

This guide assumes that you have built the small CNC machine as listed in the home robotics handbook - although it may be of use if you have built a similar machine using CDROM drives. The instructions in the book covers the construction of the CNC Machine, this guide aims to get you up and running with your creation!

### **Pre-Flight Checklist**

Before we begin controlling our CNC machine, there are a few “pre-flight” checks that we should go through to ensure our CNC machine is operating as expected.

#### **Stepper-Motor Direction:**

Stepper motors are brushless motors that can achieve relatively precise movements. Unlike servo motors, which keep track of their position using an encoder, a digital controller keeps track of the number of ‘steps’ that a stepper motor should have performed – when attached to a moving axis this allows the digital controller to know the current position of the motor.

Our CNC machine has been constructed with a stepper motor for each of its axis. If you followed the instructions in the book you should have identified the coil wires coming from each motor; however, if we were to ask our CNC machine to move there’s a 50% chance that a given axis will move in the wrong direction. To test and resolve this, we will test each axis in turn.

1. Ensure the power-supply to the CNC machine is switched off and that the USB cable is also unplugged. You must unplug the CNC machine whenever you are connecting / disconnecting wires!!
2. Unplug all of the wires for one of the stepper motors, but keep a note of which wire went where. We will be testing each axis in-turn, that way if there’s any problems it will be easier to diagnose what is going wrong.
3. For the axis with the stepper motor whose wires are still connected, manually move the gantry to a central position.
4. Turn on the power to the CNC and plug in the USB cable to a pc.
5. Open the Arduino IDE and ensure the correct “com port” is selected. You can find this in the “Tools” menu bar.
6. Click the magnifying glass icon on the menu bar (labelled “serial monitor”). You should see “Grbl x.x ['\$' for help]” appear in the console window that opens.

Through this interface, we can instruct our CNC machine to move. Grbl is an interpreter that is running on our Arduino, it understands a special language known as G-code. G-code is commonly used on many kinds of CNC machines and it is this that instructs a machine about how to make things. There are many interfaces that we could use to generate and send G-Code to our CNC machine, all Grbl cares about is that we send it valid G-Code via the serial port interface. For now, we will use the Arduino’s built in serial monitor for testing.

7. If you are testing the X-axis, type the following into the serial console: “G0 X10”.  
Alternatively, if you are testing the Y-axis, type the following into the serial console:

“G0 Y10”. Hit the enter/return key and hopefully the machine will move.

“G0” is the rapid movement G-code command. It expects two additional parameters, the axis we wish to move (e.g. X or Y) and the absolute position we would like it to move to. When we first switched on our CNC machine, Grbl defaults the current position of the axis as “0”.

If the machine did not move, this would suggest you have either muddled up the axis labelled on the controller to the wrong stepper motor or you have likely miss-wired / miss-soldered that stepper motor’s connections. First try sending the G0 command for the other axis to verify this – if it moves, swap the wires to the correct labelled ports. Otherwise, check the connections and coils with a multi-meter. Remember to unplug the machine first!! If this still doesn’t work, ensure you are using a suitable power supply with the CNC machine (or that the power to the machine is turned on!).

8. If the correct axis did move, observe the direction that the axis moved in. For the X-axis, we would expect the machine to move approximately 10mm<sup>1</sup> from the left to the right (if we were looking at the machine front on). If you were testing the Y-axis we would expect the platform to move towards you. If it did, great! You can now repeat these steps for the other axis.
9. If it didn’t, don’t worry! We just need to swap one of our motors wires over. Remember to unplug the machine first. Do one of the following: Either swap one of the coil pairs (e.g. swap the wire that’s running to 1A with the wire running to 1B) or swap the coil position (e.g. swap the wire 1A with 2A and 1B with 2B).
10. Repeat from step 3, and if it now moves in the right direction, we are ready to move on!

### **Stepper-Motor Current:**

Stepper motors are hungry devices and we must ensure we supply enough “current” from our power supply to our motors for them to run correctly. This is why we tested only one axis at a time. It’s now time to plug in both axis at the same time and try moving one of the axis. If the machine moves fine, your power supply is able to supply the power needed by both of your stepper motors. If it does not, (usually you will hear a clicking from the motors, but they will not move), you will need to replace your power supply with one that can supply a great amount of current.

If you are able to control both axis, you are now ready to proceed with controlling your CNC machine. If you like to can manually control it from this serial interface using G-Code commands (like G0), but it’s a lot more useful to use an interface that can generate G-Code for us and send it to the machine.

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<sup>1</sup> If the machine moves a lot more than 10mm, quickly shut off power to the machine before it damages itself. You have likely set your “micro-stepping” jumper wrong for that axis - ensure it’s set to x16 micro-stepping.