PRICECNC™

CNC Plasma Torch Height Controller

Installation and Operation Manual

Model: AVHC10 Rev: 1.5

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. Keep device away from water.

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 settings. For convenience, up to 30 different material or thickness settings can be saved on the AVCH10. This is discussed further in Section 4: 'AVHC10 Operation'.

CNC Plasma cutting is a complex process that can take some time to come to terms with before satisfactory cut results are consistently achieved. Particularly if you are learning it all as you build your own CNC table or through trial and error. I have included two unusual sections in this manual to make it as useful as possible for those with little experience. Section 1: 'Things you should know before Installation' and Section 3: 'Things you should know before operating your Plasma CNC with THC' are based on my personal experience from having designed and built my own CNC plasma Table and from the research taken to develop this product.

1. Things you should know before Installation

The Price**CNC** Arc Voltage Height Controller (AVHC10) 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. Additionally the user interface also connects to a power supply as well as the signal inputs and outputs on the breakout board.

In this manual, we show how to install the Price**CNC** AVHC10 on to a Plasma CNC table with the following properties, other variations are possible:

Design Software	SheetCam
Work Software	MACH3, UCCNC or LinuxCNC
Breakout Board	3-Axis with 3 spare inputs and 1 spare output (spare output not required with UCCNC, an unused axis can be used as 2 separate output signals)
CNC Machine	DIY or Professional 3-Axis CNC Table with Floating Z axis and probe switch
Plasma Cutter	Any commercially available model with cutting arc voltages in 70-250V DC range

1.1 High Frequency Plasma Cutter Interference

Some value plasma cutters use a high frequency, high voltage starting arc to strike across the air gap between the plasma cutter electrode and the work piece. This starting 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 previously 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 components should be earthed directly to the star point. 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 components to be connected are as follows:

- 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 alternative to a star point earthing system is a daisy chain earthing system. This is not recommended as it is not as effective at preventing interference. If your star point is not sufficiently connected to the mass of earth, your earthing system may spread interference instead of absorbing it into the ground.

1.3 Floating Z-Axis (not included)

A floating z-axis is a method of mounting the plasma torch to your CNC machine that allows your CNC machine to measure the height of the material to be cut before each cut starts. This feature is highly recommended as it sets the pierce height and initial cut height correctly at the start of every cut regardless of sheet warping or slope.

To achieve this, the plasma torch must be mounted to the z-axis in such a way that it will activate a micro-switch (or similar) when the tip of the torch touches the material to be cut. Usually this is achieved my mounting the torch to the z-axis using a set of rails that permit it to float up and down independent of the motorised z-axis.

This micro switch must be connected to an input on your Breakout Board (BOB) which operates the Digitize/Probe inputs in Mach3 or UCCNC.

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.

In Mach3 and UCCNC, you can also set upper and lower z-axis limits of THC operation. This is a very useful failsafe for THC and can prevent the torch raising too high or diving too low during cutting. For the z-axis limits, the pierce and initial cut height settings to work correctly, a floating z-axis or equivalent method of resetting the z-axis at the start of each cut is essential for reliable and consistent plasma cutting.

The floating z-axis operation is managed by a Post Processor, see section 3.1 for more details.

2. Installation

2.1.1 Raw Arc Measuring Point Connections

(We recommend you only use Raw/Direct Arc measurement when the 50:1 voltage divider is not provided with your plasma cutter. Most good brands of plasma cutter sold for use on CNC machines will have a 50:1 voltage divider.)

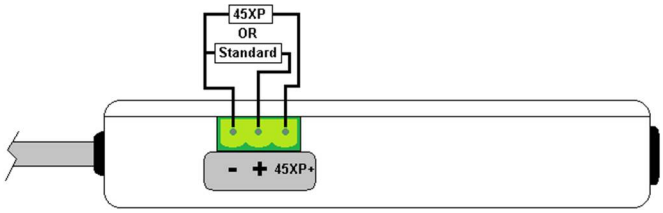
For Raw/Direct Arc measurement, a connection into the main plasma terminals on the outside of the plasma cutter will usually be sufficient.

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 can affect the measured voltage used for controlling torch height. If you have problems measuring a stable voltage during cutting, consider connecting the black connection on the Isolation Module to the work piece by a separate small clamp (this option does not apply to the 50:1 input).

2.1.2 (50:1) Measuring Point Connections

There are two separate 50:1 voltage inputs on the Isolation Module, these are:

- The standard 50:1 input
- and the 45XP input



The Standard 50:1 input is designed to work with the 50:1 voltage divider output on older Hypertherm plasma cutters and other plasma cutters that use the same resistor network to create the 50:1 voltage. The Hypertherm Powermax 45 plasma cutter uses a 100,000 and a 2,000 ohm resistor in series to produce the 50:1 voltage across the 2,000 ohm resistor. The PriceCNC AVCH10 standard 50:1 input is calibrated for use with 50:1 voltage dividers of these particular resistances. Most other brands of cutter also use this configuration.

The 45**XP** input is designed to work with the 50:1 voltage divider output on newer Hypertherm **XP** range plasma cutters. The Hypertherm Powermax 45**XP** plasma cutter uses a 50,000 and a 1,000 ohm resistor in series to produce the 50:1 voltage. The **XP** 50:1 input is calibrated for use with 50:1 voltage dividers of these particular resistances. Most Hypertherm Plasma Cutters that have small internal DIP switches to select various voltage divider output ratios will require the use of the 45**XP** 50:1 input.

2.2.1 Anti-Dive input signal on Mach3

A reduced feed rate is often used when cutting small holes or tight angles, this reduced feed rate will increase the arc voltage, which may 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 (THC) should be deactivated during the reduced feed rate. To temporarily deactivate THC you can use a selection of different methods. An option that is available in Mach3 is the THC min speed setting which will make the software ignore the up/down commands from the AVHC10 if the feed rate has dropped by the selected

percentage of the normal (G01) feed rate. This function is usually adequate for good plasma cutters.

Cheap plasma cutters may need more specific anti-dive assistance by using Cut Rules in SheetCam that tell the G-code to turn off and on THC as required. These rules are relatively easy to setup as per section 5. Another way to deactivate Torch Height Control in Mach3 is to use an anti-dive Macro. Unfortunately Mach3 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 which tells it to block 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 from commands in the G-code.

When anti-dive is activated in the AVHC10 using the anti-dive signal (yellow wire), both blue LEDs will light up.

2.2.2 Anti-Dive on UCCNC

A reduced feed rate is often used when cutting small holes or tight angles, this reduced feed rate will increase the arc voltage, which may 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 (THC) should be deactivated during the reduced feed rate. To temporarily deactivate THC you can use a selection of different methods. An option that is available in UCCNC is the THC min speed setting which will make the software ignore the up/down commands from the AVHC10 if the feed rate has dropped by the selected percentage of the normal (G01) feed rate. This function is usually adequate for good plasma cutters.

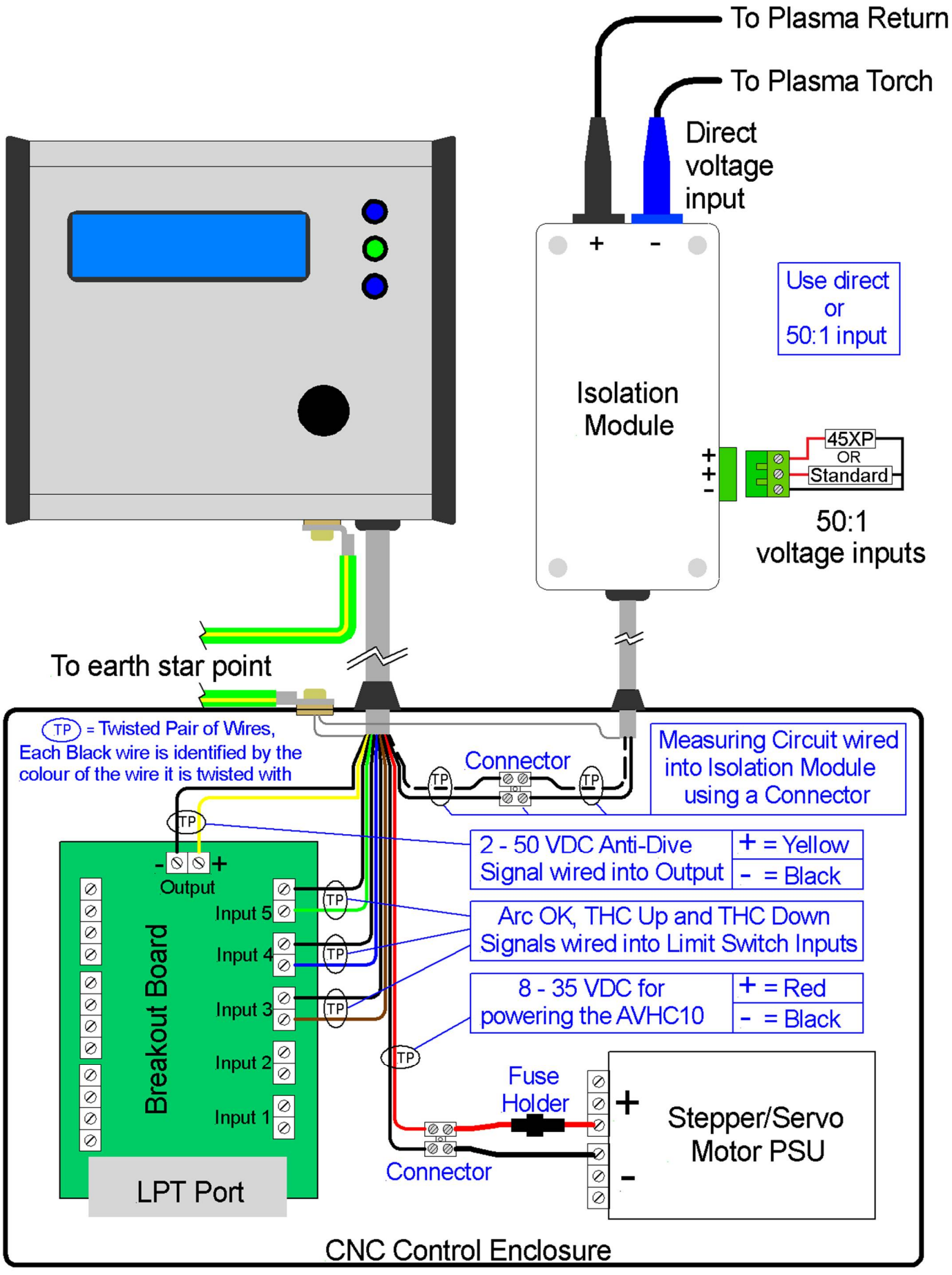
Cheap plasma cutters may need more specific anti-dive assistance by using Cut Rules in SheetCam that tell the G-code to turn off and on THC as required. The M-codes M205 and M206 can be inserted into your g-code file by using cut rules in SheetCam (M205 = THC on and M206 = THC off). These rules are setup as per Section 5.

The Anti-dive (yellow wire) input signal on the AVHC10 is not required with UCCNC software as UCCNC has special M-codes that turn on and off THC from within UCCNC.

2.3 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. M4 screws are provided.

2.4 AVHC10 Installation Wiring Diagram



2.5 Wiring Definitions

AVHC10 (user interface)

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 Mach3/UCCNC via Breakout Board	2	50	V
Black	Negative				
Green	Either	Sends **Arc OK** Signal to Mach3/UCCNC via Breakout Board		50	V
Black	Either			100	mA
Blue	Either	Sends **Torch Up** Signal to Mach3/UCCNC via Breakout Board		50	V
Black	Either			100	mA
Brown	Either	Sends **Torch Down** Signal to Mach3/UCCNC via Breakout Board		50	V
Black	Either			100	mA

Isolation Module

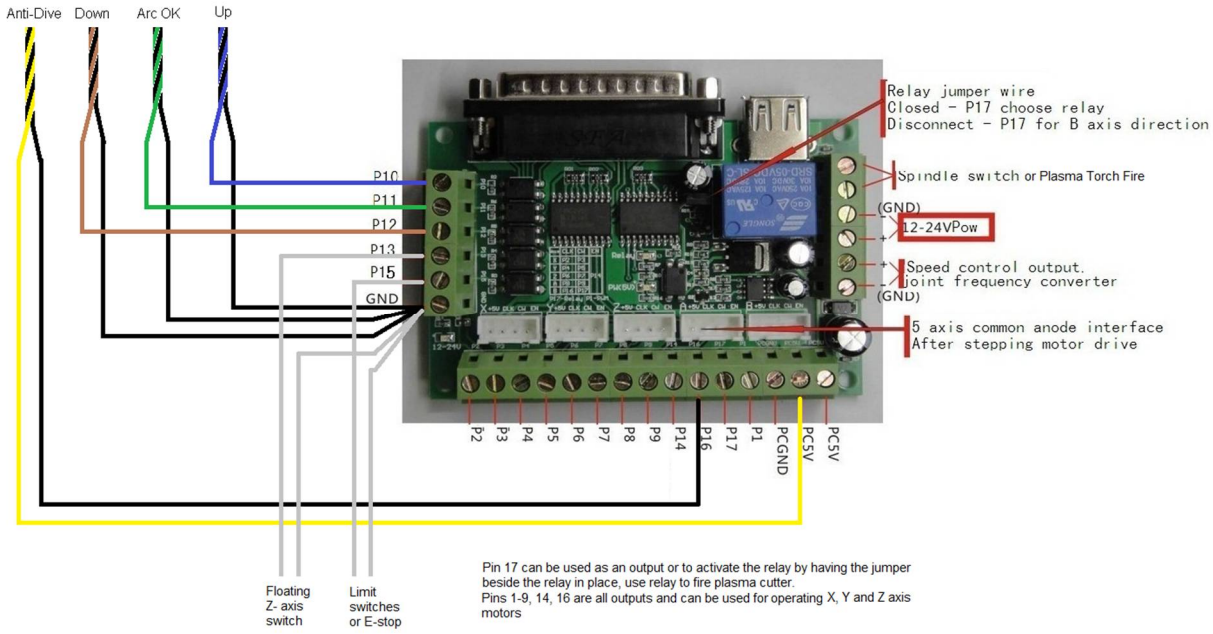
Wire Pairs	Polarity	Function	Max. Value	Unit
White	Positive	Sends Isolated and reduced signal to the AVHC10		
Black	Negative			
4mm Plug	**Polarity**	**Function**	**Max. Value**	**Unit**
Blue	Negative*	Connects to Plasma Electrode	-300 continuous* (HV starting Arc OK)	V
Black	Positive*	Connect to Plasma 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

2.6 Popular Breakout Boards (BOB) Wiring Examples

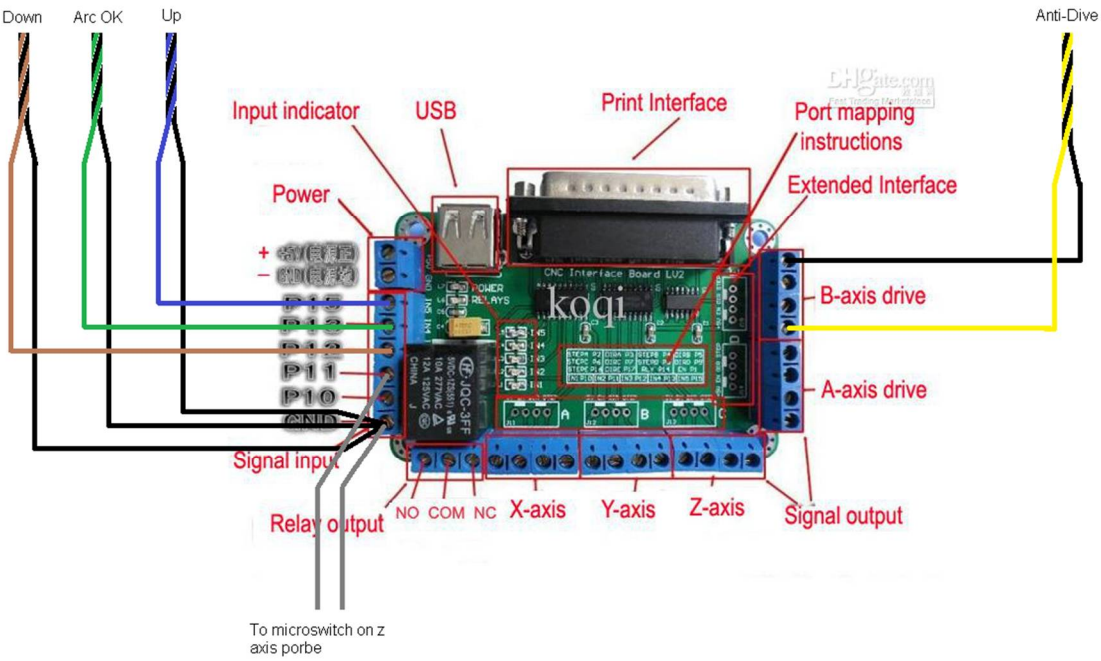
Wiring Example 1:

This board has a common terminal for all of the input signals and must be supplied with 5V via the USB port and 12-24V via the Power Terminals. Any unused axis output can be used for anti-dive. This BOB also has a spindle speed control output, useful if you plan on using a milling spindle on your CNC machine.



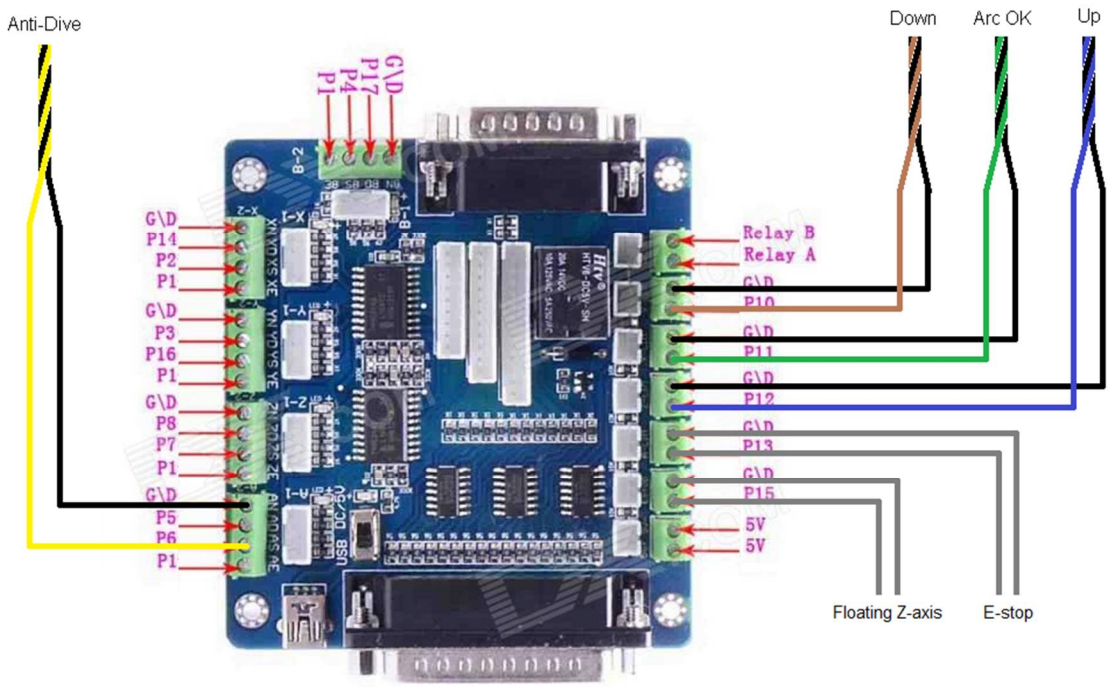
Wiring Example 2:

This board has a common terminal for all of the input signals and must be supplied with 5V via the USB or 5V via the Power Terminals.



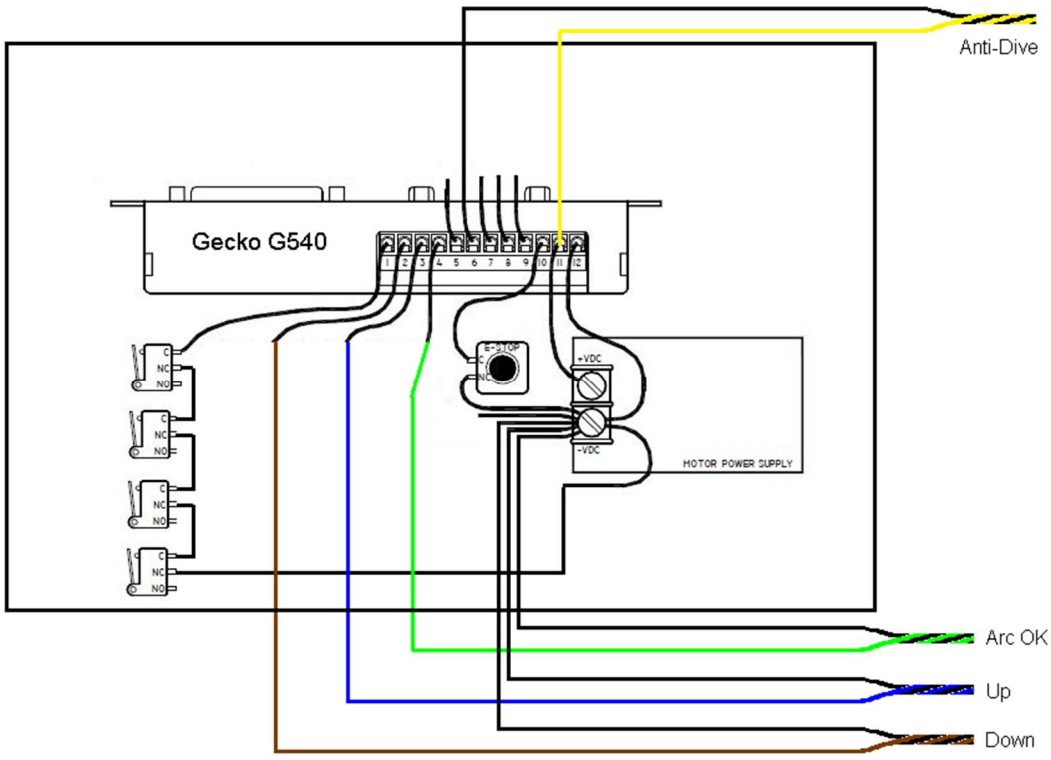
Wiring Example 3:

This board has individual terminals for all of the input signals and must be supplied with 5V via the mini USB or 5V via the Power Terminals.



Wiring Example 4:

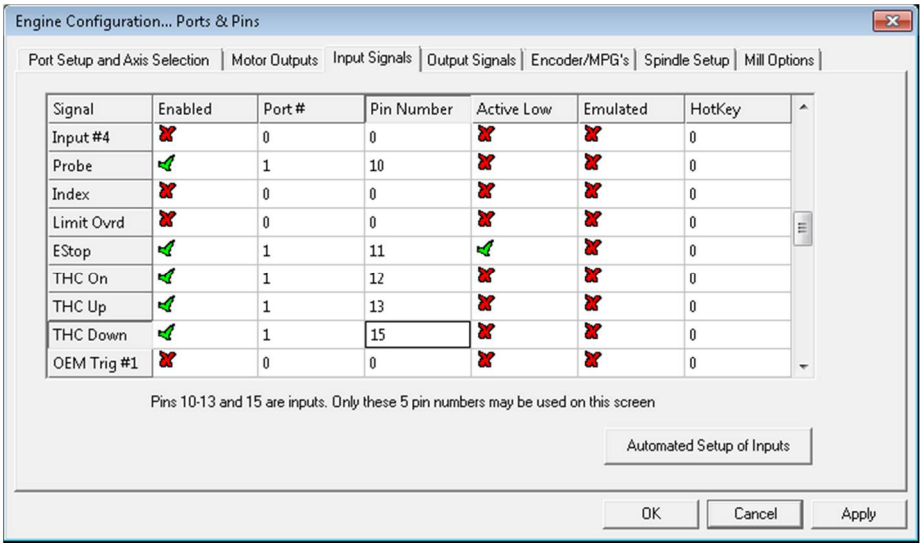
The Gecko G540 can be wired as per below.



2.7.1 Setting up the AVHC10 in Mach3

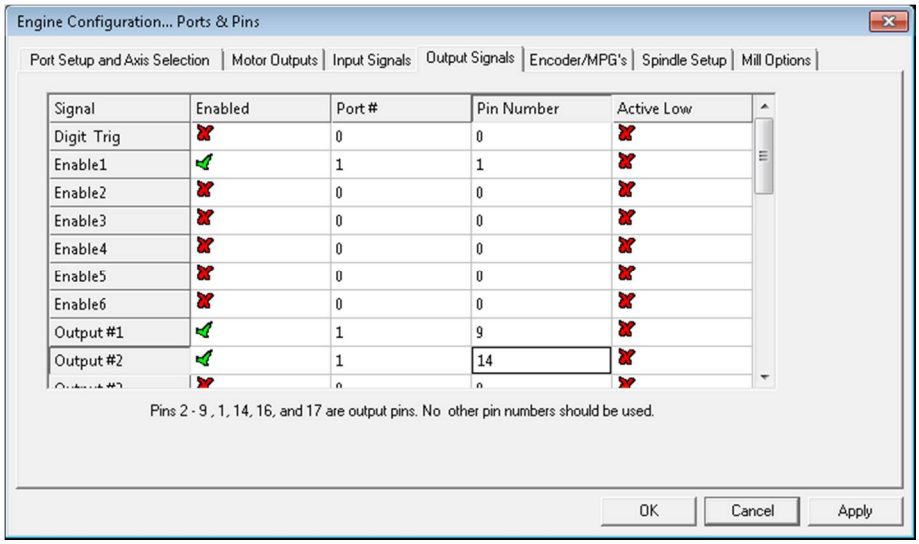
1. From the Menu Bar in Mach3, click on ‘Config’ > ‘Ports and Pins’ > ‘Input Signals’.

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.

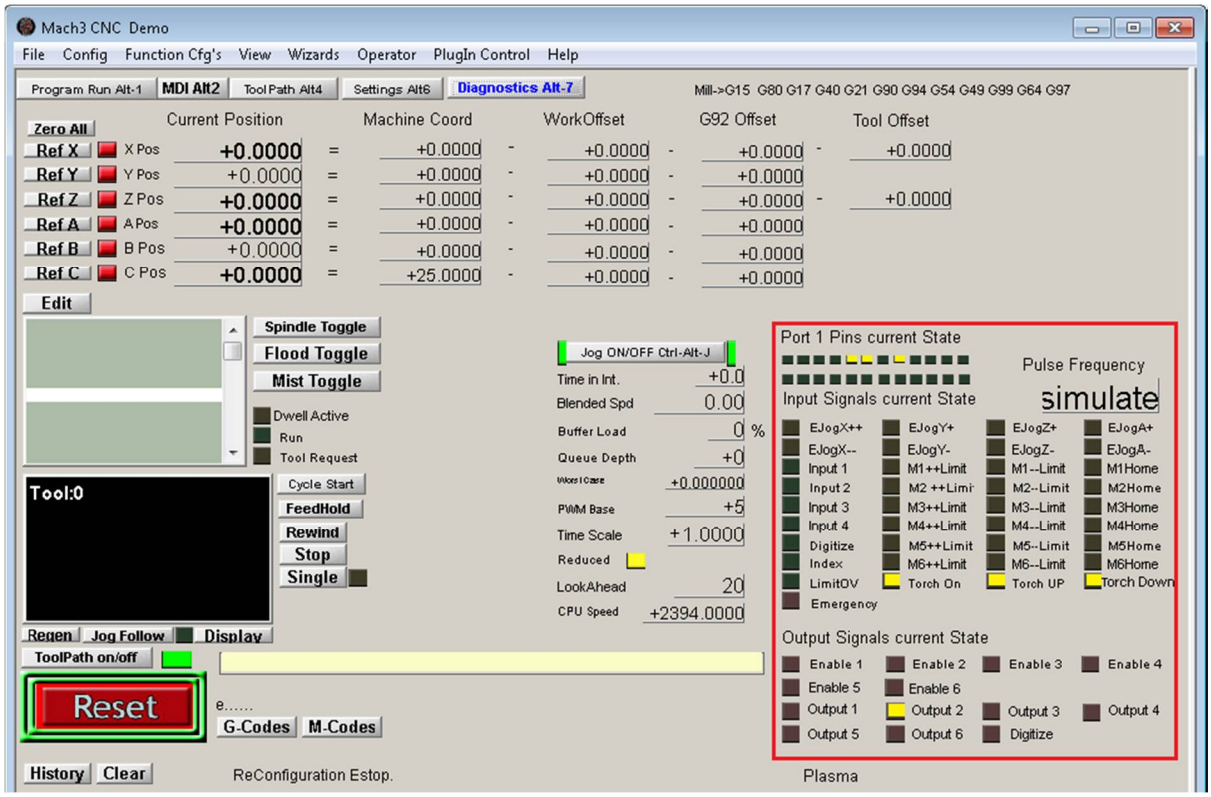
3. Click on the ‘Output Signals’ tab. Change the setting for ‘Output #2’ to the pin that will operate the AVHC10 anti-dive.



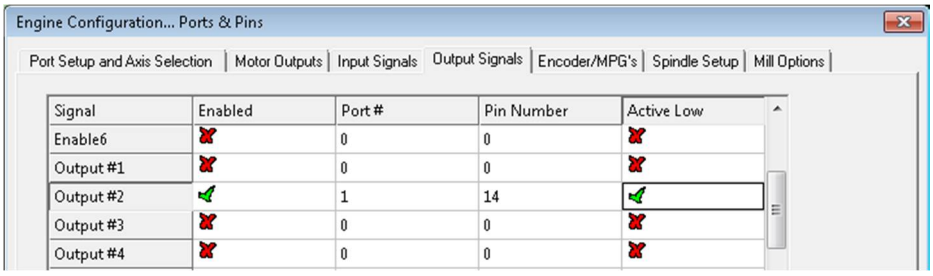
Note: A different output number can be selected from the signal list. ‘Output #**2**’ is turned on by the G-code command ‘M11P**2**’ and turned off by ‘M10P**2**’ If a different output number is required, change the ‘**2**’ in the code snippet to the required number when creating the rules in SheetCam. For details, see section 5.

To verify that Mach3 is communicating correctly with the AVHC10, view the diagnostics screen in Mach3.

Using screen 6 on the AVHC10, you can manually operate the Arc OK, Torch UP and Torch Down signals (see section 4.1 for details). If the AVHC10 is communicating correctly through the Breakout Board, the corresponding signals should light up the respective pins signal status indicators.



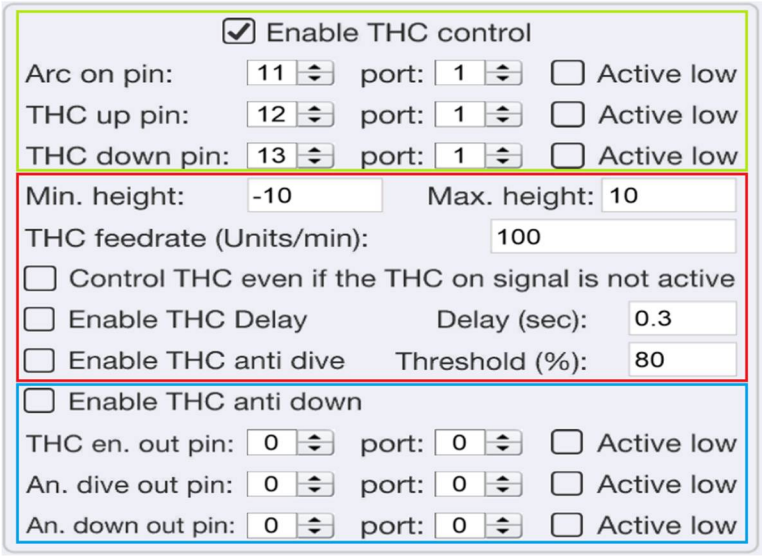
To verify the anti-dive signal is working, in Mach3 click on ‘Config’ > ‘Ports and Pins’ > ‘Output Signals’ , scroll down to ‘Output #2’ and click on ‘Active Low’ to change the state of the signal. The two blue LEDs on the AVHC10 will light together to show the anti-dive signal is activated and working. Click on ‘Active Low’ again to turn off the test signal.



2.7.2 Setting up the AVHC10 in UCCNC

1. From the Menu Bar in UCCNC, click on ‘CONFIGURATION’ > ‘I/O SETUP’.

2. In the green area below, tick the ‘Enable THC control’ box and below that, set the Port and Pin Numbers for the ‘THC On’, ‘THC Up’ and ‘THC Down’ signals. The values in the red area can be set here or on the ‘Run’ screen (shown further below) and the values in the blue area are not required.



3. Click on ‘Apply settings’ > ‘Save settings’

4. From the Menu Bar in UCCNC, click on ‘RUN’

5. Using screen 6 on the AVHC10, you can manually operate the Arc OK, Torch UP and Torch Down signals (see section 4.1 for details). If the AVHC10 is communicating correctly through the Breakout Board, the corresponding signals should light up on the ‘RUN’ screen in UCCNC.

The UCCNC signals should light with the LEDs on the AVHC10. If the signals are operating in reverse to the LEDs on the AVHC10 (on is off and off is on), go back to Step 2 and tick the ‘Active low’ boxes beside the pins and Ports and save settings again.

3. Things you should know before operating your Plasma CNC with THC

3.1 Post Processors

A post processor is a file that contains instructions that are used by SheetCam to permit SheetCam to create G-code that will work with your particular CNC machine. Generally features such as a Floating Z-axis, an Engraver or automatic Plasma Current Control will require a special Post Processor that allows SheetCam to create G-code that can operate these custom/optional features. There are many existing Post Processors that come with SheetCam that contain these features.

If you are using the Floating Z-axis as described in section 1.3 you can download a Post Processor that I have modified specifically for this purpose at www.pricecnc.com This Post Processor will reset the Z-axis to zero each time, just before the torch fires. This Post Processor also contains a switch offset value to correct for slack in the Probe switch when zeroing the Z-axis. This is set to 0.7mm by default but you can edit the post processor in SheetCam to change this number to compensate for any slack in your own Probe switch.

3.2 Basics

Your Torch Height Controller (THC) is designed to compensate for changes in the height of the work piece only. It will not compensate for other bad setting that may lead to poor quality cuts. If your feed rate, plasma current or air pressure are not set correctly or if there is a bad electrical connection between the clamp and the work piece, you will likely produce poor quality cuts with or without a THC. If any of these parameters are not correctly set, your THC will not operate reliably. It is crucial to get all these other variables correct before you even try to use Torch Height Control.

3.3 Air Pressure

The pressure that a particular plasma cutter operates at usually does not change with material thickness or type. This value should be set as per your plasma cutter manufacturer's recommendations for the material being cut. Ensure that the pressure listed is the pressure that your pressure gauge reads when the plasma cutter is firing. A pressure value set when no air is flowing will usually drop lower when the air flows through your plasma cutter. Some plasma cutters have a test switch that turns on the air without actually firing the plasma cutter. Some form of compressed-air water catcher or drier is essential to reduce changes to cutting properties brought about by water drops in the air flow.

3.4 Plasma Current Considerations

The correct Plasma Current on your plasma cutter may vary for different materials and different thicknesses. Most plasma cutters come with a guide on this but that guide is at best an indication of optimum values. The best current for your CNC table takes several factors into consideration. These are:

Material Thickness – Thicker materials require Higher Current to cleanly pierce the material. With a higher current, the feed rate can also be increased which saves time.

Material Type – Materials with a higher melting point and a higher material density require more heat energy to melt, this means that steel will require more current or a lower federate than a similar thickness piece of aluminium.

Max Feed Rate of CNC table – If the current is set to the max while cutting a relatively thin piece of material, the CNC table may not be able to move fast enough to achieve the feed rate required for a good cut.

Acceleration/Deceleration ability of CNC table – The top speed of your CNC machine is not as important as how quickly it can turn a right angle corner. Acceleration is all about how fast the machine can reach the required feed rate. If you think about it, as your machine approaches a corner, one of your axes, let's say the X-axis, has to go from the cut feed rate to stopped and the other axis, the Y-axis has to go from stopped to the cut feed rate. Depending on how fast your machine can accelerate to a given feed rate will also determine how fast you can really cut. Any amount of time that your CNC machine spends slowing down to, or speeding up from a corner is time when it is not cutting at the ideal feed rate.

Duty Cycle of Plasma Cutter – Your Plasma Cutter might be rated at (for example) 50 Amps but that does not mean you can cut all day long at 50 Amps. Most plasma cutters have a duty cycle, which if exceeded will overheat your plasma cutter and cause it to shut down. Many Plasma Cutters can only run for 60% of every 15 minutes at full current or continuously at 60% of full current. If your cut job is going to last just 5 minutes of torch on time, you may be able to achieve full current for the whole job. But if the cut job requires 30 minutes of cutting on a large sheet of metal, you may need to lower the current accordingly. The reduced current will require a reduced feed rate. See your plasma cutters manual to determine the duty cycle.

3.5 So what current do I choose?

Initially you should choose the manufacturers recommended current for the given material and material thickness and take all the above factors into consideration as your experience of your machine grows. For a given material and thickness, higher currents will permit faster feed rates when cutting. Faster is generally better as it saves time but cut quality can be negatively affected if your CNC table is not able to maintain steady movement and fast cornering at the higher speeds. If your table has poor acceleration, you may have to lower the federate and current accordingly.

3.6 Feed Rate

I find manufacturer's recommended feed rates are only a guide and the best feed rate to use should be determined by testing.

Before you decide on a feed rate you need to decide on a Plasma Current, verify air pressure is correct and ensure consumables (Plasma Electrode) are in good condition. Then look up the manufacturer's recommended feed rate for your plasma cutter and perform some test cuts on a level piece of material.

To perform your test cuts, design a cut job that has 11 parallel test lines about 10mm (3/8") apart where each line is 100-150mm (4-6') long. The cut feed rate for the centre line should be set to the value that was recommended by the plasma cutter manufacturer and the parallel lines on one side of that line should each be cut 5-10% faster and 5-10% slower to the other side. This will produce 11 cut lines where you cut each line at a different feed rate. The cut job should also cut a rectangle around the test lines so you can lift up the test piece to easily inspect the cut quality from both sides.

When the test cut is finished, try to determine which line has the best cut quality. The best cut will usually be the one with the least dross and the most uniform cut. The sides of the cut should have minimal tapering.

3.7 Torch Height Control

Unless you have verified that you can cut reliably on level materials, Torch Height Control will not improve your cut quality. THC is only able to compensate for a non-level work sheet or for material warping caused by heat from cutting. It will not compensate for other faults or bad settings.

3.8.1 Finding the correct Arc Voltage Manually

To determine the correct arc voltage for a particular material type, material thickness, feed rate and current; you should cut a 200mm (8”) long test line on a level sheet of material with THC turned off in your software (Mach3/UCCNC). As the test cut proceeds, look at and remember the measured Arc voltage on your THC (AVHC10).

Then set the Nominal Voltage on your THC to the value you witnessed on that cut and cut another test line with the THC turned on in your software. You should lower the THC feed rate in your software to about 5% of the cut feed rate until you get the other settings on your THC correct. The arc voltage may still need to be fine-tuned so be prepared to adjust the arc voltage during the first few cuts. If the torch is operating too close to the material, increase the Nominal voltage by small amounts and if the torch is operating too high above the material, lower the Nominal voltage. You may need to repeat this test cut several times until it produces a good repeatable cut. If torch height control seems under or over responsive, read the next section.

3.8.2 Auto setting the correct Arc Voltage

As an alternative to Manually setting the Arc Voltage as described above, you can let the AHVC10 automatically set the voltage for you. The auto set feature works best when the start of the cut job is simple. Detailed cut jobs usually have a reduced cut feed rate due to axis acceleration and deceleration. This can then effect the arc voltage value and make it unsuitable for auto setting.

To set the Arc voltage Automatically follow these steps:

1. Prepare a cut job and just before you click ‘Cycle Start’.
2. Go to ‘Screen 1’ on the AVHC10.
3. Press and Hold the Select on the AVHC10 for 2 second until the screen displays:

4. Start the cut job in Mach3/UCCNC.
5. After the pierce is complete and the torch starts moving, press Select on the AVHC10. The AVHC10 will now start measuring the average voltage for 2 seconds while displaying:

6. The result of the Measurement will be displayed with the option to accept or cancel the value:

   If the value is accepted, it will become the new Nominal Voltage. If the value is rejected, the Nominal voltage setting will remain unchanged.
7. The new set value can be adjusted as usual during the cut if required.
8. If you are happy with the voltage setting, remember to save the it on ‘screen 0’ before powering down the height controller.

3.9 Setting THC Sensitivity

During cutting, your THC has to react to changes in the arc voltage. As there is always some tiny delay between the time the voltage is measured and the time the Z-axis motor reacts to correct the arc voltage, it is possible that the corrective action can under or over correct the height of the torch. If your Torch seems slow to react to the contours of the work piece, it can be described as under responsive. To increase the sensitivity you can increase the THC feed rate in your software and/or reduce the tolerance voltage on your THC.

Inversely, if your THC seems to over react and is continuously raising and lowering over level parts of the work sheet (bobbing up and down). You can reduce the THC sensitivity by lowering the THC feed rate in the software and/or increasing the tolerance voltage on the THC.

I recommend you use a 5% THC feed rate until you are more confident with your THC. You can increase this to 20% or 30% as your confidence in its operation grows.

I recommend you set the Tolerance voltage on your THC to 1.0 volts initially. Increase the value to reduce Torch Bobbing (excessive up and down) or decrease the value to improve responsiveness.

3.10 Measure Period

The Price**CNC** AVHC10 has an adjustable measure period. The measure period is the duration in milliseconds over which the THC repeatedly measures the arc voltage and calculates an average value, which it compares to the nominal voltage when deciding on a corrective action (raise or lower the torch). Cheap plasma cutters often have spikes or dips in their current delivery which distorts the measured voltage and can cause undesirable operation of a THC. If these spikes and dips are averaged over a slightly longer period of time, the usefulness of the value in deciding whether to raise or lower the torch can be greater than the any problem associated with the tiny additional delay caused by averaging more measurements.

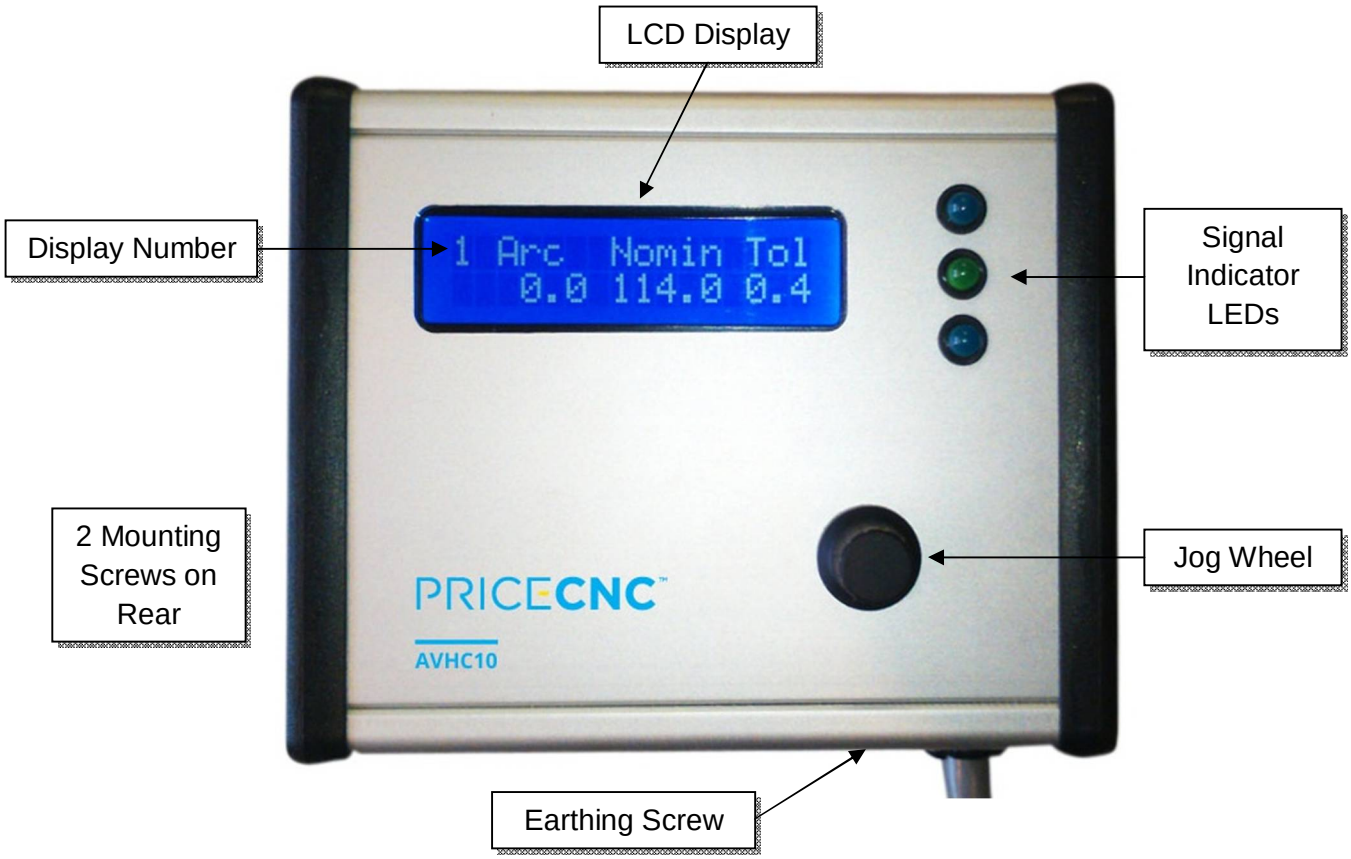
I recommend setting the measure period to 0.01 for users of high end Plasma Cutters and between 0.05 and 0.1 for users of budget plasma cutters. This value should be set to the lowest value that produces good Torch Height Control.

3.11 THC Z-Min and Z-Max

Torch Height Control can cause unexpected or undesirable results for a variety of unforeseen reasons. A good way to limit the torch rising too high or diving too low during a cut job is to narrow the range of operation by setting limits in Mach3/UCCNC that are set to the practical limits the torch should operate in. I usually set the Z-min to 0 or -5mm and the Z-Max to 10 or 20mm, depending on the warping that I expect to compensate for.

A practical Z-min, Z-Max and THC Feed Rate percentage can limit the actions of the torch to practical limits which greatly reduces the chance of messing up the job. It can also give the operator a chance to correct the Nominal Voltage on the Height Controller before the torch does something that negatively affects the cut quality. If you cannot enter negative values into the Z-Min, it is because your version of Mach3 has a common bug that is easily fixed. To see a video on how to fix this bug, search YouTube for: “mach3 thc min negative value”

4. AVHC10 Operation



The AVHC10 is always ready to work when powered on. The way the AVHC10 operates can be set by the user by using the Jog Wheel to navigate through the simple menu structure. Display List in section 4.1.

The recommended sequence of events for Plasma Cutting using the AVHC10 with a floating Z-axis and SheetCam Cut Rules is:

1. Prepare a G-code file that has:
    a. a Post Processor that permits a floating Z-axis to find a new Z-axis zero at the start of each cut and
    b. also uses SheetCam cut rules to activate 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 (Probe) is triggered by the torch touching the material to be cut (G31).
5. The Z-axis position is reset to Zero (G92).

6. The torch lifts to the switch offset value that is set in the post processor (this compensates for any slack or backlash on the Probe switch operation).
7. The Z-axis position is reset to Zero again (G92).
8. The Torch is raised to the pierce height and Plasma is turned on.
9. After the (G-code) pierce delay, the torch is lowered to the cut height.
10. The torch moves along the cut while the AVHC10 monitors the Arc Voltage and issues raise and lower commands to Mach3/UCCNC via the Breakout Board.
11. For Mach3:

    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.

    For UCCNC:

    The torch comes to a tight radius bend during the cut which contains an M206 (Turn off THC) command which turns off THC in UCCNC.
12. For Mach3:

    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.

    For UCCNC:

    The torch comes from the end of the tight radius bend to a straight section of the cut that contains an M205 (Turn on THC) command which turns on THC in UCCNC.
13. The torch moves along the cut while the AVHC10 monitors the Arc Voltage and issues raise and lower commands to Mach3/UCCNC.
14. The cut finishes and Mach3/UCCNC turns off the torch.
15. 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 Mach3/UCCNC will change. This will make Mach3/UCCNC pause the job until the Arc OK signal resumes, which may happen if your plasma cutter automatically tries to re-fire an arc.

4.1 Display List

<table>
<tr><th>AVHC10 Display</th><th>Use</th><th>Operation</th></tr>
<tr><td> 
</td><td>Displays the measured Arc Voltage.

Displays and edits the Nominal and Tolerance Voltages.

Enters Auto Voltage Set Mode</td><td rowspan="2">1. Press Select (Nomin flashes)
2. Use Jog Wheel to edit Nominal Voltage
3. Press Select (Tol flashes)
4. Use Jog Wheel to edit Tolerance Voltage
5. Press Select
OR
1. Hold Select for 2 Second(Screen Changes to Auto Set Voltage Mode)</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td> 
</td><td>Indicates that Auto Set Voltage Mode is active</td><td>2. Press Select after Pierce (Screen Changes)</td></tr>
<tr><td> 
</td><td>Indicates that the Arc Voltage is being measured</td><td>3. Wait 2 seconds (Screen Changes again)</td></tr>
<tr><td> 
</td><td>Displays the Measure Voltage

Accepts or Cancel new Nominal Voltage value</td><td>4. Use Jog wheel to highlight the required option.
5. Press Select</td></tr>
<tr><td colspan="3">Auto Set Voltage Mode lets you set the Arc Voltage by getting the AVHC10 to measure the Voltage while cutting.</td></tr>
<tr><td> 
</td><td>Displays and edits the THC Delay</td><td>1. Press Select (Seconds flashes)
2. Use Jog Wheel to edit the THC Delay
3. Press Select</td></tr>
<tr><td colspan="3">The THC Delay is a 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.</td></tr>
<tr><td> 
</td><td>Displays and edits the Arc OK Range.</td><td rowspan="2">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</td></tr>
<tr><td colspan="2">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 (after the THC Delay) the AVHC10 will issue Raise and Lower commands as needed. Outside this range, no signals are sent.</td></tr>
<tr><td> 
</td><td>Hides or Shows the Advanced Settings Displays</td><td rowspan="2">1. Press Select to change Show to Hide
2. Press Select again to change back.</td></tr>
<tr><td colspan="2">For normal operation, the Advanced displays are not usually necessary and can be hidden using this Display.</td></tr>
</table>

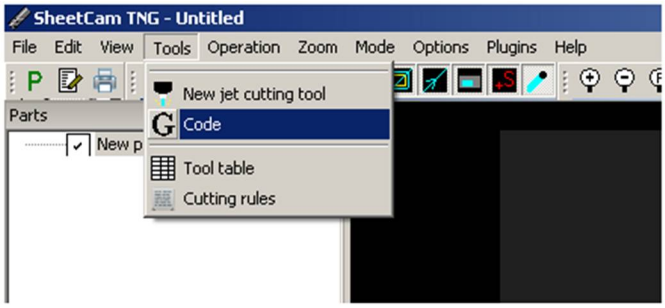
AVHC10 Display	Use	Operation
	Displays and edits the Arc Fail Duration	1. Press Select (Seconds Flashes) 2. Use Jog Wheel to edit the Arc Fail Duration 3. Press Select
The Arc Fail Duration is the length of time that the Measured Arc Voltage is permitted to be outside the Arc OK range before the Arc OK signal is stopped. This is to prevent short duration Arc Voltage spikes or dips from causing problems.		
	Tests the output signals	1. Press Select (Screen Changes)
	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/UCCNC is receiving the signals. The Diagnostics Screen in Mach 3/UCCNC displays all active inputs and the signals they represent. See section 2.7 for details.		
	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. See section 3.9 for details.		
	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 wrong (high or low) state which would stop the AVCH10 from sending Raise and Lower commands. To prevent this problem, Anti-Dive can be Disabled on this Display.		
	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.		
	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.		

5. SheetCam Cut Rules

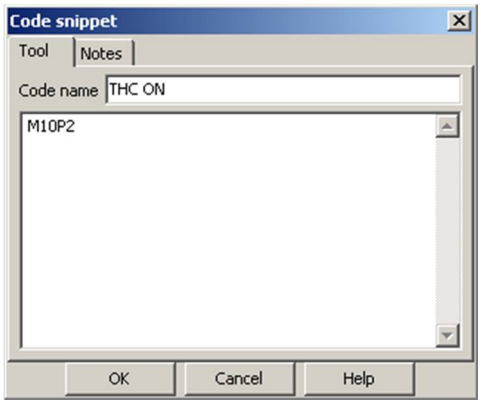
SheetCam has a useful feature where you can set rules for cutting different types of shapes. This is a great aid for improving cut quality by reducing feed rate on corners and small holes/shapes and can also be used to activate and deactivate torch height control during different parts of a cut.

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.



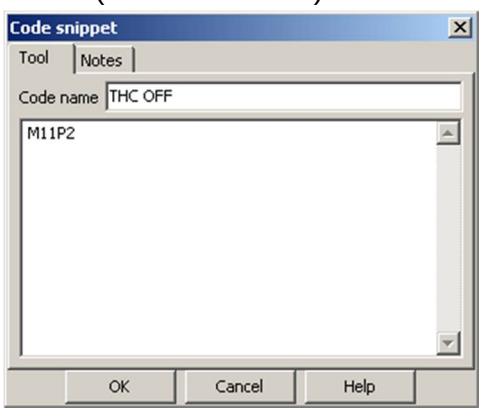
2. For Mach3 users: Type ‘THC ON’ and ‘M10P2’ as shown below, then click OK.
   For UCCNC users: Type ‘THC ON’ and ‘M205’, then click OK.



TIP

M10/M11 are on/off commands for external outputs (in Mach3 only). P2 refers to which output channel is selected. In Mach3, P2 will be allocated to a specific pin in the LPT port which will operate a digital out on the Breakout Board.

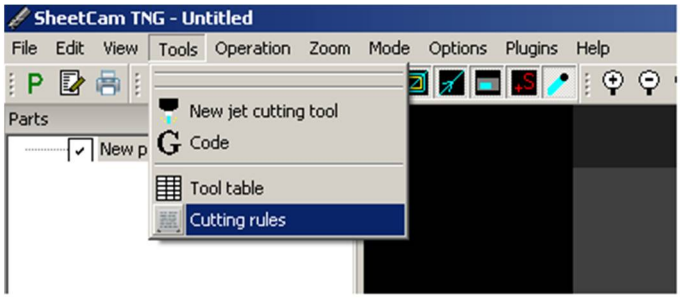
3. Repeat step 1 and make another Code snippet called ‘THC OFF’ using the code ‘M11P2’ for Mach3 (as shown below) or use ‘M206’ for UCCNC, then click OK.



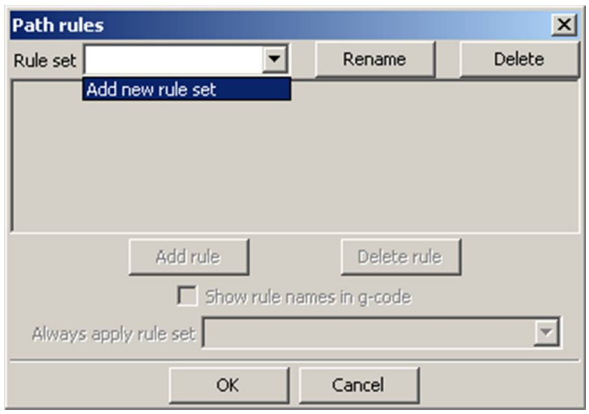
TIP

M205 and M206 are THC on/off commands for UCCNC only.

4. From the menu bar, click on ‘Tools’ and then click on ‘Cutting rules’.

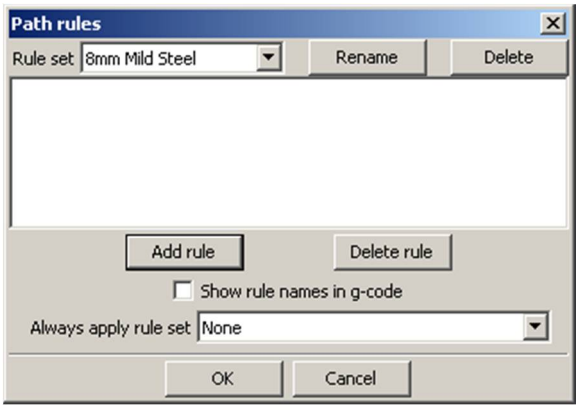


5. From the dropdown beside ‘Rule set’, select ‘Add new rule set’

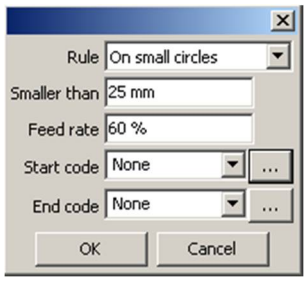


6. Create a new name for the rule and click ‘OK’

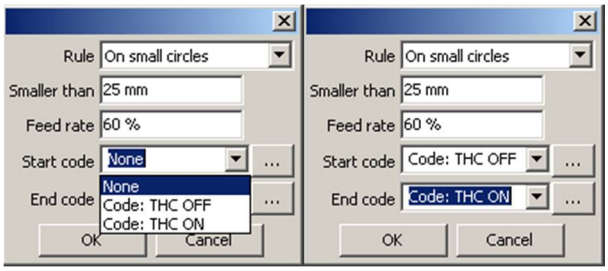
7. Click ‘Add rule’



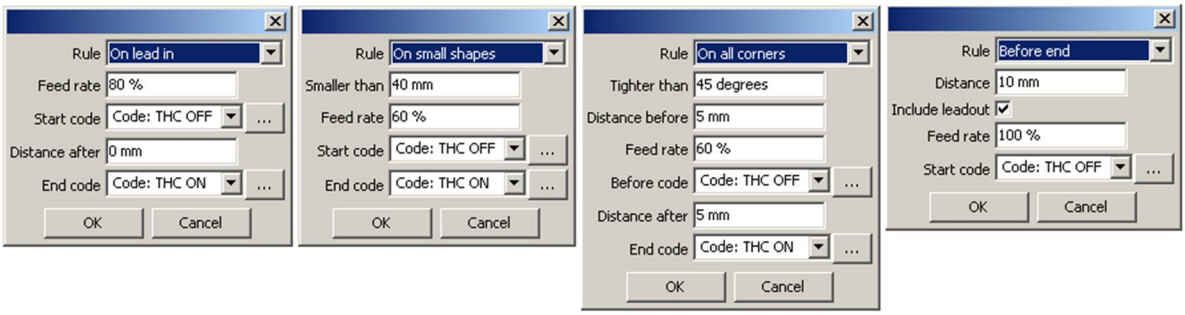
8. Click on the first dropdown to see what part or type of cut you want to apply the rule to. Here, I have selected to make a rule that affects small circles.



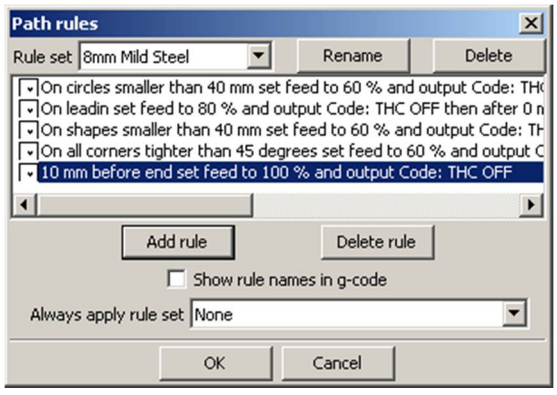
9. Click on the drop-down beside ‘Start code’ and select ‘THC OFF’, then click on the drop-down beside ‘End code’ and select ‘THC ON’. Click OK.



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



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



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 or the M205 and M206 commands should appear in the G-code file.