PRICECNC™

CNC Plasma Torch Height Controller

Installation and Operation Manual

SAFETY NOTICE

WHEN THIS DEVICE IS IN OPERATION, VOLTAGES HAZARDOUS TO HEALTH AND HUMAN LIFE ARE PRESENT INSIDE THE ISOLATION MODULE.

This device should only be connected by a qualified and authorized person. Improper connection can cause serious injury or death. Prior to installation and operation, carefully read the entire manual and be absolutely sure that you fully understand and are able to make the sole decision to determine if you are capable of a safe and proper installation. Remember that inside the Isolation Module, voltages hazardous to health and life may be present.

There must be no physical contact with any electrical connections while this device or any connected device is powered. Do not operate this product with wet hands, wet gloves, or any wet clothing. Before turning the unit on, secure the safety of others, and read and understand all instructions. If you have any questions or concerns, do not continue.

Warning: Provide adequate protection for all risks associated with plasma cutting. For more detailed information of the risk associated with plasma cutting, refer to your plasma cutter's owner manual.

This device must be earthed/grounded in accordance with this installation guide, earthing of non-electrified conductive parts (including device housings) is an essential part of electrical safety.

Touching non-insulated and non-grounded elements can be fatal. Provide a safe place for your device. After installation, securely protect against any physical contact between the terminals on the Isolation Module and any person(s).

It is strictly prohibited to perform any repairs or modifications to this product, performing either one of these actions could lead to serious injury or death to yourself and/or others.

Terms of Use: By proceeding with the installation and use of this product, you fully understand and agree that PRICE**CNC** and their distributors are not liable for any incident or event resulting in direct loss, indirect loss, injury to self or others, damage to property, or loss or damage of any kind and that the end user assumes all risks. If you do not agree to these terms in their entirety, proceed no further, and return this product for a full refund.

If you have any questions or are unsure about anything stated in this manual, please contact a PRICE**CNC** dealer or service centre for assistance.

Contents

Introduction

When using a CNC Plasma cutting table, good cut quality can only be achieved by maintaining a consistent distance between the cutting torch and the material being cut. This can be difficult to achieve as heat from the cutting process can warp the material being cut or the material that is being cut may not be level or flat. To overcome these problems during cutting, the cutting torch needs to be raised and lowered to compensate for changes in the height of the sheet.

The PRICE**CNC** Arc Voltage Height Controller measures the voltage between the plasma torch and the material being cut, this is known as the 'Arc Voltage'. As the distance between the torch and the material changes during a cut, the voltage also changes. The greater the distance, the higher the voltage and the smaller the distance the lower the voltage. By measuring the changes in the Arc Voltage, the AVHC10 can continuously adjust the arc length for optimum cutting performance.

Different materials types and thicknesses require different height controller setting. For convenience, up to 30 different material or thickness settings can be saved on the AVCH10.

1 Installation

The PRICE**CNC** Arc Voltage Height Controller has two main components. One is called the 'User Interface' and the other is called the 'Isolation Module'. Both of these units need to be connected to each other. The Isolation Module also connects to the plasma cutter and the user interface also connects to a power supply and the signal inputs and outputs on the breakout board.

In this installation example, we show how to install the PRICE**CNC** AVHC10 on to a Plasma CNC table with the following properties:

Design Software	SheetCam
Work Software	MACH 3
Breakout Board	5-axis with 1 relay output and 5 inputs
PC to Breakout Board Interface	LPT Parallel Printer Port
CNC Machine	Custom/Homemade/DIY 3 Axis CNC Table with Floating Z axis
Mechanical Drive	Stepper Motors
Plasma Cutter	R-Tech Plasma50CNC

1.1 High Frequency Plasma Cutter Interference

Some value plasma cutters use a high frequency, high voltage striking arc to strike across the air gap between the plasma cutter electrode and the work piece. This striking arc can generate massive electromagnetic fields which can interfere with surrounding electronics including CNC motors, drive units, breakout board and Computers. This electromagnetic field comes from the cables that connect the plasma cutter electrode to the plasma cutting machine. Cables that are connected to this circuit can also spread interference. The PRICE**CNC** Arc Voltage Height Controller is designed to keep this interference away from the CNC control circuitry by utilising a completely electrically isolated measuring circuit in the Isolation Module. The Isolation Module is also supplied and fitted with a shielded cable that provides the User interface with a clean signal for accurate measurement.

1.2 Earthing

To prevent the above mentioned High Frequency interference from becoming an issue on your CNC plasma cutting equipment, proper earthing/grounding must be fitted using at least 16mm^2 (AWG 5) multi strand cable. In a typical 3 axis CNC plasma cutting setup, the following components should be earthed direct to the star point:

- Arc Voltage Height Controller aluminium case.
- Fixed portion of table.
- Gantry
- Buggy
- Z axis travel plate
- Stepper/Servo motor control box
- Plasma Cutter case

The star point is a point where the earth wires from all of these individual items meet, this is then connected to the earth electrode. The alternative to a star point earthing system is a daisy chain earth system. This is not recommended as it is not as effective at preventing interference.

1.3 Raw Arc Measuring Point Connections

For best results, the cables that connect the Isolation Module to the plasma cutter should be protected from the effects of a bad connection on the circuit that carries the plasma current.

Sometimes rust or dirt on the work sheet can cause a poor clamp connection which can create a voltage difference between the clamp and the work piece which would affect the measured voltage used for controlling torch height. For best results, the black connection on the Isolation Module should be connected to the work piece by a separate small clamp.

A poor connection on the torch cable can cause the same issue, for best results, the connection from the Blue plug on the Isolation Module should be connected to the plasma torch as close to the tip as safely possible. Preferably, where the flexible air/current hose connects to the torch.

1.4   50:1 Measuring Point Connections

The 50:1 measuring circuit is designed to work with the 50:1 voltage divider output on a Hypertherm Powermax 45 Plasma Cutter and other Plasma cutters that use the same resistor network to create the 50:1 voltage. The Hypertherm Powermax 45 plasma cutter uses 100,000 and 2,000 ohm resistors in series to produce the a 50:1 voltage across the 2,000 ohm resistor. The PRICE**CNC** AVCH10 is calibrated for use with 50:1 voltage dividers with these particular resistances. Other resistor values will work but the accuracy of the measured voltage may be affected. The overall circuit resistance of the voltage divider should not exceed 120,000 ohms.

1.5 Floating Z Axis (not included)

For best plasma cutting results, the height at which each cut in a job starts should be measured by a floating Z axis. The floating Z axis operates a switch which activates the Digitize/Probe input in Mach3 when the torch descends into the work piece. When this method is used with the correct G-code (G31), the Z axis Digital Read Out (DRO) will be reset to zero at the start of each cut. This compensates for uneven sheet height and improves the cut quality.

1.6 Anti-Dive

A reduced feed rate is often used when cutting small holes or tight angles, this reduced feed rate increases the arc voltage which will cause the AVHC10 to lower the torch into the work piece. To prevent the torch diving into the work piece when a reduced feed rate is used, Torch Height Control should be deactivated during the reduced feed rate. One way to deactivate Torch Height Control is to use an anti-dive Macro in Mach 3. Unfortunately Mach 3 pauses the operation of the CNC machine momentarily while it executes the macro which may result in poor cut quality (dings/notches).
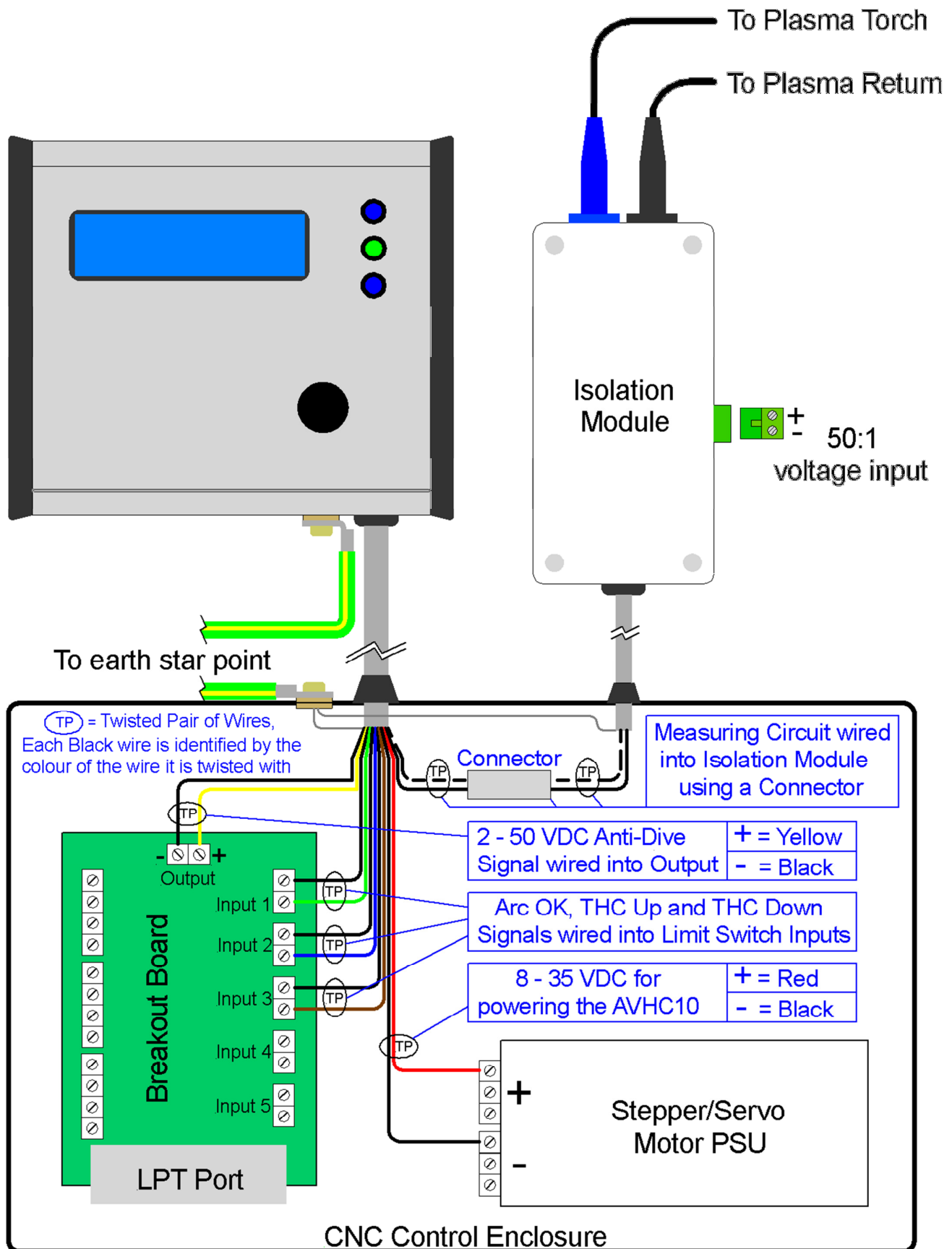
To overcome this, the PRICE**CNC** AVHC10 can take in a signal that blocks outgoing Raise and Lower commands. Using the correct cut rules in SheetCAM, the Post Processor will write G-code that includes a command to turn on and off a signal output on the breakout board. This signal is received by the AVHC10, blocking the raise and lower commands. This method is simple to install on most Breakout boards and prevents the CNC machine from needing a Macro to turn Torch Height Control on and off.

When anti-dive is activated, both blue LEDs will light up.

1.7 Mounting Holes

There are two threaded holes on the rear of the AVHC10 that can be used to mount the unit onto your CNC machine or control console.
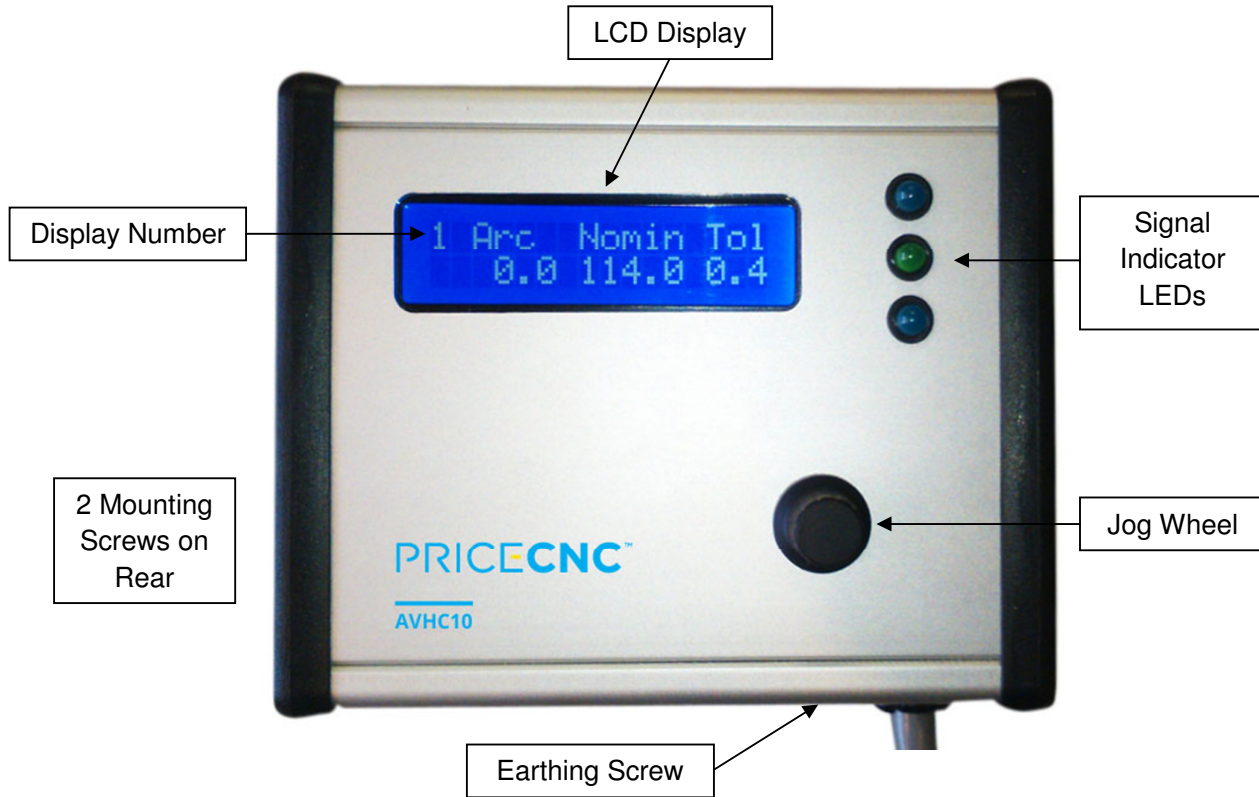
1.8 AVHC10 Installation Wiring Diagram

To Plasma Torch

To Plasma Return

Isolation Module

50:1 voltage input

To earth star point

TP = Twisted Pair of Wires, Each Black wire is identified by the colour of the wire it is twisted with

Connector

Measuring Circuit wired into Isolation Module using a Connector

Output

Input 1

Input 2

Input 3

Input 4

Input 5

Breakout Board

LPT Port

| 2 - 50 VDC Anti-Dive Signal wired into Output | + = Yellow |
| | − = Black |

Arc OK, THC Up and THC Down Signals wired into Limit Switch Inputs

| 8 - 35 VDC for powering the AVHC10 | + = Red |
| | − = Black |

Stepper/Servo Motor PSU

CNC Control Enclosure

1.9 Wiring Definitions

AVHC10

Wire Pairs		Polarity	Function	Min. Value	Max. Value	Unit
Red		Positive	Supplies power to the AVHC10	8	35	V
Black		Negative				
White		Positive	Measures the signal from the Isolation Module			
Black		Negative				
Yellow		Positive	Receives **Anti-Dive** Signal from Mach 3 via Breakout Board	2	50	V
Black		Negative				
Green		Either	Sends **Arc OK** Signal to Mach 3 via Breakout Board		50	V
Black		Either			100	mA
Blue		Either	Sends **Torch Up** Signal to Mach 3 via Breakout Board		50	V
Black		Either			100	mA
Brown		Either	Sends **Torch Down** Signal to Mach 3 via Breakout Board		50	V
Black		Either			100	mA

Isolation Module

Wire Pairs		Polarity	Function	Max. Value	Unit
White		Positive	Sends Isolated and reduced signal to the AVHC10	5	V
Black		Negative			
4mm Plug		**Polarity**	**Function**	**Max. Value**	**Unit**
Blue		Negative*	Connects to Plasma Electrode	-300 continuous* (HV starting Arc OK)	V
Black		Positive*	Connect to Plasma Return clamp		
50:1 Plug		**Polarity**	**Function**	**Max. Value**	**Unit**
Green		See Label	Connects to 50:1 voltage divider	6 (HV starting through 100k Resistor OK)	V

* Most Plasma Torch Electrodes operate at Negative Voltages

2 AVHC10 Operation

LCD Display

Display Number

Signal
Indicator
LEDs

`1 Arc  Nomin Tol`
`   0.0 114.0 0.4`

2 Mounting
Screws on
Rear

Jog Wheel

PRICE**CNC**™

AVHC10

Earthing Screw

The AVHC10 is always ready to work when powered on, minimising the need to interact with the device. The way the AVHC10 operates can be set by the user by using the Jog Wheel to navigate through the simple menu structure.

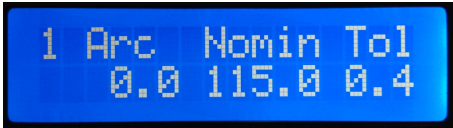The recommended sequence of events for Plasma Cutting using the AVHC10 is:

1. Prepare G-code that uses a floating Z axis to find a new Z axis zero at the start of each cut and also activates Anti-Dive on certain types of cut operations like tight radius cuts and corners.
2. Run the cut job.
3. The Torch moves over the first pierce point.
4. The Torch lowers until the floating Z axis switch is triggered by the torch touching the material to be cut. (G31).
5. The Z axis position is reset to *Zero minus the switch offset* (G92).
6. The Torch is raised to the pierce height and Plasma is turned on.
7. After the (G-code) pierce delay, the torch is lowered to the cut height.
8. The torch moves along the cut while the AVHC10 monitors the Arc Voltage and issues raise and lower commands to Mach 3 via the Breakout Board.
9. The torch comes to a tight radius bend during the cut which contains an M11P2 (Turn off THC) command which turns on the output signal that activates the AVHC10 Anti-
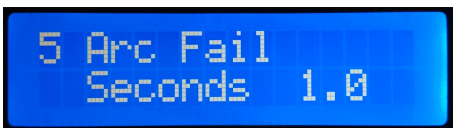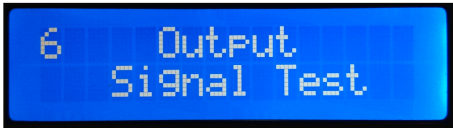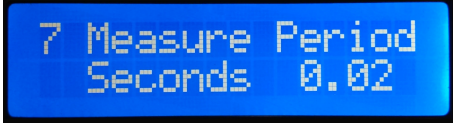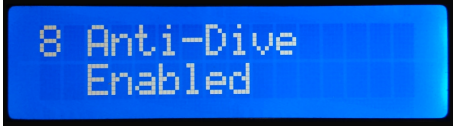
Dive. Both the Up and Down LEDs on the AVHC10 turn on to signify Anti-Dive is operating.
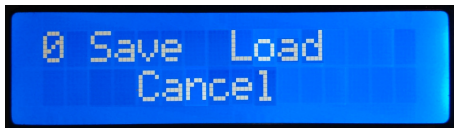
10. The torch comes from the end of the tight radius bend to a straight section of the cut which contains an M10P2 (Turn on THC) command which turns off the output signal that activated the AVHC10 Anti-Dive. Both the Up and Down LEDs on the AVHC10 turn off and the AVHC10 resumes torch Height Control.

11. The torch moves along the cut while the AVHC10 monitors the Arc Voltage and issues raise and lower commands to Mach 3.

12. The cut finishes and Mach 3 turns off the torch.

13. The AVHC10 recognises the voltage is now outside the Arc OK range and stops issuing any commands.

If the Arc OK signal is utilised and the Plasma Arc fails during a cut for longer than the Arc Fail duration that is set on the AVHC10, the Arc OK LED will go out and the Arc OK signal to Mach 3 will change. This will make Mach 3 pause the job until the Arc OK signal resumes, which may happen if your plasma cutter automatically tries to re-fire an arc.

2.1 Display List

| AVHC10 Display	Use	Operation
1 Arc Nomin Tol **0.0 115.0 0.4**	Displays the measured Arc Voltage. Displays and edits the **Nomin**al and **Tol**erance Voltages.	1. Press Select (**Nomin** flashes) 2. Use Jog Wheel to edit **Nomin**al Voltage 3. Press Select (**Tol** flashes) 4. Use Jog Wheel to edit **Tol**erance Voltage 5. Press Select
The Nominal Voltage is the Voltage the Plasma cutter operates at when cutting at the correct height. The Tolerance Voltage is amount that the Arc Voltage is permitted to differ from the Nominal Voltage before the AVHC10 will issue Raise or Lower Commands.		
2 Pierce Setup **Seconds 0.3**	Displays and edits the Pierce Delay	1. Press Select (Seconds Flashes) 2. Use Jog Wheel to edit the Pierce Delay 3. Press Select
The Pierce Setup is the delay that is used to give the Plasma Torch time to pierce and achieve a stable voltage, before the AVHC10 starts issuing Raise and Lower Torch Commands.		
3 Arc OK Range **Nomin +25 -25**	Displays and edits the Arc OK Range.	1. Press Select (**+** flashes) 2. Use Jog Wheel to edit Upper Range Voltage 3. Press Select (**-** flashes) 4. Use Jog Wheel to edit Lower Range Voltage 5. Press Select
The Arc OK Range is the Voltage above and below the Nominal Voltage that decides if the measured Arc Voltage is acceptable. If the measured Arc Voltage is within this range, the Arc OK Signal will be issued and the AVHC10 will issue Raise and Lower commands as needed. Outside this range, no signals are sent.		

AVHC10 Display	Use	Operation
4 Show Advanced Settings	Hides or Shows the Advanced Settings Displays	1. Press Select to change Show to Hide 2. Press Select again to change back.
For normal operation, the Advanced displays are not usually necessary and can be hidden using this Display.		
5 Arc Fail Seconds 1.0	Displays and edits the Arc fail Duration	1. Press Select (Seconds Flashes) 2. Use Jog Wheel to edit the Arc fail Duration 3. Press Select
The Arc Fail Duration is the length of time that the Measured Arc Voltage is permitted to be outside the Arc OK range before the Arc OK signal is stopped. This is to prevent short duration Arc Voltage spikes or dips from causing problems.		
6 Output Signal Test	Tests the output signals	1. Press Select (Screen Changes)
6 UP ARC_OK DOWN OUTPUT TEST	Selects the Signal to Test	2. (Up Flashes) 3. Use Jog Wheel to select other outputs 4. Press Select (Screen Changes Back)
This display is used to Test the Output signals of the AVHC10 and is useful for verifying that Mach 3 is receiving the signals. The Diagnostics Screen in Mach 3 displays all active inputs and the signals they represent. See section 3.1 for details.		
7 Measure Period Seconds 0.02	Displays and edits the Period of measurement. (How quickly the unit responds to Measured Voltage Changes)	1. Press Select (Seconds Flashes) 2. Use Jog Wheel to edit the Measure Period Duration 3. Press Select
The Measure Period selects how long the AVHC10 output signals take to react to changes in the Measured Voltage. This is used to tune the AVHC10 response time to best suit your system. (0.1 recommended for beginners, but this value should be raised and lower to find the response time that bests suits your equipment.)		
8 Anti-Dive Enabled	Enables or Disables the response of the AVHC10 to an Anti-Dive command	1. Press Select to change Enable to Disable 2. Press Select again to change back.
If the AVHC10 Anti-Dive is enabled but the G-code that is running the cut job does not use Anti-Dive commands, Mach 3 may leave the Anti-Dive signal in the on (high) state which would stop the AVCH10 from sending Raise and Lower commands. To prevent this problem, Anti-Dive can be Disabled on this Display.		

| AVHC10 Display	Use	Operation
0 Save Load Cancel	Selects weather to save present settings or load saved settings.	1. Press Select (SAVE, LOAD or CANCEL) flashes. 2. Use Jog wheel to highlight the required option. 3. Press Select
Settings can be saved in any of the 30 memory slots on the AVHC10. The memory slot that contains the setting for cutting a particular material or thickness should be referenced in the name of the SheetCAM tool that is used for that material or thickness.		
0 Select Memory Slot 30	Selects the Memory slot to save to or load from.	1. Use the jog wheel to scroll to the required memory slot. 2. Press Select to confirm the memory slot. (Settings will be saved or loaded)
The number that is initially displayed is the number of the last saved or loaded memory slot.		

3 Appendix

3.1 Setting up the AVHC10 in Mach 3

1. From the Menu Bar in Mach 3, click on 'Config' > 'Ports and Pins' > 'Input Signals'.

2. Scroll down the Signals list and change the setting for 'THC On', 'THC Up' and 'THC Down' to the correct Port and Pin Number.
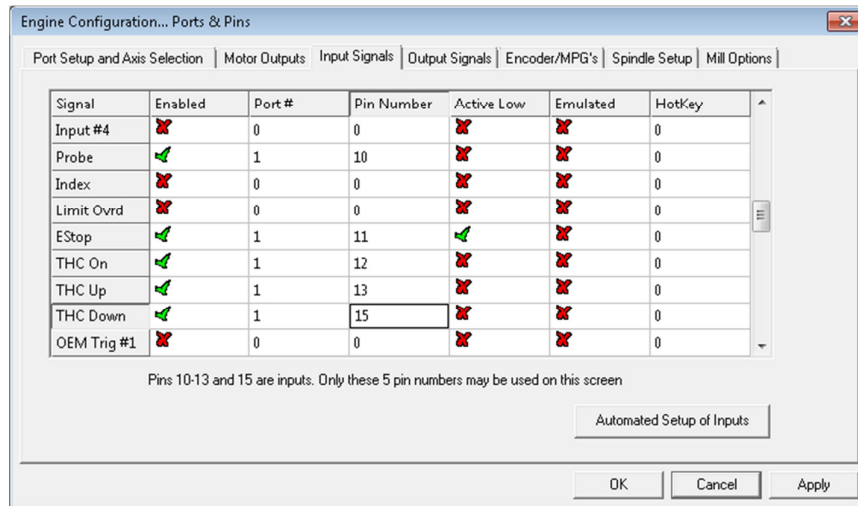
   Note: The 'Probe' signal is for the floating Z axis and responds to G31 commands.
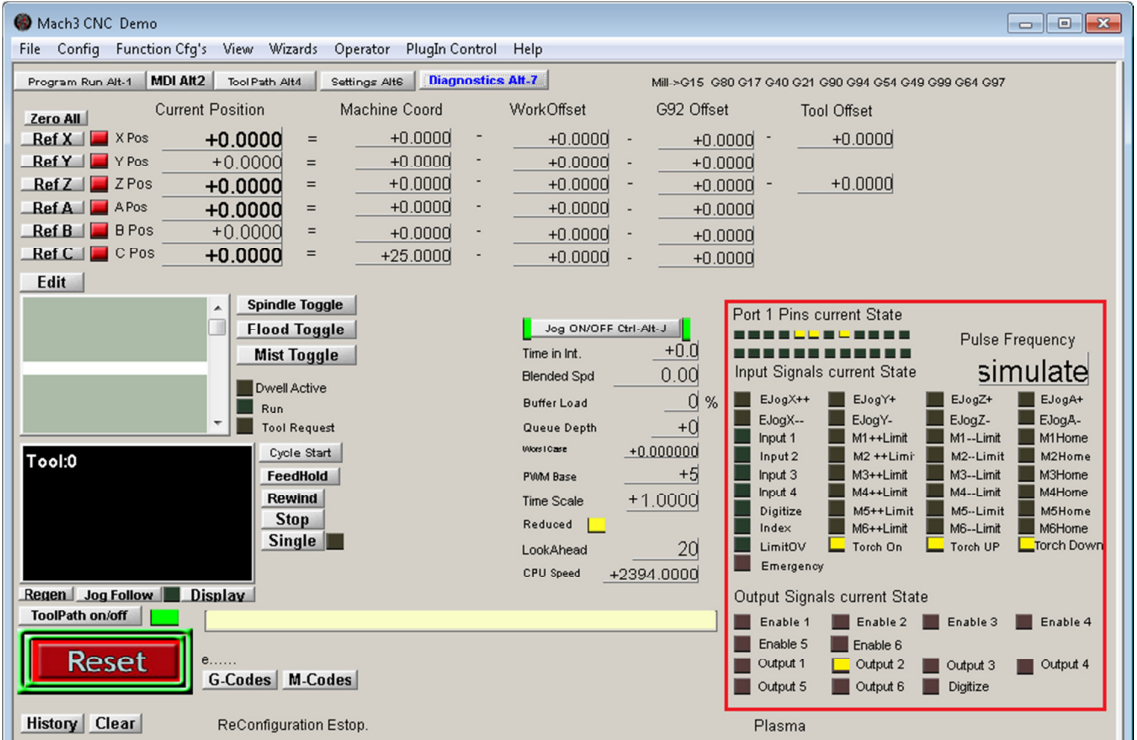
3. Click on the 'Output Signals' tab. Change the setting for 'Output #2' to the pin that will operate the AVHC10 anti-dive.
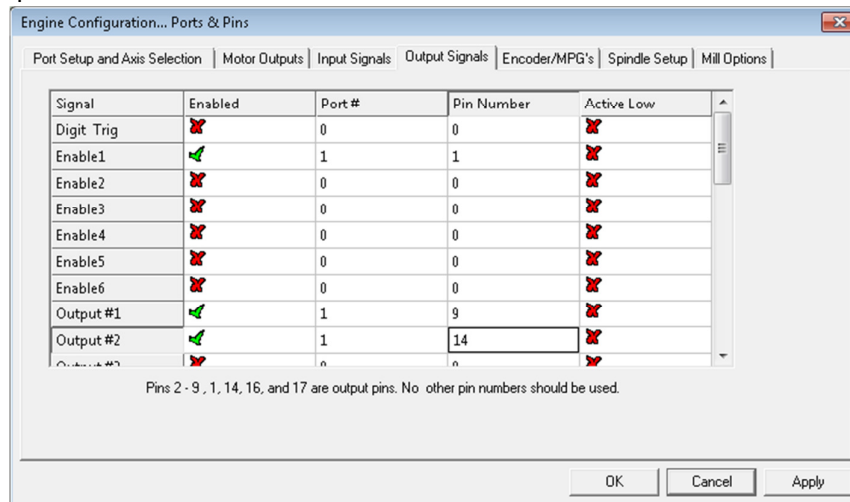

   Note: A different output number can be selected from the signal list. 'Output #2' is turned on by the G-code command 'M11P2' and turned off by 'M10P2' If a different output number is required, change the '2' in the code snippet to the required number when creating the rules in SheetCAM. For details, see section 3.2.

To verify that Mach 3 is communicating correctly with the AVHC10, view the diagnostics screen in Mach 3.

Using screen 6 on the AVHC10, you can manually operate the Arc OK, Torch UP and Torch Down signals. If the AVHC10 is communicating correctly through the Breakout Board, the corresponding signals should light up the respective pins signal status indicators.

To verify the anti-dive signal, go to the output signals configuration screen and click on 'Active Low' to change the state of the signal. If anti-dive is enabled on the AVHC10, this will make the two blue LEDs on the AVHC10 light together to show anti-dive is activated.
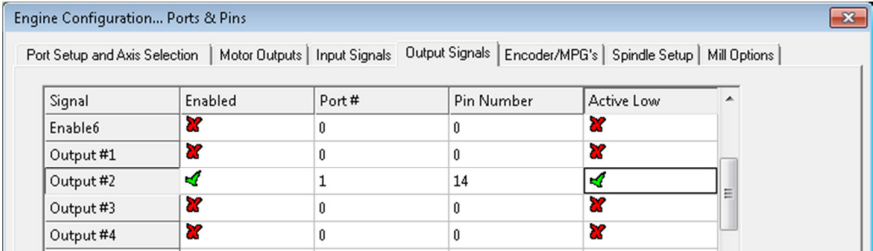
3.2 Setting up the AVHC10 in SheetCAM

SheetCAM has a useful feature where you can set rules for cutting different types of shapes. This is a great aid to improving cut quality and can also be used to activate and deactivate torch height control during different parts of a cut.

To set a rule in SheetCAM that will turn off torch height control during part of a cut, open SheetCAM and follow these steps:

1. From the menu bar, click on 'Tools' and then click on 'G Code.
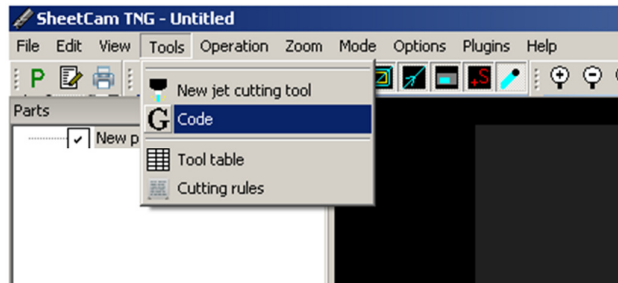
2. Type 'THC ON' and 'M10P2' as show here, then click OK.
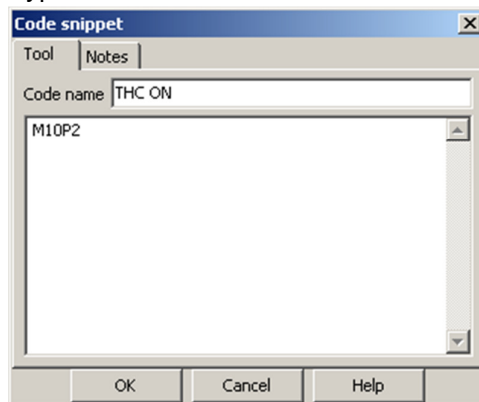
> **TIP**
>
> M10/M11 are on/off commands for external outputs. P2 refers to which output channel is selected. In Mach 3, P2 will be allocated to a specific pin in the LPT port which will operate a digital out on the Breakout Board.

3. Repeat step 1 and make another Code snippet called 'THC OFF' using the code M11P2 as shown here, then click OK.
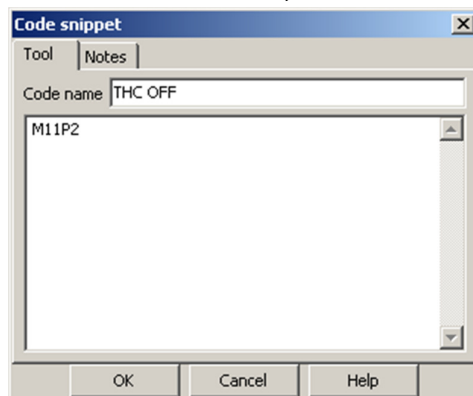
4. From the menu bar, click on 'Tools' and then click on 'Cutting rules'.
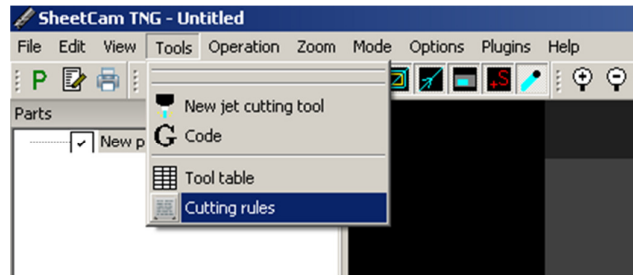
5. From the dropdown beside 'Rule set', select 'Add new rule set'
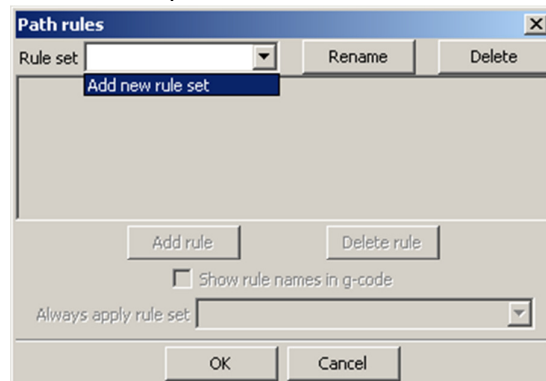
6. Create a new name for the rule and click 'OK'
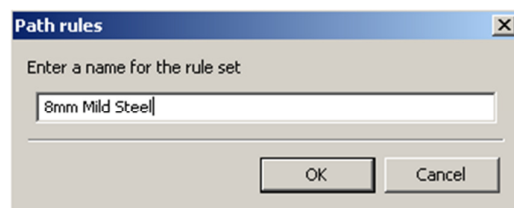
7. Click 'Add rule'
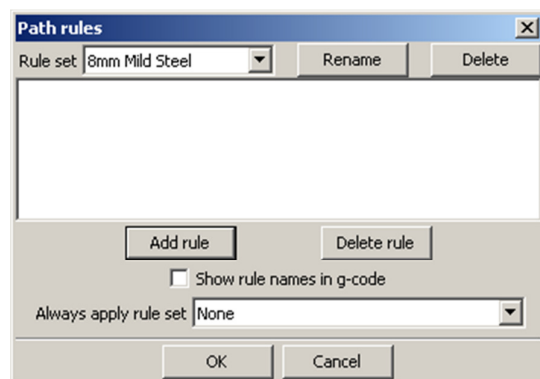
8. Click on the first dropdown to see what part or type of cut you want to apply the rule to. Here, I have selected to make a rule that affects small circles.

Rule	On small circles
Smaller than	25 mm
Feed rate	60 %
Start code	None
End code	None

OK   Cancel

9. Click on the drop-down beside 'Start code' and select 'THC OFF', then click on the drop-down beside 'End code' and select 'THC ON'. Click OK.

|	
Rule	On small circles
Smaller than	25 mm
Feed rate	60 %
Start code	None
End code	None / Code: THC OFF / Code: THC ON

OK   Cancel

Rule	On small circles
Smaller than	25 mm
Feed rate	60 %
Start code	Code: THC OFF
End code	Code: THC ON

OK   Cancel

10. Repeat steps 7 to 9 to make more rules. Additional rules like the ones show here may further improve cut quality.

Rule	On lead in
Feed rate	80 %
Start code	Code: THC OFF
Distance after	0 mm
End code	Code: THC ON

OK   Cancel

Rule	On small shapes
Smaller than	40 mm
Feed rate	60 %
Start code	Code: THC OFF
End code	Code: THC ON

OK   Cancel

Rule	On all corners
Tighter than	45 degrees
Distance before	5 mm
Feed rate	60 %
Before code	Code: THC OFF
Distance after	5 mm
End code	Code: THC ON

OK   Cancel

Rule	Before end
Distance	10 mm
Include leadout	✔
Feed rate	100 %
Start code	Code: THC OFF

OK   Cancel

11. The new Path rules should be displayed, click OK to close this window.

Path rules

Rule set | 8mm Mild Steel   Rename   Delete

- On circles smaller than 40 mm set feed to 60 % and output Code: THC
- On leadin set feed to 80 % and output Code: THC OFF then after 0 n
- On shapes smaller than 40 mm set feed to 60 % and output Code: TH
- On all corners tighter than 45 degrees set feed to 60 % and output C
- 10 mm before end set feed to 100 % and output Code: THC OFF

Add rule   Delete rule

☐ Show rule names in g-code

Always apply rule set | None

OK   Cancel

12. When creating a Jet cutting operation in SheetCAM, select the required rule from the 'Path rules' drop-down. This will use improved cut techniques and turn the height control on and off when required. If the rules are working correctly, the M10P2 and M11P2 commands should appear in the G-code file.