337200

VSL-337ND NITROGEN LASER

OPERATOR'S MANUAL

VSL-337ND - NITROGEN LASER

Table of Contents

I - PRECAUTIONS FOR SAFE USE

ALL PERSONS WHO WILL USE THE LASER, OR WILL BE IN THE AREA WHERE THE LASER IS WORKING, SHOULD BE AWARE OF POTENTIAL HAZARDS ASSOCIATED WITH THIS EQUIPMENT:

1. This device produces invisible ultraviolet radiation. Never look directly into the laser beam or directly at any specular reflections of the laser beam as eye damage may occur.

2. Warning signs should be posted at entrances and in prominent locations near the laser work area.

3. Access to the laser work area should be limited to persons required there and who have been instructed in the safe use of lasers.

4. When possible, enclose all laser beam paths.

5. Set up work stations so that the laser beam is not at eye level.

6. Set up a target for the beam. A bussiness card or photocopy paper works well.

7. The beam attenuator should be in the closed position at all times when the laser is not operating.

8. Before turning on the laser, protect the eyes by wearing laser safety goggles appropriate for use at a radiation wavelength of 337nm.

9. Maintenance of the laser unit should be done by qualified personnel only.

Additional information on the safe use of lasers may be obtained from:

American National Standards
1930 Broadway
New York, NY 10018
(ANZI Z136.1-1980)

Laser Institute of America
12424 Research Parkway, Suite 130
Orlando, FL 32826
Tel: (407) 380-1553

II - COMPLIANCE FEATURES AND PERFORMANCE REQUIREMENTS

1. Protective Housing: The laser is shielded with an all metal protective housing to prevent human access to the laser or collateral radiation.

2. Safety Interlock: Two interlock switches, electrically connected in series, are activated upon removal of the protective housing from the laser, preventing human access to laser radiation. These interlock switches must be temporarily defeated during internal adjustment of the resonator for beam alignment, but the protective housing cannot be reinstalled without first removing the interlock defeat.

3. Remote Interlock Connector: This is located on the control panel, (rear panel) of the laser. The laser is supplied with a jumpered connector fitted into this two-pin receptacle. If the terminals of this connector are not electrically joined, the laser will not be energized, thus preventing human access to all laser radiation. The voltage measured at one of the terminals is 24V max when the terminals are open, and the current is 40mA when the terminals are joined. For CE compliance, it is necessary that the laser be run using the supplied jumper connector.

4. Key Control: The key, when turned to the "ON" position activates the laser. The key can only be removed when in the "OFF" position. When the key is removed from the system, no emission is possible.

5. Laser Radiation Emission Indicator: The emisssion indicator operates from the key actuated master control, giving a visible signal prior to any emission. This indicator is located on the rear panel and can be viewed without exposure to laser radiation.

6. Time Delay: To prevent accidental exposure to laser radiation, there is a delay between the key switch and actual emission of the laser. This delay is typically 3-5 seconds after turning on the key switch.

7. Beam Attenuator or Beam Shutter: A simple push-pull operation of the beam shutter closes or opens the exit aperture of the laser beam. The exit aperture, located in the front end of the laser, is marked with the aperture label and is also marked with the appropriate class IIIb warning label.

8. Location of Controls: All controls, except the beam attenuator, are located on the rear panel of the laser. This prevents any exposure to radiation during operation or adjustment of such controls. For detailed description, see page 7.

9. Labeling Requirements: All labels and their comparison sizes pertaining to the appropriate class IIIb laser classification

are shown in the section entitled LABELS AND WARNING LOGOTYPE.

10. **WARNING!**

CAUTION: Use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.

III

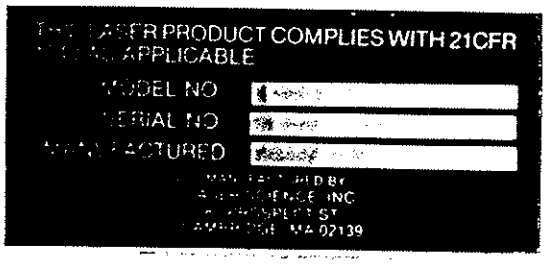
VSL-337ND Nitrogen Laser

LABELS

1.) Certification Label

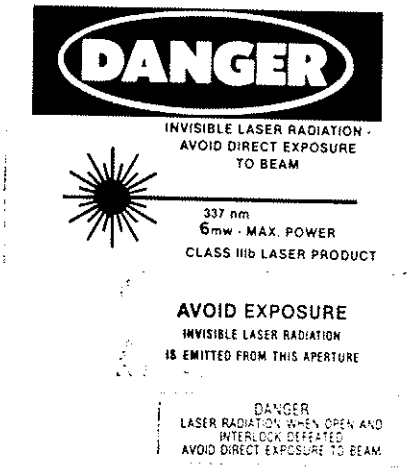
and

Identification Label
(located on bottom
of laser)



2.) Warning logotype
(Front end of
laser)

3.) Aperture Label
(Front end of
laser)



4.) Labels for
Defeatable
Interlocked Protective Housing
(located on removalable part of protective housing and
inside the laser next to defeatable interlock)

5.) WARNING labels for High Voltage
(inside of laser unit, on high voltage power supplies and
plasma cartridge modules)

IV - SPECIFICATIONS OF VSL-337ND

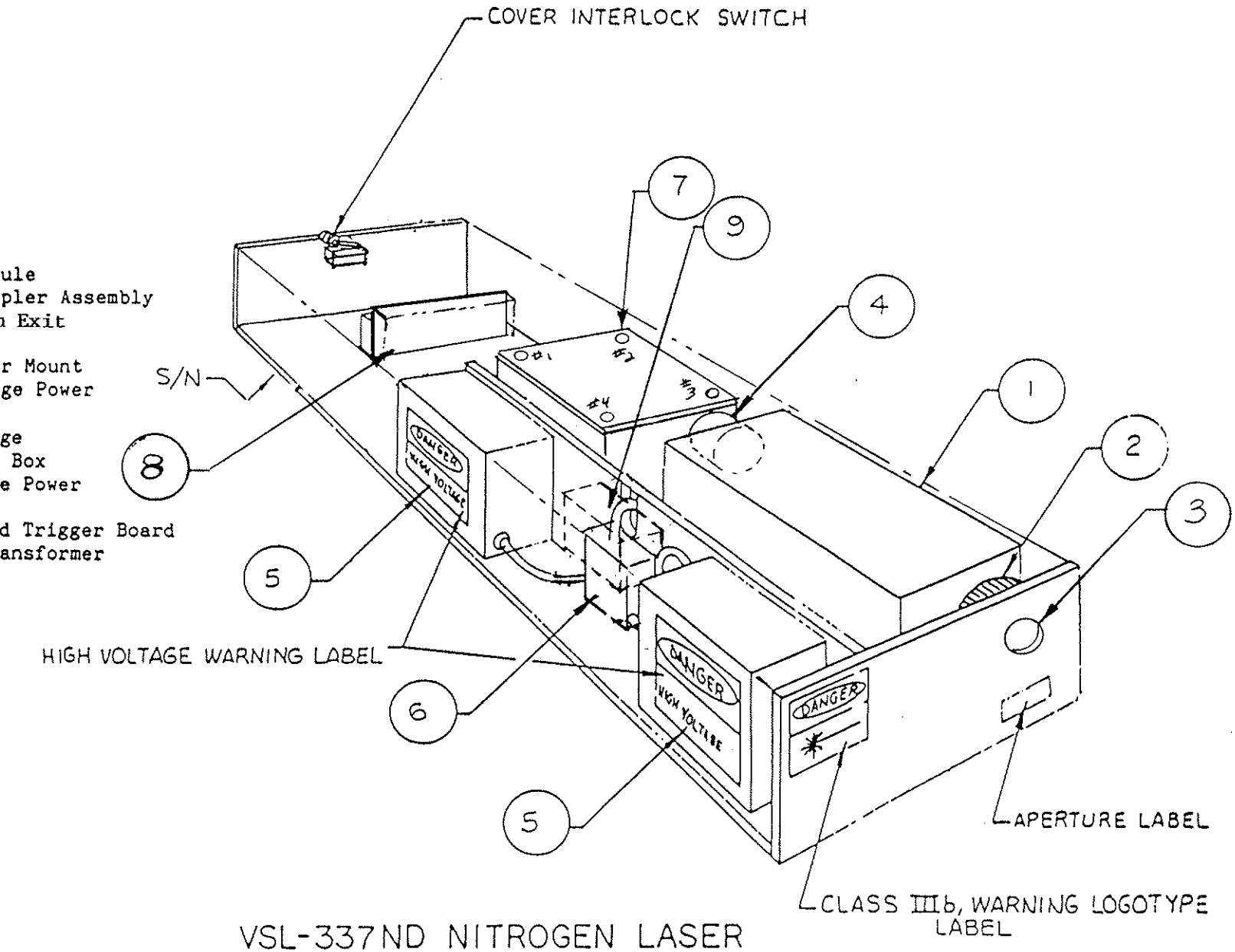
		Note
Laser Gas (sealed)	Nitrogen	(1)
Spectral Output	337.1nm	
Spectral Bandwidth	0.1nm	
Pulse Energy	300 microjoules	(2)
Pulse Duration	4ns	(3)
Repetition Rate	1-20Hz	(4)
Average Power(20Hz)	5mW	
Peak Power	85kW	
Delay	600ns	
Beam Size, Nominal	40 sq.mm	
Beam Divergence(Full Angle)	<0.3mrad	
Intensity Stability(10Hz)	+/- 4%	
Trigger Mode	EXT/INTERNAL	
External Trigger Signal	50 ohm source, TTL, 1 microsecond	(4)
Power Requirements	85-265 Volts, 50/60 Hz	
Dimensions	18.50"X7.75"X4.25"	
Weight	16lbs	
Operating Temperature	60 degrees C	
Optical Beam Height	2.75 inches	

(1) Sealed off plasma tube, energy storage capacitors, switch in one cartridge.

(2) Maximum radiant pulse energy can be up to 300 microjoules; depending on optical adjustments and tube age. A minimum energy of 150 microjoules at end of life is expected.

(3) Pulse duration is defined as the time interval between half intensity points of leading and trailing edges of pulse (FWHM).

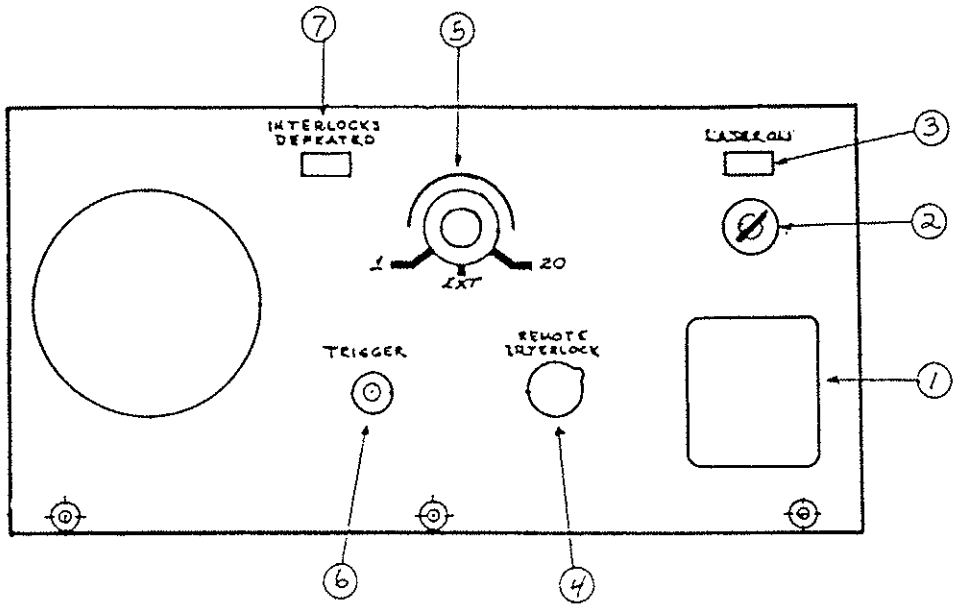
(4) Internal trigger mode: rep. rate adjustable up to 20Hz.
External trigger mode: not exceeding 20Hz.



1. Plasma Module
2. Output Coupler Assembly
3. Laser Beam Exit Aperature
4. Rear Mirror Mount
5. High Voltage Power Supply
6. High Voltage Connection Box
7. Low Voltage Power Supply
8. Control and Trigger Board
9. Trigger Transformer

VSL-337ND NITROGEN LASER

VI - CONTROL PANEL OF THE VSL-337ND LASER



The above drawing depicts the layout of the control panel of the VSL-337ND laser. All components are numbered and perform the following functions.

1.) Power Receptacle: Receives grounded standard three wire power plug for 110 OR 220 Volt (+/-20V) 3A operation. The power cord must be 6' long or less.

2.) Key Control On/Off Switch: Enables electrical power feed to the laser. Key can be removed only in "OFF" position.

3.) Laser Radiation Emission Indicator: A visible warning light to indicate that the laser has been powered and to warn that it may emit laser radiation.

4.) Remote Interlock Connector: May be used to interrupt operation of the laser from a remote location. The interrupting switch and the extension cable must be supplied and installed by the user.

5.) Dual-Function Trigger Adjustment Knob:

a) Internal Trigger: The adjustment of the pulse repetition rate can be continuously varied from 0 to 20 pulses per second by turning the knob in the clockwise direction.

b) External Trigger: This mode is selected by turning the knob fully counterclockwise until a switch-action is felt. In this mode an external electrical trigger signal must be supplied. The trigger signal must be fed into the BNC input connector adjacent to the trigger mode control knob. The maximum allowable pulse rate is 20 Hz.

WARNING: In the trigger mode, even if the laser is not firing, the laser energy storage capacitors are continuously charged and the laser is waiting for a trigger signal. Since the laser is ready to be fired at any time, all precautions should be taken to avoid accidental laser exposure should the laser trigger unexpectedly.

6.) Trigger Input BNC Connector: The external trigger should have a duration of 1 microsecond or longer and be of TTL level. The input of the trigger is protected with an opto-isolator for minimizing EMI/RF interferences. The trigger cable should be 4' long or less, and it should be a RG58C/U BNC cable.

7.) Interlocks Defeated LED: Green LED stays on indicating laser is ready to fire. When LED is off, either the cover or remote interlock is open and the laser will not fire.

VII - BEAM CROSS SECTION AND BEAM SHAPE

The cross section of the laser beam of the VSL-337ND laser has the shape of a square with 7 mm x 7 mm area, having cut out of one of its corners another smaller square of 3 mm x 3 mm area. This particular beam shape is determined by the approximately square cross section of the transverse electrical discharge combined with the blocking effect caused by the convex output coupler.

In fact, this mirror does not have the conventional circular shape of axial symmetry, instead it is a 90° circular segment with a convex surface oriented towards the plasma tube. This mirror segment intercepts,with its 90° edge, a small fraction of the laser beam ($\sim$ 20%) in order to supply the necessary optical feedback into the amplifying medium. Actually, it is not the convex mirror, but the lack of that mirror surface which allows the beam to exit from the unstable resonator. The laser beam quality is enhanced with the plasma tube having slightly tilted windows. The orientation normal to the windows forms an angle of about 3° with respect to the tube axis. This also avoids unwanted multiple reflections which would contribute to interference fringes within the beam and produce a deteriorated angular beam divergence. In addition, there are antireflection coatings on both sides of the two windows of this plasma tube. This minimizes the overall reflection losses of the cavity. The very weak remaining reflection can only give the appearance of a very faint beam being off axis, but which is readily blocked by the exit aperture of the beam attenuator assembly.
The laser resonator is shown in Figure 2, on page 14, together with the concomitant beam shape.

VIII - LASER RESONATOR

The VSL-337ND series of nitrogen lasers has been developed specifically for generating pulses of ultraviolet light at 337nm with very low angular beam divergence. The full divergence angle is less than 0.3mrad and is achieved with proper mirror alignment without compromising the high radiant pulse energy of this laser.

In the laser construction, use is made of the particular property of the beam collimation achievable with an unstable optical resonator. Such a resonator is formed by placing the laser medium, that is the plasma tube, between one concave mirror with the function of a total reflector and another convex mirror having a smaller radius of curvature than the former (Figure 2). The best beam collimation is obtained when the two mirrors are confocal, meaning the focal points of these two mirrors are coincident. Should the mirror separation be increased or decreased about this confocal position, the output beam of the laser will become either convergent or divergent correspondingly.

IX - LASER BEAM ALIGNMENT

****** WARNING ******

Ultraviolet light, such as the 337nm radiation emitted by the nitrogen laser, **is not visible to the un-aided eye.** Exposure of the eyes to this radiation must be avoided at all times, even if the laser beam is scattered from rough or absorbing surfaces. UV absorbing goggles should be worn when using the laser with an open beam, or when in an area where the laser is operating openly.

Before attempting alignment of the laser, please read sections VII and VIII.

Adjustment of the laser resonator:

The resonator mirrors are an integral part of the plasma cartridge as shown in Figure 3. The mirror mounts are designed to stay in alignment with even rough handling of the laser.
However, care must be taken in handling the plasma cartridge seperately, since undue pressure on the cantilevered ends of the mirror mounts can cause some minor misalignment.

***** CAUTION *****

CAUTION: With the cover off and the interlock defeated, great care must be taken against HIGH VOLTAGE SHOCK and exposure to 337nm radiation.

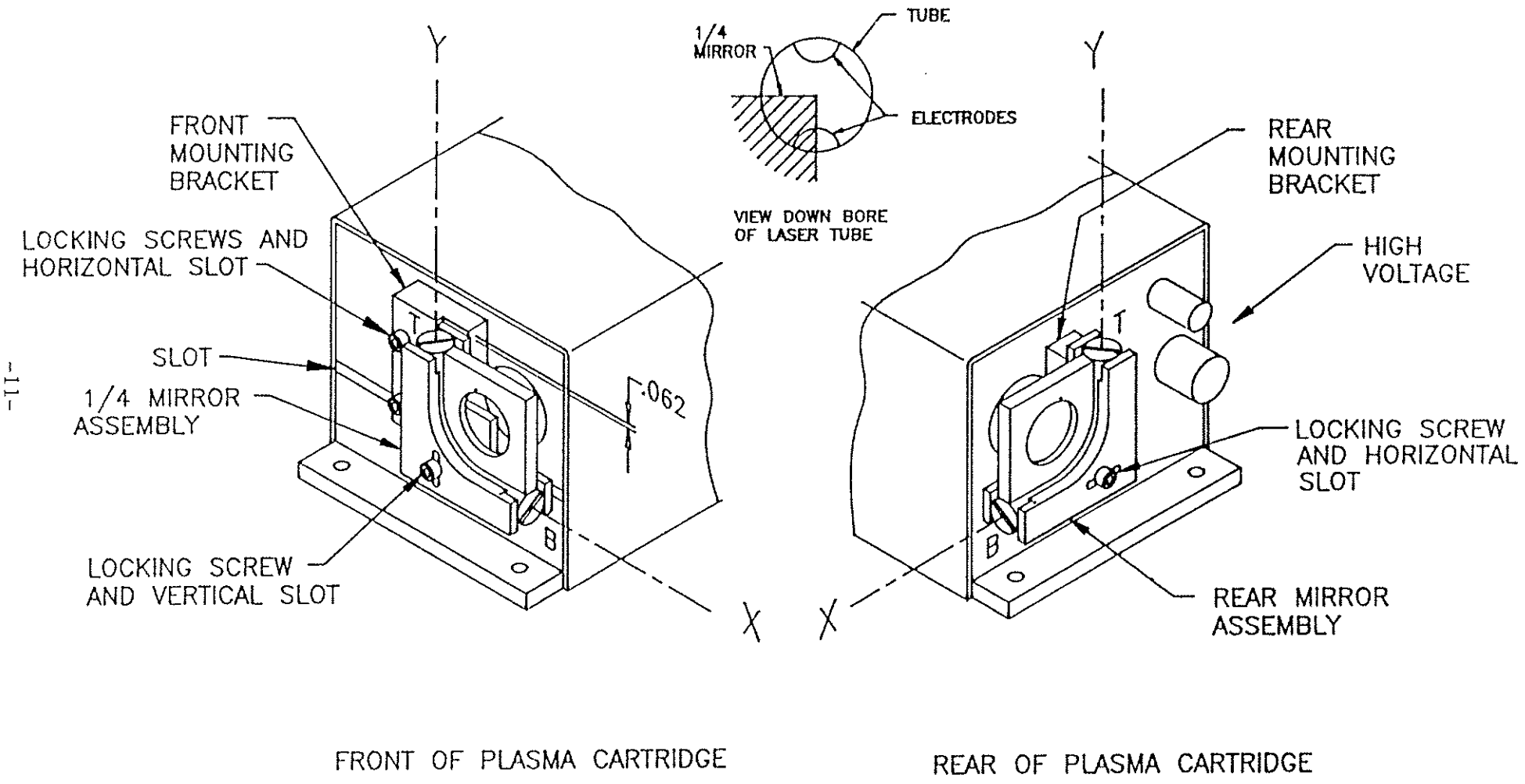


FIGURE 3. PLASMA CARTRIDGE

Minor Realignment-

The mirror mount asssemblies are secured to mounting blocks that are in turn secured to the plasma cartridge chassis. The only adjustments normally required can be achieved with the four screws marked T (Top) and B (Bottom), indicated in Figure 3- one set of 2 on the front 1/4 mirror and another set of 2 on the rear mirror. For this proceedure do not loosen any of the allen head screws.

At a distance of 6 to 12 inches from the output aperture, a well aligned beam should appear similar to that shown in Figure 2. The beam is longer in the vertical (Y) dimension than in the horizontal (X) dimension. It should appear somewhat uniformly bright with a well defined notch due to the 1/4 mirror output coupler. Some stray light of much lower intensity will always remain in a two inch or so diameter area about the main beam. There should be very little shading or what may appear as multiple beam images.

The screws marked B tilt the mirrors about the Y axis and the screws marked T tilt the mirrors about the X axis. Adjustment of B will change beam features in the horizontal direction and adjustment of T will change features in the vertical direction. Very small movement of these screws make significant changes in the beams appearence. First adjust B on the rear mirror to improve horizontal beam appearance. Next, adjust B on the front mirror. Return to the rear mirror and adjust T to improve the vertical appearance. Next adjust T on the front mirror. Repeat if necessary.

Major Realignment-

The following proceedure starts with the mirror assemblies and mounts disconnected from the plasma cartridge and with the cartridge out of the laser, as is done with the initial factory alignment/ assembly. One can start with Step 7.

The object of alignment of an unstable resonator cavity such as this is to place the optical axes of the front convex 1/4 mirror, the rear concave full mirror and the "hottest" longitudinal axis of the nitrogen discharge in complete colinearity. The initial centering described in Step 5 may not achieve this condition. The distance between mirrors is also important for proper laser divergence, but this length is pre-determined by the mechanical layout of the baseplate.

1) Attach the rear mounting bracket to the plasma cartridge housing. No adjustment required.
2) Attach the rear mirror assembly with locking screw. Slide mirror assembly against registration shoulders on the right and bottom of the rear mounting bracket. Tighten locking screw.
3) Attach front mounting bracket to plasma cartridge housing. The lip on the bottom of the bracket fits into the horizontal slot on the plasma cartridge housing. Initial positioning of this bracket is in the full up and full right position. Tighten screws over horizontal adjustment slots.

4) Attach mirror assembly to bracket and tighten locking screw over vertical adjustment slot. Leave 1/16 inch space from top of mirror assenbly to top of mounting bracket as indicated in Figure 3.
5) From the front look down the bore of the plasma tube past the 1/4 mirror at a diffuse light source such as fluorescent lights. Tilt the plasma cartridge until you see equal portions of the electrodes down their entire length. The center (corner) of the 1/4 mirror should then be centered on the electrodes as shown in Figure 3. Centering can be achieved by (a) loosening the two screws that hold the front mounting bracket- horizontal adjustment or by (b) loosening the locking screw on the mirror assembly- vertical adjustment.
6) Install the plasma cartridge following the instructions in Section XI.
7) Now follow the proceedure under "Minor Alignment" above. The object is to get all of the energy into the main central beam.
8) While holding the front mirror assembly in place, loosen the two screws that hold the front mounting bracket and move the entire assembly in X and then in Y trying to concentrate all of the energy in one spot,i.e. getting rid of stray light.
9) Repeat Step 6.
10) At this point one should have a reasonable beam. However, Steps 7 and 8 may have to be repeated a number of times.
11) Sometimes the top part of the beam can have a curved appearance due to the curvature of the electrode. This can be "straightened" by adjusting T on the rear mirror and then T on the front mirror.

X - TEMPORAL PULSE EVOLUTION AND BEAM SHAPE

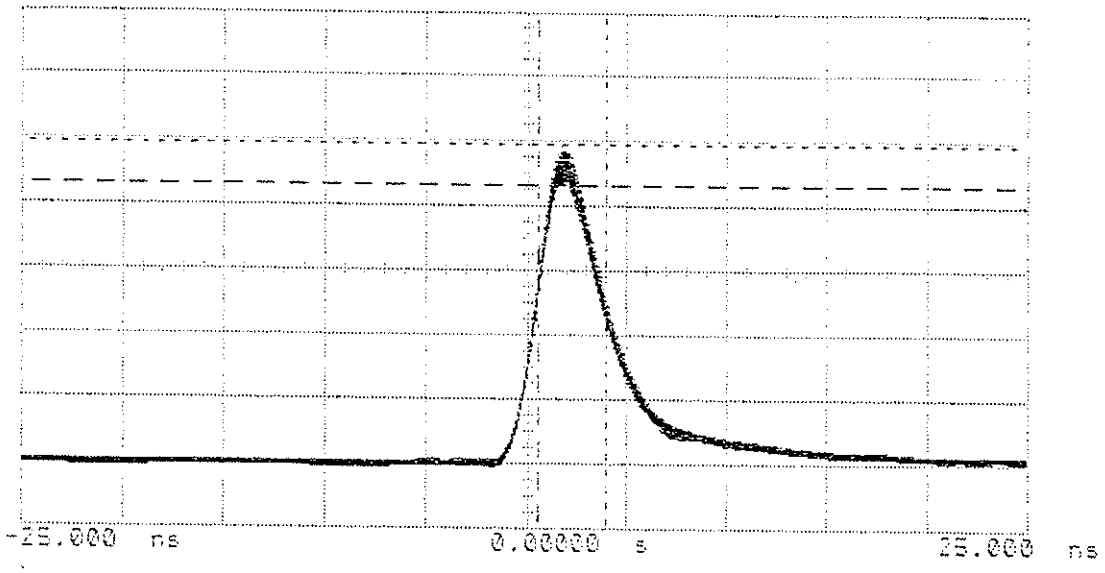


Figure 1. Temporal evolution of VSL-337ND laser pulse.

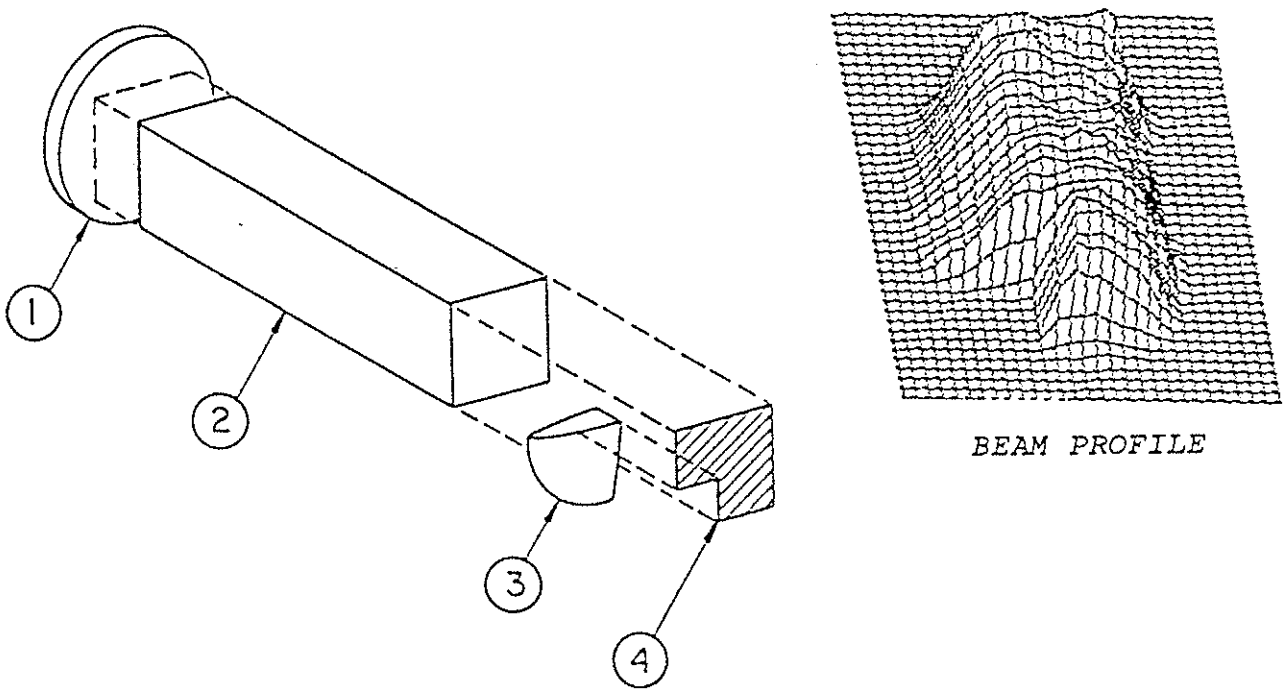


Figure 2. Schematic of resonator and 3-D beam profile.
1-Rear Mirror, 2-Discharge Volume, 3-Output Coupler, 4-Output Beam

XI - REPLACEMENT OF THE PLASMA CARTRIDGE

1. Disconnect the laser from the power line.

2. Remove the protective housing by removing all the screws, then pull the cover back towards the control panel and then up, being sure not to damage the shutter.

3. Unscrew the High Voltage cable and the Trigger Transformer cable.

4. Unscrew the 4 retaining screws which fasten the plasma cartridge to the rails on the base plate.

5. Unscrew the black ground-return wire which connects the plasma cartridge to the base plate.

6. Carefully slide the plasma cartridge out, sideways.

7. Replace with the new plasma cartridge.

8. Reconnect and fasten the plasma cartridge following all steps in reverse.

9. Try and position the HV and Trigger cables away from each other to avoid any untriggered laser pulses.

WARNING: FAILURE TO RECONNECT THE BLACK GROUND-RETURN WIRE OF THE PLASMA CARTRIDGE TO THE BASE PLATE WILL RESULT IN A SERIOUS ELECTRICAL SHOCK HAZARD. ELECTRICAL COMPONENTS COULD ALSO BE DAMAGED.

The WARRANTY IS VOIDED if defects result from user error.

10. The new plasma cartridge should not need adjustment. If alignment is necessary refer to Section IX.

XII - SERVICE AND REPAIR

If you feel the laser is not working as stated in the manual and you need further assistance, please contact us for additional instructions.

A Subsidiary of Thermo Vision

8E Forge Parkway, Franklin, MA 02038
508-553-2353 800-447-1020 fax: 508-553-2355 www.laserscience.com

LIMITED WARRANTY

Products in the VSL series by Laser Science, Inc., hereafter referred to as LSI, excluding the replaceable plasma cartridges, are warranted against defects in materials and workmanship for a period of one (1) year from the date of shipment. This warranty is limited to repair or replacement, at the option of LSI, of products returned to the factory within the warranty period. The plasma cartridges are warranted to produce the following average powers for 2×10^7 pulses or two (2) years, whichever comes first. For catalog number 337900 at least 1.6mW @ 20 pps. For catalog number 337290 at least 3.0mW @ 20 pps or 1.5mW @ 10 pps. Cartridges must be returned to LSI to qualify for warranty replacement. After the first year the cartridges will be replaced on a pro-rated basis.

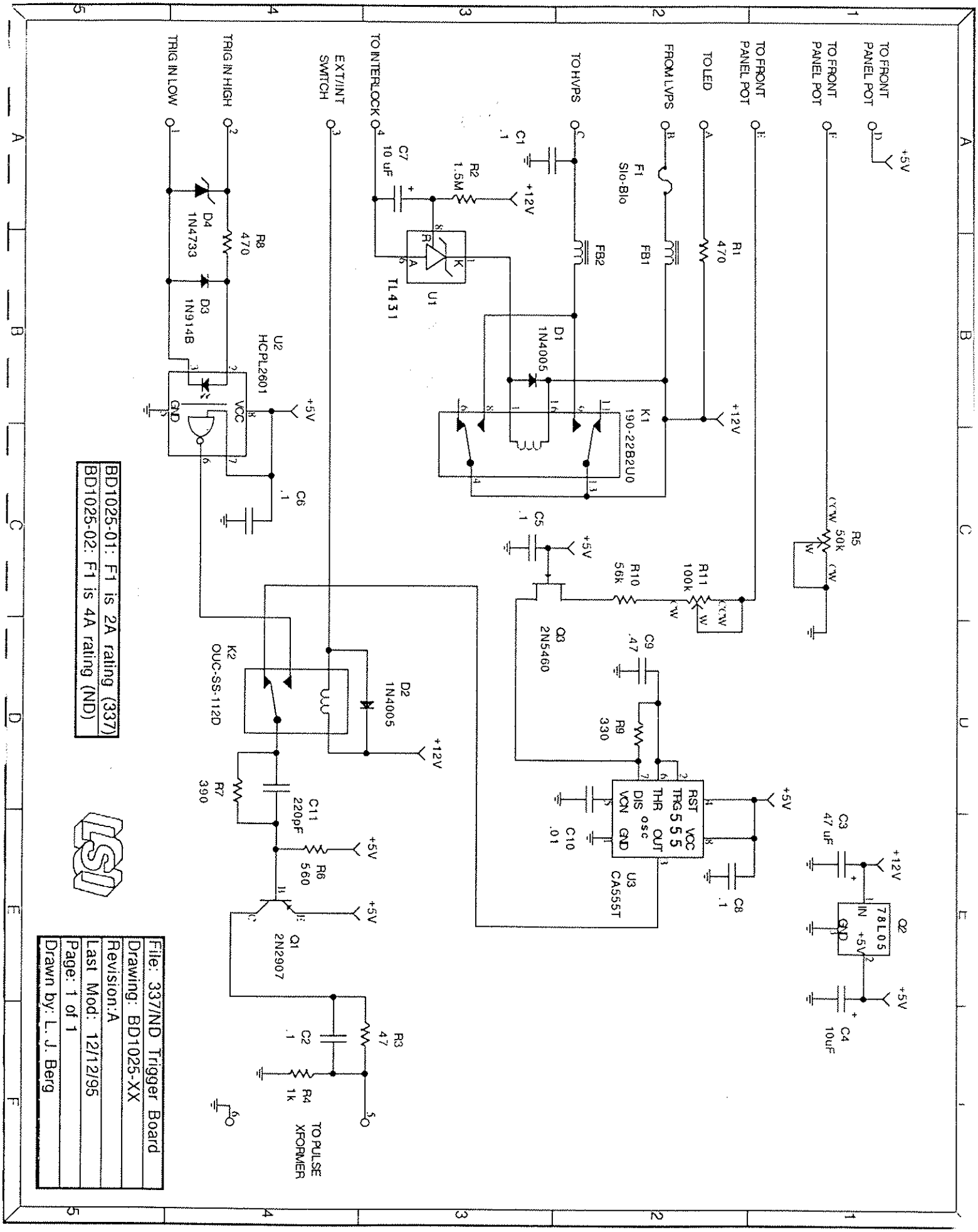
LSI warrantees its products against infringement of any United States Letters Patent, provided: (a) LSI is notified within ten (10) days after receipt of any notice of claim infringement; (b) the alleged infringement is not the result of any modification of the product by anyone other than LSI or its combination with any other equipment, circuitry or process; (c) LSI shall have the option of procuring for its customer appropriate rights to avoid claim of infringement, modifying the product to avoid infringement, or requesting the return of the product to LSI and upon such return to refund the full purchase price of the product; and (d) LSI shall have no other liability, including claims for direct, indirect or consequential damages, with respect to patent infringement.

This warranty is in lieu of all other warranties, expressed or implied, and any warranty or merchantability of fitness for a particular use is expressly disclaimed. In no event shall LSI be liable for consequential damages irrespective of the negligence of LSI or any other cause.

July 1993

XIV - SPARE PARTS LIST FOR VSL-337ND

337290	Sealed plasma cartridge. Module contains energy storage capacitors; pulse forming network and switching elements; plasma chamber with quartz AR coated optics and resonator mirrors . All components are encapsulated in epoxy. Cartridge warranted for a minimum of 20 million pulses with average power of 3.0mW.
337964	Pulse Transformer
337938	DC Power Filter
337944	Rear Full Reflector
337945	1/4 Mirror
337963	18KV High Voltage Power Supply
337955	Key Switch
337956	Key
337965	Trigger Board
337958	Remote Interlock Connector Plug
337967	Low Voltage Power Supply

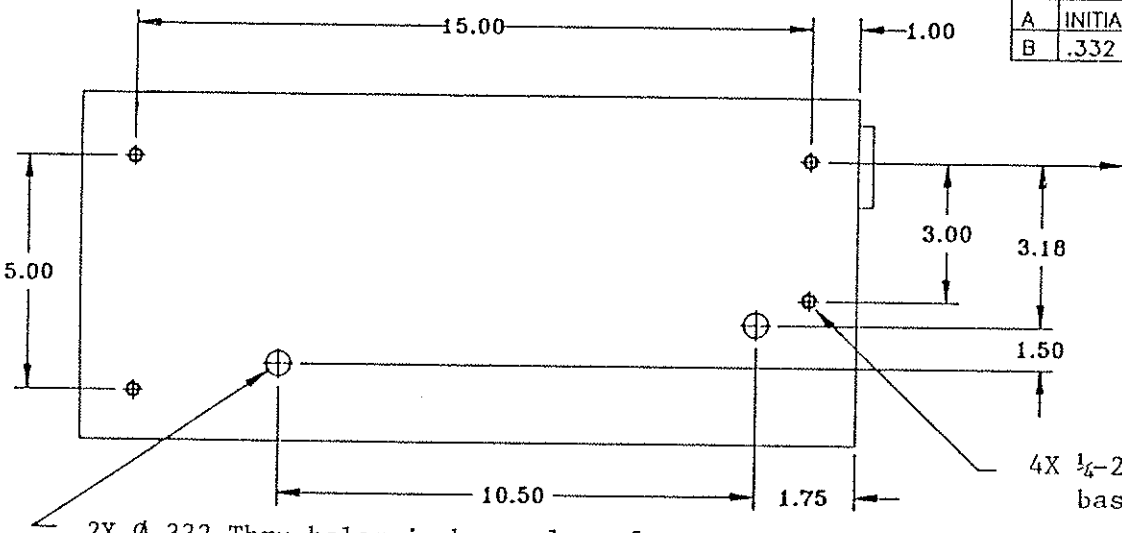


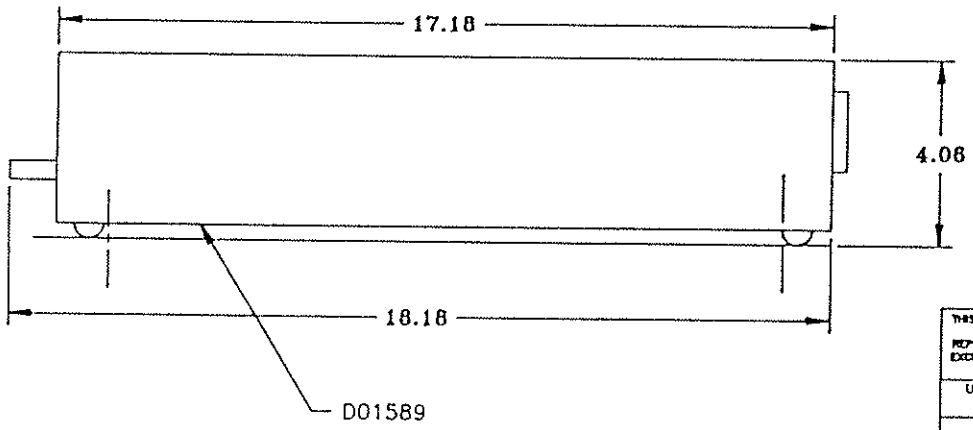
BD1025-01: F1 is 2A rating (337)
BD1025-02: F1 is 4A rating (ND)

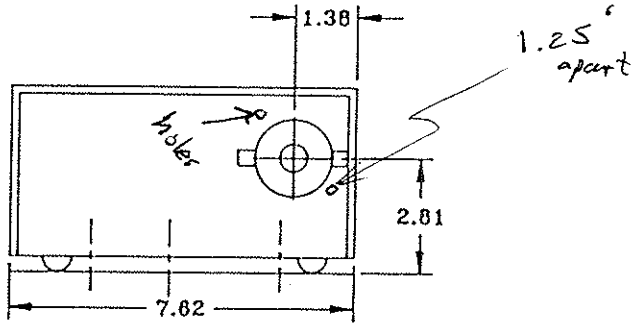
File: 337/ND Trigger Board
Drawing: BD1025-XX
Revision:A
Last Mod: 12/12/95
Page: 1 of 1
Drawn by: L. J. Berg

REV	DESCRIPTION	ECN NO.	DFTG	CHK	DATE
A	INITIAL RELEASE			L.PAUL	10/6/92
B	.332 HOLES ADDED		DOM O.		8/11/95

FOR OTHER REVISIONS SEE ECO HISTORY FILE.







DO NOT SCALE THIS DRAWING

DO NOT SCALE DRAWING

-20-

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION. IT MUST NOT BE REPRODUCED OR DISCLOSED TO OTHERS EXCEPT AS AUTHORIZED IN WRITING BY LASER SCIENCE, INC.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES
FRAC ± 1/32 ANG ± 1/4°
DEC .XX± .01 .XXX± .005
SURFACE 125 μIN Ra MAX
ANSI Y14.5M-1982

REMOVE ALL BURRS

BREAK SHARP EDGES

PROJECTION

NEXT ASSY | USED ON

LASER SCIENCE, INC
75 CHAPEL STREET, NEWTON, MA. 02158

DRAFT	DATE	CHECKED	DESIGN ENGR	MFG ENGR
L. PAUL	10/6/92			

VSL-337ND base plate dimensions with mounting holes

MATERIAL:

FINISH:

SIZE	DRAWING NO.	REV.
B	SK1383	B

SCALE: NONE SHEET 1 OF 1