

Supported G-codes

G_codes are generally movement related commands. G-codes can be referenced directly by number or indirectly using more readable case insensitive substitution strings.

G0 rapid(move)(to)

G codes 0 and 1 share the same parameter syntax G code 0 generates a rapid move, i.e., as fast as axis motors can accelerate, run and decelerate while G code 1 moves are feedrate limited, provided that a feedrate has been set.

Parameters describe a path to follow from the current machine position to a target position, however, the path to follow may be curved in an arbitrarily complex manner. A linear path will resolve to a single segment, but complex curved paths will generate a sequence of segments to more accurately describe the curve.

Each segment will impart either a relatively constant or a time varying speed to each of its respective machine axis. A time varying axis speed relative to a constant axis speed or a different time varying axis speed will result in a curved path, i.e., a Bézier curve.

Parameters consist of a set of clauses each consisting of a reference followed by a set of expressions that can each evaluate to a number at execution time. Read the Expressions document for more information on expressions.

Currently supported references consist of the nine supported independent axis letters (X,Y,Z, A,B,C, U,V,W), the nine supported vector letters (VX,VY,VZ, VA,VB,VC, VU,VV,VW) and the three supported polar transforms (PX,PY,PZ).

Expressions may be separated by either a space or comma. Each axis reference or vector reference must be followed by either one or three expressions specifying either a constant or a cubic Bézier time varying speed to the target endpoint.

References may freely mixed and even duplicated. Vector references resolve to a set of proportionally scaled axis references. Duplicated axis references are combined. A constant speed axis reference combines with a varying speed axis reference by adding a skew to the Bézier. Bézier curves combine by adding the control points.

Polar transform references evaluate expressions differently. As with the the other references, the evaluation depends upon the number of expressions.

Point evaluation

For one to three expressions, the polar transform reference will evaluate to an endpoint for a linear move.

- 1. The first expression evaluates to an angle from the current polar center relative to the zero degree reference vector.*

2. *The second expression specifies a radius from the polar center with the default being the last specified radius for the transform (zero relative).*
3. *The third expression specifies an offset along the polar axis vector from the polar center with a default of zero.*

When evaluating to a point, the polar transform must have already been configured with a center point, a normal (rotational axis) vector and zero angle reference vector.

Circular arc evaluation

A polar transform reference with four expressions evaluates to a circular arc, generating time varying axis references and path segments as required.

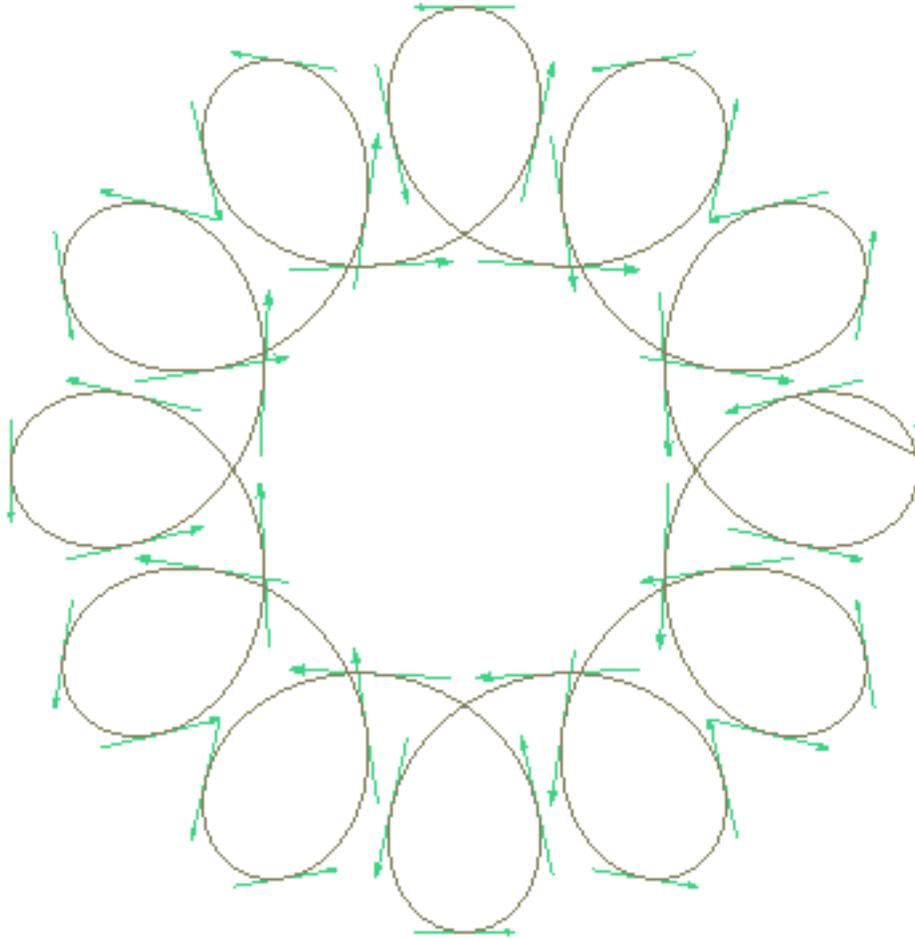
1. *The first expression evaluates to the start angle from the current polar center relative to the zero degree reference vector.*
2. *The second expression evaluates to the end angle from the current polar center relative to the zero degree reference vector. The difference between the end angle and the start angle determines the angular length of the arc and the direction. Note that the arc may exceed a single revolution.*
3. *The third expression specifies a radius from the polar center. An arc segment will span a maximum of 90°. Thus a full circle arc of 360° will generate 4 segments. However, if the radius is greater than 1, then the radius is multiplied by the arc angle when determining the number of path segments. This provides greater resolution for larger diameter arcs.*
4. *The fourth expression specifies an offset along the polar axis vector from the polar center. This will usually be zero, but otherwise will generate a helical path with the helix aligned with the polar axis vector. It is equivalent to adding a separate axis vector reference to the command/*

Note that the arc evaluation uses only the polar transform axis normal and zero vectors. The arc center is calculated relative to the current machine position given the start angle and radius.

Adding additional polar transform references will create an epicyclic path which may be quite decorative. Non polar references can add a linear skew to the circular path which may also be decorative. Some examples follow:

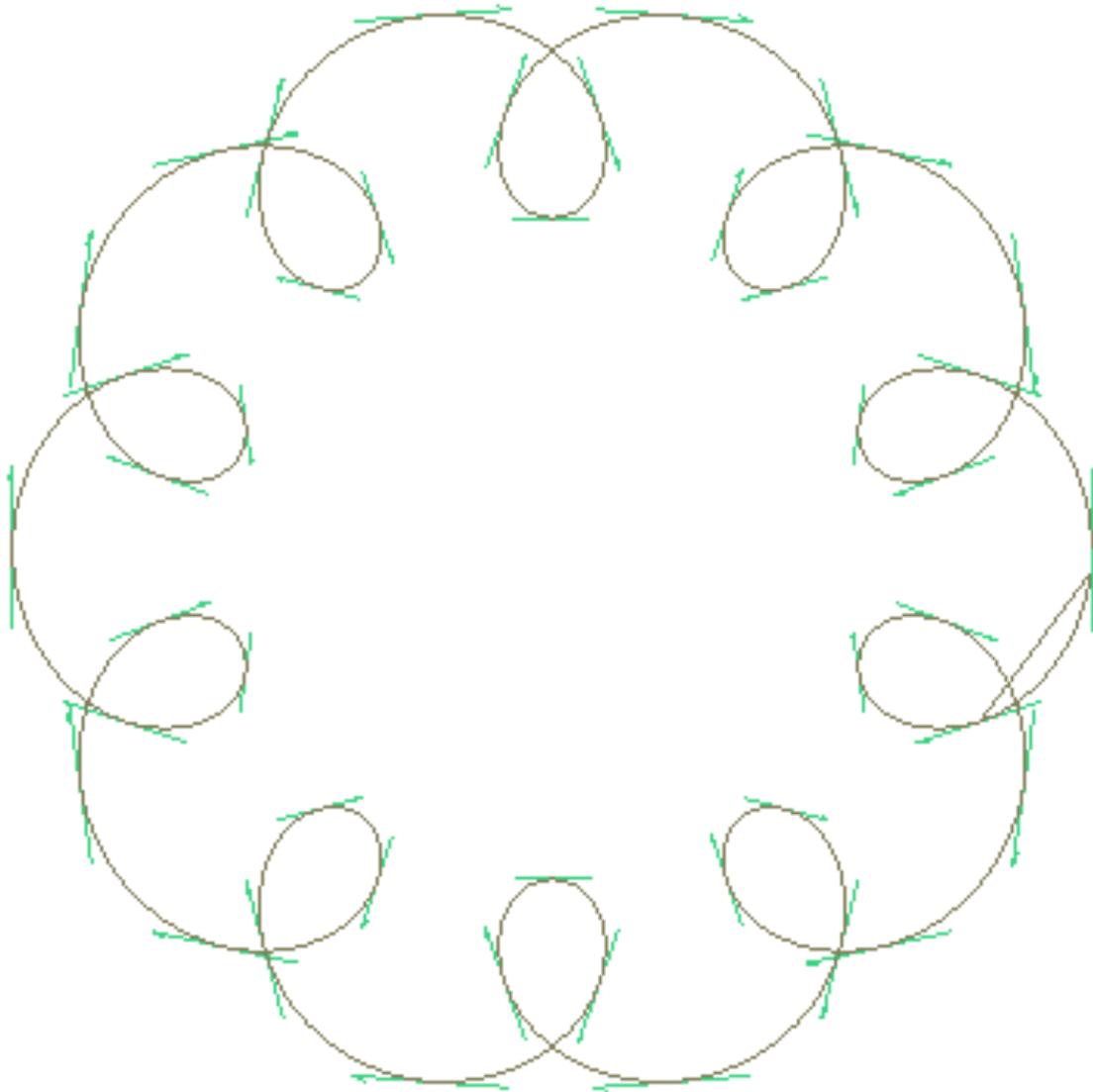
Draw a decorative epicyclic:

```
move PZ 0 360 0.5 0 PZ 0 3960 0.125 0
```



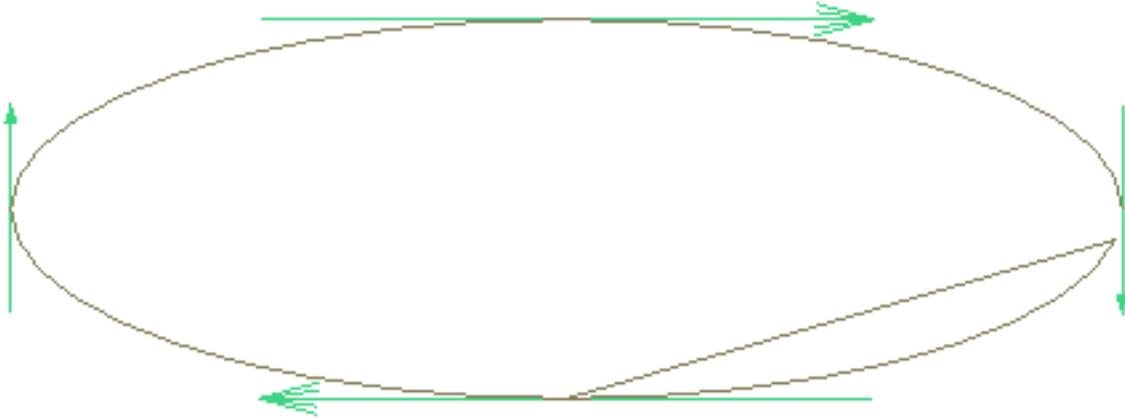
Similar but with external loops:

```
move PZ 0 360 0.5 0 PZ 0 -3960 0.18 0
```



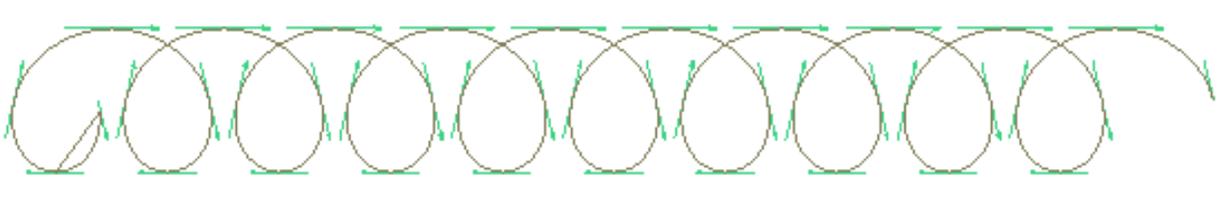
Draw an oval without using scaling:

```
move PZ 0 360 0.5 0 PZ 0 -360 0.25 0
```



Draw a trim pattern:

```
move PZ 0 3600 0.125 0 X 2
```



G1 feed(to)

Generates a feedrate limited move using the current active feedrate. Parameter specification is identical to that described for G0.

G2 circle c(lock)w(ise) or helical(motion) c(lock)w(ise)

This G-code is deprecated but supported for compatibility. Instead use G-code 105 to reference a polar transform.

Coordinate parameters (X,Y,Z) specify target endpoint for circular interpolation in the selected contour plane. Parameters (I,J,K) specify the circle center or parameter R specifies the radius and the center is calculated. The motion is helical if an endpoint for the axis not in the contour plane is specified.

G3 circle c(ounter)(-)c(lock)w(ise) or helical(motion) c(ounter) (-)c(lock)w(ise)

This G-code is deprecated but supported for compatibility. Instead use G-code 105 to reference a polar transform.

Same as G2 except that circle is counter-clockwise.

G4 dwell or pause

Dwell time is taken from parameter P or zero if P is not specified. Waits for all axes to become idle and then for the specified seconds.

G15 cancel polar(coordinates)(mode)

This G-code is deprecated but supported for compatibility. Instead use G-code 105 to reference a polar transform.

Cancels polar coordinates mode.

G16 set polar(origin)(to)

This G-code is deprecated but supported for compatibility. Instead use G-code 105 to reference a polar transform.

Sets polar coordinates mode. The polar origin is set for the three axes "X", "Y" and "Z". The current position is used for axes not specified. It is not necessary to first move to the polar origin. If polar coordinates mode is already active, then the normal polar translation occurs before the polar coordinates are reset.

The polar origin is fixed for the machine position. Changing fixture, tool or program offsets will not change the machine position of the polar origin.

Polar translation is performed for the two axes specified by the selected contour plane as follows:

Plane	Radius	Angle
XY	X	Y
ZX	Z	X
YZ	Y	Z

The previously set radius and/or angle is used if unspecified. Changing the contour plane does not cancel polar coordinates mode.

G17 (use)X(-)Y(plane)

This G-code is deprecated but supported for compatibility. Instead use G-code 105 to reference a polar transform.

The active contour plane is set to XY. This is also the default plane when the program starts. The contour plane setting is used by several G-codes including 2, 3, 16, 74 and 81-87.

G18 (use)Z(-)X(plane)

This G-code is deprecated but supported for compatibility. Instead use G-code 105 to reference a polar transform.

The active contour plane is set to ZX.

G19 (use)Y(-)Z(plane)

This G-code is deprecated but supported for compatibility. Instead use G-code 105 to reference a polar transform.

The active contour plane is set to YZ.

G20 (set)inch(units)

Coordinate specifications are in inches, feedrate specifications are in inches per minute.

G21 (set)metric(units)

Coordinate specifications are in millimeters, feedrate specifications are in millimeters per second.

G31 probe(ing)(move)(to)

Same as G1 except that interpolation will stop when probe input becomes active. Be sure to set the feedrate slow enough that motor momentum will not damage the probe. Results of the probe can be read from the special variable `__probe_stop`.

G43 apply tool(length)(offset)

Currently the tool offset can only be applied for the selected tool, i.e., the H parameter is not used. The offset is applied for the tool axis selected by the current fixture.

G49 cancel tool(length)(offset)

Cancels the offset for the selected tool

G53 (select)(default)fixture(0)

Coordinate parameters become adjusted by the default fixture 0 offsets.

Note: Fixture offsets are configured using a machine setup sheet. Programmatic configuring of fixture offsets may be supported in a future release.

G54 (select)fixture 1

Coordinate parameters become adjusted by fixture 1 offsets.

G55 (select)fixture 2

Coordinate parameters become adjusted by fixture 2 offsets.

G56 (select)fixture 3

Coordinate parameters become adjusted by fixture 3 offsets.

G57 (select)fixture 4

Coordinate parameters become adjusted by fixture 4 offsets.

G58 (select)fixture 5

Coordinate parameters become adjusted by fixture 5 offsets.

G59 (select)fixture 6

Coordinate parameters become adjusted by fixture 6 offsets.

G61 exact(stop)(mode)

Implementation automatically inserts a pause after each movement command. The firmware will wait for all axes motors to come to a stop before beginning the next command.

G64 cancel exact(stop)(mode) or constant(velocity)(mode) or maintain(motor) momentum(mode)

Cancels exact stop mode - default mode. Corners will become rounded to maintain motor momentum.

G69 cancel(coordinate) rotation

Resets all vector and polar transforms to their default settings.

G73 chip breaking drill

Chip breaking drill - peck drill with partial rapid return between pecks to break chips, rapid out.

G80 cancel fixed cycles

Clears any parameters that may have been saved for any drill cycles.

G81 drill

Continuous drill, then rapid out.

G82 drill, dwell

Continuous drill, dwell, then rapid out.

G83 chip clearing drill

Deep drilling - peck drill with rapid return to release plane between each peck.

G85 drill, feed out

Continuous drill, then feed out.

G86 drill, dwell, spindle off, out

Continuous drill, dwell, spindle off, rapid out.

G89 drill, dwell, feed out

Continuous drill, dwell, feed out.

G90 (set)abs(olute)(coordinate)(s)(mode)**G91 (set)inc(remental)(coordinate)(s)(mode)**

The current coordinates are added to specified coordinates before the command is sent to the Engine. The Engine interpolates only in absolute mode.

G92 preload(coordinate)(s) or preset(coordinate)(s)

Changes coordinate settings in the server.

G100 run

This non-standard command sets the specified axes to run at a constant speed. Axis parameter values are interpreted as a percentage of the configured maximum motor speed. Position seeking has priority over constant speed running. The run command is ignored for any axis currently seeking a position. The speed can be changed while the motor is running and stopped by setting the speed to zero. The run mode is also cancelled if the axis becomes the target of a positioning command.

G101 rotate vector(s)

Rotate one or more vectors a give angle about an axis vector. Arguments are the normal vector, the angle, then the vectors to rotate.

G102 set vector

The parameters are the vector name, then a set of axis names followed by a scale factor.

G103 set polar center

The parameters are the polar transform name, an angle, radius and optionally a normal offset.

The center is calculated and set relative to the current machine position for the given arguments.

G104 set polar axis

The parameters are the polar transform name and the normal vector name.

G105 set polar zero

The parameters are the polar transform name and the zero reference vector name.

G107 set drill vector

The drill vector is used for drilling cycles. The command takes a single argument for the drill vector name. Currently the name must be a vector transform reference and not an axis letter, but this restriction may be removed in subsequent releases.

G108 set vector position

The command takes a two arguments for the vector name and the position value.