Hypertherm®

Pipe and Tube Cutting on EDGE® Connect CNCs

Application Note

810790 | Revision 0 | March 2020

Hypertherm, Inc.
Etna Road, P.O. Box 5010
Hanover, NH 03755 USA
603-643-3441 Tel (Main Office)
603-643-5352 Fax (All Departments)
info@hypertherm.com (Main Office Email)
800-643-9878 Tel (Technical Service)
technical.service@hypertherm.com (Technical Service Email)
800-737-2978 Tel (Customer Service)
customer.service@hypertherm.com (Customer Service Email)
866-643-7711 Tel (Return Materials Authorization)
877-371-2876 Fax (Return Materials Authorization)
return.materials@hypertherm.com (RMA email)

Hypertherm México, S.A. de C.V.
Avenida Toluca No. 444, Anexo 1,
Colonia Olivar de los Padres
Delegación Álvaro Obregón
México, D.F. C.P. 01780
52 55 5681 8109 Tel
52 55 5683 2127 Fax
Soporte.Tecnico@hypertherm.com (Technical Service Email)

Hypertherm Plasmatechnik GmbH
Sophie-Scholl-Platz 5
63452 Hanau
Germany
00 800 33 24 97 37 Tel
00 800 49 73 73 29 Fax
31 (0) 165 596900 Tel (Technical Service)
00 800 4973 7843 Tel (Technical Service)
technicalservice.emea@hypertherm.com (Technical Service Email)

Hypertherm (Singapore) Pte Ltd.
82 Genting Lane
Media Centre
Annexe Block #A01-01
Singapore 349567, Republic of Singapore
65 6841 2489 Tel
65 6841 2490 Fax
Marketing.asia@hypertherm.com (Marketing Email)
TechSupportAPAC@hypertherm.com (Technical Service Email)

Hypertherm Japan Ltd.
Level 9, Edobori Center Building
2-1-1 Edobori, Nishi-ku
Osaka 550-0002 Japan
81 6 6225 1183 Tel
81 6 6225 1184 Fax
HTJapan.info@hypertherm.com (Main Office Email)
TechSupportAPAC@hypertherm.com (Technical Service Email)

Hypertherm Europe B.V.
Vaartveld 9, 4704 SE
Roosendaal, Nederland
31 165 596907 Tel
31 165 596901 Fax
31 165 596908 Tel (Marketing)
31 (0) 165 596900 Tel (Technical Service)
00 800 4973 7843 Tel (Technical Service)
technicalservice.emea@hypertherm.com
(Technical Service Email)

Hypertherm (Shanghai) Trading Co., Ltd.
B301, 495 ShangZhong Road
Shanghai, 200231
PR China
86-21-80231122 Tel
86-21-80231120 Fax
86-21-80231128 Tel (Technical Service)
techsupport.china@hypertherm.com
(Technical Service Email)

South America & Central America: Hypertherm Brasil Ltda.
Rua Bras Cubas, 231 – Jardim Maia
Guarulhos, SP – Brasil
CEP 07115-030
55 11 2409 2636 Tel
tecnico.sa@hypertherm.com (Technical Service Email)

Hypertherm Korea Branch
#3904. APEC-ro 17. Heaundae-gu. Busan.
Korea 48060
82 (0)51 747 0358 Tel
82 (0)51 701 0358 Fax
Marketing.korea@hypertherm.com (Marketing Email)
TechSupportAPAC@hypertherm.com
(Technical Service Email)

Hypertherm Pty Limited
GPO Box 4836
Sydney NSW 2001, Australia
61 (0) 437 606 995 Tel
61 7 3219 9010 Fax
au.sales@Hypertherm.com (Main Office Email)
TechSupportAPAC@hypertherm.com
(Technical Service Email)

Hypertherm (India) Thermal Cutting Pvt. Ltd
A-18 / B-1 Extension,
Mohan Co-Operative Industrial Estate,
Mathura Road, New Delhi 110044, India
91-11-40521201/ 2/ 3 Tel
91-11 40521204 Fax
HTIndia.info@hypertherm.com (Main Office Email)
TechSupportAPAC@hypertherm.com
(Technical Service Email)

Environmental stewardship is one of Hypertherm's core values, and it is critical to our success and our customers' success. We are striving to reduce the environmental impact of everything we do. For more information: www.hypertherm.com/environment.

Contents

Introduction

The Hypertherm EDGE® Connect 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. The *Dual Transverse Setup and Operation Application Note* (807610) provides information on setting up the Dual Transverse axis (also called the Transverse 2 axis).

 Pipe and tube stock profiles are shown below:

Round pipe

Rectangular or square tube: Flat sides and rounded corners
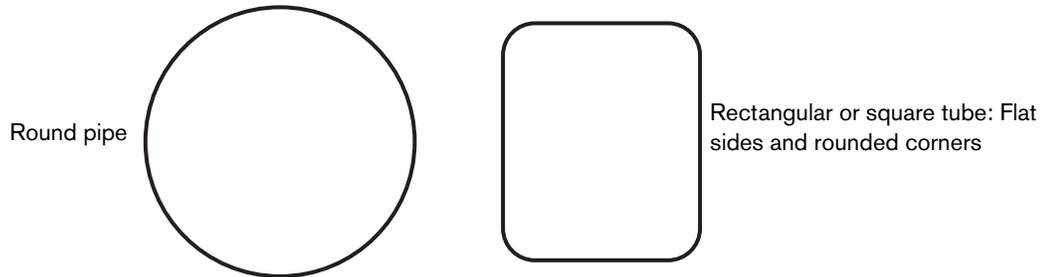
This document describes the requirements for controlling a rotating Transverse 2 axis. It also provides part programming examples for doing cut-off and feature cutting operations on rotating metal stock.

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

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.

Requirements

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

▪ Purchase one of the pipe software features from the Xnet (https://xnet.hypertherm.com/) that are needed for the application.

  To check the software features installed, choose **Setups** > **Password** and type the password **INSTALLEDFEATURES**. Under **Pipe and Tube,** make sure one of the pipe features appears.
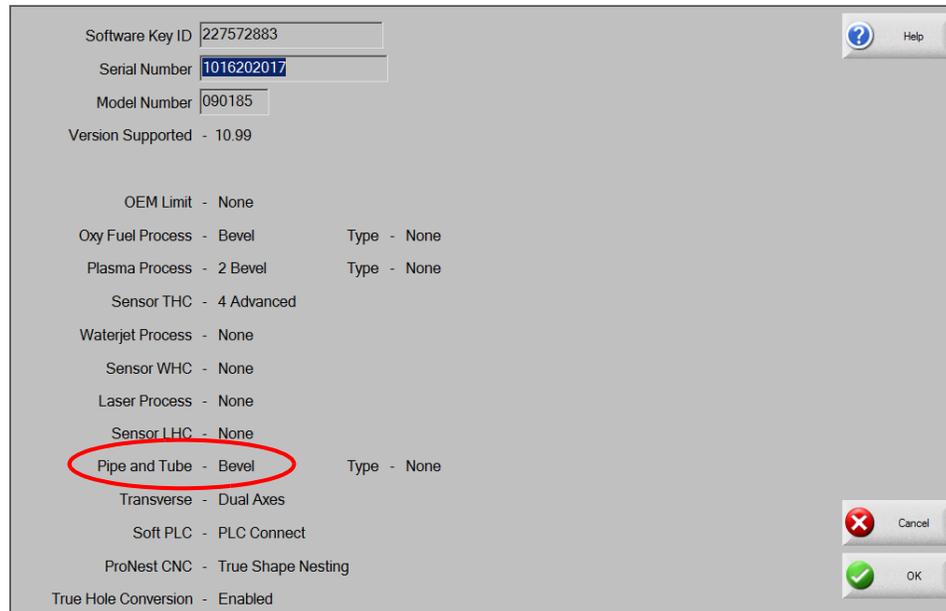
If your CNC doesn't have pipe features installed, contact the Hypertherm Product Application Engineer in your region. Refer to page 2 for a list of Hypertherm regional offices.

📄 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 axes are available if the correct features are purchased.

▪ The Transverse 2 (Pipe) axis must be parallel to the Rail axis. The CNC uses the Transverse 2 axis as the pipe or tube axis.

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

▪ 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 left or right.

▪ As of Phoenix 10.7.1.88CR or later, EDGE Connect CNCs support 3 and 4-axis tube cutting setup and operation.

- 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, when the part program doesn't include a traverse move to the start of the part.
- **Move to pierce** (**Pause** screen)
- **Save** or **Resume** part (**Pause** screen)
- **Mirror**, **Rotate**, **Scale**, **Nester**, or **Repeat Part**
- Multi-tasking
- Nest limit checks with the Pipe axis

About axes assignments on the CNC

Hypertherm CNCs are hard-coded with the axis assignments and common letter identifiers for the axes shown in the table below.

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

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

  - A 3-axis or 4-axis pipe cutting system with a Dual Gantry axis does not require a Transverse axis. However, a 3-axis pipe cutting system is preferred and recommended.

- 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.

- Bevel cutting uses Rotate and Tilt axes.

Axes assignments and passwords

Using special passwords NRT (No Rotate Tilt) and 1RT (1 Rotate Tilt) redirects certain axes signals to different axis numbers. For example, 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.

Additional examples:

- To enable the Transverse 2 axis for pipe or tube cutting using 3, 4, or 5-axes and no bevel heads, enter the NRT password.
- To set up a pipe or tube cutting system with a bevel head, enter the 1RT password. Both dual gantry and a second straight torch can be included.

The following tables identify the application, password, and axis assignments for common cutting system axis configurations.

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

Axis	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	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	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 Grantry, 1RT password

Axis	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	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	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	Axis assignment
1	Not used
2	Rail
3	Sensor THC
4	Transverse 2

> 📄 Axes 1 and 2 can be reversed so that Rail is Axis 1 and Axis 2 is not used.

4-axis pipe-only cutting system with dual gantry, NTH password

Axis	Axis assignment
1	Not used
2	Rail
3	Dual Gantry
4	Sensor THC
5	Transverse 2

> 📄 Axes 1 and 2 can be reversed so that Rail is Axis 1 and Axis 2 is not used.

A 3-axis or 4-axis pipe-only cutting system has the following requirements:

- The NTH password disables the Transverse axis and requires that Park Head 1 input be forced on at all times. Define both Park 1 and Park 2 inputs .

- The RT password can be used to turn off the NRT or 1RT passwords and re-enable the bevel axes. The TH password can be used to turn off the NTH password and re-enable the Transverse axis.

3-axis pipe and 4-axis pipe or tube setups

As of Phoenix 10.7.1.88CR, you can configure and run 3-axis pipe and 4-axis pipe or tube configurations in Phoenix and over EtherCAT.

The following axes are used for 3-axis pipe or 4-axis pipe or tube:

1. Transverse (only used for 4-axis pipe or tube configuration)

2. Rail

3. Sensor THC

4. Transverse 2 (Pipe axis)

How to setup 3-axis pipe and 4-axis pipe or tube

1. Go to the **Machine Setup** screen.

2. Disable **Dual Gantry Installed**.

3. Enable **Tilt Rotator Installed**, **Dual Tilt Rotator Installed,** and **Dual Transverse**.

4. Set **Sensor THCs Installed** to 1.

5. Choose **Axis 3** for **Installed on**.
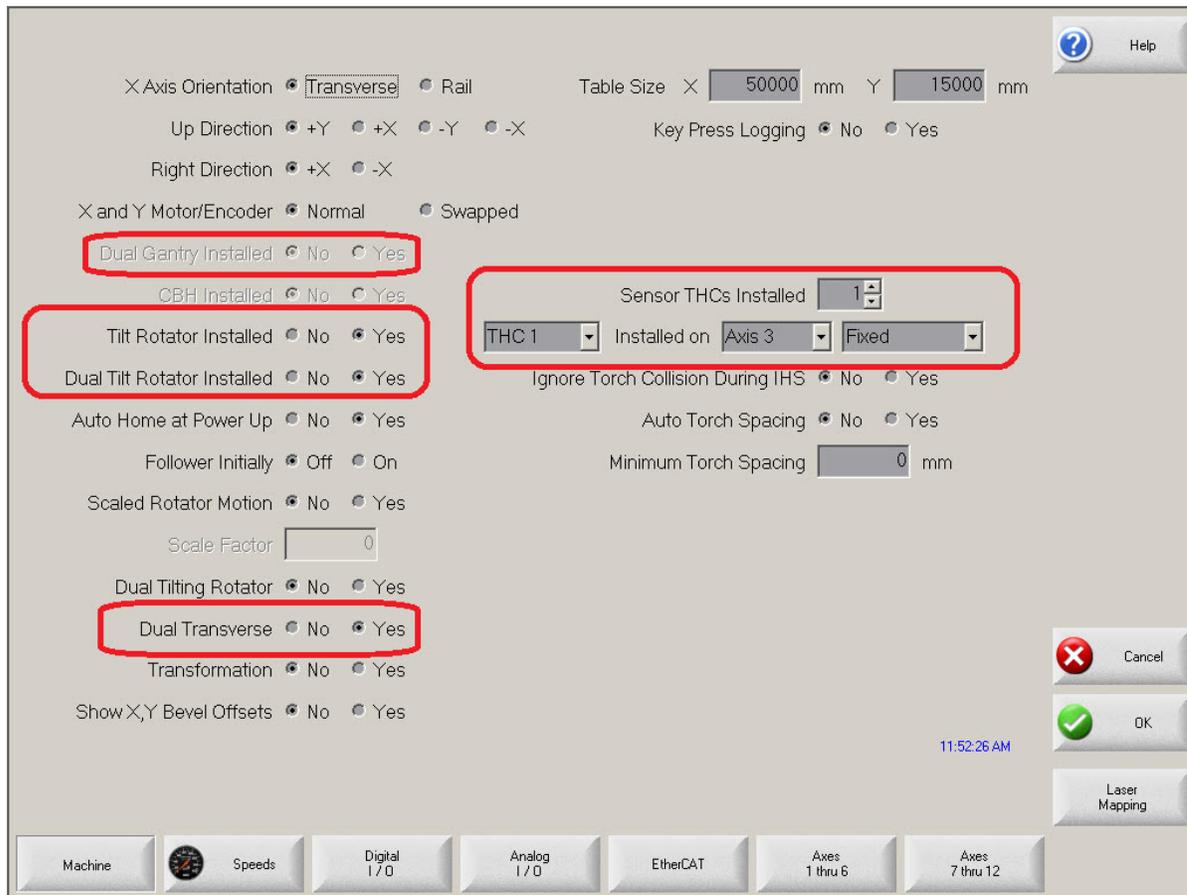
6. Go to the **Transverse 2** screen.

7. Enable **Rotating Transverse**.

8. Enter the NRT password to disable the 4 bevel axes.

9. If you are using a 3-axis pipe system, enter the NTH password to disable the Transverse axis. If you are using Transverse with a 4-axis pipe or tube system, do not enter the NTH password.

10. Turn OFF and turn ON the CNC.

Your axes screens should look like this for 3-axis pipe setup:

If you have a 4-axis pipe or tube setup, the Transverse button is not grayed out.

Notes:

- For the pipe and pipe and tube setups, pipe part programs with a G96 Pipe Diameter code, or for Tube, a code with a Pipe Corner Radius, must be loaded in order for the Pipe axis to be manually rotated. Otherwise both Park 1 and Park 2 inputs must be defined and the Park 1 input must be on, in order for the pipe or tube to be manually rotated.

- In the future, if you need to reprogram a CNC to not be pipe or pipe and tube do the following:

  ❑ Use the 'RT' password to turn off the 'NRT' password.

  ❑ Use the 'TH' password to turn off the NTH password.

- Do not turn on the Dual Gantry axes in a 4-axes, Pipe-only system, or in a 5-axes Pipe/Tube system. The Dual Gantry should not be needed on these machines.

Cutting system orientation

When you use 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.

+Y Up

0,0 ———————————————————————→ +X Right

Torch
Transverse axis

Pipe
Transverse 2 axis

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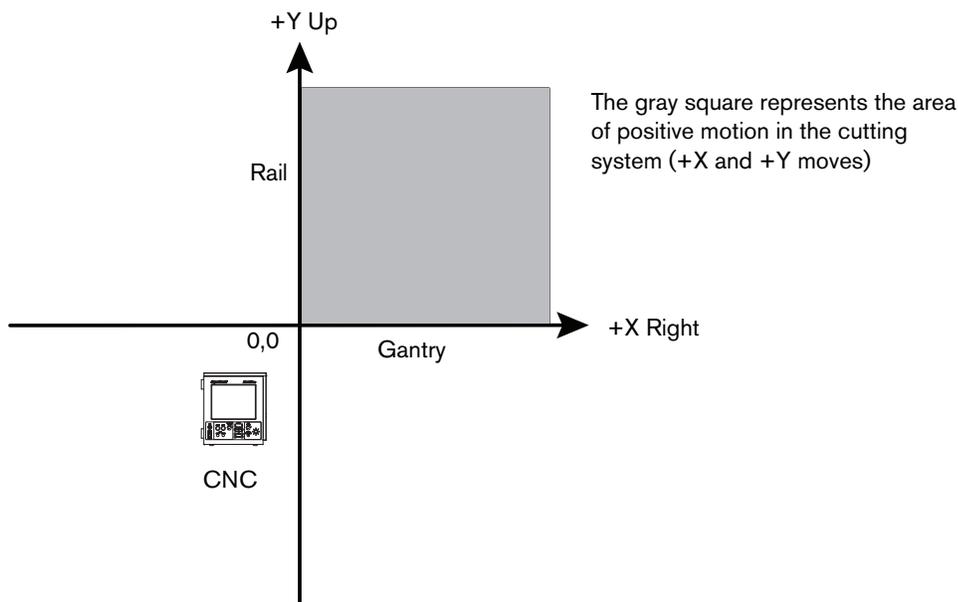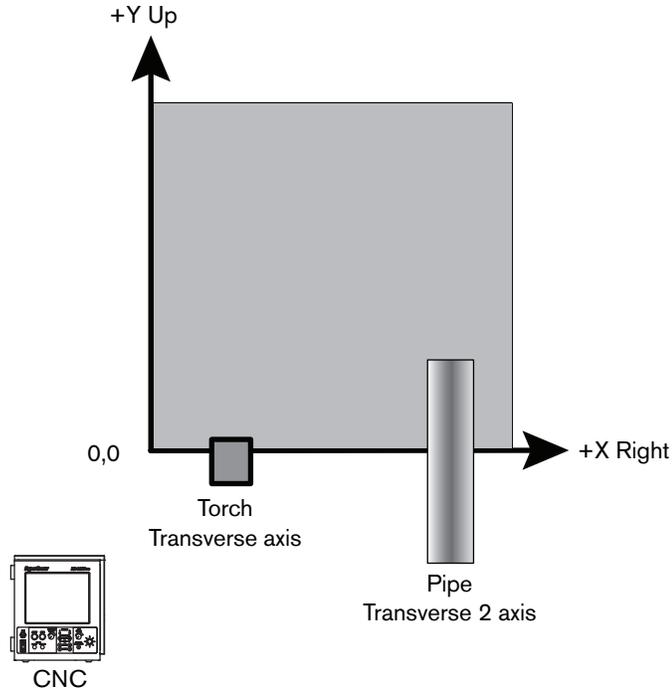
Another common orientation assigns X to the Rail. In this orientation, set Up = +X and Right = -Y, relative to the position of the CNC, to create positive motion from 0,0.

+X Up

The gray square represents the area of positive motion in the cutting system (+X and +Y moves)

Rail

-Y Right

Gantry   0,0

CNC
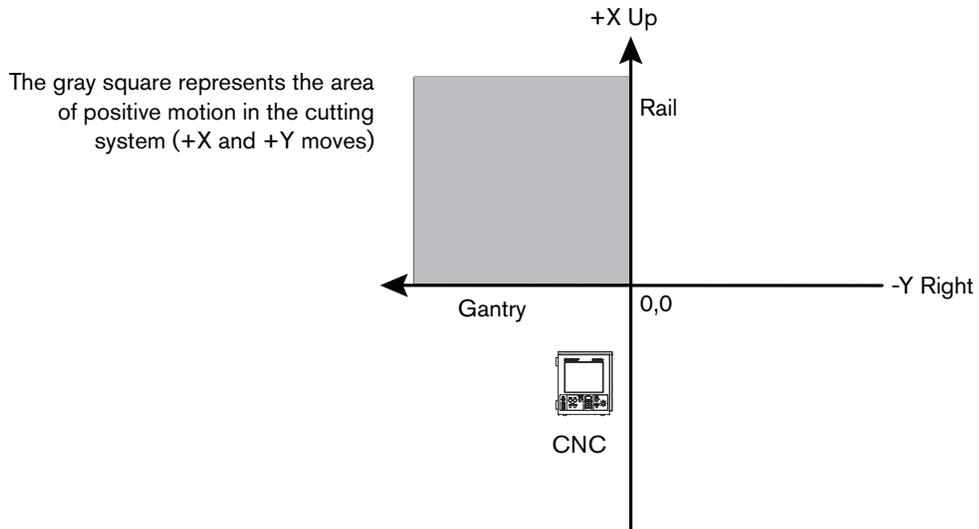
The torch axis is Transverse 1 and the pipe axis is Transverse 2, but they are positioned differently when Transverse is Y.
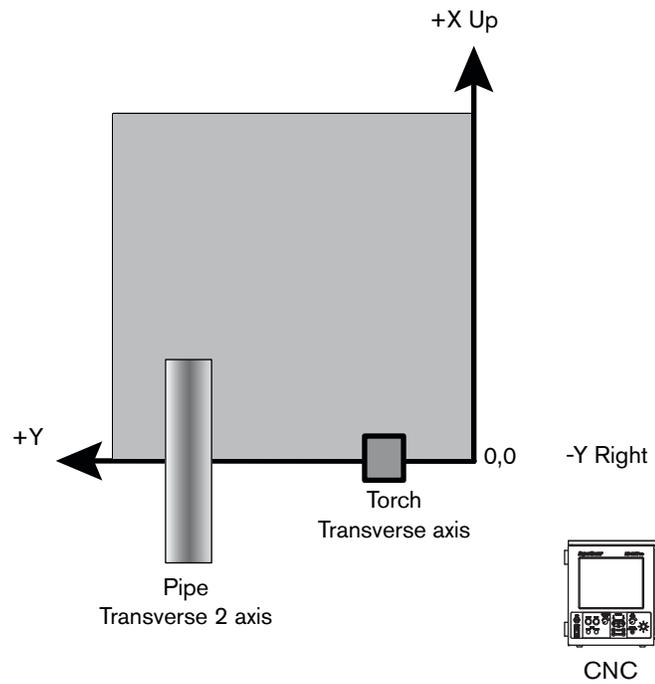
Chuck placement in a combination flat-plate and pipe cutting system

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

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).

-X Transverse (torch) home direction

Transverse (Torch)

+X is the Pipe (Transverse 2) home direction

-X

+X

X0, Y0
Home position
for torch
(Transverse)
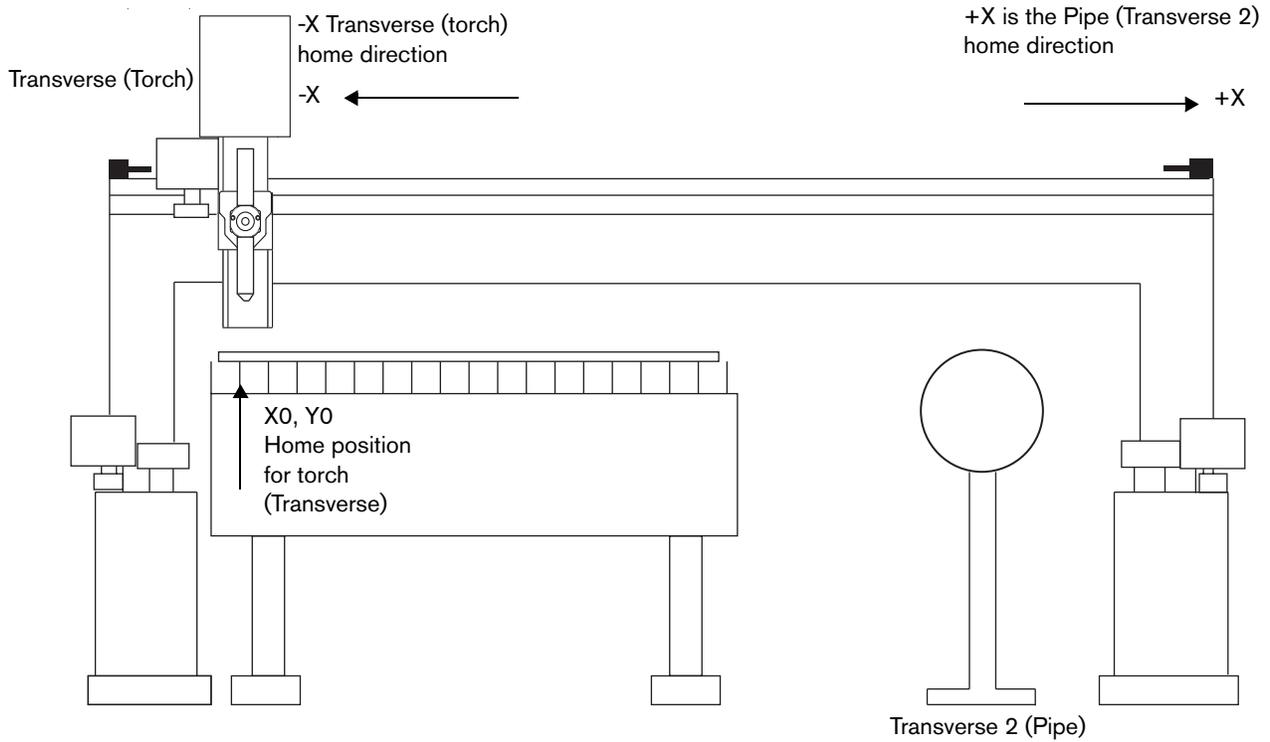
Transverse 2 (Pipe)

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

+Y is the Pipe (Transverse 2)
home direction

+Y ◄———————————

-Y Transverse (torch) home direction

Transverse (Torch)

———————► -Y

Pipe (Transverse)

X0, Y0
Home position
for torch
(Transverse)
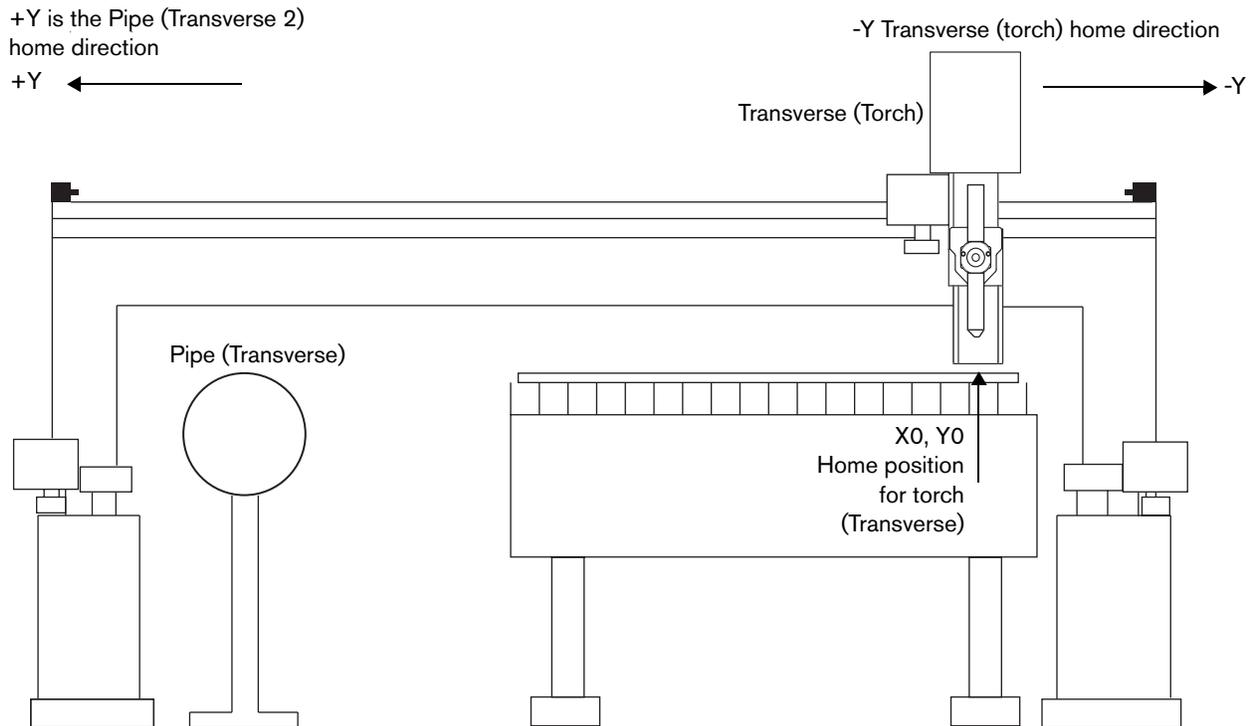
Pipe axis movement

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 Transverse (torch) 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).

■ The speed of Transverse 2 is in inches per minutes or millimeters per minute, not revolutions per minute.

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

- When the CNC runs a pipe program, the CNC parks the Transverse axis and moves the Pipe axis (Transverse 2).

- When the CNC 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 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.

- To cut in the -X, negative Transverse direction, Transverse 2 rotates clockwise.

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

When the CNC parks the Transverse axis (torch), the CNC uses the Rail and Transverse 2 axes to perform positioning. In this drawing, the pipe is represented by the gray cylinder that rotates about the Y axis. The pipe rotates either clockwise or counterclockwise and the gantry moves along the rails so that the fixed Transverse axis (the torch) can cut the shape.
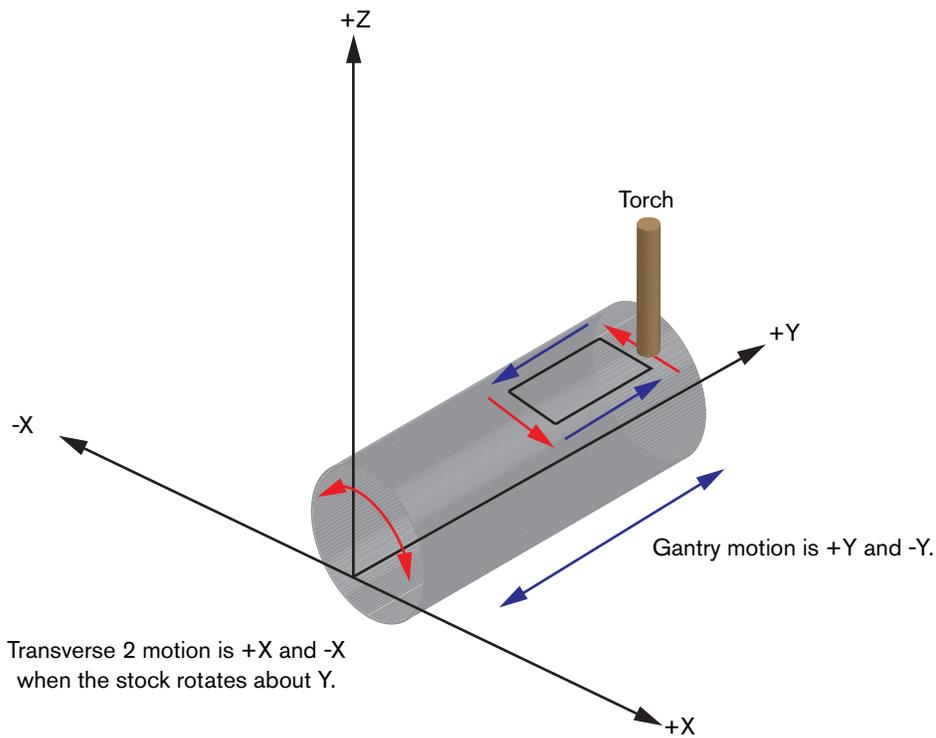
Cutting speeds

The CNC recalculates the cutting, traverse, and trial speeds for the rotating Transverse 2 axis 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 corner radius of the 4 corners on the tube.

- **G01 Pxx Fxx Txx Sxx Rxx.** The CNC uses the speed value (F) to set the rotational speed of the tube in revolutions per minute (RPM).

> Cutting speeds for tubes with very small corner radii may be limited even more by the CNC. See *Tube cutting* on page 29 for more information on program codes and examples.

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 Setups** 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 24 for more information.

Check the following settings to disable Auto Torch setting:

1. Choose **Setups** > **Machine Setups**.

2. Set **Auto Torch Spacing** to **No**.
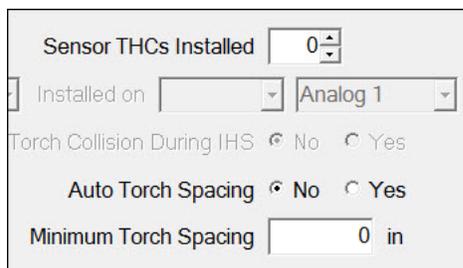
3. Choose **Setups** > **Special Setups**.

4. In the **Status/Feature** list, choose **Not Allowed** for **Torch Spacing**.

Status	Feature
Not Allowed -	Removing Processes
Allowed -	Changing Processes
Not Allowed -	Torch Spacing
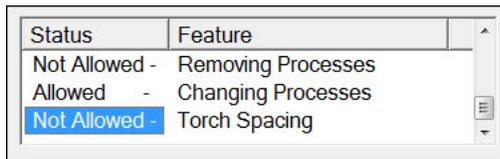
5. Choose **Main** screen > **Setups**.

6. In the **Status/Program Code** list, choose **Disabled** for **Auto Torch Spacing Override**.

Status	Program Code
Disabled -	Process Select Override
Disabled -	Station Select Override
Disabled -	Auto Torch Spacing Override
Disabled -	G97 Loop Count Prompt
Disabled -	ESAB Multi Torch Support
Enabled -	Force G40 Disable Kerf
Enabled -	G40 Used in Simple Shapes
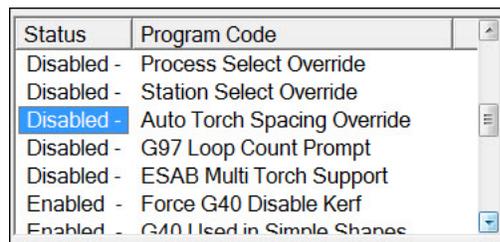
About park inputs

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.

The following park M codes are not required with pipe and tube part programs. The parking is handled automatically for parts with G96 Pipe Diameter or Tube Corner Radius part program codes.

- 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 *pi* (3.14). Increase this value by approximately10% 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 tube corner 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 its overtravel switch.

   ■ Transverse 2 rotates toward its overtravel switch but in the 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 correctly 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, 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 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.
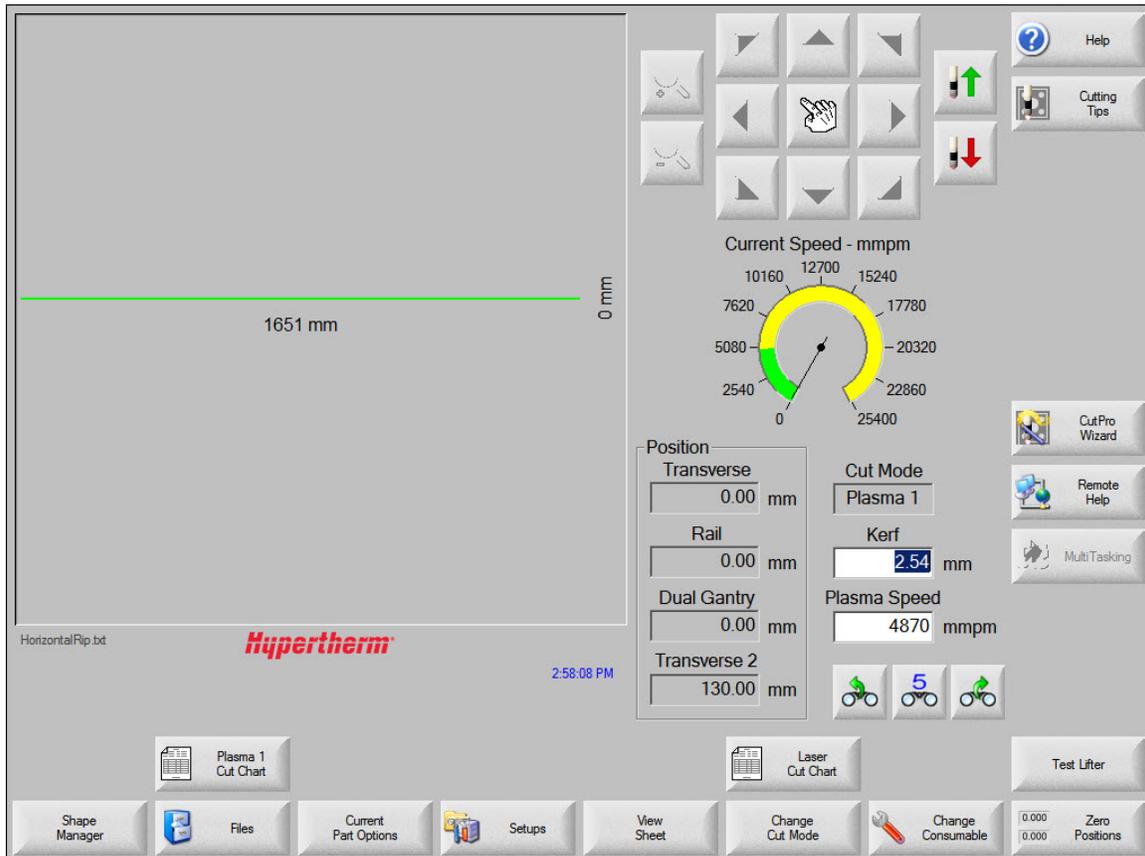
Restarting a part program

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 Program Stop (red) pushbutton on the operator console.

   ■ **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** on the **Main** screen to prevent the stock from rotating at maximum speed.

5. Press the Program Start (green) pushbutton on the operator console, or **F9** if you are using a keyboard.

6. When the torch approaches the point where you stopped the program, press the Program Stop (red) pushbutton.

7. Change **Cut Mode** to **Plasma 1**.

8. Press the Program Start (green) pushbutton 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 remains parked and Transverse 2 remains active. Do 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 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
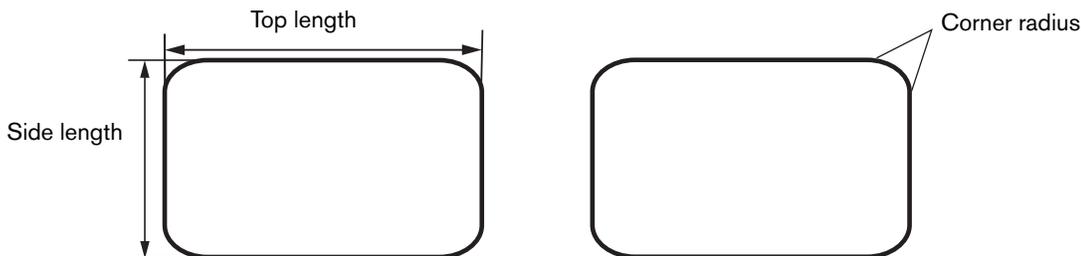
The sides of the tube are cut using G01 commands with the axis and length of the cut. Before cutting the corner radius, the Sensor THC arc voltage tracking must be disabled with the M50 code (Torch height disable). Use either of the following codes in the part program to rotate the tube and cut the corner:

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.

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.

Torch cuts along top of stock.

Torch lifts to cut corner radius as stock rotates.

Top (Txx)

Corner Radius (Rxx)

Side (Sxx)

Top (Txx)

Side (Sxx)
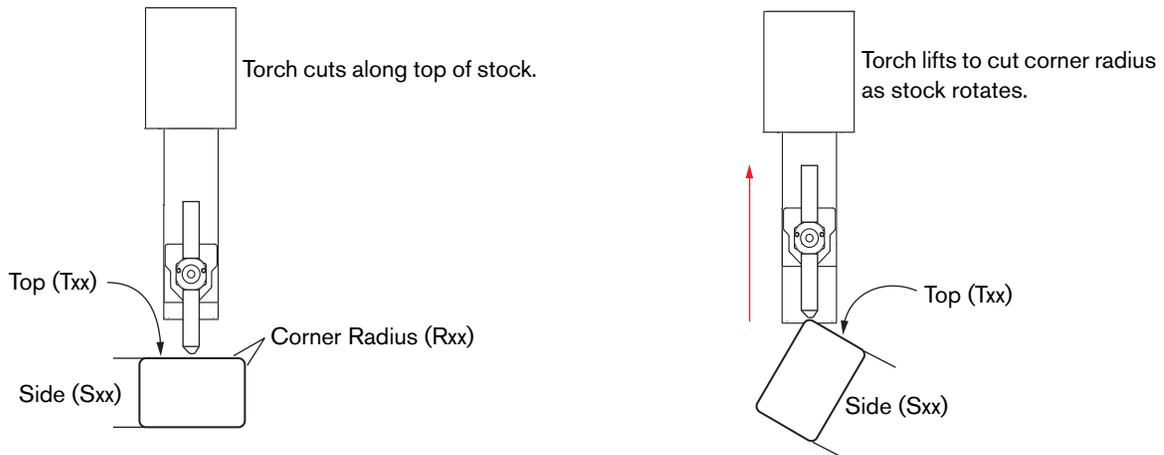
The Top dimension changes each time the stock rotates.

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 G00 Pxx Txx Sxx Rxx command.

Torch height control for tube cutting

A correctly 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 must be able to operate at a minimum of 400 in/min (10,160 mm/min).

- The following error at maximum speed must 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 stoke 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 both 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.

HPR 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.	
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.	

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 -90º, cut 0.5 inch radius, and move 0.866 along Rail axis.	
M51	Enable torch height control.	
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 -90º, cut 0.5 inch radius, and move 0.866 along Rail axis.	
M51	Enable torch height control.	

Code	Description	Comments
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.
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	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.	

Code	Description	Comments
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	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	
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	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 -90º 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 -90º 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 -90º 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 -90º 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.	

XPR tube cutting program example

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.	
FA200	Smooth motion 200 ms for any angle or direction change.	
G93 X0.03	Adjust to bevel equations for consumable lengths.	
(CutPro Wizard - Load Material: Mild Steel; 8 inch x 16.283 inch; 0.5 inch)	Material comments	
M36 T1	Select process Plasma1.	
M37 T1	Select Station 1.	
G00 X0.42223 Y0.5625	Rapid traverse	
(Seq 1 - Rect 5x4x.5)	Comment - Part Seq	
M51	Enable torch height control.	
G59 V509 F11420	Select cut chart.	
(130Amp O2/Air _True Hole_)	Comment - Consumables	
M29	Enable CBH / rotator.	Follower on
M90	Align CBH.	Rotator to tangent angle of the next cut segment
M07 HS AVO163 CHT0.30825	Turn on Cut Control.	Arc Voltage and Cut Height override
F40.	Override cut speed to 40 in/min.	Start of mitered end cut
G01Y-0.1875	Linear cut	
G59 V603 F0.308	Plasma 1 Cut Height = 0.308 inches	
G01A25.440 F20.	Set Bevel Angle.	
G01Y-0.3375	Linear cut	
M28	Disable CBH / rotator.	Follower off
G01Y-0.0375	Linear cut	
M50	Disable torch height control.	
G01X-0.375	Linear cut	

Code	Description	Comments
M29	Enable CBH / rotator.	Follower on
M90	Align CBH.	Rotator to tangent angle of next cut segment
G01Y-0.1875	Linear cut	
M51	Enable torch height control.	
G01Y-0.81855	Linear cut	
M50	Disable torch height control.	
G01 P90.00 A0. F6.366 T4. S5. R1. X-0.41203	Rotate tube 90° and cut corner.	Set bevel angle A and length motion X.
M51	Enable torch height control.	
F40.	Override cut speed to 40 in/min.	
G01X-1.24259Y-2.99988	Linear cut	
M50	Disable torch height control.	
G01 P90.00 A-23.11 F6.366 T5. S4. R1. X-0.39826	Rotate tube 90° and cut corner.	Set bevel angle A and length motion X.
M51	Enable torch height control.	
F40.	Override cut speed to 40 in/min.	
G01Y-1.9836	Linear cut	
M50	Disable torch height control.	
G01 P90.00 A0. F6.366 T4. S5. R1. X0.39826	Rotate tube 90° and cut corner.	Set bevel angle A and length motion X.
M51	Enable torch height control.	
F40.	Override cut speed to 40 in/min.	
G01X1.24259Y-2.99988	Linear cut	
M50	Disable torch height control.	
G01 P90.00 A25.44 F6.366 T5. S4. R1. X0.41203	Rotate tube 90° and cut corner.	Set bevel angle A and length motion X.
M51	Enable torch height control.	
F40.	Override cut speed to 40 in/min.	
G01Y-0.00605	Linear cut	
M50	Disable torch height control.	
G01Y-0.5	Linear cut	
G01Y-0.5	Linear cut	
M28	Disable CBH / rotator.	Follower off
G01Y-0.75	Linear cut	
M08	Turn off Cut Control.	
G01A0.000 F20.	Cancel Set Bevel Angle	

Code	Description	Comments
M51	Enable torch height control.	
M38 T1	Deselect Station.	
G04X0.5	Dwell	
M36 T1	Select process Plasma1.	
M37 T1	Select Station 1.	
G01 P-180.00 F30.	Rotate tube 180° and move position.	
G00 X-3.09267 Y0.90153	Rapid traverse	
M07 HS N2	Turn on Cut Control (Marking).	
F250.	Override cut speed to 250 in/min.	
G01X-0.30304Y-0.30305	Linear cut	
M50 H-0.02	Disable torch height control.	
G01X-0.17678Y-0.17678	Linear cut	
M08 RT	Turn off Cut Control.	
G00 X0.17678 Y0.47982	Rapid traverse	
M07 N2	Turn on Cut Control (Marking).	
M51	Enable torch height control.	
F250.	Override cut speed to 250 in/min..	
G01X0.30304Y-0.30304	Linear cut	
M50 H-0.02	Disable torch height control.	
G01X0.17678Y-0.17678	Linear cut	
M08	Turn off Cut Control.	
M38 T1	Deselect Station Marking	N_2 marking on
G04X0.5	Dwell	
M36 T1	Select process Plasma1.	
M37 T1	Select Station 1.	
G00 X-3.13135 Y0.3803	Rapid traverse	
G43X0.104	Set kerf offset to 0.104.	Rapid traverse
G41	Enable left kerf compensation.	
M07 O2S	Turn on Cut Control.	N_2 marking on
M50	Disable torch height control.	
F48.	Override cut speed to 48 in/min.	
G03Y-0.427I0.J-0.2135	Arc cut	
F80.	Override cut speed to 80 in/min.	
G03X-0.34099Y0.53106I0.J0.375	Arc cut	
G03X0.34099Y-0.53106I0.34099J-0.15606	Arc cut	
M50H-0.035	Disable torch height control.	

Code	Description	Comments
G03X0.23189Y0.08029I0.J0.375	Arc cut	
M08	Turn off Cut Control.	
G40	Disable kerf compensation.	
M51	Enable torch height control.	
G01 P180.00 F30.	Rotate tube 180° and move position.	
G00 X-2.84689 Y0.29471	Rapid traverse	
G43X0.104	Set kerf offset to 0.104.	
G41	Enable left kerf compensation.	
M07	Turn on Cut Control.	
F80.	Override cut speed to 80 in/min.	
G03X0.615I0.3075J0.	Arc cut	
G01Y1.001	Linear cut	
M50	Disable torch height control.	
G01 P-90.00 F12.732 T4. S5. R1.	Rotate tube 90° and cut around corner.	Rectangle corner and tube motion
M51	Enable torch height control.	Feedrate RPM
F80.	Override cut speed to 80 in/min.	
G01Y3.002	Linear cut	
M50	Disable torch height control.	
G01 P-90.00 F12.732 T5. S4. R1.	Rotate tube 90° and cut corner.	Rectangle corner and tube motion
M51	Enable torch height control.	Feedrate RPM
F80.	Override cut speed to 80 in/min.	
G01Y2.002	Linear cut	
M50	Disable torch height control.	
G01 P-90.00 F12.732 T4. S5. R1.	Rotate tube 90° and cut corner.	Rectangle corner and tube motion
M51	Enable torch height control.	Feedrate RPM
F80.	Override cut speed to 80 in/min.	
G01Y3.002	Linear cut	
M50	Disable torch height control.	
G01 P-90.00 F12.732 T5. S4. R1.	Rotate tube 90° and cut corner.	Rectangle corner and tube motion
M51	Enable torch height control.	Feedrate RPM
F80.	Override cut speed to 80 in/min.	
G01Y1.001	Linear cut	
M08	Turn off Cut Control.	
G40	Disable kerf compensation.	

Code	Description	Comments
M51	Enable torch height control.	
M19	Enable CBH rotator.	
M02	End of program.	