

PLASMA CUTMASTER LEVEL 1 MANUAL



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1 INTRODUCTION

This document is intended to provide general information on how to operate the Laguna Tools Plasma 1 machine, equipped with a Starfire controller. For accelerated start up, refer to the quick start section.

1.1 DOCUMENT KEY

Red text - Warns the user of potential hazards

Blue text - Additional information

1.2 WHAT IS PLASMA

Plasma is a gas heated to an extremely high temperature and ionized so that it becomes electrically conductive. Plasma arc cutting uses the plasma as an electrode to transfer an electrical arc to the work piece. The heat of the arc melts the work piece and the force of the plasma and shield gases blow away the molten metal to cut the work piece.

Different metals react differently to plasma cutting. Carbon steel can be oxidized, and is usually cut with a plasma containing oxygen to take advantage of the exothermic process. Higher levels of oxygen in the plasma result in higher heat and higher rates of oxidation. The result is a faster and cleaner cut. Stainless steel and aluminum are not subject to rapid oxidation and depend entirely on the plasma's heat for the cutting process. Because plasma produces much higher heat than the oxygen-fuel cutting process, plasma can cut stainless steel and aluminum quickly and cleanly.

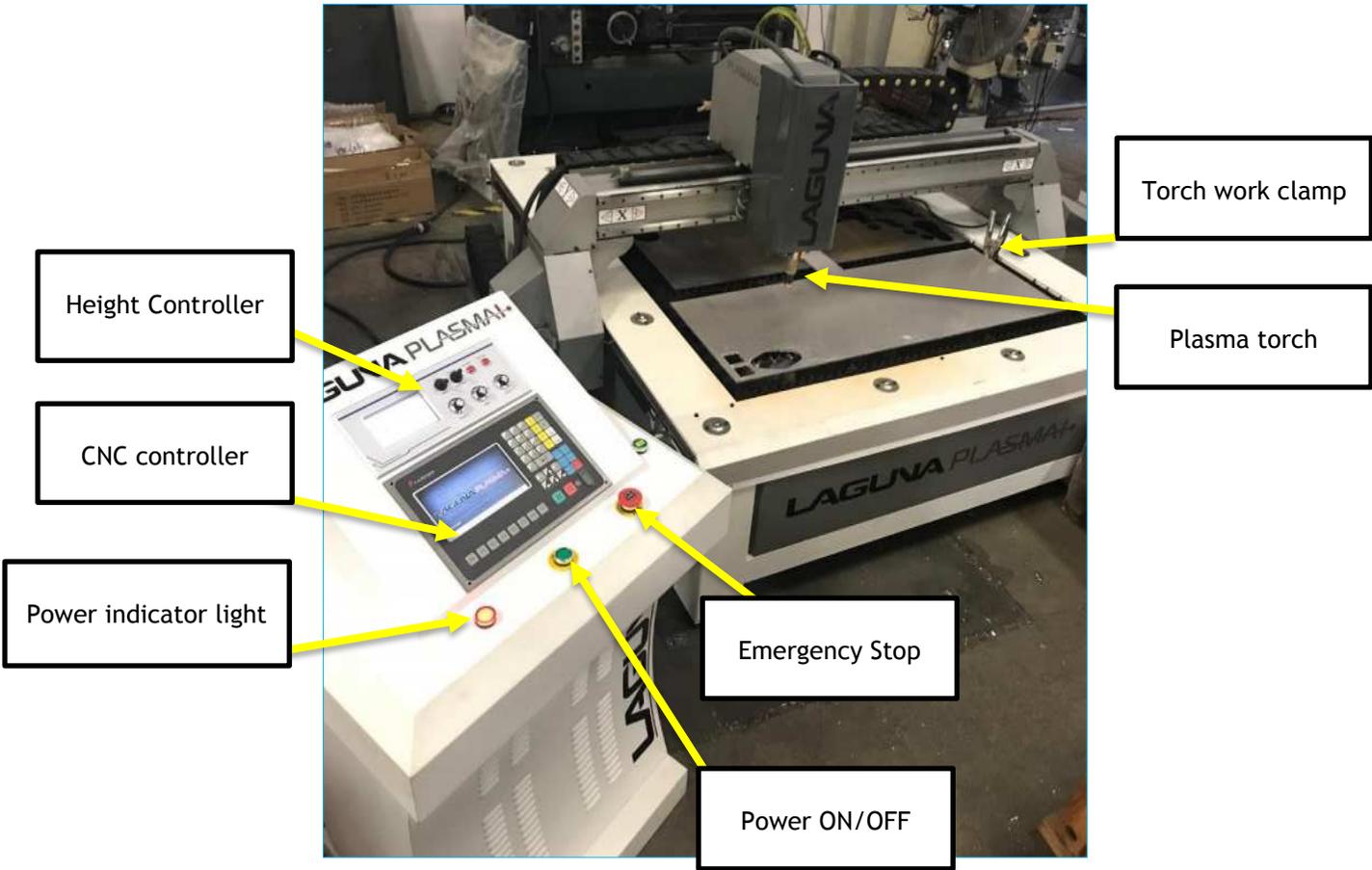
1.3 HISTORY OF PLASMA

Half a century ago Thayer Professor James Browning '44 was nicknamed Hanover's firebug for his study of flame stability and combustion at Dartmouth college.

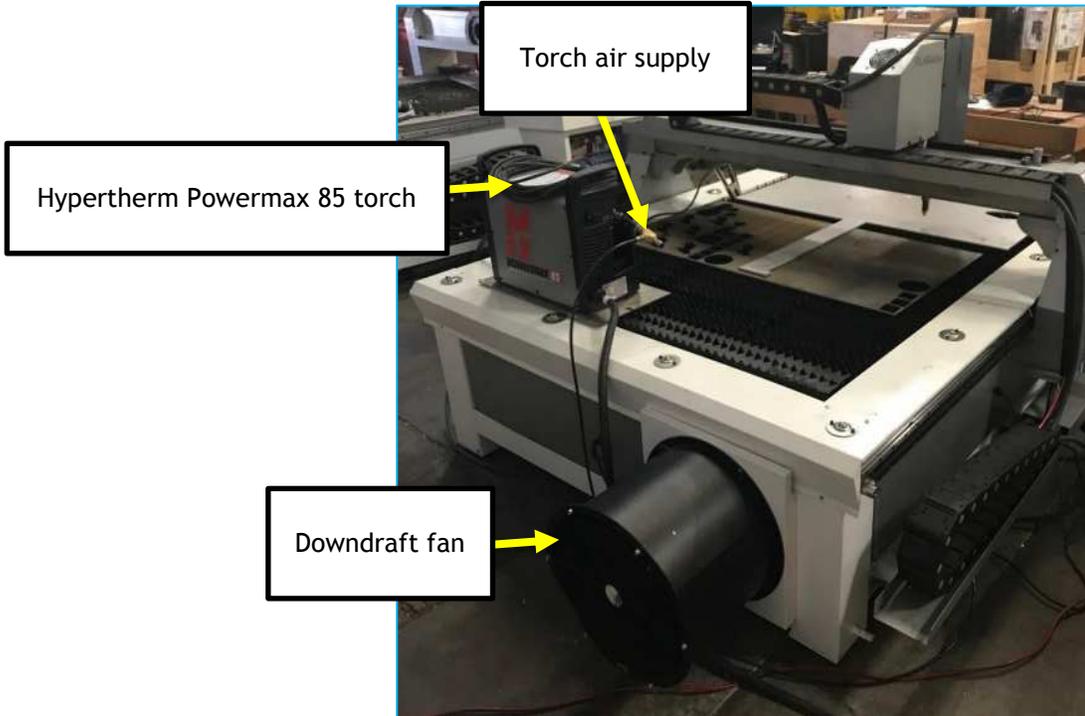
Browning will be remembered best for inventions that fired up the N.H. Upper Valley economy. In the 1950s he created a plasma torch that produced flames twice as hot as the sun's surface. Passing nitrogen or hydrogen through a high-intensity electric arc, the torch cut metal like butter. Browning and Thayer colleague Merle Thorpe founded Thermal Dynamics Corp. to manufacture the device. Within three years the start-up had sales of \$1 million. A decade later, Thayer Professor Robert Dean and Richard Couch '64, Th'65 formed Hypertherm Inc.

2 VIEWS OF MACHINE

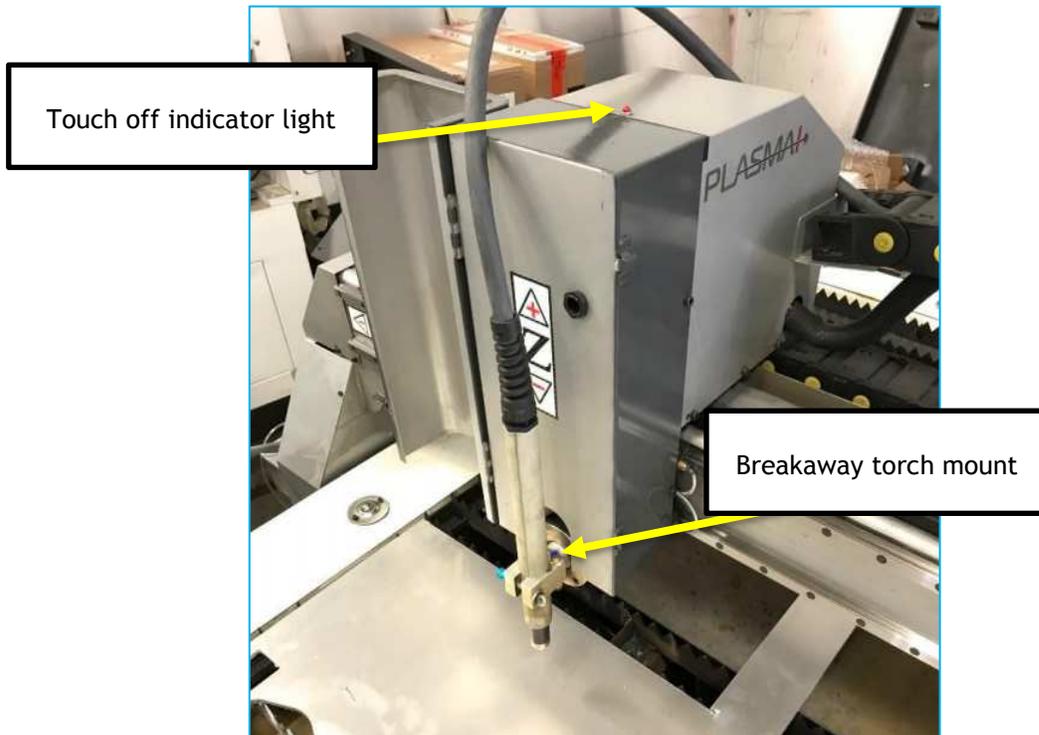
2.1 FRONT VIEW



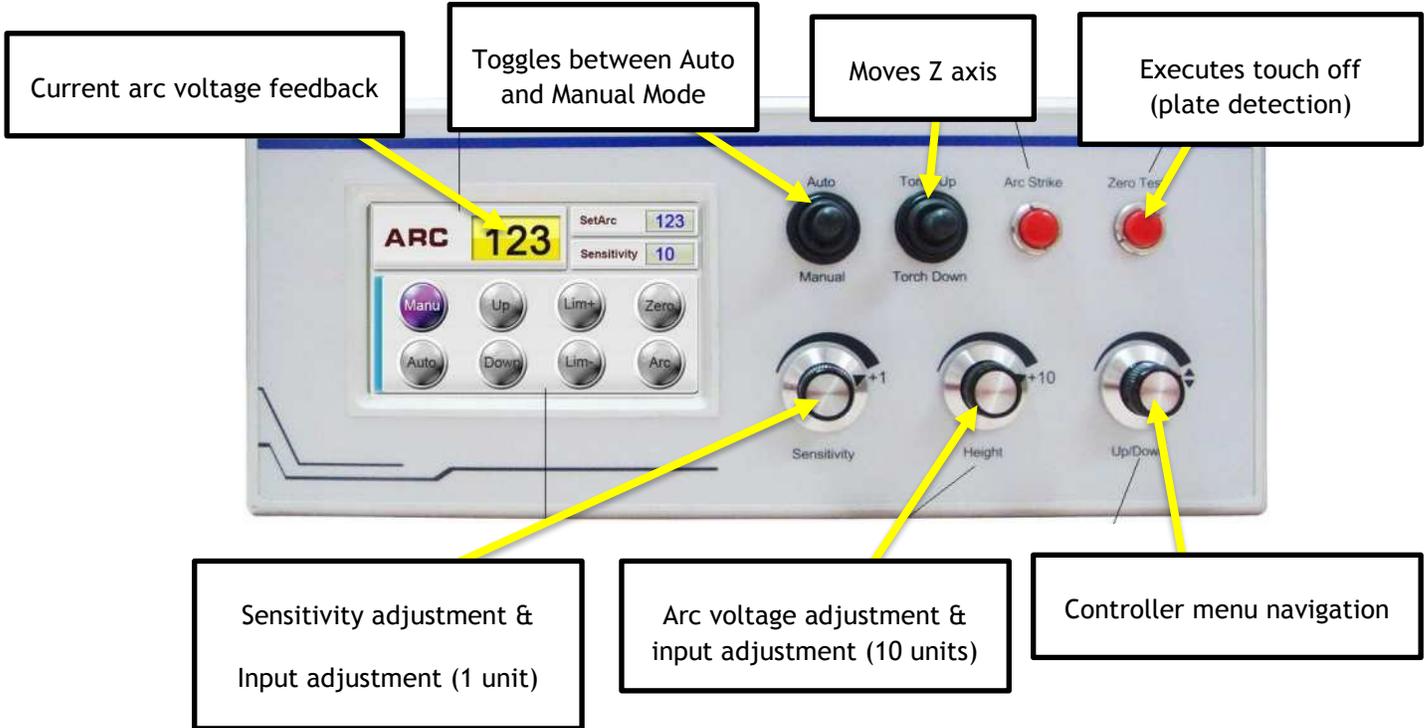
2.2 REAR VIEW



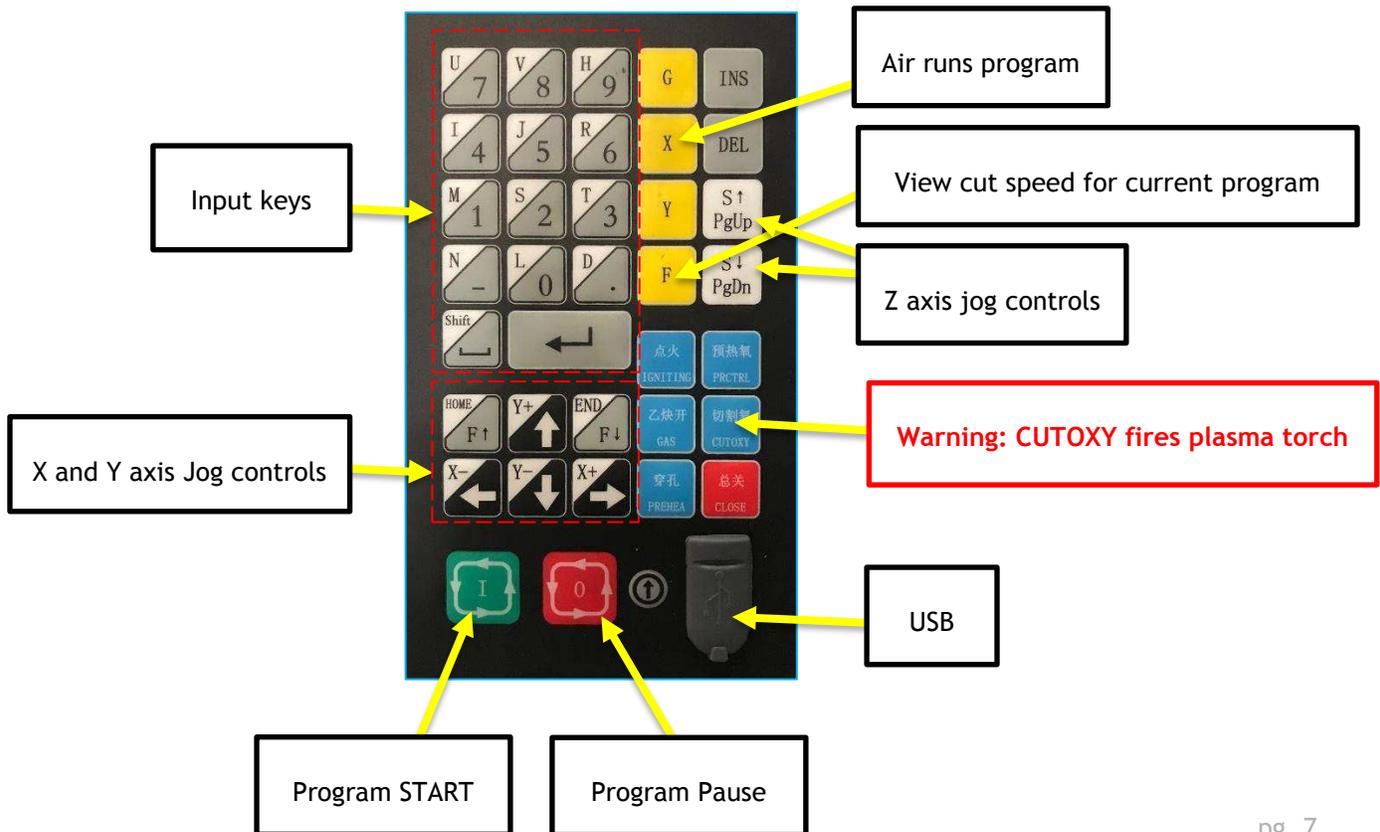
2.3 TORCH HEAD VIEW



2.4 HIEGHT CONTROLLER



2.4 STARFIRE CONTROLLER



3 INSTALLATION

3.1 RECEIVING YOUR MACHINE

Note. It is probable that your machine will be delivered by a third party. Before you unpack your new machine, you will need to first inspect the packing, invoice, and shipping documents, supplied by the driver. Ensure that there is no visible damage to the packing, or the machine. You need to do this prior to the driver leaving. All damage must be noted on the delivery documents and signed by you and the delivery driver. You must then contact the seller, Laguna Tools, within 24 hours.

3.2 WHERE TO LOCATE YOUR MACHINE

Before you unpack your machine, select the area where you will use your machine. There are no hard-and-fast rules for its location, but below are a few guidelines.

1. There should be an area around the machine suitable for the length of job that you will be cutting.
2. Adequate lighting. The better the lighting, the more accurate and safely you will be able to work
3. Solid floor. You should select a solid flat floor, preferably concrete or something similar.
4. Close to power source and ground rod.
5. Adequate air ventilation.

3.3 ELECTRICAL CONNECTIONS

The main power cable and has no plug fitted, as it will be dependent on your installation. Ensure that when installing the electrical supply to the machine, that 220v single-phase is supplied. For the plasma power supply, refer to the manufacture's technical manual for power specifications. It is not possible to recommend a breaker size, as this will be dependent on the specification of the machine that you purchase.

Note: A qualified electrician must carry out the electrical installation.

3.4 PLASMA POWER SUPPLY

Place the plasma power supply and/or remote arc starter at the rear of the frame. Keep the CNC computer controller as far from the power supply and/or remote arc starter as possible. Follow the power supply grounding diagram found in the system manual.

3.5 GROUNDING GUIDELINES

Pilot arc starting generates a certain amount of electromagnetic interference (Called EMI). This is commonly called RF noise. This RF noise may interfere with other electronic equipment such as the CNC controller and other equipment in the vicinity. To minimize the RF interference the following grounding procedures should be followed when installation of the machine is undertaken.

- Drive 5/8 diameter X 10 feet long copper clad steel earth rod as close to the table as possible. It may be necessary to weld a second rod to reach the moisture layer to achieve a proper ground. Follow the attached instructions for proper earth ground rod testing (section 3.6). If multiple ground rods are required to achieve proper grounding keep a minimum distance of 1.1 times the driven length between driven rods.

Note: Keep ground wires as short as possible. Remove any paint, rust or oxide from the connection point. Always use star washers and electrical anti corrosion paste on all connections.

- Create an auxiliary star ground point as needed to connect ground leads from moving points of the table or robot to the main ground. The point should have good metal to metal contact. Connect this star to the main star using #4 AWG minimum.
- Connect the power supply safety ground directly to the main star ground with a minimum 1/0 cable.
- Connect the remote arc starter directly to the main star ground with a minimum 1/0 cable.
- Create a main star ground on one of the table legs/robot base. The main star ground will be the only point where all grounding wires will terminate before the earth ground rod. The point should have good metal to metal contact and provide a sufficient number of ground lead attachment points to eliminate the need to stack lead terminals, see figure 2 below. Connect a minimum 1/0 AWG cable (4/0 is best) from the star to the earth ground rod. Do not connect any other grounds directly to the ground rod.

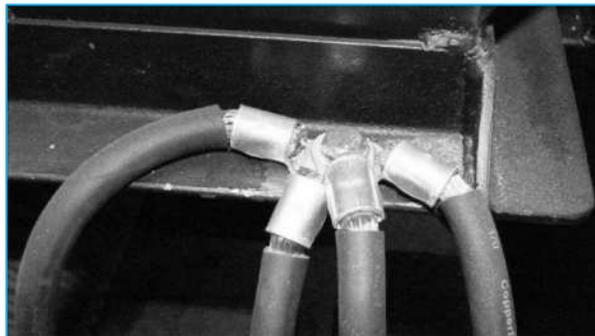
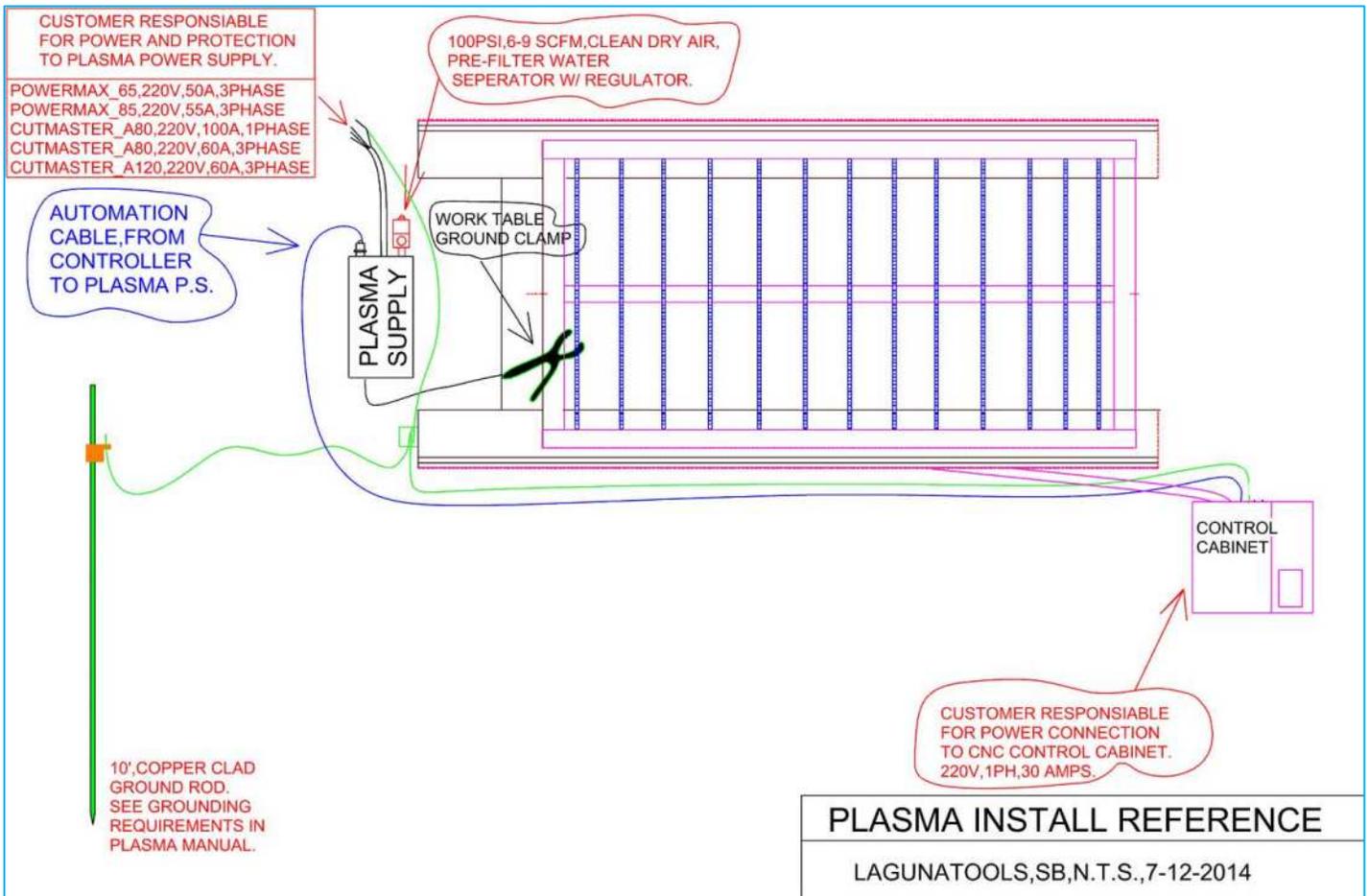


Fig. 2 Avoid stacking terminal lugs



Notes:

Increasing the ground rod length beyond 20-30ft (6.1- 9.1m) does not generally increase the effectiveness of the ground rod. A larger diameter rod which has more surface area may help. Sometimes keeping the soil around the ground rod moist by continuously running a small amount of water into it will work. Adding salt to the soil by soaking it in salt water may also help to reduce its resistance. When you use these methods periodic checking of the ground resistance is required to ensure that the ground is still good.

Keep the torch leads clean. Dirt and metal particles bleed off energy, which causes difficult starting and increases chances of RF interference.

3.6 SHIELDING

Single Shield Method (Good):

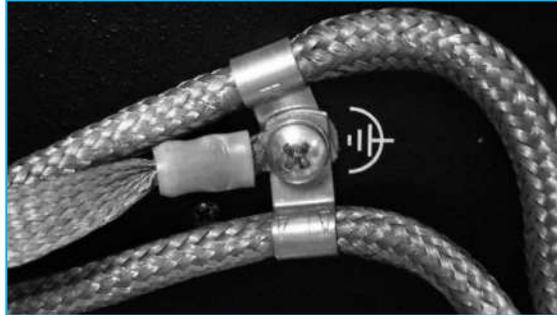
Connect the shield/drain of a shielded cable to ground at the sensitive equipment end and leave the other end of the shield disconnected.

Cover all **non-shielded** cables with a tightly woven braided shield. Slide the shield over the cable leaving enough to slide back over the electrical connectors and terminate only the one end to the

sensitive equipment side ground. Use a metal cable clamp to attach the shield to the ground. **See Figure 3.**

Double Shield Method (Better):

Cover all **shielded** cables with a tightly woven braided shield. Slide the shield over the cable leaving enough to slide back over the electrical connectors. Use a metal cable clamp to attach the shield to the nearest ground at both ends of the cable. **See Below Figure.**



Clamp On Ferrite Cores:

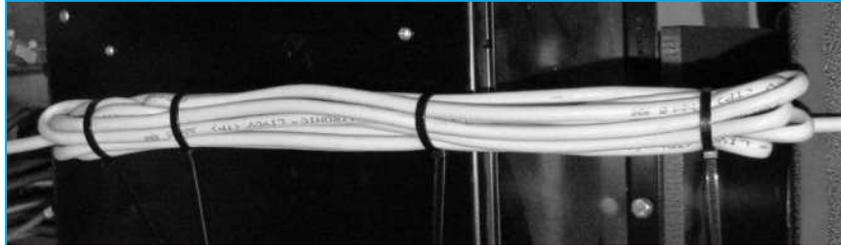
Use a clamp type ferrite core on the following cables:

- Wall Mount Transformers
- RS232 Cables (as an alternative, fiber optic converters will offer the best noise immunity)
- Computer and Motor Controller AC power cord
- Control cables and encoder cables
- I/O cables

Open the ferrites clamp and pass 4 to 10 turns around one half of the core then close and snap the clamp shut. Ferrite cores are not recommended for use with braided shielding.

Other:

- If cables must cross ground wires or at worse case torch leads do so at 90 degree angles.
- Select a power outlet rated to support the devices that will be connected.
- Avoid connecting the cutting table to multiple AC power outlets. Use one outlet with a good surge suppression device and multiple power outlets.
- The Plasma Power Supply may be connected to a different power outlet however it is best if the outlet is common to the same panel as the cutting table.
- Do not coil wires and cables. If you need to clean up the install do so by wire tying the loops of extra cable so the major length of the cable is touching. Remove as much air gap as possible from the cable bunch. **See Below Figure.**

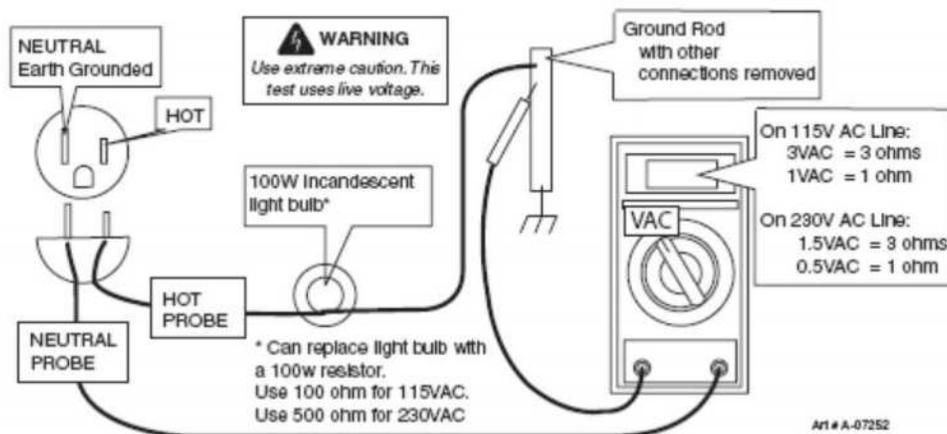


This does not apply to Ground cables, always cut ground wires & cables to minimum required length.

- Route ground cables as far apart from control cables as is possible. Keep cables that run in parallel (i.e. in the same power track) with the ground separated by as much air space or other gas hoses as possible.
- HF (High Frequency) travels on the outside of a wire. Increasing the diameter of the ground wire or using flat braid for ground wire will improve the ability to carry the HF to ground.

3.7 TESTING THE GROUND

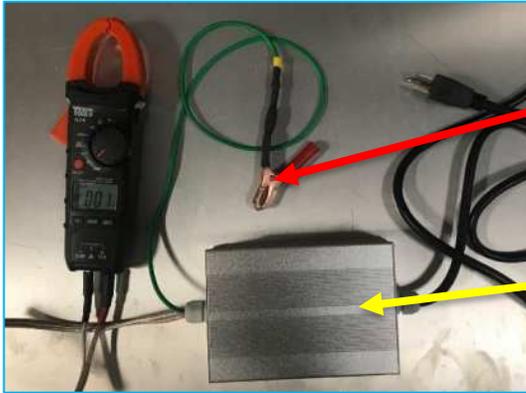
- To test for a proper ground, refer to the following diagram.



Ground Testing

Testing the ground with a Laguna Tools ground tester

1. Tools needed
 - a. Multimeter - to measure AC voltage
 - b. Laguna Tools ground tester



Once the ground tester is plugged into a 110VAC power source, the alligator clip will have electric potential.

Ground tester, based on the above diagram.

WARNING: DO NOT PLUG IN 110VAC PLUG UNTIL ALL CONNECTIONS HAVE BEEN MADE. THE ALIGATOR CLIP WILL HAVE ELECTRIC POTENTIAL.

2. Run a 110V extension cord out to the earth ground rod.
3. Connect the alligator clip to the ground rod.
4. Plug the leads into the multimeter.
5. Set the multimeter to read AC voltage.
6. Plug in the 110V plug into the 110V power source.
7. Record the voltage reading.
8. Ideally, the reading on the multimeter should be 3 VAC for 115VAC or 1.5VAC for 230 VAC line.

WARNING: DO NOT LEAVE GROUND TESTER PLUGGED IN ANY LONGER THAN NEEDED TO RECORD THE VOLTAGE. THE INTERNAL RESISTOR WILL BECOME HOT.



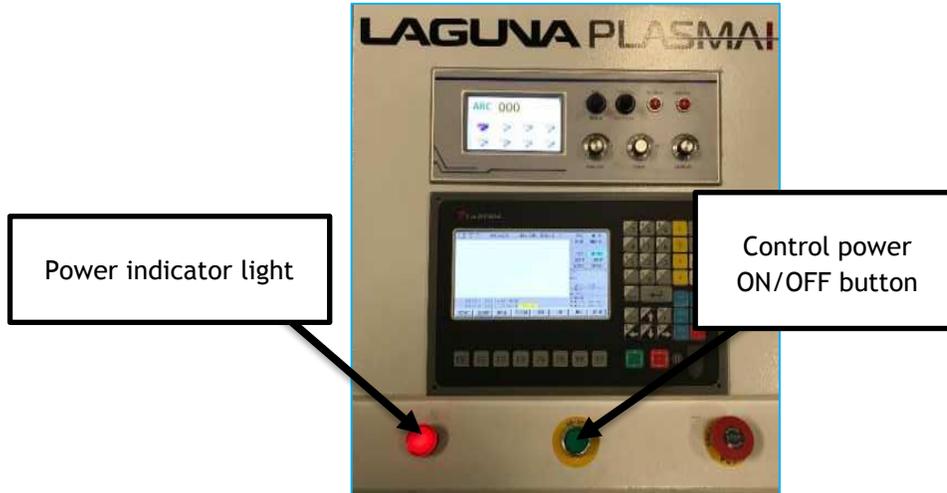
Ways to reduce resistance:

- Salt and water the area around the ground rod.
- Use a larger diameter ground rod to increase surface area.
- Add an additional ground rod.
 - If multiple ground rods are required to achieve proper grounding keep a minimum distance of 1.1 times the driven length between driven rods.
- Refer to the grounding

4 BASIC OPERATIONS AND FUNCTIONS

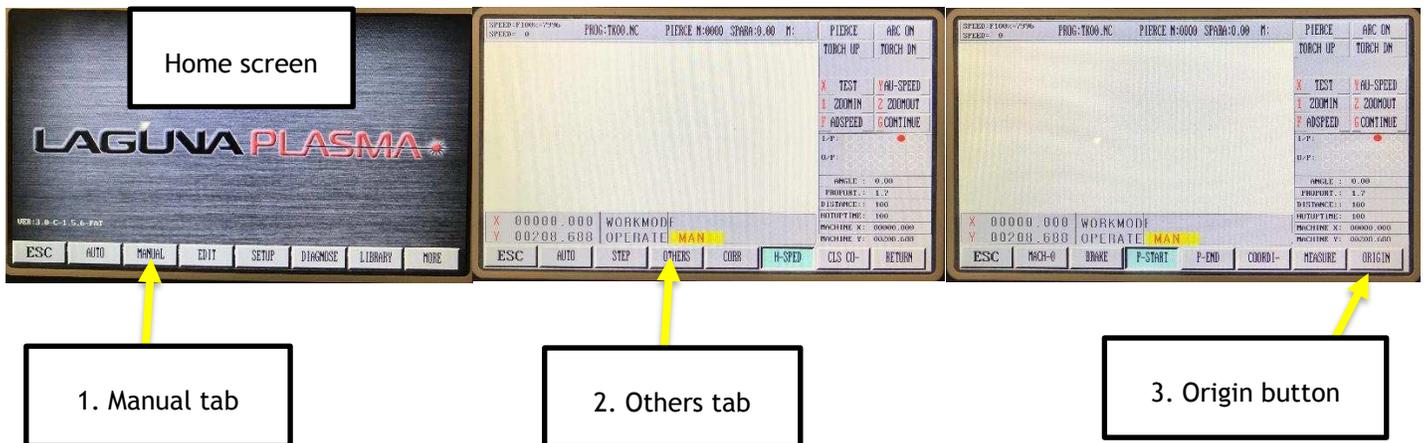
4.1 TURNING ON THE MACHINE

1. Press the power ON/OFF button on the electrical cabinet.



4.2 HOMING MACHINE

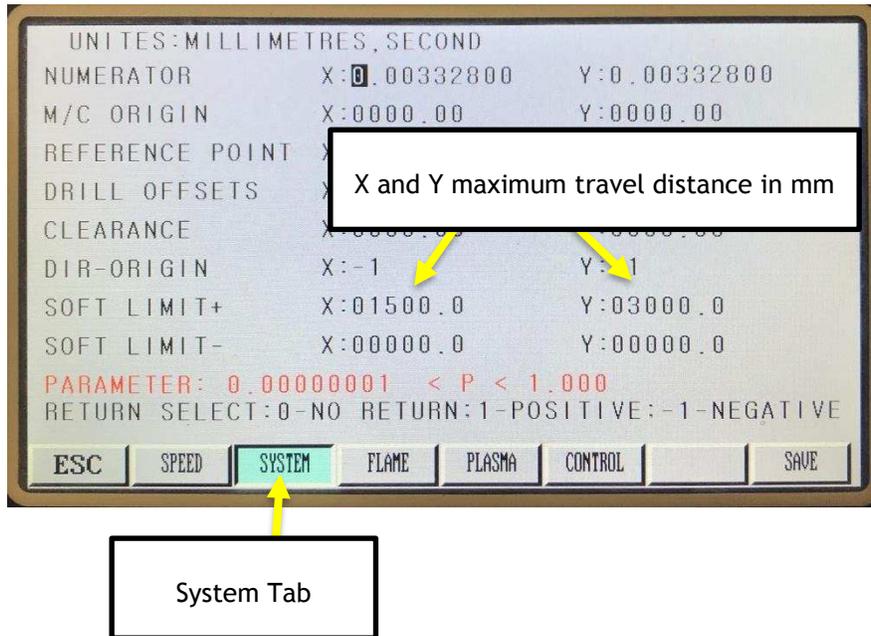
1. Use the F1-F7 hard keys to navigate between screens
2. From the home screen, select the **MANUAL** tab using the F2 key.
3. Select the **OTHERS** tab using the F3 key.
4. Select the **ORIGIN** button – the machine will begin the homing procedure.



4.3 MACHINE LIMITS

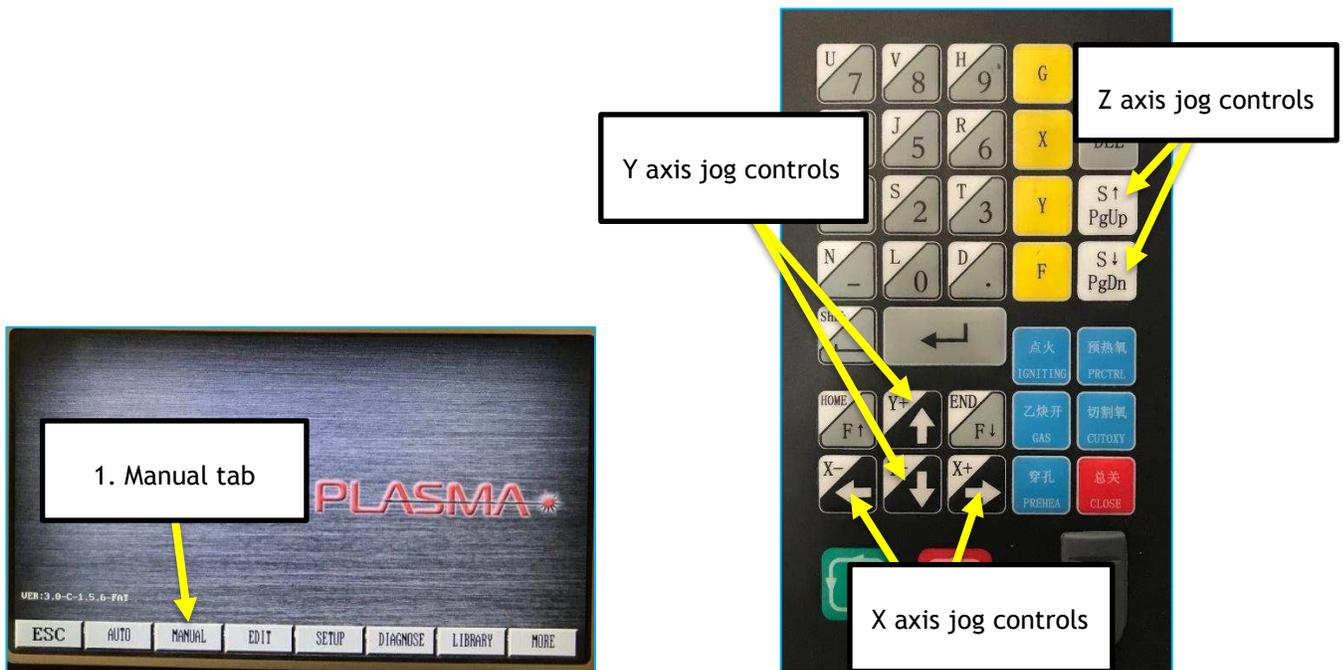
- The machine uses software limits to prevent the machine from over traveling on the X and U axes.

- To view or change the limits
 - From the home screen, select the **SETUP** tab by pressing the F4 key.
 - Select the **SYSTEM** tab.



4.3 JOGGING THE MACHINE

- Use the F1-F7 keys to navigate between screens
- From the home screen, select the **MANUAL** tab using the F2 key.
- Use the keypad buttons to jog the X and Y axes.



4.4 LOADING A PROGRAM FROM USB

1. Plug in the USB into the USB port on the control panel.
2. Home screen → Edit → USB → Load → Copy
3. To view the program
 - a. Home screen → Edit → Load → View

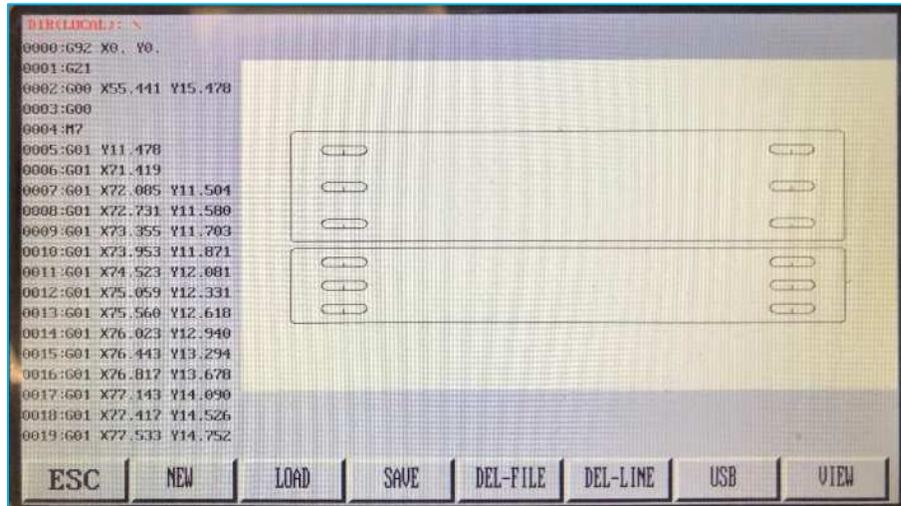


Figure 1. Screen shot of program view.

5 QUICK START

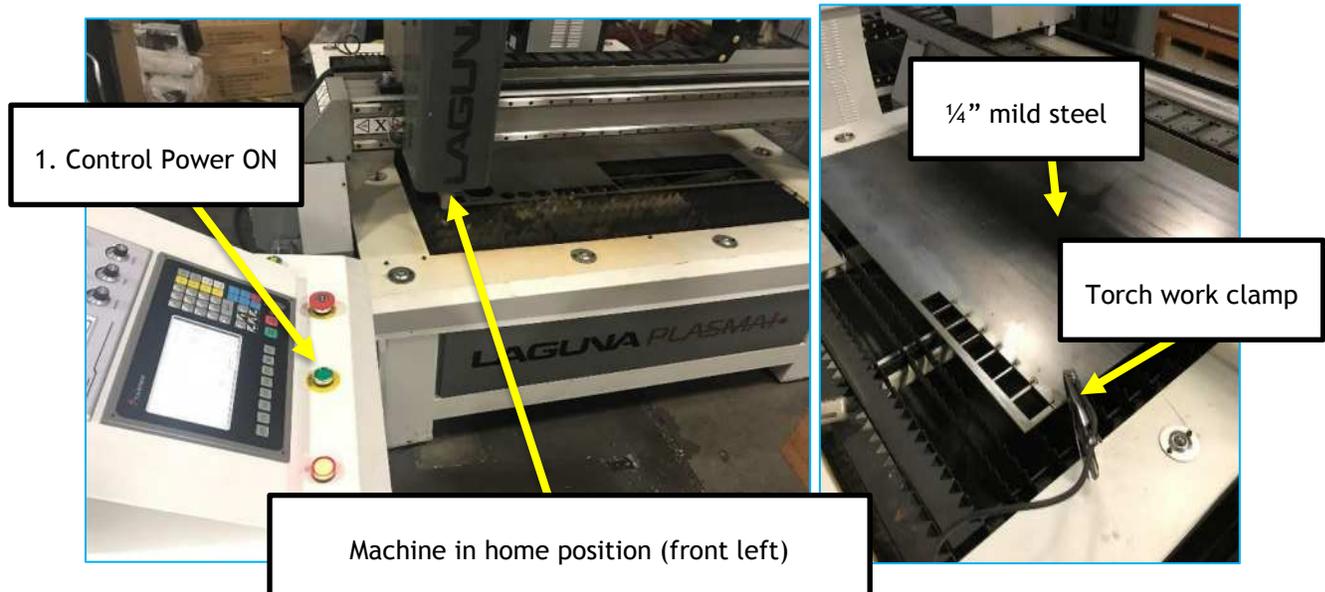
This section assumes the torch and machine installation has been completed (section 3).

Job specifications:

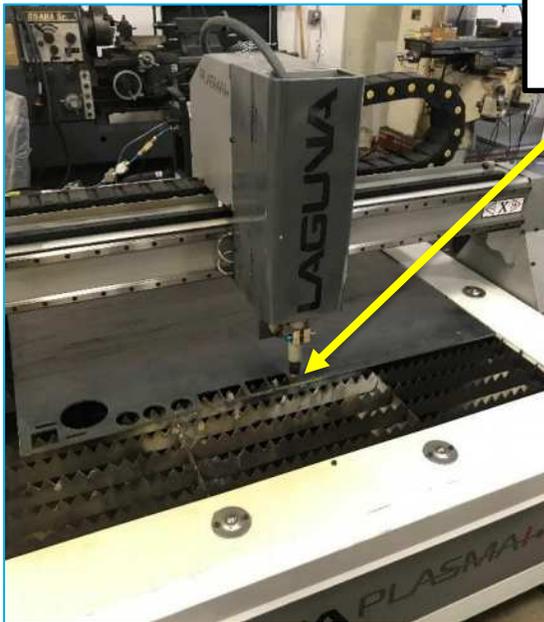
- Material - 1/4 " mild steel
- Torch - Hypertherm Powermax85

5.1 PREPARE THE MACHINE

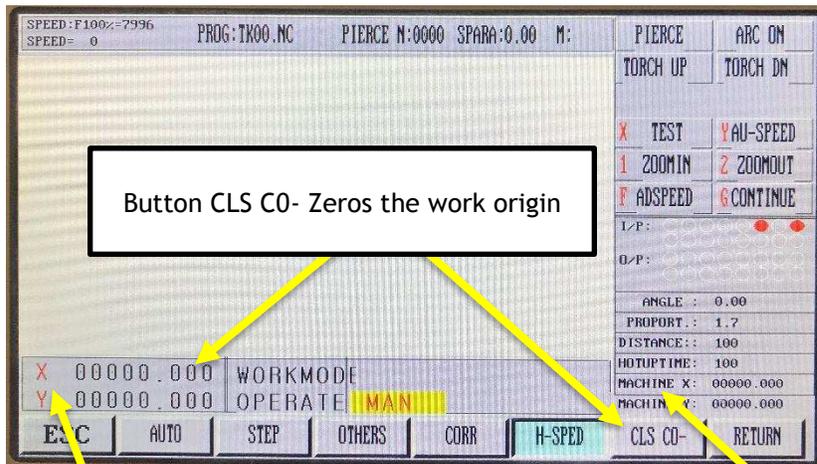
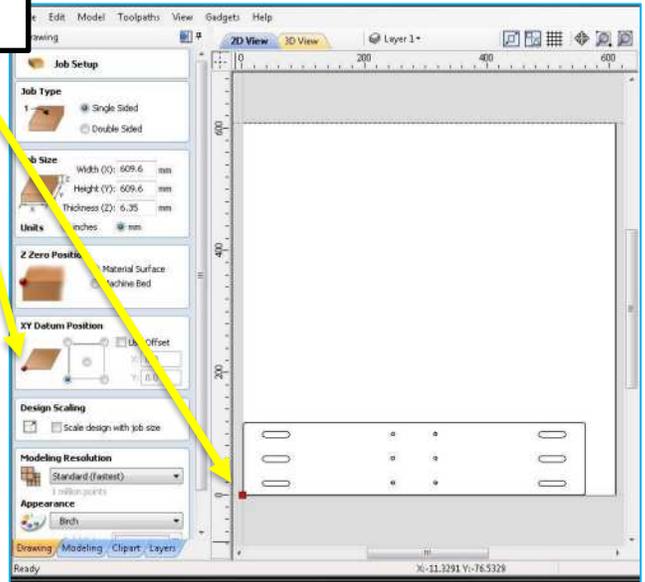
1. Verify the machine is grounded (section 3.5)
2. Turn on the machine (section 4.1)
 - Home the machine (section 4.2).
 - Manual -> Others -> Origin
3. Load material onto bed.
4. Secure torch work clamp to work piece if possible, or to the grates.



5. Jog the machine to the starting position using the jog controls (section 4.3)
6. Zero the reference origin
 - Home screen → Manual tab → CLS CO- (see below)
 - This will set the machines current position as the reference origin.
7. The reference origin is determined when the program is created.



Work origin



Button CLS CO- Zeros the work origin

Work coordinates

Machine coordinates

5.2 PREPARE THE TORCH

1. In the torch operators' manual, look up the cut chart for the job. In this case it's ¼" mild steel, 65AMPS.
 - a. What amperage do I use?
 - i. Generally, you want an amperage such that the job material thickness falls into the midrange of the cut chart. Try to avoid the extremes of the cut chart.

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
16GA	0.06	0.15	250	0.1	260	123	294	121
10GA					190	125	224	123
3/16 in				140	126	168	125	
1/4 in		0.5	90	127	116	127		
3/8 in		0.7	45	130	62	129		
1/2 in		0.18	300	1.2	30	135	40	132
5/8 in		0.24	400	2.0	23	138	26	136
3/4 in		Edge Start			15	141	19	141
7/8 in		Edge Start			12	143	14	143
1 in		Edge Start			8	145	10	145

2. Verify the correct consumables for the selected amperage, and assemble the torch head.
 - a. Look for excessive wear on the consumables, replace as needed.
 - b. Match part numbers for each consumable.

TORCH SETUP

65 A shielded consumables

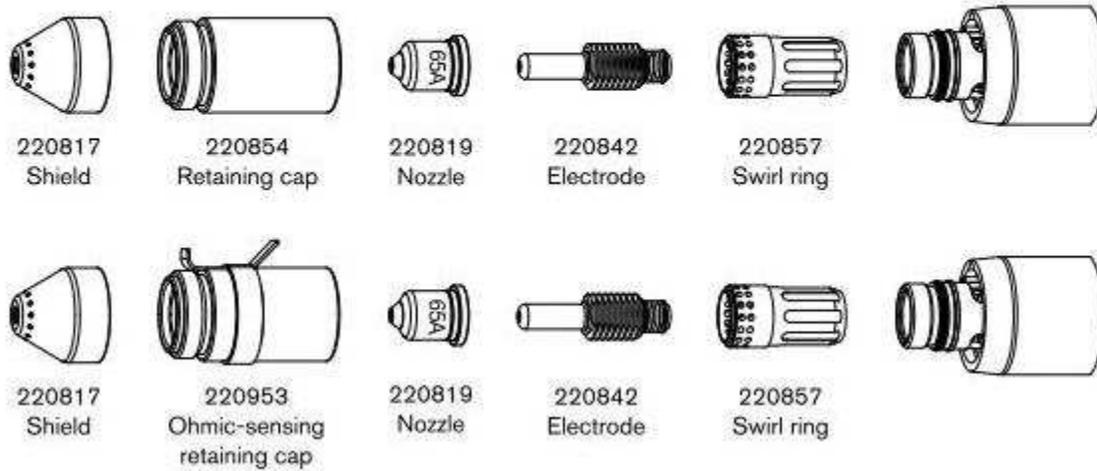
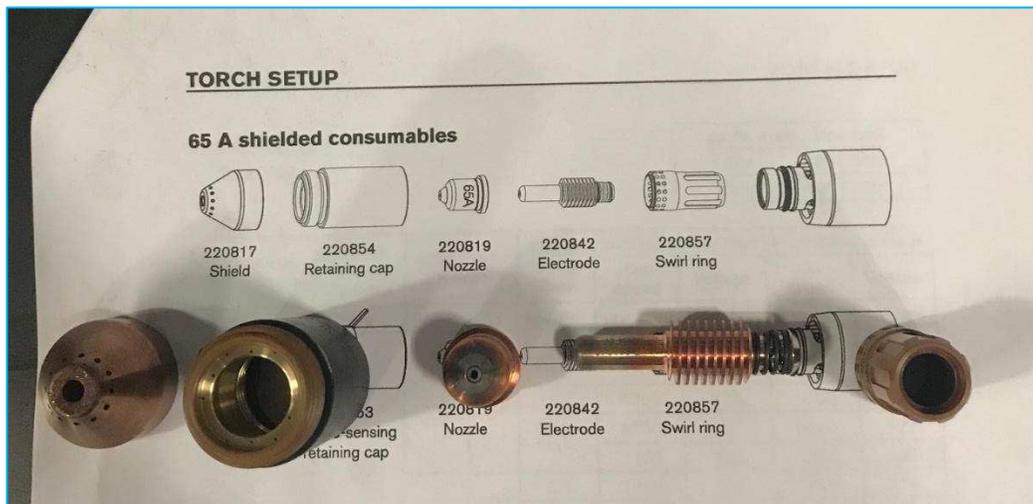
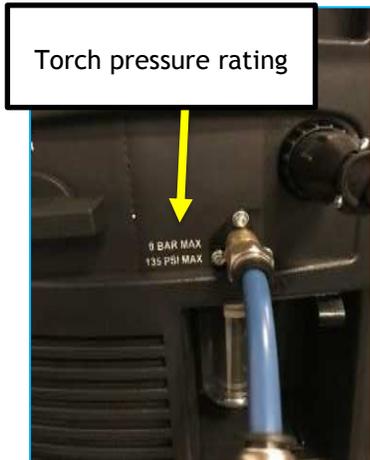


Figure 2. 3-32 powermax85 operators manual.



3. Check air pressure at the torch, as shown below.
4. Turn on the plasma torch unit.
5. Set torch amperage using the amperage adjustment knob.
6. Verify operating mode switch is set to non-continuous piolet arc.



Torch pressure rating



Torch pressure regulator



non-continuous pilot arc mode

Work lead to material

Operating mode switch
 The operating mode switch can be set in one of four positions:

- Continuous pilot arc. Cuts expanded metal or grate.
- Non-continuous pilot arc. Cuts or pierces metal plate. This is the standard setting for normal drag-cutting.
- Gouge. Gouges metal plate.
- Torch lock. Same as the non-continuous pilot arc mode except the torch is locked in the ON position when you release the trigger during a cut.

7. Understand the plasma's duty cycle, and plan accordingly.

With a Powermax85:

- At 85 A, the arc can remain on for 6 minutes out of 10 minutes without causing the unit to overheat (60% duty cycle).
- At 74 A, the arc can remain on for 8 minutes out of 10 (80%)
- At 66 A, the arc can remain on for 10 minutes out of 10 (100%).

If the duty cycle is exceeded, the power supply overheats, the temperature fault icon appears in the status screen, the arc shuts off, and the cooling fan continues to run. You can not resume cutting until the temperature fault icon disappears and the fault LED goes off.

5.3 SET CUT PARAMETERS

Cut parameters are determined by the cut chart.

English

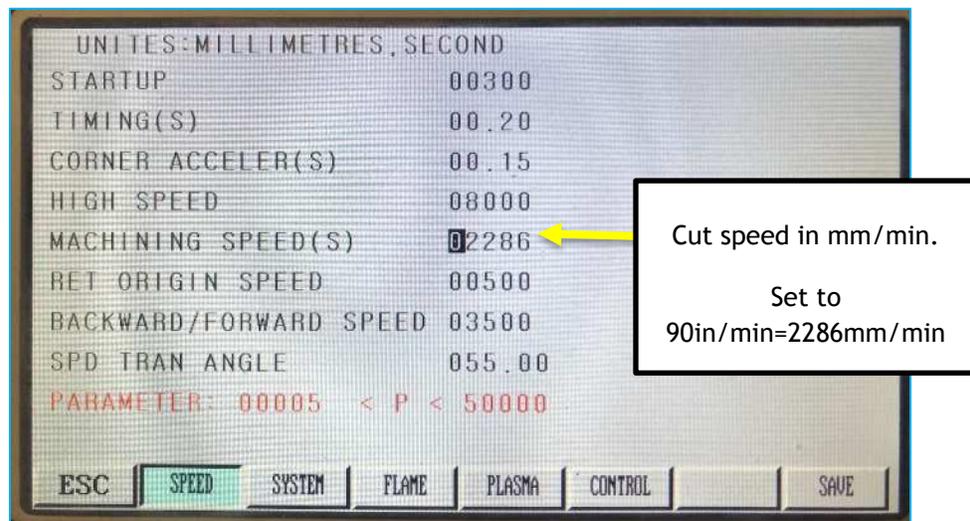
Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
16GA	0.06	0.15	250	0.1	260	123	294	121
10GA					190	125	224	123
3/16 in				140	126	168	125	
1/4 in				90	127	116	127	
3/8 in		45	130	62	129			
1/2 in		0.18	300	1.2	30	135	40	132
5/8 in		0.24	400	2.0	23	138	26	136
3/4 in		Edge Start			15	141	19	141
7/8 in					12	143	14	143
1 in					8	145	10	145

powermax65/85 Operator Manual

3-33

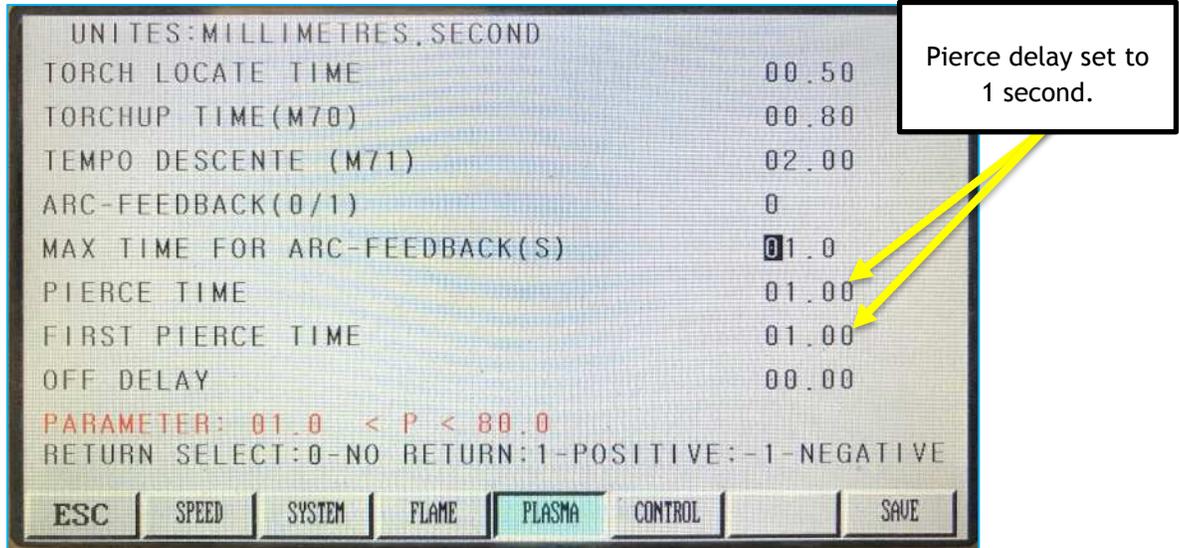
1. Adjust cutting speed (Machining speed)

- a. Home screen → Setup-> Speed



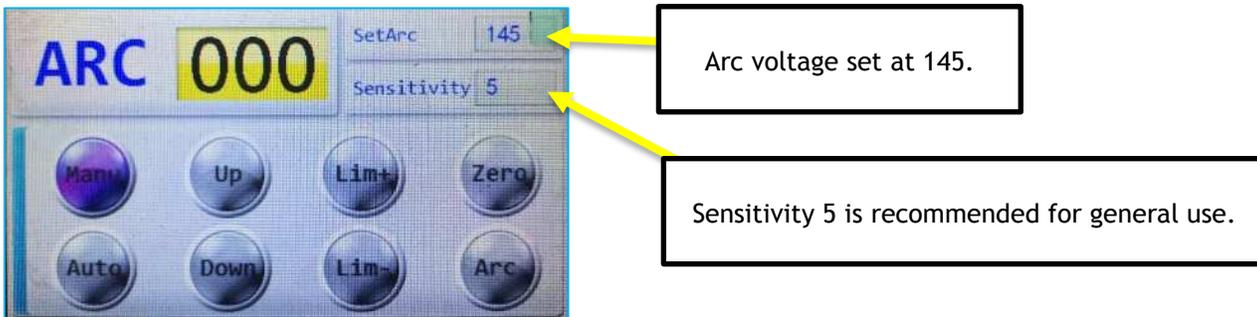
2. Set pierce delay

- a. Home screen → setup → plasma



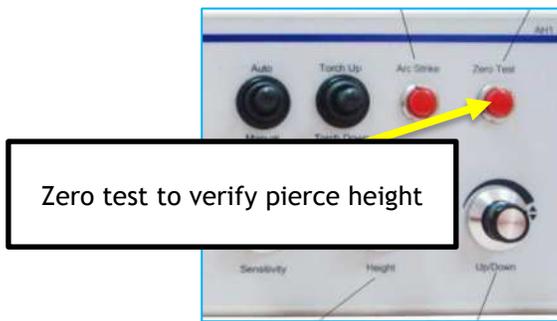
3. Set arc voltage and sensitivity

- a. **Arc voltage** -The arc voltage value determines the distance between the torch and the plate.
 - i. Set arc voltage value according to the cut chart.
 - ii. **The larger the arc voltage the further away from the plate the torch will be**
 - iii. In auto mode, during cutting, the arc voltage can be adjusted.
- b. **Sensitivity** – Controls the height controller’s responsiveness.
 - i. If the value is smaller, then the torch height adjustment response is slower, vice versa.



4. Set pierce height

- a. Press the zero test button.
 - i. The Z-axis will lower until the torch contacts the plate, at which point it will retract to a pierce height.
 - ii. The pierce height is set by the position parameter.
- b. **Position (location height)**: The torch moves down and touches the plate, then the torch moves up to the set height, unit: mm



5.4 TEST RUN THE PROGRAM

1. Load the program (section 4.4).
 - 1.1. Home screen → Edit → Load → select job file
 - 1.2. Home screen → Auto → View
2. Select the starting point.
 - 2.1. Press the STARTP key until the start point is in the bottom left corner as planned.

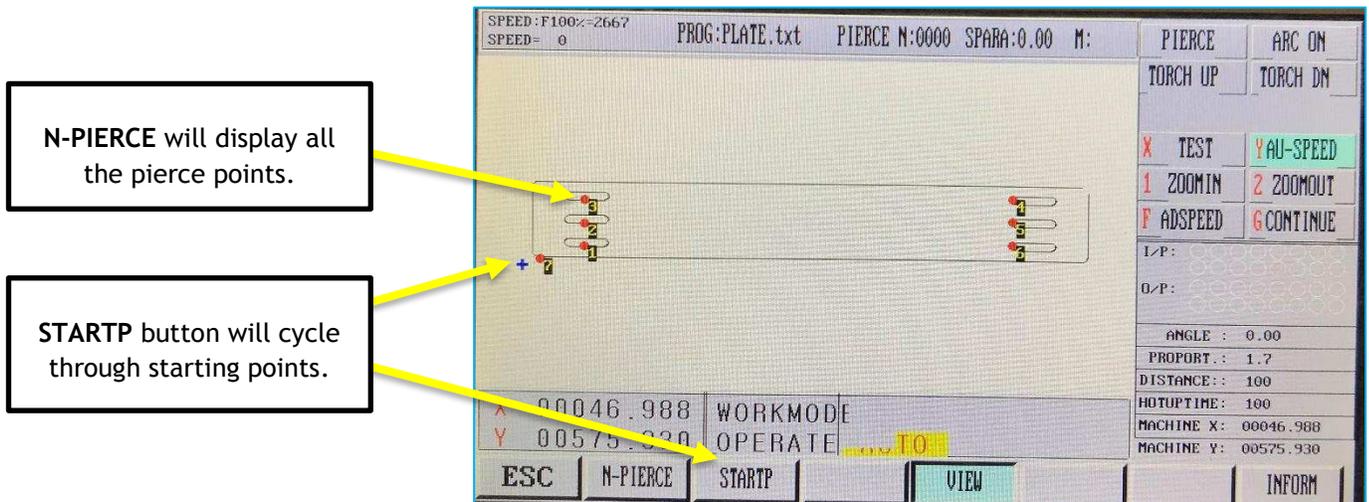
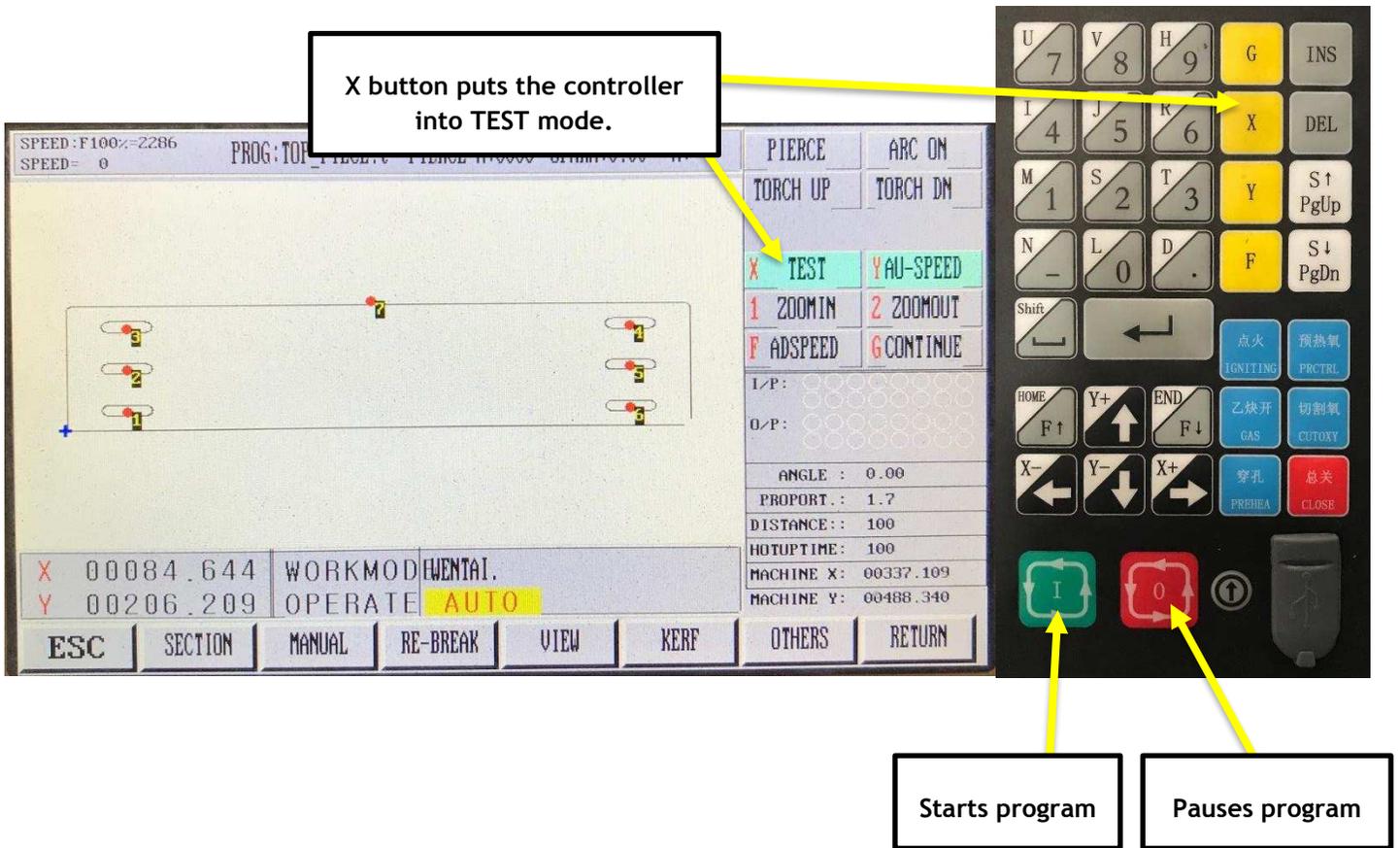


Figure 3. Screen shot, in auto mode and view.

3. Verify the pierce points are as expected.
 - 3.1. Press the N-PIERCE key to display pierce points.

4. While still in Auto mode, press the X button to enter TEST mode.
 - 4.1. Test mode will run the program without touching off or igniting the torch.
5. Air run the program by pressing the green I button.
 - 5.1. Look for cutting over voids, adjust start point if needed.



5.5 RUN THE PROGRAM

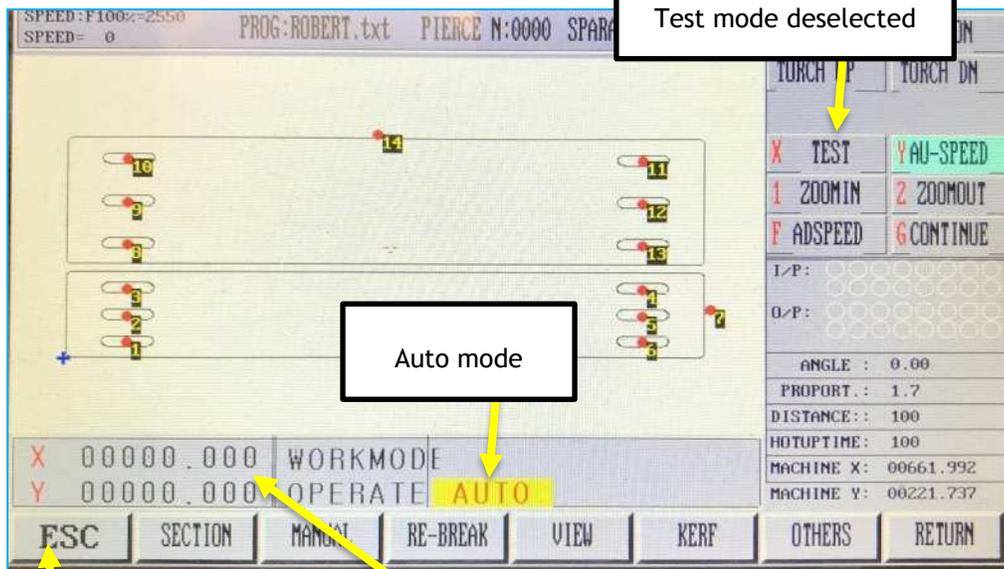
1. Verify PLC is in auto mode.
2. Deselect test mode.
3. Verify start and pierce points.
4. Press the green **I** button to run the program.



Auto mode toggled



Test mode deselected



Auto mode

Aborts program

Torch positioned at reference origin

Start program

Pauses program

5.6 CUT QUALITY ASSESMENT AND ADJUSTMENTS

Understand and optimize cut quality

There are several factors to consider in cut quality:

- Cut angle — The degree of angularity of the cut edge.
- Dross — The molten material that solidifies on the top or bottom of the workpiece.
- Straightness of the cut surface — The cut surface can be concave or convex.

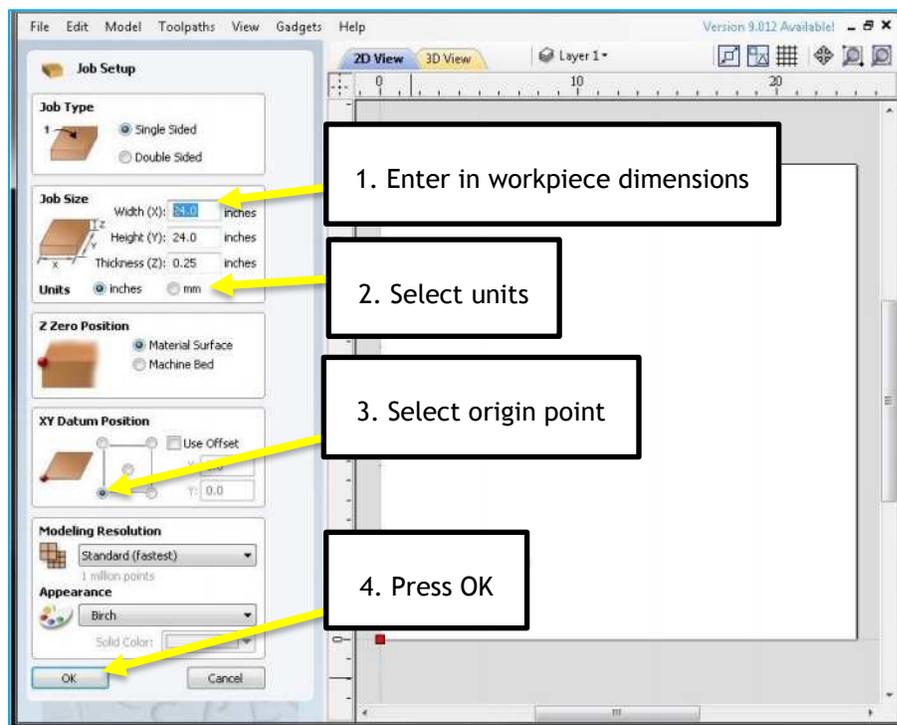
6 CREATING A CUT FILE WITH VECTRIC SOFTWARE

6.0 SOFTWARE

- Vectric's Aspire, version 9.007, V-carve is also applicable for this walkthrough.

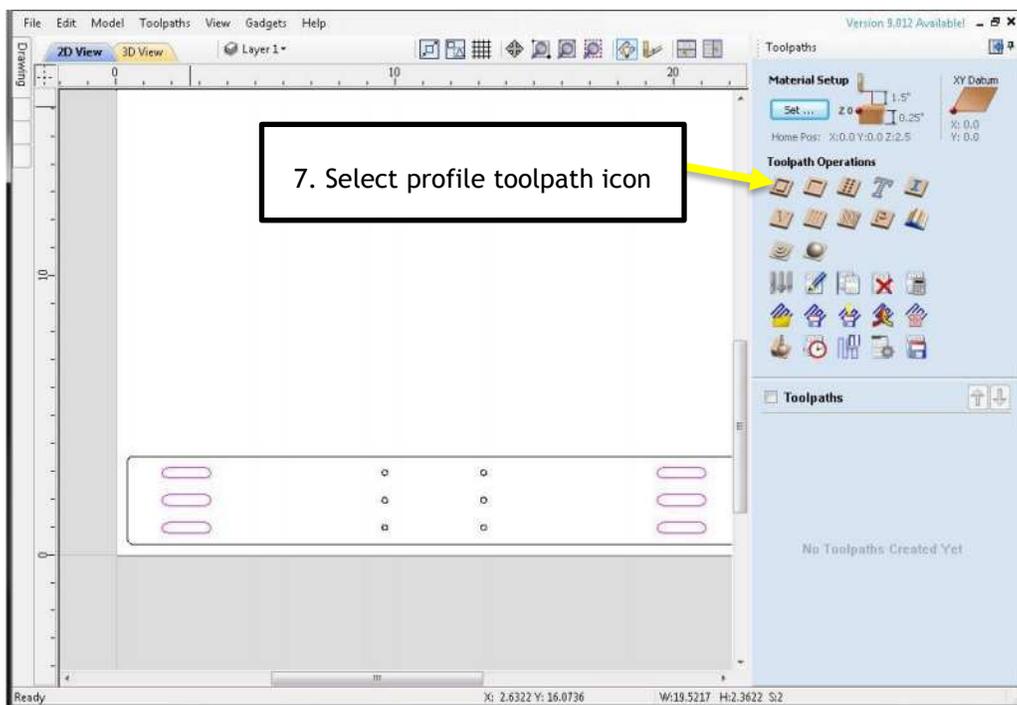
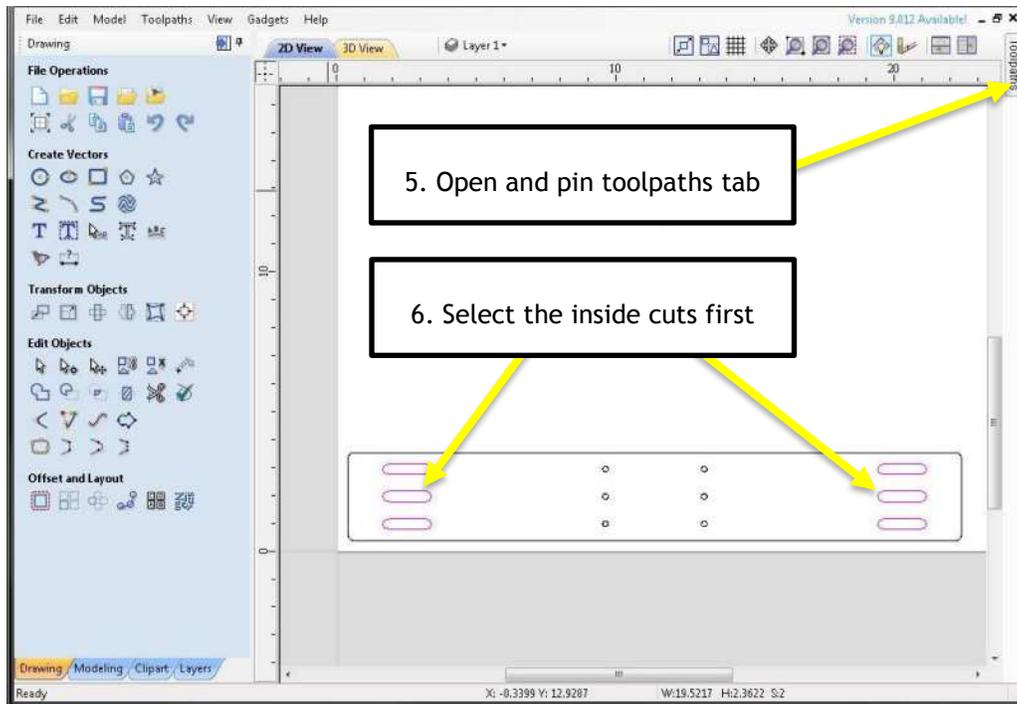
6.1 JOB SETUP

- Open Aspire.
- File→ New.
- Enter in job parameters from top to bottom as seen below.



6.2 CREATE TOOL PATH

- Sketch your part using the drawing tools, or import a pre-existing drawing.
- Open the toolpath tool bar.



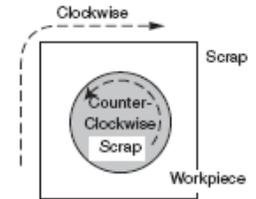
9. Create a new tool, using the endmill template.

8. Not applicable, leave cut depth at zero.

10. Plasma kerf diameter, as listed in the cut chart.

11. These settings are not applicable to plasma cutting. Speed settings are set at the machine controller. Leave default parameters.

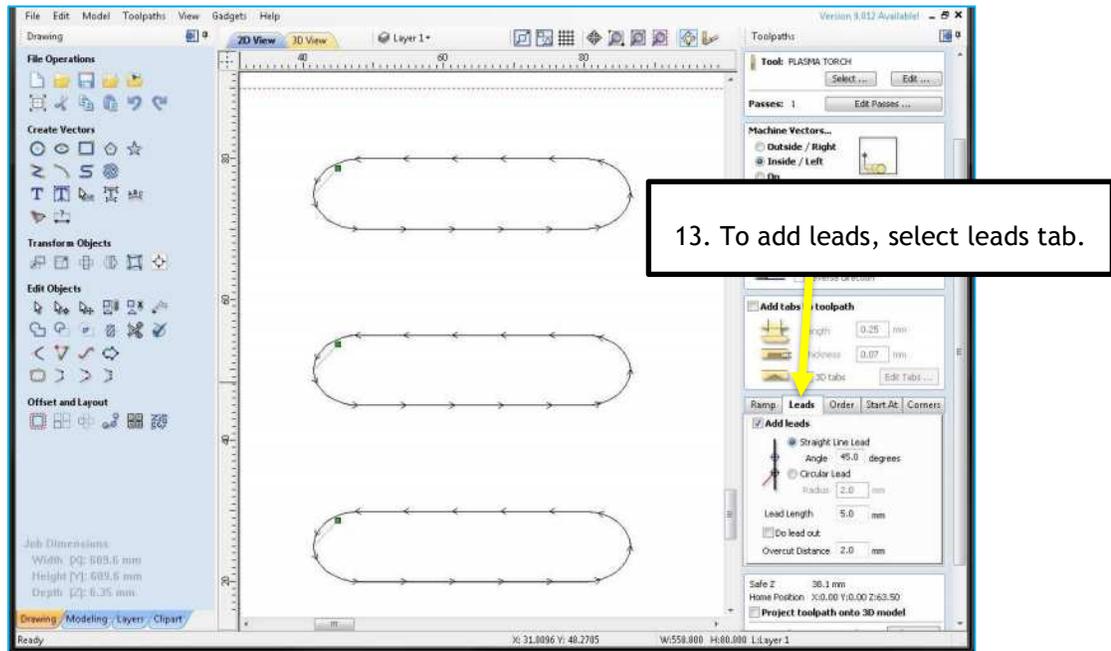
12. Select a cutting direction, applying the following principles.



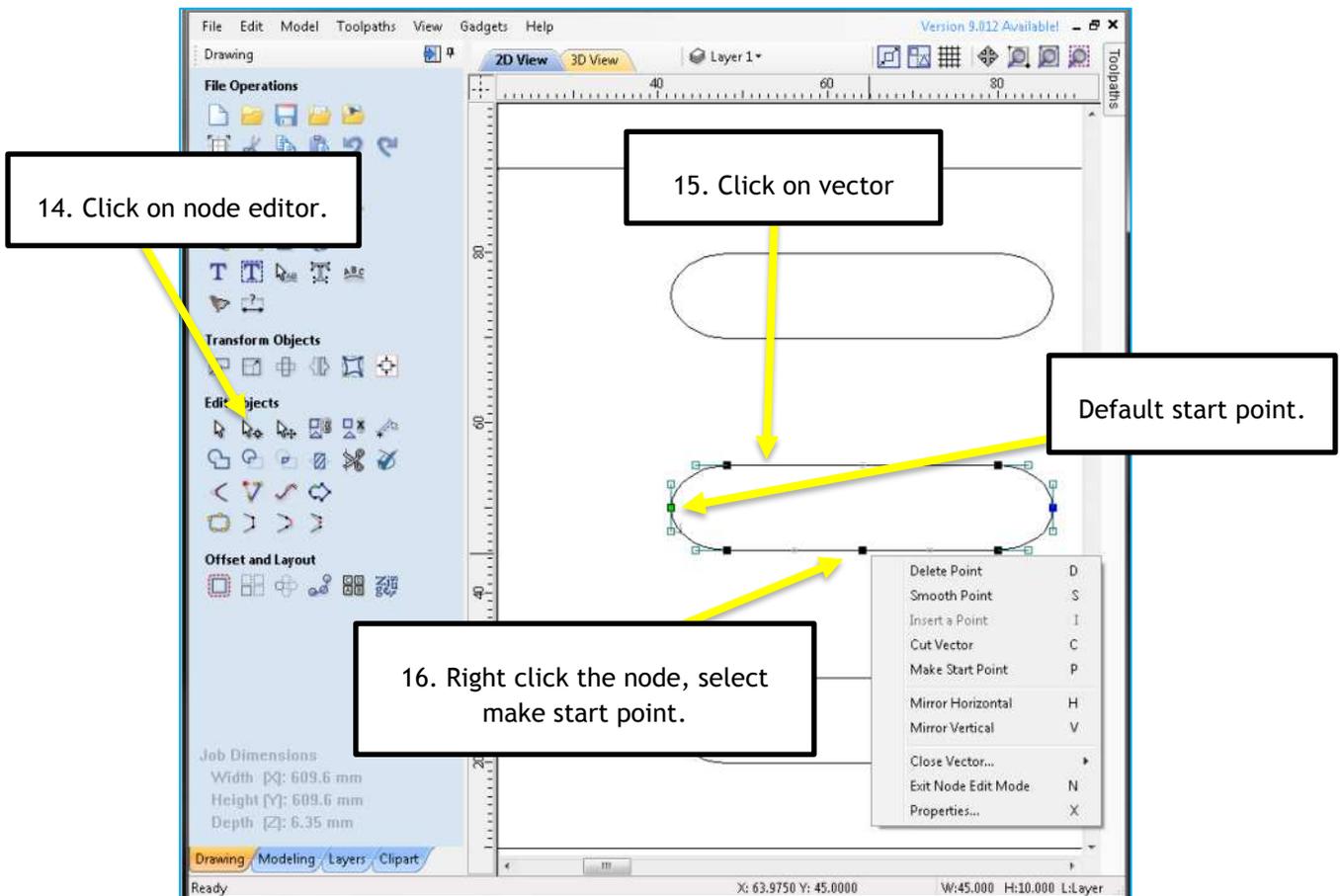
See section 7 for more details

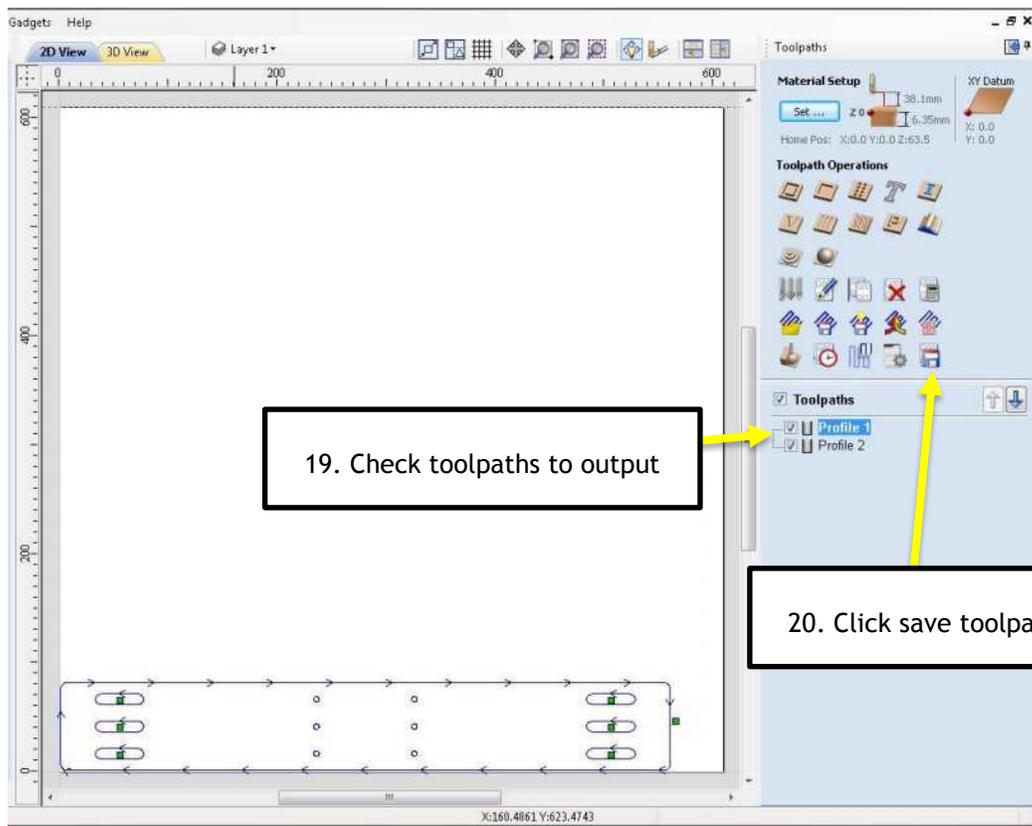
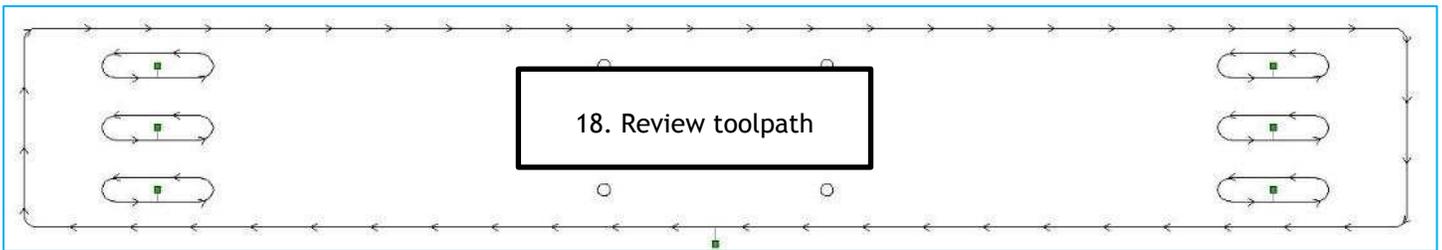
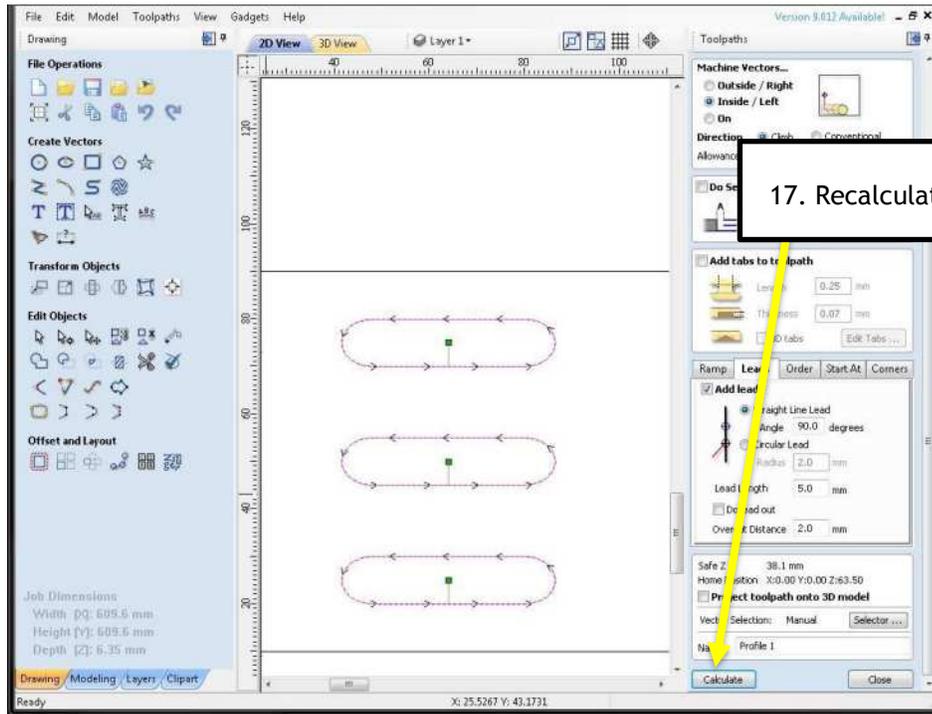
Notes:

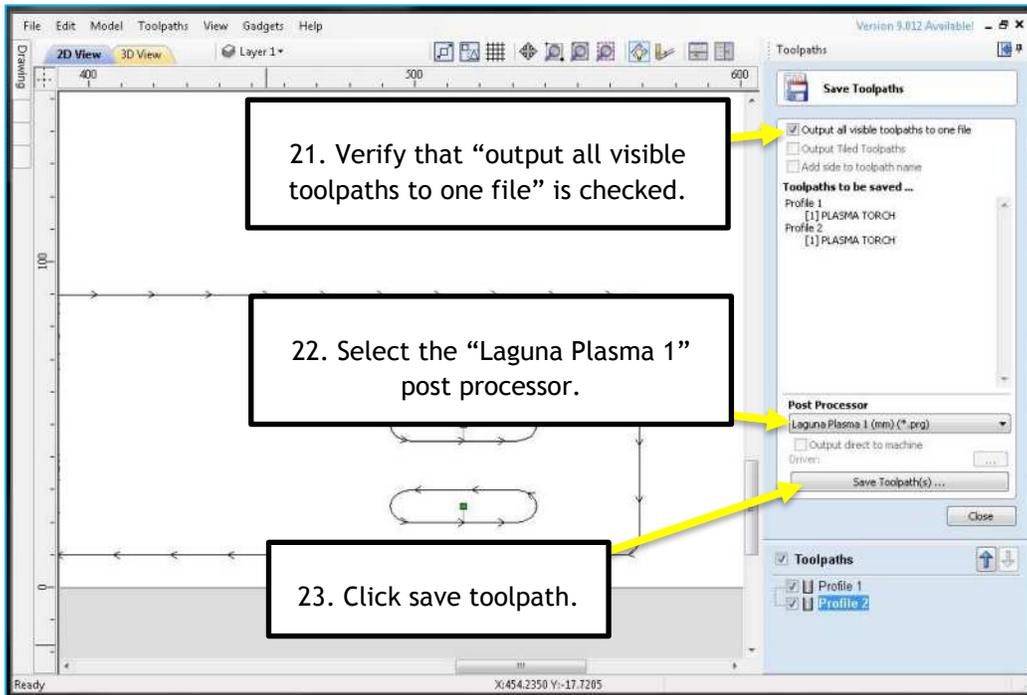
- Tool Diameter is defined in the Plasma Cut Charts. Look up your amperage and material thickness for the plasma flame diameter (Kerf)
- Cutting parameters have no effect on Plasma cutting because the Z axis moves are handled in the machine controller. Vectric however needs these fields filled in, so use what's shown to satisfy the software.
- Leads are added to have the arc stable before entering the finished parts cutting area. .3 to .5 of an inch depending on your application and material.



- Leads are attached to the start point node. To change where leads are, relocate start point as shown below.







7 CUT QUALITY OPTIMIZATION

7.1 CUT CHARACTERISTICS

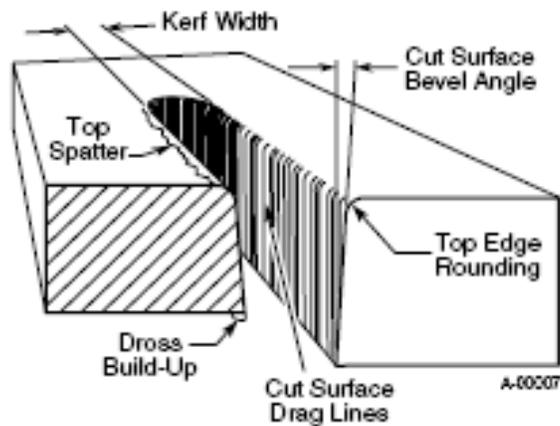
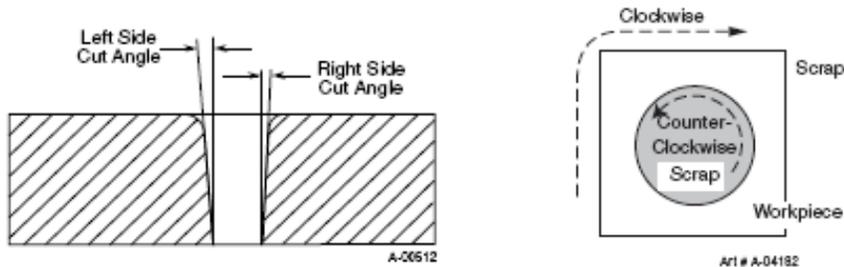


Figure 4. Plasma terminology

- Cut Surface – Cut surface is influenced by process and positioner precision more than by other parameters. For smoothest cut face on different materials, use: mild steel – oxygen plasma

Metal	Process
mild steel	oxygen plasma
stainless < 3/4"	nitrogen / WMS
stainless > 3/4"	H35 / nitrogen
aluminum < 3/4"	nitrogen / MS
aluminum > 3/4"	H35 / nitrogen

- Direction of cut – The plasma has a clockwise swirl as it exits the torch tip. Considering the direction of torch travel, the right side of the cut will always show less bevel and top edge rounding than the left side. Program cuts so that the right side will be on the finished part and the left side will be scrap.



- Top edge rounding – Caused by the heat of the plasma arc at the top surface of the cut. Proper torch height control can minimize or eliminate top edge rounding. Excessive top edge rounding is often a sign that torch cutting height should be lower.
- Top spatter – Top spatter is caused by fast cutting or by too high a torch height setting. Reducing cut speed or lowering torch cutting height will reduce top spatter. Top spatter is easy to remove.
- Bottom dross – Molten metal may build up on the bottom of the plate. Faster cut speeds reduce bottom dross as less material is melted. Bottom dross that is easy to remove is an indication of slow cutting speed. Bottom dross that is difficult to remove or requires grinding is an indication of too fast cut speed.

- Kerf – Kerf width is specified in the cut charts and can be calculated into cut programs. The kerf width is related to tip orifice size and higher current cutting will produce a wider kerf. Higher torch height will also result in a wider kerf.
- Bevel angle – Precision cut processes produce bevel angle in the 0-3° range. Conventional plasma cutting will produce larger bevel angles. Proper torch height control will produce the smallest bevel angle, as well as improved kerf width and minimal top edge rounding. A slower cut speed can be used when cutting circles and corners to reduce bevel.

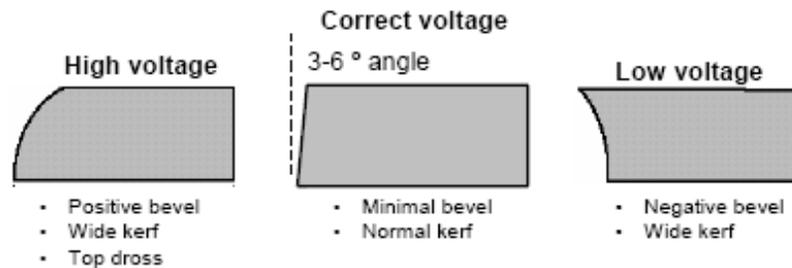


Figure 5. Effect of height control settings - General purpose cut

- Nitride contamination – Air plasma cutting will produce nitride contamination of the cut face on carbon steel and stainless steel. Nitride contaminated surfaces will require grinding before welding to eliminate weld porosity. The depth of the contamination will be close to the Heat Affected Zone, between .005 and .010" in depth.
- Nitride contamination can be eliminated by using a process other than air plasma; oxygen plasma for carbon steel, H35 or nitrogen/WMS for non-ferrous materials.
- Cut speed – Cut charts specify a cut speed that will produce high quality cut performance. Any plasma system can cut at faster or slower speeds, but cut performance will be affected. Cut speed should be reduced for corners and tight curves to reduce bevel and corner rounding.
- Optimum cut speeds produce a trailing arc which will be visible in the slight arc lines visible in the cut face. Arc lines are useful for evaluating cut speed on mild steel, but less so for aluminum and stainless steel. Arc lines that trail at less than 15° indicate that cut speed is in the optimum range when air or oxygen plasma processes are used. Optimum cut quality in precision cutting processes will result in arc lines that are near vertical. A slow cut speed may show arc lines that angle forward and a fast cut speed will show arc lines at a sharper angle relative to the top of the plate.

7.2 PIERCING

Piercing causes the molten metal to form a puddle on top of the plate. On thicker plate, pierce height is calculated to keep the torch away from the plate so that the molten metal does not adhere to the consumable parts and shorten parts life. Hold pierce height as the cutting table starts movement to allow the torch to clear the pierce puddle before moving to cut height. Using the Inova height controller, this is done using the Set Pierce Time function on the edit screen.

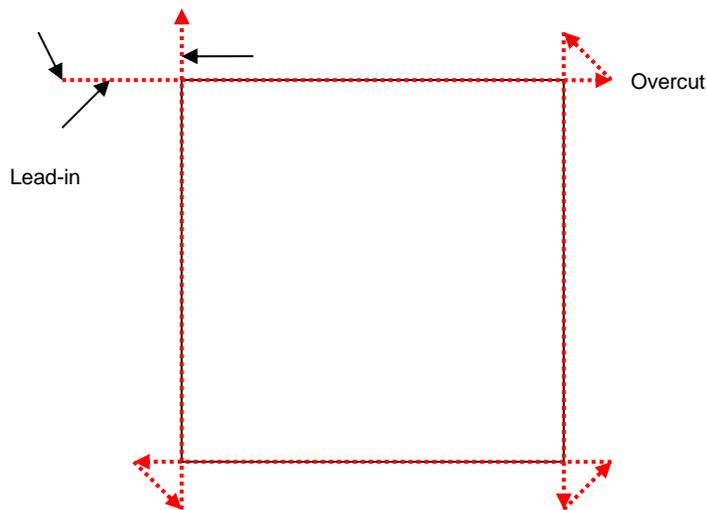
7.3 LEAD-IN AND LEAD-OUT

Lead-in and lead-out should be calculated to allow the torch to move to cut height before starting the final piece contour of the cut and to move away from the final piece before beginning end of cut current ramp down.

7.4 CORNERS

The cutting arc normally trails the torch tip orifice. When the torch makes an abrupt change in direction this trailing arc cannot change direction as quickly at the bottom of the cut as at the top of the cut. This results in undercutting of sharp corners. 2 techniques can be used to minimize this effect.

- Use cut-outs – Overcut past the corner of the shape, then return and cross over the cut line to achieve a square corner. Triangular or looped overcuts are commonly used.



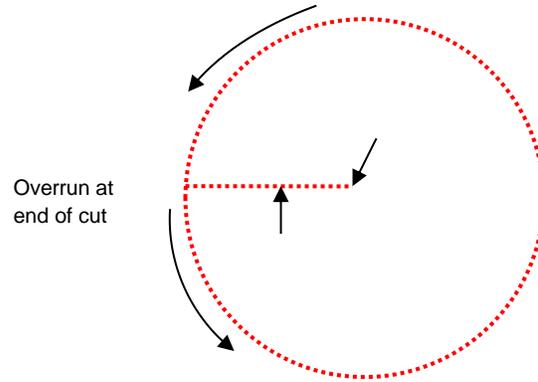
7.5 CUTTING CIRCLES

Circle cutting demands precise motion control and circle cut quality will vary as the circle diameter approaches the thickness of the plate. In general, a circle that is equal in diameter to the thickness of the plate being cut is the minimum circle diameter possible. Cut quality will decrease markedly when the circle diameter is less than 1.5 times the thickness of the plate being cut.

For maximum circle cut quality:

1. Slow down cut speed. Smaller circles may require a cut speed that is 60-50% of the speed specified in system cut charts. A slower cut speed will eliminate trailing arc and allow the arc to cut at closer to 0° of bevel.
2. Maintain constant cut height through the circle. This may require locking out the height controller. As the cut speed slows, arc voltage increases and the height controller tends to drive the torch down, changing cut bevel. Avoid torch height movement by locking out the height controller during the circle cut.

3. Start the cut in the center of the circle and use a 90° lead-in to the circle. When the positioner is in top running condition, a 90° lead-in will produce less distortion at the circle initiation. A cutting table with backlash may produce a better cut when a radial lead-in is used.
4. End the cut by overburning the circle cut line rather than by using a lead-out. Time the cut to end just as the arc completes the circle. A lead out or too much of an overburn will cause the arc to cut more of the outside of the circle and cause a distortion at the point where the circle cut is completed. Many CNC systems use an advanced off feature to ramp down cutting current end of cut. Use of the advanced off feature will improve circle cutting.



7.6 CUT SAMPLE ANALYSIS

Aluminum

Cut speed too fast



Cut drag lines are more than 15 degrees trailing the torch (torch movement right to left)

High speed bottom dross, easy to remove

Cut speed correct



Cut drag lines trail are visible, but cut surface is smooth

No dross

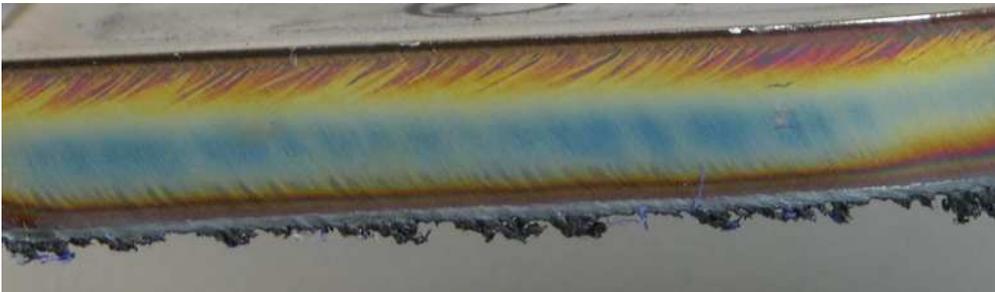
Cut speed too slow



Cut drag lines are more pronounced and cut surface is rougher

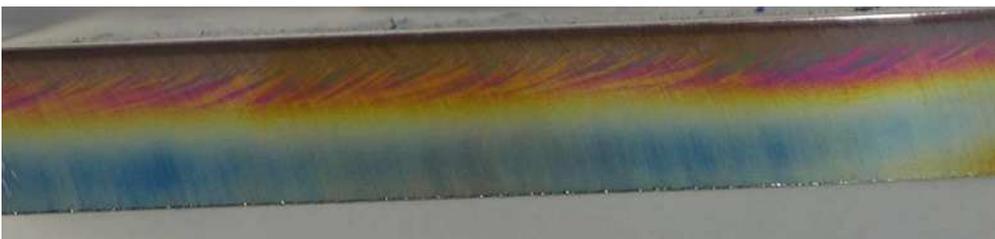
Stainless Steel (H35 plasma)

Cut speed too fast



- Gold heat discoloration swept in both directions
- Cut drag lines more than 15 degrees trailing
- High speed bottom dross, hard to remove

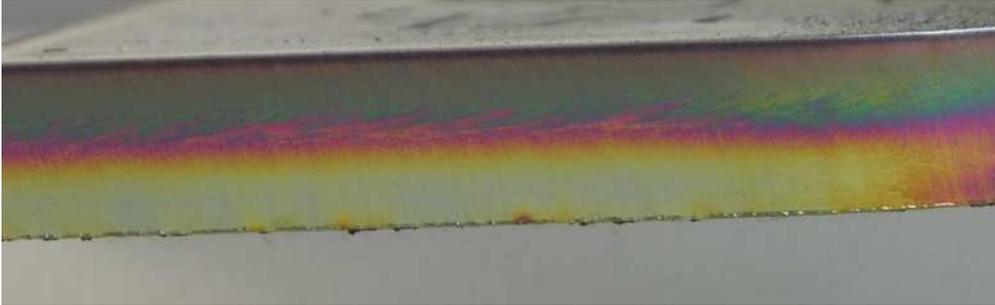
Cut Speed correct



Smooth cut surface

No dross

Cut Speed too slow



Heat discoloration is concentrated in the bottom half of the cut

Hard bottom dross, hard to remove

Mild Steel (O₂ plasma)

Cut Speed Too Fast



Trailing cut drag lines

Light bottom dross, hard to remove, some top spatter

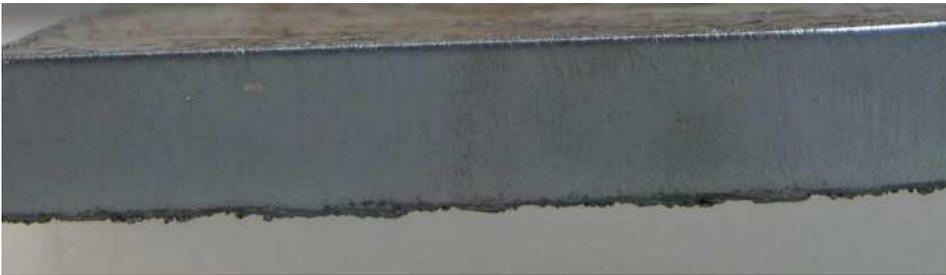
Cut Speed Correct



Cut drag lines near vertical

No dross

Cut Speed Too Slow



Cut drag lines lead the torch

Heavy bottom dross, easy to remove

Mild Steel (Air plasma)

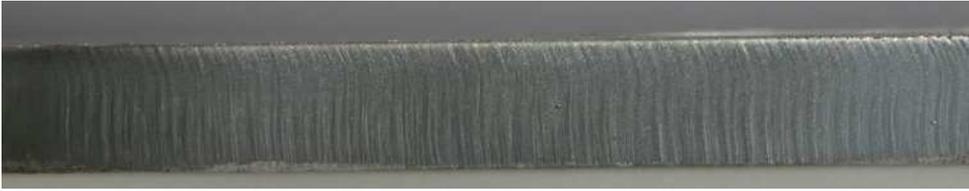
Cut Speed Too Fast



Cut drag lines curve and trail torch movement

High speed bottom dross, hard to remove

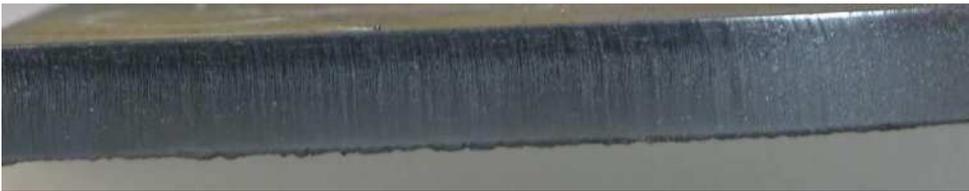
Cut Speed Correct



Cut drag lines near vertical

Minimal dross

Cut Speed Too Slow



Cut drag lines vertical or leading the torch head

Thicker bottom dross, easy to remove

8 MAINTENANCE

Lubrication.

You must regularly (minimum every 12 hours) lubricate the bearing surfaces and the ball screws. Use a thin Lithium spray or a 30wt oil lubricant. Spray daily and wipe off the excess.

Daily Checks.

1. Clean the machine and lubricate unpainted surfaces with a 30wt oil lubricant. Wipe off any excess and buff with a dry polishing cloth. This will reduce the likelihood of rust forming.

2. Generally inspect the machine for damage and loose or worn parts.

Weekly checks.

1. Generally inspect the machine for damage and loose or worn parts.
2. Check that all the electrical connectors are fitted correctly and are not loose.
3. Check that all the motor couplers are connected and that the screws are tight.

9 HEIGHT CONTROLLER



Buttons and knobs

Auto/Manual: switch of auto and manual. When the switch is for auto, THC is in the control of CNC controller THC auto/manual. When the switch is for man, THC is out of controller of CNC controller THC auto/manual, only manual state. THC LCD shows auto or manual.

Torch up/torch down: torch up/down switch. THC LCD shows up or down.

Arc strike: arc strike test, valid in manual mode. Press the button, plasma power source will get arc strike signal, THC shows arc voltage value and LCD “ARC” is on.

Zero test: initial location to check whether the initial location height is proper. During the initial location, before the torch moves down to touch the plate, torch up/down will stop the initial location test.

Sensitivity: clockwise turn the knob to increase, anticlockwise to decrease

Height: in auto mode, it's a reference value during cutting.

Up/down: in main menu, change different parameter interface.

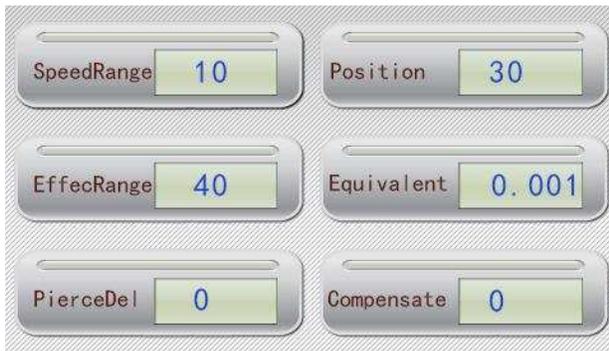
8.1 parameter setup

AHa-L1



a. Check basic parameters setup of first use

Adjust SetArc according to the plate thickness, 5 is recommended for sensitivity, set to Auto, press Zero Test to check whether the location height is proper for cutting height, if you need to adjust, rotate the knob of Up/Down (interface/parameter shift) to the following menu

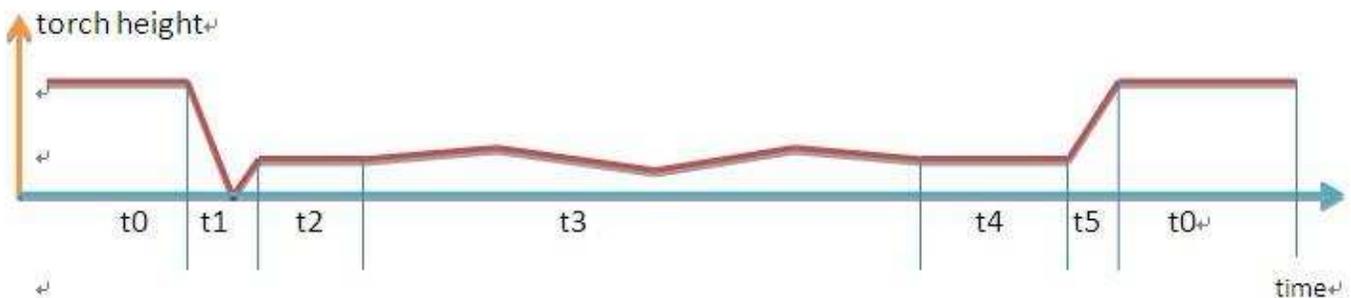


Adjust the location height by “+1” or “+10” knobs, press Zero Test to escape, and then test the location height again.

- b. Test cutting height arc voltage
- c. Start to cut

After above operations, back to the initial interface, then start to cut. During cutting, the height and sensitivity can be adjusted by knobs, or in the manual mode, the height can be set by Up/Down knob.

8.2 Height control sequence chart



T0: torch moves to the point G00

T1: initial location, CNC controllers send the signal of initial location start, after location finish, THC gives the signal of initial location finish to CNC controllers.

T2: arc strike delay, pierce delay, THC auto delay and other delays are over, CNC sends the signal of THC auto.

T3: the state of auto height control comes after THC receiving the signal of THC auto from CNC controllers.

T4: turn off auto THC in advance before finishing point

T5: torch up delay

Parameter setup



ARC: show the actual arc voltage value after arc strike, 000 is for no arc voltage value.

SetArc : set arc voltage value according to the plate thickness and cutting speed and the parameter list of plasma power source. The arc voltage value decides the torch height to the plate. The value is bigger, the height is higher. In auto mode, during cutting, arc voltage value adjustment is cutting height adjustment.

Sensitivity: the value is smaller, torch height adjustment response is slower, vice versa.

State display

Manu: without auto signal from CNC controllers, the light is on.

Auto: when receiving auto signal from CNC controllers, the light is on.

Up: when manual up, the light is on.

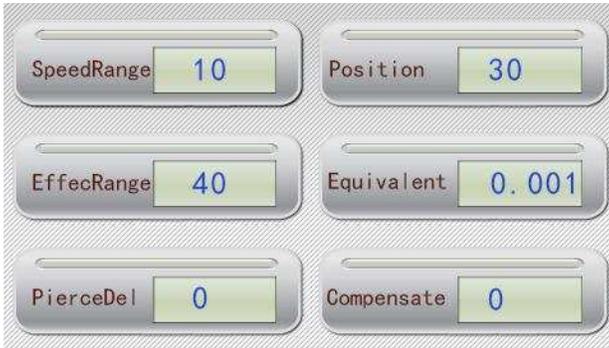
Down: when manual down, the light is on.

Lim+: when torch up, the motor gets to upper limit, the light is on.

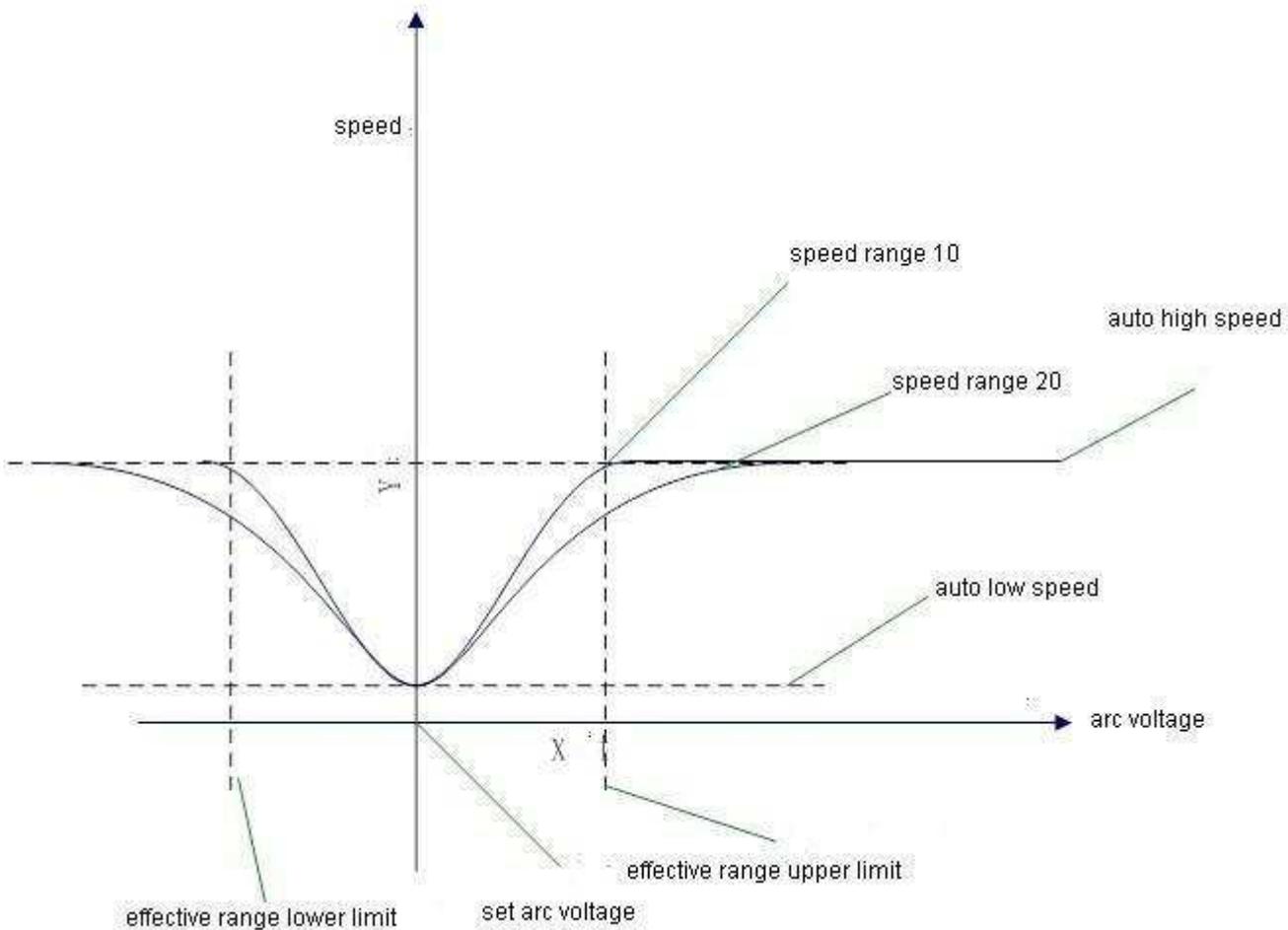
Lim-: when torch down, the motor gets to lower limit, the light is on.

Zero test: press Zero Test button, the light is on.

Arc: when detect the arc voltage, the light is on.



SpeedRange (Speed Range)



The speed range is bigger, and THC motor up/down speed change is slower, the tracing speed is slower. The speed range is smaller, and THC motor up/down speed is faster, and the motor will vibrate when too fast.

EffecRange (effective range): Arc voltage automatically cut between the effective range lower limit and the effective range upper limit. Beyond the range, torch moves up. The effective range is bigger, auto cutting range is bigger, the effective range is smaller, auto cutting range is smaller, the recommend range of effective range is 40.

PierceDel (pierce delay): In auto mode, pierce delay is the time of THC sending the signal of arc strike success to CNC controllers after THC collects arc voltage value.
Unit: ms.

Position (location height): The torch moves down and touches the plate, then the torch moves up to the height, unit: mm

Equivalent: The distance of very impulse, unit: mm

Equivalent = lead screw thread pitch * 1000 / (360 * subdivision / step angle * transmission ratio) = lead screw thread pitch * 1000 / (impulse per motor revolution * transmission ratio).

Compensate (compensation value): when the actual location height is different from set location height, the parameter will compensate the lost distance.

10 APPENDIX

10.1 G-CODE

CODE	FUNCTION
G00	Fast positioning point to point
G01	Linear cutting
G02	Circular cutting clockwise
G03	Circular cutting anti-clockwise
G04	Dwell (stop-delay)
G20	Inch
G21	Metric
G26	Back to reference point axis X
G27	Back to reference point axis Y
G28	Back to reference point axis X and Y
G40	Cancel compensation
G41	Compensation left
G42	Compensation right
G90	Absolute distance mode
G91	Incremental distance mode
G92	Reference point set-up

10.2 M-CODES

CODE	FUNCTION
M00	Stop program
M02/M30	Program ended
M07/08	Cutting oxygen valve ON/OFF Plasma cutter ON/OFF

M80	Power OFF(all output after M80 will be shut down)
-----	---

10.3 ERROR CODES

ERROR CODE	Description
01H	Overflow/illegal character(s) in program
20H	Division Overflow
21H	Error Starting/ending point of arc
22H	Error radius of arc
24H	Error condition of arc
2AH	Overflow program lines. No torch movement of this line
34H	Illegal Operation
40H	Emergency stop pressed
41H	Limit X+
42H	Limit X-
43H	Limit Y+
44H	Limit Y-
45H	Negative limit of software coordinates
46H	Positive limit of software coordinates

10.4 UNDERSTANDING DUTY-CYCLE LIMITATIONS

The duty cycle is the amount of time, in minutes, that a plasma arc can remain on within a 10-minute period when operating at an ambient temperature of 104° F (40° C).

With a Powermax65:

- At 65 A, the arc can remain on for 5 minutes out of 10 minutes without causing the unit to overheat (50% duty cycle).
- At 59 A, the arc can remain on for 6 minutes out of 10 (60%)
- At 46 A, the arc can remain on for 10 minutes out of 10 (100%).

With a Powermax85:

- At 85 A, the arc can remain on for 6 minutes out of 10 minutes without causing the unit to overheat (60% duty cycle).
- At 74 A, the arc can remain on for 8 minutes out of 10 (80%)
- At 66 A, the arc can remain on for 10 minutes out of 10 (100%).

If the duty cycle is exceeded, the power supply overheats, the temperature fault icon appears in the status screen, the arc shuts off, and the cooling fan continues to run. You can not resume cutting until the temperature fault icon disappears and the fault LED goes off.

Troubleshooting:

Symptom	Inspection	Solution
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The motor doesn't rotate	power	Turn on
	Power voltage	Check power
	Lock-rotor	Reduce load
No display	power	Turn on
Lim+ is bright	Over mechanical upper limit	Check upper limit switch
Lim- is bright	Over mechanical lower limit	Check upper lower switch
Unsteady signal	Plate connects ground	Connect ground well
Incorrect height	Working temperature	Change height setup
Detect slowing	Speed down zone value	Lower speed down zone area
Shake slightly	sensitivity	Increase sensitivity
Low accuracy	sensitivity	Decrease sensitivity

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