

# Excitech CNC router

FabLab Tampere Excitech CNC router quick guide

3-axis CNC router for material-removing machining of soft non-metal materials.

## Suitable materials for routing

- Wood: solid wood, plywood, particle board, medium-density fibreboard (MDF), high-density fibreboard (HDF), ...
- Plastic: polycarbonate, acryl, ABS, Teflon, ...
  - Some plastics are not suitable for routing because the chips weld to the work piece and the router bit clogging up the routed groove or the router bit flutes. For this reason, be careful when trying different feed parameters for a new material.

## Prerequisites for operating the machine

- Completing the router training organized by FabLab and watching the introduction video.
- Understanding the basic idea of material removing machining and making sure that CNC routing really is the correct method for achieving the desired end result.
- Selecting a suitable material for the routing operation.
- Creating a functional G code and verifying it by simulations.

## Before doing anything with the machine

Familiarize yourself with the location of the emergency switches (one on the electronics cabinet and two on the gantry supports). Do not hesitate to push these buttons at any point if something seems to be going wrong. It is much better to reset everything and start again than destroy some of the expensive components or the users.

Make sure that nothing protrudes across the router table edges or extends too high above the table so that the router will hit it when it initializes the axes.

## Going through your routing operation step-by-step

This quick guide is divided into short numbered sections. When moving from one section to another, always read all of the bullet points before executing any of the actions.

### 1. Switching on the router electronics and the computer

- Turn the black main switch in front of the machine cabinet to “ON” position.
- Press the green “POWER ON” button in the front panel.
- Start the computer by pressing the small black button on the right hand side of the computer cabinet.
- Log in to the computer with user name “EDE022” and a given password



Fig 1: The main switch and the power button.

### 2. Starting the NcStudio software and initializing the machine coordinates system

- Click the NcStudio icon on the desktop.
- In the appearing window, select “All Axes”.
  - The CNC router will find its zero position by initializing all three axes against the limit switches. It drives first Z-axis (vertical axis) to its maximum value (highest position) and after this the X- and Y-axes to the minimum value (the corner closest to the router electronics cabinet). **Make sure that the path for these movements is free of tools, protruding work pieces and all other stuff!**

- This automatic initialization process determines the origin of the machine coordinates. This is the absolute coordinate system, the position of which is determined by the physical limits of the machine. Later sections of this quick guide will refer to the working coordinates, which is a relative coordinate system with origin defined by the user. All routing operations are performed in the relative working coordinate system.
- Wait until the CNC router has initialized all axes (none of them is no longer moving).
- Click “OK” in the NcStudio.
- On the right hand pane (in “Manual” tab) you can find buttons for controlling the router movement.

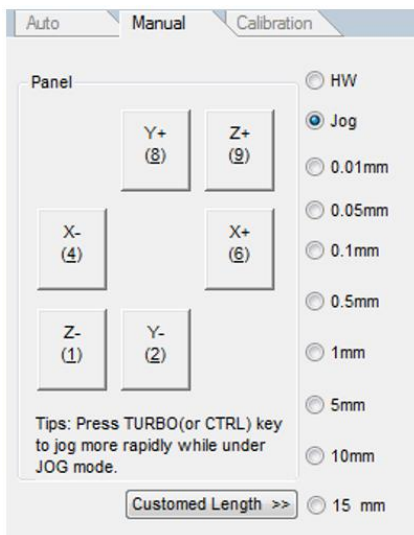


Fig 2: Picture of “manual tab”.

- X+/X- moves the router sideways (the short dimension of the table).
- Y+/Y- moves the router lengthways (the long dimension of the table).
- Z+/Z- moves the router vertically.
- Check the directions from the yellow +/- direction markers taped on each axis.
- Make sure the movement type radio button is in “Jog” position.
- Alternatively the router can be controlled with the keyboard num pad keys after you have activated the buttons by clicking one of them with a mouse.

### 3. Changing the router bit (if needed)

- Move the X axis somewhere near the middle by clicking the X+ button for a more convenient working position.
- Remove the red dust cover by loosening the two set screws in the sleeves around the vertical rod.
- Lower the dust cover and string it away from the holders.
- Use the 27 mm wrench and the special collet nut tool for loosening the collet nut.
  - When loosening the nut, hold the router bit so that it will not fall on the floor and shatter.
- Remove the router bit from the spring collet.
- If the new bit has a different diameter shank, unscrew the collet nut completely, change the right size spring collet and screw the collet nut back in place. Be really careful with the spindle thread because replacing a ruined spindle will be really expensive.
- Insert the new router bit in the spring collet.
  - Do not insert it either too deep or too shallow. Some of the bits have a triangular marker for correct installation depth.
- **Tighten the collet nut to correct tightness.**
  - If you are not sure, what is “correct”, ask the personnel for help. Wrongly tightened fast flying router bits are not good for your health!
- Reinstall the dust cover by stringing the bar in place, setting the sleeves in correct position and tightening the two set screws.

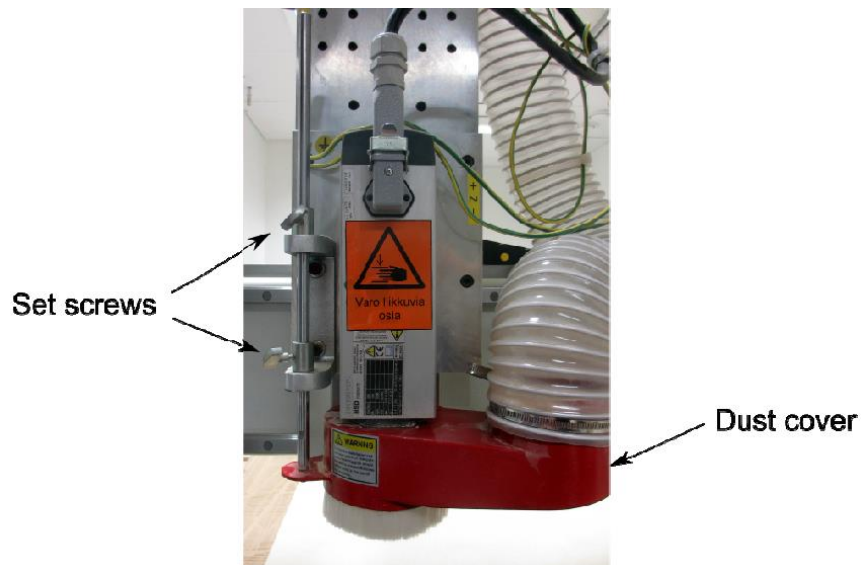


Fig 3: Dust cover.



Fig 4: Collet nut and spring collet.

## 4. Mounting the work piece

- This is one of the most critical phases, so think carefully how to do it. Forces applied by the router bit are large and the mounting must be really sturdy.
- Good options are, for example:
  - Using a sacrificial MDF board mounted on the router table T-slots and screwing the work piece to the MDF with suitable wood screws.
  - Using flat bar clamps that can be either screwed to the sacrificial MDF board or bolted directly to the T slots in the aluminum table.
  - Gluing a small work piece to a larger plywood sheet that can be mounted more easily with screws or clamps.
- Think about the routing path that you are going to make and select the mounting method and mounting positions so that the router bit, the collet nut or the dust cover will not hit the fasteners.
- Consider also, what will happen to the pieces that are cut loose from the stock material. You do not want them flying across the room or pushing in between the stock and the collet nut. Thus every single piece that will come loose during the routing operation should have some kind of a fastener.
- The position of the work piece is not critical because the working coordinates of the router will be set later to correspond to the position of the work piece.
- Usually it's a good idea to move the router gantry to some large positive Y value so that it will not obstruct the work piece mounting.

## 5. Opening the G-code

- Connect the USB stick to the USB port on the right side of the computer cabinet.
- Copy the G-code file(s) (file type .nc) to the computer hard drive (e.g. folder on the desktop).
  - The code should start with G17 G90 G21 for XY plane selection, absolute programming and millimeter units.
  - S'NN' M03 starts the spindle with 'NN' RPM.

- At the end the G-code should have M05 M02 for switching off the spindle and ending the program.
  - Otherwise the machine understands pretty standard G-code including canned cycles.
  - Tool changes with T command cause error. Thus trajectories with different tools must be split into separate nc-files.
  - If you did not understand the above points about the G-code, search for them on the Internet or ask the personnel. And do not do anything stupid because of a faulty G-code!
- In NcStudio, click “File” -> “Unload” to remove old nc-file.
  - Click “File” -> “Open and load”, select your nc-file and click “Open”.

## 6. Resetting the Z position of the working coordinates origin

- By clicking the X and Y movement buttons on the right pane of the NcStudio, move the router somewhere on top of your work piece.
- Lower the Z axis so that the tip of the router bit is about 7...10 cm above the work piece top surface
- Click “Operations” -> “Mobile calibrator...” and click “Countine” in the confirmation window. Immediately after this grab the mobile calibrator from its holder (at the left end of the gantry) and position it under the router bit.



Fig 5: The mobile calibrator.

- The router bit moves down towards the calibrator and as it touches the brass knob in the center of the calibrator, electric signal indicates the Z position of the bit to the machine.
- If you want to interrupt the calibration, press the stop button in the NcStudio (the square button near the top of the window).



Fig 6: Picture of “main tool ribbon and red circled is the “STOP button”.

- After the calibration is finished (the router bit is not moving and it has retracted about 5 mm from the calibrator) put the calibrator back to the holder.

## 7. Selecting the XY position of the working coordinates origin

Axis	M. Coord.	W. Coord.	Remained
X:	660.727	<input type="text" value="0.000"/>	0.000
Y:	992.938	<input type="text" value="0.000"/>	0.000
Z:	-60.500	<input type="text" value="-30.963"/>	0.000

Fig 7: Picture of “working coordinates origin tab”.



- By clicking the movement buttons on the right pane of the NcStudio, move the router near the XY- position where you want to place the origin of your routing trajectory.
  - Lowering the Z axis closer to the work piece surface helps with the XY- positioning. But do not hit the work piece or any fasteners.
  - The position of the origin with respect to the trajectory depends on how you have selected it in CAM software. The selection should have been made so that at least the zero of the Z coordinate always aligns with the work piece top surface.
- In NcStudio, right click the left hand pane (work space view) and click “Clear”.
- Right click the left hand pane again and select “Top view”
  - You can use the mouse wheel to zoom in and out and the left mouse button to drag the center of the view.
- Reset the X and Y working coordinates by clicking the corresponding buttons near the top left corner and confirm the resetting by clicking “Ok” in the pop-up window.
- Click “Simulate” button at the top of the screen.
  - Simulation draws the routing trajectory as it would be carved in the work piece. The trajectory displays the movement of the router bit center line.



Fig 8: Picture of “main tool ribbon and red circled is the “start simulation button”.

- By clicking the right hand pane buttons, move the router position to all extremes and other significant points of the trajectory.
  - By moving the router to different parts of the trajectory you can make sure that the router bit does not go outside the work piece.

- **Pay extreme care to the mounting points (clamps, screws etc.) and make sure that the router bit, the collet nut or the dust cover will never hit those when following the trajectory. Notice that the Z-axis will be much lower during the actual routing operation and even in this case it must be able to avoid all of the obstructions.**
- Stop the simulation by pressing the “Simulate” button again.
- If you are not satisfied with the trajectory position (for example, it goes outside the work piece, hits something etc.) move the router to a new desired origin position and reset the X and Y working coordinates again. Clear the work space view (right click -> “Clear”) and make a new simulation. Repeat the trajectory check and stop simulation. You can repeat this step as many times as needed until you find the correct working coordinates origin position and achieve the desired simulation result.
- **Ask someone of the personnel to come and verify your routing trajectory and work piece mounting.**

## 8. Machining the work piece

- Start the dust collector by pressing the green start button on the other side of the doorway.
- Once more, make sure that the working surface is free of excess stuff such as loose screws, tools etc.
- Put safety glasses and hearing protectors on.
- Adjust the feed rate slider to rather low value (usually about 20 % is a safe starting point)
  - It is better to start slowly and increase the speed later if everything looks good.

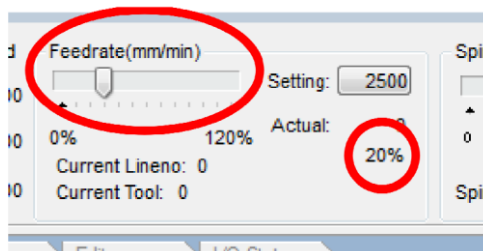


Fig 9: Picture of “feedrate tab”.

- Following the progress of the routing operation is often easier, if you right click the left hand pane (work space view) and select for example “South west” view. This gives better idea of the depth of the trajectory.
- Press “Start” button near the top of the screen.



Fig 10: Picture of “main tool ribbon and the red circled is “start workcycle button”.

- Hold your finger on the keyboard next to F10 key, which is the pause key.
  - If something seems to be going wrong, press F10. The spindle stops and the router moves out of to work piece to a higher Z value. You can continue your work by pressing the “Start” button again.
  - If something seems to be going really badly wrong, press the emergency stop button in the front panel of the electronics cabinet.
- The router should start moving along the trajectory shown by the latest simulation.
  - If everything is ok, you can increase the feed rate to some higher value by moving the feed rate slider.
  - Listen to the sound coming from the router bit and monitor the dust or chip shape and size for determining the optimal feed rate. (This takes a lot of practise, ask the personnel for help.)
- **Monitor the routing operation at all times. Do not leave the room without pausing the router.**
- You can zoom or drag the work space view during the routing to better follow the oncoming movements. You can also try different view directions (by right clicking and selecting the view) that show the current part of the trajectory more clearly.

## 9. Changing the bit between routing operations (if needed)

- In many cases you have to change to another bit to be able to perform all of the required routing operations.

- When the previous operation has finished, activate the “Manual” tab on the right hand side pane of the NcStudio and move the router to maximum Z value and minimum Y value by clicking the corresponding buttons.
- Replace the router bit by following the instructions in section 3.
- Open the next operation (next G-code) as shown in section 5.
- Reset the Z position according to the section 6.
  - This is really important because the new router bit will have different length.
  - Note that you should not reset the X or Y coordinates or otherwise you will lose your working coordinates origin and the trajectories will not overlap in the desired way.
- Start the new routing operation by following the instructions in section 8.

## 10. Cleaning up

- After the routing operation is completed, remove all work pieces and other stuff from the work surface.
- Remove all protruding marks from the sacrificial board with a chisel.
- If nobody else is going to use the machine right after you:
  - close the NC software
  - shut down the computer
  - switch of the electronics by pressing the red button at the front panel of the electronics cabinet
  - switch off the main switch
  - switch off the dust collector by pressing the red stop button
- Vacuum the dust and chips from the work surface and the floor.