

MOTION SYSTEM 15

Beam Alignment

Theory

The correct alignment between the Laser Beam and the Motion System is very critical to correct Laser System operation. The Laser Beam MUST strike each Mirror at a precise 45 degree angle to reflect 100% of the Laser Beam's energy to the other Mirrors and Focus Lens. If not, the Laser Beam can miss an entire Mirror and never reflect to the Focus Lens. If the Laser Beam never gets to the Focus Lens, then it will not be capable of engraving any material. If the alignment is slightly off and some of the Laser beam strikes the Focus Carriage instead of the Mirror, then a loss of Laser power will occur.

If the Laser System is experiencing no beam output or a reduced beam intensity (loss of power), then a few things should be checked before assuming that the Laser Tube or associated electronics are faulty. The first thing to check is the cleanliness of the Mirrors and Focus Lens as well as the Beam Window. If any of these optics are dirty, a loss of Laser power will occur. Secondly, check to see if the #2 and/or #3 Mirror is mounted correctly. An incorrectly mounted Mirror can cause a beam misalignment. A misaligned beam can cause a loss of power (or no power) as well as a shifted image in the engraving area. This can also cause a partial field engraving such as a good engraving in the upper left hand corner of the engraving area and lowered power or disappearing engraving in the lower right hand corner. If the Mirrors are mounted correctly and all the optics are clean, the alignment should be checked. Also, if the Laser Tube has been exchanged for a rebuilt one, then the Beam Alignment procedure is most likely necessary. It is important that we have correct alignment in all 5 positions of the Motion System. **We will abbreviate Mirror 1 as M1 and Position 1 as P1, etc., for all mirrors and positions.**

We do not need a special devices in order to check the Beam alignment except for a roll of masking tape, Safety Goggles, the interlock defeat tool, and a set of allen wrenches. Since the beam is invisible, we will use the masking tape to cover the area where the Laser Beam will travel through to hit the Mirror #2 (M2) and Mirror #3 (M3). We will burn a small spot in the masking tape to determine if the Laser beam is striking the center of the hole(the #2 Mirror mount and the #3 Mirror mount) in all 5 positions (P1 - P5) of the Motion System. If it strikes the center of the hole, this means that it will strike the center of the Mirror that is behind the hole. We will be testing the alignment with the Top Door open and the Safety Interlock Defeated.

CAUTION!

Before attempting to adjust the Laser Beam, it is very important that you understand these facts: The Laser Beam can produce an intense radiation of heat energy. Avoid eye or skin exposure to direct or scattered radiation. Always wear safety goggles and never cross the path of the beam with any body part. Although we will be testing the alignment of the Laser Beam at very low power levels, all safety precautions should be followed.

Alignment Mode

Make sure that the Laser System is **OFF**. **Remove M2, M3, and the Focus Lens. Put on your Safety Goggles**, open the Top Door, insert the Interlock Defeat Tool, and turn the Laser System ON. When "READY" appears on the display, press the "ESCAPE" key. Go down to "PREFERENCES" and then select "CONFIGURATION". Go to "ALIGNMENT MODE" and press "SELECT". There are two numbers that appear, they are POWER % and KHZ . These numbers have been pre-set at the factory for a very low setting. This setting should be just enough power to check alignment. While in this menu selection, press the left arrow directional key and observe the Focus Carriage move all the way to the left. Now press the other directional keys and watch the Motion System move to each corner of the engraving area respectively. Practice moving the Focus Carriage to simulate the 5 testing positions as the diagram indicates.

Before removing the Fan Enclosure and the Laser Endplate Cover, we will check the alignment between P1 and P2.

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Place a piece of Masking Tape over the #2 Mirror Holder and press the directional arrow key to position the Motion System at P1. Rub the masking tape with your finger, against the edge of the hole so that you can see an impression of the hole through the tape. With your right hand, place your finger on the “TEST” button. Press the button once to turn the Laser beam **ON** and once again to turn it **OFF**. It takes only a few seconds to start to see the Laser beam burn a hole through the Masking Tape. The objective is to have the Laser **ON** long enough to burn the smallest brown spot in the tape that is possible without burning through it. P1 is a difficult position to see because it so far into the upper left hand corner. Try counting to 3 after you press the “TEST” button then turn it **OFF**. Look at the spot and adjust your timing to get the smallest visible spot possible. After practicing, apply a fresh piece of tape and burn a dot (fire the Laser) at P1. Then, without removing the tape, burn a dot at P2 (as the diagram illustrates). Compare the two dots. If the two dots are directly on top of each other and in the center of the hole (imagine that the hole is a Bull’s Eye), then the alignment from M1 to M2 is good. We can then go to the next procedure and check the alignment between M2 and M3. If the two dots are separated and/or the combined dots are not in the center of the hole, an alignment adjustment must be performed all the way back at M1. To get to M1, follow the procedure in “Laser Tube Assembly 1” to remove the outer fan enclosure and #1 mirror cover, and then return back to this section.

There are four(4) different ways to adjust M1. The vertical angle, horizontal angle, vertical displacement, and horizontal displacement adjustments.

- If the P1 dot and the P2 dots are **NOT** on top of each other (combined), then an angular adjustment is required. Go to the “Separated Dots” section. **Always make all angular corrections before making any displacement corrections.**
- If the P1 dot and the P2 dot are directly on top of each other (combined), but the combined dots are **NOT** positioned in the direct center of the hole, then a displacement adjustment is necessary. Go to the “Combined Dots Not Centered” section.

Separated Dots - Horizontally and/or Vertically (P1 to P2)

Determine which dot is the P1 dot and which dot is the P2 dot. We will always adjust the P2 dot to meet the P1 dot regardless of whether the P1 dot is in the center of the hole or not. If the P2 dot is higher or lower than the P1 dot, turn the black knob (picture 2), in the appropriate direction (very slightly), and re-check with a fresh piece of Masking Tape. Adjust and re-check until both the P2 and the P1 dots are on top of each other. If dots are directly on top of each other and perfectly centered in the hole, go to the next page (M2 to M3 alignment). If dots are directly on top of each other(combined) but the combined dots are not perfectly centered in the hole, go to “Not Centered” section. If the P2 dot is to the left or to the right of the P1 dot, turn the black knob (picture 3), in the appropriate direction (very slightly), and re-check with a fresh piece of Masking Tape. Adjust and re-check until both the P2 and the P1 dots are combined into one dot. If both dots are combined and the combined dots are directly in the center of the hole then proceed to M2 to M3 alignment on the next page.

Combined Dots Not Centered in Hole Vertically (P1 to P2)

If the combined dots are too high or too low in the hole, then a vertical displacement adjustment is necessary. If the combined dots are too far to the right or too far to the left then a horizontal displacement adjustment is necessary. To adjust vertical displacement, **LOOSEN ONLY, DO NOT REMOVE**, the top socket head screw on the rear end of the laser tube (see diagram). Loosen, **ONLY ½ TURN**, the two(2) lockdown screws in front of M1 and also the lockdown screw that is attached to the cam nut. To raise the entire beam up, rotate the cam nut clockwise and observe the mounting plate slide upwards. Re-tighten **ALL** lockdown screws and re-check alignment between P1 and P2. If the combined dots are too high, loosen the lockdown screws ½ turn, rotate the cam nut counterclockwise, tighten **ALL** lockdown screws and re-test.

Combined Dots Not Centered in Hole Horizontally (P1 to P2)

If the combined dots are too far to the left, loosen the two(2) lockdown screws underneath M1 and slide M1 to the right the same amount that you need to move the dots. When doing this, make sure that M1's mounting plate remains flat up against the lip of the support bracket (to prevent the mirrors angle from

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changing). Tighten the lockdown screws and re-test alignment between P1 and P2. If the dots have separated, re-check to make sure that the M1 holder is flat against the lip of the mounting bracket. If not, re-adjust and re-test. Sometimes a re-adjustment of the black knobs may be necessary to bring the dots back together. **The black knobs are ONLY to be used to combine the two separated dots into one dot, never use them to center the combined dots in the hole.** If the combined dots are too far to the right, loosen the lockdown screws, and slide M1 to the left. Again, make sure that the M1 holder remains flat up against the lip of the support bracket. Re-tighten the lockdown screws and re-test. Once the P1 and P2 dots are exactly on top of each other and the combined dots are perfectly centered in the hole, then install M2 back on its holder and proceed to align the system between P2 and P3.

Separated Dots - Horizontally (P3 to P4)

Burn a dot at P3 (as diagram illustrates) and then at P4. Compare the dots. If dots are separated horizontally, adjust Horizontal Angle Adjustment Screw (Fig.2) to combine the P4 dot with the P3 dot. Turning the screw clockwise causes the beam to move towards the front of the laser system at the P4 position. There should be a significant amount of tightness to the Horizontal angle adjustment screw. This will prevent the screw from loosening during engraving. If it is not tight, tighten the Bracket Tension Screw (next to it) to create tension on the bracket. This will cause the bracket to bend slightly. After tightening this screw, you might need to go back and recheck the P4 dot because it might have moved. Re-adjust the Horizontal Angle Adjustment Screw if necessary. Sometimes it is better to simply loosen the Horizontal Angle Adjustment screw completely, tighten the Bracket Tension Screw until the dot at P4 is on the edge of the hole (towards the back of the laser system), and then go back and tighten the Horizontal Angle Adjustment screw to combine the dots between the P4 and P3 positions. What you are doing is actually bending the #2 mirror holder bracket around its pivot stem located between the two adjustment screws. Doing this will ensure that both screws have enough pressure from the bracket so that the screws do not loosen. It is **OK** if the dots are split vertically, we will adjust that later. If the combined dot's position in the hole is too far to the right (towards the front) or too far to the left (towards the rear) side of the hole, we will need to adjust Horizontal Displacement.

Combined Dots Not Centered in Hole Horizontally (P3 to P4)

Loosen, **ONLY ¼ TURN**, the two(2) Lockdown Screws that attach the #2 Mirror Bracket to the Arm (Fig.3). Slide the Bracket along the Arm in the direction you need to move the combined dots, making sure that the Lip of the Bracket remains in full contact with the Arm. Hold the Lip down while tightening the lockdown screws ensure that the bracket does not twist. Re-check and re-adjust if necessary until the combined dots are centered in the hole horizontally.

Separated Dots - Vertically (P3 to P4)

If the dots are not separated vertically then this step is not necessary, proceed to P5 position. If they are split, loosen the two(2) Nylon Tipped Set Screws, **ONLY ¼ TURN**, and rotate the Cylinder until the P4 dot is aligned with the P3 dot. **THIS IS A VERY SENSITIVE ADJUSTMENT, TURNING THE CYLINDER TOO MUCH CAN CAUSE A SEVERE MISALIGNMENT. MAKE EXTREMELY SMALL MOVEMENTS AND RE-CHECK DOTS FREQUENTLY.** When dots are aligned, tighten back the Nylon Tipped Set Screw until it is lightly snug. **DO NOT OVERTIGHTEN!** Overtightening can cause damage to the cylinder as well as disturbing the alignment adjustment that was just made.

P5 Position (Final Position)

Using a fresh piece of tape, burn a dot at P3, P4, and P5. Compare the dots. If only the P5 dot is not centered in the hole, then go all the way back to M1 and adjust the black knobs until the P5 dot is centered in the hole. This will slightly effect the alignment at P3 and P4 only slightly. Re-burn all 3 dots on a fresh piece of tape and if all 3 dots are closer to the center of the hole than the edge of the hole, alignment is complete. The dots do not need to be exactly on top of each other or exactly in the center of the hole, they just need to be closer to the middle than the edge. The P1 to P2 alignment needed to be perfect in order to make the adjustment at P5 much easier and precise.

Alignment Quick Check

If simply checking an alignment, without removing any covers, burn a dot at the P5 position with M3 and the focus lens off. If dot is closer to the center of the hole than the edge of the hole, total alignment is good, re-install 3 and lens. If bad, do the alignment checks backwards until you find the problem.