

How to Measure the Vertical Stage Backlash on the Plasmatron

Background

The plasma torch on the machine is carried on a servo-driven vertical stage that sets the height of the torch above the workpiece. The servo turns a hardened steel screw that turns in a bronze nut attached to the moving stage. When abrasive material collects in this component, the bronze wears away, causing the nut to become loose on the screw. This looseness is called “backlash” as a position error that turns up when the stage reverses direction.

The torch and stage weigh about 8 pounds. This tends to force the stage to the bottom of the slop in the nut position. When the torch touches off the workpiece at the start of a cut, the force pushes the nut to the opposite end of the backlash. Thus, all vertical position settings on the torch are lower than the ideal setting by a quantity equal to the backlash.

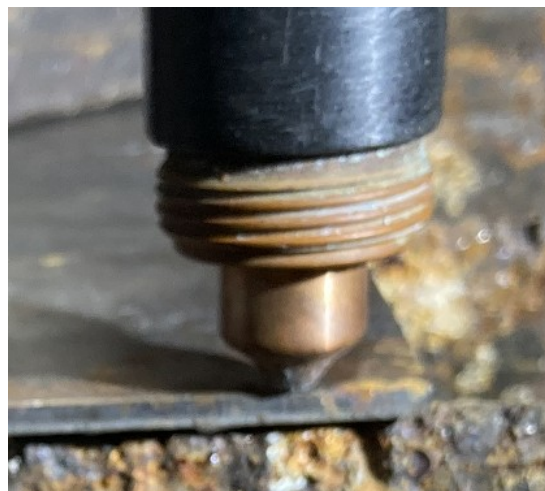
The procedure below is a relatively quick process for measuring the backlash compensation. Several measurements are averaged together to dilute the effects of measurement error. The operation is modeled after the procedure on pp. 40-41 of the "AVHC Quick Start Guide.pdf"

Tools Needed

Large-scale (not Fine-Cut) Nozzle/electrode pack without shield.
A relatively thick piece of sheet metal (~0.120" ; 10-12 Ga) to use as a substrate.
A pair of digital calipers
A cellphone with a working camera.

Step-By-Step Instructions

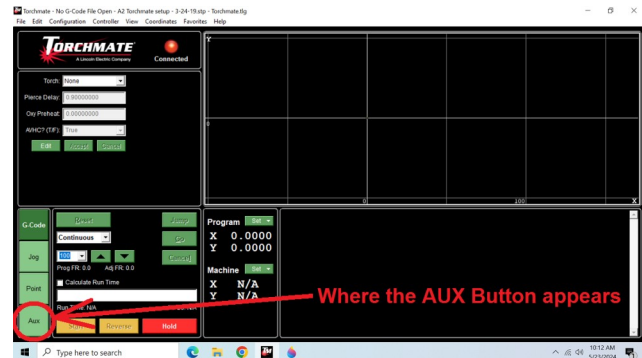
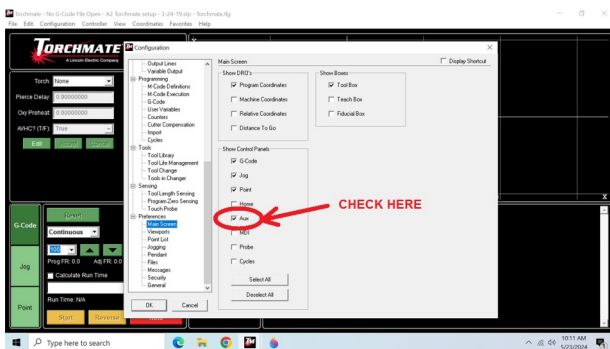
1. Measure the thickness of the sheet with the calipers. This dimension will be called A.
2. Set the edge of the sheet directly over one of the fins in the tank. Install the nozzle on the torch and jog it over the sheet so that the nozzle touches at the leading edge of the sheet. Clamp down the sheet so that it doesn't rock when the nozzle touches off. This is shown below.



First we measure the backlash compensation that pertains to the Pierce Height setting.

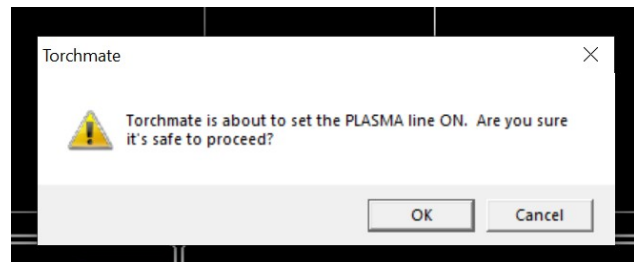
3. In the AVHC controller menu, scroll down to the "Initial Cut Height" and the "Pierce Height" height entries and set them to the same value. You will need to take three measurements at three different settings. Settings of 0.10"; 0.15"; and 0.20" are good to use. These dimension will be called B. If you are unsure how to do this, please review pp. 33-35 of the training document.

4. Open the Torchmate driver software. Go to the menu item: Config::Preferences::Main Screen and check the box labeled "AUX." This should cause a button that says "AUX" to appear in the lower left off the screen.



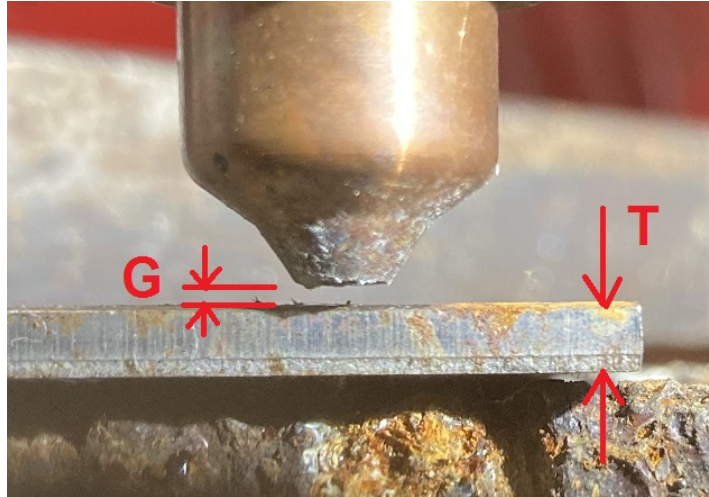
5. Do NOT enable the torch to cut. Leave the Hypertherm power supply off.

6. Hit the "AUX" button and find the button that says "Plasma OFF." Click on the button and accept the warning that appears on the screen. The nozzle will move down and touch off the substrate. It will stay there until you click on the button that now says "Plasma ON."



7. When the nozzle is in position after touching off, take the cellphone and photograph the edge of the sheet with the nozzle posed over it. Try to get them aligned so that the edge of the sheet and the gap under the nozzle are clear and sharp.

8. Zoom in on the picture and measure the image with the calipers. The size of the image, as measured off the screen, of the edge of the sheet is T. The size of the gap between the sheet of the nozzle is G.

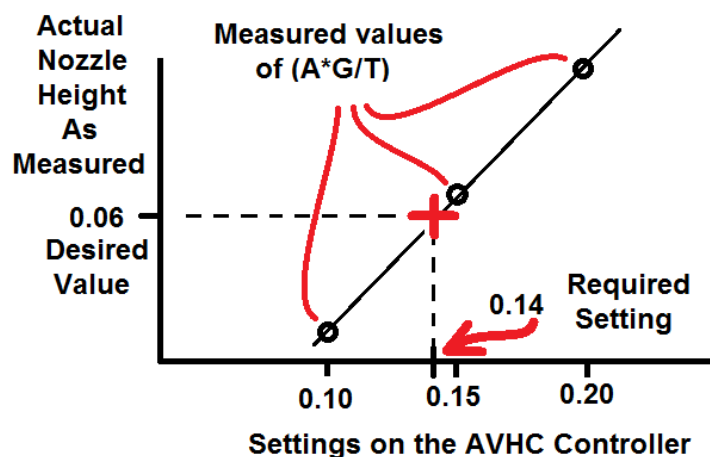


9. Calculate $A \cdot G / T$. This is the size of the gap in inches that corresponds to the pierce-height setting (B) from step 3. The ratio A/T is the magnification factor in the image. The value for the backlash is $B - (A \cdot G / T)$. This number may vary for different images, especially if the focus isn't perfect. We take several measurements and average the results to get the most accurate estimate.

10. Repeat steps 6-9 for at least two other (identical) settings (B) of Pierce Height and Initial Cut Height. 0.10, 0.15, and 0.20 are a good set.

11. Make a graph of these three points with the Pierce height setting along the X-axis and the gap width ($A \cdot G / T$) that was calculated in step 9 as the Y value.

12. Draw a line through the three points. The horizontal coordinate where the line crosses the desired value of the Pierce Height in the vertical coordinate (usually 0.15") is the preferred setting for Pierce Height in the controller menu. A sample graph is shown below for a typical backlash value of 0.08.



13. Return to Step 3 but set the Pierce Height to the value just calculated and keep it set there. Repeat steps 3 through 12 while changing the value of Initial Cut Height only. The desired value for Initial Cut Height is usually 0.06".

14. If you have perfect confidence in a single point measurement, you can calculate the backlash value and add it to the desired values of Pierce Height and Init Cut Height. Although the theory suggests that the backlash value $B-(A*G/T)$ is a constant for the mechanism, it need not be and this procedure finds the best value of both parameters without assuming anything.

14. You can uncheck the "AUX" box in the configuration dialog to make the "AUX" tab go away.