LaserStar Workstation

7000 Series
Operation & Maintenance Manual

(Doc # 11-99990-700)

(Version 7000.14 July 2011)

1957 2007 50 years EXCELLENCE

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DECLARATION OF CONFORMITY

To EC regulations for CE marking:

73/23/EEC Low Voltage Directive
89/336/EEC EMC Directive

Standards to which Conformity is declared:

EN 61010-1: 2001-02 Safety for Electrical Equipment
EN 60825-1: 2001-08 Safety of Laser Products
EN 61326-1:1998 EMC for Laboratory Equipment
IEC 61326-1 Ed 1.2 11/2000 EMC - Industrial Class
EN 61000-6-2:1999 Generic immunity standard, industrial environment.
EN 55011:1998 Emissions for industrial equipment, class A group 1

Manufacturer's Name: **LaserStar Technologies Corporation**

Manufacturer's Address: **1 Industrial Court**
PO Box 15155-0155
Riverside, Rhode Island USA 02915

Importer's Name:
Importer's Address:

Type of Equipment: ***LaserStar® Workstation*** - Nd:YAG Welding System

Model Numbers: **5xx-7xxx**

Year of Manufacture: **2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011**

I, the undersigned, hereby declare that the equipment specified above conforms to the above-identified standard(s) as described in the test record.

Place: ***Riverside, RI USA***

Date: ***March 2011***

James E. Gervais
President

DECLARATION OF COMPLIANCE

United States and Canada

Standards to which Compliance is Certified:

UL3101-1, 1st Edition "Electrical Equipment for Laboratory Use; Part 1: General Requirements"

CSA C22.2 No. 1010.1-1992, "Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use; Part 1: General Requirements"

Code of Federal Regulations (CFR) Title 21, Part 1040.10, 1040.11 for laser products.

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TABLE OF CONTENTS

BACKGROUND

The word “laser” stands for “light amplification by stimulated emission of radiation.” Lasers are possible because of the way the light interacts with electrons. Electrons are atomic particles that exist at specific energy levels. These energy levels are unique and are different for every atom or molecule. The energy levels can be compared to orbits or rings around the sun or nucleus. Electrons in outer rings are at higher energy levels than those in the inner rings. A flash of light **Figure 1** can bump electrons to higher energy levels by the injection of energy. When an electron drops from an outer ring to an inner ring or level, the excess of energy is given off as light. The wavelength or the color emitted is related to the amount of energy released. Depending on the particular lasing medium or material, specific wavelengths are emitted.

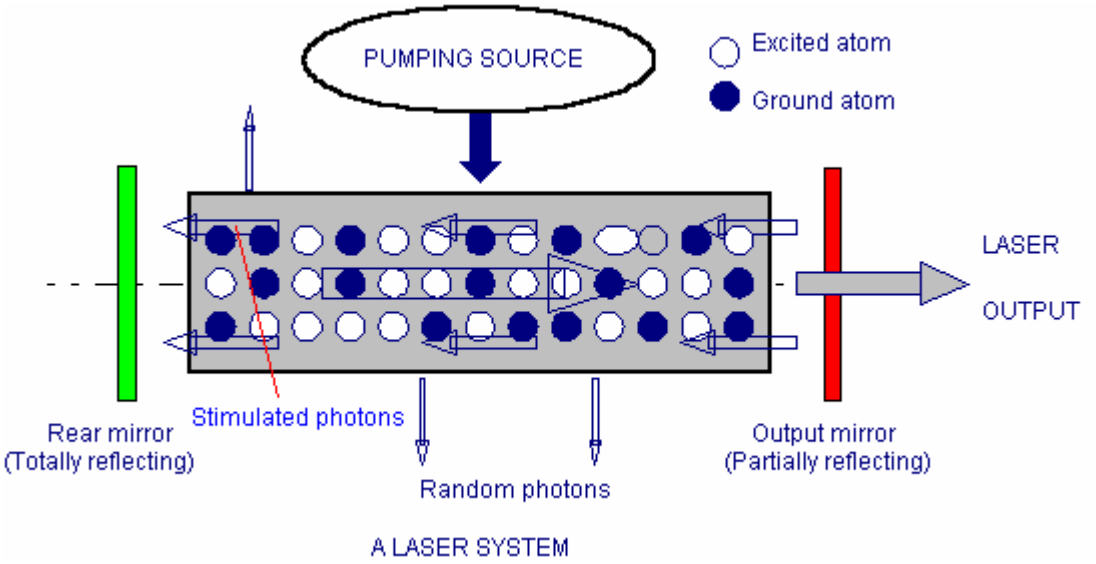


Figure 1

The propagation of light through space can be described in terms of a traveling wave motion. The wave is composed of a combination of mutually perpendicular electric and magnetic fields; therefore, the direction of propagation of the wave is at right angles to both field directions. **Figure 2** shows an *electromagnetic wave.*

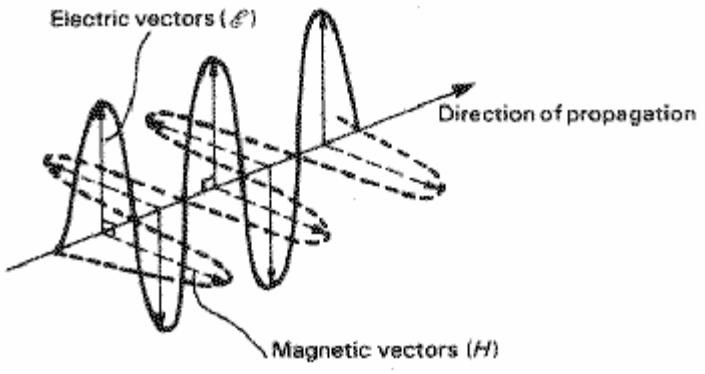


Figure 2
The electromagnetic wave

The concept of laser light is better understood by the definition of its properties. Laser light has three properties: monochromatic, coherent, and collimated. When all emitted photons bear constant phase relationship with each other in both time and phase the light is said to be coherent. It is also monochromatic (one color) due to the specificity and purity of the medium used. Last, the light is contained in a very narrow pencil, almost collimated (reference **Figure 3**).

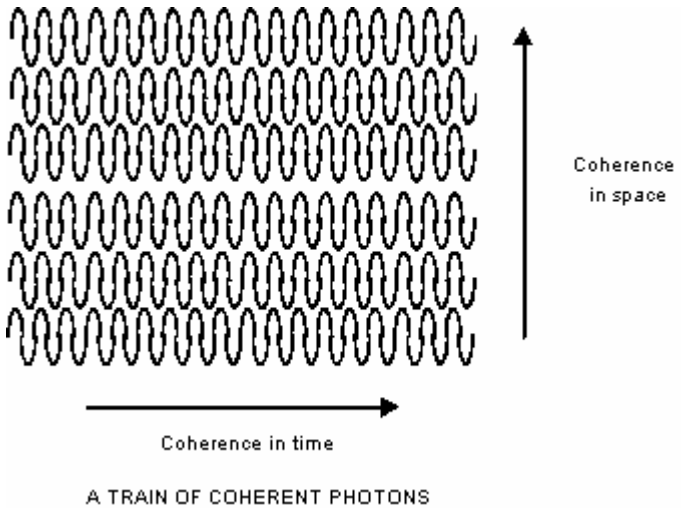


Figure 3

I. The *LaserStar® Workstation*

The *LaserStar*® Workstation is an Nd:YAG laser. The host material is a cylindrical crystal of yttrium- aluminum -garnet ($Y_3Al_5O_{12}$), YAG doped by weight with neodymium (Nd^{3+}) ions. Laser emission takes place at 1.064 µm (infrared).

Fig. 4 High-voltage electricity causes the Flash Lamp to emit an intense burst of light, exciting some of the atoms in the crystal to a higher energy levels.

Fig. 5 At specific energy level, some atoms emit particles of light called photons. At first the photons are emitted in all directions. Photons from one atom stimulate emission of photons from other atoms, and the light intensity is rapidly amplified

Fig. 6 Mirrors at each end reflect the photons back and forth, continuing this process of stimulated emission and amplification.

Fig. 7 The photons leave through the partially silvered mirror at one end. This is laser light. *(1)*

Figures 4 to 7 show a typical resonator or optical resonant cavity. This is where the Flash Lamp and the material selected (Nd: YAG crystal) are located. When intensive light is applied to the crystal, via a reflector, it initially produces non-directional light. For optimum utilization of the Flash Lamp light, both the laser crystal and the Flash Lamp are arranged just within the "focal point" of an ellipsoidal mirror. A semi-reflecting and a fully reflecting mirror are mounted outside the crystal. Only those parts of the laser light that hit these mirrors are reflected into the laser crystal can be amplified during the pulse of the Flash Lamp while passing through the crystal. The amplified laser light has the same properties as the original laser light; i.e. it has the same direction, the same

wavelength, the same phase and the same polarization. The mirrors determine the highly directional propagation characteristics of the laser light.

Part of the laser light passes through the semi-reflecting mirror and is the laser light that performs the welding function. This process produces a very high energy density light beam, many times higher than is possible with normal light at the focal point of a lens. The energy -"***hot light***"- created at the focal point in a relatively short time (0.5 to 20 ms) heats the work piece beyond its melting point and thus enables a weld.

The area affected is in a limited range of only approximately 0.20 to 2 mm, depending on the material. The laser light welds two metals together and thus permits safe, durable, precise and non-warp joining of parts in the form of a spot or seam. Because of the very short time of the laser pulse, the zone of heat influence is limited to the immediate vicinity of the welded spot or seam.

The characteristics of a laser pulse, and thus the effect on the material, can be influenced by the operating parameters VOLTAGE and PULSE LENGTH (width). The voltage has influence on the amplitude; the pulse length influences the width of the laser pulse.

In practice, the effect of both parameters while welding metals is as follows:

- The voltage first influences the welding depth.
- The pulse length predominantly influences the diameter of the welding point.
- The focus influences the welding depth as well as the diameter of the welding spot. When increasing the diameter, the welding depth is reduced at the same time.

System Description

The LaserStar® Workstation™ is a movable, stand-alone, single-user operated product that can be used to weld almost all metals and metal alloys quickly, reliably, and precisely.

The parts that are to be joined are manually arranged together under visual control and welded together by means of one or more laser pulses.

The product is equipped with a Stereo Microscope with a crosshair to facilitate the exact positioning of the parts. The crosshair marks the exact position on the work piece where the laser pulse spot will occur.

Good welding results will only be obtained if the work piece is exactly positioned with regard to the height (i.e. within the focusing area of the laser beam). The

height is correct if the surface of the work piece is in focus under the stereo microscope.

Adjusting the energy of the laser pulses can influence the quality of the welding points. This can be adjusted by means of joysticks or the keypad. With one of these controls you can adjust the intensity of the laser pulses (Voltage), and the pulse length (ms). Settings for other materials can be obtained by following the adjustment technique described.

The quality of the weld can be increased for certain materials by using inert gas. This product is equipped with a separate inert gas connection.

The vapor produced during welding can be extracted from the welding chamber/area via a Filtration Exhaust Unit.

A foot pedal switch with two operating positions can fire a single or multiple laser pulses. The first position (pedal switch slightly pressed) enables the inert gas supply, and the second position (pedal switch fully pressed) releases the laser pulse.

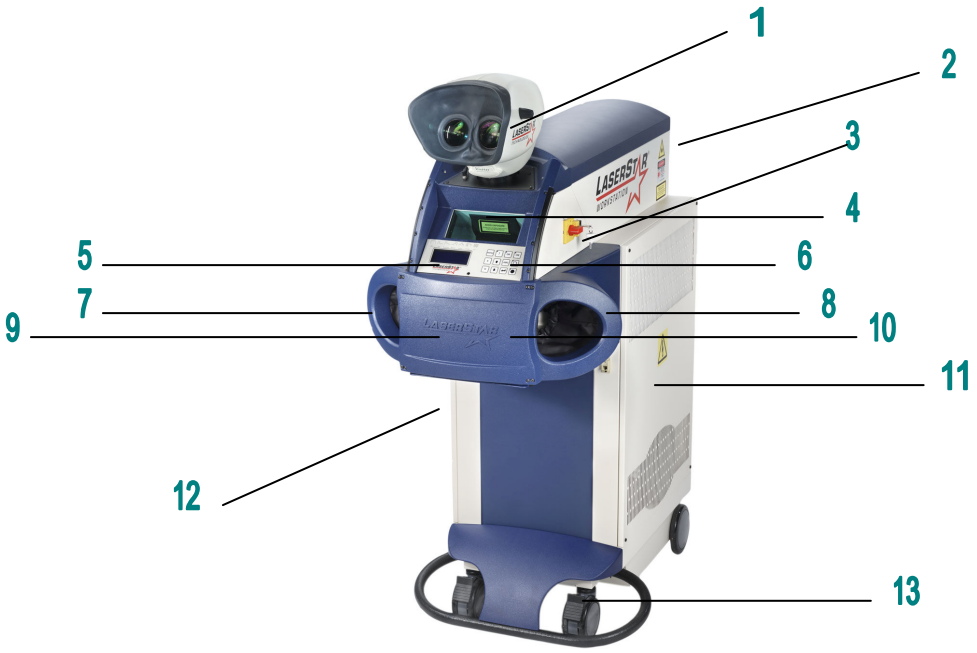


Figure 8a
LaserStar® Workstation

The illustration (**Figure 8a**) shows the general view of the laser equipment. The individual functional parts are marked by numbers and explained in the following:

Figure 8b

Figure 8b shows the general view of the model without parts 7, 8, 9, & 10.

1. Stereo Microscope
2. Exhaust Outlet and Filter (in rear of laser)
3. The main on/off emergency switch and key-operated switch are located on the right-hand side of the welding chamber/area.
4. Protective Observation Window
5. Alphanumeric Display
6. The keypad
7. Hand openings (2)
8. Welding Chamber/Area Enclosures (2)
9. Welding Chamber/Area
10. Welding Chamber/Area Access Door
11. Microprocessor and control system (inside cabinet)
12. Power Supply Unit (flash lamp power supply, capacitor bank, heat exchanger INSIDE CABINET)
13. Wheel Locks (2)

Welding Chamber/Area (referring to **Figure 8a & 8b**-model dependent)

- The welding chamber/area **(9)** is accessible through hand openings **(7)** welding chamber/area access door **(10)**.

- The work pieces within the illuminated welding chamber/area can be observed via an observation window **(4)** to facilitate a coarse positioning of the work pieces. The observation window is a special laser protective window that absorbs laser radiation as well as the ultraviolet component of the plasma light.

- The Stereo Microscope **(1)** on top of the welding chamber/area facilitates an easy and precise adjustment of the work pieces.

Technical Specifications

The modular conception of the LaserStar® Workstation facilitates time-saving repairs by changing complete modules (functional units) in case of a failure. The product consists of the following modules assembled in a mobile working table:

- Welding Chamber/Area with Stereo Microscope and work piece illumination
- High-energy pulse laser
- Microprocessor Control Unit
- Laser Power Supply (flash lamp power supply and capacitor bank)
- Heat Exchanger
- Inert gases supply and blast nozzle for cooling work pieces
- Foot pedal switch for triggering laser pulses and inert gas supply (argon)
- Welding chamber/area exhaust system with filter

Specifications

Laser crystal	Nd: YAG
Wavelength	1064 nm
Beam Divergence, minimum (Note 1)	~3 mRad
Minimum pulse energy	Joules per model
Rated power	Watts per model
Maximum pulse power	kW per model
Single/continuous pulses	Selectable

Pulse duration	Model dependent
Laser class	Class: 4 (operator)
W x H x D (cm), without microscope	50 x 112 x 92
Weight (kg)	85
Electrical connections (single phase)	Volts per model 50/60 Hz Amps per model

Note 1: Prior to beam expanding and focusing optics

Cooling

- Internal water/air heat exchanger
- Particle filter and de-ionization water filter within the internal cooling water circuit
- Maximum temperature of cooling water, 50C
- *Maximum ambient temperature, 30C*

Inert Gas

- Maximum operating pressure 4 bar (60 PSI)
- Minimum operating pressure 2 bar (30 PSI)
- Consumption ca. 15 L/min.

Noise Level
The continuous sound level produced by the product is always less than 70-dB (A).

Power Supplies

- Switching Supply Output: 3500W max, 0-400 VDC
- Power Supply Output: 24VDC
- Lamp Simmer Supply Output: 1000V/150V, 500mA

Control

Microprocessor controller connected to control circuitry for setting of welding parameters

Control Circuits for:

- Cooling water (temperature, level and flow rate)

- External safety contacts
- Laser Shutter
- Viewing Shutter within the Stereo Microscope
- Supply Voltage
- System Ready

Optical Viewing System

- Various optical viewing systems with crosshair with various magnifications
- Observation window for direct observation of the working area
- Illumination of the welding chamber/area with adjustable brightness by means of a control in the chamber/area
- View shutter closes automatically for a short time with each laser pulse to protect the eyes. There is no view shutter on workstations with the flat screen viewing system.

View Path and Laser Beam Path (Figure 9)

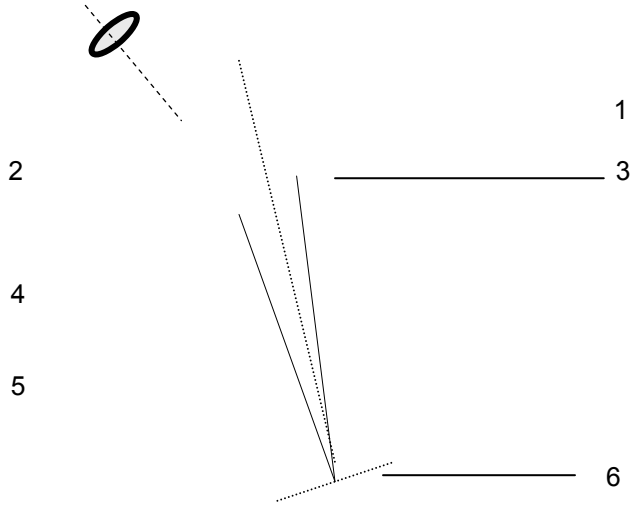


Figure 9
(Viewing path and laser beam path)

- The laser beam is fed into the optical path of the microscope via a highly reflective mirror **(3)**.

- A special laser-focusing lens **(4)** concentrates the laser beam to the work piece in the focusing plane. This laser lens acts also as the focusing lens of the Stereo Microscope.

- The laser-focusing lens is protected against working dust and metal dashes by a protective glass lens **(5)**.

- The view shutter **(2)** protects the eyes against laser radiation and the plasma light including the ultra violet components that is produced during the welding pulse. The view shutter, a light-blocking shutter, is only positioned into the optical path for the short period of the laser pulse and thus blacks out the field of view for a moment. A laser pulse can only be released if the view shutter is correctly closed. There is no view shutter on the Flat Screen System.

- The IR & UV absorbing filter **(1)** protects the eyes against laser radiation and the plasma light including the ultra violet components that is produced during the welding pulse and thus guarantees that no laser radiation hits the eye of the operator.

Miscellaneous

- Storage of operating parameters

- Motor-driven beam expander for welding point diameter

- Removable plate for inserting larger work pieces

- Accessible joysticks for setting laser parameters

- Inert gas supply through adjustable nozzles close to the work zone

- Laser pulse triggering by means of a two-stage foot pedal switch:

  first stage: inert gas supply
  second stage: laser pulse triggering

Laser Delivery System (Rail)

All components of the high-energy pulse laser are mounted on an optical rail. The individual components are explained in the following. The numbers in brackets are related to the positions of Figure 10.

- The pump chamber **(1)** contains the flash lamp and the laser crystal. The ignition unit **(3)** is fixed on the top of the pump chamber.

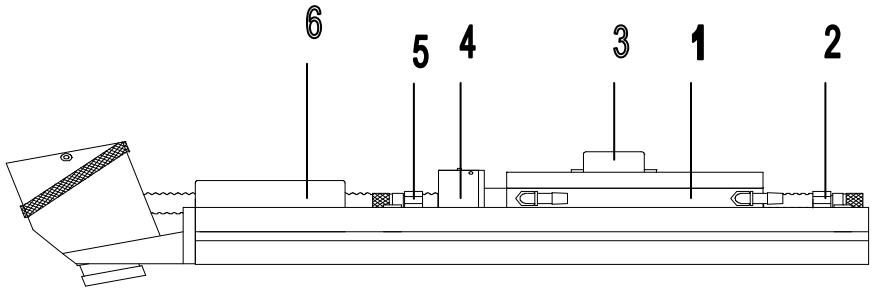


Figure 10
Laser Rail

- The rear mirror **(2)** totally reflects the laser radiation; the semi-reflecting mirror **(5)** transmits part of the laser light as useful radiation.

- In closed state, the laser shutter **(4)** prevents the formation of laser radiation. It will always be closed, for example, if the hand enclosure is opened.

- The diameter of the laser beam can be set by means of a beam-expander **(6)** driven by a stepper motor. This changes the diameter of the focal spot and the energy densities of the laser beam.

- The laser beam is fed onto the optical path of the stereo microscope via a highly reflective mirror and is focused on the work piece located in the focusing plane by the laser-focusing lens.

Microprocessor Control Unit

The microprocessor board is mounted underneath the welding rail and can easily be serviced from the side of the product. It controls:

- The flash lamp power supply for laser pulse generation

- All operating and indicating elements

- The safety elements (view shutter in the optical viewing system and laser shutter)

- Performs interlock circuits safety checks

The capacitor bank voltage, which corresponds to the intensity of the laser pulse, can be adjusted by means of joysticks or the keypad. The duration of the laser pulse, which corresponds to the pulse width, can also be adjusted.

When the power is turned "on," the microprocessor carries out a series of self-tests. In addition to the electronic components, the laser power supply, the laser shutter and the view shutter are monitored. In case of any malfunction, an error message is displayed on the display of the control panel.

The following self checks and functions will be performed:

- Flow of the cooling water

- Temperature of the cooling water

- Level of the cooling water in the storage tank

- Laser shutter

- Welding chamber/area closed

In case of malfunction of one or more functions, the flash lamp power supply will be shut down and as a consequence, any laser function will be deactivated.

The flash lamp power supply can only be switched "on" again if all faults have been eliminated and the INTERLOCK RESET key at the control panel has been pressed.

Flash Lamp Power Supply / Capacitor Bank / Simmer Supply

The flash lamp power supply system contains the following components:

- Capacitor bank

- Simmer current power supply with ignition unit

- Lamp current control

- Forced discharging of the capacitor bank (when system is OFF)

The AC input voltage supplies the capacitor bank with DC voltage from a DC supply.

After switching on the flash lamp power supply, the flash lamp will be ignited via an ignition coil on top of the excitation unit. After ignition, a small sustained current flows through the flash lamp (simmer current). The light flash that produces a laser pulse is generated by partially discharging the capacitors of the capacitor bank. For this, a transistor switch connects the charged capacitor bank to the laser flash lamp (triggered by fully pressing the pedal switch).

The “on” time is determined by the set value for the pulse length. During this time, a slight part of the energy stored in the capacitor bank is discharged via the flash lamp and the voltage of the capacitor bank drops. After the end of the lamp pulse, it is automatically recharged to the set reference input value for the voltage (recovery time). This recovery time depends on the set values for pulse length and voltage (pulse height) and needs about 0.1 and 3 seconds. After the power supply is switched off, high-power resistors automatically discharge the capacitor bank.

Heat Exchanger

Each flash of light produces heat in the lamp. This is cooled effectively by de-ionized water.

A pump draws purified de-ionized water from a tank through a combination of a particle filter and de-ionization filter. The water then circulates past the lamp in the laser pump chamber. This water absorbs the dissipated heat and then expels it into the ambient air through a water/air heat exchanger.

The water is cooled by air circulation. A fan is turned on when the temperature of the cooling water reaches a preset temperature. A flow monitor, a level monitor and an over temperature switch supervise the cooling water circuit and cut off the power supply of the laser lamp in case of malfunction (interlock).

Inert Gas Supply/ Compressed Air Supply (Optional)

The device has a connecting socket for inert gas and an optional connecting socket for compressed air (for cooling). The welding chamber/area has a fixed gas nozzle for the inert gas and a flexible plastic inert gas line or an optional factory installed compressed air nozzle.

Foot Pedal

There is a two-stage foot pedal for activating the inert gas and triggering laser pulses (see the section entitled FOOT PEDAL SWITCH).

Exhaust Unit

The top of the welding chamber/area contains an opening through which the vapor produced by welding is exhausted.

If the filtered air is not to be exhausted into the work area, the exhausted air can be directed elsewhere by an adapter with a corresponding hose. The exhaust connector is located in the rear of the laser.

Control Elements External to the Welding Chamber/Area

Caution!

Caution-Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Figure 11 below shows the location of these control elements. Their function is explained in the following:

Figure 11
Exterior Workstation Control Elements

(1) Main Switch/Emergency Off: This switch turns on or off the line voltage of the product. It directly powers the illumination within the welding chamber/area and the supply voltages. This main switch also meets the emergency-off function. It can be turned "off" (position "0") in case of emergency without preceding actions. The device will be totally disconnected from the line (independent from the polarity of the main plug.

(2) Key Switch: The laser power supply and, as a consequence, all laser functions, can only be switched "on" with the aid of the key switch.

(3) Keypad (Figure 12): See the following section for a description.

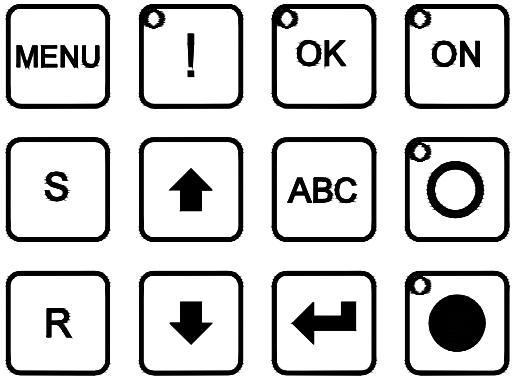


Figure 12

ON SYSTEM ON: This light comes on when the main switch of the product is turned “on” and the key switch is set to the “ON” position.

● CLOSE SHUTTER: This key closes the shutter. A continuous indicator light indicates that the shutter is closed.

O OPEN SHUTTER: This key enables the opening of the laser shutter. Green indicator light flashes when the shutter is ready to open; continuous when the shutter has opened.

↵ ENTER KEY: To enter or accept system variables and/or navigate menus.

R RECALL: To recall stored parameters

ABC: For text entry mode

OK Green light indicates laser is ready, Red: no pulse can be released (recovery time) or the system is still in the startup phase after being switched “on.”

! FAULT: System fault (yellow light). To reset fault must be corrected.

↑/↓ To change system variables and navigate menus.

S STORE: To store system parameters.

MENU To enter the menu mode.

Control Elements in the Welding Chamber/Area

On the rear wall of the welding chamber/area **(Figure 13)** there are three joysticks, a rotary light control, 2 rotary gas flow controls and three push buttons with the following functions:

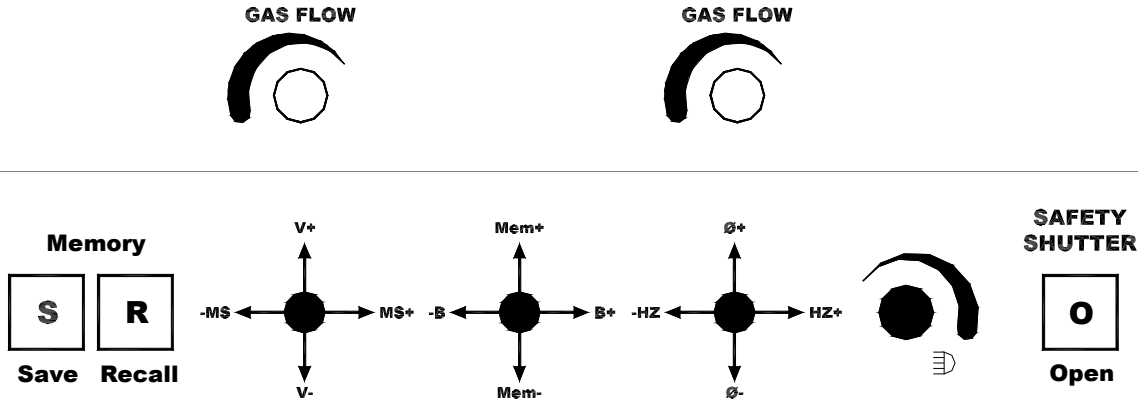


Figure 13
Welding chamber/area controls

V-/ V+ Welding voltage. The voltage influences the height of the laser pulse. This has the primary effect on the depth of the weld or hole.

Ms-/ Ms+ Pulse Width value for the duration of the laser pulse. This has the primary affect on the diameter of the weld.

MEM-/ MEM+ Memory location number.

B-/ B+ Burst Mode. Allows the operator to select the number of laser pulses for each press of the foot pedal.

To activate Burst Mode:

- Select pulse frequency (HZ) and pulse width (MS).
- Select the number of burst pulses (1-25 B).
- To achieve all selected burst pulses, the operator must hold down foot pedal.
- Bottom line will display **Burst Mode** when active.

Hz-/ Hz+ Pulse frequency:

- Single-pulse mode: 0.0
- Continuous-pulse mode: XX, XX = selected pulse frequency: 0.5 ... 10 in Hz).

Ø- / Ø+ Focus setting: This changes the diameter of the focal spot

Brightness This control allows you to control the brightness of the lights in the welding chamber/area.

R (Recall) Used to recall stored welding parameters.

S (Store) Used to store welding parameters.

O (Open Shutter) Used to open laser shutter from inside the welding chamber/area.

Gas Flow Control These controls used to control the flow of inert gas. Right control for center tube, left control for left tube.

Display

The display layout is shown in **Figure 14**. The values for the Weld Voltage, Pulse Length, Pulse Rate, Burst Mode (if activated) and Beam diameter are in the top row. The program # is in the 2nd row, left side, with the user entered program description settings to the right. The 3rd row displays the system settings for the memory location being displayed. The bottom row displays Errors and System Messages, as well as, Pulse Mode.

DIGIT POSITION	012345678901234567890
Top Row	325V 12.5mS 10.0H (B) 12
Second Row	23 User entered program description
Third Row	330V 17.5mS 10.0H 15
Bottom Row	Error or System Message and Pulse Mode

Figure 14

All the parameters can be set using either the joysticks in the welding chamber/area (see the section entitled CONTROL ELEMENTS IN THE WELDING CHAMBER/AREA on Page 14 or the keypad (see the section entitled KEYPAD on Page 13).

Foot Pedal

The system is equipped with a foot pedal for triggering pulses and the inert gas. The foot pedal is connected to the product by flexible cables and can be positioned as required by the operator.

The foot pedal that triggers the pulses has two operating positions with the following functions:

- Press the pedal switch part way until you feel initial resistance and the inert gas supply is switched “on.”

- Fully pressing the foot pedal down until it stops triggers laser pulses. The inert gas supply remains “on” until the foot pedal has been totally released (if inert gas supply is connected to the device).

If several laser pulses are to be released one after the other, the following options are available:

- You can release the foot pedal slightly after each pulse and then push it right down again.

- If the pulse frequency is set for continuous-pulse mode (HZ), the laser can release a continuous series of pulses by depressing and holding down the foot pedal.

- If the Burst Mode (B) is set, the laser will release the number of pulses that the operator chooses by depressing and holding the foot pedal.

Remote Interlock Connector

In addition to the foot pedal switch connector, there is a remote interlock connector available to readily connect the device to a secondary interlock circuit such as an entry door into a specific laser room. The remote interlock can be bypassed using the remote interlock shorting cap, p/n 101-36-0036. Refer to the Installation Section for instructions on connecting or bypassing this feature. Refer to Figure 23 for the location of the remote interlock connector.

Locking Brake

The front wheels of the system are equipped with a locking brake to secure the product at the installation site against unintentional movement

Pressing the brake lever down will activate the brake.

II. SAFETY

Radiation produced by laser light is capable of melting, burning or vaporizing almost any material. The composition of the work piece dictates the vapors or gases generated; therefore, safety precautions are necessary.

The LaserStar® Workstation is designed exclusively for welding metals and metal alloys. To use it for any other purpose or for anything beyond this is to use it improperly. **LaserStar Technologies® Corporation** does not accept any liability for any damages resulting from improper use. Proper use also includes:

- Following all the instructions and heeding all the information in this Manual.
- Carrying out all the necessary inspections and maintenance work.

In addition to general information on the safety regulations that ensure safe operation of the system, this section also contains information on other dangers that cannot be eliminated either by design or by structural means. This information is marked in the Manual with safety symbols, which are required by OSHA/CDRH.

Warning!

Indicates a **possible threat to life and health.**
Failure to heed this can cause **serious damage to health** and even **critical injuries.**

Caution!

Indicates a **possibly dangerous situation**.
Failure to heed this can cause minor injuries or damage to property.

This symbol draws your attention to **important**
Information on the correct use of the system. Failure to heed this information can cause malfunctions/problems in or around the product.

This symbol draws your attention to **operating tips** and particularly useful information that will help you use **all the functions** of your LaserStar to the **best effect.**

General Information

This laser system is a Class 4 laser. It is an Nd:YAG solid-state laser with a high optical output power. This invisible laser radiation has a wavelength of 1064 nm (near infrared range). The visible secondary radiation can cause dazzle effects if watched for any length of time.

The laser radiation generated by this device is not visible to the human eye due the wavelength involved.

Warning!

The eye is particularly endangered by this infrared (invisible) laser radiation, because its effect is multiplied by the eye lens and focused on the retina. The high radiation intensity on the retina causes extreme local heating and burns the tissue of the retina. This results in reduction or even loss of eyesight. Therefore, when working with direct access to the laser beam (maintenance, repair), always wear eye protection.

Always follow the OSHA regulations, ANSI Z136.1-2007, Safe Use of Lasers, on accident prevention for laser radiation or the equivalent national or international regulations (e.g. IEC Directive 60825-1) working with the laser equipment.

If a modification by the user affects any aspect of the performance data or intended functioning, as described in the relevant standards, of a previously classified laser device, the person or organization that undertook the modification is responsible for obtaining a new classification and new labeling for the device. This person or organization then assumes the status of “manufacturer.”

The mandatory protective goggles, with an OD >6.5 (Order No. 444-001), provide protection against direct, reflected and scattered radiation. But even if you are wearing protective goggles, never look directly at the beam. Intense laser radiation is capable of destroying the protective filter. Danger exists through: directed radiation, reflected radiation and/or diffused scattered radiation.

Warning!

When operated **without** the Workspace Protective Housing or Front Door (model dependant), all persons in the NOHA (Nominal Ocular Hazard Area) must wear appropriate protective eye goggles (OD>6.5). These goggles must meet the safety requirements for the relevant laser output energy/power. The max radiant exposure @ 10cm from laser focus is 32J/cm^2. The MPE (Maximum Permissible Exposure) @ 1s exposure is 30uJ/cm^2. The NOHD (Nominal Ocular Hazard Distance) is 150m from the laser focus (120mm focus lens @ 1s exposure).

Warning!

Although the skin can withstand considerably higher radiation intensity than the eye tissue, burning destroys the tissue. The extent to which this happens depends on the time of exposure to and the intensity of the irradiation. Appropriate protective clothing should be worn to protect the skin whenever necessary.

If laser injury or suspected laser injury has occurred, immediately:

- Turn off the laser Mains Power Switch
- Notify your laser safety officer and safety specialist
- Consult a doctor or go to the hospital

When operated **without** the workspace protective housing (model dependant), all persons in the Nominal Hazard Zone (NHZ) must wear appropriate protective eye goggles.

These goggles must meet the safety requirements for the relevant laser output power. The interlock switches can be bypassed by our service technicians or authorized specialists only for adjustment or maintenance activities.

Fire Hazard

Because of the high output power of a Class 4 laser, a wide range of material can be set on fire. Appropriate fire prevention measures must therefore be taken when the path of the beam is open.

Paper (circuit diagrams, leaflets or even posters on the wall), curtains that are not impregnated with fire retardant, thin wooden panels or similar materials can be easily set on fire by direct or reflected laser radiation. Moreover, containers holding flammable or explosive cleaning agents (e.g. used for maintenance) should be kept away from areas exposed to the laser beam.

When using solvents or cleaning agents, you must always heed the relevant warnings. Major fires and explosions can quickly result if such containers are accidentally exposed to and destroyed by the intense invisible laser beam.

FUNDAMENTAL SAFETY INFORMATION

Information on the Operating Instructions

- Knowledge of the safety information and the safety regulations is the prerequisite for safe and trouble-free operation of this product.

- This Manual contains important information on the safe operation of the product.

- All those who work with the product must follow these operating instructions, especially the safety information.

- Moreover, all regulations for accident prevention valid for the current place of installation must be complied with, especially the OHSA regulations, ANSI Z136.1-2000, Safe Use of Lasers, on accident prevention for laser radiation or the equivalent national or international regulations (e.g. IEC Directive 60825-1). There may also be various state, municipalities or local requirements or regulations.

Organizational Measures

The employer must provide the necessary personal safety equipment (in this case eye protection is required only for maintenance purposes when there is direct access to the laser beam).

The requirements of the OSHA regulations, ANSI Z136.1-2000, Safe Use of Lasers, or the equivalent national or international regulations (e.g. IEC Directive 60825-1) have to be fulfilled.

Maintain the Laser as instructed in the Operation Manual.

Requirements of the Employer

The employer must ensure not to allow anyone to work with this product unless they:

- Are familiar with the basic regulations concerning safety at work and accident prevention and have been instructed in the use of this product;

- Have read and understood the chapter concerning safety and the warnings in this Manual and have confirmed this by their signature;

- Have been instructed as to the dangerous effects of laser radiation in accordance with the valid OSHA regulations, ANSI Z136.1-2000, Safe Use of Lasers about accident prevention for laser radiation or the

equivalent national or international regulations (e.g. IEC Directive 60825-1).

- Operating personnel are to receive instruction at regular intervals.

Requirements of Personnel

All those who work with the product must undertake beforehand to:

- Comply with the basic regulations on safety at work and accident prevention for laser radiation, OSHA or
- The equivalent national or international regulations (e.g. IEC Directive 60825-1)
- To read the chapter concerning safety and warnings in this Manual and confirm this by their signature.

Dangers when working with the Product

The LaserStar® Workstation is designed according to the state-of-the-art and meets the approved safety regulations. Nevertheless, its use can still endanger life and limb (of the user or third parties) or damage the product or other material assets. The product is only to be used:

- For the intended purpose (see the information on proper use) and is in perfect condition from the point of view of safety.
- Malfunctions that may have negative consequences for safety must be dealt with immediately.

Protective Devices

- Whenever the laser product is used, all safety mechanisms have to be checked for correct mounting and function.
- Safety mechanisms may only be removed when the laser device has been switched “off” and measures have been taken to prevent it from being restarted.

Informal Safety Measures

- The Operating Instructions must always be kept at the installation site. In addition to the operating instructions, the generally valid regulations, as well as the local ones, on accident prevention and environmental

protection, must be complied with, especially the OSHA regulations, ANSI Z136.1-2000, Safe Use of Lasers on accident prevention for laser radiation or the equivalent national or international regulations (e.g. IEC Directive 60825-1).

- All safety information and warnings attached to the product must be kept in readable condition (see the section entitled LABELING).

Personnel Training

- Only personnel properly trained and instructed about the dangers of laser radiation as required by the OSHA regulations, ANSI Z136.1-2000, Safe Use of Lasers, on accident prevention for laser radiation or the equivalent national or international regulations (e.g. IEC Directive 60825-1) are allowed to work with the device.

- Trainees are only allowed to work with this product under the supervision of someone who is an experienced user.

Safety Measures for Normal Use

- Only use the product if all safety mechanisms are properly functioning.

- Check the product at least once a week for visible external damage and for the proper functioning of the safety mechanisms (e.g. defective protective viewing windows or interlock circuits). Check the Welding Chamber/Area enclosures and door for proper function and any damage (model dependent). Only use the product if there is no damage to the Welding Chamber/Area Door, Enclosures, Protective Flaps, Guards, Welding Chamber/Area View Window or any structure that could allow laser energy to exit the device (model dependent).

Danger of Electric Shock

- Only authorized personnel are allowed to carry out maintenance work on the power supply.

- The product must always remain closed. Only authorized personnel using the appropriate tools are allowed to open the product.

If any work has to be carried out on voltage-carrying parts, a second person must be there who can switch the device “off” at the power switch, if necessary (see the section entitled NOTES ON MAINTENANCE).

Particularly Dangerous Points

- Particularly dangerous points must be labeled as such. The various Warning Labels and their location on the product are described in the section entitled “LABELING.”

- There is increased danger when the welding chamber/area is open and the interlock switches are simultaneously bridged (model dependent).

- Above all, never trigger a laser pulse while your hands or fingers are positioned directly in or under the crosshair of the stereo microscope.

Emission of Noxious Gases and Vapors

- Avoid welding vapor by correct use of the inert gas.

- The laser radiation produced by this laser product is capable of melting, burning or vaporizing almost any material. Depending on the composition of the work piece, gases and vapors dangerous to health may be produced. The user should filter air exhausted as required by OSHA regulations (see “Installation”).

- Do not use this product on non-metallic materials, especially plastics.

Structural Modifications to the Laser Product

- Do not make any modifications or additions to the laser product.

- All structural modifications require the written approval of LaserStar Technologies®.

- Immediately replace all parts that are not in perfect condition.

- Only use **original-LaserStar Technologies** replacement and consumable parts.

IMPORTANT: There is no guarantee that parts purchased from companies other than **LaserStar Technologies Corporation** will meet the stipulated requirements as to safety and performance.

Safety Officer

When Class 4-laser equipment is installed, the employer must appoint a competent Laser Safety Officer in writing. In the case of Class 1 laser equipment, a Laser Safety Officer need only be present when the service technician is carrying out maintenance or service activities on the laser equipment with direct access to the laser beam. This assumes that the service technician bypasses the interlock switches or removes protective covers.

Due to the training and experience in the field of laser radiation, the Laser Safety Officer should fully understand the safety procedures and equipment used. The Laser Safety Officer bears full responsibility for the safe operation of the laser equipment and the correct implementation of mandatory safety measures. The Laser Safety Officer may receive appropriate training from an approved body (e.g. an institution providing insurance against occupational accidents). The Laser Safety Officer may receive training from LaserStar Technologies on the proper use of the LaserStar® Workstation.

Please note:

- This laser product may only be used for the intended purpose.
- Never aim the laser beam at humans or animals.
- Any person involved in the operation, maintenance or repair of the laser product must have read and understood the operating and safety instructions for the laser equipment.

WHAT TO DO IF YOU RECEIVE A BURN

If a laser pulse has burned your fingers or hand, you should have the wound treated. Depending on the degree of the burn, you should undergo medical treatment. Although a small burn is not particularly critical, you should still make sure that no infection results.

Scattered Radiation!

Caution!

Scattered radiation can also cause minor burns on the skin of your hand. Depending on the material, its reflective properties and the selected pulse energy, scattered radiation can also be dangerous. Only under very unfavorable circumstances will the scattered radiation reach intensities that can cause slight burns, because the laser pulses are very short.

Normal exposure of the skin to low levels of scattered radiation at the wavelength of 1064 nm can be regarded as physiologically safe. The infrared laser radiation acts like normal heat radiation.

LABELING: Figure (15 a-d)-Labeling: Housing, Front and Sides (Typical)

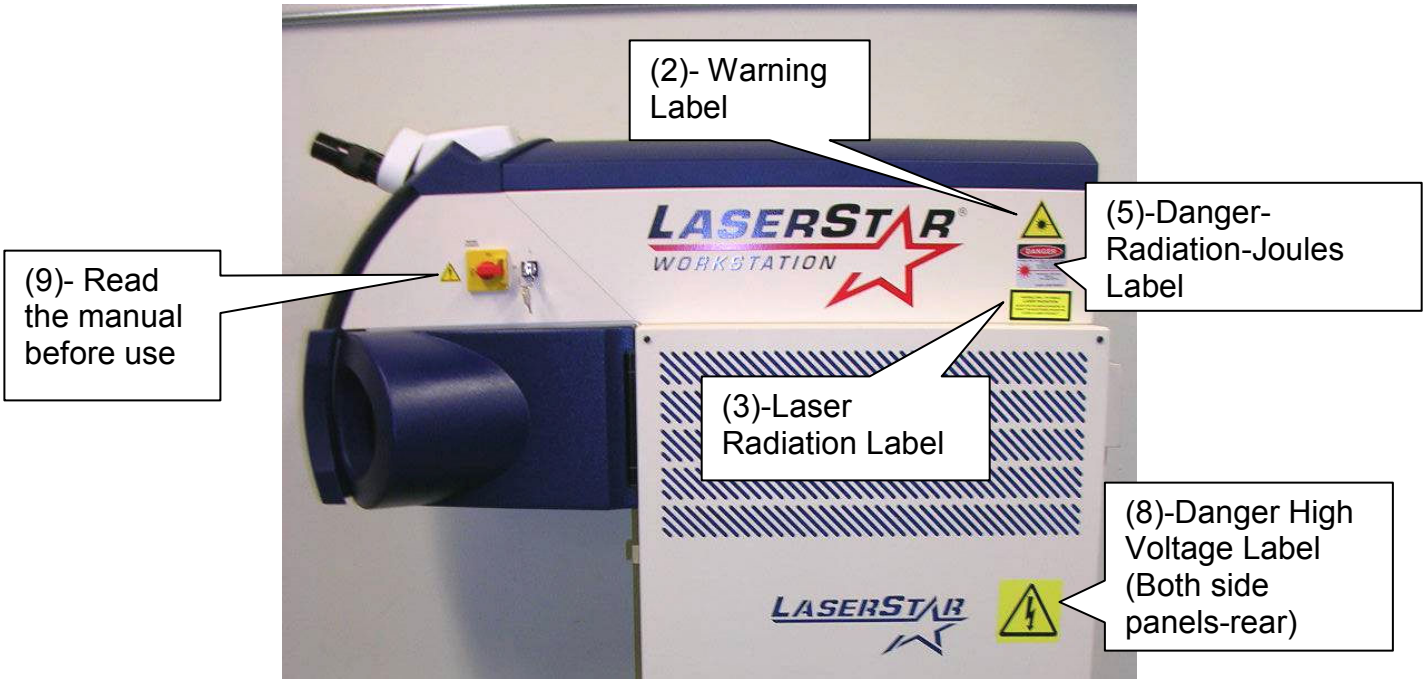


Figure 15a

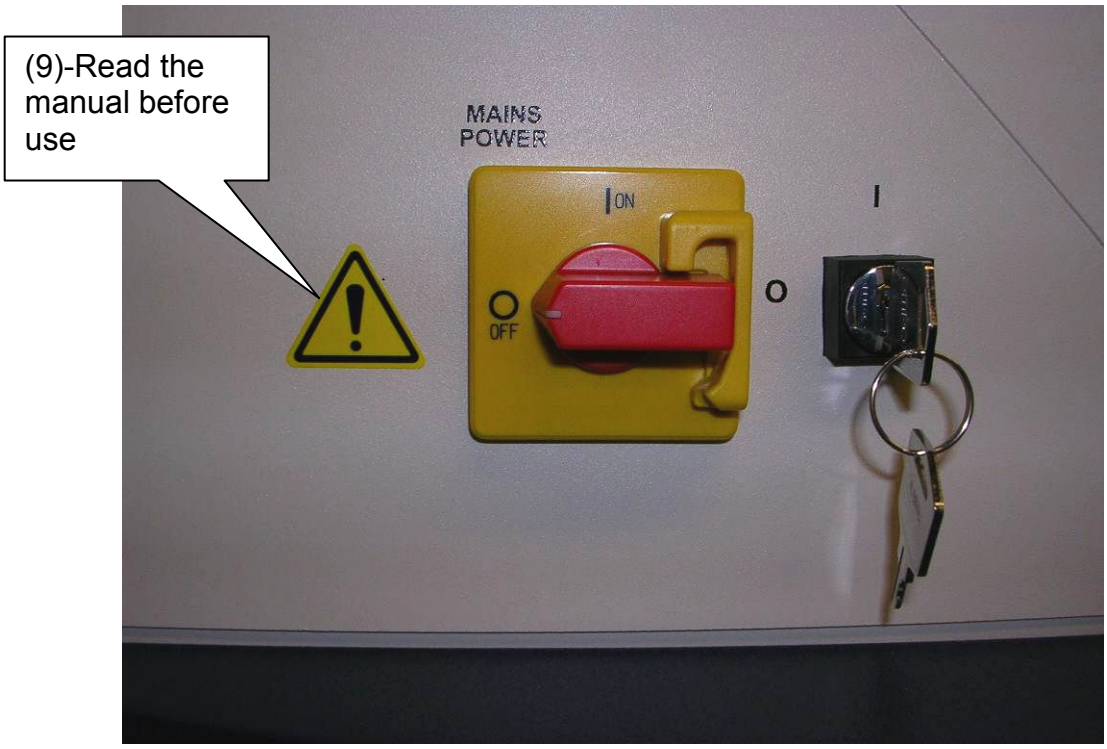


Figure 15b

Figure 15c

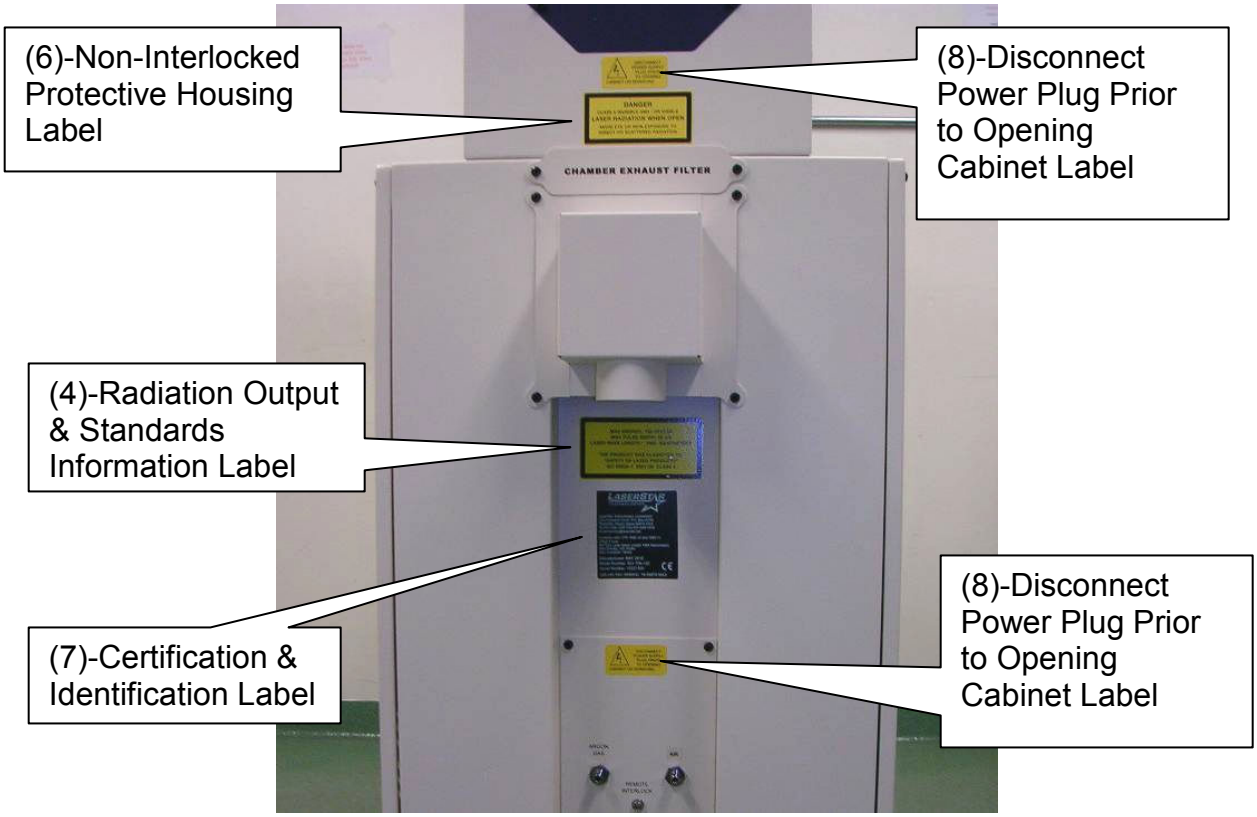
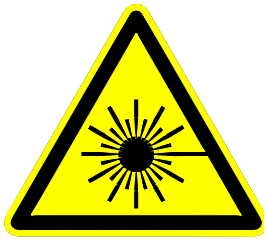


Figure 15d

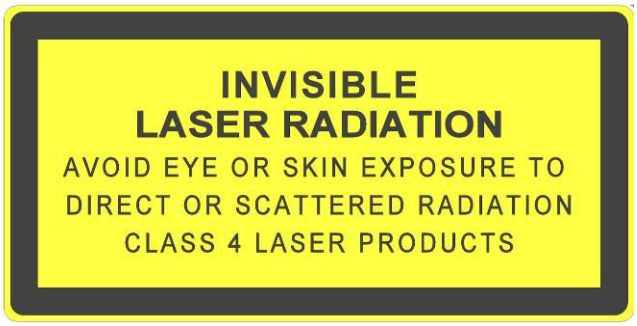
Label Reproductions: (Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated July 26,2001)

(1) Aperture Label

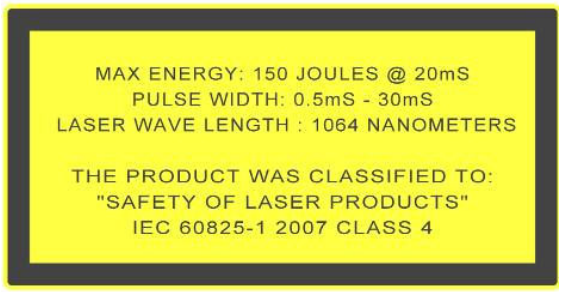
(2) Warning Label



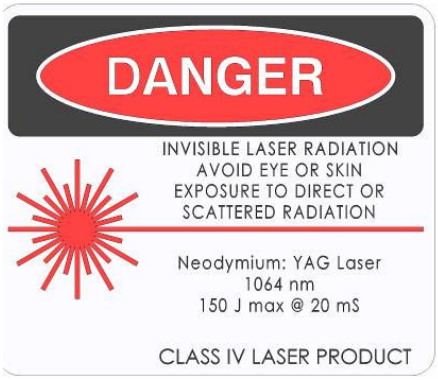
(3) Laser Radiation Explanatory Label



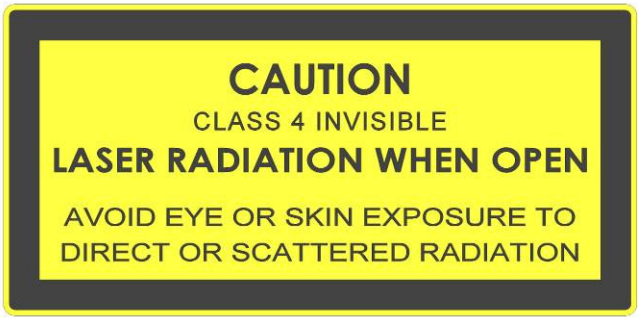
(4) Radiation Output and Standards Information Label



(5) Danger-Radiation-Joules Label

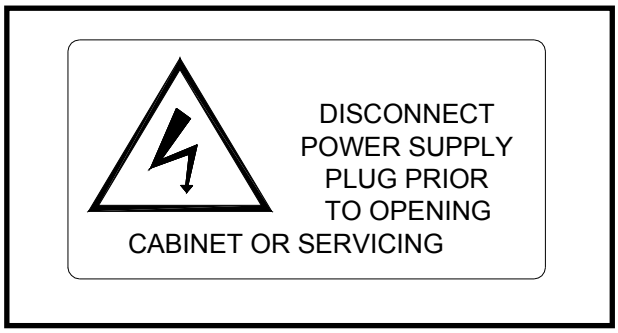


(6) Non-Interlocked Protective Housing Label



(7) Certification and Identification Label

8) Disconnect Power Plug prior to opening cabinet Label and High Voltage Warning Label: Use caution when opening



9) The user has to read the manual prior to use label

Labeling: Pump Chamber & Top Cover-**Figure 16**

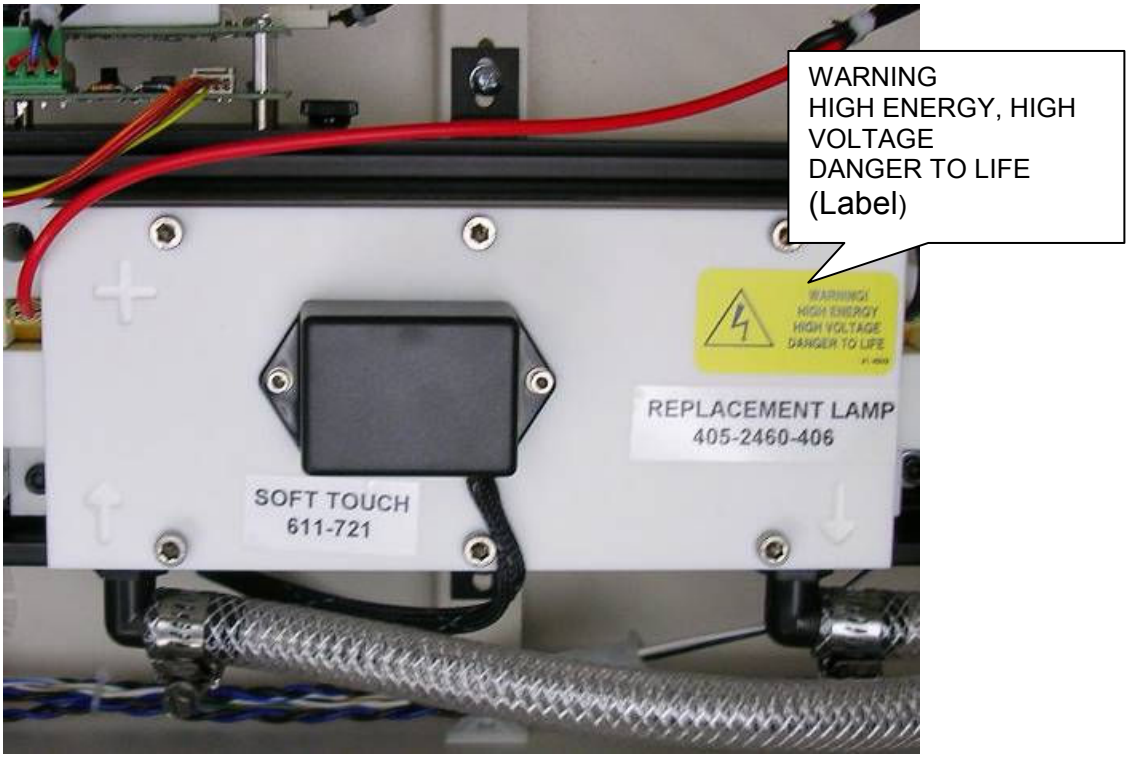


Figure 16

Labeling: Flash Lamp Power Supply & Cap Charging Supply-**Figure 17**

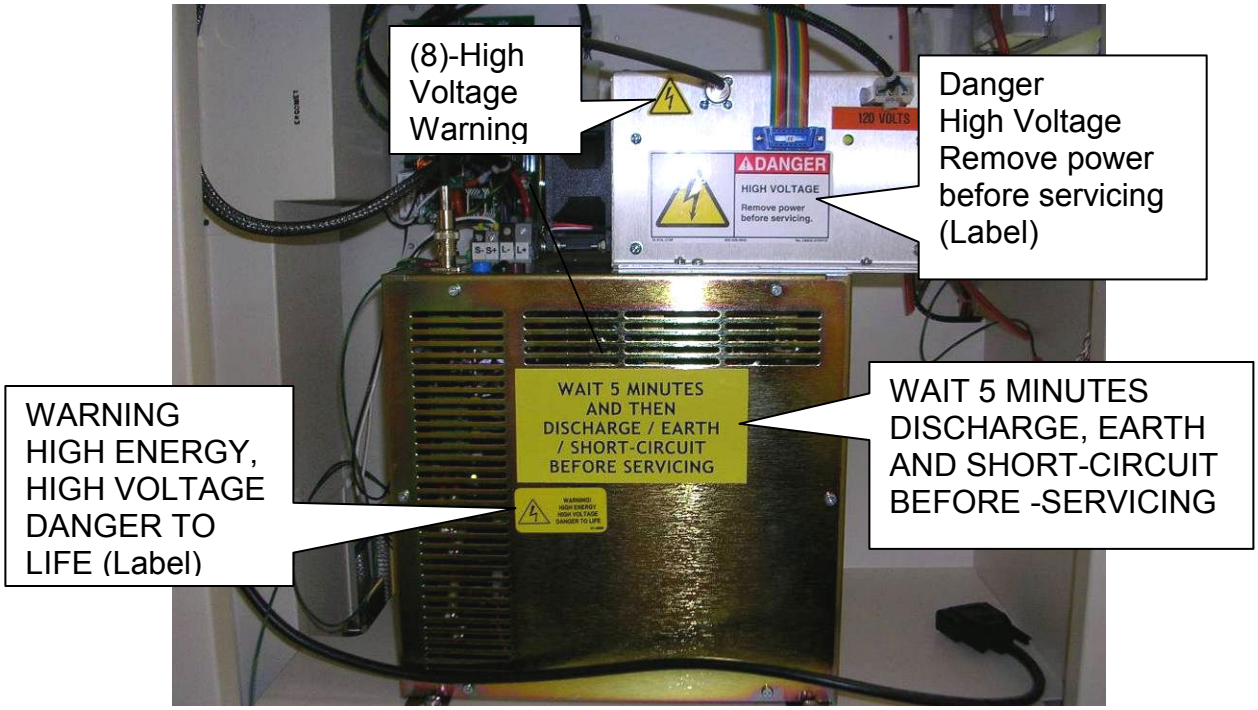


Figure 17

III. INSTALLATION

This chapter describes the requirements that have to be fulfilled for a faultless operation of the product. Information is also given on the installation, setup and transportation of the product.

Requirements

To guarantee a faultless operation of the product, the following requirements have to be met:

Installation Site. The installation site has to meet the following requirements:

- The product has to be installed in a room as dust-free as possible.
- Do not expose the product to direct sunlight.
- The minimum spacing between the product and any walls must be 12 inches (300mm) from the back and sides for proper ventilation.
- The product may be connected to the installation site's optional external filtration or exhaust system by connecting a user provided hose from the exhaust outlet on back of the product to the installation site's external filtration or exhaust system.

Caution!

When choosing the installation site, take into consideration that for servicing, the ability to limit laser area is required (see the regulations about accident prevention for laser radiation OSHA, ANSI Z136.1-2000, Safe Use of Lasers, or equivalent national or international regulations (e.g. IEC Directive 60825 -1)

Ambient Conditions

Temperature**:** Operating temperature: 5°C to 30°C (40°F to 86°F) ambient temperature

Storage: If the device contains cooling water, do not store or transport it below 3°C (frost risk).

Warning!

Never add antifreeze solution to DE-IONIZED cooling water.

Height and Humidity (Figure 18)

- 0 to 3000 m above sea level
- The permitted relative humidity depends on the current ambient temperature. It may not exceed 95% -related to the minimum temperature of the laser crystal (15°C/57°F). If the ambient temperature exceeds 15°C (57°F), the relative humidity has to be calculated based on the current temperature.
- The following graph shows the permissible relative humidity depending on the ambient temperature and the resulting working area (depicted gray). As an example, an ambient temperature of 25°C (77°F) is assumed for the depiction. For this temperature the graphic shows a maximum permitted relative humidity of 53%.

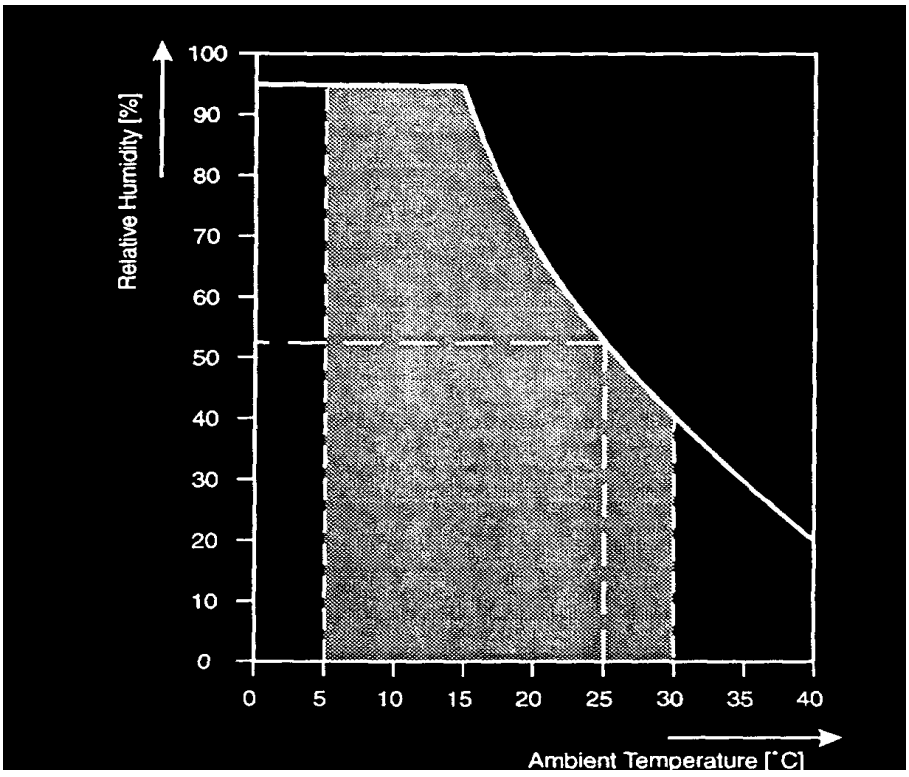


Figure 18
(Humidity)

Unpacking

Caution!

The laser product has been tested thoroughly before shipping and has been delivered in faultless condition. Check the packaging for transport damages before unpacking.

- Take the product - if possible unpacked – to the final installation site.
- Carefully remove the packaging, if any.
- Check the product for possible transport damages.

The standard parts of delivery are listed in the following:

- Stand-alone device LaserStar® Workstation
- Viewing system
- 2 gallons De-ionized water
- Operation Manual and accessories

The delivery can optionally include additional parts. Please compare the delivered parts with your packing slip.

Initial Power Connections and DI Water Filling

The activities described in this section should only be performed by our service technicians or authorized skilled personnel. For damages to persons or property caused by improper connection of the device, warranty claims are out of question.

Power Conditions

The model of the machine determines the AC requirements. Make sure your AC supply agrees with the specification on the Identification label (located on the rear of the machine) which includes the model number, serial number, AC requirements, etc.

The factory setting for the power conditions is 230 V ~50/60 Hz 16 A, single phase unless other agreements were made when the product was ordered. **Caution** Check the setting of the product in any case and compare with the power conditions at the installation site.

Remote Interlock Connector

For connection to a secondary interlock system, the product is equipped with a remote interlock connector. The product will not generate a laser pulse unless this connector is closed.

If you are not connecting the remote interlock to an additional interlock system, the shorting connector, p/n 101-36-0036, must be installed on the laser to enable laser operation.

- The shorting connector is included in the bag in the work chamber/area with the key for the key switch.
- Refer to **Figure 21a** for the location of the remote interlock connector.
- Insert the shorting connector in the mating socket on the rear power panel to enable operation of the laser.
- Tighten the locking ring by turning until finger tight.

The remote interlock connector may be used to readily connect the workstation to a secondary interlock circuit such as an entry door into a specific laser room. To connect the Remote Interlock to a secondary interlock circuit, the following requirements must be adhered to:

- The shorting jumper under the plastic cover of the connector must be removed before wiring.
- The wiring should be routed away from all power wiring and not to exceed thirty (30) feet (nine (9) meters) in length.
- The interlock is to be a voltage free “form A” contact (normally open) that is held closed to enable laser operation.
- A licensed professional in compliance with applicable electric codes should perform the wiring. The shorting connection in the connector, p/n 101-36-0036 must be removed and wired to the secondary interlock circuit.

Inert Gas

For the inert gas (example-argon, nitrogen, etc.) connection, the product is equipped with quick-acting, compressed-air closures for connecting plastic OD plastic tubing. The maximum permitted working pressure is 60psi (4 bars) and a minimum of 30psi (2 bars).

DI Water

The water tank has to be filled up with De-Ionized water before setting the product into operation for the first time. The DI Water used should be Genuine DI-Water. Call LaserStar Technologies Customer Service before filling with any other DI water. The filling up procedure is described in the section REFILLING OF COOLING WATER / BLEEDING THE PUMP in the chapter SERVICE AND MAINTENANCE.

Electromagnetic Compatibility

The device meets all requirements of the EMC-guideline (guideline for electromagnetic compatibility) for heavy industrial applications.

The limiting values for the generation of electromagnetic disturbance will be exceeded at both ends of the frequency spectrum concerning the use of the device within residential, office and trade areas.

Disassembling (Preparation for Transport)

To prepare the product for transport over minor distances, you only have to unplug the power supply and the inert gas supply and loosen the locking brake(s) on the front wheels. **The De-ionized water can be left in the tank but it must be removed from the unit!**

It is recommended to empty the De-ionized water bottle and drain the water system in case the product should be stored or transported over longer distances (transport by truck). For this purpose, see the section entitled CHANGING THE DI WATER FILTER in the chapter entitled MAINTENANCE.

Caution!

Do not store or transport the device at a temperature below 3C (37.4°F) if the cooling water remains in the tank or laser head (danger of frost)

If you anticipate storing or transporting the product at a temperature below 3C (37.4°F) or if the product is not used for more than a month, the pump chamber/area in the laser head has to be opened and dried out.

These activities should only be performed by our service technicians or authorized skilled persons. The usage of unsuitable materials for drying out the optical components can cause irreparable damages to property. Even tissues and clothing that seem to be smooth can scratch optically polished surfaces.

IV. OPERATION

Caution - Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

The next sections describe the usage of the product. The following symbolism is used:

*The symbol **" >"** marks actions that have to be carried out by the operator.*

In most cases, actions of the operator in any form will cause reactions of the product that are marked by the symbol ⊗

Initial Operation

After having properly finished all activities described in the section **Initial Power Connections and DI Water Filling**, first switch on the product as explained in the section **SWITCHING ON**. After initial power on, the product is ready to use.

SWITCHING ON

Action of Operator	System Response
> Check that the key switch is in the off position	
>Turn main switch (1) to position "I" **(See *NOTE below before continuing)**	⊗ The fan may start. The lighting in the welding chamber/area may come on.
> Turn the key switch (2) to the right	⊗ The green SYSTEM ON indicator comes on. The device carries out a series of self-tests. If any failure occurs an error message is indicated on the control panel (see the section entitled STATUS INDICATIONS).
> Wait until the self-test has completed	⊗ The green OK indicator is lit. The red LED in the SUTTER CLOSED key is on.
> Press the SHUTTER OPEN key	⊗ The green LED in the SHUTTER OPEN key comes on in blinking mode.

Note: Reference **Figure 11 or 19**

***NOTE:** For optimal Laser performance, wait approximately five minutes before turning on Key Switch. The product is ready for operation. In normal operation, special safety precautions are not required.

Adjusting the Binocular Stereo Microscope

The binocular stereo microscope is factory adjusted for normal-sighted persons. It may be necessary to readjust it for specific operators or if the operator wears glasses or to adjust the focus of the cross hair.

- Switch on the product (turn only main switch to position "I").
- Ensure eyepieces are pushed onto the eyepiece tube as far as they can go.
- Put a sample item in the visual field of the stereomicroscope so that it is sharp (in focus) when seen with the left eye open and the right eye closed. Fix the sample item in this position.
- Look with the right eye through the right eyepiece and turn the right adjustment ring so that the cross hair appears sharp and in focus through the right eyepiece.
- Rotate the entire eyepiece using the lower portion of the eyepiece to orientate the cross hair to the desired orientation. Refocus the cross hair if needed.
- Adjust the distance of the two eyepieces that both visual fields (that appear bright) of both eyepieces completely overlap each other, i.e. while observing the test item with relaxed eyes, one single round visual field appears.

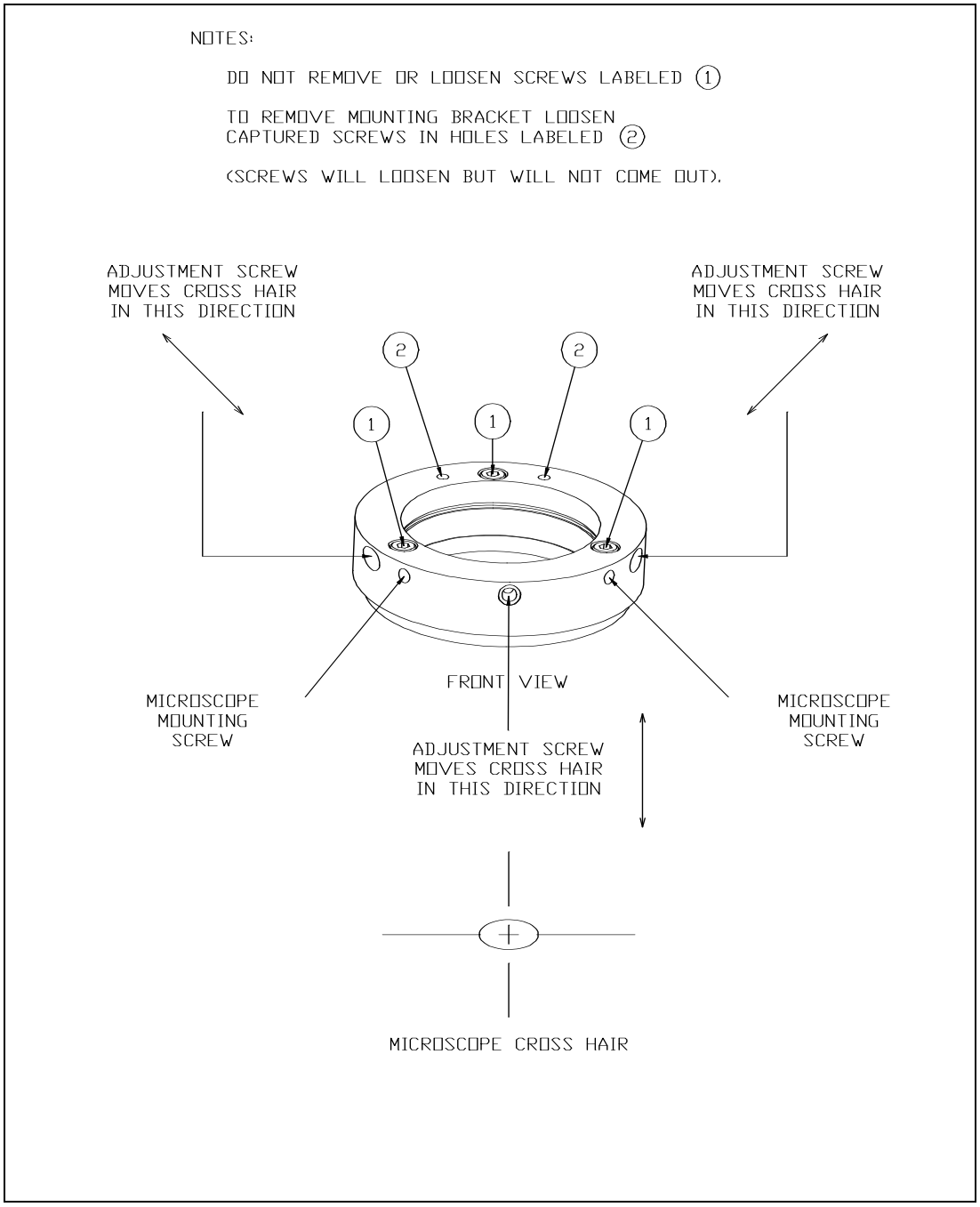
After this adjustment, the test item and cross hair will appear sharp through both eyepieces at the focus plane of the laser.

Optical Mounting and Alignment (Binocular & EZ-VIEW/Cobra)

- Place binocular or ***EZ-VIEW®/Cobra*** microscope into mounting bracket.
- Secure scope by tightening two Mounting screws.
  (Referring to diagram, the **mounting** screws are located between the center adjustment screw and the left and right adjustment screws.
- For ***EZ-VIEW®/Cobra*** Microscope, plug scope into power connector above red switch.
- Alignment of crosshair to the shot:
  1) Bring stainless steel plate into focus using an adjustable Lab Jack or equivalent.
  2) Adjust the parameters to 260 V, 1.0 Ms, 0.0 Hz, 0.5mm.
  3) Make a single shot onto the plate, do not move plate.
  4) Use the three Adjustment screws (refer to diagram) to align the shot in the center of the Crosshair.

CAUTION: DO NOT REMOVE OR OVER TIGHTEN ADJUSTMENT SCREWS

- Make an additional single shot onto the plate to ensure correct alignment.
- Check alignment periodically.



Setting Operating Parameters

Using the Keyboard: You use the ENTER key to select the operating parameters and the arrow keys to change the parameter values:

Action of Operator	System Response
> Press the ENTER key	⊗ The stored program number flashes
> Press the ENTER key as many times as necessary to select the parameter to be set.	⊗ The selected parameter value flashes
> Use the arrow keys to set the value for the selected parameter	⊗ The current value appears on display
> Either press the ENTER key to accept the value and switch to the next parameter, or wait about 5 seconds (the value will be accepted automatically). After cycling for the last parameter (beam diameter) the setting routine is exited.	⊗ All the parameter values are displayed statically.

Using the Joysticks

You can set all the operating parameters using the joysticks in the welding chamber/area (Reference-**Figure 13**) as well as storing and recalling the parameters.

STORING OPERATING PARAMETERS

The product's controller has memory locations in which sets of operating parameters (each optimized for specific applications or materials, for example) can be stored so that you can subsequently work with the same tried-and-tested operating data. (Note: Reference Appendix A for details on Pulse Shaping)

In order to identify the different memory locations more easily, you can assign them user definable texts. Memory locations may already have default designations, but you can change these as required (refer to this section and the section entitled TEXT ENTRY MODE).

A stored set of parameters consists of the following:

- Voltage
- Pulse width
- Single pulse or repetition frequency for continuous pulse

- Focus setting
- Explanatory text
- Pulse Profile Shape

To store sets of parameters, proceed as follows

Action of the Operator	System Response
> Select the memory location to be used using the ENTER KEY and arrow keys or joystick.	⊗ The selected memory location number
> Press the “S” (store) key on the keypad or inside the welding chamber/area.	The current parameters in the top line of display are stored in the selected memory location and displayed on the 3rd line of display. Any parameters in 3rd line will be over written. Last line in display shows “Storing into memory” briefly.

TO STORE TEXT, REFERENCE SECTION **TEXT ENTRY MODE**.

NOTE: To erase the stored welding parameters, press “ABC”, then press “!” then press ”ON”. The parameters can be over written at any time by using the procedure given previously.

Recalling Stored Parameters

You can use the middle joystick in the welding chamber/area or the keypad to select sets of operating parameters that you have previously stored (see the section entitled STORING OPERATING PARAMETERS on Page 36), and thus set them for your subsequent work.

Action of Operator	System Response
> Select the memory location to be used, using the ENTER KEY and arrow keys or joystick	⊗ The selected memory location
> Press the “R” (recall) key on the key pad or inside the welding chamber/area	⊗ The parameters in the third line of display are recalled from the selected memory location and displayed on the first line. Any parameters in this line will be overwritten. The last line in display shows “MEMORY RECALL” briefly. These are now the new operating parameters.

If there are not yet any parameter values stored under the selected memory location number, the set values remain unchanged. If the capacitor bank voltage is reduced as a result of the values selected, it is set automatically to the new value by pulse discharge.

WELDING

Action of the Operator	System Response
> Lift up the hand opening cover	⊗ The red SHUTTER CLOSED indicator shines. The green SHUTTER OPEN indicator flashes (if the shutter open key had been previously pressed)
> Put the work piece into the welding chamber/area	
> Close the hand opening cover	
> Put both hands through the hand openin7gs into the welding chamber/area	⊗ The green SHUTTER OPEN indicator will shine and the red SHUTTER CLOSED indicator will go out (if the shutter open key had been previously pressed). If not, press the shutter open switch inside the welding chamber/area.

Caution!

Do not position your hands in or under the crosshair. Pressing the pedal switch will release a laser pulse causing burning

Use the rotary control for the lighting (on the right of the rear wall in the welding chamber/area) to set the brightness to a suitable value. Check the brightness through the stereomicroscope. The appropriate brightness depends on the properties of the work piece material.

Use the joysticks to set the required welding parameters.

If the reference value for voltage is reduced, the safety shutter is closed for safety reasons.

For inert gas welding the inert gas outlet at the end of the gas tube is to be positioned near to the laser focal point. A position adequate for most applications is at the edge of the visual field of the stereomicroscope above the focal plane.

The exact positioning of work pieces must be carried out in all three dimensions:

- **Horizontal dimensions:** the exact- positioning is controlled by the crosshair.

- **Vertical dimension:** the exact positioning is found if the surface of the work piece appears sharp (in focus).

Action of the Operator	System Response
> Look through the stereomicroscope and join the work pieces together. Adjust them as necessary.	⊗ The crosshair shows the exact position of the laser focal point.
> If the welding point appears sharp within the crosshair, press the pedal switch half way.	⊗ The gas supply will be enabled
> Fully press the pedal switch until it stops	⊗ The view shutter shortly blacks out, the visual field and the laser pulse will be released. ⊗ The LASER OK indicator changes to red. ⊗ The laser is ready for the next pulse when LASER OK indicator is green.
> If several laser pulses are to be released one after the other, in single-pulse mode, the pedal switch must be slightly released and then fully depressed again. In continuous pulse mode, laser pulses with the set frequency are released continuously for as long as the pedal switch remains fully depressed.	
When you have finished welding, lay own the work piece in the welding chamber/area and pull both hands out of the hand openings (model dependent)	
> Lift up the hand opening cover and remove the work piece (model dependent)	⊗ The green SHUTTER OPEN indicator flashes, the red SHUTTER CLOSED indicator shines.

For different materials, suitable laser parameters (voltage, pulse length, pulse frequency, focal spot diameter and the appropriate inert gas have to be determined by trial and error. In many cases the quality of a welding point can be improved by placing several laser pulses shortly one after the other on the same welding point.

After each laser pulse and after changes to the voltage value, the red LASER OK indicator remains on until the system is ready to release the next pulse. This recovery time is between 0.1 and 3 sec. (depending on the set values for VOLTAGE and PULSE LENGTH).
The view shutter is controlled electronically. A laser pulse will only be released if the view shutter operates properly. Additionally, there is an optical filter in the viewing optic that blocks UV and laser light.

Resetting Pulse Count

You can select the various functions of the selection menu by first pressing the Menu Key means of the arrow keys, and then activate them by pressing the [ENTER] key. The following functions are available:

- Reset pulse count as follows:

    1. Press the MENU KEY to enter menu mode (Note: The laser shutter must be closed or at least one of the hand sensors must not be blocked.).

    2. Use the down arrow key to select the pulse count line. Selection is signified by a “>” in the first position of the line selected.

    3. Press “! ” key and then press “OK” key to reset to zero. If the “OK” key is not pressed, the system will time out without resetting.

- In text entry mode (see below), you can enter designations for the memory locations for processing data.

If you call the selection menu inadvertently, you can exit it by pressing the Enter Key or let the system time out (in 5 seconds).

Text Entry Mode

To enter memory location designations in text entry mode, proceed as follows:

- Activate the text entry mode by pressing the “ABC” key. A cursor appears in the 4th position of the second line.

- Use the arrow keys to select a character for the position identified by the cursor.

- Press the Store key to accept the letter displayed and move the cursor one position to the right.

- When you have entered all the characters, you can exit text entry mode by pressing the “ABC” key or enter key or let the system time out.
  You can delete existing characters by overwriting them with blanks or erase the entire line. You cannot enter text for memory location 00. A detailed description follows.

Text Entry Detail:

Pressing the text key “ABC” enters the text mode. The display cursor goes to the fourth position of the 2nd line of the display. Pressing the Up and Down keys cycles through letters, numbers, “+”,” –“,” “,”:”,”;”!”. Pressing the Store key, stores the character in current position and advances to next position. Pressing the Recall key will advance to next position without changing the current character. If Store is pressed without pressing the up or down key, the position will go blank. The text entered is stored in the program number displayed in line 2. Pressing the Text key at any time exits text mode. Since the character is stored when pressing the Store key, pressing the Text key is a way to exit without changing anything, prior to changing the character. Pressing the Enter Key will also exit text mode. Pressing the Store key when in the “Text Mode” does not change any system settings in either the top or 3rd line of the display.

To erase the complete line of text, press “ABC”, then press “!” then press ”OK”.
To erase the stored welding parameters, press “ABC”, then press “!” then press ”ON”.

Switching Off-Refer to **Figure 19**

1. Turn key switch (2) to the left.

2. Turn main switch (1) to the left (position “0”).

3. Close inert gas valves off (gas cylinder fittings).

Pull out the key and keep it in a safe place only accessible for authorized personnel.

Figure 19
On / Off Controls

Status Monitoring and Indications

During the self-test, immediately after the device has been switched on, and during operation, the current status of the laser is indicated by LED's on the keypad and by plain text messages in the status line (fourth line) of the display.

In the LaserStar® Workstation, the micro controller monitors the conditions for pulse release on the basis of the following criteria:

- If the safety shutter is open, a pulse can only be released via the pedal switch.
- In case the safety shutter is closed, the operator cannot release a laser lamp flash. (This is to avoid damages of the safety shutter.)
- On principle, all interlocks prevent a pulse release.
- Interlock failures shut off the lamp power supply.

Status Indications via LED's in the Keys-Figure 20

Display / Indicators Description

A. System on Indicator: **Green**
This indicator is "on" if the main switch and key switch is "on." This signifies the 24 VDC power is "on."

B. "OK" Flash Lamp Power Supply Ready Indicator: Bi-color LED
Red: The Flash Lamp power supply is not ready (CAP voltage and/or Simmer voltage). Laser is inhibited from firing.

Green: The Flash Lamp power supply is ready (fully charged, SIMMER ON).

C. Laser Safety Shutter Open: **Green** LED lamps
Green Flashing: The laser safety shutter is enabled to be opened.
Green Continuous: The laser safety shutter is open.

D. Laser Safety Shutter Closed: **Red** LED Lamps
Red: The Laser Safety Shutter is closed.

E. Interlock Open: **Yellow** LED Lamps. The safety interlock system is active. Laser cannot fire in this condition.

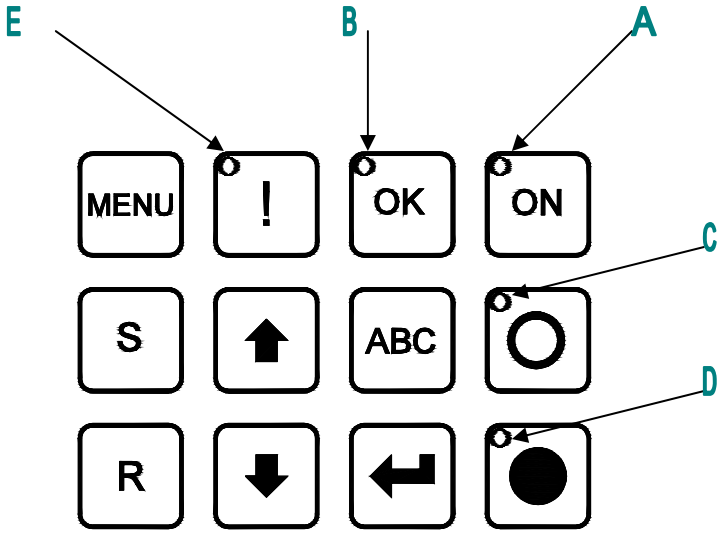


Figure 20

V. MAINTENANCE

During maintenance activities with an opened device, OSHA regulations about accident prevention for laser radiation or equivalent national or international regulations (e.g. EC Directive 608 or IEC Publication 825) absolutely must be followed!

WEAR PROPER LASER PROTECTIVE GOGGLES

Routine maintenance is required to ensure proper operation. These must be scheduled according to the manufacturer's recommendations. Prior to maintenance and/or service, several safety rules must be followed:

- Disconnect systems, subsystems and auxiliary equipment by turning them "off" and disconnecting them from any power sources or live components.

- Ensure that the disconnected equipment is secured against being switched "on" again inadvertently (e.g. by operator error) or automatically (e.g. by vibrations). Secure the mains switch with a padlock or remove the fuses. Use any mechanical locking device provided. Ensure that clear warning signs are in place while the work is being carried out.

- Check if the equipment is "live" using a voltmeter or a voltage tester. Measure the conductors against each other and against the protective ground conductor to check whether they are "live."

- Always **ground first**. Short-circuit the capacitors in low-voltage systems and devices. Short-circuit the capacitors and high-voltage lines in high-voltage systems and devices. Do not forget to remove the grounding and shorting jumpers when you have completed the work.

- If there is a risk of touching "live" components near to where you are working and it is not possible to disconnect these components from the voltage source, they must be covered with sufficiently strong and reliable insulating material, or some other method must be used to prevent direct contact. Cover with plastic sheeting/paneling or rubber matting.

NEVER WORK ALONE when performing service or maintenance activities. A second person, who should be at least familiar with the risks posed by laser radiation and high voltages, should always be present during service and maintenance activities. In the event of an emergency, this person can turn off the laser equipment and provide first aid.

HIGH VOLTAGE

Caution!

This laser device complies with all generally recognized technical standards and regulations. This includes OSHA, EC, EN, DIN and VDE standards. This laser is ignited and operated using dangerous high voltage (>1 kV), so special care has to be taken when working on the lamp power supply. When taking measurements on electrical or electronic components of this Class 4 laser product while it is "on," the required clearances have to be maintained. You must also bear in mind that the high-voltage capacitors used to produce the ignition energy and the high operating voltages take some time to discharge via the discharge resistance after the lamp power supply has been turned "off." Always comply with the relevant safety regulations (OSHA, or equivalent national standards) when working on electrical equipment of this kind.

Maintenance Intervals

Maintenance Interval Alert Reminders: The laser is equipped with the following maintenance interval reminders that will appear in the system display at the intervals indicated in the table below.

Alert	Interval	Reset Method
PROTECTIVE DISC	7 days	Press "!" to reset
LASER OPTICS	30 days	Press "!" to reset
CLEAN WELD CHAMBER/AREA	30 days	Press "!" to reset
AIR FILTERS	90 days	Press "!" to bypass, see note below
Change DI Water	90 days	Press "!" to bypass, see note below
DI Water Filter	180 days	Press "!" to bypass, see note below

Note: The "!" key will reset the first three alerts and by pass the others. This will allow for continued operation until the service can be performed. To reset the last three alerts, simultaneously press the "up" and "down" arrow keys, while the alert is displayed. If the alert is not reset it will appear again at power on.

The following maintenance should be performed in addition to the maintenance alerts discussed above.

A. Daily

1. The surface of the cabinet should be cleaned with a damp cloth or glass cleaner. Never use strong cleaning agents (i.e. powders or solvents).

2. The Laser Protective Window should be visually checked for cracks, voids or other damage. If damaged, the laser must not be used until the Laser Protective Window is replaced. Refer to section "Replacement of the Splash Protective Window and Laser Protective Window"

3. The **Protective Disk**, located inside the welding chamber/area, should be unscrewed from the focusing lens and cleaned with a lens cleaning solution. The recommended solvent is Isopropyl Alcohol.

Note: Metal splashes will adhere to the protective disk and a replacement disk will be needed. There is a danger of a local heating at these splash points on the protective disk that may result in possible cracking or destroying of the focus lens. Never install a protective disk with the side that has the metal splashes in the up position.

B. Weekly

1. Check the alignment of the crosshair to the laser spot. For a step-by-step procedure on alignment refer to the section on Microscope Mounting and Alignment in this Manual.

2. The Plastic Splash Protector behind the laser protective window should be cleaned and checked for scratches, cracks or holes.

C. Monthly

1. Inspect the welding chamber/area protective housings (model dependent) i.e., arms cuffs, chamber/area door and cuff for damage. The laser must not be used if any of the protective housings (model dependent) are damaged. Contact LaserStar for Service.

2. Vacuum clean the heat exchanger fins. **Caution!! The Fins on heat exchanger are sharp.**

3. Check the De-ionized water level. If water is low, top off tank to the Minimum Level mark.

4. Check and replace if dirty the Exhaust System Filter.
   Refer to section titled “Filter Exchange”

5. Check and replace the all Laser cabinet air filters if dirty

6. Check the laser’s energy as follows:
   - Set parameters at: 250 V, 1MS, 0.0Hz, 0,20mm Beam Diameter
   - Position the “Flash Paper,” supplied, at the bottom of the welding chamber/area and fire a single laser pulse.
   - Compare the spot to the samples provided at installation. If not similar, contact LaserStar Technical Service Department.

D. Every Three to Six Months

1. Change the De-ionized water.
2. **Change the De-ionized Water Filter every 6-12 months depending on use of laser.**

E. Yearly: All the above

Replacement of the Focus Lens Protective Glass Disk

1. Switch off the laser, turn main switch to "0." Wait five minutes for halogen lamps to cool.

2. Insert hands in hand openings.

3. Unscrew the knurled ring at the underside of the lens counterclockwise, take it off and pull it out of the welding chamber/area as horizontally as possible.

4. Replace the old protective glass disk with a new one.

5. Screw the knurled ring together with the new glass at the underside of the lens by turning it clockwise. The protective glass prevents the lens from being damaged by mechanical influences such as metal splashes or dust. In order to reduce losses by absorption, the protective glass has an antireflection coating on both sides.

Refilling of Cooling Water/Bleeding the Pump/Etc. (Reference Service Section)

Replacement of the Splash Protective Window and Laser Protective Window

The observation window is a combination of two pieces:

1. The laser protective window (outside) prevents the emission of laser radiation light.

2. The splash-protective window (inside) protects the laser protective window from soiling and damage.

3. Loosen both the hexagon socket screws on the sidewalls of the welding chamber/area until the angle brackets can be rotated or removed while pressing your hand from inside against the frame of the protective window.

4. First tip the lower edge of both protective windows inside and then pull them down into the welding chamber/area.

5. Separate both windows. Clean the laser protective window with a safe glass cleaner. If the laser protective window is being replaced, clean it prior to installation.

6. Remove the protective foils from the new splash protective window and clean it on both sides with alcohol.

Caution!

DO NOT SCRATCH THE SPLASH PROTECTIVE WINDOW

7. Put the laser protective window with the labels showing up onto the splash protective window. Put both windows from inside into the assigned openings of the cover.

8. Take good care that the laser protective window is located on the outside surface and fully seated in frame.

9. The two angle brackets over the hexagon socket screw head and the washer, apply light pressure to push them against the two windows, and then tighten the hexagon socket screws. The windows must fit well to the front elements of the frame and must not clatter after being fitted.

Filter Replacement, Chamber/Area Exhaust

1. Turn off the key and the main power switch. Unplug the power cord.

2. Wait five minutes.

3. Remove filter cover on the rear of the laser by removing the two screws.

4. Remove the filter and replace.

5. Reinstall filter cover and 2 screws

7. Plug in main cord and turn main power switch.

8. Check for fan coming on and air being exhausted out of exhaust outlet at rear of the cabinet.

Warning!

DO NOT CLEAN THE FILTER

Beating or blowing out with compressed air will destroy the filter medium. The pollutants attached to the filter will get into the air of the working area.

Fuse Replacement

General Steps for External & Internal Fuse Replacement

Warning!

1. To check or replace any fuse, shut off key switch and main power switch.
2. Remove power cord from main power and from the product.
3. Remove foot pedal cable. Wait at least five minutes.

External Fuses/Rear of Machine (Refer to **Figure 21a & Table 1**)

1. Verify AC power has been disconnected
2. Move machine to allow access to rear
3. Remove external fuses and check & replace as needed.
4. Re connect AC power & Test

Internal Fuses/DIN Rail Assembly (Refer to **Figure 21b & Table 2**)

1. Verify AC power has been disconnected
2. For internal fuses, remove the right side panel.
3. Pull lever out on top of fuse holder as needed to check or change desired fuse.
4. After replacing fuse, push fuse holder in until seated.
4. Replace the right side panel.
6. Reconnect AC power & Test.

Internal Fuses/Simmer Board Assembly (Refer to Service “D”/Figure 1)

External Fuses (Figure 21a & Table 1) & other connections

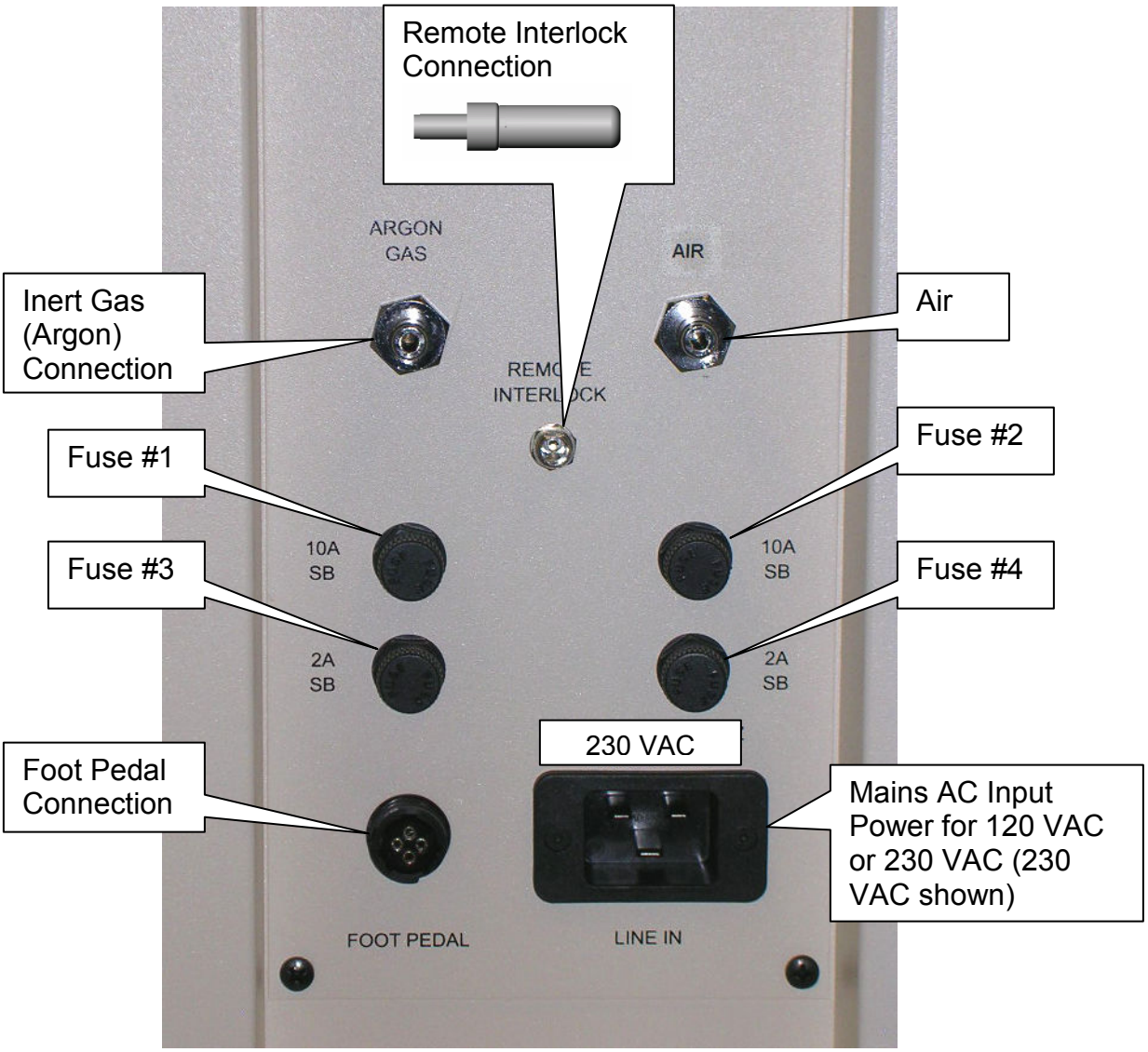


Figure 21a

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Table 1

Fuse #	LaserStar© PART NO.	AMPERAGE/ Type	Use
120 Volt AC Version			
1 & 2	405-4320-015	15.0A SB	Cap Charging & Cap Supply
3 & 4	405-4320-040	4.0A SB	24 VDC Supply
230 Volt AC Version			
1 & 2	405-4320-100	10.0A SB	Cap Charging & Cap Supply
3 & 4	405-4320-002	2.0A SB	24 VDC Supply

Internal Fuses DIN Rail Assembly showing fuse locations **Figure 21b & Table 2**
(Note: Remove welder right side panel)

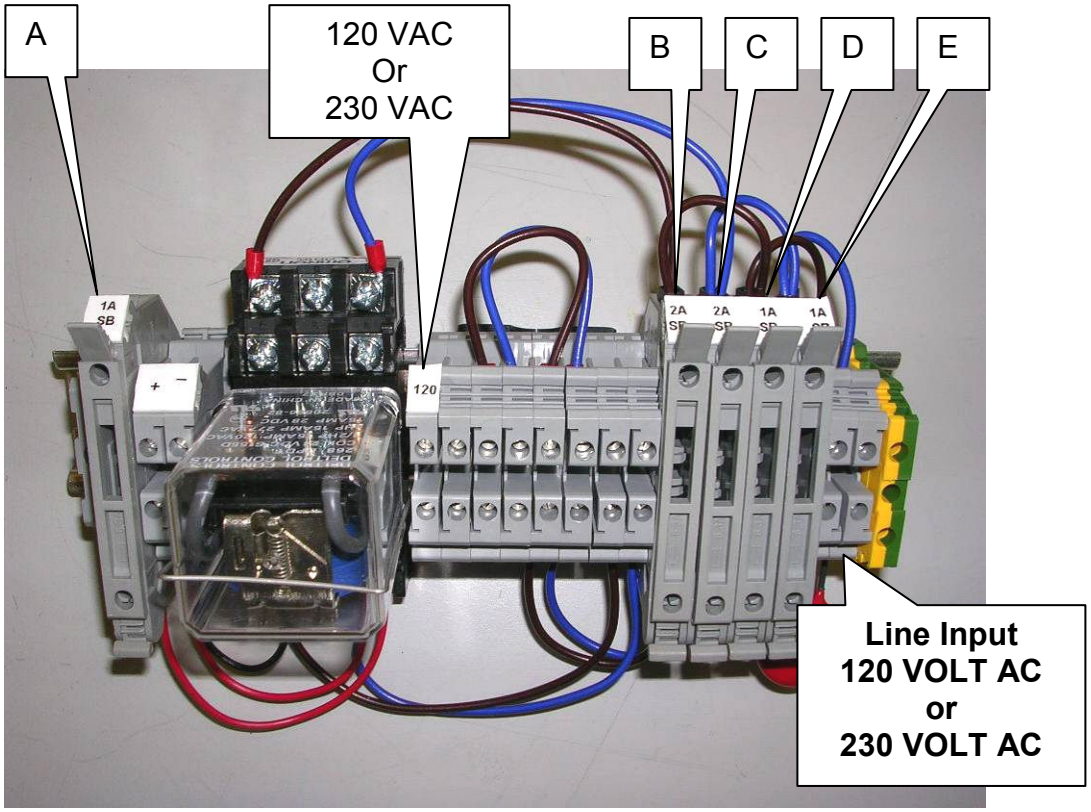


Figure 21b

Table 2

A	B	C	D	E
120 VOLT AC				
1A SB	2A SB	2A SB	1A SB	1A SB
Fluorescent Lamp	Water Pump, Cooling Fan	Water Pump, Cooling Fan	Dimmer/ Halogens, Exhaust Fan	Dimmer/ Halogens, Exhaust Fan
230 VOLT AC				
1A SB	2A SB	2A SB	0.5A SB	0.5A SB
Fluorescent Lamp	Water Pump, Cooling Fan, Exhaust Fan	Water Pump, Cooling Fan, Exhaust Fan	Dimmer/ Halogens	Dimmer/ Halogens

LaserStar© PART NO.	AMPERAGE	TYPE
405-4320-050	0.5A	SB/Time-Delay
405-4320-001	1.0A	SB/Time-Delay
405-4320-002	2.0A	SB/Time Delay

Flash Lamp Replacement (Reference Service Section)

VI. TROUBLESHOOTING

General Information

The yellow LED in the INTERLOCK RESET key indicates errors. In addition, the red LED of the SHUTTER CLOSED key is always “on “, since the shutter is always closed in the event of malfunctions.

In addition, a message appears in the status line (fourth line) of the display.

Error messages will be stored; i.e. the product always has to be manually reset by pressing the INTERLOCK RESET key. A reset will not be accepted if the reason for the failure has not yet been eliminated.

Warning!

During maintenance activities with an opened device, OSHA regulations about accident prevention for laser radiation or equivalent national or international regulations (e.g. EC Directive 608 or IEC Publication 825) absolutely must be followed!

WEAR PROPER LASER PROTECTIVE GOGGLES

Service

In case of any malfunction of the product that cannot be eliminated by one of the actions described in the sections MAINTENANCE or ERROR MESSAGES AND FAULT CLEARANCE, please immediately contact the service department of LaserStar Technologies.

Warning!

Service activities may only be performed by service technicians of LaserStar Technologies, properly trained personnel, or LaserStar supervised personnel.

LaserStar Technologies Corporation
One Industrial Ct, PO Box 15155
Riverside, Rhode Island 02915 USA
Tel: 401-438-1500
E-mail: service@laserstar.net

In case of any malfunction of the device that cannot be eliminated by one of the actions described in the sections MAINTENANCE or ERROR MESSAGES AND FAULT CLEARANCE, please immediately contact the service department of LaserStar.

SYSTEM MESSAGES	POSSIBLE REASON
Right Hand Sense*	The right hand proximity sensor is not seeing operator's hand in machine.
Left Hand Sense*	The left hand proximity sensor is not seeing operator's hand in machine.
Left Door Sensor*	Left chamber door is open (Reference Service Section "E")
Front Door Sensor*	Front chamber door is open (Reference Service Section "E")
Right Door Sensor*	Right chamber door is open (Reference Service Section "E")
Single Pulse Mode	Depressing the foot pedal will only produce one laser pulse.
Multi Pulse Mode	Hertz (HZ) activated. Depressing the foot pedal will produce multiple laser pulses.
Burst Pulse Mode	Burst (B) activated. Depressing the foot pedal will produce the number of laser pulses that the operator has selected.
Storing Into Memory	Save (S) key depressed. Parameters are being stored into a memory location.
Memory Recalled	Recall (R) key depressed. A saved memory location is being activated.
Laser Shutter Closed	The Open Shutter (O) button has not been pressed to allow the safety shutter to open.
Simmer Supply Off	Check and (or) change Flash Lamp. (Reference Service Section "D"/Simmer for details on lamp status)
Water Flow Low	Prime the water pump by opening the petcock located near water bottle. Are the inlet and outlet lines connected to the tank? Is the petcock closed after priming?

Water Level Low	Check and fill the Di-Water in the water bottle.
Water Temp High	Cooling water has exceeded normal operating temperature. Leave machine "on" to allow it to cool water down.
Warning Dead Battery	Control Board Memory Backup battery needs to be replaced. Use CLT# 405-3900-001 or 3V Lithium 2325
CHG Supply Over Temp	Check 10 amp fuses, (15 amp for High Performance models) **CONTACT SERVICE**
CHG Supply Over Volt	**CONTACT SERVICE** Calibration between charging supply and cap supply is "off".
Cap Discharge Fault	**CONTACT SERVICE** Power supply is not discharging.
Cap Supply Not Ready	Intermittent: Normal- Power supply is not recharged to the specified voltage. Continually in display: **CONTACT SERVICE**
IGBT Fault	**CONTACT SERVICE**
5 VDC Fault	**CONTACT SERVICE**
Beam Expander Fault	Beam Expander "zero" signal not detected. **CONTACT SERVICE** Operation can continue. However, beam diameter is not changing.
Beam Expander Limit Error	Beam Expander "Full Limit" signal not detected. **CONTACT SERVICE** Operation can continue. However, beam diameter is not changing.
Laser Shutter Fault	**CONTACT SERVICE** Machine detecting safety shutter error.
View Shutter Fault	**CONTACT SERVICE** Message will flash in display; view shutter is not tripping one or both of the open and close sensors.
Foot Switch Closed	Machine was turned on with the foot pedal depressed. Short in the foot Switch. **CONTACT SERVICE**

Note: (*)-Model dependent

Parts and Accessories

Description	Catalog Number
DI Water	100-75-0003
Water filter kit, DI	601-102
Air Filter Kit	611-101
Flash-lamp (Standard)	405-2460-405
Flash-lamp (High Performance)	405-2460-406
Alignment Paper	00-10020
Halogen Lamp 12V/20W	405-2460-114
Memory Backup Battery (CR2325 or BR2325)	405-3900-001
Cuff Assembly (hand opening)	111-00-0005
Flow Plate	01-10089
Laser Reflector	601-11003
Focus Lens Protective Disk	01-10112
Protective Window, Plexi-Glass	11-10071
Fuses 0.5A SB (230 Volt-Exhaust Chamber/area Light Control	405-4320-050
Fuses 1A SB (120 Volt-Exhaust Chamber/Area Light Control	405-4320-001
Fuses 2A SB (120/230 Volt-Water Pump & Cooling Fan)	405-4320-002
Fuses 4A SB (120V Fuse #2 & #3)	405-4320-004
Fuses 5A	405-4320-500
Fuses 10A SB (230 Volt-Fuse #1 & #2)	405-4320-100
Fuses 15A SB (120 Volt-Fuse #1 & #2)	405-4320-150
Laser Rod Assembly	101-00-1015
Flash Lamp Supply (230 Volt)	111-30-0005
Flash Lamp Supply (120 Volt)	115-30-0005
Cap Charging Supply (230 Volt)	405-4057-157
Cap Charging Supply (120 Volt)	405-4057-116
Simmer Supply-AC	405-4086-01
35C Temperature Switch	405-5134-035
55C Temperature Switch	405-5134-055
Laser Protective Goggles: Diffuse	444-001
Laser Protective Goggles	444-004
Remote Interlock Shorting Cap	101-36-0036
Regulator Kit (Inert Gas)	601-099
Operation Manual	11-99990-700

WARRANTY ORIGINAL EQUIPMENT

LaserStar Technologies Corporation (LaserStar) warrants for a period of one (1), two (2), or three (3) years, depending on your purchase, from date of LaserStar's invoice that equipment will be free from defects in materials and workmanship as determined at the date of shipment by LaserStar. Please reference the equipment purchase invoice for warranty details.

A) **Limited Warranty** - After notifying LaserStar's service department of a problem, at our option we will:

1. Immediately send a replacement part; or
2. Request defective part or complete machine be returned to LaserStar's Service Department for our inspection and repair or replacement; or
3. Schedule a Service Technician to inspect and repair or replace defective part at buyer's facility.

B) **Not Covered Under Warranty** -

1. This warranty does not cover any damage, misuse, or abuse to any and all optical components (lens, mirrors, glass, crystal, etc.) associated with the laser system.
2. This warranty does not cover consumable parts (flash lamp, protective disk, flash lamp connectors, water filters, air filters, De-ionized water, cuffs, fuses, halogen lamps).

The machinery warranty applies to all products when used in a normal industrial environment. Any unauthorized use, misuse, neglect, modification, or use with non-LaserStar approved or authorized accessories will make these warranties null and void. Under no circumstance will LaserStar have any liability for loss of use or for any indirect or consequential damages. Satisfaction of this warranty, consistent with other provisions herein, will be limited to the replacement or repair or modification of, or issuance of a credit for the equipment involved, at LaserStar's option, with LaserStar to determine the availability of service personnel and any absorption of associated service expenses, such warranty satisfaction available only if (a) LaserStar is promptly notified in writing upon discovery of an alleged defect and (b) LaserStar's examination of the subject: product discloses, to its satisfaction, that any defect has not been caused by misuse, neglect, improper installation by purchaser, improper operation, improper maintenance, repair or alteration, accident, or unusual deterioration or degradation of the equipment or parts thereof due to physical environment or due to electrical or electromagnetic noise environment.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES WHETHER LASERSTAR EXPRESSED, IMPLIED OR STATUTORY INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE and therefore excludes certifications or the like

for equipment performance, use or design with respect to any standard, regulation or the like (unless and to the extent independently approved in writing at LaserStar headquarters) AND EXTENDS ONLY TO BUYER OR CUSTOMER PURCHASING DIRECTLY FROM OR FROM AN AUTHORIZED RESELLER.

Return of Equipment

Authority for return of equipment, whether under the Warranty Clause or otherwise, must be obtained from LaserStar. Such authority shall be granted for each reasonable request. Unless such authority has been granted, shipment will be refused. To insure proper credit, all equipment must be returned directly to any LaserStar office as stated below. All equipment returned should include reference to all pertinent order information for that equipment to include order, part, model, and serial numbers as well as details of the system for which the equipment was removed when appropriate. Cost of placing equipment returned for credit in a salable condition will be charged to buyer at a rate of 15% of original sale price. Any and all transportation expenses associated with the repair or replacement of LaserStar's laser machines is the sole expense of the Buyer.

Governing Law

The sale and purchase of the equipment, including all terms and conditions thereof, shall be governed by the Uniform Commercial Code and laws of the State of Rhode Island.

Limited Liability

IN NO EVENT WILL LASERSTAR ASSUME RESPONSIBILITY FOR OR BE LIABLE FOR (A) PENALTIES OF PENALTY CLAUSES OF ANY DESCRIPTION, OR (B) FOR CERTIFICATIONS NOT OTHERWISE SPECIFICALLY PROVIDED HEREIN AND/OR FOR INDEMNIFICATION OF BUYER OR OTHERS FOR COSTS, DAMAGES OR EXPENSES, EACH ARISING OUT OF OR RELATED TO THE EQUIPMENT OR SERVICES OF THIS ORDER, OR C) FOR INDIRECT OR CONSEQUENTIAL DAMAGES UNDER ANY CIRCUMSTANCES.

This warranty does not cover defects or damages resulting from accidents while in transit, alterations, unauthorized repairs, failure to follow proper safety and operating instructions, misuse, fire, flood, freezing temperatures, and acts of God.

Authorized Office:

LaserStar Technologies Corporation
1 Industrial Court, P.O. Box 15155
Riverside, Rhode Island 02915 USA
Tel: 401-438-1500
E-mail: **service@laserstar.net**

VII. SERVICE (Requires Trained or Supervised Personnel)

Warning!

Service activities may be performed by service technicians of LaserStar Technologies Corporation, properly trained personnel or person(s) supervised by LaserStar personnel.

Warning!

During service activities with an opened device, OSHA regulations about accident prevention for laser radiation or equivalent national or international regulations (e.g. EC Directive 608 or IEC Publication 825) absolutely must be followed!

Wear proper laser protective goggles

Warning!

During some of the service activities/tests (Simmer/Flashlamp Status, Tri-Door Chamber, DI Water, etc.) the Mains AC Power and Key Switch will need to be on for part of the test. **Extreme care must be taken when observing the state of the led indicators, toping off the DI Water Bottle, purging air from the cooling system. Do not touch any electronic component or wire with the Mains AC Power on (Unplug the machine or switch off the circuit breaker and wait 5 minutes before servicing.)**

In case of any malfunction of the product that cannot be eliminated by one of the actions described in the sections MAINTENANCE, TROUBLESHOOTING, and SERVICE, please document your results from above sections and E-mail this information to service@laserstar.net. Make sure you include the machines model number and serial number with all correspondence. Please then follow up the E-mail with telephone call to Service.

LaserStar Technologies Corporation
One Industrial Ct, PO Box 15155
Riverside, Rhode Island 02915 USA
Tel: 401-438-1500
E-mail: service@laserstar.net

Service A: Initial Filling & Refilling of the DI Cooling Water

Tools/Supplies Required:

- Phillips Screw Driver #2
- Metric Hex Key Wrench Set (Metric 1.5 to 6 mm set)
- Adjustable Wrench (1 1/8" range) or Open End (1.0")
- Absorbent Paper Towels (Ex.-Scott Shop Towels/Blue)
- Bucket
- Small Funnel

CAUTION: Only use **de-ionized water**. Use of distilled water will damage the device and void the warranty.

A. DI Water Filling or Refilling (**Figure 1a-d**)**-(Note**: **The system is delivered without DI Water & <u>MUST</u> be filled before turning the system "On".** (Note: DI Water is supplied with the welder)

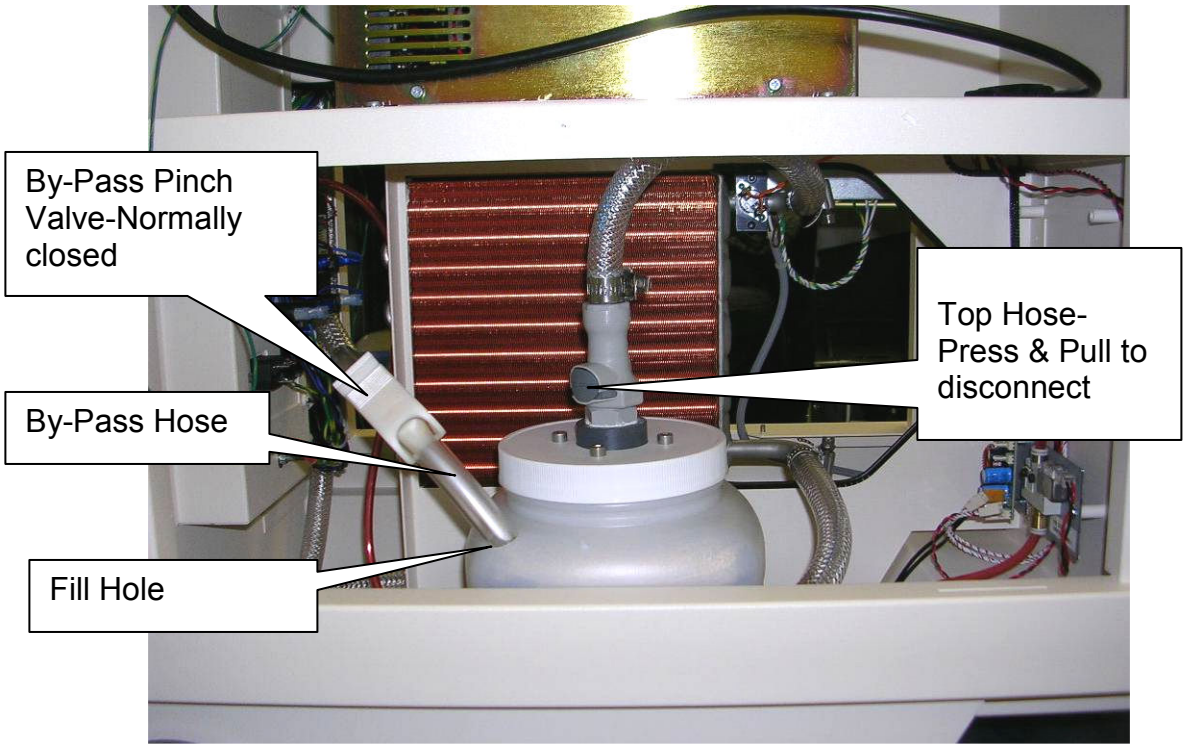


Figure 1a

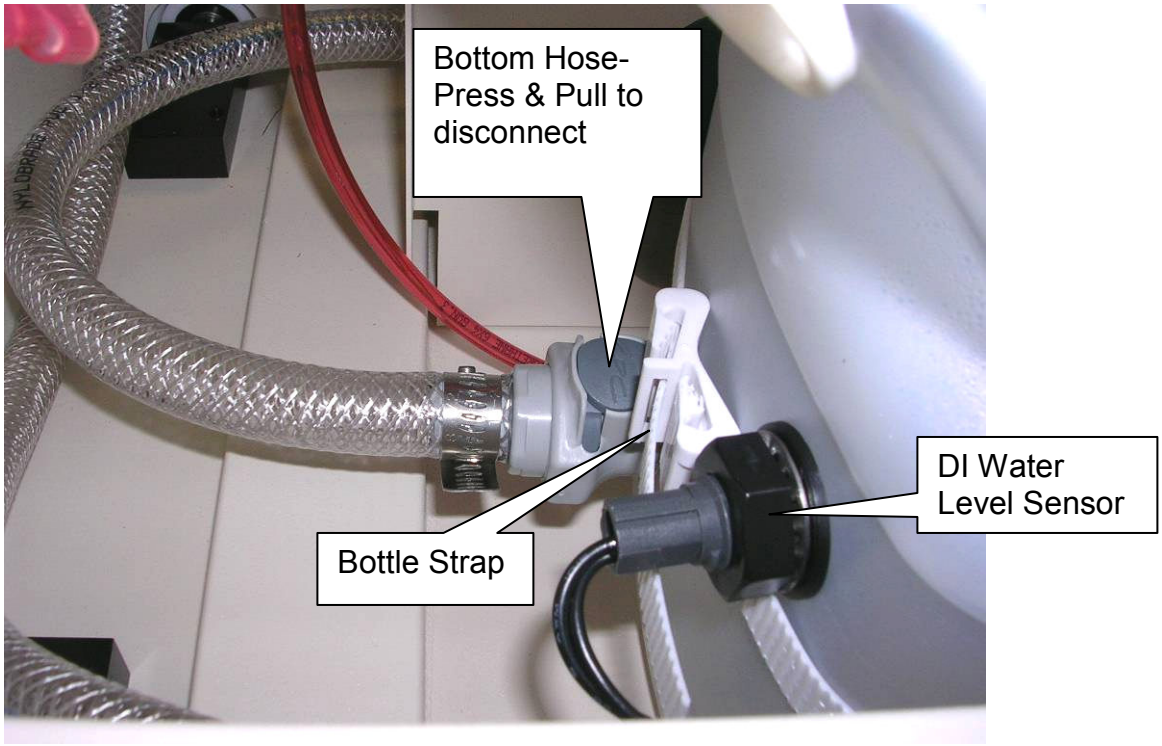


Figure 1b

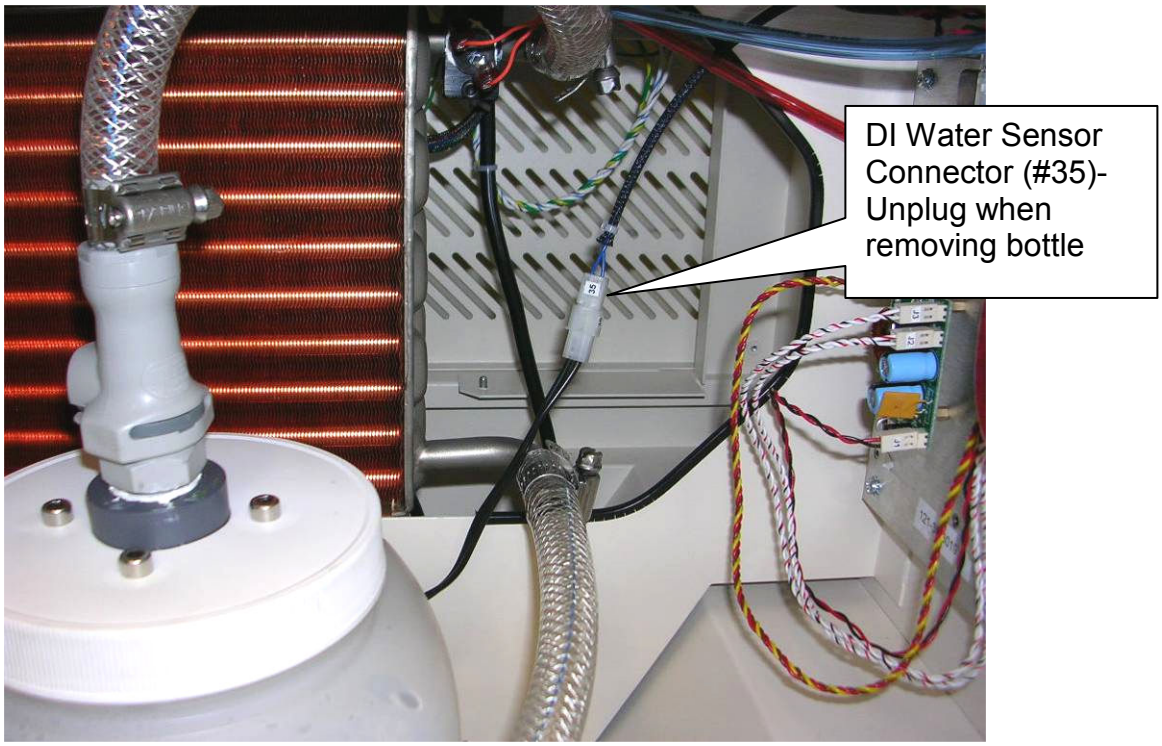


Figure 1c


Maximum Level Line-Note: Used only for initial filling
Minimum Level Line (Normal Operation)
LASERSTAR
TECHNOLOGIES
Use Deionized Water Only
(Part No. 100-75-0003)
DO NOT Use Distilled Water or Any Substitutes
Crafford-LaserStar Technologies Corporation

Figure 1d

B. Initial Filling of the DI Water Bottle & Bleeding the Pump (Figure 1a-d)

1. Make sure the laser is “Off”, turn the Key-switch to “O”/Off, turn Mains Power switch to "O”/Off.

2. Make sure the AC power is “Off”- shut off the Mains Circuit Breaker (on the rear of the machine), pull out the mains plug or shut off the wall disconnect switch.

3. **The system should be “Off” for at least five (5) minutes before servicing.**

4. Remove the screws securing the left side panel. Lift up the panel and remove (Note-Be careful not to break the panel ground wire [disconnect if required]).

5. Make sure the By-Pass pinch valve is closed tightly

6. Remove the By-Pass hose from the bottle.

7. Using a **clean** funnel in the Fill Hole, pour the DI water into the bottle up to the **maximum level line.** Reference **(Figure 1d) (Note:** This line can be seen with the bottle still in the base of the machine enclosure. The DI water is only at the **maximum fill line** if the pump chamber/flashlamp cavity has been drained due to changing the flashlamp or initial filling after installation of the welder.).

8. The next step is to bleed the system. The purpose of this step is to purge the air from the heat exchanger, hoses, flash chamber and pump.

9. Insert the By-Pass hose back into the bottle and open the By-Pass pinch valve.

10. Turn “On” the mains wall switch (or plug in) & the mains circuit breaker

11. Turn “On” the Mains Power switch only (Note: Make sure the Key-switch is still **“Off”**) on front of machine so that the pump starts up. (**Caution**: The water should immediately start to flow. **If the pump starts to squeal/strange sounds <u>immediately turn the system Off</u>**. Leave the system off for a few minutes and try again. If not okay, you should contact LaserStar Field Service.)

12. Run the pump until there are no more air bubbles visible in the hose line (Note: Normally this will take 3 to 5 minutes.)

13. Turn “Off” the Mains Power Switch

14. Top off the DI water bottle to the **<u>minimum level line</u>**

15. Replace the left side panel and install the screws. (Note: Make sure the ground wire is connected.)

16. The system is ready to weld.

C. Refilling/Topping Off the DI Water Bottle (Refer to **Figure 1a-d**)

1. Make sure the laser is “Off”, turn the Key-switch to “O”/Off, turn Mains Power switch to "O”/Off.

2. Make sure the AC power is “Off”- shut off the Mains Power Circuit Breaker (on the rear of the machine), pull out the mains plug or shut off the wall disconnect switch.

3. **The system should be “Off” for at least five (5) minutes before servicing.**

4. Remove the screws securing the left side panel. Lift up the panel and remove (Note-Be careful not to break the panel ground wire. Disconnect if required.).

5. Remove the By-pass hose from the fill hole, fill the DI water bottle up to the **minimum level line** using a clean funnel in the fill hole and install the By-pass hose.

6. Replace the left side panel and install the screws. (Note: Make sure the ground wire is still connected.)

7. The system is ready to weld when the AC power is reconnected/turned on.

D. Changing the DI Water Filter & Replacing the DI Water Filter (Figure 2-5 Typical)

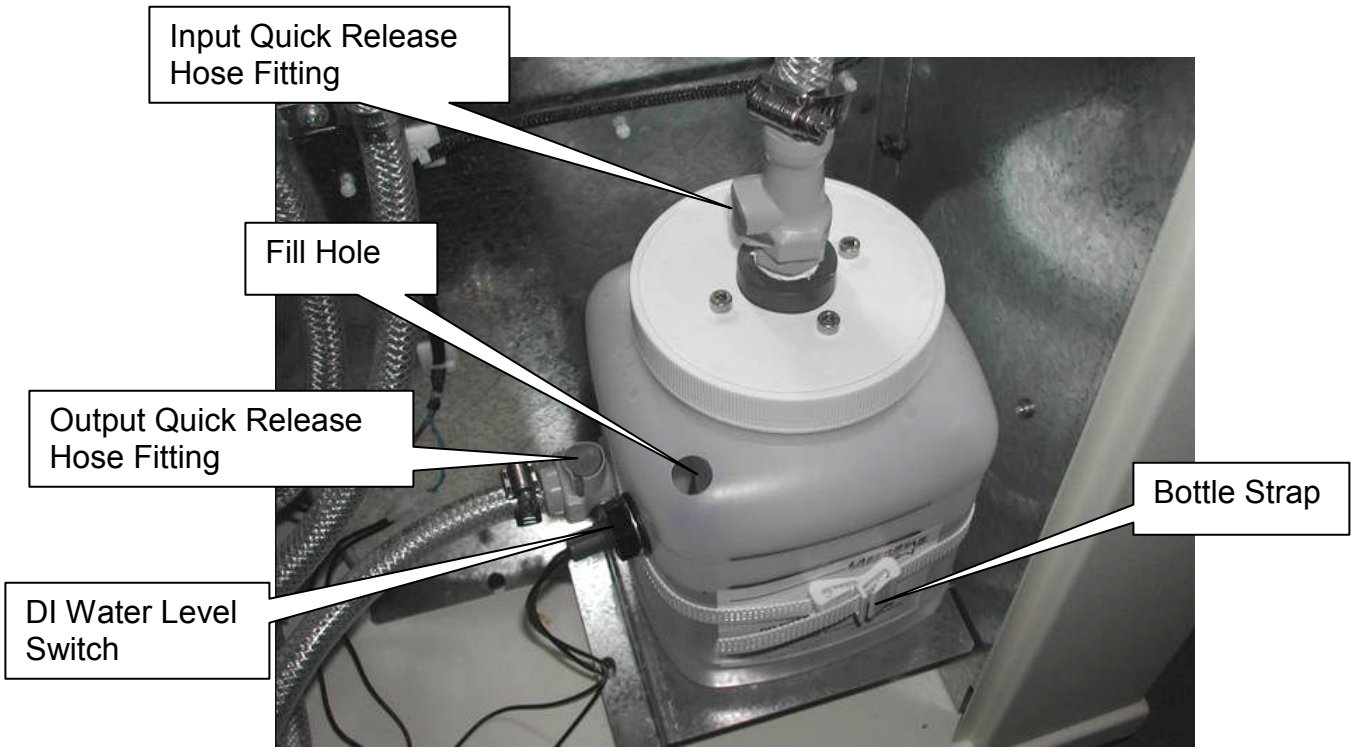


Figure 2

1. Make sure the laser is “Off”, turn the Key-switch to “O”/Off, turn Mains Power switch to "O”/Off.

2. Make sure the AC power is “Off”- shut off the Mains Circuit Breaker (on the rear of the machine), pull out the mains plug or shut off the wall disconnect switch.

3. **The system should be “Off” for at least five minutes before servicing.**

4. Remove the two screws securing the left side panel. Lift up the panel and remove (Note-Be careful not to break the panel ground wire. Disconnect the wire if required.).

5. Press the button on Input Quick Release Hose Fitting to disconnect the hose from the DI Water Bottle.

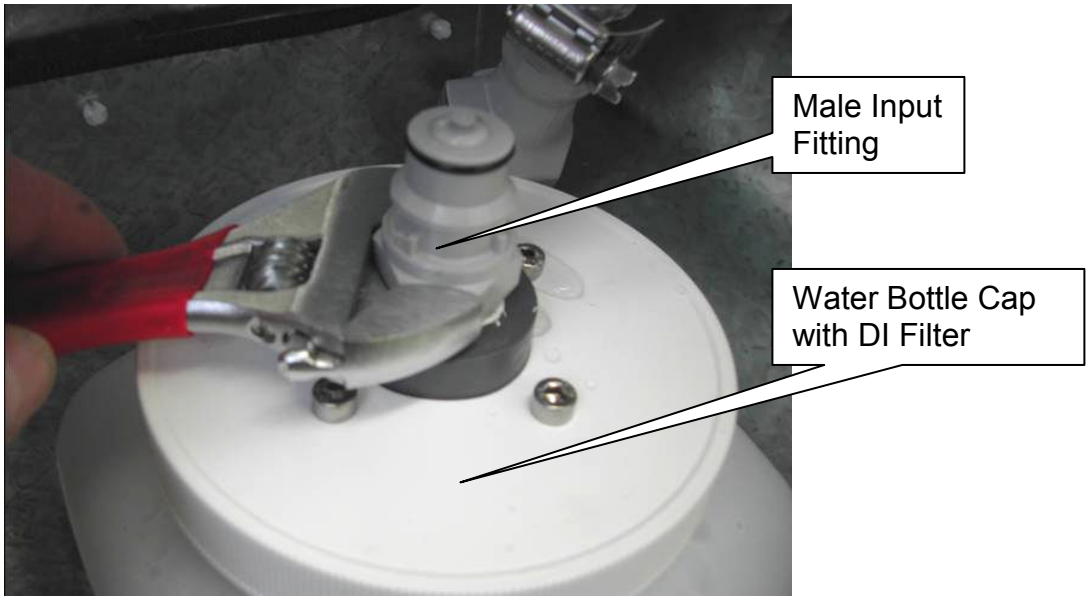


Figure 3

6. Carefully remove male input fitting (turn counter clockwise) on bottle cap **(Figure 3).** (Note: Hold cover with other hand while removing male fitting.)

7. Place Input Quick Release Hose Fitting into bucket/container and plug in male input fitting just removed from the bottle cap.

8. Make sure Mains Power and Key-switch are Off/"O"

9. Turn on the wall disconnect (or plug in) and reset the Mains Power Circuit Breaker located on the rear of the machine.

10. With the hose in the bucket turn on the Mains Power Switch (Key-switch should be Off) on front panel of machine. **(Note- Immediately, turn off the Mains Power Switch when the steady stream of water from the hose stops. This will only take a few seconds. The pump will be damaged without a steady flow of water.)**

11. Disconnect the Output Quick Release Hose Fitting from the side of the DI Water Bottle **(Figure 2)**

12. Unscrew the Water Bottle Cap with DI Filter and place in the bucket/container.

Figure 4

13. Using a screw driver, carefully pry open the bottle strap buckle until the strap can easily be removed. **(Figure 4)**

14. With DI Water Filter Switch wire **(Figure 2)** still connected (or disconnected) pour out the remaining DI Water into the bucket. (Note: Be careful not to pull on the switch wire.)

15. Install the DI Water Bottle and secure with the strap.

16. Connect the Output Quick Release Hose Fitting to the side of the bottle. (Note-Be careful to not apply too much force.) **(Figure 2)**

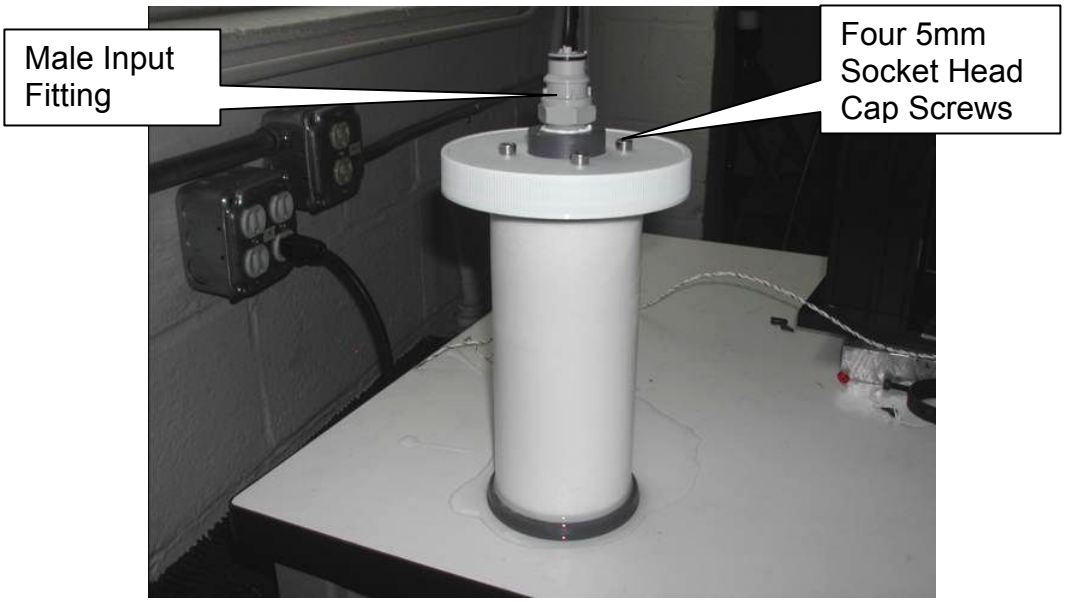


Figure 5

16. Remove the DI Filter from the Bottle Cap by removing the four screws using a Metric Hex Size #4 key. **(Figure 5)**

17. Attach the new DI Filter to the DI Water Bottle Cap. (Note: Do not over tighten the screws.)

18. Install the Male Input Fitting using Teflon pipe tape. (Note: Do not over tighten the fitting.) **(Figure 3)**

19. Install the new DI Water Filter Cap Assembly back into the DI Water Bottle

20. Connect the Input Quick Release Hose Fitting to the Bottle Cap

21. Fill the DI Water Bottle to the **minimum level line**thru the Fill Hole (Figure **1**)

22. Verify that all Quick Release Hose Fittings are properly connected.

23. Turn on the wall disconnect switch (or plug in) and reset the Mains Power Circuit Breaker located on the rear of the machine.

24. Turn “On” the Mains Power Switch only (Note: Make sure the Key-switch is still **“Off”**) located on front of machine to start the pump. (**Caution**: The water should immediately start to flow, if the pump starts to squeal/strange sounds **stop** the system. Leave the system off for a few minutes and try again. Try two times. If not okay, you should contact LaserStar Field Service.)

25. Run the pump until there are no more air bubbles visible in the hose line (Note: Normally this will take 3 to 5 minutes.)

26. Turn “Off” the Mains Power Switch

27. Top off the DI water bottle to the **minimum level line** **(Figure 1d)**

28. Replace the left side panel and install the screws. (Note: Make sure the ground wire is still connected.)

29. The system is ready to weld.

Service B: Flash Lamp Replacement

Tools/Supplies Required:

- Phillips Screw Driver #2
- Metric Hex Key Wrench Set (Metric 1.5 to 6 mm set)
- Clean Room Vinyl/PVC Gloves (**Powder-Free**/DEHP & DOP Free)
- Isopropyl Alcohol 70% **(Flammable/**Polish out any haze with a clean wipe**),** approved optic cleaning solution, or preferred LaserStar p/n 810-2353
- Lint Free Cloth or preferred wipes-LaserStar p/n 810-2356 (qty 1) or 810-2354 (qty 90)
- Absorbent Paper Towels (Ex.-Scott Shop Towels/Blue)

Flash Lamp Replacement Instructions (Figure 1-23)

WEAR EYE PROTECTION AND PROTECTIVE GLOVES! DONOTHANDLE THE LAMP UNLESS YOU ARE WEARING LABQUALITY GLOVES (Powder-less/No Lubricant)

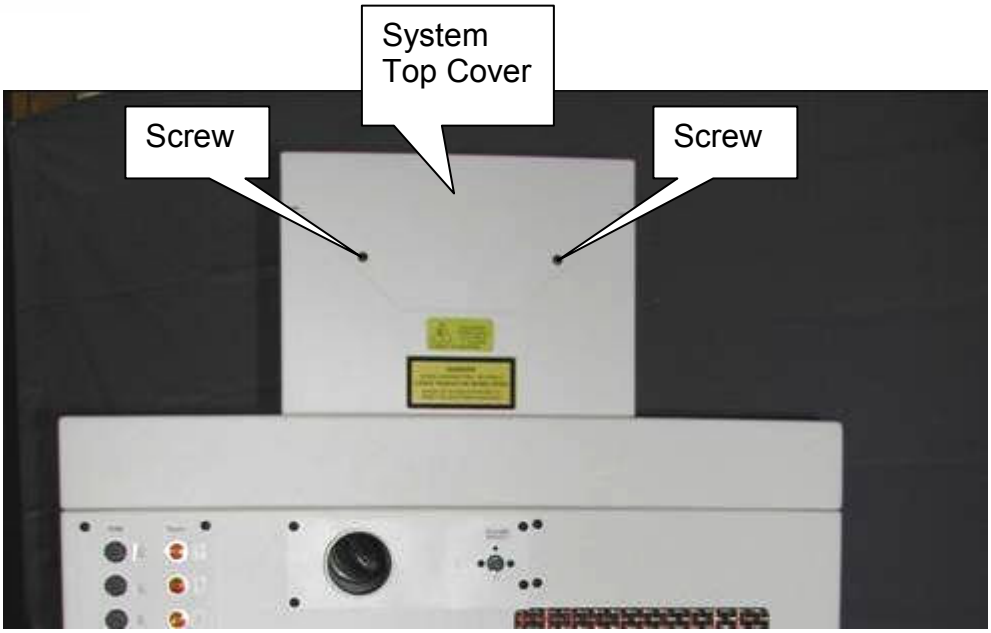


Figure 1

1. Make sure the laser is “Off”, turn the Key-switch to “O”/Off, turn Mains Power switch to "O”/Off.

2. Make sure the AC power is “Off”- shut off the Mains Circuit Breaker (on the rear of the machine), pull out the mains plug or shut off the wall disconnect switch.

3. **The system must be “Off” for at least five (5) minutes before servicing.**

4. Remove the two screws shown in **(Figure 1)** and carefully lift the Top Cover from the rear and slide it back about ½ inch and lift up and remove. (Note: Disconnect the ground wire and place the cover in a safe place.)

5. The Laser Rail orientation for service is shown in **(Figure 2).**

6. Remove the Dust Protector shown in **(Figure 2)**. Note: Remember to replace the Dust Protector after service is complete.

7. There are two styles of reflectors: Gold shown in **Figure 4a** and white ceramic shown in **Figure 4b**. The gold reflectors are secured by screws and the ceramic reflectors are held in position by end stops. (Note: Make sure the Stainless Steel Shim is installed as shown in the ceramic reflector.)

8. The remaining steps are done with pictures and picture notes. The start up procedure is at the end of this section.

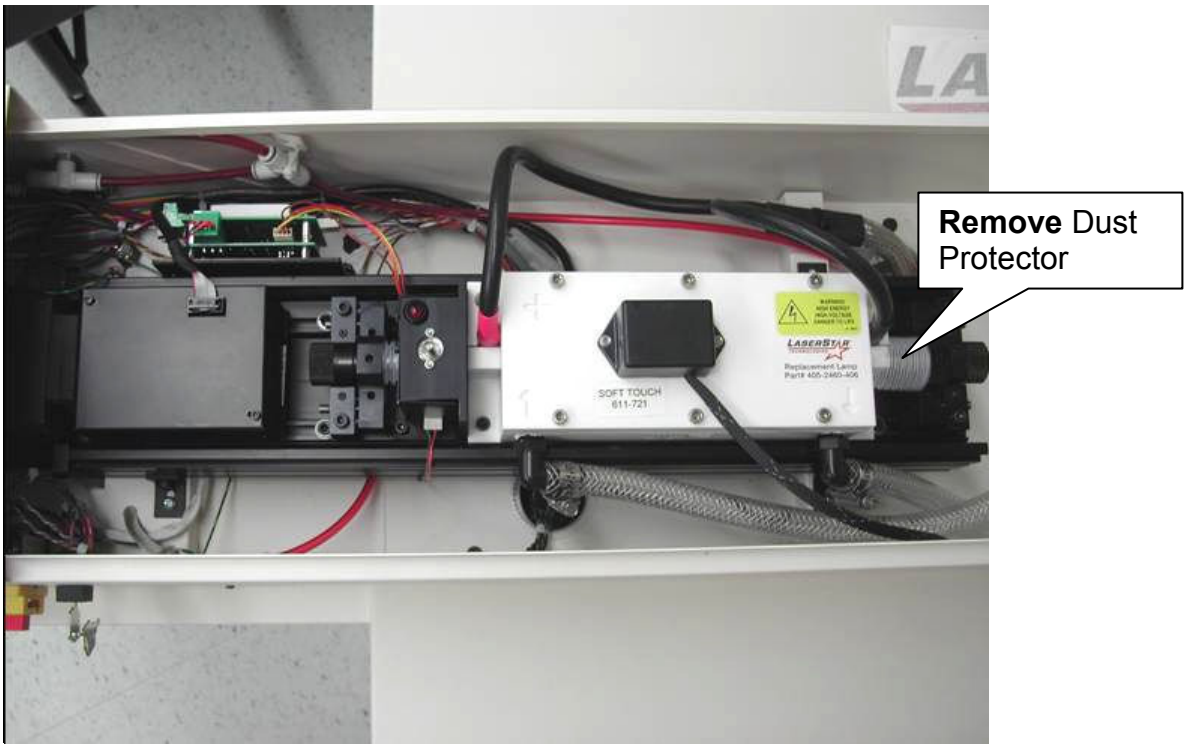
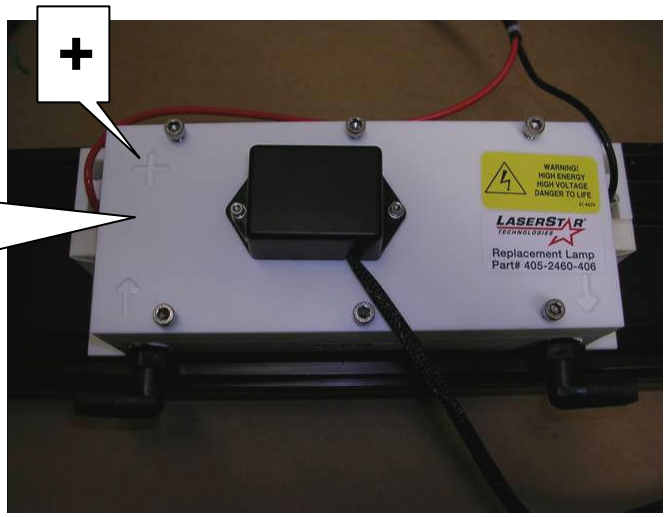


Figure 2

A lamp installed with reverse polarity will age after just a few pulses, causing rapid loss of laser power. Any contamination on the lamp will dramatically shorten the lamp's life.

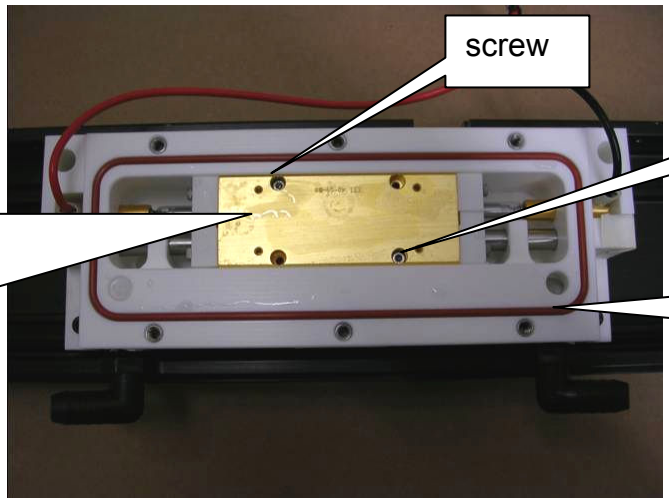
Remove Chamber Top Cover by removing (6) M5 Screws with M4 Hex Key



Note: After loosening the six screws, slowly lift the cover and let the system drain back into the DI Water Bottle.

Figure 3

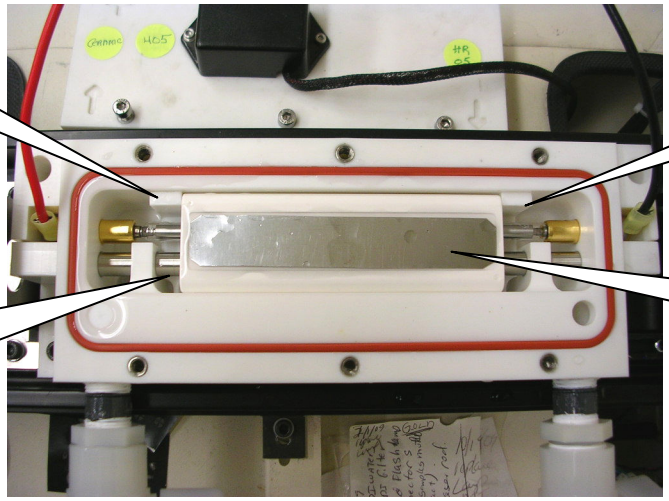
Remove Top Gold Reflector by Removing (2) M3 Screws with M2.5 Hex Key (Note: Some versions may have more than (2) screws.)



Note: Make sure O-ring remains in

Figure 4a

End Stop-Note orientation



End Stop-Note orientation

Remove Ceramic Reflectors-White (No screws)

Stainless Steel Shim

Figure 4b

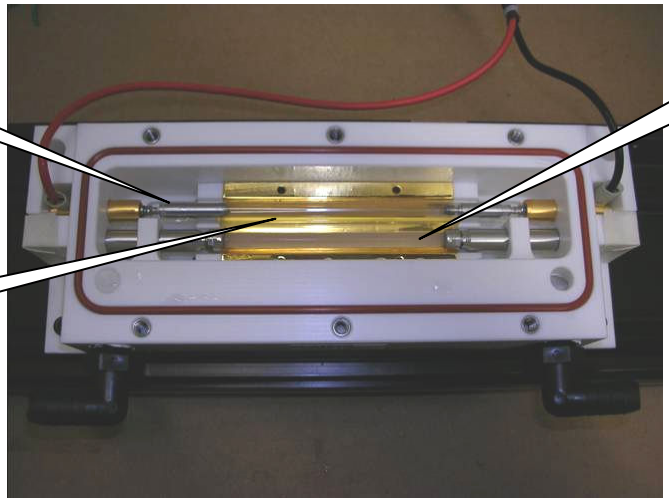


Figure 5

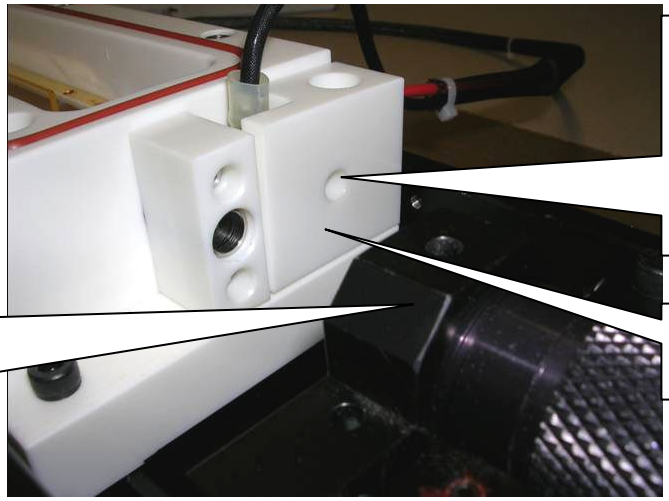


Figure 6

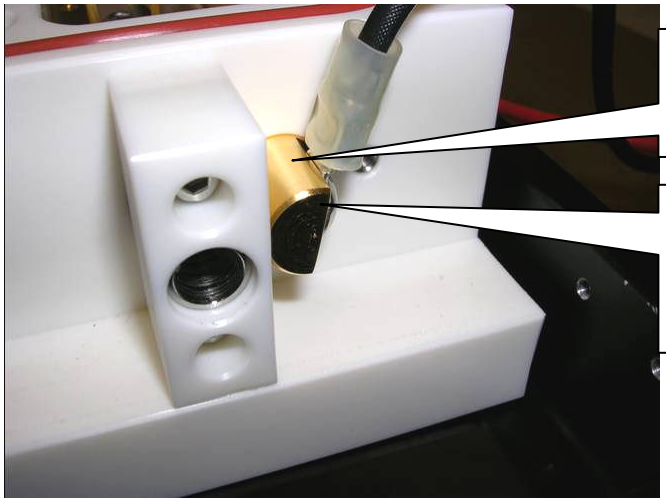
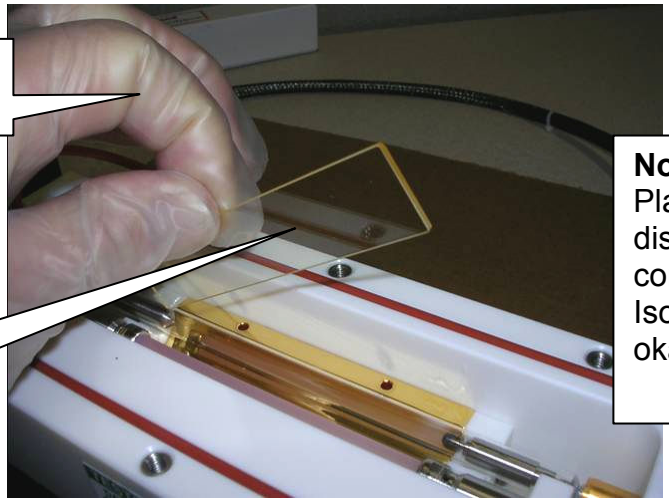


Figure 7

Required-Clean Room Gloves-Powder-free

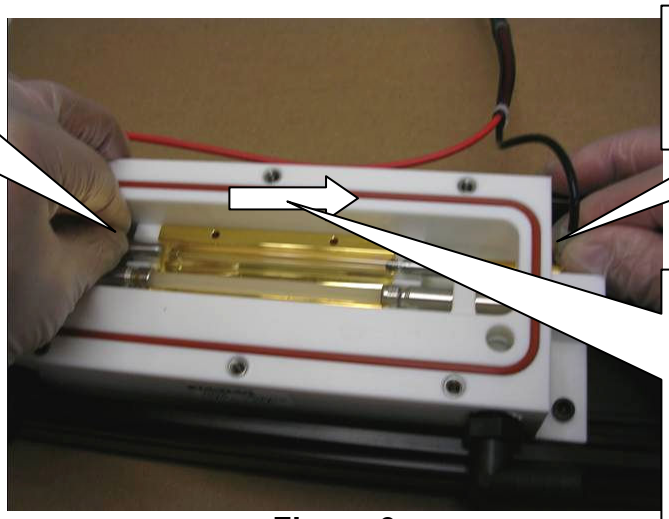
Remove Flow Plate-Clean or Replace



Note: Inspect the Flow Plate for cracks, chips, discoloration/cloudiness, or contamination. Clean with Isopropyl Alcohol, If still not okay, replace.

Figure 8

(1) Secure Front End of Flashlamp between Fingers

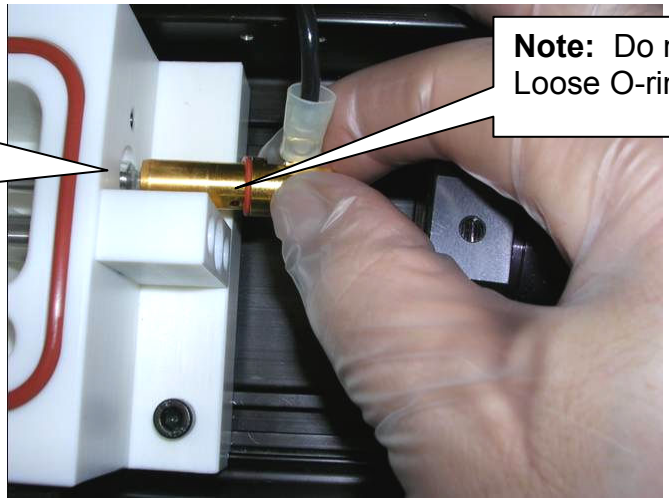


(2) Secure Rear Flashlamp Connector Between Fingers

(3) Carefully Remove Flashlamp in the Direction of the Arrow Until Unplugged from the Front Flashlamp Connector

Figure 9

Pull Rear Flashlamp Connector just Clear of the Chamber Body



Note: Do not Loose O-ring

Figure 10

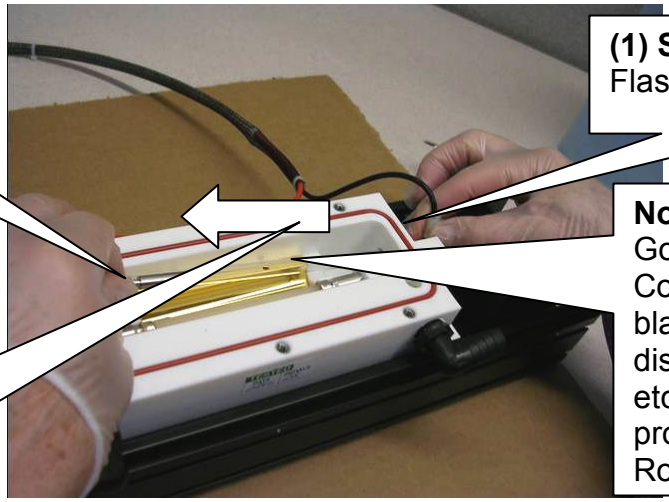


Figure 11

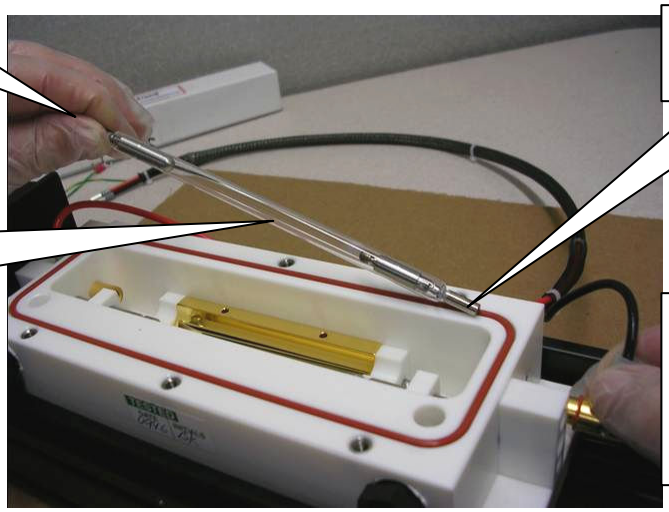


Figure 12

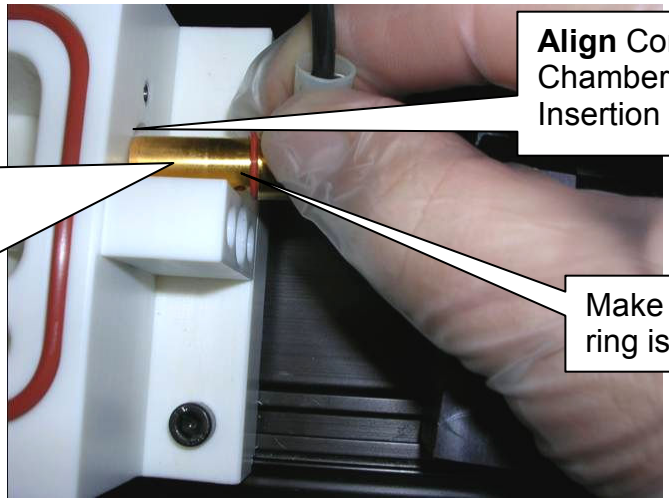


Figure 13

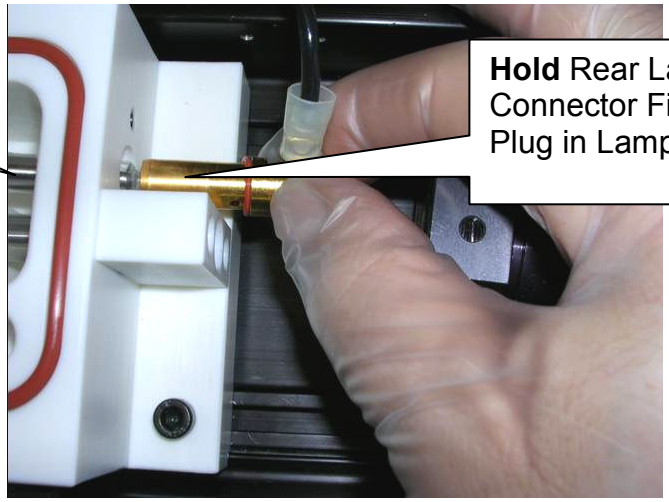


Figure 14

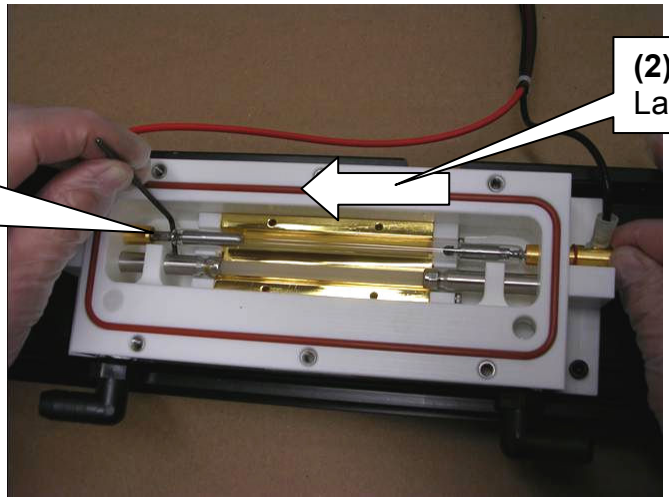


Figure 15

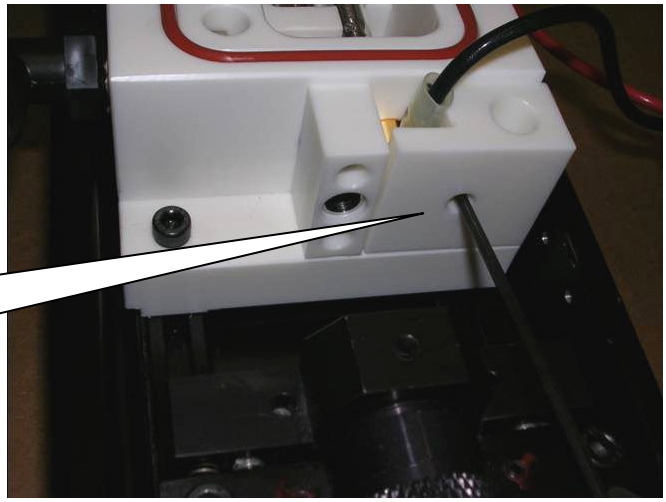


Figure 16

Carefully hold both ends of the Lamp and Centralize over Reflector. (Note: Make sure Bottom Reflector is in Position)

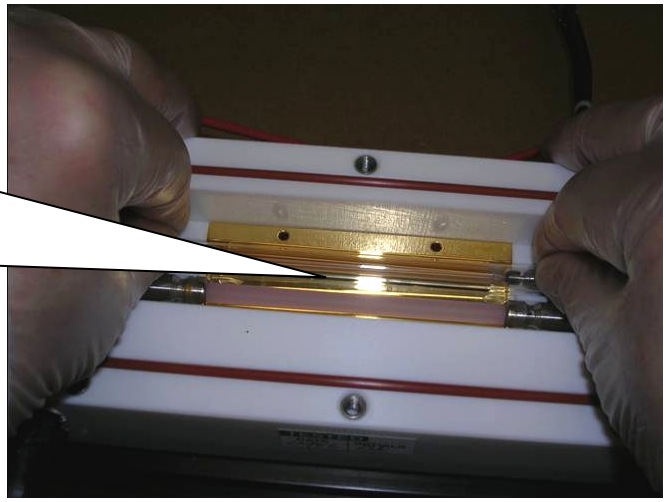


Figure 17

Install Flow Plate in Slots on both ends of Reflector End Blocks. (Note-Refer to Figure 2.19 for more Detail)

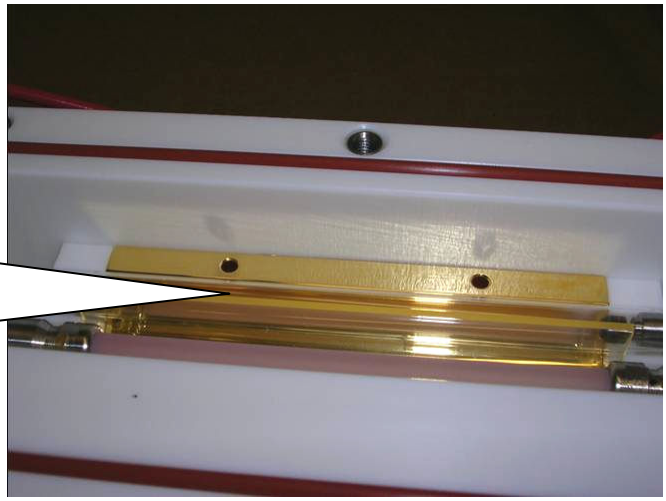


Figure 18

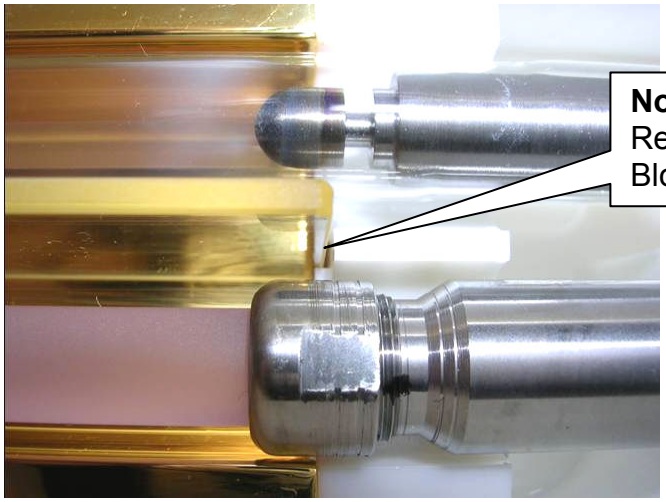
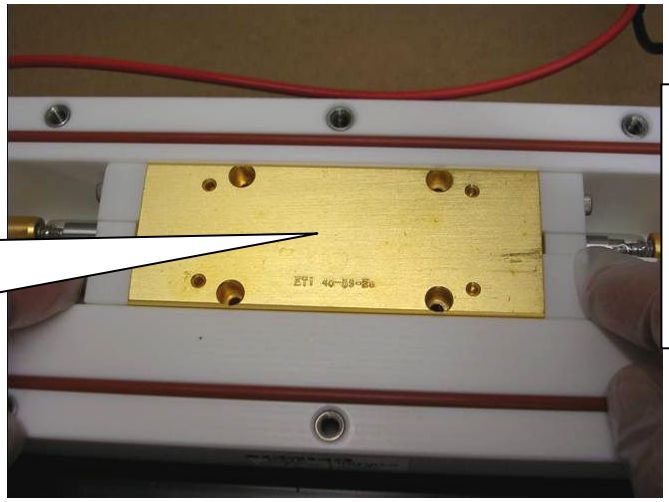


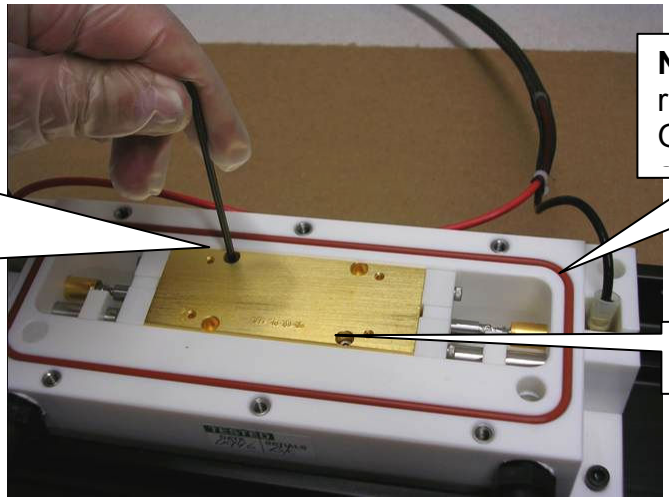
Figure 19



Install Top Reflector & Position the Reflector Assembly in the middle of the Cavity.

Note: Do not force Top Reflector onto Flow Plate. Make sure the Flow Plate is properly positioned in the slot.

Figure 20

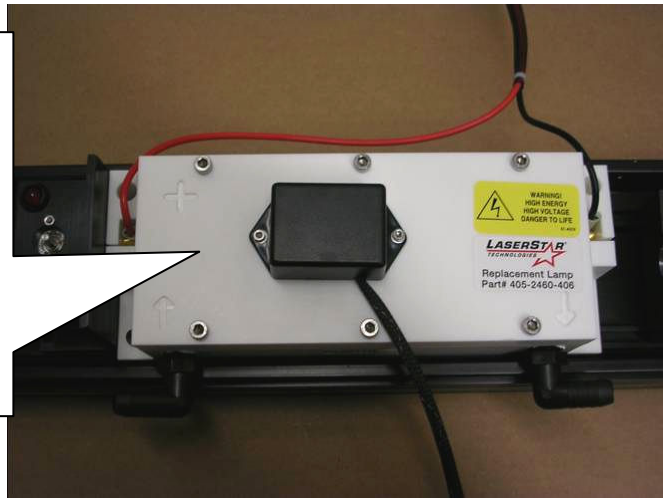


Secure the Reflector Assembly with (2) Screws. (Note: Some versions may have more than (2) Screws.)

Note: Make sure O-ring is Completely in Grove all the way

Screw

Figure 21



Install the Top Cover and Tighten the six M5 Screws. (Note: The six screws should all be tightened until resistance is felt. Final Tightening should be done using a Torque wrench tighten to 9-10 in lbs. **Do not over tighten**)

Figure 22

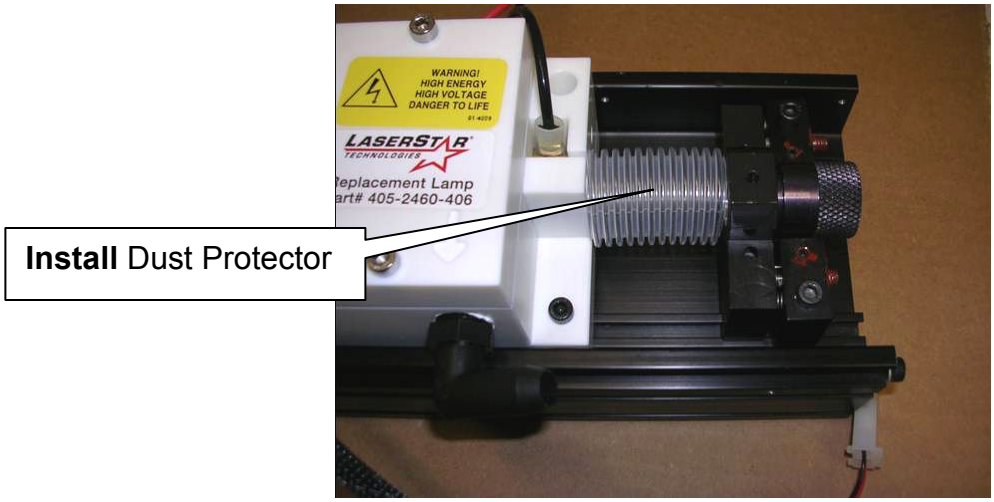

WARNING!
HIGH ENERGY
HIGH VOLTAGE
DANGER TO LIFE
LASERSTAR
TECHNOLOGIES
eplacement Lamp
art# 405-2460-406
Install Dust Protector

Figure 23

Service C: Major System Components

Control Section, DI Water Pump & Heat Exchanger-Right Side (Figure 1)
(Remove right side panel and disconnect ground wire to access)

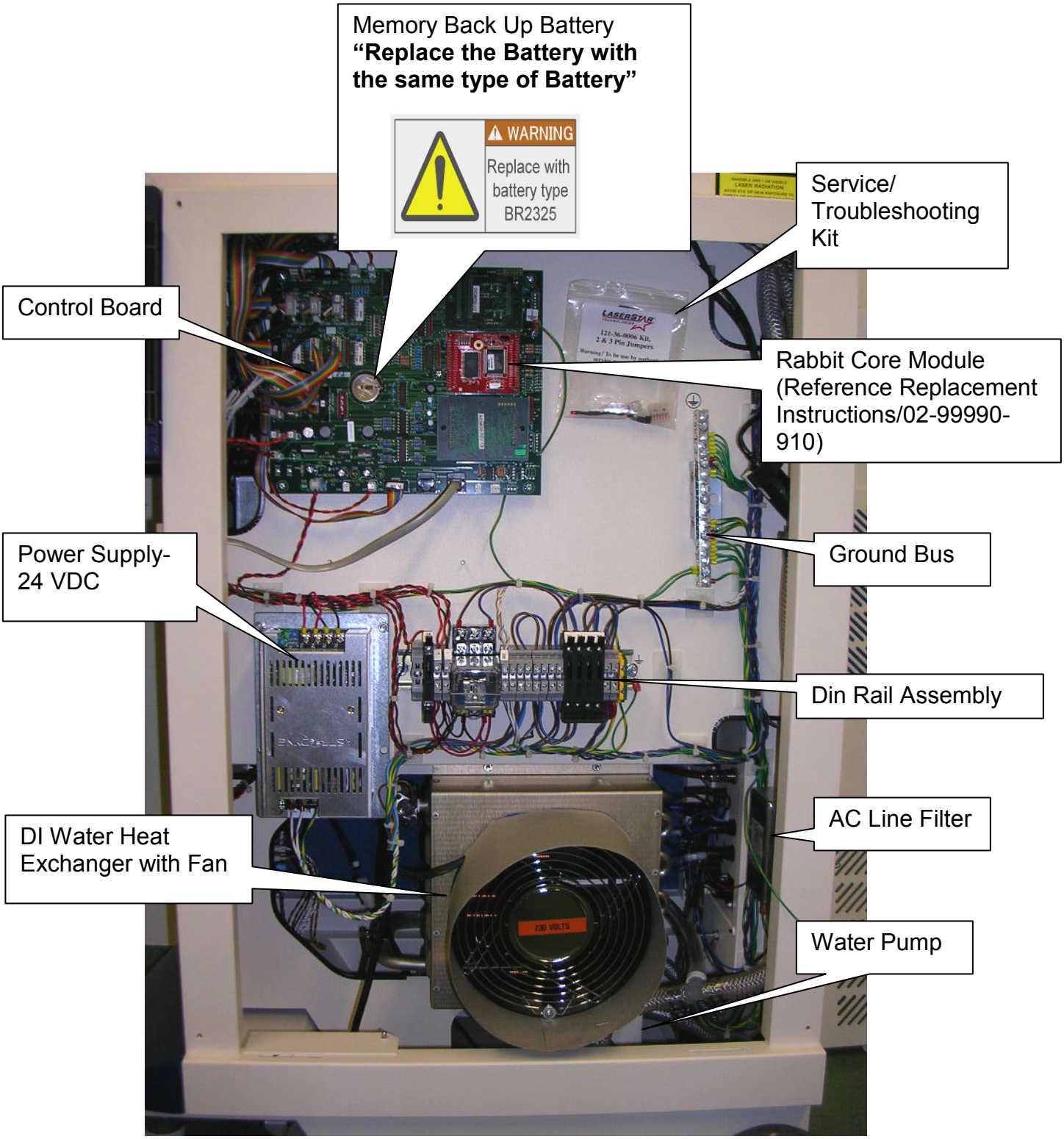


Figure 1

Power Section & DI Water Bottle-Left Side (Figure 2) (Remove left side panel and disconnect ground wire to access)

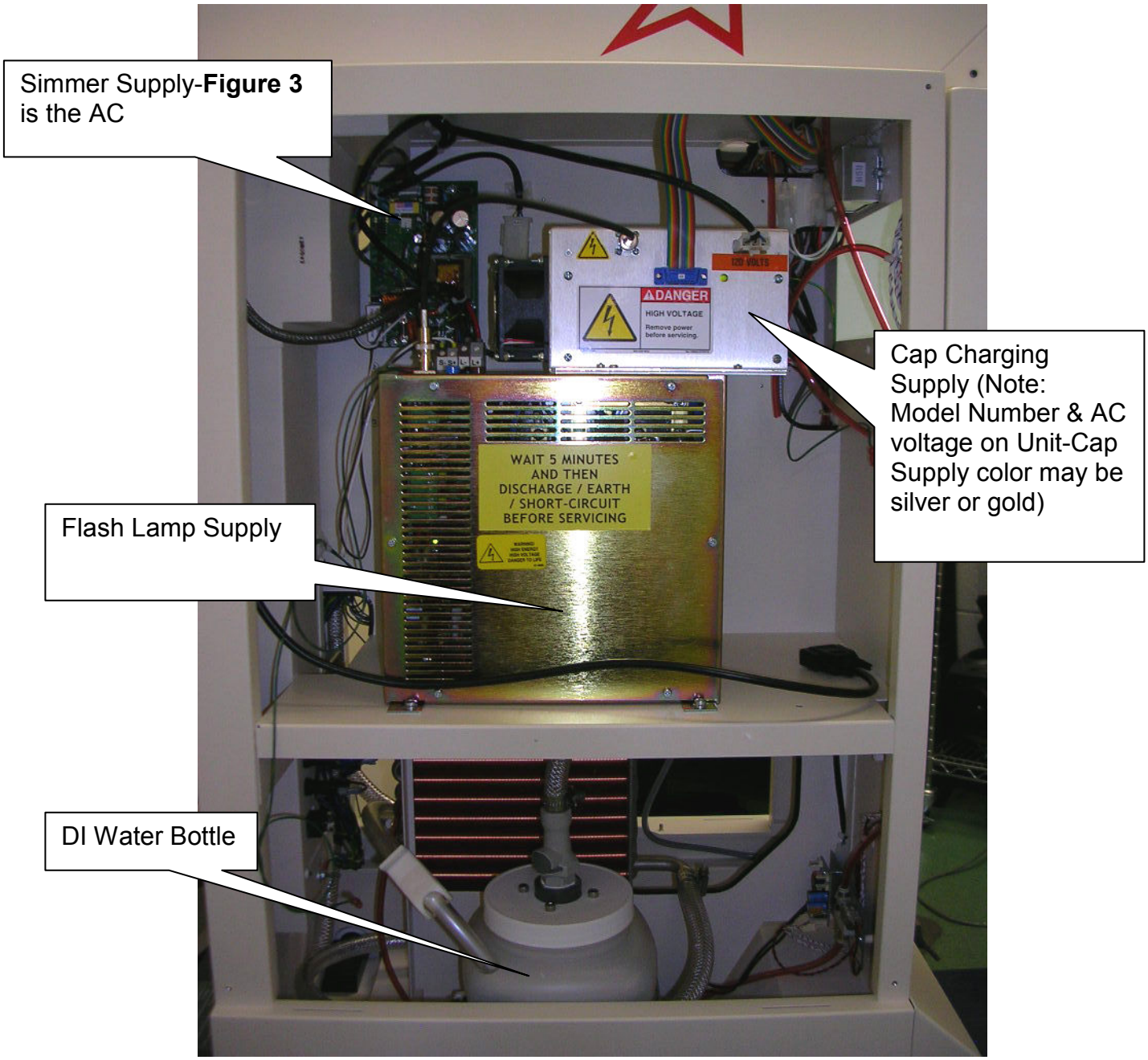


Figure 2

Service D: Simmer-AC–Left Side (Figure 1) (Remove left side panel and disconnect ground wire to access Simmer.)

The following Led Indicators can be used to indicate the status of the AC Simmer Board Assembly and the status of the Flashlamp.

Led Indicators:

- Power On Led (top)- Green “on”-Simmer board powered up
- Lamp Good Led (middle)-Green “on”-Lamp okay
- Lamp Bad Led (bottom)-Red “on”-Lamp not okay

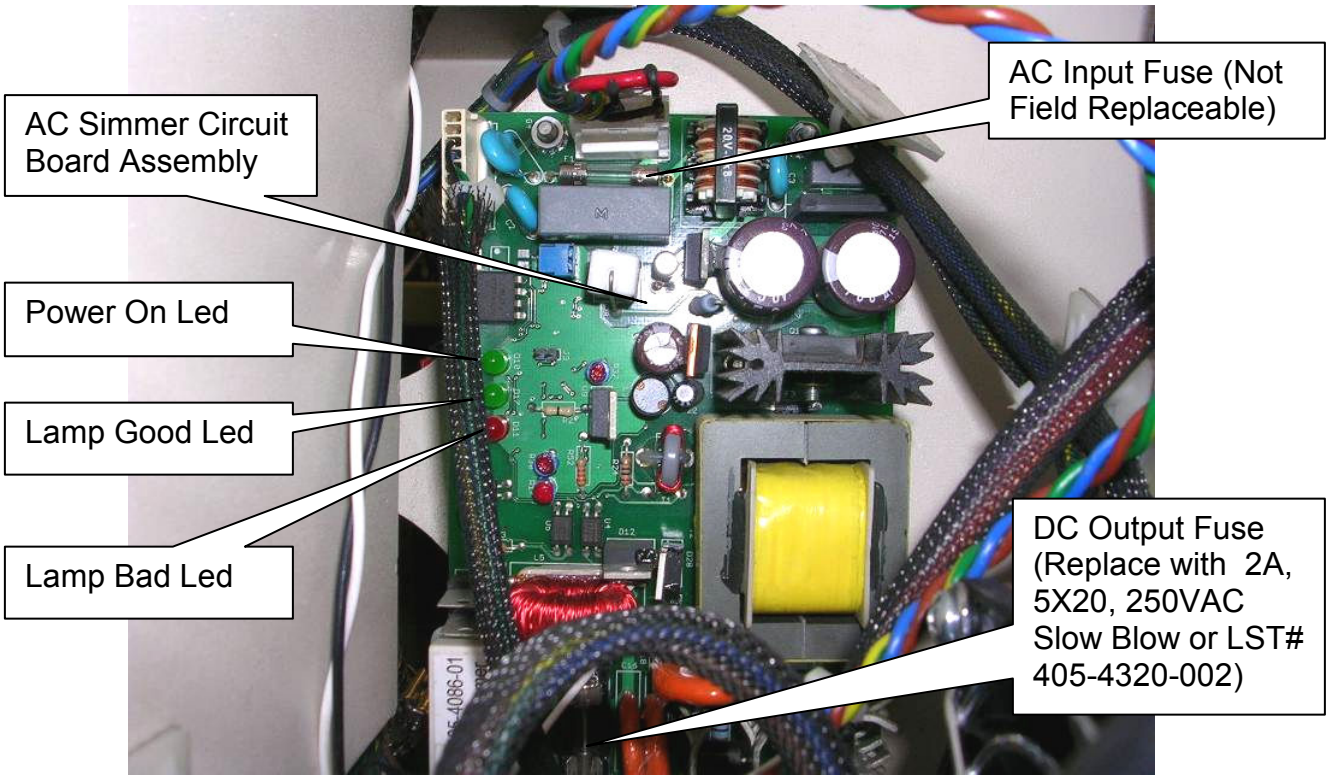


Figure 1

Notes: (All measurements taken across the flashlamp contacts with a voltmeter set to a range greater than 500 **VDC.**)

Lamp Good Led-For and output voltage between ~40V and ~300V the Lamp Good Indicator is ON and the Lamp Bad Indicator is OFF.
Lamp Bad Led-For an output voltage above ~300V the Lamp Bad Indicator is ON and the Lamp Good Indicator is off. For an output voltage below ~40V the Lamp Bad Indicator is ON and the Lamp Good Indicator is OFF.

Service E: Tri-Door Chamber Door Sensor Status (Figure 1-5)

The following figures can be used to trouble shoot the chamber doors sensors if the bottom line of the display reads-Left Door Open, Front Door Open, or Right Door Open- when in fact the doors appear to be closed.

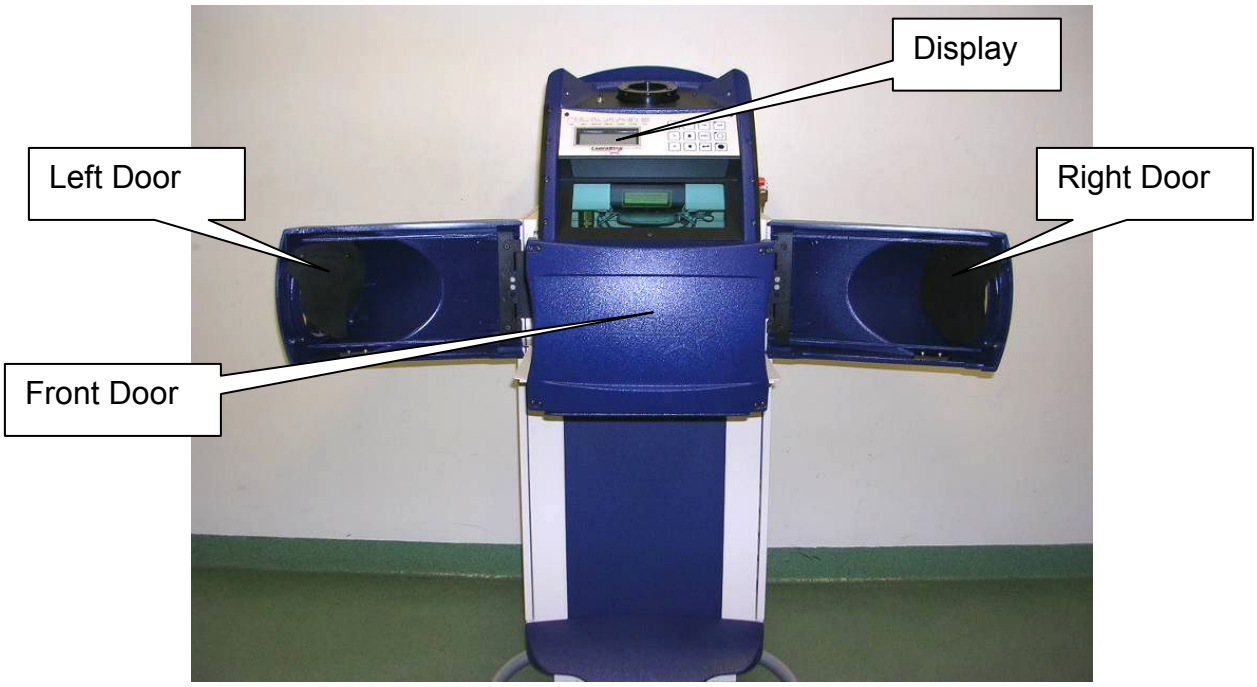


Figure 1

Figure 2

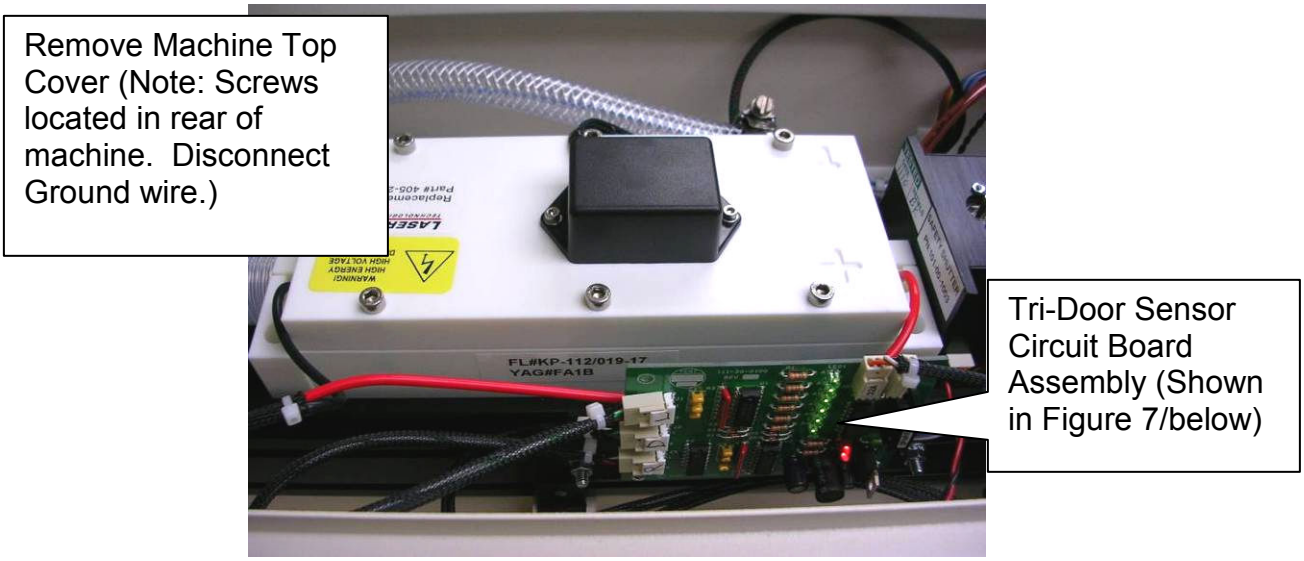


Figure 3

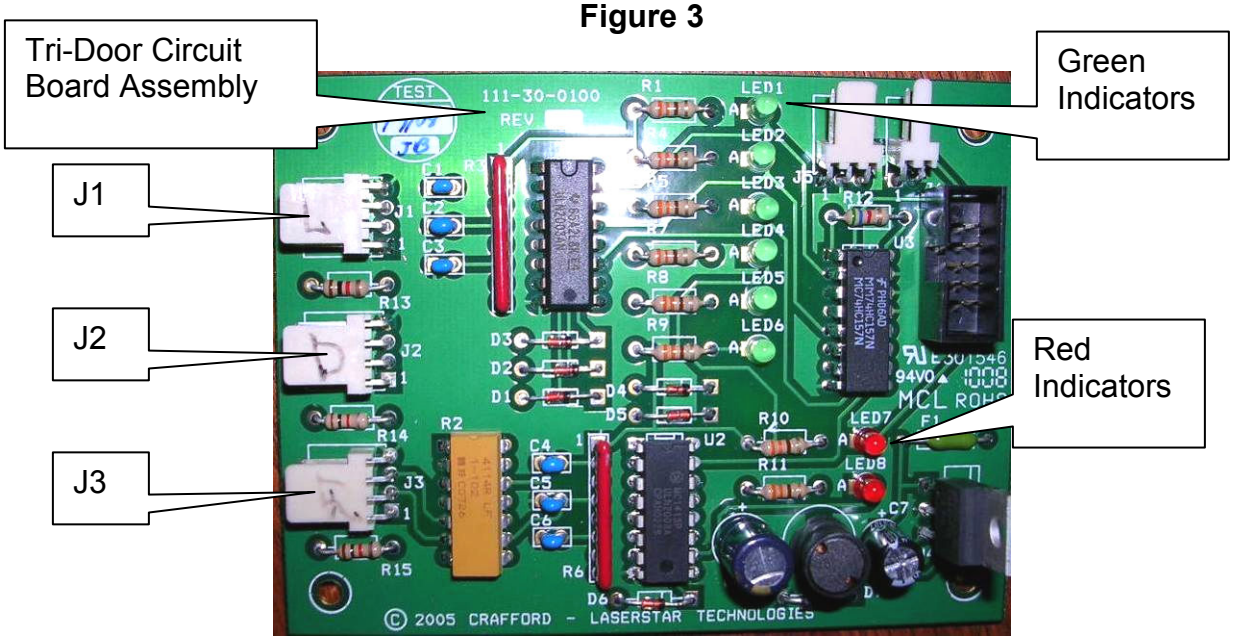


Figure 4

Tri-Door Circuit Board Assembly Status Indicators

Led Indicators			All Doors	Left Door	Front Door	Right Door
Door	**Number**	**Color**	**Okay**	**Not Okay**	**Not Okay**	**Not Okay**
Left	1	Green	On	Off	On	On
Left	2	Green	On	Off	On	On
Front	3	Green	On	On	Off	On
Front	4	Green	On	On	Off	On
Right	5	Green	On	On	On	Off
Right	6	Green	On	On	On	Off
All	7	Red	On	Off	Off	On
All	8	Red	On	On	Off	Off

Figure 5

Service F: Control Board Memory Battery Replacement (Figure 1-2)

The control board has a battery that provides power to the memory when the machine is turned off. When this battery fails, the display panel will have the following message “Warning Battery Dead”. A replacement battery can be purchased from LaserStar Technologies Corporation. The LaserStar part number is 405-3900-001. (Note: A replacement battery may be purchased at a reputable retailer. Make sure the battery is the same battery.)

1. Make sure the laser is “Off”, turn the Key-switch to “O”/Off, turn Mains Power switch to "O”/Off.
2. Make sure the AC power is “Off”- shut off the Mains Circuit Breaker (on the rear of the machine), pull out the mains plug or shut off the wall disconnect switch.
3. **The system must be “Off” for at least five (5) minutes before servicing.**
4. Remove the right side panel and disconnect the ground wire on the panel (Note: When removing the ground wire pull on the clip not on the wire.)
5. **Figure 1** shows the location of the battery. Make sure you read all the notes/instructions on **Figure 1**.
6. **Figure 2** shows the battery removal and replacement process. Make sure you read all the notes/instructions on **Figure 2**.
7. After installing the battery replace the right side panel and make sure the ground wire is connected.
8. Start the machine. The “Warning Battery Dead” message will come up in the display. The next time you start the machine you should not see this message.

Memory Back Up Battery
"Replace the Battery with the same type of Battery"

Carefully slide the battery out in the direction of the arrow. Reference **Figure 1b** (Note: Take care not to over bend the battery retaining clip.)

Battery Retaining Clip

Figure 1

Battery removal or replacement method

Make sure the battery retaining clip is securely contacting the battery.

Make sure the **(+)** side of the battery is facing up.

Note: On machine start up for the first time after battery replacement the "Warning Battery Dead" will come up on more time.

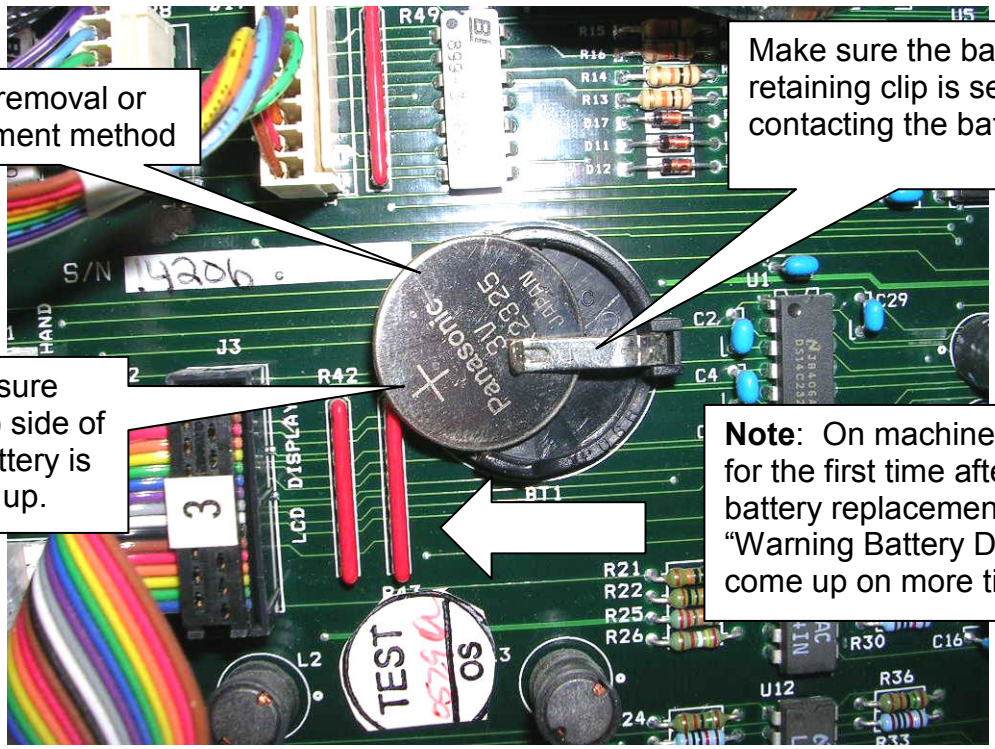


Figure 2

Service G: Mechanical View Shutter Bumper Replacement (model dependent)

- Turn off the Mains Power, the Key Switch, and unplug the AC power cord or circuit breaker (model dependent)
- Remove the microscope from the mounting bracket/ring by loosening the (2) screws with an M2 Allen wrench. **Figure 1**
- Remove the microscope mounting bracket/ring by removing the (2) M2.5 screws on the back side of the retaining ring. (**Note**: Do not remove the (3) screws labeled (1).) **Figure 2**
- Remove the View Glass Retainer **Figure 3**
- Remove the View Glass Window **Figure 4** (Note: Keep the window clean)
- Remove the plastic plug **Figure 4 & 5**
- Remove the bumper by first moving the view shutter vane to the middle- **Figure 6**
- Lift the bumper out with a pair of tweezers. (Note: The bumper may be in two parts) **Figure 7 & 8**
- Move the shutter vane back to the middle and install the new bumper. **Figure 9 & 10**
- Install the plastic plug & the View Glass Window. **Figure 11**
- Install the View Glass Retainer **Figure 12**
- Install the microscope mounting bracket (Note: Make sure the View Glass Retainer does not interfere with the bracket) **Figure13**
- Install the Microscope with the (2) set screws **Figure 14**
- Plug in the machine & make sure the microscope cross hairs are still aligned. **Figure 15** (Note: Refer to the “Optical Mounting and Alignment” section of the Operation & Maintenance Manual)

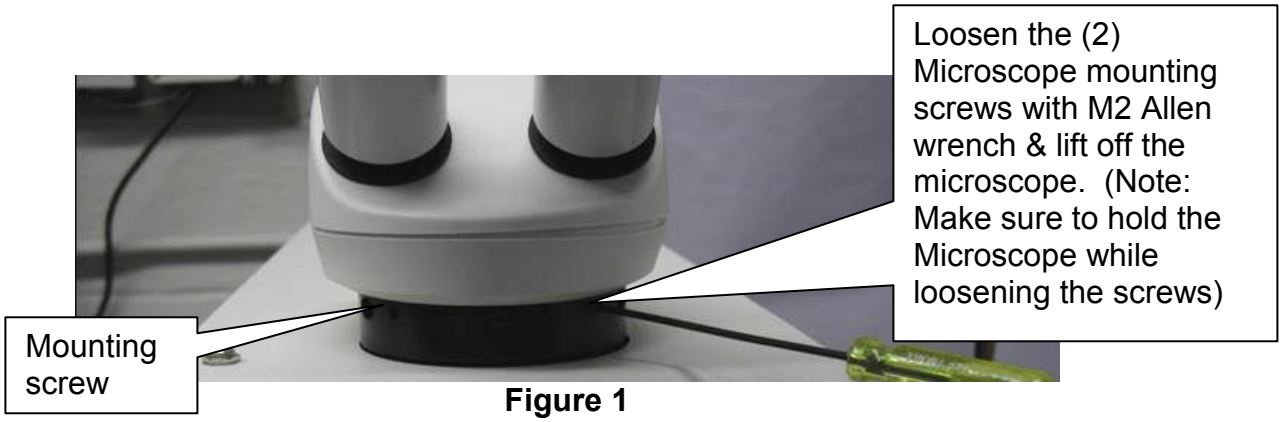


Figure 1

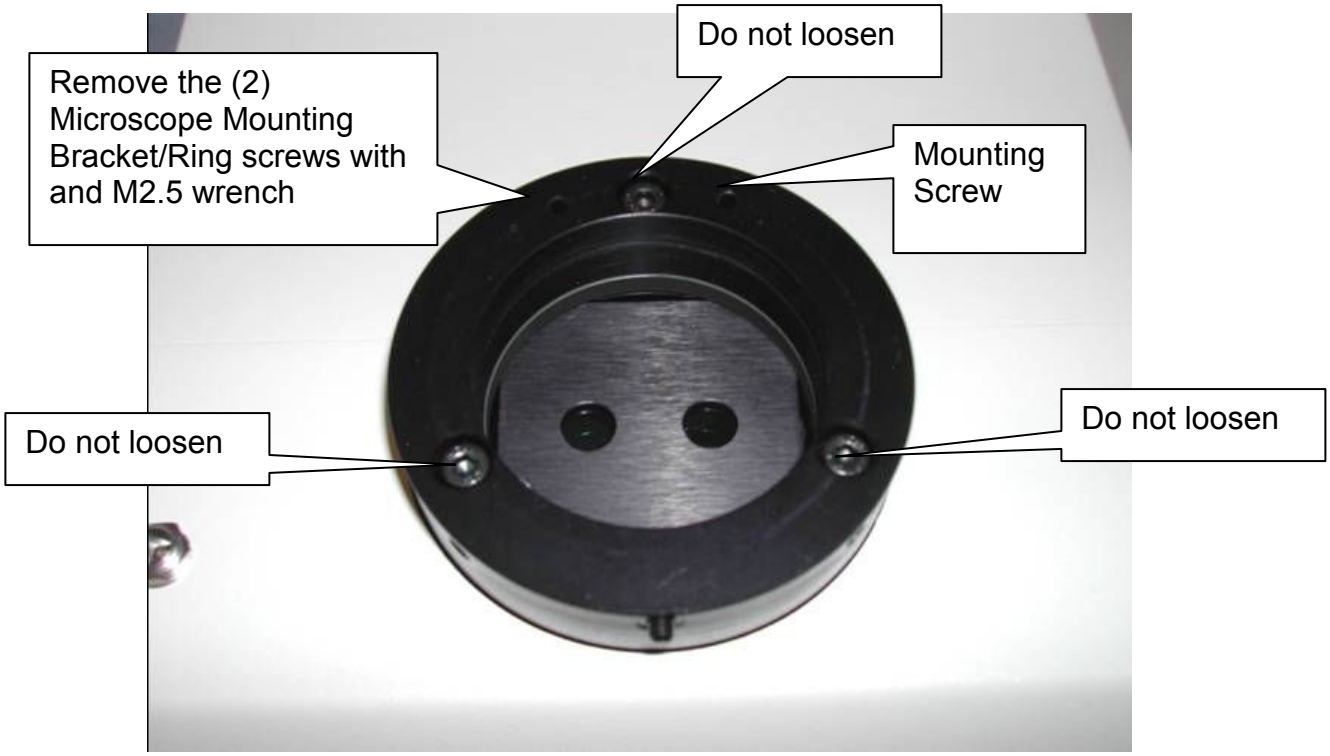


Figure 2

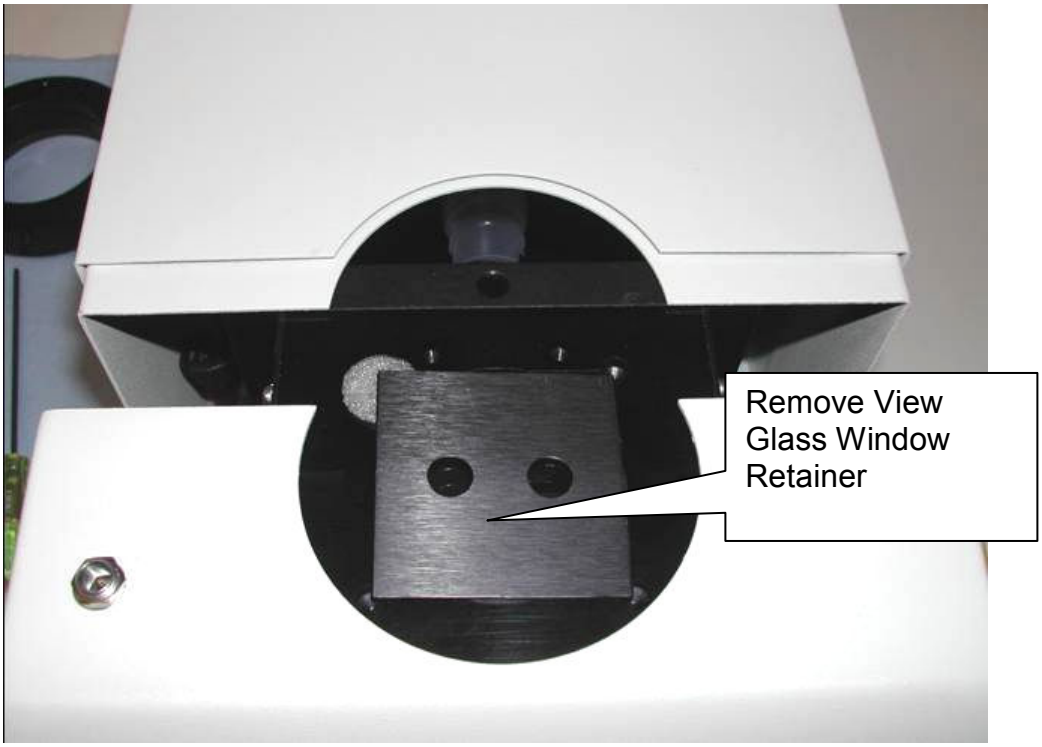


Figure 3

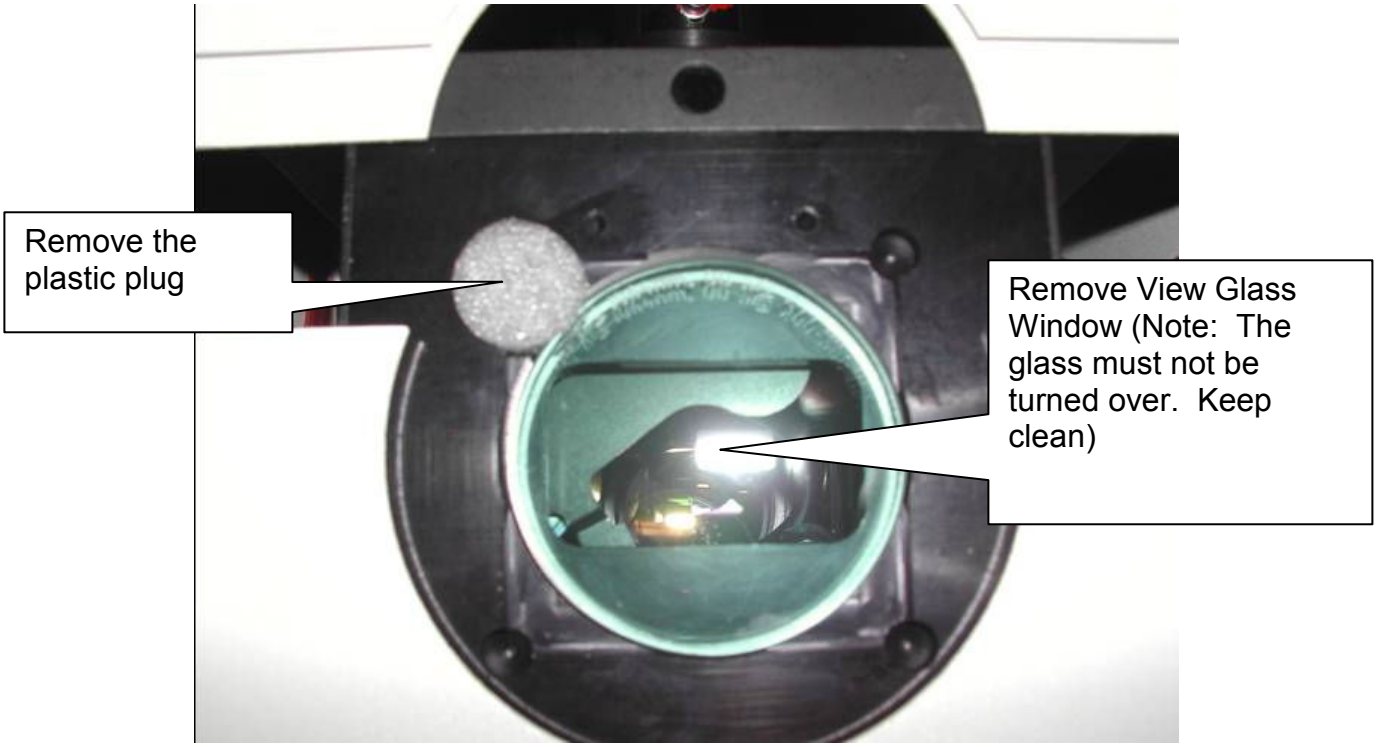


Figure 4

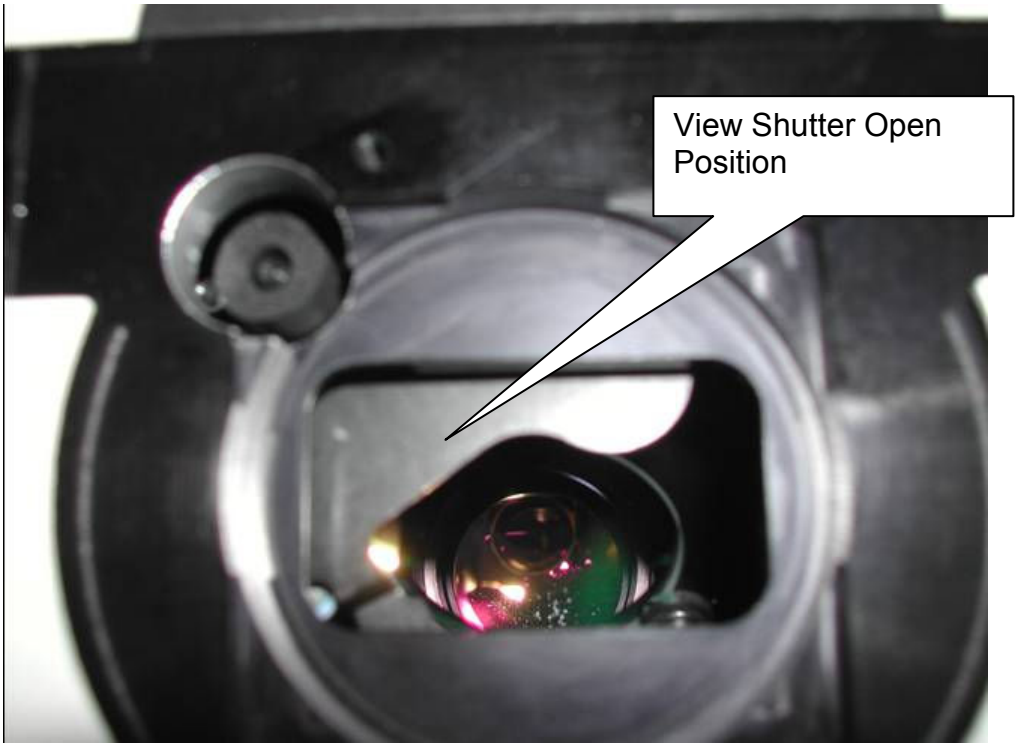


Figure 5

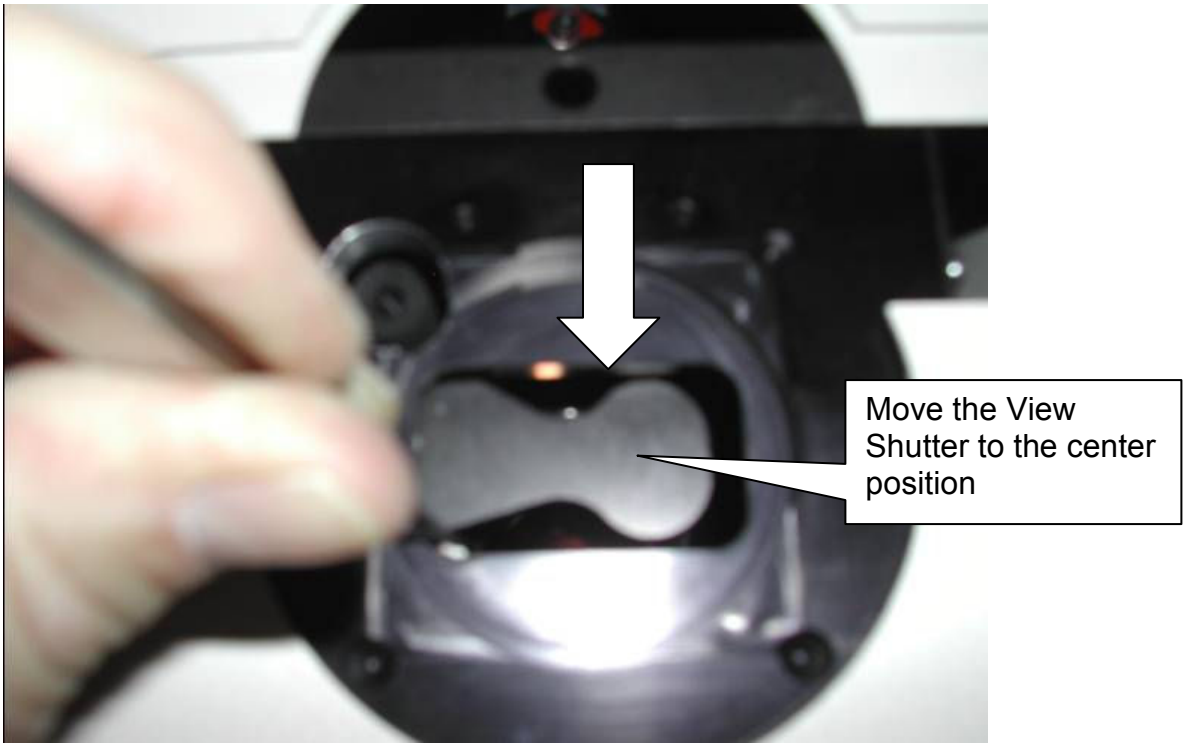


Figure 6

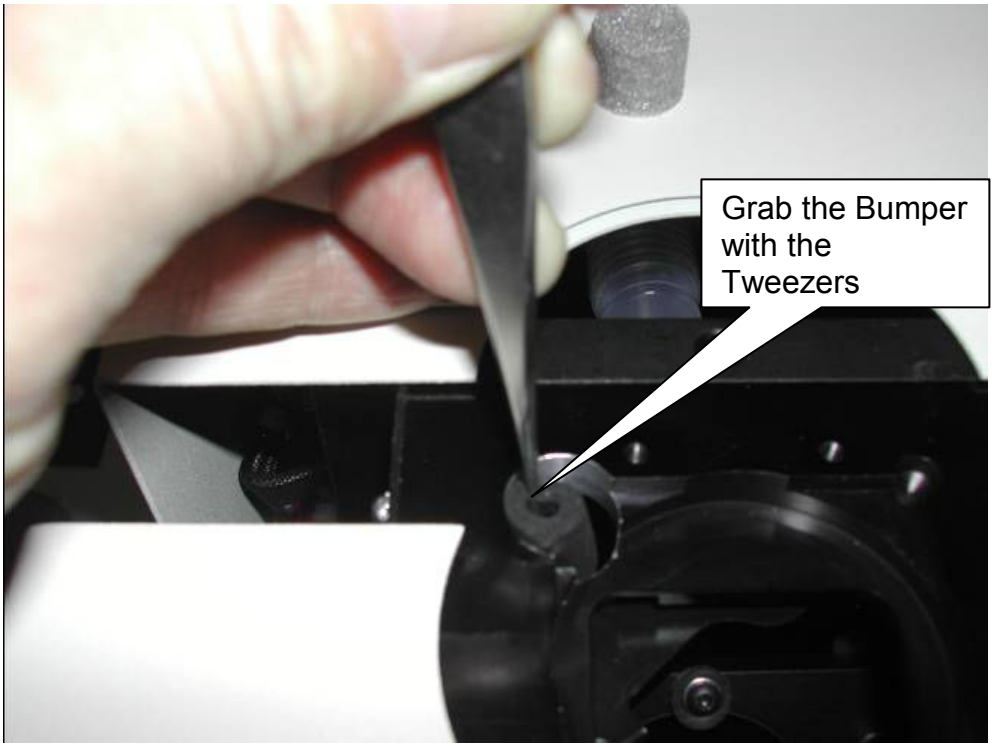


Figure 7

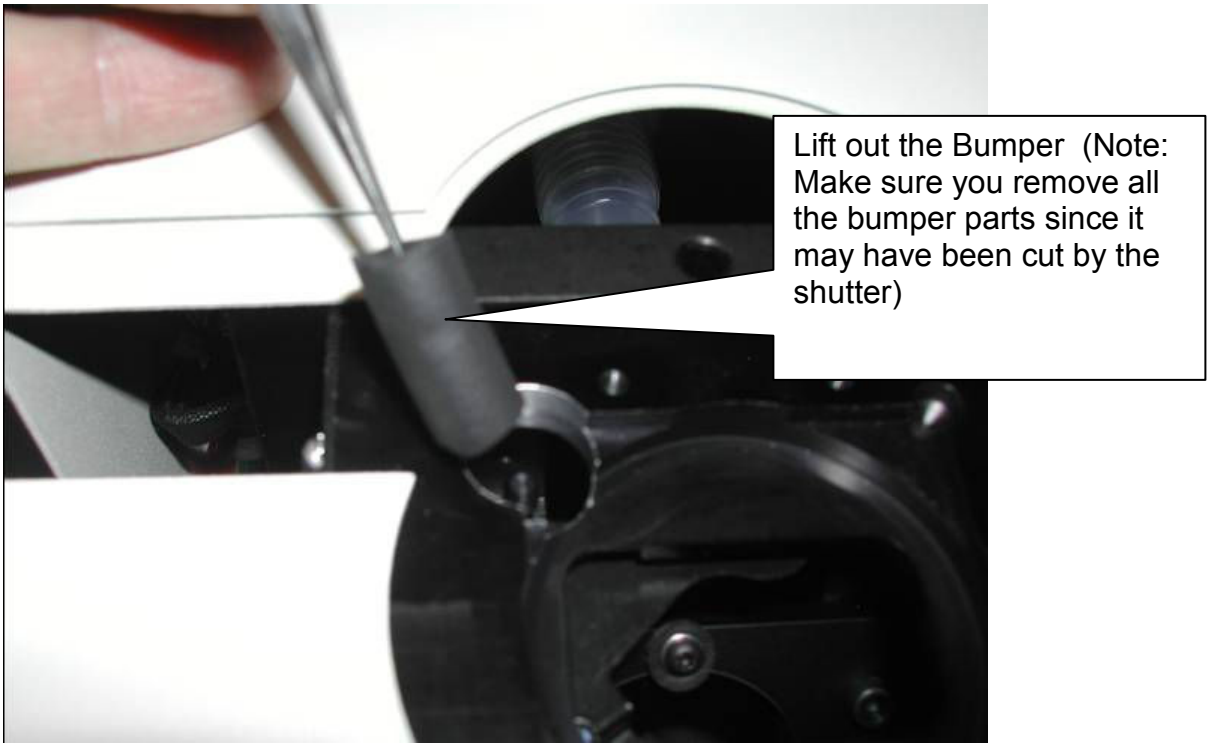


Figure 8

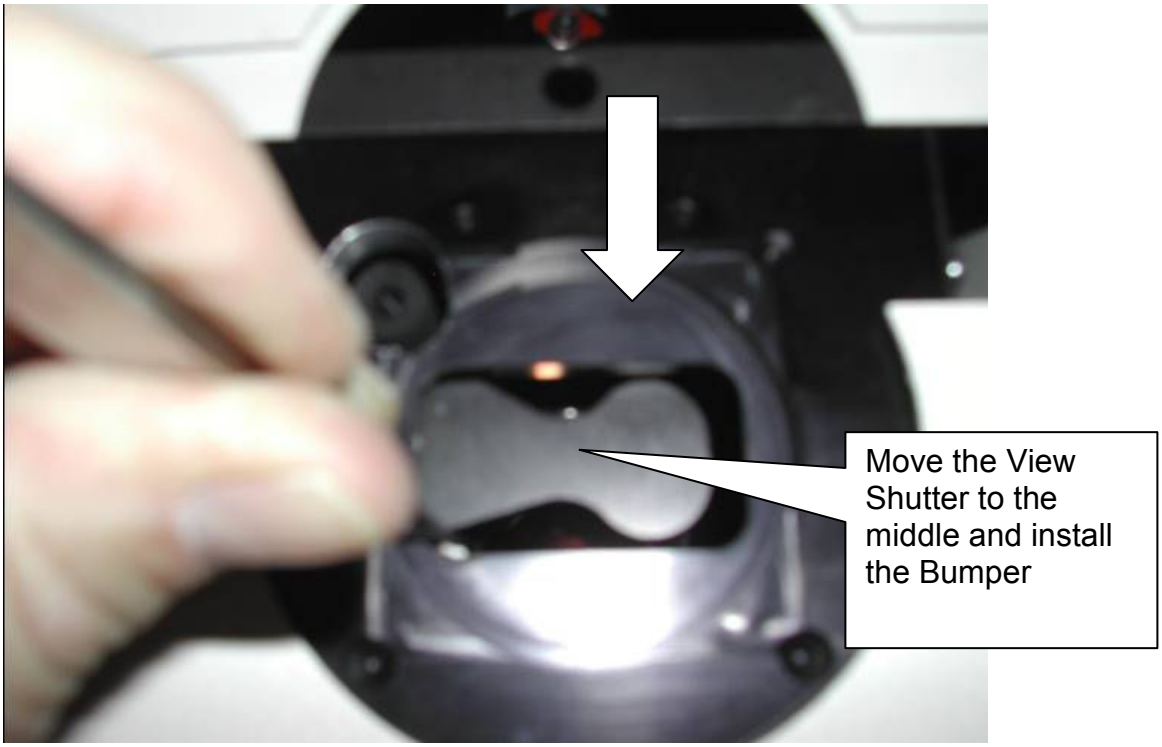


Figure 9

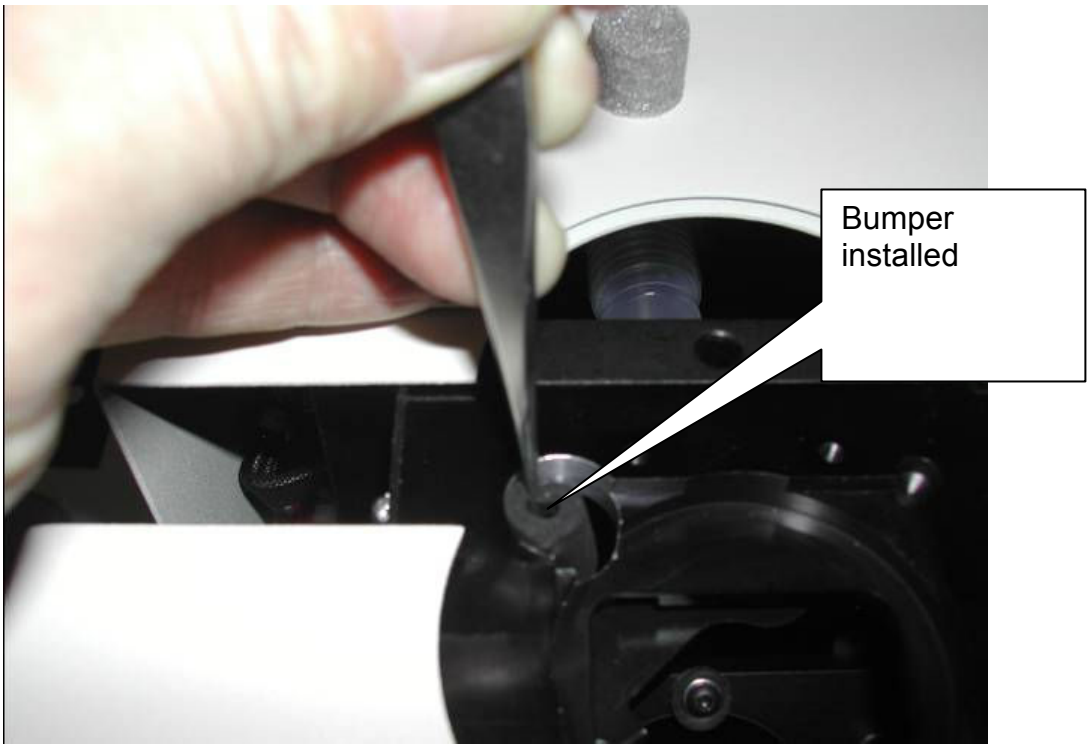


Figure 10

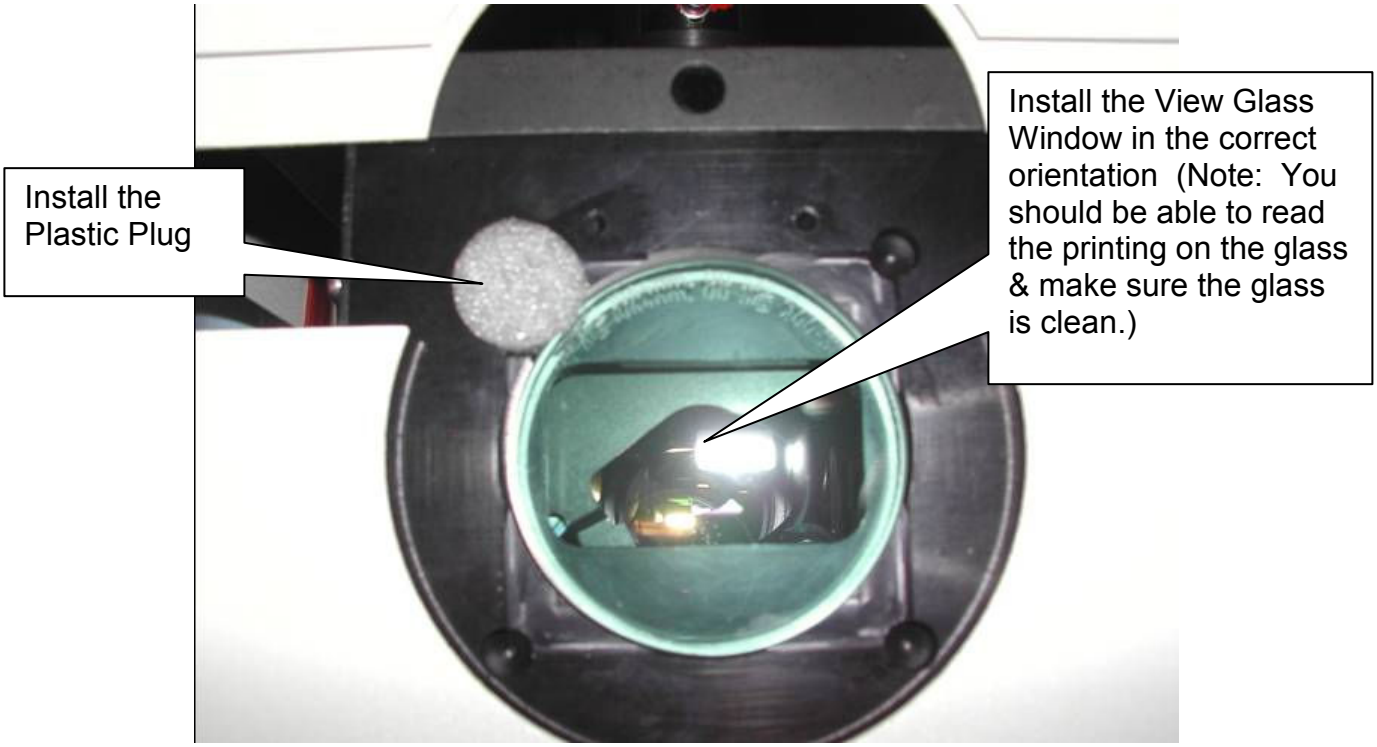


Figure 11

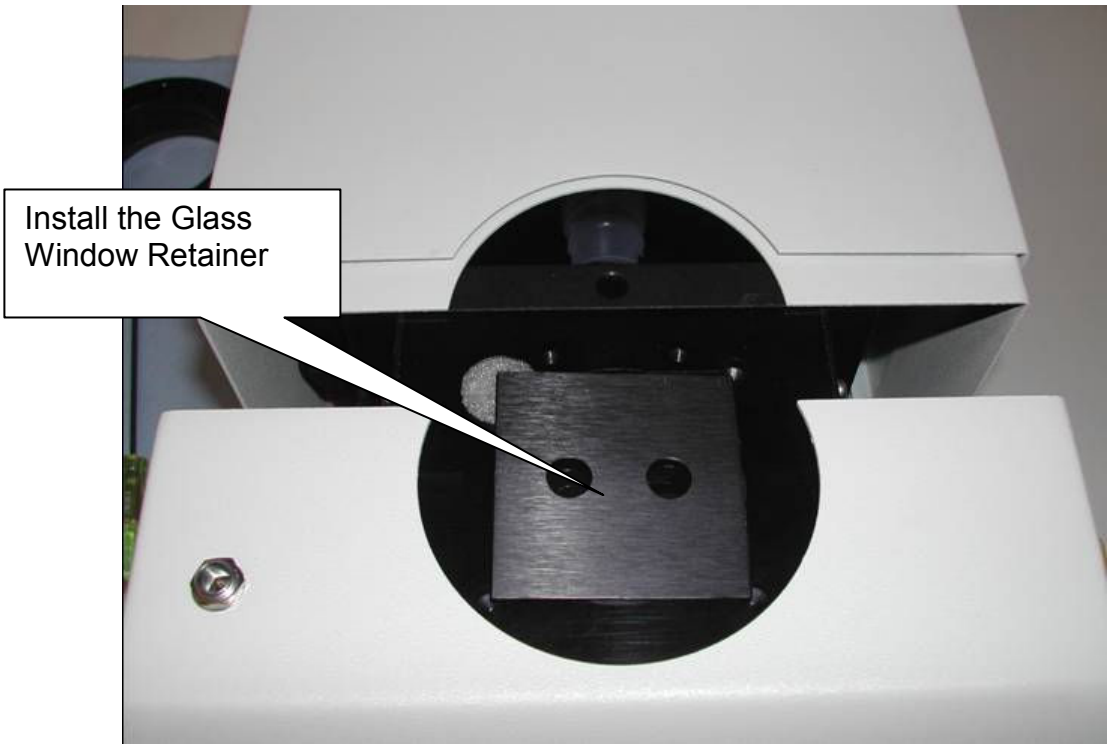


Figure 12

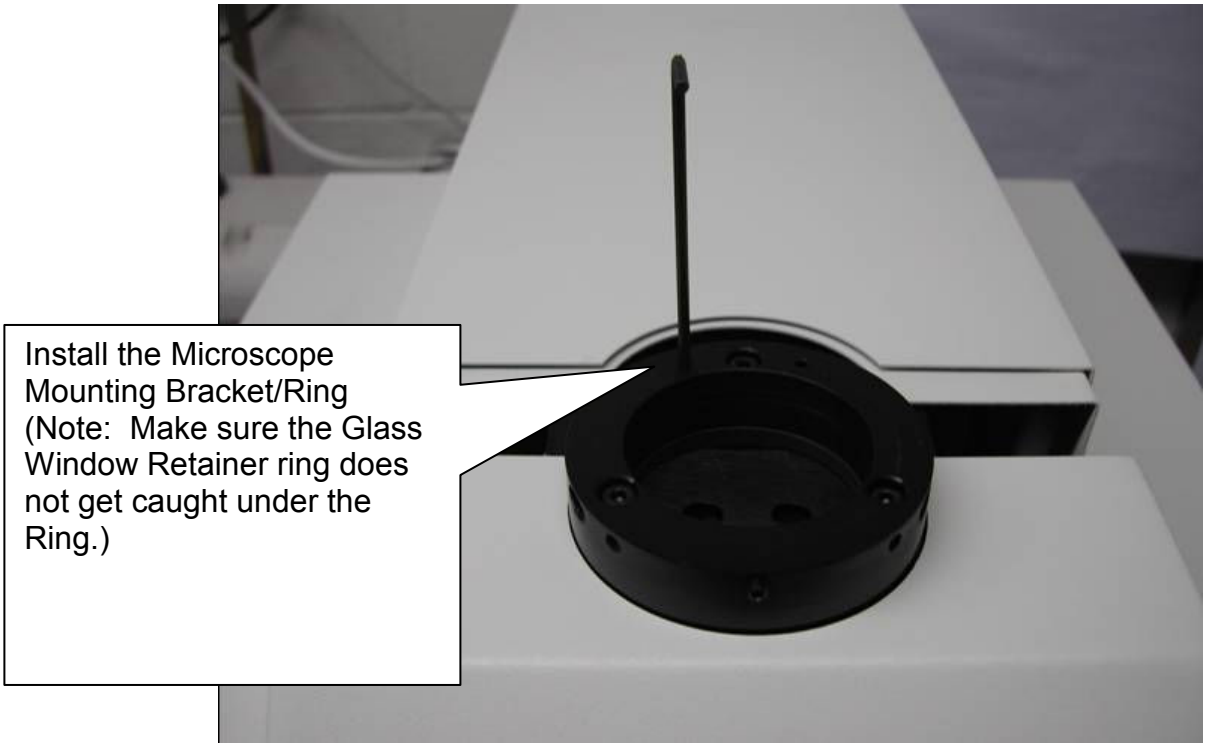


Figure 13

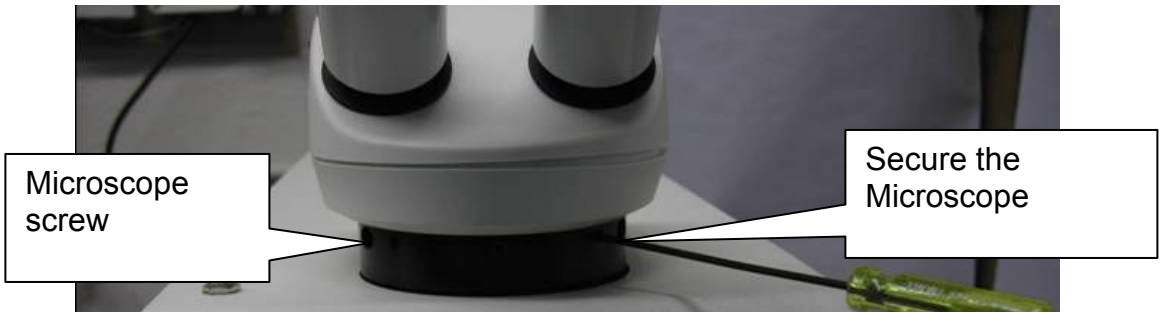


Figure 14

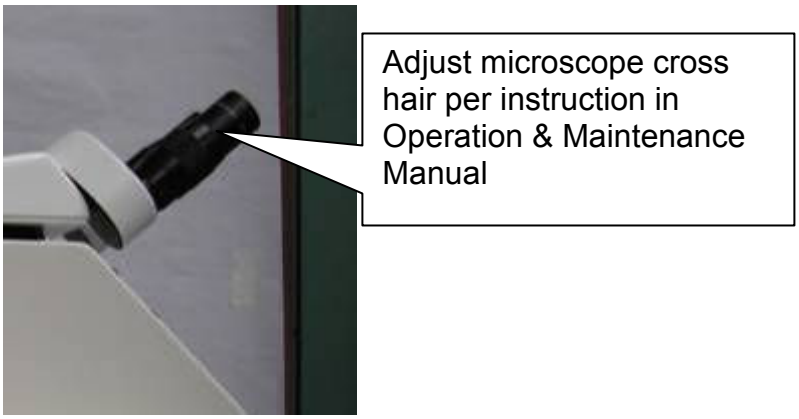


Figure 15

VIII-Appendix A: Pulse Performance Profile Technology

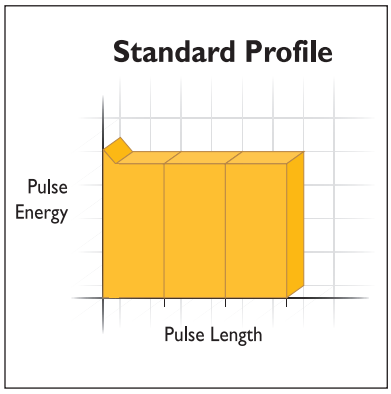
Fundamentals of Laser Welding

P3 Pulse Performance Profile Technology®

Background

A pulse of LaserStar energy consists of a number of characteristics or variables. Two of these variables are the power and duration of the pulse.

The height of a laser pulse is the laser's peak power in kW. The pulse can be charted so that the pulse height is shown on the Y-axis and the length or duration is shown along the X-axis. The area under the curve of the pulse height and length is the pulse energy in joules.



A standard pulse shape from the LaserStar is a rectangle pulse with an initial spike for the first half millisecond or so. This initial spike helps break down the reflectivity of the metal to get good energy coupling started. The spike can be removed or accentuated, as you'll see later in this technical guideline.

A number of variables can affect the dimensions and quality of laser welds. Broadly speaking, welds can be categorized into two "modes:" conduction welds and keyhole welds.

In conduction welds, the surface of the metal melts and through heat conduction into the metal, a portion of the metal beneath the laser spot melts. Heat loss through conduction limits the maximum depth of the weld to approximately 1mm depending on the material.

Keyhole welds are much deeper than conduction welds. In order to penetrate deeply into the metal, some of the metal must be vaporized to create a channel. Some metal is lost through vaporization or splatter.

The variables that affect the melt pool dimensions and quality of spot welds include:

- The spatial energy distribution of the incident beam
- The peak pulse power of the pulse
- The pulse energy
- The pulse length
- The profile shape of the pulse energy

Fundamentals of Laser Welding

P3 Pulse Performance Profile Technology®

About P³ Technology

Profiling a LaserStar pulse is simply selecting the percentage of pulse energy that is released for each one millisecond (1MS) section. Each individual section is defined at 25%, 50%, 75% or 100% of total pulse energy output. To benefit from pulse profiling, a minimum of a three millisecond (3MS) pulse duration must be employed to achieve noticeable results.

The energies required for pulsed laser welding can vary depending upon the pulse profiles selected.

If certain profiles are chosen for slower cooling or surface cleaning, then the energy is not always being used to increase penetration. Instead, it may be directed at vaporization of contaminants or bulk heating. When this is the case, the energy required (parameter selections: Voltage and Pulse-length) will increase to achieve the same weld penetration before a custom profile was applied. The parameter adjustments may reduce lamp life, reduce process speeds, and/or increase cycle times. However, it is a small price to pay and almost always worth the weld quality improvements.

Conversely, if the initial spike is increased to improve energy coupling or duty cycle, Burst Profiles are used, then the process can become much more efficient. Less energy per pulse is used with pulse profiling for the same task.

When in doubt about which pulse profile may be most beneficial, first set up a process with a Basic Profile and note the energy used (parameter selections) for a particular application. Next, select a recommended pulse profile for the same application and compare the energy used (parameter selections). Finally, compare the two different process results and choose a profile that meets your quality and process speed requirements.

Fundamentals of Laser Welding

Pulse Performance Profile Technology®

Getting Started

Normally, a Basic Profile is quite adequate when welding standard ferrous alloys without plating. However, when welding applications with reflective, very dissimilar or contaminated materials, pulse profiling may have a measurable effect on quality and consistency.

For example, a particular alloy may produce small, hair-line cracks with a Basic Profile. However, when a Ramp Down Profile is used the alloy produces a solid, excellent weld because the heat is reduced in steps.

To determine if Pulse Performance Profile Technology will benefit your applications, one must first become familiar with the parameter selection process of your LaserStar micro-welding product.

Second, you must be sure to understand what each Pulse Profile change means in terms of pulse energy output and the impact on the material.

Then, start process improvements by employing a pulse profile. Try a profile based on its description and recommended use and measure any differences you see in the weld compared to a Basic Profile. If you lose penetration, then increase the energy (V) where the real processing should take place. If the results are worse, try a different pulse profile scheme.

After trying various pulse profiles, do not be concerned if the best pulse profile for your application seems to be the Basic Profile – at least you will know that it really is optimized.

Fundamentals of Laser Welding

P3 Pulse Performance Profile Technology®

Using P³ Technology

The following seven (7) Pulse Profiles have been imbedded into your LaserStar micro-welding software. Each profile has been programmed/imbedded in a specific memory location.

All pulse profiles are voltage proportional. For a specific profile, if the voltage increases, the energy per section increases, but the percentage of the energy output remains the same.

The energy per section is proportional to the selected pulse length. A minimum of a 3 MS pulse length is required to activate the pulse profile. If the pulse length is 3 MS, then each section's pulse width is 1 MS. If the pulse length is 9 MS, then each section's pulse width is 9 MS divided by 3, which equals 3 MS, and so on.

All pulse profiles (except Basic) have a minimum pulse length of 3 milliseconds. The parameter display will automatically default to this setting and reset if a shorter pulse length is selected.

Technical Specifications:

Number of imbedded pulse profiles:	7
Pulse width:	3 – 20 MS
Energy levels per section:	5 (0%, 25%, 50%, 75%, 100%)
Number of energy sections:	3
Section pulse width minimum value:	1 MS

Pre-Programmed Pulse Performance Values:

Description	Profile Description
Basic Profile	100%, 100%, 100%
Spike Profile	100%, 25%, 25%
Ramp Down Profile	100%, 50%, 25%
Ramp Up Profile	25%, 50%, 100%
Pyramid Profile	50%, 100%, 50%
Pre-Pulse Profile	50%, 100%, 75%
Burst Profile	50%, 50%, 50%

Fundamentals of Laser Welding

Directions to Change Pulse Profiles:

There are two methods to change the Pulse Profile, they are as follows:

1. From Keypad:
   a. Press the "Enter Key." The Pulse Profile in the lower right corner of the display will blink.
   b. Press the Up or Down arrow keys to scroll through the different profiles.
   c. When the desired profile is displayed, wait for the profile to stop blinking.

2. From inside of the welding chamber:
   a. Press and hold the "Shutter Open" button on the right side of the back wall.
   b. Scroll with the MS joystick, the far left joystick, move left to right.
   c. When desired profile appears on the display, release the shutter button.

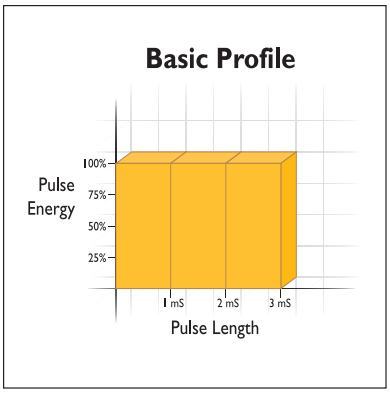
Directions to customize the power levels in each Pulse Profile manually

Some applications may require variations of these levels. The software has the ability to customize the power levels in each section of the Pulse Profile. To change the power levels manually, do the following:

1. Press the "Enter" key on the keypad. The Pulse Profile will blink.
2. Press the "ABC" key on the key pad.
3. Press the Up or Down arrow keys to scroll to the desired Pulse Profile.
4. Press the "Enter" key on the keypad. The setting of the first section of the Pulse Profile will appear.
5. Press the Up or Down arrow to change the power level.
6. Press the "Enter" key to accept the desired power level. Then the second section of the Pulse Profile will appear.
7. Repeat steps 5 and 6 for the second and third sections of the Pulse Profile.
8. Press "Enter" two more times to exit this menu.

Fundamentals of Laser Welding

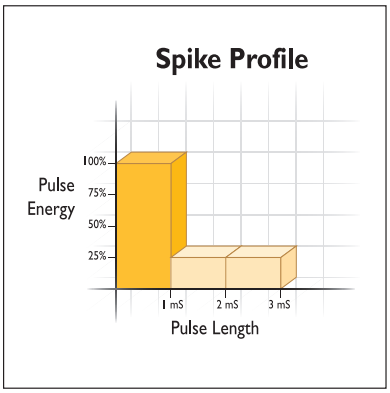
Pulse Performance Profile Technology®



Basic Profile is used by Yellow Gold, Platinum and Stainless Steel.

For very low penetration welds that require excellent cosmetics, or when welding volatile materials such as low melting point alloys, a basic pulse profile that suppresses the initial higher peak power spike can be beneficial.

By eliminating the spike, the weld puddle will vibrate less during cooling. Ripples on the melt surface caused by vibrations freeze in the puddle producing a less smooth and shiny surface. Materials with low melting points or very good absorption do not require the initial spike.



Spike Profile used with Silver and Copper.

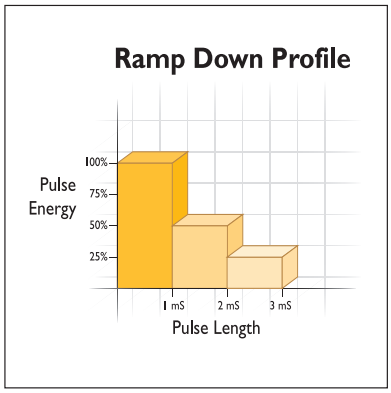
(Recommended for Silver for tacking or single pulse mode.)

A spike profile can be helpful with highly reflective metals with very high conductivity such as high pure copper alloys, silver alloys and some aluminum alloys, or in any application where the surface is very reflective and the focused spot is larger.

In this profile, the initial spike in the first section is produced to start melting the surface, then the absorption increases by up to 20 times, so the rest of the laser pulse energy can be much lower. This can reduce the energy needed to weld materials, making coupling much more consistent, and reducing weld spatter from the process.

Fundamentals of Laser Welding

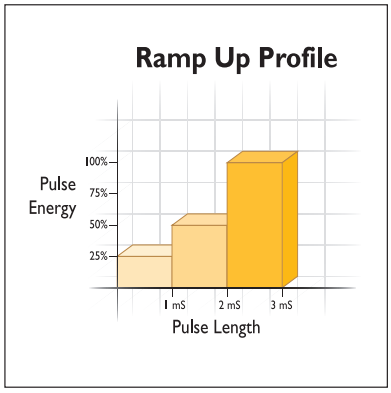
P3P3 Pulse Performance Profile Technology®



Ramp Down is used with Silver and Aluminum.

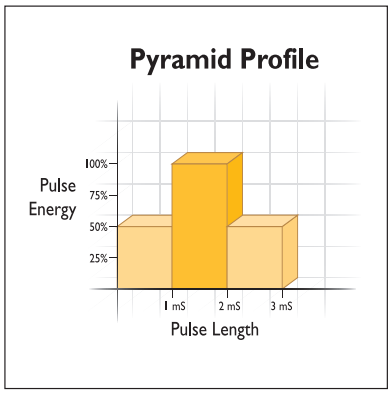
(Recommended for Silver in core welding or multi-pulse mode.)

With higher carbon steels, crack sensitive alloys, casting alloys with voids or contaminants or when the materials to be welded have very dissimilar melting points, a ramp down profile can be a huge benefit in the reduction of cracks and porosity (voids) in the weld.



Ramp Up Profile is used with White Gold.

When welding materials with low melting points of very low reflectivity or when welding materials with lots of volatile contaminants or plating, the ramp up profile is helpful.

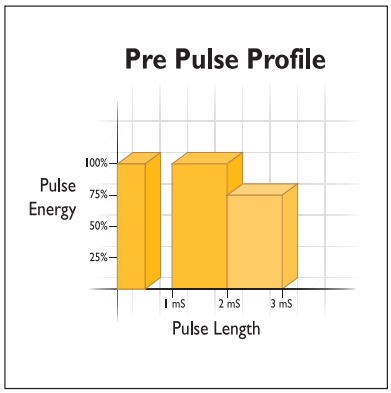


Pyramid Profile is used with Titanium.

This profile combines both the ramp up and ramp down characteristics and is suitable when welding dissimilar metals but non-reactive to oxygen.

Fundamentals of Laser Welding

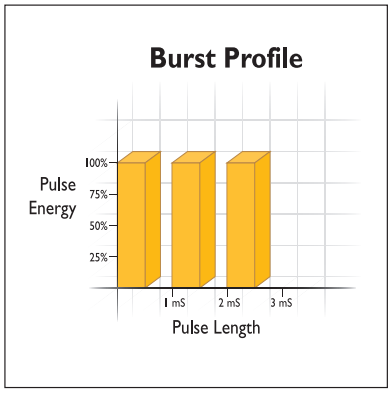
P3P3 Pulse Performance Profile Technology®



Pre Pulse Profile is used with Eyeglasses.

When welding materials that have a low melting or boiling point, a plating or surface covering, or contaminants such as pre-tinned electronic parts, anodized parts, painted parts or oil-contaminated parts, a pre-pulse profile can help. Also, parts that have varying reflectivity due to coating differences, oxidation or surface finish can benefit from a pre-pulse profile.

This pulse profile has an initial section with enough energy to vaporize and/or partially weld the materials and get heat into the part to get eliminate contaminants. This is usually followed by a delay of up to .5 MS to allow the material to get out of the weld zone and then the main weld process occurs striking a consistent surface to create a good weld.



Burst Profile is used with Pewter, Hollow (thin wall) and Low Melting Pot Metal.

Essentially, this profile delivers the pulse energy output in repeated cycles with consistent peak power. It has been found to have value in increasing the weld depth.

Fundamentals of Laser Welding

RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
40 JOULE iWELD LASER SYSTEM

NOTE: Beam diameter based on number of clicks open to the right.

WHITE GOLD POROSITY
205V 6.0MS 3.0HZ 3 CLICKS

WHITE GOLD RE-TIP
206V 4.5 MS 3.0HZ 6 CLICKS

WHITE GOLD SIZE THIN
220V 9.0MS 2.0HZ 3 CLICKS

WHITE GOLD SIZE THICK
230V 9.5MS 2.0HZ 3 CLICKS

YELLOW GOLD POROSITY
235 V 6.0MS 2.0HZ 3 CLICKS

YELLOW GOLD RE-TIP
235 V 4.5MS 3.0HZ 4 CLICKS

YELLOW GOLD SIZE THIN
245V 4.0MS 2.0HZ 3 CLICKS

YELLOW GOLD SIZE THICK
285V 6.5MS 2.0HZ 3 CLICKS

SILVER POROSITY
275V 5.0MS 2.5HZ 3 CLICKS

SILVER RE-TIP
238V 2.5MS 3.0HZ 4 CLICKS

SILVER SIZE THIN
295V 5.0MS 2.0HZ 3 CLICKS

SILVER SIZE THICK
305V 6.5MS 2.0HZ 3 CLICKS

PLATINUM POROSITY
250 V 4.0MS 3.0HZ 3 CLICKS

PLATINUM RE-TIP
248 V 3.9MS 3.0HZ 4 CLICKS

PLATINUM SIZE THIN
300V 5.5MS 2.0HZ 4 CLICKS

PLATINUM SIZE THICK
330V 7.0MS 2.0HZ 4 CLICKS

JUMP RINGS
240V 4.0MS 2.0HZ 2 CLICKS

TITANIUM
240V 5.0MS 2.0HZ 3 CLICKS

HOLLOW
195V 2.5MS 14.0HZ 0 CLICKS

PEWTER
215V 2.5MS 4.0HZ 5 CLICKS

WHITE BASE METAL
220V 3.0MS 4.0HZ 5 CLICKS

EYEGLASSES
230V 4.5MS 2.0HZ 3 CLICKS

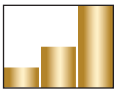
STAINLESS STEEL
245V 5.0MS 2.0HZ 3 CLICKS

CROSSHAIR ALIGN
250V 5.0MS 0.0HZ 4 CLICKS

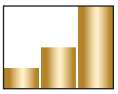
NOTE: The above parameter combinations are suggested starting points for 40 Joule iWeld Laser Systems and are subject to change based on flashlamp age and the alloy's surface condition.

Fundamentals of Laser Welding

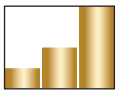
RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
40 & 60 JOULE iWELD LASER SYSTEM WITH P3



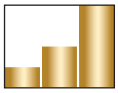
WHITE GOLD POROSITY
190V 3.5MS 3.0HZ 0.50MM
Ramp Up Profile



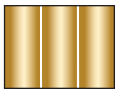
WHITE GOLD RE-TIP
195V 3.5MS 3.0HZ 0.50MM
Ramp Up Profile



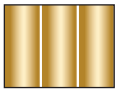
WHITE GOLD SIZE THIN
200V 4.0MS 2.0HZ 0.50MM
Ramp Up Profile



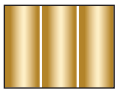
WHITE GOLD SIZE THICK
210V 4.5MS 2.0HZ 0.45MM
Ramp Up Profile



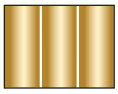
YELLOW GOLD POROSITY
220V 3.0MS 2.0HZ 0.60MM
Basic Profile



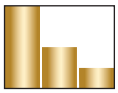
YELLOW GOLD RE-TIP
210V 3.0MS 3.0HZ 0.60MM
Basic Profile



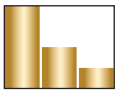
YELLOW GOLD SIZE THIN
210V 3.0MS 2.0HZ 0.40MM
Basic Profile



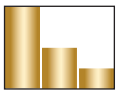
YELLOW GOLD SIZE THICK
220V 4.0MS 2.0HZ 0.45MM
Basic Profile



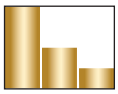
SILVER POROSITY
255V 3.0MS 2.0HZ 0.70MM
Ramp Down Profile



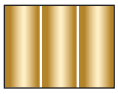
SILVER RE-TIP
240V 3.0MS 2.0HZ 0.70MM
Ramp Down Profile



SILVER SIZE THIN
250V 3.0MS 2.0HZ 0.40MM
Ramp Down Profile

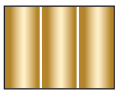


SILVER SIZE THICK
270V 3.5MS 2.0HZ 0.30MM
Ramp Down Profile

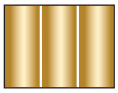


PLATINUM POROSITY
234V 3.0MS 2.0HZ 0.60MM
Basic Profile

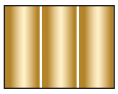
PLATINUM RE-TIP
225V 3.0MS 3.0HZ 0.60MM
Basic Profile



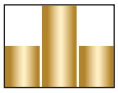
PLATINUM SIZE THIN
235V 3.0MS 2.0HZ 0.40MM
Basic Profile



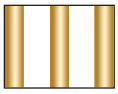
PLATINUM SIZE THICK
240V 4.0MS 2.0HZ 0.35MM
Basic Profile



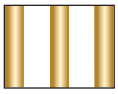
JUMP RINGS
185V 5.0MS 2.0HZ 0.70MM
Basic Profile



TITANIUM
225V 3.5MS 2.0HZ 0.55MM
Pyramid Profile

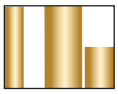


HOLLOW
200V 3.0MS 11HZ 0.35MM
Burst Profile

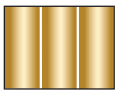


PEWTER
180V 3.0MS 10HZ 0.55MM
Burst Profile

WHITE BASE METAL
195V 3.5MS 2.0HZ 0.70MM
Burst Profile



EYEGLASSES
190V 3.5MS 2.0HZ 0.55MM
PrePulse Profile

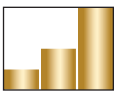


STAINLESS STEEL
215V 3.0MS 2.0HZ 0.50MM
Basic Profile

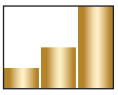
NOTE: The above parameter combinations are suggested starting points for 40-60 Joule iWeld Systems (990 Series) and are subject to change based on flashlamp age and the alloy's surface condition.

Fundamentals of Laser Welding

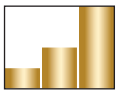
RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
80 JOULE iWELD LASER SYSTEM WITH P3



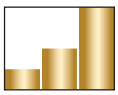
WHITE GOLD POROSITY
190V 3.7MS 3.0HZ 0.70MM
Ramp Up Profile



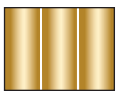
WHITE GOLD RE-TIP
193V 3.3MS 3.0HZ 0.65MM
Ramp Up Profile



WHITE GOLD SIZE THIN
204V 3.5MS 2.0HZ 0.70MM
Ramp Up Profile

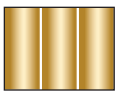


WHITE GOLD SIZE THICK
211V 3.7MS 2.0HZ 0.80MM
Ramp Up Profile

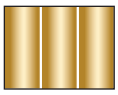


YELLOW GOLD POROSITY
205V 3.1MS 2.0HZ 0.70MM
Basic Profile

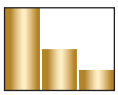
YELLOW GOLD RE-TIP
207V 2.5MS 3.0HZ 0.80MM
Basic Profile



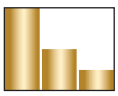
YELLOW GOLD SIZE THIN
210V 3.3MS 2.0HZ 0.60MM
Basic Profile



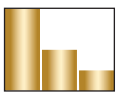
YELLOW GOLD SIZE THICK
225V 4.0MS 2.0HZ 0.70MM
Basic Profile



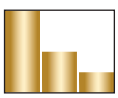
SILVER POROSITY
235V 3.5MS 3.0HZ 0.70MM
Ramp Down Profile



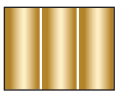
SILVER RE-TIP
235V 3.0MS 2.0HZ 0.80MM
Ramp Down Profile



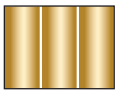
SILVER SIZE THIN
250V 4.0MS 2.0HZ 0.50MM
Ramp Down Profile



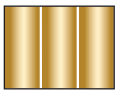
SILVER SIZE THICK
265V 5.0MS 1.0HZ 0.70MM
Ramp Down Profile



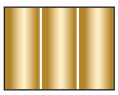
PLATINUM POROSITY
213V 2.5MS 2.0HZ 0.80MM
Basic Profile



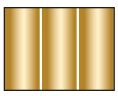
PLATINUM RE-TIP
215V 2.5MS 2.0HZ 0.80MM
Basic Profile



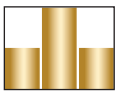
PLATINUM SIZE THIN
220V 3.0MS 2.0HZ 0.65MM
Basic Profile



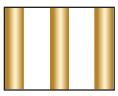
PLATINUM SIZE THICK
230V 3.5MS 2.0HZ 0.75MM
Basic Profile



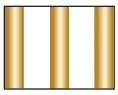
JUMP RINGS
218V 3.2MS 2.0HZ 0.75MM
Basic Profile



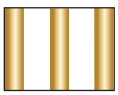
TITANIUM
216V 3.0MS 2.0HZ 0.65MM
Pyramid Profile



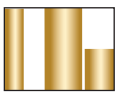
HOLLOW
205V 3.0MS 7.0HZ 0.35MM
Burst Profile



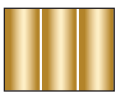
PEWTER
185V 3.0MS 9.0HZ 0.55MM
Burst Profile



WHITE BASE METAL
200V 3.5MS 2.0HZ 0.80MM
Burst Profile



EYEGLASSES
190V 3.5MS 2.0HZ 0.80MM
PrePulse Profile



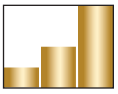
STAINLESS STEEL
198V 2.5MS 3.0HZ 0.75MM
Basic Profile

CROSS-HAIR ALIGN
205V 2.0MS 0.0HZ 0.70MM
Basic Profile

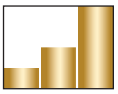
NOTE: The above parameter combinations are suggested starting points for 80 Joule iWeld Systems (990 Series) and are subject to change based on flashlamp age and the alloy's surface condition.

Fundamentals of Laser Welding

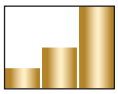
RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
100 JOULE iWELD LASER SYSTEM WITH P3



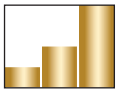
WHITE GOLD POROSITY
185V 3.7MS 3.0HZ 0.70MM
Ramp Up Profile



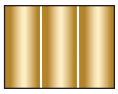
WHITE GOLD RE-TIP
188V 3.3MS 3.0HZ 0.65MM
Ramp Up Profile



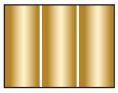
WHITE GOLD SIZE THIN
199V 3.5MS 2.0HZ 0.70MM
Ramp Up Profile



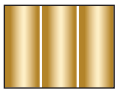
WHITE GOLD SIZE THICK
206V 3.7MS 2.0HZ 0.80MM
Ramp Up Profile



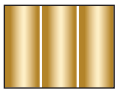
YELLOW GOLD POROSITY
200V 3.1MS 2.0HZ 0.70MM
Basic Profile



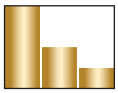
YELLOW GOLD RE-TIP
202V 2.5MS 3.0HZ 0.80MM
Basic Profile



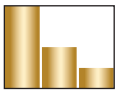
YELLOW GOLD SIZE THIN
204V 3.3MS 2.0HZ 0.60MM
Basic Profile



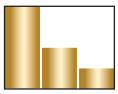
YELLOW GOLD SIZE THICK
220V 4.0MS 2.0HZ 0.70MM
Basic Profile



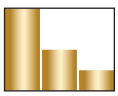
SILVER POROSITY
230V 3.5MS 3.0HZ 0.70MM
Ramp Down Profile



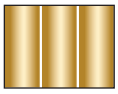
SILVER RE-TIP
230V 3.0MS 2.0HZ 0.80MM
Ramp Down Profile



SILVER SIZE THIN
245V 4.0MS 2.0HZ 0.50MM
Ramp Down Profile

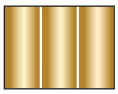


SILVER SIZE THICK
260V 5.0MS 1.0HZ 0.70MM
Ramp Down Profile

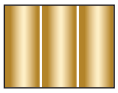


PLATINUM POROSITY
208V 2.5MS 2.0HZ 0.80MM
Basic Profile

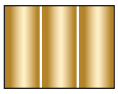
PLATINUM RE-TIP
210V 2.5MS 2.0HZ 0.80MM
Basic Profile



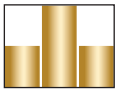
PLATINUM SIZE THIN
215V 3.0MS 2.0HZ 0.65MM
Basic Profile



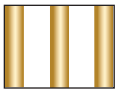
PLATINUM SIZE THICK
225V 3.5MS 2.0HZ 0.75MM
Basic Profile



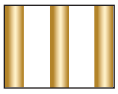
JUMP RINGS
213V 3.2MS 2.0HZ 0.75MM
Basic Profile



TITANIUM
211V 3.0MS 2.0HZ 0.65MM
Pyramid Profile

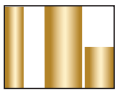


HOLLOW
200V 3.0MS 8.0HZ 0.35MM
Burst Profile

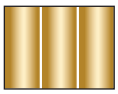


PEWTER
180V 3.0MS 10.0HZ 0.55MM
Burst Profile

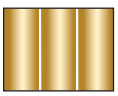
WHITE BASE METAL
195V 3.5MS 2.0HZ 0.80MM
Burst Profile



EYEGLASSES
185V 3.5MS 2.0HZ 0.80MM
PrePulse Profile



STAINLESS STEEL
193V 2.5MS 3.0HZ 0.75MM
Basic Profile

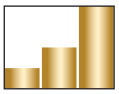


CROSS-HAIR ALIGN
200V 2.0MS 0.0HZ 0.70MM
Basic Profile

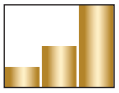
NOTE: The above parameter combinations are suggested starting points for 100 Joule iWeld Systems (990 Series) and are subject to change based on flashlamp age and the alloy's surface condition.

Fundamentals of Laser Welding

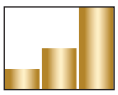
RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
80 JOULE LASERSTAR SYSTEMS WITH P3



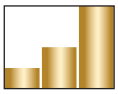
WHITE GOLD POROSITY
185V 3.0MS 3.0HZ 0.70MM
Ramp Up Profile



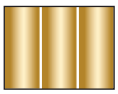
WHITE GOLD RE-TIP
190V 3.0MS 3.0HZ 0.40MM
Ramp Up Profile



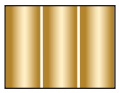
WHITE GOLD SIZE THIN
180V 3.0MS 2.0HZ 0.40MM
Ramp Up Profile



WHITE GOLD SIZE THICK
195V 3.0MS 2.0HZ 0.30MM
Ramp Up Profile

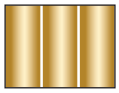


YELLOW GOLD POROSITY
220V 2.3MS 3.0HZ 0.70MM
Basic Profile

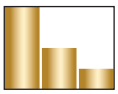


YELLOW GOLD RE-TIP
210V 2.6MS 3.0HZ 0.40MM
Basic Profile

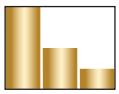
YELLOW GOLD SIZE THIN
210V 2.0MS 2.0HZ 0.40MM
Basic Profile



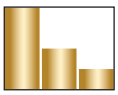
YELLOW GOLD THICK
235V 3.0MS 2.0HZ 0.30MM
Basic Profile



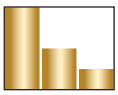
SILVER POROSITY
255V 3.0MS 2.0HZ 0.70MM
Ramp Down Profile



SILVER RE-TIP
250V 3.0MS 2.0HZ 0.40MM
Ramp Down Profile



SILVER SIZE THIN
250V 3.0MS 2.0HZ 0.40MM
Ramp Down Profile



SILVER SIZE THICK
280V 4.0MS 2.0HZ 0.30MM
Ramp Down Profile

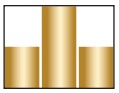
PLATINUM POROSITY
230V 2.3MS 2.0HZ 0.70MM
Basic Profile

PLATINUM RE-TIP
230V 3.0MS 2.0HZ 0.40MM
Basic Profile

PLATINUM SIZE THIN
235V 2.0MS 2.0HZ 0.40MM
Basic Profile

PLATINUM SIZE THICK
240V 4.0MS 2.0HZ 0.30MM
Basic Profile

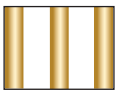
JUMP RINGS
185V 5.0MS 2.0HZ 0.70MM
Basic Profile



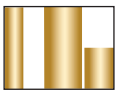
TITANIUM
190V 3.0MS 2.0HZ 0.55MM
Pyramid Profile

HOLLOW
200V 3.0MS 8HZ 0.35MM
Burst Profile

PEWTER
165V 3.0MS 3.0H 0.55MM
Burst Profile



WHITE BASE METAL
200V 8.5MS 3.0HZ 0.80MM
Burst Profile



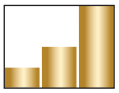
EYEGLASSES
160V 3.0MS 2.0HZ 0.55MM
PrePulse Profile

STAINLESS STEEL
220V 3.0MS 2.0HZ 0.50MM
Basic Profile

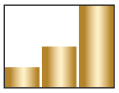
NOTE: The above parameter combinations are suggested starting points for 80 Joule LaserStar Welding Systems (7000 Series) and are subject to change based on flashlamp age and the alloy's surface condition.

Fundamentals of Laser Welding

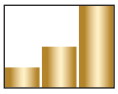
RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
80 JOULE LASERSTAR SYSTEMS WITH P3 AND SOFT-TOUCH



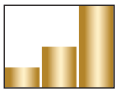
WHITE GOLD POROSITY
205V 6.0MS 2.0HZ 0.40MM
Ramp Up Profile



WHITE GOLD RE-TIP
208V 6.5MS 3.0HZ 0.45MM
Ramp Up Profile



WHITE GOLD SIZE THIN
215V 8.5MS 2.0HZ 0.40MM
Ramp Up Profile



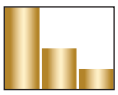
WHITE GOLD SIZE THICK
220V 9.5MS 2.0HZ 0.40MM
Ramp Up Profile

YELLOW GOLD POROSITY
225V 3.0MS 3.0HZ 0.50MM
Basic Profile

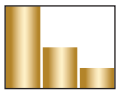
YELLOW GOLD RE-TIP
227V 3.5MS 3.0HZ 0.40MM
Basic Profile

YELLOW GOLD SIZE THIN
233V 3.7MS 3.0HZ 0.50MM
Basic Profile

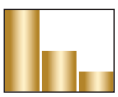
YELLOW GOLD SIZE THICK
250V 7.0MS 2.0HZ 0.60MM
Basic Profile



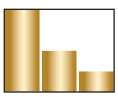
SILVER POROSITY
265V 5.0MS 2.5HZ 0.65MM
Ramp Down Profile



SILVER RE-TIP
265V 5.0MS 2.0HZ 0.70MM
Ramp Down Profile

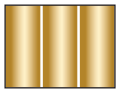


SILVER SIZE THIN
285V 4.7MS 2.0HZ 0.50MM
Ramp Down Profile

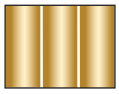


SILVER SIZE THICK
310V 6.5MS 1.5HZ 0.60MM
Ramp Down Profile

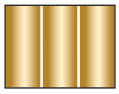
PLATINUM POROSITY
236V 2.9MS 2.0HZ 0.65MM
Basic Profile



PLATINUM RE-TIP
238V 3.0MS 3.0HZ 0.70MM
Basic Profile

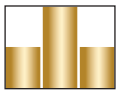


PLATINUM SIZE THIN
245V 4.1MS 2.0HZ 0.40MM
Basic Profile



PLATINUM SIZE THICK
250V 4.5MS 2.0HZ 0.40MM
Basic Profile

JUMP RINGS
230V 4.0MS 3.0HZ 0.65MM
Basic Profile

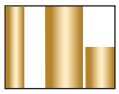


TITANIUM
230V 4.5MS 2.0HZ 0.70MM
Pyramid Profile

HOLLOW
225V 3.7MS 5.0HZ 0.35MM
Burst Profile

PEWTER
225V 5.0MS 3.0HZ 0.75MM
Burst Profile

WHITE BASE METAL
233V 5.5MS 3.0HZ 0.80MM
Burst Profile



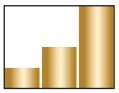
EYEGLASSES
200V 4.6MS 2.0HZ 0.50MM
PrePulse Profile

STAINLESS STEEL
228V 4.0MS 2.0HZ 0.60MM
Basic Profile

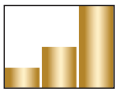
NOTE: The above parameter combinations are suggested starting points for 80 Joule LaserStar Welding Systems (7000 Series) with Soft-Touch and are subject to change based on flashlamp age and the alloy's surface condition.

Fundamentals of Laser Welding

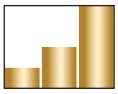
RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
100 JOULE LASERSTAR SYSTEMS WITH P3



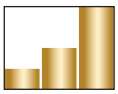
WHITE GOLD POROSITY
185V 3.0MS 3.0HZ 0.70MM
Ramp Up Profile



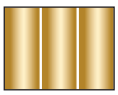
WHITE GOLD RE-TIP
190V 3.0MS 3.0HZ 0.40MM
Ramp Up Profile



WHITE GOLD SIZE THIN
180V 3.0MS 2.0HZ 0.40MM
Ramp Up Profile



WHITE GOLD SIZE THICK
195V 3.0MS 2.0HZ 0.30MM
Ramp Up Profile

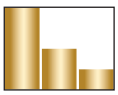


YELLOW GOLD POROSITY
220 V 2.3MS 3.0HZ 0.70MM
Basic Profile

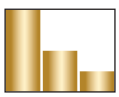
YELLOW GOLD RE-TIP
210 V 2.6MS 3.0HZ 0.40MM
Basic Profile

YELLOW GOLD SIZE THIN
210V 2.0MS 2.0HZ 0.40MM
Basic Profile

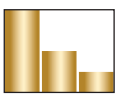
YELLOW GOLD THICK
235V 3.0MS 2.0HZ 0.30MM
Basic Profile



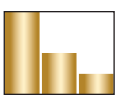
SILVER POROSITY
255V 3.0MS 2.0HZ 0.70MM
Ramp Down Profile



SILVER RE-TIP
250V 3.0MS 2.0HZ 0.40MM
Ramp Down Profile



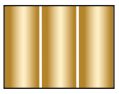
SILVER SIZE THIN
250V 3.0MS 2.0HZ 0.40MM
Ramp Down Profile



SILVER SIZE THICK
280V 4.0MS 2.0HZ 0.30MM
Ramp Down Profile

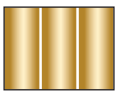
PLATINUM POROSITY
230 V 2.3MS 2.0HZ 0.70MM
Basic Profile

PLATINUM RE-TIP
230 V 3.0MS 2.0HZ 0.40MM
Basic Profile

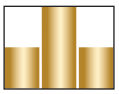


PLATINUM SIZE THIN
235V 2.0MS 2.0HZ 0.40MM
Basic Profile

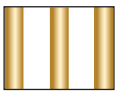
PLATINUM SIZE THICK
240V 4.0MS 2.0HZ 0.30MM
Basic Profile



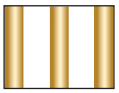
JUMP RINGS
185V 5.0MS 2.0HZ 0.70MM
Basic Profile



TITANIUM
190V 3.0MS 2.0HZ 0.55MM
Pyramid Profile

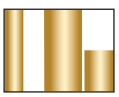


HOLLOW
200V 3.0MS 8HZ 0.35MM
Burst Profile

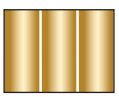


PEWTER
165V 3.0MS 3.0H 0.55MM
Burst Profile

WHITE BASE METAL
200V 8.5MS 3.0HZ 0.80MM
Burst Profile



EYEGLASSES
160V 3.0MS 2.0HZ 0.55MM
PrePulse Profile

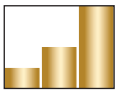


STAINLESS STEEL
220V 3.0MS 2.0HZ 0.50MM
Basic Profile

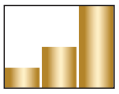
NOTE: The above parameter combinations are suggested starting points for 100 Joule LaserStar Welding Systems (7000 Series) and are subject to change based on flashlamp age and the alloy's surface condition.

Fundamentals of Laser Welding

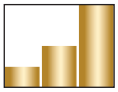
RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
100 JOULE LASERSTAR SYSTEMS WITH P3 AND SOFT-TOUCH



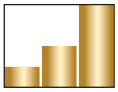
WHITE GOLD POROSITY
205V 6.0MS 3.0HZ 0.40MM
Ramp Up Profile



WHITE GOLD RE-TIP
208V 6.5MS 3.0HZ 0.45MM
Ramp Up Profile



WHITE GOLD SIZE THIN
218V 9.0MS 2.0HZ 0.40MM
Ramp Up Profile



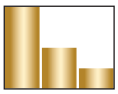
WHITE GOLD SIZE THICK
225V 10.0MS 2.0HZ 0.40MM
Ramp Up Profile

YELLOW GOLD POROSITY
225V 3.5MS 3.0HZ 0.50MM
Basic Profile

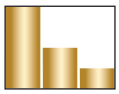
YELLOW GOLD RE-TIP
227V 3.5MS 3.0HZ 0.40MM
Basic Profile

YELLOW GOLD SIZE THIN
240V 4.0MS 2.0HZ 0.50MM
Basic Profile

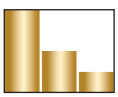
YELLOW GOLD SIZE THICK
260V 7.5MS 1.5HZ 0.60MM
Basic Profile



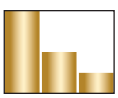
SILVER POROSITY
265V 5.0MS 2.5HZ 0.65MM
Ramp Down Profile



SILVER RE-TIP
250V 3.0MS 3.0HZ 0.45MM
Ramp Down Profile



SILVER SIZE THIN
300V 3.9MS 1.5HZ 0.45MM
Ramp Down Profile



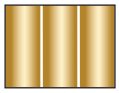
SILVER SIZE THICK
330V 4.6MS 1.5HZ 0.50MM
Ramp Down Profile

PLATINUM POROSITY
240V 4.0MS 2.0HZ 0.55MM
Basic Profile

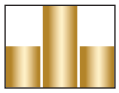
PLATINUM RE-TIP
244V 4.3MS 3.0HZ 0.70MM
Basic Profile

PLATINUM SIZE THIN
255V 5.5MS 2.0HZ 0.40MM
Basic Profile

PLATINUM SIZE THICK
275V 6.5MS 1.5HZ 0.60MM
Basic Profile

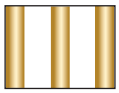


JUMP RINGS
230V 5.0MS 2.0HZ 0.65MM
Basic Profile



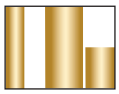
TITANIUM
245V 6.0MS 2.0HZ 0.60MM
Pyramid Profile

HOLLOW
225V 3.7MS 5.0HZ 0.35MM
Burst Profile



PEWTER
228V 7.0MS 3.0HZ 0.80MM
Burst Profile

WHITE BASE METAL
239V 7.5MS 2.0HZ 0.70MM
Burst Profile



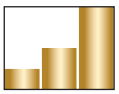
EYEGLASSES
225V 5.0MS 2.0HZ 0.50MM
PrePulse Profile

STAINLESS STEEL
230V 4.5MS 2.0HZ 0.65MM
Basic Profile

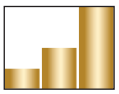
NOTE: The above parameter combinations are suggested starting points for 100 Joule LaserStar Welding Systems (7000 Series) with Soft-Touch and are subject to change based on flashlamp age and the alloy's surface condition.

Fundamentals of Laser Welding

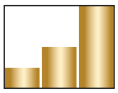
RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
100 JOULE LASERSTAR SYSTEMS WITH P3 AND SOFT-TOUCH (3X BEAM EXPANDER)



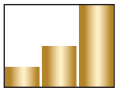
WHITE GOLD POROSITY
200V 4.8MS 3.0HZ 0.40MM
Ramp Up Profile



WHITE GOLD RE-TIP
203V 5.0MS 3.0HZ 0.45MM
Ramp Up Profile



WHITE GOLD SIZE THIN
207V 6.0MS 3.0HZ 0.45MM
Ramp Up Profile



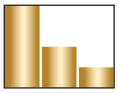
WHITE GOLD SIZE THICK
210V 7.0MS 2.0HZ 0.50MM
Ramp Up Profile

YELLOW GOLD POROSITY
223V 2.4MS 3.0HZ 0.60MM
Basic Profile

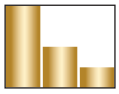
YELLOW GOLD RE-TIP
225V 2.7MS 3.0HZ 0.70MM
Basic Profile

YELLOW GOLD SIZE THIN
229V 3.0MS 3.0HZ 0.60MM
Basic Profile

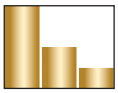
YELLOW GOLD SIZE THICK
234V 4.5MS 2.0HZ 0.60MM
Basic Profile



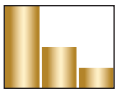
SILVER POROSITY
248V 3.3MS 3.5HZ 0.60MM
Ramp Down Profile



SILVER RE-TIP
247V 3.0MS 3.0HZ 0.80MM
Ramp Down Profile



SILVER SIZE THIN
280V 4.5MS 2.0HZ 0.50MM
Ramp Down Profile



SILVER SIZE THICK
300V 6.0MS 2.0HZ 0.60MM
Ramp Down Profile

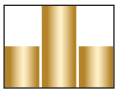
PLATINUM POROSITY
233V 2.7MS 2.0HZ 0.60MM
Basic Profile

PLATINUM RE-TIP
235V 2.9MS 3.0HZ 0.70MM
Basic Profile

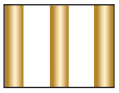
PLATINUM SIZE THIN
240V 3.8MS 2.0HZ 0.45MM
Basic Profile

PLATINUM SIZE THICK
245V 4.2MS 2.0HZ 0.40MM
Basic Profile

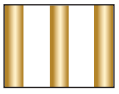
JUMP RINGS
225V 2.7MS 3.0HZ 0.80MM
Basic Profile



TITANIUM
225V 4.0MS 2.0HZ 0.70MM
Pyramid Profile

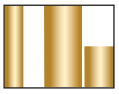


HOLLOW
220V 3.5MS 7.5HZ 0.15MM
Burst Profile



PEWTER
197V 5.0MS 3.0H 0.50MM
Burst Profile

WHITE BASE METAL
213V 8.0MS 3.0HZ 0.80MM
Burst Profile



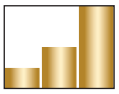
EYEGLASSES
195V 4.3MS 2.0HZ 0.60MM
PrePulse Profile

STAINLESS STEEL
225V 3.5MS 2.0HZ 0.70MM
Basic Profile

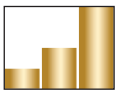
NOTE: The above parameter combinations are suggested starting points for 100 Joule LaserStar Welding Systems (7000 Series) with Soft-Touch and 3X Beam Expander and are subject to change based on flashlamp age and the alloy's surface condition.

Fundamentals of Laser Welding

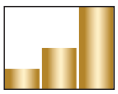
RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
120 JOULE LASERSTAR SYSTEM WITH P3



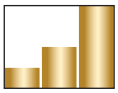
WHITE GOLD POROSITY
195V 4.0MS 3.0HZ 0.55MM
Ramp Up Profile



WHITE GOLD RE-TIP
193V 3.6MS 3.0HZ 0.40MM
Ramp Up Profile



WHITE GOLD SIZE THIN
195V 4.5MS 2.0HZ 0.40MM
Ramp Up Profile



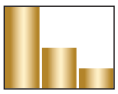
WHITE GOLD SIZE THICK
210V 7.0MS 2.0HZ 0.50MM
Ramp Up Profile

YELLOW GOLD POROSITY
220V 2.3MS 3.0HZ 0.70MM
Basic Profile

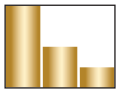
YELLOW GOLD RE-TIP
210V 2.6MS 3.0HZ 0.40MM
Basic Profile

YELLOW GOLD SIZE THIN
210V 2.0MS 2.0HZ 0.40MM
Basic Profile

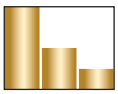
YELLOW GOLD SIZE THICK
233V 3.0MS 2.0HZ 0.45MM
Basic Profile



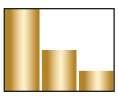
SILVER POROSITY
255V 3.0MS 2.0HZ 0.70MM
Ramp Down Profile



SILVER RE-TIP
246V 3.0MS 2.0HZ 0.55MM
Ramp Down Profile



SILVER SIZE THIN
250V 4.0MS 2.0HZ 0.50MM
Ramp Down Profile

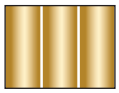


SILVER SIZE THICK
300V 4.5MS 1.5HZ 0.50MM
Ramp Down Profile

PLATINUM POROSITY
230V 2.3MS 2.0HZ 0.70MM
Basic Profile

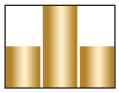
PLATINUM RE-TIP
224V 2.4MS 3.0HZ 0.60MM
Basic Profile

PLATINUM SIZE THIN
250V 2.5MS 2.0HZ 0.50MM
Basic Profile

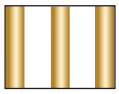


PLATINUM SIZE THICK
255V 4.0MS 2.0HZ 0.50MM
Basic Profile

JUMP RINGS
185V 5.0MS 2.0HZ 0.70MM
Basic Profile



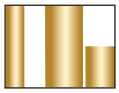
TITANIUM
210V 4.5MS 2.0HZ 0.55MM
Pyramid Profile



HOLLOW
202V 3.3MS 7.0HZ 0.35MM
Burst Profile

PEWTER
195V 4.3MS 3.0H 0.55MM
Burst Profile

WHITE BASE METAL
205V 8.5MS 3.0HZ 0.80MM
Burst Profile



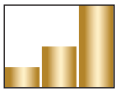
EYEGLASSES
193V 4.0MS 2.0HZ 0.55MM
PrePulse Profile

STAINLESS STEEL
220V 3.0MS 2.0HZ 0.60MM
Basic Profile

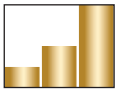
NOTE: The above parameter combinations are suggested starting points for 120 Joule LaserStar Welding Systems (7000 Series) and are subject to change based on flashlamp age and the alloy's surface condition.

Fundamentals of Laser Welding

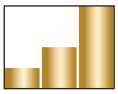
RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
120 JOULE LASERSTAR SYSTEM WITH P3 AND SOFT-TOUCH



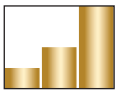
WHITE GOLD POROSITY
205V 4.8MS 9.5HZ 0.50MM
Ramp Up Profile



WHITE GOLD RE-TIP
215V 3.5MS 4.0HZ 0.45MM
Ramp Up Profile

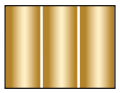


WHITE GOLD SIZE THIN
215V 4.8MS 3.0HZ 0.40MM
Ramp Up Profile



WHITE GOLD SIZE THICK
225V 5.5MS 3.0HZ 0.40MM
Ramp Up Profile

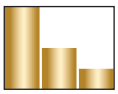
YELLOW GOLD POROSITY
216V 4.5MS 6.0HZ 0.70MM
Basic Profile



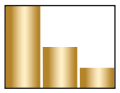
YELLOW GOLD RE-TIP
207V 2.6MS 4.0HZ 0.40MM
Basic Profile

YELLOW GOLD SIZE THIN
225V 2.0MS 2.0HZ 0.35MM
Basic Profile

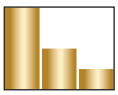
YELLOW GOLD SIZE THICK
240V 3.7MS 2.0HZ 0.40MM
Basic Profile



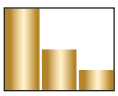
SILVER POROSITY
248V 3.1MS 7.5HZ 0.70MM
Ramp Down Profile



SILVER RE-TIP
248V 3.0MS 4.0HZ 0.80MM
Ramp Down Profile



SILVER SIZE THIN
310V 7.0MS 2.5HZ 0.25MM
Ramp Down Profile



SILVER SIZE THICK
380V 7.0MS 1.5HZ 0.30MM
Ramp Down Profile

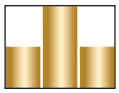
PLATINUM POROSITY
237V 3.5MS 8.0HZ 0.35MM
Basic Profile

PLATINUM RE-TIP
239V 3.7MS 8.0HZ 0.45MM
Basic Profile

PLATINUM SIZE THIN
290V 3.8MS 3.0HZ 0.35MM
Basic Profile

PLATINUM SIZE THICK
310V 4.5MS 3.0HZ 0.40MM
Basic Profile

JUMP RINGS
225V 5.0MS 2.0HZ 0.40MM
Basic Profile

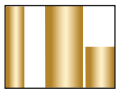


TITANIUM
250V 6.0MS 2.0HZ 0.45MM
Pyramid Profile

HOLLOW
218V 3.9MS 10.0HZ 0.20MM
Burst Profile

PEWTER
200V 3.0MS 8.0H 0.70MM
Burst Profile

WHITE BASE METAL
204V 3.5MS 8.0HZ 0.70MM
Burst Profile



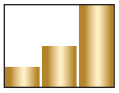
EYEGLASSES
212V 4.0MS 2.0HZ 0.70MM
PrePulse Profile

STAINLESS STEEL
225V 4.0MS 5.0HZ 0.80MM
Basic Profile

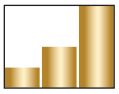
NOTE: The above parameter combinations are suggested starting points for 120 Joule LaserStar Welding Systems (7000 Series) with Soft-Touch and are subject to change based on flashlamp age and the alloy's surface condition.

Fundamentals of Laser Welding

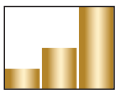
RECOMMENDED PRE-PROGRAMMED PARAMETER SETTINGS
150 JOULE LASERSTAR SYSTEM WITH P3



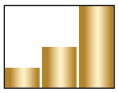
WHITE GOLD POROSITY
190V 4.0MS 3.0HZ 0.70MM
Ramp Up Profile



WHITE GOLD RE-TIP
190V 3.5MS 3.0HZ 0.55MM
Ramp Up Profile



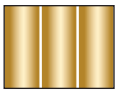
WHITE GOLD SIZE THIN
195V 4.5MS 2.0HZ 0.45MM
Ramp Up Profile



WHITE GOLD SIZE THICK
200V 5.0MS 2.0HZ 0.40MM
Ramp Up Profile

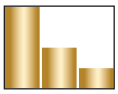
YELLOW GOLD POROSITY
210V 2.0MS 3.0HZ 0.70MM
Basic Profile

YELLOW GOLD RE-TIP
200V 2.5MS 3.0HZ 0.70MM
Basic Profile

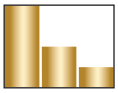


YELLOW GOLD SIZE THIN
205V 4.0MS 2.0HZ 0.50MM
Basic Profile

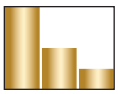
YELLOW GOLD SIZE THICK
210V 4.5MS 2.0HZ 0.50MM
Basic Profile



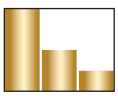
SILVER POROSITY
250V 3.0MS 3.0HZ 0.70MM
Ramp Down Profile



SILVER RE-TIP
220V 3.0MS 3.0HZ 0.80MM
Ramp Down Profile

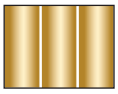


SILVER SIZE THIN
250V 3.0MS 2.0HZ 0.40MM
Ramp Down Profile

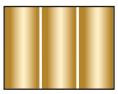


SILVER SIZE THICK
260V 5.0MS 1.5HZ 0.65MM
Ramp Down Profile

PLATINUM POROSITY
220V 2.5MS 3.0HZ 0.70MM
Basic Profile



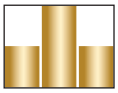
PLATINUM RE-TIP
220V 2.0MS 3.0HZ 0.80MM
Basic Profile



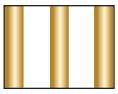
PLATINUM SIZE THIN
235V 2.5MS 2.0HZ 0.50MM
Basic Profile

PLATINUM SIZE THICK
240V 4.0MS 2.0HZ 0.40MM
Basic Profile

JUMP RINGS
185V 5.0MS 2.0HZ 0.70MM
Basic Profile



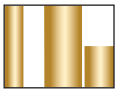
TITANIUM
205V 3.5MS 2.0HZ 0.55MM
Pyramid Profile



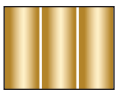
HOLLOW
195V 3.0MS 8.0HZ 0.30MM
Burst Profile

PEWTER
175V 4.5MS 3.0HZ 0.60MM
Burst Profile

WHITE BASE METAL
200V 4.5MS 3.0HZ 0.80MM
Burst Profile



EYEGLASSES
195V 4.5MS 2.0HZ 0.80MM
PrePulse Profile



STAINLESS STEEL
210V 3.5MS 2.0HZ 0.75MM
Basic Profile

STAINLESS STEEL
200V 2.0MS 0.0HZ 0.75MM
Basic Profile

NOTE: The above parameter combinations are suggested starting points for 150 Joule LaserStar Welding Systems (7000 Series) and are subject to change based on flashlamp age and the alloy's surface condition.