

FeatureCAM Post Processor Reference Manual

Cambridge
Numerical Control



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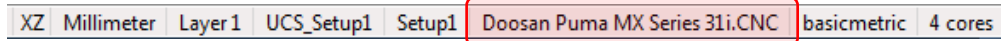
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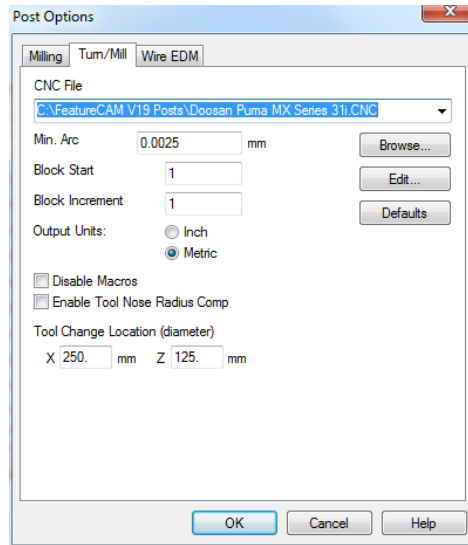
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How to Open a Post Processor for editing

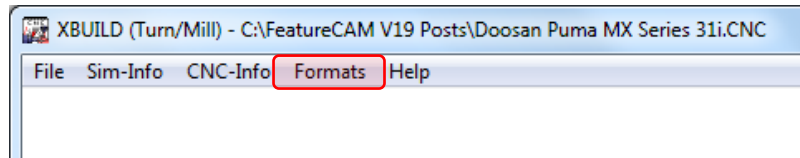
Your current post processor is located at the bottom right of your FeatureCAM screen
To open the post double click your left mouse button on the post processor name.



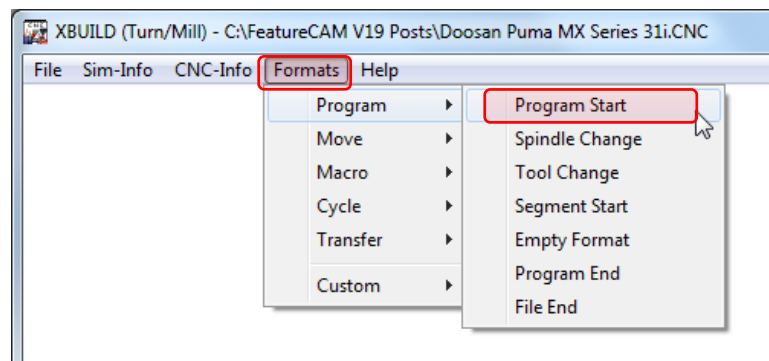
Click on the Edit Button to start editing the current post processor.



Xbuild will now open the post processor reading for editing.

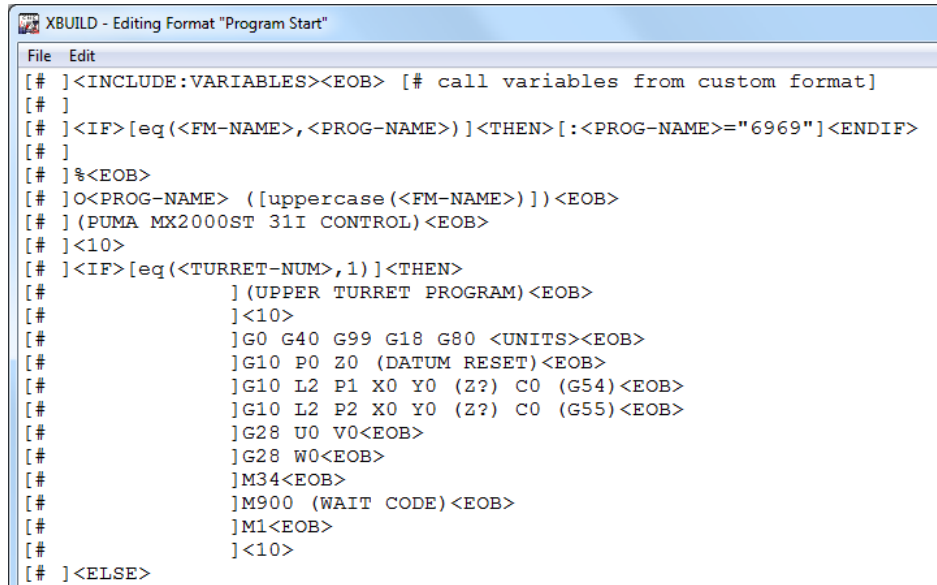


Click on Formats Menu and then Program Start to show the code for generating the start of the NC program.



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The code for the Program Start will now be opened ready for editing similar to below



```
[# ]<INCLUDE:VARIABLES><EOB> [# call variables from custom format]
[# ]
[# ]<IF>[eq(<FM-NAME>,<PROG-NAME>)]<THEN>[:<PROG-NAME>="6969"]<ENDIF>
[# ]
[# ]%<EOB>
[# ]O<PROG-NAME> ([uppercase(<FM-NAME>)])<EOB>
[# ](PUMA MX2000ST 31I CONTROL)<EOB>
[# ]<10>
[# ]<IF>[eq(<TURRET-NUM>,1)]<THEN>
[# ]      ](UPPER TURRET PROGRAM)<EOB>
[# ]      ]<10>
[# ]      ]G0 G40 G99 G18 G80 <UNITS><EOB>
[# ]      ]G10 P0 Z0 (DATUM RESET)<EOB>
[# ]      ]G10 L2 P1 X0 Y0 (Z?) C0 (G54)<EOB>
[# ]      ]G10 L2 P2 X0 Y0 (Z?) C0 (G55)<EOB>
[# ]      ]G28 U0 V0<EOB>
[# ]      ]G28 W0<EOB>
[# ]      ]M34<EOB>
[# ]      ]M900 (WAIT CODE)<EOB>
[# ]      ]M1<EOB>
[# ]      ]<10>
[# ]<ELSE>
```

If the Upper Turret is active then the start-up code will be formatted as below

```
%
O6969
(PUMA MX2000ST 31I CONTROL)

(UPPER TURRET PROGRAM)

G0 G40 G99 G18 G80 G21
G10 P0 Z0 (DATUM RESET)
G10 L2 P1 X0 Y0 (Z?) C0 (G54)
]G10 L2 P2 X0 Y0 (Z?) C0 (G55)
G28 U0 V0
G28 W0
M34
M900 (WAIT CODE)
M1
```

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Formats menu

The XBUILD **Formats** menu enters specific program formats for the various blocks which can appear in a part program. Each format is made up of combinations of reserved words, literals, comments, and user-defined variables.

The **Formats** menu lists a number of general

Program - formats that are used in almost every part program, and include commonly used formats (for example **Program Start, Tool Change, Segment Start, Program End**).

Move - formats include the rapid and feed moves which make up the largest portion of any part program (for example **Rapid, Linear, Circular**). These program formats must be carefully defined.

Macro - formats include **Open Macro, Close Macro, Macro Call, In-Macro Linear, and In-Macro Circular**.

The Macro formats are not available for turn posts.

Cycle - formats include most of the canned cycles which are found in many controls (for example **Deep Hole, Tap**).

Custom - a custom format is used as a place holder for a block of code that may be used in several different formats. The system reserved word `<INCLUDE:>` is placed into the appropriate section of a format that uses the block of code from the custom format. The name of custom format should be inserted after colon: `<INCLUDE : Custom Format Name>`.

Each of these groups contains specific formats which, when selected, are displayed in the **Formats editor**.

The formats use specific reserved words, which are discussed separately for each post type. For example, milling reserved words can be found under the **Mill Post** section, turning reserved words can be found under the **Turn Post** section and so on.

What are Reserved words

Reserved words are specific words that are used in writing the post in XBUILD. These words are 'reserved' because they have a special meaning in FeatureCAM, and cannot be used for anything else. They are place holders that will later be replaced with values provided by FeatureCAM when it generates the NC code. Reserved words are referenced in **formats** by enclosing each word with angular brackets `< >`. Additional ASCII characters (for example X, Z and F) are used to specify the letter for each word address.

In XBUILD, you can see the reserved words from:

The **CNC-Info > Words-N** menu or the **File > WordList** menu in the **Formats** editor.

In XBUILD, there are several types of reserved words:

Numeric

Numeric reserved words are replaced by their numeric values when Post is executed. For example, the numeric reserved word `<X-COORD>` is replaced by the current X axis coordinate position. You can configure the output format of numeric reserved words via the **Words Info** dialog (**CNC-Info > Words** option).

Numeric reserved words can be preceded by the symbols \$, or @ (`<$name>`, or `<@name>`). The \$ prefix signals Post to output the **previous** value of a reserved word

String

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String reserved words provide a set of characters that were previously defined in the **NC Codes** dialog (to open it, select **CNC-Info > NC codes** from the menu).
For example, G01, G02, or M03 could be strings that were previously defined as <MOTION> and <SPINDLE>.

System and logical

System and logical reserved words are used together to set up conditional statements that are evaluated by XBUILD. Depending on whether a conditional statement is TRUE or FALSE, XBUILD either *includes* or *omits* certain data from the program format.

| | |
|------------------------------|--|
| <IF> | First element in a conditional statement, always followed by a logical reserved word to verify that a condition is TRUE. |
| <IFNOT> | First element in a conditional statement, always followed by a logical reserved word to verify that a condition is FALSE. |
| <THEN> | Second element in a conditional statement, placed after a logical reserved word. |
| <ELSE> | Third element in a conditional statement following an <IF><logical reserved word><THEN> to output an alternative decision. |
| <ELSEIF> | Third and higher element in a conditional statement to verify that a condition is TRUE. Used to evaluate multiple alternative decisions within an <IF> <ENDIF> block. |
| <ELSEIFNOT> | Third and higher element in a conditional statement to verify that a condition is FALSE. Used to evaluate multiple alternative decisions within a single <IF> <ENDIF> block. |
| <ENDIF> | Last element in a conditional statement. This must be on a line by itself. |
| <INCLUDE:Custom Format Name> | Operates like a subroutine by calling a custom format from within another format. The custom format is used to eliminate duplicating large blocks of code in more than one format. |

Examples of conditional statements

```
<IF><Logical Reserved Word><THEN>  
{N<SEQ>} . . .  
<ENDIF>
```

Or

```
<IFNOT><Logical Reserved Word><THEN>  
{N<SEQ>} . . .  
<ENDIF>
```

In the conditional statement below, for example, the data between the words <THEN> and <ENDIF> is output only if in a turning operation the constant surface speed is on.

```
<IF><CSS-ON><THEN>  
{N<SEQ>}G96S<CSS-SPEED><EOB>  
<ENDIF>
```

How to Configure reserved words

When any of the **Words** commands are selected from the **CNC-Info** menu (for example, **Words-1**), the **Words Info** dialog is displayed showing a table of **numeric** reserved words.

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| | LD_ZR | TRL_ZR | DEC_PT | UNS_V | +SIGN | INCH FORMAT | METRIC FORMAT | FACTOR |
|--------------|--------------------------|--------------------------|-------------------------------------|-------------------------------------|--------------------------|-------------|---------------|--------|
| ABS-BACKCLE: | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3.4 | 4.3 | 1.0000 |
| ABS-DEPTH | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3.4 | 5.3 | 1.0000 |
| ABS-SHIFTX | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3.4 | 5.3 | 2.0000 |
| ABS-SHIFTY | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3.4 | 5.3 | 1.0000 |
| ABS-SHIFTZ | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3.4 | 5.3 | 1.0000 |
| ABS-STEP1 | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3.4 | 5.3 | 1.0000 |
| ABS-ZCLEAR | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3.4 | 5.3 | 1.0000 |
| ABS-ZRAPID | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3.4 | 5.3 | 1.0000 |
| ANG-CFEED | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 5.3 | 5.3 | 1.0000 |
| ANG-DPM | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 5.3 | 5.3 | 1.0000 |
| ANG-DPM-NOF | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3.4 | 4.3 | 1.0000 |
| ANG-FPM | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 3.4 | 5.3 | 1.0000 |
| ANG-INTIME | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | 5.3 | 5.3 | 1.0000 |
| ANGLEXY | <input type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | 5.3 | 5.3 | 1.0000 |

OK Cancel Prev Next

Use the three buttons at the bottom of the dialog, labelled **OK**, **Cancel** and **Next**, to keep the changes made, exit the table without saving any changes, and advance to the next **Words Info** dialog respectively. The words tables contain the format (symbolic name, numeric parameters and factors) for each numeric reserved word.

The **LD_ZR**, **TRL_ZR**, **DEC_PT**, **UNS_V**, and **+SIGN** fields for each reserved word all toggle **On/Off**. To change an item in the table, select/deselect the check box in the appropriate column for that item. To select the **Format** or **Factor** field for any of the reserved words, move the cursor to the appropriate box and double-click the mouse there; the selection is highlighted. To change the format or factor, type the new value, then press **Enter**.

The first column (far left side) in the tables identifies the symbolic name (sometimes abbreviated) of each numeric reserved word.

All of the words in the table that apply to the NC machine must be configured.

LD_ZR - leading zeros are output if this option is toggled **On**. Zeros are output in all leading positions of the value, excluding significant digit locations (for example, **1"** with a **3.4** format would output two leading zeros: **001**).

TRL_ZR - trailing zeros are output when this option is set to **On**. Zeros are output in all trailing positions of each value output for the designated reserved word, excluding significant digit locations (for example, **10"** with a **3.4** format would be output with four trailing zeros as **100000**).

DEC_PT - is used to turn the **Decimal Point Character On/Off** (for example, when DEC_PT is toggled ON, **100"** is output as **100.0**).

The decimal character (either a , representing the European decimal, or a . representing the US/UK decimal) is specified in the **General Info** dialog. To open it, select **CNC-Info > General** from the menu.

UNS_V - when the **Unsigned Value** option is on, the number is output without its sign. This is often useful for distances.

+SIGN - when the **Plus Sign** is toggled **ON**, the plus sign (+) is output for positive integers.

Format - specifies the number of digits in the numeric value, represented by each numeric reserved word. Numbers are specified as **N.n**, where **N** represents the maximum number of digits to the left of the decimal point, and **n** is the maximum number of digits to the right of the decimal point. For example, entering **3.4** specifies a maximum +, or - departure of **999.9999**, or a minimum departure of **0.0001**.

Use the **Words Info** dialog to specify a numeric representation for each reserved word that requires it.

Factor - is used to modify numeric values during post processing. Each value that is output by Post is multiplied by its factor. For example, some controls require arcs to be calculated from centre to start point. This requires a **-1** factor for **<ARC-Z>** and **<ARC-X>**.

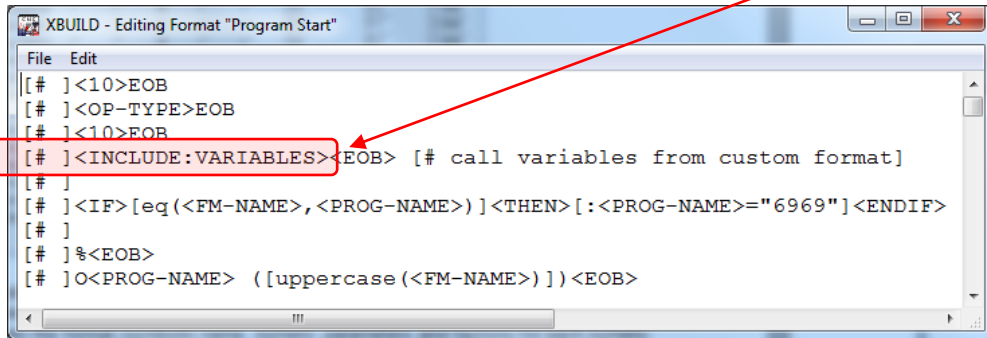
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User Defined Variables

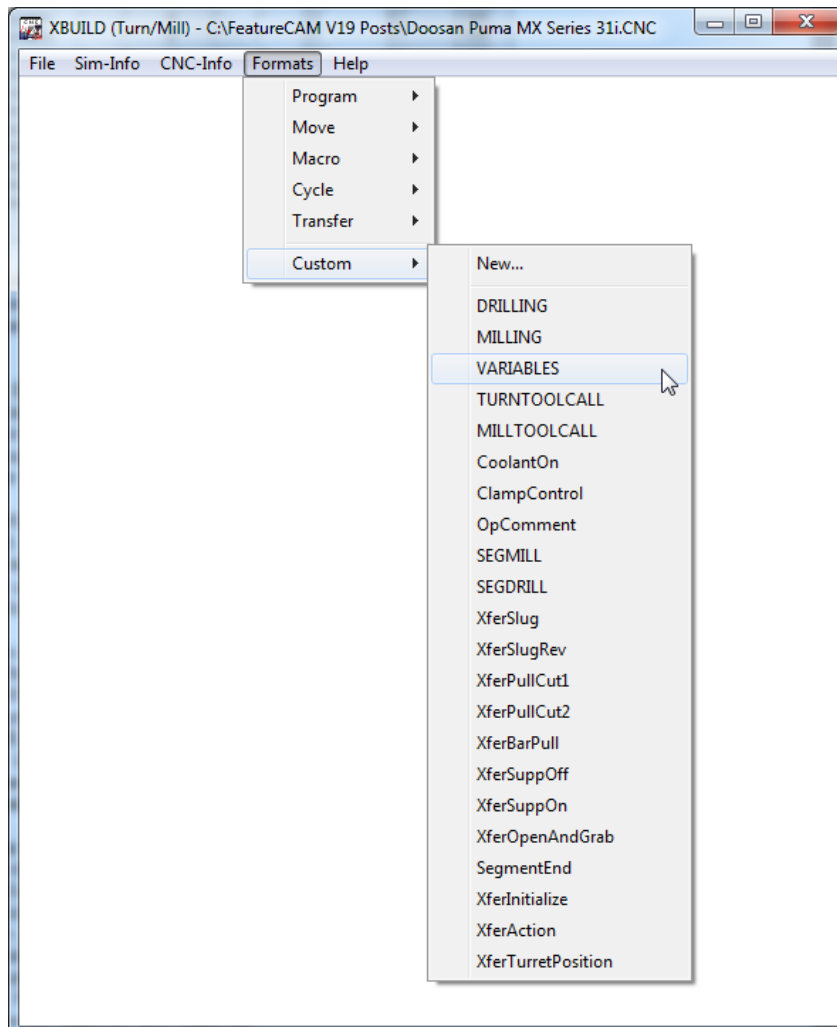
Sometimes you will need to create your own variables for doing calculations or to keep a track of a particular condition which you may need to test later on.

User defined variables must be declared in the PROGRAM START Section.

This can be done by placing them directly in The PROGRAM START by using the Include Reserved word.

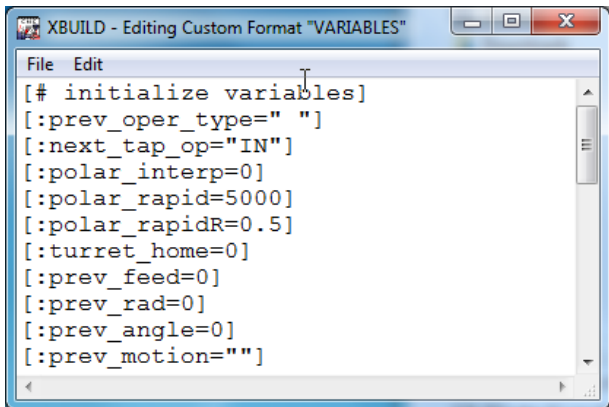


This will include all variables that have been defined in the Formats – Custom – VARIABLES Section



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All the following variables will be declared in the PROGRAM START Section.



```
XBUILD - Editing Custom Format "VARIABLES"
File Edit
[# initialize variables]
[:prev_oper_type=" "]
[:next_tap_op="IN"]
[:polar_interp=0]
[:polar_rapid=5000]
[:polar_rapidR=0.5]
[:turret_home=0]
[:prev_feed=0]
[:prev_rad=0]
[:prev_angle=0]
[:prev_motion=""]
```

This is an example of a user defined variable

```
[:prev_oper_type=" "]
```

It must be placed with [] brackets and needs a : in front of the name so that the variable value won't be sent to the NC code.

In this example we are setting the initial value of the variable to be blank. Any user defined variable needs to be declared in the Program Start section of the post, normally by using a <INCLUDE:VARIABLES> statement.

Sometimes you will need to save a condition as you will need to test for it in another section of the post processor as an example you can save the current type of process either Turning or Milling by including the following code.

```
[# ]<IF><MILLING><THEN>
[# ][:prev_oper_type="MILL"]
[# ]<ENDIF>
```

We can then test the user defined variable later to decide what code we need to send to the NC program

```
[# ]<IF>[eq(prev_oper_type,"MILL")]<THEN>
```

Here is an example which is using several user defined variables to do a number of calculations and formatting them for the NC program.

```
[# ][:p1_sav=<P1>]
[# ][:fix=(<FIXTURE> + 0)]
[# ][:no_of_datums=(p1_sav + 0)]
[# ][:datum=ceil(fix / no_of_datums)]<EOB>
[# ]
[# ][:datum_face_no=(540 + datum)]<EOB>
[# ]IF<91>#[T|3.0|1:datum_face_no] NE 1<93> GOTO [T|4.0|1:n_num=n_num + 10]<EOB>
[# ]<MOTION> G90 G80 G40 G54.1P<FIXTURE> X<X-COORD> Y<Y-COORD> B0 S<SPEED>
<SPINDLE><EOB>
[# ]G43 Z100. H<COMP-NUM> <COOLANT><EOB>
```

Turning reserved words

Numeric

| Reserved word | Definition |
|---------------|---|
| <ABS-DEPTH> | Absolute Z-axis depth from Z axis origin, calculated as <ZSURF> - <DEPTH>. |
| <ABS-STEP1> | Absolute first step, calculated as <ZSURF> - <STEP1>. |
| <BAXIS-ROT> | Returns turning tool rotary angle where turning tool is locked in B-axis spindle. Commonly used to flip turn tools when moving from main to sub. This is not the same as the B-angle of the tool. |
| <CALC-SPEED> | Calculated direct RPM speed at the path's start point; the spindle can be turned ON, or readjusted in direct RPM prior to rapid traversing to the path's start point, where CSS is turned On . The <CALC-SPEED> reserved word can be used to automatically calculate the direct RPM 'turn on' speed (to turn on CSS after position moves), which avoids rapid traversing to and from a remote indexing point in the CSS mode. |
| <CLEARANCE> | Corresponds to the Clearance attribute. |
| <CLR-DEPTH> | <CLEARANCE> + <DEPTH> |
| <COMP-NUM> | Compensation number passed from FeatureCAM as the Diameter offset register in the Tool Mapping dialog, or on the Overrides tab of the Tool Properties dialog. |
| <CSS-SPEED> | Corresponds to the Surface Speed parameter on the Feed/Speed tab of a feature. |
| <DWELL> | Corresponds to the Dwell parameter for Cutoff, Groove, and Tapping. |
| <ENG-ANGLE90> | 90 - Engage Angle for turning or 90 + Engage Angle for boring. |
| <FEED> | Passes the feed rate value to the word format of <FEED-UPM> or <FEED-UPR>, depending upon the Feed Units specified in FeatureTURN. |
| <FEED-UPM> | Format of this word is used to pass feed rate value and/or the reserved word <FEED> when Use IPR is not selected on the Feed/Speed tab for a feature. |
| <FEED-UPR> | Format of this word is used to pass feed rate value and/or the reserved word <FEED> when Use IPR is selected on the Feed/Speed tab for a feature. |
| <INC-MACX> | X location of the pattern instance to be cut by the macro. This coordinate is not usually output in the CNC program. |
| <INC-MACZ> | Z location of the pattern instance to be cut by the macro. This coordinate is not usually output in the CNC program. |
| <LIFT-OFF> | For groove only. Corresponds to Liftoff Dist. attribute. |
| <NEXT-TL> | Next tool to be used, may be required by some controls. Corresponds to the Tool column of the Tool Mapping dialog. |
| <NOSE-RAD> | Tool nose radius of an endmill or the tool tip radius of a turning or threading tool. |
| <OFFSET#> | Tool length offset register number, passed from FeatureCAM as the Length offset register in the Tool Mapping dialog, or on the Overrides tab of the Tool Properties dialog. Generally, this value is updated only in the Program Start, Tool Change, and Segment Start formats. For the finish pass of a Groove feature, however, the value may also be updated in the Rapid Move format if you have specified a second offset register. See also <OFFSET-CH> . |
| <OP-ORDERNUM> | Used to create Psync codes for Okuma machines. Because Okuma has only one file for both turrets, each operation needs an individual sync code that determines the operation order (whether synced or not). When the turrets are synced the P codes for both turrets are the same. |
| <R-CSS> | Radius value in constant surface speed; in Post, this value is set to the first X coordinate value. |
| <RTR-ANGLE-P> | The Withdraw Angle used for EZ-Path. |
| <RTR-FEED> | Withdraw feed rate. |

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| | |
|---------------|--|
| <SEQ> | This is a line sequence number identifier (when the word appears in a line, it is substituted with the current sequence number, and is subsequently incremented by the sequence step value). |
| <SPEED> | Spindle RPM value passed from feature Properties dialog. |
| <SP-MAX> | Maximum spindle RPM when CSS is On , used to set the maximum RPM at which the spindle should run. Corresponds to the CSS Max RPM turning attribute or the Max. speed for the current range specified on the Feeds&Speeds dialog of XBUILD. |
| <SPINDLE-POS> | Subspindle position. |
| <STEPOVER> | For groove only. Corresponds to Stepover % * Tool Width . |
| <STOCK-ID> | Inner diameter of the stock - for round (tube) stock only - 0 for other types of stock. |
| <STOCK-OD> | Outer diameter of the stock - for round stock only - 0 for other types of stock. |
| <STOCK-TYPE> | Type of stock: 1.0 for block, 2.0 for round, 3.0 for N-sided, 4.0 for user-defined. |
| <STOCK-XMAX> | Bounding box - maximum X value, or X coordinate of the upper most corner of the bounding box for the stock in space. |
| <STOCK-XMIN> | Bounding box - minimum X value, or X coordinate of the lower most corner of the bounding box for the stock in space. |
| <STOCK-YMAX> | Bounding box - maximum Y value, or Y coordinate of the upper most corner of the bounding box for the stock in space. |
| <STOCK-YMIN> | Bounding box - minimum Y value, or Y coordinate of the lower most corner of the bounding box for the stock in space. |
| <STOCK-ZMAX> | Bounding box - maximum Z value, or Z coordinate of the upper most corner of the bounding box for the stock in space. |
| <STOCK-ZMIN> | Bounding box - minimum Z value, or Z coordinate of the lower most corner of the bounding box for the stock in space. |
| <SYNC1> | Returns sync number from the CNC-Info > Turrets dialog. Used to synchronize multiple turrets. |
| <SYNC-SPEED> | For use in Okuma-style multi-turret posts only, this variable contains the synchronization code for a change in spindle speed. The sync code must be output on the same line as the spindle speed. |
| <TL-WIDTH> | Width of selected tool. |
| <TOOL> | The Tool number , passed from the Tool Mapping dialog in FeatureCAM. |
| <TURRET-NUM> | Returns the number of the current turret. |
| <X-CHANGE> | X coordinate of desired Tool change location passed from the Post Options dialog in FeatureCAM. |
| <X-COORD> | Returns the value of the current X coordinate. |
| <X-INDEX> | X-Index turret position passed from FeatureTURN. Corresponds to the X coordinate of the Tool Change Location (the setting in the Post Options dialog). Post Options can be reached from FeatureCAM by clicking on the Post name in the lower right portion of the FeatureCAM screen. |
| <X-PRESET> | Distance between the tool program point and the part origin when at the index position along the X axis; this value is calculated by Post as: $\langle X\text{-PRESET} \rangle = \langle X\text{-INDEX} \rangle + \langle X\text{ TOOL LENGTH} \rangle - \langle \text{distance btw turrets} \rangle$ $\langle \text{distance btw turrets} \rangle \text{ is equal to zero for primary turret.}$ |
| <X-RETURN> | X coordinate of the previous X-PRESET value plus any differences between tool change locations; this value is calculated by Post as: $\langle X\text{-RETURN} \rangle = \langle \$X\text{-PRESET} \rangle + \langle X\text{-INDEX} \rangle - \langle \$X\text{-INDEX} \rangle$ |
| <X-VECTOR> | Calculated X vector for the next move (cutter compensation vector for Cincinnati |

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| | |
|------------|---|
| | Milacron). |
| <Z-COORD> | Returns the value of the current Z coordinate. |
| <Z-CHANGE> | Z coordinate of desired Tool change location passed from the Post Options dialog in FeatureCAM. |
| <Z-INDEX> | Z-Index turret position passed from FeatureTURN. Corresponds to the Z coordinate of the Tool Change Location (the setting in the Post Options dialog). Post Options can be reached from FeatureCAM by clicking on the Post name in the lower right portion of the FeatureCAM screen. |
| <Z-PRESET> | Distance between the tool program point and the part origin when at the index position along the Z axis; this value is calculated by Post as: $\langle Z\text{-PRESET} \rangle = \langle Z\text{-INDEX} \rangle + \langle Z\text{ TOOL LENGTH} \rangle - \langle \text{distance btw turrets} \rangle.$ $\langle \text{distance btw turrets} \rangle$ is equal to zero for primary turret. |
| <Z-RETURN> | Z coordinate of the previous Z-PRESET value plus any differences between tool change locations; this value is calculated by Post as: $\langle Z\text{-RETURN} \rangle = \langle \$Z\text{-PRESET} \rangle + \langle Z\text{-INDEX} \rangle - \langle \$Z\text{-INDEX} \rangle$ |
| <Z-VECTOR> | Calculated Z vector for the next move. |
| <ZSURF> | Z coordinate of stock surface relative to UCS origin. |

Numeric canned cycle block words

The following example code fragment from a Fanuc control is used to illustrate the parameters below.

```
N012 G72 P013 Q018 U4.0 W2.0 D7000 F30 S55
N013 G00 Z58.0 F15 S58
N014 G01 X120.0 Z70.0
N015 Z80.0
N016 X80.0Z909.0
N017 Z110.0
N018 X36.0Z132.0
N019 G70P013Q018
```

| Reserved word | Definition |
|---------------|---|
| <ENG-FEED> | Turning, ezpath canned cycle, engage feed rate. |
| <NEW-ID> | Turning, ezpath canned cycle. Forces the <PATH-ID> reserved word to be incremented. |
| <PATH-ID> | The current canned cycle path ID. |
| <PRO-FEED> | Finishing feed rate. This value is usually specified along with the profile. It is often ignored during roughing. This variable has the value of 15 in the example above. |
| <RTR-LENGTH> | Length of the retract move for turn canned cycles. Corresponds to Withdraw Length in FeatureTURN. |
| <SEQ-END> | Ending NC program line number of profile for roughing and finishing canned cycle. This variable has the value of 18 in the example above. |

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|-------------|---|
| <SEQ-START> | Starting NC program line number of profile for roughing and finishing canned cycle. This variable has the value of 13 in the example above. |
| <X-ALLOW> | Corresponds to X Finish Allowance in FeatureTURN. |
| <Z-ALLOW> | Corresponds to Z Finish Allowance in FeatureTURN. |

Numeric circular block words

| Reserved word | Definition |
|---------------|---|
| <ARC-X> | Used in the circular interpolation block to specify the signed X distance from the start point of the arc, to the centre of the arc along the X axis. |
| <ARC-Z> | Used in the circular interpolation block to specify the signed Z distance from the start point of the arc, to the centre of the arc along the Z axis. |
| <RADIUS> | Returns the arc radius in a circular block. |
| <S-RAD> | Generates the signed arc radius value in a circular block, +R<180 degrees and R>180 degrees. |
| <Z-CEN> | Returns the absolute Z coordinate position from the Z axis origin to the arc's center in a circular block. |
| <X-CEN> | Returns the absolute X coordinate position from the X axis origin to the arc's center in a circular block. |

- To generate the **signed** distance from the arc's centre to the arc's start position, locate the <ARC-Z> and <ARC-X> reserved words in the **Words Info** dialog, and change their **FACTOR** values to **-1**. To generate the **unsigned** distance from the arc's start position to the centre of an arc, select the **UNS_V** check boxes for these reserved words in the **Words Info** dialog.

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Numeric drilling and threading type cycle words

| Reserved word | Definition |
|---------------|--|
| <DEPTH> | This word has different values for different operations: <ul style="list-style-type: none"> • Tap operation - calculated depth of tap. • Twist drill operation - calculated depth of drilling operation including tip. • Turning, Boring, and Face operations - depth of cut. • Groove operation - depth of cut. |
| <END-X> | The X location where the thread cutting pass ends. This is usually the same as <START-X> except for tapered threads. |
| <END-Z> | The Z location where the thread cutting pass ends. |
| <ENG-ANGLE> | Corresponds to the 90 - Infeed Angle threading attribute. |
| <LEADX> | Calculated tip to tip X axis lead. |
| <LEADZ> | Corresponds to Pitch thread dimension. |
| <MIN-INFEED> | Corresponds to the Min Infeed attribute. |
| <NUM-SPRING> | Number of thread spring passes. Corresponds to Spring Passes threading attribute. |
| <NUM-THREAD> | Number of thread passes. |
| <RTR-ANGLE> | Corresponds to Withdraw Angle. |
| <RTR-ANGLE90> | Withdraw Angle - 90. This parameter was added to support threading on a Fanuc. On that controller, a vertical retract is considered to be 0 , not 90. |
| <START-X> | The X location where the thread cutting pass starts. |
| <START-Z> | The Z location where the thread cutting pass starts. |
| <STEP1> | This word has different values for different operations: <ul style="list-style-type: none"> • Thread operation - Step 1 of threading pass. • Drill operation - First peck. • Groove operation - Stepover %. |
| <STEP2> | This word has different values for different operations: <ul style="list-style-type: none"> • Thread operation - Step 2 of threading pass. • Drill operation - Second peck. |
| <TAPER-ANGLE> | Returns the taper Angle entered on the Dimensions tab of the Thread Properties dialog. |
| <TAPER-DEPTH> | The Z distance between the lowest and highest points on the thread. |
| <THRD-DEPTH> | Corresponds to Thread Height in FeatureTURN. |
| <TIP-ANGLE> | The tip angle of the tool. |

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Logical reserved words

| Reserved word | Definition |
|----------------|---|
| <AUTO-ROUND> | TRUE if the Auto Round option is enabled in Turn properties. |
| <BAR-FEED> | TRUE if the current operation is a bar feeder operation. |
| <BAR-PULL> | TRUE if the current operation is a bar puller operation. |
| <COMP-END> | TRUE if the move represents the end section for compensation (last element, or move of path), otherwise FALSE. |
| <COMP-MID> | TRUE if the move represents the middle section for compensation (between the first and last moves of path), otherwise FALSE. |
| <COMP-ON> | TRUE if the Tool nose radius compensation option is enabled in Turn properties. |
| <COMP-START> | TRUE if the move represents the start section for compensation (first element, or move of path), otherwise FALSE. |
| <CSS-ON> | TRUE if the Constant surface speed check box is selected in Turn properties. |
| <CUTOFF-CHECK> | TRUE if the Cut-off checker check box is selected in the Position the spindle subspindle transfer feature (available for Turn and Turn/Mill posts). Checks for lack of torque between spindles to check part has been cut into two pieces, before the subspindle is sent home. Avoids damage to jaws and part which would result if Cutoff process was incomplete and the subspindle went home. |
| <CW-SPINDLE> | TRUE if the spindle is rotating in the clockwise direction, otherwise FALSE. |
| <EJECT-CHECK> | TRUE if the Eject check option is enabled in the Position the spindle page of the Subspindle transfer feature (available for Turn and Turn/Mill posts). Causes the machine's 'Eject checker' probe to check that the previous part has been ejected before grabbing the part from the opposite spindle. Avoids damage if the part has not been ejected. |
| <FACE-BFACE> | TRUE if performing a facing or back-facing operation. This would be true for a Turning feature using a Face or Back face roughing strategy or a Facing feature. |
| <FINISH> | TRUE for finish operations. |
| <FLOAT-TAP> | TRUE if Tap cycle type is set to Floating in FeatureCAM. |
| <HAS-SP-CTRL> | Currently applies to turning only. TRUE when Upper Turret is working on Main and also TRUE when Lower Turret is working on Sub. Used to suppress Lower Turret output (G96, S500, M3) when pinch turning on Main. |
| <HAS-TOOL> | TRUE if the turning operation has a tool associated with it. Used to suppress unnecessary output when an operation does not have a tool (for example bar feed). |
| <ID> | TRUE for Inside Diameter operations. |
| <IDOD-GROV> | Used to differentiate among G codes that are specialized for grooves on ID (inner diameter), OD (outer diameter), or those on the FACE as shown in the examples below: <IFNOT><IDOD-GROV> Implies that a Face Groove Cycle program format block is output. <IF><IDOD-GROV> Implies that an ID, or OD Groove Cycle format block is output. |
| <IS-FOLLOW> | TRUE if the operation uses follow turning. |
| <IS-METRIC> | TRUE if the NC code is being generated in metric units. |
| <IS-OP-STOP> | Valid in the 'Program Stop' format and indicates whether it is an optional stop. This format is called when a turn part is programmed to machine the main spindle side, output a program stop, the user manually removes the part and flips it around, and |

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| | then machines the second setup on the main spindle side. The value is set to FALSE in this case. |
| <IS-PINCH> | True if the operation uses pinch turning. |
| <IS-SYNCD> | True if turrets are synced. |
| <LAST-TOOL> | TRUE if the current tool is the very last tool in the program. |
| <LEFT-HANDED> | True if the current tool is left handed. |
| <MAIN-SPCMD> | Is only valid in the spindle transfer formats (Spindle Open, Spindle Position, and so on). If true, M codes in the transfer format should be issued for the main spindle, otherwise use M codes for the sub spindle. |
| <MAIN-SPNDLE> | True if the current operation is working on the main spindle, false if on the sub spindle. Note that this word should not be used in the spindle transfer formats (see <MAIN-SPCMD>) |
| <OD> | True for Outside Diameter operations. |
| <OFFSET-CH> | Normally used in a Segment Start block; TRUE if the <OFFSET#> is changed between segments: <pre><IF><OFFSET-CH><THEN> {N<SEQ>}T{<COMP-NUM>}<TOOL> <OFFSET#><EOB> <ENDIF></pre> <p>This value may also be true in the Rapid Move format for the finish pass of a Groove feature if you have specified a second offset register.</p> |
| <POS-DIR> | True if the operation is cutting in a positive direction. |
| <POST-RCAN> | True for the moves after rough canned cycle. |
| <PRE-GCAN> | True for the last move before groove canned cycle. |
| <PRE-PCAN> | True for the moves before finish canned cycle. |
| <PRE-RCAN> | True for the moves before rough canned cycle. |
| <RANGE-CH> | Normally used in a Segment Start block, and is true if there is a change in gear range: <pre><IF><RANGE-CH><THEN> {N<SEQ>}MO5<EOB> {N<SEQ>}<SP-RANGE><EOB> {N<SEQ>}S<CALC-SPEED> <SPINDLE-ON><EOB> <ENDIF></pre> |
| <REUSE-PATH> | True if the Reuse path in Canned cycle check box is selected in Turn properties. |
| <RIGID-TAP> | TRUE if Tap cycle type is set to Rigid in FeatureCAM. |
| <SP-MD-IS-TR> | For multi-turret turning. TRUE if the spindle is in turning mode and FALSE if the spindle is in milling mode. |
| <SPNDLEPRESS> | TRUE if using a pushing/pressing or skip function when transferring a part from one spindle to another. |
| <TAPER> | TRUE for tapered threads. |
| <TCAN-CYCLE> | TRUE if inside a turning canned cycle. |
| <TCAN-END> | TRUE for last move in the profile. |
| <TCAN-START> | TRUE for first move in the profile. |
| <TH-ATSUBPOS> | TRUE if turret home format is called because of subspindle position where subspindle is moving closer to the main spindle. |
| <TH-ATTOOLCH> | TRUE if turret home format is called because of tool change. |
| <TOOL-LEFT> | TRUE if the tool is on the left of the cutting path. |

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| <UNDER-CHECK> | TRUE if the Undercut Check check box is selected in turn properties. |
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String reserved words

| Reserved word | Definition |
|------------------------------|---|
| <AIR-BLAST> | Returns the proper air-blast codes from the CNC-Info > NC Codes dialog according to selections from the Misc. feature creation page. |
| <BOL> | Beginning of line identifier. Used to indent line in NC code output. Indents line by spacing amount between <BOL> and rest of line. |
| <CANCEL-COOL> | Used to output NC code to turn off coolant at the end of an operation. See the CNC-Info > Coolant dialog. |
| <COMP-STAT> | Returns the applicable code from the CNC-Info > NC Codes dialog, when tool nose radius compensation is selected in the Turn Properties dialog (for example G41, G42). Turns On at the first feed move of the profile path. |
| <COOLANT> | Returns the Coolant ON code for the selected turret from the Coolant dialog. |
| <COOLANT-3> | Returns string from the XBUILD Coolant dialog. |
| <COOLANT-4> | Returns string from the XBUILD Coolant dialog. |
| <COOLANT-MST> | Returns string from the XBUILD Coolant dialog. |
| <COOLANT-OFF> | Returns string from the XBUILD Coolant dialog. |
| <COOLANT-ON> | Returns string from the XBUILD Coolant dialog. |
| <DATE> | Returns the date that the NC code was posted. See also <REGION-DATE> . |
| <EOB> | Specifies the end of block code on each line of a format. |
| <FM-NAME> | Returns the FeatureCAM file name. |
| <F-UNITS> | Returns the applicable code for feed per revolution or feed per linear unit feed rates from the CNC-Info > Feeds & Speeds dialog. For example, G99, G98. |
| <FIXTURE> | Returns the current fixture offset code from the CNC-Info > Fixture ID dialog. |
| <MACH-TIME> | Returns the estimated time needed to machine the part. |
| <MATERIAL> | Outputs the name of the material. |
| <MCSID> | Returns the current Setup name, as set in FeatureCAM. |
| <MOTION> | Returns the motion code for the current move from the XBUILD CNC-Info > NC codes dialog. |
| <OP-PASS> | Returns Rough or Finish based on the type of pass. Value is always in English in order to support language-independent comparison. See also <OP-PASS-LOCAL> . |
| <OP-PASS-LOCAL> | Same as <OP-PASS> , but the value is in the local language, so it can be used for inserting comments in the NC code. |
| <OP-TYPE> | Returns the current operation type name from the following list FACE SPOTDRILL PILOT DRILL DRILL REAM TAP COUNTERSINK REAM GROOVE: OUTER GROOVE: INNER GROOVE: FACE |

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| | <p>GROOVE: BACKFACE RELIEF GROOVE THREAD: OUTER THREAD: INNER TURN BORE CUTOFF BAR FEEDER BAR PULLER</p> <p>Value is always in English in order to support language-independent comparison. See also <OP-TYPE-LOCAL>.</p> |
| <OP-TYPE-LOCAL> | Same as <OP-TYPE>, but the value is in the local language, so it can be used for inserting comments in the NC code. |
| <P1>...<P9> | <p>User-definable parameters passed from the Post Variables dialog accessed from the Turning tab of the Feature Properties dialog in FeatureCAM.</p> <p>Assigned to perform specific actions that are not normally handled as standard functions.</p> |
| <PGM-STOP> | Returns string from CNC-Info > NC Codes dialog. Used to stop program to flip part in chuck or vise to machine other setups. |
| <PRO-COMP> | When tool tip compensation and canned cycle status is selected, <PRO-COMP> returns the applicable code from the CNC-Info > NC Codes dialog to establish a right/left tool relationship with the part, and turns On at the first feed move of the profile path. |
| <PRO-FUNITS> | Used within a Turning Canned Cycle format to return applicable code for feed per revolution or feed per linear unit, for example G99, G98. |
| <PROG-NAME> | Returns the part name from the Setup definition in FeatureCAM. |
| <REGION-DATE> | Returns the date in the regional format (for example, British DD/MM/YY instead of MM/DD/YY) as specified in Windows. |
| <SEG-CMT> | Returns any Comments entered in a feature's Post Variables dialog in FeatureCAM. For controls that require comments to be a single line, <SEG-CMT> must be only one line. |
| <SEGM-ID> | Returns the name of the current feature from the part view in FeatureCAM. |
| <SPINDLE> | Returns the applicable code for spindle rotation direction from the CNC-Info > NC Codes dialog, for example M3, M4. |
| <SPNDLE-SEL> | Returns the applicable code to select main or sub spindle from the CNC-Info > Spindles dialog. |
| <SPDL-SYNCRN> | Spindle synchronization status. Valid in the spindle synchronize format. Returns the synchronize code from the XBUILD Spindles dialog. |
| <SP-RANGE> | Returns code to engage applicable speed range from the CNC-Info > Feeds&Speeds dialog. |
| <TIME> | Returns the time when the NC code was posted. |
| <TOOL-CMT> | Returns any Comments you have entered on the Overrides tab of Tool Properties . |
| <TOOL-ID> | Returns the Tool ID value from the FeatureCAM Tool Mapping dialog. |
| <TOOL-NAME> | Returns the Name of the current tool from the FeatureCAM Tool Mapping dialog. |
| <TOOL-ORIENT> | Returns the tool orientation prefix from the <TOOL-NAME> for turning tools only, for example SW , NE . |
| <TRT-TURN> | <p>Returns the applicable code for a CW or CCW turret rotation from the CNC-Info > Turrets dialog.</p> <p>Corresponds to the Turret Direction parameter from the Feature Properties > Tool</p> |

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| | Usage dialog. |
| <TURRET> | Selects the programmed turret. Corresponds to the Turret parameter from the Feature Properties > Tool Usage dialog. |
| <UDF-COMMENT> | Used in the UDF Text format to return a comment from an add-in macro, which creates a user-defined feature. |
| <UDF-TEXT> | Used in the UDF Text format to return a specific code from an add-in macro, which creates a user-defined feature. |
| <UNITS> | Returns the value from the Inch Units or Metric Units field on the CNC-Info > NC Codes dialog (commonly G20 or G21). |

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Milling reserved words

Numeric reserved words

| Reserved word | Definition |
|----------------|--|
| <ABS-DEPTH> | Absolute Z-axis depth from Z axis origin, calculated as <ZSURF> - <DEPTH>. |
| <ABS-SHIFTX> | X offset from machine zero to current Setup without any rotations applied. |
| <ABS-SHIFTY> | Y offset from machine zero to current Setup without any rotations applied. |
| <ABS-SHIFTZ> | Z offset from machine zero to current Setup without any rotations applied. |
| <ABS-STEP1> | Absolute first step, calculated as <ZSURF> - <STEP1>. |
| <ABS-ZCLEAR> | Absolute position of Z Clear -- Z Clear + Z Surf (not used in incremental programming). |
| <ABS-ZRAPID> | Absolute position of Z Rapid -- Z Rapid + Z Surf (not used in incremental programming). |
| <ANG-CFEED> | Outputs the feed value required for an Okuma or Fanuc control to maintain the programmed feed rate. This is a Cartesian feed rate value. |
| <ANG-DPM> | Wrapped feed rate, degrees per minute. |
| <ANG-DPM-NOFR> | Same as <ANG-DPM> except no feed rate reduction in corners when wrapping (for machines which do the reduction). |
| <ANG-FPM> | Wrapped feed rate, inch (or mm) per minute. |
| <ANG-INVTIME> | Wrapped feed rate inverse time. This reserved word is also calculated for 5-axis simultaneous. Computed as (linear distance traveled <i>after</i> coordinates are transformed + angular distance traveled)/feed. |
| <ARC-X> | Used in the circular interpolation block to specify the signed X distance from the start point of the arc, to the center of the arc along the X axis. |
| <ARC-Y> | Used in the circular interpolation block to specify the signed Y distance from the start point of the arc, to the center of the arc along the Y axis. |
| <ARC-Z> | Used in the circular interpolation block to specify the signed Z distance from the start point of the arc, to the center of the arc along the Z axis. |
| <BOT-LALLOW> | Corresponds to Bottom Semi Finish Allowance attribute for a milling operation. |
| <COMP-NUM> | Compensation number passed from FeatureCAM as the Diameter offset register in the Tool Mapping dialog, or on the Overrides tab of the Tool Properties dialog. |
| <COMP-VAL> | Cutter compensation diameter. |
| <DEPTH> | Outputs the maximum depth between operation depth and feature depth for the current segment. |
| <DWELL> | Returns the Dwell value passed from FeatureCAM. |
| <EXP-LENGTH> | Corresponds to the Exposed length tool parameter. |
| <FEED/MIN> | Feed rate value identifier (in minutes) passed from FeatureCAM. |
| <FEED/REV> | Feed rate value identifier (in revolutions) passed from FeatureCAM. |
| <FINI-ALLOW> | Finish allowance of a milling operation. |
| <FSHIFTX> | The X distance from the fixture offset to the local coordinate system. |
| <FSHIFTY> | The Y distance from the fixture offset to the local coordinate system. |
| <FSHIFTZ> | The Z distance from the fixture offset to the local coordinate system. |
| <HELIX-PITCH> | Pitch of helical move. Controlled by Max Ramp Angle attribute. |
| <HLDR-LENGTH> | Length of the tool holder. |
| <HOLE-DIAM> | The diameter of the hole. Intended for use with Hole Milling cycles. |
| <INC-DEPTH> | Incremental depth from Z Clear, <DEPTH> + <ZCLEAR>. |
| <INC-MACX> | X location of the pattern instance to be cut by the macro. This coordinate is not usually |

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| | output in the CNC program. |
| <INC-MACY> | Y location of the pattern instance that will be cut by the macro. Typically, this coordinate is not output in the CNC program. |
| <INC-MACZ> | Z location of the pattern instance to be cut by the macro. This coordinate is not usually output in the CNC program. |
| <INC-STEP1> | Incremental first step, <STEP1> + <ZCLEAR>. |
| <LIN-INVTIME> | Computed as (Linear distance traveled <i>before</i> coordinates are transformed)/feed |
| <MACRO#> | Macro number identifier (system-generated). Macros are not user definable, however, some Macros are generated automatically, especially with multiple fixture parts and for repeated features. This number starts at 00 and increments automatically up to the Max Macros number specified in the General Information dialog. |
| <MIN-STEP> | The Minimum Peck drilling parameter. |
| <NO-DRAG-X> | Amount to move over in X for no-drag boring. |
| <NO-DRAG-Y> | Amount to move over in Y for no-drag boring. |
| <NEXT-TL> | The next tool to be used (may be required by some controls). |
| <NEXT-TL-ID> | The next tool to be used, for Siemens controls. See also <NEXT-TOOL-NAME> (string). |
| <NOM-FEED> | The nominal feed rate |
| <NOM-PL-FEED> | The plunge feed rate |
| <NOSE-RAD> | Tool nose radius of an endmill or the tool tip radius of a turning or threading tool. |
| <OFFSET#> | Tool length offset register number, passed from FeatureCAM as the Length offset register in the Tool Mapping dialog, or on the Overrides tab of the Tool Properties dialog. |
| <OV-LENGTH> | The overall length of the tool. Corresponds to the Overall Length parameter of a tool. |
| <PITCH> | The pitch value for the Tap cycle. This value is in Z-distance per spindle revolution. |
| <PLUNGE-FEED> | The feed rate to use for plunging. Intended for use with Hole Milling cycles. |
| <PREDRILL-DIA> | Outputs the pre-drill diameter value for the Hole Milling cycle. |
| <RADIUS> | Returns the arc radius in a circular block. |
| <ROT1-ANSI> | Rotation about primary axis in ANSI style. |
| <ROT1-ANSI-R> | Reverse of the rotation values for the primary axis in ANSI style. |
| <ROT1-MATH> | Rotation about primary axis in Mathematical style. |
| <ROT1-MATH-R> | Reverse of the rotation values for the primary axis in Mathematical style. |
| <ROT1-WIND> | Rotation about primary axis in Winding style. |
| <ROT2-ANSI-R> | Reverse of the rotation values for the secondary axis in ANSI style. |
| <ROT2-ANSI> | Rotation about secondary axis in ANSI style. |
| <ROT2-MATH> | Rotation about secondary axis in Mathematical style. |
| <ROT2-MATH-R> | Reverse of the rotation values for the secondary axis in Mathematical style. |
| <ROT2-WIND> | Rotation about secondary axis in Winding style. |
| <ROT-Z> | For machines that don't support plane spatial, but do support cycle 10 (which allows for the rotation of the coordinate system about its own Z axis so that the X axis lines up with the X axis of the part file). This is the Z rotation angle. |
| <S-RAD> | Generates the signed arc radius value in a circular block, +R<180 degrees and R>180 degrees. |
| <SEQ> | This is a line sequence number identifier (when the word appears in a line, it is substituted with the current sequence number, and is subsequently incremented by the sequence step value). |
| <SHIFTX> | X offset from machine zero to current Setup after axis rotations are applied. |
| <SHIFTY> | Y offset from machine zero to current Setup after axis rotations are applied. |

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| <SHIFTZ> | Z offset from machine zero to current Setup after axis rotations are applied. |
| <SIDE-LALLOW> | Side leave allowance. Corresponds to Bottom Leave Allowance or Finish Allowance attributes for a milling operation. |
| <SPATIAL-A> | Spatial angle A for 5-axis positioning. |
| <SPATIAL-B> | Spatial angle B for 5-axis positioning. |
| <SPATIAL-C> | Spatial angle C for 5-axis positioning. |
| <SPEED> | Spindle speed value passed from FeatureCAM. |
| <START-ANG> | Initial angle of helical move. Added for Heidenhain control. |
| <STEP1> | First Peck value passed from FeatureCAM. |
| <STEP2> | Second Peck value passed from FeatureCAM. |
| <STEPOVER> | Stepover distance passed from the feature. |
| <STOCK-ID> | Inner diameter of the stock - for round (tube) stock only - 0 for other types of stock. |
| <STOCK-OD> | Outer diameter of the stock - for round stock only - 0 for other types of stock. |
| <STOCK-TYPE> | Type of stock: 1.0 for block, 2.0 for round, 3.0 for N-sided, 4.0 for user-defined. |
| <STOCK-XMAX> | Bounding box - maximum X value, or X coordinate of the upper most corner of the bounding box for the stock in space. |
| <STOCK-XMIN> | Bounding box - minimum X value, or X coordinate of the lower most corner of the bounding box for the stock in space. |
| <STOCK-YMAX> | Bounding box - maximum Y value, or Y coordinate of the upper most corner of the bounding box for the stock in space. |
| <STOCK-YMIN> | Bounding box - minimum Y value, or Y coordinate of the lower most corner of the bounding box for the stock in space. |
| <STOCK-ZMAX> | Bounding box - maximum Z value, or Z coordinate of the upper most corner of the bounding box for the stock in space. |
| <STOCK-ZMIN> | Bounding box - minimum Z value, or Z coordinate of the lower most corner of the bounding box for the stock in space. |
| <TOOL> | The Tool number , passed from the Tool Mapping dialog in FeatureCAM. |
| <TOOL-DIAM> | Tool diameter, passed from FeatureCAM. |
| <TOOL-LENGTH> | Corresponds to cutter length of endmills or length of drills. |
| <TOTAL-ANG> | Total angle of a helical move. Added for Heidenhain. |
| <TPI-PITCH> | The TPI value for the Tap cycle in an inch CNC file or the pitch value for the Tap cycle in a millimeter CNC file. |
| <UCS-X> | Absolute position in X of the Part Setup in relation to the Stock Axis. |
| <UCS-Y> | Absolute position in Y of the Part Setup in relation to the Stock Axis. |
| <UCS-Z> | Absolute position in Z of the Part Setup in relation to the Stock Axis. |
| <X-CEN> | Returns the absolute X coordinate position from the X axis origin to the arc's center in a circular block. |
| <X-CHANGE> | X coordinate of desired Tool change location passed from the Post Options dialog in FeatureCAM. |
| <X-COORD> | Returns the value of the current X coordinate. |
| <X-SURFNORM> | For 5 axis simultaneous, X component of surface normal vector. |
| <X-TOOLVEC> | For 5 axis simultaneous, X component of tool vector. |
| <X-VECTOR> | Calculated X vector for the next move (cutter compensation vector for Cincinnati Milacron). |
| <Y-CEN> | Returns the absolute Y coordinate position from the Y axis origin to the arc's center in a circular block. |
| <Y-CHANGE> | Y coordinate of desired tool change location passed from the Post Options dialog. |
| <Y-COORD> | Returns the value of the current Y coordinate. |

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| <Y-SURFNORM> | For 5 axis simultaneous, Y component of surface normal vector. |
| <Y-TOOLVEC> | For 5 axis simultaneous, Y component of tool vector. |
| <Y-VECTOR> | Calculated Y vector for the next move (cutter compensation vector for Cincinnati Milacron). |
| <Z-CEN> | Returns the absolute Z coordinate position from the Z axis origin to the arc's center in a circular block. |
| <Z-CHANGE> | Z coordinate of desired Tool change location passed from the Post Options dialog in FeatureCAM. |
| <ZCLEAR> | Z coordinate that programmed feed rate begins. This is the Plunge Clearance attribute passed from the Hole feature. |
| <Z-COORD> | Returns the value of the current Z coordinate. |
| <Z-INC> | Rough pass Z increment attribute passed from the feature. |
| <Z-INDEX-CLR> | The Z retract distance when indexing 4th axis. |
| <ZRAPID> | Z distance from surface of stock that tool rapids to. This distance is the Z rapid plane attribute plus the absolute distance from the UCS to the surface of the stock. |
| <ZSURF> | Z coordinate of stock surface relative to UCS origin. |
| <Z-SURFNORM> | For 5 axis simultaneous, Z component of surface normal vector. |
| <Z-TOOLVEC> | For 5 axis simultaneous, Z component of tool vector. |

Logical reserved words

| Reserved word | Definition |
|----------------|--|
| <4-AXIS-OPER> | TRUE if operation is 4-axis simultaneous. |
| <5-AXIS-OPER> | TRUE if operation is 5-axis simultaneous. |
| <CHIP-TAP> | TRUE if Tap cycle is set to Chip Break in the Drilling document-level attributes in FeatureCAM. |
| <COMP-3D-ON> | TRUE if 3D cutter comp is active. |
| <COMP-END> | TRUE if the move represents the end section for compensation (last element, or move of path), otherwise FALSE. |
| <COMP-MID> | TRUE if the move represents the middle section for compensation (between the first and last moves of path), otherwise FALSE. |
| <COMP-ON> | TRUE if cutter diameter compensation is ON , otherwise FALSE. |
| <COMP-START> | TRUE if the move represents the start section for compensation (first element, or move of path), otherwise FALSE. |
| <CW-SPINDLE> | TRUE if the spindle is rotating in the clockwise direction, otherwise FALSE. |
| <CYCLE-DONE> | TRUE for the last hole location in a canned cycle, otherwise FALSE. |
| <CYCLE-MACRO> | TRUE if the current segment is in a canned cycle. |
| <DEEP-TAP> | TRUE if Tap cycle is set to Deep Hole in the Drilling document-level attributes in FeatureCAM. |
| <DRILL-CPTED> | TRUE if drill moves are computed using linear moves. FALSE if canned cycles. |
| <DRILLING> | TRUE if a drilling-type cycle is used in a segment, otherwise <DRILLING> is false, and a milling segment is in process. |
| <FLOAT-TAP> | TRUE if Tap cycle type is set to Floating in FeatureCAM. |
| <INDEX> | TRUE if 4th or 5th axis indexing is set in FeatureCAM. For the Segment Start formats <INDEX> is TRUE only when the indexing move is actually being performed. |
| <INDEXING> | TRUE if you have turned on indexing for X,Y,or Z axis. |
| <IS-INC-MACRO> | TRUE if incremental macros are enabled. |
| <IS-METRIC> | TRUE if the NC code is being generated in metric units. |

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| | |
|-----------------------|---|
| <IS-MULTIPLE-FIXTURE> | TRUE if document is multiple fixture. |
| <IS-SYNCD> | TRUE if the user has set a sync point at the start of the operation. |
| <IS-WORLD> | TRUE if the current Setup is named WORLD . |
| <IS-ZINDXCLR> | Rapid move before segment start is being called as a result of a retract to the Z-index clearance. |
| <LAST-TOOL> | TRUE if the current tool is the very last tool in the program. |
| <OFFSET-CH> | Normally used in a Segment Start block; TRUE if the <OFFSET#> is changed between segments: <IF><OFFSET-CH><THEN> {N<SEQ>}T{<COMP-NUM>}<TOOL> <OFFSET#><EOB> <ENDIF> |
| <RIGID-TAP> | TRUE if Tap cycle type is set to Rigid in FeatureCAM. |
| <USE-FIXTURE> | TRUE if using 5th-axis positioning with Fixture IDs. |
| <USE-ROTFEED> | TRUE if the linear move format should use DPM feed rate instead of linear feed rate. Replaces test of <IF><WRAP>. Set for wrapped, 4axis simultaneous, and 5 axis simultaneous operations. TRUE only if there is an angular rotation for this move. |
| <WAS-WORLD> | TRUE if the previous Setup is named WORLD . |
| <WRAP> | TRUE if 4th axis wrapping is set. |
| <WRAP-Z-DOWN> | TRUE if wrapping and the tool is moving down in the Z direction. |
| <WRAP-Z-UP> | TRUE if wrapping and the tool is moving up in the Z direction. |
| <X-WRAP> | TRUE if the current milling operation is wrapping in the X direction. |
| <XY-PLANE> | TRUE if the current arc is in the XY plane. |
| <Y-WRAP> | TRUE if the current milling operation is wrapping in the Y direction. |
| <YZ-PLANE> | TRUE if the current arc is in the YZ plane. |
| <Z-CHANGED> | TRUE if current move changes Z from the previous location. |
| <Z-DOWN> | TRUE if the tool moves down in the Z direction, otherwise FALSE. |
| <ZX-PLANE> | TRUE if the current arc is in the ZX plane. |
| <Z-UP> | TRUE if the tool moves up in the Z direction, otherwise FALSE. |

String reserved words

| Reserved word | Definition |
|---------------|---|
| <BOL> | Beginning of line identifier. Used to indent line in NC code output. Indents line by spacing amount between <BOL> and rest of line. |
| <CANCEL-COOL> | Used to output NC code to turn off coolant at the end of an operation. See the CNC-Info > Coolant dialog. |
| <COMP-STAT> | Returns the appropriate code from the CNC-Info > NC Codes dialog for cutter diameter compensation. |
| <COOLANT> | Returns the proper coolant code from the XBUILD Coolant dialog. |
| <COOLANT-3> | Returns string from the XBUILD Coolant dialog. |
| <COOLANT-4> | Returns string from the XBUILD Coolant dialog. |
| <COOLANT-MST> | Returns string from the XBUILD Coolant dialog. |
| <COOLANT-OFF> | Returns string from the XBUILD Coolant dialog. |
| <COOLANT-ON> | Returns string from the XBUILD Coolant dialog. |
| <CYCLE> | Returns the appropriate drill cycle code from the CNC-Info > NC Codes dialog. |

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| | |
|-----------------|---|
| <CYCLE-RTRCT> | Returns the appropriate retract code for canned drilling cycles from the CNC-Info > NC Codes dialog. |
| <DATE> | Returns the date that the NC code was posted. See also <REGION-DATE>. |
| <EOB> | Specifies the end of block code on each line of a format. |
| <FIXTURE> | Returns the current fixture offset code from the CNC-info > Fixture ID dialog. |
| <F-UNITS> | Returns the applicable code for feed per revolution or feed per linear unit feed rates from the CNC-Info > Feeds & Speeds dialog. For example, G99, G98. |
| <FM-NAME> | Returns the FeatureCAM file name. |
| <HOLDER-NAME> | Returns the tool holder name from the Manufacturing > Spindles and Toolholders dialog in FeatureCAM. |
| <MACH-TIME> | Returns the estimated time needed to machine the part. |
| <MATERIAL> | Outputs the name of the material. |
| <MCSID> | Returns the current Setup name, as set in FeatureCAM. |
| <MOTION> | Returns the motion code for the current move from the XBUILD CNC-Info > NC codes dialog. |
| <NEXT-TL-NAME> | For Siemens controls, the name of the next tool. See also <NEXT-TL-ID> (numeric). |
| <OP-PASS> | Returns Rough or Finish based on the type of pass. Value is always in English in order to support language-independent comparison. See also <OP-PASS-LOCAL>. |
| <OP-PASS-LOCAL> | Same as <OP-PASS>, but the value is in the local language, so it can be used for inserting comments in the NC code. |
| <OP-TYPE> | Returns the current operation type name. Value is always in English in order to support language-independent comparison. See also <OP-TYPE-LOCAL>. |
| <OP-TYPE-LOCAL> | Same as <OP-TYPE>, but the value is in the local language, so it can be used for inserting comments in the NC code. |
| <P1> | Post variable number one. Returns user-defined string placed in the Post Vars in FeatureCAM. Variables up to <P100> may be defined. |
| <PGM-STOP> | Returns string from CNC-Info > NC Codes dialog. Used to stop program to flip part in chuck or vise to machine other setups. |
| <PLANE> | Returns the appropriate code for an active plane from the CNC-Info > NC Codes dialog. |
| <PROG-NAME> | Returns the part name from the Setup definition in FeatureCAM. |
| <REGION-DATE> | Returns the date in the regional format (for example, British DD/MM/YY instead of MM/DD/YY) as specified in Windows. |
| <SEG-CMT> | Returns any Comments entered in a feature's Post Variables dialog in FeatureCAM. For controls that require comments to be a single line, <SEG-CMT> must be only one line. |
| <SEGM-ID> | Returns the name of the current feature from the part view in FeatureCAM. |
| <SPINDLE> | Returns the applicable code for spindle rotation direction from the CNC-Info > NC Codes dialog, for example M3, M4. |
| <TIME> | Returns the time when the NC code was posted. |
| <TOOL-CMT> | Returns any Comments you have entered on the Overrides tab of Tool Properties . |
| <TOOL-ID> | Returns the Tool ID value from the FeatureCAM Tool Mapping dialog. |
| <TOOL-NAME> | Returns the Name of the current tool from the FeatureCAM Tool Mapping dialog. |
| <UDF-COMMENT> | Used in the UDF Text format to return a comment from an add-in macro, which creates a user-defined feature. |
| <UDF-TEXT> | Used in the UDF Text format to return a specific code from an add-in macro, which creates a user-defined feature. |

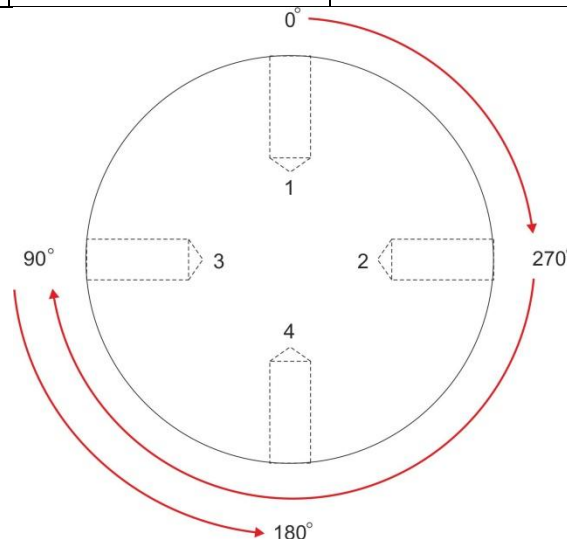
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| | |
|----------------------|--|
| <UNITS> | Returns the value from the Inch Units or Metric Units field on the CNC-Info > NC Codes dialog (commonly G20 or G21). |
|----------------------|--|

Turn/Mill reserved words

| Hole | ROT1-ANSI | ROT1-ANSI-R | ROT1-MATH | ROT1-MATH-R | ROT1-WIND |
|------|-----------|-------------|-----------|-------------|-----------|
| 1 | 0 | 0 | 0 | 0 | 0 |
| 2 | 270 | 90 | -90 | 90 | -90 |
| 3 | 90 | 270 | -270 | 270 | -270 |
| 4 | 180 | -180 | 180 | -180 | -180 |

| MDI to 0 Deg and mark 12 o'clock position | CW or CCW | Clock Position |
|---|-----------|----------------|
| MDI to -90 Deg | | |
| MDI to -45 Deg | | |
| MDI to 270 Deg | | |



There are 3 main ways of describing rotation to a machine tool. The 3 techniques are called (and this may not be common terminology) ANSI, Math and Wind.

Here's how to determine which method the machine uses. You want to make the table rotate from 12:00 to 3:00 and then back to 1:30. In each case we will MDI in three rotations. The one that moves from 12:00 to 3:00 and back to 1:30 is the method to use.

MDI the table to 0. Mark 12 O'clock with a grease pencil or marker.

MDI to +90. (record the direction it rotates and the clock position it ended up at in each case) MDI to -45.

If the table went from 12:00 to 3:00 and back to 1:30, this uses the ANSI method. FeatureCAM implements this method with the <rot1-ansi> reserved word.

MDI to 0.

MDI to +90

MDI to -315

If the table went from 12:00 to 3:00 and back to 1:30, this uses the MATH method. FeatureCAM implements this method with the <rot1-math> reserved word.

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MDI to 0
 MDI to +90
 MDI to +45

If the table went from 12:00 to 3:00 and back to 1:30, this uses the WIND method. FeatureCAM implements this method with the <rot1-wind> reserved word.

Numeric reserved words

| Reserved word | Definition |
|----------------|---|
| <ANG-DPM-NOFR> | Wrapped feed rate, degrees per minute, no feed rate reduction. |
| <ANGLEXY> | Returns the angle of the point <X-COORD>,<Y-COORD> on the front face of the part. Replaces anglexy() function. Used to determine the angular position of holes on the Z face of the part. The X axis of the part is 0 degrees. |
| <BAXIS-ROT> | Returns turning tool rotary angle where turning tool is locked in B-axis spindle. Commonly used to flip turn tools when moving from main to sub. This is not the same as the B-angle of the tool. |
| <OP-ORDERNUM> | Used to create Psync codes for Okuma machines. Because Okuma has only one file for both turrets, each operation needs an individual sync code that determines the operation order (whether synced or not). When the turrets are synced the P codes for both turrets are the same. |
| <RADIUSXY> | Returns the distance or radius of the point <X-COORD>,<Y-COORD> from the center of the part. Replaces the radiusxy() function. Used to determine the angular position of holes on the Z face of the part. |
| <SUBFIXTURE> | Used with <FIXTURE> for B-axis turn/mill features, this lets you use a separate fixture offset for each Hole (or other feature), by suffixing the <FIXTURE> value with a decimal point and the <SUBFIXTURE> value. Enter the <SUBFIXTURE> value as the Subfixture ID attribute on the Misc tab of the Feature Properties dialog in FeatureCAM. Output the <SUBFIXTURE> like this: <IF>[<SUBFIXTURE>]<THEN> G<FIXTURE>.<SUBFIXTURE><EOB> <ENDIF> |
| <SYNC-NEXT> | Returns the next available sync code and increments the internal current sync number. |
| <WRAP-RADIUS> | The wrapping radius, for use with cylindrical interpolation. |

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Logical reserved words

| Reserved word | Definition |
|----------------|--|
| <4-AXIS-OPER> | True if operation is 4 -axis simultaneous. |
| <5-AXIS-OPER> | True if operation is 5-axis simultaneous. |
| <COMP-3D-ON> | True if 3D cutter comp is active. |
| <CUTOFF-CHECK> | True if the Cutoff check option is selected in the Position the spindle page of the Subspindle transfer feature (available for Turn and Turn/Mill posts). Checks for lack of torque between spindles to check part has been cut into two pieces, before the subspindle is sent home. Avoids damage to jaws and part which would result if Cutoff process was incomplete and the subspindle went home. |
| <CYL-INTERP> | True if cylindrical interpolation is used. |
| <EJECT-CHECK> | True if the Eject check check box is selected in the Position the spindle page of the Subspindle transfer feature (available for Turn and Turn/Mill posts). Causes the machine's 'Eject checker' probe to check that the previous part has been ejected before grabbing the part from the opposite spindle. Avoids damage if the part has not been ejected. |
| <HAS-TOOL> | True if the turning operation has a tool associated with it, otherwise <HAS-TOOL> is False. Used to suppress unnecessary output when an operation does not have a tool (for example bar feed). |
| <HAS-SP-CTRL> | Currently applies to turning only. True when Upper Turret is working on Main and also true when Lower Turret is working on Sub. Used to suppress Lower Turret output (G96, S500, M3) when pinch turning on Main. |
| <IS-FOLLOW> | True if the operation uses follow turning. |
| <IS-METRIC> | True if the NC code is being generated in metric units. |
| <IS-MFDOC> | True for multiple fixture documents. |
| <IS-OP-STOP> | Valid in the Program Stop format and indicates whether it is an optional stop. This format is called when a turn part is programmed to machine the main spindle side, output a program stop, the user manually removes the part and flips it around, and then machines the second setup on the main spindle side. The value is set to FALSE in this case. |
| <IS-PINCH> | True if the operation uses pinch turning. |
| <IS-SYNCD> | True if turrets are synced. |
| <MILLING> | True if current feature is a milling feature. |
| <ROTARY-OD> | True if active tool is a rotary x tool. Applies to drilling and milling. |
| <SPINDLEPRESS> | True when Use Push/Press function is selected on the Position the spindle page of the Subspindle transfer feature. On those machines with this option, it serves to apply pressure on the part by having the sub push the part into the Main spindle jaws, thus seating the part more accurately into the subspindle jaws during transfer. |
| <TURNING> | True if current feature is a Turning feature. |
| <USE-ROTFEED> | True if the linear move format should use DPM feed rate instead of linear feed rate. Replaces test of <IF><WRAP>. Set for wrapped, 4-axis simultaneous, and 5-axis simultaneous operations. True only if there is an angular rotation for this move. |
| <ZFACE-POLAR> | True if the segment uses polar interpolation on the Z-face of the part. |
| <ZFACE-YAXIS> | True if cut feature using Y coordinates check box in feature properties dialog is selected. Machine must have Y axis to use this option. |

String reserved words

| Reserved word | Definition |
|---------------|------------|
|---------------|------------|

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| | |
|---------------|--|
| <AIR-BLAST> | Returns the proper air-blast codes from the CNC-Info > NC Codes dialog according to selections from the Misc. feature creation page. |
| <CANCEL-COOL> | Used to output NC code turning off coolant at end of operation. See the CNC-Info > Coolant dialog. |
| <CLAMP-ON> | Clamp/brake status word. Returns the clamp on or brake on reserved word (from XBUILD Spindles dialog) for the current spindle when they need to be turned on after a C rotation change. See also clamping reserved words. |
| <CLAMP-OFF> | Clamp/brake status word. Returns the clamp off or brake off reserved word (from XBUILD Spindles dialog) for the current spindle when they need to be turned off before a C rotation change. See also clamping reserved words. |
| <MAIN-BK-OFF> | Returns string from XBUILD Spindles dialog to turn main spindle brake off. |
| <MAIN-BK-ON> | Returns string from XBUILD Spindles dialog to turn main spindle brake on. |
| <MAIN-CL-OFF> | Returns string from XBUILD Spindles dialog to unclamp main spindle. |
| <MAIN-CL-ON> | Returns string from XBUILD Spindles dialog to clamp main spindle. |
| <SUB-BK-OFF> | Returns string from XBUILD Spindles dialog to turn sub spindle brake off. |
| <SUB-BK-ON> | Returns string from XBUILD Spindles dialog to turn sub spindle brake on. |
| <SUB-CL-OFF> | Returns string from XBUILD Spindles dialog to unclamp sub spindle. |
| <SUB-CL-ON> | Returns string from XBUILD Spindles dialog to clamp sub spindle. |
| <UNITS> | Returns the value from the Inch Units or Metric Units field on the CNC-Info > NC Codes dialog (commonly G20 or G21) |

Multi-turret reserved words

| Reserved words | Type | Definition |
|-------------------------------|---------|---|
| <PRV-SP-MODE> | Numeric | Indicates whether the current spindle was previously turning, and in which direction. Used to determine spindle state before the next operation starts, as follows: <pre><IF>[eq(<PRV-SP-MODE>,0)]<THEN> milling mode<EOB> <ELSEIF>[eq(<PRV-SP-MODE>,1)]<THEN> turning mode (CW)<EOB> <ELSE> turning mode (CCW)<EOB> <ENDIF></pre> |
| <SYNC1> through <SYNC5> | Numeric | The <SYNC1> through <SYNC5> reserved words allow the post author to define up to 5 synchronization points within a particular format. If these variables are blank, they will not be output. For example, you could sinc before and after a C-axis rotation to make sure that nothing else is going on while the rotation takes place. |
| <SYNC-PNUM> | Numeric | Returns the turrets that are selected for the sync. If the user sets a sync code on turrets 2 and 3, the reserved word will return 23 . Typical use is {M<SYNC-NUM1>}{P<SYNC-PNUM>}. <SYNC-PNUM> is only updated if <SYNC-NUM1> is updated. |
| <SYNC-SPEED> | Numeric | For use in Okuma style multi-turret posts only, this variable contains the synchronization code for a change in spindle speed. The sync code must be output on the same line as the spindle speed. |
| <TURRET-NUM> | Numeric | The number of the turret that is active for the current operation. |

Using expressions in formats

Expressions are surrounded by square brackets []. They are evaluated prior to being output. This example multiplies the current X coordinate by five:

```
[<X-COORD>*5]
```

This example offsets a rapid move by (5,5):

```
N<SEQ>G00 X[<X-COORD>+5] Y[<Y-COORD>+5] Z[<Z-COORD>
```

This example sets the X coordinate to 3, Y coordinate to 5 and Z coordinate to 0.0001:

```
X[<X-COORD>=3]Y[<Y-COORD>=5]Z[<Z-COORD>=0.0001]<EOB>
```

This example adds 3 to the X coordinate and then multiplies the result by 2

```
[(<X-COORD>+3)*2]<EOB>
```

This example sets the X coordinate to 1 but because there is a colon before the variable then it is not printed to the NC code

```
[:<X-COORD>=1]<EOB>
```

This example tests to see if the Z coordinate is equal to 0 within plus or minus 0.001 and if true print the work Yes in the NC code.

```
<IF>[apxeq(<Z-COORD>,0,0.001)]<THEN>  
  Yes<EOB>  
<ENDIF>
```

This example sets the variable a to the X coordinate

```
[a=<X-COORD>]<EOB>
```

This example adds the value of 5 to the a variable

```
[a+5]<EOB>
```

Numeric operators

| Operator | Description |
|-----------|--|
| + | <ul style="list-style-type: none"> • addition, adds two numbers. • string concatenation, joins two strings. • if given a string and a number, the string is converted into a number and then the two numbers are added. |
| - | subtraction, subtracts two numbers |
| * | multiplication, multiplies two numbers |
| / | division, divides two numbers |
| % | Modulo operation. Performs an integer division and returns the remainder. For example if <ROT1-WIND> returned a value of 380, then [<ROT1-WIND>%360] will return 20. This can be used to restrict the angles between 0 and 360 on machines that require this limitation. |
| tan(num) | Computes the tangent of an angle (given in radians). |
| sind(num) | Computes the sine of an angle (given in degrees). |

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| | |
|--------------------|--|
| cosd(num) | Computes the cosine of an angle (given in degrees). |
| tand(num) | Computes the tangent of an angle (given in degrees). |
| asin(num) | Computes the arcsine (in radians) of a number. |
| acos(num) | Computes the arccosine (in radians) of a number. |
| atan(num) | Computes the arctangent (in radians) of a number. |
| atan2(y,x) | Computes the arctangent (in radians) of y/x. |
| asind(num) | Computes the arcsine (in degrees) of a number. |
| fabs(num) | Computes the absolute value of the number. |
| in2mm(num) | Converts inches to millimeters. |
| anglexy(x,y) | Computes the angle between the X-axis to the line between (0,0) and (x,y). |
| acosd(num) | Computes the arccosine (in degrees) of a number. |
| atand(num) | Computes the arctangent (in degrees) of a number. |
| atan2d(y,x) | Computes the arctangent (in degrees) of y/x. |
| ceil(num) | returns the nearest integer greater than or equal to a number. |
| sqrt(num) | Returns the square root of a number. |
| mm2in(millimeters) | Converts from milliliters to inches. |
| exp(num) | Returns e^x where $e = 2.71828$. |
| log(num) | Returns $\ln(x)$ where \ln is the natural logarithm. |
| log10(num) | Returns the base-10 logarithm of a number. |
| pow(base,power) | Returns a base number raised to a power. |
| degtorad(num) | Returns an angle in radians as converted from degrees. |
| radtodeg(num) | Returns an angle in degrees as converted from radians. |
| pi | The mathematical value of pi to ten decimal places. |
| radiusxy(x,y) | Computes the distance from the origin to XY. |

Logical operators

| Operator | Function | Example | Explanation |
|----------|-----------------------|------------------------|---|
| eq | Equal | [eq(<TOOL>, 0)] | True if <TOOL> = 0 Also works for strings. |
| neq | Not Equal | [neq(<TOOL>, 0)] | True if <TOOL> not equal to 0 Also works for strings. |
| lt | Less Than | [lt(<TOOL>, 0)] | True if <TOOL> less than 0 Also works for strings. |
| gt | Greater Than | [gt(<TOOL>, 0)] | True if <TOOL> is greater than 0 Also works for strings. |
| le | Less Than or Equal | [le(<TOOL>, 0)] | True if <TOOL> less than or equal to 0 Also works for strings. |
| ge | Greater Than or Equal | [ge(<TOOL>, 0)] | True if <TOOL> is greater than or equal to 0 Also works for strings. |
| and | And | [and(<Z-UP>, <INDEX>)] | True if both |

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| | | | |
|-------|---|------------------------------|---|
| | | | <Z UP> and <INDEX> are true. |
| or | Or | [or(<Z-UP>, <INDEX>)] | True if either <Z UP> or <INDEX> is true. |
| not | Not | [not(<Z-CHANGED>)] | True if <Z CHANGE> is false. |
| apxeq | Approximately Equal within a Tolerance (if tolerance is not given, the default is 1e-6 .) | [apxeq(<Z-COORD>, 0, .0001)] | True if <Z COORD> is equal to 0 within plus or minus 0.0001 |

Examples

To output **Z** as **0** if **Z** is within **0.0001** of zero:
<IF>[apxeq(<Z-COORD>, 0, 0.0001)]<THEN>
N<SEQ> G00 X<X-COORD> Y<Y-COORD> Z0<EOB>
<ENDIF>

To output **Z** as **15** if **Z** is between **10** and **20** inclusively:
<IF>[and(ge(<Z-COORD>, 10), le(<Z-COORD>, 20))] <THEN>
N<SEQ> G00 X<X-COORD> Y<Y-COORD> Z15<EOB>
<ENDIF>

If **P1** variable is not set, set it to the string **G0**:
<IF>[eq(<P1>, "")]<THEN>
[<P1>="G0"]
<ENDIF>

String operators

| Operator | Function | Example | Explanation |
|------------------------------|---|--------------------------|---|
| uppercase | Convert string to all upper-case characters | [uppercase("abc")] | Prints ABC |
| + | If used with two strings, the strings are concatenated. | ["abc" + "def"] | Prints abcdef |
| + | If used with a string and a number the number is converted to a string and then they are added. | ["0.5" +0.0] | Prints 0.5 . This is a shortcut for converting a string into a number. |
| mid(string, startpos,length) | Extracts a substring from a string. Note that startpos is a 0-based index. | [mid("abcdef",2,3)] | Prints cde |
| strlen() | Determines the length of a string. | [strlen("abc")] | Prints 3 |
| subst(arg1,"arg2","arg3") | In argument1, replaces every occurrence of | [subst(<WIRE>,"_", " ")] | Replaces every occurrence of "_" with " " in <WIRE>. |

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| | | | |
|--|------------------------------|--|--|
| | argument2 with argument3. | | |
|--|------------------------------|--|--|

Note: Many of the logical operators also work for strings.

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Example

You can use **mid()** and **strlen()** to convert the total machining time from the *hours:minutes:seconds* format to just *seconds*:

```
[ :sec=mid(<MACH-TIME>,strlen(<MACH-TIME>)-2)]<EOB>
[ :min=mid(<MACH-TIME>,strlen(<MACH-TIME>)-5,strlen(<MACH-TIME>)-3)]<EOB>
[ :hr=mid(<MACH-TIME>,0,strlen(<MACH-TIME>)-6)]<EOB>
[hr*3600+min*60+sec]<EOB>
```

Formatting of Numbers in Post

Formatting expressions

The format for an expression can be customized by preceding the expression with an optional format specification. The format specification is separated from the expression by a colon `:`.

LTDUP|Format|Factor where:

L stands for Leading zeros.

T stands for Trailing zeros.

D stands for Decimal point.

U stands for Unsigned value.

P stands for Plus sign.

Format specifies the number of digits, for example 3.4.

Factor specifies the multiplier, for example 1.0.

Examples

| Expression | Result |
|-----------------|--------|
| [D 3.4 1.0:10] | 10.0 |
| [D 5.4 1.0:10] | 10.0 |
| [LD 3.4 1.0:10] | 010.0 |
| [LP 3.0 1.0:10] | +010 |
| [PT 3.1 1.0:10] | +100 |

```
[#      ]IF<91>#[T|3.0|1:datum_face_no] NE 1<93> GOTO [T|4.0|1:n_num=n_num + 10]<EOB>
```

When no format specification is given and there is no colon specified, XBUILD automatically uses the format of the numeric reserved word within the square brackets. For example, [`<X-COORD>+1`] is printed in the default format for the `<X-COORD>` reserved word as configured in the **Words Info** dialog. If there aren't any reserved words, such as in the expression [`1+2`], the default format for the `<Z-COORD>` reserved word is used.

Suppressing printing of an expression

To suppress the printing of the assignment result, specify only the colon as the format specification. For example, neither of the following expressions will print a value because the first character of the expression is set to '!':

```
[ :x_var=<X-COORD>+1]
[ :<Y-COORD>*2]
```

Comments

You can place a comment in a post processor file in two ways. This is useful to add documentation to explain the code so other people can understand the logic behind coding.

You can insert `//` at the start of your comment and all text from the first `/` to the end of the line is ignored by the post. The `//` may be anywhere on the line, including on a line by itself.

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For example:

```
// This is a comment. No calculation is done.
```

You can also insert a # as the first character in an expression. For example:

```
[# This is a comment. No calculation is done.]
```

Entering mixed printable ASCII and non-printable codes

Different systems may allow for ASCII (American Standard Code for Information Interchange) control character(s) (non-printable characters). Control characters such as:

- <13> for a carriage return
- <10> for a line feed
- <32> for a space
- <9> for a horizontal tab
- <91> for a left square bracket
- <93> for a right square bracket

can be imbedded in a program format. To enter control characters, type the decimal value equivalent of the ASCII code, delimited by angular brackets <>.

Previous Reserved Word Value

Numeric Reserved Words can be prefixed by a symbol such as \$ or @ (<\$ name>, or <@ name>). The \$ prefix signals Post to output the previous value of a Reserved Word.

For example to output the previous tool number to the current tool then add a \$ symbol to the variable <\$TOOL>

Incremental programming rules

The following information explains the rules for building postprocessors for controls that *only* support incremental input.

Each occurrence of the following Reserved Words must be in the specified form in PROGRAM FORMATS:
Reserved Word Form

The @ prefix tells the Post to output an **incremental** value (the difference between the current value and the previous value).

```
<X-CHANGE> <@X-CHANGE>  
<Y-CHANGE> <@Y-CHANGE>  
<X-COORD> <@X-COORD>  
<Y-COORD> <@Y-COORD>  
<Z-COORD> <@Z-COORD>
```

The PROGRAM START format may not contain any of the following Reserved Words: <@X-CHANGE>, <@Y-CHANGE>, or <@Z-COORD>. This is assuming that the first tool has been positioned at the start point (the first segment's tool change position) by the operator before starting the NC part program. The PROGRAM END format must contain the Reserved Words, <@X-CHANGE> and <@Y-CHANGE> to reposition the tool back to the start point.

Sync Codes in FeatureCAM Posting

Introduction

Sync codes, also known as wait codes, are used in CNC programs to handle synchronization on a machine that can simultaneously run two programs. Sync codes are relevant only on a turning or turn/mill machine that has more than one turret. Most of the time, the two programs run independently, but the job may need to be synchronized at a few key points in the process. Typically this occurs during transfers, when both tools are simultaneously working on the same spindle, or when there are clearance issues for the turret to access the part.

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Sync codes are very simple in principle. A command like:

M100

is placed in both programs. When either program reaches the wait code, it will halt execution until the other program reaches that same wait code. When both programs have reached that point, then both programs restart execution.

The challenge for post developers is to arrange that sync codes appear in both programs appropriately. There must be exactly the same number of sync codes, and the numbers must all match exactly. This is complicated by the fact that when FeatureCAM is posting code, it generates the two programs independently. In order for the sync codes to come out properly, the post-processor must issue the same number of commands, even though the post may be going through different formats for each program.

Note: This document only addresses sync codes from the point of view of making the post processor work. Setting up the appropriate sync points on the turrets page in the FeatureCAM part programming file is covered in the FeatureCAM documentation.

Important Hint: If you are just beginning to work with multi-turret posts in FeatureCAM, it is well worth your time to check out the macro addin called:

DisplayMultiTurretNCCodeInHTMLFormat

which ships with FeatureCAM and should automatically be listed in your AddIns dialog. When enabled, this macro provides an icon that you can click after posting. It will format the post NC code for both programs into an HTML (web browser) format so that all the sync codes are lined up, and display the results in your browser window. Using this macro can save you a lot of time whenever you are working with a multi-turret post.

Xbuild Reserved Words

There are several reserved words in XBuild that are used to generate sync codes. The main ones are:

<SYNC1>
<SYNC-NEXT>

In the majority of posts, you should only need to use these two, but this document will describe the situations in which the others may need to be used. They are:

<SYNC2>
<SYNC3>
<SYNC4>
<SYNC5>
<OP-ORDER-NUM>

You may see these reserved words in older posts:

<SYNC-NUM1>
<SYNC-NUM 2>
<SYNC-NUM 3>
<SYNC-NUM 4>
<SYNC-NUM 5>

When you load an old post containing <SYNC-NUM1> into a current XBuild, it will automatically convert it to <SYNC1>. The other words (2-5) are not converted because the new <SYNC1> handles all of their behavior. They are harmless, but for clarity should always be removed from the post.

Basic Synchronization in the Post

The two primary uses of sync codes within a post are to synchronize (1) cutting operations according to the sync points specified on the turrets page in FeatureCAM, and (2) sub-spindle transfer operations. This section will discuss sync codes for cutting operations and transfers will be addressed in a later section.

In the simplest case, a <SYNC1> call needs to be made in the following formats:

Program Start
Tool Change
Segment Start

In the Program Start and Tool Change formats, this code is usually placed near (but before) the call for the tool change. For Tool Change and Segment Start, the code is placed after any cancellations that were being applied for the previous operation, and just before starting the work for the current operation. A typical example might be:

```
{N<SEQ> }{M<SYNC1> ( Wait )}<EOB>
```

Always put <SYNC1> in modality brackets. Modality is handled somewhat differently than usual for <SYNC1>, but the brackets are necessary to suppress the comments and blank line if the wait code is not needed.

Because an operation may have more than one sync point at the beginning, the single line above can generate multiple sync code in the NC code because it has a built in "looping mechanism" which is used to output all the sync codes that are needed to get it lined up with the other turret. (This is the only Xbuild reserved word that loops in this way.)

The most important thing when using multiple sync words is to make sure they are balanced between the Program Start, Tool Change, and Segment Start formats.

Sync codes will appear in the middle of an operation only for pinch or follow turning. In this case, a <SYNC1> will be needed in the Linear Move format so it can sync up at each scan line of the turn. Usually the sync word is within an <IFNOT><TCAN-CYCLE> clause.

Another case where wait codes may appear within an operation is simultaneous milling, in which two turrets are milling at the same time on a single spindle with synchronized C-axis rotations. In this case there may be sync codes around C angle moves (also in the Linear Move format). These are extra wait codes: <SYNC1> and <SYNC2> are placed before and after the C move. If <SYNC1> produces a wait code in the output, then <SYNC2> will also produce output.

Note that no mention has been made of <SYNC3>, <SYNC4>, and <SYNC5>. It is rare that anything beyond <SYNC2> will be needed in a post.

Synchronization for Subspindle Transfer

There are currently two common methods for handling transfers in FeatureCAM:

Using the built-in sub-spindle commands in which a transfer is composed of smaller operations. With this method, there are a series of system formats (Formats > Move) which are defined to generate the transfer codes.

Using the sub-spindle transfer addin (macro) which is new in version 16. This macro defines the transfer at a high level (slug transfer or cutoff transfer, for example). With this method, a set of custom formats are provided in the post to generate the transfer codes.

When using method (1), a <SYNC1> call is generally inserted at the beginning of all the transfer formats, in a very similar way to the operation synchronization that was described in the previous section. Since all of the "atomic" operations appear in the turrets view, the part programmer can determine where the sync points need to be and set them in FeatureCAM. So the post-processing just needs to be sure to output them if one happens to be active for that operation.

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When using method (2), the operations that appear in the turrets view are higher level and it isn't possible to set sync codes from the part program that need to be generated mid-way through one of those operations. The post takes more responsibility in this case for generating the correct sequence of codes to accomplish the transfer, including synchronization.

The typical custom format used in method (2) will use a <SYNC1> call at the beginning (as usual). With the looping mechanism, this "gathers" and outputs any programmed sync points that have been encountered up to that point in time. When coding the transfer itself, if one or more (non-programmed) sync points are needed, they need to be inserted with the <SYNC-NEXT> reserved word.

The major difference between <SYNC-NEXT> and <SYNC2> is that <SYNC-NEXT> forces a new sync code to be generated, even if there was not a programmed sync point available. So <SYNC-NEXT> always produces output in the NC code. <SYNC2> will only output a sync point if it is needed.

Note: As for all the techniques in this document, it is very important that the sync codes be balanced between each spindle transfer format for each turret.

Note: In general, don't use <SYNC-NEXT> in the other formats because they can produce unnecessary sync codes.

Advanced Notes

This section contains some notes about some subtle behaviors of the reserved words. Generally, it's not necessary to think about these at all, but if things are just not coming out right, it might be worth reading through these hints to see if it might explain what you are seeing.

The value of the <SYNC1> reserved word is not set until the reserved word is output. That means that testing for a changed value using <IF>[neq(<SYNC1>,<\$SYNC1>)] does not work since test does not actually output (or update) the reserved word.

Since an operation may have more than one sync point at the start, the <SYNC1> reserved word has a looping mechanism.

This is the only reserved word that does this.

Everything between the previous <EOB> and the next <EOB> will be output for each valid sync point.

[INCLUDE:xxx] calls are not looped correctly. The <EOB> inside the included format terminates the valid text test internally. This is a bug that can be fixed.

The <SYNC-PNUM> reserved word is automatically updated anytime the <SYNC1> reserved word is changed. If <SYNC1> is not valid, then <SYNC-PNUM> is not valid either.

The supplied post in the bug report contained this in the SyncNum custom format:

```
(OLDSYNC: {M<SYNC1>} {P<SYNC-PNUM>})<EOB>
<IF>[neq(<SYNC-PNUM>,"")]<THEN>
  <IF>[eq(<SYNC-PNUM>,"1243")]<THEN>
    <INCLUDE:UDSync>
    <INCLUDE:LRSync>
    <INCLUDE:XSync>
  <ELSEIF>[or(or(eq(<SYNC-PNUM>,"123"),eq(<SYNC-PNUM>,"243")),eq(<SYNC-
PNUM>,"143"))]<THEN>
    <INCLUDE:UDSync>
    <INCLUDE:LRSync>
  <ELSEIF>[or(eq(<SYNC-PNUM>,"12"),eq(<SYNC-PNUM>,"43"))]<THEN>
    <INCLUDE:UDSync>
```

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```
<ELSEIF>[or(eq(<SYNC-PNUM>,"14"),eq(<SYNC-PNUM>,"23"))]<THEN>
  <INCLUDE:LRsync>
<ELSEIF>[or(eq(<SYNC-PNUM>,"13"),eq(<SYNC-PNUM>,"24"))]<THEN>
  <INCLUDE:XSync>
<ENDIF>
<ENDIF>
```

What happened is that the comment line containing <SYNC1> was being looped multiple times. For example you may output of M100, P12 followed by M101, P34. Then the <IF><SYNC-PNUM> test would be executed. But by this time the value of <SYNC-PNUM> would be "34" and the translation code would never be run for the "12" value.

I changed the SyncNum custom format to this:

```
{(^<SYNC1>){, P_<SYNC-PNUM>}}<13><10>
<IF>[or(eq(<SYNC-PNUM>,"1243"),eq(<SYNC-PNUM>,"1234"))]<THEN>
  // <INCLUDE:UDSync>
  M[<SYNC1>:840+UD_wait_num] (UDSync)<13><10>
  [:UD_wait_num=UD_wait_num+1]
  // <INCLUDE:LRsync>
  M[<SYNC1>:100+LR_wait_num] (LRsync)<13><10>
  [:LR_wait_num=LR_wait_num+1]
  // <INCLUDE:XSync>
  M[<SYNC1>:800+cross_wait_num] (XSync)
  [:cross_wait_num=cross_wait_num+1]
<ELSEIF>[or(or(eq(<SYNC-PNUM>,"123"),eq(<SYNC-PNUM>,"243")),eq(<SYNC-
PNUM>,"143"))]<THEN>
  // <INCLUDE:UDSync>
  M[<SYNC1>:840+UD_wait_num] (UDSync)<13><10>
  [:UD_wait_num=UD_wait_num+1]
  // <INCLUDE:LRsync>
  M[<SYNC1>:100+LR_wait_num] (LRsync)<13><10>
  [:LR_wait_num=LR_wait_num+1]
<ELSEIF>[or(eq(<SYNC-PNUM>,"12"),eq(<SYNC-PNUM>,"43"))]<THEN>
  // <INCLUDE:UDSync>
  M[<SYNC1>:840+UD_wait_num] (UDSync)
  [:UD_wait_num=UD_wait_num+1]
<ELSEIF>[or(eq(<SYNC-PNUM>,"14"),eq(<SYNC-PNUM>,"23"))]<THEN>
  // <INCLUDE:LRsync>
  M[<SYNC1>:100+LR_wait_num] (LRsync)
  [:LR_wait_num=LR_wait_num+1]
<ELSEIF>[or(eq(<SYNC-PNUM>,"13"),eq(<SYNC-PNUM>,"24"))]<THEN>
  // <INCLUDE:XSync>
  M[<SYNC1>:800+cross_wait_num] (XSync)
  [:cross_wait_num=cross_wait_num+1]
<ENDIF>
<EOB>
```

The important things to notice.

The <SYNC1> reserved word is included. This means the value will be updated.

Since it must be included but it should not be checked when the NC program runs, it is inside a comment.

It is in modality brackets so that it will only be output if a sync point has been set on the operation.

I am outputting the '^' character instead of 'M' so that I can find it in my 4 turret html macro.

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Outputting the <SYNC-PNUM> reserved word as part of the comment is not required. It is only there as a debug aid.

The entire custom format only includes 1 <EOB> reserved word. So the entire thing will be included if a loop is required.

No additional custom formats are called.

EOB after custom format is needed for proper functioning of sync word, see transfers in mazak post where custom format immediately precedes the sync line