G-ZERO
4th Axis Continuous
for Mills
(WRAP)

GØ
G·ZERO
CAM Software

RAPID
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Contents

Introduction

G-ZERO 4th Axis Continuous (WRAP) is a G-ZERO Mill option that transfers part geometry called out "in the flat to a cylinder. This makes programming easier since you can think of programming in a flat surface, and let G-ZERO wrap it to the part cylinder.

Please note: Your Post Processor must be customized for WRAP before using. If you do not have WRAP, contact your dealer or Rapid Output for purchasing information.

The G-ZERO Mill 4th Axis Continuous option offers you three types of Wraps (optional parameters are enclosed in [brackets]):

- **Normal Wrap:** Wraps around 4th axis.
  %WRAP [Y] [RAD#] [STP#] [ZC#] [FF#]
- **Wrap Control:** Defines part wall for simultaneous XYZA (or XYZB) motions.
  %WRAP CONTROL STP#
  also requires (after control curve is defined):
  %WRAP [Y] [RAD#] [STP#] [ZC#] [FF#] [CUTRAD#] [SKIPLINE]
- **Wrap Locked:** Projects onto cylinder without 4th axis motion.
  %WRAP [Y] RAD# STP# LOCK# [ZC#] [CUTRAD#]

Here are the major differences between these three options:

	WRAP	AXIS MOTION	LOCKED AXIS	Description
NORMAL	X	Y, A (or Y, B)	X	Tool center is always tangent to inner cylinder. Tool perpendicular to cylinder.
	Y	X, A (or Y, B)	Y	
CONTROL	(Set by Normal wrap)	X, Y, Z, A (or X, Y, Z, B)	None	Tool edge is always tangent to inner cylinder. Walls perpendicular to cylinder.
LOCKED	X	X, Y, Z	A (or B)	Tool can go anywhere. Walls parallel to each other.
	Y	X, Y, Z	A (or B)	

Note: Axis motion A and axis motion B refer to 4th axis motion around the X or Y axes depending on how it is set up on your CNC.

Additional Notes

COMP   When programming the COMP command, you must answer the climb/conventional prompt with a 1 (climb), 2 (conventional), or 0 (centerline). Do not use 41 (G41) or 42 (G42) -- your CNCs can't handle Y-axis cutter comp!

Degrees   To program in degrees, omit RAD parameter..
Example: %WRAP STP.05

Feed factor   **Degrees per minute (dpm):** When the CNC's 4th axis requires "degrees per minute," you may need each F (feed) code to be multiplied by a special multiplier (wrap feed factor). Enter this number in the FF section of the WRAP line. Example: if your CNC needs to feed 5.73 times faster in A axis than it does in X axis, your WRAP line should include FF5.73, such a in this case: %WRAP Y RAD1.3 STP.05 ZC0 FF5.73 (Default: the default wrap feed factor (FF) is 1.

Post processor: use #5 (wrap feedrate) in section 3054 in your post.

Inches per minute (ipm): When the CNC's 4th axis requires "inches per minute," you can omit the FF section of the WRAP line.
Post processor: use #3 (standard feedrate) in section 3054 in your post.

%WRAP

For Owners of G-ZERO 4-Axis View Option:
Place %WRAP [ZC#] or %WRAP Y [ZC#] just before the Material command to draw a cylindrical stock.

Note 1: When using WRAP X, you must give non-zero values for xmin and xmax in MAT'L command. XMIN usually controlls part radius.

Note 2: When using WRAP Y, you must give non-zero values for ymin and ymax in MAT'L command. YMIN usually controlls part radius.

Note 3: %ZTOP is ignored when you use WRAP with 4-Axis View option.

Customize axis If your CNC needs A axis instead of B axis (or vice versa), fax your Post Processor changes to: Rapid Output, Technical Support, 888-656-1945 or email to support@g-zero.com.

Wrap Normal

Description %WRAP X: (default) Wrap restrains X axis movement and maps the X to the 4th axis (A axis). The axes that perform the motions are Y and A.

%WRAP Y: Wrap restrains Y axis movement and maps the Y to the 4th axis (B axis). The axes that perform the motions are X and B.

Tool is perpendicular to the part cylinder.

Format %WRAP [Y] [RAD#] [STP#] [ZC#] [FF#] [CUTRAD#] [SKIPLINE]

- ◆ %WRAP: reserved word that tells CNCs that the current line is a machine readable Wrap command.
- ◆ Y: Y axis is the locked axis, and A axis wraps around the X axis. If this character is omitted, it is assumes that X axis is the locked axis, and B axis wraps around the Y axis.
- ◆ RAD: radius of the part cylinder.
- ◆ STP: tool's stepover amount. Arcs are broken into steps with this STP.
- ◆ ZC: Z value for the center of the cylinder.
- ◆ FF: wrap feed factor. Default value is 1.

The next two are only used after a control curve has been defined (See WRAP CONTROL)

- ◆ CUTRAD: drives tool bottom along this radius, instead of cylinder radius.
- ◆ SKIPLINE: shortens g-code output, by breaking only arcs (not lines) into points.

To Use

1. **Type the WRAP comment** in your source program before the MAT'L command.

   Example: %WRAP RAD1.3 STP.05 ZC0

2. **Program the MAT'L command.**
3. **Program the TOOL command.**
4. **Program the MILL command.** You have two options:
   - ◆ If Z0 = center of the cylinder:
     Mill zrapid1.3 zcut1
         zrapid = cylinder radius (1.2) + safe value (.1)
         depth of cut (zcut) = inner radius (1)
   - ◆ If Z0 = edge (top) of the cylinder:
     Mill zrapid.1 zcut-.2
         zrapid = safe value (.1)
         depth of cut (zcut) = negative depth of cut (-.2)

5. **Program the contour in XY** (inches).
6. **Cancel WRAP** effect by typing: %WRAP OFF
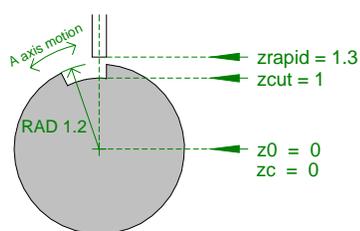
Z0 = center of the cylinder
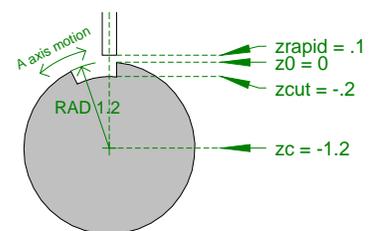
Z0 = edge of the cylinder

Examples

Example #1 **Wrap a contour in X axis with ZC=center of cylinder**

```
1              %WRAP Y RAD1.3 STP.1 ZC0
2    MAT'L     xmin-5 xmax5 ymin-1.3 ymax1.3 thk2.6 type0=ALUMALOY
3      TOOL 1  dia.25 flutes2 type0=HSS MILL rad0 ***
4    MILL      zrapid1.4 zcut1.2 passes1 zret1.4 zf5 xyf5
5    COMP      angle0 cl/con1 lookahead0
6    POINT     x-2 y.5
7    RADIUS    .25 type1 x-1.33771 y.25
8    RADIUS    -.5 type1 x.25 y-1
9    RADIUS    .25 type1 x1.83771 y.25
10   POINT     x2 y.5
11   UNCOMP    angle0
12             %WRAP OFF
```
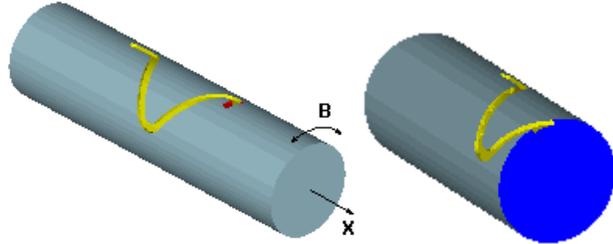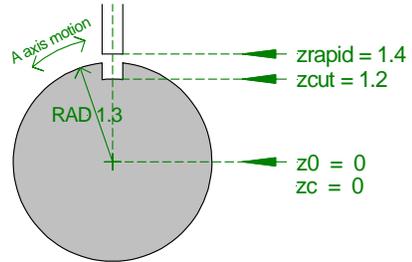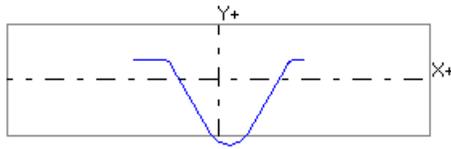

Example #2 **Wrap a contour in X axis with ZC=surface of cylinder**

```
1              %WRAP Y RAD1.3 STP.1 ZC-1.3
2    MAT'L     xmin-5 xmax5 ymin-1.3 ymax1.3 thk2.6 type0=ALUMALOY
3      TOOL 1  dia.25 flutes2 type0=HSS MILL rad0 ***
4    MILL      zrapid.1 zcut-.1 passes1 zret.1 zf5 xyf5
5    COMP      angle0 cl/con1 lookahead0
6    POINT     x-2 y.5
7    RADIUS    .25 type1 x-1.33771 y.25
8    RADIUS    -.5 type1 x.25 y-1
9    RADIUS    .25 type1 x1.83771 y.25
10   POINT     x2 y.5
11   UNCOMP    angle0
12             %WRAP OFF
```
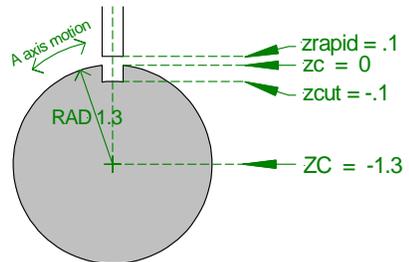
Example #3   **Wrap a contour in Y axis**

```
1                %WRAP RAD1.3 STP.1 ZC0
2    MAT'L       xmin-1.3 xmax1.3 ymin-4 ymax4 thk2.6 type0=ALUMALOY
3     TOOL 1     dia.25 flutes2 type0=HSS MILL rad0 ***
4    MILL        zrapid1.4 zcut.8 passes1 zret1.4 zf5 xyf5
5    COMP        angle0 cl/con1 lookahead0
6    POINT       x.5 y-3
7    RADIUS      -.5 type1 x.5 y-2
8    RADIUS      .5 type1 x-.5 y.25
9    RADIUS      -.5 type1 x.5 y2
10   POINT       x.5 y3
11   UNCOMP      angle0
12               %WRAP OFF
```
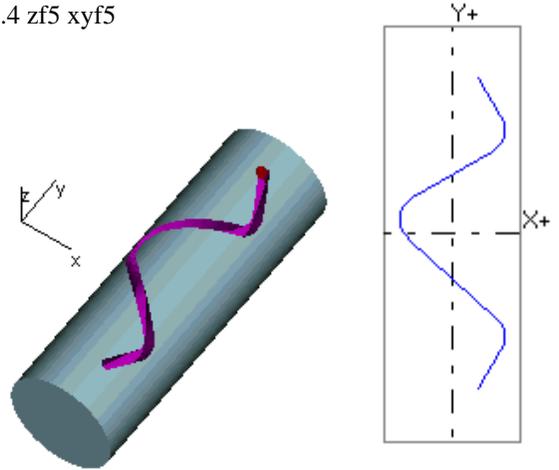

Example #4   **Pocket with island**

```
1                %WRAP Y RAD2 STP.015 ZC0
2    MAT'L       xmin-5 xmax2 ymin-2 ymax2 thk4 type0=ALUMALOY
3     TOOL 1     dia.25 flutes2 type0=HSS MILL rad0 ***
4    MILL        zrapid2.1 zcut1.8 passes1 zret2.1 zf5 xyf5
5    ROUGH       stk0 stp0 angle90 cleanup-1
6    COMP        angle180 cl/con2 lookahead0
7    POINT       x-4 y-2
8    POINT       x-4 y2
9    POINT       x1 y2
10   POINT       x1 y-2
11   POINT       x-4 y-2
12   UNCOMP      angle90
13   MILL        zrapid2.1 zcut1.8 passes1 zret2.1 zf10 xyf10
14   ROUND       dia1.5 x-.5 y0 thru0
15   ROUGH       stk0 stp0 angle90 cleanup-1
16               %WRAP OFF
```
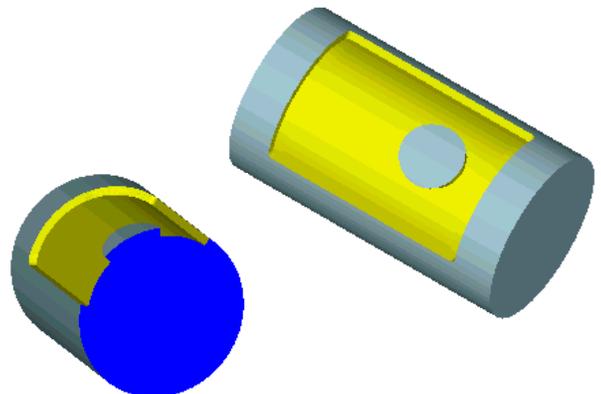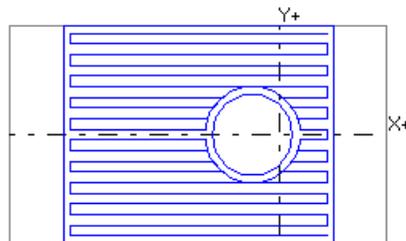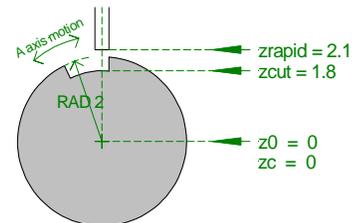
Wrap Control

Description   One of the main differences between the Wrap Control and the other two types (normal and locked) is that wrap control sets a contour called the control curve. The actual cut is then done with a normal wrap command.

All the axes perform motions: X, Y, Z, A (or B). The tool edge is always tangent to the inner cylinder; the walls are perpendicular to the cylinder.

Format   %WRAP CONTROL [STP#]

- ◆ %WRAP CONTROL: reserved word that tells CNCs that the current line is a machine readable Wrap Control command.
- ◆ STP: tool's stepover amount. Arcs are broken into steps with this STP.

To Use

1. **Type the basic WRAP comment** in your source program before the MAT'L command.
   Example 1: %WRAP ZC-1.2
   Example 2: %WRAP Y ZC0

2. **Program the MAT'L command.**

3. **Program the TOOL command.**

4. **Type the WRAP CONTROL comment** line.
   Example: %WRAP CONTROL STP.05

5. **Define control curve.**

6. **Type the Normal WRAP comment** line.
   Note: RAD value controls the depth of cut (zcut value from Mill command is ignored)
   Example: %WRAP Y RAD1 STP.015 ZC0

7. **Program the MILL command.** You have two options:
   - ◆ <u>If Z0 = center of the cylinder:</u>
     Mill zrapid1.3
        zrapid = cylinder radius (1.2) + safe value (.1)
        (Note that zcut value is ignored; depth is controlled by WRAP's RAD)

   - ◆ <u>If Z0 = edge of the cylinder:</u>
     Mill zrapid.1
        zrapid = safe value (.1)
        (Note that zcut value is ignored; depth is controlled by WRAP's RAD)

8. **Program geometry for actual cut in XY** (inches).

9. **Cancel WRAP** effect by typing: %WRAP OFF

A axis motion   zrapid = 1.3
                                                 (depth of cut)
                                                 WRAP RAD = 1
RAD 1.2
                                                 z0 = 0
                                                 zc = 0

A axis motion   zrapid = .1
                                                 z0 = 0
                                                 (depth of cut)
RAD 1.2   WRAP RAD = 1
                                                 zc = -1.2

<u>Z0 = center of the cylinder</u>   <u>Z0 = edge of the cylinder</u>
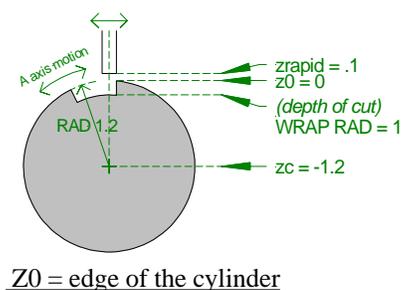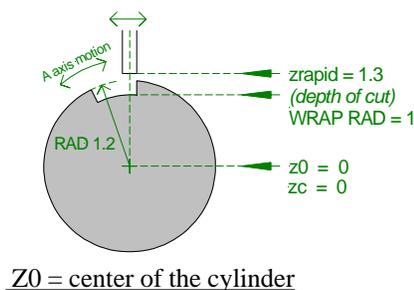
Example

Example #1 **Pocket**

```
1              %WRAP Y ZC0
2    MAT'L     xmin-5 xmax2 ymin-2 ymax2 thk4 type0=ALUMALOY
3    TOOL 1    dia.25 flutes2 type0=HSS MILL rad0 *** %#TL=1
4              %WRAP CONTROL STP.05
5              COLOR 4
6    COMP      angle180 cl/con0 lookahead0
7    POINT     x-4 y-1
8    POINT     x-4 y1
9    POINT     x1 y1
10   POINT     x1 y-1
11   POINT     x-4 y-1
12   UNCOMP    angle90
13             %WRAP Y RAD1.5 STP.015 ZC0
14             COLOR 1
15   MILL      zrapid2.1 zcut1.5 passes1 zret2.1 zf5 xyf5
16   ROUGH     stk0 stp70 angle90 cleanup-1
17   COMP      angle180 cl/con2 lookahead0
18   REPEAT    from7 thru12 ***
19   ROUGH     stk0 stp70 angle90 cleanup-1
20             %WRAP OFF
```

Defines control curve (wall contour) at which we want the tool to step over.
Control curve should not be in COMP unless we use a cl/con of 0 to drive the tool down the center. No tool radius offset.

Defines actual cutting.
Cutter path should be defined without stock to cut the tappered walls.
Adjust the cutter COMP using cl/con of 1 or 2.
RAD (from %WRAP) controls the depth of cut. (zcut value from MILL command is ignored)
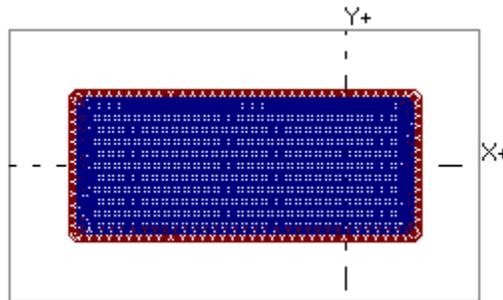
Figure 1
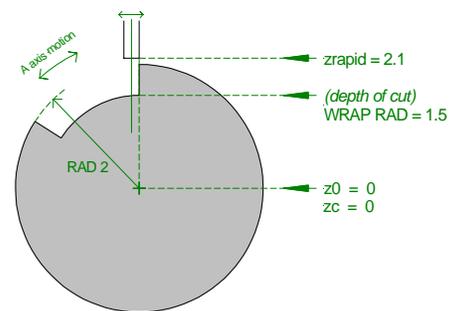
Figure 2

Notice that this source file was programmed to display the control curve in red (COLOR 4) and the actual cut was programmed to display in blue (COLOR 1) as shown in Figure 1.

The control curve (red) forces the actual cutting to be offset a distance equal to the radius of the tool. In this way, the walls of the roughed area will be perpendicular to the cylinder.

Wrap Locked

Description

Some 4th axis cylindrical work is better handled by locking the 4th axis and allowing X and Y to contour normally, while lifting (and lowering) Z. The part walls remain parallel to each other, unlike normal WRAP which normally leaves walls perpendicular to the cylinder surface.

%WRAP X: (default) Wrap Locked assumes your 4th axis is mounted perpendicular to your machine's X axis, so as the tool moves away from X0, it begins to drop. WRAP maps the X to the 4th axis (A axis). Wrap Locked allows you to lock the A axis at a certain angle, and the axes that have motion are X, Y and Z.

%WRAP Y: 4th axis is mounted perpendicular to your machine's Y axis, so as the tool moves away from Y0, it begins to drop. WRAP maps the Y to the 4th axis (B axis). Wrap Locked allows you to lock the B axis at a certain angle, and the axes that have motion are X, Y, and Z.

Format

%WRAP [Y] RAD# STP# LOCK# [ZC#] [FF#]

- %WRAP: reserved word that tells CNCs that the current line is a machine readable Wrap command.
- Y: use this character if you want to program a WRAP Y, and omit it if you want to program a WRAP X.
- RAD: radius of the part cylinder AT TOOL'S BOTTOM.
- STP: tool's stepover amount. Arcs are broken into steps with this STP.
- LOCK: degree at which the 4th axis is locked.
- ZC: Z value for the center of the part cylinder.
- FF: wrap feed factor. Default value is 1.

To Use

1. **Type the WRAP comment** in your source program before the MAT'L command.

   Example: %WRAP RAD1.3 STP.05 LOCK30 ZC0

2. **Program the MAT'L command.**

3. **Program the TOOL command.**

4. **Program the MILL command.** You have two options:
   - If Z0 = center of the cylinder:
     Mill zrapid1.3
       zrapid = cylinder radius (1.2) + safe value (.1)
       (Note: zcut value is ignored; depth is controlled by WRAP's RAD)
   - If Z0 = edge of the cylinder:
     Mill zrapid.1
       zrapid = safe value (.1)
       (Note: zcut value is ignored; depth is controlled by WRAP's RAD)

5. **Program the contour in XY** (inches).

6. **Cancel WRAP** effect by typing: %WRAP OFF

zrapid = 2.1
zcut = 1.5
RAD 2
z0 = 0
zc = 0

Z0 = center of the cylinder
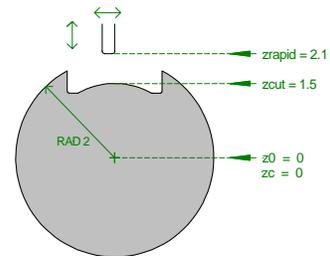
zrapid = 2.1
zcut = 1.5
zcut = 1.5
RAD 2
z0 = 0
zc = 0
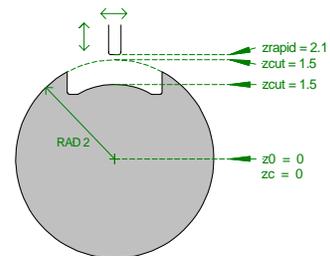
Z0 = edge of the cylinder

Examples

Example #1   **J-Slot**

1		%WRAP Y **RAD1** STP.05 LOCK12.5 ZC-1.2
2	MAT'L	xmin0 xmax4 ymin-1.2 ymax1.2 thk2.4 type0=ALUMALOY
3	TOOL 1	dia.25 flutes4 type0=HSS MILL rad0 *** %TL=2
4	MILL	zrapid.1 zcut-.2 passes1 zret.1 zf5 xyf5
5	ROUGH	stk.02 stp30 angle0 cleanup0
6	COMP	angle0 cl/con1 lookahead0
7	POINT	x0 y-.3
8	LINE	angle0
9	RADIUS	.2 type1 x1.5 y-.5
10	RADIUS	-.2 type0 (xc1.851994 yc-.6900001)
11	LINE	angle0
12	RADIUS	-.2 type1 x2.5 y-.69 (xc1.851994 yc-.6900001)
13	LINE	angle (107.5603)
14	RADIUS	-.2 type1 x2.25 y.1
15	LINE	angle180
16	POINT	x0 y.3
17	UNCOMP	angle180
18	ROUGH	stk.02 stp30 angle0 cleanup0
19		COLOR 13
20	MILL	zrapid.1 *zcut-.2* passes1 zret.1 zf50 xyf50
21	REPEAT	from6 thru17 ***
22		%WRAP OFF
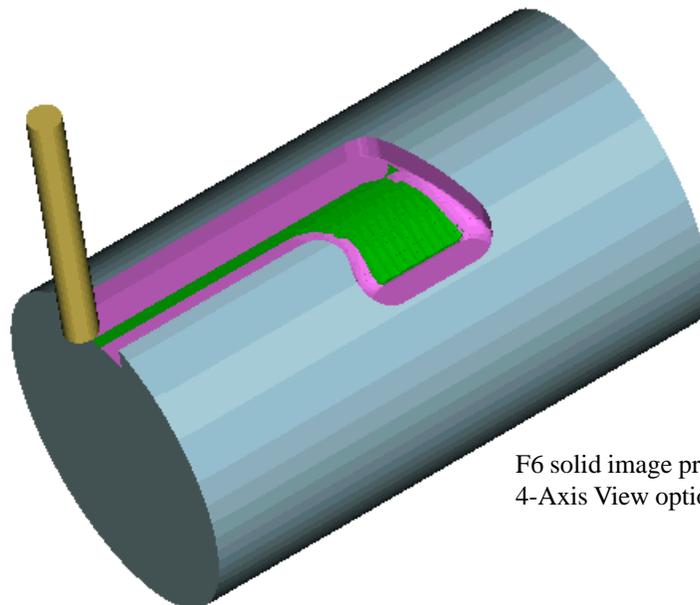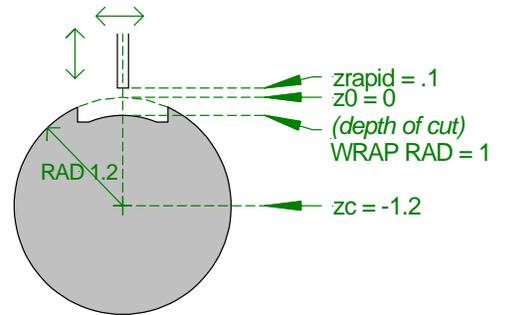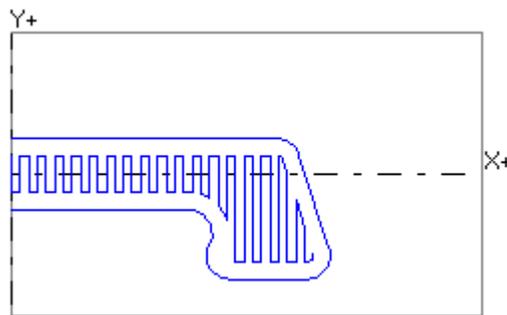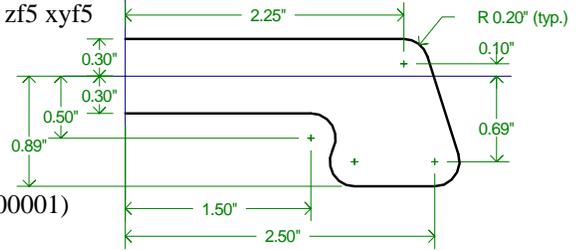
F6 solid image produced with G-ZERO's 4-Axis View option