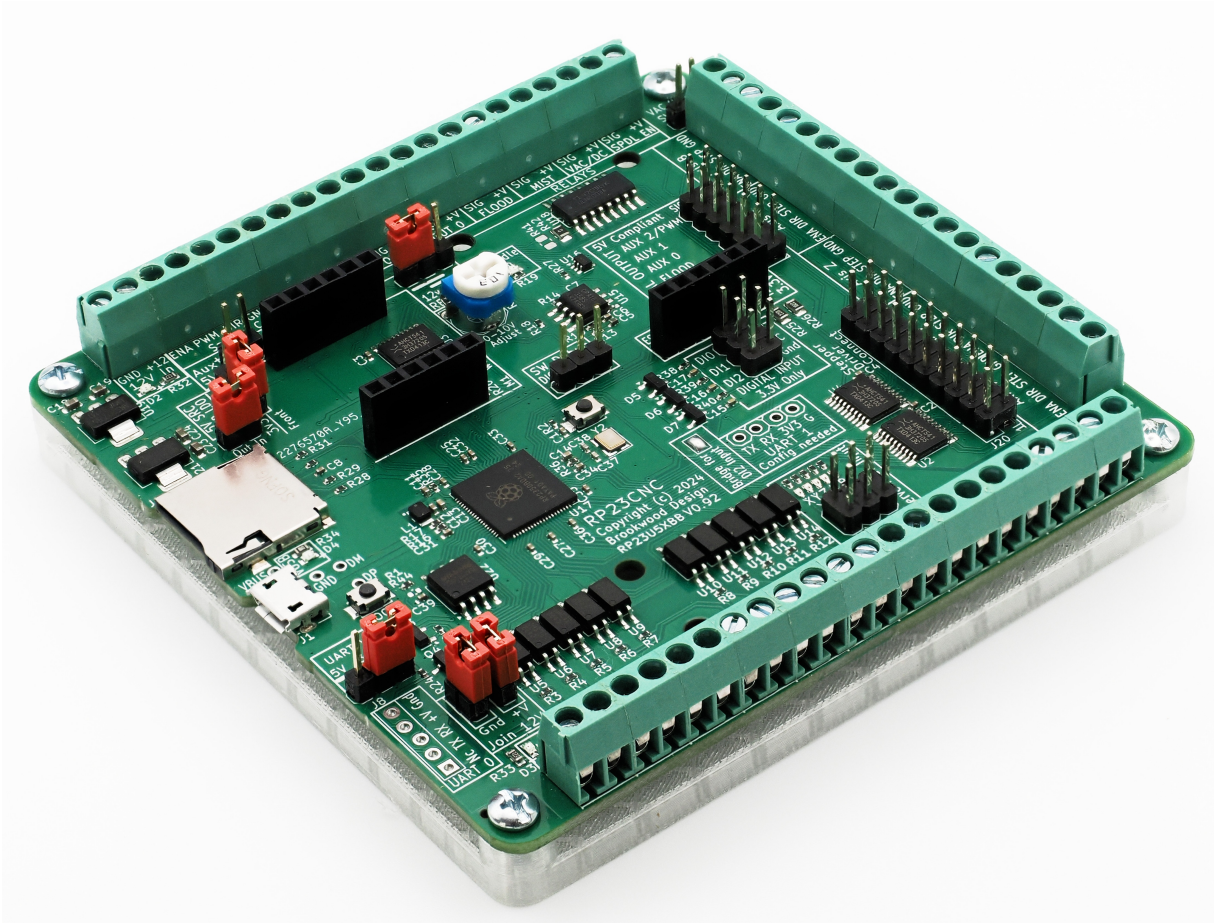
RP23CNC User Manual

RP23U5XBB Ver 0.92 Beta

Brookwood Design



Note: This is a working document for the beta test period. I will be updating it as sections are completed.

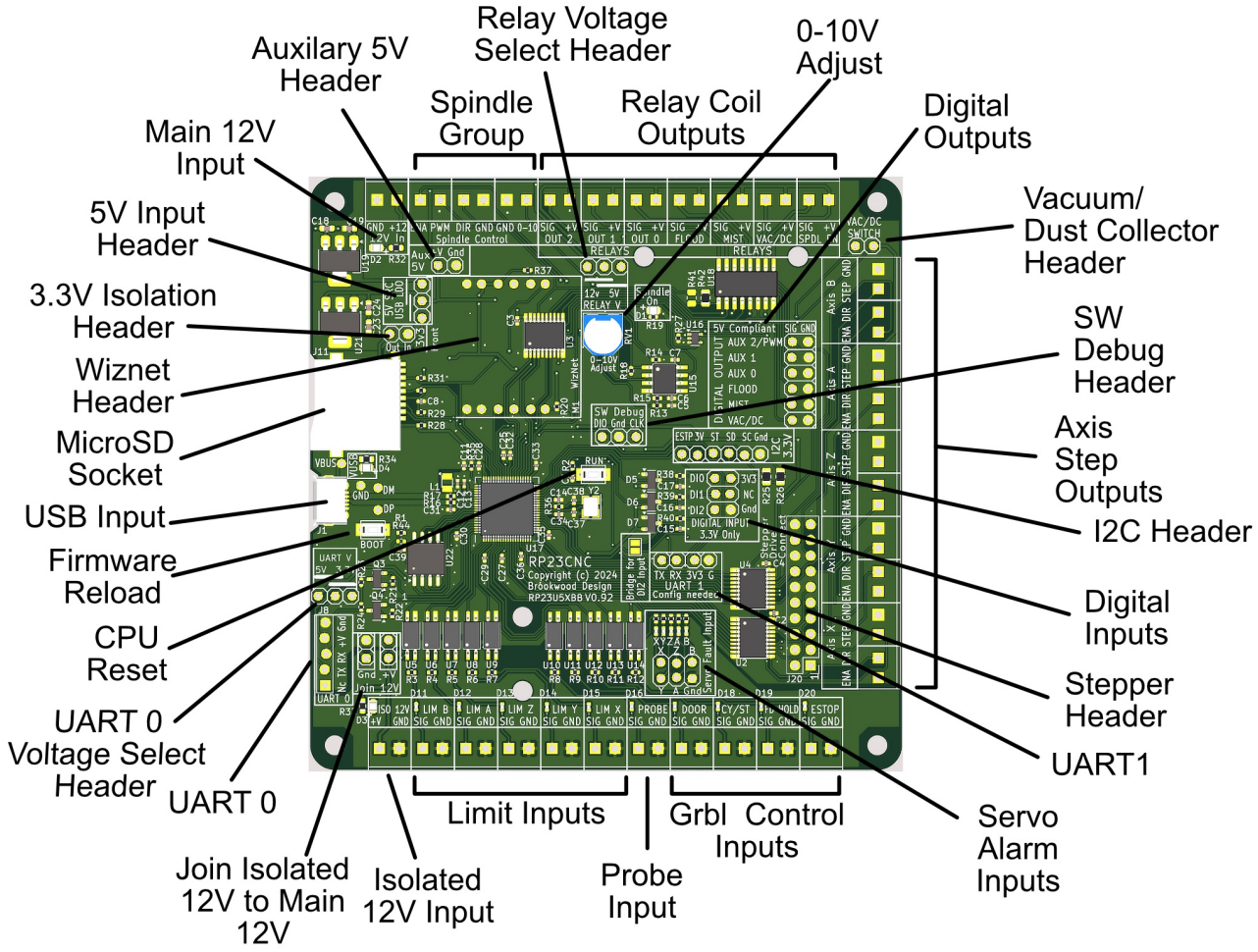
Introduction

The RP23U5XBB is a 5 Axis motion controller board that supports grblHAL. It has the following features:

- 5 Axis control outputs
  - 5V compatible
  - Step, Direction and Enable
  - Screw Terminal and Pin Header
  - Independent Enables for all axes
- Spindle control
  - PWM (5V)
  - Enable and Direction outputs (5V)
  - 0-10V Speed control with 0-10V adjustment
  - 12V PWM supported (open collector output)
- Limit inputs for all axes
  - Opto-isolated
  - Supports switch and powered proximity sensors
  - 12V for better EMI immunity
  - Separate 12V input for full isolation
- Servo Alarm Inputs for all Axes with LED indicators
- Standard Grbl control inputs
  - Opto-isolated
  - Cycle Start, Feed Hold, Safety Door, Reset
- Opto-isolated Probe input
- Relay Support
  - Directly drive up to 7 Relay coils
  - Relay Coil voltage selectable – 5V or 12V
  - Drive up to 8 SSR or Logic Level relay modules
  - Spindle Enable, Flood, Mist, Dust Collection, 3 auxiliary
- Dust Extraction Support
  - Relay Coil, SSR or Logic Level module support
  - Activated by Spindle Enable
  - Manual Control of Dust Extractor via header with external switch
- Flood and Mist coolant control
  - Relay Coil, SSR or Logic Level module support
- 5V compatible Digital Outputs (Spindle Enable, Flood, Mist, Dust Collection, 3 auxiliary)
- 3 Digital Inputs (3.3V)
- 2 UARTs
- USB
- Ethernet (via optional adapter)
- MicroSD card adapter
- I2C header
- 12V isolated limit and control input section
- 5 Axis servo alarm input
- Numerous LED indicators for installation and problem solving
- UART0 3.3/5V translation
- SWDebug header
- Boot and Run buttons for easy firmware loading and network configuration.
- Flexible power supply setup.

    - 12V Main board input
    - 12V Isolated section input
    - Main and Isolated sections maybe joined and powered by a single PSU
    - Auxiliary 5V output header.
    - 5V section may alternately be powered by USB 5V
- Broad range of LED indicators to aid system install and error diagnosis
    - Power section LEDs (12V Main, 12V Isolated, 5V USB)
    - Spindle on LED tied to PWM to show speed
    - Limit input LEDs to show state
    - Probe LED shows probe state
    - Control Input LEDs show switch state
    - Servo Alarm input show Servo state

Key Features



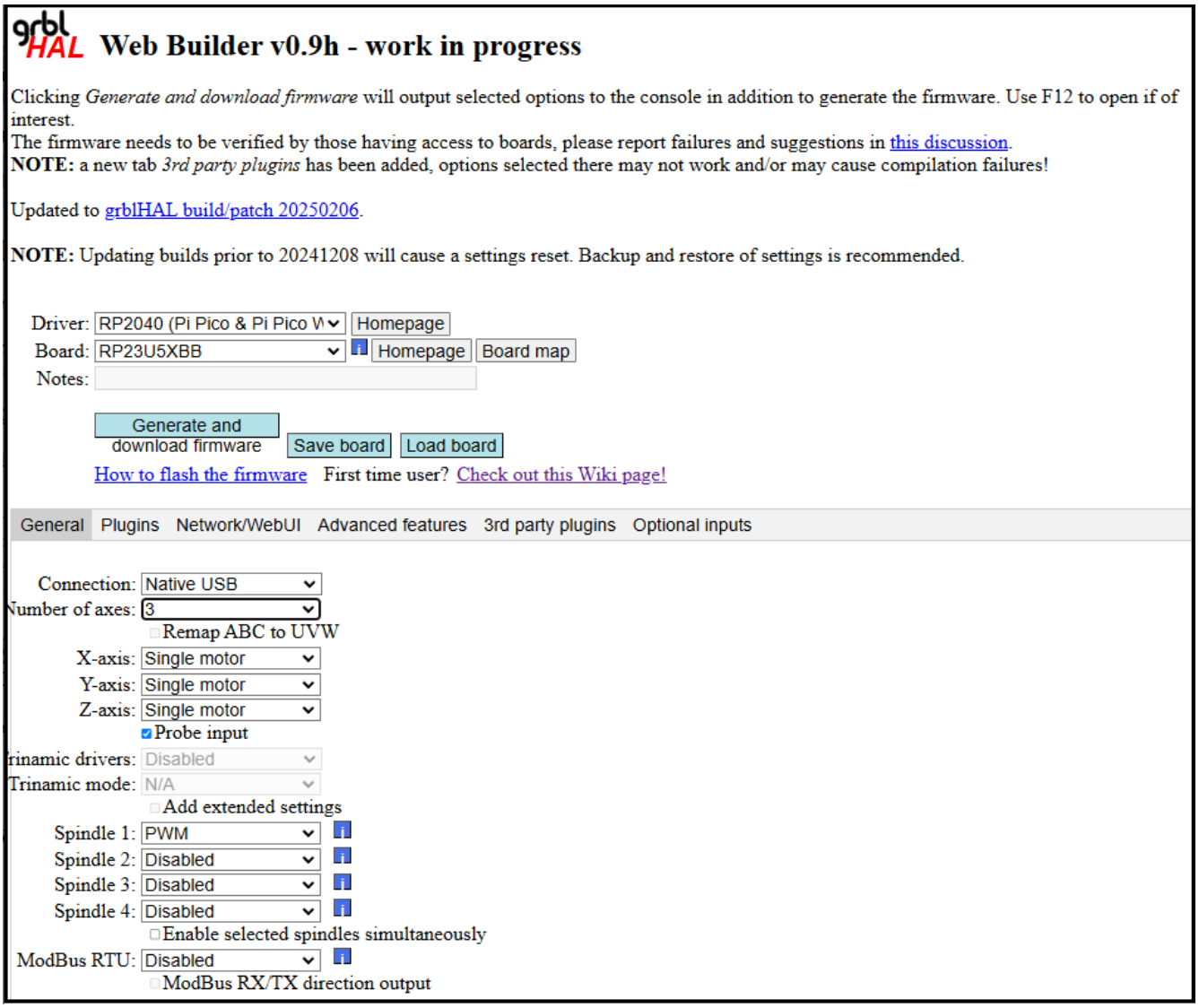
Creating and loading grblHAL Firmware

The grblHAL Web Builder site is used to create the proper firmware for your PicoCNC board.

Select RP2040 (Pi Pico and Pi Pico W) in the Driver box and RP23U5XBB in the Board box.
In the General panel, select the Number of axes and the appropriate axis configurations for your CNC machine. A moving gantry maching will typically use Ganged Motors for Y.

In the Plugins panel, select Enable or Ymodem in the SD card option. Ymodem will speed up transmission of large files.

If you have a Wiz850io Ethernet module, see the Setting up Networking section below.



Then press the Generate and Download button. Save the firmware file for use in the next section. Also, press the Save board button so that you will have the configuration if you need to make changes later.

Installing the firmware is very easy! Once you have a firmware file (.uf2 extension), connect a USB cable from your computer to the RP23U5XBB. Then:

1. Press and hold the RUN button on the board.
2. Press and hold the BOOT button on the board.
3. Release the RUN button on the board.
4. Release the BOOT button on the board.

On Windows

The first time you do this, a USB configuration notification may come up. This may also happen when you initially plug in the USB cable. For options, select "Open File Explorer Window". After that, all subsequent RUN/BOOT operations will cause a file explorer window to open. Drag and drop your firmware file onto the window. You will see a progress indicator as the firmware file is uploaded to the RP2350. When done, you can start your GCode sender application and connect to the com port associated with the RP2350. Use the Device Manager to determine which one it is if you are having difficulty finding it.

On Mac OS <untested>

A drive called RPI-RP2 will appear on your desktop. Double click on RPI-RP2 and a finder window will open. Drag and drop the firmware document onto the window. When done, you can start your GCode sender and connect to the RP2350.

If you are interested in building grblHAL from source, you can download the source code at https://github.com/grblHAL Note that there are multiple projects and libraries that you will need to download. A complete discussion of installing and building the source code is beyond the scope of this document. Start with the core wiki to understand how to build grblHAL – https://github.com/grblHAL/core/wiki/Compiling-grblHAL.

Running grblHAL on your machine

Once you have finished board assembly and installed the firmware, your grblHAL PicoCNC based Motion Controller is ready to be tested in your CNC machine. Attach it to a PC via a USB cable and run a compatible GCode sender application on the PC. We recommend this one: https://github.com/terjeio/ioSender/releases/tag/2.0.42. Check for the most recent release. Next, you will need to set up Grbl to reflect your hardware. We will use ioSender for our examples. Actual Grbl setting values are also shown. Follow these steps:

1. If you have them, hook up your control buttons: Feed Hold, Cycle Start and EStop.
2. For the beta V0.92 board, make sure that the 5V SRC header has a jumper for USB.
3. Apply 12V to the 12V In screw terminal in the upper left hand part of the board. You should see an LED turn on when powered.
4. Run ioSender to connect to the RP23U5XBB
5. Open the **Settings: Grbl** panel. You will see a list of parameters that control grblHAL.
6. If the board comes up in Alarm you need to set $14 to invert Feed Hold, Cycle Start and Estop.
7. In the Stepper section, $4, Invert stepper enable pins (s), Check all boxes. $4=7 for a 3 Axis machine. $4=15 for a 4 Axis machine.
8. Press the save button and return to the main tab (**Grbl** panel, you should see the DRO section).
9. Press the Red Reset button if an ALARM state is showing.
10. Open the **Jog** panel and click on any of the jog direction buttons. The DRO should show movement. If you have drivers and motors hooked up, they should show movement.
11. If you have any control buttons attached, test them. It should show activity. Note the associated "LED" in ioSender when you press a button. Also, note that the LED on the board associated with the button will change state. If nothing happens, you should verify your connections.
12. If everything works to your satisfaction, you should now proceed to full testing of your machine.

    Note, you must have 12V connected to the Iso 12V terminal (or installed jumpers on the headers next to the terminal) for the input signals (limit switches, probe and control inputs) to work. You will see a lit LED near the Iso 12V screw terminal if 12 is connected or the Iso 12V section is jumpered to the Main 12V section.

There is a lot more information in the grblHAL wiki at https://github.com/grblHAL/core/wiki. In particular, we recommend

you check the First Run Grbl Settings section.

Some Initial Grbl Settings

Grbl settings are dependent on your hardware so you might have to experiment a bit. Here are some key settings that will help you get going faster.

$ID	Name/meaning	Suggested Value	Comments
0	Step Pulse time in uS	3	Default is 10 but 3 will work well. Using the default will cause problems for step rates above 80 kHz. Minimum is 2 uS.
4	Step Enable bit mask, one per axis	7 (3 axis), 15 (4 axis) 31 (5 axis)	Bitmap field. A 1 bit means invert. A 3 axis machine would have 7 as the value, a 4 axis machine would have 15 and a 5 axis would have 31. Bit 0 is X, 1 is Y, 2 is Z, A is 3 and B is 4.
14	Control pin inversion bit mask, one per pin.	70	A 1 bit means invert. Reset is bit 0, Feed Hold – 1, Cycle Start – 2, Safety Door – 3. This assumes you are using NO switches for input.
30	Max spindle speed in RPM	1000 or VFD max.	Default is 1000. If you have a VFD, you will need to set this to the spindle max. In G-Code, the Sxxx parameter controls speed and to get full speed, you will need to have xxx match this parameter (S1000, in the case of the default).
100, 101, 102, 103, 104	Steps/mm. One for each Axis. 100 – X, 101 – Y, and so on.	varies	Set these based on your hardware – lead screw/belt ratios, microstepping. The Grbl defaults are likely wrong for your machine but you will still get movement. On a per axis basis, determine the number of steps (including microsteps) it will take to make one full rotation of the lead screw. Determine how many mm that axis will move with one full rotation of the lead screw, pinion gear or belt driver pulley. Divide the first number by the second to get the value you will use.
110, 111, 112, 113, 114	Max Rate	2500 mm/Min	This is a reasonable starting point for a hobby machine. Higher performance machines can easily support 5000 or higher.
120, 121, 122, 123, 124	Acceleration in mm/Sec^2	500 mm/Sec^2	This is a reasonable starting point for a hobby machine. High performance stepper motors and servos can support significantly higher acceleration.

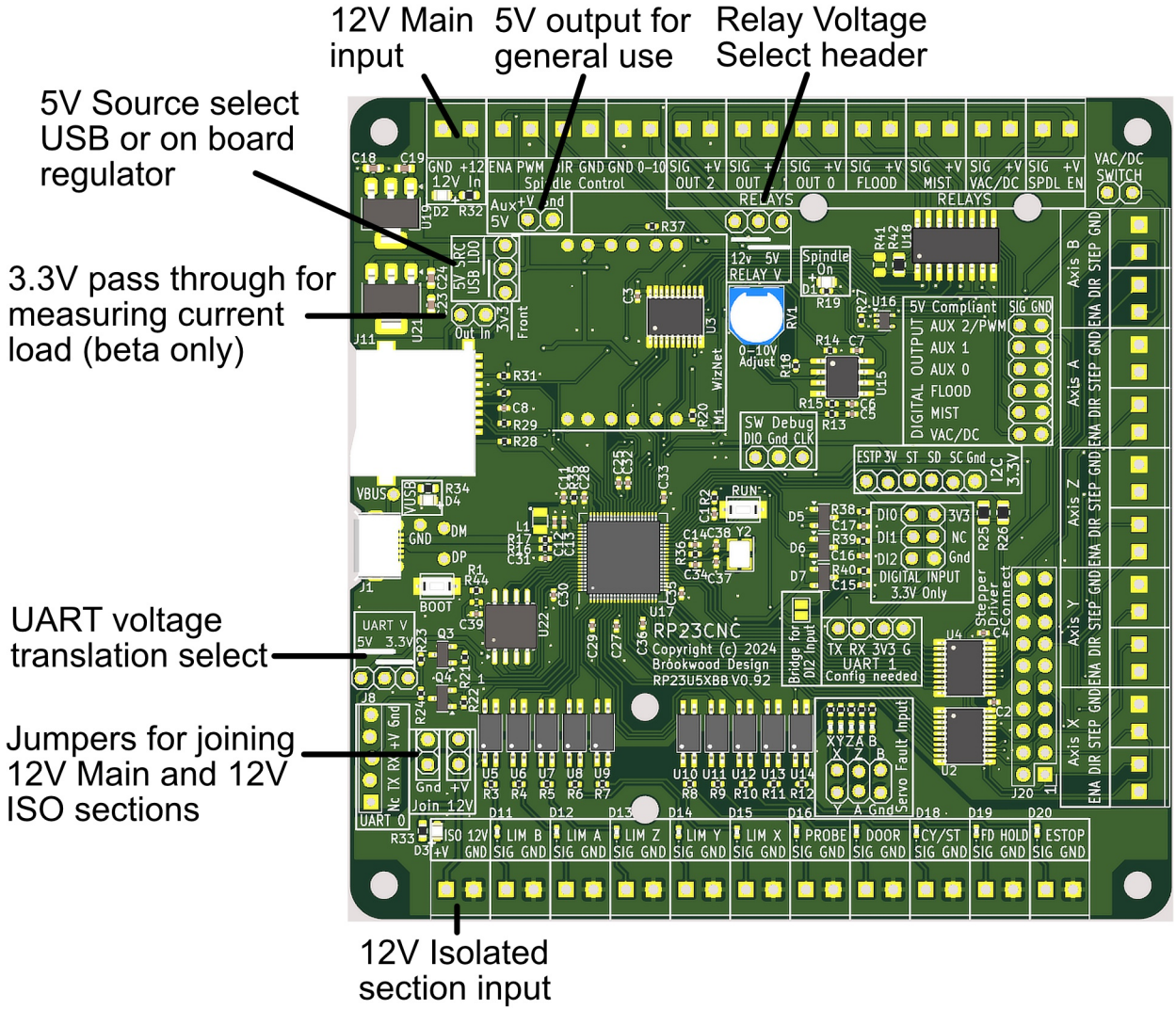
You should spend some time studying all the Grbl settings. We suggest you start conservatively and tune your machine to higher performance one parameter at a time.

Compatible G-Code Senders

Most senders will work with grblHAL. If your preferred sender is having problems, it may need to use a version of grblHAL built with compatibility settings. Use the grblHAL Web Builder interface described in the Firmware section above. Compatibility Level is set in the Advanced features panel. [**note:** this is increasingly becoming unnecessary.]

Power Inputs and Settings

This diagram shows the various power related headers and inputs. Note that if using the Wiznet Ethernet module, you should use USB as the 5V source (for 3.3V generation) as the current draw will cause the 5V LDO to exceed 100C. Future revisions will use a buck converter. This header and the 3.3V pass through header are useful for measuring current draw during beta and maybe removed from the production board.



Isolated vs Main 12V

The RP23U5XBB has an isolated 12V section for limit switches and input controls. This is not connected electrically to the rest of the board which uses the 12V main supply. Using a separate 12V PSU for the ISO section is the recommend configuration for best EMI immunity. The Join 12V jumpers allow using a single 12 PSU if the user wishes to economize. In many cases the opto-isolators provide sufficient isolation without a separate 12V PSU.

Board LED indicators

The RP23U5XBB has a number of LED indicators to help the user during installation and problem solving.

The Spindle On indicator brightness is taken from the PWM signal and thus is proportional to the spindle speed. It is useful when checking to see if the board is generating the speed signal.

USB 5V present indicator only lights when there is 5V present on the inserted USB cable.

Isolated 12V indicator will light if there is isolated 12V input or when the isolated section is joined to the main power section.

Limit input indicators light when there is voltage on the input pin. This means that for NO sensors, the light will be on when ther sensor is triggered and for NC sensors, it will be off when triggered.

Probe input indicator will be on when a NO probe makes contact and off when an NC probe makes contact.

Grbl control indicators will be lit when when an NO switch is closed and off when an NC switch is closed.

Servo Alarm Inputs expect open collector outputs from the servo driver. They will remain lit until the servo alarm condition is cleared. These will only work with NPN Open Collector outputs.