



G-Code Reference

2020/03/12

G-Codes

Mode

G20 - Inch Units

G70 - Inch Units

Usage: G20

Set units to inches.

Parameters:

#<_units> - (RW) current units

G21 - Millimeter Units

G71 - Millimeter Units

Usage: G21

Set units to millimeters.

Parameters:

#<_units> - (RW) current units

G17 - XY Plane

Usage: G17

Set XY plane. Planes are used with arcs, circles and cycles.

#<_plane> - (RW) current plane

G18 - ZX Plane

Usage: G18

Set ZX plane. Planes are used with arcs, circles and cycles.

Parameters:

#<_plane> - (RW) current plane

G19 - YZ Plane

Usage: G19

Set YZ plane. Planes are used with arcs, circles and cycles.

Parameters:

#<_plane> - (RW) current plane

G90 - Distance Mode – Absolute

Usage: G90

Set absolute distance mode. In absolute position mode machine will move to the commanded position in the active user coordinate system.

Parameters:

#<_distancemode> - (RW) current distance mode

G91 - Distance Mode – Incremental

Usage: G91

Set incremental distance mode. In incremental position mode commanded moves are interpreted as distance and direction from the current position.

Parameters:

#<_distancemode> - (RW) current distance mode

G90.1- Distance Mode – IJK Absolute

Usage: G90.1

Set absolute distance mode for I, J, K arc values. In absolute arc center mode the I, J, K values designate the position of the arc center in the user coordinate system.

Parameters:

#<_distancemode_ijk> - (RW) current distance mode for IJK

G91.1- Distance Mode – IJK Incremental

Usage: G91.1

Set incremental distance mode for I, J, K arc values. In incremental arc center mode the I, J, K values designate the distance and direction to the arc center from the start point.

Parameters:

#<_distancemode_ijk> - (RW) current distance mode for IJK

G90.2- Distance Mode – ABC Absolute

Usage: G90.2

Set absolute distance mode for A, B, C axis values. (same as M82)

Parameters:

#<_distancemode_abc> - (RW) current distance mode for ABC

G91.2- Distance Mode – ABC Incremental

Usage: G91.2

Set incremental distance mode for A, B, C axis values. (same as M83)

#<_distancemode_abc> - (RW) current distance mode for ABC

G98 - Cycle Return - Initial Z Point

Usage: G98

Specifies that a cycle ends at the initial Z level.

Parameters:

#<_cyclereturnmode> - (RW) current cycle return mode

G99 - Cycle Return - R Point

Usage: G99

Specifies that a cycle ends at the programmed R level.

Parameters:

#<_cyclereturnmode> - (RW) current cycle return mode

G07 - Lathe Mode – Diameter

Usage: G07

Use diameter mode for axis X on a lathe. When in the diameter mode the X axis moves on a lathe will be 1/2 the distance to the center of the lathe.

Parameters:

#<_lathemode> - (RW) current lathe mode

G08 - Lathe Mode – Radius

Usage: G08

Use radius mode for axis X on a lathe. When in radius mode the X axis moves on a lathe will be the distance from the center.

Parameters:

#<_lathemode> - (RW) current lathe mode

G15 - Polar Coordinate Cancel

Usage: G15

Cancel polar mode coordinate positioning.

Parameters:

#<_polarmode> - (RW) current polar mode

G16 - Polar Coordinate Enable

Usage: G16

Enable polar mode coordinate positioning. In the polar coordinate mode movement end points are specified as a radius and angle. Origin is determined by the absolute/incremental position mode setting.

The current plane setting determines which word is radius and which is angle.

G17 – XY Plane – X is radius, Y is angle

G18 – ZX Plane – Z is radius, X is angle

G19 – YZ Plane – Y is radius, Z is angle

Parameters:

#<_polarmode> - (RW) current polar mode

Example:

(square with corners -30,-30 and 30,30)

G0 X0 Y0

G16

G00 X42.4264 Y225

G01 X42.4264 Y135

G01 X42.4264 Y45

G01 X42.4264 Y315

G01 X42.4264 Y225

G15

G61 - Blend Cancel

Usage: G61

In canceled blend mode movement is exactly as programmed. Moves will slow or stop as needed to reach every programmed point. If two sequential moves are exactly co-linear movement will not stop.

Parameters:

#<_blendmode> - (R) current blend mode

G64 - Blend Enable

Usage: G64 <P> <Q> - P (optional) = tolerance

In blend mode sharp corners will be rounded and the machine may never reach the programmed point before a direction change. Optional tolerance can be set.

Parameters:

#<_blendmode> - (R) current blend mode
#<_blend_tol> - (R) current blend tolerance

G93 - Feed Mode - Inverse Time

Usage: G93

In inverse time feed mode, an F word means the move should be completed in [one divided by the F number] minutes. When inverse time feed mode is active, an F word must appear on every motion line.

Parameters:

#<_feedmode> - (RW) current feed mode

G94 - Feed Mode - Units per Minute

Usage: G94

In units per minute feed mode, an F word is interpreted to mean the controlled point should move at a certain distance per minute.

Parameters:

#<_feedmode> - (RW) current feed mode

G95 - Feed Mode - Units per Revolution

Usage: G95

In units per revolution feed mode, an F word is interpreted to mean the controlled point should move at a certain distance per spindle revolution. This mode requires RPM feedback from the spindle.

Parameters:

#<_feedmode> - (RW) current feed mode

G96 - Spindle Mode – CSS

Usage: G96

In this mode surface speed is constant and based on cutting diameter. Surface speed is specified in units per minute. This requires special hardware and is usually not used on simple machines.

Parameters:

#<_spindlemode> - (RW) current spindle mode

G97 - Spindle Mode – RPM

Usage: G97

In this mode the spindle speed is specified in revolutions per minute.

Parameters:

#<_spindlemode> - (RW) current spindle mode

Tools

G40 - Tool Compensation Cancel

Usage: G40

Cancel tool compensation.

Parameters:

#<_toolcomp>	- (R) tool compensation side
#<_toolcomp_dia>	- (R) tool compensation diameter

G41 - Tool Compensation Left

G42 - Tool Compensation Right

Usage: G41 <D> - D (optional) = tool number

Start tool compensation with diameter from tool table.

If D word is not specified then current tool number is used.

Parameters:

#<_toolcomp>	- (R) tool compensation side
#<_toolcomp_dia>	- (R) tool compensation diameter

G41.1- Tool Compensation Dynamic Left

G42.1- Tool Compensation Dynamic Right

Usage: G41.1 D - D = tool diameter

Start tool compensation.

D word specifies tool diameter.

Parameters:

#<_toolcomp>	- (R) tool compensation side
#<_toolcomp_dia>	- (R) tool compensation diameter

G43 - Tool Offset+ Enable

G44 - Tool Offset- Enable

Usage: G43 <H> - H (optional) = tool number

Set tool offset to value from tool table.

If H word is not specified then current tool number is used.

Parameters:

#<_tooloff>	- (RW) true if tool offset is currently enabled
#<_tooloff_x..w>	- (RW) current tool offset

G43.1- Tool Offset+ Enable

G44.1 - Tool Offset- Enable

Usage: G43.1 X..W - X..W = tool offset

Set tool offset to value from axis words.

Parameters:

#<_tooloff>	- (RW) true if tool offset is currently enabled
#<_tooloff_x..w>	- (RW) current tool offset

G49 - Tool Offset Cancel

Usage: G49

Cancel tool offset

Coordinate Systems

G54 - Coordinate System 1

G55 - Coordinate System 2

G56 - Coordinate System 3

G57 - Coordinate System 4

G58 - Coordinate System 5

G59 - Coordinate System 6

G59.1- Coordinate System 7

G59.2- Coordinate System 8

G59.3- Coordinate System 9

Usage:	G54	- select coordinate system 1
	G55	- select coordinate system 2
	G56	- select coordinate system 3
	G57	- select coordinate system 4
	G58	- select coordinate system 5
	G59	- select coordinate system 6
	G59.1	- select coordinate system 7
	G59.2	- select coordinate system 8
	G59.3	- select coordinate system 9

Select coordinate system.

G54.1- Coordinate System P

G59 P- Coordinate System P

Usage:	G54.1 P	- P = select coordinate system P+6
	G59 P	- P = select coordinate system P

Select coordinate system.

Coordinate system can be set with G10 L2 code.

1000 different coordinate systems are available.

Parameters:

#<_coordsys>	- (RW) current coordinate system number
#<_coordsys_x..w>	- (RW) current coordinate system offset
#<_coordsys_rot>	- (RW) current coordinate system rotation

Offsets

G92 - Working Offset

Usage: G92 X..W - X..W = desired position

Set working offset. Offset is calculated so that current position becomes desired position specified with axis words.

Parameters:

#<_workoff>	- (R) true, if working offset is set
#<_workoff_x..w>	- (RW) current work offset

G92.1 - Working Offset Cancel

Usage: G92.1

Cancel work offset and set it to zero.

G52 - Axes Offset

Usage: G52 X..W - X..W = desired offset

Set axis offset.

Parameters:

#<_axisoff>	- (R) true if axis offset is enabled
#<_axisoff_x..w>	- (RW) current axis offset value

G52.1 - Axes Offset Cancel

Usage: G52.1

Cancel axis offset.

G51 - Axes Scale Enable

Usage:	G51 X..Z I..K	- X..Z = scale center - I..K = scale value
	G51 X..Z P	- X..Z = scale center - P = scale value
	G51 U..W I..K	- U..W = scale center - I..K = scale value
	G51 U..W P	- U..W = scale center - P = scale value

Set axis scale.

Parameters:

#<_axisscale>	- (R) true if axis scale is enabled
#<_axisscale_i..k>	- (RW) current axis scale value
#<_axisscale_x..z>	- (RW) current axis scale center
#<_axisscale_iuvw..kuvw>	- (RW) current axis scale value
#<_axisscale_u..w>	- (RW) current axis scale center

G50 - Axes Scale Cancel

Usage: G50

Cancel axis scale.

G68 - Axes Rotate Enable

Usage:	G68 X..Z R	- X..Z – rotation center - R – rotation angle
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Set axis rotation.

Parameters:

#<_axisrot>	- (R) true if axis rotation is enabled
#<_axisrot_ang>	- (RW) current axis rotation angle
#<_axisrot_x..z>	- (RW) current axis rotation center
#<_axisrot_anguvw>	- (RW) current axis rotation angle
#<_axisrot_u..w>	- (RW) current axis rotation center

G69 - Axes Rotate Cancel

Usage: G69

Cancel axis rotation.

Parameters:

#<_axisrot>	- (R) true if axis rotation is enabled
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Motion

G80 - Cancel Motion

Usage: G90

Cancels all motion.

G00 - Rapid Move

Usage: G00 <X..W@^>

Rapid move machine to programmed position.

G01 - Linear Feed Move

Usage: G01 <X..W@^>

Move machine to programmed position with feed speed.

G02 - Clockwise Arc Feed Move

G03 - Counter Clockwise Arc Feed Move

Usage: G02 <X..W@^> <IJK> <P>

G03 <X..W@^> <IJK> <P>

G02 <X..W@^> <R> <P>

G03 <X..W@^> <R> <P>

Move machine to programmed position with feed speed in arc motion.

G02 - clockwise arc

G03 - counterclockwise arc

Arc can be in 3 different planes, depending of G17, G18 or G19 modal state.

XY plane, G17 state, Z rotation axis

ZX plane, G18 state, Y rotation axis

YZ plane, G19 state, X rotation axis

If motion in direction of rotation axis is specified then helical motion is generated.

Arc is specified in center format using IJK words or in radius format using R word.

Center format – arc center is defined with IJ (in XY plane), KI (in ZX plane) or JK (in YZ plane) words.

In incremental arc distance mode (G91.1) arc center is set as offset from start position.

In absolute arc distance mode (G90.1) arc center is set as distance from zero position.

Radius format – arc is defined with arc radius. This format is depreciated because it can in certain conditions produce cuts that are out of tolerances.

Number of rotations can be set with optional P word. If, for example, P3 is set then we have two full circles before final arc.

Example:

G17 G21 G90 G91.1 G94

F1000

G0 X0 Y0

G1 X80 Y0

G3 X100 Y20 I0 J20

G1 X100 Y80

G3 X80 Y100 I-20 J0

G1 X20 Y100

G3 X0 Y80 I0 J-20

G1 X0 Y0

G05 - Cubic Spline

Usage: G05 XYZ IJK PQR X – end position X
 Y – end position Y
 Z – end position Z
 I – incremental offset X from start point to first control point
 J – incremental offset Y from start point to first control point
 K – incremental offset Z from start point to first control point
 P – incremental offset X from end point to second control point
 Q – incremental offset Y from end point to second control point
 R – incremental offset Z from end point to second control point

Cubic B-spline move.

Spline can be in 3 different planes, depending of G17, G18 or G19 modal state.

XY plane, G17 state, XY, IJ and PQ words used

ZX plane, G18 state, ZX, KI and RP words used

YZ plane, G19 state, YZ, JK and QR words used

Example:

```
G17 G21 G90 G91.1 G94
F1000
G0 X0 Y0
G1 X80 Y0
G5 X100 Y20 I20 J0 P0 Q-20
G1 X100 Y80
G5 X80 Y100 P20 Q0
G1 X20 Y100
G5 X0 Y80 P0 Q20
G1 X0 Y0
```

G05.1- Quadratic Spline

Usage: G05.1 XYZ IJK X – end position X
 Y – end position Y
 Z – end position Z
 I – incremental offset X from start point to control point
 J – incremental offset Y from start point to control point
 K – incremental offset Z from start point to control point

Quadratic B-spline move.

Spline can be in 3 different planes, depending of G17, G18 or G19 modal state.

XY plane, G17 state, XY and IJ words used

ZX plane, G18 state, ZX and KI words used

YZ plane, G19 state, YZ and JK words used

Example:

```
G17 G21 G90 G91.1 G94
F1000
G0 X0 Y0
G1 X80 Y0
G5.1 X100 Y20 I20 J0
G1 X100 Y80
G5.1 X80 Y100 I0 J20
G1 X20 Y100
G5.1 X0 Y80 I-20 J0
G1 X0 Y0
```

G05.3- NURBS Block End

L (optional) – curve order (default 3)
P (optional) – control point weight (default 1)
X – control point position X
Y – control point position Y
Z – control point position Z

end NURBS block

Spline can be in 3 different planes, depending of G17, G18 or G19 modal state.

XY plane, G17 state, XY and IJ words used

ZX plane, G18 state, ZX and KI words used

YZ plane, G19 state, YZ and JK words used

Example:

G17 G21 G90 G91.1 G94

F1000

G0 X0 Y0

G1 X80 Y0

G5.2 L3

G5.2 X100 Y0 P2

G5.2 X100 Y20 P2

G5.3

G1 X100 Y80

G5.2 L3

G5.2 X100 Y100 P2

G5.2 X80 Y100 P2

G5.3

G1 X20 Y100

G5.2 L3

G5.2 X0 Y100 P2

G5.2 X0 Y80 P2

G5.3

G1 X0 Y0

G28 - Go To Home 1 Position

Usage: G28

G28 <X..W>

Rapid move machine to Home 1 position. If intermediate move is specified then machine will rapid move to intermediate position first and only axes specified will move to final position.

This command is often used with G91. For example: G91 G28 Z0

Parameters:

#<_home1_x..w> - (RW) home 1 position

G28.1 - Set Home 1 Position

Usage: G28.1

G28.1 <X..W>

Set current or set position as Home 1 position.

Parameters:

#<_home1_x..w> - (RW) home 1 position

G30 - Go To Home 2 Position

Usage: G30

G30 <X..W>

Rapid move machine to Home 2 position. If intermediate move is specified then machine will rapid move to intermediate position first and only axes specified will move to final position.

This command is often used with G91. For example: G91 G30 Z0

Parameters:

#<_home1_x..w> - (RW) home 1 position

G30.1 - Set Home 2 Position

Usage: G30.1

G30.1 <X..W>

Set current or set position as Home 2 position.

Parameters:

#<_home2_x..w> - (RW) home 2 position

G33 - Spindle Synchronized Motion / Threading

Move machine with speed synchronized to spindle speed.

Usage: G33.1 X..W K

- X..W – end position
- K – distance per revolution

G31 - Probe

G38.2- Probe

G38.3- Probe

G38.4- Probe

G38.5- Probe

Move machine with feed speed towards position. Immediately stop when sensor is signaled and store position to probe parameters.

G31 – axis words are position, stop on contact, error if failure

G38.1 – axis words are direction, stop on contact, error if failure

G38.2 – axis words are position, stop on contact, error if failure

G38.3 – axis words are position, stop on contact

G38.4 – axis words are position, stop on loss of contact, error if failure

G38.5 – axis words are position, stop on loss of contact

Parameters:

```
#<_probe> - (R) true if probe tripped
#< probe x..w> - (R) probe position
```

Settings

G10 L9 - Set Controller Position

Usage: G10 L9 <X..W>

Set controller position without move

Sends axis words to controller. Controller will set its current motor position to this value.

See also: G09

Parameters:

#<_hw_motor_x..w> - (R) motor position

G10 L3 - Transformation

Usage: G10 L3 X Y Z A B C U V W I J K

- X – Transformation A0 parameter
- Y – Transformation B0 parameter
- Z – Transformation C0 parameter
- A – Transformation A1 parameter
- B – Transformation B1 parameter
- C – Transformation C1 parameter
- U – Transformation A2 parameter
- V – Transformation B2 parameter
- W – Transformation C2 parameter
- I – Transformation A3 parameter
- J – Transformation B3 parameter
- K – Transformation C3 parameter

Set transformation parameters.

If any of XYZABCUVWIK words are missing or values are invalid transformation is reset.

Reset state is A0=1, B0=0, C0=0, A1=0, B1=1, C1=0.

See also: M55

Parameters:

- #<_trans_en> - (R) true if transformations are enabled
- #<_trans_a0> - (R) transformation A0 parameter
- #<_trans_b0> - (R) transformation B0 parameter
- #<_trans_c0> - (R) transformation C0 parameter
- #<_trans_a1> - (R) transformation A1 parameter
- #<_trans_b1> - (R) transformation B1 parameter
- #<_trans_c1> - (R) transformation C1 parameter
- #<_trans_a2> - (R) transformation A2 parameter
- #<_trans_b2> - (R) transformation B2 parameter
- #<_trans_c2> - (R) transformation C2 parameter
- #<_trans_a3> - (R) transformation A3 parameter
- #<_trans_b3> - (R) transformation B3 parameter
- #<_trans_c3> - (R) transformation C3 parameter

G10 L1, L10 - Tool Table

Usage: G10 L1 P <X..W> <D or R>

- P – tool number
- X..W (optional) – tool offset
- D (optional) – tool diameter or
- R (optional) – tool radius

G10 L10 P <X..W> <D or R>

- P – tool number
- X..W (optional) – tool offset
- D (optional) – tool diameter or
- R (optional) – tool radius

Use L1 or L10 to set tool in tool table.

L1 will set tool offset as entered. L10 will set offset so that current working position becomes entered value.

Parameters:

#<_current_tool>	- (RW) current tool number
#<_selected_tool>	- (RW) selected tool number
#<_tooloff>	- (RW) true if tool offset is currently enabled
#<_tooloff_x..w>	- (RW) current tool offset
#<_tool_exists>	- (R) true, if tool exists in tooltable
#<_tool_dia_num>	- (R) tool diameter from tooltable
#<_tool_off_x_num>..#<_tool_off_w_num>	- (R) tool offset from tooltable
#<_tool_tc_x_num>..#<_tool_tc_x_num>	- (R) tool change position from tooltable

G10 L2, L20 - Coordinate System

Usage: G10 L2 P <X..W> <R>

- P – coordinate system number
- X..W (optional) – coordinate system offset
- R (optional) – rotation in XY plane

G10 L20 P <X..W> <R>

- P – coordinate system number
- X..W (optional) – coordinate system offset
- R (optional) – rotation in XY plane

Use L2 or L20 to set coordinate system.

L2 will set coordinate system offset as entered. L20 will set offset so that current working position becomes entered value.

Optionally coordinate system rotation in XY plane is set with R word.

1000 different coordinate systems are available.

Parameters:

#<_coordsys>	- (RW) current coordinate system number
#<_coordsys_x..w>	- (RW) current coordinate system offset
#<_coordsys_rot>	- (RW) current coordinate system rotation
#<_coordsystem_exists>	- (R) true, if coordinate system exists in table
#<_coordsystem_x_num> .. #<_coordsystem_w_num>	- (R) coordinate system offset from table
#<_coordsystem_rot>	- (R) coordinate system rotation from table

Other

G04 - Dwell

Usage: G04 P

Delays execution for duration P seconds.

G09 - Stop, Sync & Set Controller Position

Usage: G09
G09 <X..W>

Stop motion any synchronize controller and interpreter state. Usually it is used before reading inputs from controller. For example:

G00 X0

G01 X100

G09 ;wait for motion to stop before reading _hw_input parameter.

(print,Value of input is #<_hw_input>)

If axis words are present then controller will set its current motor position to this value.

For example:

G09 X10 Y20 ;controller motor position is set to X10 Y20

G53 - Machine Coordinate System

Usage: G53

Use G53 in same line with motion code to execute motion in machine coordinates.

Cycles

G75 - Lathe: Pattern Repeating (Finishing) TODO

G76 - Lathe: Threading

G77 - Lathe: X Roughing TODO

G78 - Lathe: Z Roughing TODO

G79 - Lathe: Grooving TODO

G73 - Cycle: Drill, Speed Peck, Dwell

G74 - Cycle: Tapping Left

G81 - Cycle: Drill

G82 - Cycle: Drill, Dwell

G83 - Cycle: Drill, Peck, Dwell

G84 - Cycle: Tapping Right

G85 - Cycle: Boring, Feed Out

G86 - Cycle: Boring, Spindle Stop, Rapid Out, Spindle Start

G87 - Cycle: Boring, Spindle Reverse, Rapid Out, Spindle Reverse

G88 - Cycle: Boring, Spindle Stop, Feed Out, Spindle Start

G89 - Cycle: Boring, Spindle Reverse, Feed Out, Spindle Reverse

Lathe Cycles

G75 - Lathe: Pattern Repeating (Finishing) TODO

G76 - Lathe: Threading

Usage: G76 Z P <X> I J K
 <R> <Q> <H>
 <E> <A> <L>

- Z – final position of threads
- P – thread pitch in distance per revolution
- X – final X position
- I – thread peak offset from the drive line
- J – positive value specifying the initial cut depth
- K – positive value specifying the full thread depth
- R – depth degression
- Q – compound slide angle
- H – number of spring passes
- E – distance along the drive line used for the taper
- A – angle of taper
- L – which ends of the thread get the taper

Negative I values are external threads, and positive I values are internal threads.

R1.0 selects constant depth on successive threading passes. R2.0 selects constant area. Values between 1.0 and 2.0 select decreasing depth but increasing area. Values above 2.0 select decreasing area. Beware that unnecessarily high degression values will cause a large number of passes to be used.

The compound slide angle is the angle (in degrees) describing to what extent successive passes should be offset along the drive line. This is used to cause one side of the tool to remove more material than the other. A positive Q value causes the leading edge of the tool to cut more heavily. Typical values are 29, 29.5 or 30.

Spring passes are additional passes at full thread depth. If no additional passes are desired, program H0.

The angle of the taper will be so the last pass tapers to the thread crest over the distance specified with E. E10 will give a taper for the first/last 10 length units along the thread. For a 45 degree taper program E the same as K. Alternatively you can use A to set angle of the taper.

L specifies which ends of the thread get the taper. Program L0 for no taper (the default), L1 for entry taper, L2 for exit taper, or L3 for both entry and exit tapers. Entry tapers will pause at the drive line to synchronize with the index pulse then move at the feed rate in to the beginning of the taper. No entry taper and the tool will rapid to the cut depth then synchronize and begin the cut.

G77 - Lathe: X Roughing TODO

G78 - Lathe: Z Roughing TODO

G79 - Lathe: Grooving TODO

Drill Cycles

G73 - Cycle: Drill, Speed Peck, Dwell

Usage: G73 X Y Z R <P> Q <L>

- X, Y – coordinate of drill center
- Z – drill position
- R – retract plane
- P – dwell time
- Q – delta increment
- H – initial delta
- D – chip break distance (default 0.2)
- E – chip clear
- L – repetition

Example 1:

```
G00 Z15
G98 G73 X0 Y0 R5 Z-3 Q1
```

Pseudocode:

```
G00 Z15
G00 X0 Y0
G00 H2 E5        (initial - rapid down to R5)
G01 H2 E4        (drill - feed down for Q1)
G00 H2 E4.2      (chip break - rapid up for 0.2)
G01 H2 E3        (drill - feed down for Q1)
G00 H2 E3.2      (chip break - rapid up for 0.2)
G01 H2 E2        (drill - feed down for Q1)
G00 H2 E2.2      (chip break - rapid up for 0.2)
G01 H2 E1        (drill - feed down for Q1)
G00 H2 E1.2      (chip break - rapid up for 0.2)
G01 H2 E0        (drill - feed down for Q1)
G00 H2 E0.2      (chip break - rapid up for 0.2)
G01 H2 E-1       (drill - feed down for Q1)
G00 H2 E-0.8     (chip break - rapid up for 0.2)
G01 H2 E-2       (drill - feed down for Q1)
G00 H2 E-1.8     (chip break - rapid up for 0.2)
G01 H2 E-3       (drill - feed down to Z-3)
G00 H2 E15       (final - rapid up to Z level Z15)
```

Example 2:

G00 Z15

G98 G73 X0 Y0 R5 Z-4 Q1 H1.5 D0.1 E3

Pseudocode:

G00 Z15

G00 X0 Y0

G00 H2 E5 (initial - rapid down to R5)

G01 H2 E2.5 (initial drill - feed down for Q1+H1.5)

G00 H2 E2.6 (chip break - rapid up for D0.1)

G01 H2 E1.5 (drill - feed down for Q1)

G00 H2 E1.6 (chip break - rapid up for D0.1)

G01 H2 E0.5 (drill - feed down for Q1)

G00 H2 E0.6 (chip break - rapid up for D0.1)

G01 H2 E-0.5 (drill - feed down for Q1)

G00 H2 E5 (clear - rapid up to R5)

G00 H2 E-0.4 (clear - rapid back down -D0.1)

G01 H2 E-1.5 (drill - feed down for Q1)

G00 H2 E-1.4 (chip break - rapid up for D0.1)

G01 H2 E-2.5 (drill - feed down for Q1)

G00 H2 E-2.4 (chip break - rapid up for D0.1)

G01 H2 E-3.5 (drill - feed down for Q1)

G00 H2 E5 (clear - rapid up to R5)

G00 H2 E-3.4 (clear - rapid back down -D0.1)

G01 H2 E-4 (drill - feed down to Z-4)

G00 H2 E15 (final - rapid up to Z level Z15)

G74 - Cycle: Tapping Left

Usage: G74 X Y Z R K <L>

- X, Y – coordinate of drill center
- Z – drill position
- R – retract plane
- K – thread pitch
- L – repetition

G81 - Cycle - Drill

Usage: G81 X Y Z R <L>

- X, Y – coordinate of drill center
- Z – end drill position
- R – retract plane
- L – repetition

Example 1:

G00 Z15

G99 G81 X0 Y0 R5 Z-3

Pseudocode:

G00 Z15

G00 X0 Y0

G00 H2 E5 (initial - rapid down to R5)

G01 H2 E-3 (drill - feed down to Z-3)

G00 H2 E5 (final - rapid up to R plane R5)

G82 - Cycle: Drill, Dwell

Usage: G82 X Y Z R <P> <L>

- X, Y – coordinate of drill center
- Z – drill position
- R – retract plane
- P – dwell time
- L – repetition

Example 1:

G00 Z15

G99 G82 X0 Y0 R5 Z-3 P0.5

Pseudocode:

G00 Z15

G00 X0 Y0

G00 H2 E5 (initial - rapid down to R5)

G01 H2 E-3 (drill - feed down to Z-3)

G04 P0.5 (dwell for 0.5s)

G00 H2 E5 (final - rapid up to R plane R5)

G83 - Cycle: Drill, Peck, Dwell

Usage: G83 X Y Z R P Q <L>

- X, Y – coordinate of drill center
- Z – drill position
- R – retract plane
- P – dwell time
- Q – delta increment
- H – initial delta
- D – chip break distance (default 0.2)
- L – repetition

Example 1:

```
G00 Z15  
G98 G83 X0 Y0 R5 Z-3 Q1
```

Pseudocode:

```
G00 Z15  
G00 X0 Y0  
G00 H2 E5      (initial - rapid down to R5)  
G01 H2 E4      (drill - feed down for Q1)  
G00 H2 E5      (clear - rapid up to R5)  
G00 H2 E4.2    (clear - rapid back down -0.2)  
G01 H2 E3      (drill - feed down for Q1)  
G00 H2 E5      (clear - rapid up to R5)  
G00 H2 E3.2    (clear - rapid back down -0.2)  
G01 H2 E2      (drill - feed down for Q1)  
G00 H2 E5      (clear - rapid up to R5)  
G00 H2 E2.2    (clear - rapid back down -0.2)  
G01 H2 E1      (drill - feed down for Q1)  
G00 H2 E5      (clear - rapid up to R5)  
G00 H2 E1.2    (clear - rapid back down -0.2)  
G01 H2 E0      (drill - feed down for Q1)  
G00 H2 E5      (clear - rapid up to R5)  
G00 H2 E0.2    (clear - rapid back down -0.2)  
G01 H2 E-1     (drill - feed down for Q1)  
G00 H2 E5      (clear - rapid up to R5)  
G00 H2 E-0.8   (clear - rapid back down -0.2)  
G01 H2 E-2     (drill - feed down for Q1)  
G00 H2 E5      (clear - rapid up to R5)  
G00 H2 E-1.8   (clear - rapid back down -0.2)  
G01 H2 E-3     (drill - feed down to Z-3)  
G00 H2 E15     (final - rapid up to Z level Z15)
```

Example 2:

G00 Z15

G98 G83 X0 Y0 R5 Z-3 Q1 H1.5 D0.1

Pseudocode:

G00 Z15

G00 X0 Y0

G00 H2 E5 (initial - rapid down to R5)

G01 H2 E2.5 (initial drill - feed down for Q1+H1.5)

G00 H2 E5 (clear - rapid up to R5)

G00 H2 E2.6 (clear - rapid back down -D0.1)

G01 H2 E1.5 (drill - feed down for Q1)

G00 H2 E5 (clear - rapid up to R5)

G00 H2 E1.6 (clear - rapid back down -D0.1)

G01 H2 E0.5 (drill - feed down for Q1)

G00 H2 E5 (clear - rapid up to R5)

G00 H2 E0.6 (clear - rapid back down -D0.1)

G01 H2 E-0.5 (drill - feed down for Q1)

G00 H2 E5 (clear - rapid up to R5)

G00 H2 E-0.4 (clear - rapid back down -D0.1)

G01 H2 E-1.5 (drill - feed down for Q1)

G00 H2 E5 (clear - rapid up to R5)

G00 H2 E-1.4 (clear - rapid back down -D0.1)

G01 H2 E-2.5 (drill - feed down for Q1)

G00 H2 E5 (clear - rapid up to R5)

G00 H2 E-2.4 (clear - rapid back down -D0.1)

G01 H2 E-3 (drill - feed down to Z-3)

G00 H2 E15 (final - rapid up to Z level Z15)

G84 - Cycle: Tapping Right

Usage: G84 X Y Z R K <L>

- X, Y – coordinate of drill center
- Z – drill position
- R – retract plane
- K – thread pitch
- L – repetition

G85 - Cycle: Boring, Feed Out

Usage: G85 X Y Z R <P> <L>

- X, Y – coordinate of boring center
- Z – bore position
- R – retract plane
- P – dwell time
- L – repetition

G86 - Cycle: Boring, Spindle Stop, Rapid Out, Spindle Start

Usage: G86 X Y Z R <P> <L>

- X, Y – coordinate of boring center
- Z – bore position
- R – retract plane
- P – dwell time
- L – repetition

G87 - Cycle: Boring, Spindle Reverse, Rapid Out, Spindle Reverse

Usage: G87 X Y Z R <P> <L>

- X, Y – coordinate of boring center
- Z – bore position
- R – retract plane
- P – dwell time
- L – repetition

G88 - Cycle: Boring, Spindle Stop, Feed Out, Spindle Start

Usage: G88 X Y Z R <P> <L>

- X, Y – coordinate of boring center
- Z – bore position
- R – retract plane
- P – dwell time
- L – repetition

G89 - Cycle: Boring, Spindle Reverse, Feed Out, Spindle Reverse

Usage: G89 X Y Z R <P> <L>

- X, Y – coordinate of boring center
- Z – bore position
- R – retract plane
- P – dwell time
- L – repetition

Other Cycles

G12 - Clockwise Circle

G13 - Counter Clockwise Circle

Usage:	G12 I J ...	I – circle lead-in direction X J – circle lead-in direction Y
	G12 W <A> ...	W – circle width (diameter) A – lead-in angle
	... <Q> <P> <D> <H> ...	Q (optional) – inner circle width (diameter) P (optional) – stepover D (optional) – tool diameter H (optional) – number of finish passes
	... <X> <Y> ...	X (optional) – circle center X Y (optional) – circle center Y
	... <Z> <R> ...	Z (optional) – pocket depth R (optional) – retract plane K (optional) – stepover Z E (optional) – plunge speed

Cut a circle with current position as circle center.

G12 – circle is in clockwise direction.

G13 – circle is in counter clockwise direction.

W word defines circle/spiral width (diameter). A word defines starting angle. Other option is using I word and J word to define lead-in direction and radius. Radius can be calculated as $\sqrt{I^2 + J^2}$.

If optional P word is used then series of circles/spirals will be generated with P distance between them. If optional Q word is used then inner circle will have diameter Q.

D word is used for tool diameter compensation.

H word defines number of finish passes.

X and Y words define circle/spiral center. Z word defines end depth, K is used to set stepover in Z (plunge) direction and E word defines plunge feed speed.

R word is used to define retract plane.

This code is only valid in XY plane and with no tool compensation.

Example 1:

```
G00 Z15  
G98 G12 X0 Y0 W50 A45 P5 Q30 D0 R5 Z-10 K1 E100 H0
```

Example 2:

```
G98 G12 X0 Y0 W50 A0 P2.5 Q20 D0
```

Example 3:

```
G98 G12 X0 Y0 W50 A0 P2.5 Q20 D0 H-1
```

M-Codes

Program

M0 - Pause

Usage: M0

Pause a running program.

M1 - Optional pause

Usage: M1

Pause a running program if „Optional Pause“ is enabled.

M2 - Program End

M30 - Program End

Usage: M2

M30

End the program. Code after M2 will not be executed. Wrapping G-Code between % does the same thing.

Customization is possible by modifying M2.gcode script file (for example, to turn spindle off and restore modal state at end of g-code execution).

Spindle

M3 - Spindle CW

Usage: M3

Start spindle clockwise with S speed. Customization is possible by modifying M3.gcode script file.

Parameters:

#<_spindle>	- (R) spindle state
#<_spindle_on>	- (R) true if spindle is running
#<_spindle_cw>	- (R) true if spindle is running clockwise
#<_spindle_ccw>	- (R) true if spindle is running counterclockwise

M4 - Spindle CCW

Usage: M4

Start spindle counterclockwise with S speed. Customization is possible by modifying M4.gcode script file.

Parameters:

#<_spindle>	- (R) spindle state
#<_spindle_on>	- (R) true if spindle is running
#<_spindle_cw>	- (R) true if spindle is running clockwise
#<_spindle_ccw>	- (R) true if spindle is running counterclockwise

M5 - Spindle Stop

Usage: M5

Stop spindle. Customization is possible by modifying M5.gcode script file.

Parameters:

#<_spindle>	- (R) spindle state
#<_spindle_on>	- (R) true if spindle is running
#<_spindle_cw>	- (R) true if spindle is running clockwise
#<_spindle_ccw>	- (R) true if spindle is running counterclockwise

Tools

M6 - Tool Change

Usage: M6

Change tool with change procedure. Tool change will set tool selected with T as current tool. Tool change customization is possible by modifying M6.gcode script file.

Parameters:

#<_selected_tool>	- (RW) selected tool number
#<_current_tool>	- (RW) current tool number

M61 - Tool Select

Usage: M61 Q - Q = tool number

Select current tool number without tool change procedure.

Parameters:

#<_selected_tool>	- (RW) selected tool number
#<_current_tool>	- (RW) current tool number

Coolant

M7 - Mist On

Usage: M7
Turn mist output On.

Parameters:

#<_mist>	- (R) mist state
#<_mist_on>	- (R) true if mist is on

M17 - Mist Off/On

Usage: M17
M17 P - P = zero for Off, otherwise On

Turn mist output Off or On.

Parameters:

#<_mist>	- (R) mist state
#<_mist_on>	- (R) true if mist is on

M8 - Flood On

Usage: M8
Turn flood output On.

Parameters:

#<_flood>	- (R) flood state
#<_flood_on>	- (R) true if flood is on

M18 - Flood Off/On

Usage: M18
M18 P - P = zero for Off, otherwise On

Turn flood output Off or On.

Parameters:

#<_flood>	- (R) flood state
#<_flood_on>	- (R) true if flood is on

M9 - Mist & Flood Off

Usage: M9
Turn mist and flood output Off

Parameters:

#<_mist>	- (R) mist state
#<_mist_on>	- (R) true if mist is on
#<_flood>	- (R) flood state
#<_flood_on>	- (R) true if flood is on

Overrides and options

M48 - Enable Override Feed & Spindle

Usage: M48

Enables feed and spindle override.

M49 - Disable Override Feed & Spindle

Usage: M49

Disables feed and spindle override.

M50 - Enable/Disable Override Feed

Usage: M50 P - P = zero for Off, otherwise On

Enables or disables feed override.

M51 - Enable/Disable Override Spindle

Usage: M51 P - P = zero for Off, otherwise On

Enables or disables spindle override.

M53 - Enable/Disable Pause

Usage: M53 P - P = zero for Off, otherwise On

Enables or disables program pause command.

M54 - Enable/Disable THC

Usage: M54 P <Q> <R> - P = zero for Off, otherwise On
- Q = speed limit
- R = constant speed

If speed limit is set then THC will not move if machine speed is below set speed.

If constant speed is enabled then THC will not move if machine is accelerating or decelerating.

Example:

M54 P1 Q1000 R1 – enable THC for constant speeds (no acceleration) above 1000.

M55 - Enable/Disable Transformations

Usage: M55 P - P = zero for Off, otherwise On

Enable or disable transformations.

See also: G10 L3

M56 - Enable/Disable Warp

Usage: M56 P - P = zero for Off, otherwise On

Enable or disable warp.

M57 - Enable/Disable Swap

Usage: M57 P - P = zero for Off, otherwise On

Enable or disable axis swapping.

Inputs & Outputs

M10 - Enable/Disable motor enable signal

Usage: M10 P - P = zero for Off, otherwise On

Enables or disables motor enable signal.

M11 - Enable/Disable limits

Usage: M11 P - P = zero for Off, otherwise On

Enables or disables limits.

M59 - Wait For Input

Usage: M59 P - P = pin number (1-8)

Waits for input pin.

Parameters:

#<_hw_input> - (R) output signals state

M62 - Output

Usage: M62 Q - Q = value for all eight outputs

 M62 P Q - P = output number
 - Q = zero for Off, otherwise On

Set signals on output connector.

Parameters:

#<_output> - (R) output signals state

#<_hw_output> - (R) actual output signals on controller

M63 - Output PWM

Usage: M63 P Q <E>

- P = output number
- Q = frequency
- E (optional) = duty cycle (0% - 100%)

M63 P R

- P = output number
- R = RC servo motor position (0% - 100%)

Set PWM signal on output connector. It is possible to set frequency, frequency with duty cycle of RC servo motor position.

Parameters:

#<_hw_output>

- (R) actual output signals on controller

#<_hw_output_freq1>

- (R) actual PWM frequency on first PWM output

#<_hw_output_duty1>

- (R) actual PWM duty cycle on first PWM output

#<_hw_output_freq2>

- (R) actual PWM frequency on second PWM output

#<_hw_output_duty2>

- (R) actual PWM duty cycle on second PWM output

#<_hw_output_freq3>

- (R) actual PWM frequency on third PWM output

#<_hw_output_duty3>

- (R) actual PWM duty cycle on third PWM output

M64 - Output ExtOut

Usage: M64 H Q <L>

- H = ExtOut SSEL value (1 or 2)
- Q = data send to ExtOut
- L (optional) = number of bytes send to ExtOut

M64 H Q E <R> <D> <L>

- H = ExtOut SSEL value (1 or 2)
- Q = parameter number of first data location
- E = data count
- R (optional) = parameter number for returned data
- D (optional) = returned data count
- L (optional) = number of bytes send to ExtOut

M64 H P Q <L>

- H = ExtOut SSEL value (1 or 2)
- P = bit position
- Q = zero for Off, otherwise On
- L (optional) = number of bytes send to ExtOut

M64 H L0

- H = ExtOut SSEL value (1 or 2)
- L = zero bytes send to ExtOut

Send data to OutExt.

Parameters:

#<_hw_extout1>

- (R) actual ExtOut1 value on controller

#<_hw_extout2>

- (R) actual ExtOut2 value on controller

M65 - Output TX

Usage: M65 Q
 M65 Q E

- Q = data send to TX
- Q = parameter number of first data location
- E = data count

Send data to TX.

M66 - Output I2C

Usage: M66 H Q
 M66 H Q E <R> <D>

- H = I2C address in 8bit mode
- Q = data send to I2C
- H = I2C address in 8bit mode
- Q = parameter number of first data location
- E = data count
- R (optional) = parameter number for returned data
- D (optional) = returned data count

Send and receive data from I2C.

Modal State

M70 - Modal State Store

Usage: M70

Store current modal state. Stored modal state can be restored with M72. Modal state is stored only in current call level. Storing/restoring modal state between call levels is not possible.

Stored modal state values are:

- Units (G20/G21)
- Plane (G17/G18/G19)
- DistanceMode (G90/G91)
- DistanceModeIJK (G90.1/G91.1)
- DistanceModeABC (G90.2/G91.2)
- LatheMode (G7/G8)
- CycleReturnMode (G98/G99)
- PolarMode (G15/G16)
- ToolOffset (G43/G49)
- ToolCompensation (G40/G41/G42)
- Coordinate System (G54..G59)
- BlendMode (G61/G64)
- FeedMode (G93/G94/G95)
- FeedSpeed (F)
- SpindleMode (G96/G97)
- SpindleSpeed(S)
- MotorsEnable (M10)
- LimitsEnable (M11)
- Overrides & Options (M48/M49/M50/51/M53/M54/M55/M56/M57)

M71 - Modal State Invalidate

Usage: M71

Invalidates stored modal state. Modal state can no longer be restored.

M72 - Modal State Restore

Usage: M72

Restore modal state stored with M70 or M73 in current call level.

M73 - Modal State Store & Autorestore

Usage: M73

Store current modal state and automatically restore on program or subroutine end. If stored state was invalidated with M71 it will not be restored.

Other Codes

F - Feed Speed

Usage: Fn - F = feed speed

Set feed speed. Value depends on feed mode which can be „Units Per Minute“, „Units Per Revolution“ or „Inverse Time“. In inverse time F must be specified on every motion line.

Parameters:

#<_feedspeed>	- (R) feed speed value dependant on current feed mode
#<_feedspeed_upm>	- (R) feed speed value in units per minute
#<_feedspeed_upr>	- (R) feed speed value in units per minute per revolution

S - Spindle Speed

Usage: Sn - S = spindle speed

Set spindle speed. Value depends on spindle mode which can be „Revolution Per Minute“ or „Constant Surface Speed“.

Parameters:

#<_spindlespeed>	- (R) spindle speed value dependent on current spindle mode
#<_spindlespeed_rpm>	- (R) spindle speed value in units per minute mode
#<_spindlespeed_css>	- (R) spindle speed value in constant surface speed mode

T - Select Tool

Usage: Tn - T = tool number

Select tool number that will be used in next tool change (M6)

Parameters:

#<_selected_tool>	- (RW) selected tool number
#<_current_tool>	- (RW) current tool number

O-Words

sub..endsub subroutine block

Osub	- Begin subroutine
Oendsub	- End subroutine
Oreturn	- Exit subroutine
Ocall	- Call subroutine

do..while loop block

Odo	- Begin block
Owhile	- End block [condition evaluation]
Obreak	- Exit block immediately
Ocontinue	- Skip to next condition evaluation

while..endwhile loop block

Owhile	- Begin block [condition evaluation]
Oendwhile	- End block
Obreak	- Exit block immediately
Ocontinue	- Skip to next condition evaluation

repeat..endrepeat loop block

Orepeat	- Begin block [count]
Oendrepeat	- End block

if..endif condition block

Oif	- Begin block [condition evaluation]
Oendif	- End block
Oelseif	- Else [condition evaluation]
Oelse	- Else

Comments

CLEAR	- clears output window
PRINT	- prints message to output window
LOG	- writes message to log
LOGCREATE	- creates new log file
LOGOPEN	- opens existing log file
LOGCLOSE	- closes log file
POINTSCLEAR	- clears points collection
POINTSSAVE	- saves points collection to file
POINTSLOAD	- loads points collection from file
POINT	- adds point to collection
MSG	- shows dialog with message
STATUS	- shows message in status bar
PY	- executes python script
PYTHR	- executes python script
NAME	- sets program name
DESC	- sets program description
DLGNAME	- sets dialog name
DLG	- sets dialog property
ARRAY	- creates parameters from data
ARCHR	- creates parameters from characters
SW_RESET	- stopwatch reset
SW_PRINT	- stopwatch print
BLOCK_BEGIN	- begin block
BLOCK_END	- end block
COLOR=0xRRGGBB-	g-code color

Operators

+	- Addition
-	- Subtraction
*	- Multiplication
/	- Division
MOD	- Modulus
DIV	- Integer Division
**	- Power
EQ	- Relational equality
NQ	- Relational inequality
GT	- Relational strictly greater than
LT	- Relational strictly less than
GE	- Relational greater than or equal to
LE	- Relational less than or equal to
AND	- Logical AND
OR	- Logical non-exclusive OR
XOR	- Logical exclusive OR

Operator precedence

1. **
2. * / MOD DIV
3. + -
4. GT GE LT LE
5. EQ NE
6. AND XOR OR

Functions

Exists	- Checks is value exists
NotExists	- Checks is value does not exists
Nop	- No operation (returns zero)
Abs	- Absolute value
Sqrt	- Square Root
Sqr	- Square
Sin	- Sine
Cos	- Cosine
Tan	- Tangent
ASin	- Inverse sine
ACos	- Inverse cosine
ATan	- Inverse tangent
ATan2	- Four quadrant inverse tangent
Pi	- Pi constant value
Rad2Deg	- Radians to degrees
Deg2Rad	- Degrees to radians
E	- e constant value
Pow	- Power
Exp	- e raised to the given power
Exp10	- 10 raised to the given power
Exp2	- 2 raised to the given power
Log	- Base e logarithm
Log10	- Base 10 logarithm
Log2	- Base 2 logarithm
Rand	- random value
Inc	- Increases number
Dec	- Decreases number
Min	- Minimum
Max	- Maximum
DateTime	- Current time (seconds since 1970)
Year	- Year from DateTime value
Month	- Month from DateTime value
Day	- Day from DateTime value
Hour	- Hour from DateTime value
Minute	- Minute from DateTime value
Second	- Second from DateTime value
MilliSec	- Millisecond from DateTime value
Round	- Round to nearest integer
Floor	- Round down to integer
Ceil	- Round up to integer
Trunc	- Truncate to integer
And	- Bitwise AND
Or	- Bitwise non-exclusive OR
Xor	- Bitwise exclusive OR
Not	- Bitwise complement
Shl	- Bitwise shift left
Shr	- Bitwise shift right
LAnd	- Logic AND
LOr	- Logic non-exclusive OR
LXor	- Logic exclusive OR
LNot	- Logic complement
Hex	- Converts string to number
Bin	- Converts string to number
ToWork	- Converts machine coordinate to work
ToMachine	- Converts work coordinate to machine

List of G-Codes

G00 - Rapid Move
G01 - Linear Feed Move
G02 - Clockwise Arc Feed Move
G03 - Counter Clockwise Arc Feed Move

G04 - Dwell

G05 - Cubic Spline
G05.1 - Quadratic Spline
G05.2 - NURBS Block
G05.3 - NURBS Block End

G07 - Lathe Mode - Diameter
G08 - Lathe Mode - Radius

G09 - Stop, Sync & Set Position

G10 - Settings

G12 - Clockwise Circle
G13 - Counter Clockwise Circle

G15 - Polar Coordinate Cancel
G16 - Polar Coordinate Enable

G17 - XY Plane
G18 - ZX Plane
G19 - YZ Plane

G20 - Inch Units
G21 - Millimeter Units

G28 - Go To Home
G28.1 - Set Home
G30 - Go To Home
G30.1 - Set Home

G32 - Spindle Synch Motion
G33 - Spindle Synch Motion
G33.1 - Spindle Synch Motion With Return

G31 - Probe
G38.1 - Probe
G38.2 - Probe
G38.3 - Probe
G38.4 - Probe
G38.5 - Probe

G40 - Tool Compensation Cancel
G41 - Tool Compensation Left
G41.1 - Tool Compensation Dynamic Left
G42 - Tool Compensation Right
G42.1 - Tool Compensation Dynamic Right

G43 - Tool Offset+ Enable
G43.1 - Tool Offset+ Enable
G44 - Tool Offset- Enable
G44.1 - Tool Offset- Enable
G49 - Tool Offset Cancel

G50 - Axes Scale Cancel
G51 - Axes Scale Enable

G52 - Axes Offset
G52.1 - Axes Offset Cancel

G53 - Machine Coordinate System

G54 - Coordinate System 1
G54.1 - Coordinate System P
G55 - Coordinate System 2
G56 - Coordinate System 3
G57 - Coordinate System 4
G58 - Coordinate System 5
G59 - Coordinate System 6 (or P)
G59.1 - Coordinate System 7
G59.2 - Coordinate System 8
G59.3 - Coordinate System 9

G61 - Blend Cancel
G64 - Blend Enable

G65 - Call Macro

G68 - Axes Rotate Enable
G69 - Axes Rotate Cancel

G70 - Inch Units
G71 - Millimeter Units

G73 - Cycle: Drill, Speed Peck, Dwell
G74 - Cycle: Tapping Left
G75 - Lathe: Pattern Repeating (Finishing) TODO
G76 - Lathe: Threading
G77 - Lathe: X Roughing TODO
G78 - Lathe: Z Roughing TODO
G79 - Lathe: Grooving TODO

G80 - Cancel Motion

G81 - Cycle: Drill
G82 - Cycle: Drill, Dwell
G83 - Cycle: Drill, Peck, Dwell
G84 - Cycle: Tapping Right
G85 - Cycle: Boring, Feed Out
G86 - Cycle: Boring, Sp Stop, Rpd Out, Sp Strt
G87 - Cycle: Boring, Sp Rev, Rpd Out, Sp Rev
G88 - Cycle: Boring, Sp Stop, Fd Out, Sp Start
G89 - Cycle: Boring, Sp Rev, Fd Out, Sp Rev

G90 - Distance Mode - Absolute
G90.1 - Distance Mode - IJK Absolute
G90.2 - Distance Mode - ABC Absolute
G91 - Distance Mode - Incremental
G91.1 - Distance Mode - IJK Incremental
G91.2 - Distance Mode - ABC Incremental

G92 - Working Offset
G92.1 - Working Offset Cancel

G93 - Feed Mode - Inverse Time
G94 - Feed Mode - Units per Minute
G95 - Feed Mode - Units per Revolution

G96 - Spindle Mode - CSS
G97 - Spindle Mode - RPM

G98 - Cycle Return - Initial Z Point
G99 - Cycle Return - R Point

List of M-Codes

M0	- Pause
M1	- Pause (optional)
M2	- Program End
M30	- Program End
M3	- Spindle CW
M4	- Spindle CCW
M5	- Spindle Stop
M6	- Tool Change
M61	- Tool Select
M7	- Mist On
M17	- Mist Off/On
M8	- Flood On
M18	- Flood Off/On
M9	- Mist & Flood Off
M48	- Enable Override Feed & Spindle
M49	- Disable Override Feed & Spindle
M50	- Enable/Disable Override Feed
M51	- Enable/Disable Override Spindle
M53	- Enable/Disable Pause
M54	- Enable/Disable THC
M55	- Enable/Disable Transformations
M56	- Enable/Disable Warp
M57	- Enable/Disable Swap
M59	- Wait For Input
M62	- Output
M63	- Output PWM
M64	- Output ExtOut
M65	- Output TX
M66	- Output I2C
M70	- Modal State Store
M71	- Modal State Invalidate
M72	- Modal State Restore
M73	- Modal State Store & Autorestore
M82	- Distance Mode - ABC Absolute
M83	- Distance Mode - ABC Incremental
M98	- Call Subprogram
M99	- Return From Subprogram

List of parameters

Work position:

<code>_x</code>	(R)
<code>_y</code>	(R)
<code>_z</code>	(R)
<code>_a</code>	(R)
<code>_b</code>	(R)
<code>_c</code>	(R)
<code>_u</code>	(R)
<code>_v</code>	(R)
<code>_w</code>	(R)
<code>_work_axis</code>	(R)

Machine position:

<code>_machine_x</code>	(R)
<code>_machine_y</code>	(R)
<code>_machine_z</code>	(R)
<code>_machine_a</code>	(R)
<code>_machine_b</code>	(R)
<code>_machine_c</code>	(R)
<code>_machine_u</code>	(R)
<code>_machine_v</code>	(R)
<code>_machine_w</code>	(R)
<code>_machine_axis</code>	(R)

Probe position:

<code>_probe</code>	(R)
<code>_probe_x</code>	(R)
<code>_probe_y</code>	(R)
<code>_probe_z</code>	(R)
<code>_probe_a</code>	(R)
<code>_probe_b</code>	(R)
<code>_probe_c</code>	(R)
<code>_probe_u</code>	(R)
<code>_probe_v</code>	(R)
<code>_probe_w</code>	(R)
<code>_probe_axis</code>	(R)

THC:

<code>_thc</code>	(R)
<code>_thcen</code>	(R)

Mode:

<code>_motion</code>	(R)
<code>_units</code>	(RW)
<code>_plane</code>	(RW)
<code>_distancemode</code>	(RW)
<code>_distancemode_ijk</code>	(RW)
<code>_distancemode_abc</code>	(RW)
<code>_polarmode</code>	(RW)
<code>_cyclreturnmode</code>	(RW)
<code>_lathemode</code>	(RW)

Blend:

<code>_blendmode</code>	(R)
<code>_blend_tol</code>	(R)

Feed:

<code>_feedmode</code>	(R)
<code>_feedspeed</code>	(R)
<code>_feedspeed_upm</code>	(R)
<code>_feedspeed_upr</code>	(R)

Spindle:

<code>_spindlemode</code>	(R)
<code>_spindlespeed</code>	(R)
<code>_spindlespeed_rpm</code>	(R)

<code>_spindlespeed_css</code>	(R)
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Tools:

<code>_selected_tool</code>	(RW)
<code>_current_tool</code>	(RW)
<code>_tooloff</code>	(RW)
<code>_tooloff_x</code>	(RW)
<code>_tooloff_y</code>	(RW)
<code>_tooloff_z</code>	(RW)
<code>_tooloff_a</code>	(RW)
<code>_tooloff_b</code>	(RW)
<code>_tooloff_c</code>	(RW)
<code>_tooloff_u</code>	(RW)
<code>_tooloff_v</code>	(RW)
<code>_tooloff_w</code>	(RW)
<code>_tooloff_axis</code>	(RW)

<code>_toolcomp</code>	(R)
<code>_toolcomp_dia</code>	(R)
<code>_toolcomp_orient</code>	(R)

Tool Table:

<code>_tool_exists</code>	(R)
<code>_tool_name</code>	(R)
<code>_tool_off_x_num</code>	(R)
<code>_tool_off_y_num</code>	(R)
<code>_tool_off_z_num</code>	(R)
<code>_tool_off_a_num</code>	(R)
<code>_tool_off_b_num</code>	(R)
<code>_tool_off_c_num</code>	(R)
<code>_tool_off_u_num</code>	(R)
<code>_tool_off_v_num</code>	(R)
<code>_tool_off_w_num</code>	(R)
<code>_tool_dia_num</code>	(R)
<code>_tool_front_num</code>	(R)
<code>_tool_back_num</code>	(R)
<code>_tool_orient_num</code>	(R)

<code>_tool_tc_x_num</code>	(R)
<code>_tool_tc_y_num</code>	(R)
<code>_tool_tc_z_num</code>	(R)
<code>_tool_tc_a_num</code>	(R)
<code>_tool_tc_b_num</code>	(R)
<code>_tool_tc_c_num</code>	(R)
<code>_tool_tc_u_num</code>	(R)
<code>_tool_tc_v_num</code>	(R)
<code>_tool_tc_w_num</code>	(R)

<code>_tool_so_x_num</code>	(R)
<code>_tool_so_y_num</code>	(R)
<code>_tool_so_z_num</code>	(R)

<code>_tool_par1_num</code>	(R)
<code>_tool_par2_num</code>	(R)
<code>_tool_par3_num</code>	(R)
<code>_tool_par4_num</code>	(R)
<code>_tool_par5_num</code>	(R)
<code>_tool_par6_num</code>	(R)

<code>_tool_skipmeasure_num</code>	(R)
<code>_tool_skipchange_num</code>	(R)

Offset:

<code>_workoff</code>	(R)
<code>_workoff_x</code>	(RW)
<code>_workoff_y</code>	(RW)
<code>_workoff_z</code>	(RW)

_workoff_a	(RW)		
_workoff_b	(RW)		
_workoff_c	(RW)	CameraOffset:	
_workoff_u	(RW)	_cam_offset_x	(R)
_workoff_v	(RW)	_cam_offset_y	(R)
_workoff_w	(RW)		
_workoff_axis		Home:	
		_home1_x	(RW)
_axisoff	(R)	_home1_y	(RW)
_axisoff_x	(RW)	_home1_z	(RW)
_axisoff_y	(RW)	_home1_a	(RW)
_axisoff_z	(RW)	_home1_b	(RW)
_axisoff_a	(RW)	_home1_c	(RW)
_axisoff_b	(RW)	_home1_u	(RW)
_axisoff_c	(RW)	_home1_v	(RW)
_axisoff_u	(RW)	_home1_w	(RW)
_axisoff_v	(RW)		
_axisoff_w	(RW)	_home2_x	(RW)
_axisoff_axis	(RW)	_home2_y	(RW)
		_home2_z	(RW)
_axisscale	(R)	_home2_a	(RW)
_axisscale_i	(RW)	_home2_b	(RW)
_axisscale_j	(RW)	_home2_c	(RW)
_axisscale_k	(RW)	_home2_u	(RW)
_axisscale_iuvw	(RW)	_home2_v	(RW)
_axisscale_juvw	(RW)	_home2_w	(RW)
_axisscale_kuvw	(RW)		
_axisscale_x	(RW)	Transformation:	
_axisscale_y	(RW)	_trans_en	(R)
_axisscale_z	(RW)	_trans_a0	(R)
_axisscale_u	(RW)	_trans_b0	(R)
_axisscale_v	(RW)	_trans_c0	(R)
_axisscale_w	(RW)	_trans_a1	(R)
		_trans_b1	(R)
_axisrot	(R)	_trans_c1	(R)
_axisrot_ang	(R)	_trans_a2	(R)
_axisrot_anguvw	(R)	_trans_b2	(R)
_axisrot_x	(R)	_trans_c2	(R)
_axisrot_y	(R)	_trans_a3	(R)
_axisrot_z	(R)	_trans_b3	(R)
_axisrot_u	(R)	_trans_c3	(R)
_axisrot_v	(R)		
_axisrot_w	(R)	_trans_shift_x	(R)
		_trans_shift_y	(R)
CoordinateSystem:		_trans_shift_z	(R)
_coordsys_num	(R)	_trans_rot_x	(R)
_coordsys_x	(RW)	_trans_rot_y	(R)
_coordsys_y	(RW)	_trans_rot_z	(R)
_coordsys_z	(RW)	_trans_scale_x	(R)
_coordsys_a	(RW)	_trans_scale_y	(R)
_coordsys_b	(RW)	_trans_scale_z	(R)
_coordsys_c	(RW)		
_coordsys_u	(RW)	Warp:	
_coordsys_v	(RW)	_warp_en	(R)
_coordsys_w	(RW)	_warp_count	(R)
_coordsys_axis	(RW)		
_coordsys_rot	(RW)	PointList:	
		_pointcnt	(R)
CoordinateSystem Table:		_point_x_num	(R)
_coordsystem_exists	(R)	_point_y_num	(R)
_coordsystem_x_num	(R)	_point_z_num	(R)
_coordsystem_y_num	(R)	_point_a_num	(R)
_coordsystem_z_num	(R)	_point_b_num	(R)
_coordsystem_a_num	(R)	_point_c_num	(R)
_coordsystem_b_num	(R)	_point_u_num	(R)
_coordsystem_c_num	(R)	_point_v_num	(R)
_coordsystem_u_num	(R)	_point_w_num	(R)
_coordsystem_v_num	(R)		
_coordsystem_w_num	(R)	Output:	
_coordsystem_rot_num	(R)	_output	(R)

Spindle & Coolant:		_motoracc_u	(RW)
_spindle	(R)	_motoracc_v	(RW)
_spindle_on	(R)	_motoracc_w	(RW)
_spindle_cw	(R)	_motoracc_axis	(RW)
_spindle_ccw	(R)	_motordec_x	(RW)
_mist	(R)	_motordec_y	(RW)
_mist_on	(R)	_motordec_z	(RW)
_flood	(R)	_motordec_a	(RW)
_flood_on	(R)	_motordec_b	(RW)
		_motordec_c	(RW)
		_motordec_u	(RW)
Settings:		_motordec_v	(RW)
_set_units	(RW)	_motordec_w	(RW)
		_motordec_axis	(RW)
Settings - Motors:		Settings - Motors/Limits:	
_motoroutputorder_1	(RW)	_motorlimit_xn	(RW)
_motoroutputorder_2	(RW)	_motorlimit_yn	(RW)
_motoroutputorder_3	(RW)	_motorlimit_zn	(RW)
_motoroutputorder_4	(RW)	_motorlimit_an	(RW)
_motoroutputorder_5	(RW)	_motorlimit_bn	(RW)
_motoroutputorder_6	(RW)	_motorlimit_cn	(RW)
_motoroutputorder_7	(RW)	_motorlimit_un	(RW)
_motoroutputorder_8	(RW)	_motorlimit_vn	(RW)
_motoroutputorder_9	(RW)	_motorlimit_wn	(RW)
_motoroutputorder_axis	(RW)		
		_motorlimit_xp	(RW)
_motoroutputreverse_1	(RW)	_motorlimit_yp	(RW)
_motoroutputreverse_2	(RW)	_motorlimit_zp	(RW)
_motoroutputreverse_3	(RW)	_motorlimit_ap	(RW)
_motoroutputreverse_4	(RW)	_motorlimit_bp	(RW)
_motoroutputreverse_5	(RW)	_motorlimit_cp	(RW)
_motoroutputreverse_6	(RW)	_motorlimit_up	(RW)
_motoroutputreverse_7	(RW)	_motorlimit_vp	(RW)
_motoroutputreverse_8	(RW)	_motorlimit_wp	(RW)
_motoroutputreverse_9	(RW)		
_motoroutputreverse_axis	(RW)	_motorlimit_xn_en	(RW)
		_motorlimit_yn_en	(RW)
Settings - Motors/StepsPerUnit:		_motorlimit_zn_en	(RW)
_motorspu_x	(RW)	_motorlimit_an_en	(RW)
_motorspu_y	(RW)	_motorlimit_bn_en	(RW)
_motorspu_z	(RW)	_motorlimit_cn_en	(RW)
_motorspu_a	(RW)	_motorlimit_un_en	(RW)
_motorspu_b	(RW)	_motorlimit_vn_en	(RW)
_motorspu_c	(RW)	_motorlimit_wn_en	(RW)
_motorspu_u	(RW)		
_motorspu_v	(RW)	_motorlimit_xp_en	(RW)
_motorspu_w	(RW)	_motorlimit_yp_en	(RW)
_motorspu_axis	(RW)	_motorlimit_zp_en	(RW)
		_motorlimit_ap_en	(RW)
Settings - Motors/Speed:		_motorlimit_bp_en	(RW)
_motorspeed_x	(RW)	_motorlimit_cp_en	(RW)
_motorspeed_y	(RW)	_motorlimit_up_en	(RW)
_motorspeed_z	(RW)	_motorlimit_vp_en	(RW)
_motorspeed_a	(RW)	_motorlimit_wp_en	(RW)
_motorspeed_b	(RW)		
_motorspeed_c	(RW)	Settings - Motors/Limit Switch:	
_motorspeed_u	(RW)	_limitpin_xn	(RW)
_motorspeed_v	(RW)	_limitpin_yn	(RW)
_motorspeed_w	(RW)	_limitpin_zn	(RW)
_motorspeed_axis	(RW)	_limitpin_an	(RW)
		_limitpin_bn	(RW)
Settings - Motors/Acceleration:		_limitpin_cn	(RW)
_motoracc_x	(RW)	_limitpin_un	(RW)
_motoracc_y	(RW)	_limitpin_vn	(RW)
_motoracc_z	(RW)	_limitpin_wn	(RW)
_motoracc_a	(RW)	_limitpin_n_axis	(RW)
_motoracc_b	(RW)		
_motoracc_c	(RW)	_limitpin_xp	(RW)

_limitpin_yp (RW)
 _limitpin_zp (RW)
 _limitpin_ap (RW)
 _limitpin_bp (RW)
 _limitpin_cp (RW)
 _limitpin_up (RW)
 _limitpin_vp (RW)
 _limitpin_wp (RW)
 _limitpin_p_axis (RW)

Settings - Motion:

_motion_maxspeed (RW)
 _motion_maxacc (RW)
 _motion_maxdec (RW)

Settings - Jogging:

_jog_speeddef (RW)
 _jog_stepdef (RW)
 _jog_rounddef (RW)

 _jog_speedkbd (RW)

 _jog_speed (RW)
 _jog_step (RW)
 _jog_round (RW)

Settings - IO/Spindle:

_spindle_pin_mode (RW)
 _spindle_pin_cw (RW)
 _spindle_pin_ccw (RW)
 _spindle_pin_speed (RW)
 _spindle_speed_min (RW)
 _spindle_speed_max (RW)
 _spindle_delay_start (RW)
 _spindle_delay_stop (RW)

 _spindle_freq_mode (RW)
 _spindle_usefreq (R)
 _spindle_freq_min (RW)
 _spindle_freq_max (RW)
 _spindle_freq_stepwidth (RW)
 _spindle_usepwm (R)
 _spindle_pwm_freq (RW)
 _spindle_userc (R)
 _spindle_rc_lo (RW)
 _spindle_rc_hi (RW)

Settings - IO/Coolant:

_mist_pin (RW)
 _flood_pin (RW)

Settings - Program Options:

_program_units (RW)
 _program_plane (RW)
 _program_distmode (RW)
 _program_distmodeijk (RW)
 _program_distmodeabc (RW)
 _program_cyclereturn (RW)
 _program_lathemode (RW)

 _speed_traverse (RW)
 _speed_traverseabc (RW)
 _speed_feed (RW)
 _speed_spindle (RW)

 _ovrd_speedfeed (RW)
 _ovrd_speedtraverse (RW)
 _ovrd_spindle (RW)

Settings - Measure:

_probe_pin_1 (RW)
 _probe_pin_2 (RW)

 _probe_speed (RW)
 _probe_speed_low (RW)
 _probe_swdist (RW)

 _probe_sizeZ (RW)
 _probe_sizeXY (RW)
 _probe_size_axis (RW)
 _probe_safeheight (RW)

Settings - Home:

_home_speed (RW)
 _home_speed_low (RW)
 _home_swdist (RW)

 _home_order_x (RW)
 _home_order_y (RW)
 _home_order_z (RW)
 _home_order_a (RW)
 _home_order_b (RW)
 _home_order_c (RW)
 _home_order_u (RW)
 _home_order_v (RW)
 _home_order_w (RW)
 _home_order_axis (RW)

 _home_dir_x (RW)
 _home_dir_y (RW)
 _home_dir_z (RW)
 _home_dir_a (RW)
 _home_dir_b (RW)
 _home_dir_c (RW)
 _home_dir_u (RW)
 _home_dir_v (RW)
 _home_dir_w (RW)
 _home_dir_axis (RW)

 _home_swpos_x (RW)
 _home_swpos_y (RW)
 _home_swpos_z (RW)
 _home_swpos_a (RW)
 _home_swpos_b (RW)
 _home_swpos_c (RW)
 _home_swpos_u (RW)
 _home_swpos_v (RW)
 _home_swpos_w (RW)
 _home_swpos_axis (RW)

 _home_moveto_x (RW)
 _home_moveto_y (RW)
 _home_moveto_z (RW)
 _home_moveto_a (RW)
 _home_moveto_b (RW)
 _home_moveto_c (RW)
 _home_moveto_u (RW)
 _home_moveto_v (RW)
 _home_moveto_w (RW)
 _home_moveto_axis (RW)

 Settings - Tool Change
 _tc_enable (RW)
 _tc_skipsame (RW)
 _tc_spindlecheck (RW)
 _tc_safeheight_en (RW)
 _tc_safeheight (RW)
 _tc_pos_en (RW)
 _tc_pos_x (RW)

_tc_pos_y	(RW)	_tooloff_swdist	(RW)
_tc_pos_z	(RW)	_tooloff_safeheight	(RW)
_tc_action	(RW)	_tooloff_sensorX	(RW)
_tc_toolmeasure	(RW)	_tooloff_sensorY	(RW)
_tc_tooloff_en	(RW)	_tooloff_sensorZ	(RW)
_tc_autoreturn	(RW)		
		Settings - Work Offset:	
_tc_atc_en	(RW)	_workoff_speed	(RW)
_tc_atc_speed	(RW)	_workoff_speed_low	(RW)
_tc_atc_speed2	(RW)	_workoff_swdist	(RW)
		_workoff_size	(RW)
		Settings - Gantry Square	
_tc_unload_in1_x	(RW)	_gantrysquare_speed	(RW)
_tc_unload_in1_y	(RW)	_gantrysquare_axis	(RW)
_tc_unload_in1_z	(RW)	_gantrysquare_dir	(RW)
		_gantrysquare_move_u	(RW)
_tc_unload_in2_x	(RW)	_gantrysquare_move_v	(RW)
_tc_unload_in2_y	(RW)		
_tc_unload_in2_z	(RW)		
		HW:	
_tc_unload_pin1	(RW)	_hw_isinit	(R)
_tc_unload_pin1set1	(RW)	_hw_serial	(R)
_tc_unload_pin1delay1	(RW)	_hw_version	(R)
_tc_unload_pin1set2	(RW)	_sw_version	(R)
_tc_unload_pin1delay2	(RW)		
		_hw_buffavail	(R)
_tc_unload_pin2	(RW)	_hw_buffempty	(R)
_tc_unload_pin2set1	(RW)	_hw_buffutil	(R)
_tc_unload_pin2delay1	(RW)		
_tc_unload_pin2set2	(RW)	_hw_cmdbufffull	(R)
_tc_unload_pin2delay2	(RW)	_hw_cmdbufffree	(R)
		_hw_cmdbuffunread	(R)
_tc_unload_out1_x	(RW)		
_tc_unload_out1_y	(RW)	_hw_idle	(R)
_tc_unload_out1_z	(RW)	_hw_estop	(R)
		_hw_stop	(R)
_tc_unload_out2_x	(RW)	_hw_pause	(R)
_tc_unload_out2_y	(RW)		
_tc_unload_out2_z	(RW)		
		_hw_speed	(R)
_tc_load_in1_x	(RW)	_hw_accel	(R)
_tc_load_in1_y	(RW)	_hw_spindle	(R)
_tc_load_in1_z	(RW)	_hw_spindle_dir	(R)
_tc_load_in2_x	(RW)	_hw_mist	(R)
_tc_load_in2_y	(RW)	_hw_flood	(R)
_tc_load_in2_z	(RW)		
		_hw_ovrdspeed_enabled	(R)
_tc_load_pin1	(RW)	_hw_ovrdspindle_enabled	(R)
_tc_load_pin1set1	(RW)		
_tc_load_pin1delay1	(RW)	_hw_motor_x	(R)
_tc_load_pin1set2	(RW)	_hw_motor_y	(R)
_tc_load_pin1delay2	(RW)	_hw_motor_z	(R)
		_hw_motor_a	(R)
_tc_load_pin2	(RW)	_hw_motor_b	(R)
_tc_load_pin2set1	(RW)	_hw_motor_c	(R)
_tc_load_pin2delay1	(RW)	_hw_motor_u	(R)
_tc_load_pin2set2	(RW)	_hw_motor_v	(R)
_tc_load_pin2delay2	(RW)	_hw_motor_w	(R)
_tc_load_out1_x	(RW)	_hw_work_x	(R)
_tc_load_out1_y	(RW)	_hw_work_y	(R)
_tc_load_out1_z	(RW)	_hw_work_z	(R)
		_hw_work_a	(R)
_tc_load_out2_x	(RW)	_hw_work_b	(R)
_tc_load_out2_y	(RW)	_hw_work_c	(R)
_tc_load_out2_z	(RW)	_hw_work_u	(R)
		_hw_work_v	(R)
		_hw_work_w	(R)
Settings - Tool Offset:			
_tooloff_speed	(RW)		
_tooloff_speed_low	(RW)	_hw_srcidx	(R)

_hw_linenum	(R)	_prog_linelimit	(R)
_hw_output	(R)	_prog_looplimit	(R)
_hw_output_num	(R)	_prog_loadtime	(R)
_hw_output_freq1	(R)	_prog_min_x	(R)
_hw_output_duty1	(R)	_prog_min_y	(R)
_hw_output_freq2	(R)	_prog_min_z	(R)
_hw_output_duty2	(R)	_prog_min_a	(R)
_hw_output_freq3	(R)	_prog_min_b	(R)
_hw_output_duty3	(R)	_prog_min_c	(R)
		_prog_min_u	(R)
_hw_extin1	(R)	_prog_min_v	(R)
_hw_extin1_num	(R)	_prog_min_w	(R)
_hw_extin2	(R)		
_hw_extin2_num	(R)	_prog_max_x	(R)
_hw_extout1	(R)	_prog_max_y	(R)
_hw_extout1_num	(R)	_prog_max_z	(R)
_hw_extout2	(R)	_prog_max_a	(R)
_hw_extout2_num	(R)	_prog_max_b	(R)
		_prog_max_c	(R)
_hw_input	(R)	_prog_max_u	(R)
_hw_input_num	(R)	_prog_max_v	(R)
		_prog_max_w	(R)
_hw_limit	(R)		
_hw_limit_num	(R)	_prog_mintrav_x	(R)
		_prog_mintrav_y	(R)
_hw_jog	(R)	_prog_mintrav_z	(R)
_hw_jogpot	(R)	_prog_mintrav_a	(R)
		_prog_mintrav_b	(R)
_hw_ctrl	(R)	_prog_mintrav_c	(R)
		_prog_mintrav_u	(R)
_hw_aux1	(R)	_prog_mintrav_v	(R)
_hw_aux2	(R)	_prog_mintrav_w	(R)
_hw_aux3	(R)		
_hw_aux4	(R)	_prog_maxtrav_x	(R)
		_prog_maxtrav_y	(R)
_hw_error	(R)	_prog_maxtrav_z	(R)
_hw_motors_en	(R)	_prog_maxtrav_a	(R)
_hw_limits_en	(R)	_prog_maxtrav_b	(R)
_hw_axislock	(R)	_prog_maxtrav_c	(R)
		_prog_maxtrav_u	(R)
_hw_ctrlspindleidx_rpm	(R)	_prog_maxtrav_v	(R)
_hw_ctrlspindleidx_val	(R)	_prog_maxtrav_w	(R)
_hw_ctrlspindle_rpm	(R)	_prog_minfeed_x	(R)
_hw_ctrlspindle_dir	(R)	_prog_minfeed_y	(R)
_hw_ctrlspindle_val	(R)	_prog_minfeed_z	(R)
		_prog_minfeed_a	(R)
_hw_ctrlmpg_rpm	(R)	_prog_minfeed_b	(R)
_hw_ctrlmpg_dir	(R)	_prog_minfeed_c	(R)
_hw_ctrlmpg_val	(R)	_prog_minfeed_u	(R)
_hw_ctrlmpg_velocity	(R)	_prog_minfeed_v	(R)
		_prog_minfeed_w	(R)
_hw_ctrlenc_rpm	(R)	_prog_maxfeed_x	(R)
_hw_ctrlenc_dir	(R)	_prog_maxfeed_y	(R)
_hw_ctrlenc_val	(R)	_prog_maxfeed_z	(R)
		_prog_maxfeed_a	(R)
_hw_mpg_mode	(R)	_prog_maxfeed_b	(R)
_hw_mpg_axis	(R)	_prog_maxfeed_c	(R)
_hw_mpg_key	(R)	_prog_maxfeed_u	(R)
_hw_mpg_delta	(R)	_prog_maxfeed_v	(R)
_hw_mpg_value	(R)	_prog_maxfeed_w	(R)
_hw_mpg_axisnum	(R)		
_hw_mpg_velocity	(R)	_prog_maxspeed	(R)
		_prog_minspeed	(R)
Program:		_prog_maxspindle	(R)
_prog_size	(R)	_prog_minspindle	(R)
_prog_linecount	(R)		
_prog_totallen	(R)		
_prog_totaltime	(R)	UI:	

<code>_isuiready</code>	(R)
<code>_progress</code>	(R)
<code>_progress_timetoend</code>	(R)
<code>_progress_loop</code>	(R)
<code>_progress_loopcnt</code>	(R)

<code>_ui_width</code>	(R)
<code>_ui_height</code>	(R)

<code>_selected_gcode_line</code>	(R)
<code>_selected_gcode</code>	(R)
<code>_selected_gcode_x</code>	(R)
<code>_selected_gcode_y</code>	(R)
<code>_selected_gcode_z</code>	(R)
<code>_selected_gcode_a</code>	(R)
<code>_selected_gcode_b</code>	(R)
<code>_selected_gcode_c</code>	(R)
<code>_selected_gcode_u</code>	(R)
<code>_selected_gcode_v</code>	(R)
<code>_selected_gcode_w</code>	(R)

Dialogs:

<code>_toolnumber</code>	(R)
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<code>_coord_x</code>	(R)
<code>_coord_y</code>	(R)
<code>_coord_z</code>	(R)
<code>_coord_a</code>	(R)
<code>_coord_b</code>	(R)
<code>_coord_c</code>	(R)
<code>_coord_u</code>	(R)
<code>_coord_v</code>	(R)
<code>_coord_w</code>	(R)
<code>_coord_rot</code>	(R)

<code>_coord_x_en</code>	(R)
<code>_coord_y_en</code>	(R)
<code>_coord_z_en</code>	(R)
<code>_coord_a_en</code>	(R)
<code>_coord_b_en</code>	(R)
<code>_coord_c_en</code>	(R)
<code>_coord_u_en</code>	(R)
<code>_coord_v_en</code>	(R)
<code>_coord_w_en</code>	(R)
<code>_coord_rot_en</code>	(R)

Other:

<code>_start_firstline</code>	(R)
<code>_start_lastline</code>	(R)
<code>_start_loops</code>	(R)
<code>_return</code>	(R)

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