

THE 5 COMMANDMENTS OF THE LASER CUTTER

THOU SHALT NOT USE MATERIALS ON THE BANNED MATERIALS LIST

Materials on the banned list are there for a reason—they pose a huge risk of damaging the laser cutter and/or any nearby humans.

Using any banned material in the laser cutter will get you banned from the laser cutter!

THOU SHALT NOT LEAVE THE LASER CUTTER WHILE IT IS RUNNING

Materials being cut can burst into flame without warning. Even material you've cut before with no fire can suddenly become a flaming mass. While the laser is running you must remain by the cutter, monitoring your job.

Leaving the laser cutter while it is running will get you banned from the laser cutter!

THOU SHALT NOT FUTZ AROUND WITH THE LASER CUTTER INTERNALS

Don't play around with the laser's mirrors or belts. The laser cabal knows how to adjust these properly, and they are checked periodically. If you think the laser is out of alignment or acting funky, notify the laser cabal.

Futzing with the laser's internals will get you banned from the laser cutter!

THOU SHALT NOT HACK THE CONTROL COMPUTER

The control computer is set up the way it is for Reasons. If you want a certain piece of software installed or a setting changed, contact the laser cabal.

Hacking the control computer will get you banned from the laser cutter!

THOU SHALT NOT LEAVE A MESS IN THE LASER CUTTER ROOM

When you're done make sure to remove any off-cuts and dropped bits from the cutter itself. Throw out your trash, and take your stuff with you when you leave.

Leaving a mess in the laser cutter room will get you banned from the laser cutter!

(Maybe not as quickly as the other commandments, but nonetheless it will get you banned.

We don't want to be constantly cleaning up your crap.)

Banned Materials

<i>Material</i>	<i>DANGER!</i>	<i>Cause/Consequence</i>
Chlorinated plastics (PVC, vinyl, pleather/artificial leather, Sintra, Kydex)	Emits chlorine gas when cut	Destroys the focus lens and mirrors, corrodes metal parts and motion control system.
Thick (>1mm) polycarbonate/Lexan	cuts poorly, discolors, catches fire	Polycarbonate absorbs infrared energy, and thus cuts very poorly -- it tends to melt or burn instead. Surfaces near cut edges discolor badly.
ABS	Emits cyanide gas, melts, bursts into flame	Tends to melt rather than vaporize, leaving behind gooey deposits on the honeycomb bed. Easily bursts into flame. Also engraves poorly (again, it melts rather than etches).
HDPE (milk bottle plastic)	Catches fire and melts	Do we need to say more? Don't use it!
Polystyrene foam	Catches fire	This is the #1 cause of laser fires!
Polypropylene foam	Catches fire	Just as bad as polystyrene, with the added feature of leaving behind rock-hard deposits.
Fiberglass	Emits dangerous fumes	Glass can't be cut, and the resin emits dangerous fumes.
Coated carbon fiber	Emits dangerous fumes	The coating emits dangerous fumes. Thin, uncoated carbon fiber mat can be cut, but will fray along the cut edges.
Pressure treated wood	Emits dangerous fumes	Should never be burned -- not in your fireplace, and definitely not in our laser.
Galvanized metal	Emits dangerous fumes	Zinc fumes are poisonous. Galvanized metal should never be super heated (so don't weld on it either).
Mirrored surfaces	Will not cut, reflects laser beam	Mirror surfaces can reflect the laser beam, damaging the cutter's interior components. Some mirrored materials can be placed reflective-side down and cut.

Materials you can cut

Solid wood

Avoid resinous or oily wood, as it may catch fire.

Plywood

Interior or "hobby" grades work best. The glue in exterior plywood is tough to cut, and tends to leave ragged charred edges.

MDF and LDF

MDF may char when cut.

Paper, card stock, cardboard

Cut at very low power. Don't stack—it's a fire hazard. Corrugated cardboard may be hard to cut due to the corrugations.

Cork

Cut quality varies with the amount of glue.

Acrylic (Lucite, Plexiglas, PMMA)

Thin polycarbonate sheet (1-2mm)

Not a great material for laser cutting. Smokes a lot, may catch fire. Leaves yellow stains along the cut edges.

Delrin sheet

Harder Delrin is better than soft.

Kapton (polyimide) sheet

Mylar sheet

Thicker sheet tends to bubble and warp.

Styrene sheet

Smokes a lot! Use thin sheets (1/16").

Depron foam (1/4")

Watch carefully for flames.

Gatorfoam sheets

Foam core will shrink away from the paper surfaces. Burns easily. Not a great laser cutter material, but it can work.

Natural-fiber cloth

Don't use any plastic-coated or impregnated material.

Leather and suede

Vegetable-tanned only. Very stinky when cut, and the smell will linger on the cut pieces for a few days.

Magnet sheet

Non-chlorinated rubber

If you're not sure, assume it's chlorinated rubber, and don't cut it!

Teflon (PTFE) sheet

Thin sheets cut OK.

Carbon fiber mat without epoxy

Cuts, but leaves a ragged/frayed edge. Do not cut coated carbon fiber!

Coroplast (corrugated plastic)

Usually takes multiple passes to get through the ribs.

Materials you can etch

You can etch (almost) any material that you can cut. In addition, you can etch but not cut the following materials:

Glass

Flat glass only—we don't have the lathe attachment yet.

Ceramic tile

Stone

Anodized aluminum

Burns away the anodized layer.

Painted metals

Burns away the paint.

Making Files

How the laser cutter works

RetinaEngrave creates a printer on the control computer. To cut a file, you open it in a program that can read the file, then print it on the "LaserPrinter" printer. The job will be loaded into RetinaEngrave, where you can adjust the laser cutter settings and run your job. Any file you can print on the control computer can be used on the laser cutter.

The control computer has the following software installed:

- Inkscape
- Adobe Reader
- Autodesk 123D Make
- Trimble Sketchup

Preparing files for the laser cutter

You will need to prepare your files away from the laser cutter. The software on the control computer is provided for printing files and for making quick changes. **The control computer is not a design workstation!**

Color mode

Your file must be in RGB color mode for colors to be recognized and assigned to layers. Documents in CMYK mode will have all colors assigned to the black layer. Adobe Illustrator defaults to CMYK mode for new documents, so make sure you change the mode before saving out your file.

Colors for vector cutting

RetinaEngrave will create up to seven "layers" for vector cutting, based on the colors used. Each color can be assigned different settings for cutting order, speed, power and number of passes. The colors used and the RGB values are:

Black (0, 0, 0)
Red (255, 0, 0)
Green (0, 255, 0)
Blue (0, 0, 255)
Cyan (0, 174, 239)
Magenta (236, 0, 140)
Yellow (255, 242, 0)

Any other colors will be assigned to the black layer.

Resolution for raster engraving

Images for raster engraving are best generated at the desired output resolution. 252 by 252 pixels works best for most types of engraving. 525 by 525 pixels may work better for photographic or highly detailed images, but will double the engraving time.

White space is automatically cropped

RetinaEngrave will automatically crop away white space surrounding your image. To prevent this, draw a box around your image. Yellow is the best color for this, as it can be easily dropped out of the raster engrave using the threshold control.

Preferred formats

If possible, save your file out as either PDF or SVG format. Both formats have provided good results in testing.

Getting files to the control computer

Use a USB flash drive to bring you files onto the control computer. The computer also has Internet access, so you can download your files from your favorite online storage provider.

Powering Up

Switch on the water pump

The pump sits on the floor to the left of the laser cutter. The power switch is on the front. When switched on the alarm will sound until the pump comes up to speed, which takes about 10 seconds. **If the alarm does not shut off within 30 seconds, do not proceed.**

Check the water temperature

The display on the water pump shows the water temperature. **If the temp is over 30° C, don't run the laser.**

Switch on the air assist compressor

The air assist compressor is controlled by the power strip on the wall, above the water pump. The compressor itself is on the floor behind the laser cutter.

Check the air assist flow

Open up the laser cutter and place your hand beneath the cutting head. You should be able to feel air flowing. If you don't, check that the compressor is running, and that the air hose isn't kinked.

Switch on the exhaust fan

The exhaust fan switch is on the wall below the built-in shelf. As the fan comes up to speed, the silver exhaust ducting behind the laser should lift off the floor.

Check the exhaust air flow

Place your hand inside the laser toward the back; you should feel the exhaust flow.

Turn on the laser cutter

Turn the keyswitch to the right, then turn the safety switch clockwise. The laser cutter will give a small thump as the drive motors are powered. The internal controller will take about a minute to boot up.

Start the control computer ("Burn-E")

Burn-E is the control computer; it sits on the countertop opposite the laser cutter. Power it up with the switch on the front of the tower. Once it's booted, log in as **tcmaker**, with the password provided to you.

Make sure RetinaEngrave is running

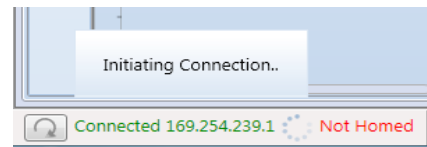
RetinaEngrave is the laser control software. It should start automatically when you log in. If it doesn't, there's a shortcut for it on the desktop.



Setting up your job

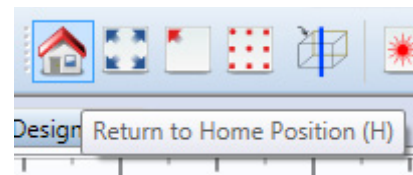
Check the connection

In the lower left-hand corner of the RetinaEngrave window, you should see *Connected*.



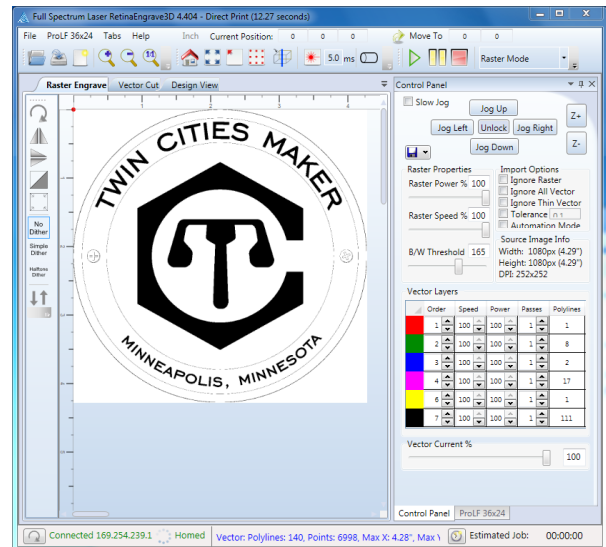
Home the laser head

Click the Home button in the toolbar. The laser head will travel to the upper right of the bed, stopping when it hits the sensors there. The status in the lower left will switch to *Homed*. (If the status bar already says *Homed* you don't need to do this step.)



Open your file and print it to the "LaserCutter" printer

The print output will open in RetinaEngrave. RE must be running for this to work!

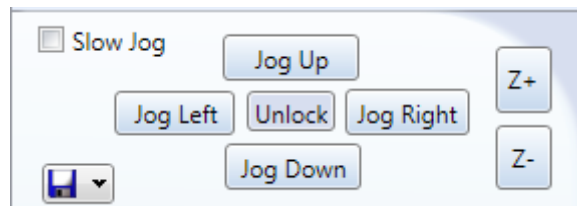


Position your material on the laser bed

Place your material on the honeycomb cutting bed. The honeycomb matches the cutting area, so make sure you don't run off. For raster etching, you need to leave a margin of 1 inch on the left and right for the laser head to run out on each pass.

Position the laser head over your material

Use the jog buttons in the RetinaEngrave control panel to position the laser where you want the upper left corner of your image. The red aiming laser dot will help you align your material.

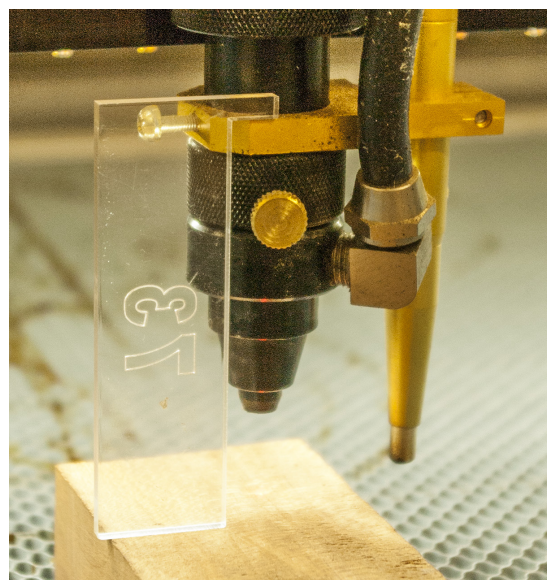


You can also use the arrow keys on the keyboard to jog the laser head. To jog in smaller steps, click the *Slow Jog* checkbox in the RE control panel.

Focus the laser

Use a focus ruler to set the table's Z-height properly. Place the lip of the focus ruler on top of the brass collar on the laser head. Use the *Z+* and *Z-* buttons in the control panel to raise or lower the cutting bed, until the bottom of the focus ruler touches the surface of your material.

You can also use the keyboard's PageUp and PageDown keys to adjust the bed height. The *Slow Jog* checkbox will slow the rate the height changes, which is useful for fine adjustments.



Raster engraving

Select the Raster Engrave tab

The Raster Engrave tab converts the input image to black & white. Black areas are where the laser will fire. Use the *B/W Threshold* slider to adjust the cutoff level.

In the example shown, the cutoff has been moved down to 65. This drops out lighter-colored circles and screw heads, leaving the text and logo to be engraved.

Set the Raster Power and Raster Speed

Use the *Raster Power* and *Raster Speed* sliders according to your needs. Power and speed settings will vary by the type of material and the desired depth and finish of the engraving.

Set the mode and resolution

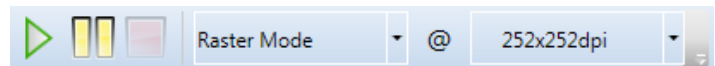
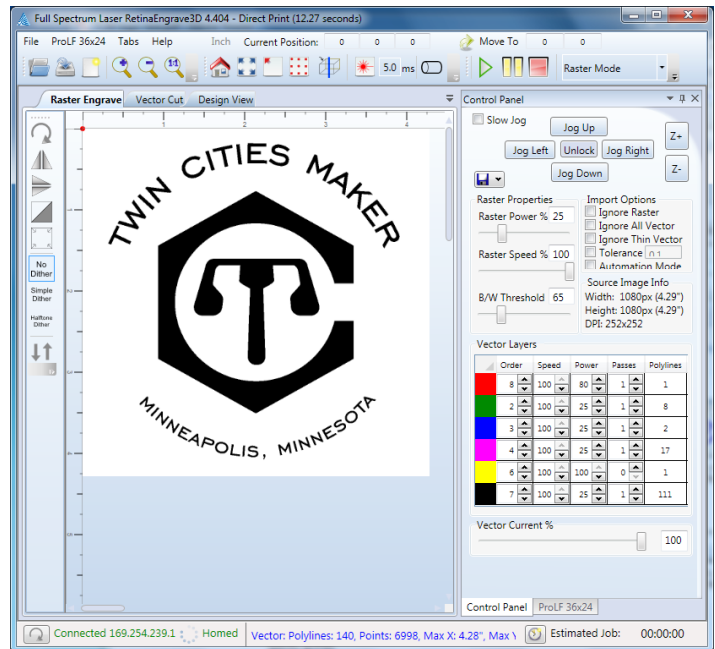
In the toolbar, set the mode dropdown to *Raster Mode* and the resolution to *252x252 dpi*. There is rarely a need to go any higher on the resolution. Each resolution step over 252x252 will **double** your job's run time over the previous step!

Click the *Start Job* button to start your job

The laser will start running from its current position.

Monitor your job until it is finished

Do not walk away while the laser is cutting!



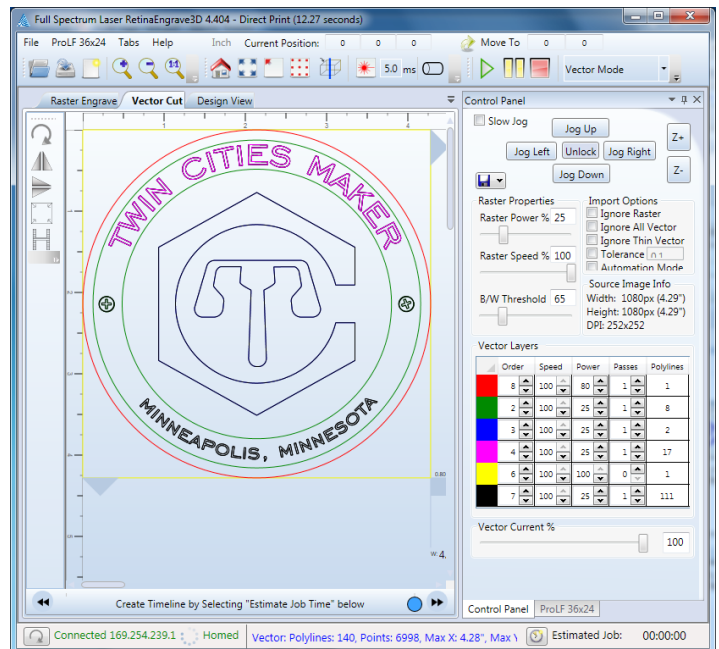
Vector cutting

Select the Vector Cut tab

RetinaEngrave will show the vector data found in your graphic. Note that bitmap files don't contain vectors, so if they are used then the vector cut display will be blank.

Adjust settings for each color layer

Each color layer can have its own settings for power, speed and number of passes. You can also adjust the order in which layers are cut. To prevent a layer from being cut, set its number of passes to zero.



In the example shown:

- The red layer has been set to cut last, at a higher power. This will cut the logo out of the wood.
- The yellow layer has been set to 0 passes, so it will not be cut.
- The other layers are set to the same power and speed. The low power setting will scribe a line in the material, but not cut all the way through.

Order	Speed	Power	Passes	Polylines
8	100	80	1	1
2	100	25	1	8
3	100	25	1	2
4	100	25	1	17
6	100	100	0	1
7	100	25	1	111

Set the cutting mode

Set the mode to *Vector Mode*. The resolution setting has no effect on vector cutting.



Click the Start Job button

The laser will start running from its current position.

Monitor your job until it is finished

Do not walk away while the laser is cutting!

Safety

Flames

In general you should never see a flame while running the laser cutter. Some materials may produce an occasional small flame, which should immediately extinguish. There should never be a sustained flame of any size.

If you are seeing sustained flames, stop the laser cutter immediately, and make sure that the air assist and exhaust are working properly. Recheck the laser's focus. Reduce your laser power and/or increase the speed to prevent flareups.

Smoke

Smoke from your material should visibly be blown away from the cutting point and drawn toward the back of the laser cutter's bed. If smoke is building up, stop the laser cutter immediately. Make sure the air assist and exhaust are working properly, and that your material is safe to cut.

In case of fire

- Immediately stop the laser cutter by hitting the red power switch.
- Use the fire extinguisher by the door to put out any burning materials.
- When the fire is out, shut down the air assist compressor and the water pump. Leave the exhaust running for at least 15 minutes to clear out the room.
- Notify the laser cabal immediately (laser@tcmaker.org).

In case of unexpected behavior

- Stop the machine with the red power switch.
- Restart the laser cutter.
- Quit and restart Retina Engrave, and re-home.
- If odd behavior continues, try shutting down both the laser and computer. Restart the laser cutter; when it is up, restart the computer.

Troubleshooting

I hit Print, but nothing happens

- Make sure RetinaEngrave is running
- Make sure LaserCutter is the selected printer

Colors in my file aren't being found; RetinaEngrave shows only black in the vector layers list

- Make sure your source file is in RGB color mode
- Make sure you are using the recommended color values

The laser cutter is running, but nothing is being engraved/cut

- Check that the water pump is running
- Check that the power is set to at least 0.2
- Make sure the vector layer(s) are set to at least 1 pass

RetinaEngrave only shows an image on the Raster Engrave tab

- The file you are printing contains only bitmap information; no vector data was found
- The printing application only sends bitmap data