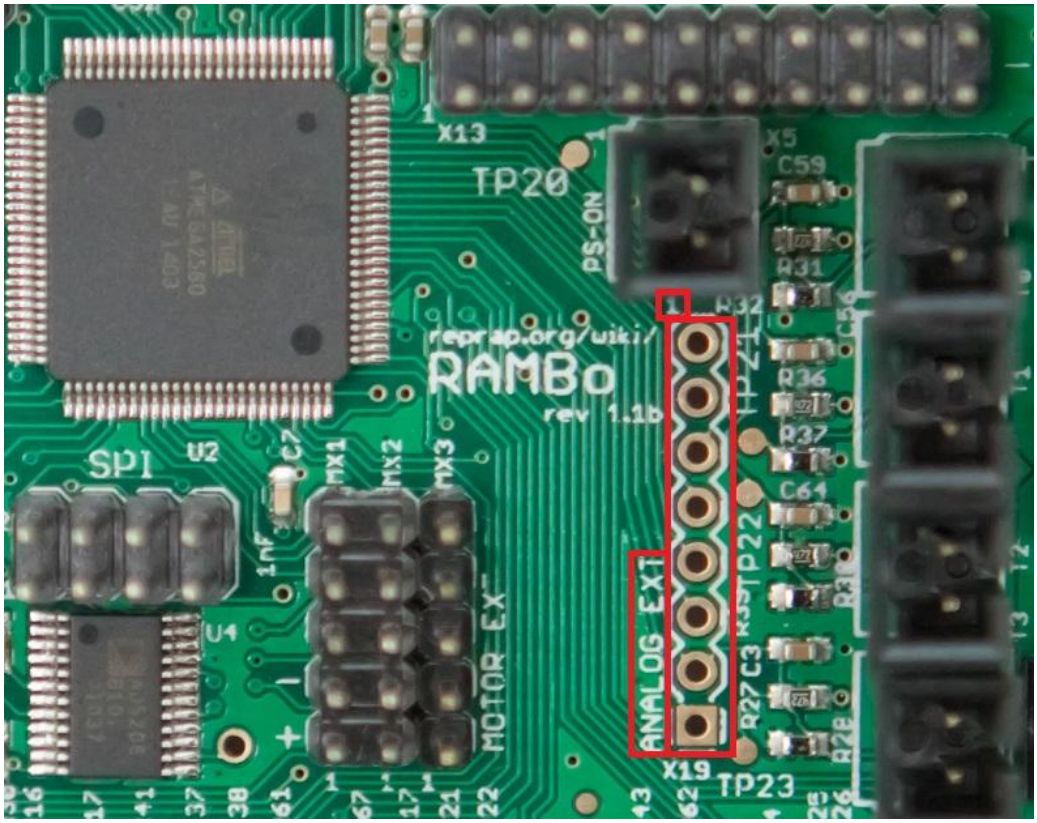


Figure 54 - Analog-Ext pins

Image by Thomas Sanladerer

MOTOR-EXT

The Motor-Ext pins can be used to connect extra motors to the board.

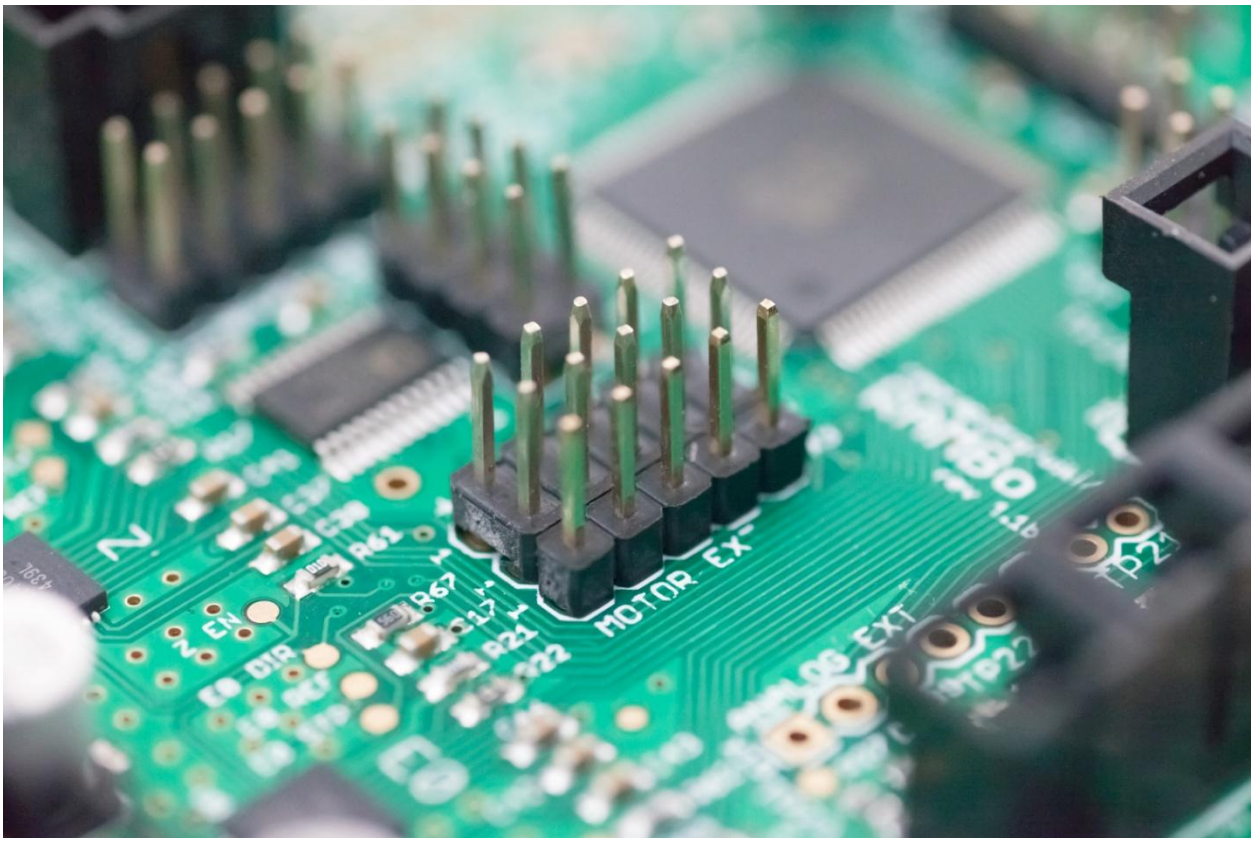


Figure 55 - Motor-Ext connector

Image by Thomas Sanladerer

There are extension pins for 3 extra motors in the Motor-Ext connector, called MX1, MX2 and MX3:

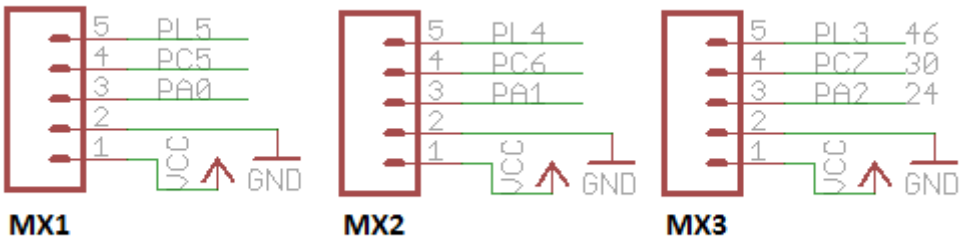


Figure 56 - Motor Ext Schematic

Note, the position of the pin 1 in Figure 51, it represents the VCC pin while pin 2 represents the Ground. The 3rd, 4th and 5th pins should be used as the STEP, DIR and EN pins for the stepper driver. The pin mapping for the MX1 pins MX1-3, MX1-4, MX1-5, for the MX2 pins MX2-3, MX2-4, MX2-5 and for the MX3 pins MX3-3, MX3-4 and MX3-5 can be found in the following table :

Port	Arduino Digital Number	Function	RAMBo Function
PA0	22	D22	MX1-3
PC5	32	D32	MX1-4
PL5	44	D44	MX1-5
PA1	23	D23	Y-Max/MX2-3
PC6	31	D31	MX2-4
PL4	45	D45	MX2-5
PA2	24	D24	X-Max/MX3-3
PC7	30	D30	Z-Max/MX3-4
PL3	46	D46	SPI Ext 2/MX3-5

Note however that the MX2-3, MX3-3, MX3-4 and MX3-5 pins are shared with the Y-Max, X-Max, Z-Max and SPI Ext 2 pins respectively. If you use the Max endstops or the second pin of the SPI extension, you may not be able to use the MX2 and MX3 expansion headers.

I2C

The I2C connector can be used to connect I2C compatible devices, such as the Viki LCD or the Panelolu 2 controller.

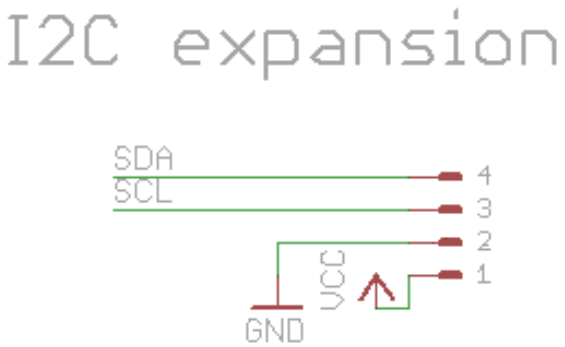


Figure 57 - I2C Expansion schematic

Please refer to Figure 51 for the indication on where the pin 1 is located on the board. Pin 1 is VCC, pin 2 is Ground, pin 3 is SCL and pin 4 is SDA.

Port	Arduino Digital Number	Function	RAMBo Function
PD1	20	I2C_SDA	I2C Ext 3
PD0	21	I2C_SCL	I2C Ext 4

SERIAL

The Serial connector can be used to communicate using with the Atmega2560 chip over UART.

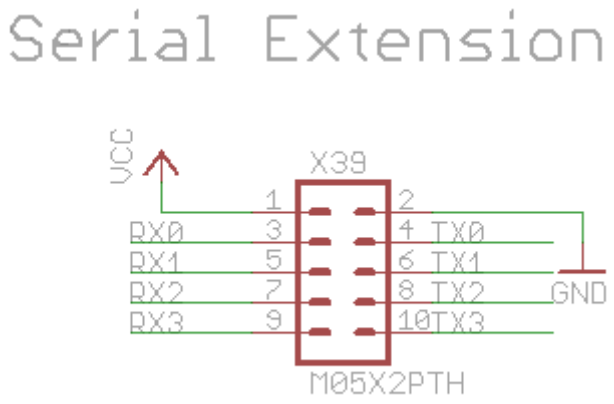


Figure 58 - Serial Extension Schematic

Here is the pin mapping for the Serial extension. You will notice that the Serial-Ext3 and Serial-Ext4 are used to communicate with the USB connection.

Port	Arduino Digital Number	Function	RAMBo Function
PE0	0	USART0_RX	USB/Serial Ext 3
PE1	1	USART0_TX	USB/Serial Ext 4
PD2	19	USART1_RX	Serial Ext 5
PD3	18	USART1_TX	Serial Ext 6
PH0	17	USART2_RX	Serial Ext 7
PH1	16	USART2_TX	Serial Ext 8
PJ0	15	USART3_RX	Serial Ext 9
PJ1	14	USART3_TX	Serial Ext 10

SD/SPI

The SD/SPI extension header can be used to communicate with any device supporting SPI, such as an SD card.

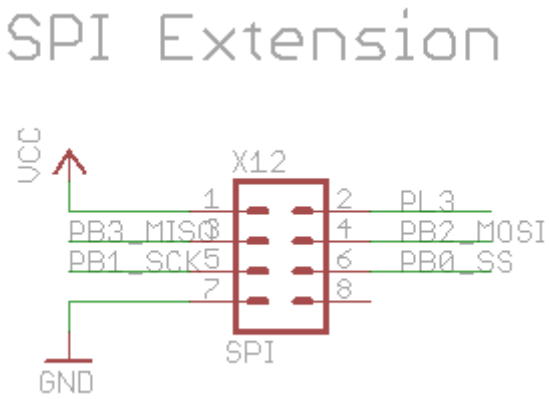


Figure 59 - SPI Extension Schematic

Please refer to Figure 51 for the indication on where the pin 1 is located on the board. Note that pin 1 is VCC and pin 7 is Ground, the pin 2 is shared with the MX3-5 pin but is not needed for the SPI protocol. The SPI protocol only requires the use of the MISO, MOSI, SCK and SS pins which are respectively SPI-Ext-3, SPI-Ext-4, SPI-Ext-5 and SPI-Ext-6.

Port	Arduino Digital Number	Function	RAMBo Function
PL3	46	D46	SPI Ext 2/MX3-5
PB3	50	SPI_MISO	SPI Ext 3
PB2	51	SPI_MOSI	SPI Ext 4
PB1	52	SPI_SCK	SPI Ext 5
PB0	53	SPI_SS	SPI Ext 6

PWM-EXT

The PWM-Ext header can be used as a general purpose PWM extension. It can be used for example to control servo motors for auto bed leveling.

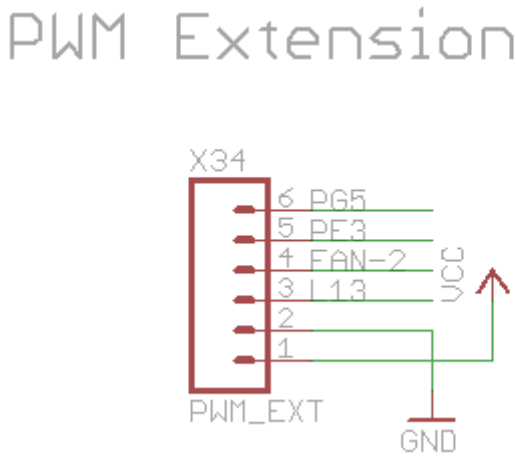


Figure 60 - PWM Extension Schematic

Please refer to Figure 52 for the position of the pin 1 on the Board. The PWM Extension header shares some pins with other features of the board: PWM-Ext-3 also controls the Status LED of the Baord, PWM-Ext-4 also controls the Mosfet for the FAN-2 power output and PWM-Ext-6 also controls the PS-On pin.

Port	Arduino Digital Number	Function	RAMBo Function
PB7	13	PWM13	LED/PWM Ext 3
PE4	2	PWM2	Fan-2/PWM Ext 4
PE3	5	PWM5	PWM Ext 5
PG5	4	PWM4	PS-On/PWM Ext 6

EXT2

The EXT-2 extension header is a general purpose digital header which can be used any way you want. It is currently being used by Marlin to communicate with the Smart LCD controller.

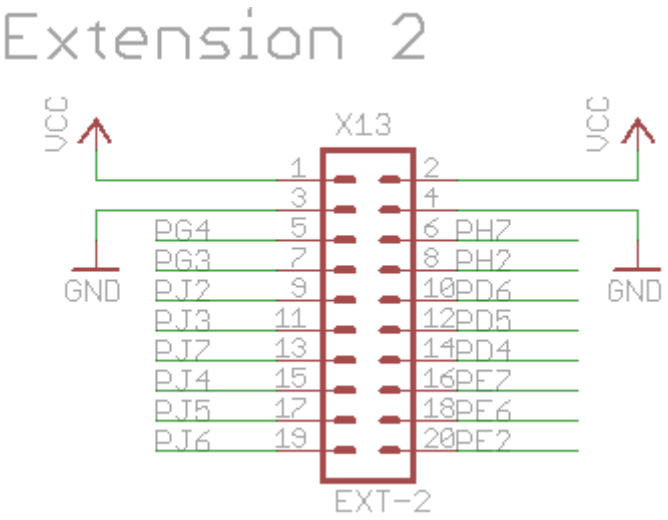


Figure 61 - Extension 2 Schematic

Please refer to Figure 52 for the position of the pin 1 on the board.

Port	Arduino Digital Number	Function	RAMBo Function
PG4	70	D70	Ext2 5
PH7	85	D85	Ext2 6
PG3	71	D71	Ext2 7
PH2	84	D84	Ext2 8
PJ2	72	D72	Ext2 9
PD6	83	D83	Ext2 10
PJ3	73	D73	Ext2 11
PD5	82	D82	Ext2 12
PJ7	74	D74	Ext2 13
PD4	81	D81	Ext2 14
PJ4	75	D75	Ext2 15
PE7	80	D80	Ext2 16
PJ5	76	D76	Ext2 17
PE6	79	D79	Ext2 18
PJ6	77	D77	Ext2 19
PE2	78	D78	Ext2 20

ANALOG-EXT

The Analog-Ext extension header gives access to the unused Analog pins of the Atmega2560 and it can be used for additional thermistors or any other uses which require an analog input or output.

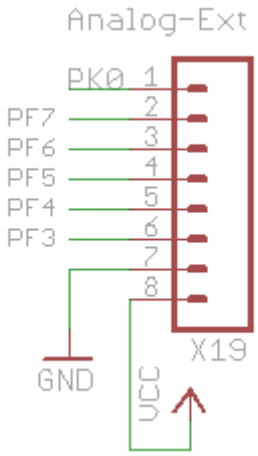


Figure 62 - Analog Ext Schematic

Please refer to Figure 53 for an indication of the position of pin 1 of the Analog-Ext header. Note that the square pad on the header actually represents pin 8 of the extension and not pin 1.

Please also note that the Analog-Ext-5 pin is shared with the T3 thermistor connector.

Port	Arduino Digital Number	Function	RAMBo Function
PF6	60	A6	Analog Ext 3
PF5	59	A5	Analog Ext 4
PF7	61	A7	T3/Analog Ext 5
PF4	58	A4	Analog Ext 6
PK0	62	A8	Analog Ext 7
PF3	57	A3	Analog Ext 8

CONFIGURATION AND TROUBLESHOOTING

CONFIGURATION OF THE DIGITAL POTENTIOMETER

During the calibration process of your 3D printer, you will want to calibrate the motor current. The RAMBo comes with a digital potentiometer which allows you to fine tune the motor current to give the most optimal current to your motors without having the motors heat up until they start skipping steps. A correctly tuned motor current can keep the printer running for hours while the motor stays barely warm.

To set the current for your motors, open *Configuration_adv.h* in Marlin firmware and look for the **DIGIPOT_MOTOR_CURRENT** :

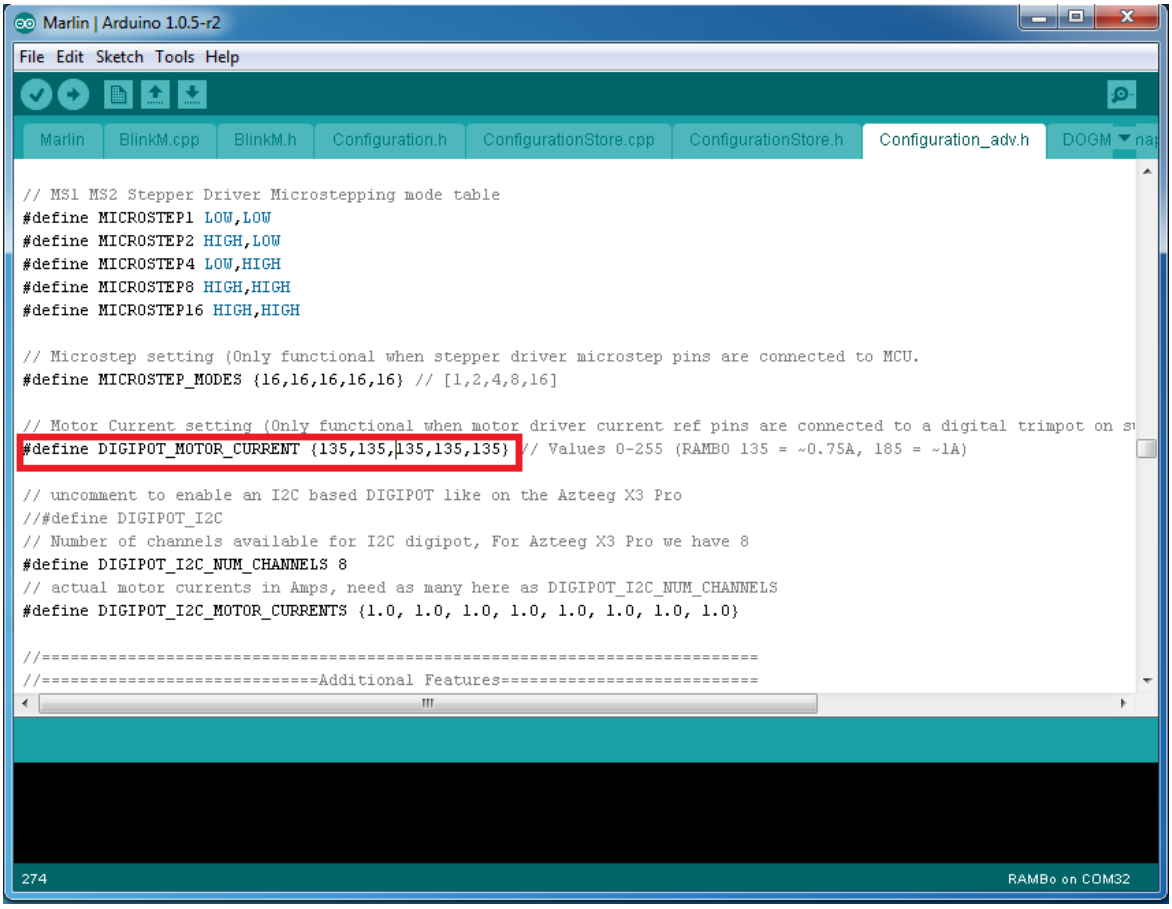


Figure 63 - Digital motor current variable in Marlin

You can then set the value between 0 and 255 to set the current for the X, Y, Z, E0, E1 motors where 255 is the maximum current of 2A. The values will be depend on your motors and input voltage.

You can also set the current dynamically with GCode (in Pronterface). It is very useful to test different currents this way until you find the right values for your motors before setting them in the Marlin *Configuration_Adv.h* file.

You can set the current with the following GCode :

```
M907 X<current> Y<current> Z<current> E<current> B<current>
```

Where B is used for the second extruder.

For example, the following command will set the X current value to 75 (which is 75/255, which is 29% of the maximum current) and the Y current value to 100 :

```
M907 X75 Y100
```

SETUP OF A SERVO MOTOR FOR AUTO-BED LEVELING

In order to configure the Marlin firmware for using servo motors, you need to edit the **pins.h** file from the Marlin directory, and look for the **Rambo Pin Assignments** section. Then add the following lines inside that section :

```
#ifdef NUM_SERVOS
 #define SERVO0_PIN       <First servo pin number>

 #if NUM_SERVOS > 1
  #define SERVO1_PIN       <Second servo pin number>
 #endif

 #if NUM_SERVOS > 2
  #define SERVO2_PIN       <Third servo pin number>
 #endif

 #if NUM_SERVOS > 3
  #define SERVO2_PIN       <Fourth servo pin number>
 #endif
#endif
```

You can use one of the auxiliary connectors for controlling the servo motor. We would recommend the use of the PWM Ext connector.

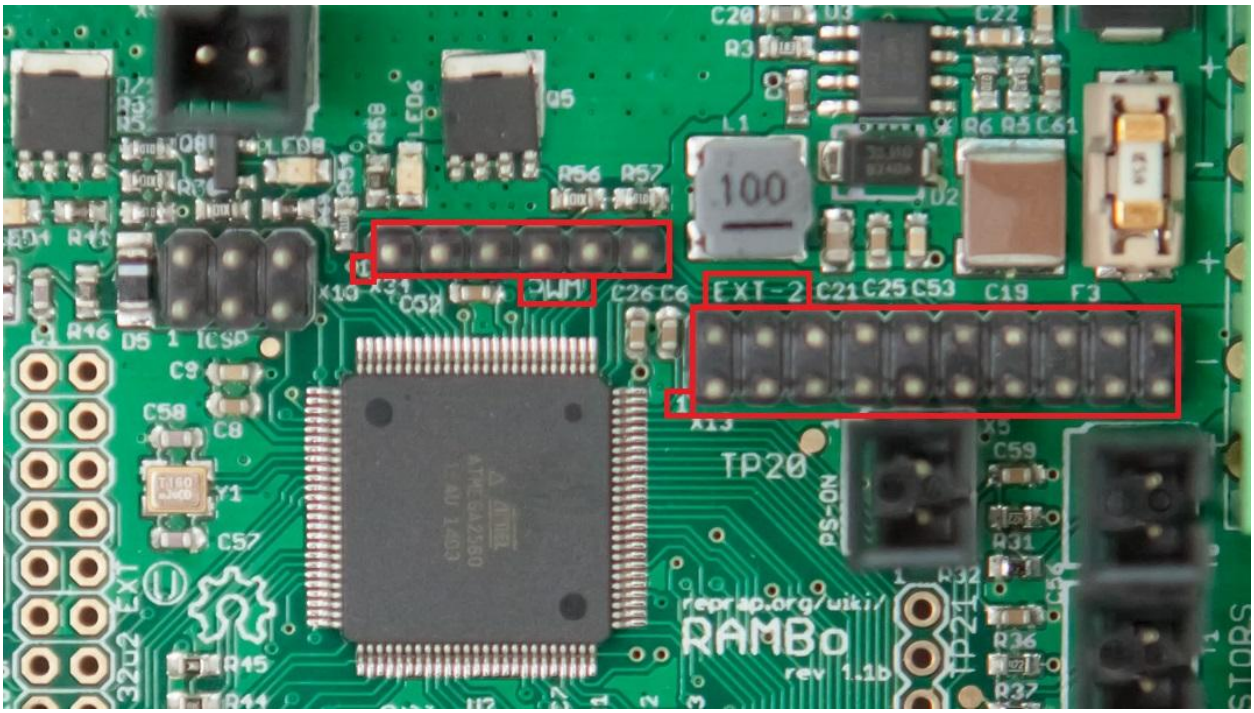


Figure 64 - PWM and EXT-2 pins

Image by Thomas Sanladerer

The first pin on the left is marked with a '**1**' on the board and represents the VCC pin, the second pin represents ground. The PWM-Ext-3, PWM-Ext-4, PWM-Ext-5 and PWM-Ext-6 can be used as extensions.

You can refer to the **PWM Ext** section of this user manual for more information, the pin mapping for the PWM-Ext are :

Port	Arduino Digital Number	Function	RAMBo Function
PE4	2	PWM2	Fan-2/PWM Ext 4
PG5	4	PWM4	PS-On/PWM Ext 6
PE3	5	PWM5	PWM Ext 5
PB7	13	PWM13	LED/PWM Ext 3

Since PWM-Ext-3 is shared with the Status LED of the board, PWM-Ext-4 is shared with the mosfet control of the second fan connector, you can use PWM-Ext-5 or PWM-Ext-6 (if you do not use the PS-On pin) for example.

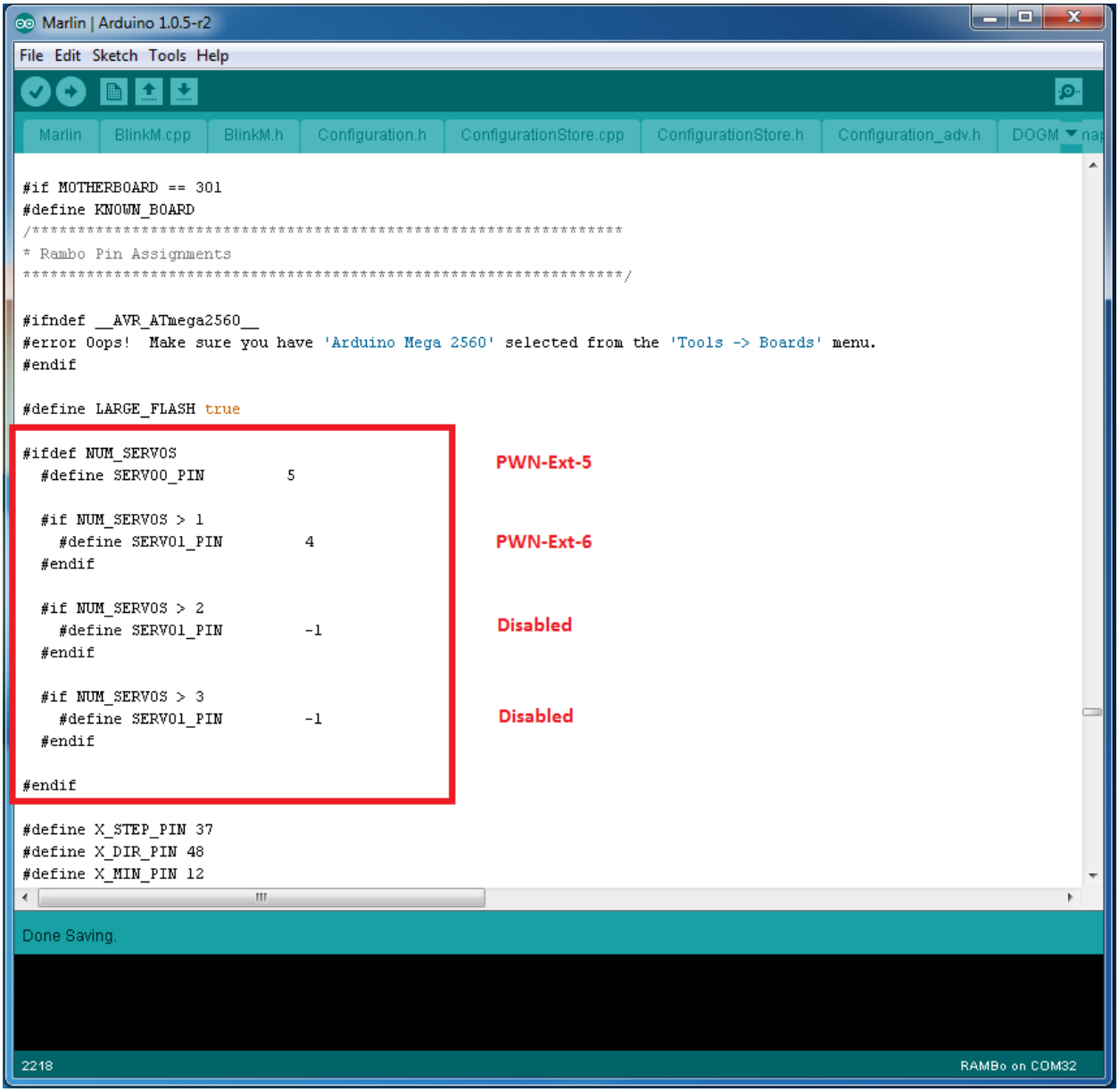


Figure 65 - Adding Servo configuration to Marlin

You can also use other auxiliary connectors, such as the Motor-Ext (even though it is meant to be used for extra stepper motors, it can also be used for the servo motors or anything else) or Ext2 connectors.

CONFIGURATION OF BOARD POWER SELECTOR

The RAMBo can either be powered by USB or by the power supply. Selection of the power input can be done by changing the position of a jumper on the board.

Next to the USB connector, you will find the PSEL jumper. Put the jumper on the USB side to power the RAMBo from USB :

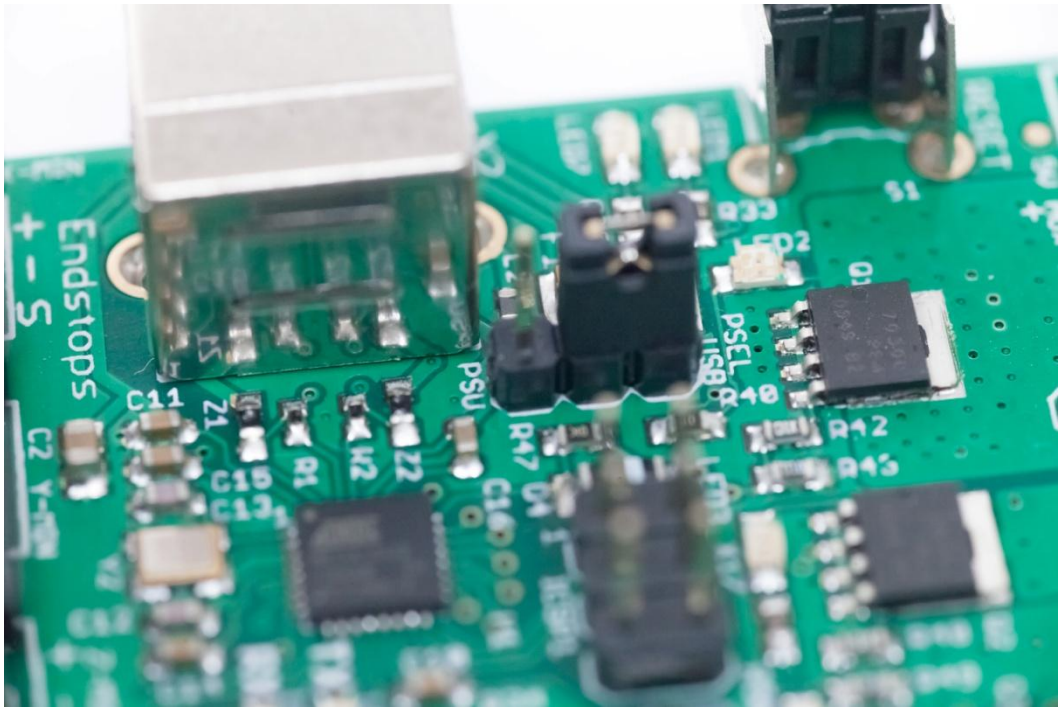


Figure 66 - PSEL Power Selection jumper : USB

Image by Thomas Sanladerer

Or put the jumper on the PSU side to power the board from the power supply :

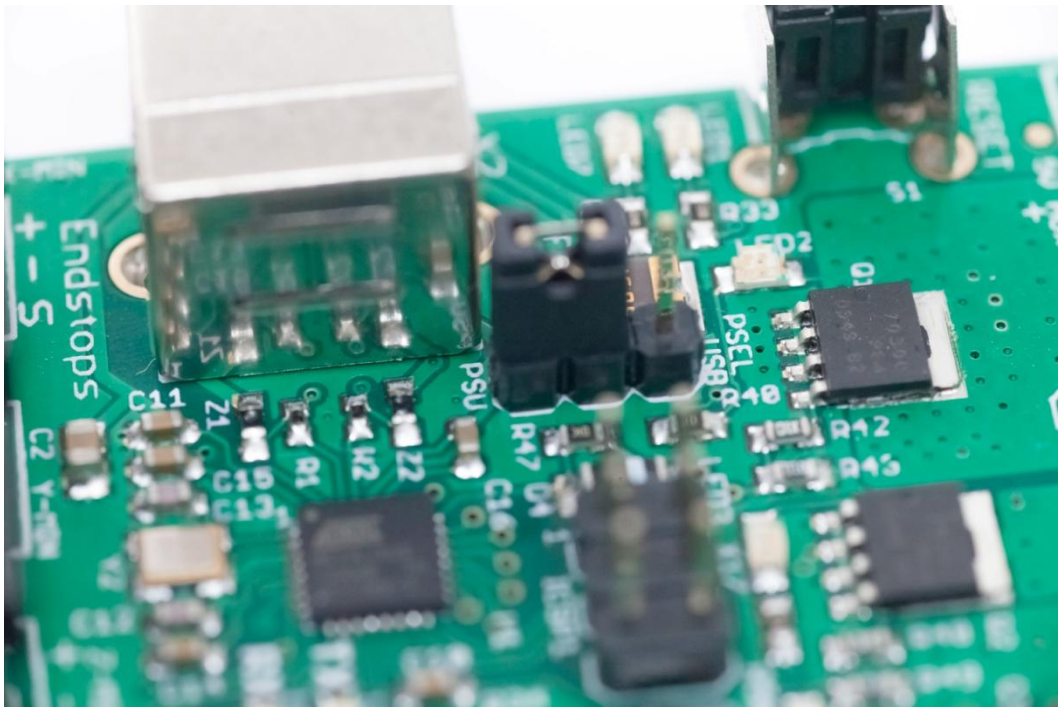


Figure 67 - PSEL Power Selection jumper : PSU

Image by Thomas Sanladerer

When the board is powered by the Power Supply, it will use the same power rails as the Motors.

REPLACING FUSES

The RAMBo controller uses three separate power rails, one for powering the heat-bed, one for the mosfets and one for the motors and the board logic.

RAMBo has 3 replaceable fuses. In case of over-current or if power gets shorted, a fuse might be blown, in which case, the heat-bed, mosfets or motors will stop working. You can replace the fuses easily, by buying compatible fuses, removing the blown fuse from the board, either manually for the heat-bed fuse or by popping out the small white fuses with a screwdriver and replacing them.

The small white fuse holders are Little Fuse OMNI-BLOCK fuse holders. They are compatible with NANO2 Fuses. Fast or very fast acting are recommended. The fuses used in the retail RAMBo are rated at 5A with a maximum voltage of 125V and an example part number for a replacement is 0448005.MR.

The heat-bed fuse F4 is an ATO (the type found in many automotives) rated at 15A with a maximum voltage of 32V. An example part number for a replacement is 0287015.PXCN.

F2 supplies the motors and on-board power supply. It is located next to the thermistor connectors. F3 supplies the extruder heater and fan outputs. It is located next to the power input connector :

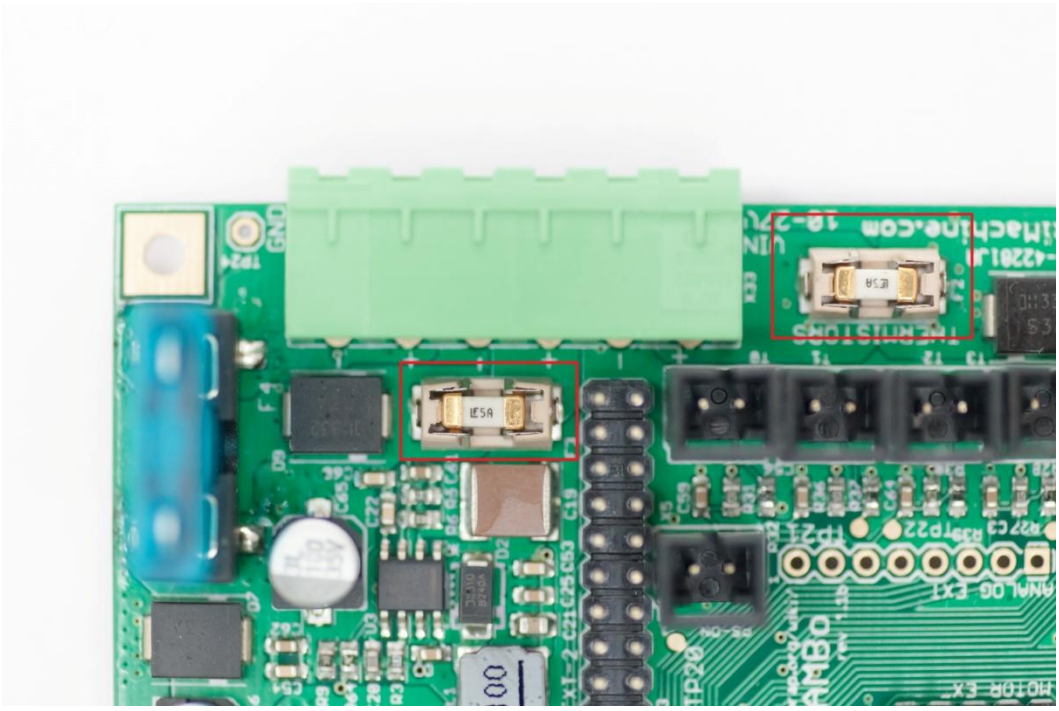


Figure 68 - F2 and F3 LittleFuse 5A fuses

Image by Thomas Sanladerer

F4 supplies the heated bed output and it is located in the top right corner of the board :

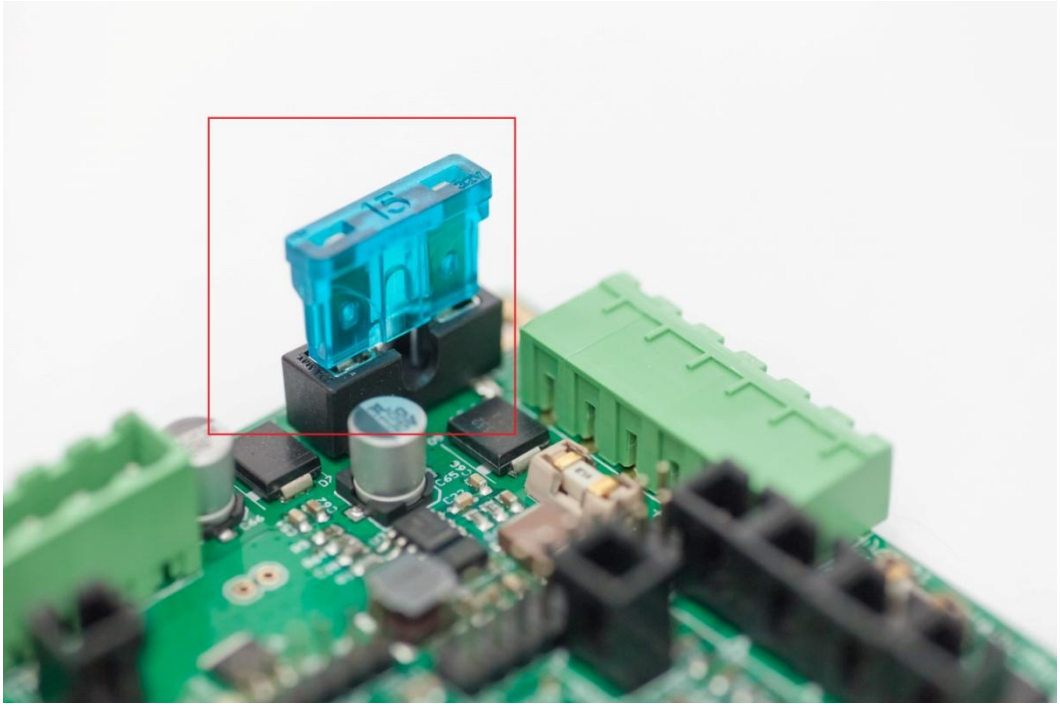
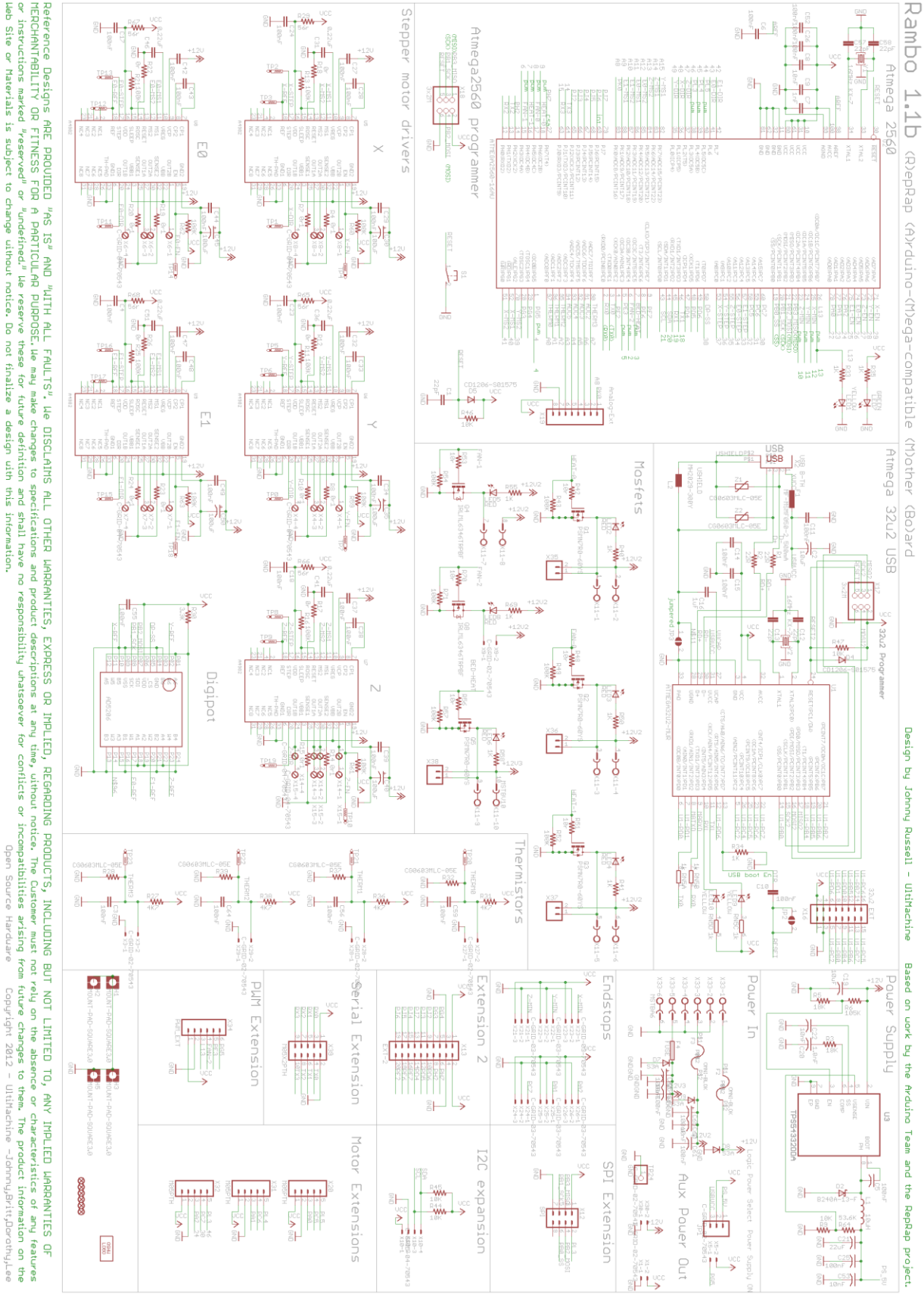


Figure 69 - F4 ATO blade 15A fuse

Image by Thomas Sanladerer

APPENDIX A - RAMBO 1.1B SCHEMATIC

The board schematic for RAMBo 1.1B can be downloaded in full resolution from
https://raw.githubusercontent.com/ultimachine/RAMBo/1.1b/board/RAMBo-Schem.png



APPENDIX B - RAMBO ARDUINO MEGA 2560 PIN MAPPINGS

Port	Arduino Digital Number	Function	RAMBo Function
PE0	0	USART0_RX	USB/Serial Ext 3
PE1	1	USART0_TX	USB/Serial Ext 4
PE4	2	PWM2	Fan-2/PWM Ext 4
PE5	3	PWM3	Bed-Heat
PG5	4	PWM4	PS-On/PWM Ext 6
PE3	5	PWM5	PWM Ext 5
PH3	6	PWM6	Fan-1
PH4	7	PWM7	Heat-1
PH5	8	PWM8	Fan-0
PH6	9	PWM9	Heat-0
PB4	10	PWM10	Z-Min
PB5	11	PWM11	Y-Min
PB6	12	PWM12	X-Min
PB7	13	PWM13	LED/PWM Ext 3
PJ1	14	USART3_TX	Serial Ext 10
PJ0	15	USART3_RX	Serial Ext 9
PH1	16	USART2_TX	Serial Ext 8
PH0	17	USART2_RX	Serial Ext 7
PD3	18	USART1_TX	Serial Ext 6
PD2	19	USART1_RX	Serial Ext 5
PD1	20	I2C_SDA	I2C Ext 3
PD0	21	I2C_SCL	I2C Ext 4
PA0	22	D22	MX1-3
PA1	23	D23	Y-Max/MX2-3
PA2	24	D24	X-Max/MX3-3
PA3	25	D25	E1-En
PA4	26	D26	E0-En
PA5	27	D27	Z-En
PA6	28	D28	Y-En
PA7	29	D29	X-En
PC7	30	D30	Z-Max/MX3-4
PC6	31	D31	MX2-4
PC5	32	D32	MX1-4
PC4	33	D33	E1-Step
PC3	34	D34	E0-Step
PC2	35	D35	Z-Step
PC1	36	D36	Y-Step
PC0	37	D37	X-Step
PD7	38	D38	DigiPot-SS

PG2	39	D39	Y-MS2
PG1	40	D40	X-MS1
PG0	41	D41	X-MS2
PL7	42	D42	E1-Dir
PL6	43	D43	E0-Dir
PL5	44	D44	MX1-5
PL4	45	D45	MX2-5
PL3	46	D46	SPI Ext 2/MX3-5
PL2	47	D47	Z-Dir
PL1	48	D48	X-Dir
PL0	49	D49	Y-Dir
PB3	50	SPI_MISO	SPI Ext 3
PB2	51	SPI_MOSI	SPI Ext 4
PB1	52	SPI_SCK	SPI Ext 5
PB0	53	SPI_SS	SPI Ext 6
PF0	54	A0	T0
PF1	55	A1	T1
PF2	56	A2	T2
PF3	57	A3	Analog Ext 8
PF4	58	A4	Analog Ext 6
PF5	59	A5	Analog Ext 4
PF6	60	A6	Analog Ext 3
PF7	61	A7	T3/Analog Ext 5
PK0	62	A8	Analog Ext 7
PK1	63	A9	E1-MS1
PK2	64	A10	E1-MS2
PK3	65	A11	E0-MS1
PK4	66	A12	E0-MS2
PK5	67	A13	Z-MS2
PK6	68	A14	Z-MS1
PK7	69	A15	Y-MS1
PG4	70	D70	Ext2 5
PG3	71	D71	Ext2 7
PJ2	72	D72	Ext2 9
PJ3	73	D73	Ext2 11
PJ7	74	D74	Ext2 13
PJ4	75	D75	Ext2 15
PJ5	76	D76	Ext2 17
PJ6	77	D77	Ext2 19
PE2	78	D78	Ext2 20
PE6	79	D79	Ext2 18
PE7	80	D80	Ext2 16
PD4	81	D81	Ext2 14

PD5	82	D82	Ext2 12
PD6	83	D83	Ext2 10
PH2	84	D84	Ext2 8
PH7	85	D85	Ext2 6

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