# Version History

10/15/2025 Created  
10/18/2025 Updated to use the dedicated ‘GenerateCarouselClean’ program as the DXF2Gcode did not generate optimal G code for this complex shape.

10/21/25 Updated laser power, feedrate. Shifted the geometry to the pads to be the outer edges of the grooves instead of the inner grooves. Changed the reference points to the same and added a target picture.

10/22/25 Updated pad geometry to shift the cleaning from the center of the grooves to the outside of the grooves. Need to confirm calculations with actual measurements.

10/24/25 Updated the g-code adjustment process to use 3 reference points and least mean squares to improve the alignment accuracy. Added ability to adjust laser targeting power to make it more visible in the red resin. Added an auto origin button to simplify setup.

# Table of Contents

[Version History 1](#_Toc211759844)

[Table of Contents 1](#_Toc211759845)

[Process Steps 1](#_Toc211759846)

[Creation of the G-Code Files 1](#_Toc211759847)

[Using the G-Code Files to Clean 6](#_Toc211759848)

[#1 Connect and Set the working origin coordinates for the Laser 6](#_Toc211759849)

[#2 Load the G-Code File 7](#_Toc211759850)

[#3&4 Fine Alignment of the G-Code to the actual Carousel 8](#_Toc211759851)

[#5 Running the Cleaning Process 10](#_Toc211759852)

# Process Steps

## Creation of the G-Code Files

A dedicated program is used to generate G Code for cleaning of the masking resin off the Carousel part. This program makes is easy to decide how many cleaning passes and at what spacing to use for each pad. Then it generates an optimal cleaning path for the top, sections 1 and 3, and the bottom, section2.

Note the program uses linear approximations of the pad’s outer and inner curve. This avoids getting GRBL errors if the curve’s coordinates have 0.001mm error, which happens with rounding and small errors in controller positioning. The linear approximation accurate enough with a maximum error of 0.016mm compared to the curves.

The first screen that comes up is the “Geometry” tab. The G-code that defines the shape of the pad is listed and can be modified if needed. Then the pass spacings for the cleaning paths can be defined. The default is 5 passes starting at a 0.1mm spaccing from the pad edge and then stepping out 0.08mm per pass after that.

When the template and passes are defined, press the Calculate Cleaning Passes button and the Calculated passes G code will be shown and a graphical view of the passes on an ideal pad. The ideal pad is one with a yaw of zero degrees so aligned along the X axis. This pad will be rotated to get the G code for each actual pad on the Carousel.

A screenshot of a computer

AI-generated content may be incorrect.

You can zoom in on the pads to see how the cleaning passes in orange relate to the pad in green. Below you can see a zoomed in view of the cleaning paths.

A screenshot of a graph

AI-generated content may be incorrect.

Once the cleaning paths are defined, move to the Layout tab and press generate plot. This will generate all the g-code for sections 1 and 3. It will use an offset of (0, -50) to get the top of the Carousel on the the work table. You can then save this G code by pressing the Save Section 1&3 button. If you want to view the G code, you can change the drop down selector from “Plot View” to “G-Code Text” to see that.

A screen shot of a graph

AI-generated content may be incorrect.

Note in this view you can change where the table center is by changing the table lower left and upper right coordinates. You can change the offset of the Carousel on that table with the offset. You can also change which pads you want to generate G code for. This is useful if you only want to clean a few pads, just edit the list.

To the below you can see the G Code view. Note it includes the preamble, and postscript that you can define on the G-Code settings tab.

Note laser power is set in just one place at the top of the file with the M4 S command, so it is easy to change.

A screenshot of a computer

AI-generated content may be incorrect.

Note the latest thinking is to set:

* Laser height MPos: -63.1mm and WPos: -60.1mm when setting the origin. This is 5mm higher than earlier.
* Feedrate is 50 mm/min or 0.8mm/sec
* Power is S10000, full 100% power on the 40W laser

Perform the same actions for Section 2 by changing the drop-down selection in the “Select Section:” drop down. Note the offset changes to (0, 50) so section 2 is on the worktable.A screen shot of a graph

AI-generated content may be incorrect.

Note the G-code preamble is difference with different reference points for the fine alignment process that will be done in the Gcode2Laser.py program.

A screenshot of a computer

AI-generated content may be incorrect.

Note there is no particular reason section 1 and 3 is blue and section 2 is red. That is left over from a prior feature that isn’t used and doesn’t matter.

# Using the G-Code Files to Clean

Place the Carousel on the in the shifted down position, so the bottom of the carousel is slightly off the bottom of the worktable. See the picture of the DXF2Gcode for the top section above.

Run the Gcode2Laser.exe program (or Gcode2Laser.py).

A screenshot of a computer

AI-generated content may be incorrect.

## #1 Connect and Set the working origin coordinates for the Laser

Connect to the Laser system (GRBL) likely on serial port COM4 and do the initial setup of laser’s coordinate system.

* Select the COM port in the drop down and press the Connect button
* Clear any errors by pressing the Soft Reset button – hardware and firmware restart, reboots GRBL. Alternatively Clear Errors – is a software clean up, keeps GRBL running.
* Home the system by pressing the Home button. The laser will perform its homing process. When it finishes check the laser machine’s position.   
  It should be MPos: -797, -397, -3
* Set the working origin to this position by pressing the Set Origin (G10 L20 P1 X0 Y0 Z0) button. Then check the laser position, it should be MPos: -797, -397, -3   
  and WPos: 0, 0, 0
* Execute a move command to put the laser head in the approximate center of the Carousel’s template by entering the following text in the G-Code: box G0 X320 Y200 Z-60.1 then hit return or press the Execute button. Check the laser position, it should be MPos: -477, -197, -63.1 and WPos: 320, 200, - 60.1
* Set the working origin to this position. Now the laser is set to the same origin as the DXF file. Press the Set Origin (G10 L20 P1 X0 Y0 Z0) button. Check the laser position, it should be MPos: -477, -197, -63.1 and WPos: 0, 0, 0

## #2 Load the G-Code File

Now that the working origin is set to approximately the right position, it is time to load the G code file by pressing the Load G-code File. You will see the laser path update in the Toolpath plot. You can zoom and pan this display to see what the tool path will be.

Make sure the path shown matches the position of the Carousel on the Laser worktable.

Sections 1 and 3:

A diagram of a graph

AI-generated content may be incorrect.

Section 2

A graph of a tool path

AI-generated content may be incorrect.

## #3&4 Fine Alignment of the G-Code to the actual Carousel

To get submillimeter alignment of the laser tool path to the actual Carousel work piece, a fine alignment of the laser head position to the work piece is done next. The alignment is done using two reference points.

These can be any points on the Carousel that the operator can easily align to. The default is to use the outer bottom corner of section 3 pad 1 and section 1 pad 16. The coordinates of these points are shown next to arrow #3 above.

The GenerateCarouselGcode program inserts these reference points in the comment section of the G code. For the top g-code file, section1and3.nc, you should see these four lines at the top of the file:

|  |
| --- |
| ; Cleaning G-code for Carousel - top: sections 1 and 3  ; Reference points are the bottom outside corners of S3P1 and S1P16  ; reference\_point1 = (-199.2901, -152.4163)  ; reference\_point2 = (199.2901, -152.4163) |

For the bottom g-code file, section2.nc, you should see these four lines at the top of the file:

|  |
| --- |
| ; Cleaning G-code for Carousel - bottom: section 2  ; Reference points are the bottom outside corners of S3P1 and S1P16  ; reference\_point1 = (-199.2901, -52.4163)  ; reference\_point2 = (199.2901, -52.4163) |

A screenshot of a computer

AI-generated content may be incorrect.The reference points are shown in both the expected (Exp: ) and the (Act: ) values. Start the alignment process by pressing the Goto button for Pt1. This will move the laser head to the approximate position of the first reference point.

A screenshot of a computer

AI-generated content may be incorrect.

Then turn the laser on in low power mode by pressing the Laser Off button. It will turn on the laser at 10% power and the label will change to say Laser On, showing its current state. Use the laser jog buttons to position the laser over the target reference point as accurately as possible. Adjust the step size does to 0.1mm to get the fine alignment needed. Once the laser is aligned, capture the current location by pressing the Set button for Pt1. You will see the Act: values update to match the current laser head position.

Now repeat this process for Pt2. Start by pressing the Goto button, then do the laser jogging for fine alignment and finally press the Set button to capture the value.

The next step is to press the Adjust G-Code button (arrow number #4 in the picture above). This will calculate any translation and rotation needed to align the ideal G-code to the actual Carousel part on the worktable. You will see the calculation appear in the text box below the button. These calculations are just for reference.

You will also see the tool path plot update with the original, ideal, tool path shown in red and the updated adjusted tool path shown in orange. You can toggle off the original path with the check box button above the plot.

The pictures below show an exaggerated error in position being corrected. In reality the errors will be small, just a few millimeters of adjustment.

A diagram of a graph

AI-generated content may be incorrect.

Here’s the view with the original tool path turned off. This view is the most useful when running the laser to track progress.

A diagram of a curve

AI-generated content may be incorrect.

## #5 Running the Cleaning Process

Now its time to get googles on and run the cleaning process. Press the Run button to run through the entire G code file. Press Step if you want to single step through the program. The STOP button will halt execution and reset the GBRL controller. HOWEVER, the Stop button is software controlled so it will not instantly turn off the laser or stop the motor. A physical EMO button is needed for that capability.

A screenshot of a computer

AI-generated content may be incorrect.

As the system runs the G-code a pop-up window will show the progress, you can also see the I/O to the controller in the text box below the tool path plot. The tool path will also periodically update the laser head position on the tool plot. The GUI became too slow if the position was updated too frequently, the plot does not plot the real time position of the laser, just after the position after the completion of each command.

# Issues

* Rather than have the user do all the typing to setup home, add a button… home, set origin, move to fixture center, set origin.
* Having the target be the outside of the pad might be easier because of all the mask covering the pad.
* The postscript in the G-code files has the laser head return to the center of the carousel. This requires the operator to jog the laser to remove the carousel after cleaning. They can do this by pressing the home button. Alternatively, the g-code could be modified to have the last command move the laser head out of the way.
* The g-code files are setup for low power laser operation. For actual cleaning the M4 S10 command needs to be modified to higher power. On the S3 Masuter system that is likely: M4 S10000
* The Feedrate may need to change. That can be done by recreating the G-code files or just doing a find and replace of the F1500 string. Note F50 vs. F1500.
* Section 2 is red instead of blue in the GenerateCarouselGcode program.
* Need to show what the G-code settings table looks like in the GenerateCarouselGcode program.
* Show a visual of the points we are aligning to.
* Open the tolerance for validation from 0.01
* Reset the show original G-Code when a new G code file is loaded.

# Geometry of a Pad and the Cleaning Paths

## Geometry of the pad to the center of the grooves

The geometry of the pad comes from the outer and inner diameter of the circumference grooves at 17.643” and 16.837” from page 5 detail P of the dimension drawing. These translate to outer and inner radius in mm of 224.0661mm and 213.8299mm.

The sides come from the lines that intersect these arcs. The lines are defined on page 6 detail M, as the lines parallel to the X axis but offset +/-0.300” or +/-7.62mm.

A diagram of a piece of metal

AI-generated content may be incorrect. A drawing of a basketball court

AI-generated content may be incorrect.

Using g-code the polygon that traces the center of the grooves can be written as:

|  |
| --- |
| ; Pad definition to center of grooves  G0 X223.936 Y7.620 ; initial move to pt 1  G2 X223.936 Y-7.620 R224.0661 ; CW arc pt1->pt2  G1 X213.694 Y-7.620 ; Linear pt2->pt3  G3 X213.694 Y7.620 R213.8299 ; CCW arc pt3->pt4  G1 X223.936 Y7.620 ; Linear pt4->pt1 |

However, the GRBL software controlling the laser is very particular about G2 and G3 commands. For the start and end points, it checks the radius to of what it calculates the center to be. If these do not match and are even slightly off, it generates an error. These errors can occur because of slight errors in the starting position from a prior move caused by 32-bit floating math in the GRBL that can accumulate. The Laser GRBL apparently adjusts the G code commands to avoid this problem.

Because the arcs are extremely shallow, it is easier to just approximate the arcs with a few linear segments approximating the arcs with an error below 0.02 mm.

|  |
| --- |
| A screen shot of a white board  AI-generated content may be incorrect.; pad definition to center of the grooves using linear moves  G0 X223.936 Y7.62 ; initial move to pt 1, not needed by the program  G1 X224.034 Y3.81 ; arch to pt 2  G1 X224.066 Y0 ; arch to pt 2  G1 X224.034 Y-3.81 ; arch to pt 2  G1 X223.936 Y-7.62 ; arch to pt 2  G1 X213.694 Y-7.62 ; side pt 2 to pt 3  G1 X213.796 Y-3.811 ; arch to pt 4  G1 X213.83 Y0 ; arch to pt 4  G1 X213.796 Y3.811 ; arch to pt 4  G1 X213.694 Y7.62 ; arch to pt 4  G1 X223.936 Y7.62 ; side pt 4 to pt1 |

To move the cleaning to the outer edges of the center of the grooves, the points need to be adjusted, outwards. The amount of the offset can be determined from the CAD drawings of the grooves. Details P and N show the edge of the arc grooves from the center is 0.004” \* tan(30) = 0.0023” or 0.059 mm. A very small amount.

A blueprint of a circular object with lines and numbers

AI-generated content may be incorrect. A drawing of a circular object with lines and numbers

AI-generated content may be incorrect.

The distance from the center of the side U shaped grooves to the edge is in Detail T. The full radius would be (0.03”/2) = 0.015” or 0.381mm but the surface is at at the center of the circle, so the distance calculates to 0.01375” or 0.34925mm.

A drawing of a circular object with a line and a line

AI-generated content may be incorrect.

Because the circumference offset at 0.059mm is quite different from the radial groove offset, 0.34935mm, we can’t use a uniform offset, we need to recalculate the pad geometry.

## Geometry of Pad to outer edges of the Grooves

Change in the radius

|  |  |  |  |
| --- | --- | --- | --- |
| Path | To Groove center | Offset | To Groove outer |
| Outer | 224.0661 | +0.0590 | 224.1251 |
| Inner | 213.8299 | -0.0590 | 213.7709 |

Change in the side

|  |  |  |  |
| --- | --- | --- | --- |
| Path | To Groove center | Offset | To Groove outer |
| upper | 7.62 | +0.3494 | +7.96935 |
| Inner | -7.62 | -0.3494 | -7.96935 |

|  |
| --- |
| G0 X223.983 Y7.969 ; move to pt1  G1 X224.09 Y3.985 ; arch to point 2  G1 X224.125 Y0 ; arch to point 2  G1 X224.09 Y-3.985 ; arch to point 2  G1 X223.983 Y-7.969 ; arch to point 2  G1 X213.622 Y-7.969 ; side move pt 2 to pt 3  G1 X213.734 Y-3.985 ; arch to pt 4  G1 X213.771 Y0 ; arch to pt 4  G1 X213.734 Y3.985 ; arch to pt 4  G1 X213.622 Y7.969 ; arch to pt 4  G1 X223.983 Y7.969 ; move to pt1 |

The new pad geometry is spaced further out on the side, avoiding the wide groove on the sides.