3 Parameters

This section provides a description of all the parameters used for cutting on your CINCINNATI laser.

3.1 Piercing

Power Mode
The power mode for piercing is the power profile of the beam. Set as either continuous wave, superpulse or gated pulse. Refer to section 1.5.

Pierce Power
The power (watts) delivered to the work piece.

Frequency
The number of pulses of laser power per unit time (second).

Duty Cycle
A percentage of the pierce power (5% to 99%) which establishes the maximum power delivered to the workpiece.

Dwell
The amount of time (seconds) that the laser head stays in the pierce position. The laser beam is still on during this time.

Assist Gas Type
The type of gas employed during the pierce. Refer to section 1.2.1.

Assist Gas Pressure
The gage pressure (psi) of assist gas.

Coolant State
When the coolant state is set to "On", optional part coolant is delivered to the workpiece during the pierce. Refer to section 1.5.1.

Stand-off
The distance (inches) that the tip of the nozzle is from the top of the material.

Ramped Power Piercing
A technique for piercing such that the power is ramped up to maximum pierce power over a period of time intervals.

3.2 Cutting

Power Mode
The power mode for piercing is the power profile of the beam. Set as either continuous wave, superpulse or gated pulse. Refer to section 1.5.

Pierce Power
The power (watts) delivered to the work piece.

Frequency
The number of pulses of laser power per unit time (second).

Duty Cycle
A percentage of the cutting power (5% to 99%) which establishes the maximum power delivered to the workpiece.

Assist Gas Type
The type of gas employed during the cutting process. Refer to section 1.2.1.

Assist Gas Pressure
The gage pressure (psi) of assist gas.

Coolant State
When the coolant state is set to "On", optional part coolant is delivered to the workpiece during the cutting process. Refer to section 1.5.1.

Stand-off
The distance (inches) that the tip of the nozzle is from the top of the material.

DPC Max Feed Rate
For any actual feedrate realized above this value, maximum power is delivered to the workpiece.

DPC Min Value
A percentage of the maximum power at zero feedrate.

Feedrate
The rate at which the laser head is programmed to cut (inches per minute).

Kerf Width

The diameter of the focused laser beam. This value sets the compensation for the tool path.

4 Diagnostics

The following section provides tables for diagnosing and correcting adverse cutting for selected materials.

Important Note

These tables are to be used as a general guide. Material composition varies such that the recommended fix may not completely remedy the cutting condition. Consult the Laser Applications Group at CINCINNATI if desired cutting results are not achieved.

4.1 General Diagnostic Procedure

When diagnosing and documenting a cutting problem, follow these simple steps.

1) Find out what happened since it last worked correctly. Even those events which seem to be insignificant often help identify the cause of the problem. Talk to other operators, programmers, and maintenance personnel.

2). Look for patterns in the problem. Does the problem occur at a certain time of day or after a certain period of cutting time? Is it related to position on the worktable, orientation of the part, size of cutout, upper/lower pallet, personnel, or material condition? Does the problem occur at certain points such as pierce, lead-in, cut?

CINCINNATI Incorporated recommends using the worksheet in the back of this section when diagnosing cutting problems. Complete this worksheet in full and keep a record of it for future reference.

4.1 Diagnostic Charts for Selected Materials

Aluminum

Mild Steel and Tool Steel (Oxygen Assist)

Mild Steel, Galvanized, and Stainless Steel (Nitrogen Assist)

Copper Alloys

Composites, Acrylics, Plastics

Wood

Aluminum

Important note: Review the general diagnostic guidelines (section 4.1) before using this chart.

Problem	Possible Causes	Remedy
Pierce Problems		
Blowout at the beginning of the pierce.	• Power too high at start of pierce.	• Reduce start % of ramped pierce power.
Blowout during the pierce.	• Power too high too fast during pierce. • Assist gas pressure too high.	• Reduce pierce power (duty cycle). • Increase ramped pierce time. • Reduce assist gas pressure (app 10%).
Blowout at the end of a pierce just as cutting head starts to move.	• Pierce not complete. Test: observe pierce process.	• Increase pierce power (duty cycle). • Increase pierce time.
Edge quality problems (independent of location along part edge)		
Loud popping noises during cutting and gouges in the part edge.	• Assist gas too high. • Feedrate too fast.	• Reduce assist gas pressure. • Reduce feedrate.
Fine dross.	• Focus incorrect..	• Adjust focus (app. 0.020 inch) and observe effect.
Heavy dross, not easily removed with fingernail.	• Focus is too high. • Assist gas pressure is too high. • Feedrate is too high.	• Lower the focus (app. 0.020 inch). • Reduce assist gas pressure (app. 10%) • Reduce feedrate (app. 10%).
Edge quality problems (depends on location along part edge or size of cutout)		
Dross on one side or two opposite sides of a part.	• Lens is not centered. • Nozzle is partially clogged or damaged. • Lens is dirty or damaged. Test: cut with a known good lens. • Beam delivery system is out of alignment. Test: check beam alignment. • Laser mode is asymmetric. Test: check mode quality.	• Center the lens. • Clean or replace nozzle. • Clean or replace lens. • Call maintenance to align beam delivery system. • Call maintenance to correct the mode problem.
Very rough edge or lost cut at beginning of part edge (1/2 inch to 2 inch).	• Pierce not complete. Test: observe pierce process. • Start-of-cut feedrate and assist gas pressure too high. • Power burst not on. • Pre-cut dwell too short. • Dynamic power minimum % too low.	• See remedy for blowout at end of pierce. • Use start-of-cut technique (reduced assist gas pressure, reduced feedrate). • Set power burst time. • Increase pre-cut dwell time. • Increase dynamic power minimum %.
Loss of cut or burr present at corners and on intricate features.	• Power density too low.	• Increase the dynamic power minimum duty cycle value.
Icicle dross at corners and on intricate features.	• Power density too high.	• Decrease the dynamic power minimum duty cycle value.
Loud popping noise just as cut head starts to move.	• Assist gas pressure too high.	• Reduce assist gas pressure.
Spatter spraying above material as the cut head starts to move.	• Feedrate too fast at start-of-cut.	• Reduce the start-of-cut feedrate.

Mild Steel and Tool Steel (Oxygen Assist)

Important note: Review the general diagnostic guidelines (section 4.1) before using this chart.

Problem	Possible Causes	Remedy
Pierce Problems		
Blowout at the beginning of the pierce.	• Power too high at start of pierce.	• Reduce start % of ramped pierce power.
Blowout during the pierce.	• Power too high too fast during pierce. • Assist gas pressure too high.	• Reduce pierce power (duty cycle). • Increase ramped pierce time. • Reduce assist gas pressure (app 10%).
Blowout at the end of a pierce just as cutting head starts to move.	• Pierce not complete. Test: observe pierce process.	• Increase pierce power (duty cycle). • Increase pierce time.
Edge quality problems (independent of location along part edge)		
Deep gouges, closely spaced. Very rough part edge.	• Process is too hot at the cutting point.	• Raise the focus 1/4 turn to reduce the power density. • Reduce assist gas pressure (app. 10%). • Reduce power (app. 5%). • Increase feedrate (app. 5%).
Small gouges, widely spaced. Typical gouge extends from the middle to the bottom of the part edge.	• Process is slightly hot at the cutting point.	• Same remedies as for deep gouges, but make smaller changes.
Heavy dross. Part usually will not drop.	• Process is too cool at the cutting point.	• Lower the focus 1/4 turn to increase the power density. • Increase assist gas pressure (app. 10%). • Increase power (app. 5%). • Reduce the feedrate (app. 5%).
Slight dross, feels like the "burr" on a sheared edge.	• Process is slightly cool at the cutting point.	• Same remedies as for heavy dross, but make smaller changes.
Edge quality problems (depends on location along part edge or size of cutout)		
Dross on one side or two opposite sides of a part.	• Lens is not centered. • Nozzle is partially clogged or damaged. • Lens is dirty or damaged. Test: cut with a known good lens. • Beam delivery system is out of alignment. Test: check beam alignment. • Laser mode is asymmetric. Test: check mode quality.	• Center the lens. • Clean or replace nozzle. • Clean or replace lens. • Call maintenance to align beam delivery system. • Call maintenance to correct the mode problem.
Very rough edge or lost cut at beginning of part edge (1/2 inch to 2 inch).	• Pierce not complete. Test: observe pierce process. • Lead-in feedrate too high. • Lead-in transition too sharp.	• See remedy for blowout at end of pierce. • Reduce lead-in feedrate. • Use angled lead-in or radius the transition from lead-in to part edge.
Dross at corners, in small holes, and/or in first part of cut after pierce.	• Power density too low for the cutting speed.	• Increase the dynamic power minimum duty cycle value (V).

Problem	Possible Causes	Remedy
Gouges at corners, in small holes, and/or in first part of cut after pierce.	• Power density too high for the cutting speed.	• Decrease the dynamic power minimum duty cycle value (V).
Gouges just past the corners.	• Localized overheating of sharp corner.	• Use a radius (0.050 inch) at the corner.
Very rough edge or lost cut on small cutouts (such as small diameter holes).	• Feedrate too high.	• Reduce feedrate for small cutouts to 70% of normal feedrate.
	• Overheating of cutout (slug).	• Reduce lead-in length. • Use angled lead-in or radius the transition from lead-in to part edge to clean up transition.
	• Pre-heating of adjacent work material.	• Re-sequence closely spaced cutouts to allow cooling time for adjacent cutouts.

Mild Steel, Galvanized, and Stainless Steel (Nitrogen Assist)

Problem	Possible Causes	Remedy
Pierce Problems		
Blue plasma formation during pierce (slows material penetration).	• Assist gas pressure too high. • Focus too low.	• Reduce assist gas pressure. • Raise focus and/or standoff.
Spatter on bottom of lens.	• Standoff too low. • Assist gas pressure too low.	• Raise standoff. • Increase assist gas pressure.
Edge quality problems (independent of location along part edge)		
Consistent long icicle type dross on part and /or parent material.	• Assist gas too low. • Feedrate too slow for commanded power. • Focus not deep enough into material.	• Increase assist gas pressure. • Increase feedrate or decrease dynamic power minimum %. • Lower focus.
Consistent sharp burr.	• Assist gas too high. • Feedrate too fast for commanded power. • Focus too deep into material.	• Lower pressure. • Reduce feedrate. • Raise focus.
Lower portion of cut edge is not smooth and uniform.	• Standoff is incorrect. • Nozzle orifice diameter is incorrect.	• Check standoff calibration and commanded standoff distance. • Check nozzle size.
ty problems (depends on location along part edge or size of cutout)		
Dross on one side or two opposite sides of a part.	• Lens is not centered. • Nozzle is partially clogged or damaged. • Lens is dirty or damaged. Test: cut with a known good lens. • Beam delivery system is out of alignment. Test: check beam alignment. • Laser mode is asymmetric. Test: check mode quality.	• Center the lens. • Clean or replace nozzle. • Clean or replace lens. • Call maintenance to align beam delivery system. • Call maintenance to correct the mode problem.
Very rough edge or lost cut at beginning of part edge (1/2 inch to 2 inch).	• Pierce not complete. Test: observe pierce process. • Start-of-cut feedrate and assist gas pressure too high.	• See remedy for blowout at end of pierce. • Use start-of-cut technique (reduced assist gas pressure, reduced feedrate).
Loss of cut or burr present at corners and on intricate features.	• Power density too low.	• Increase the dynamic power minimum duty cycle value.
Icicle dross at corners and on intricate features.	• Power density too high.	• Decrease the dynamic power minimum duty cycle value.

Copper Alloys

Problem	Possible Causes	Remedy
Pierce Problems		
Blue plasma formation during pierce.	• Assist gas pressure too high • Focus too deep into material	• Reduce assist gas pressure (app 10%). • Raise the focus (app. 0.020 inch).
Splatter on lens from pierce.	• Tip stand-off too low • Assist gas pressure too low	• Raise the stand-off (app. 10%) • Increase assist gas pressure (app 10%).
Edge quality problems (independent of location along part edge)		
Consistent long "icicle-type" dross on part and/or on parent material.	• Assist gas pressure too low. • Feedrate too slow. • Focus not deep enough into material.	• Increase assist gas pressure (app. 10%) • Increase feedrate. • Lower focus (app. .020 inch).
Consistent sharp burr.	• Assist gas pressure too high • Feedrate too fast • Focus too deep into material	• Reduce assist gas pressure (app 10%). • Reduce feedrate. • Raise the focus (app. 0.020 inch).
Lower portion of cut edge not smooth and uniform.	• Tip stand-off is not correct. • Nozzle orifice diameter is incorrect.	• Check stand-off calibration and commanded stand-off distance. • Verify proper nozzle and size.
Edge quality problems (depends on location along part edge or size of cutout)		
Dross on one side or two opposite sides of a part.	• Lens is not centered. • Nozzle is partially clogged or damaged. • Lens is dirty or damaged. Test: cut with a known good lens. • Beam delivery system is out of alignment. Test: check beam alignment. • Beam delivery mirrors are dirty or damaged. Test: check mode quality. • Beam mode is asymmetric. Test: check mode quality.	• Center the lens. • Clean or replace nozzle. • Clean or replace lens. • Call maintenance to align beam delivery system. • Call maintenance to inspect mirrors and clean or replace as necessary. • Call maintenance to correct the mode problem.
Dross at lead-in tangency, small holes and/or sharp corners.	• Feedrate too slow.	• Increase feedrate.
Loss of cut during lead-in.	• Feedrate too fast. • Assist gas pressure too high. • Insufficient power. • Pierce hole not completely through the material.	• Decrease feedrate. • Reduce assist gas pressure (app. 10%) • Activate power burst. • Increase the pierce dwell time.
Loss of cut or burr present at corners and on intricate features.	• Power level too low in areas of reduced feedrate.	• Increase Dynamic Minimum power level.
Icicle-type dross present at corners and on intricate features.	• Power level too high in areas of reduced feedrate.	• Reduce Dynamic Minimum power level.

Composites & Plastics

Problem	Possible Causes	Remedy
Pierce Problems		
Popping noise at the end of the pierce.	• Pierce not going through the material. • Assist gas pressure change too great from pierce to cut pressure(s).	• Increase pierce dwell time (app 10%). • Reduce cutting assist gas pressure (app. 10%). • Increase pierce assist gas pressure (app. 10%).
Large resultant pierce hole.	• Pierce power too high. • Focus not set correctly. • Pierce assist gas pressure too high.	• Lower the pierce power. • Reduce the pierce duty cycle. • Adjust focus. • Lower the pierce assist gas pressure (app. 10%)
Edge quality problems (independent of location along part edge)		
Gouges in side of part.	• Assist gas pressure too high. • Cut power too high. • Feedrate too slow. • Focus too deep into material.	• Increase assist gas pressure (app. 10%) • Decrease cut power or duty cycle. • Increase feedrate. • Raise focus (app. .020 inch).
Rough edge near bottom side of cut.	• Cut power too low. • Assist gas pressure too low. • Incorrect nozzle.	• Increase cut power or duty cycle. • Increase assist gas pressure (app. 10%). • Use larger orifice nozzle.
Material re-casting onto bottom of part.	• Assist gas pressure too low. • Feedrate is too fast.	• Increase assist gas pressure (app. 10%). • Reduce feedrate.
Edge quality problems (depends on location along part edge or size of cutout)		
Dross on one side or two opposite sides of a part.	• Lens is not centered. • Nozzle is partially clogged or damaged. • Lens is dirty or damaged. Test: cut with a known good lens. • Beam delivery system is out of alignment. Test: check beam alignment. • Beam delivery mirrors are dirty or damaged. Test: check mode quality. • Beam mode is asymmetric. Test: check mode quality.	• Center the lens. • Clean or replace nozzle. • Clean or replace lens. • Call maintenance to align beam delivery system. • Call maintenance to inspect mirrors and clean or replace as necessary. • Call maintenance to correct the mode problem.

Wood

Pierce Problems

Symptom	Possible Causes	Remedy
• Loud popping sound	• Wrong assist gas • Power to high	• Change assist gas to Nitrogen • Reduce pierce power or duty cycle
• Pierce not through material	• Pierce power to low • Pierce time to short	• Increase pierce power or duty cycle • Increase pierce dwell time

Edge quality problems (independent of location along part edge)

Symptom	Possible Causes	Remedy
• Lower section of edge rough or uncut	• Cut power to low • Feedrate to high • Focus to high	• Increase cut power or duty cycle • Lower cut feedrate by 5-10% • Lower focus
• Edge not perpendicular	• Typical edge condition with some thicker materials • Focus to low • Speed to slow	• Raise focus to decrease kerf width on top of material • Increase feedrate to decrease kerf width on bottom of material
• Corners burnt	• Cut power to high • Feedrate at corner to low	• Decrease cut power or duty cycle • Decrease DPC MIN% • Increase cut feedrate

Edge quality problems (depends on location along part edge or size of cutout)

Symptom	Possible Causes	Remedy
• Mark at lead-in location	• Cut power is to high • Lead-in at wrong angle • Lead-in feedrate to slow	• Decrease cut power or duty cycle • Decrease DPC MIN% • Change lead-in angle to 90° or less • Decrease lead-in length • Increase lead-in feedrate

Laser Cutting Diagnostic Worksheet

Date: __________ CI Laser Model: __________

Date of laser PMS: __________ Laser S/N: __________

Programming: __________________ Resonator Size: __________

Material Type: __________________ Material Thickness: __________

Nature of Cutting Problem:

____

____

____

What changes to the machine/process have been made prior to this problem (if any)

____

____

____

Diagnostic Checklist

Have you try to solve the problem using the diagnostic charts provided?

Is the lens centered?

Is focus set properly?

Is the standoff set properly?

Is the demanded power being delivered?

Is the demanded assist gas pressure being delivered?

5 Basic Machine Adjustments & Tests

This section is intended to provide the instructions for making basic machine adjustments as they pertain to diagnosing and correcting cutting conditions. The procedures are presented such that they may not apply to your specific machine.

Refer to the CINCINNATI Operation, Safety and Maintenance Manual of your machine for the proper methods of machine adjustments.

5.1 Optics Inspection and Cleaning

The beam handling mirrors and the focusing lens are the most critical components in the external beam delivery system. These optical elements are made of materials which either reflect the laser beam (mirrors) or transmit the laser beam (lens).

An unfortunate property of the optical materials is that they are easily scratched or chipped and will absorb the beam when damaged. Foreign materials such as oil, mist, dust, smoke, fingerprints or water vapor can cause the optic to absorb the energy of the beam. An excess beam absorption by these optical elements can cause poor cutting performance and eventual destruction of the optic.

The external beam delivery system is designed to protect the optics from most airborne industrial contaminants by enclosing the beam path in an air-tight environment which is continuously purged with an inert gas. To further extend the optics' life, periodic cleaning is also required.

The following materials are recommended for optics cleaning:

Acetone - reagent grade of rectified ACS grade

Propanol - anhydrous grade or certified ACS grade

Surgical quality cotton balls

Paper-bodied cotton swabs

Air bulb or clean, dry filtered air supply

Lens tissue (Note: Common lens tissue for eyeglasses or camera lenses are not recommended).

Acetone is a more aggressive solvent than alcohol and is used for the more difficult-to-remove contaminants. Acetone also leaves a slight residue which should be removed with alcohol in the final cleaning step. Alcohol is the preferred solvent if it can successfully remove the contaminants on the optic.

Handling

1. Access to optics should be restricted to trained personnel.

2. Clean the optics in a clean area away from the machine. Before handling the optics, make sure that your hands are clean, and that a clean, soft working area is prepared with all cleaning supplies ready. Cover the area where optics may be setting with the lens tissue. Finger cots or rubber gloves are recommended.

3. Handle and clean the optics one at a time and avoid unnecessary handling. Leave the optics in their mounts until ready for cleaning and replace them immediately after cleaning. Always handle the optic by the edge only and avoid sliding the optic on its polished surface.

4. Each mirror is held in its mount be a mirror cap fastened with four socket head cap screws and springs. To remove a mirror for cleaning, remove these (4) screws and springs using a 3/32" hex key. Lift the mirror cap off so that the mirror stays in the mount. Gently remove the mirror from the mount.

5. The focus lens is installed with a locknut threaded into the lens holder "drawer" in the cutting head assembly. Slide the lens holder out of the cutting head assembly. Remove the locknut from the lens holder using the tool provided. Remove, clean and re-install the lens optic in the lens holder. An indium seal is located under the lens in the holder. If this seal is removed from the holder, be sure that to re0install if before re-installing the lens. Be sure to install the lens with the curved side facing up. The curve side can be identified by noting that reflected images from the curved side (convex) appear smaller than the reflected images from the flat side.

6. Storage: Spare optics should be wrapped in lens tissue and kept closed in their shipping containers to prevent exposure to contaminants. Store optics in a cool, dry environment.

Cleaning

1. Use an air bulb or clean, dry, filtered air to blow away any loose particles on the surface of the optic. Do not blow on an optic to remove loose particles. The moisture in your breath may damage the optic.

2. Flush the optic with acetone or alcohol and gently wipe with a cotton swab to remove most of the contaminants. Rotate the cotton swab as you wipe so particles on the optic are picked up rather than dragged across the optic.

3. Place a piece of lens tissue over the optic. Moisten the tissue with solvent (acetone or alcohol) and gently drag the tissue across the surface so the solvent just evaporates behind the tissue.

4. After each wipe, discard the tissue and repeat Step 3 with a clean tissue and solvent until the optic is clean. The last time that Step 3 is repeated, use alcohol rather than acetone to remove any residue from the acetone.

5. Inspect the optic for changes in the surface finish and for non-uniform color. If the optic appears damaged, contact CINCINNATI Incorporated Service for further information.

5.2 Nozzle Tip Inspection and Cleaning

Material build-up on the nozzle tip can adversely affect cutting. It is recommended that prior to each shift, and when cutting conditions warrant, the nozzle tip should be removed, inspected, and cleaned (if required).

To remove the nozzle tip, unscrew the threaded collar, which holds the tip, from the laser head. If the tip has evidence of material build-up on the nozzle, or in-and-around the orifice, remove this build-up by lightly sanding the tip. Using weld wire to clean the orifice is also recommended. Wipe the nozzle and nozzle tip clean of all residual particulate.

Replace the nozzle tip by inserting it into the nozzle collar and screwing it back onto the laser head.

5.3 Lens Centering

A misaligned lens will often result in the formation of dross on one side of the cut. If you observe this, verify that the lens is centered correctly. If the lens is centered and you still are getting dross on one side of the cut, try a different nozzle tip.

Materials Required

Masking Tape

Ink pad or felt tip marker

One 1/8" x 2" long hex socket key

One 10X eyepiece

Centering Procedure

1. If the lens is not already in its spring-loaded holder, insert the lens into the holder (curved side of lens up, flat side down) and tighten securely with the tool provided. Inspect both sides of the lens for dirt, and clean the lens if necessary. See Section 5.1 for lens cleaning procedure.

2. Insert the lens holder in the cutting head. Make sure that the lens holder is inserted with the seal down (curved side of lens up). Push the lens holder into the slot against he spring pressure and turn the locking thumbscrew to lock the holder in place. The center of the exposed surface of the lens holders should be flush with the cutting head when the lens holder is installed correctly.

3. Remove the nozzle and insert the brass alignment tip.

4. Apply a small amount of ink to the alignment tip by pressing an inkpad against the tip or by rubbing the tip with a felt marker pen. Place a two to three inch length of masking tape over the orifice in the alignment tip. Press the tape firmly on the tip.

5. Take an alignment shot as described in the appropriate section of the OPERATION, SAFETY and MAINTENACE Manual for your machine.

6. Remove the masking tap, noting the orientation of the strip.

7. Using a 10X eyepiece, look at the burn and impression of the orifice on the tape. A very small burned hole should appear within the impression of the orifice. The objective is to center the hole as closely as possible in the orifice.

8. If an adjustment is necessary, locate the two adjustment screws for the lens. These screws require a 1/8" hex socket key for adjustment. Loosening either screw will move the lens toward the screw. Tightening will move the lens away from the screw. Since the screws are 90° apart, it may be necessary to adjust both screws to move the lens in the required direction.

9. After the adjustment is made, repeat Steps 5 through 8 to check the alignment. A number of adjustments may be required until proper centering is achieved.

10. Remove the brass alignment tip and replace the cutting nozzle. Repeat the centering procedure described in Steps 5 through 9 with the nozzle installed.

5.4 Focus Adjustment

The location of the laser beam focal point is a critical parameter which affects the quality and accuracy of the cutting process. The focal point is different for every lens due to manufacturing and mounting variations.

The diameter of the laser beam remains essentially constant as its travels through the beam delivery system. Beyond the focusing lens in the cutting head assembly, however, the beam diameter decreases with the distance to a minimum at the focal point. Since the total energy of the incoming “raw” beam is concentrated in the small area of the focused spot, the resulting power density is high enough to vaporize or melt most materials. Maximum power density occurs at the focal point . The beam diameter increases beyond the focal point of the lens, unless the beam is absorbed by some material.

The cutting head assembly is designed such that turning the Lens Focus Adjusting Nut (LFAN) changes the distance from the lens to the tip. Adjusting the LFAN thus moves the beam focal point above or below the material surface.

Materials Required

One sheet of 16 gauge (.060”) or thinner mild steel 24’ x 36” (minimum), clamped in place on either pallet.

One set of feeler gages with .004” to .020” gages in .001” increments.

Prerequisites

1. Machine Start procedure completed
2. Warm Up/Calibration procedure completed
3. Lens Centering procedure completed
4. Stand-Off Setpoint Calibration procedure completed
5. A test square program with an internal kerf cut.

Focal Adjustment Procedure

1. Adjust the focus ring to the center of its travel by:

   Contact Head

   Thread the LFAN fully into the cutting head.
   Set the dial indicator to read .500 inch.

Back the focusing ring out 4 turns (the indicator should read .300)

Non-Contact Head

Thread the LFAN fully into the cutting head.
Back out the head three turns.
Measure focal position with the vernier scale and numbers on the focus ring.
(One increment on the LFAN = .005" change in focus)

2. Cut a test square with an internal kerf cut from 16 gauge mild steel. Measure the kerf width with the feeler gages. Record the kerf width and the focus setting on the test square.
3. Change the focal position in .010" increments (.2 turns), then cut test squares at each setting until you find the range of settings where you get the narrowest kerf width.
4. Position the LFAN in the range that produces the narrowest kerf. The focus is now at the top of the material. This will be your reference position for changing focus setting when changing materials.

5.5 Standoff (Non-Contact head only)

Materials Required

Shim Stock (.025" - .075")

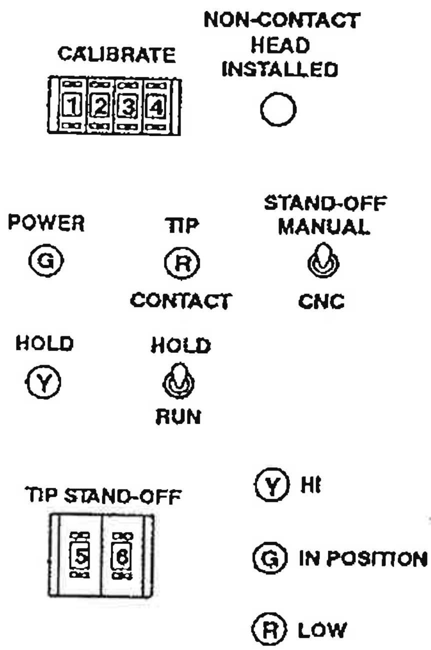
One piece of 16 gauge (.060")

Prerequisites

Machine Start procedure

Procedure

1. Jog the head all the way up
2. With the material on the pallet below the head, adjust the "calibrate" switches until the yellow "hi" indicator is lit and the "tip contact" indicator is off .



CALIBRATION (STAND-OFF SWITCH)

1. JOG THE HEAD ALL THE WAY UP.
2. WITH THE MATERIAL ON THE PALLET BELOW THE HEAD, ADJUST THE "CALIBRATE" SWITCHES UNTIL THE YELLOW "HI" INDICATOR IS LIT AND THE RE "TIP CONTACT" INDICATOR IS OFF.
3. ENTER THE DIMENSION IN THE "TIP STAND-OFF" SWITCHES OF A KNOWN SHIM.
4. JOG THE HEAD DOWN TO REFERENCE MATERIAL ON THE PALLET.
5. FLIP THE "HOLD/RUN" TOGGLE SWITCH TO "HOLD" POSITION.
6. WITH THE SHIM, CHECK THE TIP STAND-OFF DISTANCE. AS NEEDED, CHANGE THE SETTINGS OF "CALIBRATE" SWITCHES IN SMALL INCREMENTS BETWEEN THE SHIM TESTS. INCREASE SWITCH VALUE TO RAISE THE HEAD, DECREASE VALUE TO LOWER IT.
7. FLIP THE "HOLD/RUN" TOGGLE SWITCH TO "RUN" POSITION AND JOG THE HEAD UP. REPEAT STEPS 4 THROUGH 6 UNTIL THE TIP STAND-OFF DISTANCE IS THE SAME AS THAT OF THE "TIP STAND-OFF" SWITCH SETTINGS.
8. WHEN CALIBRATION IS COMPLETE, SET THE TIP STAND-OFF DISTANCE TO THE DESIRED CUTTING HEIGHT.

3. Obtain a piece of shim stock of a known thickness and program the standoff accordingly, via a part program.

4. Flip the toggle switch to the "HOLD" position.

5. Jog the head down to the reference material on the pallet.

6. With the shim, check the tip standoff distance. If needed, change the settings of the "CALIBRATE" switches in small increments between the shim tests. Increase switch value to raise the head, decrease it to lower the head.

7. Repeat steps 5 and 6 until the tip standoff is the same as that of the tip stand-off settings.

NOTE: If the calibration number has changed, note its current value.

8. When calibration is complete, the tip standoff can be programmed using a G89 material library call or a G102 macro call in the part program.

5.6 Laser Power Stability Test

1. Perform laser "Warm-up" procedure (approximately 10 mins)
2. Turn laser beam "OFF" - allow laser to sit with no power for approximately 5 mins
3. Turn laser power "ON" to 100% laser power
4. Using a stop watch - Determine the time needed to achieve 100% laser power
5. Determine the amount of laser power loss in 15 mins
6. Record this information for further reference
7. Record machine hours

Beam Alignment Check - Card Shots at Cutting Head

For further reading see CI Operators Manual Sections: ????

1. Using CI shutter flash timer setting procedure - Set shutter flash timer to approximately .3 seconds
2. Set laser power requested to 100 Watts
3. Turn "Shutter Lock" key to the "Locked" position
4. Position gantry near operator control panel
5. Remove cutting head assembly at the magnetic "breakaway" joint
6. Insert "Cross-hair" alignment fixture into Z-axis (Z-block) - into flange at bottom of Z-block
7. Jog Z-axis to the top of its travel
8. Ensure nozzle purge gas is flowing at specified level
9. Insert a target card into alignment fixture
10. Unlock shutter and turn "Station Enable" key to enable remote station. Arm shutter and turn "Shutter Flash" key. Quickly remove target card noting orientation with axis.
11. Jog Z-axis to the bottom of its travel.
12. Repeat steps 9 & 10
13. Jog Z-axis to the top of its travel
14. Repeat steps 9 through 12 for each corner of the cutting table - Note location and orientation with respect to axis for each card shot.
15. Compare each corner's up/down position alignment shots. They must be the same; HOWEVER, they can be off-center by no more than 0.06".
16. Alignment in the X & Y axis directions must also be within 0.06" centering.
17. If centering is NOT within 0.06" CALL Cincinnati Service for further advice. It may be necessary to re-align X & Y axis beam path.

5.7 Mode Quality Test

1. Perform laser warm-up procedure
2. Remove Cutting nozzle from Z-axis block at the magnetic "breakaway" flange
3. Position gantry/Z-Axis such that the laser beam path is at its greatest length
4. Allow laser to sit with no laser power for 3-5 mins
5. Jog Z-axis to its full up position
6. Get an air hose with a nozzle trigger ready for use in the entire cutting area of the machine
7. Set shutter flash timer for approximately 3 seconds
8. Set laser power requested for maximum power
9. Place an acrylic block below the Z-block such that the laser beam will strike it when commanded - Use a sheet of WOOD as the foundation for the acrylic block
10. ENSURE AREA BELOW Z-AXIS IS CLEAR OF ANY PERSON OR REFLECTIVE MATERIAL BEFORE CONTINUING!
11. Arm shutter on remote station and press shutter flash for a brief time to ensure acrylic block placement
12. Use air hose to keep acrylic vapors from igniting or traveling up into Z-axis
13. Arm shutter on remote station and press shutter flash for approximately 3 seconds - allowing beam to burn into acrylic block
14. Note orientation of acrylic block with respect to X & Y axis
15. This is a "**Cold Mode Burn**"
16. Enable laser beam and allow laser to warm up for 5 mins at full power
17. *AS QUICKLY AS POSSIBLE*: Repeat steps 5 through 14 (Try not to allow more than 1 min to elapse from time the laser beam is turned off till time shutter is commanded to open for mode burn - we need laser optics to remain HOT)
18. This is a "**Hot Mode Burn**"
19. Lock Shutter
20. Move gantry & Z-axis such that the X & Y beam path is at its shortest length
21. Repeat steps 4 through 19
22. Compare mode burns with Cincinnati original mode burns and mode burn standards
23. Mode burns MUST be symmetrical and have the "cold" spot be centered within ±10% of burn's diameter
24. If there are any discrepancies please call Cincinnati Service for further advice