Guide to the ShopBot

Learn how to use the ShopBot to precisely manufacture parts from wood for furniture or other projects

Notice:

This guide is intended to supplement the in-person ShopBot training, not serve as a replacement. Use this guide as a reference and ask staff any questions as needed.

Standard Operating Procedures:

- Only use the ShopBot only to mill woods.
- Ensure that tools are securely mounted. Never mill with a dull tool.
- Always double check that your material is securely fixtured to the ShopBot Vacuum Bed before starting operations.
- Keep hands clear of rails when Control Box is switched on. Keep hands clear of the spindle and any mounted endmills when the Spindle Interlock Switch is engaged.
- For your CAM routine, note how your axes are set up and the dimensions of your stock. Do not run a cut that intersects with the bed. Never run the tool faster or deeper than the recommended tool settings.
- **Always supervise your cut at all times while it is running.**
- **If at any time you are unsure if you are operating the ShopBot correctly, stop and ask a staff member for help.**
- **If your mill performs any undesired behavior, press the emergency stop button immediately.** Do not attempt to stop the gantry with your hands, use the Emergency Stop button.
Diagrams and Keywords

**Keywords:** Gantry, Carriage, Spindle, Dust Guard, Control Box, Emergency Stop, Remote, Collet, Alligator Clip, Z-zero Plate, Key/Wrench, Spindle Interlock Switch, Vacuum Bed, Vacuum Zones, Vacuum Blower, KeyPad, Endmills

*Figure 1.* Important parts of the ShopBot are labeled here. These terms will be used in this guide.
1) Exporting CAM routines in Fusion 360

Using the software you generated your toolpath in, simulate your toolpath and ensure the settings (speeds and feeds), stock, and coordinate systems are correct. For more instruction on the toolpath designing process, see the tutorial How to design toolpaths for CNC Milling in Autodesk Fusion 360.

Because the bed does not use adhesive for mounting material, use breakout tabs on parts that will be detached from the stock material when cut out. To add tabs, use the “Geometry” tab of the “Process” window of your operation in Fusion 360.

Once you are certain that your toolpath is correct, export it as a .sbp file using the post processor configuration file for “ShopBot OpenSBP.” Do this for every toolpath separately. Make sure to include in the filename the order which that toolpath is to be run in, a word or two on what it is cutting, and what tool the toolpath was generated for.

2) Turning on equipment

Before turning on equipment, ensure that there are no obstructions along any rails. Ensure that an Emergency Stop button is within reach at all times.

To turn on the ShopBot, turn the red switch on the Control Box. (The key does not need to be inserted yet.) Press the blue “Reset” button on the Remote. This step must be done BEFORE opening the software.

Then, open the software called “ShopBot 3” on the Desktop of the computer.

Figure 2. You can control the ShopBot by selecting commands from dropdown menus or typing them.
3) Giving commands

You can either **click options** from the menu bar or **type keyboard shortcuts**.

To type the command “zero [X] axis” under the “[Z]ero” menu, you would type “ZX” and then click the “EASY” button or press the enter/return key on your keyboard.

4) Absolute vs. relative coordinates

**Absolute coordinates** means the command “MX 10” will move the spindle to X = 10 and not move X to the right by 10.

**Relative coordinates** means the command “MX 10” would move the spindle to the right by 10. If relative coordinates are used, the red “Position” window will display “RELATIVE.”

Switch between absolute and relative mode using the “[S]ettings” menu:

- “[S]ettings > set to [A]bsolute mode” or shortcut “SA”
- “[S]ettings > set to [R]elative mode” or shortcut “SR”

The ShopBot will retain its coordinate location when switching between absolute and relative coordinates and while moving with relative coordinates.

---

**Figure 3.** The “Position” window will indicate if the ShopBot is moving with relative coordinates. If it is using absolute coordinates, no indication will be shown.
5) Homing vs. zeroing

**Homing** uses proximity switches to determine where the endmill is relative to the bed. It is required for absolute coordinates.

Always home the X- and Y-axes immediately after turning on ShopBot if you plan on using absolute coordinates for navigating the spindle.

**Zeroing** simply sets the current coordinate to zero. Because it redefines zero, it undoes any homing step.

You may choose to zero X- and Y-axes at a point on your material to set the origin of your CAM routine.

6) Homing the X- and Y-axes

Note: Do NOT use the [Z]ero menu for this step. It will simply set the X-, Y-, or Z-coordinate to 0.000 without actually telling the tool where it is on the bed.

Always home the X- and Y-axes immediately after turning on the ShopBot.

To home the X- and Y-axes, use “[C]uts > C3 – Home X Y Axes using Prox Switches.”

7) Navigating the spindle

You can move/jog the spindle in the X-, Y-, and/or Z-directions using either the “[M]ove” commands, “[J]og” commands, or KeyPad navigation.

For “[M]ove” commands, you can either select options from the dropdown menu or type in the commands (e.g. “MX,” “MY,” “MZ”, “M2”, “M3,” etc.).

The “[J]og” commands function are just like the “[M]ove” commands except the gantry will move faster.

To use KeyPad navigation, click the yellow KeyPad icon on the “Position” window.
8) Homing the Z-axis

Note: Do NOT use the “[Z]ero” menu for this step. It will simply set the X-, Y-, or Z-coordinate to 0.000 without actually telling the tool where it is relative to the bed.

Always home the Z-axis after turning on ShopBot, and also home the Z-axis after changing endmills.

First, ensure the spindle's collet contains the endmill you plan on using. If not, follow the steps for loading tools in the next section.

Navigate the spindle to the location you want to zero at.

This location will depend on how your CAM routine is set up. If you have your stock set so the TOP has Z = 0, you will want to zero with the Z-zero Plate on top of your material (so you will need to load your material first). If you have your stock set up so the BOTTOM has Z = 0, you will want to zero with the Z-zero Plate on top of the Vacuum Bed.

Be sure that your tool and your bed are both clean when calibrating tool height, and that your tool placement is over the bed in a position where there is minimal bed damage.

Figure 4. The setup for homing the z-axis is pictured above. The alligator clip is clipped around the shaft of the endmill, the tip of the endmill is exposed so that it can make contact with the Z-zero Plate without obstruction, and the Z-zero Plate is flat against the ShopBot bed.
Clamp the **Alligator Clip** to your endmill, ensuring it does not interfere with the tip (lowest point) of the endmill.

Place the **Z-zero Plate** below the loaded endmill and select "[C]uts > C2 – Zero Z Axis w/ Zzero Plate." Follow the instructions on the dialogs that appear. Note the endmill will **touch down twice** so do not immediately remove the Z-zero plate or Alligator Clip immediately after the first touch.

Return the Alligator Clip and Z-zero Plate to their storage positions.

**9) Loading/switching tools (endmills)**

*Note: Pay attention to the geometry of the bits you use: right-handed vs. left-handed. They may look similar but will cut differently.*

The Wrench for changing endmills is attached to a Key. This is a safety feature so that the spindle will never start rotating as you are loading/switching tools. For this reason, do NOT separate the Key from the Wrench.

Loosen the **black thumb screw** above the fan on the Carriage to lower the Dust Guard for access to the Spindle. Using two wrenches, loosen the Collet and remove the current Endmill (if necessary) and insert your desired endmill. **Endmills can be sharp and should be handled with care. Do not let the endmill fall as that can dull it.**

*Figure 5. Lowering the Dust Cover allows access to the Collet for changing the Endmill.*
If the collet that is already installed does not match the shaft of the tool you wish to install, unscrew the entire collet and pop out the collet from its attached holder by pressing the protruding end to the side. To install a collet, press a collet into its holder until it clicks, then insert an endmill.

Tighten the collet by hand and raise the Dust Guard to check if the endmill has enough clearance to cut through your material. Adjust as needed. (You want the endmill to stick out enough so that it can mill through your material but not stick out so much that the Dust Guard is not effective.) Finally, tighten the collet using wrenches.

Raise the Dust Guard, tighten the black knob, and follow steps for zeroing the Z-axis.

10) Vacuum zones

The ShopBot has four vacuum zones. Three of these zones divide the left 3/4’s of the bed longitudinally; these first, second, and third zones are in the order of closest to farthest from you. The fourth zone runs along the entire right length of the bed.

![Figure 6](image_url)

**Figure 6.** This diagram shows the valves and their corresponding zones. As pictured above, only zone 1 is active (with an open valve) and zones 2 to 4 are closed.
Suction for the zones is created by the Vacuum Blower and controlled by four valves which from left to right correspond to the order of the four zones. Note there are five valves in front of the ShopBot, but the middle valve is not connected to a zone and should always be closed. A valve is closed when the knob runs perpendicular to the direction of flow.

11) Loading material

Place your material on the bed. Turn on the Vacuum Blower to ensure that the suction from the Vacuum Bed is sufficient enough to hold down your material. Sometimes warped material may need to be pressed down for suction. However, sometimes material is too warped for suction; in this case the material should not be used.

12) Zeroing the X- and Y-axes

If you want the origin of your part setup to be different from the origin of the ShopBot (e.g. your material is not left and front oriented), you will want to zero the X- and Y-axes.

Use the command “[Z]ero > zero [2] axes (X and Y)” to set your origin to a point other than home. This allows you to relocate your part on the bed (assuming you know where your part is relative to the origin of its setup).

Never zero the Z-axis. An accurate Z-axis value is needed to avoid milling into the Vacuum Bed.

13) Warmup routine

The Warmup Routine must be completed before each operation (unless you are performing subsequent operations without wait time in between).

Before running the Warmup Routine, move the Carriage so that the tip of the Endmill is not in contact with the bed or any material.

To run the Warmup Routine, insert the Key into the Interlock on the Control Box and turn the Key clockwise to engage spindle motors. Then select “[C]uts > C5 – Spindle Warmup Routine.” Press the red “Start” button on the Remote. Allow Warmup Routine to run for at least 3 minutes.
14) Running routines

ShopBot has two modes, “Move/Cut” and “Preview.”

“Preview” will allow you to visualize on the computer the paths the ShopBot will follow, but it will not move the spindle around. To preview a toolpath, set the ShopBot to “Preview mode, click the “Cut Part” button to load a file, and click the green “START” button to view the preview.

![Image of Preview mode](image1)

*Figure 7. Preview mode allows visualizing the toolpaths the ShopBot will follow.*

To cut a part, ensure the ShopBot is in “Move/Cut” mode. Click the green “Cut Part” button on the “Position” window, then select your file. Click the green “START” button and follow additional instructions that popup to start cutting.

![Image of Move/Cut mode](image2)

*Figure 8. Move/Cut mode is used to run files and cut out your part.*

Change tools and load additional files between cuts to complete your project as necessary.
15) After pressing the Emergency Stop button

If the Emergency Stop button is pressed, the “Position” window will prompt you to press “Reset” on the remote. You may need to rehome X, Y, and/or Z-axes if they were in motion during the Emergency Stop.

16) Clean up

Turn off the Vacuum Blower and Control Box, unmount any material from the bed, and remove any bits.

Always supervise your cut!
Appendix A: Determining Speeds and Feeds

Spindle speed can be determined by dividing SFM (surface feet per minute, recommended by the manufacturer) by a cutting tool's circumference (pi multiplied by its diameter).

\[
\text{SFM (ft/min) / Diameter (ft/rev) = Spindle speed (rpm)}
\]

The cutting feedrate can be calculated by multiplying the spindle speed (rpm), number of teeth, and feed per tooth (recommended by the manufacturer).

\[
\text{Number of teeth (teeth/rev) * Feed per tooth (in/tooth) * Spindle speed (rpm)}
\]

\[
= \text{Feed rate (in/min)}
\]

Cutting tools used with ShopBot are manufactured by Onsrud. Their suggested SFM and feed per tooth are on their website. For the ShopBot, reference hard plywood.

http://www.onsrud.com/xdoc/FeedSpeeds

Calculations using recommended SFM and feed per tooth may be optimistic, so consider using a spindle speed or feed rate lower than what is calculated. Also keep in mind stepover and stepdown.