ArcPro v4 Mach4 Plasma

User Guide

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Atlanta, GA USA

For more information please visit the product web page:

https://www.vitalsystem.com/arcpro

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License Agreement

Before using the HiCON and accompanying software tools, please take a moment to go thru this License agreement. Any use of this hardware and software indicate your acceptance to this agreement.

It is the nature of all machine tools that they are dangerous devices. In order to be permitted to use HiCON on any machine you must agree to the following license:

I agree that no-one other than the owner of this machine, will, under any circumstances be responsible, for the operation, safety, and use of this machine. I agree there is no situation under which I would consider Vital Systems, or any of its distributors to be responsible for any losses, damages, or other misfortunes suffered through the use of the HiCON board and its software. I understand that the HiCON board is very complex, and though the engineers make every effort to achieve a bug free environment, that I will hold no-one other than myself responsible for mistakes, errors, material loss, personal damages, secondary damages, faults or errors of any kind, caused by any circumstance, any bugs, or any undesired response by the board and its software while running my machine or device.

I fully accept all responsibility for the operation of this machine while under the control of HiCON, and for its operation by others who may use the machine. It is my responsibility to warn any others who may operate any device under the control of HiCON board of the limitations so imposed.

I fully accept the above statements, and I will comply at all times with standard operating procedures and safety requirements pertinent to my area or country, and will endeavor to ensure the safety of all operators, as well as anyone near or in the area of my machine.

WARNING: Machines in motion can be extremely dangerous! It is the responsibility of the user to design effective error handling and safety protection as part of the system. VITAL Systems shall not be liable or responsible for any incidental or consequential damages. By using the HICON motion controller, you agree to the license agreement.

Preface

IMPORTANT

This document makes the assumption that the reader has thoroughly reviewed the necessary documentation:

- *Manual for specific HiCON Model (7866, 77E4AN)*
- *Mach4 HiCON Integration Manual*

The reader has also completed the proper hardware setup for their controller, and possesses basic knowledge and understanding of Mach4 CNC Software.

This document DOES NOT serve as a primer or tutorial for the use of Mach4. As such, readers without basic understanding of Mach4, and other software components not associated with Vital System Inc. are advised to consult the appropriate user manual and/or software vendor.

This document only serves as a supplemental user guide for the additional setup of Torch Height Control using the 77ISO tip voltage sensor with the HiCON and Mach4.

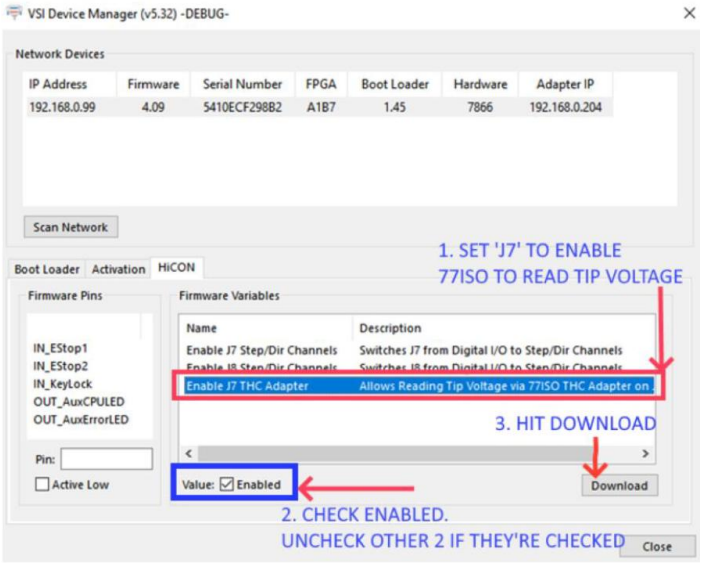
NOTE: *Several notes such as this can be found throughout this document which list key points and comments worth remembering.*

Setup 77ISO - (7866 Only)

The 77ISO board works with the HiCON motion controller to read the plasma tip voltage. This adapter accepts 0 to 10volts from the Plasma unit. You **must** select the proper divider to reduce the tip voltage (usually in the range of 300V) down to the 0-10 volts range.

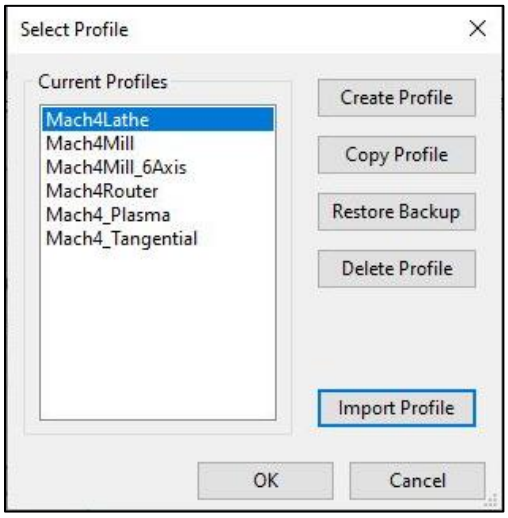
WARNING: **If you connect the Tip voltage directly to the 77ISO without a divider, the adapter and the motion controller will be damaged instantly.**

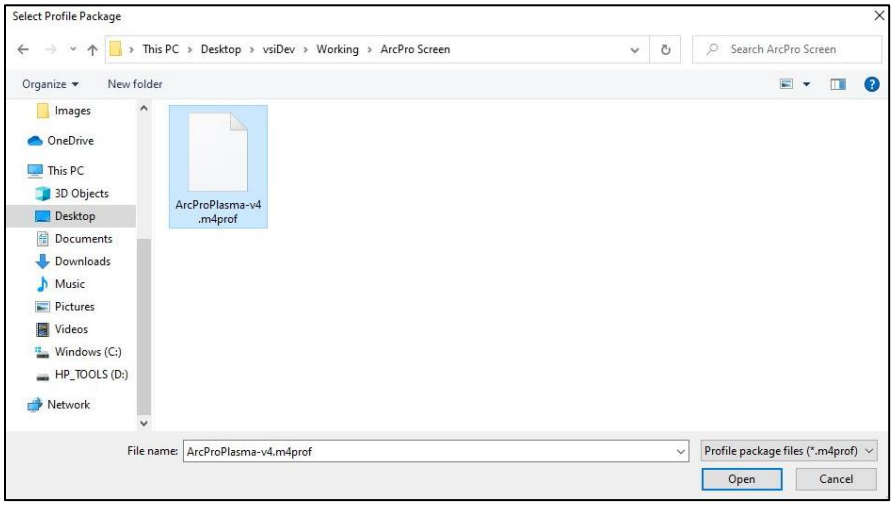
Plug the 77ISO directly into the J7 port on the 7866. Open the VSI Device Manager, scan for and select the 7866, and go to the HiCON tab. Select 'Enable J7 THC Adapter', check 'Enabled', and press 'Download'. This will configure the J7 port for use with the 77ISO sensor.



Import Mach4 Profile

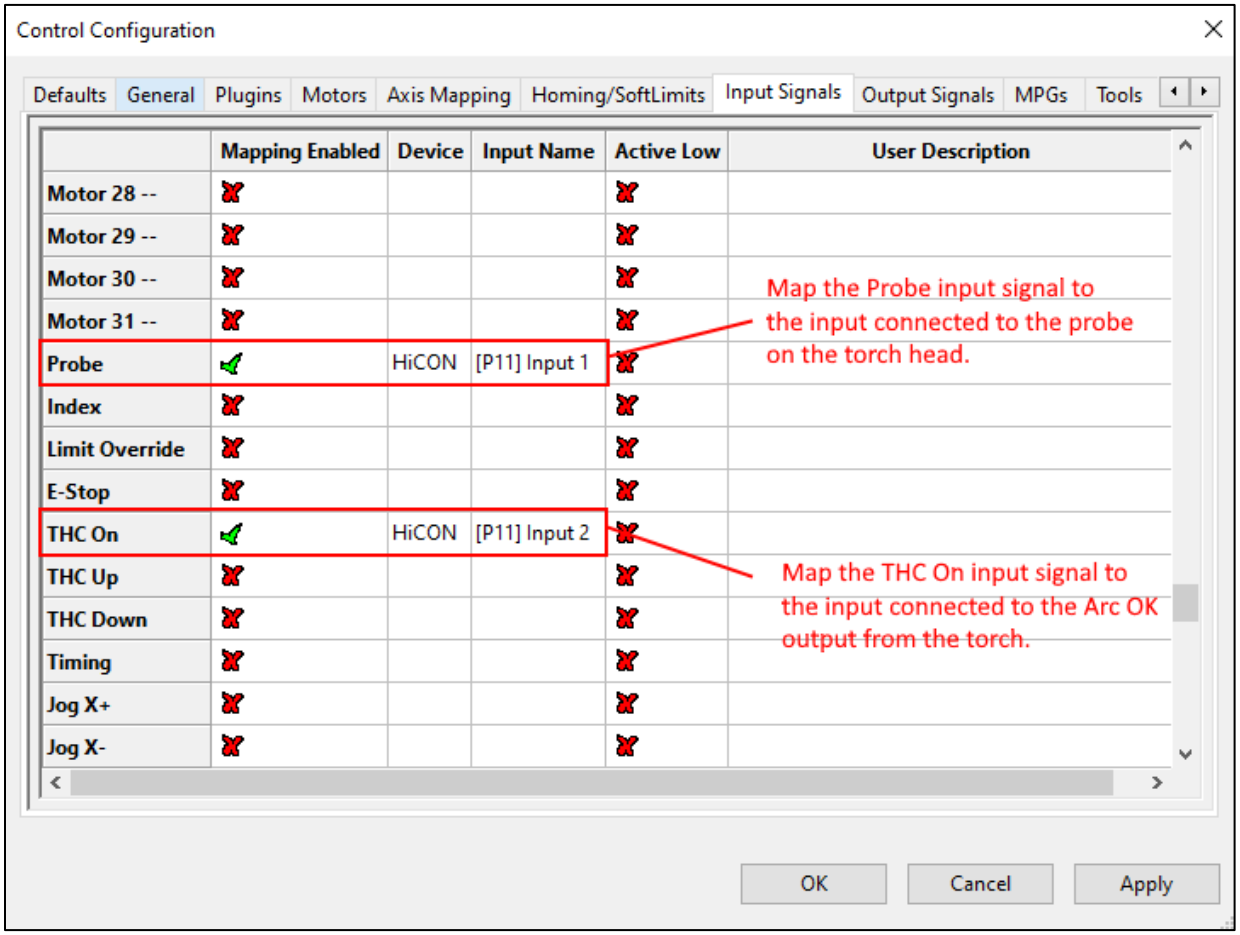
Open Mach4 loader and click on Import Profile. Browse for the downloaded profile (.m4prof) file and click Open. If you wish to rename the imported profile, change the name and click OK. Otherwise, press OK to finish.





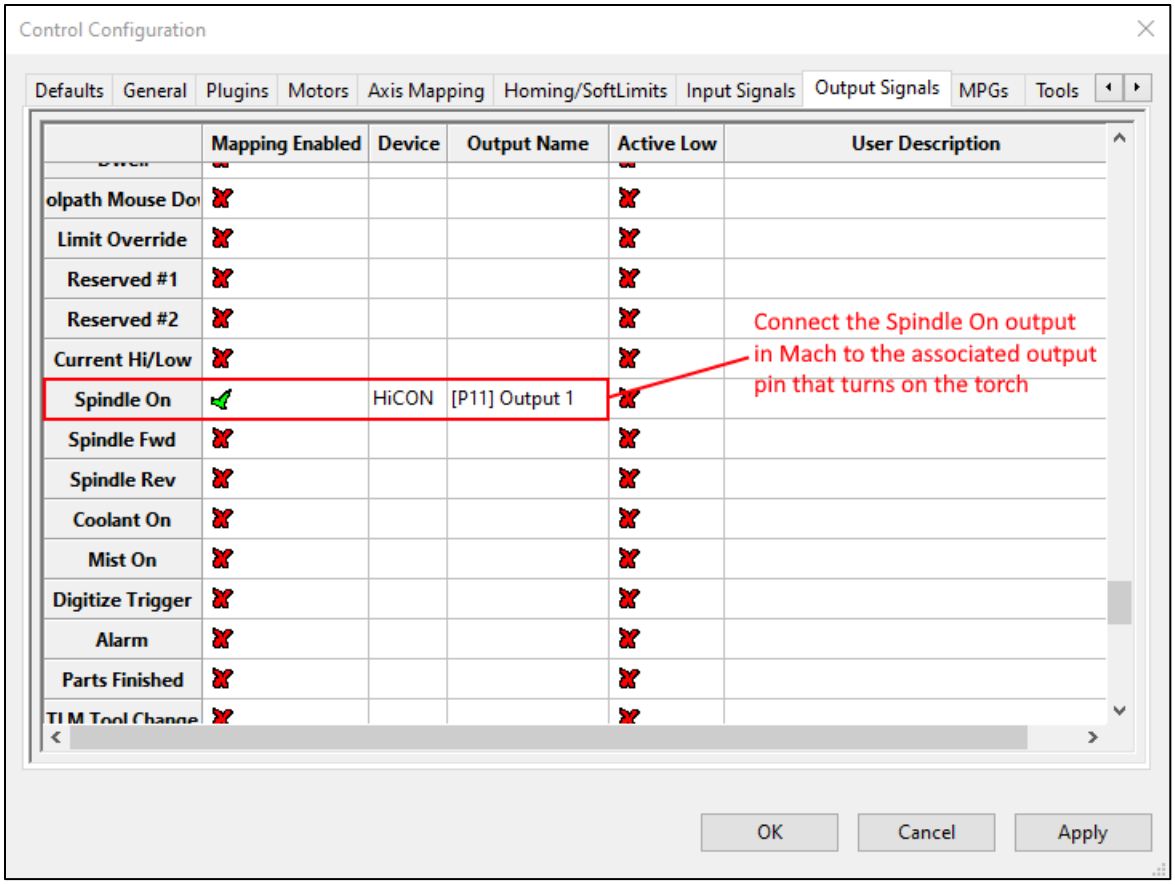
If you have not already, follow the HiCON Mach4 Integration Manual to install the HiCON plugin. It is required for the ArcPro Plasma Screen to operate as intended.

Mach4 Profile Configuration



Make sure the above signals are configured properly in the Input Signals tab of the Control Configuration window in Mach. Failure to do so will prevent Mach4 from receiving either the ***[Probe]*** or ***[THCOn/ArcOK]*** signals, causing the THC Start sequence to fail.

Note that the touchoff step of the THC Start sequence uses GCode G31. This means that the THC Start sequence requires the use of the ***[Probe]*** signal, and that any other Probe signal such as ***[Probe1]*** or ***[Probe2]*** will not suffice.



Make sure to connect the Spindle On output in Mach to the digital output that enables the torch. Failure to do so will prevent the torch from ever firing.

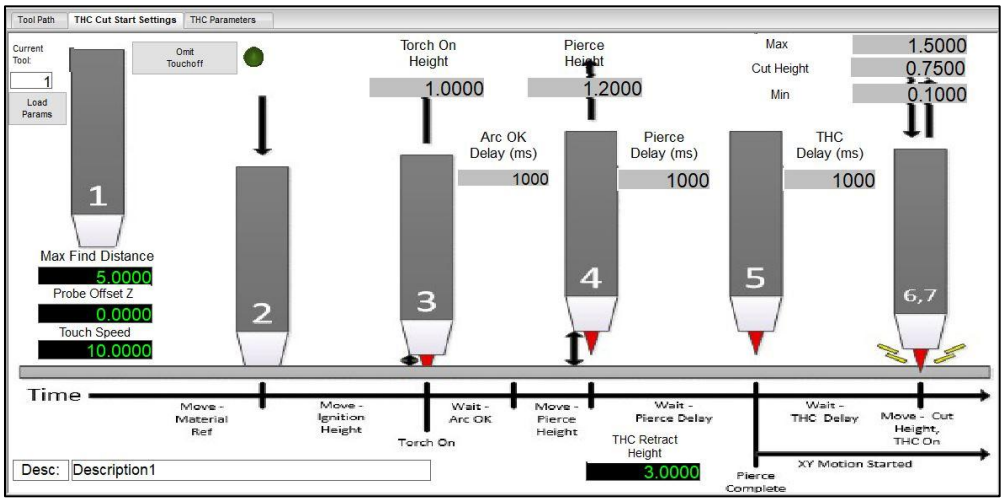
For further instruction on configuring Mach4, refer to the Mach4 HiCON Integration Manual.

ArcPro v4 Plasma Screen Overview

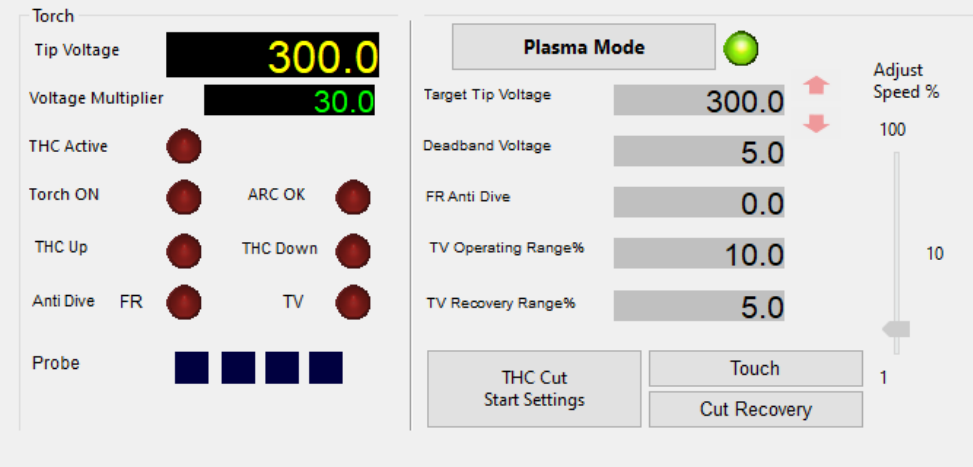
This screen provides advanced functions such as Tip Voltage antidive, which prevents the torch head from diving when encountering existing holes. Other features include a saving/loading system for material dependent THC settings so the operator will only have to enter settings once when changing materials frequently.

This section describes the different tabs and panels available to the user in the ArcPro screen. It may be useful to refer to the Plasma Cut Sequence section as necessary.

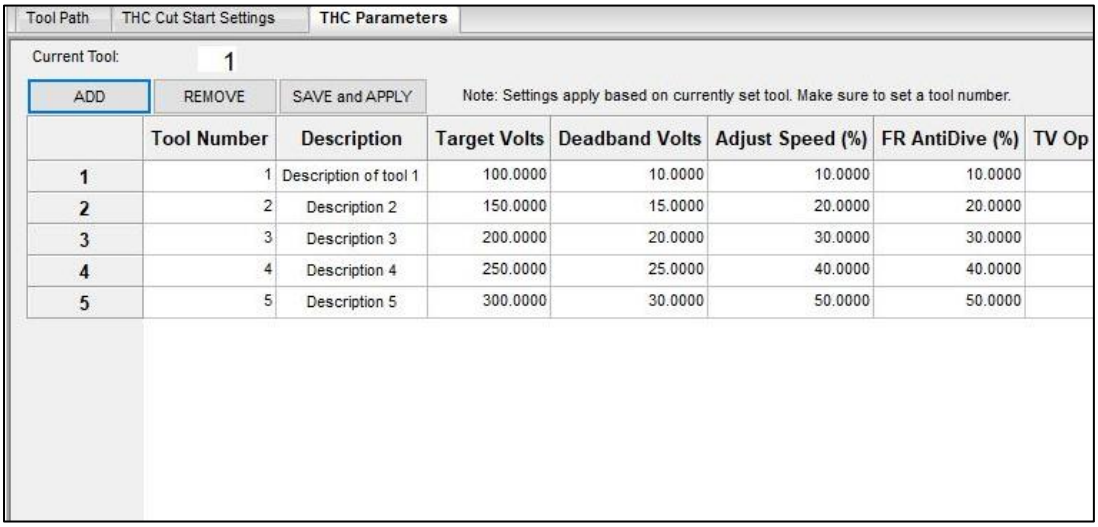
THC Cut Start Settings – This tab contains various indicators for settings related to THC startup. Note that many of these indicators are read-only, and that these must be edited from within the THC Parameters tab.



Torch – The left half of this panel contains indicators for the current state of THC operations. The right half of the panel contains readouts for various THC settings. Note that Plasma Mode enables and disables all THC operations, and that all THC settings and displays will be disabled when not in Plasma Mode. Read-only entries must be edited from within the THC Parameters tab.

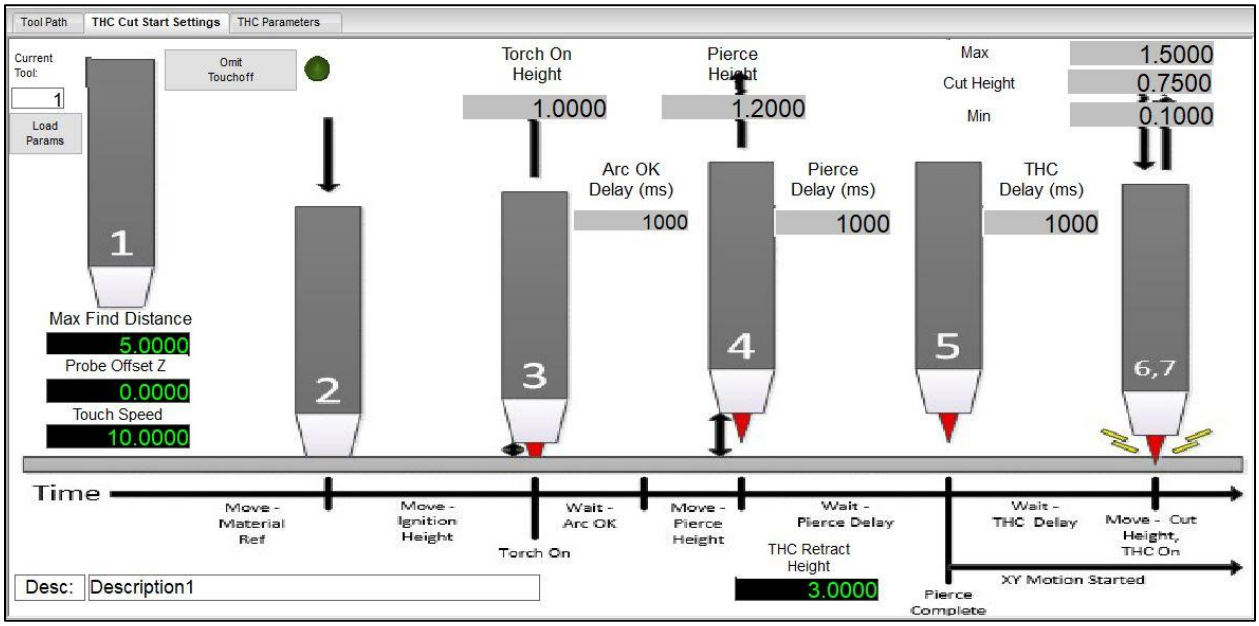


THC Parameters – This tab contains an editable table of all THC settings. Multiple entries can be created, and are identified by the entered tool number. The settings associated with the current tool number are loaded automatically when THC is enabled. This means you only have to enter the settings for each material once, and switching materials is as simple as changing the tool number.



	Tool Number	Description	Target Volts	Deadband Volts	Adjust Speed (%)	FR AntiDive (%)	TV Op
1	1	Description of tool 1	100.0000	10.0000	10.0000	10.0000	
2	2	Description 2	150.0000	15.0000	20.0000	20.0000	
3	3	Description 3	200.0000	20.0000	30.0000	30.0000	
4	4	Description 4	250.0000	25.0000	40.0000	40.0000	
5	5	Description 5	300.0000	30.0000	50.0000	50.0000	

THC Cut Start Settings



Current Tool/Load Params

The Current Tool field allows the user to view and change the current tool. The Load Params button allows the user to load the settings for the current tool from the THC Cut Start Settings screen (Note that these settings will be loaded regardless when THC is enabled with M3.)

Material-Independent Settings

These settings are not material dependent and are not loaded from the THC Parameters Table when THC is enabled. These are set directly from the screen.

Reference Position (Not shown on screen)

Z axis position that many THC Height values are relative to. This is set by the Touch-Off (probe) step of the startup sequence. If the Touch-Off is omitted, the reference position is the Z axis position in which M3 was called.

Omit Touch-off

The Omit Touch-off button allows the THC Cut Start process to skip the touch-off (probe) step.

Max Find Distance

This value is used in the Touch-off process, and represents the max distance the Z axis will travel while probing.

Probe Offset Z

This value is used in the Touch-off process, and represents the offset created by the digitize mechanical switch. The actual material height is calculated by subtracting this offset from the probe position. For ohmic sensor this value is usually zero.

Touch Speed

This value is used in the Touch-off process, and represents the speed at which the Z axis will move while probing.

Retract Distance

This value represents the distance that the Z axis will move up after turning off the torch with M5. This value must be positive.

Material-Dependent Settings

These values are set in the THC Parameters Table, and are loaded automatically based on the current tool number when THC is activated in M3.

Desc

The user defined description of the currently loaded materials settings.

Torch On Height

The height that the Z axis will move to after performing (or skipping) the touch-off process. This value is relative to the reference position and therefore must be positive.

Arc OK Delay

The amount of time in milliseconds after turning on the torch that Mach will wait for the Arc OK signal before timing out.

Pierce Height

The height that the Z axis will move to after receiving a successful Arc OK signal within the time window. This value is relative to the reference position and therefore must be positive.

Pierce Delay

The amount of time in milliseconds after reaching Pierce Height that Mach will wait before moving on.

Cut Height

The height that the Z axis will move to after the Pierce Delay has finished. This represents the optimal cutting distance for the given torch and material. This value is relative to the reference position, and must be positive.

THC Delay

The amount of time in milliseconds after reaching Cut Height that Mach will wait before activating THC (Torch Height Correction) on the motion controller. Please note that during this time span the GCode has already begun and that the torch is moving in the XY plane.

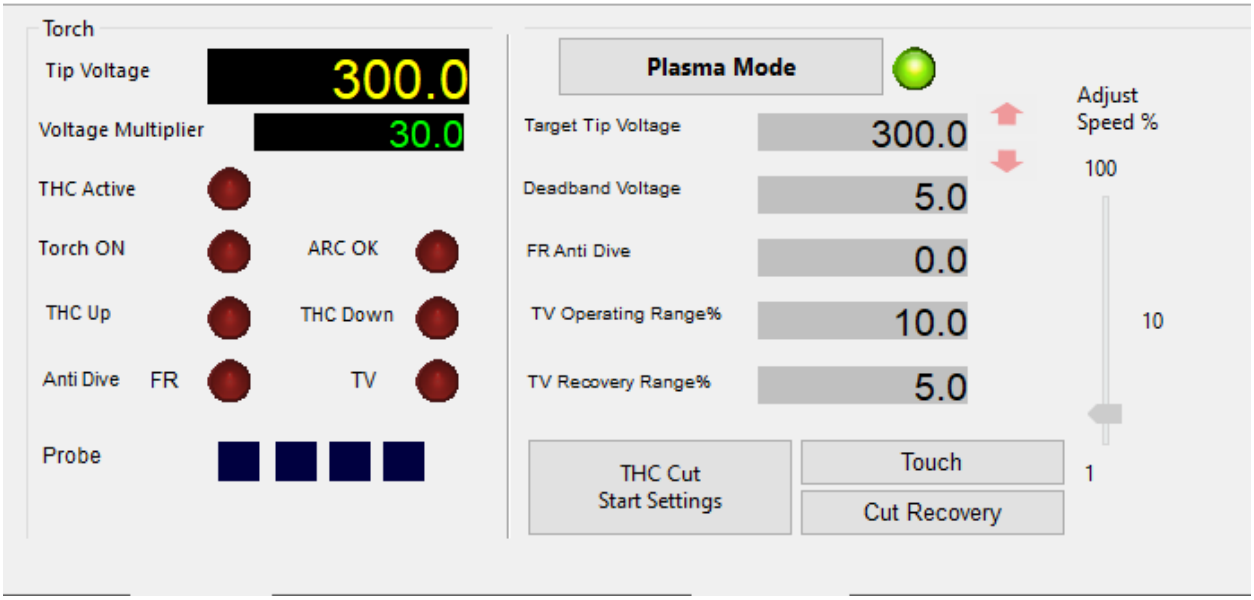
Max Cut Height

The max distance above the reference position that the torch is allowed to go to due to THC. This value is relative to the reference position and should be greater than or equal to the Cut Height. For example, if the cut height is 1”, and max Z is allowed to go up 0.4” above the Cut Height, then the Max Cut Height should be set at 1.4”.

Min Cut Height

The min distance above the reference position that the torch is allowed to go to due to THC. This value is relative to the reference position and should be less than or equal to the Cut Height. For example, if the cut height is 1”, and Z is only allowed to go to 0.3” below the cut height, then the Min Cut Height should be set at 0.7”.

Torch



Tip Voltage

Displays the current Tip Voltage of the torch. The tip voltage is calculated by multiplying the voltage multiplier by the analog voltage read by the motion controller.

Voltage Multiplier

The voltage multiplier will multiply the analog voltage read by the 77iSO adapter board or HiCON Mini analog input (0-10v) to calculate the actual Tip Voltage. For example, if your plasma system is using 50:1 multiplier circuit, this parameter must be set to 50.

THC Active

Indicates whether THC logic is currently active on the motion controller. The THC logic can be temporarily disabled if Antidive logic is triggered by too-low XY feedrate or tip voltage changing too quickly because of existing holes in the material.

Torch ON

Output signal that tells the Torch to turn on. This is internally referred to by Mach as Spindle ON.

ARC OK

Input signal received from the Plasma system that indicates whether the torch actually has turned on or not. This is internally referred to by Mach as THC ON.

THC Up/Down

LEDs that indicate whether the controller is trying to moving up or down due to THC. Once the Z axis has reached THC Min/Max, the motion will not continue past that point, but the LED may still be lit due to the difference between Target Voltage and Tip Voltage.

Anti Dive (FR/TV)

Indicates whether either Feedrate(FR) or Tip Voltage(TV) Anti-Dive are active and Z is frozen.

Probe

Indicators for probe signals 0, 1, 2, and 3.

Plasma Mode

Enables or disables THC and all related settings and UI controls. If Plasma mode is off, M3 will only turn on the spindle output and will not go through the THC Startup sequence.

Target Tip Voltage

The THC logic will attempt to bring the Tip voltage as close as possible to the Target Voltage by moving the Z up or down. A higher target voltage will place the torch further up from the material, while a lower target voltage will bring the torch closer. This setting must be set from the THC Parameters Table. During run time the Arrow buttons next to this value will be enabled, allowing the user to fine tune the target voltage on the fly. Once an optimal value is found, the parameters table should be updated with this value manually, otherwise the value will be overwritten the next time M3 is called.

Deadband Voltage

Represents a range around the Target Voltage in which the THC will not be activated. For example, a Deadband Voltage of 5 and a Target Tip Voltage of 150 would mean that the THC will not update within the range of 145-155.

Feed Rate Anti Dive (FR)

Feedrate Anti-Dive prevents the THC from dropping the torch into a cut hole, diving into corners, or diving at the end of a cut. When the XY cutting speed slows down, the plasma tip voltage increases, and as a result, the response from the THC is to lower the torch. When the actual cutting feedrate drops below the Anti-Dive Feedrate, FR Anti-Dive is engaged and the Z-Axis motion is disabled and stays locked in position until XY feedrate increases above the FR antidive value. (Note that for ArcPRO screen v4.1.2 and before, Anti-Dive Feed Rate was a ***percentage*** of the commanded feedrate, not an absolute value. If

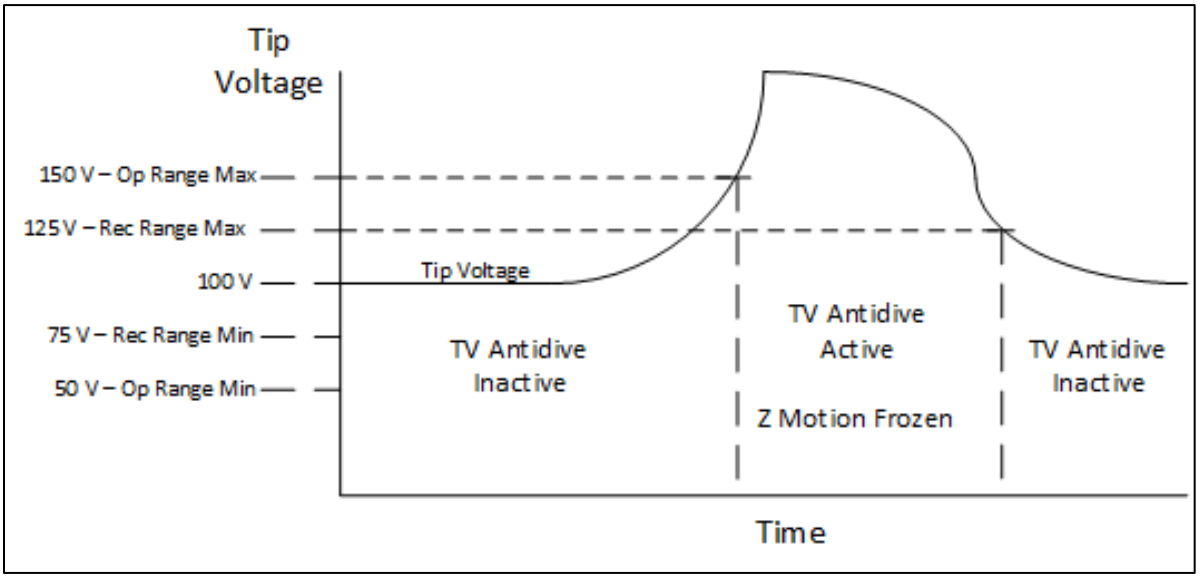
you want to use the old percentage-based approach, in Mach4, go to Diagnostics->RegFile, open up HiCON, and set DRO_To_Ctrl_8 to 0)

Tip Voltage Operating Range %

This value determines a Tip voltage operating range above and below the current tip voltage every 50milli seconds. For example, a value of 50% for Tip Voltage Operating Range and a Tip Voltage of 100 would result in an effective THC range of 50-150V. Tip Voltage antidive will be activated (Z movement frozen) if the Tip Voltage leaves this range during a 50 msec interval. This will prevent the torch head from diving when encountering existing holes.

Tip Voltage Antidive Recovery Range %

This value determines a Tip voltage recovery range above and below the current tip voltage every 50milli seconds. For example, a value of 25% for Tip Voltage Antidive Recovery Range and a current Tip Voltage of 100 would result in an effective recovery range of 75-125V. Tip Voltage Antidive will be deactivated (Z allowed to move) if the Tip Voltage enters this range in a 50 milli second interval. Note that the Recovery Range % must always be lower than the Operating Range %.



Adjust Speed %

This value represents the % of the speed configured for the Z axis that the THC should move Z at when performing THC corrections. For example, in Mach if Z is configured for 100 inches/minute, setting Adjust speed % to 10 will move Z at 10 inches/minute during THC correction moves.

THC Cut Start Settings (Button)

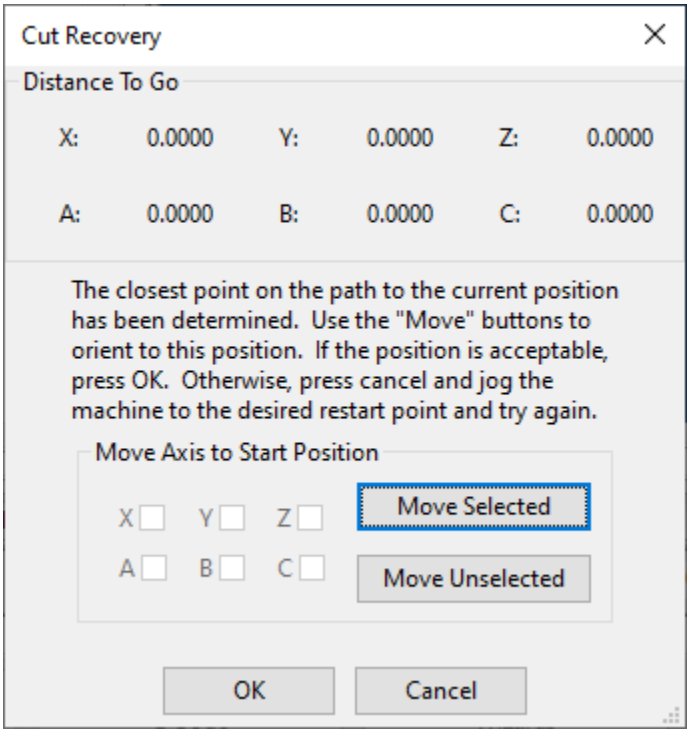
This button is simply a shortcut that opens the THC Cut Start Settings tab from anywhere in Mach.

Mach4 Touch

Wizard that allows the user to perform various different types of touch operations. For more details, please refer to the official Mach4 documentation.

Mach4 Cut Recovery

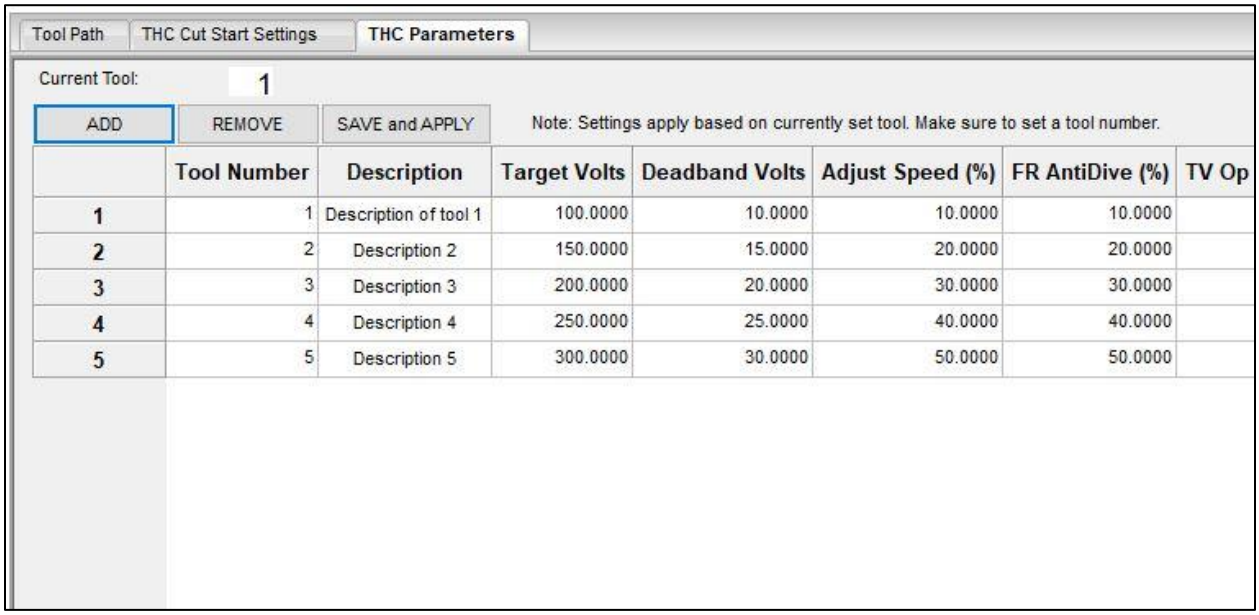
Wizard that allows a failed job to be manually recovered from. Move the torch head near the desired point on the toolpath, then click the 'Cut Recovery' button. The below window will appear:



Distance To Go – The offset from the nearest point on the toolpath

Move Axis to Start Position – This box has several axis check boxes and buttons to aid in precisely moving to the nearest point on the toolpath. You may select or deselect axes, then click either the 'Move Selected' or 'Move Unselected' buttons to move those axes onto the toolpath. Once on the toolpath, clicking OK will begin the startup steps listed previously in this document, and resume the gcode from the current position.

THC Parameters



	Tool Number	Description	Target Volts	Deadband Volts	Adjust Speed (%)	FR AntiDive (%)	TV Op
1	1	Description of tool 1	100.0000	10.0000	10.0000	10.0000	
2	2	Description 2	150.0000	15.0000	20.0000	20.0000	
3	3	Description 3	200.0000	20.0000	30.0000	30.0000	
4	4	Description 4	250.0000	25.0000	40.0000	40.0000	
5	5	Description 5	300.0000	30.0000	50.0000	50.0000	

Current Tool

Field to view and edit the current tool number.

Add

Adds an empty row to the end of the table. Uninitialized entries will default to 0.

Remove

Removes the most recently clicked row from the table.

Save and Apply

Saves the settings to the profile to be loaded later. If any row has the same tool number as the current tool number, loads the settings from that row. Note that it is required to click this button after making changes for them to have any effect. The button will appear red when changes have been made, but not yet saved. It will change to green once these settings have been successfully saved.

Macros

The ArcPro screen has a few different macros that are integral to its operation. They are:

M3 – This Macro fires the torch and initiates the THC startup process. It performs these steps, in order:

1. Loads settings from the THC Parameters table based on the current tool number.
2. Performs a touchoff to find a reference position for the rest of the steps (uses current position as a reference if touchoff was omitted)
3. Moves to a specified Torch On Height, then fires the torch. Then waits for a specified amount of time for an ArcOK signal. If the signal is not received, M3 times out and returns an error.
4. Moves to a specified Pierce Height, then waits for a specified Pierce Delay.
5. Moves to a specified Cut Height, enables Torch Height Control (THC), then starts the following GCode.
6. After a specified THC Delay, THC logic will activate on the controller.

M5 – In order, this Macro:

1. Turns off the plasma torch.
2. Disables THC logic on the controller.
3. Retracts the torch head away from the material by a specified Retract Distance.

M6 – This Macro simply changes the current tool number to the selected tool number.

Typical Plasma Cut Sequence

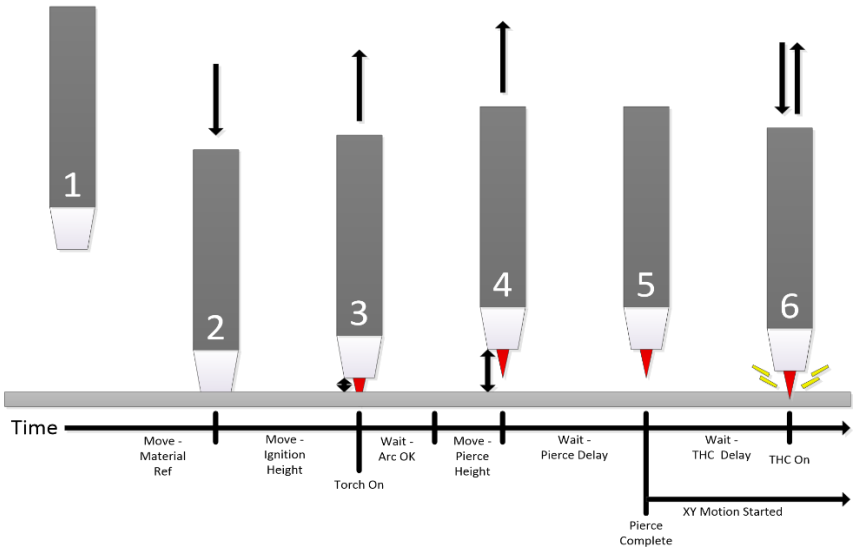
The typical plasma cut sequence begins with a call to M3, which initiates the THC startup sequence. Before the startup sequence begins however, the THC settings are loaded from the THC Parameters table based on the current tool number. Then, the startup sequence begins by probing the material height. After the probe is done, the torch is raised to Torch On Height and the torch on sequence can begin. The torch output is turned on, then waits until either the Arc OK signal is found or the sequence times out. Once the Arc OK signal is found, the Z axis moves to the pierce height and the pierce delay starts. Immediately following the pierce delay, the Z axis moves to the cut height, at which point the XY motion begins. After a delay equal to THC Delay, the torch height control can begin.

Both the Torch and THC process are disabled by a call to M5. This will also retract the torch head away from the material by a specified Retract Distance.

The following Gcode shows how a typical plasma cut sequence can be programmed. The entire setup process is handled by M3:

```
(Set tool number for desired material prior to sequence start)
M3          (turn on torch and begin torch height control sequence)
G1 X50Y50   (perform XY motions)
...
M5          (turn off torch and end torch height control sequence)
```

The figure below shows the plasma cut sequence.



Step 1: The height that the Z-Axis was at when the cut sequence began

Step 2: The torch head comes down to contact the material to determine the material height

Step 3: The torch head lifts to torch on height and turns on

Step 4: Once the Arc Ok signal turns on, the torch lifts to the pierce height

Step 5: Once Pierce delay is complete, the torch moves to cut height and XY motion begins

Step 6: THC delay is complete and the THC takes over Z-Axis control

How to Launch GCode File for Plasma Cut:

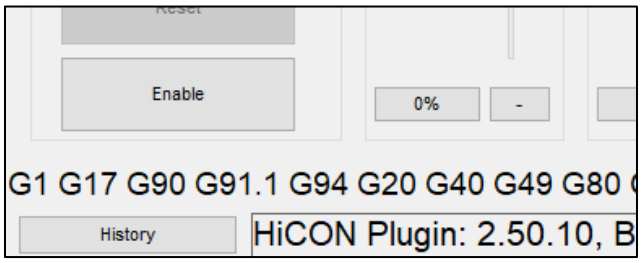
1. Load your GCode file. Make sure file contains M3/M5 macros to turn ON/OFF the torch/THC.
2. Enable Mach4 (click the enable button).
3. Enable Plasma Mode (click the “Plasma Mode” Button to toggle)
4. Click Cycle Start to launch the GCode file.

How to Launch Start and Stop THC Motion via MDI

1. Enable Mach4 (click the enable button).
2. Enable Plasma Mode (click the “Plasma Mode” Button to toggle)
3. Turn on the Torch/THC (use the M3 command)
4. Wait for the THC Startup sequence to complete successfully.
5. XY motion can now be performed with the Z axis Torch Height being automatically adjusted.
6. The Torch/THC can be turned OFF with the M5 command.
7. The Z axis is now back in Mach control.

Troubleshooting

Most error messages can be viewed in the history log of Mach4 and can indicate problems with the configuration or the runtime operation.



NOTE: *Please follow the proper setup instructions for wiring, Mach4 configuration, and the setting the on-screen THC parameters before attempting any tests.*

Error: The system disarms when calling the M3 command

Cause	**Solution**
One of the THC settings may be bad.	Review the THC settings on the ArcPro screen and make sure each of the values is valid.
The probe signal is active prior to touchoff.	The ***[Probe]*** signal must be off when beginning the touchoff sequence. Mach4 will error if it is not. Either start M3 from far enough away that the ***[Probe]*** signal is not on prior to calling M3, or omit the touchoff step by pressing the Omit Touchoff button.
The torch is currently active.	Make sure that M3 isn't being called twice unless M5 has been called since. The torch should not be on prior to M3 being called.
The probe move reached the indicated limit without detecting the digitize signal.	Check that the ***[Probe]*** signal in Mach4 is mapped to the correct digital input, and that the ***[Probe]*** signal toggles correctly by checking the signal state in the diagnostic tab on the Mach4 screen.
The THC feature is currently not activated on the unit.	Please contact the vendor of your unit, or Vital System Inc.
The **[THC On/ArcOK]** signal is not being detected after Torch Ignition.	Check that the ***[THC On/ArcOK]*** input signal is enabled and mapped to the correct digital input on the HiCON Integra. Also, check that the ArcOK signal LED on the ArcPro screen changes state when toggling the digital input.

Error: The Torch completes the M3 setup sequence, but does not move up or down afterwards

Cause	Solution
The THC max or THC min parameters values are too small.	The THC max and THC min control the maximum and minimum heights relative to the reference position that the torch will be allowed to move while cutting. Set these two parameters further apart to allow a greater window for height correction.
The Adjust Speed is set to a very small value	This parameter controls the speed at which the torch will move up or down. Set the Adjust speed to a greater value. (NOTE: speeds that are too high may stall stepper motors).
Feedrate antidive is active	The actual XY speed of the torch is falling considerably short of the commanded speed. Confirm that there are no mechanical issues involved. FR Antidive % may be too high. If the lower feedrate is acceptable, you can lower the feedrate antidive % futher to avoid the anti-dive logic to engage.
Tip Voltage antidive is active	The tip voltage is outside the acceptable operating range around the target voltage. Confirm that the tip voltage sensor is functioning properly, and that the appropriate voltage divider is being used. If these are correct, consider increasing the Tip Voltage Operating %.

Error: The Torch only moves in one direction, or the wrong direction while cutting

Cause	Solution
The system was not configured correctly.	Make sure that the target voltage and voltage multiplier are correct. Before placing the Z axis under THC control, it is also highly recommended to manually jog the Z axis to test if the axis direction is correct.

Error: The Z axis moves too fast while cutting

Cause	Solution
The Adjust Speed slider is set to a large value	Decrease the Adjust Speed value as necessary

Misc Error Codes:

Code	Solution
10005	Either: The THC axis is mapped to a motor that has not been activated. For example, if the device has 6 activated motors, this error will appear if the THC axis is mapped to motor 7, as this is outside the range of activated motors. The other scenario where this error will appear is if any of Min/Max Cut Height or the Feedrate AntiDive Threshold are below zero.

Additional References

- Mach4 HiCON Integration Manual
- Integra 7866 User Guide
- HiCON Mini User Guide