NEURON
CNC ELECTRONICS

TORCH HEIGHT CONTROL "SIMPLICITY"

USER'S MANUAL

NEURON CNC ELECTRONICS

10.01.2020

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 full standalone 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 software servo control loops to control speed, position and arc voltage with unparalleled precision.

The Neuron.THC can attain speeds in excess of 6000 mm/min (250 inches per minute) in the arc voltage control mode and speeds in excess of 10000 mm/min (400 inches per minute) in the position control mode.

Safety

The Neuron.THC system use 12 V DC for operation. In addition, it will be necessary to make connections to the DC 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 PCB
- CNC interface PCB
- Motor driver interface PCB

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 machine through the discrete I/O interface, and the plasma system through standard discrete I/O interfaces.

Plasma system interface PCB

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.

CNC interface PCB

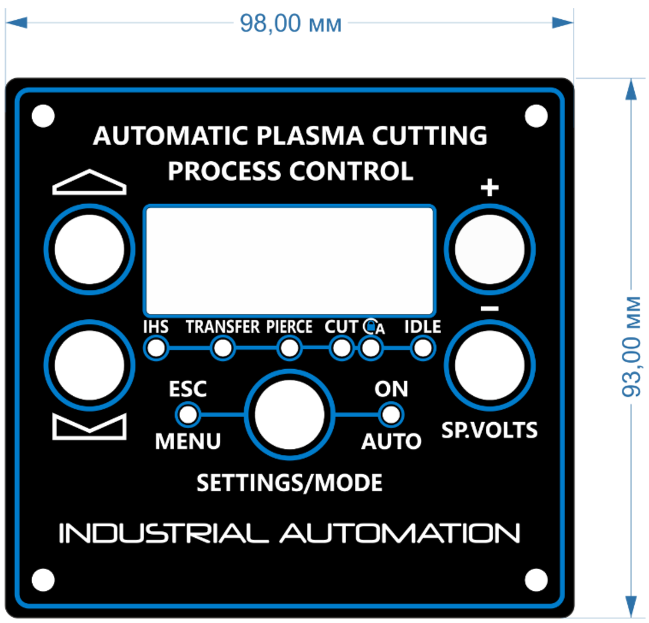
The module provides discrete I/O interface between THC and CNC.

Motor driver interface PCB

The module provides easy connection to the motor driver.

Specifications

Input power	12V DC, 0.5A
Operating temperature	0º C to 40º C
Operating humidity	95% relative humidity
Pulse/Dir interace	Differential output, protected +5V 100mA
Parallel digital input	NO/NC dry contact
Lifter switches	Home sensor, IHS sensor (float head or/and Ohmic sensor
Maximum Z axis speed	10000 mm/min (400 in/min)
Voltage divider ratio	10:1(internal divider), 20:1 (input for Hypertherm cutter)
Arc voltage range	0-350V
Warranty	1 year



Features

The Neuron.THC comes standard with the following features:

- Single chip computer based compact control, industrial grade protection, easy to install almost anywhere
- Digital display and set arc voltage and other parameters, easy to learn and operate
- Works with ALL plasma cutters
- Controls Z axis directly (Internal motion controller, Software PID control loop)
- 30 cut profiles for different metal thicknesses. Quickly switch between profiles and the ability to quick edit them
- Set point voltage range 25 - 250V
- Set Point voltage resolution 0.5V
- Maximum control accuracy +/- 0.25V
- Height control accuracy +/-0.125 mm (.005") using a properly configured Z-axis.
- Works in Inches or Millimeters mode
- Automatic or manual control of the cutting sequence
- "Sample and Hold" 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.
- Automatic Collision Avoidance, provided that the Ohmic sensor is used. This safety feature allows the control to automatically adjust the torch height during a cut to help prevent torch crashes
- THC OFF control from CNC (on corners, end of cut, circle of small radius)
- Programmable arc voltage limiter Lock Head Down to help prevent torch crashing when crossing a kerf, corners, end of cut
- Programmable arc voltage control loop dynamic (gain) value
- Shot mode – can use for marking centers of the circles
- Works with Float Head and Ohmic sensors for IHS simultaneously
- Built in Testing of the cutting sequence
- Integrated diagnostic system informs the operator of the errors that occurred
- Programmable automatic positioner speed
- Programmable jog positioner speed
- Programmable IHS (initial height sensing) touch speed
- Programmable acceleration
- Programmable arc transfer height
- Programmable pierce height
- Programmable pierce time
- Programmable cutting height
- Programmable AVC (automatic voltage control) delay time
- Programmable crossover (IHS start) height (high-to-low speed transition point)
- Programmable torch retract height
- Programmable torch retract delay
- Programmable maximum torch slide length (Soft Limit)
- Easy setup for Float Head switch offset value
- 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
- Voltage feedback (divider) - Raw arc voltage divider (houses on the plasma interface board) or 1:20 (input for Hypertherm cutters)
- 50 kHz maximum step frequency 50% duty cycle.
- Buffered Step & Direction outputs for direct interface to Motor Drive
- All inputs (include arc voltage) are isolated and simple wiring (RJ45 connectors)

System Requirements

The Neuron.THC system has a terminal block power plug. 12V DC 0.5A 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), Probe sensor (Float torch holder) for Initial Height Sensing procedure.
• Lifter capable of 200 in/min.
• Lifter should have low backlash and little mechanical play
• If the functions are required the lifter should provide for the electrical interface to torch tip sensing.

WARNING:

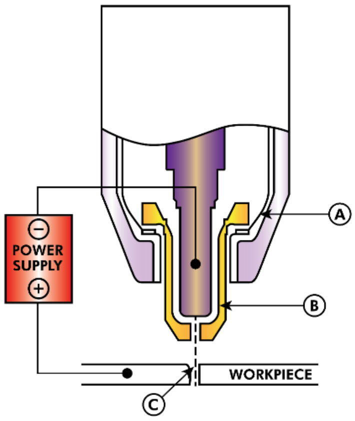
The performance of the Neuron.THC is tightly coupled to the lifter and motor characteristics. To ensure proper operation, a customer designed lifter should be fully tested with this controller under all anticipated operating conditions.

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.



TYPICAL TORCH HEAD DETAIL

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

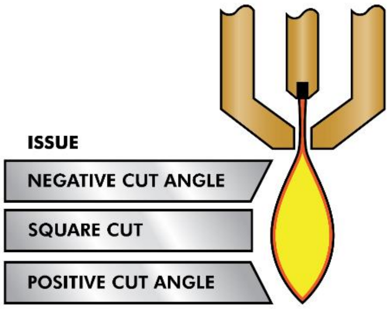
For entry level air plasma CNC systems, the blowback style is much preferred to minimize electrical interference with electronics and standard PCs but the High frequency start still rules supreme in larger machines from 200 amps and up. These require industrial level PC's and electronics and even commercial 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.

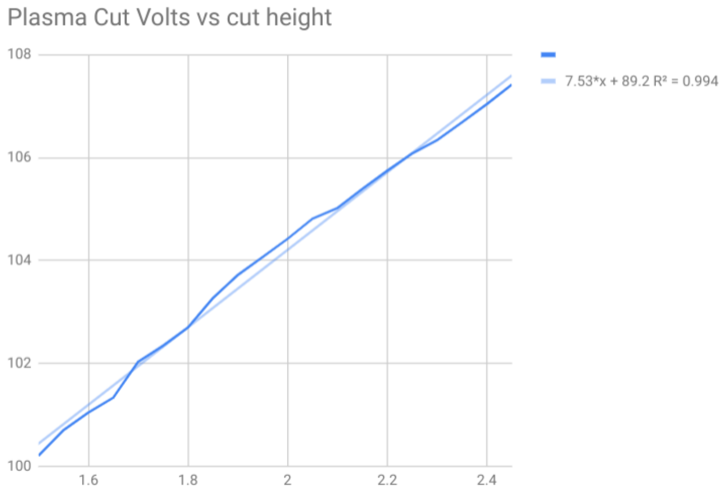
A plasma Arc is oval in shape and the cutting height needs to be controlled to minimize beveled edges. If the torch is too high or too low then the edges can become excessively beveled. It is also critical that the torch is held perpendicular to the surface.

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 bought out onto pins on the Neuron 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.

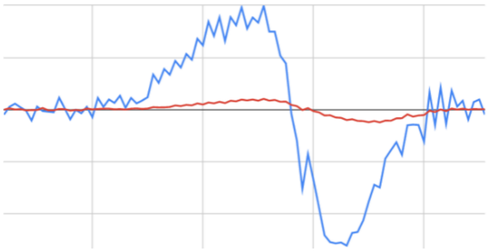
Corner Lock / Velocity Anti-Dive

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.

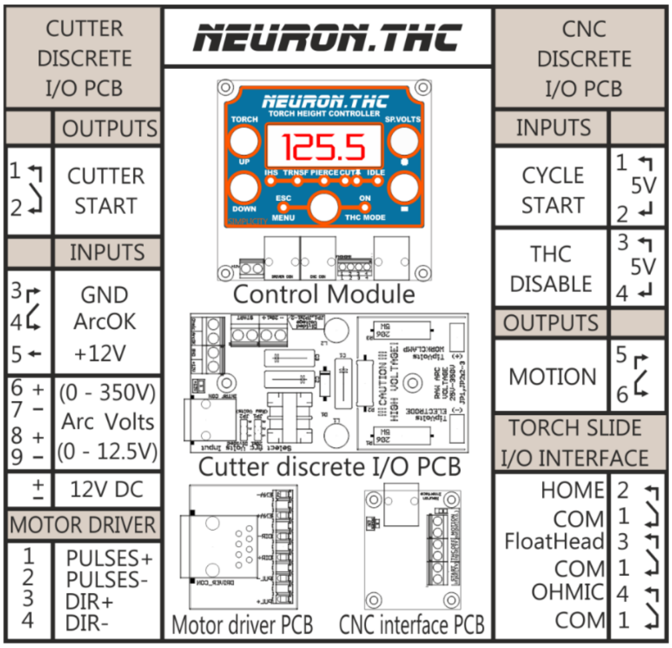
You will need to experiment to get exact hole size because the kerf with this method will be wider than your usual straight cut.

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).

Electrical Connection

Block diagram of system

This diagram shows basic I/O interface of the Neuron.THC system to plasma cutter, CNC, torch slide and motor driver. To the main control module connects plasma cutter discrete I/O PCB (voltage divider), CNC interface PCB and motor driver interface PCB through Cat5e cable crimped pin to pin on RJ45 plugs. Torch slide sensors (homing, float head and ohmic (optional)) are connected to the screw terminals on the main control module PCB.



- **Cutter Start (Start/Stop)** This is a dry contact signal to a plasma device. This signal is used to start the plasma arc. 100 mA protected.

- **ArcOK (Main arc)** This needs to be a dry contact signal from a plasma device. This signal is used to determine that the plasma arc has been established and still on.

- **Voltage Divider** Neuron provided voltage divider must be used and wires connected. Arc voltage: 0-12.5V (20:1 input) or 0-350 V - input

- **Pulses+, Pulses-** differential output to the z axis motor driver.

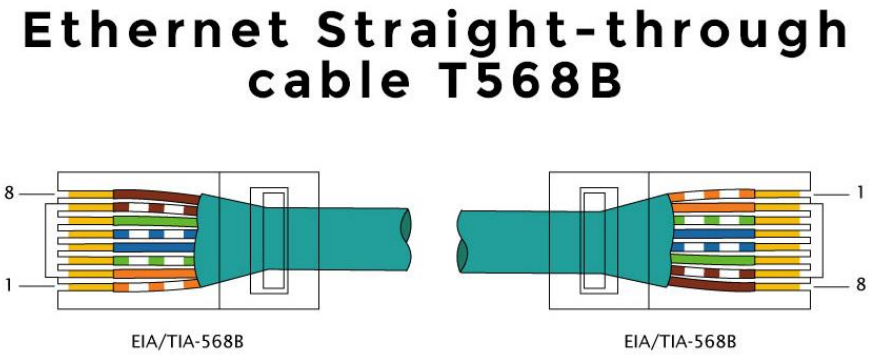
- **Dir+, Dir-** differential output to the z axis motor driver.

- **Cycle Start** This needs to be a 5V signal from a CNC device. The CNC activates this signal to begin the Initial Height Sensing and start a plasma cut. Polarity is not important.

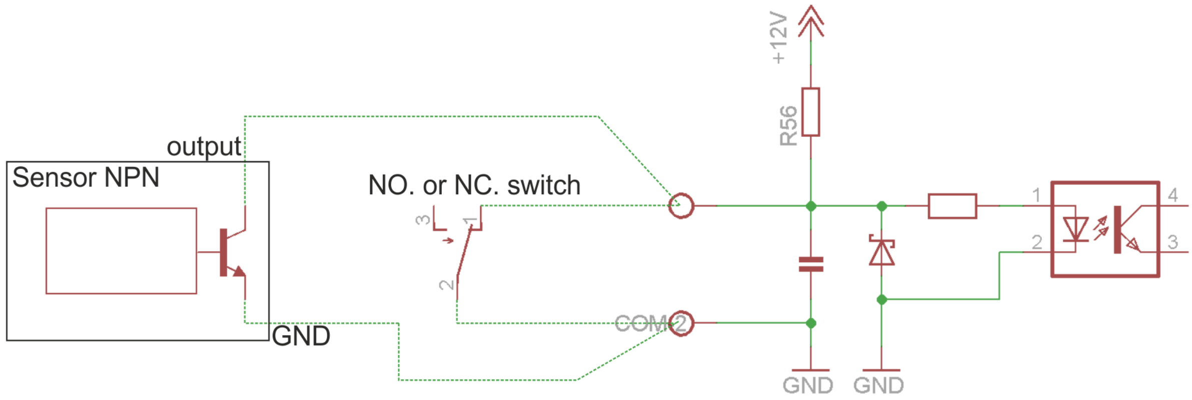
- **THC Disable (THCOFF, Corner Freeze)** This needs to be a 5V signal from a CNC device. This output from the CNC is activated to turn off the automatic voltage control and freeze the position of the torch. Polarity is not important.

- **Motion** This is a dry contact signal to a CNC device. This signal is an output from the Neuron and an input to the CNC. The signal is issued after plasma ignition and the Neuron set pierce delay time. It indicates to the CNC that the pierce delay is complete and the cut motion should begin. Normal Open relay contacts 100 mA protected.

NOTE: All interconnection RJ45 Cat5e cable has the PIN TO PIN connection.



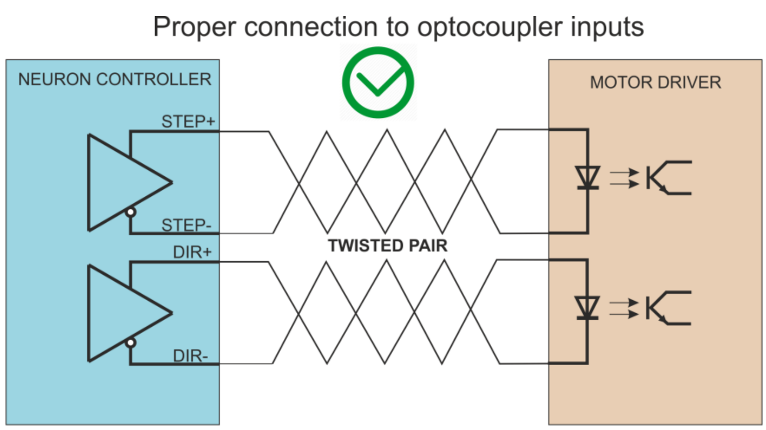
Lifter Input signals interface schematic (home, float head and ohmic)



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.

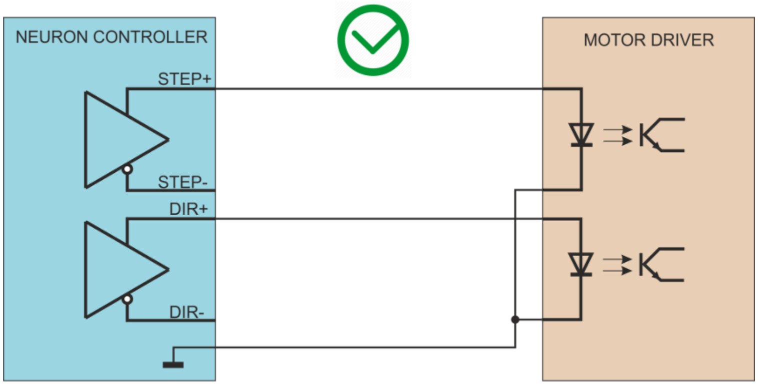
If motor driver has optocoupler inputs then there is no need to connect GND of the devices too.



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 microstep drivers) is a little bit worse because of lower interference resistance and it is a bit more difficult to connect.

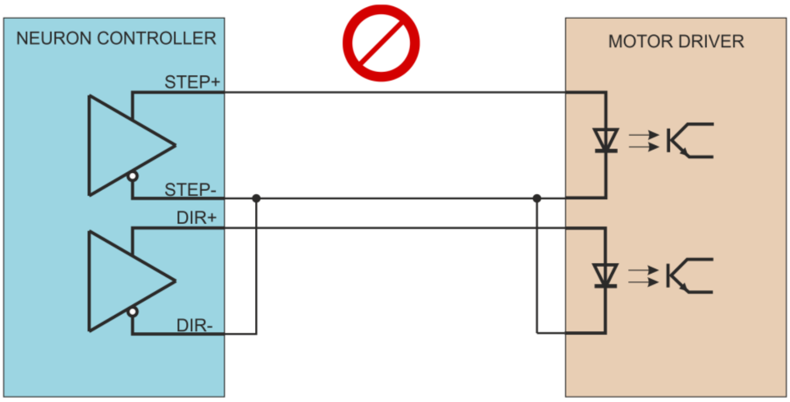
Proper connection to optocoupler inputs with shared cable



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.

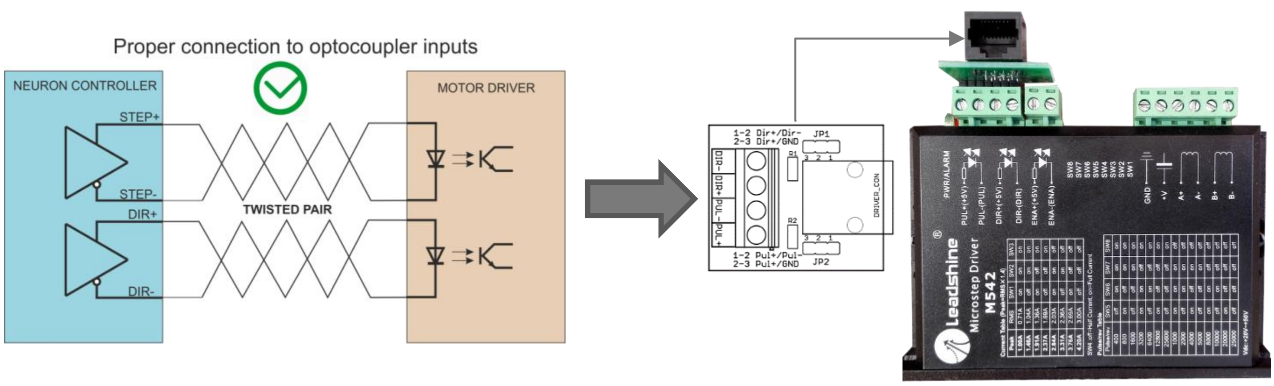
Incorrect connection to optocoupler inputs sample



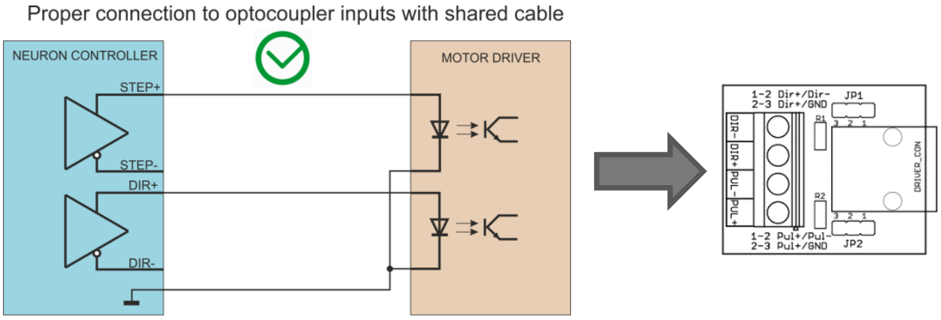
Because of short circuit between STEP- and DIR- signals in such a connection the Neuron controller will be damaged. Warranty does not cover damages caused by incorrect connection!

There is a special PCB for connecting Neuron differential Step/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:

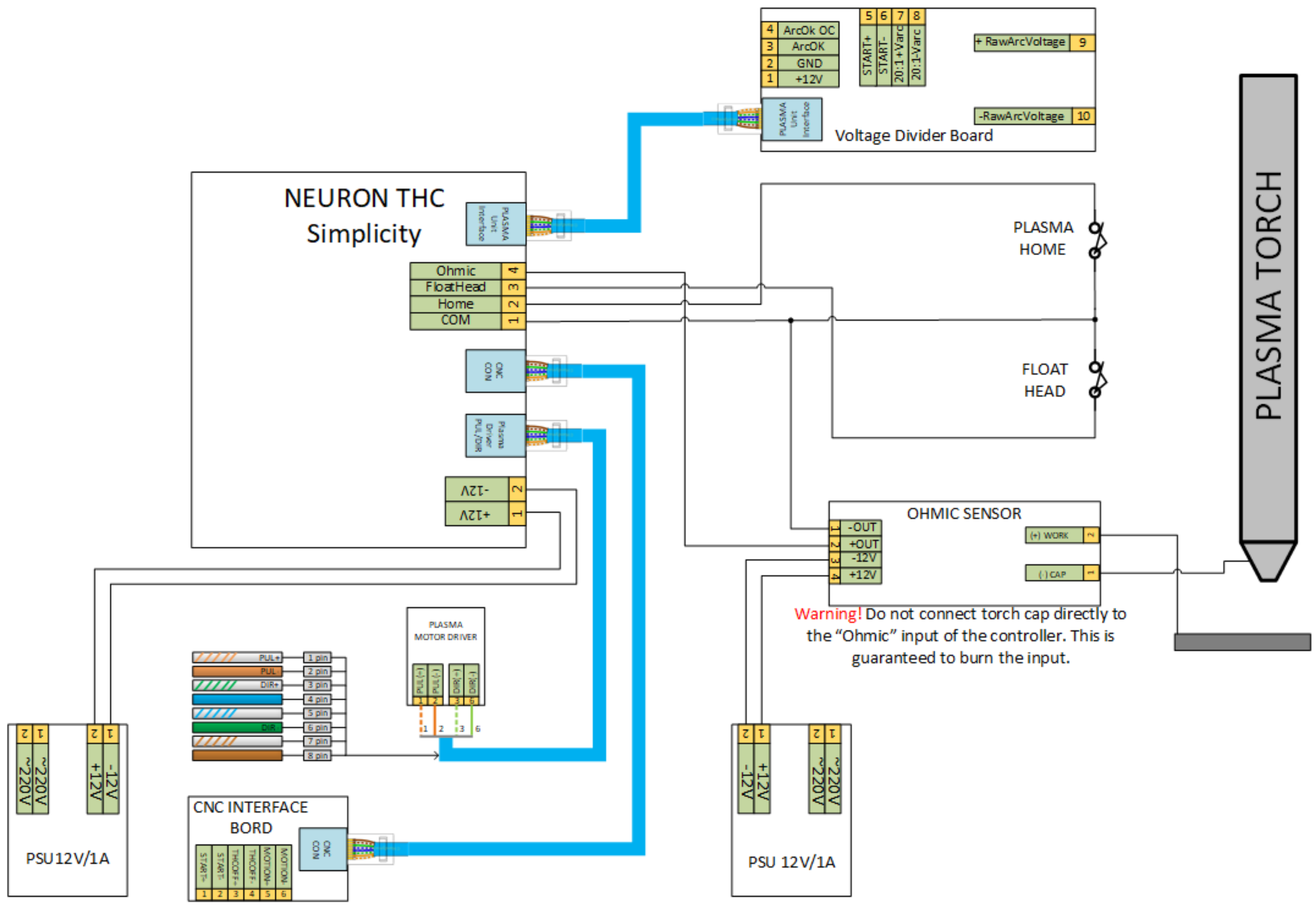


INSTALLATION

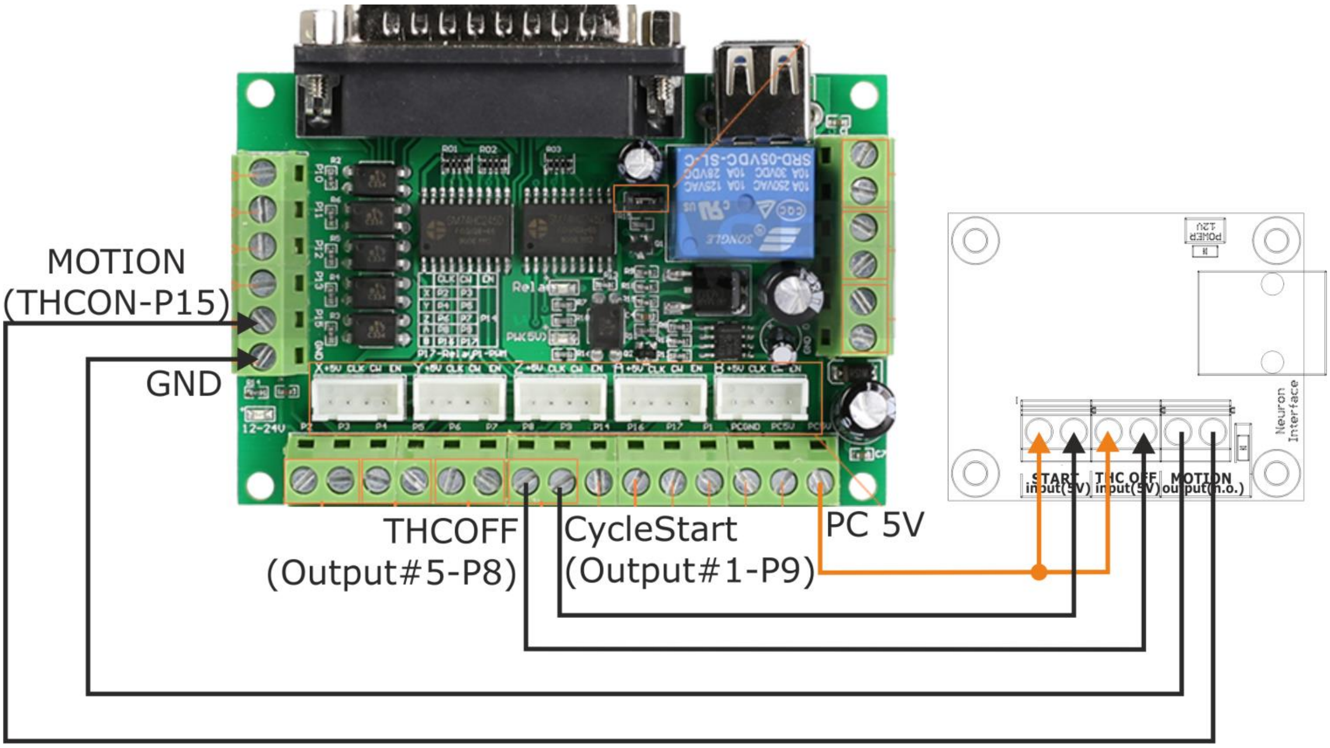
1. Mount the Neuron.THC control module.
2. Connect Home and Initial Height Sensing (Float Head and/or Ohmic Sensor) switches to screw terminals on the Control Module.
3. Connect CNC interface PCB to the "CNC Interface" RJ45 socket on the Control Module.
4. Connect the plasma cutter interface PCB to the "Plasma Interface" RJ45 socket on the Control Module.
5. Connect the Torch Lifter Driver to Pulse/Direction to the "Motor Driver" RJ45 socket on the Control Module.
6. Connect the power supply (DC 12 volt / 0.5A) to screw terminals on the Control Module.

NOTE: All interconnection RJ45 Cat5e cable has the PIN TO PIN connection.

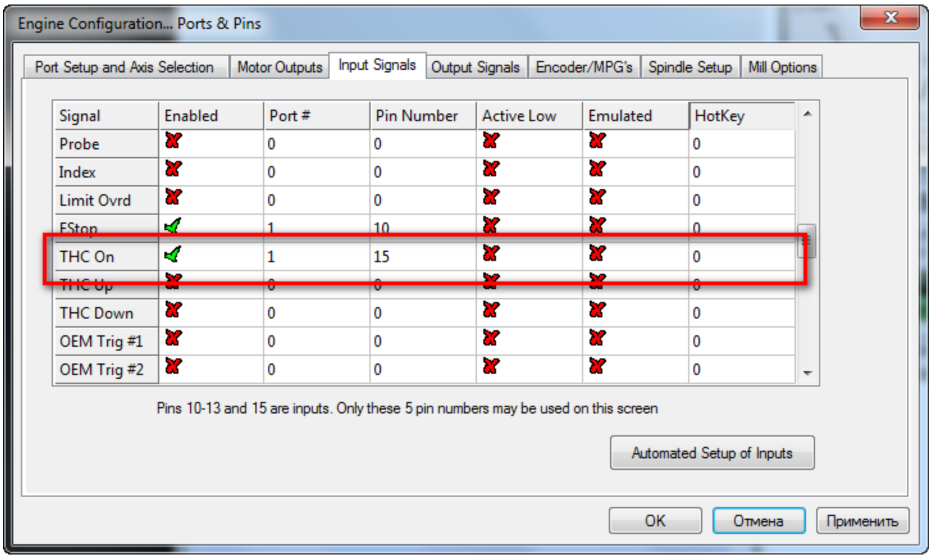
Printed circuit board (PCB) block diagrams



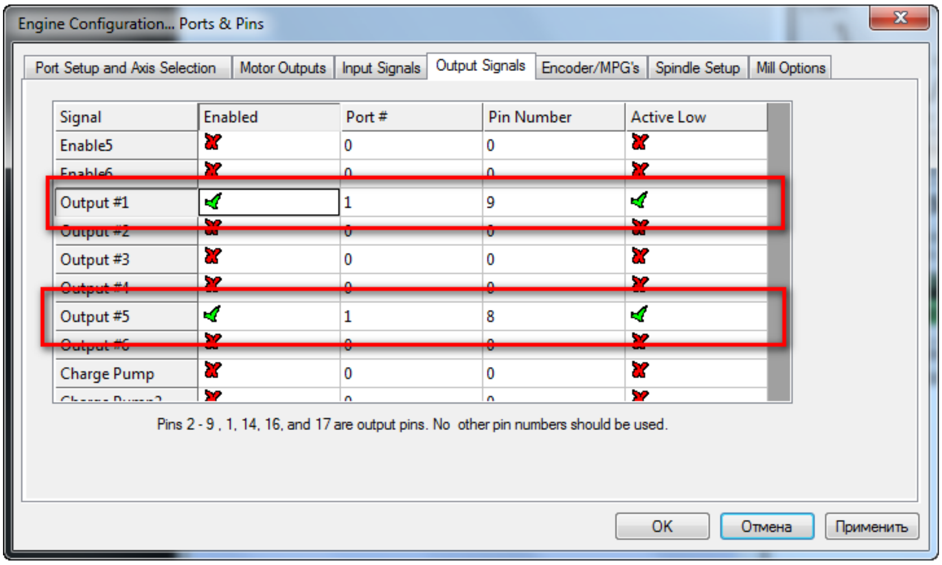
Connection diagram for Mach3/Mach4/UCCNC CNC and regular BOB (example)



Configure Mach3 Input signals:



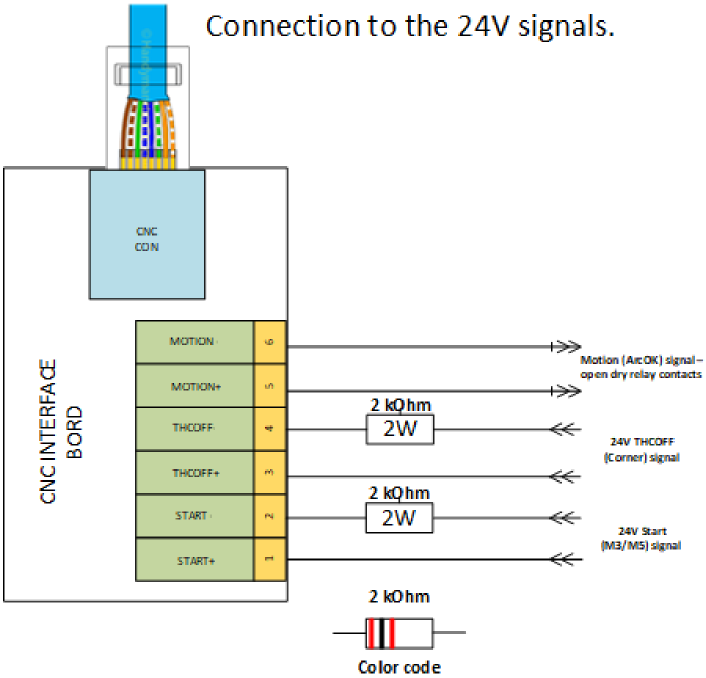
Configure Mach3 Output signals:



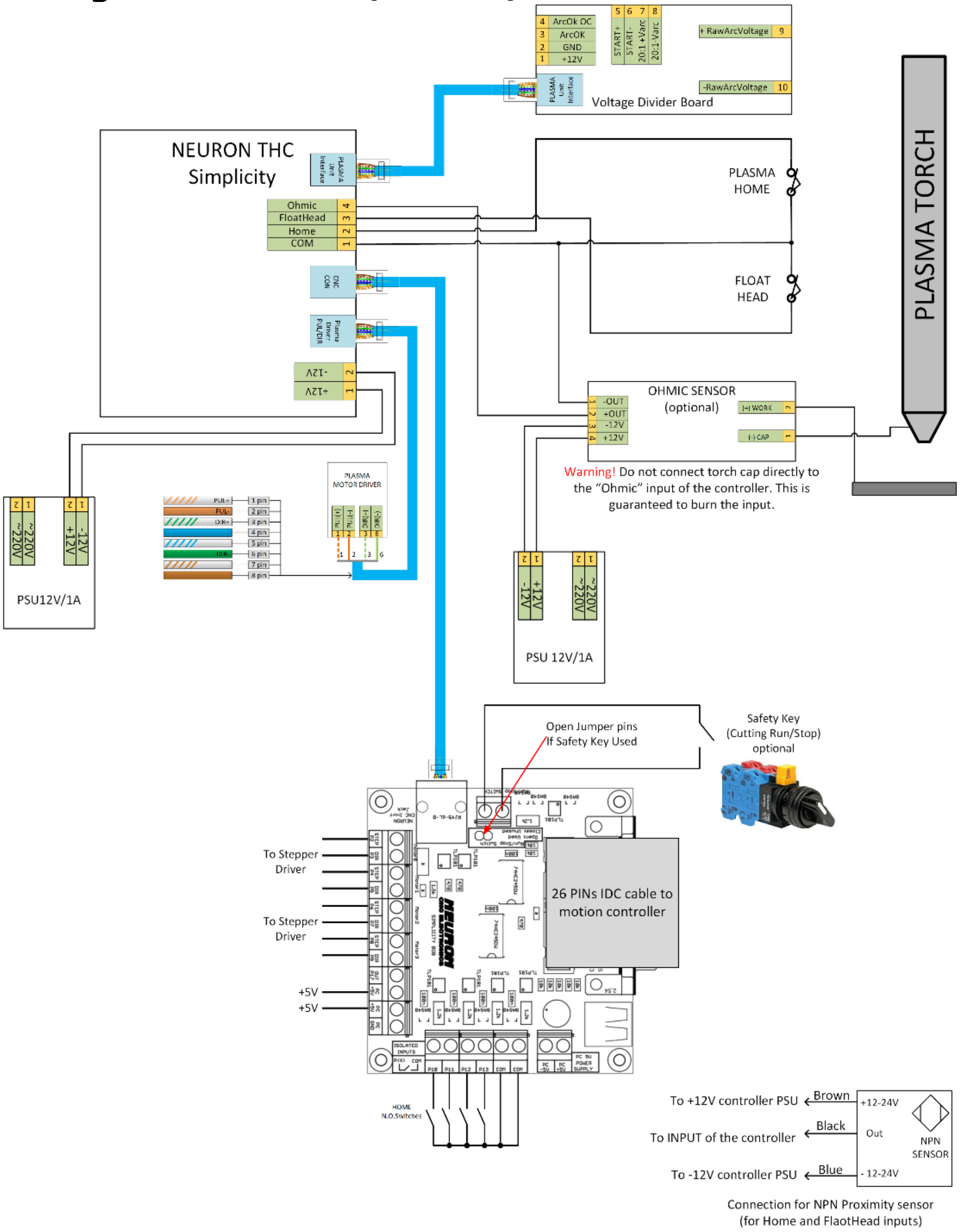
For THC OFF control from G-Code use SheetCam TNG rules. Install SheetCam Tools file downloaded from our website. Use Mach3PlasmaNoZ postprocessor.

- Configure Output#1 signal to port1 pin9 for CYCLESTART
- Configure Output#5 signal to port1 pin8 for THC OFF control
- Configure THCON input to port1 pin15 for Motion signal from controller.

NOTE: Depend from used BOB you have to setup ActiveLow properties for used pins.



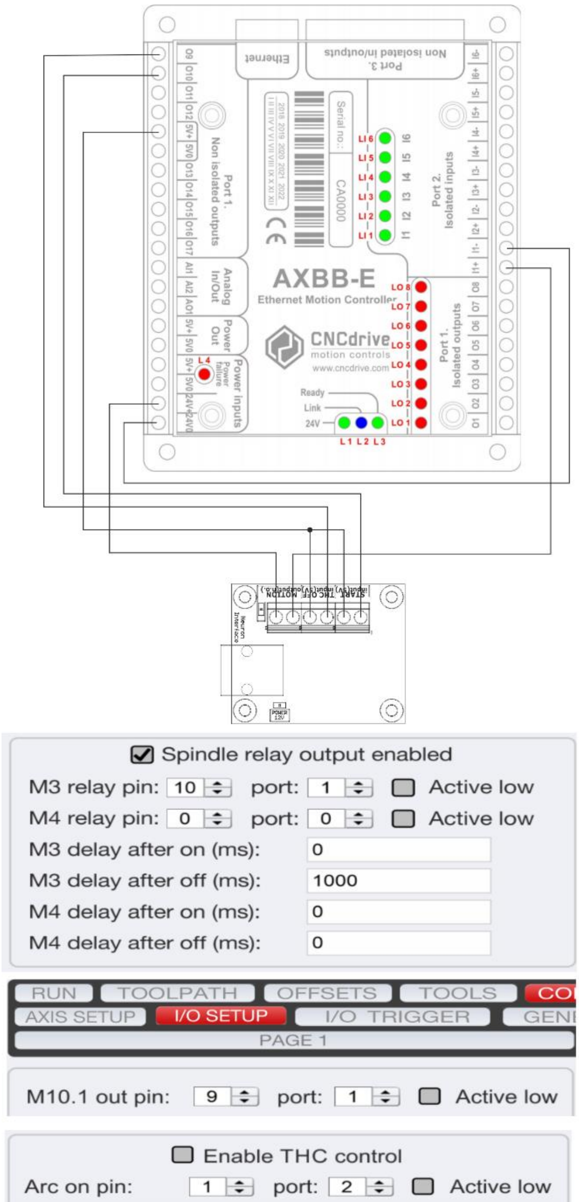
Connection diagram for Mach3/Mach4/UCCNC CNC to the Neuron BOB

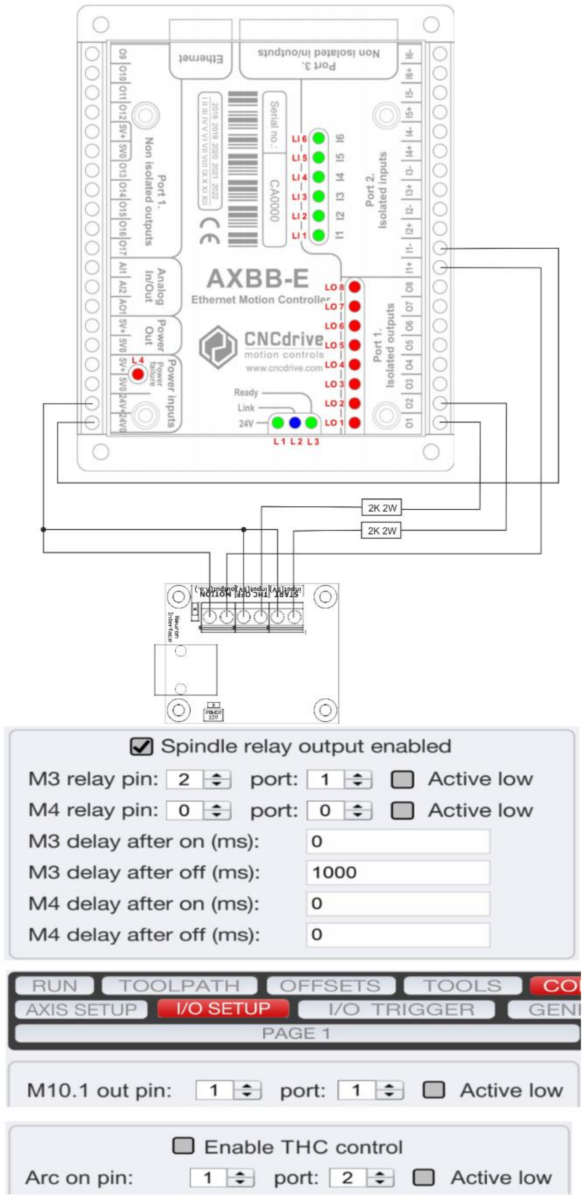


Configure Mach3/mach4/UCCNC Output signals for Neuron BOB:

- Configure Output#1 signal to port1 pin1 for CYCLESTART
- Configure Output#5 signal to port1 pin16 for THC OFF control
- Configure THCON input to port1 pin15 for Motion signal from controller.

Connection to the UCCNC AXBB-E controller





Configure UCCNC Output signals for Neuron BOB:

- Configure M3 relay pin for CYCLESTART
- Configure M10.1 out pin for THC OFF control
- Configure Arc on pin for Motion signal from controller.

Recommended grounding and shielding practices

Introduction

Make sure that the machine is properly grounded. Plasma cutters generate voltage dangerous for human health and life. No grounding may result in electric shock and / or damage electronic equipment.

This chapter describes 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 then 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.

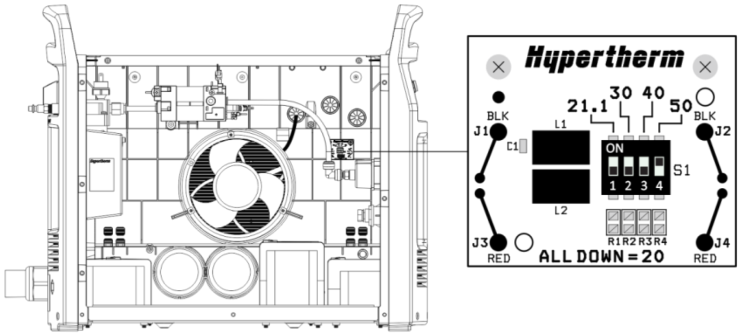
The star ground point should be right on the ground rod, or within about 6 feet, any extra cable length should be shortened, no cables on the machine should have any coiled extra length.

Voltage Divider Installation - General

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

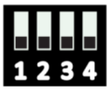
The voltage divider provides a feedback signal which is derived from the actual cutting arc voltage of the plasma power supply. The Neuron.THC control uses this feedback signal to control the cutting height of the torch. The voltage divider used in the Neuron.THC a 10:1 signal. This simply means that 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.

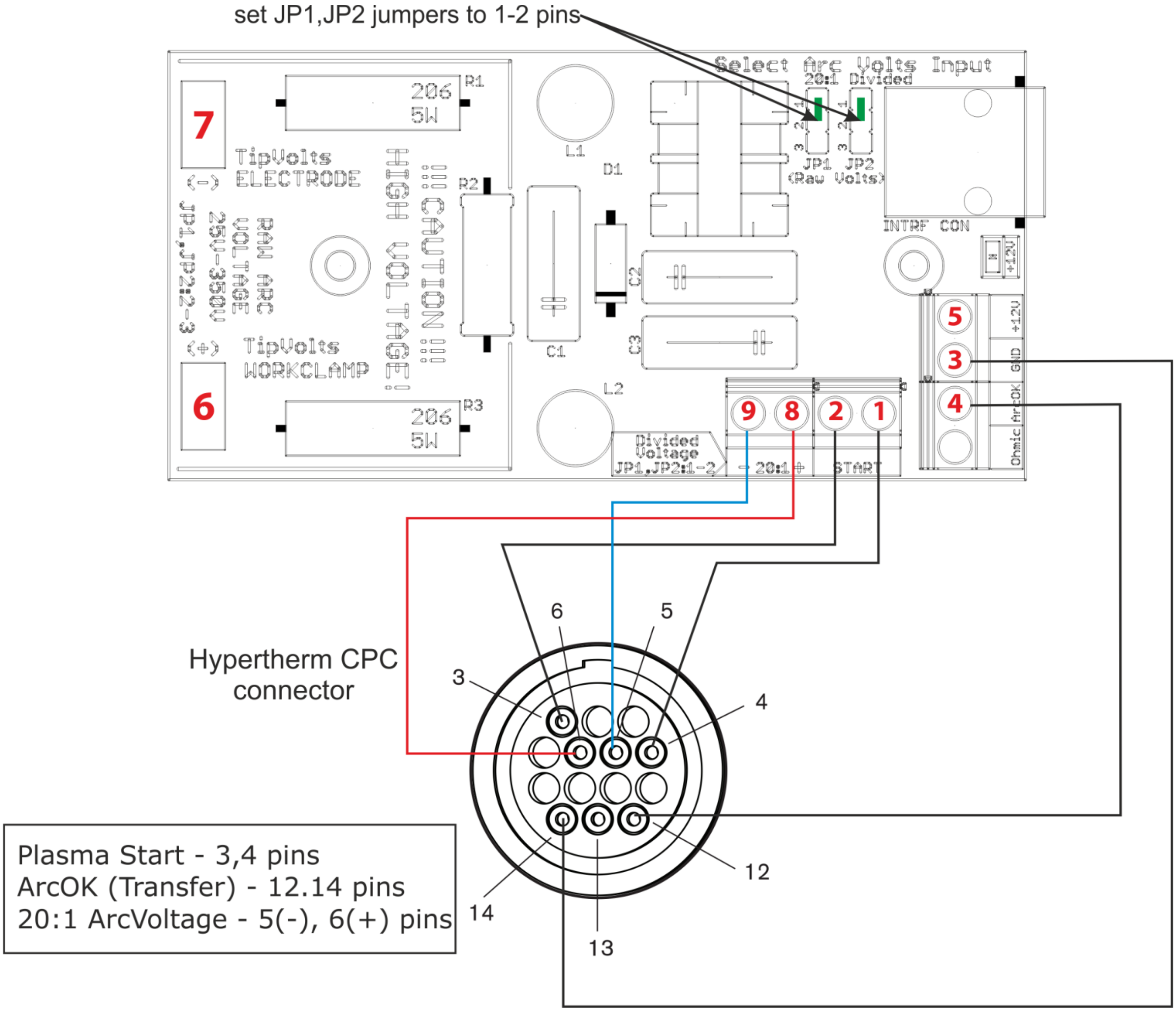
Powermax cutter. Internal divider 20:1



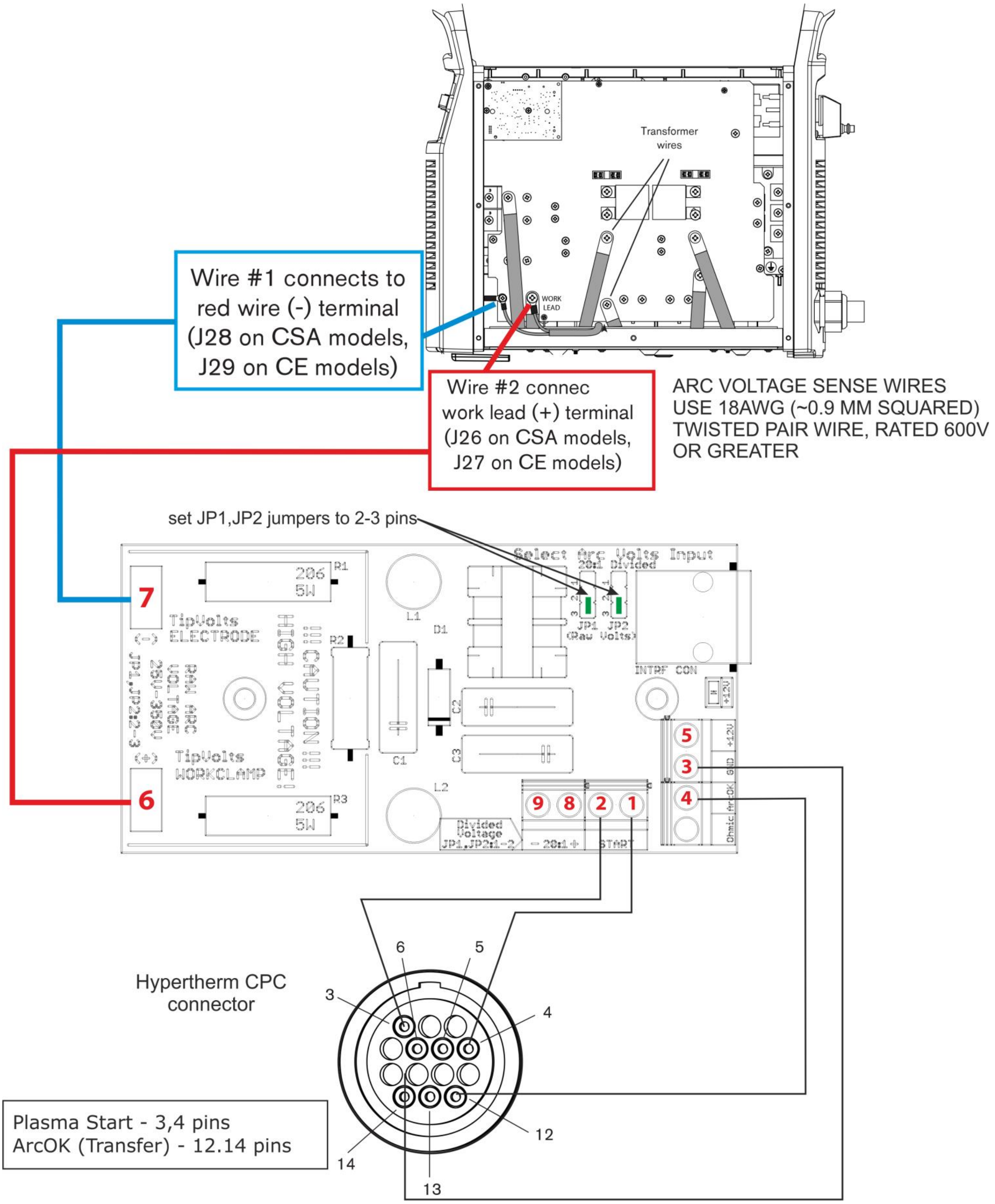
Установите переключатель в показанное положение, что соответствует коэффициенту деления 20:1.

20:1



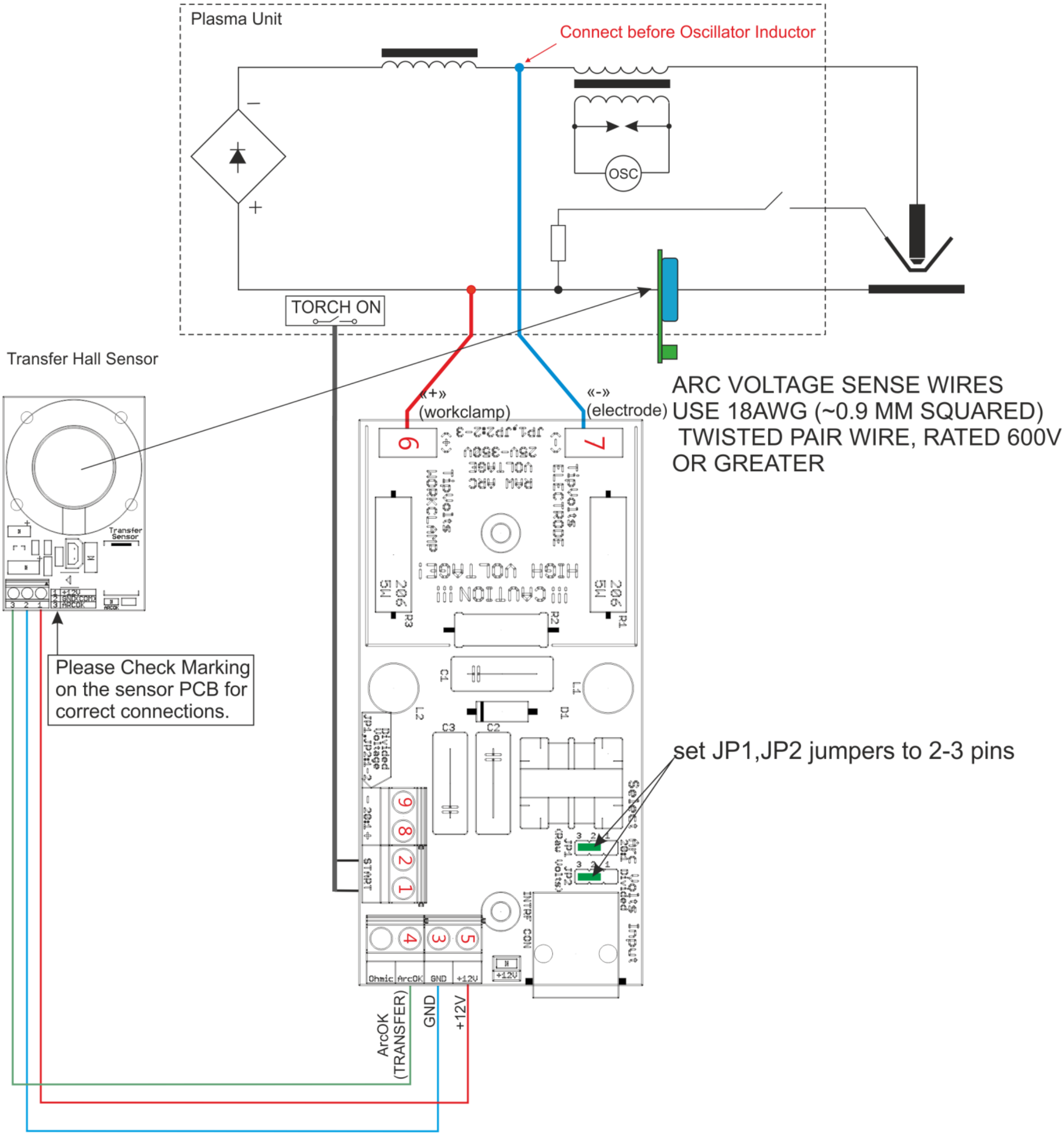


Powermax cutter. Raw Arc Voltage.



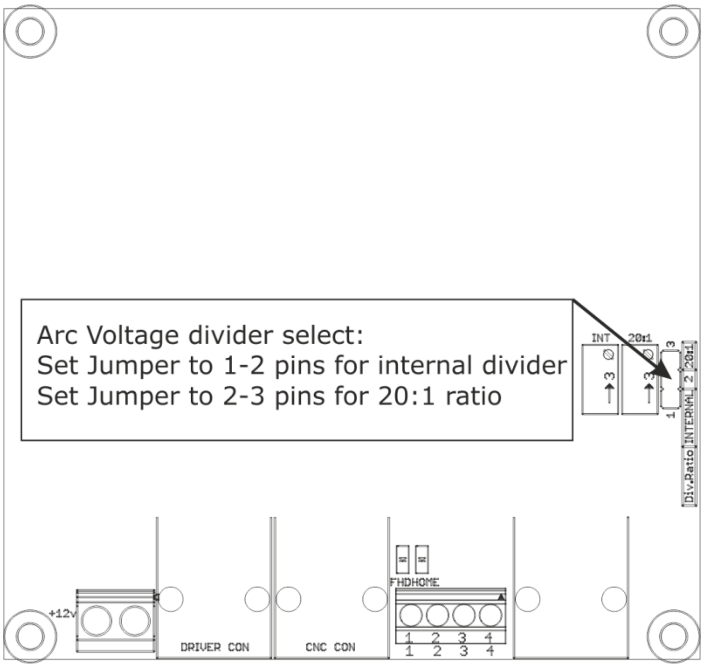
Plasma Start - 3,4 pins
ArcOK (Transfer) - 12.14 pins

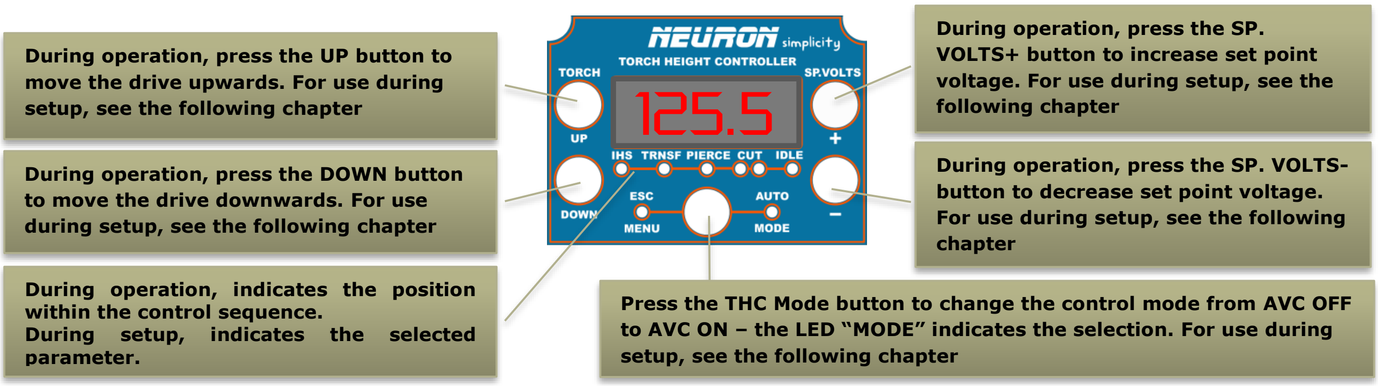
Other plasma unit. Onboard divider.



Setup Main module.

Set jumper for setup divider ratio for arc voltage input.

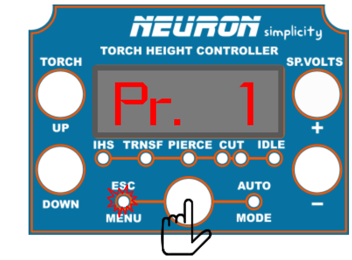




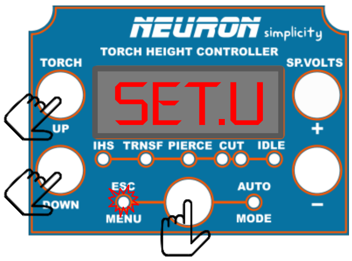
The THC Mode Toggle button can be used to turn off THC control at any time. With the THC turned off, your torch slide will function as normal, but with no THC adjustments during cutting.

Controls

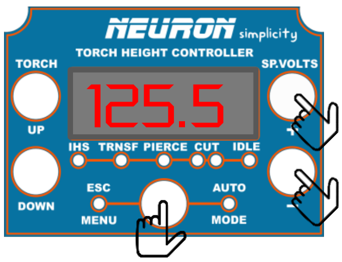
- Press and hold the "THC MODE" button for entering to the setup menu.



- When profile select menu will be appear release "THC MODE" button. "ESC MENU" LED will flash.



- Press Torch UP/Down buttons to navigate to a parameter.
- Press the THC MODE button to enable a change in parameter.



- Press SP.VOLTS +/- buttons for change the parameter.
- Press again THC MODE button to return from submenu.
- Press and hold THC MODE button to exit from setup menu and store the parameter in the operator interface.

Set-Up of Cutting Sequence

Parameters

NOTE: Default unit is mm. To change to inches, first change the units. Controller has two independent profiles and general settings data bases for mm and inches systems. If you change units, please check all parameters.

The cutting profile setup menu allows you to set up the following parameters:

Parameter	Range	Steps
Cutting profile select menu	Allow to select cutting profile from database	
Set Point Voltage	25 volts to 250 volts	0.5 volts
Pierce Height	2 mm to 20 mm 0.08 in to 0.8 in	0.1 mm 0.01 in
Pierce Time	0 s to 10 s	0.1 s
Cut Height	0.5 mm to 25 mm 0.01 in to 1.0 in	0.1 mm 0.01 in
AVC Delay	0 s – 10 s	0.1 s
THC Dynamic	1.0-30.0	0.1
Lock Head Down Level	4-20% of Arc Voltage	1%
Retract Height	10 mm to 60 mm 0.4 in to 2.5 in	1 mm 0.01 in
Transfer Height	50 - 450% of cut height	1%
SHOT mode select	On/Off	
Testing mode	Select to start test of the cutting sequence	
Re Reference	Select to start homing procedure	
Configuration menu	Select to enter to the configuration menu of the controller	

Set Point Voltage

The Neuron.THC system maintains the Set Point Voltage during a cut in the Auto mode. Raising the Set Point Voltage will increase the torch height during a cut, while lowering it will decrease the cutting height of the torch. The Set Point Voltage can be adjusted from 50 to 250 volts in 0.5 volt increments.

Pierce Height

This value determines the height at which the torch pierces the workpiece.

Pierce time

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

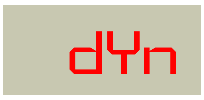
Cut Height

This value for the height at which the torch cuts the workpiece, but before then AVC closed loop control will be started (if AVC ON).

AVC Delay

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.

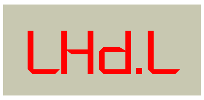
THC Dynamic



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 7 is appropriate.

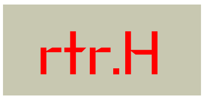
Very high speeds on very thin or highly warped metal may require increasing the Response setting to respond faster. Be careful to not go so high the torch overshoots and oscillates up and down. Remember you will generally want to go back to 7 normal cutting. To optimize this response, raise this value until a very slight oscillation is detected during a cut and then reduce the setting by 1 or 2.

Lock Head Down Level



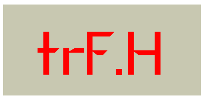
This feature avoids that the plasma torch moves down which arc voltage is up (for example on the end of cut, when crossing a kerf or hole or going off the edge of the plate). If the adjustable Lock Head Down Level exceeds the limit during cutting, the clearance control will be disabled.
Description: 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%.
Note: For disabling this future set the Lock Head Down Level to lower than 4 value.

Retract Height



This parameter specifies height above the workpiece to which the torch retracts at the end of a cut.
Note: for set full retract mode set the Retract Height value more than 60 mm (2.5 in).

Transfer Height

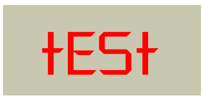


This value determines the height above the workpiece where the torch is initially fired. It is the torch height after an IHS and is entered as a percentage of the Cut Height.
This setting can be used to improve the ability of the torch to transfer to the workpiece for processes that use a very high Pierce Height or have difficulty in transferring.

SHOT mode

This mode can be used to marking (for example make small corner on the centers of the holes). When the CNC issues Cycle Start signal, the controller turns on the cutter. After receiving the ArcOK (transfer) signal from the plasma supply starts "Torch ON" delay timer. When the delay timer will end, controller turns off the cutter. If SHOT mode enabled, controller will make request for "Torch ON" time (0 – 10 sec).

Testing Mode



This mode allows starting test of the cutting sequence procedure.

THC Control Mode (Voltage control/Sample voltage)

This menu allows to select THC mode – Voltage control mode (SET.U) or Sample and Hold voltage mode (SET.H).
When Sample Voltage is ON (SET.H), the THC measures the voltage at the end of the AVC Delay and uses it as a set point for the remainder of the cut. When Sample Voltage is OFF (SET.U), the "Set Point Voltage" is used as the set point for torch height control.

Display in IDLE mode:

Set Point Voltage mode. Operator can change set point arc voltage value by "SP.Voltage+/-" buttons.

Sample Voltage mode. Operator can change "Cut Height" value by "SP.Voltage+/-" buttons.

Configuration Menu

Push on the THC MODE button to enter to configuration menu. See Setup main controller settings.

Start Homing (reference) menu

This menu allows to start homing procedure. Select "YES" and exit from menu. Controller will start Homing procedure.

Setup main controller settings

Parameters

The basic configuration menu allows you to set up the following parameters:

Parameter	Range	Steps
IHS Start Height	5 mm to 40 mm 0.2 in to 1.6 in	1 mm 0.01 in
Transfer Time	0 s to 20 s	1 sec
Retract Delay	0 s to 10 s	0.1 sec
Dead Band	0.25 volts to 3 volts	0.25 volts
Automatic velocity	3000 mm/s – 10000 mm/s 120 in/s – 400 in/s	10 mm/s 1 in/s
Jog velocity	1000 mm/s – 10000 mm/s 40 in/s – 400 in/s	10 mm/s 1 in/s
IHS Velocity	100 mm/s – 500 mm/s 4 in/s – 20 in/s	10 mm/s 1 in/s
Acceleration	50 mm/s^2 to 500 mm/s^2 4 in/s^2 to 20 in/s^2	10 mm/s^2 1 in/s^2
Automatic Collision Detect	Stop (stop cutting) – run (ignore) - ACA	
Float Head offset setup	Select to start float head offset setup	
Slide length setup	Select to start slide length setup	
Preflow In IHS	enable/disable, torch on time 0.02-1 sec	
Tune arc voltage	correction factor = (0.5 – 1.5)	
Pulse In Unit Integer Part	0. – 20000. pulses (integer part)	1
Pulse In Unit Decimal Part	.0 – .999 pulses (decimal part)	1
Inches/Millimeters Setup	Select to enter to select Metric or Imperial system	

IHS Start Height

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.

Transfer time

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

Retract delay

The Retract Delay time is the time between the removal of a start signal and the retraction of the positioner. In this case the plasma power supply turn off immediatly, then delay timer will start. After finishing of the delay Motion signal will off and retraction of the torch will start. This future for example can use for disabling plasma power supply before end of cut (few tens of milliseconds) for reducing divots.

Dead Band

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

Automatic Speed

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.

Jog Speed

UEL.J

Jog speed is the speed at which the positioner moves when operator push on the Torch UP/DOWN buttons. Note, the positioner moves at an IHS speed when the up/down buttons are initially pressed. The speed is increased to the jog speed if the buttons are held down.

IHS Speed

VEL.I

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 jog moves.

Acceleration

ACC

This acceleration is used for all automatic, manual, IHS moves end arc voltage closed loop control. This value depends on the motor parameters, the weight of the lifter load and the desired speed of operation.

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 if 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.

Automatic Collision Avoidance

COLL

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 retracts while ohmic contact will lose, provided that the Use Ohmic function is enabled.
Allowed modes on collision – Stop cutting – Ignore collision – ACA.

Float head offset setup

FLHD

This function allows to setup offset for floating head switch.

Slide Length setup

SLd.L

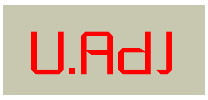
This value is the length of the lifter's usable travel (Soft Limit function).

Preflow In IHS (enable/disable)

PrFL

This menu allows to enable/disable preflow in IHS if using ohmic 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. This blow water out of the torch and keeps water away from the sensing area. If Preflow in IHS will enabled, controller turn on cutter on "Torch ON" time (0.02-1 sec). Usually 0.05 second value is OK.

Tune Arc Voltage converter



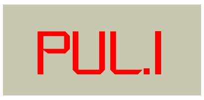
This future allows to tune the measured arc voltage value.
As a rule, on each individual plasma cutting system, the real arc voltage with the same cut settings will differ from the value recommended by the manufacturer. It depends on the design of the table, the length of the power cable and etc. So 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 by pressing the "THC MODE" button - the "AUTO" LED is off
2. Put a flat sheet of metal on the cutting 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 cutting program with a length of 100 or 200 mm, set the cut speed recommended by the manufacturer.
5. Start the cut.
6. During the cut, the controller will display the actual value of the arc voltage - remember this value.
7. After the end of the cut, calculate the correction factor according to the following formula:

$$k = \frac{Vbook}{Vreal}$$

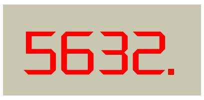
Where the $Vbook$ is the value of the arc voltage recommended by the manufacturer for current cutting settings, and the $Vreal$ is the real arc voltage that the controller displayed during the cut.
Possible values of the correction factor are in the range from 0.5 to 1.5

Pulses in unit integer part



The value is based on the counts of pulses for motor driver. It is equal to the number of pulses in the one unit (millimeters or inches). For example, slide has 5.08 mm pitch screw and the motor driver has a 1000 pulses per one motor shaft revolution value. Pulses in unit will be 1000/5.08 = 196.850
You have to set pulses in unit integer part value to 196.

NOTE: value of the PUL.I less, then 10000 displayed like this



If PUL.I more then 9999, controller divide this value on two parts – 10000 and rest. First (10000) part not showed. Only rest value, comma in second digit is on.
For example, if you set PUL.I = 12500, controller show it's like this

Pulses in unit decimal part

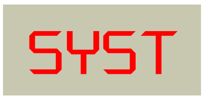
The value is based on the counts of pulses for motor driver. It is equal to the number of pulses in the one unit (millimeters or inches). For example, slide has 5.08 mm pitch screw and on the motor driver set 1000 pulses per one motor shaft revolution value. Pulses in unit will be 1000/5.08 = 196.850
You have to set pulses in unit decimal part value to 850.

NOTE: after changes pulses in unit value Slide Length and Float head offset setup required.

Reverse direction

This menu allows changing the polarity for Direction signal (for reverse motor direction). Please note that motion direction is also related to motor-driver wiring match. Exchanging the connection of two wires for a coil to the driver will reverse motion direction.

Inches/Millimeters setup



This menu allow to change of units (mm/inches)
NOTE: controller has two independent profiles and settings databases for mm and inches. If you change the units, check all settings and make initial setup of the controller motion engine.

Cutting sequence LEDs

During operation, indicates the position within the control sequence.
During set up, indicates the selected parameter.
- AVCOFF led indicates that the Automatic Voltage Control (AVC) is OFF.

In IDLE mode indicates:

- **IHS led**: show state of the IHS input (float head or ohmic sensor).
- **TRNSF LED**: show state of the ArcOK (Transfer) input.
- **AVCOFF LED**: show state of the THC OFF input.
- **IDLE LED**: show the state of the Home input.

Requirements and Check List for first Start-up

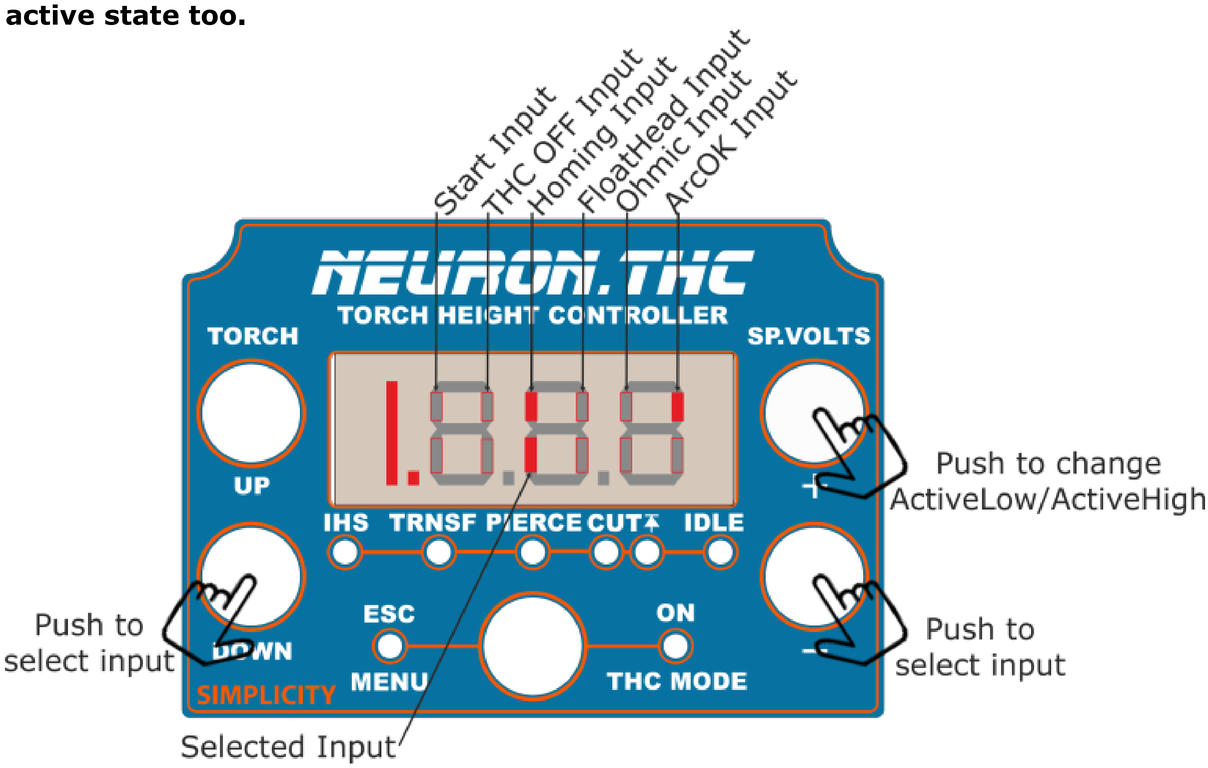
Step	Instructions	OK
1.	Are all cables and wires connected and locked properly?	
2.	Can the torch move in all directions without hitting anything? Is the slide in vertical direction and mounted correctly?	
3.	Are all settings and signals from and to Neuron THC correct?	
4.	Is the power supply (+ 12V/0.5A) of the Neuron THC System installed properly?	
5.	All shields of cables going to the plasma source should not be connected at the plasma source. They must be connected in the control cabinet with the shortest possible connection to the machine ground.	

Power Up

1. Power off plasma cutter.
2. Push on the "TORCH UP/DOWN" buttons and hold, then **switch on** controller power supply.
3. Controller will switch to the initial setup and diagnostic mode. Display will show state of the inputs. Also, controller will activate/deactivate output signals for checking (1.5 sec On/Off period). Push on the "Torch DOWN" or "SP. VOLTS -" for select input (lower segment), then push on the "SP. VOLTS +" for change "ActiveLow/ActiveHigh" properties for selected input (upper segments).

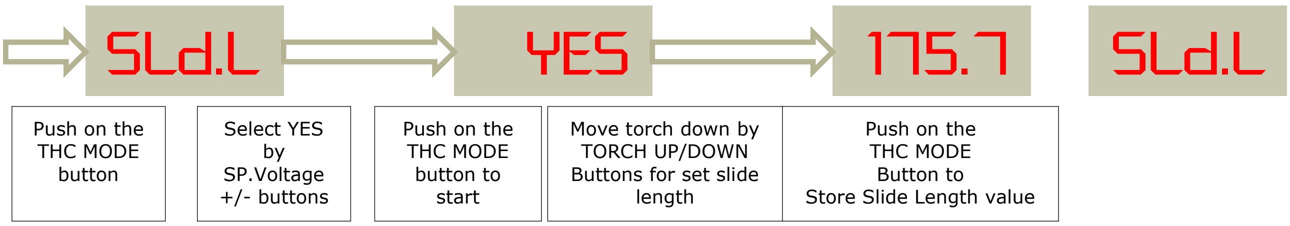
In the IDLE mode all inputs must be in the "OFF" states. Change "ActiveLow/ActiveHigh" properties for set "off state" on the display (upper segments).

For example, in this picture shows the state of the controller inputs. Homing input has active state and has selection for change ActiveLow/ActiveHigh. Also, ArcOK input has active state too.

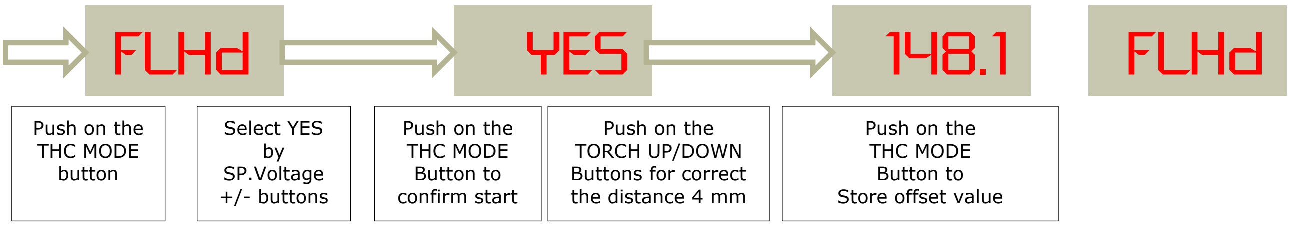


4. Push on the "THC MODE" button to exit from this mode.

5. Controller will start homing procedure. Check, that the torch move UP to homing switch. If direction is wrong, push on the TORCH UP or DOWN button to terminate homing procedure. Error (Er.01 - Fail go to home) will issue. Push on the "THC MODE" button to clear Error.
6. Enter to the configuration menu.
7. If torch move direction during homing procedure was incorrect, set reverse motor direction in the "Reverse direction" menu.
8. Select mm or inches system. After exit from mm/inches menu controller will reboot.
9. After the reboot an initialization process runs for approx. 2 s. – The LED screen at the main control module show "BOOT" message. If the LED screen shows error, check the error table in Chapter Trouble-Shooting.
10. If all is correct controller show "PUSH" message for start homing procedure. Push on the "THC MODE" button for starting. The torch slide automatically moves to the upper reference position.
11. Enter to the configuration menu.
12. Setup integer part and decimal part of the "StepInUnit" value.
13. Setup the maximum values of the acceleration and Automatic, Jog, IHS velocities values of the torch moving as your system allowed (avoid lost steps for steppers motors).
14. Push and hold "THC MODE" button to exit from configuration menu and save configuration.
15. Power OFF controller.
16. Power ON controller.
17. Enter to the configuration menu.
18. Setup Slide Length value.



19. Setup Float Head offset value. Put on the table plate, thickness not less 3 mm.



19.1 Push on the THC Mode button for entering to the Float Head offset setup menu.

19.2 Select YES by "SP.Voltage+/-" buttons and push on the "THC MODE" button to start procedure.

19.3 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 TORCH UP/DOWN buttons.

19.4 Push on the THC MODE button to exit from submenu.

20. Setup IHS Start Height, Transfer Time, Retract Delay, Dead Band to desired values.
21. Push and hold "THC MODE" button to exit from menu and store values in the operator interface.

Cutting sequence test

You can make cutting sequence test procedure for control all settings.

1. Push and hold THC MODE button to go in the cutting setup menu. Navigate to “TEST” submenu.
2. Push “THC MODE” button to enter to Cutting sequence Test submenu.
3. On the display will appear current torch position. For starting push “SP.VOLTS +” button.
4. Controller will start Initial Height Sensing procedure.
5. Push on the “SP.VOLTS +” button to go to next cutting state.
6. After then Retract state will complete, controller finished testing and exit from submenu.

System Control State

IDLE	In this state, the plasma system is OFF. The system waits for the Cycle Start input signal from CNC and enters either the IHS Fast Approach state or the IHS Slow Approach state, depending on whether the workpiece position is known.
Homing	The lifter moves the torch up at the programmed IHS Speed till the Upper Limit Switch. For terminate homing procedure push on the TORCH UP or DOWN button.
Soft Limit	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.
IHS FAST APPROACH	The torch moves down at the programmed Automatic Speed to the Start IHS Height then enters the IHS Slow Approach state. NOTE: For make next IHS on the slow speed (for example if cutting material was changed) - push on the TORCH UP and then DOWN buttons simultaneously when torch in zero position ("-CLr." Message will issue).
IHS SLOW APPROACH	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.
WORKPIECE CONTACT	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.
IHS RETRACT	The lifter moves up at the programmed Automatic Speed to the Transfer Height.
START PLASMA	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.
PIERCE START	The lifter moves the torch to Pierce Height. When the torch is in position, the lifter enters the Piercing state.
PIERCING	The lifter holds the torch at the Pierce Height for the Pierce Delay interval. When Pierce Delay is complete, the lifter enters the Cut Prepare State.
CUT PREPARE	The lifter move the torch to the Cut Height and sends to the CNC "Motion" signal to begin X/Y motion. The THC waits for the AVC Delay and then enters either the Sample state or the Cutting state, depending on the operating mode.
CUTTING	If AVC ON Mode is active and the THC OFF signal from the CNC is not active, the lifter controls the torch height using arc voltage feedback. If AVC OFF Mode is active operator can adjust the torch height by pushing on the Torch Up/Down buttons. When the cut is complete and the Cycle Start input signal from the CNC is deactivated, the THC enters the retract state.
MANUAL UP	The lifter initially jogs up 0.25 mm. After 0.5 second, it begins continuous upward motion at the IHS Speed. After 1.5 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.
MANUAL DOWN	The lifter initially jogs down 0.25 mm. After 0.5 second, it begins continuous downward motion at the IHS Speed. After 1.5 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.

RETRACT	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.

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 torch slide 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

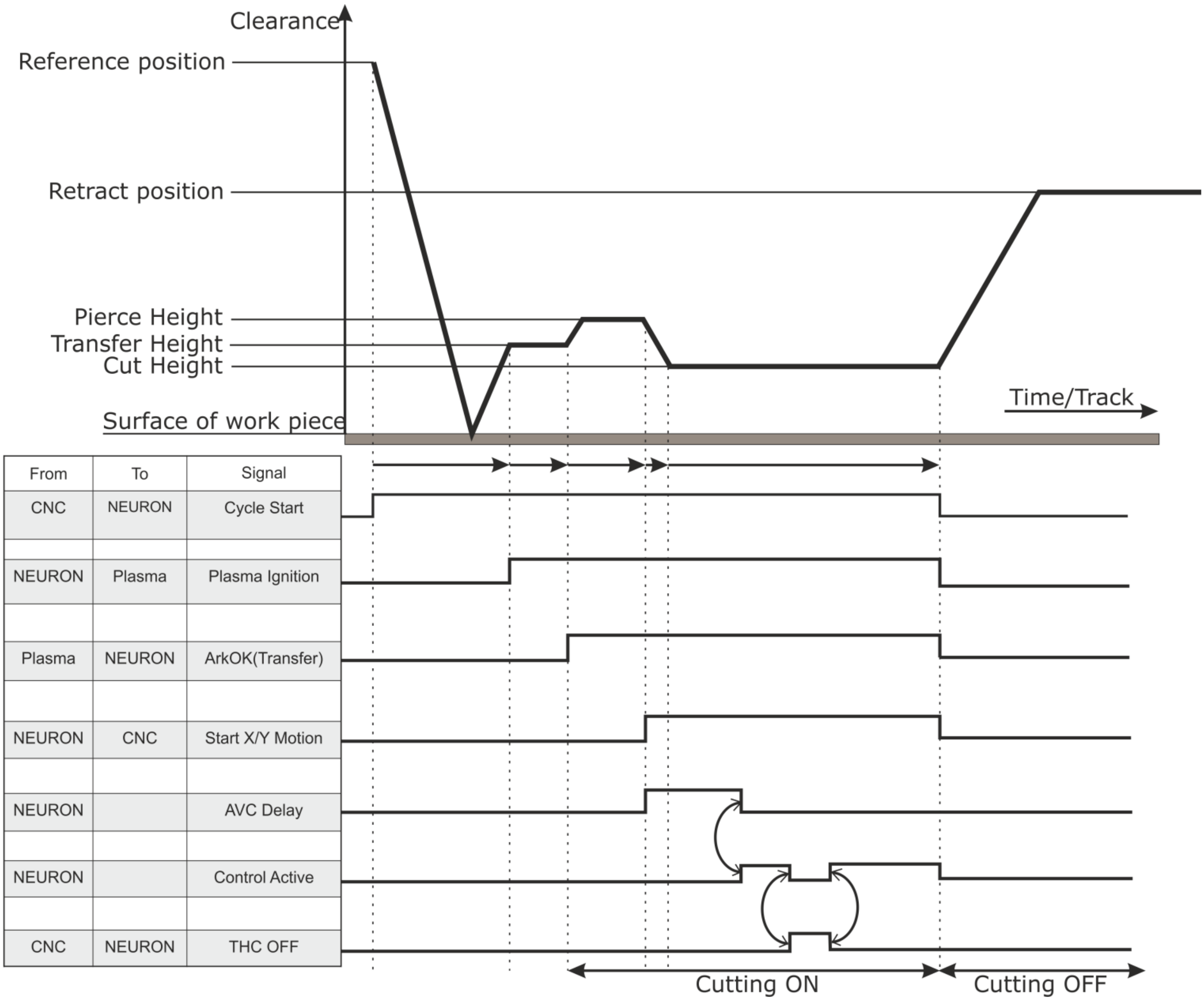
that the distance to the metal has changed from the initial cut height. To determine the correct setting, first determine how far you want the torch to move before turning on arc voltage control. Then considering the cutting speed, figure how long it takes the torch to move that far.

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 Dynamic 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 Dynamic.
   - 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, Set Point Voltage/Height).
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.

Sequence of Operation



1. Operator runs the work program by click on the "START" button on the CNC.
2. The CNC control move torch (x/y) to the IHS start position and wait the Motion signal from the controller. CYCLESTART command issue.
3. The torch travels towards the plate at Automatic speed and switches to the IHS Speed when the crossover "Start IHS Height" is reached. The torch touches the plate at the IHS Speed.
   NOTE: For make next IHS on the slow speed (for example if cutting material was changed) - push on the TORCH UP and then DOWN buttons simultaneously when torch in zero position ("-CLr." Message will issue).
4. The torch immediately retracts to the Arc Transfer Height.
5. Plasma Start signal is issued to the plasma cutter.
6. Plasma cutter initiates an arc and the Neuron.THC receives an ArcOK (Transfer) signal from the power supply.
7. The torch moves to the Pierce Height and the Pierce Time timer is initiated.
8. When the Pierce Time elapses, the torch moves to the Cut Height.
9. The Neuron.THC issues a Motion signal to the x/y machine.
10. The x/y machine begins profiling the part.
11. The AVC Delay timer is initiated.

12. AVC Delay time starts. If sample voltage mode enabled (SET.H) THC is sampling the arc voltage, at end of AVC Delay. THC uses the last stable sampled voltage as a reference to control height for rest of cut. If sample mode is disabled (SET.U) THC uses the Set Point Voltage as a reference to control height.
13. THC start closed loop height control.
14. The Set Point Voltage, thus the torch height, can be increased and decreased while in AVC ON by "SP.Voltage +/-" buttons. AVC mode is disabled, thus freezing the torch height, any time a THC OFF signal is received (from CNC).
15. If AVC is disabled (AVC OFF) the torch height, can be increased and decreased by "Torch UP/DOWN" button. One short push on the button will move torch on 0.25 mm (0.01 in).
16. If Lock Head Down 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. In this time controller show next message: 

17. In any time, operator can switch AVC ON/OFF mode using the "THC MODE" button. <u>When switch to the AVC ON mode issue, controller re-sample real arc voltage and set it as Set Point Voltage for rest of cut.</u>
18. If collision avoidance is enabled (provided that the Ohmic sensor is used), at any time when contact is sensed between the torch cap and the plate, the torch will move up (until contact will loss). After the contact is lost, the controller will turn on the automatic voltage mode and the cutter will be transferred back to the cutting height.
19. When the Cycle Start signal is removed from the Neuron.THC, the torch retracts to the Full or programmed Partial Raise Height depending on the Retract Height value.

Common cutting faults and Trouble-Shooting

Error codes

Note: for reset error state push on the "THC Mode" button. If in this time CYCLESTART signal present on the controller input – "Er.00" will issue. Deactivate the CYCLESTART input on the CNC interface to clear the error.

Code	Meaning	Cause/Action/Remedy
Er.00	• CYCLESTART at power up Error • CYCLESTART on the Error reset event	The CNC CYCLESTART input was active when the THC was powered up or operator reset error state. Deactivate the CYCLESTART input to clear the error.
Er.01	Failed Go To Home During homing operation, the lifter failed to reach the Homing switch.	• A mechanical problem in the lifter such as the motor coupling to the lifter mechanics has loosened. • The torch lead set is binding and limiting the lifter motion. • A problem with the motor wiring, motor drive, or with the motor itself. • A problem with the homing switch. Check homing switch input into the diagnostic "Display digital inputs" menu.

Er.02	Failed To Clear Home	• A mechanical problem in the lifter such as the motor coupling to the lifter mechanics has loosened. • The torch lead set is binding and limiting the lifter motion. • A problem with the motor wiring, motor drive, or with the motor itself. • A problem with the homing switch. Check homing switch input into the diagnostic "Display digital inputs" menu.
Er.03	Down Limit In Fast Jog moves operation. • The torch tip made excess contact with the plate during fast jog operation. After this controller will automatically initiate homing procedure	• Verify that the lifter has adequate range of motion while jog moving. The torch may need to be raised within the mounting clamp. • Check Ohmic and float head input into the diagnostic Display digital inputs menu. • Decrease the Jog velocity value.
Er.04	Down Limit • The torch tip made excess contact with the plate during automatic move operation.	• Verify that the lifter has adequate range of motion while automatic moving. The torch may need to be raised within the mounting clamp. • Check Ohmic and float head input into the diagnostic Display digital inputs menu.
Er.05	Failed To Contact Plate During auto operation or IHS test, the lifter failed to reach the IHS Start height. • The IHS Start Height may be programmed too low. • Something is on the cutting surface keeping the torch from reaching the IHS Start Height.	Check the value of IHS Start Height. This value should be 0.75 inches (20 mm) or more. Lower values will work but at high speeds, the torch may not have enough travel to slow down before making plate contact. Check for part tip-ups or debris on the surface of the plate that can limit the torch travel distance to the plate.
Er.06	Failed To Clear Plate This error occurs if the IHS sensors input remains active after making plate contact and while the torch is retracting after an IHS. • The Ohmic contact wire could be damaged. • The nozzle and shield could be shorted together or the wrong consumable combination was installed in the torch. • There could be a problem with the lifter mechanics. • Water from a water table is causing a short between the shield and the nozzle.	• Check the condition of the Ohmic contact wire and replace it if necessary. Check Float Head switch. • Check the torch tip for an electrical short between the shield and nozzle. • Check the consumables for damage and for the correct combination. • Disable Nozzle Contact if a water table is used or water injection plasma system is used. • Verify that the lifter is not binding mechanically and that it can retract. • Check Ohmic input into the diagnostic Display digital inputs menu. If input is always active, disconnect the Ohmic wire from ohmic sensor and verify that the input shuts off. If the input stays on, check the condition of the Ohmic sensor and cable. • Enable "Preflow in IHS" function.

	• The plate might be bowing during an IHS and following the torch up while retracting.	
Er.07	Fail To Transfer	The Plasma torch was fired but that the TRANSFER signal was not received within transfer time. Possible causes: • A faulty IHS sequence that resulted in an improperly transfer height. • Failure to transfer due to bad consumables. • Improper plasma gas settings. • Bad work piece grounding. • The TRANSFER signal on the power supply interface is missing or improperly connected to the THC Plasma PCB • Increase the transfer time value
Er.08	Arc Lost The plasma torch lost arc during operation before CYCLESTART was removed	• Cutting off the edge of the plate. • Bad consumables. • Improper height control settings.
Er.09	Low Arc Voltage • Arc Voltage Feedback was lost while cutting.	Watch the actual arc voltage while doing a manual (AVC OFF) cut at fixed height. If the voltage is displayed as less than 25.00: • Check arc voltage input to the plasma interface PCB. • Do the test again and check the arc voltage output from the plasma interface board.
Er.10	The upper limit (home) switch was activated while cutting. • The upper limit switch is faulty. • Arc Voltage Feedback was lost while cutting.	Verify that the lifter has adequate range of motion while cutting. The torch may need to be raised within the mounting clamp. Go into the diagnostic Display digital inputs menu and check the operation of the Home Switch. Watch the actual arc voltage while doing a manual cut (AVC OFF) at fixed height. If the voltage is displayed as less than 25.00: • Check arc voltage input to the plasma interface PCB. • Do the test again and check the arc voltage output from the plasma interface board.
Er.11	IHS Signal On Cutting Start • The nozzle (ohmic) contact or Float head inputs is active while the CYCLESTART command issue. • The nozzle contact wire may be damaged.	• Go into the diagnostic Display digital inputs menu and verify that the Ohmic or Float head inputs are operating properly. • Check the condition of the Ohmic contact wire, replace it if it is faulty. • Check the torch tip for an electrical short between the shield and nozzle. • Disable Ohmic contact sense if the THC is being used with a water table or water injection torch.

Er.12	IHS Signal During Cut The torch tip made excess contact with the plate during a short period of time.	• The voltage set point is too low. • The consumables are worn and the voltage set point needs to be increased. • THCOFF signal on the corners, end of the cut does not turn off AVC and torch hit the plate.
Er.13	Stop On Lock Head Down Cutting was stopped. Lock Head Down issue during 3 seconds.	• If this issue on start of the cut (after AVC delay) target arc voltage value was set lower than real arc voltage value and LockHeadDown protect future block automatic control. Please see LockHeadDown setting section of this user manual. Set correct target arc voltage. • Torch goes out from plate.
Er.14	Lifter Timeout Error • Lifter motion was commanded but the lifter destination was not sensed within the timeout period.	• A mechanical problem in the lifter such as the motor coupling to the lifter mechanics has loosened. • The torch lead set is binding and limiting the lifter motion. • A problem with the motor wiring, motor drive, or with the motor itself.
Er.15	Homing switch triggered during automatic and jog moves. • The homing switch is faulty. • Lifter lost steps during operations	• Check homing input into the diagnostic Display digital inputs menu. • Check acceleration and velocities values for of the torch moving as your system allowed (avoid lost steps for steppers motors).
Er.16	Unable To Start - Homing Required The CYCLESTART command issue before Homing procedure was complete.	• Repower controller for start homing procedure.
Er.17	Slide Length Limit During Cut • The lifter reaches a Slide Length limit during arc voltage controlled operation.	The lifter does not have the range of travel to accommodate the thickness of the material being cut. Solution: Adjust the lifter or torch mounting to make more effective use of the lifter travel range.
Er.18	Arc Voltage PWM module Fault. Controller can work, but close loop control during cutting will be off (AVC OFF).	Fatal error. Arc voltage feedback module fault. Consult with manufacturer.

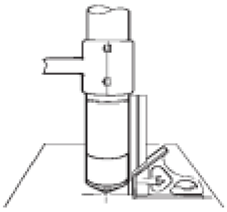
Possible Faults

Faults	Possible causes
Transfer Fail	1. Work cable connection on the cutting table is not making good contact. 2. Torch-to-work distance is too high. 3. The surface of the workpiece is rusty, oiled, or painted.
Failed to completely pierce the workpiece and there is excessive sparking on top of the workpiece.	1. Current is set too low (check Cut chart information). 2. Cut speed is too high (check Cut chart information). 3. Torch parts are worn (change consumable parts). 4. Metal being cut is too thick. 5. The surface of the workpiece is rusty, oiled, or painted. 6. Pierce Delay is set too low.
Dross forms on the bottom of the cut.	1. Cutting speed is not correct (check Cut chart information). 2. Arc current is set too low (check Cut chart information). 3. Torch parts are worn (change consumable parts).
Cut angle is not square.	1. Wrong direction of machine travel. The high-quality side is commonly on the right with respect to the forward motion of the torch. 2. Torch-to-work distance is not correct (check Cut chart information). 3. Cutting speed is not correct (check Cut chart information). 4. Arc current is not correct (check Cut chart information). 5. Damaged consumable parts. 6. The torch is not mounted perpendicular to the workpiece. 7. Damaged torch.
Short consumable life.	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. 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. 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.
Part is the wrong size.	The Kerf value is set incorrectly.
No arc voltage	1. Loose or poor connections to voltage divider. Check for loose and broken cables.
Lifter stalls	1. Maximum speed too high. Reduce maximum speed. 2. Acceleration too high. Reduce acceleration. 3. Lifter jammed. Check for smooth movement by moving the lifter up and down by hand (turn off torch motor driver before).
Lifter does not move	1. Poor or no connection to lifter motor. Check cable and wires. 2. Loose or broken axis coupler. Open the motor driver cover and check axis coupler. 3. Floating Head switch or Ohmic contact sensor is ON. 4. Upper limit switch (Home) switch is ON.

Lifter crashes to the plate after piercing	1. Bad Consumables. Replace consumables 2. AVC delay too short. Increase AVC delay. 3. Target arc voltage is lower than real arc voltage.
Lifter sits in pierce point	1. ArcOK signal from plasma cutter is broken or loose. 2. Motion signal from controller to CNC device is broken.

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

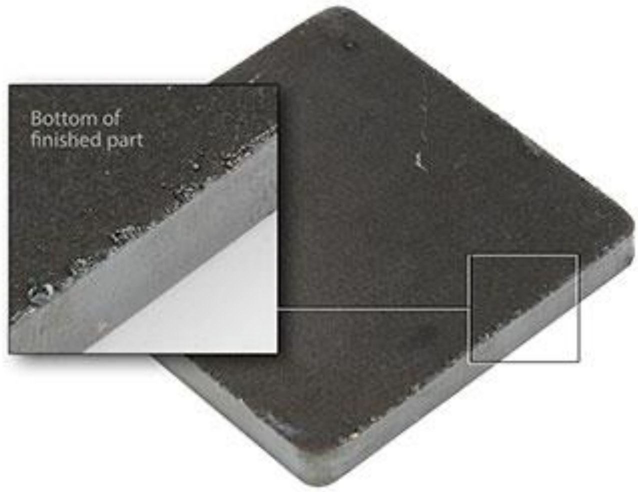
Cut angle
A cut part whose 4 sides average less than 4° of cut angle is considered acceptable.
Note: The squarest cut angle will be on the right side with respect to the forward motion of the torch.
Note: To determine whether a cut-angle problem is being caused by the plasma system or the drive system, 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 re moved 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



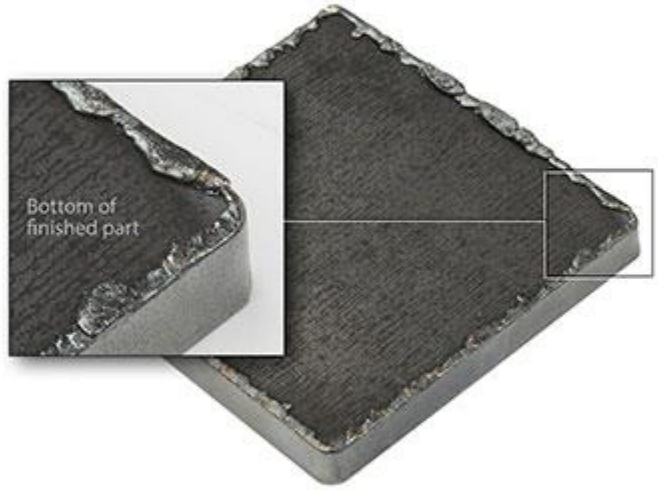
Cause:
When the programmed cutting speed is too fast for the amperage being used or the material thickness being cut, the bottom of the arc will lag behind the top. When this happens, the high pressure gas found at the orifice of the nozzle is not as effective at material removal, allowing small amounts 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



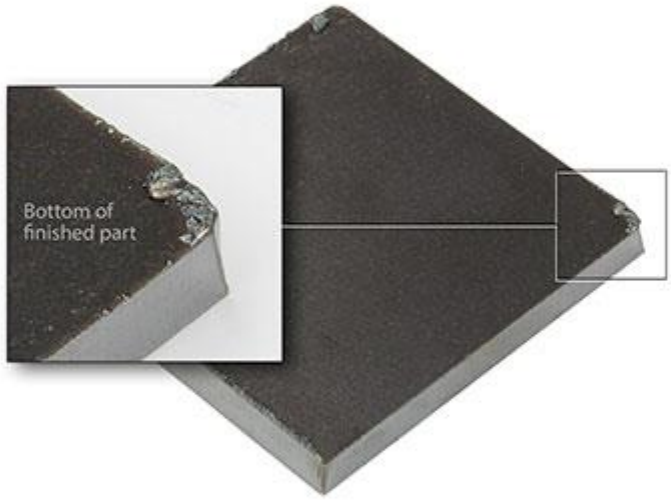
Cause:
If the cutting speed is too slow for the material thickness or selected amperage, a solid line of dross that resembles a weld bead will form on the bottom of the part. To understand why, remember that the plasma cutting process is electrical in nature. When the torch is moving too slowly, the 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:

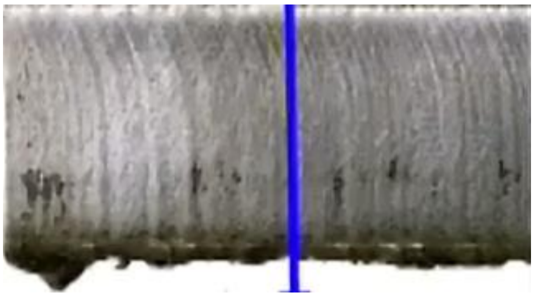
- Allow a lead-in distance that is about the same as the thickness of the material being pierced. 50 mm (2 in) material requires a 50 mm lead-in.
- To avoid damage to the shield from the build up of molten material created by the pierce, do not allow the torch to descend to cut height until it has cleared 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 check cutting speed and arc current for cut quality

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.