



Tool No.	Seq No.	Tool Name	Z Offset	Tool Diameter
0		EDGE FINDER	0.0000	0.0000
1		1/8" E MILL	-6.80196	0.34930
2		3/8" CARB E MILL	-6.79566	0.37300
3		1/4" END MILL	-6.85163	0.25000
4		1/16" BALL EMILL	-7.65526	0.06250
5			0.00000	0.00000
6			0.00000	0.00000
7			0.00000	0.00000
8			0.00000	0.00000
9			0.00000	0.00000
10			0.00000	0.00000
11			0.00000	0.00000
12			0.00000	0.00000
13			0.00000	0.00000
14			0.00000	0.00000
15			0.00000	0.00000

Work Offset	Work Off	Z	A
54	CLIP	0.00000	0.00000
55		0.00000	0.00000
56		0.00000	0.00000
57		0.00000	0.00000
58		0.00000	0.00000
59		0.00000	0.00000
60		0.00000	0.00000
61		0.00000	0.00000



INCORPORATED 1974

Sherline/MASSO Controller Programming

Related Sherline Videos

1. **Work Position and Tool Offsets for Tools** (This video goes through setting up your tools, tool offsets, machine home position, and work position.) <https://youtu.be/Btu5tLLVY7o>
2. **Loading Programs on the Sherline Controller** (This video goes over the control functions to load programs, and use conversation programming.) <https://youtu.be/3DJ9a6Rgm4k>
3. **Sample Program on the Sherline CNC Controller** (This video walks through the cup holder program one tool at a time.) <https://youtu.be/t1WbVXzodLA>

Programming

1. For MASSO, the programs don't need to start with a percentage sign (%) or anything else. They don't need to start with the letter "O" and a program number either.
2. Save your file with your chosen file name. Files can be saved as: .TXT, .NC, or .CNC.
3. You can open and edit your files in any CNC editor program, Notepad, or WordPad®.
4. Supported G-code and M-code definitions can be found here* (<https://masso.com.au/masso-documentation/?section=supported-g-m-codes>).

*NOTE: Not all of these G and M-codes apply to our Sherline machines. The G and M-codes that do apply are listed below.

⚠ CAUTION

Protect your motors, cables, and driver board!

- Do not unplug stepper motors using the rectangular white plug that goes into the motor. Disconnect only at the cable plug.
- Do not pull on cable wires to disconnect plug—*grip at connector*.
- Turn handwheels slowly (1 rev/sec) with driver power OFF when manually positioning. For longer travels use Jog Mode.

List of Supported G-codes

- G00 – Rapid Motion
- G01 – Linear Interpolation Motion
- G02 – Circular Interpolation (Clockwise)
- G03 – Circular Interpolation (Counter Clockwise)
- G04 – Dwell
- G10 – Set Work Offset Values
- G17 – XY Plane Selection
- G18 – ZX Plane Selection
- G19 – YZ Plane Selection
- G20 – Set Machine Units To Inches
- G21 – Set Machine Units To Millimeters
- G28 – Return To Machine Home
- G32 – Threading Cycle
- G38.2 – Straight Probe Cycle

G53 – Move In Absolute Machine Coordinates
G54 to G59 – Select Work Offset Coordinate System
G73 – High Speed Peck Drilling
G80 – Cancel Modal Motion
G81 – Drilling Cycle
G82 – Drilling Canned Cycle With Dwell
G83 – Peck Drilling For Deeper Holes
G90 – Set Distance Mode To Absolute
G91 – Set Distance Mode To Incremental
G92 – Temporary Work Offset
G92.1 – Cancel Temporary Work Offset
G93 – Inverse Time Mode
G94 – Units Per Minute Mode
G96 – Turn on Constant Surface Speed (CSS)
G97 – Turn off Constant Surface Speed (CSS)
G98 – Canned Cycle – Retract Back To The Initial Z
G99 – Canned Cycle – Retract Back To R Plane

List of Supported M-codes

M00 – Program Stop
M01 – Optional Program Stop
M02 – Program End
M03 – Spindle ON (Clockwise)
M05 – Spindle OFF
M06 – Tool Change
M07 – Turn Mist Coolant On (Does not apply to Sherline)
M08 – Turn Flood Coolant On (Does not apply to Sherline)
M09 – To Turn All Coolant Off (Does not apply to Sherline)
M10 – Chuck Or Rotary Table Clamp On (Does not apply to Sherline)
M11 – Chuck Or Rotary Table Clamp Off (Does not apply to Sherline)
M30 – End The Program And Rewind
M98 & M99 – Sub Program Call

Parentheses Use

When programming, any notes or tooling information need to be in parentheses (), or the computer will try to read it. See example below.

(tool 1 ENDMILL ROUGH D.25 C0. L5.)

(tool 2 ENDMILL ROUGH D.375 C0. L5.)

(tool 4 BALL END MILL D.0625 C0. L5.)

(note tool offsets for tools 1 and 2 are Z0 at the top of the part)

(The tool offset for tool 4 is Z0 at the surface to be engraved)

(SHERLINE PRODUCTS CUP HOLDER.NC)

G90 G20

G54 G17 G20 G90 G00 G94 X0 Y0

T2 M6

S2800 M03

(MSG, " Change to .375 ENDMILL ROUGH")

(MSG, " Spindle Speed 2800")

1. Because the MASSO software keeps track of every move that your tool makes, there is no need for “Length Compensation” codes such as G43, G49, or G30
 - a. G-Code to make a tool change is [T (the tool number) M06] EX. T1 M06.
 - b. To bring the tool down to a clearance point above the part [G0 Z (desired distance above the part zero plane)] EX G0 Z.100.
 - c. When the tool is finished, raise it to a clearance plane [Z.1 or Z1.0].
 - d. If you are going to change a tool for the next operation, all you need to do is type in [T2 M06].
At this point, Tool #1 will retract to the Z “Machine home position”. Then it will move to the X and Y machine home. These moves will happen every time your program does a tool change.
 - e. If you are at the end of the program and you want to send the tool home, use G53. G53 is the work coordinate system for the “Machine”. The home position of each axis is G53 Zero point for each axis. [G0 G53 Z0]. This will send the Z axis to the Z Machine Zero point or machine home position in the Z axis.
2. Below is a short program sample with explanations showing the program header, a tool change, Z axis movements, and the program ending.

NOTE: If you are trying to get a Post Processor for your Cad-Cam software. The information below along with the G and M-codes and a sample program, is what your software maker will be asking you for.

Program Sample

(tool 1 ENDMILL ROUGH D.25 C0. L5.) [Tool information in parentheses]

(SHERLINE PRODUCTS CUP HOLDER.NC) [Program file name in parentheses]

G90 G20 [G90 is Absolute Positioning and G20 is for Inch dimensions in the program]

G54 G17 G20 G90 G00 G94 X0 Y0 [G54 is the Work Coordinate that we are using for this part, G17 tells the computer that we are machining on the X/Y Planes, G94 is “feed in In/Min]

T1 M6 [T1 tells the computer to use the tool offset information for tool #2, and M6 is a Tool Change]

(MSG, " Change to .250 ENDMILL ROUGH") [Tool message]

S2800 M03 [Spindle RPM set to 2800, M03 is Clockwise rotation of the spindle]

NOTE: Our spindles do not turn Counter Clockwise M04.

(MSG, " Spindle Speed 2800") [Spindle speed message]

G0 X-1.8125 Y2.2568 [G0 Rapid move in the X and Y axis]

G0 Z.1

G1 Z-.02 F2. [G1 Linear move with a feed rate of 2 In/Min]

Y2.0068 F10.

Y-2.0067

X-1.625 Y-2.1178

Y2.1179

G0 Z.1 [Rapid move in Z to .100 above the part surface]

T2 M6 [M6 Tool change, to Tool #2] [When the machine reads this line, The spindle will stop, Tool #1 and the Z axis will go to machine zero in the Z axis. Then the machine will move to the tool change position and the machine will stop so you can change the tool. The control will ask you to click on Cycle Start to continue with the program.]

S2000 M03 [M03 turn spindle clockwise at 2000 RPM]

(MSG, " Change to .375 ENDMILL ROUGH") [Tool message]

(MSG, " Spindle Speed 2000") [Spindle RPM message]

If this is the end of the program and you want to send all three axis home, then this is the ending G-code for your program:

G0 Z.1 [Rapid move in Z to .100 above the part surface]

M5 [M5 Spindle Stop]

G0 G53 Z0.0 [G53 Absolute machine coordinate, Z axis rapid to Z0 Machine Home position]

G53 G0 X0.0 Y0.0 [G53 X and Y axis move rapid to X and Y Machine Home position]

M30 [End of program, and rewind]

NOTE: You could also use an M02 which is just a Program End.

How to Calculate Feed in Inches/Minute

Sherline machines feed in Inches per Minute, not Inches per Revolution.

To calculate a feed in In./Min., take the spindle RPM and multiply it by the desired feed per revolution.

Example:

I have a 2-flute 1/4" HSS end mill.

I will be cutting 6061 aluminum which has an SFM of 300 to 400

First I calculate my Max RPM.

$$\text{RPM} = \frac{3.82 \times \text{SFM}}{\text{Tool Diameter}}$$

$$(3.82 \times 300) / .25 = \text{RPM}$$

$$1146 / .25 = 4584 \text{ RPM max}$$

Since the Maximum RPM for our spindle is 2800, we will use 2800 RPM.

Next figure out how much material you are going to cut with each flute in one revolution of the cutter.

Let's go with .001"/flute. Two flutes x .001" = .002"/rev

Given feed rate of **.002"/rev x 2800 RPM = 5.6 In/Min** feed rate

Drilling Program: File Name (Spot Drill and Drill 4 Holes.NC)

(tool 5 90 Degree Spot Drill .375 C0. L5.)

(tool 6 #7 Drill .201 C0. L5.)

(this program will spot drill and drill 4 .201 holes .800 deep for a 1/4-20 tap)

(Spot Drill and Drill 4 Holes.NC)

G90 G20

G54 G17 G20 G90 G00 G94 X0 Y0

T5 M6

S2000 M03

(MSG, " Change to 3/8" Spot Drill")

```
G54 G17 G20 G90 G00 G94 X-1.438 Y1.438
G99 G81 X-1.438 Y1.438 Z-.135 R.1 F6.0
X1.438
Y-1.438
X-1.438
G00 Z.1
T6 M6
S2500 M03
(MSG, "CHANGE TO #7 DRILL)
```

```
G99 G83 X-1.438 Y-1.438 Z-.800 Q.25 R.1 F6.0
X1.438
Y1.438
X-1.438
G0 Z.1
M5
G0 G53 Z0.0
G53 G0 X0.0 Y0.0
M30
```

Notes on Thread Milling

Tool #5 is an 1/8" diameter single-tip thread mill

Z zero is the top of the hole. **NOTE:** we are going to start the threading cycle .100" above the part so we are guaranteed to have a complete thread at the start of the hole.

We are milling 1/4"-20 threads.

$1.0" / 20 \text{ Tpi} = .050$. This is how much the z axis will move for each full revolution.

`G17 G20 G90 G00 X-1.438 y1.438` (first line `g17=x,y` axis, `g20=` inch, , `g90` is absolute positioning)

(Begin feature thread mill 1/4-20 hole .600 Deep)

(Line explanation)

`N1 g91 g01 x-.0625 f6.0` (G91 is incremental)(Subtract the radius of the cutter “.0625” from the radius of the thread OD “.125” This equals .0625. feed out .0625 fom CL of the hole to the major dia. of thread.)

`N10 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0`

(G91 = incremental) (G02 = circular cutting in the clockwise direction) (X0 and Y0 = arc finish point) (Z = the thread lead or pitch. A 20 TPI thread moves .050 for each full rotation) (**NOTE:** If you wanted to cut a half circle, you would change X0 to X.125 and Z-.050 to Z-.025) (I = the incremental distance and direction from start point to arc center in the X-axis) (J = the incremental distance and direction from start point to arc center in the Y-axis)

`N20 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0` (Each line will cut one thread)

`N30 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0`

`N40 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0`

`N50 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0`

`N60 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0`

`N70 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0`

`N80 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0`

`N90 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0`

`N100 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0`

N110 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N120 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N130 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N140 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0

N150 g91 g00 x.06250 (Cutter moves to the center of the hole)
N160 g90 g00 z.700

NOTE: Depending on the desired finish and the material that you are cutting, you may want to do a rough and finish pass. To accomplish this, program a rough and finish pass. For the ID thread, you would change the initial X move from “X-.0625 to X-.0605. Then change the (I) value from i.0625 to i.0605 for the roughing pass.

Rough: g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6
Finish: g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6

Main Program Only, or Main and Subprograms?

There are two ways to create your program.

1. Use a main program only. This means that you will need to type in lines N1 – N160 for each hole.
2. Use a main program to move your cutter to each hole center position and then call up a Subprogram to mill the threads in each hole. Your Subprogram will be lines N1 – N160.

Thread Milling Program: File name (Thread Mill 4 Holes.NC)

Main Program Only Sample:

(tool 5 Thread Mill D.125 C0. L5.)
(this program will thread mill 4 1/4-20 holes)

(THREAD MILL 4 Holes.NC)
G90 G20
G54 G17 G20 G90 G00 G94 X0 Y0

T5 M6
S2000 M03
(MSG, " Change to “.125 Dia Thread Mill")

G54 G17 G20 G90 G00 G94 X-1.438 Y1.438
G0 Z.1

N1 g91 g01 x-.0625 f6.0
N10 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N20 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N30 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N40 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N50 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N60 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N70 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0

N80 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N90 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N100 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N110 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N120 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N130 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N140 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N150 g91 g00 x.06250
N160 g90 g00 z.700

G90 g0 X1.438

N1 g91 g01 x-.0625 f6.0
N10 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N20 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N30 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N40 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N50 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N60 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N70 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N80 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N90 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N100 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N110 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N120 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N130 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N140 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N150 g91 g00 x.06250
N160 g90 g00 z.700

G90 g0 Y-1.438

N1 g91 g01 x-.0625 f6.0
N10 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N20 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N30 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N40 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N50 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N60 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N70 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N80 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N90 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N100 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0

N110 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N120 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N130 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N140 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N150 g91 g00 x.06250
N160 g90 g00 z.700

G90 g0 X-1.438

N1 g91 g01 x-.0625 f6.0
N10 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N20 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N30 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N40 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N50 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N60 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N70 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N80 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N90 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N100 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N110 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N120 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N130 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N140 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N150 g91 g00 x.06250
N160 g90 g00 z.700
M5
G0 G53 Z0.0
G53 G0 X0.0 Y0.0
M30

Thread Milling Program: File name (Thread Mill 4 Holes with Subprogram.NC)

Main Program Using Subprogram To Mill Threads Sample:

See this MASSO link for additional information regarding subprograms (<https://masso.com.au/masso-documentation/?section=m98-m99-sub-program-call>)

First we start with a subprogram. Each subprogram is a separate program that the Main program is going to call up.

Our subprogram is going to be called (2520.nc). Once this program has been made, you can use it in other programs and either increase or decrease the number of threads in the program.

NOTE: The file name for subprograms can be **Numbers Only**. No letters, no hyphens or dashes(-), no periods (.).

(2520)

(tool 5 Thread Mill D.125 C0. L5.)

(this program will thread mill a 1/4-20 hole .600 deep with the tool starting at .100 above the part surface.)

N1 g91 g01 x-.0625 f6.0
N10 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0

N20 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N30 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N40 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N50 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N60 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N70 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N80 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N90 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N100 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N110 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N120 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N130 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N140 g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0
N150 g91 g00 x.06250
N160 g90 g00 z.700
M99 (return to original program)

Now the Main Program

File name: Thread Mill 4 Holes with Subprogram.NC

(tool 5 Thread Mill D.125 C0. L5.)
(this program will thread mill (4) 1/4-20 holes)

(Thread Mill 4 Holes with Subprogram.NC)

G90 G20

G54 G17 G20 G90 G00 G94 X0 Y0

T5 M6

S2000 M03

(MSG, " Change to “.125 Dia Thread Mill”)

G54 G17 G20 G90 G00 G94 X-1.438 Y1.438

G0 Z.1

M98 P2520 (This line calls up subprogram 2520 and runs it)

G90 G00 X1.438

M98 P2520

G90 G00 Y-1.438

M98 P2520

G90 G00 X-1.438

M98 P2520

G90 G00

M5

G0 G53 Z0.0

G53 G0 X0.0 Y0.0

M30

SPECIAL NOTE:

In the thread milling programs above we are cutting a right hand thread in a CW direction and moving in a Z minus direction. This is "Conventional Milling" form.

If we wanted to use the cutter in a "Climb Milling" form, we would move the thread mill to the bottom of the hole, then we would cut CWW and in the Z positive direction up and out of the hole.

To do this, change each single thread move in the subprogram from this:

g91g02 x0 y0 z-0.050 i0.0625 j0.0 f6.0

To this:

g91**g03** x0 y0 **z0.050** i0.0625 j0.0 f6.0

In the main program you would move to the hole centerline, then go Z-.600 to the bottom of the hole, then call up the reverse subprogram like this:

(Thread Mill 4 Holes with Subprogram G03.NC)

G90 G20

G54 G17 G20 G90 G00 G94 X0 Y0

T5 M6

S2000 M03

(MSG, " Change to ".125 Dia Thread Mill")

G54 G17 G20 G90 G00 G94 X-1.438 Y1.438

G0 Z-.6

M98 P2521

G90 G00 X1.438

G0 Z-.6

M98 P2521

G90 G00 Y-1.438

G0 Z-.6

M98 P2521

G90 G00 X-1.438

G0 Z-.6

M98 P2521

G90 G00

M5

G0 G53 Z0.0

G53 G0 X0.0 Y0.0

M30

Subprogram (2521.nc)

(2521.nc)

(tool Thread Mill D.125 C0. L5.)

(this program will thread mill a 1/4-20 hole .600 deep with the tool .100 above the part surface.)

```
N1 g91 g01 x-.0625 f2.0
N10 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N20 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N30 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N40 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N50 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N60 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N70 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N80 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N90 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N100 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N110 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N120 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N130 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N140 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
N150 g91 g00 x.06250
M99
```

Nesting Subprograms Two Programs Deep

Next we are going to make a roughing thread milling subprogram that will feed CW and down. It will also be .002" smaller on the radius.

The main program will call up this subprogram. Then this subprogram will call up subprogram 2521 and the cutter will cut out to the finish radius and cut reverse and upward to make a finish thread mill pass.

Rough Thread Mill Program 2522.NC

(2522.NC)

(tool 5 Thread Mill D.125 C0. L5.)

(this program will thread mill a 1/4-20 hole .600 deep with the tool .100 above the part surface.)

```
N1 g91 g01 x-.0605 f6.0
N10 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N20 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N30 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N40 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N50 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N60 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N70 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N80 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N90 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N100 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N110 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N120 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N130 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N140 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
N150 g91 g00 x.06050
```

M98 P2521

M99

The Main Program

(Thread Mill 4 Holes with 2 Sub Programs.NC)

G90 G20

G54 G17 G20 G90 G00 G94 X0 Y0

T5 M6

S2000 M03

(MSG, " Change to “.125 Dia Thread Mill”)

G54 G17 G20 G90 G00 G94 X-1.438 Y1.438

G0 Z.1

M98 P2522

G90 G00 X1.438

M98 P2522

G90 G00 Y-1.438

M98 P2522

G90 G00 X-1.438

M98 P2522

G90 G00

M5

G0 G53 Z0.0

G53 G0 X0.0 Y0.0

M30

This is how the two subprogram above work.

(MSG, " Change to “.125 Dia Thread Mill”)

G54 G17 G20 G90 G00 G94 X-1.438 Y1.438

G0 Z.1

M98 P2522 (This line calls up subprogram 2522)

Next it will run subprogram 2522.

At the end of the subprogram it calls up subprogram 2521

N140 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0

N150 g91 g00 x.06050

M98 P2521

M99

Now it will run subprogram 2521. At the end of this program is an M99 which will send it back to the next line in the 2522 program.

```
N140 g91g03 x0 y0 z0.050 i0.0625 j0.0 f6.0
```

```
N150 g91 g00 x.06250
```

M99

The next line in subprogram 2522 is an M99 also. This sends it back to the main program.

```
N140 g91g02 x0 y0 z-0.050 i0.0605 j0.0 f6.0
```

```
N150 g91 g00 x.06050
```

```
M98 P2521
```

M99

Now the main program goes onto the next line after the M98 line and that starts the next sequence of the program.

```
G54 G17 G20 G90 G00 G94 X-1.438 Y1.438
```

```
G0 Z.1
```

```
M98 P2522
```

```
G90 G00 X1.438
```

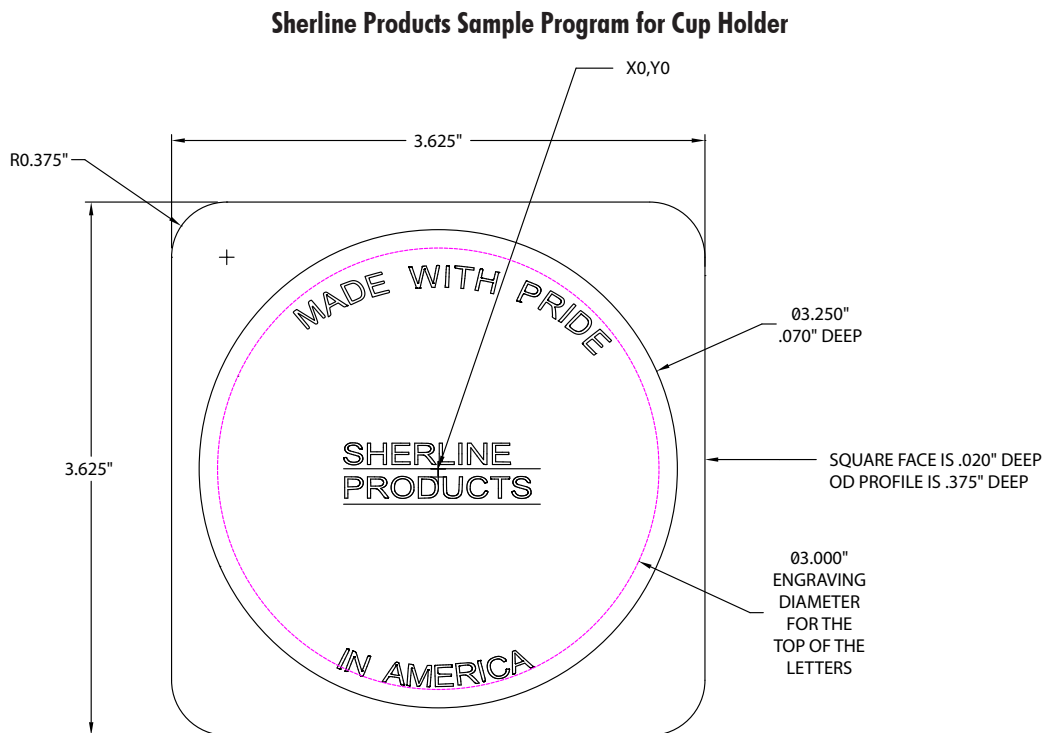


FIGURE 1—Diagram of the engraving program for the ball screw test cut cup holder.

Below is the program that we used to machine the Sherline Products cup holder that was in our video.

<https://youtu.be/t1WbVXzodLA>

File name: SHERLINE PRODUCTS CUP HOLDER.NC

(tool 1 ENDMILL ROUGH D.375 C0. L5.)

(tool 2 ENDMILL ROUGH D.250 C0. L5.)

(tool 4 BALL END MILL D.0625 C0. L5.)

(Note tool offsets for tools 1 and 2 are Z0 at the top of the part)

(The tool offset for tool 4 is Z0 at the surface to be engraved)

(SHERLINE PRODUCTS CUP HOLDER.NC)

G90 G20

G54 G17 G20 G90 G00 G94 X0 Y0

T2 M6

S2800 M03

(MSG, " Change to .375 ENDMILL ROUGH")

(MSG, " Spindle Speed 2800")

G0

(Begin FEATURE 2 AXIS FACE TOP OF PART)

G0 X-1.8125 Y2.2568

G0 Z.1

G1 Z-.02 F2.

Y2.0068 F10.

Y-2.0067

X-1.625 Y-2.1178

Y2.1179

X-1.4375 Y2.15

Y-2.15

X-1.25

Y2.15

X-1.0625

Y-2.15

X-.875

Y2.15

X-.6875

Y-2.15

X-.5

Y2.15

X-.3125

Y-2.15

X-.125

Y2.15

X.0625

Y-2.15

X.25

Y2.15

X.4375

Y-2.15
X.625
Y2.15
X.8125
Y-2.15
X1.
Y2.15
X1.1875
Y-2.15
X1.375
Y2.15
X1.5625 Y2.136
Y-2.1359
X1.75 Y-2.0552
Y2.0552
Y2.3052
G0 Z.1
Z1.
S2000
(Begin FEATURE 2 AXIS CUT 3.3 DIAMETER CIRCULAR POCKET)
Z.1
G1 X.0376 Y.4891 Z0. F2.
X.0566 Y.4943 Z-.001
X.0799 Y.4982 Z-.0023
X.1073 Y.5 Z-.0037
X.1324 Y.499 Z-.005
X.1466 Y.4973 Z-.0058
X.1608 Y.4948 Z-.0065
X.1739 Y.4917 Z-.0072
X.1889 Y.4873 Z-.0081
X.2144 Y.4772 Z-.0095
X.2366 Y.4656 Z-.0108
X.2526 Y.4554 Z-.0118
X.2696 Y.4425 Z-.0129
X.2868 Y.4268 Z-.0141
X.3023 Y.4098 Z-.0153
X.3149 Y.3933 Z-.0164
X.3275 Y.3733 Z-.0177
X.3374 Y.3541 Z-.0188
X.3468 Y.3302 Z-.0201
X.3514 Y.3152 Z-.021
X.3547 Y.3011 Z-.0217
X.3587 Y.2758 Z-.0231

X.3599 Y.2576 Z-.024
X.3598 Y.2407 Z-.0249
X.3588 Y.2252 Z-.0257
X.3571 Y.2117 Z-.0264
X.352 Y.1872 Z-.0278
X.3456 Y.1662 Z-.0289
X.3353 Y.1416 Z-.0303
X.3225 Y.1182 Z-.0317
X.3132 Y.1043 Z-.0326
X.304 Y.0923 Z-.0334
X.295 Y.0819 Z-.0341
X.284 Y.0705 Z-.0349
X.2635 Y.0527 Z-.0363
X.2498 Y.0428 Z-.0372
X.2364 Y.0343 Z-.0381
X.219 Y.025 Z-.0391
X.2012 Y.0173 Z-.0401
X.1861 Y.0119 Z-.041
X.1697 Y.0073 Z-.0418
X.1558 Y.0043 Z-.0426
X.1404 Y.0019 Z-.0434
X.1245 Y.0005 Z-.0442
X.11 Y0. Z-.045
G3 X-.11 Y0. I-.11 J0. F5.
X.11 Y0. I.11 J0.
G1 X.2975
G3 X-.2975 Y0. I-.2975 J0.
X.2975 Y0. I.2975 J0.
G1 X.485
G3 X-.485 Y0. I-.485 J0.
X.485 Y0. I.485 J0.
G1 X.6725
G3 X-.6725 Y0. I-.6725 J0.
X.6725 Y0. I.6725 J0.
G1 X.86
G3 X-.86 Y0. I-.86 J0.
X.86 Y0. I.86 J0.
G1 X1.0475
G3 X-1.0475 Y0. I-1.0475 J0.
X1.0475 Y0. I1.0475 J0.
G1 X1.235
G3 X-1.235 Y0. I-1.235 J0.
X1.235 Y0. I1.235 J0.

G1 X1.4225
G3 X-1.4225 Y0. I-1.4225 J0.
X1.4225 Y0. I1.4225 J0.
G0 Z.1
X.0376 Y.4891 Z.055
G1 Z-.045 F2.
X.0566 Y.4943 Z-.046
X.0799 Y.4982 Z-.0473
X.1073 Y.5 Z-.0487
X.1324 Y.499 Z-.05
X.1466 Y.4973 Z-.0508
X.1608 Y.4948 Z-.0515
X.1739 Y.4917 Z-.0522
X.1889 Y.4873 Z-.0531
X.2144 Y.4772 Z-.0545
X.2366 Y.4656 Z-.0558
X.2526 Y.4554 Z-.0568
X.2696 Y.4425 Z-.0579
X.2868 Y.4268 Z-.0591
X.3023 Y.4098 Z-.0603
X.3149 Y.3933 Z-.0614
X.3275 Y.3733 Z-.0627
X.3374 Y.3541 Z-.0638
X.3468 Y.3302 Z-.0651
X.3514 Y.3152 Z-.066
X.3547 Y.3011 Z-.0667
X.3587 Y.2758 Z-.0681
X.3599 Y.2576 Z-.069
X.3598 Y.2407 Z-.0699
X.3588 Y.2252 Z-.0707
X.3571 Y.2117 Z-.0714
X.352 Y.1872 Z-.0728
X.3456 Y.1662 Z-.0739
X.3353 Y.1416 Z-.0753
X.3225 Y.1182 Z-.0767
X.3132 Y.1043 Z-.0776
X.304 Y.0923 Z-.0784
X.295 Y.0819 Z-.0791
X.284 Y.0705 Z-.0799
X.2635 Y.0527 Z-.0813
X.2498 Y.0428 Z-.0822
X.2364 Y.0343 Z-.0831
X.219 Y.025 Z-.0841

X.2012 Y.0173 Z-.0851
X.1861 Y.0119 Z-.086
X.1697 Y.0073 Z-.0868
X.1558 Y.0043 Z-.0876
X.1404 Y.0019 Z-.0884
X.1245 Y.0005 Z-.0892
X.11 Y0. Z-.09
G3 X-.11 Y0. I-.11 J0. F5.
X.11 Y0. I.11 J0.
G1 X.2975
G3 X-.2975 Y0. I-.2975 J0.
X.2975 Y0. I.2975 J0.
G1 X.485
G3 X-.485 Y0. I-.485 J0.
X.485 Y0. I.485 J0.
G1 X.6725
G3 X-.6725 Y0. I-.6725 J0.
X.6725 Y0. I.6725 J0.
G1 X.86
G3 X-.86 Y0. I-.86 J0.
X.86 Y0. I.86 J0.
G1 X1.0475
G3 X-1.0475 Y0. I-1.0475 J0.
X1.0475 Y0. I1.0475 J0.
G1 X1.235
G3 X-1.235 Y0. I-1.235 J0.
X1.235 Y0. I1.235 J0.
G1 X1.4225
G3 X-1.4225 Y0. I-1.4225 J0.
X1.4225 Y0. I1.4225 J0.
G0 Z.1
Z1.
S2800
(Begin FEATURE 2 AXIS)
Z.1
G1 X1.4375 Z-.1 F3.
G2 X-1.4375 Y0. I-1.4375 J0. F8.
X1.4375 Y0. I1.4375 J0.
G0 Z.1

T1 M6
S2000 M03
(MSG, " Change to .25 ENDMILL ROUGH")

(MSG, " Spindle Speed 2000")

G0

G1 F5

(Begin FEATURE 2 AXIS PROFILE OUTSIDE 3.625 SQUARE)

G0 X-1.4375 Y2.2025

G0 Z.1

G1 Z-.075 F2.

X-1.6875 F5.

G3 X-1.4375 Y1.9525 I.25 J0.

G1 X1.4375

G2 X1.9525 Y1.4375 I0. J-.515

G1 Y-1.4375

G2 X1.4375 Y-1.9525 I-.515 J0.

G1 X-1.4375

G2 X-1.9525 Y-1.4375 I0. J.515

G1 Y1.4375

G2 X-1.4375 Y1.9525 I.515 J0.

G3 X-1.1875 Y2.2025 I0. J.25

G1 X-1.4375

G0 Z.1

Z.025

G1 Z-.15 F2.

X-1.6875 F5.

G3 X-1.4375 Y1.9525 I.25 J0.

G1 X1.4375

G2 X1.9525 Y1.4375 I0. J-.515

G1 Y-1.4375

G2 X1.4375 Y-1.9525 I-.515 J0.

G1 X-1.4375

G2 X-1.9525 Y-1.4375 I0. J.515

G1 Y1.4375

G2 X-1.4375 Y1.9525 I.515 J0.

G3 X-1.1875 Y2.2025 I0. J.25

G1 X-1.4375

G0 Z.1

Z-.05

G1 Z-.225 F2.

X-1.6875 F5.

G3 X-1.4375 Y1.9525 I.25 J0.

G1 X1.4375

G2 X1.9525 Y1.4375 I0. J-.515

G1 Y-1.4375

G2 X1.4375 Y-1.9525 I-.515 J0.

G1 X-1.4375
G2 X-1.9525 Y-1.4375 I0. J.515
G1 Y1.4375
G2 X-1.4375 Y1.9525 I.515 J0.
G3 X-1.1875 Y2.2025 I0. J.25
G1 X-1.4375
G0 Z.1
Z-.125
G1 Z-.3 F2.
X-1.6875 F5.
G3 X-1.4375 Y1.9525 I.25 J0.
G1 X1.4375
G2 X1.9525 Y1.4375 I0. J-.515
G1 Y-1.4375
G2 X1.4375 Y-1.9525 I-.515 J0.
G1 X-1.4375
G2 X-1.9525 Y-1.4375 I0. J.515
G1 Y1.4375
G2 X-1.4375 Y1.9525 I.515 J0.
G3 X-1.1875 Y2.2025 I0. J.25
G1 X-1.4375
G0 Z.1
Z-.2
G1 Z-.375 F2.
X-1.6875 F5.
G3 X-1.4375 Y1.9525 I.25 J0.
G1 X1.4375
G2 X1.9525 Y1.4375 I0. J-.515
G1 Y-1.4375
G2 X1.4375 Y-1.9525 I-.515 J0.
G1 X-1.4375
G2 X-1.9525 Y-1.4375 I0. J.515
G1 Y1.4375
G2 X-1.4375 Y1.9525 I.515 J0.
G3 X-1.1875 Y2.2025 I0. J.25
G1 X-1.4375
G0 Z.1
Z1.
S2500
(Begin FEATURE 2 AXIS)
Z.1
G1 Y2.1875 Z-.375 F5.
X-1.6875 F8.

G3 X-1.4375 Y1.9375 I.25 J0.
G1 X1.4375
G2 X1.9375 Y1.4375 I0. J-.5
G1 Y-1.4375
G2 X1.4375 Y-1.9375 I-.5 J0.
G1 X-1.4375
G2 X-1.9375 Y-1.4375 I0. J.5
G1 Y1.4375
G2 X-1.4375 Y1.9375 I.5 J0.
G3 X-1.1875 Y2.1875 I0. J.25
G1 X-1.4375
G0 Z1.0

(NOTE THE TOOL OFFSET FOR THE ENGRAVING CUTTER IS ACQUIRED FROM THE FINISHED SURFACE TO BE CUT, NOT FROM THE TOP OF THE PART)

(tool 4 end mill engrave .0625)

(ENGRAVE SHERLINE PRODUCTS Made in USA)

T4 M6
S2800 M03
(MSG, " Change to .0625 BALL MILL")
G17 G64 P0.001
F5.00
G0 Z0.2500
G0 X0.1185 Y1.4849
G1 Z-0.0050
G1 X0.1185 Y1.4849
G1 X0.1196 Y1.4790
G1 X0.1241 Y1.4763
G1 X0.1568 Y1.4703
G1 X0.1729 Y1.4690
G1 X0.1603 Y1.3324
G1 X0.1801 Y1.3308
G1 X0.1804 Y1.3330
G1 X0.1862 Y1.3813
G1 X0.1948 Y1.4682
G1 X0.2524 Y1.4611
G1 X0.2537 Y1.4781
G1 X0.1263 Y1.4918
G1 X0.1199 Y1.4899
G1 X0.1185 Y1.4849

G0 Z0.0500
G0 X0.0590 Y1.4904
G1 Z-0.0050
G1 X0.0590 Y1.4904
G1 X0.0563 Y1.4669
G1 X0.0495 Y1.3503
G1 X0.0573 Y1.3396
G1 X0.0686 Y1.3386
G1 X0.0735 Y1.3382
G1 X0.0737 Y1.3423
G1 X0.0765 Y1.4132
G1 X0.0782 Y1.4882
G1 X0.0762 Y1.4910
G1 X0.0692 Y1.4928
G1 X0.0626 Y1.4928
G1 X0.0590 Y1.4904
G0 Z0.0500
G0 X-0.0119 Y1.4918
G1 Z-0.0050
G1 X-0.0119 Y1.4918
G1 X-0.0298 Y1.3984
G1 X-0.0373 Y1.3677
G1 X-0.0858 Y1.4912
G1 X-0.1065 Y1.4891
G1 X-0.1110 Y1.4880
G1 X-0.1134 Y1.4854
G1 X-0.1369 Y1.3870
G1 X-0.1393 Y1.3707
G1 X-0.1414 Y1.3690
G1 X-0.1444 Y1.3699
G1 X-0.1474 Y1.3735
G1 X-0.1862 Y1.4824
G1 X-0.1900 Y1.4853
G1 X-0.1941 Y1.4854
G1 X-0.2081 Y1.4828
G1 X-0.1607 Y1.3540
G1 X-0.1548 Y1.3362
G1 X-0.1562 Y1.3335
G1 X-0.1295 Y1.3350
G1 X-0.0983 Y1.4682
G1 X-0.0461 Y1.3402
G1 X-0.0236 Y1.3382
G1 X0.0089 Y1.4909

G1 X0.0071 Y1.4939
G1 X-0.0002 Y1.4950
G1 X-0.0078 Y1.4944
G1 X-0.0118 Y1.4919
G1 X-0.0119 Y1.4918
G0 Z0.0500
G0 X0.2809 Y1.4051
G1 Z-0.0050
G1 X0.2809 Y1.4051
G1 X0.2625 Y1.3310
G1 X0.2576 Y1.3254
G1 X0.2471 Y1.3227
G1 X0.2719 Y1.3217
G1 X0.2789 Y1.3200
G1 X0.2789 Y1.3175
G1 X0.2817 Y1.3159
G1 X0.2944 Y1.3155
G1 X0.2857 Y1.3191
G1 X0.2845 Y1.3221
G1 X0.2996 Y1.3883
G1 X0.3167 Y1.3867
G1 X0.3837 Y1.3731
G1 X0.3870 Y1.3711
G1 X0.3739 Y1.3126
G1 X0.3692 Y1.3035
G1 X0.3630 Y1.3010
G1 X0.3756 Y1.2995
G1 X0.3835 Y1.2945
G1 X0.3913 Y1.2970
G1 X0.3939 Y1.3004
G1 X0.3979 Y1.3149
G1 X0.4286 Y1.4448
G1 X0.4076 Y1.4511
G1 X0.3941 Y1.3982
G1 X0.3913 Y1.3936
G1 X0.3860 Y1.3918
G1 X0.3059 Y1.4073
G1 X0.3157 Y1.4568
G1 X0.3152 Y1.4666
G1 X0.3122 Y1.4698
G1 X0.3025 Y1.4721
G1 X0.2995 Y1.4706
G1 X0.2953 Y1.4623
G1 X0.2907 Y1.4461

G1 X0.2809 Y1.4051
G0 Z0.0500
G0 X0.5900 Y1.3173
G1 Z-0.0050
G1 X0.5900 Y1.3173
G1 X0.5566 Y1.2467
G1 X0.5568 Y1.2448
G1 X0.5603 Y1.2426
G1 X0.5832 Y1.2349
G1 X0.5841 Y1.2356
G1 X0.5806 Y1.2398
G1 X0.5825 Y1.2492
G1 X0.5956 Y1.2778
G1 X0.6055 Y1.2939
G1 X0.6676 Y1.2745
G1 X0.6857 Y1.2730
G1 X0.6964 Y1.2748
G1 X0.7075 Y1.2805
G1 X0.7166 Y1.2888
G1 X0.7254 Y1.3033
G1 X0.7285 Y1.3132
G1 X0.7289 Y1.3212
G1 X0.7260 Y1.3325
G1 X0.7231 Y1.3374
G1 X0.7167 Y1.3449
G1 X0.7092 Y1.3505
G1 X0.6888 Y1.3607
G1 X0.6269 Y1.3851
G1 X0.6246 Y1.3839
G1 X0.6175 Y1.3723
G1 X0.6073 Y1.3531
G1 X0.5900 Y1.3173
G0 Z0.0500
G0 X0.6954 Y1.3371
G1 Z-0.0050
G1 X0.6954 Y1.3371
G1 X0.6999 Y1.3328
G1 X0.7040 Y1.3257
G1 X0.7051 Y1.3130
G1 X0.7025 Y1.3060
G1 X0.6973 Y1.2994
G1 X0.6852 Y1.2930
G1 X0.6750 Y1.2922

G1 X0.6638 Y1.2942
G1 X0.6198 Y1.3082
G1 X0.6131 Y1.3125
G1 X0.6363 Y1.3626
G1 X0.6728 Y1.3483
G1 X0.6940 Y1.3381
G1 X0.6954 Y1.3371
G0 Z0.0500
G0 X0.8716 Y1.2444
G1 Z-0.0050
G1 X0.8716 Y1.2444
G1 X0.8714 Y1.2336
G1 X0.8646 Y1.2229
G1 X0.8550 Y1.2172
G1 X0.8435 Y1.2155
G1 X0.8282 Y1.2203
G1 X0.7829 Y1.2440
G1 X0.7763 Y1.2492
G1 X0.8060 Y1.2923
G1 X0.8584 Y1.2593
G1 X0.8671 Y1.2519
G1 X0.8713 Y1.2456
G1 X0.8716 Y1.2444
G0 Z0.0500
G0 X0.8922 Y1.2230
G1 Z-0.0050
G1 X0.8922 Y1.2230
G1 X0.8946 Y1.2317
G1 X0.8949 Y1.2413
G1 X0.8917 Y1.2536
G1 X0.8875 Y1.2599
G1 X0.8661 Y1.2758
G1 X0.7969 Y1.3155
G1 X0.7526 Y1.2549
G1 X0.7081 Y1.1900
G1 X0.7170 Y1.1818
G1 X0.7247 Y1.1786
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G1 Y-0.0810
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G1 Z-0.0050
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G1 X-0.0222 Y-0.0810
G1 X-0.0241 Y-0.0991
G1 X-0.0271 Y-0.1099
G1 X-0.0322 Y-0.1195
G1 X-0.0427 Y-0.1300
G1 X-0.0550 Y-0.1348
G1 X-0.0879 Y-0.1371
G1 X-0.1188
G1 X-0.1186 Y-0.0596
G1 X-0.1164 Y-0.0227
G1 X-0.1055 Y-0.0214
G1 X-0.0660 Y-0.0227
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G1 X-0.0414 Y-0.0306
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G1 X0.1668 Y-0.1177

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G1 X0.0606 Y-0.1163
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G1 Y0.1015
G1 X0.0296
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G1 X0.0070
G1 Y0.1581
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G1 Z-0.0050
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G1 X-0.0557 Y0.2041
G1 X-0.0525 Y0.1945
G1 X-0.0551 Y0.1836
G1 X-0.0644 Y0.1735
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G1 X-0.0837 Y0.1687
G1 X-0.1430 Y0.1677
G1 X-0.1449 Y0.2177
G1 X-0.0841 Y0.2171

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G1 X-0.0657 Y0.2133
G1 X-0.0647 Y0.2127
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G1 Z-0.0050
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G1 X-0.0531 Y0.2285
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G1 Y0.1581
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G1 X-0.6602 Y0.2098
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G1 X-0.6591 Y0.1791
G1 X-0.6514 Y0.1699
G1 X-0.6406 Y0.1633
G1 X-0.5663 Y0.1406
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G1 X-0.5571 Y0.1253
G1 X-0.5581 Y0.1171
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G1 X-0.5782 Y0.1007
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G1 X-0.6171 Y0.1002
G1 X-0.6257 Y0.1027
G1 X-0.6359 Y0.1091
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G1 X-0.6502 Y0.1298

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G1 X-0.6699 Y0.1281
G1 X-0.6704 Y0.1257
G1 X-0.6672 Y0.1141
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G1 X-0.6537 Y0.0969
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G1 X-0.6269 Y0.0835
G1 X-0.6133 Y0.0807
G1 X-0.5988 Y0.0798
G1 X-0.5840 Y0.0809
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G1 X-0.6340 Y0.1831
G1 X-0.6401 Y0.1913
G1 X-0.6409 Y0.2025
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G1 X-0.6177 Y0.2181
G1 X-0.6009 Y0.2196
G1 X-0.5896 Y0.2184
G1 X-0.5781 Y0.2142
G1 X-0.5690 Y0.2070
G1 X-0.5610 Y0.1964
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G1 X-0.5703 Y0.2318
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G1 X0.5360 Y-0.0622
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G1 X0.5962 Y-0.0026
G1 X0.5757 Y-0.0029
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G1 Y-0.0130

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G0 X0.0338 Y-1.3400
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G1 X-0.0703 Y-1.3762
G1 X-0.0761 Y-1.4561
G1 X-0.0805 Y-1.4950
G1 X-0.0627 Y-1.4947
G1 X-0.0589 Y-1.4931

G1 X-0.0574 Y-1.4898
G1 X-0.0493 Y-1.3857
G1 X-0.0478 Y-1.3435
G1 X-0.0773
G1 X-0.1370 Y-1.4698
G1 X-0.1756 Y-1.3405
G1 X-0.1823 Y-1.3375
G1 X-0.2087 Y-1.3331
G1 X-0.2104 Y-1.3439
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G1 Z-0.0050
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G1 X-0.2818 Y-1.4140
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G1 X-0.3330 Y-1.4045
G1 X-0.3293 Y-1.3949
G1 X-0.2976 Y-1.3403
G1 X-0.2958 Y-1.3411
G1 X-0.2904 Y-1.3625
G1 X-0.2875 Y-1.3764
G0 Z0.0500
G0 X-0.3515 Y-1.3898
G1 Z-0.0050
G1 X-0.3515 Y-1.3898
G1 X-0.3985 Y-1.4589
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G1 X-0.3477 Y-1.4223
G1 X-0.3242 Y-1.4240
G1 X-0.2769 Y-1.4313
G1 X-0.2648 Y-1.4778
G1 X-0.2566 Y-1.4812
G1 X-0.2450 Y-1.4820
G1 X-0.2421 Y-1.4807
G1 X-0.2677 Y-1.3714
G1 X-0.2801 Y-1.3261
G1 X-0.2824 Y-1.3235
G1 X-0.2881 Y-1.3215
G1 X-0.2954 Y-1.3209
G1 X-0.3002 Y-1.3222
G1 X-0.3098 Y-1.3308
G1 X-0.3220 Y-1.3468
G1 X-0.3515 Y-1.3898

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G1 Z-0.0050
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G1 X-0.6560 Y-1.3854
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G1 X-0.6423 Y-1.3841
G1 X-0.6391 Y-1.3806
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G1 X-0.5374 Y-1.4204
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G1 X-0.5341 Y-1.3659
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G1 X-0.5827 Y-1.2536
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G1 X-0.6066 Y-1.2425
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G1 Z-0.0050
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G1 X-0.6324 Y-1.2307
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G1 X-0.6438 Y-1.2241
G1 X-0.6476 Y-1.2253

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G1 X-0.9263 Y1.0437
G1 X-0.9218 Y1.0450
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G1 X-0.8933 Y1.2042
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G1 X-0.8109 Y1.1219
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G1 X-0.8024 Y1.1290
G1 X-0.8036 Y1.1354
G1 X-0.8093 Y1.1437
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G1 X-0.9056 Y1.2466
G1 X-0.9147 Y1.2410
G1 X-0.9195 Y1.2351
G1 X-0.9207 Y1.2283
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G1 X-1.0224 Y1.1699
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G1 X-0.7595 Y1.2017
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G1 X-0.5516 Y1.2468
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G1 X-0.6205 Y1.2171
G1 X-0.6238 Y1.2203
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G1 X-0.6916 Y1.3583
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G1 X-0.5683 Y1.3778
G1 X-0.5578 Y1.3704
G1 X-0.5523 Y1.3655
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G1 X-0.4089 Y1.4474

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G1 X-0.3967 Y1.4330
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G0 Z.1
M5
G0 G53 Z0.0
G53 G0 X0.0 Y0.0
M30