



OPERATION AND MAINTENANCE MANUAL

Model ULS 1720C

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INTRODUCTION

The ULS series of Laser Processing Systems are designed to provide the user with the flexibility of computer control combined with a wide variety of functions.

The main features of the ULS 1720C system are:

- Air cooled, RF driven 20 watt CO₂ laser based on the latest technology in sealed carbon dioxide devices.
- Digital laser controller providing a wide range of parameters for material processing.
- Class I safety enclosure.
- Fast X-Y laser beam positioning system for quality laser processing at high speed.
- Large material processing area.
- Extended vertical adjustment.
- Two types of computer interface -- parallel (Centronics) and serial (RC-232C).

Note: Serial interface is not available if the High Speed Raster Engraving Option is installed.

- A variety of controls for quick setting of parameters.
- Complete emulation of HP 7475 and Roland DXY 1300 B size plotters.
- Compact design.

SECTION 1 - SAFETY

Please read this section before operating the equipment.

1.1 SAFETY SUMMARY

1. Exposure to laser radiation may produce physical burns and can cause severe eye damage.
2. Exposure to the beam may cause ignition of combustible materials.
3. **When operator or maintenance personnel are working with the laser beam "ON" and any of the safety interlocks defeated, or covers removed, laser safety glasses must be worn.** Care must be exercised not to place one's self or reflective objects in the path of the beam. Never view laser beam radiation directly or by specular reflection. Failure to wear appropriate eye protection can result in severe eye damage. Please contact ULS with any questions concerning laser safety before operating the system.
4. Operation and maintenance must be accomplished in accordance with this manual.
5. The laser in this system emits radiation at a wavelength of 10.6 microns in the infrared invisible spectrum.
6. A solenoid operated shutter is located between output of the laser and top compartment of the system. In the OFF position the shutter completely blocks the laser beam before it enters the work area. Shutter control is located on the lower right corner of the system control panel. When the shutter switch is open, the LED is on. If any interlocked doors are open, the shutter blocks the beam regardless of the position of shutter control switch.

NOTE: The LED indicates only whether the shutter switch has been set to open or closed. It does not indicate the physical position of the shutter itself.
7. Under regulations established by the Center for Devices and Radiological Health of the Food and Drug Administration, the laser contained in this system is a Class IV instrument. ULS systems are Class I instruments as long as no interlocks are defeated and cover panels are not removed.
8. Improper use of controls and adjustments or performance of procedures other than those specified in this manual may invalidate the Class I rating and result in hazardous laser radiation exposure.
9. ULS systems are specifically designed to comply with CDRH performance requirements under 21CFR 1040.10 and 1040.11. No guarantees of suitability or safety are provided for any use other than those specified by Universal Laser Systems, Inc.

1.2 SAFETY LABELS

According to CDRH standards, all interlocked and non-interlocked covers that allow access to a Class IV laser beam **must** have appropriate laser safety labels attached to them. These labels must be visible to personnel prior to the removal of the covers. Additional labels must be installed inside the machine and be visible if the covers are removed from the machine.

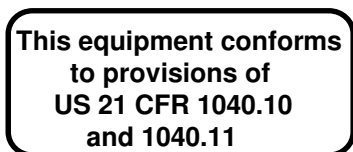
Labels that provide manufacturer's name, date of manufacture, description of product, model number, serial number and compliance statement must also be visible on the outside of the machine. All CDRH required labels are properly affixed to the machine in the appropriate locations at the time of manufacture. These labels are not to be removed. If they become damaged or removed for any reason, please request additional labels from the manufacturer.

1.2.1 EXAMPLES OF SAFETY LABELS

Label Positions



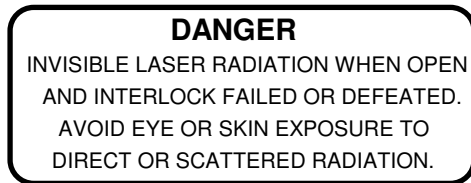
Lower left corner of rear panel, on the outside of the machine



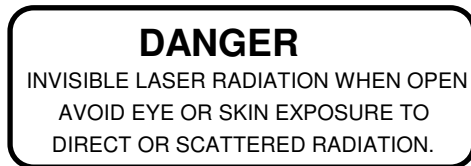
Lower left corner of rear panel below manufacturing label (see above label information).



Above beam entrance aperture in top compartment.



Interlocked Panels



Non-interlocked Panels

Label Positions

Inside front door (visible when door is open).

Bottom panel (visible when door is open)

Inside top door (visible when door is open).

Rear panel of top compartment (visible when top cover is removed).

One on each side of interlock defeat tool (visible when interlock tool is installed).

Bottom panel on the right and left sides and in the back (visible when front door is open and through lexan panels).

1.3 SAFETY INTERLOCK

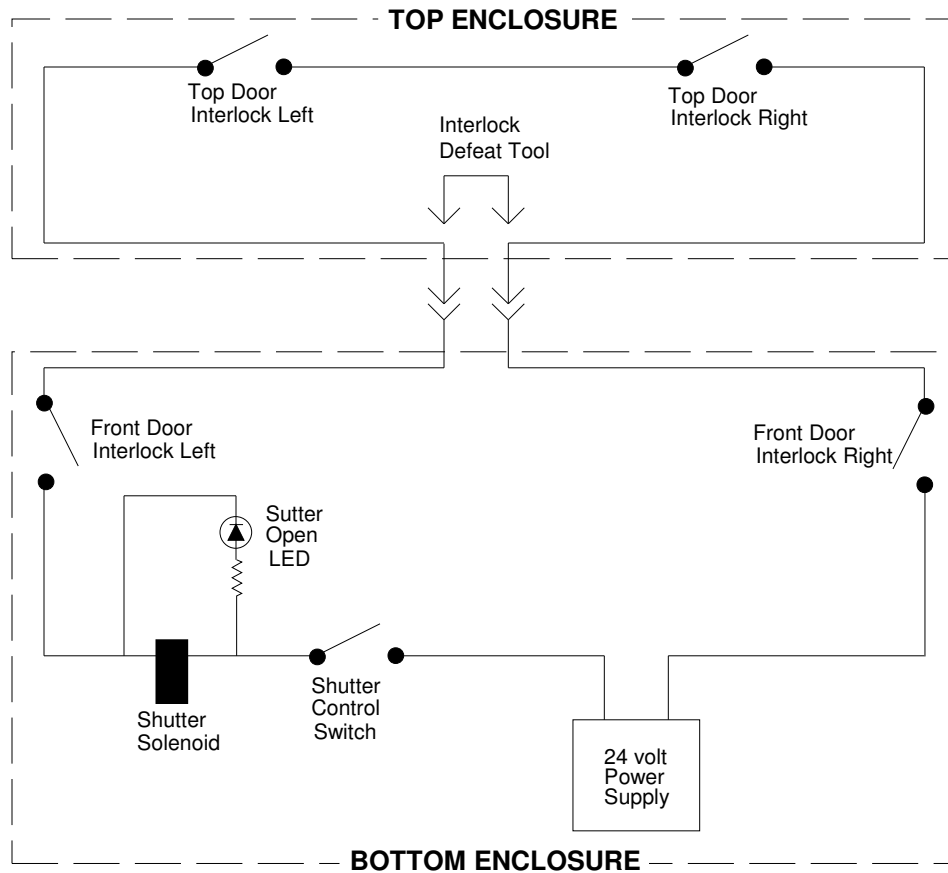
The laser system incorporates a safety interlock having an electrical potential of 24V DC between terminals. When the top enclosure of the chassis is removed, the terminals of the interlock connector at the front of the enclosure are no longer in contact and the laser beam will be blocked by the shutter. A shorting plug, called an interlock defeat tool, is provided to override the safety interlock for testing and alignment procedures only. The diagram below is an electrical schematic detailing the interlock system and the interlock defeat tool.

Caution: The interlock defeat tool is utilized only when the top enclosure must be removed for testing purposes and beam alignments. **Laser safety glasses must always be worn when the defeat tool is in use.** Failure to wear appropriate eye protection can result in severe eye damage.

1.4 ELECTRICAL SAFETY

A NEMA type 1 service box mounted to the right side of the machine contains all of the exposed 120 Volt AC in the system. The box incorporates a lockable electrical disconnect and a screw driver is required to open the lid. This box should only be accessed by qualified service personnel

and only for the purpose of servicing the equipment contained within. The service box should remain closed at all other times.



Electrical Schematic of Interlock System

SECTION 2 - INSTALLATION

2.1 CAUTIONS

- Install the system on a flat stable base 18-24" high, only in the upright position. Ideally, the top of the system should be mid thigh to waist high.
- Avoid places where the system may be exposed to high temperatures, dust, or high humidity (humidity exceeding 60% or where the temperature is near the dewpoint).
- Avoid places where the system may be exposed to high levels of vibration or electrical noise. We recommend using a high quality surge protector (20 Amp capability) to protect the laser system's electronics.
- The power supply cord and input/output cables for the computer should be connected firmly to avoid disconnection or malfunctioning during operation. Use grounded (3 prong) outlets only. Do not defeat the ground connection under any circumstances.
- When the power is turned on, the system performs an automatic origin setting procedure and the arm and focusing optics carriage move. Keep hands or objects out of the path of the arm/optics carriage.
- When not using the system, unplug the power cord.
- NEVER lubricate any of the mechanical parts!
- Do not apply any pressure or shock to the arm or optical carriage.
- When the X-Y rails become dirty, wipe them off with a soft dry cloth. If the dirt is severe, wipe it off lightly with alcohol. Do not use water. **Do not use silicone-impregnated cloth, neutral detergents or organic solvents.** See the maintenance section for details on cleaning of the system.
- Do not move arm or optical carriage manually if the power to the system is on!

2.2 SET UP PROCEDURE

The following is a description of the basic procedure for connecting the ULS 1720C laser system to a computer for the first time:

1. Install the system on a flat, stable stand. A stand from 18 to 24 inches in height will provide the most comfortable working height. Custom designed, ergonomic stands are available from ULS.

2. Connect the fume exhaust tube on the machine to an external exhaust unit (see the exhaust system section below for details). (For the optional ULS closed loop exhaust, connect the two hoses between the laser system and the filtration unit and plug the filtration unit into an AC power source.)
3. Connect the laser system to the computer. Both serial and parallel connections are available. (The system is set for parallel connection at the factory.) Most software is set to run in parallel mode, so switching interfacing to serial mode is not normally required.

Note: Serial interface is not available if the High Speed Raster Engraving Option is installed.

If your software requires serial interfacing, continue with Steps 4-7, otherwise skip to step 8.

4. The cover must be removed to access the DIP switches. To Remove the top enclosure:
 - a. Loosen enclosure hold down screws inside front door at the left and right side that go up through the frame. Remove knob for Z stage (table height adjustment).
 - b. Tilt the front of the enclosure up approximately two to three inches until the enclosure can be pulled forward without obstruction.
 - c. Carefully pull the enclosure forward and up until off of the machine. Set the cover out of the way being careful not to scratch it.
5. Set the type of interface to serial using the DIP Switches. Refer to the DIP switch location section below and Appendix A DIP Switch Settings Table.
6. Set the communication parameters for the serial port using the DIP switches. Refer to the DIP switch location section below and Appendix A DIP Switch Settings Table. The proper communication parameters will depend on the computer and software being used, refer to the computer and software manuals for details.
7. After the setup for serial communication is completed, replace the top cover.
8. Connect the AC power cord.

The system is now ready for initial power up. Turn to Section 3 - Operation for details.

2.2.1 VENTILATION PROCEDURES

To properly exhaust fumes and smoke from the material surface during processing, an exhaust unit moving a minimum of 400 cfm of air is required. Rigid duct work should be used between the blower unit and the laser system. Use duct work with a diameter that matches the blower unit and reduce the duct work to four inches just before the point of attachment to the laser system.

Locate laser system where a straight connection to the duct work can be achieved. A short piece of flexible hose should be used to connect the laser system to the rigid duct work.

The exhaust system should be equipped with an on/off switch and wired in accordance with local electrical codes. We recommend plugging the laser system into a 110V switched outlet, controlled by the on/off switch for the ventilator, to ensure the laser system cannot be operated without the ventilator. It is also advisable to power the laser system through a surge protector to prevent damage to the electronics and laser.

Installation of the ventilation system should comply with all applicable local and government regulations. We recommend the use of licensed contractors for installation of the exhaust system.

2.2.2 CONNECTION WITH COMPUTERS

There are two methods for establishing a connection with the computer:

- Parallel connection (Centronics)
- Serial connection (RS-232C)

Note: Serial connection is not available if the High Speed Raster Engraving Option is installed.

The system is set for a parallel connection at the factory. This will work well with the majority of computers and software packages. To change to a serial interface connection refer to the "DIP Switch Setting Table" in Appendix A and set the DIP switch settings to match the settings required by the software being used.

2.2.3 DIP SWITCH LOCATION

There are two DIP switch blocks on the main control board for the laser system and the cover must be removed to access them. Each block contains ten switches and the two blocks are referred to as DIP Switch one and two.

1. DIP Switch 1 - Located on the right side of the system (under top enclosure) on the printed circuit board with the parallel and serial interface connections. DIP Switch 1, marked "DSW1", has 10 small switches, and is located next to the parallel interface connection.

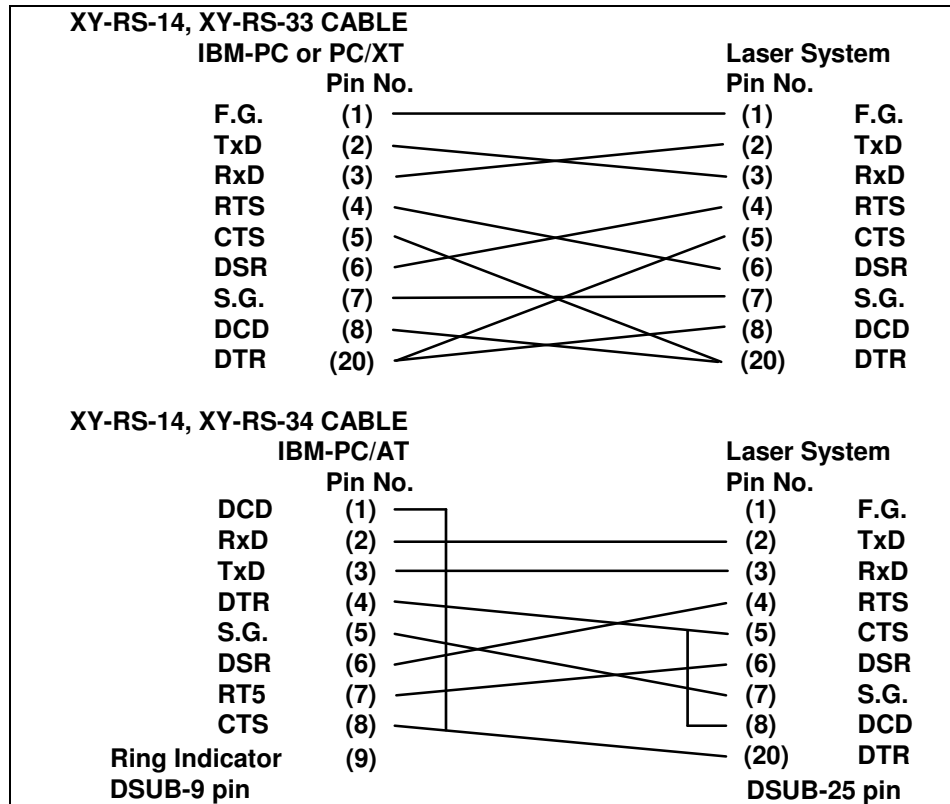
This switch is used to select the interface (parallel or serial), set field size, and character font, etc. For details refer to "DIP Switch Setting Table" in Appendix A.

2. DIP Switch 2 - Located on the right side of the system (under top enclosure) on the printed circuit board with the parallel and serial interface connections. DIP Switch 2, marked "DSW2", has 10 small switches, and is located next to DIP Switch 1.

This switch is used to set the data format and baud rate when the serial interface is used. For details refer to the "DIP Switch Setting Table" in Appendix A.

2.2.4 RS-232 SERIAL CABLE CONFIGURATION

To use the serial connection on the laser system, the proper serial cable must be used. The diagram below describes the serial cable configuration required.



SECTION 3 - OPERATION

3.1 BASIC OPERATING PROCEDURE

1. Turn power to the system ON.
2. Insert the material to be processed.
3. Adjust the focus (reference Section 3.8).
4. Close all access doors.
5. Choose a laser power setting (reference Section 3.6).
6. Set the processing speed (reference Section 3.5) (can also be set from software).
7. Be sure the shutter switch is in the open position.
8. Be sure the external exhaust is on.
9. Transmit drawing data from the computer.

Laser processing of the material should now begin.

3.2 TURNING THE LASER SYSTEM ON

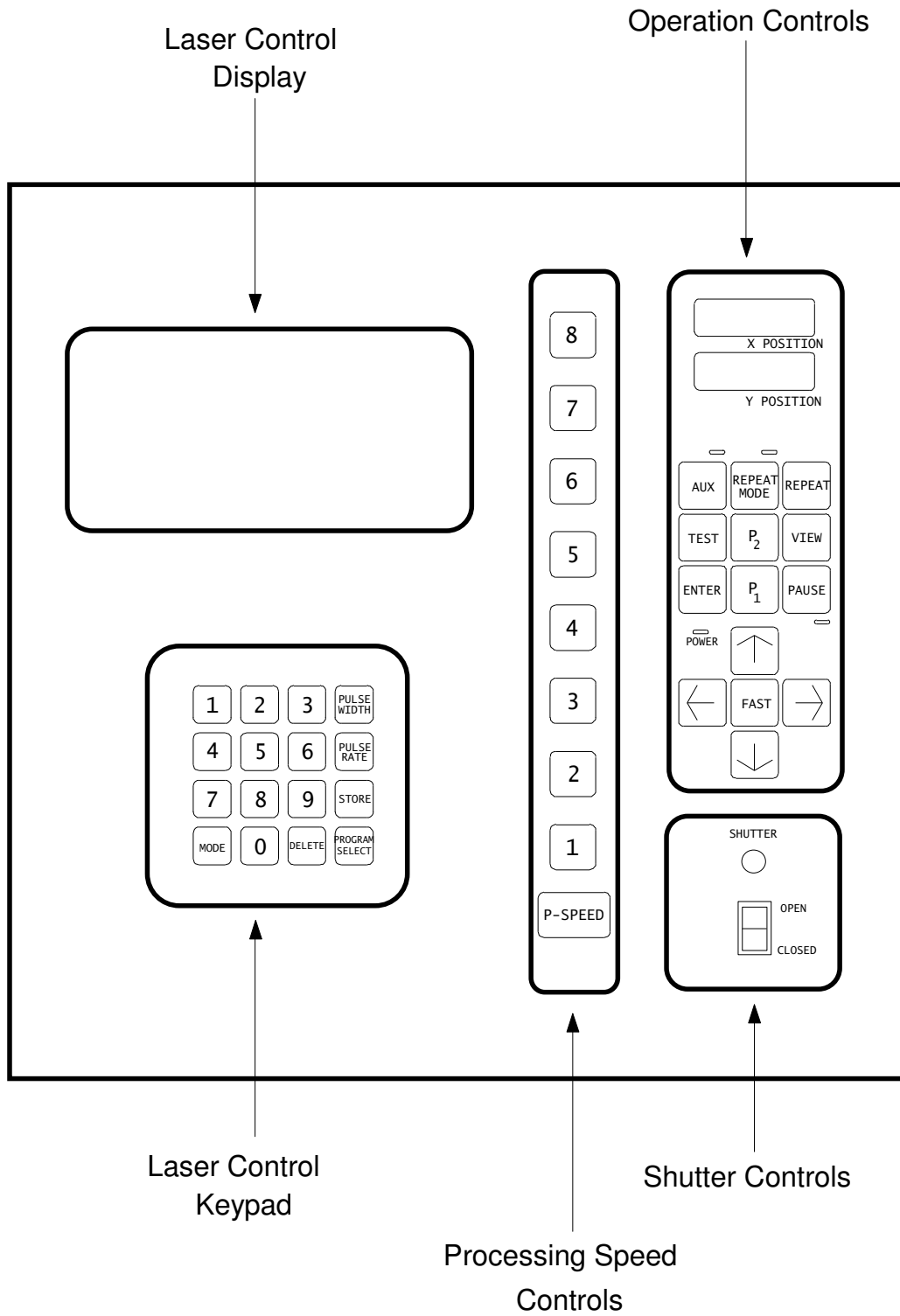
Power to the system is controlled by two momentary pushbutton switches found on top of the electrical service box mounted on the right side of the system. To turn the system on press and release the green on switch. To turn the system off press and release the red off switch. Do not block movement of the motion system when turning the power on.

NOTE: The service disconnect lever on the side of the service box is for use of qualified service personnel only. This lever should be left in the on position.

3.2.1 EMERGENCY OFF SWITCH

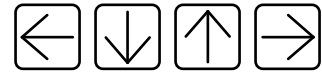
An emergency off switch located on the top of the service box is provided for operator safety. In the event of an emergency the mushroom shaped emergency off switch can be pressed and power to the system will be shut off. Power can not be restored to the system until the emergency off switch is manually reset by twisting the mushroom cap in the direction indicated on the switch. Once the emergency off switch is reset the system can be turned on in the normal manner by pressing the green on button.

3.3 CONTROL PANEL LAYOUT



3.4 OPERATION CONTROLS

POSITIONING KEYS



These keys are used to move the focusing optics manually in any of the arrow directions (four directions) indicated on the keys. Pressing two adjacent keys together moves the optics carriage in a diagonal direction.

FAST KEY



Pressing this key together with an arrow POSITIONING key increases the positioning speed at which the optics carriage moves.

REFERENCE POINT KEYS - P₁ AND P₂



Pressing the P₁ or P₂ keys will move the optics to the lower left or upper right corners, respectively, of the engraving area. These keys are typically used to position the system for checking power or performing a beam alignment. They can also be used in conjunction with the Test key to manually mark lines on material to indicate the edges of the engraving field or as alignment marks.

VIEW KEY



Pressing this key causes the focusing optics carriage to move to the upper right corner (VIEW position) of the system.

PAUSE KEY AND LED



When this key is pressed once during processing, the PAUSE LED light illuminates and motion of the optics is temporarily halted. Pressing this key once more turns the PAUSE LED off and allows operation of the system to resume. If the system is paused for more than one minute, the optics carriage will move to the view position (extreme upper right). In either case, the system will resume operation at the point the pause was initially activated.

CAUTION: If the laser is in Continuous pulse mode (see section 3.6), the Laser beam might be on during pause. To prevent damage to work piece, always close shutter switch (located on control panel) prior to pressing PAUSE key.

REPEAT MODE KEY AND LED



Used to temporarily store drawings that are being sent by the computer. This function allows the user to repeat the processing of a drawing while freeing up the computer for other tasks. To use, press the Repeat Mode key and note that the Repeat Mode LED should illuminate (indicating that all incoming drawings will be stored). Next, send the drawing to the laser system from the computer. The laser will process the drawing and simultaneously store the drawing in the laser system's memory. The computer can be used for other tasks once the drawing has been stored. To repeat the drawing stored in the laser system memory, press the Repeat key (next to the Repeat Mode key). To turn off the Repeat Mode and erase all stored drawings, press the Repeat Mode key again and note the Repeat Mode LED has gone dark (indicating that all drawings have been erased).

CAUTION: Turning off the laser system power will erase all drawings in the repeat mode memory.

NOTE: The repeat mode will continue to store drawings until it is full (the capacity is 1 megabyte). If multiple drawings are stored in memory, pressing the repeat key will cause all of the stored drawings to be processed in the order they were received. If the 1 megabyte limit on memory is exceeded, the laser system automatically turns off repeat mode (REPEAT MODE LED goes out) and erases all the drawings.

NOTE: Repeat mode is not functional if the High Speed Raster Engraving Option is used to engrave bitmapped or filled images. The repeat mode and high speed raster engraving option can only be used together to engrave vector or outline images.

REPEAT KEY



Pressing this key will repeat the drawings stored in the laser's repeat mode memory, starting with the first drawing stored after the REPEAT MODE key was pressed.

RESET FUNCTION

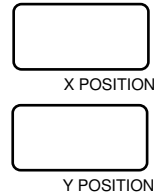


If the ENTER KEY is pressed and held down, then the VIEW KEY is pressed, the system will perform a soft reset similar to turning the power on and off. This procedure is often sufficient for resetting the machine after a communication error has occurred. If a more drastic reset of the system is necessary, the power switch can be turned off and on.

POWER L.E.D.



Normally this indicator is illuminated and not flashing when power to the laser system is on. If a communication error occurs, the indicator will begin flashing. A communication error is caused by either an improper connection to the computer or the transfer of an unknown command from the computer. If the L.E.D. begins flashing, identify and remedy the source of the error and then reset the system.



X-Y COORDINATE DISPLAY

This displays the position of the focusing optics carriage in millimeters from the extreme lower left of the current engraving field.

AUX. KEY AND LED



Not used - Aux. Key may light when PAUSE or REPEAT MODE are used.

TEST KEY



Used to manually turn the laser power on and off. This key is used to perform beam alignments, power tests and to manually mark origins (with arrow keys), etc. A dot will appear to the right of the pulse mode character in the laser control display when the laser is on (see section 3.6 for details).

3.5 SHUTTER CONTROLS

The shutter controls are used to open and close the mechanical solenoid driven shutter which blocks the beam and stops it from entering the engraving area. The switch will provide power to open and close the shutter and the LED will glow when the shutter switch is in the open position. If any interlocked doors are open, the shutter will close to block the beam regardless of the position of the shutter control switch.

NOTE: The LED indicates only whether the shutter switch has been set to open or closed. It does not indicate the physical position of the shutter itself.

3.6 PROCESSING SPEED CONTROLS

ULS Laser Systems are capable of beam positioning at a maximum speed of 42 cm/sec and this is the default speed selected when the laser system is powered on. However, for optimum performance processing speed can be adjusted. The proper processing speed will be dependent

on the material being used, the type of engraving or cutting being performed, and the depth of material removal required.

There are two methods for adjusting the processing speed:

1. Control Panel Processing Speed Adjustment:

SPEED SELECT KEYS



Press and hold the P-speed key on the control panel then press one of the processing Speed keys (1 to 8) to change the processing speed. The processing speed set by each speed key is as follows:

P-Speed Key No.	Processing Speed (cm/sec)	Processing Speed (inch/sec)
1	3	1.2
2	4	1.6
3	6	2.4
4	9	3.5
5	12	4.7
6	16	6.3
7	22	8.7
8	42	16.5

Processing speed can also be adjusted during engraving, and this is helpful in identifying the best speed for a particular engraving or cutting job. But, if processing speed is being controlled by software, speeds should not be adjusted manually during engraving.

2. Computer Software Package Processing Speed Adjustment

Since the ULS 1750Y Laser System emulates an HP-GL plotter device, drawings sent to the laser system from many software packages can include a processing speed which is analogous to the plotter pen speed for a plotting device. See your software manuals for information on how to select plotter pen speeds.

Example:

Using DesignCAD, from within the plot dialogue box the HP-GL command for pen velocity "VS" can be entered with an appropriate speed 1-42 cm/sec (this is an HP-GL velocity command in cm/sec and should not be confused with the P-Speed numbers on the control panel) before sending the drawing to the laser system.

If software resident in Windows is being used, the processing speed can be set through the ULS Windows printer driver. The procedure for setting speed is explained in the documentation included with the driver. (This driver is required if Windows is being used and can be purchased from ULS.)

NOTE: If software is being used to control speed then the speed at the control panel should be set to P-SPEED 8.

NOTE: The processing speeds referred to above represent only the maximum straight line speed of the positioning system. The system will accelerate and decelerate as it moves and may never reach the maximum processing speed in a complex vector drawing with many curves and small line segments.

3.7 LASER CONTROLS

For optimum engraving performance, the ULS Laser Systems have been designed so that the laser's power output is directed by a digital control board. This control board produces a square wave type signal which is essentially a sequence of on and off commands which cycle the laser at high speed. The Laser Control keypad is used to enter the parameters for the TTL (square wave) signal which drives the power output of the laser, and an LED display window is provided to visually display the settings for the laser control signal.

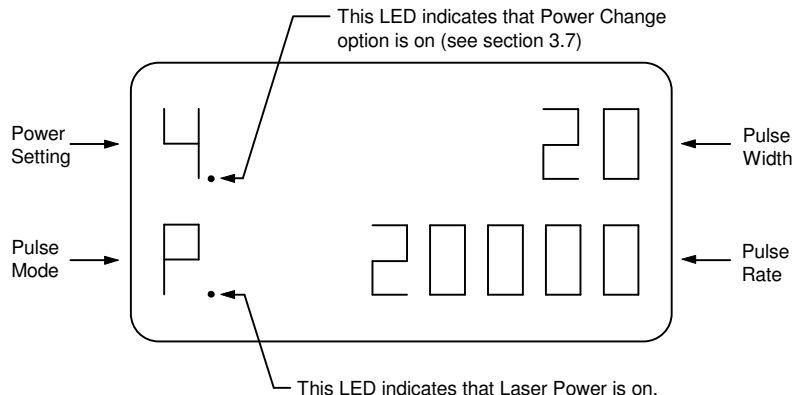


Figure Showing Typical Laser Control Display

There are three parameters which must be entered to define the characteristics of the signal sent to the laser, these are pulse width, pulse rate, and pulse mode. Pulse width is entered in microseconds and defines the length of time the laser remains on during a pulse cycle. The pulse rate is a relative number and its meaning is dependent on the pulse mode being used.

There are two pulse modes to choose from:

- Proportional Pulse Mode (PPM)

Proportional pulse mode will be used for most cutting and engraving operations. PPM will provide an even exposure of laser radiation to the material and eliminate variations in depth and line thickness due to acceleration and deceleration of the optical arm. This even exposure is obtained by linking the laser control pulses with the movement of the motion system. In this way the number of pulses per unit of travel can be made constant and even exposure of the material to laser radiation can be obtained. In PPM the pulse rate of the laser control signal is defined in pulses per unit of travel. The lower left corner of the display will indicate "P" if proportional pulse mode is active.

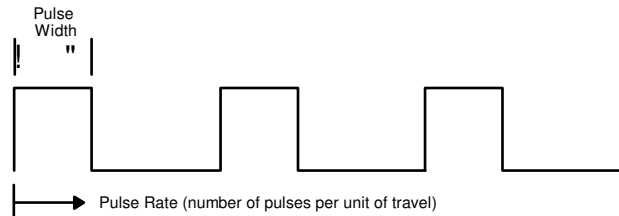


Figure showing laser control signal in proportional pulse mode

- Continuous Pulse Mode (CPM)

In continuous pulse mode, pulse width and pulse rate are both measured in microseconds and the pulse rate is defined as the time that elapses between the start of one pulse and the start of the next pulse. CPM may be used when engraving or marking materials such as coated metals where a higher degree of removal is required; or when cutting materials such as acrylic. CPM can be used only on materials that are not sensitive to laser beam overexposure which can occur during acceleration and deceleration of the optical carriage in continuous pulse mode. The lower left corner of the display will indicate "C" if continuous pulse mode is active.

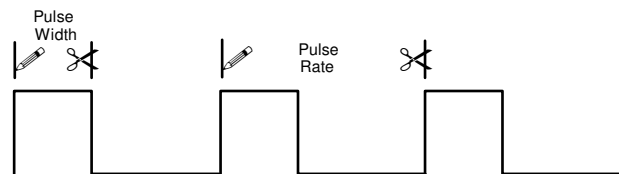


Figure showing laser control signal in continuous pulse mode

To Set Laser Control Parameters:

The ULS Laser Systems have the ability to store 10 different laser power settings. Each power setting is made up of the three laser control parameters discussed earlier. Each power setting is identified by a number 0 through 9.

1. Press the PROGRAM SELECT key to enter power setting program mode (the power setting number, in the upper left corner of display will start to blink). Then select the power setting number 0 through 9 on the keypad to bring up the stored power setting to

be edited. The power setting number selected should appear blinking in the upper left corner of the display panel along with the previously stored laser control parameters. Editing is then performed as follows:

To change Mode:

- a. Press Mode key to select the desired mode (P = PPM; C = CPM, \equiv =OFF)

To set Pulse Width (0 - 1400):

- a. Press PULSE WIDTH key and the pulse width data in upper right corner of the display will start blinking.
- b. Enter new pulse width data with number keys, or edit with the DELETE key then enter new data
- c. Press PULSE WIDTH key to set the new pulse width

To set Pulse Rate (10 - 39999):

- a. Press PULSE RATE key and pulse rate data in the lower right corner of the display will start blinking
- b. Enter new pulse rate data with number keys, or edit with DELETE key then enter data
- c. Press PULSE RATE key to set the new pulse rate

2. Repeat step 1 until all desired power settings are stored.
3. Press the STORE key to exit the power setting program mode.
4. After all of the desired power settings have been stored, it is a good idea to permanently save the programmed settings so that they will not be lost when the laser system is turned off. To permanently save the settings, press in rapid sequence the zero key, the store key, and the mode key. The entire display will blink once to indicate that the power settings are permanently stored.

NOTE: A power setting can be adjusted during laser processing but do not attempt to permanently store the setting as described in step 4 above while the system is processing.

To Recall Stored Power Settings:

During normal operation the laser system will use the power setting which is currently displayed on the control panel. To recall a different stored power setting for use, press in sequence the program select key, the power setting number which contains the desired power setting, and the store key.

3.8 SOFTWARE CONTROLLED POWER CHANGE (OPTIONAL)

The ULS Laser Engraving Systems have the optional ability to accept software commands to change power settings before and during engraving, which comes from the fact that the laser systems emulate an HP-GL plotting device. The power setting numbers mentioned in section 3.6 are analogous to the pen numbers used in HP-GL to change pens on a plotter. A color in a software package assigned a pen number will be processed using the corresponding stored power setting. Once the power settings have been stored as described in section 3.6, accessing a power setting using software is only a matter of assigning the appropriate color to a particular portion of a drawing.

The color/pen number combinations vary between software packages and it is best to consult your software manual to find out which colors correspond to which pen numbers. Many software packages also give the user the ability to assign a color or several colors to a pen. If Microsoft Windows is being used, the color pen/number combinations are found in the ULS Windows Printer Driver. Use of the driver is explained in the documentation which comes with it. (The ULS Windows Printer Driver is required if Windows is being used and can be purchased from ULS.)

Turning the Power Change Option on and off:

Power Change ON  and 

Power Change OFF  and 

The power change option can be turned on and off by pressing a sequence of keys. If the option is turned off the machine will operate in manual mode as described in section 3.6. To turn the option on, press in sequence the 0 and 8 keys and to turn the option off, press in sequence the 0 and 9 keys. A dot will appear on the display to the right of the program number to indicate that the option is turned on.

3.9 FOCUSING PROCEDURE

Laser processing should be done with the laser beam focused on the top surface of the work piece. The focal length of the standard optics, provided with the system, is 2.5 inches. To find the proper focus position for the work piece, measure the distance between the top surface of the work piece and bottom of the focusing lens housing. Adjust the Z axis so the distance between the two is 2.5 inches. The laser system can accomodate materials up to 10.5 inches (11.5 inches

with high resolution optics) thick provided the material fits within the engraving area. A convenient focusing tool with the proper length for the standard optics is provided with the system. To use this tool follow the instructions below.

To use the focusing tool with the system:

- a. Set the focus tool base on the top surface of the material to be processed.
- b. Move the Z axis stage down by turning the crank knob at the top of the system counterclockwise until the flat of the focus tool can be placed flat against the round lens holder as in the diagram below.
- c. Observe the top of the focus tool. Now raise the Z axis stage (by cranking the knob clockwise) until the focus tool just starts to tilt away from the lens holder as shown in the diagram below. Back the Z stage down again slightly so the focus tool again sets flat against the side of the lens holder. This is the proper focus distance for the lens.

CAUTION: Do not apply force on the optics, housing or arm. Severe damage may result! Don't position the focus tool under the lens - lens damage may occur.

NOTE: The focal length of high resolution optics is 1.5 inches. The 2.5 (standard resolution) and 1.5 (high resolution) lenses require different focus tools.

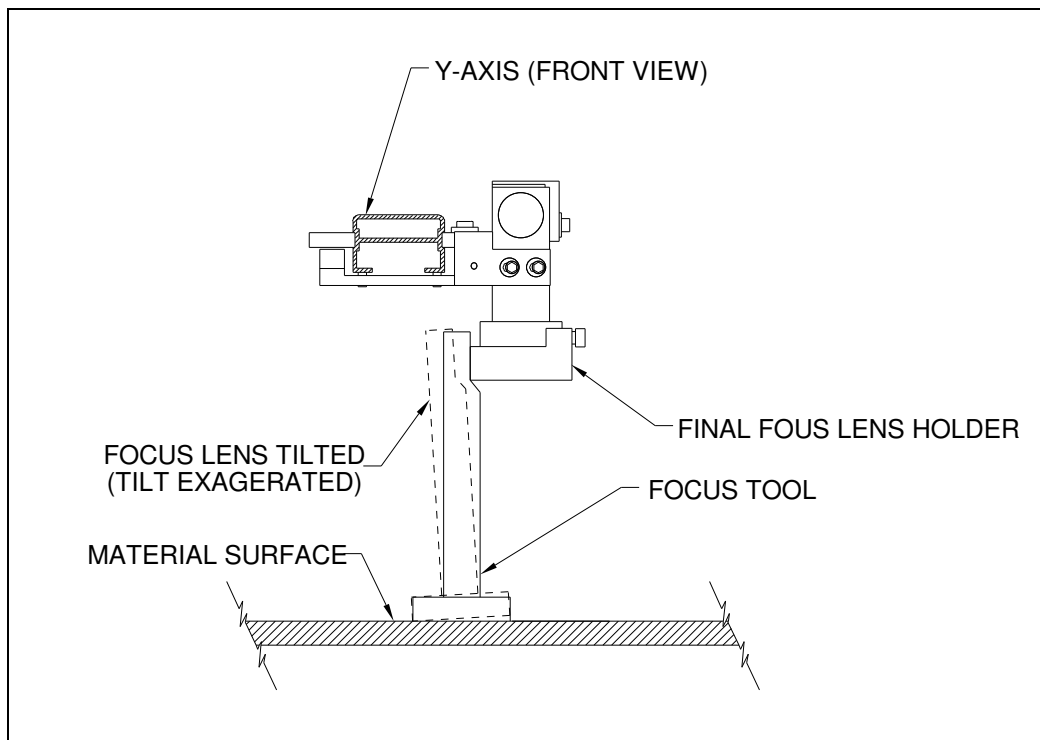


Diagram of Focus Tool Use

3.10 COMMAND SYSTEM

The ULS laser systems emulate an HP-GL plotting device and therefore are controlled by a built in library of HP-GL Commands. The HP-GL command set used is actually RD-GL-I which is a superset of HP-GL commands written by Roland Digital Corporation. Some of the characteristics of this command language are listed below.

1. There are 56 types of command.
2. Several commands must be combined to execute one action.
3. The commands can be used to write custom software applications.
4. They permit high definition engraving. (Enlargement, reduction, origin movement, window clipping and terminator definition among others.)

When using commercial software, the user does not need to understand RD-GL-I, since the software will perform the conversions to RD-GL-I invisibly before outputting to the laser system. However, if the user desires to write custom software applications, a reference manually detailing the RD-GL-I command language is available from ULS.

3.11 VIEW POSITION INDICATOR

A green dome light mounted on the top of the system just above the control panel will light up to indicate that the motion system is in the home position. The home position in the upper right corner of the engraving area is the position the motion system returns to when the machine is idle. The indicator is useful for signaling that the laser system is finished with a task and ready to begin a new task.

3.12 LASER PROCESSING AREA

The range and maximum processing area of the ULS engraving systems will vary according to the field size selected by the DIP switches.

The origin of each field will lie at the bottom left corner of the field. The following table shows the areas for each standard field size. The DIP switches are set to the expanded field size at the factory providing the maximum processing area (17 x 11.69"). This is the most useful size for the majority of users since it allows the full engraving area to be accessed at all times and it is recommended that the machine be operated in this configuration. (To change the field size, refer to Appendix A - DIP Switch Settings Table and Section 2.2.5 DIP Switch Location.)

NOTE: Setting the field size for the Laser System will not guarantee access to the entire field unless the software being used is configured with the same page size dimensions. For the procedure required to configuring software page size please consult the software manuals for the program being used.

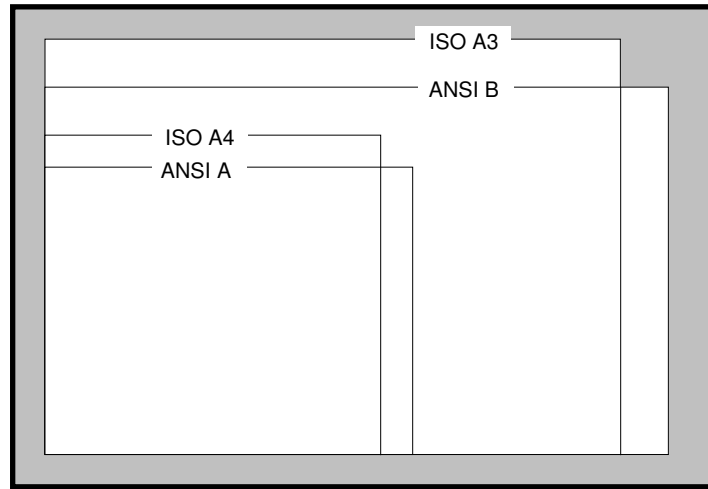


Figure showing Field sizes superimposed on the engraving table

Field Size	Maximum Processing Area	DIP Switch Settings		
		SW1-6	SW1-7	SW1-8
420 x 297 mm	403.95 x 276 mm	OFF	OFF	OFF
297 x 210 mm	276 x 193.025 mm	OFF	ON	OFF
431.8 x 279.4 mm 17 x 11 in	416 x 259.125 mm 16.37 x 10.20 in	OFF	OFF	ON
279.4 x 215.9 mm 11 x 8.5 in	259.125 x 199.05 mm 10.20 x 7.83 in	OFF	ON	ON
Expanded	431.8 x 297 mm 17 x 11.69 in	ON	--	--

SECTION 4 - MAINTENANCE

Please read the safety summary before performing any maintenance procedures.

4.1 SAFETY SUMMARY

1. Exposure to laser radiation may produce physical burns and can cause severe eye damage.
2. Exposure to the beam may cause ignition of combustible materials.
3. **When operator or maintenance personnel are working with the laser beam "ON" and any of the safety interlocks defeated, or covers removed, laser safety glasses must be worn.** Care must be exercised not to place one's self or reflective objects in the path of the beam. Never view laser beam radiation directly or by specular reflection. Failure to wear appropriate eye protection can result in severe eye damage. Please contact ULS with any questions concerning laser safety before operating the system.
4. Operation and maintenance must be accomplished in accordance with this manual.
5. The laser in this system emits radiation at a wavelength of 10.6 microns in the infrared invisible spectrum.
6. A solenoid operated shutter is located between output of the laser and top compartment of the system. In the OFF position the shutter completely blocks the laser beam before it enters the work area. Shutter control is located on the lower right corner of the system control panel. When the shutter switch is open, the LED is on. If any interlocked doors are open, the shutter blocks the beam regardless of the position of shutter control switch.

NOTE: The LED indicates only whether the shutter switch has been set to open or closed. It does not indicate the physical position of the shutter itself.
7. Under regulations established by the Center for Devices and Radiological Health of the Food and Drug Administration, the laser contained in this system is a Class IV instrument. ULS systems are Class I instruments as long as no interlocks are defeated and cover panels are not removed.
8. Improper use of controls and adjustments or performance of procedures other than those specified in this manual may invalidate the Class I rating and result in hazardous laser radiation exposure.
9. ULS systems are specifically designed to comply with CDRH performance requirements under 21CFR 1040.10 and 1040.11. No guarantees of suitability or safety are provided for any use other than those specified by Universal Laser Systems, Inc.

4.2 GENERAL CLEANING

Perform a visual inspection of the machine at least once a day. If dirt or debris is present a general cleaning should be performed. The frequency of cleaning will depend entirely on the type of material being cut or engraved. Dirt allowed to build up in any parts of motion system will cause uneven engraving or loss of position as well as damage to optics and premature failure of the motion system components. Use good judgment and keep in mind that a clean machine is the best performing machine.

NOTE: The rails of the system should be wiped down with a dry lint free cloth at least once a day regardless of whether a general cleaning is required. This will guarantee longer bearing life.

General cleaning procedure:

1. Ensure system power is off and power cord is unplugged and remove top cover as follows
 - a. The cover is removed by loosening two screws that go up through the frame just inside the front door at the left and right sides of the frame (reference Figure 1) Also, remove knob for Z stage (table height adjustment)
 - b. Tilt the front of the enclosure up approximately two to three inches until the enclosure can be pulled forward without obstruction.
 - c. Carefully pull the enclosure forward and up until off of the machine. Set cover out of the way being careful not to scratch it.
2. Thoroughly remove all loose dirt and debris from the interior of the machine being careful not to scratch the lexan surfaces.
3. With engraving table fully in the up position, clean engraving table surface with glass cleaner and paper towel.
4. Move engraving table down to bottom position and clean the linear slide which moves the plate up and down with glass cleaner and paper towel. Be sure to clean the V grooves on the linear slide.
5. Clean Y rail of the motion system, top and bottom, and rail groove on both sides using a cotton swab and alcohol. (Note: Swabs used in lens and mirror cleaning can be reused for general cleaning.)
6. After rail is clean, use a clean swab and alcohol to clean black bearings by holding swab against bearing and moving the optics assembly back and forth several times. Repeat for each bearing.

7. Clean front X rail and groove on both sides using a cotton swab and alcohol.
8. Clean white bearings using a swab and alcohol by holding swab against bearing and moving Y rail assembly left and right several times. Repeat for each bearing.
9. Clean rear X rail top and bottom with a tissue and alcohol.
10. Remove exhaust hose and clean inside and outside of exhaust tube with glass cleaner and paper towel, then replace exhaust hose.
11. Check intake air filter and clean when dirty by soaking in a mild soap solution, rinsing clean and drying. The intake filter is found on the right side of the system behind the grill if equipped with an open loop exhaust systems. The intake filter is found in the intake tube next to the engraving table if equipped with a closed loop exhaust system.
12. The intake air filter grill may be removed by removing the four screws which attach it to the laser system. Grill may be cleaned in gentle detergent such as Ivory and warm water. Rinse in hot water, dry and replace.
13. Wipe the surface of control panel with tissues. If large particles are present on the control panel, dust the panel lightly with an oil free compressed air source before wiping with tissue as large particles will scratch the surface of the control panel.
14. Clean fan grilles and spray fan enclosure with glass cleaner and paper towels.
15. Once the system is clean, clean all painted surfaces of the top cover inside and out with glass cleaner and replace the top cover.
16. Open top door completely and spray underside of door with glass cleaner and wipe gently with tissue.
17. Close top door and spray topside of door with glass cleaner. Wipe the door with tissues. Clean door handle top, side and bottom.
18. Clean smoked lexan panels on the front, back, sides, and bottom inside and out by spraying thoroughly with glass cleaner and wiping gently with tissues. Use several tissues when cleaning each panel as too much dirt built up on a tissue will start to scratch the lexan.

CAUTION: All Lexan surfaces should be cleaned with tissue, NOT paper towels. Paper towels scratch lexan.

4.3 OPTICS CLEANING

The optics are provided with a durable, multilayer coating and will withstand repeated cleanings if care is taken and they are cleaned properly. A visual inspection should be performed at least

once a day. If haze or debris is present on the optical surfaces an optics cleaning should be performed. As a general rule, if the machine itself is dirty the optics are probably dirty as well.

Follow these instructions to clean the optics:

4.3.1 FINAL FOCUS LENS

- a. Remove the 4-40 thumb screw from the side of the lens holder located on movable optics carriage. Hold on to lens holder while removing the screw so holder and lens do not drop (reference Figure 3).
- b. Disassemble the lens holder assembly (lens holder housing, threaded insert, two lens spacers, one lens reference Figure 4) by unscrewing the threaded insert keeping housing flat so spacers and lens do not fall out.
- c. Stand over a table with hands resting on table top and remove lens from lens holder. Hold lens holder in left hand and a clean sheet of lens tissue flat in right hand. Carefully turn lens holder upside down onto tissue so that lens and spacers drop out onto lens tissue.
- d. Inspect lens spacers and clean if necessary with a swab and lens cleaner.
- e. Hold lens by edges using lens tissue and thoroughly dust off the lens using a source of oil free compressed air. A small hand held compressed Freon duster sold for use by photographers is satisfactory. Take caution to hold can upright so propellant does not escape with compressed air onto the optical element.. If lens is extremely dirty use a stream of lens cleaning solution #1 from the small plastic wash bottle to flush both surfaces instead.
- f. Apply lens cleaning solution #1 to one surface of the lens. Let sit for one minute
- g. Final cleaning is done by gently wiping, using several sheets of photographic lens tissue soaked with lens cleaning solution #1.
- h. Dry optical surface with lens tissue.

NOTE: Never use the same tissue twice. Dust build-up on the tissue may scratch the surface of the lens.

- i. Repeat steps f through h for second side of optical element.
- j. Inspect lens. If still dirty repeat cleaning procedure steps f through i until lens is clean.

- k. Replace spacer in lens housing and gently insert lens into lens holder ensuring convex side of lens is up away from spacer.
- l. Place remaining spacer on top of lens and screw threaded insert snugly into place.

CAUTION: Over-tightening the threaded insert can cause the optical element to break.

- m. Carefully slide the lens holder assembly back onto the optics carriage on the rail.
- n. Replace the 4-40 thumb screw and tighten gently, just snug.

4.3.2 FOURTH MIRROR CLEANING

- a. The fourth mirror is located just above the final focus lens and is held in place by a single 2-56 socket head cap screw (reference Figure 3).
- b. While holding on to mirror bracket, remove the 2-56 screw and lift mirror and holder straight off optics holder.
- c. Thoroughly dust off the mirror using the oil free compressed air or Freon duster as described previously. If mirror is extremely dirty use a stream of lens cleaning solution #1 from the small plastic wash bottle to flush the surface instead.
- d. Apply lens cleaning solution #1 to the mirror. Let sit for one minute.
- e. Using a cotton swab, gently roll across mirror once.
- f. Use new swabs and repeat rolling across mirror once with each new swab until the mirror is clean and dry. Never use a swab twice as dust build-up on the swab may scratch mirror's surface.
- g. Inspect mirror and repeat procedure if necessary until mirror is clean.
- h. Replace mirror on optics assembly by setting mirror and bracket straight down on to optics holder and replacing 2-56 screw.

NOTE: Sliding mirror on optics holder will cause scratching of mirror.

4.3.3 THIRD MIRROR CLEANING

- a. The third mirror is at the front of the movable arm in a mirror holder (reference Figure 3). The top cover must be removed to access this mirror.

- i. The cover is removed by loosening two screws that go up through the frame just inside the front door at the left and right sides of the frame (reference Figure 1) Also, remove knob for Z stage (table height adjustment)
 - ii. Ensure power cord is unplugged then tilt the front of the enclosure up approximately two to three inches until the enclosure can be pulled forward without obstruction.
 - iii. Carefully pull the enclosure forward and up until off of the machine. Set cover out of the way being careful not to scratch it.
- c. While holding on to the mirror bracket on the front end of the Y arm, remove the 2-56 socket head cap screw holding the mirror bracket in place and pull mirror and bracket straight away from mirror holder (reference Figure 3).
 - d. Thoroughly dust off the mirror using an oil free compressed air source or the Freon duster described earlier. If mirror is extremely dirty use a stream of lens cleaning solution #1 from the small plastic wash bottle to flush the surface instead.
 - e. Apply lens cleaning solution #1 to the mirror. Let sit for one minute.
 - f. Using a cotton swab, gently roll across mirror once.
 - g. Use new swabs and repeat rolling across mirror once with each new swab until mirror is clean and dry. Never use a swab twice as dust build-up on swab may scratch the surface. A lens tissue can be used for final drying if desired.
 - h. Inspect mirror and repeat procedure if necessary until mirror is clean.
 - i. Replace mirror on mirror holder by setting mirror and bracket straight on mirror holder and replacing 2-56 screw.

Caution: Sliding mirror on mirror holder will cause scratching of mirror.

4.3.4 SECOND MIRROR CLEANING

- a. The second mirror is located in the front left corner of the machine and should be cleaned while the top is removed (reference Figure 3).
- b. Thoroughly dust off the mirror using an oil free compressed air source or the Freon duster described earlier. If mirror is extremely dirty use a stream of lens cleaning solution #1 from the small plastic wash bottle to flush the surface instead.
- c. Fold a lens tissue in half and place next to the mirror surface. Soak mirror with lens cleaning solution #1 through the cloth and leave cloth against mirror for one minute.

Finally, drag the lens tissue across the mirror surface cleaning and drying the lens with the dry portion of the lens tissue in one movement.

- d. Inspect mirror and repeat procedure if necessary until mirror is clean.

NOTE: Never use the same tissue twice as dust build-up on the tissue may scratch the surface of the mirror.

4.3.5 BEAM WINDOW CLEANING

1. The beam window is located in front of the port through which the laser beam enters the engraving area after passing through the first mirror shutter block assembly (reference figure 3).
2. Usually it is only necessary to clean the outside surface of the window. This can be done with the window in place. Thoroughly dust off the window using an oil free compressed air source or the Freon duster described earlier. If window is extremely dirty use a stream of lens cleaning solution #1 from the small plastic wash bottle to flush the surface instead.
3. Apply lens cleaning solution #1 to the window using the sprayer bottle. Let sit for one minute.
4. Wet a cotton swab and gently wipe across window.
5. Use new dry swabs and repeat wiping across window to dry.
6. Inspect window and repeat procedure if necessary until window is clean.
7. If window appears dirty on the inner surface as well, it can be removed by removing the four screws which attach the window holder to the system and removing the window from the holder. Be careful not to lose the white nylon window spacers. If the window is removed it should be cleaned in the same manner as the final focus lens then replaced.

4.4 TOP DOOR ADJUSTMENT

The top door is an integral part of the Class I enclosure which contains the laser beam. If the top door becomes damaged in any way it should be replaced immediately. Periodic inspection and adjustment is necessary to ensure the door is operating properly. The hinges on the door will wear with time and can be adjusted as follows:

1. Hold door in vertical position and tighten hinge screws so door just stays up in vertical position and if tilted to one side or the other begins to fall.

2. Close door and ensure it is flat against top cover. If hinges are too tight, the door will bow at the hinges. Check for bow at front and back of the door and adjust front or back hinges as necessary, so door lays flat.
3. If adjustment is required to flatten door ,check at vertical again and repeat steps 1 and 2 to fine tune.

CAUTION: Excessive bow in door will create openings for the beam to escape the enclosure. This can invalidate the Class I rating and result in hazardous laser radiation exposure.

4.5 SET SCREW REPLACEMENT

Set screws in the motion system will slowly wear with use and will eventually require replacement. This is not a regular maintenance procedure and a ULS technician should be consulted before proceeding to ensure that replacement is necessary. Typical symptoms of worn set screws are:

- corners of objects do not connect or overshoot
- wiggly lines occur in either X, Y or diagonal movement.

To replace set screws (new set screws can be ordered from Universal Laser Systems):

1. Y Axis
 - a. Turn off system power.
 - b. Remove the top cover as follows:
 - i. The cover is removed by loosening two screws that go up through the frame just inside the front door at the left and right sides of the frame (reference Figure 1) Also, remove knob for Z stage (table height adjustment)
 - ii. Ensure power cord is unplugged then tilt the front of the enclosure up approximately two to three inches until the enclosure can be pulled forward without obstruction.
 - iii. Carefully pull the enclosure forward and up until off of the machine. Set cover out of the way being careful not to scratch it.
 - c. Set engraving table to lowest position.
 - d. Move optics carriage in both X and Y directions manually and center it in the top opening.

- e. Using a small jeweler's screwdriver remove the four nylon ball tipped setscrews from the bottom of the optics carriage (see Figure 6).
- f. While periodically looking from the front of the machine, carefully insert new nylon ball tipped set screws into the optics carriage just far enough to start the threads but not far enough to bring the ball tips in contact with the rail. It is helpful to place a piece of white paper behind the Y rail to use as a background.
- g. Once all four set screws are in place, each set screw must be properly seated. This is done by observing the gap between the ball tip of the set screw and the rail (see Figure 6) as the set screw is carefully turned forward until the ball tip just touches the rail. Once the ball tip is just barely brought into contact with the rail turn the set screw another $1/8$ of a turn forward and no more. Repeat the procedure with each set screw.
- h. When the new set screws have been adjusted slide the optics carriage back and forth slowly and check for smoothness. If the motion is not smooth, back each set screw off of the rail and repeat the adjustment procedure.

2. X Axis

- a. Move Y arm until centered in motion system.
- b. Open front door of system.
- c. Using a small jeweler's screwdriver remove the two nylon ball tipped setscrews from the rear assembly of the Y-arm (see Figure 5).
- d. While periodically looking from the front of the machine, carefully insert new nylon ball tipped set screws into the rear assembly of the Y-arm just far enough to start the threads but not far enough to bring the ball tips in contact with the rail. It is helpful to place a piece of white paper behind the Y rail to use as a background.
- g. Once both set screws are in place, each set screw must be properly seated. This is done by observing the gap between the ball tip of the set screw and the rail (see Figure 5) as the set screw is carefully turned forward until the ball tip just touches the rail. Once the ball tip is just barely brought into contact with the rail turn the set screw another $3/8$ of a turn forward and no more. Repeat the procedure for the other set screw.
- h. When the new set screws have been adjusted slowly slide the Y-arm back and forth and check for smoothness. If the motion is not smooth, back each set screw off and repeat the adjustment procedure.

4.6 FIRST MIRROR CLEANING AND BEAM ALIGNMENT

First mirror cleaning and beam alignment must be performed together. This is not a regular maintenance procedure and should only be performed after consulting with a Universal Laser Systems Technician.

1. The first mirror is located inside the fan housing at the left end of the laser looking from the front and the cleaning of this mirror will require total realignment of optics (reference Figure 3).

Caution: Be sure power cord is disconnected.

2. The top enclosure will have to be removed.
 - a. The cover is removed by loosening two screws that go up through the frame just inside the front door at the left and right sides of the frame (reference Figure 1) Also, remove knob for Z stage (table height adjustment)
 - b. Gently lift the front edge of the cover up approximately two to three inches until the cover can be moved forward with out obstruction.
 - c. Carefully pull the enclosure forward and up until off of the machine. Set cover out of the way being careful not to scratch it.
3. With the top cover removed cut the wire tie which restrains the access loop in the power wires for the fans.
4. Remove fan housing by first removing all screws on rear Lexan cover.
5. Loosen but do not remove the two screws that attach the exhaust tube to the frame.
6. With the screws removed from the lexan and the mounting screws for the exhaust tube loose, the lexan and rear of the exhaust tube can be lowered 1/2 to 3/4 inch.
7. Remove the seven button head cap screws from the fan housing.
8. Remove the fan enclosure from around the laser and pull the fan power wires gently through the vertical panel until the fan assembly can be set down vertically behind machine.
9. While holding onto the round mirror holder underneath the shutter support block, loosen set screws on shutter support block on rear and side and remove mirror holder from the shutter support block (reference Figure 3).

10. Thoroughly dust off the mirror using an oil free compressed air source or the Freon duster described earlier. If mirror is extremely dirty use a stream of lens cleaning solution #1 from the small plastic wash bottle to flush the surface instead.
11. Fold a lens tissue in half and place next to the mirror surface. Soak mirror with lens cleaning solution #1 through the cloth and leave cloth against mirror for one minute. Finally, drag the lens tissue across the mirror surface cleaning and drying the lens with the dry portion of the lens tissue in one movement.
12. Inspect mirror and repeat procedure if necessary until mirror is clean.

NOTE: Never use the same tissue twice. Dust build-up on the tissue may scratch the surface of the mirror.

13. Reinstall mirror holder into shutter support with mirror surface towards front of machine and tighten set screws until mirror holder rotates with some friction.
14. Realign optics as follows.
16. The interlock defeat tool must be inserted into the receptacle in the center at the front of the machine (reference Figure 3).



Special laser safety goggles must be worn during alignment to avoid exposure to invisible laser radiation when system is open and interlock defeated. Avoid eye or skin exposure to direct or scattered radiation. Severe eye damage can result from exposure to laser radiation.

17. Be sure shutter switch is in the closed position then reconnect power cord and turn system on.
18. Set laser power at system control panel.
 - a. Depress and release keypad "Program Select".
 - b. Depress and release keypad "Pulse Width".

NOTE: Upper display should be flashing.

- c. Using keypad, enter 50.
- d. Depress and release keypad "Pulse Width".
- e. Depress and release keypad "Pulse Rate".

NOTE: Lower display should be flashing.

- f. Using keypad, enter 1000.
- g. Depress and release keypad "Pulse Rate".
- h. Depress and release keypad "Mode" until lower left of display is "C".
- i. Depress and release keypad "Store".

NOTE: While aligning the laser, it may be necessary to raise or lower the pulse width slightly to ensure that a beam shows up on the thermal paper and tape used in the alignment procedure without setting the paper or tape on fire.

- 19. Place a small piece of thermal paper in front of the laser outlet from the shutter block assembly, open the shutter and press the TEST button on the control panel. Insure that a beam is present. The beam should produce a small mark on the thermal paper.

NOTE: Use the TEST button to turn the laser on and off as necessary. Depressing test button turns on laser, depressing again turns off laser.

- 20. If no beam is present, loosen the set screws on the #1 mirror just enough to turn the mirror with some friction and adjust mirror #1 by turning it one way or the other until a beam appears on the thermal paper. If unable to obtain a beam, increase the pulse width by 5 and attempt to find the beam again by adjusting the #1 mirror. If a beam still does not appear, contact a Universal Laser Systems Technician.
- 21. Place a piece of thermal paper in front of mirror #2 (reference Figure 3) and center the beam on mirror #2 by adjusting mirror #1. Mirror #1 is adjusted in one axis by swiveling the mirror itself and it is adjusted in the other axis by swiveling the shutter block in which the mirror is mounted. The shutter block is adjusted by loosening the set screws which hold the shutter block to the front of the laser just enough to turn the block with some friction.
- 22. Turn the beam off by pressing the TEST button.
- 23. Remove and set aside mirrors #3 and #4 and the focus lens (see Optics Cleaning Section 4.3 for details on removal of mirrors and optics).
- 24. Place a short piece of brown masking tape over the beam entrance hole to the mirror #4 holder (reference Figure 3). Indent the tape with a finger to make the inner circle visible in the tape.

25. Move the motion system to the P_1 position by pressing the P_1 key and turn the laser on and off with the test key, leaving it on long enough to mark the brown tape. If no mark is produced find the beam with a piece of thermal paper and center it on the tape with the knobs on the back of mirror #2.
26. Move the motion system to the P_2 position by pressing the P_2 key and again make a mark on the tape with the TEST key.
27. Compare the two marks. If the marks are centered and on top of one another proceed to step 28. If not, make the following adjustments while continuously comparing marks at positions P_1 and P_2 (if tape becomes too cluttered replace it with a new piece):
 - a. If marks are spread side to side, adjust the upper knob on mirror #2 until the marks are aligned in the side to side direction.
 - b. If marks are spread up and down, adjust the lower knob on mirror #2 until they are aligned in the up and down direction.

Once the marks are aligned in both directions so that they lie on top of each other:

- c. To center the marks horizontally, move the block on which mirror #2 is mounted to one side or the other side (usually a very small amount of movement is needed) while keeping it square against the rail (reference Figure 3).
 - d. To center the marks vertically, adjust shutter block in which mirror #1 is mounted.
28. Reinstall mirror #3 (see Optics Cleaning Section 4.3 for details on installation of mirror).
29. Place a piece of brown masking tape over the beam entrance hole for the mirror #4 (reference Figure 3) mount and again indent the tape to make the inner circle visible in the tape.
30. Make a mark in the tape at both positions P_1 and P_2 using the TEST button.
31. Compare the two marks. If the marks are centered and on top of one another proceed to step 32. If not make the following adjustments while continuously comparing marks at positions P_1 and P_2 (if tape becomes too cluttered replace it with a new piece):
 - a. If mark at P_1 is centered and mark at P_2 is high or low, rotate mirror #3 in its mount until marks at P_1 and P_2 line up in that direction (reference Figure 3).
 - b. If mark at P_1 is not centered in the up or down direction, adjust the lower knob on the back of mirror #2 until mark at P_1 is centered in that direction.

- c. If mark at P_1 is centered and mark at P_2 to one side or the other, adjust the upper knob on the back of mirror #2 until the marks at P_1 and P_2 line up in that direction.
 - d. If mark at P_1 is not centered in the side to side direction, move the block on which mirror #2 is mounted to one side or the other side (usually a very small amount of movement is needed) while keeping it square against the rail (reference Figure 3)
32. Reinstall mirror #4 (see Optics Cleaning Section 4.3 for details on installation of mirror).
33. Place a piece of brown masking tape over the hole underneath the fourth mirror holder where the optics holder attaches and indent the tape with a finger to make the inner circle visible.
34. Make a mark in the tape at both positions P_1 and P_2 using the TEST button.
35. Observe the two marks by looking through the front door at the underside of the motion system. If the marks are centered and on top of one another proceed to step 36. If not make the following adjustments while continuously comparing marks at positions P_1 and P_2 (if tape becomes cluttered replace it with a new piece):
- a. If marks are aligned but to the left or right of center (looking from the front of the machine) move the block on which mirror #2 is mounted to one side or the other side (usually a very small amount of movement is needed) while keeping it square against the rail (reference Figure 3).
 - b. If marks are aligned but to the front or back of center, (looking from the front of the machine) adjust shutter block in which mirror #1 is mounted a very slight amount.
 - c. If the marks are split in either direction, use steps a or b respectively to center the mark at P_1 and then use the two knobs on the back of mirror #2 to center the mark at position P_2 .
36. Reinstall the focus lens holder (see Optics Cleaning Section 4.3 for details on installation of lens holder).
37. Reinstall the top cover and laser fan enclosure by reversing the steps used to remove the two covers.

4.7 LASER REPLACEMENT

The plasma within the laser will deteriorate over time and eventually the laser will have to be replaced. This is a normal occurrence with sealed CO₂ lasers and ULS laser systems have been designed with a field replaceable laser. This is not a routine maintenance procedure and you should consult with a Universal Laser Systems technician as arrangements for a replacement laser will have to be made.

1. A first mirror cleaning and beam alignment will be necessary as part of replacing the laser. Begin with the procedure for first mirror cleaning and replace the laser by following the steps below before proceeding with beam alignment.
2. Laser Removal
 - a. Unplug the small mini-jack connector at the end of the laser opposite the shutter support block.
 - b. Remove green, white and black power wires for the laser from the terminal block noting their positions on the terminal block for installation and push them through grommet on vertical plate.
 - c. Remove the four 6-32 button head screws which mount the laser to the end plate on which the shutter support block is mounted (reference Figure 2). Do not remove the two 10-32 socket head cap screws which hold the end plate to the laser support bracket and do not remove the shutter support block.
 - d. Remove the six 10-32 socket head cap screws from the three retainer bars on side of the laser (reference Figure 2).
 - e. From rear of machine, slide laser left so fuse caps clear the left support bracket (reference Figure 2).
 - f. Slide laser back out of support brackets.

CAUTION: Laser weight is approximately 20 pounds. DO NOT DROP.

5. Laser Installation

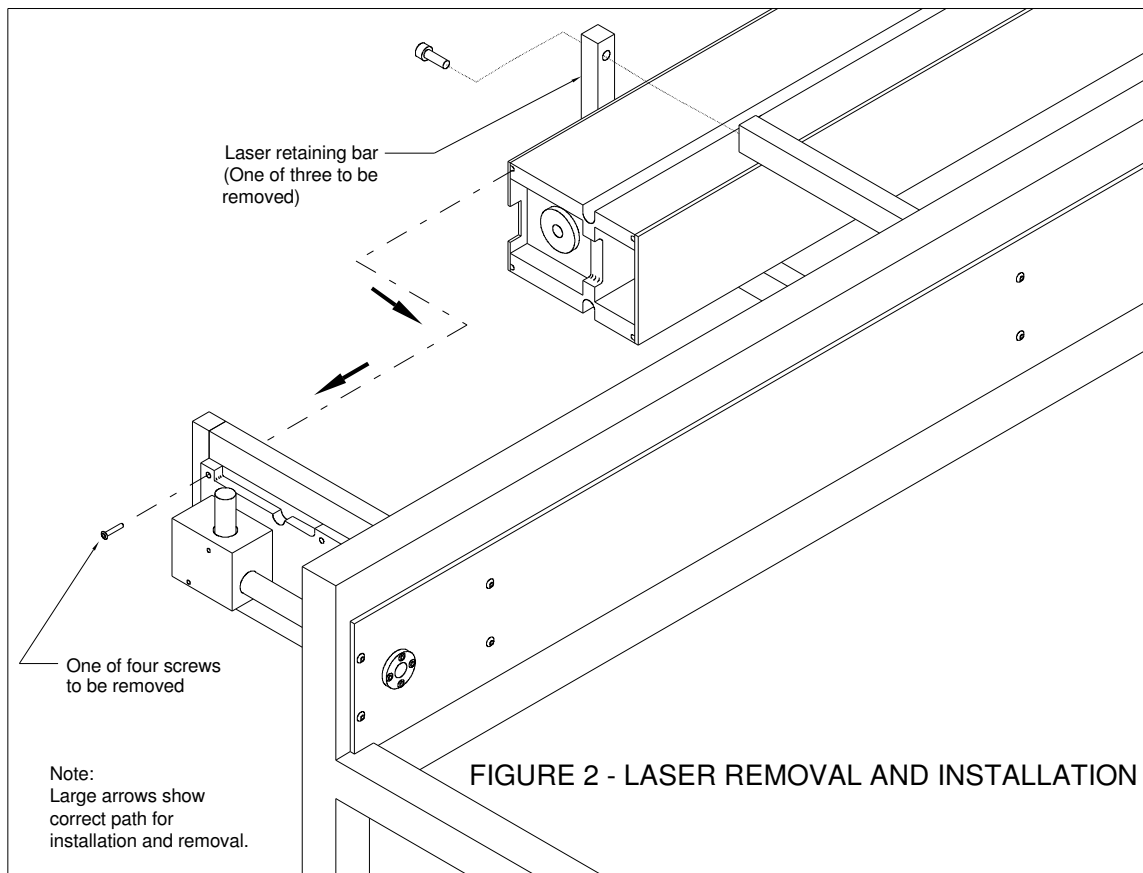
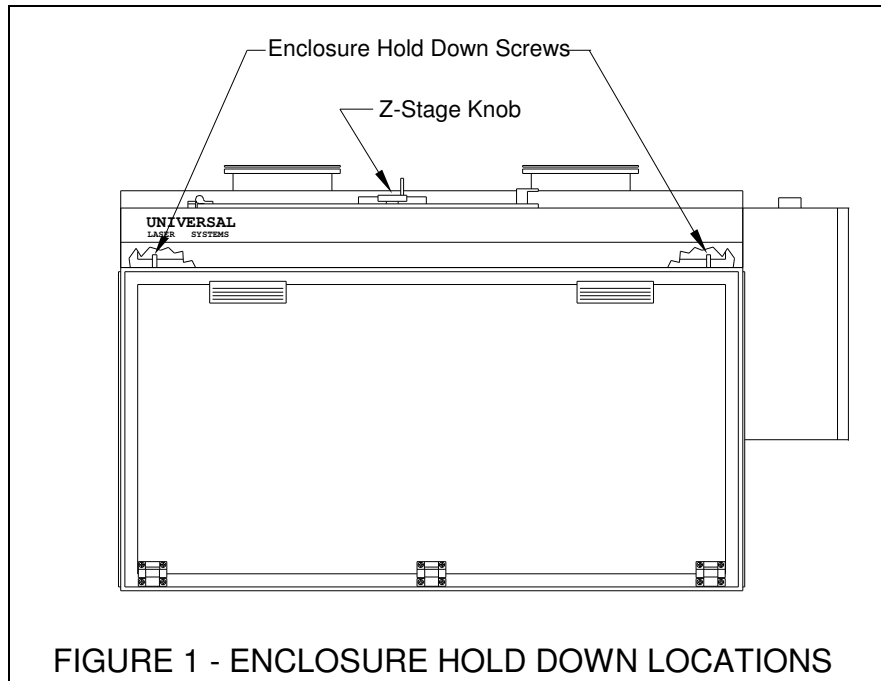
- a. Remove laser from box.

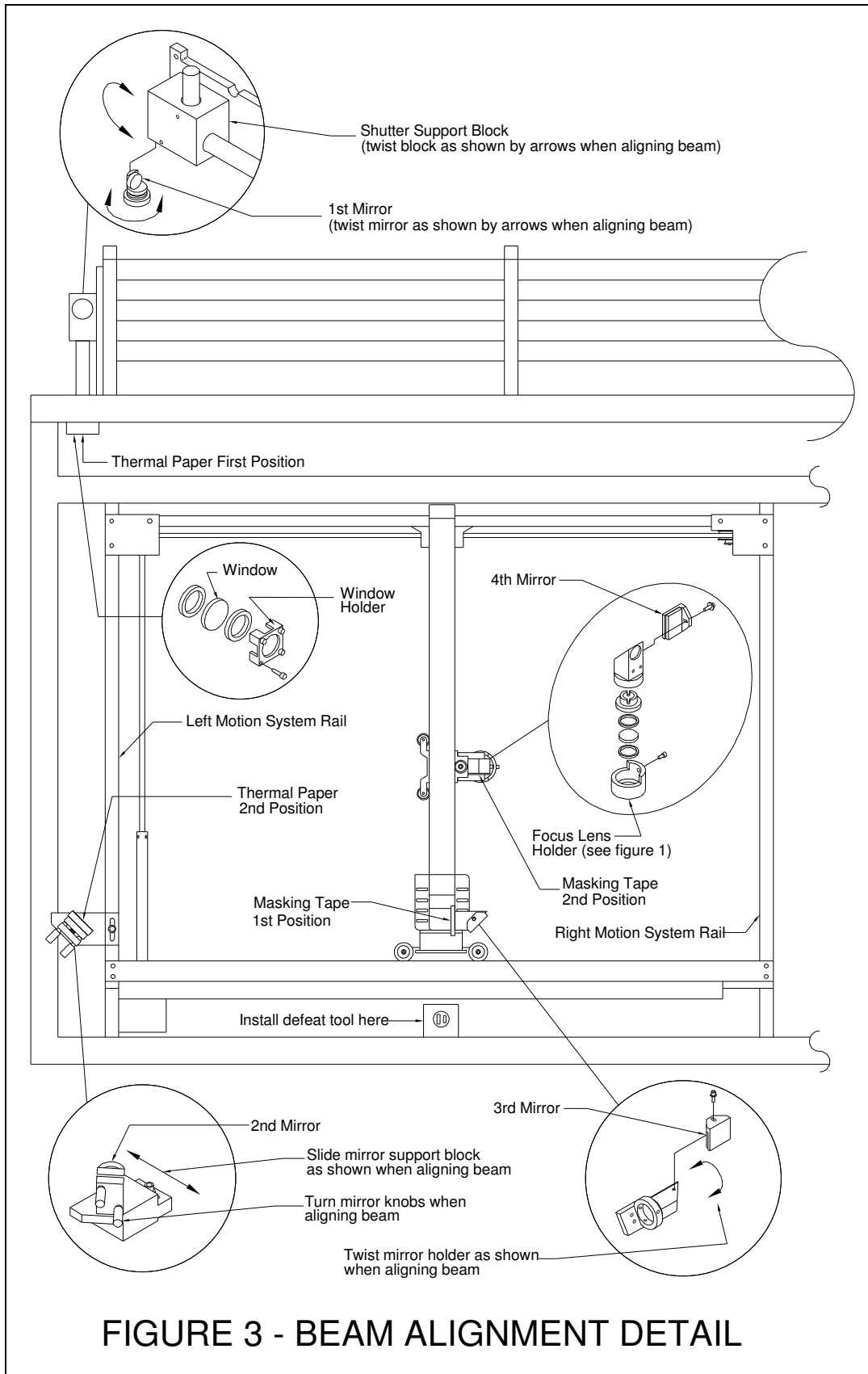
CAUTION: Laser weight is approximately 20 pounds. DO NOT DROP.

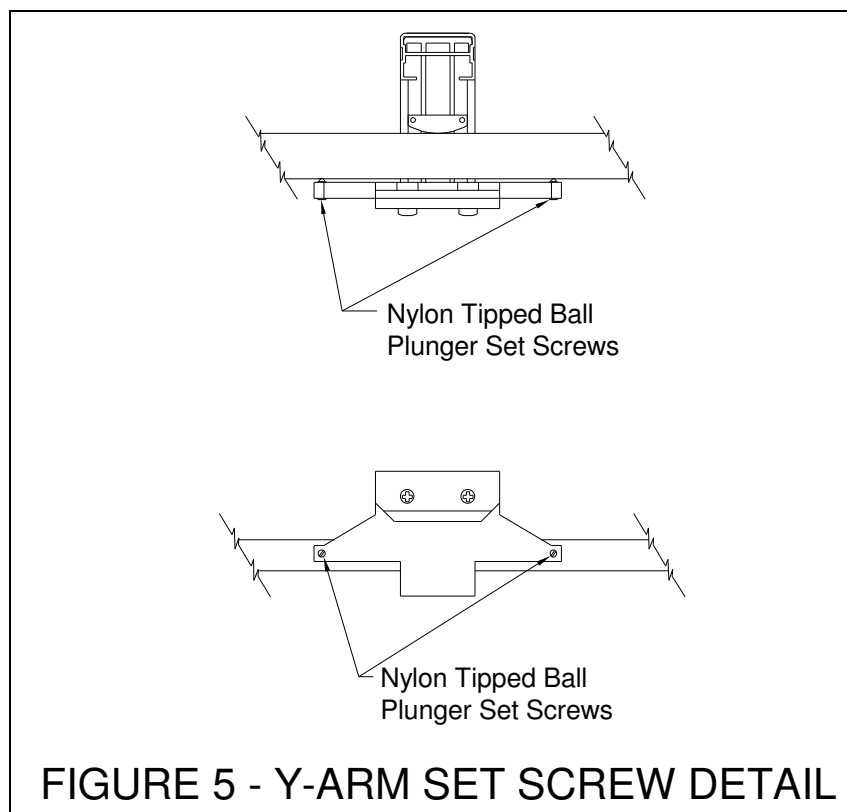
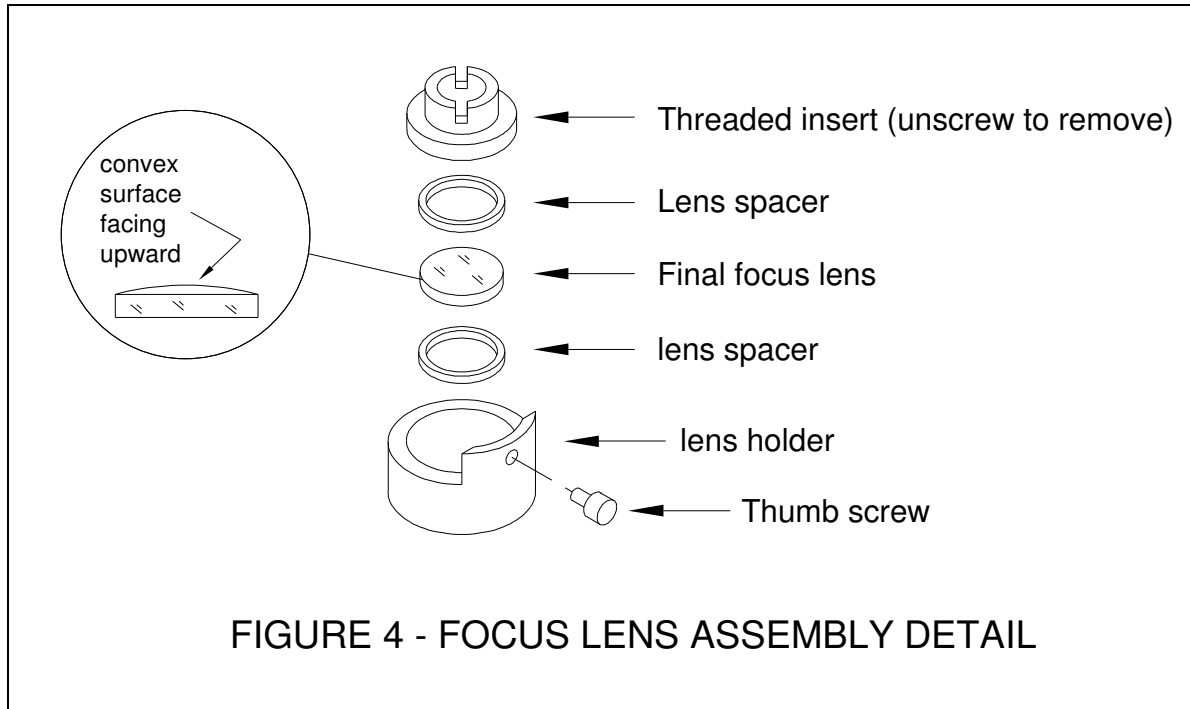
- b. Orient laser in your hands so that power cord is on left side and two silver channels are in towards the palms of your hands. Make sure the fuse caps are facing up.
- c. Keeping the left end of the laser 6 inches to the left side of the left laser support (facing the machine from behind), slide laser into middle and left support brackets.
- d. Make sure the end gasket for the laser is in place and slide laser right until the right end of the laser is flush against the laser end plate (reference Figure 2).
- e. Install four 6-32 button head screws through the end plate and laser end gasket into the laser and tighten.

- f. Install the three retainer bars on rear of laser supports using six 10-32 socket head cap screws.
- g. Plug mini jack into end of laser.
- h. Carefully push green, white and black wires of the power cable through grommet in vertical plate. Push the wires through one at a time.
- i. Attach green, white and black wires to the terminal block in their proper positions.
- j. Proceed with beam alignment procedure as outlined in the beam alignment section of this manual.

4.8 FIGURES FOR MAINTENANCE SECTION







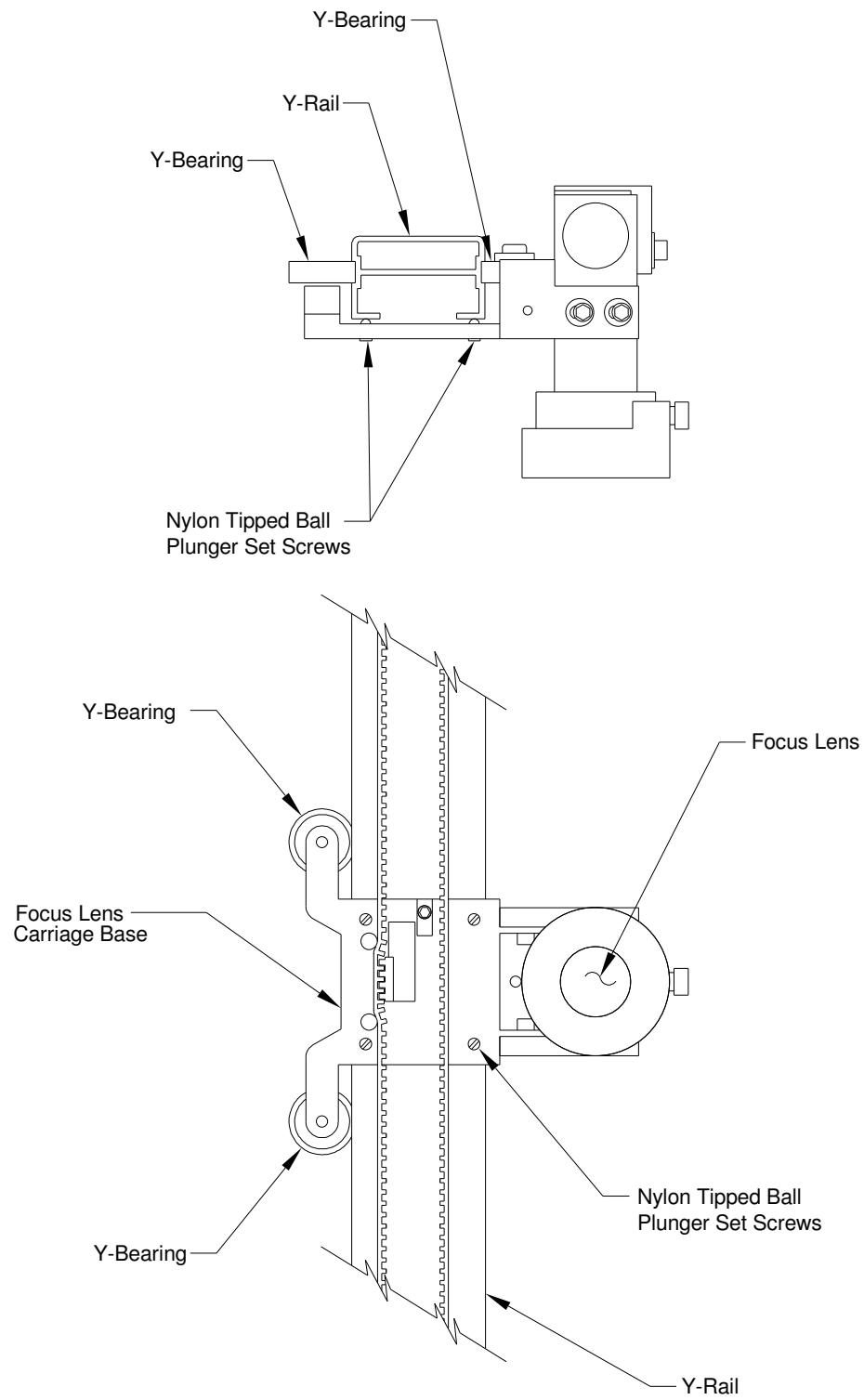


FIGURE 6 - FOCUS LENS CARRIAGE
SET SCREW DETAIL

SECTION 5 - WARRANTY

5.1 ONE YEAR LIMITED WARRANTY

All new ULS Laser Engraving Systems come with a one year limited warranty which provides that the product ULS manufactures or assembles will remain in good working condition, free from defects in material and workmanship under normal use and service, for a period of one year from the date of shipment from ULS. Perishable components (lenses, mirrors, indicator lamps, batteries, fuses) are warranted for 90 days. The laser is covered by a one year manufacturers warranty.

This warranty is limited to the original purchases and is not transferable. During this one year period, ULS will repair or replace, at its option, any defective products or parts at no additional charge to the customer, provided that the defective product or part is returned to ULS. This limited warranty does not extend to any products which have been damaged as a result of accident, misuse, abuse (such as incorrect voltages, power surges, improper or insufficient ventilation, failure to follow ULS provided operating instruction, "acts of God" or other situations beyond the control of ULS), or as the result of service or modification by anyone other than ULS. Non-ULS installed parts or components are not covered, nor is damage to ULS provided components, damaged as a result of their installation. This warranty does not cover work performed by others. All warranty work must be performed by ULS.

Universal Laser Systems reserves the right to request that the system be returned to the factory for repair, or to provide on-site repair. During the warranty period, shipping charges will be paid by ULS. If the customer prefers on-site repair and the nature of the repair is such that it can be done at the customer's facility, ULS will provide a field service technician free of charge during the warranty period. However, the customer is responsible for the technician's travel and lodging expenses.

ULS provides no warranties whatsoever on software.

Limitation of remedies and liabilities: ULS's entire liability and customer's exclusive and sole remedy for damages from any cause whatsoever (including without limitation any nonperformance, misrepresentation, or breach of warranty) shall be limited to repair or replacement of the specific products or services that do not comply with the limited warranty given by ULS. Any products or services repaired or replaced by ULS pursuant to this Paragraph shall be warranted as of the original date of delivery of the system in accordance with the terms and conditions herein for the duration of the one-year term of Limited Warranty given by ULS. In no event will ULS be liable for any damages caused, in whole or in part, by customer, or for any economic loss, physical injury, lost revenue, lost profits, lost savings or other indirect, incidental, special or consequential damages incurred by any person, even if ULS has been advised of the possibility of such damages or claims.

Some states do not allow the exclusion or limitation of incidental or consequential damages, and some states do not allow limitations on how long an implied warranty lasts, so the above limitations or exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

NOTE: This warranty applies only to systems sold for use within the United States of America. If the system was purchased for export from the U.S.A., please see the international warranty included with the system.

5.2 IN-WARRANTY SERVICE

A defective laser system may be shipped to Universal Laser Systems, Inc. F.O.B. Scottsdale, Arizona after an R.M.A. number has been issued. Please call for an R.M.A. number. Systems will not be accepted without an R.M.A. number. Defective units will be repaired or replaced at manufacturer's option depending upon the severity of the defect. Charges, if any, will be assessed pursuant to the provisions of the Universal Laser Systems, Inc. warranty policy. The equipment must be packed for shipment per Section 5.4. A description of the problem along with the owner's name, address, telephone number, and equipment serial number should be included.

The equipment will be repaired, tested for proper performance, and burned-in for 24 hours. It will then be shipped prepaid to the owner. A brief description of the work performed and materials used will be included with the equipment.

5.3 OUT-OF-WARRANTY SERVICE

The procedure for out-of-warranty service is the same as that for in-warranty service except that a minimum charge is used. This minimum charge guarantees a repair estimate and is used as credit against actual material and labor costs. A purchase order must be received by Universal Laser Systems, Inc. before repair work may be started.

5.4 REPACKAGING FOR SHIPMENT

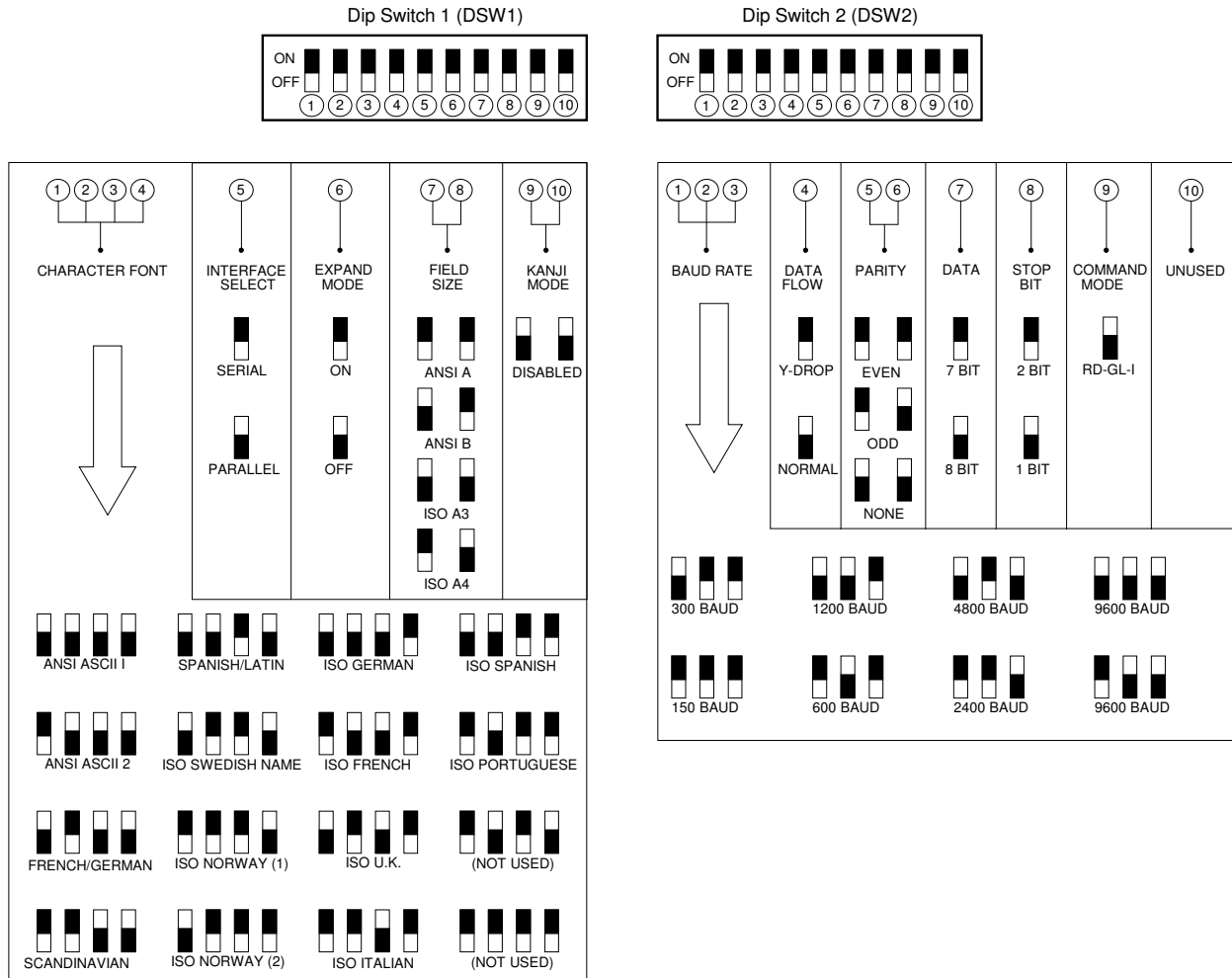
A tag must be attached to returned equipment listing the owner's name, address, and phone number. The complete equipment serial number and a description of the service requested must also be included.

The original shipping container should be used if possible. In any case, the equipment must be packaged so as not to be damaged in transit. New shipping containers can be purchased through ULS.

5.5 FIELD SERVICE

For current information regarding field service call Universal Laser Systems, Inc., Scottsdale, Arizona, (602)483-1214.

APPENDIX A - DIP SWITCH SETTINGS TABLE



NOTE: BLACK SQUARE INDICATES POSITION OF SWITCH

Functions (Locate DSW-1 & DSW-2 on edge of printed circuit board.)

DSW1 1-4: Select character sets out of the 19 sets according to country (factory set to ANSI ASCII (I)).

DSW1 5: Select serial (RS232) or parallel (Centronics) interfacing.

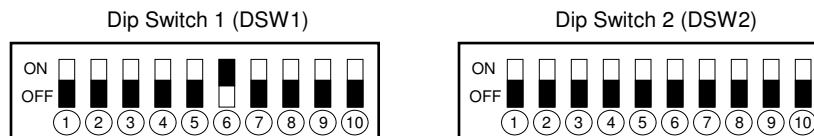
DSW1 6: Sets field size to maximum available. This switch overrides the field size switches.

DSW1 7-8: Sets the field size as long as expand mode is turned off (see DSW1 Switch 6).

DSW2 1-8: Used to setup the serial interface communication parameters.

DSW2 9: OFF sets the command mode to RD-GL I. This switch should always be in the OFF position.

The default switch positions set at the factory are as shown in the diagram below:



APPENDIX B - LASER SYSTEM SPECIFICATIONS

<u>Model Number</u>	ULS 1720C
Maximum Engraving Area	17" x 11.5"
Maximum Engraving Speed	16.5"/second
Laser Source	20 Watt CO ₂
Laser Beam Diameter	
- Standard Optics	0.007"
- High Resolution Optics (Optional)	0.003"
Repeatability	+/- 0.002"
Interfaces	Parallel = Centronics Serial = RS-232C
Manual Speed Selection	8 Stage
Commands	HP-GL, RD-GL1
Buffer Memory Size	1MB
System Dimensions	37" x 32" x 21"
System Weight	165 lbs.
Safety Classification	Class I
Support Table Dimensions:	19" x 14"
Focal Plane (Z axis) Adjustment	10.5"

Facility Requirements

Electrical Power:	Single phase, 120 VAC, 60 Hz, 15 Amp
Exhaust:	400 CFM minimum required at point of 4 inch connection to system
Cooling:	Air cooled ambient temperature less than 76°F

Specifications are subject to change without notice.

APPENDIX C - LASER OPERATING PARAMETERS

This appendix is divided into two sections. One contains graphs for maximum usable pulse width at varying speeds and pulse rates. The other section contains useful power settings for various materials. Instructions for the use of the graphs follows.

When operating in proportional pulse mode the electronics track the movement of the motion system and pulse the laser in a manner such that a constant number of pulses per unit of measure is applied to the material. In other words, although the motion system is constantly accelerating and decelerating a constant number of Dots per Inch (DPI) is applied to the material. But there are practical limits to proportional pulsing and if these limits are exceeded then the laser will not operate in a proportional manner and the DPI will not be constant across the material. When this occurs the material will be cut deeper in some areas and shallower in others giving the overall impression of an uneven depth of cut. The limits on proportional pulsing are exceeded when the pulse width for a particular pulse rate and speed causes the pulses to overlap. The graphs on the following pages show the pulse width limit for particular speeds. The parameters used for pulse width and pulse rate should always lie within the gray area.

Use the following procedure for choosing laser power parameters:

1. Choose a processing speed and turn to the graph for that speed.
2. Choose a pulse rate. The pulse rate is shown in pulses per meter which is entered into the control panel on the machine and in Dots per Inch (DPI) for reference. 250 DPI is generally the best compromise between available power and image quality.
3. The point on the curve for the pulse rate chosen in step 2 is the maximum usable pulse width. This number can be considered as 100% of the available power for the particular speed and pulse rate chosen. A pulse width less than the maximum usable pulse width can be considered a decrease in the power applied to the material. Choose a desired pulse width between 0 and the maximum usable pulse width.
4. Make a trial run with scrap material and observe the results:
 - a. If the power needs to be adjusted start by increasing or decreasing pulse width but do not use a pulse width higher than the maximum usable pulse width for the speed and pulse rate chosen. If the maximum usable pulse width does not provide enough power than choose either step i or ii below:
 - i. If speed is not critical to the job then decreasing speed will increase the maximum usable pulse width thus increasing overall power.
 - ii. If speed is critical to the job then the pulse rate can be decreased in order to increase the maximum usable pulse width. However, this will effect the resolution/quality of the image/cut so a compromise must be made.

- b. If the resolution of the image is inadequate (for example an image is too coarse or a cut edge is not sharp enough) then the pulse rate can be increased. Choose a higher pulse rate and repeat steps 3-4.
5. After acceptable results are obtained the next step is to optimize the settings. If the pulse width which provides good results is near the maximum usable pulse width for the speed and pulse rate chosen then the settings are fairly optimized and can be used. If the pulse width which provides good results is much less than the maximum usable pulse width then the speed or pulse rate can be increased. Optimizing is not necessary but if there is room for optimizing it can improve the quality and speed of processing.

NOTE:

In general, optimum performance is obtained from the laser engraving machine when the power settings used lie on the curve of the graphs. This should be kept in mind when using the procedure outlined above.

Laser Settings for Common Materials

The following is a list of laser power settings for various materials. This list is meant to be a starting point only and power settings will have to be fine tuned for best results.

LEGEND: PW= Pulse Width
PR= Pulse Rate
Mode= P or C
Speed= Maximum straight line speed in centimeters per second.

<u>PW</u>	<u>PR</u>	<u>MODE</u>	<u>SPEED</u>
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Anodized Aluminum (See Applications Note 1):

bleach anodize coating	125	39999	P	1
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Enamel Coated Brass (See Applications Note 4):

remove enamel 2-3 passes:	150-300	39999	P	1
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Lycra(See Applications Note 8):

Cut	150	39999	P	1
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Glass:

Mark (fills produce fogged look)	100-200	4500-5500	P	1
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Silvered Glass [Mirror] (See Applications Note 1 or 2):

Remove Backing	100-200	39999	P	1
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Cowhide (See Applications Notes 5 and 9):

Mark	50-150	20000-39999	P	1
Cut (1/16")	300-500	30000	P	1

Construction Paper (See Applications Notes 5 and 9):

Mark	35	39999	P	1
Cut	110	39999	P	1-15

	PW	PR	MODE	SPEED
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Acrylic [Plexiglass] (See Applications Notes 5 and 9):

Engrave	100	39999	P	1-10
Cut (1/16") One Pass:	800	39999	P	1
Cut (1/8") 2-3 Passes:	1200-1400	39999	P	1

Clear Polyester [Mylar]:

Engrave	20-80	39999	P	1
Cut (See Applications Note 7)	100	39999	P	1-20
Cut (See Applications Note 14)	800	39999	P	1

DAP:

Mark	80-90	19999	P	1
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PVC:

Mark	200	8000	P	1
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Vinyl (1-20 thousandths):

Mark	40	12500	P	1
Cut to Backing	50-100	20000	P	1-10
Cut through Backing	50-100	39999	P	1-10

Marble (See Applications Note 17):

Mark (Black marble turns white)	100	39999	P	1-10
Solid Fill(Black marble turns white)	60-100	39999	P	1-10

Slate:

Mark	100-215	39999	P	1-10
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Balsa, Basswood (1/16") (See Applications Note 5 and 9):

Mark	50	39999	P	1
Cut	220	39999	P	1

	PW	PR	MODE	SPEED
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Oak (See Applications Notes 5, 9, and 10):

Mark	100-150	39999	P	1
Cut (Less than 1/16" per pass)	00-1000	39999	P	1
Remove Fill	950	12000	P	1

Walnut (See Applications Notes 9 and 10):

Mark	100-150	39999	P	1
Cut (Approximately 1/8" per pass)	800-1000	39999	P	1
Remove Fill	800	7000	P	1

Lexan:

Cut (20-40 thousandths)	500-1000	39999	P	1
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Avonite:

Mark	100-300	39999	P	1
Cut	100-1400	39999	P	1

Kapton (See Applications Notes 2, 3, and 15):

Strip (Top layer only) 3 passes	50	28000	P	1
Cut (Top and bottom layers)	350	39999	P	1

Teflon Coated Ribbon Cable (See Applications Notes 12 and 13):

Strip	400-500	39999	P	4
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APPLICATION NOTES:

1. Clean with alcohol after final pass.
2. Clean with acetone after final pass.
3. Clean with alcohol between passes.
4. Clean with acetone after final pass.
5. Use masking paper to prevent smoke damage.
6. Use wet masking paper or liquid soap to prevent flame damage/edge defects.
7. Use wet paper towel to prevent edge effect.
8. May be cut wet or dry - wetness will often reduce edge effect.
9. When cutting through material, raise material off of work surface to allow laser beam to exit and to dissipate fumes.
10. Fill spacing should be three to five thousandths (.003-.005").
11. Use a medium stiffness camel hair brush to clean.
12. Brush off wires between passes with a stiff camel hair brush.
13. Cut one side, then brush. Flip over cable, cut and brush. Repeat two or more times for each side until wire is bare. Make a final pass to clean up any residual teflon.
14. When cutting very small stencils (1/8" or .0125"), use a high resolution lens and cut the stencil in two passes. Suspend the Mylar so it doesn't touch the plate and is level. This setting will produce a stencil that is clean, and not melted, but will require some punching through of the waste material.
15. When stripping Kapton, remove only a small amount on each pass and make three to five passes to strip down to the conductor surface. Set fill spacing to 3 thousandths. This method will prevent damage to the lower piece of Kapton, strip away the top Kapton and leave a clean top surface on the copper traces.
16. Avonite can be cut to depths up to 1/16" or .060" and filled.
17. Use low power to avoid bubbling material. Focus can be changed to increase line width, but power must also be increased to maintain the same effect.