Laser Photonics, Inc.

LN300
SEALED NITROGEN LASER

Operator's Manual

May 1995

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Laser Photonics, Inc. • 12351 Research Parkway • Orlando, Florida 32826 • (407) 281-4103

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LASER PHOTONICS, INC.
Scientific Product Warranty

LASER PHOTONICS, INC. (LPI), hereinafter, the "Company", warrants to the original purchaser, that the instrument sold hereunder is free from defects in material and workmanship under normal usage for a period of one (1) year from the date of shipment (*see the following page for warranty of consumables*). The Company will replace, at is own expense, all broken or defective parts during the period for which such part is warranted (excluding consumables). Equipment returned to the Company for warranty repair requires prior authorization from Laser Photonics Customer Service. The Company will pay freight charges (ground services only) for all warranty repairs.

Defects or breakage due to negligence, tampering, abuse of the instruments, or intrusion of the instrument by other than Company personnel or their authorized representative shall not be warranted. The Company shall not be liable for consequential or incidental damage caused by normal wear and tear or exposure to contaminated environments. Contamination includes: dust, graphite (from pencils), soot, lint, dew (city water below dew point), tobacco smoke, oils (including fingerprints), condensible vapors, e.g., resin smoke, outgassing from products generated when the beam strikes partial absorbers such as optic mounts, o-rings, rubber pads, "footprint" surfaces). Please note that "blow off" dust generated at the aperture in an under-coupled or misaligned oscillator can move to contaminate the optics on both sides of the aperture.

The Company strongly recommends that the laser chassis be kept closed. When the top covers must be removed, the laser chassis should be inside a polyethylene clean tent or laminar flow bench. Before opening the beam line, wipe down the laser and table using a lint-free wiper moistened with alcohol. Do no set open containers of liquid (e.g., coffee cups or dye cuvettes) on or in the laser chassis. Where warranty labels/seals exist, authorization from Laser Photonics Customer Service must be obtained prior to breaking the seals. Failure to do so voids the warranty.

The buyer expressly agrees that the instrument has been selected BY THE BUYER as a proper design, size, fitness, and capacity; and the buyer is satisfied that the instrument is suitable and fit for the buyer's purposes.

Consumables

All consumables are warranted for ninety (90) days, except as noted below.

Flashlamps	Thyratrons
Arc Lamps	D.I. Cartridges/Filters
Tubes	

Pulsed YAG Lasers

Flashlamps are warranted free of defects in material or workmanship for 5,000,000 shots or 90 days, whichever comes first. Warranty replacement of flashlamps will be charged on a pro-rated basis based on the number of shots actually fired.

Continuous Wave Solid-State Lasers

Arc lamps are warranted free of defects in material or workmanship for 200 hours or 90 days, whichever comes first.

Sealed Gas Lasers

- Model LN300 Sealed Tube - warranted to be at least 50% of rated power after 100,000,000 shots or one (1) year, whichever comes first.
- CO_2 Sealed Tubes - warranted to be at least 80% of rated power after 2,000 hours or one (1) year, whichever comes first.
- Thyratron (Model LN300) - warranted for ninety (90) days.
- Thyratron (UV Series) - warranted for ninety (90) days.

Deionizer Cartridges/Filters

Deionizer Cartridges are warranted free of defects in materials and workmanship for a period of ninety (90) days.

THIS WARRANTY IS EXPRESSED IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, AND THE COMPANY DISCLAIMS ANY WARRANTY OR MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE. NO OTHER OBLIGATIONS OR LIABILITIES ARE ASSUMED BY THE COMPANY.

Prior to the return of a unit, or any portion thereof, the Laser Photonics Service Department must be consulted to avoid unnecessary shipping. If return of the equipment is deemed necessary, a Return Material Authorization (RMA) number will be assigned. This number must be recorded on the outside of the shipping container and on the packing list.

Laser Photonics, Inc.
Customer Service Department
12351 Research Parkway
Orlando, Florida 32826

Telephone:	(407) 281-4103
	(800) 624-3628
Facsimile:	(407) 281-4114 or 380-3479

INTRODUCTION

The LN300 represents the latest generation of a proven, safe, and reliable laser technology. This ultraviolet laser produces 250 μJ per pulse at 337 nm and the highest average power yet available from a sealed nitrogen laser.

FEATURES

- The sealed tube design eliminates expensive and inconvenient gas tanks and vacuum pumps.
- Reliable, low jitter thyratron triggering delivers uniform pulse energy for improved data quality.
- High repetition rates increase data acquisition speed.
- Rugged metal construction reduces expense by dramatically increasing tube lifetime.

MODEL DESCRIPTION

The LN300 is a compact, portable ultraviolet laser which is convenient to use, inexpensive and reliable. The hard sealed tube eliminates the need for cumbersome nitrogen cylinders and expensive vacuum pumps. "Hard Sealing" also extends operating and storage life compared to conventional "soft sealed" lasers. "Soft sealing", while less expensive, often compromises performance and tube longevity because of continued outgassing and inferior seal integrity. Consistent pulse energetics are derived from the use of effective pre-ionization techniques, an efficient switch mode power supply, and an over specified thyratron. Thyratron switching provides the additional benefit of reduced timing (command) jitter thereby facilitating precise synchronization with other devices. The LN300 provides high average power, high repetition rate and simplified turn key operation -- the hallmarks of an OEM laser.

APPLICATIONS

The LN300 is well-suited for a wide variety of applications which require the use of an energetic, compact, ultraviolet light source such as fluorescence and photoacoustic spectroscopy, video imaging, and microscopy illumination.

Section I.
SAFETY

OVERVIEW

All persons operating the Laser Photonics, Inc. LN300 Sealed Nitrogen Laser, and all persons in the vicinity of the laser must be aware of the hazards of laser beams. All personnel should carefully review the safety precautions listed in this chapter before operating the laser.

When recommended safety measures are consistently adopted and adhered to, potential hazards are minimized. Most laser-related accidents and injuries are operator-caused due to inexperience or carelessness.

This section will review some safety considerations, precautions, and warning related to the use of the Laser Photonic's Inc. LN300 Sealed Nitrogen Laser system.

SAFETY CONSIDERATION SUMMARY

- Only qualified personnel should operate the laser system.
- Equip the work area with a UL approved fire extinguisher in case of equipment or material fire.
- Wear safety glasses or goggles when operating laser for extended periods of time.*
- Do not look directly into the laser beam.
- Do not expose skin to laser beam for extended periods of time; skin burns could result. Extended exposure may also cause photochemical injury to skin.
- Do not defeat the safety interlocks. The high voltages and current available may cause lethal shock. Therefore, Laser Photonics, Inc. recommends that only qualified factory technicians access the inside of the laser while it is operating.
- Read this document, in its entirety, before operating the laser system.

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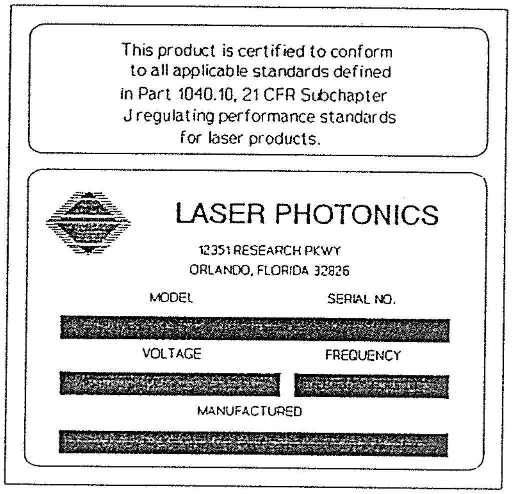
*Consult the *Handbook of Laser Science and Technology (Vol. I.), Section G: Laser Safety* for more information.

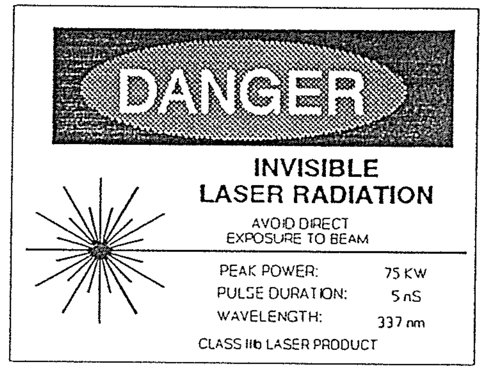
LABELS AND SAFETY FEATURES

In compliance with the U.S. Code of Federal Regulations Title 21;21 CFR Subchapter J, Part 1040.10, this laser product has incorporated the required safety features: keyswitch, mechanical beam shutter, panel lights, remote interlock and cover interlock. In addition, in compliance with the above, the following labels have been affixed to this product:

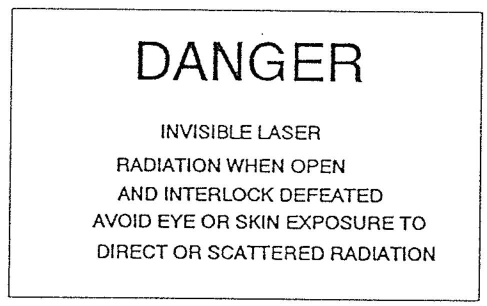
Figure 1-1. Warning Labels/Locations



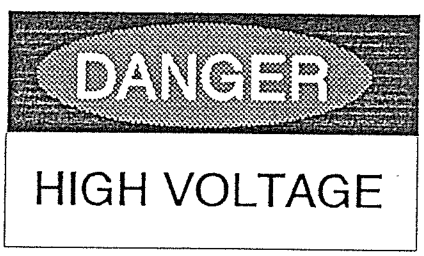
Location: Bottom Panel



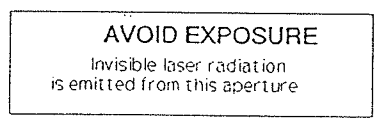
Location: Front Panel near laser aperture



Location: (1) Internal (near rear panel)
(1) External (near rear panel)



Location: Chassis near capacitor bank assembly



Location: Front Panel near laser aperture

Section II.
SYSTEM DESCRIPTION

OVERVIEW

The LN300 Nitrogen Laser system specifications are described below. Brief descriptions of nitrogen laser characteristics, overall optical, and system layout are discussed in this section.

SYSTEM SPECIFICATIONS

Item	*Description*
Spectral Output (nm)	337
Spectral Bandwidth (nm)	0.1
Pulsewidth (ns)	5
Energy/Pulse (μJ)	250
Energy/Stability (@ 10 Hz)	3%
Peak Power (kW)	50
Repetition Rate (Maximum) (Hz)	40
Maximum Average Power (mW)	7
Beam Dimensions (hor. x ver.) (mm)	9 x 4
Beam Divergence hor. x ver.) (mrad)	1.6 x 0.7
Trigger In	TTL
Trigger Out	TTL
Command Jitter (ns)	±2
Input voltage	110/220 V 50/60 Hz
Dimensions (in.) (L x W x H)	20 x 8.5 x 6
Dimensions (cm.) (L X W X H)	50 x 22 x 15
Weight (lbs)	20
Weight (kg)	9
Internal Trigger Operation	30 Hz
External Trigger Operation	30 Hz
Tubelife (shots)	10^8

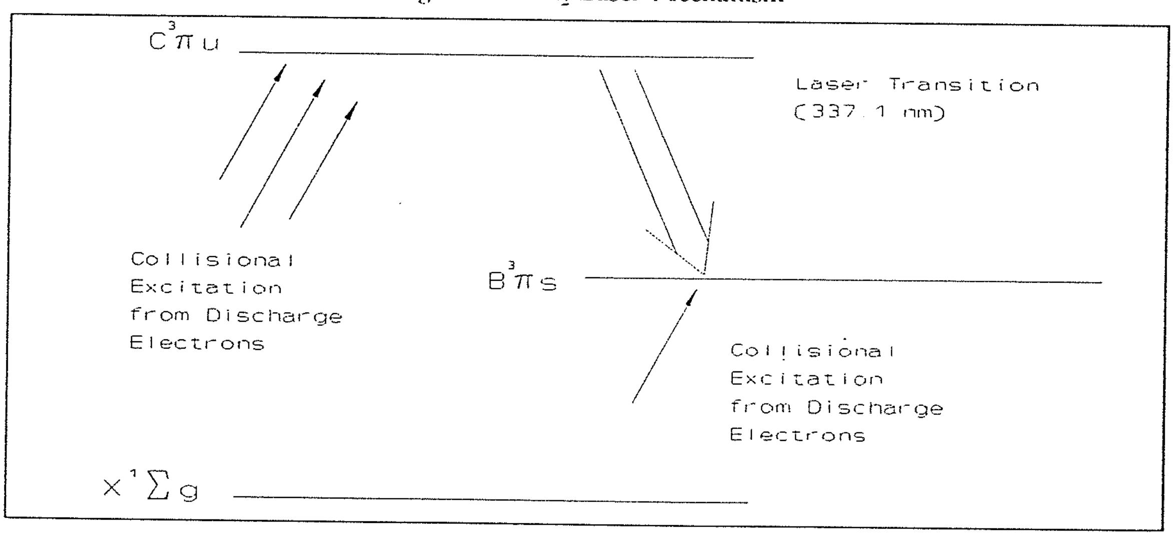
NITROGEN LASERS

Nitrogen lasers are unique, high peak power devices, producing ultraviolet light at 337.1 nm. Although the terminal state of the laser transition is metastable, and the upper level is extremely short-lived, this three-level laser (the third level is the ground state) can exhibit extremely high gain. In fact, the laser is capable of "super radiant" performance, requiring no mirrors. Most nitrogen lasers, however, have mirrors to enhance and direct the super radiant output. (*See Figure 2-1. "N_2 Laser Mechanism".*)

The mechanism, which allows the high gain population inversion between the two upper levels (C^3u and B^3g) of the N_2 molecule, is the enhanced free electron collisional rate for the C^3U state excitation in comparison the to the lower B^3g state excitation. Although the B^3g state is metastable, there can still be gain very early in time, before the lower state is greatly populated. This property of the N_2 molecule is the reason the laser pulses are extremely short (< 10 ns).

As a result of the short inversion time for the N_2 laser, special high speed electrical circuits are required. The two basic types are the capacitor transfer method and the "Blumlein" method (*see Figure 2-2. "Excitation Circuits for the N_2 Laser"*).

Figure 2-1. N_2 Laser Mechanism

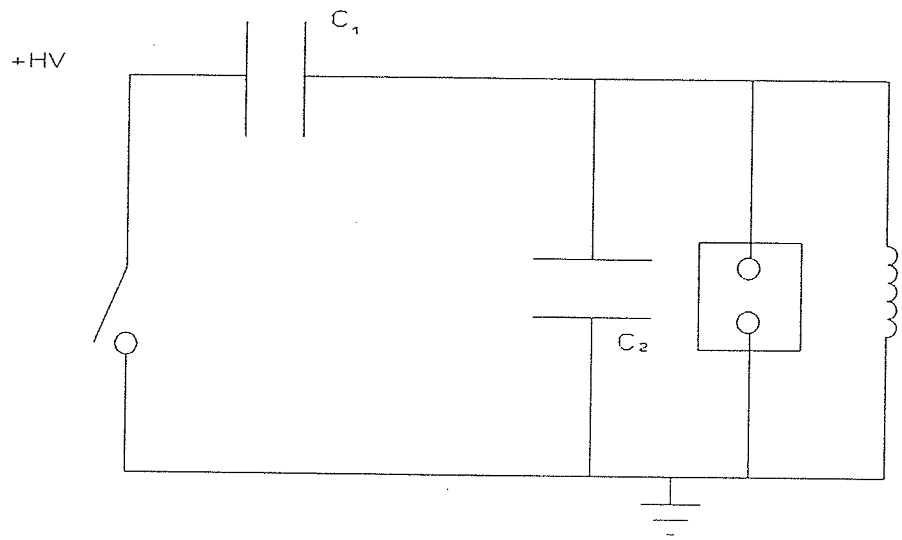


Transfer Method

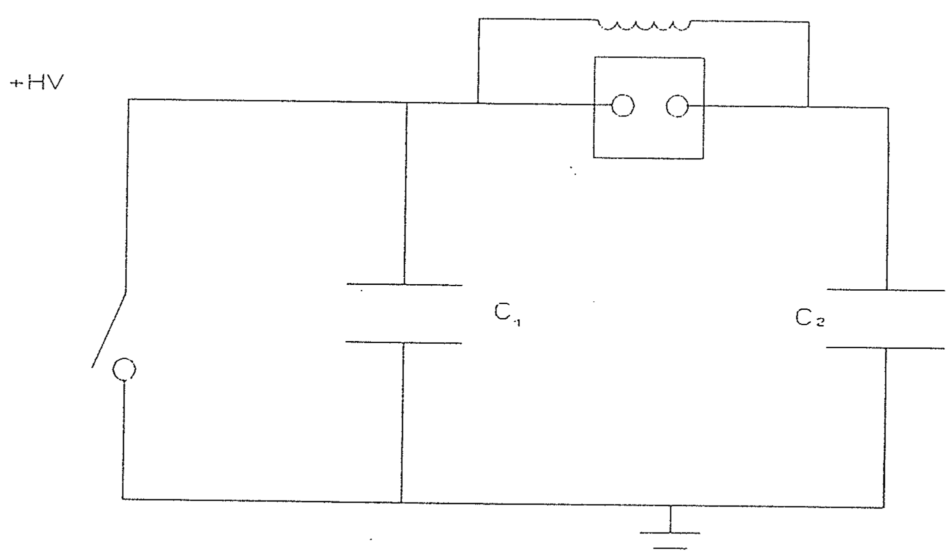
In the transfer method, the high voltage source charges the main storage capacitor, while the switching element isolates the secondary capacitor and laser channel from the high voltage. When the switch is closed, the charge on C_1 is transferred to C_2. The faster C_2 is charged, the higher the overvoltage reached, before the gas has sufficient time to break down. Both loops must have low enough inductance so as to transfer the charge quickly. This constraint is especially important for the secondary loop since C_2 is the main contributor of energy to the laser channel. Typically, this type of circuit can produce pulse durations of 5 - 10 ns. Shorter pulses are possible only with careful design.

Figure 2-2. Excitation Circuits for the N_2 Laser

Capacitor Transfer



Blumlein Circuit



Blumlein Method

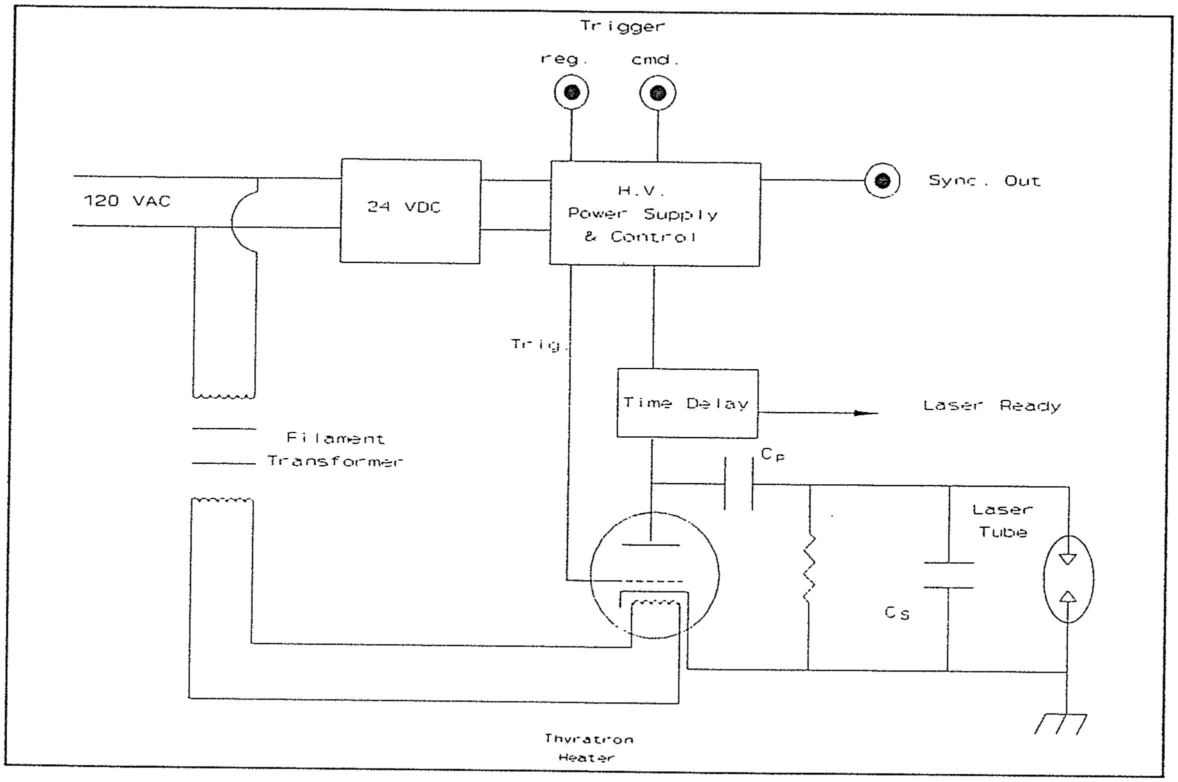
In the Blumlein method, both capacitors C_1 and C_2 are initially charged in parallel to the applied high voltage potential, while the laser channel electrodes are effectively shorted by an inductive lead. When the switch is triggered, the capacitor C_1 is rapidly shorted through the switch. Because of the inherent inductance in the loop, damped oscillation occurs such that voltage reversal occurs on C_1. Thus, the laser channel immediately becomes overvoltaged by the series potential of both capacitors C_1 and C_2. This equivalent potential can be nearly twice the applied potential. The Blumlein method can produce pulses typically from 1 - 5 ns.

In general, the Blumlein method is well-suited to Transverse Electric Atmospheric (TEA) N_2 lasers, since the gain for these lasers can be only sustained for about 1 ns. In comparison, the capacitor transfer method is sufficiently fast for sub-atmospheric N_2 laser, for which gain can typically be sustained for up to 10 ns. The transfer technique has a further advantage in reliability since the laser channel and secondary capacitors do not have to be maintained statically at a high voltage potential.

Major Components

A system layout for the LN300 is shown below (*see Figure 2-3. "LN300 System Layout"*). The major components of the laser are the DC power supply - which powers most of the laser, the high voltage module, and control circuitry board, and the laser head - which includes tube and capacitors. A filament supply directly from the AC line, powers the thyratron heater. The thyratron acts as the switching element for this capacitor transfer circuit, and is triggered by a high voltage signal from the control board.

Figure 2-3. LN300 System Layout



Section III.
INSTALLATION

OVERVIEW

Instructions given on the following pages of this manual provide safe, step-by-step procedures to be followed in setting up and operating the laser.

PRE-INSTALLATION PROCEDURES

First, remove the laser from the packing case and visually inspect for shipping damage. If no damage is apparent, proceed. Otherwise, contact a Laser Photonics, Inc representative immediately so that the proper claims may be filed with the shipping agent. Save the packing crates - lasers returned for servicing should be repackaged in these boxes. Shipping damage resulting from improper packaging by the customer will be repaired at the customer's expense.

Section IV.
OPERATING INSTRUCTIONS

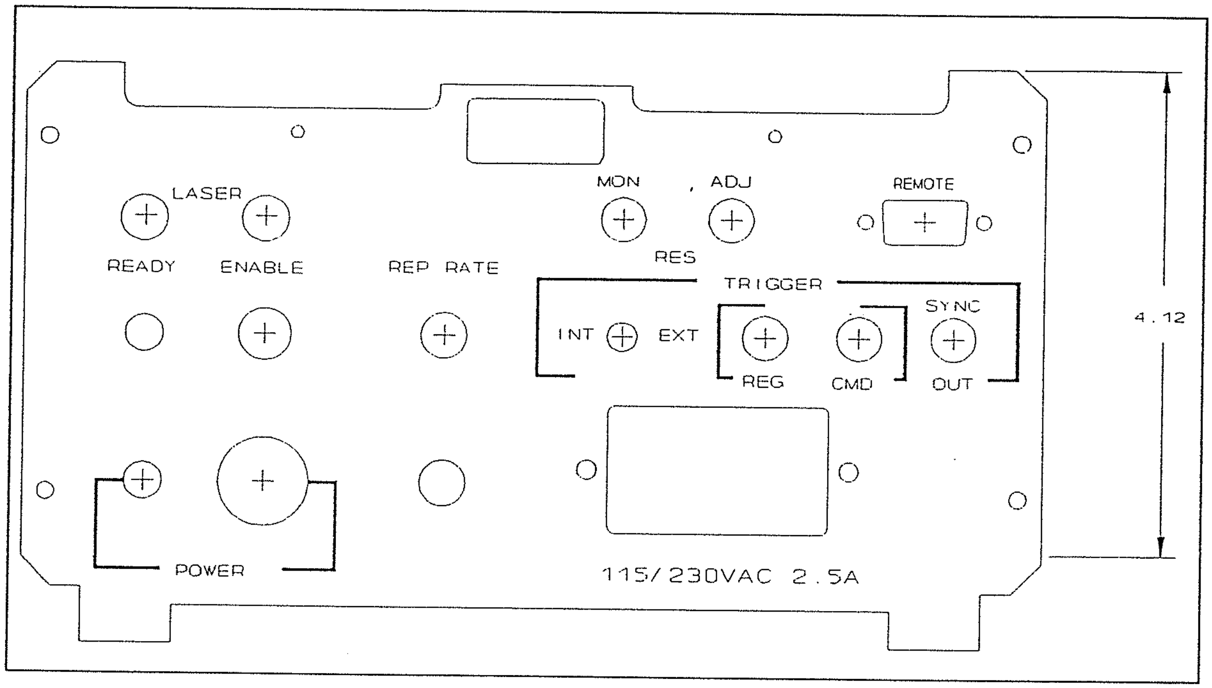
OVERVIEW

It is important that this section is read thoroughly. A clear understanding of the laser operating controls will minimize any initial difficulties when attempting to power the unit. In addition, the operating instructions should be read carefully before turning on the unit for the first time.

CONTROLS FOR OPERATION

All of the controls to operate the laser are conveniently located on the rear panel of the laser (*see Figure 4-1. "Control Panel"*).

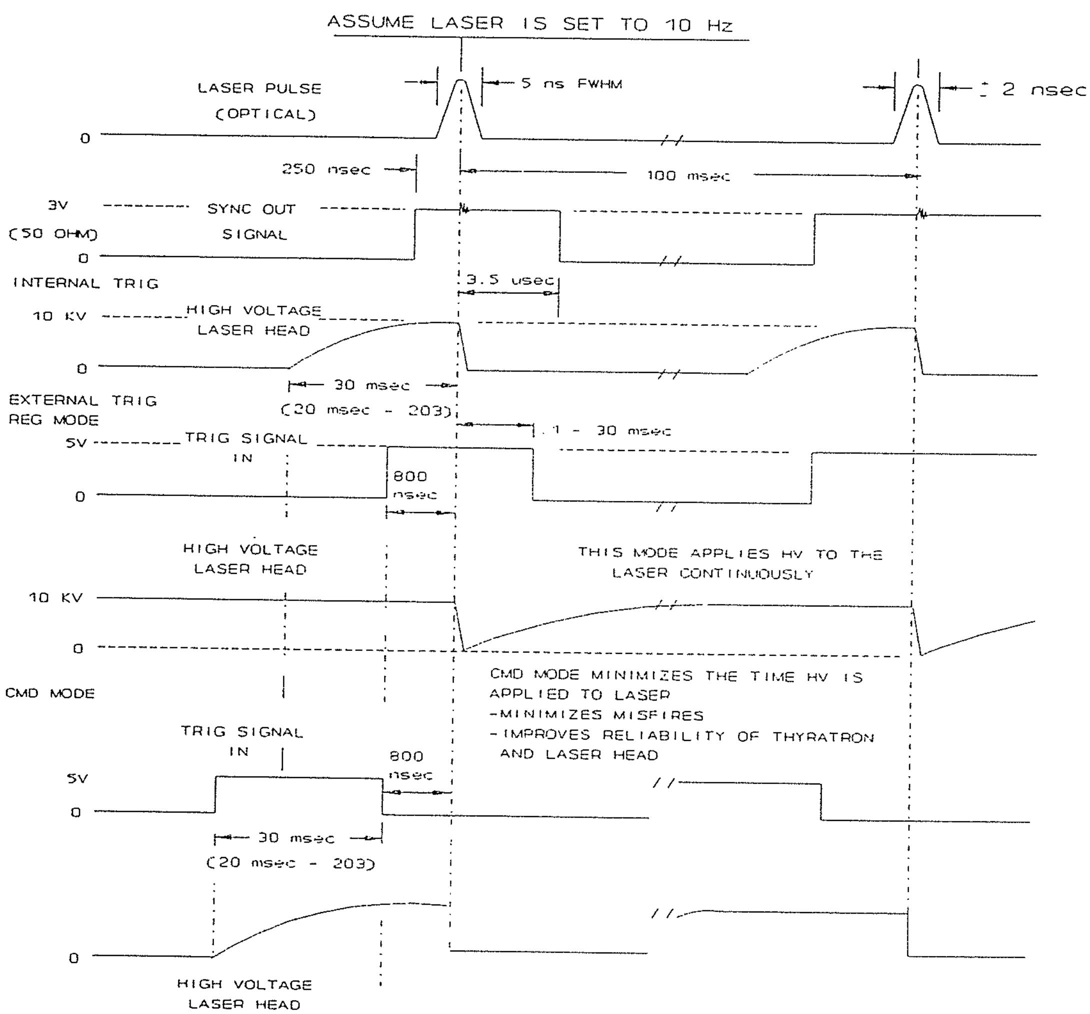
Figure 4-1. Control Panel



Control	*Description*
POWER (Switch)	This keyswitch provides AC power to the system (but does not energize the laser), activates a five minute delay circuit for the high voltage, and supplies current to the thyratron heater. The key cannot be removed with *POWER* on.
POWER (LED)	Illuminates when the *POWER* keyswitch is activated to indicate AC power to the system.
VAC RECEPTACLE	Standard IEC "mains" connector. It contains a replaceable fuse and a small voltage selection board that allows 120/240 VAC selection.
LASER READY	Illuminates (green) after the five minute warm-up time, indicating that the laser is ready to be fired.
LASER ENABLE (switch)	To activate firing, the *ENABLE* switch must be raised toward the enable position, and released. This switch will prevent automatic restart due to remote interlock cover-interlock or main electrical power interruption. The enable switch must be reactivated after any interruption. To terminate lasing, the operator may either depress the *ENABLE* switch or de-energize the entire system via the keyswitch. In the latter case, the delay circuit will be activated upon reenergizing. Always deactivate the switch before making any cable connections to the rear panel. When a dye module is installed, this switch also controls power to the dye stirring motor.
LASER ENABLE (LED)	Illuminates (red) when the laser is enabled. This light indicates laser operation and the presence of high voltage.
TRIGGER IN/EXT	This toggle switch can be set for internal trigger source (generated from the laser circuit) or external trigger source coupling. Caution. *Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.*
REP RATE	This potentiometer controls the repetition rate of the laser. The trigger source must be set to the internal position in order to allow the *REP RATE* control to function between 1-30 Hz. In external trigger mode, the repetition rate can also be set up to 30 Hz.

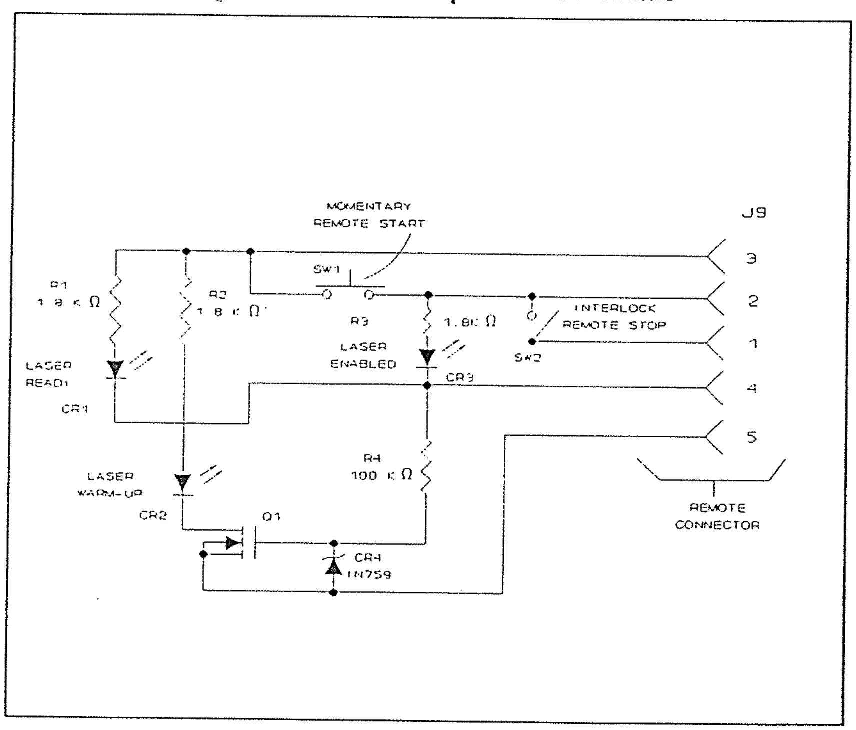
Control	*Description*
TRIGGER REG/CMD	When the trigger source is in the *EXTERNAL* position, the BNC trigger input (co-axial cable connector) can be either regular (*REG*) mode or command (*CMD*) mode. *See figure 4-2 for more detail on the timing signals.*
REG	In regular mode, a positive TTL type input signal (5V) will fire the laser on the rising edge of the input pulse. In this mode,the laser high voltage is continuously applied to the laser head components, allowing the laser to fire immediately upon triggering (approximately 800 nsec. delay). This mode is most useful for synchronization.
CMD	In this mode, the laser high voltage is not activated until a "rising edge" 5 volts signal appears at the connector. The laser is configured to fire on the "falling edge" of the signal. (A 30 ms wide pulse is required for achieving full charge.) This mode should be used when synchronization with another device is not required but external triggering is required, (i.e., very low repetition rates). In contrast to regular mode, command mode minimizes the time that static high voltage is held on the laser head, thus improving long term reliability of the head components (thyratron, capacitors, etc).
TRIGGER SYNC OUT	Outputs a TTL type signal approximately 250 ns before the laser optical pulse is emitted.

Figure 4-2 Timing Diagram



Control	*Description*
REMOTE	This multi-pin connector input allows remote interlock control, as well as remote staus check and remote high voltage enable. If the connection between pins 1 and 2 is interrupted, the high voltage will be automatically disabled, and re-enableing is required to re-activate the laser. This is the normal interlock feature. In addition, pins 3 and 5 can be monitored and controlled with a remote auxiliary circuit. Referring to *Figure 4-3. "Remote Operation Schematic"*, only a few components are required to remotely monitor or enable the laser. *Note: The laser must be reenabled after remote interruption.*
RES MON	This jack is intended as a convenience for maintenance. The monitor voltage corresponds to the thyratron reservoir voltage and can be measured with a standard DVM. ☞ WARNING! DO NOT MEASURE THE RESERVOIR VOLTAGE WHEN THE LASER IS OPERATING OR METER DAMAGE MAY OCCUR. The reservoir voltage setting at the time of factory testing is documented on the test sheet.

Figure 4-3 Remote Operation Schematic



Control	Description
RES ADJ	This control permits adjustment of the reservoir voltage for the thyratron and is mainly intended as a convenience for maintenance. A locking device is normally used on the control to ensure the reservoir voltage is not altered inadvertently.
COVER INTERLOCK	A cover interlock switch is located between the top panel and the rear control panel. In the event the top panel is removed for servicing, the cover interlock will be disrupted, thus disabling the laser.
BEAM SHUTTER	A push-pull aperture shutter is located on the beam exit aperture panel., i.e, the panel located at the opposite end of the cabinet from the control panel. Both the dye laser and nitrogen laser apertures are closed by the shutter.
CUVETTE ACCESS PORT	Located near the exit aperture and permits cuvettes to be inserted into, or removed from, the dye laser. During operation, the access port is covered by a movable port cover.
DYE AGITATOR POWER ON	A small toggle switch is located on the base of the dye laser module near the beam input aperture. When in the *ON* position, the dye stirrer motor is activated. If only the nitrogen laser beam is required, it is advisable to switch the motor *OFF*.

OPERATING INSTRUCTIONS

General

- Position the laser on a stable platform. Position the output aperture in the desired direction and use safeguards to ensure that the laser beam cannot directly contact any personnel. Ensure that the beam aperture is closed.
- Connect the AC line cord between the laser and the wall plug.
- Insert the key into the keyswitch.
- Plug the remote interlock connector into the remove receptacle, and ensure continuity.
- Turn the key switch to the right and energize the laser. The power light will illuminate.
- Wait approximately five minutes until the green *READY* light is illuminated and check that the turning mirrors of the dye module do not intercept the nitrogen beam. This would prevent beam exit from the cabinet.
- Turn the *TRIGGER TOGGLE* switch to the internal position.
- Adjust the *REP RATE* control to the desired position. (Repetition rate may be monitored form the *SYNC OUT BNC* connector.)
- Raise the *ENABLE* toggle switch toward the *LASER ENABLE* label. The laser will begin firing.
- Open the beam aperture when ready and view the effect on a fluorescent card placed a few centimeters from the aperture.

☞ WARNING! DO NOT LOOK INTO THE FRONT APERTURE OF THE LASER HEAD UNDER ANY CIRCUMSTANCES!

Section V.
MAINTENANCE

OVERVIEW

The LN300 Nitrogen laser and companion dye laser modules are designed for minimal maintenance. To ensure optimum system performance, only a few simple procedures are recommended.

LN300

Check pulse energy and thyratron reservoir voltage periodically. Record the readings in a lab book, together with the estimated shot count. A copy of this record should be included with the unit, in case the unit is returned for Laser Photonics, Inc. for service. The thyratron voltage should not exceed 7.5 volts. The tube resonator is aligned at the factory. However, severe temperature changes can slightly alter the alignment. If adjustment is ever required, *only the rear optic* should ever be adjusted. The front optic is kept as a reference. Follow all labeled precautions and warnings when accessing the laser tube. Only qualified personnel should access the tube. Normally, the unit should be returned to the factory if re-alignment is required.

Section VI.
TROUBLESHOOTING

OVERVIEW

The section covers basic troubleshooting of the LN300. The questions listed below are some common problems that can be solved by the operator. This section also includes instructions of how to return parts on both warranty and non warranty service.

TROUBLESHOOTING

Problem: Power Light does not illuminate.

Action:
- Check that the AC power cord is connected to an active AC socket.
- Ensure that the keyswitch is in the ON position.
- Check the fuse.

Problem: Laser Enable light does not illuminate.

Action
- Check that the remote interlock connector is providing continuity.
- If the top cover is removed, ensure the cover interlock is providing continuity. <u>Only qualified service personnel should remove access panels.</u>
- Check that the green ready light is illuminated. A 5 minute time delay from power on is required before the green light will illuminate.

Problem: No laser output.

Action:
- Check that in the case of external trigger source selection, a trigger source is provided. Otherwise, keep the trigger source selection to internal.
- Make sure the beam aperture is open.

SERVICE RETURN INSTRUCTIONS

Warranty

Please obtain prior authorization before returning a product for warranty repair or service. Please call (407) 281-4103 or fax (407) 281-4114 to obtain a return authorization number (RMA).

- A product subject to warranty repair should be returned freight prepaid to:

Laser Photonics, Inc. *12351 Research Parkway* *Orlando, Florida 32826*

Note: Please show RMA number on shipping label and packing list.

- Repack the product carefully using the original shipping carton. Insert a description of the malfunction inside the packing case.

- Please submit a malfunction report with the following information:
  - Buyer's name; company affiliation; date
  - RMA number
  - Return shipping address
  - Telephone number where contact can be made
  - Original purchase date and purchase order number (if known)
  - Laser model and serial number
  - Describe briefly how the laser was used, including the operating environment.
  - Describe malfunction

Non Warranty

Follow the instructions listed above for products covered under the warranty.

APPENDICES

- Appendix A - Laser References
- Appendix B - 220 V Operation
- Appendix C - Wiring Diagram

Appendix A. N_2 AND DYE LASER LITERATURE REFERENCES

1. "Pulsed UV Nitrogen Laser: Dynamical Behaviour", P. Richter et al, Appl. Optics, Vol. 15, No. 3, March 1976, p. 756.

2. "Cascade Population Mechanism in Nitrogen Lasers", L. Scaffardi et al, L.E.S. Mathias and J.T. Parker, Appl. Optics, Vol. 24, No. 1, Jan. 1985, p. 22.

3. "Stimulated Emission in the Band Spectrum of Nitrogen", Appl. Phys. Lett. Vol. 3, P. 16 (1963).

4. "Pulsed Molecular Nitrogen Laser Theory", E.T. Gerry, Appl. Phys. Lett., Vol. 7, p. 6-8, July 1965.

5. "UV TEA Laser with 760-Torr N_2", E.E. Bergmann, Appl. Phys. Lett., Vol. 28, No. 2, January 15, 1976, p. 84.

6. "Ultraviolet Gas Laser at Room Temperature", H.G. Heard, Nature (London) 200, p. 667, 1963.

7. "Dye Lasers". Ed: F.P. Schafer, Springer - Verlag, New York, 1977 (TA1690.S33) (Text).

8. "Lasers: Physics, Systems, and Techniques". Ed: W.J. Firther and R.G. Harrison, Published by Scottish Universities Summer School in Physics, 1983 (TA1673.S38). (Text).

9. "Lasers and Light". Readings from Scientific American, San Francisco, W.H. Freeman (1969) (QC 351.L35).

10. "Laser, Supertool of the 1980's New Haven". Ticknor and Fields, 1982 (TA1675.H3).

Appendix B. - 220 V OPERATION

1. Remove the power cord from the laser plug receptacle.

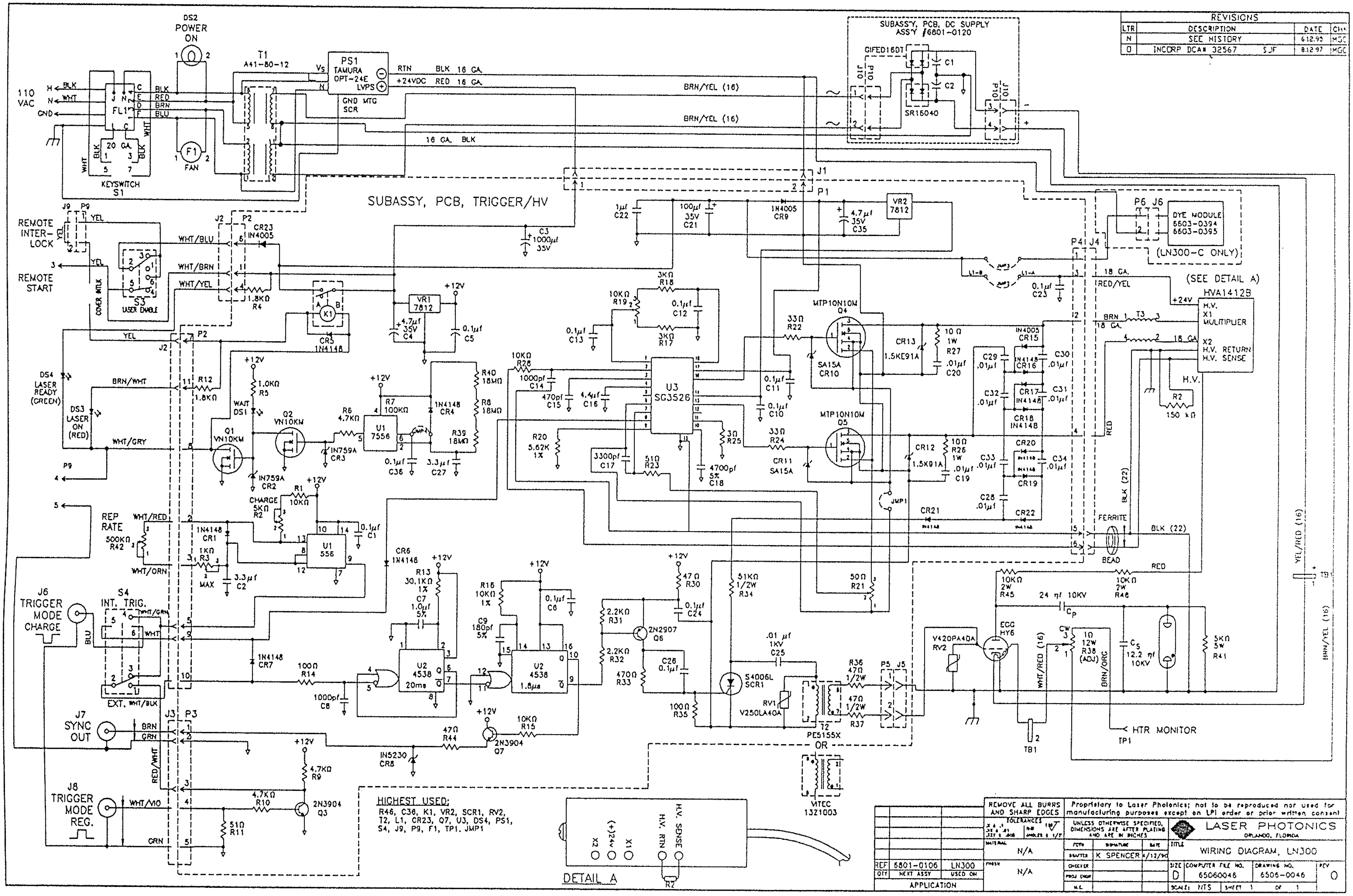
2. Slide the clear plastic fuse cover to the left to expose the fuse.

3. Remove the fuse by using the fuse puller.

4. Remove the printed circuit board located beneath the fuse holder. To do this, firmly grip the printed circuit board at one end with a pair of needle nose pliers and pull gently. By alternately pulling at either end, the board will eventually become dislodged.

5. Re-insert the board such that the desired voltage level is legible (120 V or 240 V are the only allowable choices. The laser will not function if any other voltage is chosen).

6. Install the fuse and replace the fuse cover.



LTR	DESCRIPTION	DATE	CHK
N	SEE HISTORY	6.12.95	MGC
O	INCORP DCA# 32567 SJF	8.12.97	MGC

REMOVE ALL BURRS AND SHARP EDGES

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LASER PHOTONICS ORLANDO, FLORIDA

TITLE: WIRING DIAGRAM, LN300

MATERIAL: N/A

FINISH: N/A

DRAFTER: K SPENCER 4/12/90

REF 6801-0106 LN300

NEXT ASSY / USED ON

APPLICATION

SIZE D | COMPUTER FILE NO. 65060046 | DRAWING NO. 6506-0046 | REV 0

SCALE: NTS | SHEET 1 OF 1

GLOSSARY:
Terms Used with Laser Systems

GLOSSARY:
Terms Used with Laser Systems

Term	*Description*
Ablation	Volume removal of material by vaporization.
Absorption	Uptake of light energy by tissue, converting into heat.
Absorption coefficient	Factor describing light's ability to be absorbed. Optical properties of different material alters the absorption coefficient.
Acetic Acid	CH_3COOH; a clean colorless liquid with a pungent odor miscible with water or alcohol; a component of vinegar.
Acetone	CH_3COOH_3; a colorless, volatile, extremely flammable liquid, miscible with water; used as a solvent and reagent.
Activate	To start activity or motion in a device or material.
Active Medium	(laser Medium) The material used to emit the laser light.
Aiming Beam	A HeNe (or other visible light source) used as a guide light. Used coaxially with infrared or other invisible light.
Align	To adjust the components of a system for proper interrelationship.
Alternating current	AC; electric current that flows in one direction and then in the opposite direction.
Amplifiers	A device which acts upon an incoming signal (input) to increase or amplify it.
Amplitude	The maximum height of a wave. Implies power.
Angstrom (Å)	A unit of length equal to one hundred millionth (10^{-8}) of a centimeter.
Anode	The primary source of positive charges in a laser.
Argon	A gas used as a laser medium. It emits blue/green light at 488 and 515 nm.
Articulated	A configuration in which relative motion is allowed to occur between parts, usually by means of a hinged or sliding joint or joints.
Atom	The basic unit of any chemical element. It is composed of a dense, positively charged nucleus orbited by negatively charged electrons.
Attenuation	The decrease in energy as a beam passes through an absorbing or scattering medium.
Bandpass	A specification which defines the wavelengths which a device will transmit.
Bandwidth	Defines the wavelength range over which a signal exists.
BBO	Beta Barium Borate. A (frequency doubling) crystal which converts an incident range of visible wavelengths to an ultraviolet range at one half the incident wavelengths.
Beam	A concentrated, nearly unidirectional flow of photons, or a like propagation of electromagnetic or acoustic waves.
Beam Diameter	The distance between diametrically opposed points in the cross section of a beam.
Beveled	The angle between one line or surface and another line or surface; a sloping surface or line.

Term	*Description*
Binoculars	Any optical instrument designed for use with both eyes to provide depth of field focus.
Biostimulation	The use of a low-power (usually milliwatts) laser, to stimulate metabolic activity on a subcellar level; experimentally used for pain relief and wound healing.
Calibrate	To determine the settings of the control devices so that a system will operate or perform within certain limits.
Carbon	C; a nonmetallic chemical element that occurs in many inorganic and in all organic compounds.
Carbon Dioxide	CO_2; A colorless, odorless, tasteless gas about 1.5 times as dense as air.
Cathode	The primary source of negative charges in a laser.
Cautery	Achieving hemostasis of bleeding vessels, usually by heat from laser, or electro-surgical units. Contrasts with laser-induced protein coagulation.
Centimeter	cm; a unit of length equal to 0.01 meter or 0.3937 inch. (1 inch = 2.54 cm).
Chromophore	Optically active (colored) material in tissue which acts as the target for the laser light.
Circuit	A path or group of interconnected paths capable of carrying electric currents.
Circuit Breaker	An electromagnetic device that opens a circuit automatically when the current exceeds a predetermined value.
Coagulation	Destruction of tissue by heat without physically removing it.
Coating (Optical)	A surface additive of an optical component to achieve a desired effect; e.g., an anti-reflective coating to reduce surface reflection.
Coherence	Orderliness of wave patterns by being in phase in time and space.
Coherent Radiation	Radiant electromagnetic energy of the same wavelength and with definite phase relationships between different points in the field.
Collimation	Waves or rays traveling in a nearly parallel direction, with negligible divergence.
Combiner Mirror	The mirror in a laser which combines two or more laser beams of different wavelengths into a coaxial beam, i.e., CO_2 and HeNe beams.
Contact Probe	Synthetic ceramic material, like sapphire, used with laser fibers to allow touch of tissue with the probe, intensifying its effects and allowing cutting, vaporizing, or coagulation if tissue at relatively low powers and high degree of control.
Continuous Wave	Laser beams with a continuous flow of photons.
Cornea	The transparent anterior portion of the outer coat of the eye covering the iris and pupil.
CW	Continuous Wave
Debris	Fragments arising from disintegration.
DHE	Dihematoporphyrin Ether. A photosensitizing agent used in photodynamic therapy (PDT). DHE is a more refined form of HpD.
Dichroic Filter	Filter that allows selective transmission of colors

Term	*Description*
Diffraction	The bending of a light beam as it passes near an object.
Diffuse	To transmit and scatter light particles through a translucent material.
Diopter	An optical instrument that allows field of view adjustment.
Direct Current	DC; electric current which flows in one direction only.
Distal	Located away from the point of origin or attachment.
Distortion	To change from the original or usually shape or character of signals or objects.
Divergence	The amount of spread of a laser beam with distance travelled, usually measured in milliradians.
Dosimetry	Measuring the amount (joules) of light energy delivered to tissue.
Doubling Crystal	An optical crystal which generates radiation at a wavelength of one-half of that of the incident radiation.
Dovetail	A horizontal and/or vertical mounting bracket on a microscope to accommodate accessories.
Electricity	Physical phenomenon involving electric charges and their effects when at rest and when in motion.
Electromagnetic Radiation	The flow of energy consisting of orthagonally vibrating electric and magnetic fields lying transverse to the direction of propagations.
Electromagnetic Spectrum	The span of frequencies (wavelengths) considered to be light from radio & t.v. waves to gamma and cosmic rays.
Electron	Negatively charged particle of an atom.
Emission enable	Any radiation of energy by means of electromagnetic waves. To allow an activity which would otherwise be suppressed.
Endoscope	An instrument inserted into the body through an orifice (either therapeutic or surgical) that allows viewing and manipulation of tissue. May be rigid or flexible.
Energy	Potential forces, capacity for vigorous action expressed in Joules (watts/second).
ENT Surgery (ears, nose and throat)	Surgery performed in the ears, nose and throat area including laryngeal papillomatosis, polyps, nodules, polyposis, hemangioma, hyperkeratosis, cordal lesions, cordectomy, repair of stenosis and webs, excision of benign lesions, excision of malignant lesions of oral cavity, and dermatological, intranasal and major head and neck surgery.
Excimer	"Excited Dimer." A gas mixture used as the basis of lasers emitting ultraviolet light.
Excitation	The state of increased internal energy of an atom or molecule gained when an electron assumes a large orbit after the absorption of light energy.
Excited State	The state of an atom or molecule after the absorption of energy.
Excited State Lifetime	The length of time during which an excited state exists.
Extinction Length	The thickness of a substance in which 98% of the incident energy is absorbed.
Femtosecond	10^{-15} second. Shorter than a picosecond or a nanosecond.

Term	*Description*
Fiberoptics	A system of flexible quartz or glass fibers with internal reflective surfaces that pass light through thousands of glancing reflections. Many hundred or thousands of individual fibers are needed to transmit an image, but only single fibers are used to transmit laser light during treatment.
Field of View	The area which can be viewed through an optical instrument.
Filter	That which passes as output a portion of the input; as of an optical or electrical signal; a discriminator.
Fine Focus	The most precise ability to move an optical lens toward or away from an object to obtain the sharpest possible image of the object.
Fixed	Firmly in position; unmovable.
Fluorescence	The process by which an atom or molecule on decaying from an excited state emits light energy. Also known as spontaneous emission.
Focal Length	The distance from the focal point of a lens or curved mirror to the lens or mirror surface.
Focal Point	The point to which rays that are initially parallel to the axis of a lens, mirror, or other optical system are converged or appear to diverge.
Focus	The point or small region at which rays converge or appear to diverge; to move an optical lens toward or away from an object to obtain the sharpest possible image of the object.
Frequency	The rate of occurrence of an event; the symbol, f; units per second or Hertz (*see "Wave Equation"*).
Frequency Doubling	The action of doubling the frequency of a signal (halving the wavelength).
Fuse	An expandable device for opening an electric circuit when the current therein becomes excessive.
Gated Pulse	A discontinuous burst of laser light, made by timing (gating) a continuous wave output - usually in fractions of a second.
Gaussian Curve	Normal Statiscal curve showing a peak with even distribution on both sides. May either be a sharp peak with steep sides, or a blunt peak with shallower sides. Used to show power distribution in a beam. The concept is important in controlling the geometry of the laser impact.
Grating	An optical device consisting of a number of closely space grooves or lines which has the ability to break up or resolve in incident light beam into its constituent
Gross Focus	The first of two focusing systems that moves an optical lens toward or away from an object to obtain the sharpest possible image of the object.
Ground	A conducting path between an electric circuit or equipment and the earth, or some conducting body serving in place of the earth.
Ground State	The energy state to which an atom or molecule returns an excited state and in which it is most often found.
Harmonic Generation	The production of signals at frequencies which are multiples of the frequency of an original signal (*see "Frequency Doubling"*).

Term	Description
Helium	He; a colorless, odorless, tasteless, inert gaseous element used in laser media.
Hemostasis	The arrest of a flow of blood; the stopping or slowing of circulation.
HeNe	Helium Neon. A laser-producing, low-power (milliwatts). Used as a guide light for infrared lasers, or experimentally for biostimulation.
Hertz	Hz; unit of frequency; also know as cycles per second.
Hologram	A three-dimensional picture made by interference patterns created by the coherence of laser light. Created as transmission, reflection or integral holograms.
Horizontal	Being in a plane perpendicular to the gravitational field, that is, perpendicular to a plumb line, at a given point on the earth's surface.
HpD	Hematoporphyrin Derivative. A photosensitizing drug used with photodynamic therapy as a treatment for cancer.
Illumination	The density of lighting on a surface.
Impact Size	The size crater or width of incision left by a laser impact. Related to spot size of the beam, except impact size varies depending on how the energy is applied.
Infrared	*See "Spectrum".*
Infrared Radiation	Electromagnetic radiation with a wavelength that lies in the range of 0.7 microns to 1 micrometer.
Intensity	The strength of amount of a quantity; the power transmitted by a light wave across a unit area perpendicular to the wave.
Intermittent	Stopping and starting at intervals.
Ionizing Radiation	Radiation commonly associated with X-Ray, that is of a high energy enough to cause DNA damage with no direct, immediate thermal effect. Contrasts with non-ionizing radiation of surgical lasers.
IR	Infrared (*see "Spectrum"*).
Irradiance	See Power Density.
Jitter	The uncertainty of a specification during operation of timing signals.
Joule	A unit of energy. Laser powers are sometimes described in joules per second. A power of one (1) per second is known as one (1) watt as is the rate of energy delivery.
Joystick	A device for moving the CO_2 and Helium Neon laser beams with a microscopic beam delivery attachment.
KTP	Potassium Titanyl Phosphate. A crystal used to change the wavelength of a Nd:YAG laser from 1060 nm (infrared) to 532 nm (green).
Laser	A light source which produces narrow, directional, intense and monochromatic ("pure color") beams. Light amplification by the stimulated emission of radiation.
Laser Energy Source	The mechanism - either heat, chemical, electrical or laser radiation-- which initiates and supports lasing action.

Term	*Description*
Laser Head	The laser medium, together with mechanical supports, optical components and electrical connections from which laser radiation is emitted.
Laser Medium	(Active Medium) material used to emit the laser light and for which the laser is named.
Laser Plume	Smoke, vapor, and airborne particles that are the by-products of CO_2 laser vaporization.
Laser Pump	See laser energy source.
Lens	A curved piece of ground and polished or molded material, usually glass, used for the refraction of light.
Light	Electromagnetic radiation with wavelengths capable of causing the sensation of vision.
Loupes (magnifying)	Small magnifying glasses set in eye pieces.
Magnification	A measure of the effectiveness of an optical system in enlarging or reducing an image.
Metal Vapor Lasers	A class of lasers using vaporized metal as the laser medium, such as the copper vapor emitting yellow light at 578 nm and gold vapor emitting red light at 630 nm. These are usually high frequency pulsed systems.
Metastable state	The state of an atom, just below a higher excited state, which an electron occupies momentarily before destabilizing and emitting light.
Meter	The fundamental unit of length (equivalent to 39.37 inches) in the metric system; a device designed to measure, indicate, record, or regulate power, etc.
Methanol	CH_3OH; a colorless, toxic, flammable liquid miscible with water either, and alcohol.
Micromanipulator	Device attached to a microscope that controls delivery of the laser beam into the microscopic field of view. In non-ophthalmic surgery are most commonly used with CO_2 lasers, then with Argon & KTP, and least with Nd:YAG lasers.
Micrometer	(μm) Limit of
Microprocessor	A digital chip (computer) that operates and monitors some lasers.
Microscope	An instrument through which minute objects are enlarged by means of a lens or lens system.
Millimeter	(mm); a unit of length equal to one-thousandth of a meter or 0.00394 inch.
Milliradian	A unit of angular measure used to describe beam divergence, one thousandth of a radian.
Minimal Thermal Effect	When CO_2 is absorbed in water and minimizes conductivity of heat.
Mirror	A surface which specularly reflects a large fraction of incident light.
Mode	A term used to describe how the power of a laser beam is distributed within the geometry of the beam. Also used to describe the operating mode of a laser such as continuous or pulsed.

Term	*Description*
Mode-Locking	A process similar to Q-switching except that the pulses produced are even shorter (about 10^{-12} seconds) and energy in short trains of pulses instead of singularly. It is usually achieved with a dye cell.
Molecule	A group of atoms held together by chemical forces; the smallest unit of matter which can exist by itself and retain all its chemical properties.
Monochromatic	Consisting of electromagnetic radiation having an extremely small range of wavelength; having only one color.
Monochromaticity	The state in which laser waves are the exact same length.
Nanometer	Abbreviated nm--measure of length. One nm equal 10^{-9} meters, and is the usual measure of light wavelength. Visible light ranges from about 400nm in the purple to about 760 nm in the deep red.
Nanosecond	10^{-9} (one billionth) of a second. Longer than a picosecond or a femtosecond, but shorter than a microsecond. Associated with Q-switched ophthalmic Nd:YAG lasers.
National Center for Devices and Radiological Health	Section of U.S. Government Department of Health and Human Services that regulates the laser industry.
Nd:YAG	Neodymium:Yttrium Aluminum Garnet. The crystal used as a laser medium to produce 1064 nm light.
Necrosis	The pathologic death of living tissue.
Neodymium	The rare earth element that is the active element in a Nd:YAG laser.
Neon	Ne; a rare, inert gaseous element occurring in the atmosphere. It is colorless, but glows reddish-orange in an electric discharge.
Nitrogen	N_2; a gaseous, colorless odorless element.
Nonlinear Effect	Not a normal, linear temperature rise induced by laser. Refers to the plasma "spark" and snap created by the Q-switched Nd:YAG laser.
Nuclear	The positively charged core of an item.
Objective	The first lens or lens system through which light passes in an optical system.
Optical Breakdown	Plasma formation by stripping electrons off atoms/molecules. Caused by high laser energy densities and used to create a "spark." Used in ophthalmology with Q-switched or mode-locked Nd:YAG lasers to cut membranes.
Optical Cavity	(Resonator) Space in between the laser mirrors where lasing action occurs.
Optics	Components of an optical instrument designed to assist sight.
Output Coupler	The partially transmissive mirror that allows laser output from the optical cavity.
PDT	Photodynamic Therapy. The use of photosensitizing drugs, activated by certain pure colors of light produced by the laser, to achieve selective tissue destruction. Its current major use is investigational as a selective treatment for cancer.
Phase	Waves are in phase with each other when all the troughs and peaks coincide and are "locked" together. The result is a reinforced wave in increased amplitude (brightness).

Term	*Description*
Photocoagulation	Tissue coagulation caused by light (laser).
Photodisruption	Creating an acoustical shock wave, through Q-switching or mode-locking, to gently "snap" apart membranes. This is a "cold cutting" technique with laser. Ophthalmologists use the Q-switched Nd:YAG to photodisrupt an opacified posterior capsule secondary to cataract surgery.
Photon	The quantum of electromagnetic energy, generally regarded as a discrete particle having zero rest mass or no electric charge.
Picosecond	10^{-12} seconds. Longer than a femtoseconds but shorter than a nanosecond. Associated with mode-locked ophthalmic Nd:YAG lasers.
Plane	A surface containing any straight line through any two of its points.
Plasm	The fourth state of matter in which electrons have been stripped off the atoms. The extremely high internal temperature expands rapidly, setting up an acoustical shock wave. Usually experienced as a lightning bolt (plasma) and resulting thunderclap (shock wave).
Plasma Shield	The ability of plasma to stop transmission of laser light.
Plastic Surgery and Dermatology	Excision of benign, malignant, and/or highly vascular tumors; operations in highly vascular areas such as scalp or tongue; operations involving infected or necrotic tissue, aesthetic plastic procedures, removal of tattoos, Moh's surgery, vaporization of basal cell carcinoma, condyloma acumulata, and removal of plantar warts.
Pockel's Cell	An electro-optical crystal used to achieve a Q-switch.
Population inversion	A state in which a substance has been energized, or excited, so that more atoms or molecules are in a higher given excited state than in a lower resting state. This is a necessary prerequisite for lasing action.
Power	The rate of energy delivery expressed in watts (joules per second).
Power Density	The strength of intensity of the laser beam; measured in watts/square centimeter; determined by the watts delivered at the tissue site and the spot size of the beam at the tissue surface.
Precise	Exact or sharply defined.
Proximal	Near the point of attachment or origin.
Pulse	A discontinuous burst of laser as opposed to a continuous beam. A true pulse achieves higher peak powers than that attainable in a continuous wave output - usually pulsed in microseconds or shorter. (See also gated pulse.)
Pulse Mode	Operation of a laser when the beam is intermittently on in fractions of a second.
Pulsed	A transient amplification or intensification of a wave characteristic of a system, followed by a return of equilibrium or steady state.
Pumped Medium	The energized laser medium.
Pumping	The process of supplying energy to the laser medium.
Q	Quality factor of resonator (energy storage); the ratio of total stored energy to the energy (removed) per cycle; the number of cycles to energy depletion.

Term.	*Description*
Q-Switching	Switching the "quality" of a resonator, producing very high peak powers (millions of watts) but for very short bursts (nanoseconds) - frequently achieved with a Pockel's cell. This creates a "sparking" and shock wave effect. (See photodisruptors, plasma, and mode-locking.)
Quartz	SiO_2; a colorless, transparent rock-forming mineral with vitreous luster; the most abundant and widespread of all minerals.
Quartz Fiber	Beam delivery material for the Nd:YAG laser.
Radian	A unit of angular measure which is the ratio of the divergence distance to the travel distance of a light beam.
Radiation	The energy transmitted by waves through space or some medium; also known as electromagnetic radiation or radiant energy.
Radio Frequency	Any frequency in the range within which radio waves are transmitted.
Reagent Grade	Any substance used in a chemical reaction to detect, measure, examine, or produce other substances; a very pure chemical.
Reflect	To throw or bend light from a surface.
Refraction	The bending of a light beam as it passes from one medium to a different one.
Repetition Rate (Rep Rate)	The rate of occurrence of a particular event; pulses per second; Hertz.
Resonator	The chamber that allows oscillation of the light waves back and forth at the speed of light.
Rotate	To turn or spin on an axis.
Scientific Notation	A method of numerical comparison and manipulation based on multiples of 10, e.g., $10 \times 10 \times 10 = 1000 = 1 \times 10^3$; and $2500 = 2.5 \times 10^3$
Shutter	A mechanical device that cuts off a beam of light by opening and closing at different rates of speed.
Signal	A specific anticipated, detectable event, e.g., a laser pulse.
Spectral Line	A specific wavelength, usually with a defined line width.
Spectral Range	A defined continuum of wavelengths; e.g., G80 to 720 nm.
Spectral Region	A specific continuum of wavelengths; e.g., the visible 400-760 nm, V1S
Spectrum	The characteristic group of wavelengths radiated by a substance; spectral output; a group of wavelengths with a common basis, e.g., groups or ranges adjacent wavelengths; infrared wavelengths.
Spot Size	The mathematical measurement of a focused laser spot. In a TEMoo beam it is the area that contains 86% of the incident power. This is the "optical" spot size and does not necessarily indicate the size of the laser crater that will be made. The latter is the impact size.
Stability	The consistency over time of a given signal.
Sterilize	To render free from bacteria or other microorganisms.

Term	*Description*
Stimulated Emission	The process of excited state decay with photon emission induced by the interaction with another like photon.
Superpulse	An operating mode on the CO_2 laser describing a fast pulsing output (250-1000 times per second), with peak powers per pulse higher than the maximum attainable in the continuous wave mode. Average powers of superpulse (speed of tissue removal) are always lower than the maximum in continuous wave.
Switch	A device used to break or open an electrical circuit or to divert current from one conductor to another.
Target Site	Tissue that is aimed or fired at with the laser beam.
TEM	An acronym for T (transverse) E (electromagnetic) M (mode).
Thermal Effect	Impact of heat on tissue or cell matter.
Thermal Necrosis	Death of tissue or cell matter due to thermal impact.
Thermal Relaxation Time	The rate at which a structure can conduct heat. When pulse times of a laser are shorter than the time required for heat to spread out of a target, the heat damage will be confined to that target.
Tunable Dye Laser	A laser using a jet of liquid dye, pumped by another laser or flashlamps, to produce various colors of light. The color of light may be tuned by adjusting optical tuning elements and/or changing the dye used. Common medical applications are with the 630 nm continuous wave red, and the pulsed 577 nm yellow and 504 nm green.
Vertical	At right angles to the horizon; extending perpendicularly from a plane; upright.
Volt	V; the International System unit of the electric potential and electromotive force, equal to the difference of electric potential between two points on a conducting wire carrying a constant current of one ampere when the power dissipated between the points is one watt.
Watt	W; unit of power in the International System equal to one joule per second.
Wave Equation	The equation which relates the wavelength and frequency of wave motion to its speed of propagation. In the case of light waves, $c=f\lambda$; where c, the speed of light, has been measured as (approximately) $3x10^8$ m per second or $3x10^{17}$ nm per second. F, the frequency (number of wave per second); λ, the wavelength. A light source emitting 300 nm wavelength light would, therefore, do so at a frequency of $f\,\frac{c}{\lambda} = \frac{3x10^{17}}{300} = 1x10^{15}$ *cycles per second*
Wavelength	Distance between two points of corresponding phase in consecutive cycles.
X-Ray	A very short wavelength of light, producing ionization effects commonly associated with radiation hazards. Not a problem with surgical laser units.

LASER PHOTONICS, INC. 12351 Research Parkway Orlando, Florida 32826		Drawing No.: 7014-0053					Rev: C
		Title: LN300, LN300C Acceptance Test Record					
		Current Release Date: February 27, 1991				Sheet 1 of 1	

Approval	Date	Approval	Date	Revisions					
				LTR	ECO No.	Date	LTR	ECO No.	Date
Prep: A. Atkins	2/05/91	Engrg Mgr		X1		2/5/91			
Check: B.Johnson		Mfg Engr Wm. Cable		A	31012	2/15/91			
				B	31020	2/20/91			
Project Engr K.Menard				C	[illegible]	2/27/91			

LN300, LN300C Acceptance Test Record

LN300 299 ✓ LN300C ______

Work Order #: LN 2449

Job #: ______

Laser Serial Number: 299

Energy/Pulse @ 10 Hz: 300uJ

Average Power (Maximum): 8.0mW @ 30Hz

Reservoir Voltage: -6.78 VDC

Energy Stability: ±2.0% @ 10Hz

Command Jitter: ±1.5nS @ 10Hz

Tube S/N X036

Tested By: Chip White Date: 3/1/00

Q.A. By: [signature] Date: 3/1/2000

LASER PHOTONICS, INC. 12351 Research Parkway Orlando, Florida 32826				Drawing No.: 7014-0040					Rev: C
				Title: LN300, LN300C Shipping Checklist					
				Current Release Date: February 27, 1991				Sheet 1 of 1	
Approval	**Date**	**Approval**	**Date**	Revisions					
Prep: A. Atkins	1/31/91	Engrg Mgr		LTR	ECO No.	Date	LTR	ECO No.	Date
				X1		1/30/91			
Check: B. Johnson		Mfg Engr W. Cable		A	31012	2/15/91			
				B	31020	2/20/91			
Project Engr: K. Menard				C	31042	2/27/91			

Serial Number: 299

Model LN300 X

Model LN300 C ____

Part Number	Description	Qty. Requested	Qty. Shipped
P7372-0013	Line Cord	1	1
P7271-1054	Fuse	1	1
7011-0019 LN300 OR 7011-0029 LN300C	Manual	1	1
	Remote Interlock	1	1
	Key, A126	2	2
7014-0053	ATR (COPY)	1	1

Q.A. Signature: [signature] Date: 3/6/00

FORM 2007-V1