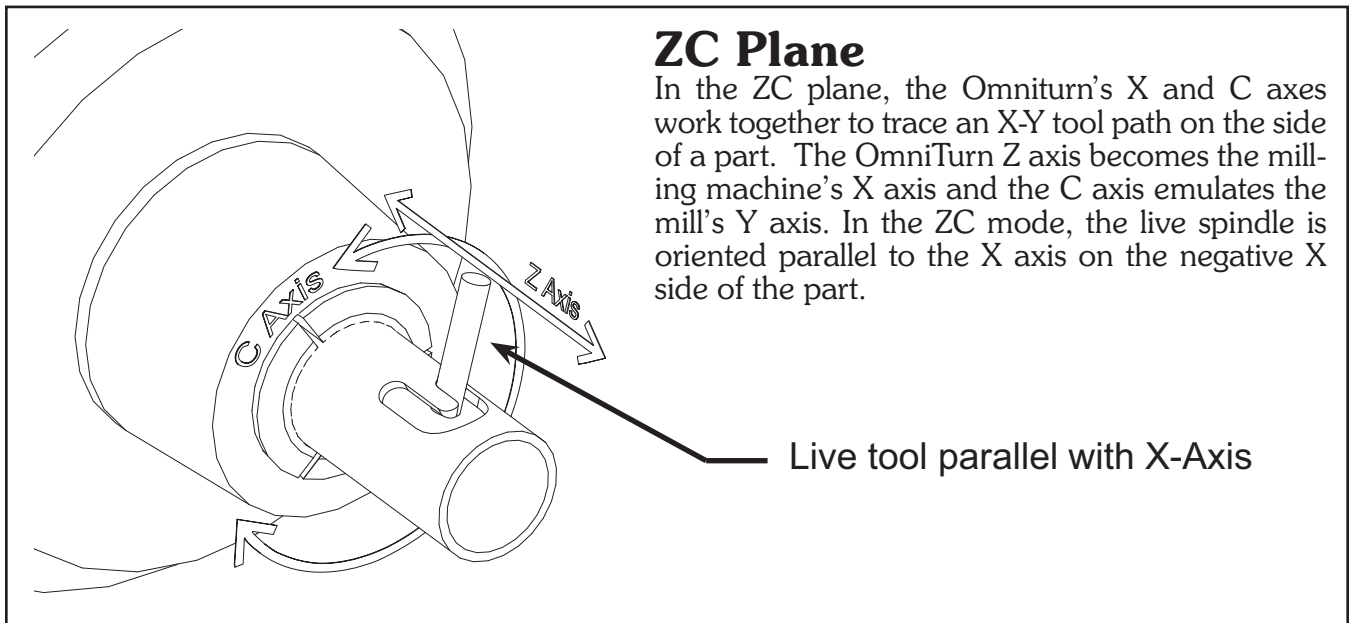
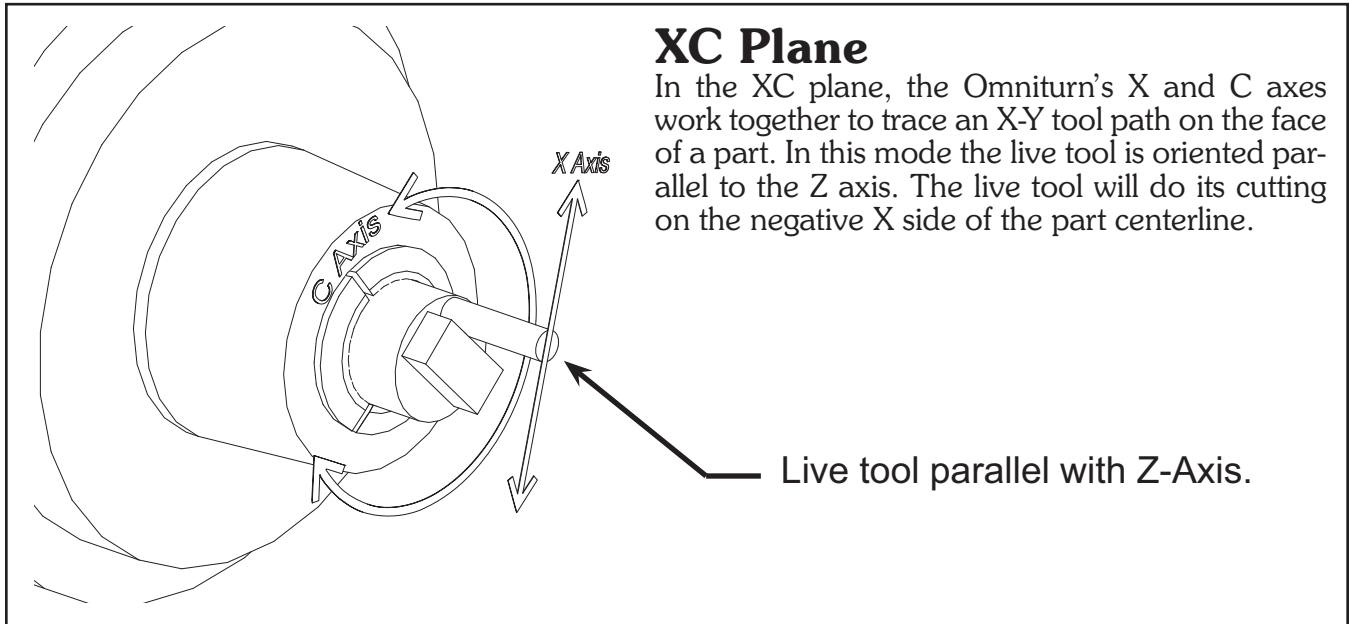


Spindle Positioning

C-Axis Plane Switching

Plane switching allows the programming of parts using the C axis in combination with the X or Z axis as if you were programming a milling machine.

There are two plane-switched modes: XC and ZC:



Spindle Positioning

C-Axis Plane Switching: Commands

The programming details for plane switching are not yet finalized, so currently plane-switching commands need to be hidden from the error checking software by placing them in parentheses. The only commands permitted in the plane-switched part of the program are axis moves and feedrate commands. There is no cutter compensation, so it is up to you to write the program for the endmill you are using. All dimensions in the plane-switched mode are in absolute coordinates.

The commands are as follows:

(~PLXC): Start XC mode. The tilde character “~” in a (comment) alerts the Omniturn’s parsing program to scan for a plane switching command.

(~PLZC): Start ZC mode. The tilde character “~” in a (comment) alerts the Omniturn’s parsing program to scan for a plane switching command.

(Xnn): moves the X axis to the specified coordinate

(Ynn): moves the Y axis to the specified coordinate

(G02XnnYnnInnJnn): moves X and Y to the specified coordinates clockwise along a circular path with its center located at the I dimension in X and the J dimension in Y.

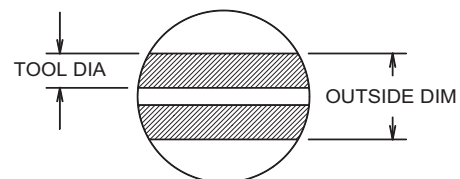
(G03): same as G02 but travels CCW along the arc.

(Fnnn): feedrate specified in inches per minute

(Znn): moves the virtual mill’s Z axis.

In the ZC plane, the Z dimension is specified as the diameter of the cylinder the tool’s tip would touch. In the XC plane, the Z axis is the same as it would be if plane switching was not in effect.

(Hnn)(XC plane only): how far the the centerline of the live tool is above 1/2”; should be first block after (~PLXC). Easily determined by cutting two slots in face 180° apart. Measure outside distance, subtract tool diameter, then divide by two.



(Dnn)(ZC plane only): specifies the part diameter at which the Y dimensions are translated to C axis rotation.

This value defaults to the virtual mill’s Z position (that is, the diameter at the tool’s tip) at the start of the plane-switched operation.

It should only be changed when the Y position is 0, since it causes a re-scaling of the Y dimensions on the first move after it is programmed.

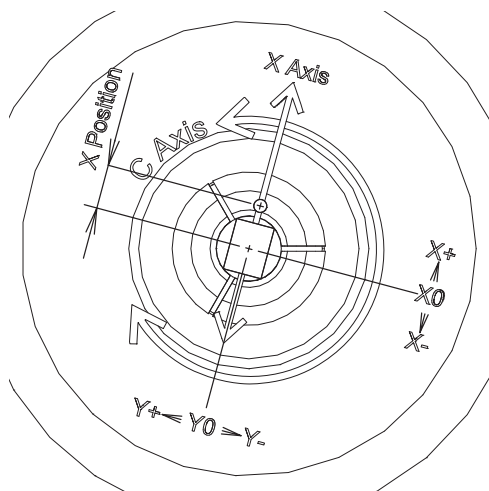
(END): cancel plane-switch mode

Note: if you copy the plane-switch programs, do not include comments in the plane switched section. Nothing is allowed in the plane-switched program except the program statements described above.

Spindle Positioning

C-Axis Plane Switching: Using the XC Plane

In this mode the live tool works on the face of the part.



The XC mode is started with the command (\sim PLXC).

Before entering this command the live tool must be located on the negative X side of the part, with its spindle centerline parallel to the lathe's Z axis.

On entry, the Y position is 0, and the X position is the distance from the spindle center to the center of the tool.

The computer constantly calculates the tool's X-Y position along the programmed path, and the X-Y coordinates are converted to polar coordinates, with X axis motion controlling the distance from center and C axis rotation controlling the angle.

As seen from the tool's point of view, motion to the right is X+ and up is Y+.

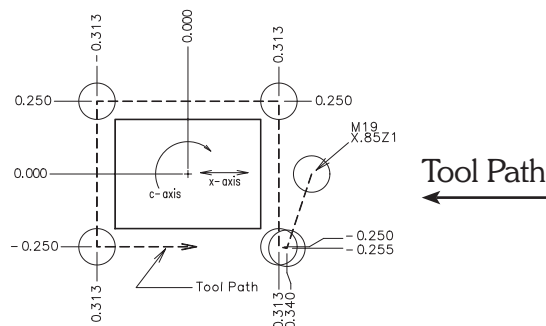
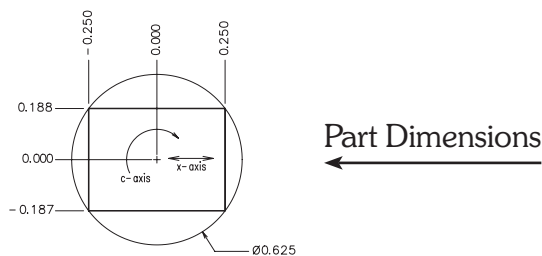
The Z axis remains the same as in normal turning mode.

C-Axis XC Plane Switching Programming

The following programs use a 1/8" endmill to cut various shapes on the end of a 5/8" bar. Note that the programmed dimensions allow for the cutter size

The first program cuts a 3/8" x 1/2" square (5/8" diagonal measurement). Note that it begins cutting at a corner of the square and goes around the outside of the square in a CCW direction. Starting at the corner minimizes the initial chip load, which reaches its maximum at the center of each side. Going around the part CCW (conventional cutting) avoids the tendency of small cutters to dig in and snap off when climb cutting.

```
g90g94g72f300
m19 (c-axis at 0° absolute)
t21 (live tool)
x-.85z1 (safe location)
f100z.05
f10z-.1 (at depth)
m27 (turn on live tool)
( $\sim$ PLXC) start XC mode
(x.340y-.255) safe near corner
(x.313y-.250) at first corner
(x.313y.250) next corner
(x-.313y.250) third corner
(x-.313y-.250) fourth
(x.313y-.250) back at first
(end) end plane-switch mode
f200Z1.5
m30
```



Spindle Positioning

C-Axis XC Plane Switching: Programming continued

These programs use a 1/8" endmill to cut various shapes on the end of a 5/8" bar. Note that the programmed dimensions allow for the cutter size

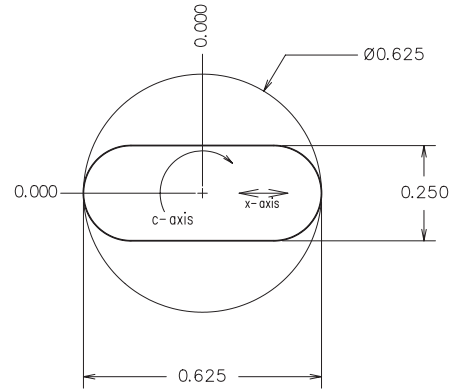
Note: if you copy these programs, do not include comments in the plane switched section. Nothing is allowed in the plane-switched program except the program statements described above.

This program cuts an oval 5/8" long by 1/4" wide.

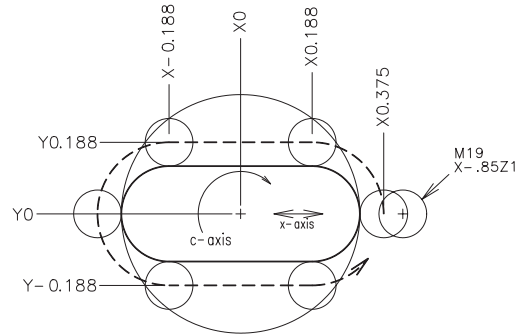
```

g90g94g72f300
m27
m19
t21
x-.85z1
f100z.05
f5z-.1
(~PLXC)
(x.375y0) right end of oval is .3125" from center, +.0625 cutter radius
(g03x.1875y.1875i.1875j0) ccw turn 90 deg w/.1875 radius,
(x-.1875)
(g03x-.375y0i-.1875j0)
(g03x-.1875y-.1875i-.1875j0)
(x.1875)
(g03x.375y0i.1875j0)
(x.4)
(end)
f200Z1.5
m30
    
```

Part Dimensions



Tool Path

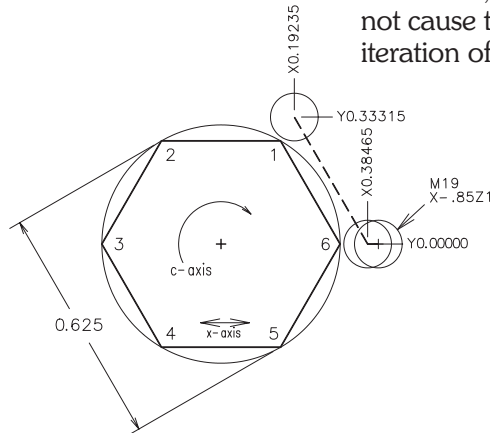


This one uses looping to cut 6 flats.

```

g90g94g72f300
m03s1000
g04f5
m05
m27
m19
t21
x-.85z1
f100z.05
f5z-.1
ls6
(~PLXC)
(x.38465y0)
(x.19235y.33315)
(end)
x-.8
lf
m05
f200Z1.5
m30
    
```

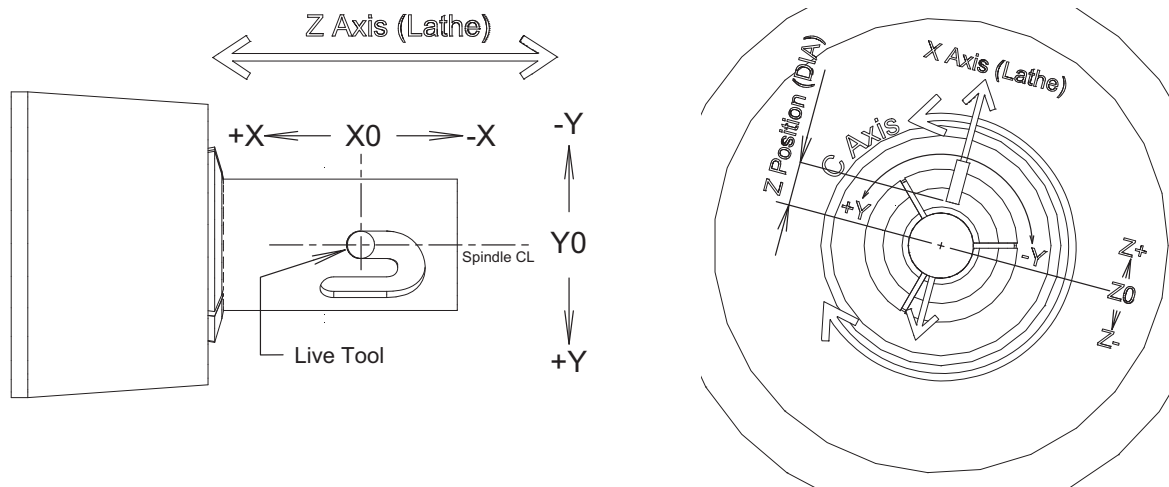
As each flat is cut, the spindle turns 1/6 of a revolution; canceling plane-switch mode does not cause the spindle to move, so on the next iteration of the loop, the next flat is cut.



Spindle Positioning

C-Axis Plane Switching: Using the ZC Plane

In this mode the live tool works on the side of the part.



The ZC mode is started with the command (\sim PLZC).

Before entering this command the live tool must be located on the negative X side of the part, with its spindle centerline parallel to the lathe's X axis.

On entry, the tool is centered at X0 and Y0 position in the virtual milling machine, so before switching planes you need to locate the Z and C axes to the location you want to be X0,Y0 on the part surface. **NOTE:** You must accommodate the tool diameter, and program accordingly.

X positive motion is to the right (toward the spindle face) as viewed from the live spindle's point of view, and Y positive motion is up from the live tool's point of view.

The virtual mill's Z axis is set to the X position prior to the plane switch, but the sign is inverted, so that a positive Z move moves the tool tip away from the part center.

Because most lathe programming refers to radial positions as diameters, Z dimensions are given as the diameter of the cylinder the tool tip would touch.

For example, in this code:

```
g72g94f300
m19
T11(call up live tool)
x-1z.5 (tool is at a 1inch diameter on -X side of part)
z-.2
( $\sim$ plzc) plane switch mill position is x0,y0,z1
(f5z.85) tool tip moves in to cut at a diameter of .85
```

Note that the z.85 command moves the tool tip **in** toward the center of the part.

Spindle Positioning

C-Axis ZC Plane Switching: Programming

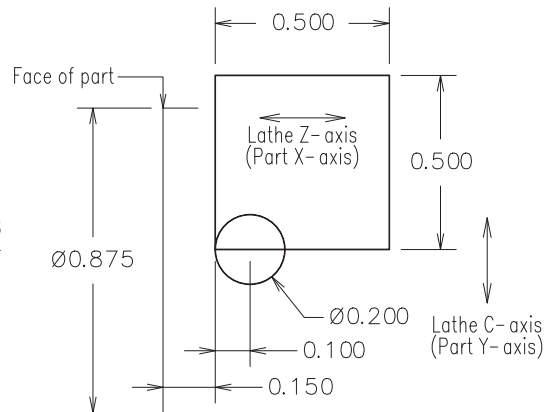
These examples were cut in a 7/8" delrin bar with a 1/16" end mill.

Note: if you copy these programs, do not include comments in the plane switched section. Nothing is allowed in the plane-switched program except the program statements described above.

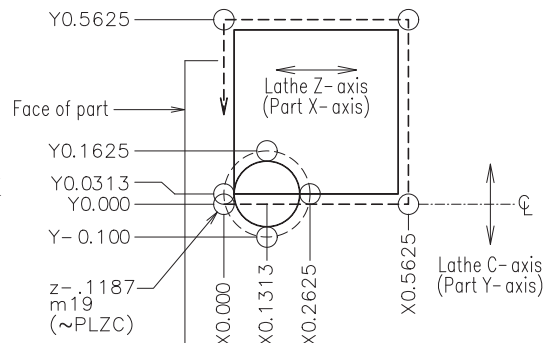
This one does a 1/2" square with a .2" diameter circle in the lower left corner.

```
g90g72g94f100
m27
t11
x-1z1
z-.1187 (x0y0 on virtual mill puts edge of square at Z-0.150)
m19 (enable C axis)
(~PLZC) start ZC mode
(f10)
(z.85) feed tool into workpiece
(d.875) set diameter for Y axis scaling
(x.5625) move toward spindle face .5+ tool diameter
(y.5625) up .5625
(x0) back to start in X
(y0) then Y
(y.0313) start point for circle
(g02x.1313y.1625i.1313j.0313) do a cw circle in 4 segments centered at x.1313,y.0313
(g02x.2625y.0313i.1313j.0313)
(g02x.1313y-.1i.1313j.0313)
(g02x0y.0313i.1313j.0313)
(z1) withdraw tool
(end) cancel plane-switch mode
x-1
z1
m30
```

Part Dimensions



Tool Path



Spindle Positioning

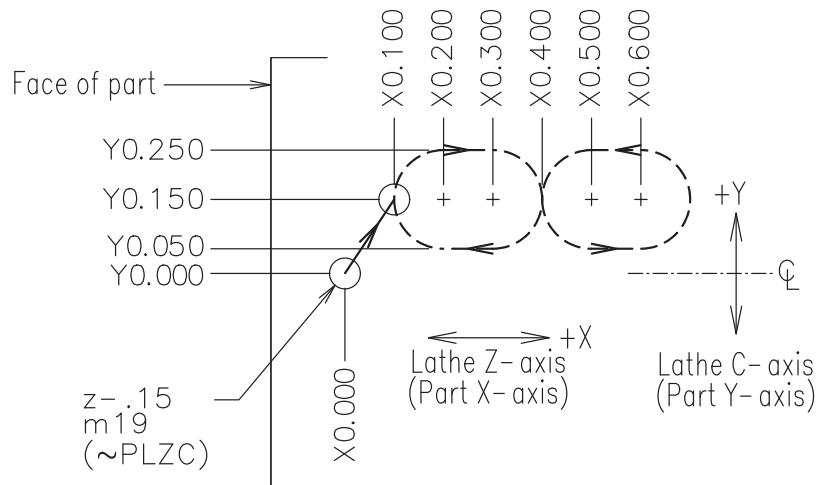
C-Axis ZC Plane Switching: Programming *continued*

These examples were cut in a 7/8" delrin bar with a 1/16" end mill.

Note: if you copy these programs, do not include comments in the plane switched section. Nothing is allowed in the plane-switched program except the program statements described above.

This one does a figure-8 pattern consisting of 2 oval "racetrack" patterns joined together.

```
g90g72g94f100
m27 (turn on live tool)
t11
x-1z1
z-.15 (x0y0 on virtual mill)
m19 (turn on C axis)
(~PLZC) start CZ mode
(d.875) set Y axis scaling to 7/8" diameter
(x.1y.15f20) move to starting X-Y position
(z.775f10) plunge tool in to a depth of .05"
(g02x.2y.25i.2j.15) cw 90 deg arc moving right .1", up .1" centered at x.2, y.15
(x.3) straightaway to the right .1"
(g02x.4y.15i.3j.15) another 90 deg. cw arc
(g03x.5y.05i.5j.15) now a ccw 90 deg arc
(x.6) bottom straight on right-hand oval
(g03x.6y.25i.6j.15) ccw 180 deg arc
(x.5) top straight on right oval
(g03x.4y.15i.5j.15) ccw arc back to start of right oval
(g02x.3y.05i.3j.15) cw arc to bottom straightaway of left oval
(x.2) bottom straight
(g02x.1y.15i.2j.15) cw arc back to start point
(z1) withdraw cutter
(end) cancel plane-switch
x-1
z1
m30
```



Spindle Positioning

C-Axis ZC Plane Switching: Programming *continued*

These examples were cut in a 7/8" delrin bar with a 1/16" end mill.

Note: if you copy these programs, do not include comments in the plane switched section. Nothing is allowed in the plane-switched program except the program statements described above.

This cuts a J-slot like those found on electrical connector housings.

```
g90g72g94f100
m27 (turn on live tool)
t11
x-1z1
z.075 (x0y0 on virtual mill)
m19 turn on C axis
(~PLZC) start ZC mode
(d.875) set Y axis scaling to 7/8" diameter
(z.775f10) move in to a cut depth of .05"
(x.475) cut straight side of J
(g02x.675y-.2i.475j-.2) right turn at end of long side
(y-.3) short straight segment
(x.375) move back in x to create detent notch
(z1) withdraw tool
(end) cancel plane switch
x-1
z1
m30
```

