

Pipe and Tube Cutting on EDGE® Pro, MicroEDGE® Pro, and EDGE® Connect CNCs

Application Note

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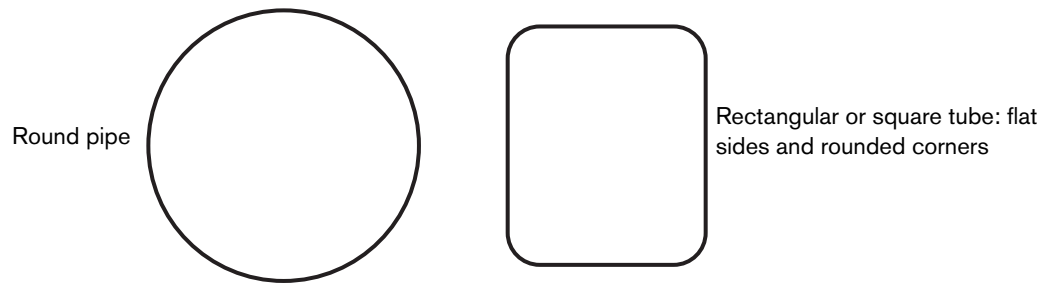
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Pipe and tube cutting on EDGE Pro, MicroEdge Pro and EDGE Connect CNCs

Introduction

The Hypertherm EDGE® Connect, EDGE® Pro, and MicroEDGE® Pro CNCs provide support for round pipe and square or rectangular tube-cutting applications for plasma cutting.

These applications use a dual transverse setup on the CNC. Pipe and tube stock profiles are shown below:



This document describes the requirements for controlling a rotating Transverse 2 axis. It also provides part programming examples for performing cut-off and feature cutting operations on rotating metal stock.

Additional resources

- *Dual Transverse Setup and Operation Application Note (807610)* provides information on setting up the Dual Transverse axis (also called the Transverse 2 axis).

Recent changes to pipe and tube cutting

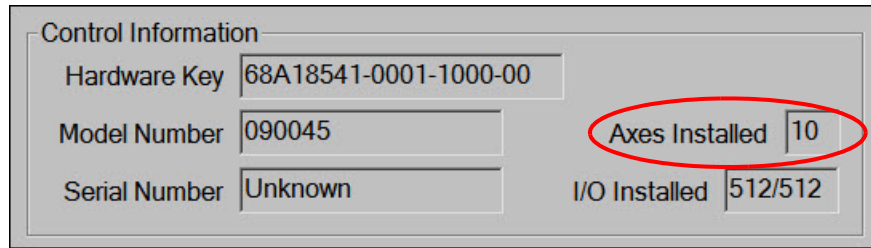
- Park and unpark codes M86, M87, M88, M89 are no longer required in pipe and tube part programs. However, Phoenix can still run any part program that includes park and unpark codes.
- When a pipe or tube part is loaded, the CNC turns off all vent control outputs except for the lowest numbered vent output to avoid fan noise issues.

Hardware and software requirements

EDGE Pro and MicroEdge Pro

The CNC must be equipped with a minimum of four physical axes for pipe or tube cutting (or five physical axes for EDGE Connect CNCs). Purchase the CNC based on the number of physical axes needed for the application. Refer to Axis assignments and passwords on page 9 for the axes required for different types of cutting systems.

The CNC must also have at least 10 axes installed in the software. You can check the number of axes installed in the software by choosing Setups > Diagnostics to view the Control Information screen.



The screenshot shows the 'Control Information' window with the following fields:

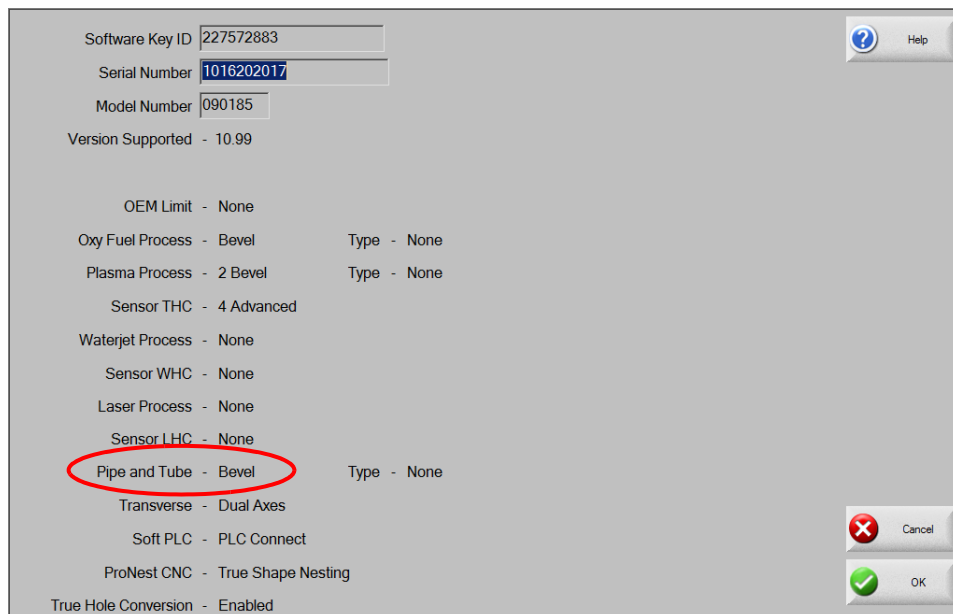
| Control Information | |
|---------------------|-----------------------|
| Hardware Key | 68A18541-0001-1000-00 |
| Model Number | 090045 |
| Serial Number | Unknown |
| Axes Installed | 10 |
| I/O Installed | 512/512 |

The 'Axes Installed' field is circled in red.

If your CNC has fewer than 10 axes installed, contact the Hypertherm Product Application Engineer in your region for assistance in obtaining a password to enable the additional axes. A list of Hypertherm regional offices appears at the beginning of this document.

EDGE Connect

The CNC must be equipped with a minimum of FIVE physical axes for pipe or tube cutting. Purchase one of the pipe software features from the Xnet that are needed for the application. You can check the software features installed by choosing Setups > Password and typing the password **INSTALLEDFEATURES**. Under Pipe and Tube make sure one of the pipe features appears.



The screenshot shows the 'Password' window with the following fields:

| Password | |
|----------------------------------|-------------|
| Software Key ID | 227572883 |
| Serial Number | 1016202017 |
| Model Number | 090185 |
| Version Supported - 10.99 | |
| OEM Limit - None | |
| Oxy Fuel Process - Bevel | Type - None |
| Plasma Process - 2 Bevel | Type - None |
| Sensor THC - 4 Advanced | |
| Waterjet Process - None | |
| Sensor WHC - None | |
| Laser Process - None | |
| Sensor LHC - None | |
| Pipe and Tube - Bevel | Type - None |
| Transverse - Dual Axes | |
| Soft PLC - PLC Connect | |
| ProNest CNC - True Shape Nesting | |
| True Hole Conversion - Enabled | |

The 'Pipe and Tube - Bevel' field is circled in red.

If your CNC doesn't have one of the pipe features installed, contact the Hypertherm Product Application Engineer in your region for assistance in purchasing additional software features from the Xnet. A list of Hypertherm regional offices appears at the beginning of this document.



EDGE Connect CNCs use software features to turn on items purchased through the Xnet. Throughout the document there are references to axis count, by default the correct axis's are available if the correct feature(s) are purchased.

Pipe and tube cutting on Hypertherm CNCs also has the following requirements and restrictions:

- The CNC uses the Transverse 2 axis as the pipe or tube axis. This axis must be parallel to the Rail axis.



Motor drives for Transverse 2 should be configured as standard linear axes. Do not use special modulo features for rotational axes available in some motor drives. These features will not work properly with Phoenix software.



Throughout this document, Transverse 2 is also referred to the "Pipe" axis, even though it can be used to rotate both pipe and tube material.

- A combination flat plate and pipe-cutting system requires both Rail and Transverse axes.
- A pipe-only cutting system can run without a Transverse axis, using only the Rail, Sensor THC, and Transverse 2 (Pipe) axes, but the torch does not move. This type of pipe system runs only on analog CNCs, not on SERCOS II or SERCOS III CNCs.
- A tube-cutting system requires a minimum of 4 axes (or 5 axes for EDGE Connect CNCs) and must have Transverse, Rail, and Sensor THC axes. Tube cutting cannot be accomplished on a 3-axis CNC.
- The Transverse (torch) axis must be positioned in the center of the stock at the start of the part program for both pipe and tube cutting.


Do not use the following features on the CNC for pipe or tube cutting:


- Plate alignment features (Shape Manager > Shape Wizard > Shape Options > Align and Align Wizard)
- Return to start (can be selected in two different ways):
 - From the Manual screen
 - In response to the Return to Start message that appears at the end of a part program that doesn't include a traverse move to the start point of the part.
- Move to pierce (Pause screen)
- Save or Resume part (Pause screen)
- Mirror, Rotate, Scale, Nest, or Repeat Part
- Multitasking
- Software overtravel limits are not supported on the Pipe axis at this time.


About axes assignments on the CNC

Hypertherm CNCs are hard-coded with the axis assignments. The table below shows the axis numbers that the CNC uses for 12 axes, and common letter identifiers for the axes.

| Axis | Axis assignment |
|------|------------------------|
| 1 | Transverse or Rail (X) |
| 2 | Rail or Transverse (Y) |
| 3 | Dual Gantry (W) |
| 4 | Sensor THC 1 (Z) |
| 5 | Rotate 1 (B or C) |
| 6 | Tilt 1 (A) |
| 7 | Transverse 2 |
| 8 | Rotate 2 |
| 9 | Tilt 2 |
| 10 | Sensor THC 2 |
| 11 | Sensor THC 3 |
| 12 | Sensor THC 4 |

 All cutting systems require both Transverse and Rail axes, but you can assign either to X or Y.

 A Dual Gantry axis is parallel to the Rail axis (think of it as a “Rail 2” axis). In a dual gantry cutting system, the second rail axis is powered by its own motor using the same signal as the Rail axis.

 Rotate and Tilt axes are used for bevel cutting.

Axis assignments and passwords

Using special passwords NRT and 1RT (No Rotate Tilt and 1 Rotate Tilt respectively) redirects certain axes signals to different axis numbers. A 2-station cutting system on a 6-axis CNC requires the NRT password so that the Transverse 2 and Sensor THC 2 signals are output on axes 5 and 6 instead of 7 and 10. (Previously the Transverse 2 axis was available only on a dual bevel-head cutting system).

Additional examples:

- To enable the Transverse 2 axis for pipe or tube cutting on a CNC with 6 or fewer axes, enter the NRT password.
- To set up a cutting system with both a straight torch and a bevel head, enter the 1RT password.

The following tables identify the application, password, and axis assignments for common cutting system axis configurations. Use these tables to identify the axis number, and for SERCOS cutting systems, the drive address where the CNC will output the axis signals.

4-axis (analog-only) I-cutting on pipe or tube, no Dual Gantry, NRT password

| Axis/drive address | Axis assignment |
|--------------------|--------------------|
| 1 | Transverse or Rail |
| 2 | Rail or Transverse |
| 3 | Sensor THC |
| 4 | Transverse 2 |

5-axis I-cutting on pipe or tube, with Dual Gantry, NRT password

| Axis/drive address | Axis assignment |
|--------------------|--------------------|
| 1 | Transverse or Rail |
| 2 | Rail or Transverse |
| 3 | Dual Gantry |
| 4 | Sensor THC |
| 5 | Transverse 2 |

6-axis, 2-station, I-cutting on flat plate, with Dual Gantry, NRT password

| Axis/drive address | Axis assignment |
|--------------------|--------------------|
| 1 | Transverse or Rail |
| 2 | Rail or Transverse |
| 3 | Dual Gantry |
| 4 | Sensor THC |
| 5 | Transverse 2 |
| 6 | Sensor THC 2 |

6-axis bevel cutting on pipe or tube, no Dual Gantry, 1RT password

| Axis/drive address | Axis assignment |
|--------------------|--------------------|
| 1 | Transverse or Rail |
| 2 | Rail or Transverse |
| 3 | Sensor THC |
| 4 | Transverse 2 |
| 5 | Rotate |
| 6 | Tilt |

7-axis bevel cutting on pipe or tube, with Dual Gantry, 1RT password


| Axis/drive address | Axis assignment |
|--------------------|--------------------|
| 1 | Transverse or Rail |
| 2 | Rail or Transverse |
| 3 | Dual Gantry |
| 4 | Sensor THC |
| 5 | Rotate |
| 6 | Tilt |
| 7 | Transverse 2 |

8-axis, 2-station, bevel and I-cutting on flat plate, 1RT password

| Axis/drive address | Axis assignment |
|---------------------------|------------------------|
| 1 | Transverse or Rail |
| 2 | Rail or Transverse |
| 3 | Dual Gantry |
| 4 | Sensor THC |
| 5 | Rotate |
| 6 | Tilt |
| 7 | Transverse 2 |
| 8 | Sensor THC 2 |

3-axis pipe-only cutting system, NTH password

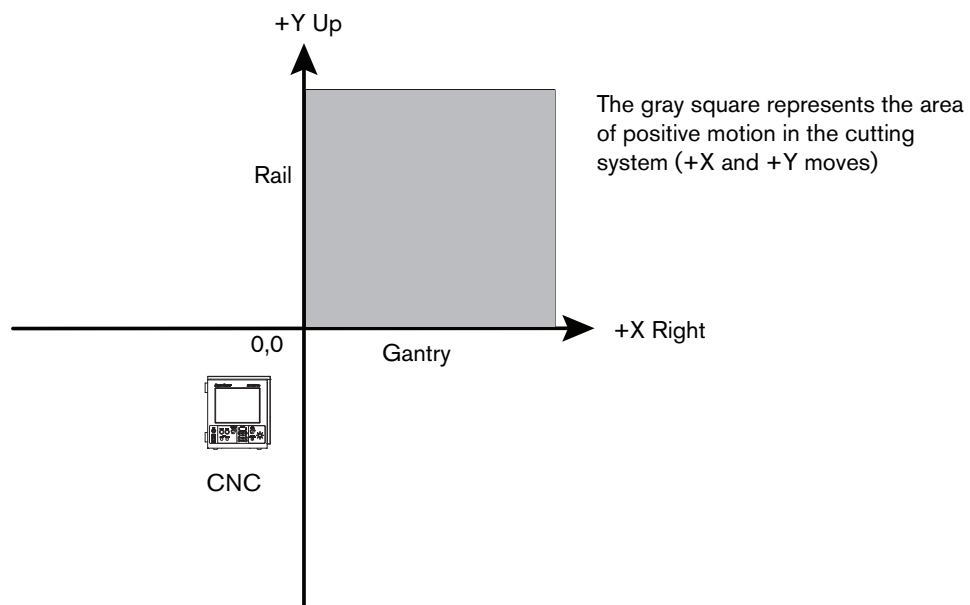
| Axis/drive address | Axis assignment |
|---------------------------|------------------------|
| 1 | Not used |
| 2 | Rail |
| 3 | Sensor THC |
| 4 | Transverse 2 |

 A 3-axis pipe cutting system has the following requirements:

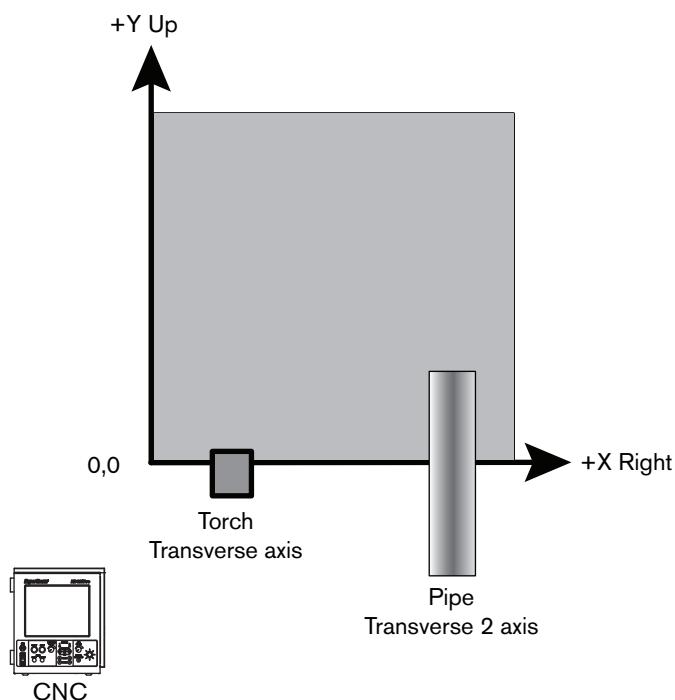
- ❑ Axes 1 and 2 can be reversed so that Rail is Axis 1 and Axis 2 is not used.
- ❑ The 3-axis pipe system is supported only on EDGE Pro or MicroEDGE Pro Hypath or Picopath CNCs. SERCOS CNCs do not support this axis configuration.
- ❑ The NTH password disables the Transverse axis and requires that Park Head 1 input be forced on at all times.

Cutting system orientation

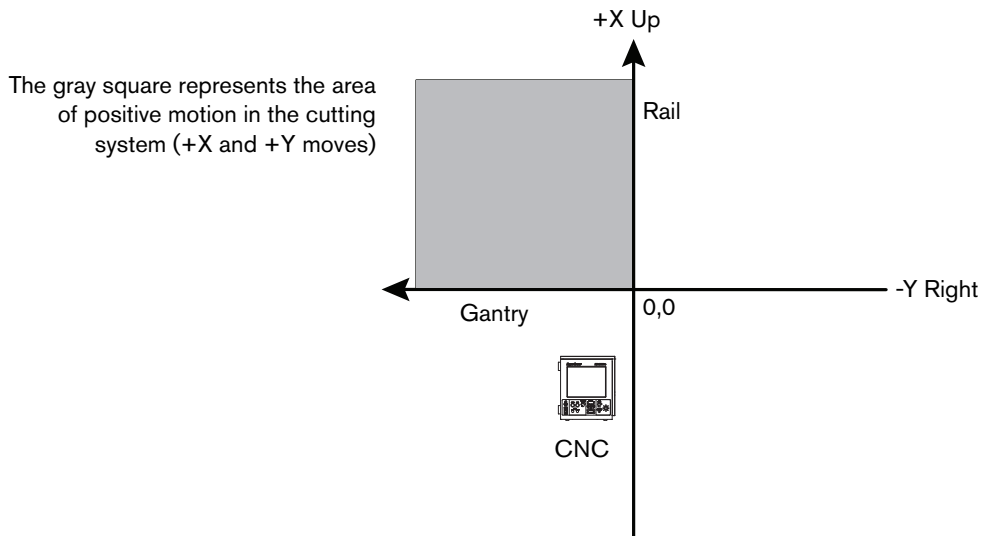
When using two Transverse axes (both a torch axis and a pipe axis) the cutting system must be set up for positive motion in the X and Y axes relative to the 0,0 position on the cutting system. Hypertherm CNCs allow you to assign X to either the Transverse (torch) axis or the Rail axis. When X is the Transverse axis, positive motion is represented as shown below. On the Machine Setups screen, you would set Up = +Y and Right = +X, relative to the position of the CNC in the cutting system.



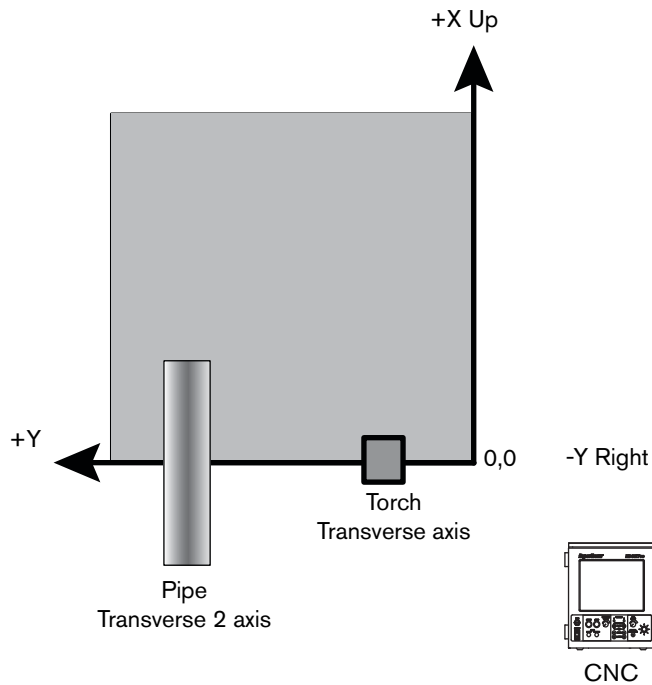
The torch axis is Transverse 1 and the pipe axis is Transverse 2.




Another common orientation assigns X to the Rail. In this orientation, you would set Up = +X and Right = -Y, relative to the position of the CNC, to create positive motion from 0,0.



The torch axis is Transverse 1 and the pipe axis is Transverse 2, but they are positioned differently when Transverse is Y.

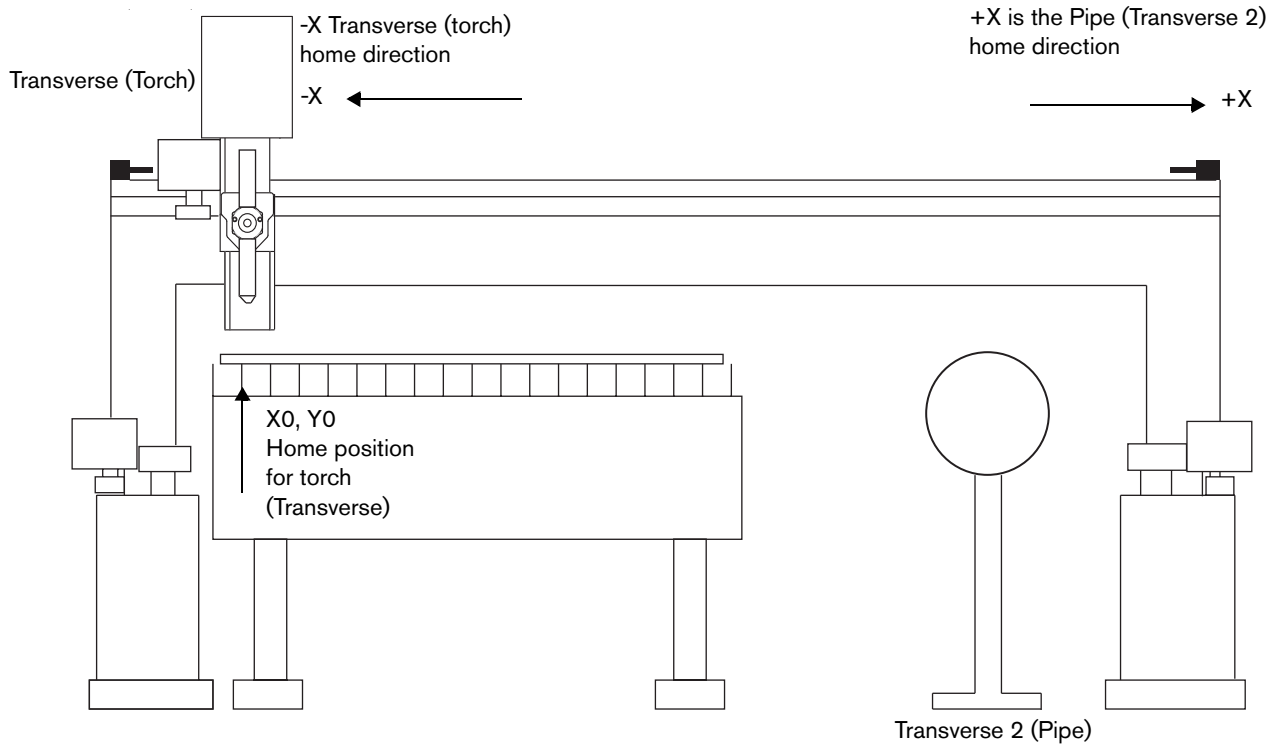


Chuck placement in a combination flat-plate and pipe cutting system

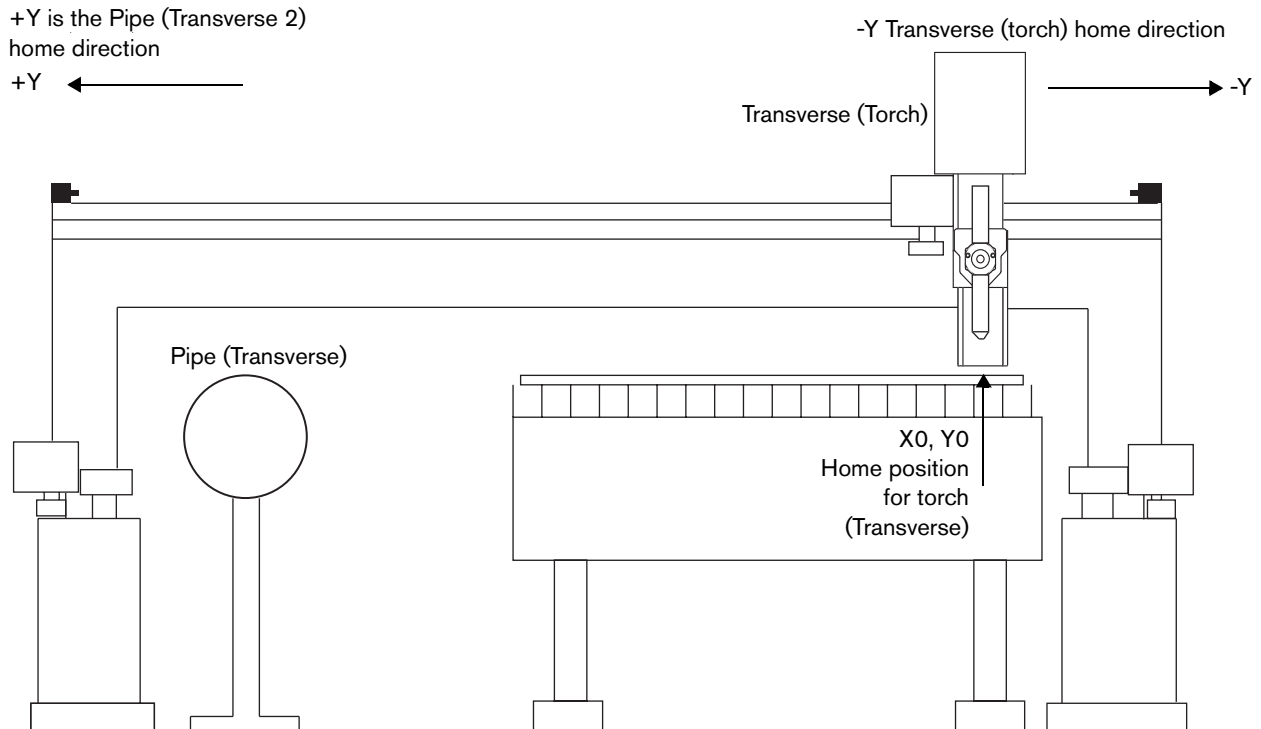
 The examples in this document that show machine orientation and chuck placement are for illustration purposes and may differ from your implementation.

Pipe and tube cutting on EDGE Pro, MicroEdge Pro and EDGE Connect CNCs

The Transverse and Transverse 2 axes must home in opposite directions. The table orientation, and home position and direction, determine the placement of the chuck in a combination flat-plate and pipe cutting system. In the example below, the chuck is placed to the right of the cutting table because the Torch axis (Transverse) homes in the -X direction and the Pipe axis (Transverse 2) always homes in the opposite direction of the Transverse axis (+X).



In another example, Assigning Y as Transverse, would place the chuck to the left of the cutting table.



Pipe axis movement

The Pipe axis, Transverse 2, axis has these characteristics when it is set up as a rotational axis:

- Transverse 2 always rotates about the Rail axis.
- During pipe cutting, all motion is initiated from the center of the pipe where the torch (Transverse) is parked. The CNC moves the Transverse 2 axis (rotates the pipe) and Rail axis (moves the gantry along the rails).
- For pipe cutting, the full amount of rotation of Transverse 2 is determined by the circumference of the pipe.
- The CNC executes both clockwise and counterclockwise rotation when cutting a contour.
- The CNC executes clockwise *or* counterclockwise rotation for a cut-off.
- A move by the Transverse 2 is a linear distance, not an angular distance (measured in degrees).
- Speed of Transverse 2 is in/min or mm/min, not RPM.

The CNC automatically parks and unparks the axes as needed to cut the rotating stock.

- When it runs a pipe program, the CNC parks the Transverse axis and moves the Pipe axis (Transverse 2).
- When it runs a tube program, the CNC moves the Transverse axis and parks the Pipe axis. When the CNC cuts the radius of the tube, however, it enables and moves the Transverse, Pipe, and Sensor THC axes together in coordinated motion around the tube corner radius.

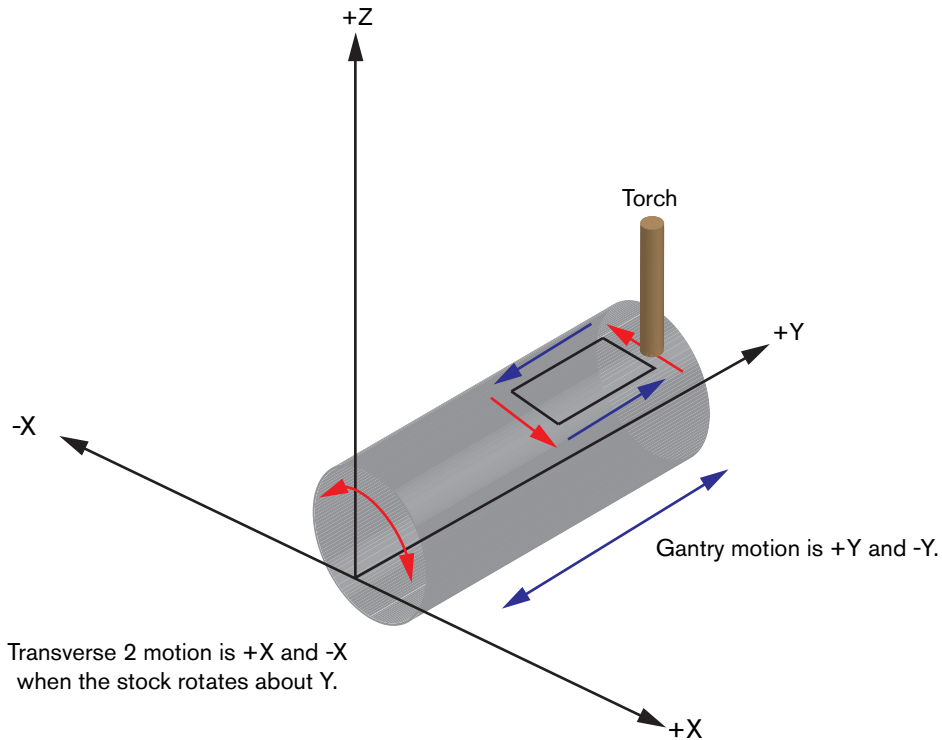
The direction of the pipe axis rotation depends on the linear direction of the cuts and is always opposite the travel direction of the Transverse axis. If Transverse is designated as X and right direction is +X, then:

- To cut in the +X, positive Transverse direction, the Pipe axis rotates counterclockwise (CCW).
- To cut in the -X, negative Transverse direction, Transverse 2 rotates clockwise (CW).

Regardless of how Transverse and Transverse 2 are assigned to X or Y, Transverse 2 always rotates about the Rail axis.

Pipe and tube cutting on EDGE Pro, MicroEdge Pro and EDGE Connect CNCs


When the Transverse axis (torch) is parked, positioning is performed by the Rail and Transverse 2 axes. In this drawing, the pipe is represented by the gray cylinder that rotates about the Y axis. The pipe will rotate either clockwise or counterclockwise and the gantry will move along the rails so that the fixed Transverse axis (the torch) can cut the shape.



Cutting speeds

The cutting, traverse, and trial speeds for the rotating Transverse 2 axis are recalculated by the CNC when you load a part program with one of the following codes:

- G96 Xxx. The Xxx value (or Yxx if Transverse is Y) is the diameter of the pipe. The CNC saves this value in the Phoenix.ini file as pipe circumference and adjusts pipe rotational speed using the pipe diameter and the program speed. The CNC retains the diameter value until you load a new part program with a different value.
- G00 Pxx Txx Sxx Rxx. The CNC uses the radius (R) value to set the rotational speed of the tube.
- G01 Pxx Fxx Txx Sxx Rxx. The CNC uses the speed value (F) to set the rotational speed of the tube.

 Note that cutting speeds for tubes with very small corner radii may be limited even more by the CNC. See Tube cutting on page 25 for more information on program codes and examples for tube cutting.

Transverse 2 setup for stock rotation

This section summarizes the selections you make on the Transverse 2 axis screen. See *Dual Transverse Setup and Operation Application Note* (807610) for more information on setting up the Dual Transverse axis.

The CNC requires that 10 axes be enabled so that the following selections can be activated in the Machine screen:

- Tilt Rotator Installed = Yes
 - Dual Tilt Rotator Installed = Yes
 - Dual Transverse = Yes
1. Activate the axes on the Setups > Password > Machine Setups screen.
 2. Choose Password and enter NRT.
 3. Choose Setups > Machine Setups > Axes 6 - 12 > Transverse 2.
 4. Choose Yes for Rotating Transverse, and enter the encoder counts per revolution.
 5. Choose No for Use Software Travel Limits.

Hardware overtravel switch and homing for Transverse 2

The Transverse 2 axis requires that you select Home to Overtravel Switch in Machine Setups > Transverse 2 screen. To use an overtravel switch on Transverse 2, wire the overtravel switch to the Rotate 2 Home input. Set the following options on the Transverse 2 screen:

| Option | Setting |
|--------------------------|----------------------|
| Use Hardware Overtravels | Yes |
| Home | To Overtravel Switch |
| Absolute Home Position | 0 |
| Home Offset Distance | 0 |

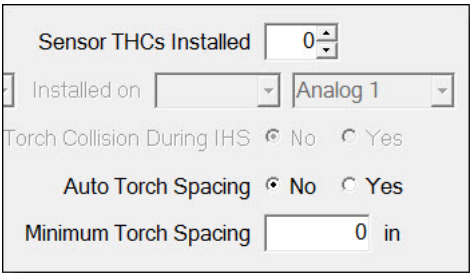
| Axis | I/O point |
|--------------|------------------|
| Transverse | -X/-Y overtravel |
| Transverse 2 | Rotate2Home |

Disabling Auto Torch Spacing

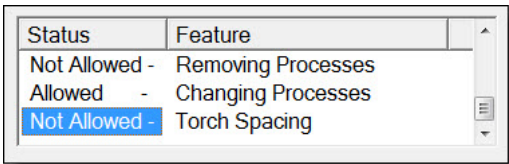
Using Transverse 2 to rotate stock requires that you disable Auto Torch Spacing on the CNC. Instead, you can use Go To Home Position on the Home Axes screen to send the Transverse (torch) axis to a position over the pipe axis. See Homing the axes on page 20 for more information.

Check the following settings to disable Auto Torch setting:

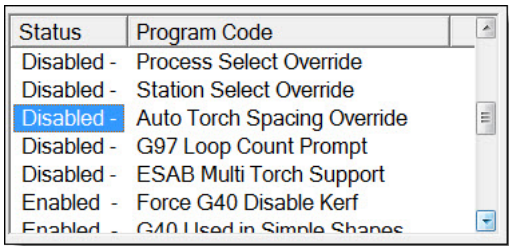
- 1. Choose Setups > Machine Setups and set Auto Torch Spacing to No.



- 2. Choose Setups > Special Setups. In the Status/Feature list, choose Not Allowed for Torch Spacing.



- 3. Choose Main screen > Setups. In the Status/Program Code list, choose Disabled for Auto Torch Spacing Override.



About park inputs

As of Phoenix software version 9.73.0 or higher, once a pipe or tube program is loaded, the CNC controls the parking and unparking of Transverse and Transverse 2 axes. After you load a pipe program, the CNC parks the Transverse axis and unparks Transverse 2. Before you can perform any manual motion with the Transverse axis, such as any of the options on the Manual screen or jogging using the joystick, you must park Transverse 2 and unpark Transverse. The CNC gives you control of parking and unparking only after you have canceled the pipe or tube part program.

Many pipe and tube cutting systems include dedicated switches on the operator console to control parking of the Transverse and Transverse 2 axes. In Hypertherm CNCs, the inputs for parking the axes are called Park Dual Head 1 and Park Dual Head 2. Assign Park Dual Head 1 to Transverse and Park Dual Head 2 to Transverse 2.

Part programs created before Phoenix 9.73.0 may have used the following park M codes. These codes are no longer required. However, an older pipe or tube part program with these codes will still run on the CNC in newer versions of Phoenix.

- M86 Unpark Head 1 - Unpark Transverse
- M87 Park Head 1 - Park Transverse
- M88 Unpark Head 2 - Unpark Transverse 2
- M89 Park Head 2 - Part Transverse 2

Operation

Pipe and tube cutting operations generally follow this order:

1. Set the Plate Size in the Cutting screen.

If Transverse is the X axis, enter the pipe circumference for X and enter the pipe length for Y. If Transverse is the Y axis, enter the pipe length for X and the pipe circumference for Y.



If these dimensions aren't accurate, the CNC may show the Part Larger than Plate warning message. To determine the pipe circumference, measure the pipe diameter and multiply by π (3.14). Increase this value by approximately 10% to prevent any warning messages.

2. Load a part program:

- ❑ A pipe program includes the G96 Xxx where *value* equals the pipe diameter.
- ❑ A tube program includes the G00 Pxx Txx Sxx Rxx (Xxx or Yxx) code with the rotational angle, and top, side, and radius dimensions, and optional rail travel distance (Xxx or Yxx).

3. Home the cutting system (Manual > Home Axes).

4. Position the torch axis over the center of the stock using a Go To Home position.

On the Home Axes screen, enter a distance from the home position of the Transverse axis to the center of the pipe axis. The Rail axis position of the Go To Home position should be the point along the rail to begin all pipe or tube programs.

5. Switch both park inputs off. The part program takes control of the parking and unparking of the axes.

6. Run the part program.

Homing the axes

Be sure to load the pipe- or tube-cutting program before homing the cutting system. The part program contains the codes and dimensions that the CNC uses to set the speed for homing. You want the part program to match the size of the stock you have loaded in the machine. Otherwise, the machine may move too fast or slow in relation to the stock you have loaded.

Transverse 2 homes in the opposite direction of the Transverse axis. If Transverse homes in the negative direction, Transverse 2 homes in the positive direction.

1. Choose the Manual screen using one of these methods:
 - ☐ Press Manual Options on the operator's console of the CNC
 - ☐ Press the Manual soft key (located in the center of the jog keys).
 - ☐ Press F11 on the keyboard
2. Choose Home Axes.
3. Choose either the Transverse soft key or the All soft key.
 - ☐ Transverse and Transverse 2 home at the same time.
 - ☐ The CNC displays the status message *Fast Homing*.
 - ☐ Transverse moves toward overtravel switch.
 - ☐ Transverse 2 rotates toward its overtravel switch but in opposite direction of Transverse.
 - ☐ Motion for each axis stops when the axes engage their overtravel switches. This position equals absolute home.
 - ☐ The CNC changes the status message to *Slow homing*.
 - ☐ Set the Home Offset Distance to 0 (zero) for Transverse 2 to eliminate any travel distance inaccuracies that could occur if the pipe diameter was not properly set before homing.

Centering the torch over the stock

Pipe and tube part programs start with the torch centered over the stock. In most chuck-based systems, the center of the stock does not shift even when cutting different pipe diameters or different tube widths. The following steps describe a method for programming this position into the CNC so that you can move the torch to the center point before each job.

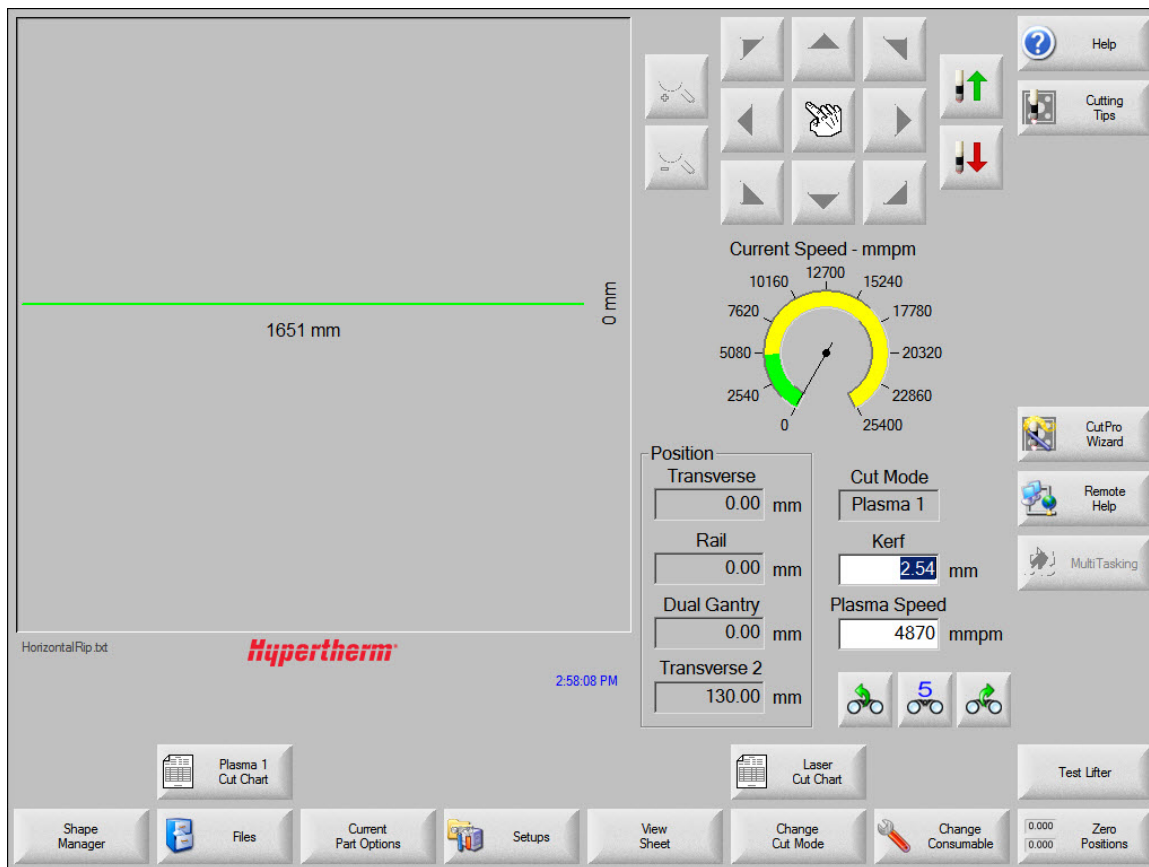
1. Locate a reference point on the gantry. This point could be the Transverse axis home position or another mechanical reference on the gantry.
2. Measure the distance between the reference point and the center of the chuck.
3. Set this value as a Go To Home position in the Home Axes screen:
 - a. Choose Manual > Home Axes.
 - b. Choose a Go To Home Position soft key from 1 to 12.
 - c. Either enter the coordinates of the position on the gantry that represents the center of the pipe or tube stock or choose Use Current Position if the torch is already at the correct location.

Running a part program

Before pressing Start to run the part program, be sure to check the following:

- The current part program has a G96 code with a diameter value that equals the diameter of the loaded pipe stock, or a G00 or G01 code with the dimensions of the tube stock.
- The cutting system has been homed.
- The torch has been positioned over the center of the stock.
- Park inputs are off.

The graphical user interface on the CNC shows parts and machine movement in two dimensions. Because cutting rotational stock is three dimensional process, it may not always be represented on the screen as you would expect. For example, the geometry for a pipe cut-off would look like this in the preview window.



Restarting a part program

Sometimes, after you begin cutting a part on rotating stock, the stock can shift in the chuck. Follow these steps to recover from this condition:

1. Stop and cancel the part program using one of these methods:
 - ❑ Press the emergency stop. This cancels the part program and requires that you re-home the cutting system.
 - ❑ Press the Program Stop button on the operator console, or F10 if you are using a keyboard, then press Cancel on the screen.
2. Take corrective action to reseat the stock.
3. With the original part program loaded, home the cutting system, then reposition the torch at the center of the stock using the Go To Home position.
4. On the Main screen, change Cut Mode to Trial. You may need to reduce the trial speed (located on the Main screen) to prevent the stock from rotating at maximum speed.
5. Press Program Start (green pushbutton on the operator console) or press F9 if you are using a keyboard.
6. When the torch approaches the point where you stopped the program, press Program Stop (red pushbutton).
7. Change Cut Mode to Plasma 1.
8. Press Program Start to restart cutting at the point where the program was interrupted.

Canceling a program

In some cases, if you cancel the part program, the Transverse axis will remain parked and Transverse 2 will remain active. Perform the following routine to restart motion in the Transverse axis:

1. Turn on and off Park Head 1 input.
2. Turn on Park Head 2 input.
3. Jog the Transverse axis to move the torch.

Pipe Cutting Program examples


The CNC supports two common pipe cutting applications:

- Feature cutting – The torch axis is parked and the pipe and rail axes move together to cut a feature (for example, a circular hole) into the pipe.
- Pipe cut-off – The torch axis is parked in position and the pipe rotates while the torch cuts through it.

In both applications, the CNC determines the cutting speed based on the diameter of the pipe and requires the torch to be positioned above the center of the pipe.

Cutting a feature into a pipe

This program assumes the X axis is the Transverse axis and the Y axis is the Rail axis, and that the torch has been positioned over the center of the pipe.

| Code | Description |
|--------------------------|--|
| G20 | Select English units. |
| G91 | Use incremental mode. |
| G96 X9.50 | Set a pipe diameter of 9.5 inches.  Replace X with Y if the Transverse 1 axis is assigned to Y. |
| M36 T1 | Select process Plasma 1. |
| M37 T1 | Select Station 1. |
| G41 | Enable left kerf compensation. |
| M07 | Turn on Cut Control. |
| G02 X0 Y0 I0.707 J-0.707 | Cut a circle 2 inches in diameter. |
| M08 | Turn Cut Control off. |
| G40 | Disable kerf compensation. |
| M19 | Cancel all stations. |
| M02 | End of program. |

Cutting off the end of a pipe

This program assumes the X axis is the Transverse axis and the Y axis is the Rail axis, and that the torch has been positioned over the center of the pipe axis.

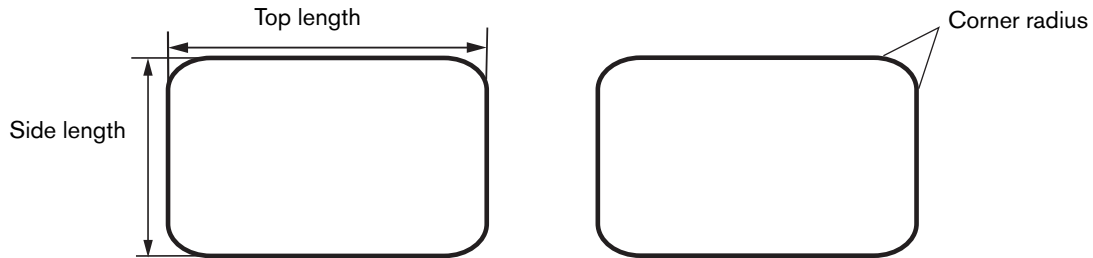
| Code | Function |
|------------|--|
| G20 | Select English units. |
| G91 | Use incremental mode. |
| G96 X9.50 | Set a pipe diameter of 9.5 inches. |
| M36 T1 | Select process Plasma 1. |
| M37 T1 | Select Station 1. |
| G41 | Enable left kerf compensation. |
| M07 | Turn on Cut Control. |
| G01 X30 Y0 | Linear cut that exceeds the circumference of the pipe (29.83 inches) |
| M08 | Turn off Cut Control. |
| G40 | Disable kerf compensation. |
| M19 | Cancel all stations. |
| M02 | End of program. |

Tube cutting

When cutting square tube, the CNC creates Z-axis motion to lift the torch and cut each corner's radius as the stock rotates. Tube cutting requires the Sensor THC.

The CNC requires the following tube dimensions in the part program:

- Corner radius
- Top length
- Side length



The sides of the tube are cut using G01 commands with the axis and length of the cut. Before cutting the corner radius, the Sensor THC arc voltage tracking must be disabled with the M50 code (Torch height disable). Use either of the following codes in the part program to rotate the tube and cut the corner:

G00 Pxx Fxx Txx Sxx Rxx Yxx or Xxx

G01 Pxx Fxx Txx Sxx Rxx Yxx or Xxx

Where:

P = Degrees of rotation, from -90 degrees to +90 degrees

F = Program speed override (Optional for G00 command; required for G01 where Fxx is rotational speed (RPM)).

T = Top length

S = Side length

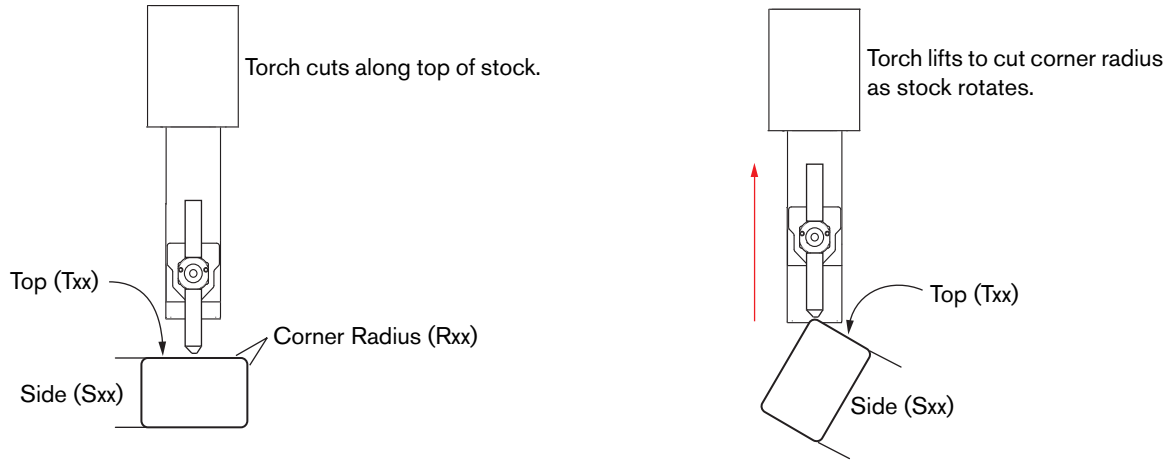
R = Corner radius

Y or X = Optional rail offset distance

T is always the surface being cut. S is always the *next* surface to be cut. With the Sensor THC disabled, the CNC makes the Z-axis moves needed to cut the corner radius and to avoid colliding with the rotating tube.

Pipe and tube cutting on EDGE Pro, MicroEdge Pro and EDGE Connect CNCs

In tube cutting, the transverse motion uses both Transverse and Transverse 2 axes. The Transverse axis cuts on the flat sides of the stock with Transverse 2 parked, and then the Transverse axis parks after a height offset, and Transverse 2 rotates so that the Transverse can cut the radius of the stock. When the radius cut is complete, Transverse 2 parks and Transverse unparks to cut the next flat side of the stock. The CNC controls the unparking and parking of the axes.



The Top dimension changes each time the stock rotates.

A tube program follows this sequence:

- Before starting the tube program, the torch must be positioned over the center of the stock.
- An M50 code before the G00 Pxx Txx Sxx Rxx disables automatic voltage control on the Sensor THC.
- The Transverse axis is parked when the G00 Pxx Txx Sxx Rxx command is executed.
- The Sensor THC makes a height offset that is controlled by the CNC, not by a code embedded in the part program.
- The CNC maintains the cut height around the radius cut.
- An M51 reenables automatic voltage control on the Sensor THC. Transverse is parked and Transverse 2 is unparked.
- The values for T and S switch for the next command G00 Pxx Txx Sxx Rxx.

Torch height control for tube cutting

A properly tuned THC axis is recommended to maintain the cut height when cutting the corner radii. The THC has to accelerate quickly enough so that the torch can move to the offset distance as the stock rotates. A slow response from the lifter, or a high following error, affects the cut quality in the radius of the tube and can result in a torch collision.

- The Z axis should be able to operate at a minimum of 400 in/min (10160 mm/min).
- The following error at maximum speed should be low to maintain an accurate cut height while cutting a radius. You can observe the following error in the Watch Window, and run this test:
 - Set THC Fast IHS Speed equal to Maximum Speed (temporarily).
 - Set THC Jog Speed to Fast IHS Speed in Manual Options screen.
 - Jog the lifter up and down the entire stroke and watch the following error.
- THC acceleration also affects the response of lifter. The recommended setting for acceleration is 100 mGs, but be sure to check the lifter mechanics and drive to make sure they are capable of 100mG acceleration.
- These considerations are affected by the maximum cut speed of the tube cutting system: the slower the cut speeds, the lower the required responsiveness of the Z axis.

Tube cutting program examples

The following part program example assumes the torch is positioned above the center of the stock, and that the 10 inch side of the tube is face up, ready to be cut first. All units are in inches.

| Code | Description | Comments |
|---------------------|--------------------------------------|---------------------------|
| G20 | Select English units. | |
| G91 | Use incremental mode. | |
| M36 T1 | Select process Plasma1. | |
| M37 T1 | Select Station 1. | |
| G41 | Enable left kerf compensation. | |
| M07 | Turn on Cut Control. | |
| G01 X3.5 Y0 | Linear cut | Start cut at tube center. |
| M50 | Disable torch height control. | |
| G00 P90 T6 S10 R1.5 | Rotate tube 90° and cut tube radius. | |
| M51 | Enable torch height control. | |
| G01 X3 Y0 | Linear cut | Cut side of tube. |
| M50 | Disable torch height control. | |
| G00 P90 T10 S6 R1.5 | Rotate tube 90° and cut tube radius. | |
| M51 | Enable torch height control. | |

Pipe and tube cutting on EDGE Pro, MicroEdge Pro and EDGE Connect CNCs

| Code | Description | Comments |
|---------------------|--------------------------------------|-------------------------------------|
| G01 X7 Y0 | Linear cut | Cut side of tube. |
| M50 | Disable torch height control. | |
| G00 P90 T6 S10 R1.5 | Rotate tube 90° and cut tube radius. | |
| M51 | Enable torch height control. | |
| G01 X3 Y0 | Linear cut | Cut side of tube. |
| M50 | Disable torch height control. | |
| G00 P90 T10 S6 R1.5 | Rotate tube 90° and cut tube radius. | |
| M51 | Enable torch height control. | |
| G01 X3.5 Y0 | Linear cut | Finish cut on 10 inch side of tube. |
| M08 | Turn off Cut Control. | |
| G40 | Disable kerf compensation. | |
| M19 | Cancel all stations. | |
| M02 | End of program. | |

Pipe and tube cutting on EDGE Pro, MicroEdge Pro and EDGE Connect CNCs

The following part program example assumes the torch is positioned above the center of the stock, and shows the rail offset in the tube cutting command. In this program, the Rail axis is X. In addition, this program shows G00 rotate commands that rotate the tube without making the radius cut. All units are in inches.



The G00 rotational commands must appear in the part program *after* the first occurrence of the G00 or G01 Pxx Fxx Txx Sxx Rxx command.

| Code | Description | Comments |
|---------------------------------|--|-----------------------------------|
| G20 | Select English units. | |
| G91 | Use incremental mode. | |
| M36 T1 | Select process = Plasma 1 | |
| M37 T1 | Select Station 1. | |
| G00 X-3.306 Y-0. | Rapid traverse | |
| G59 V502 F35 | Plasma 1 Torch Type = HPRXD Bevel | Process section codes (V5xx) |
| G59 V503 F1 | Plasma 1 Material Type = Mild Steel | |
| G59 V504 F80 | Plasma 1 Current = 80 A | |
| G59 V505 F2 | Plasma 1 Plasma gas = O ₂ , shield gas = air | |
| G59 V506 F1 | Plasma 1 Cutting Surface = above water | |
| G59 V507 F29 | Plasma 1 Material Thickness = 0.25 inches | |
| G59 V600 F119. | Plasma 1 Set Arc Voltage = 119 V | Torch height control codes (V6xx) |
| G59 V601 F0.3 | Plasma 1 Pierce Time = 0.3 seconds | |
| G59 V602 F200 | Plasma 1 Pierce Height Factor = 200% | |
| G59 V603 F0.08 | Plasma 1 Cut Height = 0.08 inches | |
| G59 V604 F200. | Plasma 1 Transfer Height Factor = 200% | |
| M07 | Turn on Cut Control. | |
| M51 | Enable torch height control. | |
| F110. | Override cut speed to 110 in/min. | |
| G01Y-1.5 | Linear cut | |
| M50 | Disable torch height control. | |
| G01 P-90.00 T4. S4. R0.5 X0.866 | Rotate tube -90°, cut 0.5 inch radius, and move 0.866 along Rail axis. | |
| M51 | Enable torch height control. | |

Pipe and tube cutting on EDGE Pro, MicroEdge Pro and EDGE Connect CNCs

| Code | Description | Comments |
|-----------------------------------|--|--|
| G01X2.44Y-1.4087 | Linear cut | |
| G01Y-0.1826 | Linear cut | |
| G01X-2.44Y-1.4087 | Linear cut | |
| M50 | Disable torch height control. | |
| G01 P-90.00 T4. S4. R0.5 X-0.866 | Rotate tube -90°, cut 0.5 inch radius, and move 0.866 along Rail axis. | |
| M51 | Enable torch height control. | |
| G01Y-3. | Linear cut | |
| M50 | Disable torch height control. | |
| G01 P-90.00 T4. S4. R0.5 X0.8665 | Rotate tube -90°, cut 0.5 inch radius, and move 0.866 along Rail axis. | |
| M51 | Enable torch height control. | |
| G01X-0.0004Y0.0003 | Linear cut | |
| G01X2.44Y-1.4088 | Linear cut | |
| G01Y-0.1825 | Linear cut | |
| G01X-2.44Y-1.4087 | Linear cut | |
| G01X-0.0005Y-0.0003 | Linear cut | |
| M50 | Disable torch height control. | |
| G01 P-90.00 T4. S4. R0.5 X-0.8655 | Rotate tube -90°, cut 0.5 inch radius, and move 0.866 along Rail axis. | |
| M51 | Enable torch height control. | |
| G01Y-1.5 | Linear cut | |
| M08 | Turn off Cut Control. | |
| G59 V607 F1 | Set Plasma 1 THC operating mode to Manual. | Change THC to manual mode in preparation for Z axis move before tube rotation. |
| G00 Z-5 | Z-axis traverse. | Lift up the torch 5 inches. |

| Code | Description | Comments |
|---------------------------------|--|--|
| M11 | Turn on Marker Offset 1. | Use marker offset to execute an X/Y move to position the torch clear of the rotating tube. |
| G00 P90. | Rotational traverse. Rotate pipe 90°. | |
| M12 | Cancel Marker Offset 1. | |
| G59 V607 F2 | Set Plasma 1 THC operating mode to Automatic. | Change back to Automatic THC mode. |
| G00 X-0.5837 Y-0.4495 | Linear rapid traverse | |
| G43X0.068 | Set kerf offset to 0.068. | |
| G41 | Enable left kerf compensation. | |
| M07 | Turn on Cut Control. | |
| F110. | Override cut speed to 110 in/min. | |
| G03 X-0.3 Y-0.52 I-0.15 J-0.26 | Counterclockwise arc at XY endpoint and IJ centerpoint (radius value). | |
| G03I0.7389J0.7389 | | |
| M50 | Disable torch height control. | |
| G03 X0.248 Y-0.035 I0.27 J1.009 | Counterclockwise arc at XY endpoint and IJ centerpoint (radius value). | |
| M08 | Turn off Cut Control. | |
| G40 | Disable kerf compensation. | |
| M51 | Enable torch height control. | |
| G59 V607 F1 | Set Plasma 1 THC operating mode to Manual. | Repeats sequence of THC Manual mode, Z axis move, marker offset, tube rotation, then return to Automatic THC mode. |
| G00 Z-5 | Z-axis traverse. | |
| M11 | Turn on Marker Offset 1. | |
| G00 P180. | Rotational traverse. Rotate pipe 180°. | |
| M12 | Cancel Marker Offset 1. | |
| G59 V607 F2 | Set Plasma 1 THC operating mode to Automatic. | |
| G00 X0.057 Y0.547 | Linear rapid traverse | |
| G43X0.068 | Set kerf offset to 0.068. | |

Pipe and tube cutting on EDGE Pro, MicroEdge Pro and EDGE Connect CNCs

| Code | Description | Comments |
|---------------------------------|---|----------|
| G41 | Enable left kerf compensation. | |
| M07 | Turn on Cut Control. | |
| F110. | Override cut speed to 110 in/min. | |
| G03 X-0.3 Y-0.52 I-0.15 J-0.26 | Counterclockwise arc | |
| G03I0.7389J0.7389 | Counterclockwise arc | |
| M50 | Disable torch height control. | |
| G03 X0.248 Y-0.035 I0.27 J1.009 | Counterclockwise arc | |
| M08 | Turn off Cut Control. | |
| G40 | Disable kerf compensation. | |
| M51 | Enable torch height control. | |
| G59 V607 F1 | Set Plasma 1 THC operating mode to Manual. | |
| G00 Z-5 | Z-axis traverse. Move up lifter 5 inches. | |
| M11 | Turn on Marker Offset 1. | |
| G00 P90. | Rotational traverse. Rotate pipe 90°. | |
| M12 | Cancel Marker Offset 1. | |
| G59 V607 F2 | Set Plasma 1 THC operating mode to Automatic. | |
| G00 X-2.0172 Y0.893 | Linear rapid traverse. | |
| M07 | Turn on Cut Control. | |
| F110. | Override cut speed to 110 in/min. | |
| G00 X-2.0172 Y0.893 | Rapid traverse | |
| M07 | Cut on | |
| F110. | Override cut speed to 110 in/min. | |

| Code | Description | Comments |
|-------------------------|---|---|
| G01X-0.Y1.5 | Linear cut | This sequence of linear cuts is the tube cut-off. |
| M50 | Disable torch height control. | |
| G01 P90.00 T4. S4. R0.5 | Rotate tube -90° and cut 0.5 inch radius. | |
| M51 | Enable torch height control. | |
| G01X-0.Y3. | Linear cut | |
| M50 | Disable torch height control. | |
| G01 P90.00 T4. S4. R0.5 | Rotate tube -90° and cut 0.5 inch radius. | |
| M51 | Enable torch height control. | |
| G01X-0.Y3. | Linear cut | |
| M50 | Disable torch height control. | |
| G01 P90.00 T4. S4. R0.5 | Rotate tube -90° and cut 0.5 inch radius. | |
| M51 | Enable torch height control. | |
| G01X-0.Y3. | Linear cut | |
| M50 | Disable torch height control. | |
| G01 P90.00 T4. S4. R0.5 | Rotate tube -90° and cut 0.5 inch radius. | |
| M51 | Enable torch height control. | |
| G01X-0.Y1.5 | Linear cut | |
| M08 | Turn off Cut Control. | |
| M19 | Cancel all stations. | |
| M02 | End of program. | |

