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# Speedy 400

Author: Ritesh

Editor: Panda, Reed

## Tool Name:

Trotec Speedy 400 (Goji)

Picture of Tool

## Link to Manufacturer’s Manual:

<https://www.troteclaser.com/fileadmin/content/images/Contact_Support/Manuals/Speedy-400-Manual-EN.pdf>

## 3 Sentence Description:

The Trotec Speedy 400, known as Goji, uses a precisely calibrated laser to quickly engrave, cut, or mark a variety of materials including wood, plastics, and metal. The Trotec Speedy 400 is very similar in terms of specs and functionality to the Speedy 300s (Elderberry, Fig), with the main difference being their sizes.

## Physical Limitations:

* Cut Area: 39” x 24”
* Maximum Workpiece Height: 12”
* Max Cutting Thickness: ~0.5in (depending on lens, and material) [1]
* Laser Wattage: 120 W [1]
* Cutting Kerf: ~0.005-0.010in (depending on lens, material, settings) [1]

## Control Panel:

A picture of the control panel used to turn on, move, and calibrate the laser is shown here:

(Image: Goji Control Panel)

## Materials:

The laser can work on a wide variety of materials. Common materials include:

* Wood
* Paper
* Cardboard
* Acrylic
* Fabric

Some Materials release harmful chemicals when burned and cannot be used in the laser. Common prohibited materials include

* PVC
* Polycarbonate
* Carbon Fiber
* Teflon
* Vinyl

For more in depth information about laser materials see [Laserable Materials].

## PPE:

No PPE is specifically required for this tool

*Note that some laser systems require special filtering safety glasses. This is not needed for the Speedy 300 or Speedy 400 because the lid serves as a filter for harmful light waves*.

## E-Stops and Safety Procedures:

**E-stops:**

* The E-Stop for Goji is located on the top of the machine near the ON/OFF key.

(include image)

* There is also an emergency stop wired into the lid of the laser cutter. If at any point you need to immediately stop the laser, slightly lift the lid and the laser will stop firing. (Note that this will cancel the job in process.)

**When to use the E-Stop:**

* If the material in the laser bed catches on fire
* If the smoke from the material is building up in the machine and not being evacuated through the ventilation system
	+ Jobs can also be paused and stopped using buttons on the JobControl user interface on the computer screen.

**Other Safety Information:**

* Brief tongues of flame while the laser is firing are acceptable, but if a constant flame is started, stop the job and adjust settings.

## Project Ideas:

* Veneer Lamp
	+ http://www.instructables.com/id/Laser-cut-wood-veneer-lamp/
* NamePlates
	+ http://www.instructables.com/id/Laser-Cut-Wooden-Name-Sign/
* 3D puzzles
	+ http://www.instructables.com/id/Laser-Cut-Triceratops/
* Robot Arm
	+ http://www.instructables.com/id/MeArm-Robot-Arm-Your-Robot-V10/

For more examples of cool projects done with a laser engraver, check out this Pinterest board curated by Invention Studio PI’s!:

<https://www.pinterest.com/InventionStudio/laser-cutter-projects/>

## Startup Procedure:

1. Turn on the exhaust system. Open the exhaust valve for the laser.
2. Turn Startup Key on the Control Panel clockwise to the ON position
3. Close the lid of the laser and allow it to perform its homing sequence. The laser will beep when this is complete. The laser is now ready for use.

## Operation:

1. Once the laser has finished homing, open the cover and place the material into the laser cabinet. Material can be squared against the edges of the grid table.
2. Focus the laser by maneuvering the laser head above the material. Identify which lens is being used (red, blue, or black) and select the matching positioner. Hang the positioner from the lip on the right side of the laser head. Raise the laser bed until it just barely knocks the positioner off the ledge. The laser is now focused.

{lens and positioner}, {positioner hung}

1. Open the job file in Inkscape on the computer connected to the laser. Ensure that the dimensions are correct for the material selected. Print the prepared file and select the Trotec Engraver as the printer (this will launch JobControl). Connect the laser to Jobcontrol. Use the laser head to position to the job on the material. Set the power and speed for each cut and engrave in the job. Click Start to run the job.
2. Monitor the job while it runs. If there is excessive flaming or a fire starts, immediately stop the job.

● **Note:** For more information on using Inkscape see [Inkscape]. For more information on using JobControl see [Trotec JobControl]

## Clean-Up:

* Remove all material from the laser cabinet. Any excess material can be thrown away or donated to the scrap pile.
* Occasionally the aluminum grid table will need to be removed and the table underneath vacuumed of debris. Otherwise if enough debris accumulates, it may catch on fire during operation. In order to do so, push down on the 4 pins on the left and right of the table. (These pins should pop up if done correctly.) Then simply remove the table and vacuum the debris. To put the table back on, place it properly and push the pins down.
* If the studio is closing or is closed, shut down the laser, computer, and exhaust system.

## Basic Troubleshooting:

**Laser won’t fire/very weak:**

There are a few reasons why the laser won’t fire.

* The first thing to check is the lens. The lens in the laser head can become clouded with smoke and debris. If the lens is clouded, it can weaken the laser. Follow the proper steps to clean the lens below (under Advanced Troubleshooting/Maintenance).
* The second common reason that would prevent the laser from firing is overheating. If the laser is overheating check the cooling fans for blockage. Turn the laser off and allow it to cool for about 10min before powering it up again.
	+ The cooling fans are situated on top of the laser generator behind the lid.

**General File Troubleshooting Tips:**

A number of problems can stem from formatting issues in the job graphic, particularly if the file was imported into Inkscape. A good strategy when troubleshooting is to make the file as “simple” as possible. Ungroup any groups. Combine all objects with the same fill and stroke into a single path entity using tools like: Union, Difference, Combine, etc as appropriate (All found in the Path Menu). Convert any objects to paths (Path > Object to Path).

**Job that show up empty or cut off:**

Return to Inkscape. Reposition the job so that it is inside the top and left of the page. A job can overflow the right and bottom of the job, but anything above or the left will be cut off in printing.

**Job shows up as a solid black box:**

This usually indicates a transparent or partially transparent object. Return to Inkscape select all objects. Open the fill and stroke toolbox. Set opacity to 100%. Reprint.

* If problem persists, Return to Inkscape. Select each object individually. Invert selection (Edit > Invert Selection). Delete any “invisible” objects this reveals. Reprint.

**Cut lines won’t cut:**

Return to Inkscape. Ensure that the color of the cutlines matches perfectly with one of the 16 trotec colors (The color bar at the bottom of the program has the 16 trotec colors). Reprint.

**Font is different on the laser:**

This happens when the font originally selected is not installed on the computer that runs the laser. This problem can be most easily worked around by returning to the original computer. Make a copy of the file for backup. Open the file. Convert the text to a path (Path > Object to Path). This will convert the text to a shape. Note that the text cannot be edited as text anymore (this is why the backup was created).

● **Note:** For more information on using Inkscape see [Inkscape].

## Advanced Troubleshooting:

**Lens Cleaning:**

Gently loosen the lens housing. Remove the lens and check its surface. Gently wipe both sides of the lens with the microfiber cloth and cleaning solution from the maintenance kit.

**Lens Changing:**

If there’s a visible crack in the lens that can be felt by touching or if there’s a uncleanable burn mark present, changing the lens is necessary. There are a few different types of lenses identified by their colors: red, blue, and black with blue being the most common. The different lenses have different properties that can be advantageous in certain cases. Changing the lens also requires changing the nose cone of the head.

{unavailable pic}

1. Remove the lens by carefully loosening the fixing ring. Slide the lens forward to free it from its housing.
2. Unscrew and remove the nose cone. There are two different nose cones; one with a small hole and one with a large hole.
3. Remove the fixing ring by unscrewing it the rest of the way. Note that the fixing ring can be screwed into the top or the bottom of its housing.

{unavailable pic}

There is a different combination and orientation depends on which lens is being inserted.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Red Lens | Black Lens | Blue Lens1 |
| Cone Size  | Small | Small | Large |
| Position of Fixing Ring | Top | Top | Bottom |
| Position of Lens | Bottom  | Middle2 | Top |

1**Note:** When using a blue lens on the Speedy 400, be sure to use the custom made positioner when focusing

2**Note:** The squarish black lens cartridge that is used for the Speedy 300s cannot be used on Goji due to a difference in size of the laser heads. A different setup is required. If attempting to use a black lens on Goji, slide the black lens holder (image holder) into the bottom of the head, then proceed to place the round black lens cartridge in the center of it. Rotate the fixing ring until the cartridge is snug.

{Picture of black lens holder and round black lens cartridge too}

## References:

● [Speedy 400]. (n.d.). Retrieved July 8, 2018, from: <https://www.troteclaser.com/fileadmin/content/360/Speedy400/TRO_Speedy400_DTA_.23.png>

● Laser Engravers and Cutters | Speedy Series of Trotec Laser. (n.d.). Retrieved July 7, 2018, from:

<https://www.troteclaser.com/en-us/laser-machines/laser-engravers-speedy-series/>

● Materials not suited for laser processing. (n.d.). Retrieved July 7, 2018, from: <https://www.troteclaser.com/en/knowledge/faqs/unsuitable-materials-laser-processing/>

#

# Speedy 300

Author: Reed

Editor: Panda

## Tool Name:

Trotec Speedy 300 (Elderberry, Fig)

 Picture of Tool

## Link to Manufacturer’s Manual:

<https://www.troteclaser.com/fileadmin/content/images/Contact_Support/Manuals/Speedy-300-Manual-EN.pdf>

## 3 Sentence Description:

The Trotec Speedy 300 is a laser cutter: a tool that can cut or engrave a pattern on a variety of materials. The laser beam is focused to a point and burns or vaporizes the material underneath. The laser cutter is a very precise tool and has endless uses for both artistic and engineering proposes.

## Physical Limitations:

* Working area: 29in x 17in [1]
* Max Cutting Thickness: ~0.5in (depending on lens, and material) [1]
* Max Material Height: ~12in (depending on bed configuration) [1]
* Laser Wattage: 120 W [1]
* Cutting Kerf: ~0.005-0.010in (depending on lens, material, settings) [1]

## Control Panel:

A picture of the control panel used to turn on, move, and calibrate the laser is shown here:

(Image: Elderberry/Fig Control Panel)

## Materials:

The laser can work on a wide variety of materials. Common materials include:

* Wood
* Paper
* Cardboard
* Acrylic
* Fabric

Some Materials release harmful chemicals when burned and cannot be used in the laser. Common prohibited materials include

* PVC
* Polycarbonate
* Carbon Fiber
* Teflon
* Vinyl

For more in depth information about laser materials see [Laserable Materials].

## PPE:

No PPE is specifically required for this tool

*Note that some laser systems require special filtering safety glasses. This is not needed for the Speedy 300 or Speedy 400 because the lid serves as a filter for harmful light waves*.

## E-Stops and Safety Procedures:

**E-stops:**

* The E-Stop for Goji is located on the top of the machine near the ON/OFF key.

(include image)

* There is also an emergency stop wired into the lid of the laser cutter. If at any point you need to immediately stop the laser, slightly lift the lid and the laser will stop firing. (Note that this will cancel the job in process.)

**When to use the E-Stop:**

* If the material in the laser bed catches on fire
* If the smoke from the material is building up in the machine and not being evacuated through the ventilation system
	+ Jobs can also be paused and stopped using buttons on the JobControl user interface on the computer screen.

**Other Safety Information:**

* Brief tongues of flame while the laser is firing are acceptable, but if a constant flame is started, stop the job and adjust settings.

## Project Ideas:

* Veneer Lamp
	+ http://www.instructables.com/id/Laser-cut-wood-veneer-lamp/
* NamePlates
	+ http://www.instructables.com/id/Laser-Cut-Wooden-Name-Sign/
* 3D puzzles
	+ http://www.instructables.com/id/Laser-Cut-Triceratops/
* Robot Arm
	+ http://www.instructables.com/id/MeArm-Robot-Arm-Your-Robot-V10/

For more examples of cool projects done with a laser engraver, check out this Pinterest board curated by Invention Studio PI’s!:

<https://www.pinterest.com/InventionStudio/laser-cutter-projects/>

## Startup Procedure:

1. Turn on the exhaust system. Open the exhaust valve for the laser.
2. Turn Startup Key on the Control Panel clockwise to the ON position
3. Close the lid of the laser and allow it to perform its homing sequence. The laser will beep when this is complete. The laser is now ready for use.

## Operation:

1. Once the laser has finished homing, open the cover and place the material into the laser cabinet. Material can be squared against the edges of the grid table.
2. Focus the laser by maneuvering the laser head above the material. Identify which lens is being used (red, blue, or black) and select the matching positioner. Hang the positioner from the lip on the right side of the laser head. Raise the laser bed until it just barely knocks the positioner off the ledge. The laser is now focused.

{lens and positioner}, {positioner hung}

1. Open the job file in Inkscape on the computer connected to the laser. Ensure that the dimensions are correct for the material selected. Print the prepared file and select the Trotec Engraver as the printer (this will launch JobControl). Connect the laser to Jobcontrol. Use the laser head to position to the job on the material. Set the power and speed for each cut and engrave in the job. Click Start to run the job.
2. Monitor the job while it runs. If there is excessive flaming or a fire starts, immediately stop the job.

● **Note:** For more information on using Inkscape see [Inkscape]. For more information on using JobControl see [Trotec JobControl]

## Clean-Up:

* Remove all material from the laser cabinet. Any excess material can be thrown away or donated to the scrap pile.
* Occasionally the aluminum grid table will need to be removed and the table underneath vacuumed of debris. Otherwise if enough debris accumulates, it may catch on fire during operation. In order to do so, push down on the 4 pins on the left and right of the table. (These pins should pop up if done correctly.) Then simply remove the table and vacuum the debris. To put the table back on, place it properly and push the pins down.
* If the studio is closing or is closed, shut down the laser, computer, and exhaust system.

## Basic Troubleshooting:

**Laser won’t fire/very weak:**

There are a few reasons why the laser won’t fire.

* The first thing to check is the lens. The lens in the laser head can become clouded with smoke and debris. If the lens is clouded, it can weaken the laser. Follow the proper steps to clean the lens below (under Advanced Troubleshooting/Maintenance).
* The second common reason that would prevent the laser from firing is overheating. If the laser is overheating check the cooling fans for blockage. Turn the laser off and allow it to cool for about 10min before powering it up again.
	+ The cooling fans are situated on top of the laser generator behind the lid.

**General File Troubleshooting Tips:**

A number of problems can stem from formatting issues in the job graphic, particularly if the file was imported into Inkscape. A good strategy when troubleshooting is to make the file as “simple” as possible. Ungroup any groups. Combine all objects with the same fill and stroke into a single path entity using tools like: Union, Difference, Combine, etc as appropriate (All found in the Path Menu). Convert any objects to paths (Path > Object to Path).

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* If problem persists, Return to Inkscape. Select each object individually. Invert selection (Edit > Invert Selection). Delete any “invisible” objects this reveals. Reprint.

**Cut lines won’t cut:**

Return to Inkscape. Ensure that the color of the cutlines matches perfectly with one of the 16 trotec colors (The color bar at the bottom of the program has the 16 trotec colors). Reprint.

**Font is different on the laser:**

This happens when the font originally selected is not installed on the computer that runs the laser. This problem can be most easily worked around by returning to the original computer. Make a copy of the file for backup. Open the file. Convert the text to a path (Path > Object to Path). This will convert the text to a shape. Note that the text cannot be edited as text anymore (this is why the backup was created).

● **Note:** For more information on using Inkscape see [Inkscape].

## Advanced Troubleshooting/Maintenance:

**Lens Cleaning:**

Gently loosen the lens housing. Remove the lens and check its surface. Gently wipe both sides of the lens with the microfiber cloth and cleaning solution from the maintenance kit.

**Lens Changing:**

If there’s a visible crack in the lens that can be felt by touching or if there’s a uncleanable burn mark present, changing the lens is necessary. There are a few different types of lenses identified by their colors: red, blue, and black with blue being the most common. The different lens have different properties that can be advantageous in certain cases. Changing the lens also requires changing the nose cone of the head.

{unavailable pic}

1. Remove the lens by carefully loosening the fixing ring. Slide the lens forward to free it from its housing.
2. Unscrew and remove the nose cone. There are two different nose cones; one with a small hole and one with a large hole.
3. Remove the fixing ring by unscrewing it the rest of the way. Note that the fixing ring can be screwed into the top or the bottom of its housing.

{unavailable pic}

There is a different combination and orientation depends on which lens is being inserted.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Red Lens | Black Lens | Blue Lens |
| Cone Size  | Small | Small | Large |
| Position of Fixing Ring | Top | Bottom  | Bottom |
| Position of Lens | Bottom  | Top | Top |

## References:

● [1] Trotec Laser. Operation Manual: Trotec Speedy 300. [online]. Available at: <https://www.troteclaser.com/fileadmin/content/images/Contact_Support/Manuals/Speedy-300-Manual-EN.pdf> [Accessed 7 Jul. 2018]

# Inkscape

Author: Reed

Editor: Panda

## Tool Name:

Inkscape 0.92

## Link to Manufacturer’s Manual:

<http://tavmjong.free.fr/INKSCAPE/MANUAL/html/>

## 3 Sentence Description:

Inkscape is a free vector graphics editor. Vector graphics are files that can be used for laser cutting, embroidery, and vinyl cutting.

## Materials:

The default file type of Inkscape is a .svg

Inkscape can import many file types including:

* .dxf
* .ai
* .pdf
* .png
* .jpg
* .bmp

Inkscape can export several file file types including:

* .pdf
* .png
* .jpg
* .bmp
* .dxf

**Note:** Adobe Illustrator is a widely used vector graphics editor program similar to Inkscape. However, it is not recommended to use this program to create files for the Invention Studio’s lasers as various tedious issues may occur such as automatic multi-layered grouping and scaling mismatch.

## E-Stops and Safety Procedures:

NA -- see Elderberry/Fig or Goji

## Project Ideas:

* Low Poly Portrait -- Ideal for Vinyl cutting
	+ https://www.youtube.com/watch?v=Qzf\_W8hg7rw
* Line Portrait -- Ideal for laser cutting
	+ <https://www.youtube.com/watch?v=3ONjSNpbQ74>
* Make Flourishes
	+ https://www.youtube.com/watch?v=q8XORGTMjIs

## Startup Procedure:

Inkscape can be downloaded here:

<https://inkscape.org/en/> (under download)

A useful set of extensions and palettes for laser cutting can be downloaded here:

[https://inkscape.org/en/gallery/=extension/](https://inkscape.org/en/gallery/%3Dextension/)

## Operation of Equipment:

**Understanding the difference between pixel and vector images:**

* The vast majority of digital images are called bitmap or raster images. These images are composed of a mosaic like pattern of square pixels, each with its own color. The density of these pixels relates to the resolution of the image. Resolution becomes very important when scaling an image size. An image of high resolution that is scaled down, and the up to the original size will have lost much of its detail. This loss can be very troublesome for machines like the laser cutter. Vector images are not made of pixels. That means they have no resolution and will never lose detail will scaling.
* The methods for editing vectors differs from raster images and can be unituitive to those used to raster images. Raster editors all have types of brush tools that change the color of individual pixels. Most raster programs also have a paint bucket tool that changes the color of an entire region.
* Editing vector images is similar to using that paint bucket tool. Vector images can be thought of as shapes. Each shape can have color applied to it in two ways; as a fill or as a stroke. Assigning a fill color will fill the entire region of the selected shapes with that color (The laser cutter identify a filled shape as an engrave job). Assigning a stroke color will outline the selected shapes with that color (The laser cutter will identify a stroke as a cut job).

**Convert a pixel image to vector:**

1. Often it is easier to start from a traditional source image comprised of pixels such as a .jpg, .png, or .bmp file.
2. Once you have uploaded your pixelated image into inkscape, go to Path >Trace Bitmap.
3. This will present a variety of tracing options. In general, Brightness Cuttoff is the best tracing option for laser work. The Colors option can be used as well, but these traces will require additional modification after tracing.

**Setting Fill and Stroke**

1. Select the path that you’d like to modify. Go to Object > Fill and Stroke. (You can also right click the path and select the option that appears)
2. Use the window that pops up to assign the fill and stroke of your path. Take note that unique settings can be assigned to up to 16 predefined colors. The colors of the path must match the exact RGB values that JobControl is expecting. For more information on Jobcontrol, see Jobcontrol.
* Alternatively, at the bottom of Inkscape is a color bar that has the 16 predefined colors. To use it, simply select your path and click on the color that you’d like your path to be. To apply a stroke, click shift while selecting the color of your choice.

## Additional Resources:

* Inkscape: Help > Tutorials
	+ https://inkscape.org/en/learn/tutorials/
* Lynda.com | Inkscape Essentials
	+ https://www.lynda.com/Inkscape-tutorials/Inkscape-Essential-Training/418854-2.html
* Youtube | Nick Saporito
	+ https://www.youtube.com/watch?v=hauMpp6gBvQ&list=PLynG8gQD-n8BMplEVZVsoYlaRgqzG1qc4
* Inkscape Manual
	+ http://tavmjong.free.fr/INKSCAPE/MANUAL/html/

## Basic Troubleshooting:

NA-- see troubleshooting section for jobcontrol/embird/silhouette studio

## Advanced Troubleshooting/Maintenance:

NA -- see respective tools

## References:

Inkscape: Guide to a Vector Drawing Program. (n.d.). Retrieved July 8, 2018, from: <http://tavmjong.free.fr/INKSCAPE/MANUAL/html/>

# Trotec JobControl

Author: Reed

Editor: Panda

## Tool Name:

Trotec JobControl X

## Link to Manufacturer’s Manual:

<http://techshoptips.com/files/Trotec-Laser-JobControl-Manual-EN.pdf>

## 3 Sentence Description:

JobControl is the software that interfaces directly with the laser. JobControl is where position, power, and speed are set before each laser job.

## E-Stops and Safety Procedures:

NA -- see Elderberry/Fig or Goji

## Project Ideas:

NA -- see Elderberry/Fig or Goji

## Startup Procedure:

* A file is sent to the laser by printing the file while selecting Trotec Engraver as the printer. Print settings can be selected during the printing process.
* Using the standard settings in the Favorites tab works best in most cases. Advanced settings can be accessed in the Print tab.
	+ Consult the user's manual for more information on the advanced print settings

## Operation of Equipment:

* Files printed to the Trotec Engraver are listed in the job queue on the right side of JobControl. Jobs can be individually selected and dragged onto the workspace.
* Click the USB button on the bottom right to connect to the laser. A cross hair cursor should show up in the workscape corresponding to the lasers position.
* Position the laser in a corner or the center of the material in the laser cabinet. In JobControl, a job’s corner or center can be snapped to the position of the laser cursor.
* The laser can now be moved around the material while watching JobControl to ensure that the job is positioned correctly on the material.
* Next material settings can be configured by clicking the {Insert Pic} button. Unique settings can be assigned to up to 16 predefined colors. The colors in the job must match the exact RGB values that JobControl is expecting. These colors can be found by consulting the user manual.
* For each color in the job, select the correct process mode: cut, engrave or positioning. Assign appropriate power and speed settings. Note that, in general, engrave settings have mid-high power and speed while cut settings tend to have much higher power and much lower speeds. Engraving will typically only require a single pass, whereas cutting may take several passes to completely cut through the material.
* In general, Air Assist should always be left on and Z-Offset set to zero.
* It is good practice to preview the job to ensure that it will be printed correctly. Any job in the workspace can be previewed by clicking the WYSIWYG button (the “eye” button).
* Once the job is positioned and the material settings are configured, begin the job by clicking the start button in the bottom right corner of JobControl

## Basic Troubleshooting:

**Cannot connect to laser engraver:**

* Check the connection of the white USB cable that connects the laser to the computer. Restart JobControl. Power cycle the laser engraver. If the problem persists consult a PI.

**Job shows up empty or cut off:**

* Return to Inkscape. Reposition the job so that it is inside the top and left of the page. A job can overflow the right and bottom of the job, but anything above or the left will be cut off in printing.

**“Cannot position any more jobs on this plate”**

* If the job doesn’t fit in the page on inkscape, go to File, Document Properties, Resize page to content, Resize page to Drawing or Selection.
* This usually indicates a transparent or partially transparent object. Return to Inkscape select all objects. Open the fill and stroke toolbox. Set opacity to 100%.

**Job is not listed in Job Queue:**

* Go to the bottom of the Job queue. Click on the Filter button and select no Filter.
* If the problem persists and other jobs don’t appear when you upload them, consult a PI.

## Advanced Troubleshooting/Maintenance:

**Marking job position:**

* One useful technique is the ability to mark the position of a job. The laser cursor can be used to position a job, but once the cursor is moved away that position is easily lost. This can be solved by marking the job position with the {Insert Pic} button. When a marker is added to a job, a small cursor is added at the top corner of the selected job.
	+ You can also remove or reposition this marker by double clicking it.
* For example - if a job was run, but the user decides to add something else to it. The user must then return to Inkscape to make some modifications.
	+ The Inkscape file can be modified by changing the color of any portion that had already run. The new geometry can be added with the original color. The modified job can then be printed to JobControl. The new job can then be snapped to the marker saving the original position.

**Job has a ridiculously high time estimate or none at all:**

* Go back to your file in Inkscape and double check that the opacity is set to 100%, that the file you sent was the vector file, and that your fill and stroke is correctly set and reprint.
* If the file is grouped, try ungrouping all of the layers, copy and paste the file to a new Inkscape window and reprint.

## References:

[1] Trotec Laser. Operation Manual: Trotec JobControl X. [online]. Available at: <http://techshoptips.com/files/Trotec-Laser-JobControl-Manual-EN.pdf> [Accessed 7 Jul. 2018]

# Rotary Engraver

Author: Reed

Editor: Panda

## Tool Name:

Rotary Engraver (Rotary Attachment)

Picture of Tool

## Link to Manufacturer’s Manual:

<https://www.troteclaser.com/fileadmin/content/images/Contact_Support/Manuals/Speedy-300-Manual-EN.pdf>

## 3 Sentence Description:

The Rotary Engraver attachment is an add-on piece of hardware that can allow the laser cutter to engrave on round/cylindrical objects. This means the laser engraver is not limited to merely 2D surfaces and can work on items such as drinking glasses, rings, pens, etc.

## Physical Limitations:

* Max Diameter: 7.25in [1]
* Max Length: 19in [1]
* Compatible with: Trotec Speedy 300 [1]

## Materials:

The rotary attachment is an extension of the laser cutter. It can work with all the same materials as a laser cutter. The most common materials used with the rotary attachment are

* Glass
* Metal (Especially Aluminum and Stainless Steel)
* Wood

For additional information about materials see [Laserable Materials]

## PPE:

No additional PPE is required to use this specific tool.

## E-Stops and Safety Procedures:

To immediately stop a rotary engrave, simply lift the lid the same as with any laser job.

## Project Ideas:

* Rotary Engraved Drinking Glasses
* Engraved lathed pens & pencils

## Startup Procedure:

1. Lower the laser bed down to its minimum height. Turn off the laser.
2. Remove the honeycomb table from the bed. Vacuum all debris from the bed.
3. Place the rotary attachment inside the laser cabinet. Align the attachment so that the two L shaped feet hook on the alignment bar on the bed and so that the left side of the attachment rests against the left alignment bar

{unavailable pic}

1. Plug the rotary attachment cable into the socket on the left side wall of the laser cabinet. Close the lid to the laser and turn on the laser. Verify that moving the laser along the y axis spins the rotary attachment and movement along the x axis is along the center of rotation of the rotary attachment. The attachment is now ready to use.

## Operation of Equipment:

**Mounting a Glass:**

* Loosening the slide lever will allow the left side of the rotary chuck to to move freely. Insert a glass and clamp it firmly, compressing the springs in the chuck. Lock the glass in place by tightening the slide lever. Spin the glass and ensure that it is clamply in straight and doesn’t wobble. The glass is now ready for engraving.
* If the glass surface is curved/not leveled, adjust the angle of the rotary attachment by holding down the base of it with one hand and use the other hand to move the clamped subsystem up and down. Find a desired angle that makes the surface flat as possible when viewed from the side. Lock the lever on the leftmost side of the rotary.

**Note:** A blue lens is preferred if performing a rotary job with large, uneven surfaces since the black and red lens don’t engrave well on curved objects.

**Configuring the Job:**

● The process for preparing a file for the rotary engraver is the same up until the print settings. When printing to the Trotec Engraver open the preferences check “Rotary Attachment” and enter the diameter of the glass. Accept the print settings.

● Once JobControl has launched, drag the job from the queue into the workspace. Two things should happen differently from a normal job. The workspace should update from the honeycomb pattern to a diagram of the rotary engraver, The job should also have been rotated 90 degrees to align with the orientation of the cup.

● Proceed with assigning settings and positioning the job as if this were a normal job.

For additional information on using JobControl [click here].

## Recommended Clean-Up:

● Open a new inkscape file and print the default test squares. In the print settings, click the Favorites Tab and select the default settings. This prevents the next print from inheriting the rotary settings from the previous job.

● Power off the laser

● Unplug and remove the rotary attachment.

● Insert the honeycomb table.

● Power up the laser.

● Ensure that the x and y motion is back to normal.

## Basic Troubleshooting:

**Moving the X and Y axis does not control the rotary attachment:**

● If after install the rotary attachment, the X and Y axis continue to move normally, turn off the Laser. Carefully unplug and replug the rotary cable. Power on the laser.

**JobControl doesn’t recognize the Rotary Job:**

● If the workspace does not update to reflect the rotary job, it will have to be set manually. Open the Settings > Options menu.

● Select Accessories. Uncheck the honeycomb table. Check the Rotary Attachment and enter in the diameter of the glass.

● Press Ok to accept the changes. When the job is done, changes must be put back to the default honeycomb table.

## Advanced Troubleshooting/Maintenance:

In the event of extreme errors such as continuous beeping and flashing lights from the laser or damage of the rotary attachment, power down the laser and remove the rotary attachment. Consult the Laser Master.

## References:

[1] Trotec Laser. Operation Manual: Trotec Speedy 300. [online]. Available at: <https://www.troteclaser.com/fileadmin/content/images/Contact_Support/Manuals/Speedy-300-Manual-EN.pdf> [Accessed 7 Jul. 2018]

# CerMark

Author: Reed

Editor: Panda

## Tool Name:

CerMark LMM6000 -- Black

CerMark LMM6151 -- Copper

CerMark LMM6150 -- White

## Link to Manufacturer’s Manual:

CerMark Metal Marking Solution

Optimizing CerMark Settings

## 3 Sentence Description:

CerMark is a liquid compound that allows a laser engraver to make permanent marks on metal surfaces. Normally, the laser isn’t effective on metals because they melt instead of burning, and CerMark doesn’t change that. Instead, CerMark bonds to the surface of the metal and leaves a clean, visible mark when it is engraved upon.

## Materials:

CerMark works on almost any uncoated metal. This list includes: [1]

● Aluminum

● Brass

● Bronze

● Chrome

● Pewter

● Stainless Steel

● Titanium

● Tool Steel

Common Metals that CerMark will not work on includes: [1]

● Trophy brass (coated)

● Anodized Aluminum (coated)

● Copper

● Gold

● Silver

## PPE:

● No additional PPE is needed to work with brush-on CerMark

● If using spray-on CerMark, a respirator is required and application should be performed in the paint booth

## Project Ideas:

<http://www.instructables.com/id/Decide-on-your-image/>

<http://www.instructables.com/id/Laser-Marking-Stainless-Steel-1/>

## Startup Procedure:

1. Shake the bottle of CerMark thoroughly before use.
2. Apply CerMark in a thin even coating on the area on the metal for engraving.
3. Allow the Cermark to dry completely (~5-10 min depending on thickness of coat) before engraving. Ensure that the CerMark bottle is sealed when not in use to prevent it from drying out.

## Operation of Equipment:

● Engraving on CerMark is very similar to a normal engraving process with a few exceptions.

○ CerMark jobs should be simple, limited to a single color for engraving and no cutlines. This is because there is a single “sweet spot” of settings for engraving CerMark. Varying the power won’t make lighter or darker markings on the metal, it just risks a poor bonding.

○ The two images below show examples of possible laser jobs. The file on the left would not be successful for two reasons: 1) Either only one engrave level will succeed; or they’ll both succeed and look the same. 2) the Invention Studio Lasers can’t cut through metals. The file on the right represents best practices for laser engraving with CerMark.

 {Insert files/images here}

● In general, CerMark settings involve high power and low speeds. Several factors affect the setting requirements: the type of metal being worked, the thickness of the metal, how quickly heat conducts through the metal, surface finish, etc. Having excess project material to test settings before running the actual job is strongly advised. Begin with settings in the range of 70-100 for power and 15-30 for speed.

**WARNING**: Unlike other materials, care must be taken handling metal after engraving. The metal will be hot from the engraving and needs to cool before removing from the laser.

## Recommended Clean-Up:

Once the laser engraving is complete, wash the surface thoroughly in a work sink (NOT a bathroom sink). CerMark is safe to be washed down the sink [2].

## Basic Troubleshooting:

**Engraving rubs off:**

There are two main reasons for CerMark to fail to bond to a metal. Either the metal is coated or the settings are incorrect.

Coating is particularly a problem with brass. Most brass easily available is “trophy brass” and has a coating to protect its glossy finish. This finish will prevent the Cermark from bonding with the brass. Attempts to polish off the coating has had unreliable success.

1. If the engraving rubs off or leaves very faint marking, then more heat is needed to bond the CerMark . Either reduce the speed or increase the power. [3]
2. If the engraving starts to become pale and flaky in some sections, then too much heat is being applied. Either reduce power or increase speed. [3]

## Advanced Troubleshooting/Maintenance:

**CerMark Dilution:**

CerMark is sold and shipped in a concentrated form and must be diluted before use. For brush on applications, the most commonly used CerMark (CerMark LMM 6000 - Black) should be diluted 1:1 with denatured ethanol. [1] The others have different requirements, but if more is needed, consult the Laser Master.

**Note:** Do not attempt to use CerMark without diluting it first. It will negatively impact the performance of the job.

## References:

[1] johnsonplastics.com. (2018). CerMark Metal Marking FAQ. [online] Available at: <http://s3.amazonaws.com/jpmagento-public/documents/techtips/JPP_TechTips_CerMarkMetalMarkingFAQ.pdf> [Accessed 7 Jul. 2018].

[2] johnsonplastics.com. (2018). CerMark LMM6000 Metal Marking Paste. [online] Available at: <https://www.johnsonplastics.com/engraving/engraving-supplies/cermark/cermark-lmm6060-100gram-metal-marking-paste> [Accessed 7 Jul. 2018].

[3] johnsonplastics.com. (2018). How to Optimize Laser Settings When Using CerMark Products. [online] Available at: <http://s3.amazonaws.com/jpmagento-public/documents/techtips/Tech_Tips_Optimize_Laser_Settings_Cermark.pdf> [Accessed 7 Jul. 2018].

# Laserable Materials

Author: Collin

Editor: Panda

## Tool Name:

Laserable Materials

## Link to Manufacturer’s Manual:

N/A

## 3 Sentence Description:

Lasers are incredibly powerful tools for fabrication, but not all materials are suitable for lasering. Some materials can’t be cut with a laser and some others will produce toxic fumes if lasered. This article contains information on acceptable and unacceptable materials for the laser.

## Materials:

**Acceptable Materials:**

Here is a table that lists the possible laser operations that can be performed on common materials:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Engrave | Mark | Cut |
| Acrylic | yes | yes | yes |
| Aluminum | no | yes1 | no |
| Anodized Aluminum | yes2 | yes2 | no |
| Glass | yes3 | no | no |
| Fabric | yes4 | yes4 | yes |
| Laminates | yes | yes | yes |
| Leather | yes5 | yes5 | no |
| Paper | yes6 | yes6 | yes |
| Plastic | yes/no7 | yes/no7 | yes/no7 |
| Cardboard | yes | yes | yes |
| Stainless Steel | no | yes1 | no |
| Stone | yes | no | no |
| Wood | yes | yes | yes |

**Note:**

1In order to mark any of the metals mentioned above, an additional laser marking ink called CerMark must be painted onto the surface to be marked. Note that only a thin layer of CerMark is needed, applying more CerMark will not give better results. For more information on all the different types of metals that CerMark can and can’t work with, see CerMark.

2Any metal that’s anodized has a thin coat on it. When you laser engrave an anodized metal, you’re burning off the coat and revealing the metal beneath. You can use cermark for the non-anodized part of the metal after you have already burnt it off.

3If glass is subjected to a laser with high power settings, it’ll overheat and break. Thus, when laser engraving glass, it’s recommended to have low power settings (10-50 power) and fairly high speeds (50-100 speed).

4Nearly all types of fabric can be laser engraved, marked, and cut. However most fabrics, such as cotton and polyester, does not have a good-looking finish when engraved or marked, so it is not recommended.

5Commercial leather is chemically tanned which includes chromium and chlorine (which release toxic chemicals when lasered). Therefore, only light engraves should be done on leather.

6Most types of paper is very thin so low power is recommended for engraving (1-20 power), otherwise it’ll burn through the material.

7Most plastics such as ABS, PLA, PTFE does not engrave/cut well with the laser since they either release toxic fumes or melt terribly in the laser cutter. Some other plastics however, (most notably acrylic) works very well with the laser. So, if there is an unknown plastic part that a user want to laser cut/engrave, conduct research on it and consult the Laser Master before giving consent.

**Unacceptable Materials:**

The following materials cannot be used in the laser engraver since they release toxic fumes that can potentially harm the laser and the user when engraved or melt and stick to the laser:

● PVC and Vinyl contain chlorine which releases toxic fumes when subjected to a laser.

● Carbon Fiber

● Polytetrafluoroethylenes such as PTFE /Teflon

○ PTFE is commonly found in milk jugs, and Teflon is the non-stick coating found on most frying pans

● Leather and artificial leather that contains chromium (VI)

● Polyvinyl butyrale (PVB)

● Beryllium oxide

● Any materials containing halogens (fluorine, chlorine, bromine, iodine and astatine), epoxy or phenolic resins

**Additional notes:**

● Polycarbonate creates toxic fumes when subjected to a laser. Note that Acrylic bought from Home Depot will contain a significant percentage of polycarbonate and should not be used in the laser.

● Pink Insulation Foam and nearly all types of foam should not be used in the laser since it contains polyurethane and will melt if subjected to a laser.

## PPE:

N/A

## E-Stops and Safety Procedures:

● If material is constantly flaming, stop the job immediately and wait for the fire to die down. If the fire is continuously burning, shut the exhaust valve for the laser cutter, get the fire extinguisher and spray just enough to put the fire out. Report the incident to the Laser Master.

 ● If the material is unknown and it could potentially be a hazardous item to laser cut, do not laser cut it. It is best to not take any risks and avoid any potential damage to the laser cutter.

● If the material being lasercut is releasing a very pungent odor, exuding blackish, grayish soot, and carbonizing, stop the job immediately and wait for the exhaust to clear away the smoke. If possible, put on a respirator, opent the laser cabinet and throw away the material.

## Project Ideas:

● Metal Etching (CerMark Invention Studio Article)

● 3D Acylic Miniature Chess Pieces (<http://www.instructables.com/id/3D-Miniature-Chess-Pieces-made-with-a-Laser-Cutter/> )

## Startup Procedure:

1. Ensure that material being used is safe and acceptable to laser cut.
2. Place material into laser cutter.

## Operation of Equipment:

For information regarding using the material for laser cutting, see [Elderberry/Fig] or [Goji].

## Basic Troubleshooting:

**Material won’t fit into the laser**:

● Unfortunately, if the material doesn’t fit within the parameters of either the Speedy 300 (17”x 29”x 12”) or the Speedy 400 (24”x 39”x 12”), then it has to be slimmed down using another piece of equipment first.

**Don’t know if material is acrylic or polycarbonate:**

● The easiest way to check is to break off a corner of the material, if it snaps off easily and leaves a clean mark (no bent corners), then it’s acrylic. Polycarbonate pieces will be quite flexible and hard to break off.

● Otherwise, they can tell by cutting one of the test squares on the material. If it cuts cleanly with no or minor discoloration, it’s acrylic. If it leaves behind curled, discolored edges, it is polycarbonate.

## Advanced Troubleshooting/Maintenance:

**Material is not being cut all the way through:**

● First, check the thickness of the material. If it is very close to 0.5”, it may not cut all the through because by that point the laser loses most of its focus and can’t go much further. It is recommended to use a saw or another similar piece of equipment to cut through the small amount of material left.

● If the material being cut is much thinner than 0.5” but not cutting all the way through. Check the status of the mirror and the lens which may be clouded or burnt. If clouded or slightly burnt, clean them and put them back on. Otherwise, replace with new lens/mirror. For more information on this topic, see the troubleshooting section under [Elderberry/Fig] or [Goji].

## References:

● Materials not suited for laser processing. (n.d.). Retrieved July 7, 2018, from: <https://www.troteclaser.com/en/knowledge/faqs/unsuitable-materials-laser-processing/>

# Laser Settings

Author: Jeff Park

## Tool Name:

Laser Settings

## Link to Manufacturer’s Manual:

N/A

## 3 Sentence Description:

Lasers cutters are powerful tools that can engrave and cut through a variety of different materials. However a poor selection of settings will lead to undesirable results including but not limited to charred images, unfocused details, and incomplete cut jobs. This article will share good practices to quickly discover effective settings to use.

## Materials:

● Each laserable material will have different settings that are optimal for engraving and cutting. At the Invention Studio, there will be a collection of engraving and cutting templates depicting various power & speed settings that users can use as a reference when adjusting their power & speed parameters on JobControl. (For more information on JobControl, click here. For Laserable Materials, click here.)

## PPE:

N/A

## E-Stops and Safety Procedures:

● If material is constantly flaming, stop the job immediately and wait for the fire to die down. If the fire is continuously burning, shut the exhaust valve for the laser cutter, get the fire extinguisher and spray just enough to put the fire out. Report the incident to the Laser Master.

## Project Ideas:

N/A

## Startup Procedure:

1. Print the vector file from Inkscape and open the Materials Setting button on the top bar in Job Control where you’ll be able to adjust your power & speed parameters.

## Operation of Equipment:

● If there isn't a template of a material available, the best practice would be to bring in some extra material to use to test.

● Engrave/Cut the default test squares that appear on a new Inkscape page. To start, use low power and high speed settings for both engraves/cuts and adjust until you find settings that you like. If high power and low speed is used, the material may end up burnt .

● It is important to note that when cutting, numerous passes with lower power and higher speed settings are often times more effective than a single run with high power and low speed.

● In general, good settings for the most commonly used materials used in the Invention Studio fall within these ranges:

Plywood (ex: Birch)

 ● Engrave: Low Power, High Speed

 ● Cut: High Power, Low Speed

 Natural Wood (ex: Walnut)

 ● Engrave: Low Power, Medium Speed

 ● Cut: Medium Power, Low Speed

 Acrylic

 ● Engrave: Low Power, Medium Speed

 ● Cut: High Power, Low Speed

 Aluminum/Stainless Steel

 ● Engrave: High Power, Low Speed

Glass

● Engrave: Low Power, Medium Speed

**Note:**

Engrave:

● Low Power/Speed: 10-30

● Medium Power/Speed: 40-60

● High Power/Speed: 70-100

Cut:

● Low Power: 10-30, Low Speed: 1-5

● Medium Power: 40-60 Medium Speed: 6-10

● High Power: 70-100 High Speed: 11-20 (Any higher usually leads to ineffective cuts)

● If you do not have enough material on hand to make test cuts, ask the P.I. on duty for suggestions or use the Trotec pre-loaded settings on the left side of the Material Settings in JobControl if applicable (Keep in mind that these settings, while nice, may not give your idea of optimal results).

## Basic Troubleshooting:

**Material keeps flaming and scorching my job**:

● Pause your job and double check that the air assist and the ventilation is turned on. If they weren’t, do so and tell a P.I. on duty to check the lens since they may have been damaged.

● Reduce the power and/or increase the speed. If excessive heat is applied too quickly, it will cause burning and other undesirable side effects to the material.

**Material is not being engraved upon:**

 ● Increase the power and/or decrease the speed, if the laser is set to apply very little power very quickly, the laser may not have enough energy to actually engrave anything on the material.

## Advanced Troubleshooting/Maintenance:

**The laser is not registering a certain color as an engrave/cut job:**

● Check that the order of colors of the Material Settings page corresponds to the order of colors at the bottom of the Inkscape program. If they do not match, the Laser may skip certain color settings.

## References:

● Laser Parameters - Basics and Settings. (n.d.) Retrieved September 2, 2018 from:

<https://www.troteclaser.com/en-us/knowledge/tips-for-laser-users/laser-parameter-basics-settings/>