# AZpost

## User Guide

to

Multi-Axis Vertical Machining Centers

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**Postprocessor vocabulary and syntax is based on and complies with the ANSI X3.37-199X Standard (June 30, 1992) for APT programming Language. Working draft published as X3J7/55-323-06-92**

| UPDATE | DATE | AUTHOR | REASON |
|---|---|---|---|
| A0000 | 12/15/2004 | LJones | Initial delivery |

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# AUXFUN syntax.

Output an auxiliary machine function using the M0 register. This code is usually output with an "M" letter and a two digit integer code, but depends on the word address and format specification of the predefined M0 register.

Effect of configuration file on AUXFUN output:

Word address and format of M0 register

AUXFUN effect on configuration file:

None

APT Syntax

```
AUXFUN / m
```

| APT example | | Example machine code |
|---|---|---|
| AUXFUN / 5 | ===> | M05 |

# BREAK Syntax.

```
Break the machine output file.
Causes the current machine output file (.ncd) to end
and a new output file to be started.  Each new output
file will have the same base name with a sequential
integer number appended to it.

Causes a warning to be output in the .NCL file when
the .NCD file exceeds the specified SIZE in bytes.

APT Syntax:
-----------
BREAK / [SIZE, n]

Example:
-------------
GOHOME
BREAK                          End file 123456.ncd
PARTNO 123456 (tape file 2)    Start file 123456.nc2
FROM/ 0.0, 0.0, 10.5
```

# CIRCLE & CYLNDR syntax.

Defines the circular interpolation information for output to the machine code file.

---

Effect of configuration file on CIRCULAR output:

Word address and format of G1,I,J,K,R registers
Values for CLW & CCLW set with G1 register

CIRCULAR effect on configuration file:

None

APT Syntax

---

```
INDIRV/ x-value, y-value, z-value

TLON,GOFWD/(CIRCLE/ x-center,y-center,z-center,radius),$
          ON,(LINE/ x-center,y-center,z-center,       $
                    x-endpnt,y-endpnt,z-endpt)

        ---- or ----

TLON,GOFWD/(CIRCLE/ x-center,y-center,z-center,radius),$
 ON, 2,INTOF,(LINE/ x-center,y-center,z-center,       $
                    x-endpnt,y-endpnt,z-endpnt)

        ---- or ----

TLON, GOFWD/   (CYLNDR/ x-center, y-center, z-center,$
                        i-value,  j-value,  k-value, radius),$
ON,2,INTOF, (PLANE/ (POINT/ x-center,y-center,z-center),$
                    (POINT/ x-endpnt, y-endpnt, z-endpnt), $
                    (POINT/ x-center, y-center, z-center))

        ---- or ----

TLON, GOFWD/ (CYLNDR/ x-center, y-center, z-center,$
                      i-value,  j-value,  k-value,  radius),TANTO,$
     (PLANE / (POINT/ x-endpnt, y-endpnt, z-endpnt),$
    ,PERPTO, (VECTOR/ i-value,  j-value,  k-value))

where: x-center, y-center, z-center = arc center point coordinates

       x-endpnt, y-endpnt, z-endpnt = arc end point coordinates

       x-value, y-value, z-value    = direction vector values
```

```
Example:
-----------
INDIRV/     .00000,    1.00000,     .00000

TLON,GOFWD/   (CIRCLE/   16.00000,   11.00000,  .00000, 4.00000),$
             ON,(LINE/   16.00000,   11.00000,  .00000,$
                         16.00000,   15.00000,  .00000)


Example machine code
--------------------
G03 X16. Y15. I-4. J0.
```

# CLAMP Syntax.

Controls the clamping of the rotary axes.

```
APT Syntax:                      NCData:
------------                     ----------
 CLAMP / ON              ===>  M10
                         ===>  M12

         OFF             ===>  M11
                         ===>  M13

 CLAMP / AAXIS, ON       ===>  M10
                OFF      ===>  M11

 CLAMP / BAXIS, ON       ===>  M12
                OFF      ===>  M13

 CLAMP / AUTO            ===>  ACCORDING TO AXIS MOTION
```

# CLEARP syntax.

Used to define a clearance plane parallel to the part origin XY Plane for reference by other postprocessor functions such as RETRCT, LOADTL and CYCLE. This statement also sets the the value of the macro variable "CLEARP" used in the configuration file.

Effect of configuration file on CLEARP output:

None

CLEARP effect on configuration file:

Sets value of CLEARP variable for use in Macro section

```
Syntax:                          NCdata:
------------                     -----------
CLEARP / d              ===>     No output
         ON
         OFF
```

where:
d = distance from the origin of the XY plane

used by RETRCT and CYCLE

```
Example:                                        NCdata
-----------                                     -----------
CLEARP / 5.5                              ===>  No output
CYCLE/ DRILL, DEPTH, 1.5, CLEAR, .06      ===>  No output
GOTO/ 4.0, 6.0, 3.0                       ===>  G00 X4. Y6. Z5.5
                                          ===>  G81 X4. Y6. Z.5 R3.06
```

# COOLNT syntax.

APT syntax used to specify for output the desired coolant feature to the machine code file. If syntax is specified after LOAD and before GOTO syntax the output will be held for output by RESTAR macro.

Effect of configuration file on COOLNT output:

Word address and format of M2 register
Values for minor words set with M2 register

COOLNT effect on configuration file:

Sets value of COOLNT variable for use in Macro section

| APT Syntax | | Example machine code |
|---|---|---|
| COOLNT / ON | ===> | M08 |
| FLOOD | ===> | M08 |
| MIST | ===> | M07 |
| THRU | ===> | M20 |
| TAP | ===> | M21 |
| AIR | ===> | M22 |
| OFF | ===> | M09 |

# CUTCOM syntax.

APT syntax used to specify the desired Cutter Radius Compensation function to the machine code file. Syntax should be used before a linear motion (GOTO) is programmed.

Effect of configuration file on CUTCOM output:

Word address and format of G7 register
Values for minor words set with G7 register

CUTCOM effect on configuration file:

None

| Syntax: | | NCData: |
|---|---|---|
| CUTCOM / RIGHT [,n ]<br>LEFT<br>OFF | ===> | applies to next motion |

Where n = register number
Register number = tool unless specified

| APT Example | | Example machine code |
|---|---|---|
| LOAD/TOOL,2 | ===> | M6 T3 |
| CUTCOM / RIGHT | ===> | No output |
| GOTO / 1, 2, 3 | ===> | G42 X1. Y2. Z3. D3 |
| CUTCOM / OFF | ===> | No output |
| GOTO / 2, 3, 3 | ===> | G40 X2. Y3. |

Note: applies only to the next motion

# CUTTER Syntax.

Defines the current cutter configuration. The only value used by the postprocessor is the "d" diameter value. This value is used for computing spindle speed and feed rates when constant surface speed "SFM" is used in the "SPINDL" statement and must be greater than zero.

| Syntax: | NCdata: |
| --- | --- |
| CUTTER / d, r [, e, f, a, b, h] | No output |

where: d = cutter diameter
r = cutter radius
e = radial corner offset
f = axial corner offset
a = tip angle
b = flank angle
h = cutter height

Example:

```
CUTTER / .5, .125, .125, .125, 0.0, 0.0, 5.0
```

# CYCLE syntax.

APT syntax used to specify for output the desired CYCLE type to the machine code file.

Effect of configuration file on CYCLE output:

Word address and format of G9,Z1,RR & QQ register
Values for CYCLE type set with G9 register

CYCLE effect on configuration file:

None

Syntax:
---

```
CYCLE/ EXPAND, ON                    - Expands CYCLEs into G01 motion.
               OFF                   - Turns off CYCLE expansion.

CYCLE/ ON                            - Turns last cycle
       OFF                           - Turns cycle mode

CYCLE/ DRILL, CLEAR, c, DEPTH, d, UPM, f
              RAPTO                  UPR

CYCLE/ CSINK, CLEAR, c, DIAMTR, d UPM, f [,TLANGL,a]
              RAPTO                  UPR

CYCLE/ TAP, CLEAR, c, DEPTH, d, LEAD, f
            RAPTO                 TPI

CYCLE/ CBORE, CLEAR, c, DEPTH, d, UPM, f [,DWELL,p]
              RAPTO                  UPR      REV, p

CYCLE/ DEEP, STEP, q, CLEAR, c, DEPTH, d, UPM, f
             DECR     RAPTO                 UPR

CYCLE/ BRKCHP, STEP, q, CLEAR, c, DEPTH, d, UPM, f
               DECR     RAPTO                 UPR

CYCLE/ FBORE, CLEAR, c, DEPTH, d, UPM, f , OFFSET,q
              RAPTO                  UPR      NODRAG

CYCLE/ BORE, CLEAR, c, DEPTH, d, UPM, f [,DWELL,p]
       REAM  RAPTO                 UPR      REV, p

CYCLE/ BORE6, CLEAR, c, DEPTH, d, UPM, f , DRAG
       BORE   RAPTO                  UPR

CYCLE/ BORE7,  CLEAR, c, DEPTH, d, OFFSET,q, UPM,f, MANOP
       PULBOR  RAPTO                 NODRAG     UPR
```

```
CYCLE/ BORE8, CLEAR, c, DEPTH, d, UPM, f ,DWELL,p , MANOP
       BORE   RAPTO               UPR     REV

CYCLE/ BORE9, CLEAR, c, DEPTH, d, UPM, f ,DWELL,p
       BORE   RAPTO               UPR     REV

CYCLE/ MILL, DIAMTR, c, DEPTH, d, PITCH, k, UPM, f
                                            UPR
       [NPASS, n, STEP, s]

CYCLE/ THREAD, DIAMTR, c, DEPTH, d, PITCH, k, UPM, f
                                              UPR
```

where:
- c = Clearance from part surface
- d = Depth from part surface
- f = Feed rate in either IPM,IPR,MMPM,MMPR (thread LEAD or Threads Per Inch for TAP)
- p = Dwell at bottom of operation in either seconds or REVolutions
- q = Delta step depth for DEEP or BRKCHP drill
- k = Pitch value for helical milling cycle
- s = Radial pass depth of cut

Note: TAP or Counter TAP cycle is selected based on programmed spindle direction G84 for (CLW) or G74 for (CCLW)

RTRCTO modifier can be added to all cycle types to output G98 vs G99 on cycle activation

APT Syntax

```
CYCLE / DRILL, DEPTH, 1.0, CLEAR,.06, IPM, 10,
```

```
                                    Example machine code
                                    ----------------------------
GOTO / 5.0, 7.5, 0.0          ==>   G81 G99 X5. y7.5 Z-1. R.06 F10
```

# DEBUG Syntax.

This postprocessor function causes printing of AZpost system variable values in the partno.NCL listing file. These values are printed to help analyze a problem with the postprocessor.

APT Syntax

```
DEBUG /  SEC4, 0          Turns debug off
               1          High level variables
               2          Low level variables
```

# DELAY syntax.

APT syntax used to specify the desired program dwell to the machine code file.

Effect of configuration file on DELAY output:

Word address and format of PP register

DELAY effect on configuration file:

None

APT Syntax
---
DELAY / REV, r
s

where: s = Dwell in (SEConds or REVolutions)

| APT Example: | | Example machine code |
|---|---|---|
| DELAY / 2, SEC | ===> | G04 P2.0 |

# DISPLY syntax.

APT syntax used to specify comments in the output listing file and the machine code file.

Effect of configuration file on DISPLY output:

None.

DISPLY effect on configuration file:

None.

APT Syntax
---
DISPLY character text

Where: character_text = alpha-numeric character string will be included in machine code file.

| APT Example | | Example machine code |
|---|---|---|
| DISPLY THIS IS A MESSAGE | ===> | (THIS IS A MESSAGE) |

# END syntax.

APT syntax used to specify the end of the program. Mostly used for continuous loop to the program start type of programs.

Effect of configuration file on END output:

Word address and format of M5 register.
Values set with M5 register in configuration file.
Contents of the PRGEND macro.

END effect on configuration file:

None

Syntax

```
END
```

| APT Example | | Example machine code |
|---|---|---|
| END | ===> | M09<br>G0 G53 H0 ZO.<br>X0. Y0.<br>M2 |

# FEDRAT syntax.

APT syntax used to specify the desired feed rate to the machine code file. If syntax is specified after LOAD and before GOTO syntax the output will be held for output by RESTAR macro.

Effect of configuration file on FEDRAT output:

Word address and format of FF register

FEDRAT effect on configuration file:

Sets value of FEED variable for use in Macro section

Syntax:

```
FEDRAT / (UPM), f
         UPR
         IPM
         IPR
         MMPM
         MMPR
         MAXIPM        Sets maximum cutting feed rate
         FAST          Sets positioning feed rate for CYCLE expansions
```

where: f = feed rate value in the specified units

```
APT Example:                      Example machine code
-----------                       --------------------
FEDRAT / 8, IPM           ===>
GOTO / 5.0, 6.0, 0.0      ===>    G01 X5. Y6. Z0. F8.
```

# FINI syntax.

APT syntax used to specify the end of the program input.  This syntax causes the postprocessor to produce reports is specific output files and close all input and output files.

Effect of configuration file on FINI output:

SET/ FOOTER in section one of configuration file.

FINI effect on configuration file:

None

APT Syntax
---
FINI

# FROM syntax.

APT syntax used to specify the initial machine position at program start. The values of X,Y & Z axis specified set the postprocessor HOME positions. This syntax must be specified prior to first LOAD and GOTO syntax. This syntax outputs the initial machine code block.

Effect of configuration file on FROM output:

Contents of the FROM macro in section three of configuration file.

FROM effect on configuration file:

None.

APT Syntax:

```
---------
FROM / x, y, z [,i ,j ,k]
```

| APT Example | | Example machine code |
|---|---|---|
| FROM / 0, 0, 0 | ===> | G90 G20 G80 G40 |

# GODLTA syntax.

APT syntax used to specify an incremental machine position relative to the previous motion. The values of X,Y & Z axis specified are the incremental values. The I J & K values are the vector components of the unit tool axis.

Effect of configuration file on GODLTA output:

None.

FROM effect on configuration file:

None.

APT Syntax:

```
---------
GODLTA / x, y, z [,i ,j ,k]
```

```
APT Example                                    Example machine code
-----------                                    -----------
GOTO   / 1.0, 2.0, 3.0, 0.0, 0.0, 1.0
GODLTA / 0.0, 0.0, .50, 0.0, 0.0, 1.0 ===> X1.0 Y2.0, Z3.5
```

# GOHOME syntax.

APT syntax used to specify machine motion to the machine home position.

Effect of configuration file on GOHOME output:

Contents of GOHOME macro in section three of configuration file.

GOHOME effect on configuration file:

Sets value of HOMEX, HOMEY and HOMEZ variables for use in Macro section.

APT Syntax:
---
GOHOME [/ XAXIS ][, YAXIS ][,ZAXIS ]

| Example: | | Example machine code |
|---|---|---|
| FROM / 0, 0, 0 | ===> | G90 G20 G80 G40 |
| GOHOME/ ZAXIS | ===> | G91 G28 Z0. |

# GOTO syntax.

APT syntax used to specify the desired linear machine motion. The first GOTO syntax after LOAD/TOOL syntax causes the RESTAR macro activation.

The current feed rate is used unless the command is preceeded with a "RAPID" command.

Note: when ADJUST,OFF is programmed in LOAD/TOOL a component of tool LENGTH + PIVOTZ is added to the output of all motion blocks as follows:

```
   Xaxis = Xapt + (Iapt * (length + pivotz))
   Yaxis = Yapt + (Japt * (length + pivotz))
   Zaxis = Zapt + (Kapt * (length + pivotz))
```

Effect of configuration file on GOTO output:

SET/ CLIPZ, value is used to ignore GOTO if Z-axis is over value.
Word address and format of G1, XX, YY, & ZZ registers.
First GOTO after LOAD/TOOL syntax activates RESTAR macro.

GOTO effect on configuration file:

None.

Syntax:

```
--------
GOTO / x, y, z [,i ,j ,k]

where:  x, y, z  =  coordinate position
        i, j, k  =  tool axis vector components

if RAPID and x = 0 and y = 0 and z > CLIPZ value then motion is ignored
```

| APT Example: | | Example machine code |
|---|---|---|
| GOTO / 1, 2, 3 | ===> | G01 X1. Y2. Z3. |

# INDIRV syntax.

APT syntax used before a CIRCLE or CYLNDR syntax to indicate the direction of travel on the circle by using unit vector components as a direction vector from the current position.

Effect of configuration file on INDIRV output:

None.

INDIRV effect on configuration file:

None.

APT Syntax:
---
INDIRV/ X-Component, Y-Component, Z-Component

Example:
---
INDIRV / 1, 0, 0 direction in plus X-axis

# INSERT syntax.

APT syntax used to specify a literal output machine block. This syntax is not checked for correctness or completeness. This syntax is mostly used to output blocks of special characters. Use of '/' immediately following INSERT causes sequence numbers to be added immediately before character text.

Effect of configuration file on INSERT output:

None.

INSERT effect on configuration file:

None.

APT Syntax:

```
--------
INSERTcharacter text
       or
INSERT/character text
```

| APT Example: | | Example machine code |
|---|---|---|
| INSERTG80G49 | ===> | G80G49 |
| INSERT/G80G49 | ===> | N12G80G49 |

# INTOL Syntax.

This APT syntax specifies the tolerance used when creating linear tool path points inside the part drive surface CIRCLE or CYLNDR.

```
APT Syntax
------------
INTOL /  value
```

Where value is the distance from the circle allowed.

# LIMITS syntax.

APT syntax used to specify the axis limits for the machining envelope of the part to be machined.

Effect of configuration file on LIMITS output:

None.

LIMITS effect on configuration file:

Limits (XAXIS,YAXIS,ZAXIS,AAXIS & BAXIS) can be specified in the program using the LIMITS syntax overriding limit values in the configuration file and MACHIN syntax.

Syntax:
---

```
LIMITS/ [XAXIS,min,max][,YAXIS,min,max][,ZAXIS,min,max][,AAXIS,min,max] $
                                                       [,BAXIS,min,max]
        OFF
        ON
```

Example:
---

```
LIMITS/ XAXIS,-20,20, YAXIS,-10,10, ZAXIZ,0,20
```

# LINTOL Syntax.

This postprocessor function inserts additional points (only during pivot point fanning) in the pivot point path while maintaining control of the tool tip gouging.

```
APT Syntax
------------
LINTOL / value
         ON
         OFF
```

Where value is the amount of tool tip deviation (from linear) allowed.

Note: See section on Multax (5-Axis) machinig

# LOAD or LOADTL syntax.

APT syntax used to specify the desired TOOL change to the machine code file. If syntax is used in conjunction with the CUTTER syntax to completely define the tool.

Effect of configuration file on LOAD output:

Use of SELECT/TOOL,AUTO in section one
Use of SET/TOOL,MAX,value in section one
Use of SET/TOOL,LIST,ON in section one
Word address and format of TT & M1 register
Contents of RETRCT, TLCHG, TLCHG1 & RESTAR macros

LOAD effect on configuration file:

Sets value of CURTL, NEXTL & GAGEZ variables for use in Macro section

Syntax:

```
LOAD   / type, t [, LENGTH, z][, ADJUST, h  ]
LOADTL                                  OFF
```

where: type = tool type (Tool, MILL or DRILL)
t = tool number
z = set length of tool
h = length compensation register

OFF = turns off control length compensation
must be programmed for non-vertical cutting

Note: when ADJUST,OFF is programmed a component of tool LENGTH + PIVOTZ is added to output of all motion blocks.

Example:

```
LOAD/ TOOL, 1, LENGTH, 6.500, ADJUST, OFF        ===>       T01 M06
```

# MACHIN syntax.

APT syntax used to specify the desired postprocessor, configuration file, UNITS, and Axis limits. The MACHIN syntax should be programmed in the beginning of the program.

Effect of configuration file on MACHIN output:

None.

MACHIN effect on configuration file:

Specifies the name of the configuration file (.cfg) for the required machine tool. If configuration file name is not specified or file is not found the postprocessor will prompt the user for the configuration file name.

UNITS and limits (XAXIS,YAXIS & ZAXIS) can be specified in the program using the MACHIN syntax overriding UNITS and LIMITS in the configuration file.

Syntax:

```
MACHIN/ vmc5x, mchtool [,UNITS,INCHES,OUT,MM]   [,ON ]
                              MM         INCHES   OFF
                                    [,XAXIS,min,max][,YAXIS,min,max]
                                                    [,ZAXIS,min,max]
```

vmc5x - Specifies the postprocessor executable
mchtool - Sepcifies the machine tool configuration file name

Example:

```
MACHIN / HAASVR, VR0001, UNITS,INCHES, OUT,INCHES
```

# MODE syntax.

APT syntax used to specify the desired machining mode to the machine code file.

Effect of configuration file on MODE output:

None.

MODE effect on configuration file:

None.

Syntax:

```
--------
MODE/  INCHES
       MM
       XYPLAN
       YZPLAN
       ZXPLAN
       ABSOL
       INCR
```

| APT Example: | | Example machine code |
|---|---|---|
| MODE / INCH | ===> | G20 |
| MODE / MM | ===> | G21 |

# OPSKIP syntax.

APT syntax used to specify a block delete code to the machine code file.

Effect of configuration file on OPSKIP output:

None.

OPSKIP effect on configuration file:

None.

AP Syntax:

```
--------
OPSKIP [/ ON ]
       / OFF
```

| APT Example: | | Example machine code |
|---|---|---|
| OPSKIP | ===> | No output |
| GOTO/ 1,2,3 | ===> | /N1234 G01 X1. Y2. Z3. |

# OPSTOP syntax.

APT syntax used to specify an optional stop code to the machine code file.

Effect of configuration file on OPSTOP output:

Word address and format of M5 register.
Values specified with M5 register.

OPSTOP effect on configuration file:

None.

APT Syntax:

```
OPSTOP
```

| APT Example: | | Example machine code |
|---|---|---|
| OPSTOP | ===> | M01 |

# OUTTOL Syntax.

This APT syntax specifies the tolerance used when creating linear tool path points outside the part drive surface CIRCLE or CYLNDR.

```
APT Syntax
------------
OUTTOL / value
```

Where value is the distance from the circle allowed.

Example:

```
OUTTOL/ .010
```

# ORIGIN syntax.

APT syntax used to specify the desired coordinate system origin. If syntax is specified after LOAD and before GOTO syntax the output will be held for output by RESTAR macro.

Effect of configuration file on ORIGIN output:

Word address and format of G10 register.
Values defined for G10 register.

ORIGIN effect on configuration file:

Sets value of FIXTUR variable for use in Macro section

Syntax:
---
ORIGIN / FIXTUR, m
ORIGIN / DATUM, x, y, z
ORIGIN / x, y, z

where: m = work coordinate system select (FIXTUR)
0 = 1st value (G53)
1 = 2nd value (G54)
2 = 3rd value (G55)
3 = 4th value (G56)
4 = 5th value (G57)
5 = 6th value (G58)
6 = 7th value (G59)

ORIGIN/ DATUM x, y & z = values output with 7th value of G10 (G92)

ORIGIN/ x, y & z = values are subtracted from following GOTO x, y, z (translation)

| APT Example | | Example machine code |
|---|---|---|
| ORIGIN / FIXTUR, 2 | ===> | G55 |
| ORIGIN / DATUM, 1, 2, 3 | ===> | G92 X1, Y2. Z3. |
| ORIGIN / 10, 5, 2 | ===> | No output |
| GOTO/ 1, 2, 3 | ===> | G00 X-9. Y-3. Z1. |

# PARTNO syntax.

APT syntax used to specify the desired Program ID and part information to the machine code file. The PARTNO syntax should be programmed in the beginning of the part program.

Effect of configuration file on PARTNO output:

Contents of START macro in configuration file

PARTNO effect on configuration file:

Sets value of PROGID variable for use in Macro section.
Sets value of PARTNO variable for use in Macro section.

APT Syntax
---
PARTNO numeric_id character_text

Where: numeric_id = numeric value specifying Program ID (PROGID).
character_text = text string specifying the Part Information (PARTNO).

| APT Example | | Example machine code |
|---|---|---|
| PARTNO 1234 OPERATION A | ====> | %<br>O1234 (OPERATION A) |

# PIVOTZ syntax.

APT syntax used to specify the distance from the spindle gage line to the tool head pivot point. The PIVOTZ syntax should be programmed before any tool motion resulting in head rotation.

Effect of configuration file on PIVOTZ output:

PIVOTZ/ n can be used in section one to set default value.

PIVOTZ effect on configuration file:

Sets value of PIVOTZ variable for use in Macro section

Syntax:
---
PIVOTZ/ n

where: n = distance from spindle gage line to tool head pivot point.

| APT Example | | Example machine code |
|---|---|---|
| PIVOTZ / 3.500 | ===> | None |

# PPRINT syntax.

APT syntax used to specify comments in the output listing file and conditionally to the machine code file. If the PPRINT syntax is specified before the first CUTTER syntax and SET/PPRINT,LIST,ON is used in the configuration file the output will be displayed in the machine code file as comments.

Effect of configuration file on PPRINT output:

SET/PPRINT,LIST,ON in section one of the configuration file

PPRINT effect on configuration file:

None.

APT Syntax
---
PPRINT character text
PPRINT(character text)

Where: character_text = alpha-numeric character string and
(character_text) = character text enclosed in () will also be included in machine code file.

| APT Example | | Example machine code |
|---|---|---|
| PPRINT(THIS IS A MESSAGE) | ===> | (THIS IS A MESSAGE) |

# PPLIST syntax.

APT syntax used to specify the format of the output for the NC listing (.NCL) file.

Effect of configuration file on PPLIST output:

None.

PPLIST effect on configuration file:

None.

APT Syntax

```
PPLIST/   OFF      -  Turns off output to listing file.
          MIXED    -  MIXED APT and Machine Code in listing.
          FORMAT   -  Classic column formatted listing.
```

# PREFUN syntax.

Output an preparatory machine function using the G0 register. This code is usually output with a "G" letter and a two digit integer code, but depends on the word address and format specification of the predefined G0 register.

Effect of configuration file on PREFUN output:

Word address and format of G0 register

PREFUN effect on configuration file:

None

APT Syntax
---
PREFUN / g

where: g = G-code

| APT example | | Example machine code |
|---|---|---|
| PREFUN / 98 | ===> | G98 |

# RAPID syntax.

APT syntax used to specify a rapid motion to the next cutter path point (GOTO syntax). This syntax is not modal and must be specified for each GOTO syntax

Effect of configuration file on RAPID output:

Defines the G1 register code used for RAPID motion G1(0).

RAPID effect on configuration file:

None.

APT Syntax
---
RAPID

| APT example | Example machine code |
| --- | --- |
| RAPID | |
| GOTO/ 1.0, 2.0, 3.0 | GO X1. Y2. Z3. |

# RETRCT syntax.

APT syntax used to specify a retract Z-axis motion to the predefined clearance plane.

Effect of configuration file on RETRCT output:

Uses the value of CLEARP for clearance plane.

RETRCT effect on configuration file:

None.

APT Syntax

```
RETRCT [/ON ]
        OFF
```

| APT example | | Example machine code |
|---|---|---|
| RETRCT/ON | | |
| GOTO/ 1.0, 2.0, 0.0 | ==> | G98 X1. Y2. |
| RETRCT/OFF | | |
| GOTO/ 4.0, 5.0, 0.0 | ==> | G99 X4. Y5. |
| | | |
| CLEARP/ 6.0 | | |
| RETRCT | ==> | G0 Z6. |

# REWIND syntax.

APT syntax used at the end of the program (before FINI) to output a program (tape) rewind code (M30 typically).

Effect of configuration file on REWIND output:

Uses the value of M2 register code M2(30).

REWIND effect on configuration file:

None.

APT Syntax
---
REWIND

| APT example | Example machine code |
| --- | --- |
| REWIND | M30 |

# ROTATE syntax.

APT syntax used to specify for output the desired coolant feature to the machine code file. If syntax is specified after LOAD and before GOTO syntax the output will be held for output by RESTAR macro.

Effect of configuration file on ROTATE output:

None.

ROTATE effect on configuration file:

None.

APT Syntax

```
ROTATE / AAXIS, ATANGL, a (,CLW )
         BAXIS  INCR        CCLW

 where:  a      = angle of rotation
         ATANGL = Absolute angle
         INCR   = Incremental angle
```

| APT example | | Example machine code |
|---|---|---|
| RAPID | | |
| ROTATE / AAXIS, ATANGL, 30 | ===> | G00 A30. |
| ROTATE / BAXIS, INCR, -45, 10 | ===> | G01 B-15 F10. |

# SEQNO syntax.

APT syntax used to specify the sequence numbers (N) assigned to the machine code records (blocks).

Effect of configuration file on SEQNO output:

Uses the value of NN register.

SEQNO effect on configuration file:

None.

APT Syntax

| | |
|---|---|
| SEQNO/ n, INCR, I | Specifies sequence start and increment values. |
| ON | Turns sequence numbering off. |
| OFF | Turns sequence numbering on. |

Where:

n = Start number

I = Increment number

| APT example | Example machine code |
|---|---|
| SEQNO/ 10, INCR, 5 | N10… |
| | N15… |
| | N20… |

# SET Syntax.

SET/CUTD is used to not apply the feed rate to the tool tip, but to a point along the tool axis at a depth of cut. This is only done when there is rotary motion, the pivot point is fanning, and tool tip motion is at or near zero. This depth of cut value is controlled by the following AZpost syntax:

| APT Syntax: | | NCdata: |
|---|---|---|
| SET/ CUTDP, value | ===> | No output |

Where value is the distance from tool tip along tool axis toward pivot point used by postprocessor to compute feed rate from, when pivot point fanning is occuring.

Note: See section on Multax (5-Axis) machinig

Example:

```
SET / CUTDP, .5
```

# SPINDL syntax.

APT syntax used to specify spindle speed for output to the machine code file. If syntax is specified after LOAD and before GOTO syntax the output will be held for output by RESTAR macro.

Effect of configuration file on SPINDL output:

Word address and format of SS & M3 register
Values for minor words set with M3 register

SPINDL effect on configuration file:

Sets value of RPM variable for use in Macro section

APT Syntax
---

```
SPINDL / (RPM) ,s (,CLW)
          SFM       CCLW

SPINDL / s (,RPM)(,CLW)
                  CCLW

SPINDL/ ON
        OFF

SPINDL /  MAXRPM, s                Sets maximum programmable RPM
```

where: s = Spindle speed in RPM or SFM

| APT example | | Example machine code |
|---|---|---|
| SPINDL / RPM, 600, CLW | ===> | S600 M03 |

# STOP syntax.

APT syntax used to specify a program machine stop to the machine code file. The first motion after STOP will be output by RESTAR macro.

Effect of configuration file on STOP output:

Word address and format of M5 register.
Values for minor words set with M5 register.
The first motion after STOP will be output by RESTAR macro.

STOP effect on configuration file:

None.

APT syntax

```
--------
STOP
```

| APT example | | Example machine code |
|---|---|---|
| STOP | ===> | M00 |

# TLAXIS syntax.

APT syntax used to define the desired tool axis for 3-axis machining by specifying a 3D unit vector.

Effect of configuration file on TLAXIS output:

None.

TLAXIS effect on configuration file:

None.

APT syntax

```
TLAXIS / i, j, k
```

where: i, j, k = values of 3D unit vector components

| APT example | | Example machine code |
|---|---|---|
| TLAXIS / .00000, .00000, 1.00000 | ===> | No output |

# TPRINT syntax.

APT syntax used to specify tool comments in the output listing file and to the machine code file. The TPRINT syntax must be used prior to each LOAD /TOOL syntax. The postprocessor will collect all the TPRINTs in the part program and output them as comments at the beginning of the machine code file if SET/TOOL,LIST,ON is specified in section one of the configuration file.

Effect of configuration file on PPRINT output:

SET/TOOL,LIST,ON in section one of the configuration file

PPRINT effect on configuration file:

None.

APT Syntax
---
TPRINT character text

Where: character_text = alpha-numeric character string and

| APT Example | | Example machine code |
|---|---|---|
| TPRINT 1/2-13 TAP 6.500 LGH<br>LOAD/TOOL,4,LENGTH,6.5 | ===> | (1/2-13 TAP 6.500 LGH) |

# TRANS syntax.

APT syntax used to specify a desired translation on the part coordinate system.

Effect of configuration file on TRANS output:

None.

TRANS effect on configuration file:

None.

APT syntax

```
TRANS / x, y, z

 where:  x, y, z   = values are added to all following motions
```

| APT example: | | Example machine code |
|---|---|---|
| TRANS / .5, .5, 0 | ===> | No output |
| GOTO / 1, 2, 3 | ===> | G00 X1.5 Y2.5 Z3. |

# MULTAX (5-axis Machining)

## *Effect of pivot point motion versus tool tip motion*

When one or both rotary axis are moved during a feed rate (cutting) motion the resultant machine motion is either considered to be fanning the tool tip or fanning the pivot point. This is determined by the comparing the lengths of the motion (in 3D) of the tool tip versus the pivot point.

The CAD system only considers the tool tip motion since it does not typically know the machine axis configuration or the length from the tool tip to the machine tool pivot point.

The postprocessor **MUST** consider the pivot point since this is the machine program reference point. The postprocessor must also consider the effect of the pivot point motion on the tool tip.

**Figure 1** shows tool tip fanning on the left and pivot point fanning on the right.

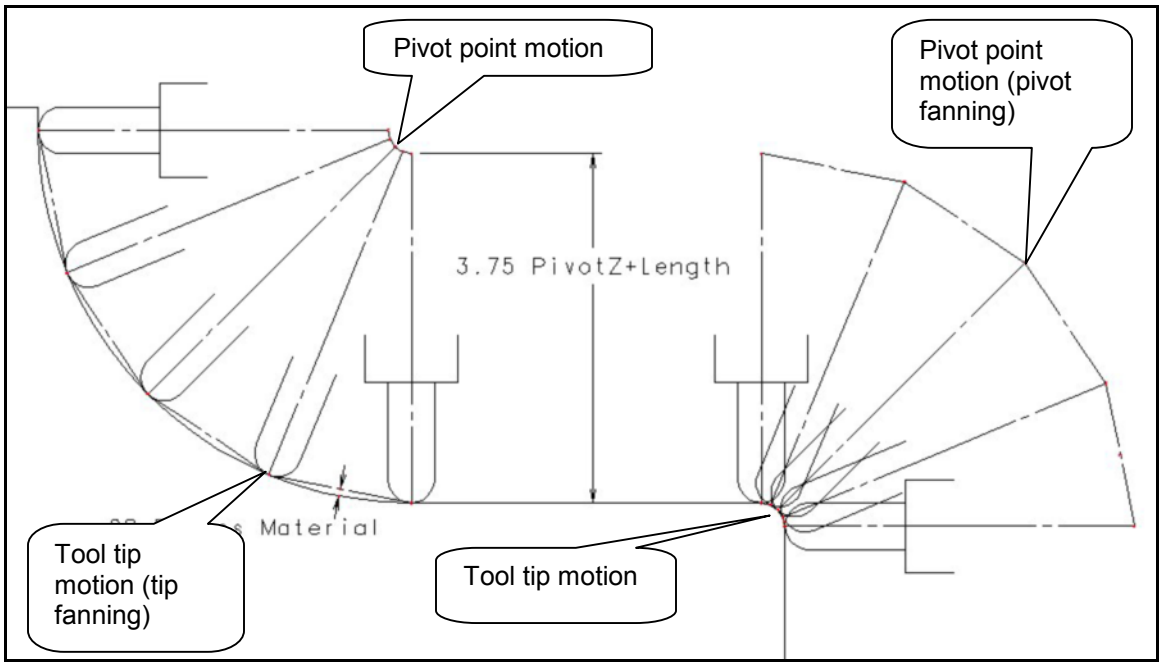



**Figure 1**

There is typically no problem when tool tip fanning is occurring since the CAD system controls the output of points (linearization) along tool tip path. The problem occurs when pivot point fanning is occurring. **Figure 2** shows the gouging that theoretically results from the CAD system linearization. This gouge is controlled by the CAD system.

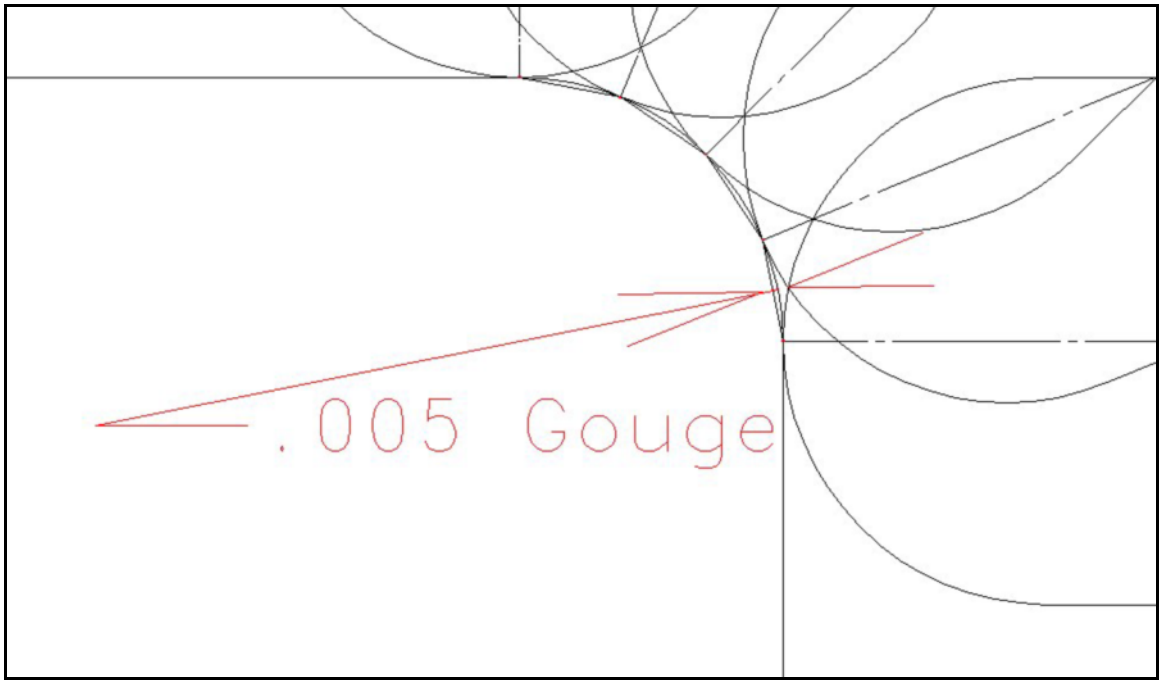
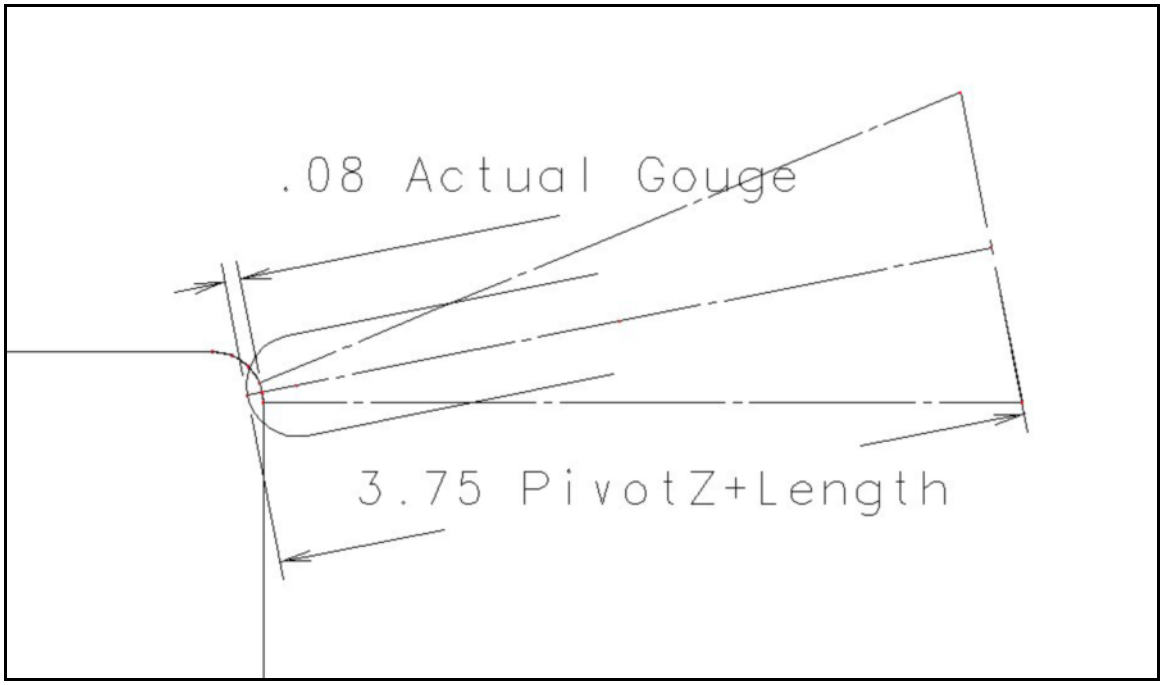



**Figure 2**

The problem is that the actual gouge is MUCH larger and occurs between the CAD points because the pivot point moves in a straight line while the rotary axes are being interpolated. See **Figure 3** showing actual gouge at midpoint of motion between the two points.




**The solution** is provided by using the postprocessor function called **LINTOL**.
This postprocessor function inserts additional points (only during pivot point fanning) in the pivot point path while maintaining control of the tool tip gouging.

The LINTOL syntax is defined by ANSI X3.37 as follows:

**LINTOL /** **value**
**ON**
**OFF**

Where **value** is the amount of tool tip deviation (from linear) allowed.

## *Effect of pivot point motion on tool tip feed rate.*

The machine tool control typically does not know where the tool tip is on a 5-axis machine tool. In order to achieve the correct (programmed) feed rate at the tool tip while positioning the machine pivot point the machine uses the inverse time feed rate method. This is because the **TIME** for the motion (both tip and pivot point) is the only common value.

**Distance = Rate X Time**

**Time = Distance / Rate**

**Inverse Time = 1 / Time = Rate / Distance**

Note:

**Rate** is the programmed tool tip feed rate and that **Distance** is the tool tip distance. The **Time** is common for both tool tip and pivot point.

There is a problem computing inverse time when Pivot point fanning is occurring and the tool tip motion (Distance) is very small approaching zero.

As you can see from the formula, **Time** approaches zero and **Inverse Time** approaches infinity (division by zero). At the same time the pivot point is required to move a relatively large amount (large rotary axes motion). The postprocessor typically limits the inverse time feed rate number in this case, but the limiting value is typically to high and causes the rotary axis to jerk.

**The Solution** is to not apply the feed rate to the tool tip, but to a point along the tool axis at a depth of cut. This is only done when there is rotary motion, the pivot point is fanning, and tool tip motion is at or near zero. This depth of cut value is controlled by the following **AZpost** syntax:

**SET / CUTDP, value**

Where **value** is the distance from tool tip along tool axis toward pivot point used by postprocessor to compute feed rate from, when pivot point fanning is occuring.

# Example APT source Part Program file.

```
MACHIN/HAASVR,VR0001,UNITS,INCHES,OUT,INCHES,OFF
PARTNO 0001 PROCESSED USING VR1 PPTABLE
PPRINT PROGRAM TO MACHINE FROM BLOCK
PPRINT USE 50.0" X 32.0" X 5.0" ALUMINUM
MULTAX/ON
FROM  /    0.00000,    0.00000,   10.00000, 0.000000, 0.000000, 1.000000
CUTTER/  0.590551,  0.000000,  0.295276,  0.000000, 30.000000,$
         0.000000,  1.969000
TPRINT T1 Spot Drill D 15
LOAD/TOOL,1,LENGTH,    3.937000
DISPLY/ **** SPOT DRILL 4 PLACES ***
SPINDL/RPM, 1050.0000,CLW
RAPID
GOTO  /    0.50000,    0.50000,    0.60000, 0.000000, 0.000000, 1.000000
CYCLE/DRILL,DEPTH,    0.072169,CLEAR,    0.100000,DWELL,    2.000000,$
IPM,    5.000000
GOTO  /    0.50000,    0.50000,    0.50000, 0.000000, 0.000000, 1.000000
GOTO  /    0.50000,    3.50000,    0.50000, 0.000000, 0.000000, 1.000000
GOTO  /    7.50000,    3.50000,    0.50000, 0.000000, 0.000000, 1.000000
GOTO  /    7.50000,    0.50000,    0.50000, 0.000000, 0.000000, 1.000000
CYCLE/OFF
CUTTER/  0.375000,  0.000000,  0.187500,  0.108253, 30.000000,$
         0.000000,  2.000000
TPRINT T2 Drill Dia .375
LOAD/TOOL,9,LENGTH,    4.000000
DISPLY/ **** DEEP DRILL 4 HOLES ****
SPINDL/RPM, 1250.0000,CLW
RAPID
GOTO  /    0.50000,    0.50000,    0.60000, 0.000000, 0.000000, 1.000000
CYCLE/DEEP,DEPTH,    0.500000,CLEAR,    0.100000,STEP,    0.250000,IPM,$
   12.000000
GOTO  /    0.50000,    0.50000,    0.50000, 0.000000, 0.000000, 1.000000
GOTO  /    0.50000,    3.50000,    0.50000, 0.000000, 0.000000, 1.000000
GOTO  /    7.50000,    3.50000,    0.50000, 0.000000, 0.000000, 1.000000
GOTO  /    7.50000,    0.50000,    0.50000, 0.000000, 0.000000, 1.000000
CYCLE/OFF
CUTTER/  0.500000,  0.000000,  0.250000,  0.000000,  0.000000,$
         0.000000,  0.625000
TPRINT T6 Counterbore Dia .50
LOAD/TOOL,8,LENGTH,    4.000000
DISPLY/ *** COUNTER BORE 4 HOLES ****
SPINDL/RPM, 1200.0000,CLW
RAPID
GOTO  /    0.50000,    0.50000,    0.78750, 0.000000, 0.000000, 1.000000
CYCLE/CBORE,DEPTH,    0.100000,CLEAR,    0.100000,DWELL,    2.000000,$
IPM,    5.000000
GOTO  /    0.50000,    0.50000,    0.50000, 0.000000, 0.000000, 1.000000
GOTO  /    0.50000,    3.50000,    0.50000, 0.000000, 0.000000, 1.000000
GOTO  /    7.50000,    3.50000,    0.50000, 0.000000, 0.000000, 1.000000
GOTO  /    7.50000,    0.50000,    0.50000, 0.000000, 0.000000, 1.000000
CYCLE/OFF
```

```
CUTTER/  0.500000,  0.005000,  0.245000,  0.005000,  0.000000,$
         0.000000,  2.000000
TPRINT T3 End Mill Dia. .50
LOAD/TOOL,10,LENGTH,    4.000000, ADJUST, OFF
DISPLY/ **** PROFILE CONTOUR OUTER PROFILE *****
PPRINT/NO_COMPENSATION
FEDRAT/IPM,    5.0000
SPINDL/RPM, 1050.0000,CLW
GOTO  /    0.50000,   -0.25000,    0.00000, 0.000000, 0.000000, 1.000000
INTOL /    0.00394
OUTTOL/    0.00000
AUTOPS
INDIRV/   -1.00000,    0.00000,    0.00000
TLON,GOFWD/      (CIRCLE/      0.50000,      0.50000,      0.00000,$
       0.75000),ON,(LINE/      0.50000,      0.50000,      0.00000,$
                              -0.25000,      0.50000,      0.00000)
GOTO  /   -0.25000,    3.50000,    0.00000, 0.000000, 0.000000, 1.000000
INDIRV/    0.00000,    1.00000,    0.00000
TLON,GOFWD/      (CIRCLE/      0.50000,      3.50000,      0.00000,$
       0.75000),ON,(LINE/      0.50000,      3.50000,      0.00000,$
                              0.50000,      4.25000,      0.00000)
GOTO  /    7.50000,    4.25000,    0.00000, 0.000000, 0.000000, 1.000000
INDIRV/    1.00000,    0.00000,    0.00000
TLON,GOFWD/      (CIRCLE/      7.50000,      3.50000,      0.00000,$
       0.75000),ON,(LINE/      7.50000,      3.50000,      0.00000,$
                              8.25000,      3.50000,      0.00000)
GOTO  /    8.25000,    0.50000,    0.00000, 0.000000, 0.000000, 1.000000
INDIRV/    0.00000,   -1.00000,    0.00000
TLON,GOFWD/      (CIRCLE/      7.50000,      0.50000,      0.00000,$
       0.75000),ON,(LINE/      7.50000,      0.50000,      0.00000,$
                              7.50000,     -0.25000,      0.00000)
GOTO  /    0.50000,   -0.25000,    0.00000, 0.000000, 0.000000, 1.000000
DISPLY/ **** PROFILE CONTOUR INNER PROFILE ****
SPINDL/RPM, 1050.0000,CLW
RAPID
GOTO  /    5.26244,    1.36340,    0.75000, 0.000000, 0.000000, 1.000000
FEDRAT/IPM,   30.0000
GOTO  /    5.26244,    1.36340,    0.25000, 0.000000, 0.000000, 1.000000
AUTOPS
INDIRV/    0.86603,    0.50000,    0.00000
TLON,GOFWD/      (CIRCLE/      5.21244,      1.45000,      0.25000,$
       0.10000),ON,(LINE/      5.21244,      1.45000,      0.25000,$
                              5.29904,      1.50000,      0.25000)
FEDRAT/IPM,    5.0000
GOTO  /    4.43301,    3.00000,    0.25000, 0.000000, 0.000000, 1.000000
INDIRV/   -0.50000,    0.86603,    0.00000
TLON,GOFWD/      (CIRCLE/      4.00000,      2.75000,      0.25000,$
       0.50000),ON,(LINE/      4.00000,      2.75000,      0.25000,$
                              3.56699,      3.00000,      0.25000)
GOTO  /    2.70096,    1.50000,    0.25000, 0.000000, 0.000000, 1.000000
INDIRV/   -0.50000,   -0.86603,    0.00000
TLON,GOFWD/      (CIRCLE/      3.13397,      1.25000,      0.25000,$
       0.50000),ON,(LINE/      3.13397,      1.25000,      0.25000,$
                              3.13397,      0.75000,      0.25000)
GOTO  /    4.86603,    0.75000,    0.25000, 0.000000, 0.000000, 1.000000
INDIRV/    1.00000,    0.00000,    0.00000
TLON,GOFWD/      (CIRCLE/      4.86603,      1.25000,      0.25000,$
```

```
       0.50000),ON,(LINE/      4.86603,      1.25000,      0.25000,$
                               5.29904,      1.50000,      0.25000)
FEDRAT/IPM,   50.0000
INDIRV/   -0.50000,    0.86603,    0.00000
TLON,GOFWD/      (CIRCLE/      5.21244,      1.45000,      0.25000,$
       0.10000),ON,(LINE/      5.21244,      1.45000,      0.25000,$
                               5.16244,      1.53660,      0.25000)
GOTO  /    5.16244,    1.53660,    0.75000, 0.000000, 0.000000, 1.000000
DISPLY/ **** MULTI-AXIS FLANK CONTOUR OUTER PROFILE ****
SPINDL/RPM, 1050.0000,CLW
RAPID
GOTO  /   -0.24634,    0.50000,    0.04262, 0.173648, 0.000000, 0.984808
FEDRAT/IPM,    5.0000
GOTO  /   -0.24634,    3.50000,    0.04262, 0.173648, 0.000000, 0.984808
GOTO  /   -0.22806,    3.66069,    0.04330, 0.176117,-0.006619, 0.984347
GOTO  /   -0.19995,    3.75876,    0.04325, 0.173319,-0.031746, 0.984354
GOTO  /   -0.14760,    3.87083,    0.04316, 0.164590,-0.061891, 0.984418
GOTO  /   -0.07917,    3.97062,    0.04305, 0.150576,-0.089968, 0.984496
GOTO  /   -0.01845,    4.03598,    0.04297, 0.136751,-0.109023, 0.984588
GOTO  /    0.09589,    4.12744,    0.04283, 0.108775,-0.136461, 0.984655
GOTO  /    0.22434,    4.19297,    0.04272, 0.075247,-0.156762, 0.984766
GOTO  /    0.36134,    4.23335,    0.04265, 0.038187,-0.169505, 0.984789
GOTO  /    0.50009,    4.24634,    0.04262,-0.000119,-0.173648, 0.984808
GOTO  /    7.50000,    4.24634,    0.04262,-0.000119,-0.173648, 0.984808
GOTO  /    7.66070,    4.22806,    0.04329,-0.006734,-0.176093, 0.984351
GOTO  /    7.75879,    4.19994,    0.04324,-0.031860,-0.173279, 0.984357
GOTO  /    7.87089,    4.14757,    0.04316,-0.061997,-0.164533, 0.984421
GOTO  /    7.97071,    4.07910,    0.04305,-0.090068,-0.150500, 0.984499
GOTO  /    8.03609,    4.01834,    0.04296,-0.109112,-0.136665, 0.984590
GOTO  /    8.12755,    3.90394,    0.04283,-0.136531,-0.108676, 0.984657
GOTO  /    8.19306,    3.77545,    0.04272,-0.156804,-0.075150, 0.984766
GOTO  /    8.23340,    3.63841,    0.04265,-0.169525,-0.038095, 0.984789
GOTO  /    8.24634,    3.49991,    0.04262,-0.173648, 0.000122, 0.984808
GOTO  /    8.24634,    0.50000,    0.04262,-0.173648, 0.000122, 0.984808
GOTO  /    8.22806,    0.33931,    0.04329,-0.176092, 0.006737, 0.984351
GOTO  /    8.19994,    0.24122,    0.04324,-0.173279, 0.031859, 0.984357
GOTO  /    8.14758,    0.12914,    0.04316,-0.164534, 0.061992, 0.984421
GOTO  /    8.07912,    0.02932,    0.04305,-0.150505, 0.090061, 0.984499
GOTO  /    8.01836,   -0.03607,    0.04296,-0.136668, 0.109108, 0.984590
GOTO  /    7.90397,   -0.12753,    0.04283,-0.108682, 0.136526, 0.984657
GOTO  /    7.77549,   -0.19304,    0.04272,-0.075160, 0.156800, 0.984766
GOTO  /    7.63841,   -0.23340,    0.04265,-0.038095, 0.169525, 0.984789
GOTO  /    7.49991,   -0.24634,    0.04262, 0.000122, 0.173648, 0.984808
GOTO  /    0.50000,   -0.24634,    0.04262, 0.000122, 0.173648, 0.984808
GOTO  /    0.33930,   -0.22806,    0.04329, 0.006737, 0.176092, 0.984351
GOTO  /    0.24123,   -0.19995,    0.04324, 0.031856, 0.173279, 0.984357
GOTO  /    0.12915,   -0.14759,    0.04316, 0.061988, 0.164536, 0.984421
GOTO  /    0.02934,   -0.07914,    0.04305, 0.090056, 0.150508, 0.984498
GOTO  /   -0.03605,   -0.01838,    0.04296, 0.109102, 0.136674, 0.984590
GOTO  /   -0.12752,    0.09602,    0.04283, 0.136522, 0.108687, 0.984657
GOTO  /   -0.19304,    0.22450,    0.04272, 0.156799, 0.075162, 0.984766
GOTO  /   -0.23340,    0.36156,    0.04265, 0.169523, 0.038104, 0.984789
GOTO  /   -0.24634,    0.50009,    0.04262, 0.173648,-0.000123, 0.984808
END
FINI
```