

# NEURON

CNC ELECTRONICS

## INDUSTRIAL TORCH HEIGHT CONTROL

### USER MANUAL



NEURON CNC ELECTRONICS

08.01.2020

## System Description

When operating a CNC Plasma table, it is important to maintain a fixed cutting height of the torch throughout the cutting process in order to achieve good cut quality. While the plasma torch tip-to-plate distance can be automatically set at the start of a cut by the Initial Height Sensing (IHS) switch, it is difficult to maintain this exact height throughout the cut. Remember that a typical plasma cutting torch tip-to-plate distance is only 1.5 mm and that normal sheet metal and plate stock are not perfectly flat. In addition, the heat generated during the cutting process can cause warpage in the material which makes it even more difficult to maintain this stand-off height. If the torch gets too close to the material during cutting it can cause premature wear to the cutting nozzle and also result in more backside dross. Even worse, the torch can crash into the material if the plate is warped enough over a longer cut which consumes some of the 1.5 mm starting cut height. Conversely, if the torch pulls too far away from the material it can negatively impact the cut quality and also cause the torch to lose the arc during cutting.

The THC module functions based on the principle that the amount of voltage in the plasma arc between the torch and the material is directly proportional to the length of the plasma arc. In other words, if the torch is closer to the plate the arc voltage will be less than if the torch is further away from the plate assuming all other cutting parameters are equal.

The Neuron.THC torch height control system is the most technologically advanced arc voltage control system in the plasma cutting industry. It is designed to offer arc voltage control capabilities to any plasma cutting system. The Neuron.THC quickly and accurately sets the arc transfer height of the torch using an "Ohmic" or/and "Float Head" plate sensing technique. The Neuron.THC system uses advanced DSP (digital signal processing) software servo control loops to control speed, position and arc voltage with unparalleled precision. The system is fully programmable via 10/100 Base-T Ethernet communications.

The Neuron.THC can attain speeds in excess of 200 inches per minute in the arc voltage control mode and speeds in excess of 500 inches per minute in the position control mode.

## Safety

Installation, as well as repairs, made to the Neuron.THC System should only be performed by qualified personnel. The Neuron.THC system use D.C. for operation. In addition, it will be necessary to make connections to the D.C. output of the plasma power supply. These voltages can be in excess of 300 volts. Fatal shock hazard does exist. Exercise extreme caution while working in these areas. Please refer to the plasma power supply manufacturer's operating manual for additional information.

Various other safety hazards exist while operating a plasma arc cutting system. Please see the plasma power supply manufacturer's operating manual for information on eye, skin, and hearing protection, as well as other information required to safely operate the equipment.

## System Components

The Neuron.THC System consists of the following components:

- Control module
- Plasma interface module
- Operator's control module
- UCCNC Plugin and Screen set for plasma cutting applications

### Control module

The control module houses a microcontroller, and I/O interface. This unit provides arc voltage control, and interfaces with the torch driver through the Pulse/Direction interface, the CNC UCCNC machine through the Ethernet interface, and the plasma system through standard discrete I/O interfaces.

### Plasma system interface module

It provides precise, scaled feedback of the plasma arc voltage to the control module. It also provides a convenient control signal interface to the Neuron.THC.

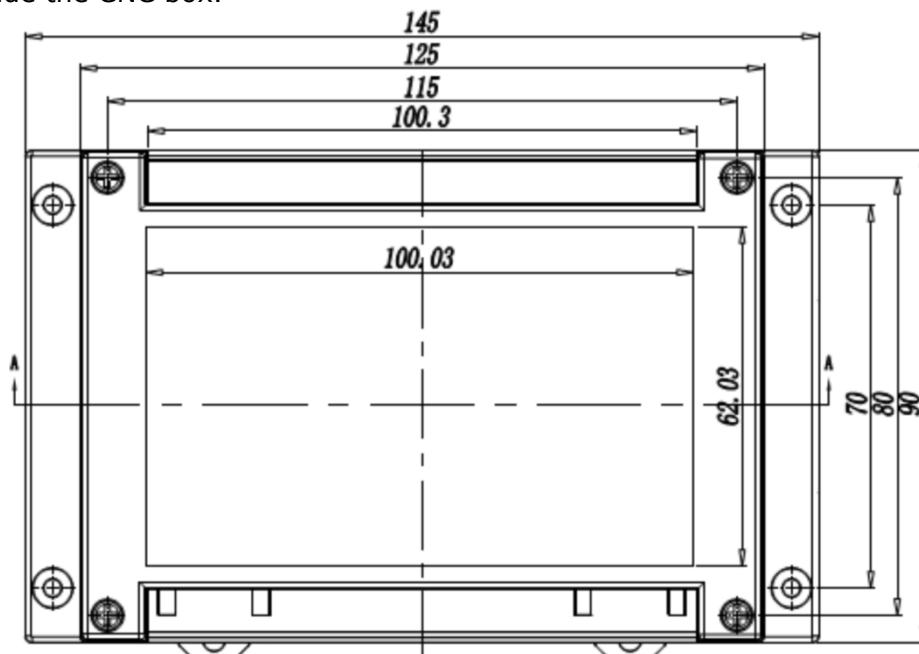
### Operator Control Module

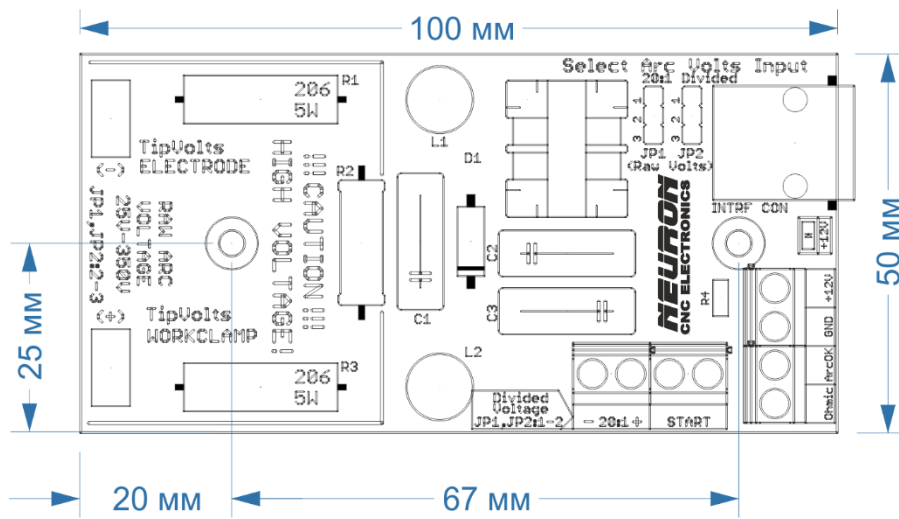
The Operator Control Module includes screw terminals for connection "Cutting Run/Stop" switch, "Torch Up", "Torch Down" buttons and an installed rotary/push knob selector for THC setup and control.

## Specifications

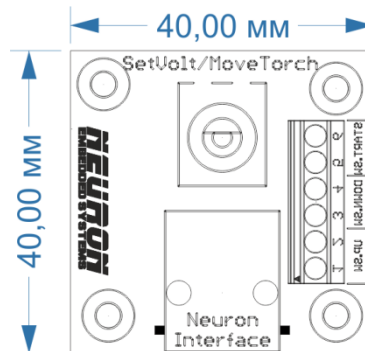
Input power	12V DC, 0.8A
Operating temperature	-10° C to 40° C
Operating humidity	95% relative humidity
Pulse/Dir interace	Open collector, protected +5V 100mA
Ethernet communication	Shielded RJ-45 Cat-5e, Up to 100 m (4-wire Cat-5e), I/O transmission speed 10/100 Mbps auto-negotiation
Parallel digital input	NO/NC dry contact
Lifter limit switches	Home switch, IHS switch and Ohmic sensor
Maximum Z axis speed	15000 mm/min
Voltage divider ratio	10:1(internal), 20:1 (Hypertherm cutter)
Arc voltage range	25-250V
Warranty	1 year

Control module has a size 145x90x45 mm with DIN mounting standard and can be easily embedded inside the CNC box.





Plasma interface board (Divider)



Operator panel board

## Features

The Neuron.THC comes standard with the following features:

- Works with ALL plasma cutters
- Connect via 10/100 Base-T Ethernet interface to UCCNC CNC and controls Z axis directly (Internal motion controller, Software DSP (digital signal processing) control loop, 500 uSec cycle)
- Unlimited number of cut profiles for different metal thicknesses. Quickly switch between profiles and the ability to quick edit them
- Set point resolution - 0.25V
- Set point range - 25 - 250V (set just by clicking the mouse button and wheel on the Target Arc Voltage textbox on Control Panel or turning the encoder knob on the operator panel)
- Maximum control accuracy - +/- 0.25V
- Height control accuracy +/-0.125 mm (.005") using a properly configured Z-axis.
- Voltage feedback (divider) - 1:20 (for Hypertherm), 1:10 (internal) of Arc Voltage
- 100 kHz maximum step frequency (50% Duty cycle)
- Automatic or manual control of the cutting sequence
- Sample voltage mode - THC measures the voltage at the end of the AVC Delay and uses it as a set point for the remainder of the cut.
- Programmable THC OFF (Hold signal) control to help prevent torch crashing when end of cut, circle of small radius - enable/disable, mm.
- Programmable arc voltage limiter to help prevent torch crashing when crossing a kerf - enable/disable, level, voltage
- Programmable arc voltage control loop proportional gain (system response)
- Skip IHS mode - If the next starting point is within this distance of the end of the previous cut, the THC skips the IHS.
- Improved Jog - the lifter initially jogs 0.25 mm. After 0.5 second, it begins continuous motion at the IHS Speed. After 1.5 seconds, the lifter increases the speed to the programmed Manual Speed  
Jog just by clicking the mouse button and wheel on the Position textbox or by pressing the up / down button on Operator Panel
- Automatic Collision Avoidance. This safety feature allows the control to automatically adjust the torch height during a cut to help prevent torch crashes.
- Retract height selectable between full or programmed partial raise height
- Programmable automatic positioner speed
- Programmable manual positioner speed
- Programmable maximum Z axis stroke (Soft Limit function)
- Programmable arc transfer height
- Programmable pierce height
- Programmable pierce time
- Programmable cutting height
- Programmable AVC (automatic voltage control) delay time
- Programmable torch retract height
- Programmable Jump height above the workpiece that the torch is raised to clear the top dross puddle that can form during the pierce.
- Programmable IHS (initial height sensing) touch speed
- Programmable crossover height (high-to-low speed transition point)
- Buffered Step & Direction for direct interface to Motor Drive
- All inputs (include arc voltage) are isolated and Simple wiring (RJ45 connectors)
- Built-in pierce and cut time counter to control consumables
- Integrated diagnostic system informs the operator of the errors that occurred
- Ability to tune arc voltage converter
- Plotting the arc voltage and save to file for diagnostics
- Easy Software update using the utility Neuron Flasher

## System Requirements

### Power Requirements

The Neuron.THC system has a terminal block power plug. 12V DC 0.8A required. Do not use 12V power from CNC PC! Use separated power supply.

The performance of the Neuron.THC is tightly coupled to the lifter and motor characteristics. The Neuron.THC was designed as a conventional plasma height control and the lifter does not include any position feedback.

The lifter screw pitch affects the lifter linear speed and the control loop gain when operating with arc voltage. The lifter friction and maximum torch weight affect the point at which the lifter will require a brake to maintain position. For these reasons, the motor and lifter characteristics are critical and must be tightly controlled.

The following is a partial list of lifter and motor characteristics that are compatible with this controller.

- Lifter Ball screw/Rack pitch = 4 – 20 mm/rev
- Lifter with UP limit (homing sensor)
- Lifter capable of 200 in/min.
- Lifter should have low backlash and little mechanical play

### WARNING:

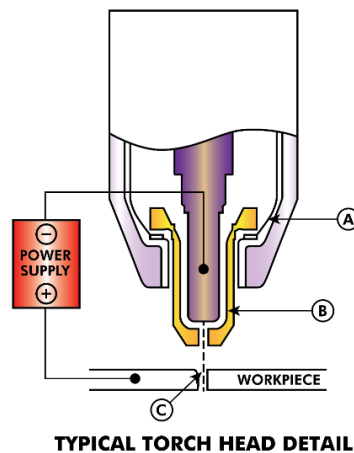
**The performance of the Neuron.THC is tightly coupled to the lifter and motor characteristics. To ensure proper operation, a customer designed lifter should be fully tested with this controller under all anticipated operating conditions.**

### What Is Plasma

Plasma is a fourth state of matter, an ionized gas which has been heated to an extremely high temperature and ionized so that it becomes electrically conductive. The plasma arc cutting and gouging processes use this plasma to transfer an electrical arc to the workpiece. The metal to be cut or removed is melted by the heat of the arc and then blown away. While the goal of plasma arc cutting is the separation of the material, plasma arc gouging is used to remove metals to a controlled depth and width.

Plasma torches are similar in design to the automotive spark plug. They consist of negative and positive sections separated by a center insulator. Inside the torch, the pilot arc starts in the gap between the negatively charged electrode and the positively charged tip. Once the pilot arc has ionized the plasma gas, the superheated column of gas flows through the small orifice in the torch tip, which is focused on the metal to be cut.

In a Plasma Cutting Torch a cool gas enters Zone B, where a pilot arc between the electrode and the torch tip heats and ionizes the gas. The main cutting arc then transfers to the workpiece through the column of plasma gas in Zone C. By forcing the plasma gas and electric arc through a small orifice, the torch delivers a high concentration of heat to a small area. The stiff, constricted plasma arc is shown in Zone C. Direct current (DC) straight polarity is used for plasma cutting, as shown in the illustration. Zone A channels a secondary gas that cools the torch. This gas also assists the high velocity plasma gas in blowing the molten metal out of the cut allowing for a fast, slag - free cut.



## Arc Initialization

There are two main methods for arc initialization.

### High Frequency Start

This start type is widely employed, and has been around the longest. Although it is older technology, it works well, and starts quickly. But, because of the high frequency high voltage power that is required generated to ionize the air, it has some drawbacks. It often interferes with surrounding electronic circuitry, and can even damage components. Also, a special circuit is needed to create a Pilot arc. Inexpensive models will not have a pilot arc, and require touching the consumable to the work to start. Employing a HF circuit also can increase maintenance issues, as there are usually adjustable points that must be cleaned and readjusted from time to time.

### Blowback Start

This start type uses air pressure supplied to the cutter to force a small piston or cartridge inside the torch head back to create a small start between the inside surface of the consumable, ionizing the air, and creating a small plasma flame. This also creates a "pilot arc" that provides a plasma flame that stays on, whether in contact with the metal or not. This is a very good start type that is now used by several manufacturers. Its advantage is that it requires somewhat less circuitry, is a fairly reliable and generates far less electrical noise

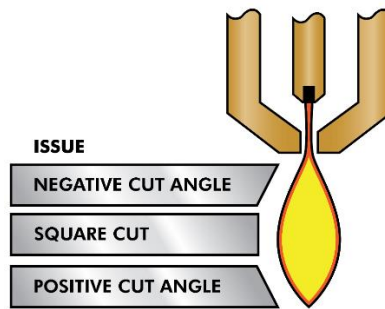
For entry level air plasma CNC systems, the blowback style is much preferred to minimize electrical interference with electronics and standard PCs but the High frequency start still rules supreme in larger machines from 200 amps and up. These require industrial level PC's and electronics and even commercial manufacturers have had issues with faults because they have failed to account for electrical noise in their designs.

## CNC Plasma

Plasma operations on CNC machines is quite unique in comparison to milling or turning and is a bit of an orphan process. Uneven heating of the material from the plasma arc will cause the sheet to bend and buckle. Most sheets of metal do not come out of the mill or press in a very even or flat state. Thick sheets (30mm plus) can be out of plane as much as 50mm to 100mm. Most other CNC gcode operations will start from a known reference or a piece of stock that has a known size and shape and the gcode is written to rough the excess off and then finally cut the finished part. With plasma the unknown state of the sheet makes it impossible to generate gcode that will cater for these variances in the material.

A plasma Arc is oval in shape and the cutting height needs to be controlled to minimize beveled edges. If the torch is too high or too low then the edges can become excessively beveled. It is also critical that the torch is held perpendicular to the surface.

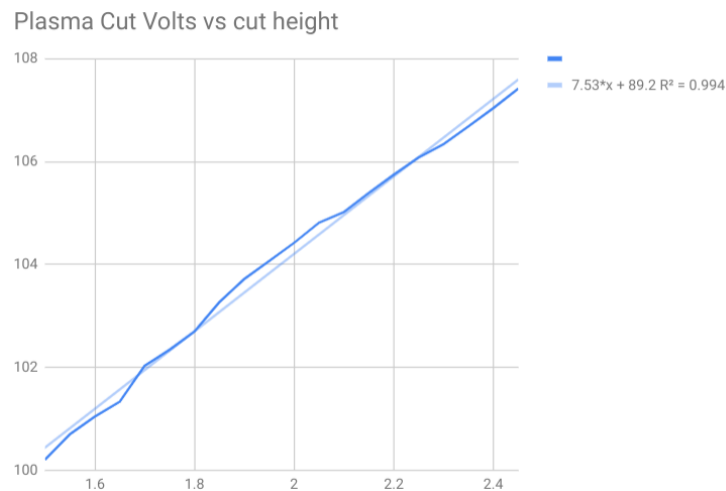
Torch to work distance can impact granularity



**Negative cut angle:** torch too low, increase torch to work distance.

**Positive cut angle:** torch too high, decrease torch to work distance.

**Note:** A slight variation in cut angles may be normal, as long as it is within tolerance. The ability to precisely control the cutting height in such a hostile and ever-changing environment is a very difficult challenge. Fortunately, there is a very linear relationship between Torch height (Arc length) and arc voltage as this graph shows.



This graph was prepared from a sample of about 16,000 readings at varying cut height and the regression analysis shows 7.53 volts per mm with 99.4% confidence. In this particular instance this sample was taken from an Everlast 50 amp machine.

Torch voltage then becomes an ideal process control variable to use to adjust the cut height. Let's just assume for simplicity that voltage changes by 10 volts per mm. This can be restated to be 1 volt per 0.1mm (0.04"). Major plasma machine manufacturers (e.g. Hypertherm, Thermal Dynamics and ESAB), produce cut charts that specify the recommended cut height and estimated arc voltage at this height as well as some additional data. So, if the arc voltage is 1 volt higher than the manufacturers specification, the controller simply needs to lower the torch by 0.1 mm (0.04") to move back to the desired cut height. Neuron torch height control unit is used to manage this process.

### Arc OK Signal

Plasma machines that have a CNC interface contain a set of dry contacts (e.g. a relay) that close when a valid arc is established and each side of these contacts are brought out onto pins on the CNC interface. A plasma table builder should connect one side of these pins to field power and the other to an input pin. This then allows the Neuron controller to know when a valid arc is established and also when an arc is lost unexpectedly.



## Initial Height Sensing

Because the cutting height is such a critical system parameter and the material surface is inherently uneven, a Z axis mechanism needs a method to sense the material surface. There are two methods this can be achieved. A "float" switch and an electrical or "ohmic" sensing circuit that is closed when the torch shield contacts the material.

### Float Switches

The torch is mounted on a sliding stage that can move up when the torch tip contacts the material surface and trigger a switch or sensor. Also, Neuron controller use the switch hysteresis obtained in the setup procedure.

Regardless what probing method is implemented, it is strongly recommended that float switch is implemented so that there is a fallback or secondary signal to avoid damage to the torch from a crash.

### Ohmic Sensing

Ohmic sensing relies on contact between the torch and the material acting as a switch to activate an electrical signal that is sensed by the Neuron controller. Provided the material is clean, this can be a much more accurate method of sensing the material as a float switch which can cause deflection of the material surface. This ohmic sensing circuit is operating in an extremely hostile environment so a Neuron Ohmic contact sensor is implement to ensure safety of both the CNC electronics and the operator. In plasma cutting, the earth clamp attached to the material is positive and the torch is negative. It is recommended that The ohmic circuit uses a totally separate isolated power supply that activates an opto-isolated relay to enable the probing signal to be transmitted to the Neuron controller.

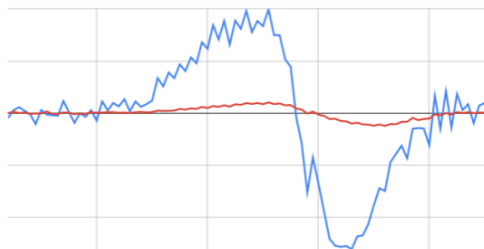
### Corner Lock / Velocity Anti-Dive

The CNC trajectory planner is responsible for translating velocity and acceleration commands into motion that obeys the laws of physics. For example, motion will slow when negotiating a corner. Whilst this is not a problem with milling machines or routers, this poses a particular problem for plasma cutting as the arc voltage increases as motion slows. This will cause the THC to drive the torch down. Modern CNC systems like Mach3, Mach4, UCCNC, LinuxCNC support the real-time macros that allow to enable or disable automatic voltage control from program g-code. Neuron controllers has a separated Hi-Speed "THCOFF" input for this.

### Head Safety Lock /Kerf Detect

If the plasma torch passes over a void while cutting, arc voltage rapidly rises and the THC responds by violent downward motion which can smash the torch into the material possibly damaging it. This is a situation that is difficult to detect and handle. To a certain extent it can be mitigated by good nesting techniques but can still occur on thicker material when a slug falls away. This is the one problem that has yet to be solved within the Neuron controller.

One suggested technique is to monitor the rate of change in torch volts over time ( $dv/dt$ ) because this parameter is orders of magnitude higher when crossing a void than what occurs due to normal warpage of the material. The following graph shows a low-resolution plot of  $dv/dt$  (in blue) while crossing a void. The red curve is a moving average of torch volts.



So, it should be possible to compare the moving average with the  $dv/dt$  and halt THC operation once the  $dv/dt$  exceeds the normal range expected due to warpage.

## Hole and Small Shape Cutting

It is recommended that you slow down cutting when cutting holes and small shapes.

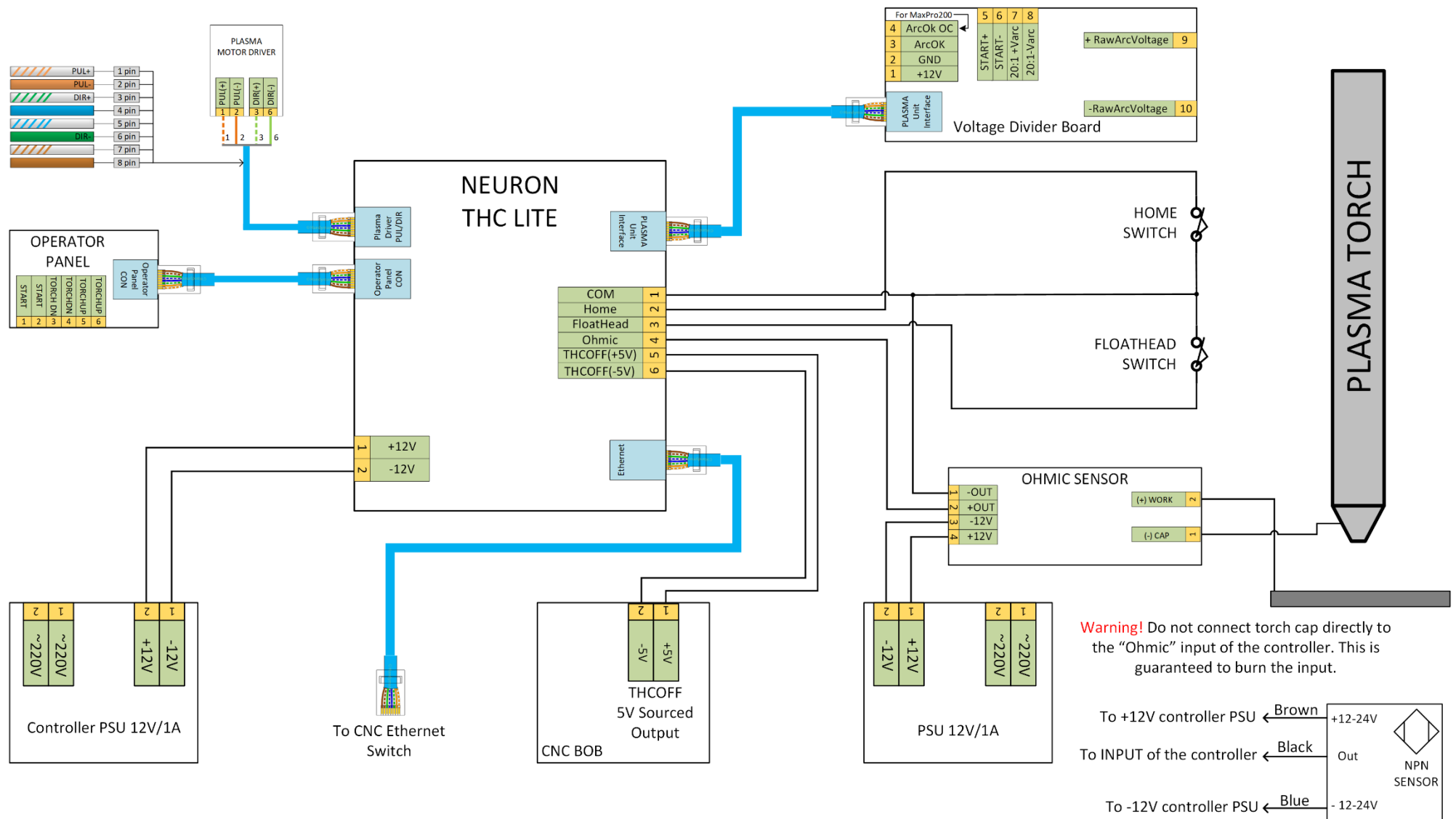
The generally accepted method to get good holes from 37mm dia. and down to material thickness with minimal taper using an air plasma is:

1. Use recommended cutting current for consumables.
2. Use fixed (no THC) recommended cutting height for consumables.
3. Cut at 60% to 70% of recommended feed rate for consumables and material.
4. Start lead in at or near center of hole.
5. Use perpendicular lead in.
6. No lead out, either a slight over burn or early torch off depending on what works best for you.

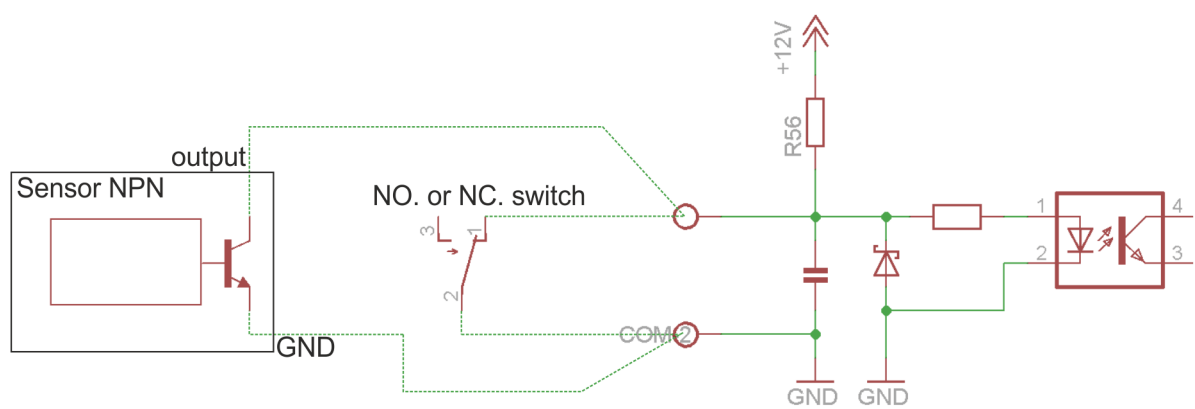
You will need to experiment to get exact hole size because the kerf with this method will be wider than your usual straight cut.

This slow down and real-time macro for THCOFF can be achieved by manipulating the feed rate directly in your post processor or by using special rules (for Sheetcam or Plasmicon CAM software).

## Connection diagram



Input signal interface schematic



## INSTALLATION

1. Mount the Neuron.THC into the CNC box.
2. Connect Home and Initial Height Sensing (Float Head and/or Ohmic Sensor) switches to screw terminals on the Control Module.
3. Connect the Neuron.THC Control Module to the RJ45 (Cat5e) Ethernet connector on the PC or Ethernet switch (0.5 m minimal cable length).
4. Connect the plasma system interface PCB to the RJ45 (CAT5) connector on the Control Module.
5. Connect the Torch Lifter motor driver to Pulse/Direction RJ45 connector (using adapter) on the Control Module.
6. Connect the power supply (DC 12 volt / 0.8A) to screw terminals on the Control Module.

**NOTE: All interconnection RJ45 cat5e cable has the PIN TO PIN connection.**

## Recommended grounding and shielding practices

### Introduction

This part is describing the grounding and shielding necessary to protect a plasma cutting system installation against radio frequency interference (RFI) and electromagnetic interference (EMI) noise. It addresses the three grounding systems described below.

Note: These procedures and practices are not known to succeed in every case to eliminate RFI/EMI noise issues. The practices listed here have been used on many installations with excellent results, and we recommend that these practices be a routine part of the installation process. The actual methods used to implement these practices may vary from system to system, but should remain as consistent as possible.

### Types of grounding

1. The safety, protective earth (PE), or service ground. This is the grounding system that applies to the incoming line voltage. It prevents a shock hazard to any personnel from any of the equipment, or the work table. It includes the service ground coming into the plasma system and other systems such as the CNC controller and the motor drivers, as well as the supplemental ground rod connected to the work table. In the plasma circuits, the ground is carried from the plasma system chassis to the chassis of each separate console through the interconnecting cables.
2. The DC power or cutting current ground. This is the grounding system that completes the path of the cutting current from the torch back to the plasma system. It requires that the positive lead from the plasma system be firmly connected to the work table ground bus with a properly sized cable. It also requires that the slats, on which the workpiece rests, make good contact with the table and the workpiece.
3. RFI and EMI grounding and shielding. This is the grounding system that limits the amount of electrical "noise" emitted by the plasma and motor drive systems. It also limits the amount of noise that is received by the CNC and other control and measurement circuits. This grounding/shielding process is the main target of this document.

### Steps to take

1. All motor and drive related leads need full shielding and twisted pair connectors. The shields should all be connected back to a star ground point at the driven ground rod.
2. Torch leads need to be shielded (outer cover with braided metal shield) that should be grounded only at the high frequency generator end.....back to the star ground point. The

rest of the leads must be isolated from any machine metallic parts.... preferably inside a plastic nonconductive power track.

3. Chassis of plasma power supply (with high frequency generator should be mounted away (as far as practically possible) from the PC, and should be grounded directly to the star ground point.
4. PC should be as far away from the plasma power supply, should get its AC sourced through an uninterruptible power supply with surge protection. PC chassis should be grounded directly to the star ground point.
5. If a remote wired pendant is used, it should have a shielded cable, also grounded to the star ground point.
6. The gantry of the cutting machine should be grounded to the star ground point.
7. The torch carriage and z axis slide should be grounded to the star ground.
8. The computer monitor should be connected to the computer with a shielded cable. The mouse also needs to be shielded.

Note: each ground wire to the star ground needs to be separate....no "daisy chaining" as this can create ground loops.

The work ground from the plasma should be bolted directly to the star ground (no welding clamp)

The cutting slat bed should be connected directly to the star ground as well.

The star ground point should be right on the ground rod, or within about 6 feet, any extra cable length should be shortened, no cables on the machine should have any coiled extra length.

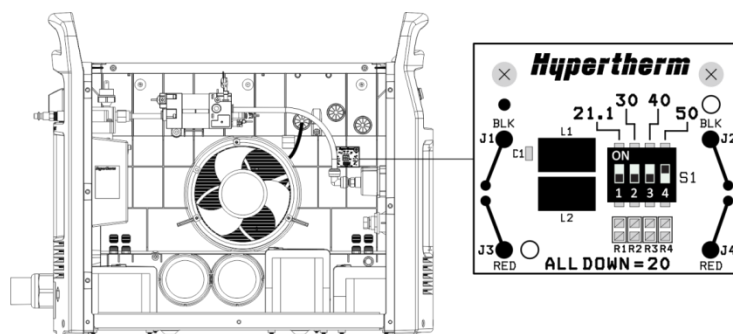
This is the minimum that should be done on any CNC installation with high frequency plasma.... this often, but not always, eliminates electrical noise interference problems!

## Voltage Divider Installation - General

### **!!!! WARNING!!!!** **TURN OFF ALL POWER BEFORE WORKING ON** **EQUIPMENT**

The voltage divider provides a feedback signal which is derived from the actual cutting arc voltage of the plasma power supply. The Neuron.THC control uses this feedback signal to control the cutting height of the torch. The voltage divider used in the Neuron.THC a 10:1 signal. This simply means that a cutting voltage of 100 volts results in a signal of 10 volts provided to the control. The power supply positive and power supply negative connections on the voltage divider should be connected to the proper output points of the plasma power supply.

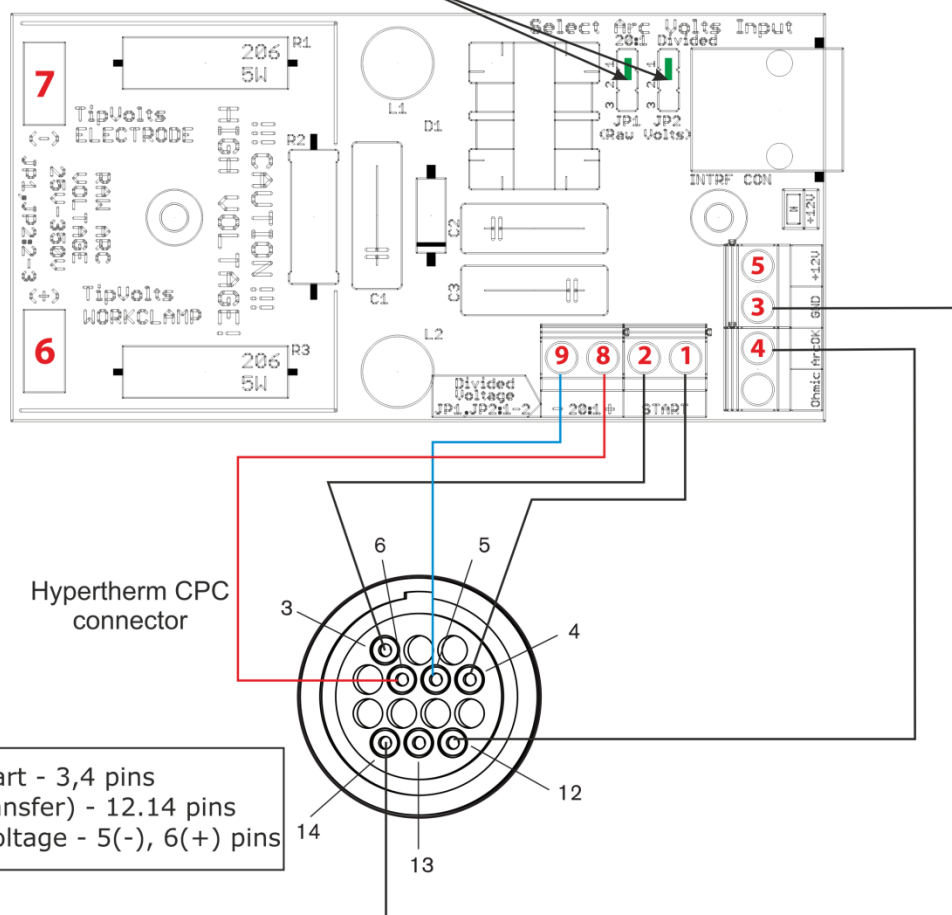
## Powermax plasma unit. Internal divider 20:1



Установите переключатель в показанное положение, что соответствует коэффициенту деления 20:1.

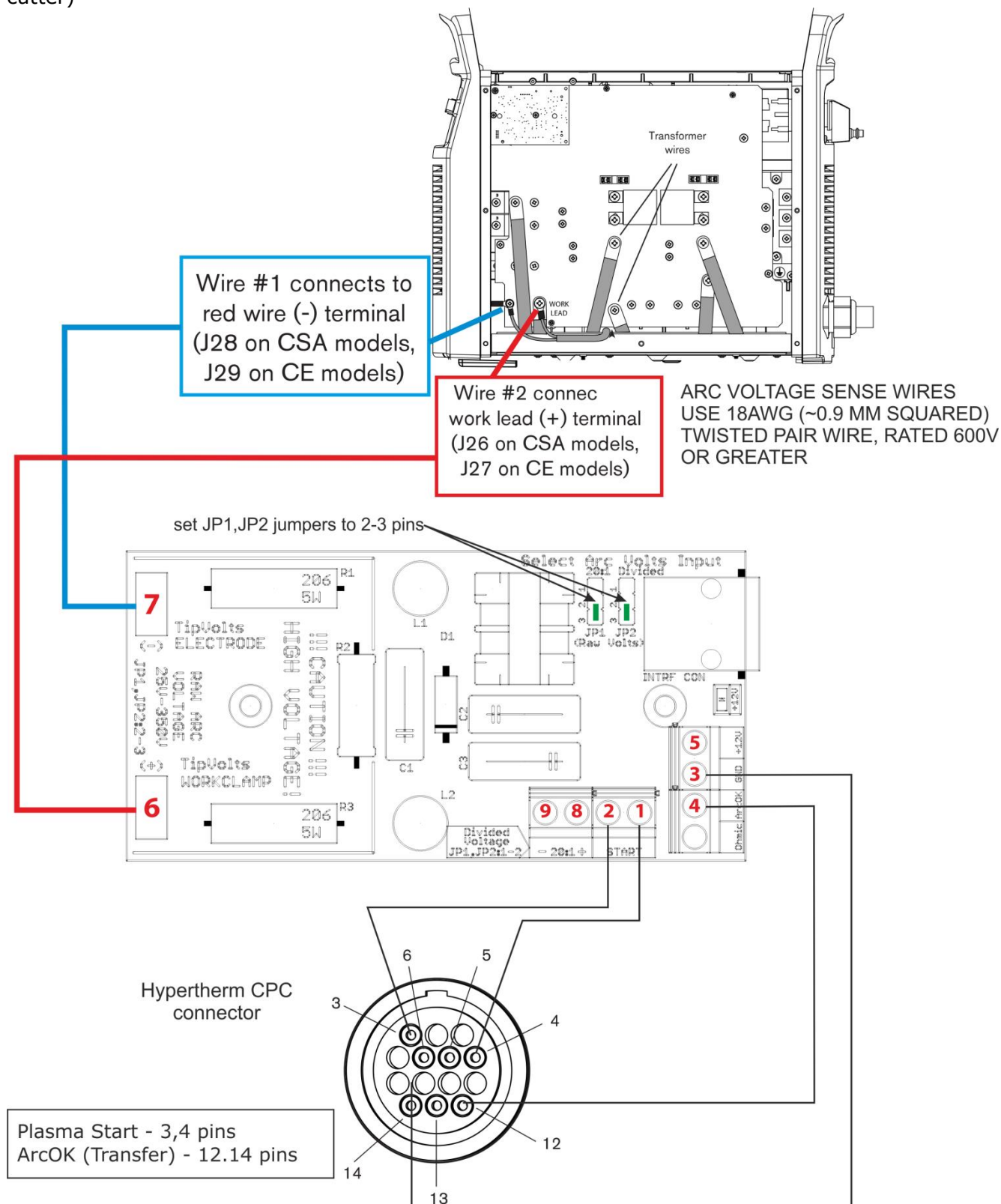


set JP1,JP2 jumpers to 1-2 pins



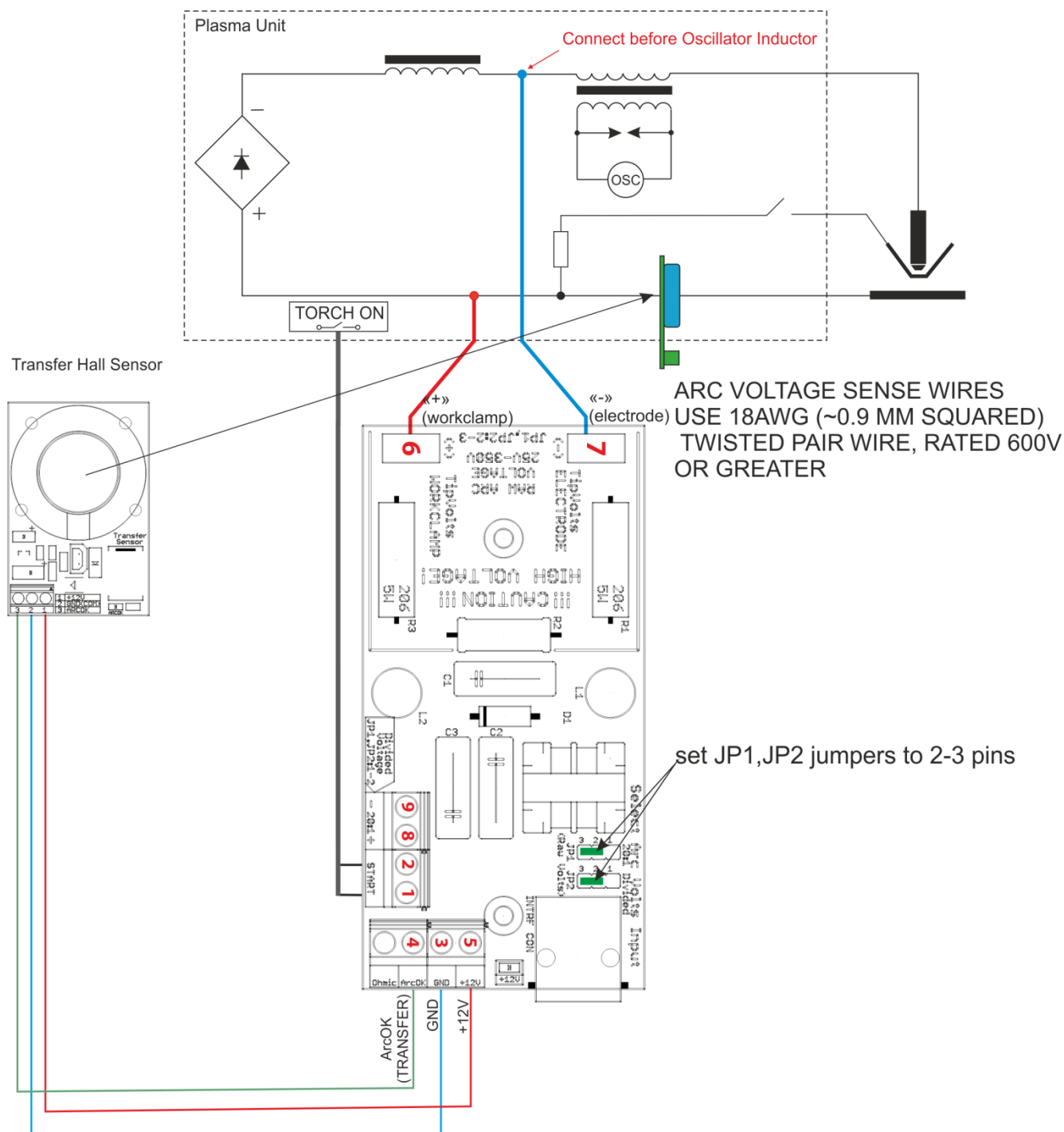
## Powermax plasma unit. Raw Arc Voltage.

Note: connection points for raw arc voltage can be different (depend from the model of the cutter)

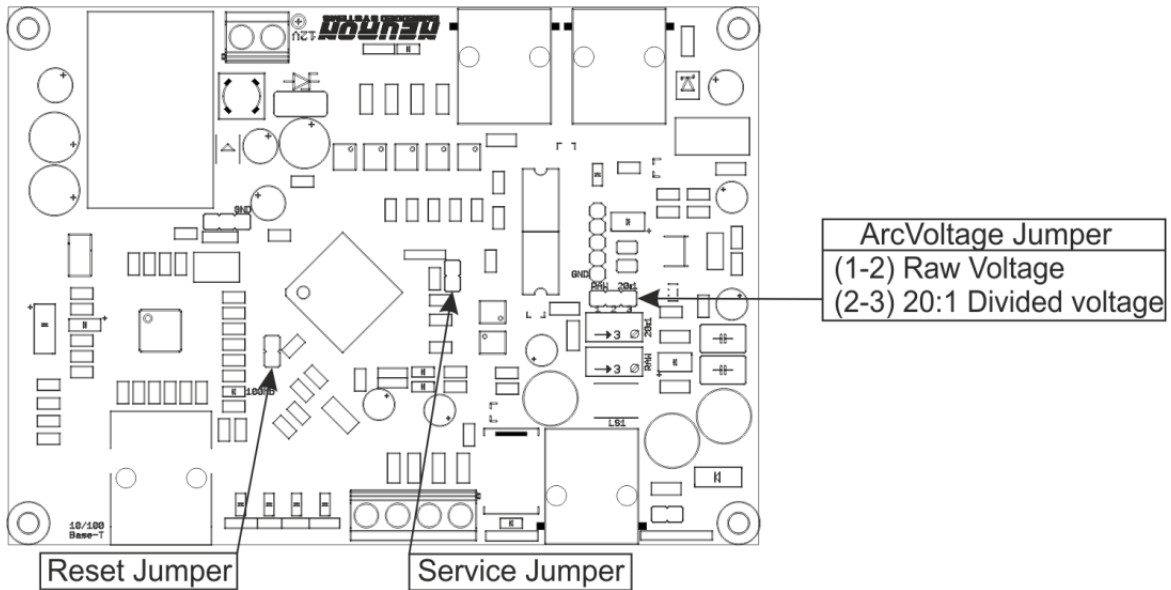




## Other plasma unit. Raw Arc Voltage.



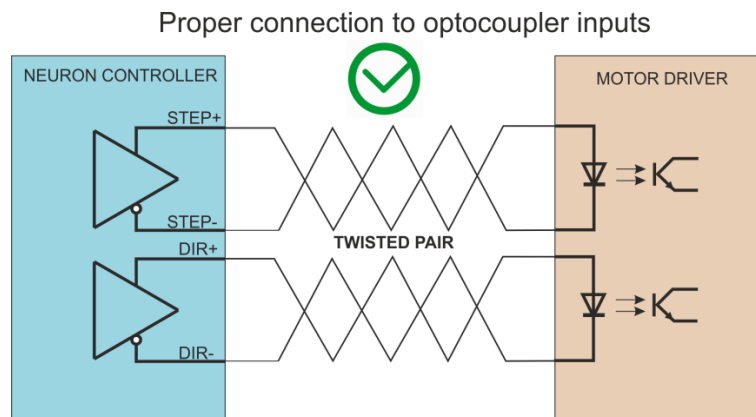
## Setup Main module.



### Motor driver differential interface schematic

Optocoupler input is the best available option in terms of resistance to interference and convenience of connection. For each signal, twisted pair of cables is needed.

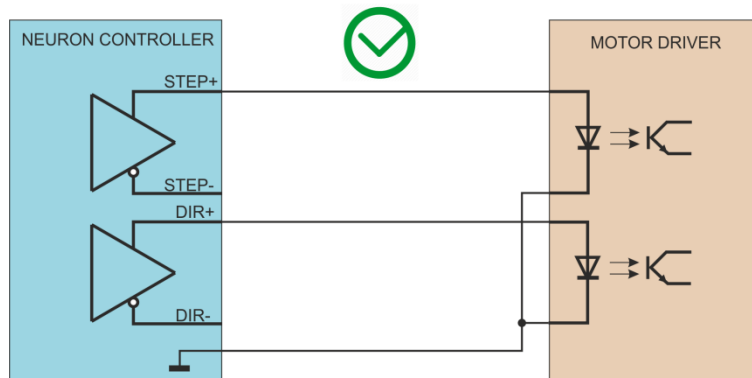
If motor driver has optocoupler inputs then there is no need to connect GND of the devices too.



Signs on the drive may differ so you should first read the documentation carefully. It can be e.g. PUL+/PUL- and SIGN+/SIGN-, however it is not a rule. Servo drives often have two different types of STEP/DIR inputs.

There is connection variant with shared (common) GND wire. This variant (most Gecko micro step drivers) is a little bit worse because of lower interference resistance and it is a bit more difficult to connect.

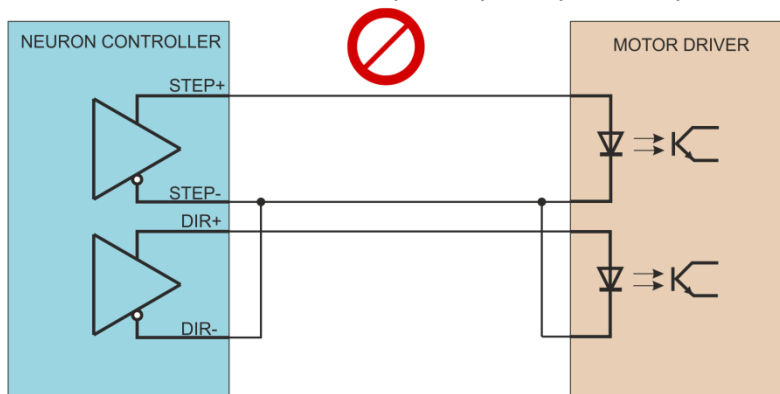
Proper connection to optocoupler inputs with shared cable



In this case, we do not use twisted cable and that is why the connection is more exposed to the influence of interferences.

**It is important to do not connect STEP- and DIR- pins with GND of the device because it will cause short circuit and output stages damage.**

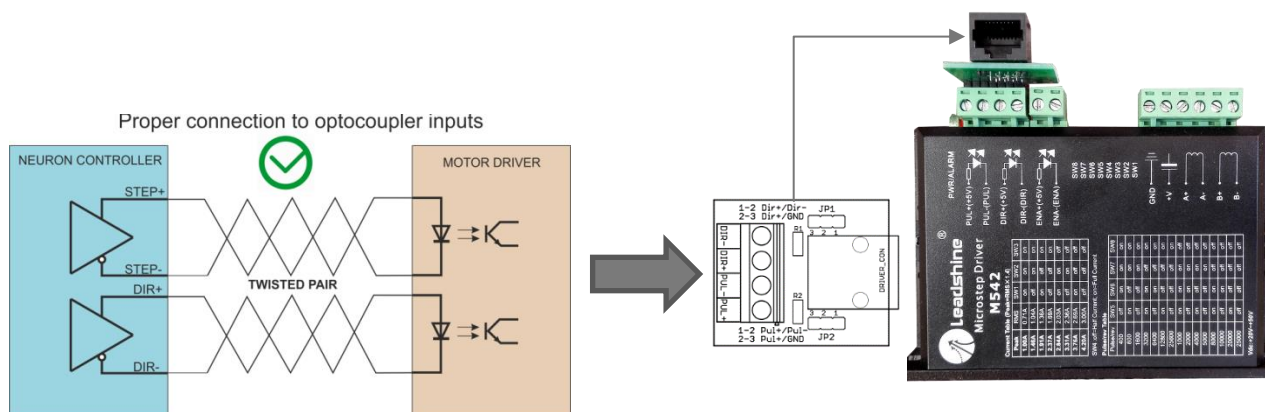
Incorrect connection to optocoupler inputs sample



Because of short circuit between STEP- and DIR- signals in such a connection the Neuron controller will be damaged. Warranty does not cover damages caused by incorrect connection!

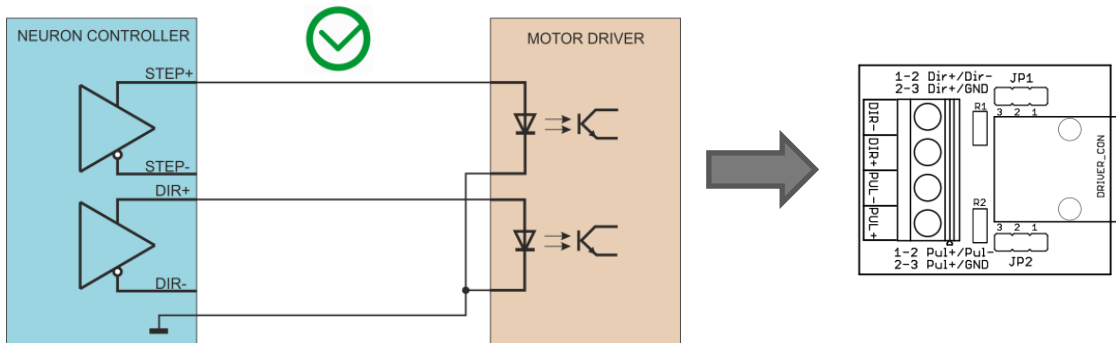
THC kit has a special adapter PCB for connecting Neuron differential Pulse/Dir output to the motor driver.

Set JP1, JP2 jumpers to 1-2 pins for differential connection:



Set JP1, JP2 jumpers to 2-3 pins for shared ground connection:

Proper connection to optocoupler inputs with shared cable



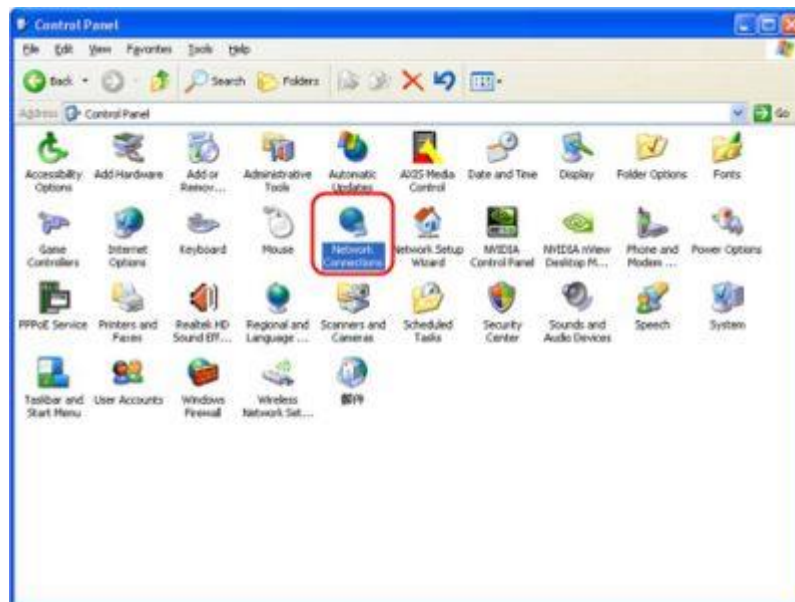
## Setting up the network

To setup the network for the device next steps has to be done.

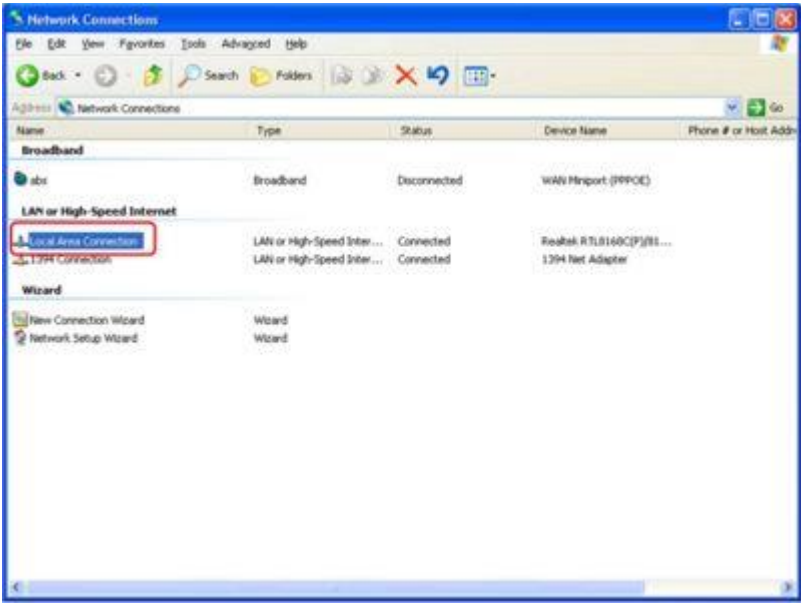
### 1. Setting up the network on the PC side

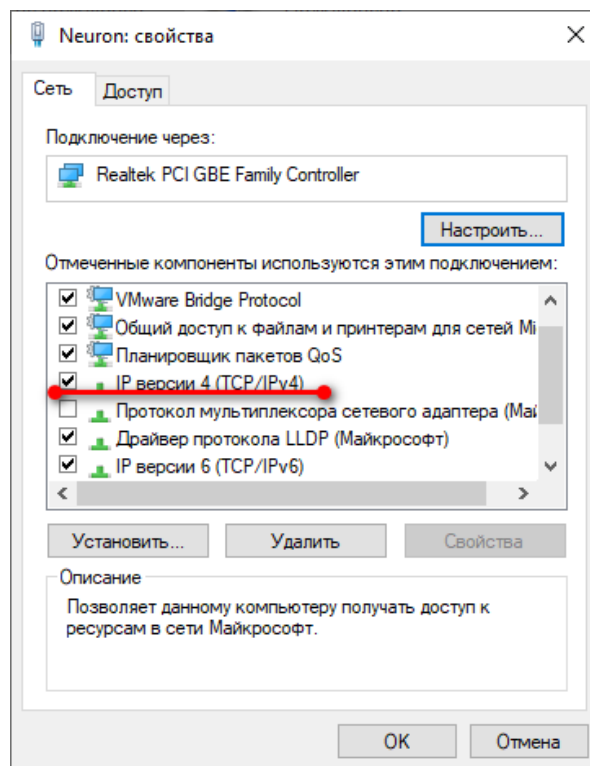
To setup the network on the computer side first connect the Neuron device to the network and power it up with connecting an external power supply to the green screw terminals on the board. For direct cable connection to the LAN card use a crossover cable (crossed wiring.) and if connecting the device to a switch or router use an ethernet patch cable (straight wiring). The cable length for the direct connection can be a maximum of 100meters (330feet). It also must be noted here that if the LAN network card or the router where the Neuron is connected to supports MDI/MDIX auto cross functionality then it does not matter if the cable used is a Patch cable or a Crossover cable, because the MDI/MDIX function will detect the cable type. The following image shows the wiring of the different cables.

#### 1.) Go to **[Control Panel]->[Network Connections]**

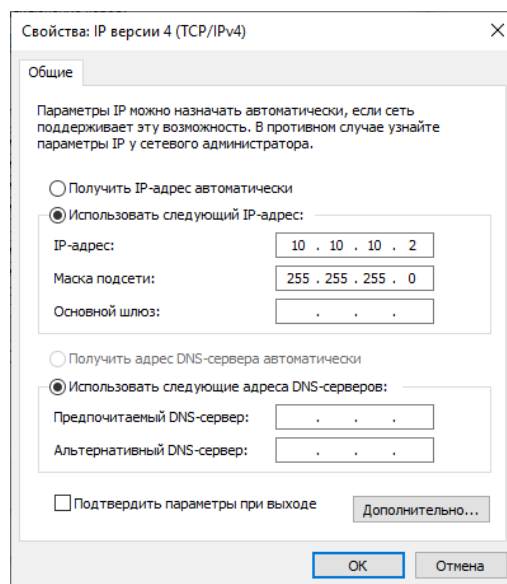


#### 2.) Right click on **[Local Area Connection]->[Properties]**



3.) Select **[Internet Protocol(TCP/IP)]->[Properties]**4.) Select **[Use the following IP address:]** and fill the fields.

- **Set the IP address [XXX.XXX.XXX.1] (XXX.XXX.XXX – first three digit must be equivalent to controller IP address. For example controller has the 10.10.10.100 address. You have to set 10.10.10.1-99 or 10.10.10.101-255 IP address for the CNC computer.**



## UCCNC configuration

Macro	out pin	port	Active low
M10.1	0	0	<input type="checkbox"/>
M10.2	5	3	<input type="checkbox"/>
M10.3	0	0	<input type="checkbox"/>
M10.4	0	0	<input type="checkbox"/>
M10.5	0	0	<input type="checkbox"/>
M10.6	0	0	<input type="checkbox"/>
M10.7	0	0	<input type="checkbox"/>
M10.8	0	0	<input type="checkbox"/>
M10.9	0	0	<input type="checkbox"/>
M10.10	0	0	<input type="checkbox"/>

Apply settings      Save settings

### Setup THCOFF signal.

This signal turns OFF/ON "AVC" (Automatic Voltage Control) during cutting from G-code program. For example, on the picture Port 3 Pin5 was set for "M10.2" and "M11.2" real time macros.

1. Go to the Configuration->I/O Setup->Page2 panel. Set port and pin for THCOFF signal.
2. Route Port 3 Pin5 output (5V sourced) to the THCOFF input of the controller.
3. Setup "Active Low" settings for selected macro so the "LOCK" indicator in the Neuron control panel in the UCCNC will be BLUE on "M10.2" macro issue. And reverse Gray on "M11.2".

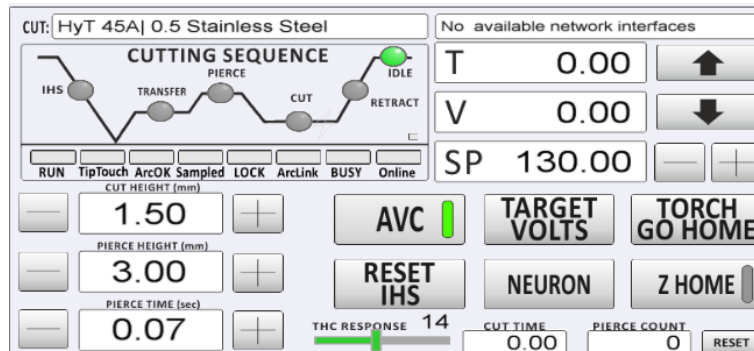
NOTE: For proper operation is necessary to enable "Torch Height Control" function (wait for ArcOK) by click on the THC ON button. Then after "M3" the UCCNC must wait for the Motion signal from controller to begin moving on X/Y plane. In the Demo mode of the UCCNC the THC function is not working.



## Functions and Definitions

### Main parameters

The UCCNC Control panel screen that the operator sees during operation.



NOTE: for edit the values you can click the right mouse button on the value box to open the MDI widow for input new value.

Parameter	Value
<b>AVC Enabled</b>	When AVC is enabled (ON), Automatic Height Control is active. When AVC is disabled (OFF), the torch height sequences in Auto mode (IHS, Cut Height, Retract) but the torch height remains fixed during the cut and can changes with manual commands only.
<b>Target Volts (SP)</b>	Click on the plus/minus target voltage buttons on the UCCNC control panel to change the Set Arc Voltage value. The Neuron.THC system maintains the Set Arc Voltage during a cut in the Auto mode. Raising the Arc Voltage will increase the torch height during a cut, while lowering it will decrease the cutting height of the torch. The Arc Voltage can be adjusted from 50 to 250 volts in .25 volt increments.
<b>Real Volts (V)</b>	Real arc voltage value
<b>Position (T)</b>	Torch axis position
<b>Cut Height</b>	Cut Height value – 0.254 mm to 25.40 mm. Click the right mouse button on this DRO to open the MDI window.
<b>Pierce Height</b>	Pierce Height mm – 0.254 mm to 25.40 mm. Click the right mouse button on this DRO to open the MDI window.
<b>Pierce Time</b>	0 to 10 seconds with 0.01 second resolution. Click the right mouse button on this DRO to open the input calculator.
<b>ZHOME button</b>	Click on the ZHOME button for start the torch homing procedure. If ZHOME button led is flash – the system waits for the homing procedure.
<b>Torch Up button</b>	The lifter initially jogs up 0.254 mm. After 0.5 second, it begins continuous upward motion at the IHS Speed. After 2 seconds, the lifter increases the speed to the programmed Manual Speed. You can disable "Advanced Jog" in the Neuron Plasma Engine tab.
<b>Torch Down button</b>	The lifter initially jogs down 0.254 mm. After 0.5 second, it begins continuous downward motion at the IHS Speed. After 2 seconds, the lifter increases the speed to the programmed Manual Speed. You can disable "Advanced Jog" in the Neuron Plasma Engine tab.
<b>Torch Go Home button</b>	Click on this button to lift up torch to home position.

<b>Neuron settings button</b>	Click on this button to open the Neuron settings window
<b>RESET IHS button</b>	Click on this button for reset the last known workpiece position in IHS procedure. Next IHS procedure will be executed at the IHS speed.
<b>Cut time, Pierce count, Reset button</b>	Cut time and Pierce count for consumables control. Click on the RESET button for clear values.
<b>THC Response Track Bar</b>	This gain is used when the THC is operating closed-loop arc voltage control (see description in the Plasma profile section)

## Neuron Cut profile

The screenshot shows the 'Neuron Cut profile' settings window. The 'Cut Profile' tab is selected, displaying settings for 'HyT 45A | 6.0 mm Stainless Steel'. The window is organized into several sections: 'THC Mode' with 'Automatic Voltage Control' checked; 'Cut Chart Values' with fields for Set Arc Voltage (140.00V), Cut height (1.50 units), Pierce Height (3.80 units), and Pierce Time (0.50 sec); 'TIP Saver' with 'LockHeadDown' set to OFF and 'KerfDetect' set to OFF; 'Plasma Process Parameters' with various fields for Arc Current, Start IHS Height, Skip IHS within, Transfer height, Retry On Transfer Fail, Transfer Time, Puddle Jump Height, Puddle Jump Time, AVC Delay, Partial Retract, and Retract Height; 'OxyFuel Settings' with fields for Preheat Height, Preheat Time, Pierce Height, Pierce Time, and Cut Height; and 'Messages' with 'Show Errors' checked. A status bar at the bottom indicates 'Professional Version', 'Firmware ver.', 'S/N', and 'IP: 10.10.10.100'.

NOTE: for edit the values you can click the right mouse button on DRO to open the MDI window.

### Automatic Voltage Control

Description: If Voltage Control is ON, the torch height is controlled by the measured arc voltage. If Voltage Control is OFF, the torch maintains a constant position during the cut that is independent of the Arc Voltage.

Setting: OFF / ON

### Sample and Hold Arc Voltage Mode

Description: The Voltage Control must be ON. When Sample Voltage is ON, the THC measures the voltage at the end of the AVC Delay or removing the Hold signal (from G-Code) and uses it as a set point for the remainder of the cut.

When Sample Voltage is OFF the Set Arc Voltage is used as the set point for torch height control.

Setting: OFF / ON

### **Max Allowable Sampling Error**

Description: the maximum value of the difference between the last two measurements of the arc voltage in the "Sample and Hold" mode. If the difference is less than the set value, the controller will use the current sampled arc voltage value. If not, then this value is rejected and the last successful one is used.

### **Set Arc Voltage**

Description: The Voltage Control must be ON, and the Sample Voltage must be OFF.

When Sample Voltage is OFF, the Set Arc Voltage is used as the set point for torch height control. Setting: 50 to 250 VDC

### **Cut Height**

This value for the height at which the torch cuts the workpiece. Setting: 0.25 – 25.4 mm (0.01 – 1.0 in)

### **Pierce Height**

Description: This value determines the height at which the torch pierces the workpiece. Setting: 0.25 – 25.4 mm (0.01 – 1.0 in)

### **Pierce time**

Description: This is the value for the Pierce Delay. During this time, the X/Y cutting motion is delayed to allow the plasma to fully pierce the workpiece.

Setting: 0 – 10 seconds

### **THC Response**

Description: This gain is used when the THC is operating closed-loop arc voltage control.

How to use: If this value is set too high, the lifter positioning during closed-loop arc voltage control will become unstable and prone to oscillation. If this value is set too low, the arc voltage control can become slow and inaccurate. The value of 8 is appropriate.

The THC Response can be tested by change value during cutting under closed-loop arc voltage control and checking that the THC quickly and accurately reaches the set arc voltage.

Very high speeds on very thin or highly warped metal may require increasing the Response setting to respond faster. Be careful to not go so high the torch overshoots and oscillates up and down. Remember you will generally want to go back to 8 normal cutting.

To optimize this response, raise this value until a very slight oscillation is detected during a cut and then reduce the setting by 1 or 2.

Range: 1 to 30, the default setting = 8

### **LockHeadDown**

Description: This feature avoids that the plasma torch moves down which arc voltage is up (for example on the end of cut, when crossing a kerf or hole or going off the edge of the plate). If the adjustable Lock Head Down Level exceeds the limit during cutting, the clearance control will be disabled.

Setting: OFF / ON

### **LockHeadDown Level**

Description: When crossing a kerf or hole or going off the edge of the plate, arc voltage rises very rapidly. System will respond to the rise in voltage by lowering the torch trying to keep voltage constant. To prevent this a LockHeadDown Level is set so when arc voltage exceeds the cutting voltage by the % specified by the LockHeadDown Level setting system stops trying to control height.

Hint: For thicker metal which tend to be fairly flat and using lower cutting speeds the arc voltage doesn't change very rapidly except when crossing kerfs & holes so using a lower % will respond

quicker, typically 5-10%. For higher speeds on thinner or warped metal where normal cutting voltage changes more rapidly, use a higher number around 10-15% or even 20%.

### **Kerf Detect**

Description: If the plasma torch passes over a void while cutting, arc voltage rapidly rises and the THC responds by violent downward motion which can smash the torch into the material possibly damaging it. This is a situation that is difficult to detect and handle. To a certain extent it can be mitigated by good nesting techniques but can still occur on thicker material when a slug falls away. One suggested technique is to monitor the rate of change in torch volts over time ( $dv/dt$ ) because this parameter is orders of magnitude higher when crossing a void than what occurs due to normal warpage of the material.

Controller compare the moving average with the  $dv/dt$  and halt AVC operation once the  $dv/dt$  exceeds the normal range (Kerf Detect Level) expected due to warpage.

Setting: OFF / ON

### **Kerf Detect Level**

Description: This parameter sets the sensitivity of the Auto Kerf Detection level on a relative scale. A value of 1 is the most sensitive and will activate at lower voltage increases, 15 is the least sensitive and will activate at higher voltage increases.

Setting: 1 – 15, default value is 12.

### **Start IHS Height**

Description: This is the height above the last known workpiece position that the THC switches from Automatic speed to the slower IHS speed. This height should be set high enough to avoid contacting the workpiece.

Setting: 2.54 – 50.8 mm (0.1 – 2.0 in)

### **Skip IHS Within**

Description: If the next starting point is within this distance of the end of the previous cut, the THC skips the IHS. When this happens, the torch goes directly to the Transfer Height and skips contact with the workpiece. This setting can improve the overall machine production rate but should not have any effect on the part being cut. Clear the checkbox to disable this feature.

Setting: 0 – 3000 mm

### **Transfer Height**

Description: This value determines the height above the workpiece where the torch is initially fired. It is the torch height after an IHS and is entered as a percentage of the Cut Height.

This setting can be used to improve the ability of the torch to transfer to the workpiece for processes that use a very high Pierce Height or have difficulty in transferring.

Setting: 50% – 400% of Cut Height, commonly 150%

### **Retry on transfer fail**

Description: This value determines the number of times that the controller will attempt to re-start the plasma after failing to transfer. The controller removes and reapplies the start signal on each re-start attempt.

Setting: 0 – 10

### **Transfer time**

Description: This is the number of seconds that the controller will wait for transfer before attempting a retry.

Setting: 0 – 10 seconds

### **Jump Height**

Description: This value determines the height above the workpiece that the torch is raised to clear the top dross puddle that can form during the pierce. It is the torch height after Pierce. This

height is entered as a percentage of the Cut Height. The torch remains at this height until the Jump Time Delay has elapsed. If this feature is not used, clear the Enabled checkbox.  
Setting: 50% – 450% of Cut Height

### **Jump Time**

Description: This value sets the number of seconds to hold the torch at the Puddle Jump Height before transitioning to the Cut Height. This time is used to allow the torch to clear the top dross puddle that forms during a pierce. If this feature is not used, clear the Enabled checkbox.  
Setting: 0 – 10 seconds

### **AVC Delay**

Description: This value sets the number of seconds that are required for the cutting machine and plasma torch to achieve steady-state operation at the cut height. After this delay, the AVC is enabled for the remainder of the cut. If the THC is in Sample Voltage mode and Hold signal is removed, the arc voltage sample is taken after this delay.  
Setting: 0 – 10 seconds

### **Partial Retract**

Description: Set this checkbox to select Partial Retract of the torch at the end of a cut.

### **Retract Height**

Description: This parameter specifies height above the workpiece to which the torch retracts at the end of a cut.  
Setting: from 0 mm – to the maximum lifter length

### **Messages**

**Show Errors:** set this checkbox to show messages to operator about issued errors in the popup window.

Note: also, all errors are stored in the log box in the diagnostic tabs.

**Inform the operator if diff. between Real and Target on cutting start more than:**  
plugin on the each cutting cycle check the difference between real arc voltage on the start of the cutting and target arc voltage. If the difference is bigger than this parameter – plugin inform about this using warning sign in the Set Arc Voltage DRO. It's helps to operator to correct target arc voltage depend from state of the consumables or when plate thickness was changed. Default value is 5 volts.

## Plasma Engine

The screenshot shows the 'Plasma Engine' settings window. It includes the following settings:

- Pulses In Unit:** 300.000 pulses
- Automatic speed:** 5000 units/min
- Jog Speed:** 3000 units/min
- IHS Speed:** 400 units/min
- Acceleration:** 350 units/sec<sup>2</sup>
- Acceleration In Cut:** 250 units/sec<sup>2</sup>
- Axis Length:** 125.0 units
- Safe Jog height:** 75 %SlideLength
- Waite Clear Plate:** 10.0 mm
- Main Loop Time:** 15 msec
- Input Debounce Time:** 1 msec
- Dead Band:** 0.50 volts
- Reverse Engine:** ☐
- Push and Jog Mode:** ☐
- Lift Up Torch after 60 sec IDLE:** ☐
- Ohmic Sensor Options:**
  - Ohmic Contact Issue During Cutting:**
    - ☐ Move Torch UP until contact is lost
    - ☐ Stop Cutting
  - Ohmic on Water Table:**
    - ☐ Allow
    - ☐ Torch Preflow (Short ON) Torch On Time: 0.10 sec
    - ☐ Disable Soft Touch-Off
- Arc Voltage Converter Tuning:**
  - real value: 0 volts (5V source: 123.75V (20:1), 56.75V (internal))
  - k - correction value: 1.000 (Varc=Vreal\*k, k=Vbook/Vreal)
- Float Head Microswitch Offset Setup:** 0.000 mm
- Marking Mode (Hole Center):** ☐ Enable (use "M405" macro)
- Ref. Z Axis After:** 30 pierces (enter 0 to disable)
- Ventilation:** ☒ ON ☐ OFF
- Rump UP Time:** 0 sec
- PostFlow Time:** 0 sec
- Use AdvBOB Output#:** Not Use
- Delay before ArcLost error issue:** 500 msec

Buttons: Change Settings, Save Settings

**Note for stepper motors:** a stepper works in open loop, so it can lose steps from too high running speed where there is not enough torque, or too high accelerations/decelerations or can be a mechanical problem which causes higher torque requirement on the axis, or a combination of these. Or it can be a power supply problem that the Voltage drops down too much when more axis moving together. Or it could be the capacitors in the power supply not holding the voltage (electrolyte dry out) causing more EMI which causes lost or extra steps. Please pay attention for this.

### Steps in mm

Description: The value is based on the counts of pulses for 1 mm torch move.

### Automatic Speed

Description: This speed is used for all automatic rapid moves such as the End-of-Cut-Retract or the Initial Approach to the workpiece. This value depends on the lifter motor speed, the screw pitch, the weight of the lifter load and the desired speed of operation.

**NOTE:** The maximum 'Speed' value can be calculated using the following formula

$$V_{max} = 60 * \frac{f_{max}}{N_{unit}}$$

where  $f_{max}$  is the maximum step frequency of the Neuron pulse engine 100 kHz and  $N_{unit}$  is the 'Counts per Unit' of your torch slide.

Example: let the torch slide Counts per Unit be 3200. The maximum velocity is then

$$V_{max} = 60 * \frac{100000}{3200} = 1875 \text{ units/min}$$

Neuron plugin will automatically reduce the maximum velocity if it is configured above the limit.

### **Manual Speed**

Description: Manual speed is the speed at which the positioner moves when the control is in the manual mode. Note that in Manual, the positioner moves at a IHS speed when the up/down buttons are initially pressed. The speed is increased to the manual speed if the buttons are held down.

### **IHS Speed**

Description: This parameter sets the slow speed for the final approach to the workpiece during an IHS operation. It is also used as the slow speed for manual moves.

### **Acceleration**

Description: This acceleration is used for all automatic, manual and IHS moves. This value depends on the motor parameters, the weight of the lifter load and the desired speed of operation.

### **AVC Acceleration**

Description: This acceleration is used for moves during arc voltage close-loop operation. This value depends on the motor parameters, the weight of the lifter load and the desired speed of operation. Typically, this value is equal to the Acceleration.

### **Slide Length**

Description: This value is the length of the lifter's usable travel (Soft Limit function).

### **Safe Jog Height**

Description: This value is the length of the lifter's travel in % from Home position, when torch will be move on the Manual speed. The rest of the slide length, torch will be move at the IHS speed.

### **Clear Plate Distance**

Description: This value is the distance where system expects the Ohmic or Float head clear plate signal in IHS procedure.

Settings: 0 – 20 mm

### **Pooling period**

Description: This value is the time constant of the plugin main loop.

Setting: 15 – 63 msec – recommend value is 15 msec

### **Input Signal Debouncing**

Description: This value is the time constant of the input signals filter.

Setting: 5 – 63 msec – recommend value is 5 msec

### **Dead Band**

Description: This value is an interval of an arc voltage where no AVC occurs.

Setting: 0.25 – 3.0 V.

### **Push and Jog mode**

This allow to enable advanced jog mode. The lifter initially jogs on 0.25 mm. After 0.5 second, it begins continuous motion at the IHS Speed. After 2 seconds, the lifter increases the speed to the programmed Manual Speed.

Uncheck this check box for using regular Jog mode.

### **Reverse Engine**

Description: Set this checkbox to reverse torch move direction.



### **Torch go home after 60sec in IDLE**

Description: Set this checkbox if you need to automatically rise torch in zero position after 60sec in the IDLE mode.

### **Automatic Collision Avoidance**

This safety feature allows the control to automatically adjust the torch height during a cut to help prevent torch crashes. If automatic collision avoidance is enabled, the torch will move up any time when contact is sensed between the torch and the plate. If the torch contacts the plate the torch will retract while ohmic contact will lose, provided that the Use Ohmic function is enabled.

Allowed modes on collision are "Move torch up until ohmic contact is lost" and "Stop Cutting". Uncheck both checkboxes to disable ACA future.

### **Using Ohmic on the water table.**

This menu allows to enable/disable preflow in IHS if using ohmic contact sensor on the water table.

If you keep the water low enough so it does not splash mass quantities on the torch, then ohmic will work fine with a water table. If water gets on the surface of the material, expect the ohmic sensor to sense the surface of the water, not the metal. If water gets back inside the torch, often it will cause a false sense as well as it shorts from the shield to the nozzle internally. The water in a water table becomes full of suspended solids of the metal you are cutting which raises the conductivity of the water.

Enable the "Preflow in IHS" mode to activate the torch preflow before sensing the material and to make the ohmic function work better with high water levels. These blows water out of the torch and keeps water away from the sensing area. If "Preflow in HIS" is enabled, controller make a short start push of the plasma unit on short time (0.05 - 10 sec). Usually 0.05 second value is fine – it's enabled air flow, but the cutter does not have time to initiate a main arc.

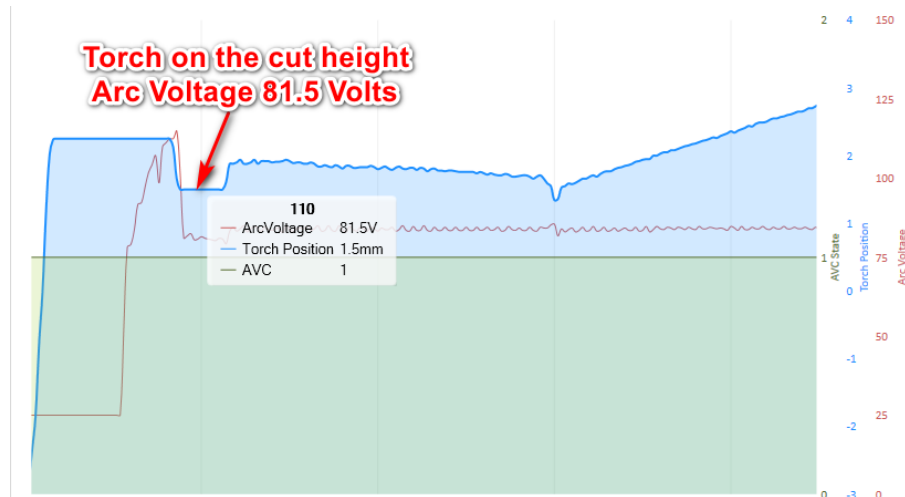
### **Arc Voltage Converter Tuning**

This future allows to tune the measured arc voltage.

As a rule, on each individual plasma cutting system, the real arc voltage with the same cut settings will differ from the value recommended by the manufacturer. It depends from the design of the table, the length of the power cable and etc. So that the value of the measured arc voltage to be equal to recommended by the manufacturer, it is necessary to determine the correction factor k. To do this, follow these steps:

1. Turn off automatic control – AVC button on the Neuron panel in UCCNC.
2. Put a flat plate on the table.
3. Set the cutting height, pierce height and pierce time recommended by the manufacturer for the metal thickness used.
4. Create a straight line cut program with a length of 100 or 200 mm, set the cut speed recommended by the manufacturer.
5. Go to the Plotting tab of the Neuron settings and set checkbox "Allow Plotting". Plugin will plot a graph of the cut.
6. Start the cut.
7. After the end of the cut go to the "Plotting" tab and find real arc value on the start of the cut. For example, on the next picture real arc voltage was 81.5 volts on the 1.5 mm cut height.





8. Calculate the correction value according to the following formula:

$$k = \frac{V_{book}}{V_{real}}$$

Where the  $V_{book}$  is the value of the arc voltage recommended by the manufacturer for this cut and the  $V_{real}$  is the real arc voltage that the controller displayed during the cut.

Possible values of the correction value are in the range from 0.5 to 1.5.

Enter this value in the "Correction Value" box.

### Float Head Microswitch offset setup

This future allows to setup offset of the float head switch.

Set "Start Setup" checkbox. Controller will start Initial Height Sensing procedure. When the IHS will be completed the torch will be moved up on the 4mm for metric system or 0.2 in for inches system under surface of the plate. Check the distance between the surface of the plate and torch nozzle. If it's not 4mm (0.2 in.) (check it for example by standard drill) correct it by rotating multiturn encoder on the operator panel. For finish – uncheck "Start Setup" checkbox.

### Marking mode

This mode can be used to marking (make small corner on the centers of the holes).

To do this, the controller will turn on the cutter and immediately off after receiving the ArcOk signal from cutter.

Setting: Enable/Disable.

### Ref Z axis after

This setting allows to make an automatic homing procedure after each count of the pierces. Count can be set up to 30 pierces. Set "0" for disabling this future.

### Ventilation

This future allows to control fume extractor motor. You can set "Rump UP" and "Post Flow time".

If "Neuron BOB" used – select from drop down list number of the output for motor on/off control.

If "Neuron BOB" is not used – select "Not Use" and set port and pin for this output in the Neuron Plugin THC configuration Window.

### Delay Before ArcLost error issue

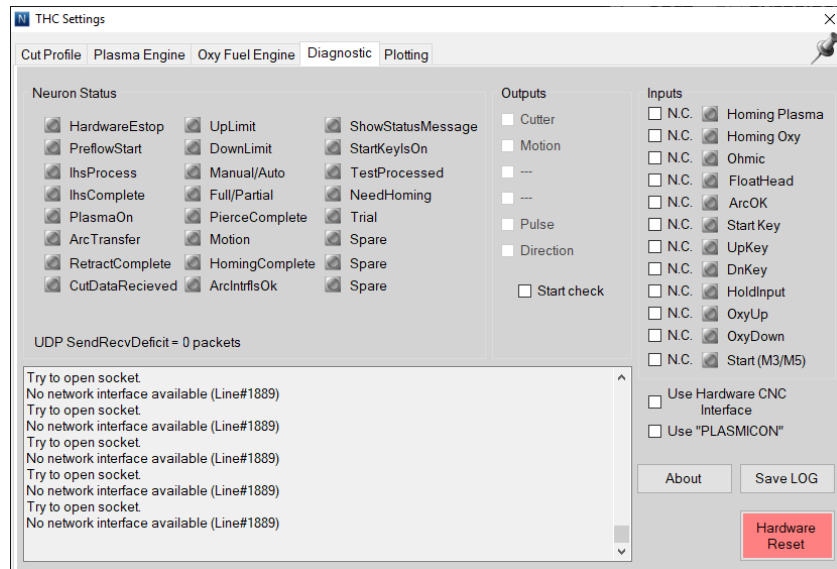
This setting sets the delay time between ArcLost issue and the time when controller stop cutting process due this issue.

Default value 200 msec.

### Torch off before "M5" mode

This feature not present in the Neuron Lite controller.

## Plasma Engine



This tab allows to diagnose current controller state, state of the I/O signals and have information about all events in the LOG field.

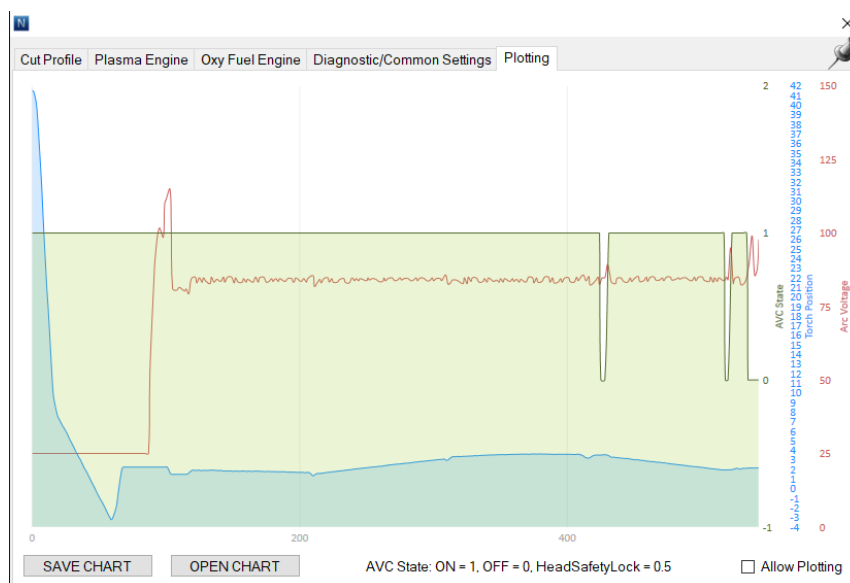
### Hardware Reset

Click on this button for Neuron controller hardware restart.

### Plotting

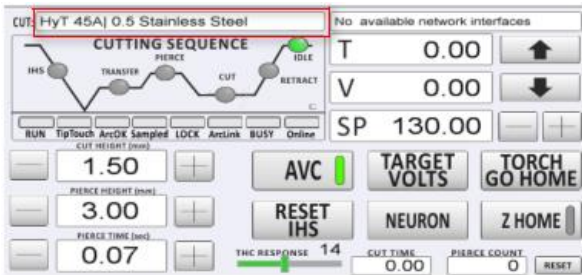
Set "Allow Plotting" checkbox for enable plotting of the cut parameters.

"Save Chart" button store current plotting and "Load Chart" button open previously stored plotting.

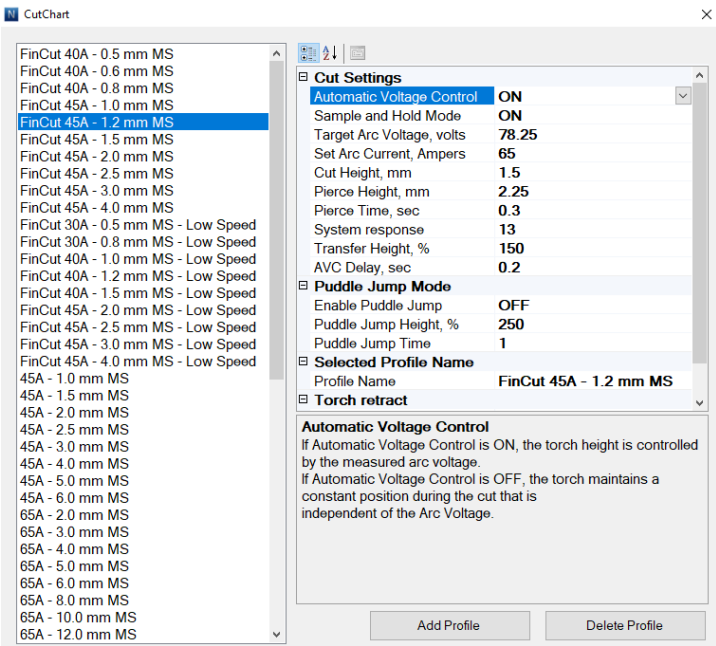


Cut Chart

Click on the Cut Profile name text field.



Cut chart window will be open.



In this window you can select profile from the list and change all profile settings.

## THC configuration window

Go to the UCCNC Configuration->General Settings and click on the "Configure Plugins" button. In the opened window select "NeuronTHC" plugin and click on the "Configure" button. THC configuration window will be opens.

This window consists main settings for Neuron plugin.

Main Settings Tab:

**THC configuration**

Main Settings Y axis Settings Go To Settings Rectangle Tube Cutter

**AVC On/Off**

AVC On Macro  
M10

AVC off Macro  
M11

**Hardware Torch Control**

TorchOnMacro  
TorchOffMacro

Torch port and pin  
Port# 0  
Pin# 0  
Set Port and Pin to zero if not used

**LaserPointer**

Set Port and pin  
Port# 3  
Pin# 4

Plasma Torch offset  
Xofs: 25 mm  
Yofs: 30 mm

OxyFuel Torch offset  
Xofs: 0 mm  
Yofs: 0 mm

**PortPins number for ventilation control**

Port: 0 Pin: 0  
If you planned to use any port and pin for ventilation control turn off "Use Neuron BOB" in the plasma setup

**System**

☒ MM ☐ Inches  
☐ Russian language

Allowed macros: M205/206; M10/11; M10.1-10/M11.1-10

☒ Allow Oxy Fuel Mode ☒ Allow to use CutStart Future  
☐ Use Neuron BOB

**AVC On/Off**

**Hardware Torch Control**

**Laser Pointer**

**PortPins number for ventilation control**

**Allow Oxy Fuel Mode**

**Allow to use CutStart future**

**Use Neuron BOB**

**System**

Y axis Settings

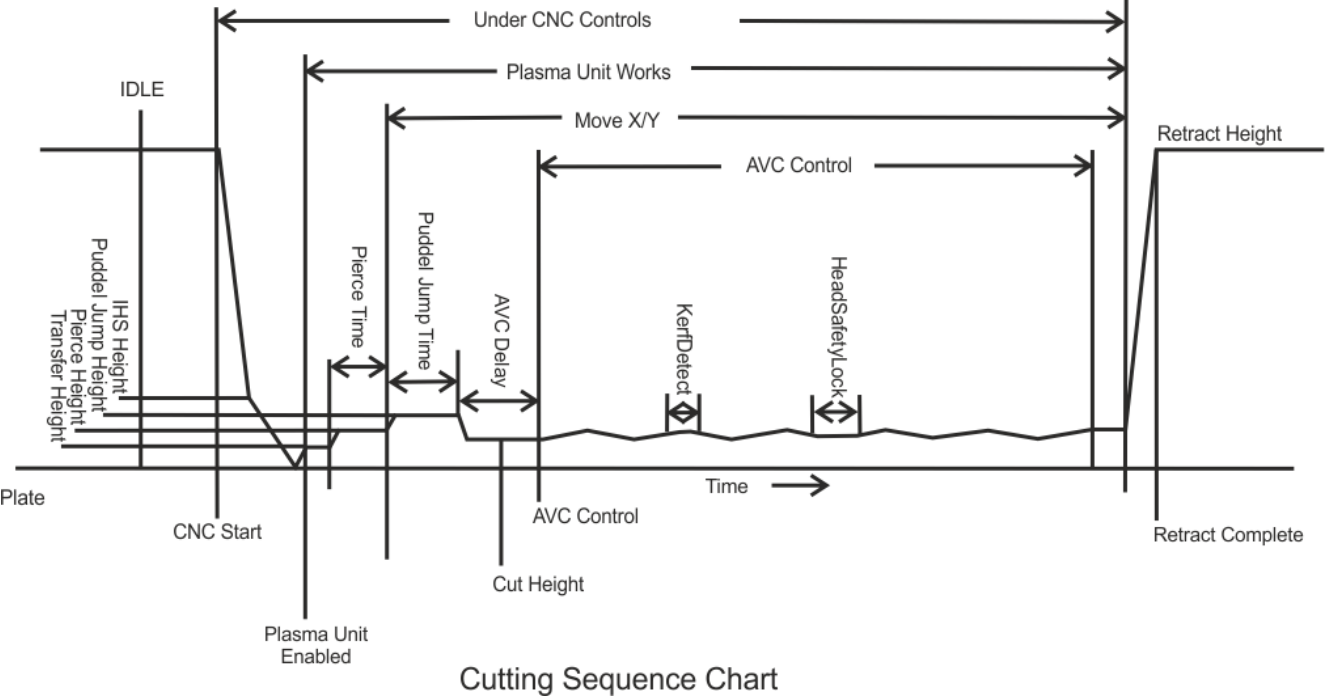
Go To Settings

## Control State

<b>IDLE</b>	In this state, the plasma system is OFF, the motor is holding position. The system waits for the Cycle Start ("M3") signal and enters either the IHS Fast Approach state or the IHS Slow Approach state, depending on whether the workpiece position is known.
<b>Homing</b>	The lifter moves the torch up at the programmed IHS Speed till the Upper Limit Switch.
<b>Soft Limit</b>	The THC enters this state when the actual position is the programmed Slide Length. The motor is stopped and the torch maintains its position. Only up motion is allowed during this state.
<b>IHS FAST APPROACH</b>	The torch moves down at the programmed Automatic Speed to the Start IHS Height then enters the IHS Slow Approach state.
<b>IHS SLOW APPROACH</b>	The lifter continues to move down at IHS Speed, using Ohmic or float head sensor, until the lifter receives the Tip Sense input signal. When the THC receives the Tip Sense input signal, it enters the Workpiece Contact state.
<b>WORKPIECE CONTACT</b>	The torch lifter begins to move up slowly until Ohmic sense or float head contact is clear. The lifter then records the workpiece position and enters the IHS Retract state.
<b>IHS RETRACT</b>	The lifter moves up at the programmed Automatic Speed to the Transfer Height.
<b>START PLASMA</b>	The lifter holds the torch at the IHS Transfer position, waits for the Transfer input signal from the plasma system, and then enters the programmed Pierce Start state.
<b>PIERCE START</b>	The lifter moves the torch to Pierce Height. When the torch is in position, the lifter enters the Piercing state.
<b>PIERCING</b>	The lifter holds the torch at the Pierce Height for the Pierce Delay interval. When Pierce Delay is complete, the lifter enters the Puddle Jump state if it enabled or Cut Prepare State.
<b>PUDDLE JUMP</b>	The lifter moves the torch to the Puddle Jump Height. It waits for Puddle Jump Delay, and then enters the Cut Prepare state
<b>CUT PREPARE</b>	The lifter moves the torch to the Cut Height and sends the UCCNC Motion signal to begin X/Y cutting motion. The THC waits for the AVC Delay and then enters either the Sample state or the Cutting state, depending on the operating mode
<b>SAMPLE</b>	The controller receives a new Arc Voltage sample for this cut. It modifies the operating Arc Voltage Control set point and enters the Cutting state.
<b>CUTTING</b>	<p>If AVC ON Mode is active and the Hold signal from the UCCNC CNC is not active, the lifter controls the torch height using arc voltage feedback.</p> <p>If AVC OFF Mode is active operator can adjust the torch height by rotating the encoder on the operator panel.</p> <p>If Ohmic contact sense is enabled, the torch retracts if it makes Ohmic contact. When the cut is complete and the Cycle Start input signal from the CNC is deactivated, the THC enters the retract state.</p>
<b>MANUAL UP</b>	The lifter initially jogs up 0.25 mm. After 0.5 second, it begins continuous upward motion at the IHS Speed. After 2 seconds, the lifter increases the speed to the programmed Manual Speed. Outputs do not change, if the torch is already cutting, it continues to cut.
	The lifter initially jogs down 0.25 mm. After 0.5 second, it

<b>MANUAL DOWN</b>	begins continuous downward motion at the IHS Speed. After 2 seconds, the lifter increases the speed to the programmed Manual Speed. The lifter does not change the output signals, if the torch is already cutting, it continues to cut.
<b>RETRACT</b>	The lifter moves the torch up at Automatic Speed to the Retract Height. When the torch is in position at the Retract Height and enters the Idle state.


Sequence of Operation



1. Operator runs the work program by click on the "START" button on the UCCNC.
2. The UCCNC CNC control move torch (x/y) to the IHS start position and wait the Motion signal from the controller. "RUN" indicator on the Neuron control panel is flash.
3. Operator turn ON the "Cutting Start" switch on the operator panel.
4. The torch travels towards the plate at Automatic speed and switches to the IHS Speed when the crossover IHS Height is reached. The torch touches the plate at the IHS Speed.
5. The torch immediately retracts to the Arc Transfer Height.
6. Plasma Start signal is issued to the power supply.
7. The power supply initiates an arc and the Neuron.THC receives a Transfer signal from the power supply.
8. The torch moves to the Pierce Height and the Pierce Time timer is initiated.
9. When the Pierce Time elapses, the torch moves to the Cut Height.
10. The Neuron.THC issues a Motion signal to the x/y machine.
11. The x/y machine begins profiling the part.
12. The AVC Delay timer is initiated.
13. AVC Delay time starts. If sample mode enabled THC is sampling the arc voltage, at end of AVC Delay or after removing the Hold signal from CNC. THC uses the last stable sampled voltage as a reference to control height for rest of cut. If sample mode is disabled THC uses the Set Arc voltage as a reference to control height.
14. When AVC Delay elapsed, the THC start closed loop height control.
15. The programmed Arc Voltage, thus the torch height, can be increased and decreased while in AVC ON by rotating the encoder on the operator's panel or click on the target voltage DRO on the UCCNC control panel and mouse wheel. AVC mode is disabled, thus freezing the torch height, any time a Hold signal is received (from G-Code).
16. If AVC is disabled (AVC OFF) the torch height, can be increased and decreased by rotating the encoder on the operator's panel or click on the Position DRO on the UCCNC control panel and mouse wheel.
17. If Head Safety Lock is enabled, AVC mode is disabled any time a sudden increase in arc voltage is sensed, such as when crossing a kerf or running off the plate.
18. If collision avoidance is enabled, the arc voltage is automatically increased any time contact is sensed between the torch and the plate, provided that the Ohmic function is enabled. If the torch contacts the plate while a Corner signal is applied, the torch retracts to the programmed Cut Height
19. When the Cycle Start signal is removed from the Neuron.THC, the torch retracts to the Full Raise or Partial Raise Height depending on the Partial/Full setting.

## Requirements and Check List for first Start-up

After the Neuron.THC system is installed, perform the following setup sequence to ensure proper operation.

1. Open the settings window by clicking "NEURON" button on the control panel.
2. Move to the tab «Engine Settings» and click on the «Change Settings» button. It opens Motion control configuration.
3. Set parameters of the motor driver «pulses in unit» (numbers of pulses in the 1 mm).
4. To apply changing click on the "Save Settings" and then "Hardware Reset" for restarting the controller. Restart UCCNC.
5. Click on the "NEURON" button after restarting and select the tab "Diagnostics".
6. Check the Homing, Float Head, Ohmic sensors inputs, "Cutting Start" switch input. If sensor is activated you will see green indicator on the "check inputs" field. You can select type of the sensor and inputs signals N.O. or N.C.
7. In IDLE mode state of the all sensor are off and all indicators are gray.
8. Turn on motor driver power supply. Clicking the buttons torch "UP/DOWN" on the control panel or operator control module, make sure that torch moving in the correct direction. If not – set "Reverse Engine" checkbox on the Motion control group.
9. Click  button. System will be starting the homing procedure.

10. Move the torch down as it possible (buttons UP/DOWN). Copy the value of the torch position and put it in the "Slide Length" box (Soft Limit function).
11. Set up the maximum values of the acceleration and velocity of the torch moving as your system allowed (avoid lost steps for steppers motors). Usually Acceleration in cut is equivalent acceleration.
12. Set up manual and IHS velocity.
13. Set up "Safe Jog Height" in percent's of "Slide Length" value. "Safe Jog Height" is the distance from home position where the fast jog is allowed. Below this point the torch will move with IHS velocity only.
14. Tune up the Float Head:
  - Put the flat plate on the cutting table. Thickness not less 3 mm. Open the settings window by clicking "NEURON" button.
  - Move to the tab «Engine Settings» and set the check box «Start Setup» in the field "Float Head correction".
  - Set "Start Setup" checkbox. Controller will start Initial Height Sensing procedure.
  - When the IHS will be completed the torch will be moved up on the 4mm for metric system or 0.2 in for inches system under surface of the plate.
  - Check the distance between the surface of the plate and torch nozzle. If it's not 4mm (0.2 in.) (check it for example by standard drill) correct it by rotating multiturn encoder on the operator panel.
  - For finish – uncheck "Start Setup" checkbox.
15. Connect plasma interface PCB with plasma unit according the schematic in the user manual.
16. Calibrate Arc voltage converter module by calculating correction value.



## Pre-Cut Setup

Before making a cut with the Neuron.THC system, perform the following setup sequence to ensure proper operation.

1. Edit the Set Point Voltage. Enter the recommended arc voltage for the material being cut.
  - Arc voltage control uses feedback from the plasma system to measure the voltage between the electrode (negative) and the plate (positive). At a given cut speed and fixed torch to work distance this voltage remains constant. If the plate is warped that it moves away from the torch during steady state cutting the arc between the electrode and the plate gets longer, a longer arc means the voltage gets higher. The torch height control sees an increase in arc voltage and signals the z axis drive to move the torch closer to the plate.
  - If your torch height noticeably changes during the transition between cut height and AVC, then you should adjust your arc voltage setting so that there is no change during this transition. If the torch indexes to cut height, starts moving, then moves further away from the plate.... reduce the arc voltage setting. A rule of thumb is that 5 volts will equal approximately 1 mm (.020") torch movement, reducing arc voltage by 5 volts will move the torch closer to the plate by roughly 1 mm (.020") and increasing voltage will do the opposite.
2. Edit the Arc Transfer Height. Enter the recommended arc transfer height for the material being cut. If this data is not listed for thinner materials, try setting the arc transfer height to the same value as the pierce height. For thicker materials, try setting the arc transfer height to one-half the pierce height. Default Transfer height set to 150% from Cut Height.
3. Edit the Pierce Height. Enter the recommended pierce height for the material being cut. If this data is not listed for thinner materials, set the pierce height the same as the cutting height. For thicker materials, try setting the pierce height to 1.5 or 2 times the cutting height.
4. Edit the Cut Height. Enter the recommended cutting height for the material being cut.
 

Things that affect torch height when operating in AVC (arc voltage control)

  - Gas pressure fluctuation. Changing gas pressure changes the resistance of the plasma arc, which changes the arc voltage.
  - Speed change. Slower cut speed makes the kerf wider, which means the arc is longer, which means the voltage is higher...so the THC moves the torch closer to the plate.
  - Worn electrode. Plasma electrodes wear by forming a pit in the hafnium emitter. If the pit is 1 mm deep, the torch will run closer to the plate by 1 mm....as the arc is 1 mm longer and the height control is trying to maintain a constant voltage.
  - The proper physical height is more important than setting the exact arc voltage that is listed in the plasma torch manufacturer's manual. Adjust the voltage so the physical height is correct. Don't worry about the voltage reading!
5. Edit the Pierce Time. Enter the recommended pierce time for the material being cut. The pierce time should be adjusted such that the torch moves from the pierce height to the cutting height after the arc pierces completely through the workpiece.
6. Edit the AVC Delay. This is delay before system starts controlling height using arc voltage. Set in second (0-10.0 sec).
 

Hint: Set the delay long enough so cutting table is up to full cutting speed, torch has moved beyond cutting slag and arc voltage has stabilized. But don't set the delay so long that the distance to the metal has changed from the initial cut height. To determine the correct setting, first determine how far you want the torch to move before turning on arc voltage control. Then considering the cutting speed, figure how long it takes the torch to move that far.

7. Edit Retract Height.

- Sets the height the torch is raised (retracted) following end of a cut. For full retract to the top position select more than 60 mm (2.5 inches) value, that selection causes it to rise to the top.
- At end of a cut, before moving to the next cut, torch is normally retracted to clear any obstructions such a part that tips up. Time is saved if a full retract is not required.

Hint: If cutting small parts that may tip up or thin metal that is likely to spring up, set for higher retract to make sure the torch clears the cut piece. Use lesser amounts for larger pieces.

8. Edit Lock Head Down.

- Sets voltage upper limit as percent (4-20%) of operating arc voltage.
- When crossing a kerf or hole or going off the edge of the plate, arc voltage rises very rapidly. System will respond to the rise in voltage by lowering the torch trying to keep voltage constant. Without Lock Head Down torch will be driven into the plate. When voltage exceeds Lock Head Down setting, system stops trying to control height. Also refer to the System Response setting.

Hint: For thicker metal which tend to be fairly flat and using lower cutting speeds the arc voltage doesn't change very rapidly except when crossing kerfs & holes so using a lower % will respond quicker, typically 5-10%. For higher speeds on thinner or warped metal where normal cutting voltage changes more rapidly, use a higher number around 10-15% or even 20%.

9. Edit System Response.

- Sets gain (response) of system (1-30). Factory setting of 7 is usually OK.
- With thicker metal and lower cutting speeds where a faster response is not needed a lower Dynamic setting in combination with a lower Lock Head Down level %, can help prevent or limit torch diving when crossing kerfs or holes or when the part or scrap drops out before finishing the cut.
- Very high speeds on very thin or highly warped metal may require increasing the Dynamic setting to respond faster. Be careful to not go so high the torch overshoots and oscillates up and down. Remember you will generally want to go back to 7 normal cutting.

10. Place the system in the correct cutting modes desired (AVC ON/OFF, Test/Run).

11. Now a cut can be made with the Neuron.THC system. Verify the status of the LED's on the cutting sequence LEDs during operation.

## Cut Recovery

Cut recovery future allow to start cutting from Arc Lost position or from current position on the cutting path.

When plasma unit is lost plasma arc, it's turns off "ArcOK" signal and controller stop program. UCCNC stop motion with deceleration. In same time controller store arc lost position for next using. For continue cutting click on the "Cut Recovery" button. Dialog window will be open.

If plugin has a captured arc lost position, "Automatic mode" will be available.

Now operator can restart from arc lost position ("Automatic Mode") or from current position ("Manual Mode"). These two positions are on the cutting path and very close to each other. First – arc lost position and then the current position (machine was stopped with deceleration).

"Cut recovery Data" group box consists information about selected position.

Set "Skip Pierce" check box if need to skip pierce.

Set "Enable AVC" check box if need to turn on Automatic voltage control.

Click on the "Cut Recovery" button for start cutting. Your machine will make the IHS procedure and then begin cutting from the selected location.

## Rip Cut

Rip Cut future can be use for straight cut. Click on the "Rip Cut" button. Rip cut dialog will open:

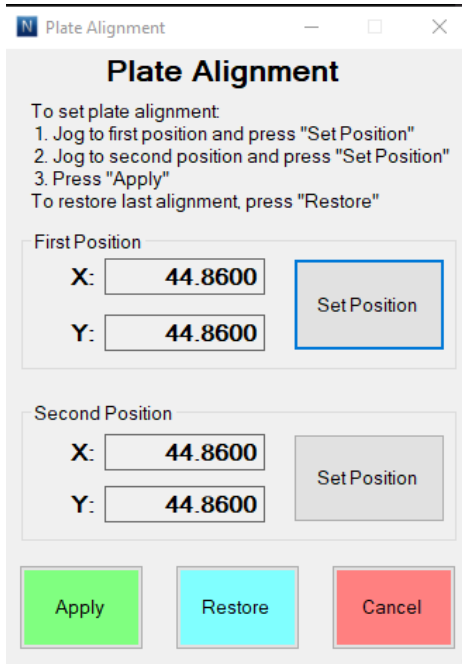
Select desired direction, feedrate and length of the cut.

Set "Enable AVC" check box if need to turn on Automatic voltage control.

Click on the "START" button for start cutting. Your machine will make the IHS procedure and then begin cutting from the current location.

## Plate Alignment

Plate Alignment allow to rotate coordinate system. Follow step by step procedure for set the angle of the rotation using two points.



**Plate Alignment**

To set plate alignment  
 1. Jog to first position and press "Set Position"  
 2. Jog to second position and press "Set Position"  
 3. Press "Apply"  
 To restore last alignment, press "Restore"

First Position

X:  Y:

Second Position

X:  Y:

Click on the "Apply" button for finish.

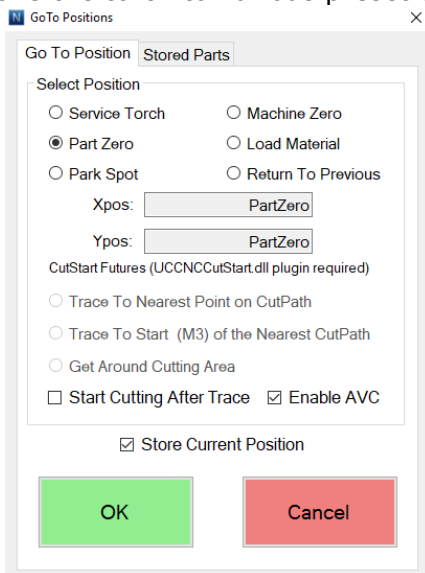
Click on the "Restore" button for restore previous coordinates rotation angle.

Click on the "Cancel" button for reset rotation angle to zero.

**Note:** coordinates are rotated around a part zero point.

## Go to Position

Go to position future allow to move the torch to various preset or previously saved positions.



**GoTo Positions**

Go To Position **Stored Parts**

Select Position

☐ Service Torch ☐ Machine Zero  
☒ Part Zero ☐ Load Material  
☐ Park Spot ☐ Return To Previous

Xpos:  Ypos:

CutStart Futures (UCCNCCutStart.dll plugin required)

☐ Trace To Nearest Point on CutPath  
☐ Trace To Start (M3) of the Nearest CutPath  
☐ Get Around Cutting Area

☐ Start Cutting After Trace ☒ Enable AVC

☒ Store Current Position

Select desired position and click on the "OK" button.

Note: Positions on this tab are stored in the UCCNC profile file and can be changed in the THC configuration (plugin configuration) window.

The screenshot shows the 'THC configuration' window with the 'Rectangle Tube Cutter' tab selected. The window contains several input fields for different torch service positions and reference points.

Position Type	Xpos (mm)	Ypos (mm)
Plasma Torch Service Position	24.56	28.32
OxyFuel Torch Service Position	23.56	28.78
Go from home after reference	10	10
Park Position	45.895	20.256
Load Material Position	14.56	128.587

On the "Stored Position" tab operator can store current position on the cutting patch and then restore this position. Plugin store all data for this point, include g-code file name and path to this file.

Click on the "Add New Position" button to store current position data.

Click on the "Load Selected Position" button to move torch to the stored position.

Note: all positions are stored in machine coordinates. If machine was not homed then this future will not available.

The screenshot shows the 'GoTo Positions' window with the 'Stored Parts' tab selected. It displays a list of stored positions and configuration options for the 'Go To Position' tab.

Line	File	Time
Line:20	File:'MotorHolder.tap'	Time:'06-26T14:59'
Line:28	File:'MotorHolder.tap'	Time:'06-26T14:45'
Line:44	File:'450.tap'	Time:'06-26T14:09'

Work Offset	Coord	Angle
X: 0	X: 17.6400	0.0000
Y: 0	Y: 46.8850	G68 Rotation Angle

Path to Gcode File: C:\UCCNC\Example\_codes\MotorHolder.tap

Time Stamp: 06-26T14:59

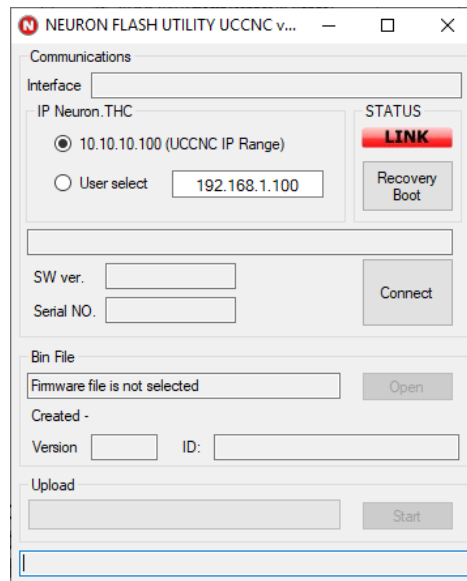
Buttons: Add New Position, Load Selected Position

## Common cutting faults

Fault	Possible causes
Transfer Fail	<ol style="list-style-type: none"> <li>1. Work cable connection on the cutting table is not making good contact.</li> <li>2. Torch-to-work distance is too high.</li> <li>3. The surface of the workpiece is rusty, oiled, or painted.</li> </ol>
Failed to completely pierce the workpiece and there is excessive sparking on top of the workpiece.	<ol style="list-style-type: none"> <li>1. Current is set too low (check Cut chart information).</li> <li>2. Cut speed is too high (check Cut chart information).</li> <li>3. Torch parts are worn (change consumable parts).</li> <li>4. Metal being cut is too thick.</li> <li>5. The surface of the workpiece is rusty, oiled, or painted.</li> <li>6. Pierce Delay is set too low.</li> </ol>
Dross forms on the bottom of the cut.	<ol style="list-style-type: none"> <li>1. Cutting speed is not correct (check Cut chart information).</li> <li>2. Arc current is set too low (check Cut chart information).</li> <li>3. Torch parts are worn (change consumable parts).</li> </ol>
Cut angle is not square.	<ol style="list-style-type: none"> <li>1. Wrong direction of machine travel. The high-quality side is commonly on the right with respect to the forward motion of the torch.</li> <li>2. Torch-to-work distance is not correct (check Cut chart information).</li> <li>3. Cutting speed is not correct (check Cut chart information).</li> <li>4. Arc current is not correct (check Cut chart information).</li> <li>5. Damaged consumable parts.</li> <li>6. The torch is not mounted perpendicular to the workpiece.</li> <li>7. Damaged torch.</li> </ol>
Short consumable life.	<ol style="list-style-type: none"> <li>1. Arc current, arc voltage, travel speed, motion delay, gas flow rates, or initial torch height was not set as specified in the cut charts.</li> <li>2. Attempting to cut highly magnetic metal workpiece, such as one with a high nickel content, will shorten consumable life. Long consumable life is difficult to achieve when cutting a workpiece that is magnetized or becomes magnetized easily.</li> <li>3. Beginning or ending the cut off the surface of the workpiece. To achieve consumable long life, all cuts must begin and end on the surface of the workpiece.</li> </ol>
Part is the wrong size.	The Kerf value is set incorrectly.

## Neuron Firmware Update Utility

1. Launch the NeuronFlash.exe file for start firmware update utility.



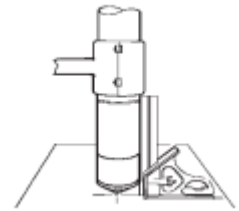
2. Select IP address of the Neuron controller from list.
3. Click on the "Connect" button. Utility will try to connect to controller. If connection will set, the "Status" LED in the utility window will be green and blinking.
4. Click on the "Open" button. In new window select firmware file with \*.bin extension.
5. Click on the "Start" button for firmware upload.
6. After finishing of the update close NeuronFlash window.

### **If during update process any error will issue, use BootRecovery mode for upload firmware.**

1. Launch the NeuronFlash.exe file for start firmware update utility.
2. Select IP address of the Neuron controller from list.
3. Close and open (short) "Reset" pins on the controller PCB.
4. When "BOOT" LED on the controller PCB will flash (during 5 second after Reset), click on the "Recovery Boot" button. Utility will try to connect to controller. If connection will set, the "Status" LED will be green and blinking.
5. Click on the "Open" button. In new window select firmware file with \*.bin extension.
6. Click on the "Start" button for firmware upload.
7. After finishing of the update close NeuronFlash window.

## How to optimize cut quality

The following tips and procedures will help produce square, straight, smooth and dross-free cuts.



### Tips for table and torch:

- Use a square to align the torch at right angles to the workpiece.
- The torch may travel more smoothly if you clean, check and “tune” the rails and drive system on the cutting table.
- Unsteady machine motion can cause a regular, wavy pattern on the cut surface.
- The torch must not touch the workpiece during cutting. Contact can damage the shield and nozzle, and affect the cut surface.

### Plasma set-up tips

Follow carefully each step in the operating cycle for each operating mode, described earlier in this section. Purge the gas lines before cutting.

### Maximize the life of consumable parts

The long life requires that cuts start and stop on the workpiece.

- The torch should never fire into the air.
  - Start the cut at the edge of the workpiece is acceptable, as long as the arc is not fired in the air.
  - To start with a pierce, use a pierce height that is 1.5 to 2 times the torch-to-work distance.
- Each cut should end with the arc still attached to the workpiece.
  - When cutting drop parts (small parts that drop down after being cut from the workpiece), check that the arc stays attached to the edge of the workpiece.

Note: Use a continuous cut between parts if possible, so the path of the torch can lead directly from one cut part into the next, without stopping and starting the arc. However, do not allow the path to lead off the workpiece and back on, and remember that a chain cut of long duration will cause electrode wear.

### Additional factors of cut quality

#### Cut angle

A cut part whose 4 sides average less than 4° of cut angle is considered acceptable.

Note: The squarest cut angle will be on the right side with respect to the forward motion of the torch.

Note: To determine whether a cut-angle problem is being caused by the plasma system or the drive system, make a test cut and measure the angle of each side. Next, rotate the torch 90° in its holder and repeat the process. If the angles are the same in both tests, the problem is in the drive system.

If a cut-angle problem persists after “mechanical causes” have been eliminated check the torch-to-work distance, especially if cut angles are all positive or all negative.

- A positive cut angle results when more material is removed from the top of the cut than from the bottom.
- A negative cut angle results when more material is removed from the bottom of the cut.

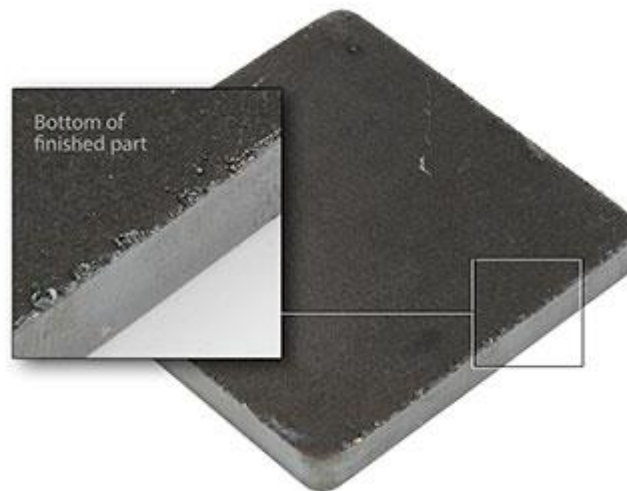
### Dross

#### What is dross?



Dross is molten metal that does not blow away during the cutting process and instead adheres to the bottom or top of the part in a re-solidified state. There are many factors that can contribute to the accumulation of dross. The most common are: cutting speed, torch standoff height or damaged consumables. In most instances, dross can be reduced or eliminated completely by adjusting the cutting speed to the optimum condition as prescribed in the operator's manual. However, there may be times when a simple speed adjustment is not possible or will have little effect, such as when the thickness of the material or the cutting amperage requires a slow cutting speed. In this case, dross accumulation is inevitable and cannot be eliminated. Also, the quality, grade and composition of the material are factors that can increase the likelihood of dross and are outside of the control of cutting parameters. For example, a lower quality sheet of carbon steel may be more susceptible to dross buildup due to the increased level of impurities. Finally, as the temperature of the plate increases from the plasma cutting process, dross is more likely to stick to the bottom even with optimum parameters.

### High Speed Dross



#### Cause:

When the programmed cutting speed is too fast for the amperage being used or the material thickness being cut, the bottom of the arc will lag behind the top. When this happens, the high pressure gas found at the orifice of the nozzle is not as effective at material removal, allowing small amounts of dross to form on the bottom of the plate. High speed dross is typically dotted in appearance and cannot be removed easily by scraping with a hand tool. It must be removed by grinding or machining the finished part.

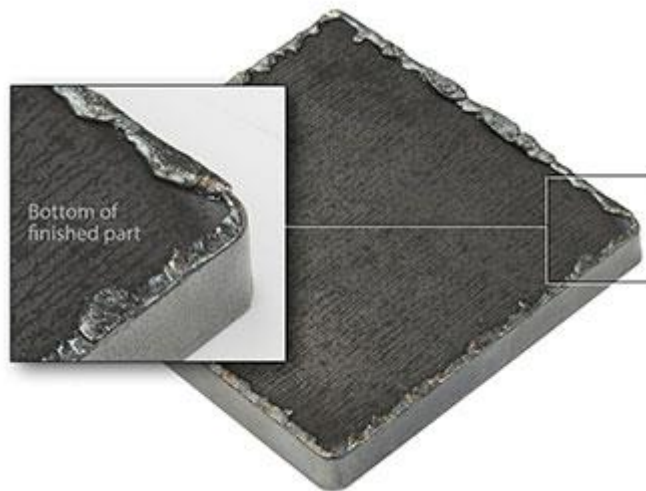
#### Solution:

Verify the cutting speed for the selected amperage, material type and thickness. If it already does, decrease the cutting speed in small increments (5-10 inches per minute) until the best result is achieved.

Select a lower cutting amperage

Examine the electrode and nozzle for excessive wear and replace as needed.

### Low Speed Dross

**Cause:**

If the cutting speed is too slow for the material thickness or selected amperage, a solid line of dross that resembles a weld bead will form on the bottom of the part. To understand why, remember that the plasma cutting process is electrical in nature. When the torch is moving too slowly, the arc begins to expand in an effort to maintain contact with the edge of the kerf in order to keep its path to ground through the plate. As the arc widens, the distance from the cut edge to the high pressure section of the plasma jet increases to the point where the gas is no longer able to blow away the material effectively. Low speed dross is easily removed with a hand scraping tool.

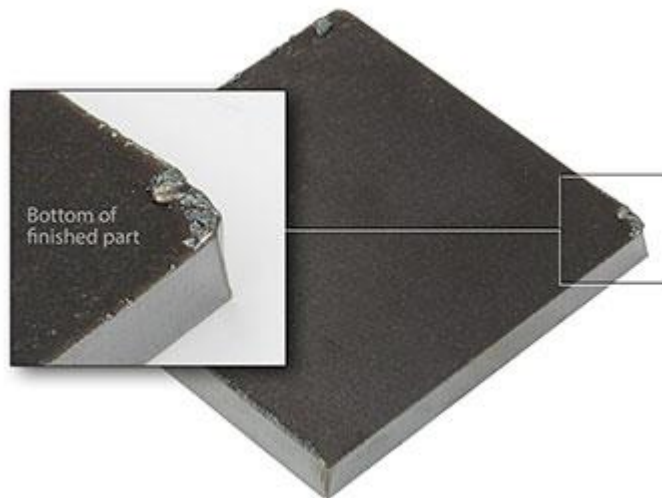
**Solution:**

Verify the cutting speed for the selected amperage. If it already does, increase the cutting speed in small increments (2-5 in. per minute) until the best result is achieved.

Select a higher cutting amperage and adjust the parameters accordingly.

Examine the nozzle and shield cap for damage and replace as needed.

## Corner Dross



### Cause:

Dross will intermittently form in the corners of a part due to the speed reduction required for a cutting machine to perform an extreme change in direction, such as a right angle. The likelihood of this occurring varies depending on the thickness of the material, cutting amperage, and material composition.

### Solution:

This is a normal occurrence and cannot be avoided without altering the part drawing to include options such as corner loops.

Fortunately, the amount of dross this condition presents is minimal and is easily removed with a hand scraping tool.

## Top Dross



### Cause:

Occasionally, small amounts of dross will form on the top of the part when the programmed cutting speed is too fast or the torch standoff distance is too high. This is caused by the plasma arc's inability to blow all the molten metal through the bottom of the kerf when the tip of the

nozzle is too high above the plate. Top dross is normally a very light accumulation that can be removed easily with a scraping tool.

**Solution:**

1. Reduce cutting speed in 5 in. per minute increments, while monitoring for the introduction of low speed dross.
2. Lower the arc voltage setting in 2 volt increments.
3. Check the nozzle for damage and replace as needed.

**Additional improvements**

Some of these improvements involve trade-offs, as described.

**Piercing**

The pierce delay should allow sufficient time to penetrate the full thickness of the material, but not so long that it allows the arc to “wander” while trying to find the edge of a large pierce hole. As consumables wear, this delay time may need to be increased. Pierce delay times given in the cut charts are based on average delay times throughout the life of the consumables.

When piercing materials close to the maximum thickness for a specific process, there are several important factors to consider:

- Allow a lead-in distance that is about the same as the thickness of the material being pierced. 50 mm (2 in) material requires a 50 mm lead-in.
- To avoid damage to the shield from the build up of molten material created by the pierce, do not allow the torch to descend to cut height until it has cleared the puddle of molten material.
- Different material chemistries can have an adverse effect on the pierce capability of the system. In particular, highstrength steel and steel with a high manganese or silicon content can reduce the maximum pierce capability.
- Starting torch motion immediately after transfer and during the pierce process can extend the piercing capability of the system in some cases. Because this can be a complex process that can damage the torch or other components, a stationary or edge start is recommended.

### How to increase cutting speed

Decrease the torch-to-work distance. This will increase the negative cut angle.

Note: The torch must not touch the workpiece while piercing or cutting.

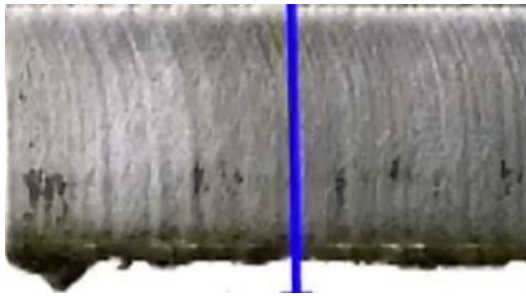
The thin lines are almost straight and at an angle of 15-30 degrees.

**The cutting speed and Arc current is correct.**



Lines are not straight and have a curved form in the upper part and further parts directed vertically as shown in Figure.

**The cutting speed is low. Increase the cutting speed.**



Lines are not straight and have a curved form in the lower portion of the part as shown.

**The cutting speed is too high or arc current is too low.**

