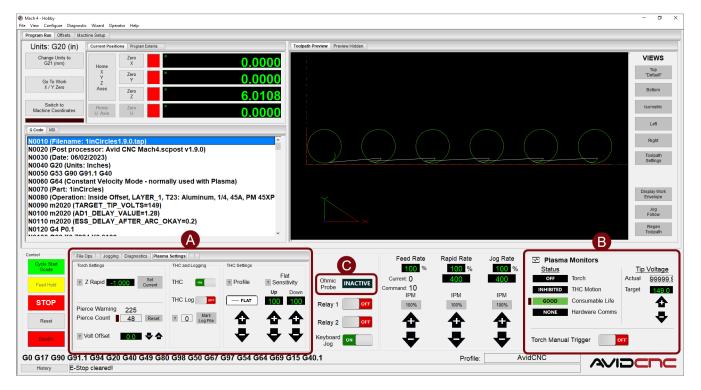


Mach4 Plasma Users Guide

v2023Q1.1

Main Screen Plasma Functions



A. Plasma Settings Group

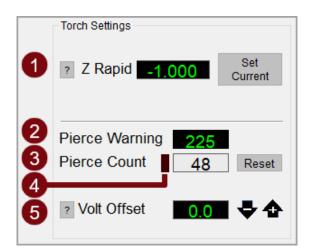
File Ops Jogging Diagnostics Plasma	Settings		
Torch Settings	THC and Logging	THC Settings	
? Z Rapid -1.000 Set Current	THC ON	? Profile	Flat ? Sensitivity
	THC Log	FLAT	Up Down 100 100
Pierce Warning 225	Hark		
Pierce Count 48 Reset	? 0 Mark Log File	1	•
? Volt Offset 0.0 ↓ ↓		₽	₽ ₽



Tooltip Popups



Next to many elements of the Mach4 Screenset, you will see a '?' icon. Clicking on icons will bring up help windows breifly describing screen functions.

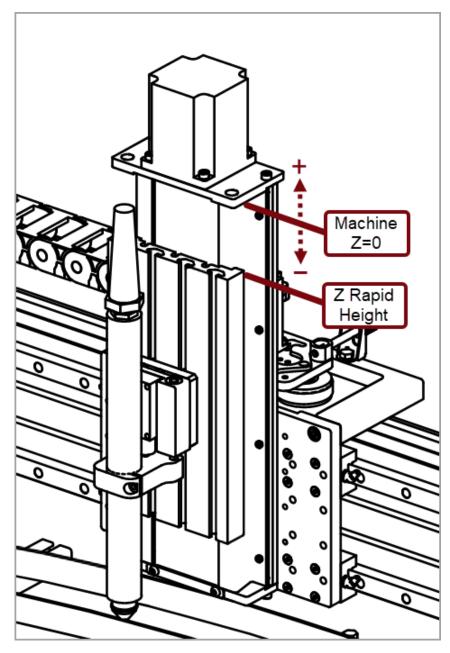


Torch Settings

1. Z Rapid Height

The Z Rapid DRO sets the height **IN MACHINE COORDINATES** that the torch will retract to in between cuts. The default setting of -1.000in (-25.4mm) means the torch will retract to 1 **�** below the Z home proximity sensor.





The **Set Current** button will set the Z Rapid position to the current position. This height should be set for each new program or material. The rapid position should be above the highest point of the material and above any likely tip-ups.

i Note

The Z Rapid setting should always be negative(-).



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2. Pierce Warning

The Pierce Warning DRO sets the number of pierces(cuts) allowed before triggering a warning to replace consumables. This DRO is editable when Mach4 is Disabled.

3. Pierce Count

The Pierce Count DRO shows the number of times the torch has fired since the last pierce count reset.

This DRO cannot be adjusted but should be reset using the **Reset** button each time consumables are replaced.

4. Pierce Count Warning LED

The Pierce Count Warning LED turns red when Pierce Warning limit is exceeded.

5. Volt Offset

The Volt Offset DRO sets the tip volt zero point and can be used to trim the voltage for consumable wear or a known offset. It can be edited directly, or with the incremental buttons.

- A **negative** volt offset will cause the torch to cut higher. This can be helpful when cutting with worn consumables as they may cut lower than desired.
- A **positive** Volt Offset will cause the torch to cut lower.
- As a rule of thumb: 1V = -0.003 of electrode wear.



THC & Logging

4	THC and Logging
0	THC ON
3	THC Log
4	? 0 Mark Log File

1. THC toggle

Toggles the Torch Height Control (THC) ON/OF. By default, torch height control is turned on and is reccomended for most cutting operations.

2. THC Log toggle

Toggles THC log creation on and off. When ON, THC logs are saved in the C:\Mach4Hobby\W9_HC folder

3. Mark Log File

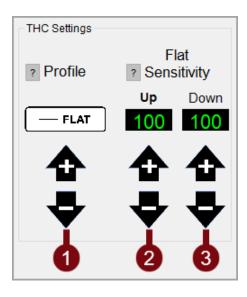
This button adds a numbered mark in the THC log file at the current timestamp. This can be useful in diagnosing consistent cut issues at a specific point in a program.

4. Log file mark number

This button allows the user to mark the log file at a point of interest. Clicking the button marks the log at the current time with the current number. The mark number will automatically increase with each mark. The DRO cannot be edited.

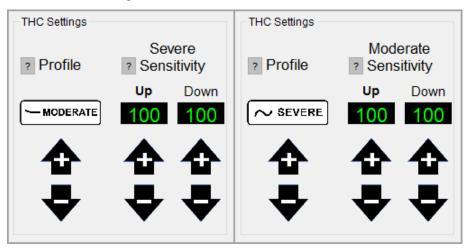


THC Settings



1. Material Profile

The material profile is used to set THC speed and Anti-Dive settings. Use the arrows to choose the profile that best matches the profile of the material being cut.



The FLAT setting is recommended unless there is significant variation in material height.

2. Up Sensitivity

Default of 100 uses the recommended precalculated THC settings. Increasing will increase the Z axis response speed in the UP direction. Decreasing will slow Z speed in the UP direction. This override setting is specific to a Material Profile and will be saved for FLAT, MODERATE, SEVERE.

3. Down Sensitivity

Default of 100 uses the recommended precalculated THC settings. Increasing will increase the Z axis response speed in the DOWN direction. Decreasing will slow Z speed in the DOWN direction. This override setting is specific to a Material Profile and will be saved for FLAT, MODERATE, SEVERE.



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B. Plasma Monitors Group

	🖸 Plasma	Monitors			
1	<u>Status</u>		<u>Tip</u>	Voltage	
	OFF	Torch	Actual	99999.	-6
2	INHIBITED	THC Motion	Target	149.0	-7
3	GOOD	Consumable Life			
4	NONE	Hardware Comms		, E	
5				\mathbf{V}	
	Torch Manua	l Trigger	FF		-8

1. Torch

The torch indicator shows the status of the torch in Mach4, ON or OFF

2. THC Motion

The THC Motion indicator displays the current status of THC motion - UP, DOWN, or INHIBITED.

i THC Note

INHIBITED does not mean that THC is turned off or is not working. It means that for some reason THC motion is currently inhibited which could be because of an inhibit in the gcode or an Anti Dive rule.

3. Consumable LED

The Consumable LED warns the operator that the Pierce Warning limit is exceeded.

4. Consumable Life

The Consumable Life indicator shows whether the number of pierces since last reset is under the pierce count warning, GOOD, or the consumables should be changed, REPLACE.

5. Hardware Comms

The Hardware Comms indicator shows the status of Mach4 communication with the WarpRunner/TMC3in1 THC controller - **NONE**, **ACTIVE**, or **UPDATING**.

Operation Note

ACTIVE status is required to start G-Code.

Software Update Note

UPDATING indicates that the WarpRunner/TMC3in1 firmware is being updated. This is common after updating Mach4 to a new plugin version. The status should return to **ACTIVE** once the update is complete.

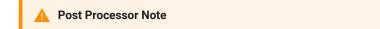


6. Actual

The Actual indicator displays the current Tip Volts as measured by the plasma power supply and WarpRunner/TMC3in1 (After applying the Volt Offset).

7. Target

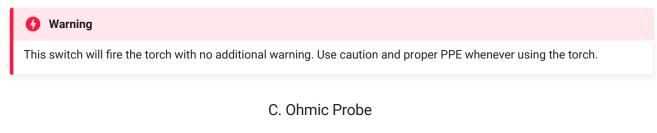
The Target Tip Volts indicator displays the target voltage read from the G-Code once the program is started. The target can be adjusted up and down during a program using the arrows.



The Avid CNC post processor is required to properly format the G-Code so that the target voltage is included.

8. Torch Manual Trigger

The Torch Manual Trigger switch turns the torch ON or OFF.





The Ohmin Probe indicator displays the state of the Ohmic Probe signal - ACTIVE or INACTIVE.

ACTIVE means that there is conductivity between the torch tip and the material clamp, generally from the torch tip touching material properly connected to the material clamp.



Plasma Workflow

Workflow Overview

The list below shows the typical order of operations for a plasma cutting operation.

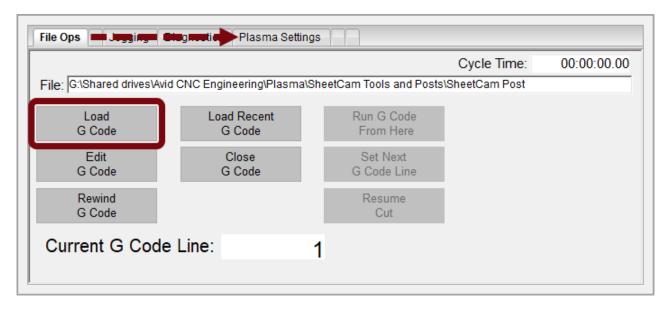
- 1. Home the machine and set work XY zero
- 2. Load G-Code
- 3. Set Z Rapid Height
- 4. Check consumable state
- 5. Check THC state
- 6. Verify THC settings
- 7. Cycle Start

Operation Note

For more detailed instructions of the plasma cutting workflow, check out our Plasma First Cut Instrucions



Load G-Code



First, load a program by clicking the Load G-Code button in the File Ops tab.

After loading a new program, Mach4 will automatically switch to the **Plasma Settings** tab to continue setup of the program.



Set Z Rapid Height

Torch Settings	THC and Logging	THC Settings	
? Z Rapid -1.000 Set Current	THC ON	? Profile	Flat ? Sensitivity
	THC Log	FLAT	Up Down 100 100
Pierce Warning225Pierce Count48Reset	? 0 Mark Log File		<u>ት</u>
? Volt Offset 0.0 ↓ ↓		4	44

Next, jog the torch to a safe Z height for the material. Then, set the Z Rapid Height by clicking the **Set Current** button.

i Operation Note

This height should be above the highest point of the material and potential tip ups of small parts being cut.



Check Consumable Status

Torch Settings	THC and Logging	THC Settings	
? Z Rapid -1.000 Set Current	THC ON	? Profile	Flat ? Sensitivity
	THC Log	FLAT	Up Down 100 100
Pierce Warning225Pierce Count48Reset	? 0 Mark Log File	♠	\$
? Volt Offset 0.0 + 4		₽	₽₽

Next, check that the current consumables are within their useful life - that the pierce count is below the pierce warning.



Check THC State

Torch Settings	THC and Logging	THC Settings	
? Z Rapid -1.000 Set Current	THC 💽	? Profile	Flat ? Sensitivity
	THC Log	FLAT	Up Down
Pierce Warning 225 Pierce Count 48 Reset	? 0 Mark Log File		\$
? Volt Offset		-	55

After check the consumables, ensure that the torch height control setting is correct. In most cases, THC should be **ON**.



Verify THC Settings

Torch Settings	THC and Logging	THC Settings	
? Z Rapid -1.000 Set Current	THC ON	? Profile	Flat ? Sensitivity
	THC Log	FLAT	Up Down 100 100
Pierce Warning 225 Pierce Count 48	? 0 Mark Log File		☆ ☆
? Volt Offset 0.0 ↓ ↓		-	-

Finally, make sure the material profile and sensitivity settings are appropriate for the program.



Torch Height Control

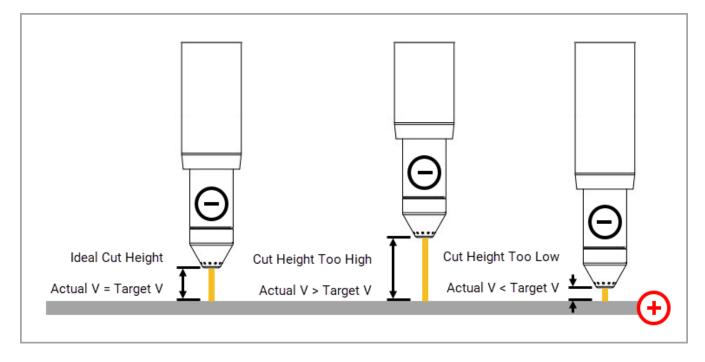
Operating Theory

The purpose of a THC system is to maintain a consistent torch-to-material offset across a workpiece. This allows for the best cut quality on materials that vary in height due to warping or inherent waviness.

Most THC systems use Arc Voltage (Tip Volts) as an indirect measurement of height. The arc voltage is measured between the Electrode (in the consumable stack) and the workpiece. The plasma arc voltage between the electrode (-) and workpiece (+) is governed by the equation below:

V = I x R or Voltage = Current x Resistance

The arc current is constant but the resistance increases with increasing arc length. This means the required arc voltage increases as the arc lengthens and can be used as an indirect measurement of torch-to-material offset.





The THC system attempts to bring the **Actual Tip Volts** closer to the **Target Tip Volts** by moving the Z axis (torch) up/down.

Because the measurement is indirect, **Actual Tip Volts** and torch height will not always directly correlate. Some common situations that can cause fluctuation in tip voltage include:

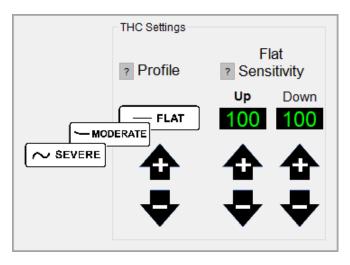
- Leadin/leadout the voltage is unstable when the XY velocity changes significantly.
- Tight corners the voltage typically increases as the XY motion slows around a corner.
- Small holes/shapes the voltage will increase as XY motion slows
- Pre-cut material (voids) the voltage will increase rapidly as the torch-material distance gets very large because there is no material directly under the torch.

These situations can lead to unwanted THC motion. In most cases, this motion will be toward the material. In many cases, this unwanted motion can be prevented with Anti Dive settings. If the unwanted motion cannot be eliminated with the Anti Dive settings, they can typically be correct tuning the THC to suit the material.

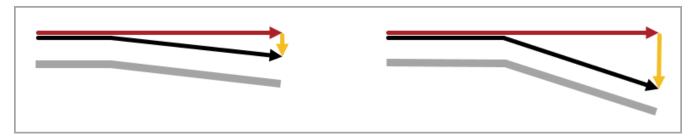


Tuning Torch Height Control

Material Profile Settings



The Z axis speed necessary for the torch to maintain a consistent height above the material is dependent on the severity of the slope and the XY feedrate (set in SheetCam). In the two illustrations below, the torch needs to follow the black path to maintain this consistent cut height. Because the XY feedrate is the same between both examples, the Z axis will need to move more quickly to follow the material slope on the right than on the left.



Most disruptive events (corners, holes, etc) during a cut lead to an increase in tip voltage which will cause the torch to dive. To avoid this, it is useful to limit the Z axis speed to follow the likely material curve while correcting for delayed response. The Profile Settings of **FLAT**, **MODERATE**, and **SEVERE** allow increasingly faster Z motion to correct for voltage fluctuation. These settings also adjust Anti Dive settings in an attempt to maximize cut quality.

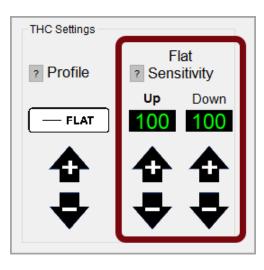
The **FLAT** material profile is intended for material that is nominally flat and should be used in most cases. Thin materials are prone to warping during cutting but the warpage is typically not significant enough to warrant a more drastic material profile setting. For reference, a 5% slope (0.6in/12in) can easily be handled by the **FLAT** profile setting.

The **MODERATE** and **SEVERE** settings should only be used for material with significant variation or severely warped thin material. Using either of these profiles on flat material can lead to excessive torch movement and crashes due to the torch diving into the material.



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Fine Tuning



Each Profile Setting allows for independent adjustment of the Up/Down Z-axis response speed. The number displayed is the percentage of the default setting. By defualt, it is set to 100%, but can be adjusted as needed from 10-200%.

If the torch fails to follow the material closely, use the **plus** arrows to increase the Up or Down setting(s) accordingly.

If the torch moves up or down too much, dives/crashes or cuts excessively high, use the **minus** arrows to decrease the Up or Down setting(s) accordingly.

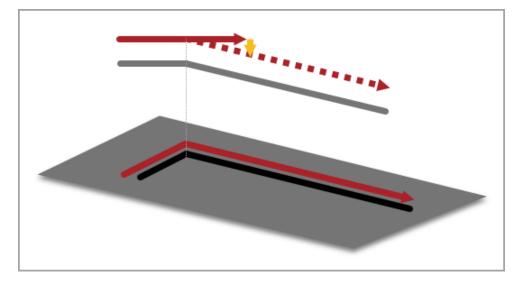
These settings are linked to each Material Profile and can be adjusted on-the-fly during a cut.



Additional Torch Height Control Settings

There are several other torch height control settings that are available but rarely needed.

Each material Profile has default Anti Dive settings that are intended to only allow the Z motion necessary to track the material. In general steeper material slopes require Anti Dive settings that allow motion more often.



The example above is a corner on sloped material. The torch path is shown in red, following the black cut profile. As the torch moves around the corner, tip volts are likely to spike. As the voltage spikes, THC would move the torch downward. The profile shown in the upper portion of the image illustrates Velocity Anti-Dive briefly inhibiting Z-axis motion leading to a higher cut height as the material drops away. Depending on the Anti Dive settings, this could result in poor cut quality or a failed cut.



Velocity Anti-Dive Threshold

Avid CNC Mach4 Configuration \times
General Advanced Options Machine Revision Custom Warnings About
Additional custom options:
Machine Options
Require machine to be homed
Enable soft limits after machine is homed
Use custom soft limits
Use custom homing settings
Configuration Options
Advanced logging
Disable Avid CNC Mach4 Configuration
Disable cutting method selections
Tool Changes
Ignore all tool changes
Feed Rate Override Increment
Percentage increment for FRO arrows 25 %
Torch Height Control
Disable Avid CNC THC menu
Velocity Anti-Dive Thresholds (% of XY Feedrate)
Flat 95
Moderate 90
Severe 85
voitage Anti-Dive Inresnoids (% above average tip voits)
Flat 3
Moderate 7
Severe 12
Save Cancel



The **Velocity Anti-Dive Threshold** sets the percentage of programmed XY feedrate that will momentarily inihibit THC. For example, if the actual feedrate drops below the threshold due to acceleration limits in corners and small arcs, THC motion is inhibited until the feedrate recovers.

To access this setting, select Configure -> Avid CNC Mach4 Configuration from the top menu in Mach4.

If the torch is frequently diving in low speed situations but otherwise tracking the material properly, increasing the Velocity Anti-Dive Threshold could help prevent the dives.

If the torch is failing to track the material during or after low speed situations, decreasing the Velocity Anti-Dive Threshold could help to allow more motion.



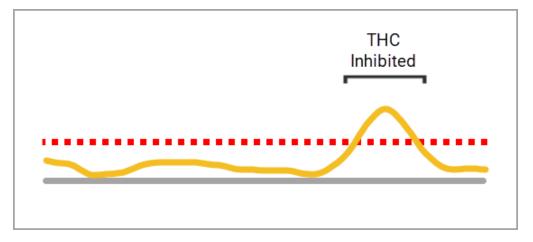
Voltage Anti-Dive Threshold

Avid CNC Mach4 Configuration $\qquad \qquad \qquad$
General Advanced Options Machine Revision Custom Warnings About
Additional custom options:
Machine Options
Require machine to be homed
Enable soft limits after machine is homed
Use custom soft limits
Use custom homing settings
Configuration Options
Advanced logging
Disable Avid CNC Mach4 Configuration
Disable cutting method selections
Tool Changes
Ignore all tool changes
Feed Rate Override Increment
Percentage increment for FRO arrows 25 %
Torch Height Control
Disable Avid CNC THC menu
Velocity Anti-Dive Thresholds (% of XY Feedrate)
Flat 95
Moderate 90
Severe 85
Voltage Anti-Dive Thresholds (% above average tip volts)
Flat 3
Moderate 7
Severe 12
Save Cancel

The **Voltage Anti-Dive Threshold** sets the percentage above the Average Tip Volts that will momentarily inihibit THC. If the Actual (or **\$** instantaneous **\$**) tip voltage exceeds the threshold, THC motion is inhibited until the actual voltage returns to the expected range.

To access this setting, select Configure -> Avid CNC Mach4 Configuration from the top menu in Mach4.

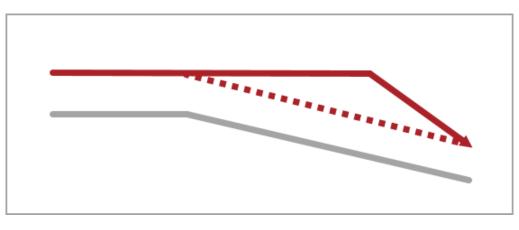




The image above shows the Actual Voltage (yellow), Average Voltage (grey) and Voltage Anti-Dive Threshold (red). When the Actual Voltage spikes above the threshold, THC motion would be inhibited during the spike.

If the torch is frequently diving when crossing voids or other irregularities, decreasing the Voltage Anti-Dive Threshold could help prevent the motion.

If the torch fails to begin following changes in material slope, increasing the Voltage Anti-Dive Threshold could help allow motion sooner. This would look like the image below where the torch path (red) does not follow the intended path (dashed red) and has to quickly recover.





Advanced Manual THC Anti-Dive

Disabling THC

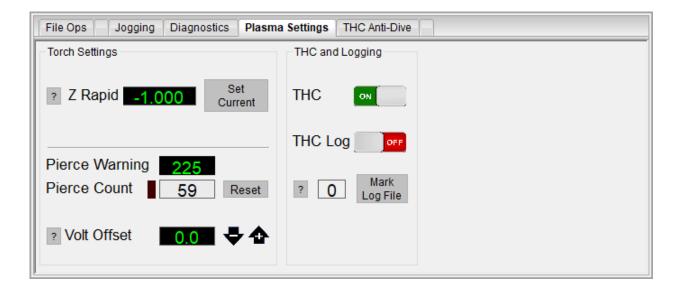
vid CNC	Mach4 Configuration	>			
General	Advanced Options Machine Revision Custom Warnings	About			
	Additional custom options:				
	Machine Options				
	Require machine to be homed				
	Enable soft limits after machine is homed				
	Use custom soft limits				
	Use custom homing settings				
	Configuration Options				
	Advanced logging				
	Disable Avid CNC Mach4 Configuration				
	Disable cutting method selections				
	Tool Changes				
	Ignore all tool changes				
	Feed Rate Override Increment				
	Percentage increment for FRO arrows 25 %				
	Jorch Height Control				
	Disable Avid CNC THC menu				
	Velocity Anti-Dive Thresholds (% of XY Feedrate)				
	Flat 95				
	Moderate 90				
	Severe 85				
	Voltage Anti-Dive Thresholds (% above average tip volts)				
	Flat 3				
	Moderate 7				
	Severe 12				
	Save Cancel				

If necessary or desired, the Avid CNC THC parameter calculations can be disabled. Doing so will disable all feedrate and profile based Z axis response calculations. This should only be done by users that have an understanding of each Anti-Dive setting, including the Linear Response Band.

This will hide the Profile and Sensitivity settings and expose the THC Anti-Dive tab



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THC Anti-Dive Functions

File Ops Jogging Diagnostics Plasm	ma Settings THC Anti-Dive		
Time Delay Anti-Dive	Voltage Based Anti-Dive		
Inhibiting THC	Inhibiting THC		
0.25 (sec) Delay After Arc OK	800 ms of ATV (Avg Tip Volts) buffer (800 ms max)		
M62 / M63 Anti-Dive	10.0 % for precondition		
Inhibiting THC	0.0 % of normal speed to throttle THC when outside of voltage range		
Velocity Based Anti-Dive	Disable THC if ATV is: 30.0 % above actual tip volts		
Inhibiting THC	Disable THC if ATV is: 3.0 % below actual tip volts		
95.0 % of Commanded Feedrate	Save as DefaultRestore DefaultAnti-Dive SettingsAnti-Dive Settings		

Anti-dive settings are used to handle exception cases during THC movement, i.e. cutting over voids, cutting into corners, leading out of interior profiles etc.

Time Delay Anti-Dive

Time delay anti-dive will pause THC motion for a specified amount of time after a plasma arc is initiated.

- **Time Delay Anti-Dive Toggle** This switch will enable or disable time delay anti-dive functionality. When disabled there will be no delay in THC response after arc initiation.
- Delay After Arc OK Time Setting This value specifies the amount of time (in seconds) to delay THC functionality after the Arc OK signal is received from the plasma supply. New values may be typed directly into this box.
- Time Delay Anti-Dive Inhibiting THC Indicator Light This indicator will be illuminated if time delay anti-dive is currently inhibiting THC motion.

M62/M63 Anti-Dive

M62/M63 anti-dive turns THC functionality on when a M62P4 is executed and off when a M63P4 is executed. These M codes can be generated by your CAM software. (Using SheetCam with the Avid CNC post processor is recommended)

• M62/M63 Anti-Dive Inhibiting TCH Indicator Light - This indicator will be illuminated if M62/M63 anti-dive is currently inhibiting THC motion.



Velocity Based Anti-Dive

Velocity based anti-dive will prevent THC motion when the actual X-Y velocity of the machine is less than the specified percentage of the current commanded feedrate.

- Velocity Based Anti-Dive Toggle This switch will enable or disable velocity based anti-dive functionality. When disabled THC motion will be allowed at any machine velocity.
- % of Commanded Feedrate Setting This value specifies the percentage of the commanded feedrate the machine must achieve to enable THC motion. New values may be typed directly into this box.
- Velocity Based Anti-Dive Inhibiting THC Indicated Light This indicated will be illuminated if velocity based anti-dive is currently inhibiting THC motion.

Voltage Based Anti-Dive

Voltage based anti-dive will prevent THC motion when the current tip voltage and average tip voltage are too dissimilar.

- Voltage Based Anti-Dive Toggle This switch will enable or disable voltage based anti-dive functionality.
- **ms of ATV (Avg Tip Volts) buffer** This value specifies the number of milliseconds which will be used for the tip voltage rolling average calculation. 800 milliseconds (ms) is the maximum value. As this value is increased, the number of recorded tip voltage values which will be used for the rolling average is increased, making the average slower to respond to tip voltage variation. 800 ms is the recommended setting. New values may be typed directly into this box.
- % for precondition Voltage based anti-dive is not allowed when the torch is first lit. Once the average tip volts are within the precondition percentage of target tip volts, voltage based anti-dive will be allowed for the rest of the cut.
- % of normal speed to throttle THC when outside of voltage range When THC is throttled due to voltage based antidive, this percentage determines the response rate of changes in Z height. Setting this value to 0 will disable THC response and is the default setting.
- **Disable THC if ATV is XX % above actual tip volts** This prevents rising when the material warps up towards the torch or if surface contamination is present, causing the actual tip volts to rapidly drop below the average tip volts. Decreasing this percentage will disable THC response at a lower difference and stop the torch from rising sooner.
- **Disable THC if ATV is XX % below actual tip volts** This prevents diving when crossing a pre-cut line or if surface contamination is present, causing the actual tip volts to rapidly rise above the average tip volts. Decreasing this percentage will disable THC response at a lower difference and stop the torch from diving sooner.

Save as Default Anti-Dive Settings Button

This button will save the current THC anti-dive settings as set in the Mach4 main screen interface as the default THC settings. When Mach4 is closed and reopened these default THC anti-dive settings will be loaded. If you adjust the THC settings and do not save them as the default, they will return to the saved defaults on restart.

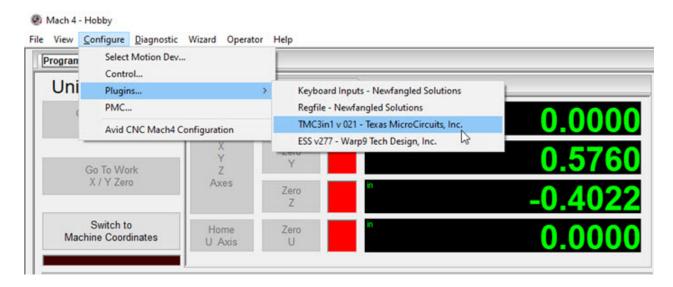
Restore Default Anti-Dive Settings Button

This button will change the current THC anti-dive settings to the saved default settings.



TMC3in1 Plugin Configuration

There are additional TMC3in1 settings that can be accessed in the TMC3in1 plugin configuration menu shown below. Settings that will be used routinely in the operation of your PRO CNC Plasma system can be accessed directly in the Mach4 screen.



To access the TMC3in1 Plugin configuration navigate to TMC3in1 in the Plugins menu under the Configure pull down menu. *Any settings changes made from the TMC3in1 Plugin menu will be saved as defaults.*

Info
Mach4 must be disabled to access the TMC3in1 Plugin Configuration menu.



GENERAL

M TMC3in1 -v017	>
Info General THC Response Time Delay Anti Dive M62 & M63 Anti Dive Velocity Anti Dive Voltage Anti Dive	
A) Logging to Profile Folder B) Plugin Frequency C Log Data Files Dpen Log File Folder	
One Time Specials C) Reflash Master Processor after clicking 'Enable' D) Reflash THC Processor after clicking 'Enable'	
D) Reflash THC Processor after clicking 'Enable' A) This will log data sets to your log file folder.	
B) The plugin frequency controls how fast your screenset is updated with TMC3in1 data.	

- (A) Logging to Profile Folder This checkbox is the same as the toggle on the mainscreen diagnostics tab. The button will open the default logging file location (C:\Mach4Hobby\W9_HC).
- (B) Plugin Frequency This setting should not be changed without consulting Avid CNC support or Warp9 Tech Design support.
- One Time Specials These settings should not be used without consulting Avid CNC support or Warp9 Tech Design support.

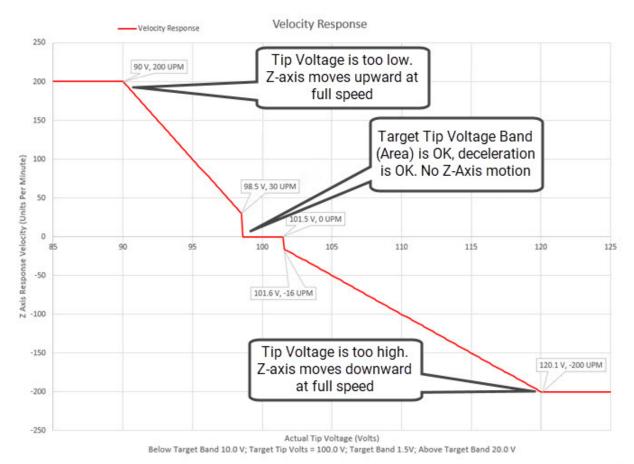


THC RESPONSE

A) Tip Voltage Divider Ratio	B) Tip Voltage Source	
50:1 ~	Negative Tip Volts, J7 Pin4 (+) NEG, J7 Pin3 (-) POS [Hyper Therm] REVERSED 🗸	
C) Target (Dead) Band (Volts) 0.5	D) Linear Response Band (Volts) Above Target Voltage 40 Below Target Voltage 40 0.001	
Tip Voltage Source: The TMC3in Target Band: This is the +/- vol	is the divider ratio matching the one set in the plasma power supply. 11 has two tip voltage polarities. Choose "Positive Tip Volts" or "Negative Tip Volts" based upon your plasma system. tage band that no THC action occurs within. This is also sometimes called a Dead Band, because of no new movement.	
Tip Voltage Source: The TMC3in Target Band: This is the +/- vol FAULT = 1.0V Linear Response Band: This is the naller values are faster and more	11 has two tip voltage polarities. Choose "Positive Tip Volts" or "Negative Tip Volts" based upon your plasma system.	
Tip Voltage Source: The TMC3in Target Band: This is the +/- vol FAULT = 1.0V Linear Response Band: This is the haller values are faster and more rger values are slower, calmer ar sually make the ABOVE Target V	al has two tip voltage polarities. Choose "Positive Tip Volts" or "Negative Tip Volts" based upon your plasma system. tage band that no THC action occurs within. This is also sometimes called a Dead Band, because of no new movement. he +/- voltage band that proportionally reduces the Z axis commanded velocity response above and below the target voltage. aggressive (5V or 10V would be the smallest recommended)	
Tip Voltage Source: The TMC3in Target Band: This is the +/- vol (FAULT = 1.0V Linear Response Band: This is the naller values are faster and more rger values are slower, calmer ar sually make the ABOVE Target V	11 has two tip voltage polarities. Choose "Positive Tip Volts" or "Negative Tip Volts" based upon your plasma system. tage band that no THC action occurs within. This is also sometimes called a Dead Band, because of no new movement. he +/- voltage band that proportionally reduces the Z axis commanded velocity response above and below the target voltage. aggressive (SV or 10V would be the smallest recommended) nd less likely to overshoot or oscillate. (S0V on the larger side) foltage value a little LARGER, so it will try to approach the work piece a little slower and not crash if it were to overshoot. /oltage value a little SMALLER, so it will try to get away from the work piece FASTER.	

- (A) Tip Voltage Divider Ratio This setting is based on the brand of plasma torch in use. Hypertherm torches always output a 50:1 divided arc voltage.
- (B) Tip Voltage Source This setting is based on the brand of plasma torch in use. Hypertherm torches always output "Negative Tip Volts."
- (C) Target Band This setting changes the "width" of the target voltage band. When the actual voltage is within this target band there will be no THC motion. (See next section).
- (D) Linear Response Band This setting controls the +/- distance from the target tip volts which will produce a linearly proportional THC motion response. Above or below these set limits the THC motion will be commanded at maximum speed.
- (D) THC Offset This setting is only useful in specific applications as a 'trim' adjustment and should not be used without consulting Avid CNC support or Warp9 Tech Design support.





The above is a graphical representation of the THC motion (Z Axis Response Velocity - Y axis of graph) produced as a result of the incoming tip voltage signal from your plasma torch (Actual Tip Voltage - X Axis of graph). Reading the graph left to right, the data represents the following scenarios:

- Z Axis Response Full Positive From 85 to 90 tip volts the actual voltage is below the target tip voltage by more than the negative linear response band setting. THC commanded Z-axis motion is positive at maximum velocity (in this example 200 units per minute).
- **Z Axis Response Linearly Positive** From 90 to 98.5 tip volts the THC motion is commanded in the positive direction at a speed which is linearly proportional to the difference between the actual and target tip voltage.
- **Target Tip Voltage** The target tip voltage is set to 100 volts in this example and the target tip voltage band is 3. From 98.5 to 101.5 (3 volt band) there is no commanded THC velocity as the actual voltage is within the target tip voltage band.
- **Z** axis **Response Linearly Negative** From 101.5 to 120 tip volts the THC motion is commanded in the negative direction at a speed which is linearly proportional to the difference between the actual and target tip voltage.
- Z Axis Response Full Negative From 120 to 125 tip volts the actual voltage is above the target tip voltage by more than the positive linear response band setting. THC commanded Z-axis motion is negative at maximum velocity (in this example 200 units per minute).



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₹ ^M T	MC3in1 -v021
Info	General THC Response Time Delay Anti Dive M62 & M63 Anti Dive Velocity Anti Dive Voltage Anti Dive
	me Delay Anti Dive Choice 1: THC Delay After Arc Okay In Enable THC Delay After Arc Okay of 0.250 Seconds
The	 Enabling THC delay after Arc Ok is used to prevent diving at the start of a cut (right after the pierce). Field provided is the length of delay in seconds that THC will be inhibited after the Arc Okay signal activates. AULT = 0.750

These anti-dive settings are the same as the THC main screen THC Anti-Dive tab. Changes made in the TMC3in1 plugin menu will be saved as default and overwrite defaults set by the THC main screen "Save as Default Anti-Dive Settings" button.



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M TMC3in1 -v017	>
Info General THC Response Time Delay Anti Dive M62 & M63 Anti Dive Velocity Anti Dive Voltage Anti Di	ve
- M62 & M63 Anti Dive Choice 2: Enable/Disable THC with M62/M63	
Use M62/M63 to Enable/Disable THC	
AD2) When enabled, the TMC3in1 will need to receive a M62P# command in GCode before THC response is allowed.	
A M63P# command will disable THC response.	
Port 3 Pin 14 controls this feature, and needs to be assigned to an Output#.	
I will assume you are using Output03, but you may use any available output modifying the code accordingly.	
M62P03	
G1 X0	
(THC will be allowed)	
(It will move the X from 0.0 to 5.0 with THC active)	
M63P03	
G1 X5	
(THC is NOT allowed)	

When enabled, the TMC3in1 will need to receive M62P4 commands in your GCode before THC response will be allowed. M63P4 commands can then be used to disable THC response. This type of anti-dive should not be disabled without consulting Avid CNC support.



VELOCITY ANTI DIVE

TM	1C3in1 -v01	7					
Info	General	THC Response	Time Delay Anti Dive	M62 & M63 Anti Dive	Velocity Anti Dive	Voltage Anti Dive	
En	able Velocit	y Based Anti Div	e Choice 3:				
	Stop THC	Response when >	-Y Velocity is less than				
L F	97.000	St all	edrate				
1	377000	2011	culate				
AD3)	This is a vel	ocity based Anti	Dive feature to prevent	the torch from diving			
			nning of a cut, the end o				
The p	provided fiel	d allows you to s	pecify the lower end ve	ocity %			
			ed if 'i' is enabled.				
This r	requires that	t you enable the	Laser PWM/XY Velocity	PWM output signal in th	he ESS on Port 3 Pin	16.	

These anti-dive settings are the same as the main screen THC Anti-Dive tab. Changes made in the TMC3in1 plugin menu will be saved as default and overwrite defaults set by the THC main screen "Save as Default Anti-Dive Settings" button.



VOLTAGE ANTI DIVE

EM TMC3in1 -v021

Info General THC Response Time Delay Anti Dive M62 & M63 Anti Dive Velocity Anti Dive Voltage Anti Dive
Voltage Anti Dive Choices 4, 5 & 6:
A) I Enable These Anti Dive choices based on Averaged Tip Volts (ATV)
B) 800 ms of ATV (Averaged Tip Volt) buffer (800 ms max)
C) Precondition: Allow Voltage based Ant Dives once ATC is within 10 % of Target Tip Volts
AD Choice 4) Throttle THC response to 0.000 % of normal speed when AD5 or AD6 activates
AD Choice 5) Throttle THC if ATV is 30 % Above Current (Actual) Tip Volts
AD Choice 6) Throttle THC if ATV is 10 % Below Current (Actual) Tip Volts
A) Enable Voltage Based Anti Dive Choices 4, 5 and 6. When Enabled, Voltage based Anti Dive is disabled until precondition C) is met once, after the Arc Okay turns on at the beginning of each cut. B) Averaged Tip Volts (ATV) Buffer size, 1 ms to 800 ms. DEFAULT = 800 This ATV value is used for Anti Dive Choices 4, 5 and 6. A longer buffer reacts slower to changes in tip voltage. C) When the torch is first lit, voltage based Anti Dive is not allowed.
This is so the pierce can complete and THC can move to the target tip voltage. This precondition will wait until after the Arc Okay signal turns on and then watch the ATV (average tip volts) value until it comes with the desired percentage of Target Tip Volts, and at this point Voltage Based Anti Dive will be allowed for the rest of the cut. This precondition only needs to be satisfied once per cut. The expected range is between 3% and 20%. DEFAULT = 4%
AD4) If Anti Dive choices 5 or 6 activates, THC is throttled to this response rate percentage: 100% will give normal THC speed response. (This effectively disables Voltage based Anti Dive.) 50% means THC will bel throttled to half speed. 0% will disable THC response. DEFAULT = 0% This choice throttles the change in Z height, when the Actual Tip Voltage changes rapidly for a short period of time.
This will prevent diving into pre-cut lines, but allow for responding to inclined or bent metal.
AD5) This prevents the torch from rising when the material warps up towards the torch or if surface contamination is present. If the ATV is this percentage (in volts) below the current tip volts, the THC response speed will be throttled. DEFAULT = 15%
AD6) This prevents diving when crossing a pre-cut line or if surface contamination is present. If the ATV is this percentage (in volts) above the current tip volts, the THC response speed will be throttled. DEFAULT = 3%

These anti-dive settings are the same as the main screen THC Anti-Dive tab. Changes made in the TMC3in1 plugin menu will be saved as default and overwrite defaults set by the THC main screen "Save as Default Anti-Dive Settings" button.



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Restart/Resume a Plasma Cut

Because a plasma torch cannot simply re-cut parts of a program that are already complete, there are specific steps required to resume a cut correctly. There are two methods for resuming a plasma cut.

The Resume Cut button can be used if the program stopped in the middle of a cut, after a successful pierce sequence, and did not lose position. This could be due to a Feed Hold or the torch losing arc. This method only works properly if the machine has NOT lost position (still referenced and next to the DROs are green) and is NOT in a stopped state.

If the torch stopped due to a void or re-cut line this may not work, and the most reliable way to continue will be at the next pierce location (see *Restart Point*).

If the machine axes are de-referenced (due to a Stop or E-stop) or the cut failed in a location without enough material to use the Resume Cut button, the cut must be restarted at a probe location. These are noted in the G-Code with a <<<<<RESTART POINT>>>>> tag.



Resume Cut Button

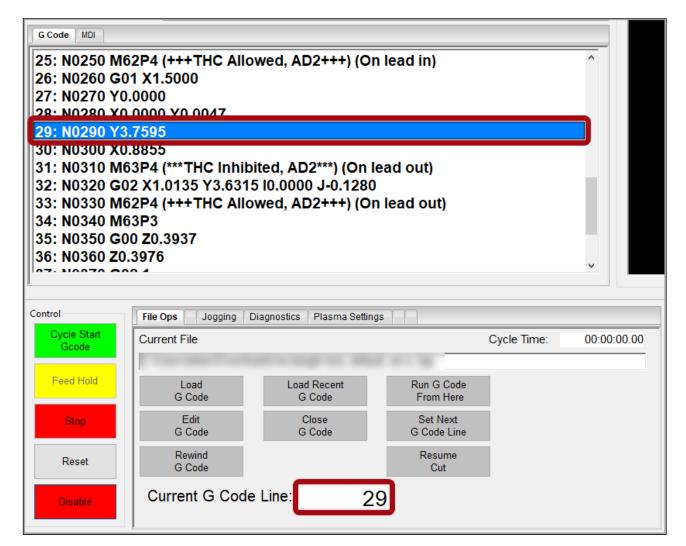
For this method to work, the torch must still be in the correct XYZ location and the machine can the value to an Emergency Stop.

1. Check that the Axis Referenced LEDs next to the DRO are still green, indicating the machine is still referenced properly.



- 2. Re-enable the machine if necessary.
- 3. Make sure the G-Code and & Current G Code Line is on the same G-Code line it stopped at (double click in the G-Code window to toggle line numbers). Click on the correct line if needed.





4. On the main File Ops tab, click the Set Next G Code Line button (1).

File Ops Jogging D	iagnostics Plasma Settings			
Current File			Cycle Time:	00:00:00.00
Concentration of the sector	and the second second			
Load G Code	Load Recent G Code	Run G Code From Here		
Edit G Code	Close G Code	Set Next G Code Line	1	
Rewind G Code		Resume Cut	2	
Current G Code	Line: 29)		

5. Click the Resume Cut button (2). This will issue a new cycle start command, turn on the torch, and resume movement once the controller receives an Arc OK signal from the torch.

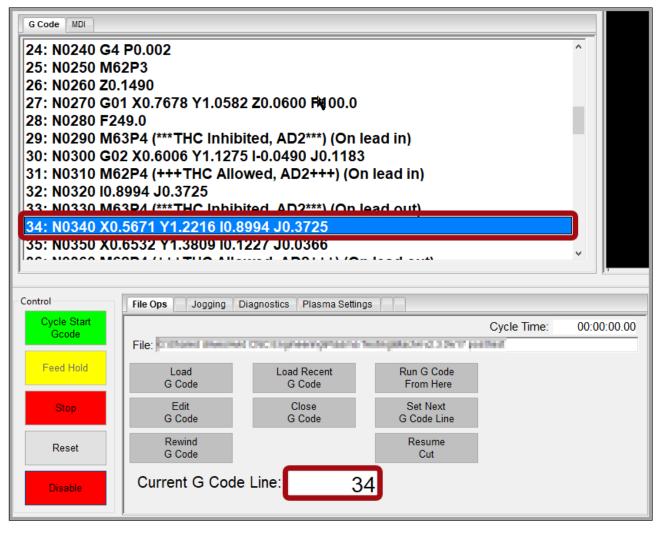


Restart Point

•	Note
(re (h th	his method is only available with Mach4 for Avid CNC Machines v2.3.2+ and Avid CNC SheetCam post processor v1.7+ eleased 9/14/2021). You can check your Mach4 version on the About tab https://www.avidcnc.com/support/instructions/software/mach4Configuration/#7-about). If an upgrade is needed, go to he Mach4 for Avid CNC Machines (https://www.avidcnc.com/support/instructions/software/downloads/mach4) pownloads page for the latest installer.

These steps are necessary if the program stops during a pierce sequence, or pierces but fails to continue. It can also be used at the next pierce location if the torch went out and **\$** Resume Cut **\$** didn**\$** t work.

1. Note the line of G-Code that the program stopped at.



2. Look back through the G-Code to find the most recent <<<<<RESTART POINT>>>>> tag (or the next tag if **@**Resume Cut**@** failed and you need to skip a profile). A sample of G-Code output from SheetCam with the Avid CNC Mach4 post processor is below; the highlighted line is the proper place to restart a cut.



G Code MDI						
39: N0390 G9	1 G00 Z0.0197				^	
40: N0400 G9	0					
	000 (Set work shift	t)				
42: N0420 G0						
43: N0430 X3.						
	2P4 (+++THC Allov	ved, AD2+++)				
	0 G91 Z-0.0039					
46: N0460 C0						
	<<< <restart po<="" th=""><th><u>INT #2>>>>>)</u></th><th></th><th></th><th></th><th></th></restart>	<u>INT #2>>>>>)</u>				
	1.0 Z-100 F19.685	0 I				
	002 (Zero Z Axis - (
50: N0500 M3	001 (Clear work sh				~	
	· · ·	~				
Control	File Ops Jogging Dia	agnostics Plasma Setting	gs			
Cycle Start Gcode				Cycle Time:	00:00:00.00	1
	File: File:	O.C. Expression/Plasma	Contrapilitativa di 1924 Per	al festi		
Feed Hold	Load	Load Recent	Run G Code			
	G Code	G Code	From Here			
Stop	Edit	Close	Set Next			
Citop	G Code	G Code	G Code Line			
Reset	Rewind		Resume			
Reset	G Code		Cut			
Disable	Current G Code	Line: 4	7			

3. Select that line in the G-Code window in Mach4. Click the Set Next G Code Line button (1) and then the Run G-Code From Here button (2) in the File Ops tab.

File Ops Jogging D	iagnostics 🎽 Plasma Settings			
			Cycle Time:	00:00:00.00
File:				
Load G Code	Load Recent G Code	Run G Code From Here	1	
Edit G Code	Close G Code	Set Next G Code Line	2	
Rewind G Code		Resume Cut		
Current G Code	Line: 47	7		

4. Follow the instructions on the window shown to restart the G-Code. The G-Code should move the machine to the correct position and then use the Cycle Start button to restart that pierce sequence and cut.



1 00 0	Run Fro	m Here					×		¥
	Distanc	e To Go						_	
File Ops Tool Change	X:	-2.4554	Y:	0.5846	Z:	0.0000			
Current File	A:	0.0000	B:	0.0000	C:	0.0000		cle Time:	00:00:00.00
Load G Code Edit G Code	"M _ M		ns to Start	orient to t Position –	he cor	Then use the rect position. Selerted	:		
Rewind G Code						Inselected			
Current G Cod			ОК		Canc	el	.:		

- 5. If the original cut pierced through but did not move, restarting at the previous pierce may not work. In this case you can move the torch close to, but not exactly on (.050 � off should be enough), the intended pierce position. This will give the torch fresh material to pierce.
- 6. In this case don't use the Run G Code From Here feature, only use the Set Next G-Code Line and Cycle Start buttons. This will pierce in the new location, completing the leadin and cut as intended.



Logging and Diagnostics

Files for troubleshooting

If you have performance issues that cannot be resolved with the available settings, the following files can help with further troubleshooting:

- 1. SheetCam project file (.job extension)
- 2. G-code file (.tap or other text file equivalent)
- 3. THC log file (.thc extension). These will be saved by default in C:\Mach4Hobby\W9_HC
- 4. Mach4 log file (.log extension), saved wherever you choose.

Recording a THC Log

- 1. Make sure the THC Log toggle is ON.
- 2. Run the program that is experiencing issues.
- 3. Copy the log file. Log files are saved in C:\Mach4Hobby\W9_HC with a timestamp filename and a .thc extension.



1. In Mach4 go to the **Diagnostic -> Logging** menu.

ile View Configure	Diagnostic	Wizard Operator Help
Program Run Off	s Loggir	ng 📐
Units: G2	n -	ard Inputs - Newfangled Solutions e - Newfangled Solutions
Change Uni G21 (mm		in1 v 022 - Texas MicroCircuits, Inc. .77 - Warp9 Tech Design, Inc.

2. Click the Play button to start logging.

Log Facility				×
A - 2				
Start logging.				
	Close	Clear	Save	

3. Click Save after capturing the relevant events to save the log as a text file. **Note:** Mach4 logs capture many events and can be very long. Try to focus the log on a specific event for easier diagnostics.

Cog Facility	\times
A 🕨 II 🗕 💥	
2021-09-29 08:28:17.164 - SoftSync()! Clearing planner. controller.cpp:2336	^
2021-09-29 08:28:17.176 - SoftSync()! Clearing planner. controller.cpp:5249	
2021-09-29 08:28:17.197 - API: mcSpindleSetOverride(inst = 0, percent = 1.00) (unknown caller)	
2021-09-29 08:28:17.198 - API: mcSpindleSetCommandRPM(inst = 0, RPM = 6000.0000) (unknown ca	2
2021-09-29 08:28:18.874 - API: mcCntlEnable(inst = 0, FALSE) (Mach4GUI Button)	
2021-09-29 08:28:18.875 - Signal id 1018, (Enable #0), changed from HIGH to LOW.	
2021-09-29 08:28:18.875 - Signal id 1019, (Enable #1), changed from HIGH to LOW.	
2021-09-29 08:28:18.876 - Signal id 1020, (Enable #2), changed from HIGH to LOW.	
2021-09-29 08:28:18.876 - Signal id 1021, (Enable #3), changed from HIGH to LOW.	
2021-09-29 08:28:18.877 - Signal id 1022, (Enable #4), changed from HIGH to LOW.	
2021-09-29 08:28:18.877 - Signal id 1120, (Machine Enabled), changed from HIGH to LOW.	~
	-
Close Clear Save	



THC Log Analyser

1. Log Analyser Installation

DOWNLOAD AND INSTALL .NET FRAMEWORK

.NET Framework - Microsoft .NET Framework 2.0 is required for the THC Log Analyser to install properly. Please confirm you have .NET Framework 2.0 installed, or download and install .NET Framework 3.5 (which includes 2.0) from Microsoft: https://www.microsoft.com/en-us/download/details.aspx?id=21.

DOWNLOAD AND INSTALL THE THC LOG ANALYSER

- Download THC Log Analyser Download the Log Analyser from Avid CNC. (https://www.avidcnc.com/cdata/cad/2018Q2/THCLogAnalyser.msi)
- Install THC Log Analyser Run the "THCLogAnalyzer.msi" you downloaded from the above link.

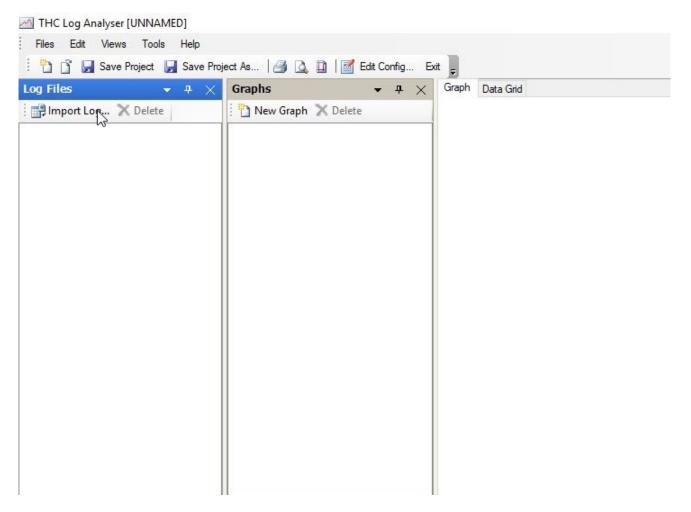
	×
Windows protected your PC	
Windows Defender SmartScreen prevented an unrecognized app from starting. Running this app might put your PC at risk. <u>More info</u>	
Don't run	

• You may see a Windows Defender alert display in some versions of Windows. Press "More Info" and then "Run Anyway" to run the Log Analyser Installer. Follow the on screen prompts to complete the installation.



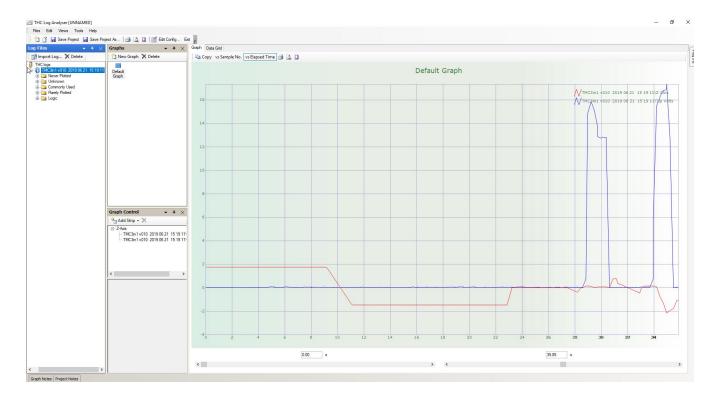
2. Import Data into Log Analyser

• **Open Log Analyser** - Open the windows start menu, search for "THC Log Analyser" and open the application.



• Import Data - Click the "Import Log" button and navigate to the log file which you collected earlier. The default location of the THC log files is C:\Mach4Hobby\W9_HC.





• **Default Graph** - By default the Tip Volts and Z Axis motion of the imported log file will be graphed on the right side of the application window.



THC Log Analyser [UNNAMED]		
Files Edit Views Tools Help		
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Log Files 👻 म 🗙	Graphs 👻 🕂	Graph Data Grid
📑 Import Log 🗙 Delete	🎦 New Graph X Delete	🗈 Copy 🛛 vs Sample No. 🛛 vs Elapsed Time 🎒 🞑 🗎
THC logs THC logs THC 3in 1 v010 2019 06 21 15 19 11 Vever Plotted Unknown GCode Line THC Allowed Commanded Velocity Z Velocity Inhibiting THC Using M11 M10 M10 Inhibit Active Commonly Used Rarely Plotted Logic	Default Graph	

• Adding Log Data to the Graph - Expanding the THC log menu on the left of the screen will display the different data which can plotted and compared. To plot specific data, select it on the left of the screen then click, drag, and drop the data onto the graph (right side of the screen).





• **Changing the Graph Scale** - The sliders at the bottom of the graph will change the time scale of the graph and the position of the graph along said time scale. Shorten the timescale (right slider) and scroll across the graph (left slider) to the point during the cut you wish to analyze.



Graph (Control			-	 .	×
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	MC3in1					
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• Scaling Log Data - The Graph Control menu allows you to change the scale of individual data. The original scale of different data (Z axis height 0-8in, Tip volts 100-200V) can be altered (scale x10 or scale /10) to make them more easily comparable.



3. Example Data Analysis

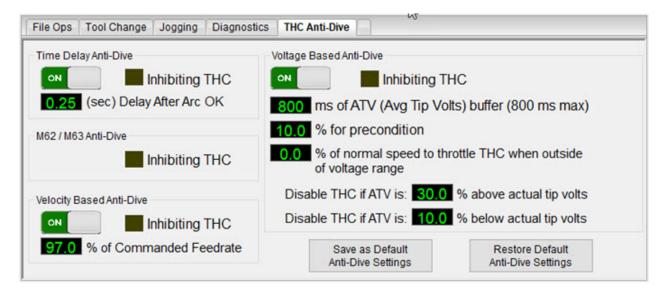


Analyzing the Plotted Data - This data represents a single pierce and small circular cut.

- **M Code Anti-Dive** The green line represents M-code based anti-dive and is shown inhibiting THC movement (green line goes up to 13 at 28.6 seconds) until 29.6 seconds (when the green line returns to 0). This represents the M62P3 and M63P3 lines in the g-code file which occur before the pierce movement and ends after the descend to cut height from pierce height.
- **Tip Volts** The blue line represents the tip voltage. The tip voltage is very high during the pierce operation, this is normal. The tip voltage stabilizes near the target after the torch descends to cut height, torch height control then takes over and modulates Z-axis height to bring actual voltage in line with target voltage. The tip voltage then goes to 0 when the cut finishes.
- XY Velocity Anti-Dive The yellow line represents XY velocity based anti-dive and is shown inhibiting THC movement after the torch descends to cut height but before the machine XY motion is up to speed during the cut feed. XY velocity anti-dive prevents THC motion directly after M Code based anti-dive goes to zero (yellow line spike at 29.8 seconds). Once the machine accelerates and achieves 97% cut feed velocity THC motion is allowed. At 30.4 seconds when the cut ends the machine decelerates and velocity drops below 97% commanded feed, THC motion is once again inhibited.
- **Z** Axis Position The red line represents the Z axis position. At 28.8 seconds the Torch jumps to pierce height and then descends to cut height at 29.5 seconds. From 29.5 to 30.4 seconds the Z axis slowly increases in height, this mirrors the tip voltage (blue line) which increases steadily to achieve target voltage.



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Adjusting the THC settings - The cut analyzed in the above example was successful, so the settings may not need adjustment. However, if an unsuccessful cut (crashed torch, low cut quality) is analyzed it may identify the fault with the THC settings causing the issue.

- **Torch Crash** The cut may have ended with a torch crash due to a THC diving response, this can generally be avoided by increasing the sensitivity of the anti-dive settings. The anti-dive settings will be shown by the graph to not have inhibited THC motion during the crash. In Mach4 the anti-dive settings may be adjusted on the main screen under the THC Settings operations tab. Increasing the Time Delay after Arc OK, the % of commanded feedrate or decreasing the % change in ATV that activates voltage-based anti-dive may be appropriate depending on the situation. For more information on these anti-dive settings please see Mach4 Plasma Users Guide.
- **Poor Cut Quality** The cut may have completed but failed to follow the material and achieve target voltage during the bulk of the operation, this can potentially cause a poor cut. The graph will show the anti-dive settings as inhibiting THC motion during most of or the entire cut. The solution to this issue is to decrease the sensitivity of the anti-dive settings. Decreasing the Time Delay after Arc OK, the % of commanded feedrate or increasing the % change in ATV that activates voltage-based anti-dive may be appropriate depending on the situation. For more information on these anti-dive settings please see Mach4 Plasma Users Guide.
- **Path Rules** Another way cut issues may be addressed is to identify which part of the cut is causing the problem (using the log analyzer) and then create a "Cut Rule" in sheetcam which will inhibit or allow THC motion during this feature of the program using M code based anti-dive. For more information on SheetCam cut rules please see SheetCam Software Setup Guide.

