Apogee Elite/Apogee 5500/Acclaim 7000
Technical Guide
Doc #850-1257-000

REVISION HISTORY

Rev.	ECO #	Description	Approved by:	Date
1	n/a	First Draft	J. Boll	3/04
2	n/a	Replaced calibrating the Cal Port section	J. Boll	4/04

Apogee Elite/
Apogee 5500/Acclaim 7000
Long Pulse Infrared Lasers
TECHNICAL GUIDE

CYNOSURE®
10 Elizabeth Drive, Chelmsford, MA 01824
Phone 978-256-4200 Fax: 978-256-6556
Toll Free: 800-886-2966 www.cynosurelaser.com
Document #850-1257-000

This technical guide is intended for both U.S. and International distribution.

Document #850-1257-000, Rev. 2, 4/04

TABLE OF CONTENTS

Glossary of Symbols and Abbreviations **5**

Figure 1–Symbols and Abbreviations 5

Section 1 INTRODUCTION **7**

Disclaimer 7
About the Lasers 7
About the Technical Guide 8

Section 2 EQUIPMENT SAFETY **9**

Introduction 9
Potential Hazards 9
Optical Hazard 9
Electrical Hazard 10
Grounding 10
Fire Hazard 11
Hot Water Hazard 11
Service Equipment 11
Hand Tools 11
Electrical Equipment 12
Optical Equipment 12
Miscellaneous Equipment 12

Section 3 LASER DESCRIPTION **13**

Main Components 13
Figure 2A–System Block Diagram, Apogee Elite 13
Figure 2B–Block Diagram, Apogee 5500/Acclaim 7000 14
Figure 2C–Main Components 15
High Voltage Power Supply 15
Fuse Board 16
Capacitor Bank 16
Figure 3–Capacitor Bank Assembly 16
High Voltage Subsystem and Flashlamp Drive Circuit 17
Figure 4A–High Voltage Subsystem, Apogee Elite 17
Figure 4B–High Voltage Subsystem, Apogee 5500/Acclaim 7000 17
IGBT Driver Board 18
IGBT and Snubber Module 18
Figure 5–Snubber Module Across an IGBT 18

Simmer Board and Trigger Transformer 19
Figure 6–IGBT Plate Assembly 20
System Control Electronics 21
Figure 7–System Control Electronics 21
Laser Head(s) 23
Flashlamps 23
Laser Rod 23
Rear Total Reflector, Nd: YAG 23
Safety Shutter 23
Figure 8A–Resonator Rail, Apogee Elite 24
Beam Path: Energy Monitor/Beam Combiner 25
Aiming Source: LED and Laser 25
XYZ Mount 25
Figure 8B–Resonator Rail, Apogee 5500/Acclaim 7000, Isometric View 26
Figure 8C–Resonator Rail, Apogee 5500/Acclaim 7000, Top View 27
Delivery System 28
Trigger Switches 28
Figure 9–Delivery System 28
Cal Port 29
Figure 10–Cal Port Assembly 29
Coolant Circulation System 30
Figure 11–Coolant Flow Diagram 30

Section 4 INSTALLATION 31

Section 5 ROUTINE MAINTENANCE 33

Section 6 SERVICE PROCEDURES—PANEL REMOVAL 35

Removing the Dress Panels 35
Removing the Top Cover 35
Accessing the Laser Resonator 36
Removing the Side Panels 36
Removing the SMA Access Panel 36
Removing the Front and Rear Panels 36

Section 7 SERVICE PROCEDURES–PERFORMANCE 37

Performance Criteria 37
System Performance 37
Resonator Performance 37
Checking the Condition of the Fiber 38

Checking the Condition of the Handpiece 39
Checking the Focus Lens 39

Section 8 SERVICE PROCEDURES–MECHANICAL 41

Performance Test Sequence/Field Evaluation 41
Pump Chamber Maintenance 42
Removing the Pump Chamber 42
Replacing the Flashlamps 42
Figure 12A–Pump Chamber, Apogee Elite 43
Figure 12B–Pump Chamber, Apogee 5500/Acclaim 7000 43
Inspecting and Cleaning the Laser Rod 44
Checking and Replacing the Focusing Lens 44
Aligning the Resonator 45
Alexandrite Lasers 45
Nd: YAG Lasers 45
Inspecting and Replacing the Resonator Mirror, Nd:YAG 45
Aligning the Turning Mirror, Apogee Elite Nd:YAG 46
Inspecting the Beam Combiner Glass/Removing the Holder 46
Replacing the Beam Combiner Glass 46
Replacing the Glass Only, Apogee Elite 46
Replacing the Glass Only, Apogee 5500/Acclaim 7000 47
Replacing the Aim LED 47

Section 9 SERVICE PROCEDURES–ELECTRICAL 49

Replacing the Front Panel Display/Membrane Switch PCB 49
Replacing and Calibrating the Control Logic PCB 49
Programming the Microcontroller 49
AC Fuses and AC Relay PCB 50
Replacing the High Voltage Power Supply 50
Calibrating the High Voltage Power Supply 50
Low Voltage Power Supply 50
Replacing the Voltage Selection PCB 51

Section 10 SERVICE PROCEDURES–FLUID 53

Draining the Coolant System 53
Draining the Water 53
Replacing the Deionizer (DI) Cartridge 53
Replacing the Water Pump 54
Replacing the Flow Switch 54
Figure 13–Water Pump Assembly 55
Replace the Temperature Sensor 55

Section 11 SERVICE PROCEDURES–CALIBRATING 57

Calibration of the Energy Monitor 57
Introduction and Overview 57
Schedule for Calibration 57
Required Equipment 58
Calibration Procedure, Apogee 5500/Acclaim 7000 Lasers 58
Calibration Procedure, Apogee Elite Lasers 59

Section 12 SERVICE PROCEDURES–FINAL CHECK 61

Final Check Procedure 61

Section 13 TROUBLESHOOTING 63

Troubleshooting 63
Operational Faults 63
Operational Fault Codes 63
Critical Faults 65
Critical Fault Codes 65
Self Test 66
Miscellaneous Troubleshooting 66

Appendix A Laptop Computer 67

Attaching a Laptop Computer 67
HyperTerminal Setup 67

Appendix B Calibration Form 69

Glossary of Symbols and Abbreviations

The following international symbols and abbreviations may be used on the Apogee Elite/Apogee 5500/Acclaim 7000 laser system and/or in this technical guide.

Symbols

	Declaration of Conformity to Medical Device Directive 93/42/EEC CE Mark to Directive 93/465/EEC		Off (power disconnection from mains)
	Type B equipment per IEC 513		On (power connection to mains)
	Attention		Start (initializes connection to Mains)
	Laser Hazard Warning		Laser Ready Mode
	Dangerous Voltage		Laser Standby Mode
	Remote Interlock Connector per EN60601-2-22: 1996		Foot Switch
	Optical Fiber Applicator per EN60601-2-22: 1996		Hand Switch

Abbreviations

ºC	Degrees Celsius	DVM	Digital Voltmeter
A	Amperes	Hz	Hertz
mA	Milliamp	J	Joule
µA	Microamp	J/cm^2	Joules per square centimeter
AC	Alternating current	W	Watts
cm	Centimeter	kW	Kilowatt
mm	Millimeter	µs	Microsecond
nm	Nanometer	ms	Millisecond
CW	Continuous Wave	W	Ohms
V	Volts	mW	Milliohms

Figure 1–Symbols and Abbreviations

This page has been intentionally left blank.

Disclaimer

The *Apogee Elite/Apogee 5500/Acclaim 7000 Technical Guide* is written specifically for service technicians and customers who have received formal training in the servicing of Cynosure laser systems. Cynosure requires that all technicians who plan to service these lasers attend an authorized training program. Information on service training programs may be obtained by calling Cynosure Customer Service at (978) 256-4200.

The *Technical Guide* provides useful information about the maintenance and servicing of the laser. It is not intended to be a complete guide.

Cynosure does not accept responsibility for personal injury or property damage resulting from the servicing of Cynosure equipment by its customers or by third parties, except where such injury or damage is a direct result of Cynosure's negligence. Customers, by accepting the service manual, agree to indemnify Cynosure against any claims alleging personal injury or property damage resulting from the servicing of Cynosure equipment by the customer or by third parties, except where such injury or property damage is a direct result of Cynosure's negligence. These limitations include situations where Cynosure personnel advise customers on the repair of Cynosure equipment over the telephone.

Any servicing of Cynosure equipment by individuals who have not completed a current Cynosure training program for that equipment will void Cynosure's product warranty.

About the Lasers

In 2004, the external appearance of the Apogee 5500/Acclaim 7000 laser system was changed to include a sleeker look and the fiber exiting the upper chassis on an angle to the back. Included in the new laser system is the Apogee Elite, which has both of these resonators, combined and coupled to the same output fiber. All the lasers are built on nearly identical platforms with the only major difference being the optical rail assembly. High voltage systems, fluid systems and control electronics are the same. For this reason, only one manual is required to repair and maintain all three lasers. NOTE: If the laser has a white enclosure with purple trim, it is the older design and requires the *Apogee 5500/Acclaim 7000 Service Manual*, document #850-1247-000.

The laser display is available in various languages and is configured prior to shipping. If for any reason the language needs to change, first connect a laptop computer, described in "Appendix A" on page 67. Then start the laser in the testall mode, as described in the *Final Test and Calibration Procedure*. At the laptop TESTALL menu, choose selection "m" to cycle through the available languages. When the desired language is displayed on the screen, cycle the power and the laser will run with the display in that language.

About the Technical Guide

This *Technical Guide* provides service technicians with information on the following topics:

- Equipment Safety
- Installation
- Fundamentals of Laser Operation
- Laser Description
- Service Procedures
- Troubleshooting
- Calibration of Energy Output

This *Technical Guide* applies to the Apogee Elite, Apogee 5500 and Acclaim 7000 lasers, but for reasons of brevity sometimes uses photographs, illustrations and drawings that depict the Apogee Elite laser only. Service personnel are encouraged to familiarize themselves with the laser and its operation. Make sure all components within the laser can be identified. Understand the Performance Criteria as outlined in the on page 37. Follow the Troubleshooting Sequence to restore performance if the laser does not meet or exceed the defined performance criteria.

The complete service manual, 850-1257-100 includes a comprehensive drawing set and procedures that will aid in the understanding of salient mechanical and electrical assemblies in addition to providing electrical schematics and technical illustrations. It is important to check the revision level of controlled drawings as designs change.

Upon request, Cynosure will provide circuit diagrams, component part lists, descriptions, calibration instructions, or other information not already contained within the technical guide, to assist appropriately qualified technical personnel to repair those parts of the laser system that are designated by Cynosure as repairable. “Appropriately qualified technical personnel” refers to personnel who have undergone Cynosure’s Service Training Course for the Apogee Elite/Apogee 5500/Acclaim 7000 laser system and have been authorized to repair this laser system.

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

Introduction

As with any electrical equipment, there are potential hazards involved with the operation and servicing of the Apogee Elite/Apogee 5500/Acclaim 7000 laser systems. This section of the technical guide identifies these potential hazards and suggests precautions to avoid them.

Potential Hazards

Optical Hazard

The Apogee 5500 laser generates laser light at a wavelength of 755 nm with a maximum energy of approximately 45 joules delivered from the handpiece. The Acclaim 7000 laser generates laser light at a wavelength of 1064 nm with a maximum energy of approximately 63 joules delivered from the handpiece. The Apogee Elite laser generates laser light at a wavelength of 755 nm and 1064nm with a maximum energy of approximately 45 joules at 755nm and 63 joules at 1064nm delivered from the handpiece.

Greater energies can be generated from the laser head especially during service operations. At these wavelengths and energy levels, serious and permanent damage to the eyes can occur when there is direct or even indirect optical exposure.

WARNING: These lasers produce laser light each time the flashlamps fire. <u>Do not</u> look directly at laser resonator as the flashlamps fire or severe and permanent eye damage may occur. Make certain to wear the correct laser eyewear for the wavelength you are testing.

Please adhere to the following precautions to avoid optical damage during the operation or servicing of the laser:

- Ensure that everyone present during service procedures wears the appropriate protective eyewear recommended by Cynosure.
- Never look directly into the laser light, even while wearing protective eyewear.
- Mark treatment rooms clearly to avoid unexpected entry during treatment or servicing.
- Limit entry to the treatment or servicing room to trained, necessary personnel only.
- Cover windows and other openings in the treatment room to avoid the inadvertent escape of laser light.
- Cover reflective objects, such as jewelry or mirrors, which could reflect the laser beam to an area other than the intended treatment area.
- Put the laser into the standby mode when the laser is not in use.
- Ensure that everyone present during service procedures can shut down the laser in an emergency.

Electrical Hazard

The system requires 220 VAC ± 10%, 30 A, 50-60 Hz, single-phase electrical service to operate.

WARNING: Even when the laser is off and the AC line cord is disconnected, DC voltages on various laser components, such as capacitors may exist. This can present a potentially fatal electrical hazard during service procedures. Proceed with caution!

Take the following precautions to avoid an electrical shock during servicing:

- Always turn the laser off and disconnect the AC line cord from the receptacle before removing the protective housing of the laser system.
- With the laser off, allow the dump resistors to dissipate the energy in the Pulse Forming Network capacitors to a safe level, approximately 45 seconds. Monitor the voltage on the capacitors with a DVM probe to ensure it is at a safe level.
- If it is necessary to test or adjust any electrical component while the system power is on, be careful not to touch any electrical components with bare fingers. Use only appropriate probes or insulated tools.
- Become familiar with the electrical schematics and layout of the system before attempting to service the laser.

If the AC must be connected during service routines, exercise caution around mains connected components, such as power supply feeds, circuit breakers, key switches, etc. A remote interlock fault condition will reduce high voltage electrical hazards to service personal. This fault condition disables the high voltage power supply control and simmer circuits, as well as ensuring that the dump relay is closed, grounding the potential of the pulse forming network. When possible, remove the remote interlock plug during “live” service routines.

Grounding

Even when the laser is turned off and the AC line cord disconnected, high DC voltage levels may remain. Before performing any procedure, use a shorting stick to ground all interior components.

The main capacitor bank stores large amounts of electrical energy. Measure the voltage on the capacitor bank before attempting any service. Ground the capacitor bank with a shorting stick for at least five seconds.

WARNING: Do not attempt to short directly (i.e., with a screwdriver) or a potentially fatal electrical shock can occur.

Fire Hazard

When the laser beam contacts any exterior surfaces, the surface absorbs the laser energy, which raises the surface temperature of any flammable substance. Service personal must take the following precautions.

- Always keep a small fire extinguisher and water in the treatment room.
- Never direct the laser beam onto any surface except a power meter or an appropriate beam dump.

Hot Water Hazard

The laser system uses a hot water system to maintain the laser medium at 65 °C. This water is very hot and could cause scalding. Do not perform any maintenance on the water system while hot. Always let the system cool down before changing the deionizing filter or adding deionized or distilled water.

Service Equipment

A full complement of tools is required to service this laser system. It is expected that service personnel carry at least the following tools to an installation or laser repair call.

Hand Tools

- Screwdriver set
- Allen Wrench or Hex Head Ball Driver set
- Nut Driver set
- Adjustable wrenches
- Wire cutters
- Wire strippers
- Needle nose pliers
- X-ACTO knife

Electrical Equipment

- Calibrated oscilloscope, 50 MHz or better, 2-channel (LeCroy 9310); or Cynosure # 706-0107-000 TEKSCOPE THS-720 or equivalent
- Calibrated high input impedance hand-held digital multimeter (Fluke 87) or equivalent
- Computer or laptop with any serial communication program, i.e. windows "HyperTerminal" or DOS "COMM," monitor and keyboard. DB9 F-F null modem serial cable

Optical Equipment

- Appropriate protective laser eyewear:
  > 5.5 O.D. at 755 nm (min.) for the Alexandrite lasers;
  > 5.5 O.D. at 1064 nm (min.) for the Nd: YAG lasers
- Laser energy/power meter with carbon head (OPHIR AN2 , F250A-HL-SH Detector or equivalent) calibrated for 755 nm/1064 nm operation. Older Scientech models may not be adequate. Check with Cynosure Technical Support for meter compatibility.

Miscellaneous Equipment

- Funnel or small bottle
- Laser alignment paper (Zap-it)
- Distilled water
- Lens tissue
- Methanol and/or acetone for cleaning optics
- Teflon tape
- Finger cots or lint-free gloves
- Pressurized gas-jet lens cleaner (e.g., Coherent bottled nitrogen gas)
- Magnifying/measuring loupe
- XYZ alignment fixture, Cynosure # 706-0125-000
- Fiber SMA centering pin, Cynosure # 706-0054-002
- Ring stand and clamps or tripod

Main Components

This section of the manual gives a detailed description of the main components of the laser systems. All lasers share common elements, as outlined below.

- An active medium in which laser action takes place—the laser rod (or rods in the case of the Apogee Elite laser system),
- A source of pump energy—the inert gas-filled flashlamps,
- An optical resonator—the front partial reflector and rear 100% reflector,
- A control system—the system control electronics,
- A power supply that provides electrical power to the flashlamps.

Figure 2A illustrates the system diagram of the Apogee Elite laser with its two laser resonators. The Apogee 5500 and Acclaim 7000 diagram is shown in **Figure 2B**. For an illustration of the main internal systems of the lasers see **Figure 2C**.

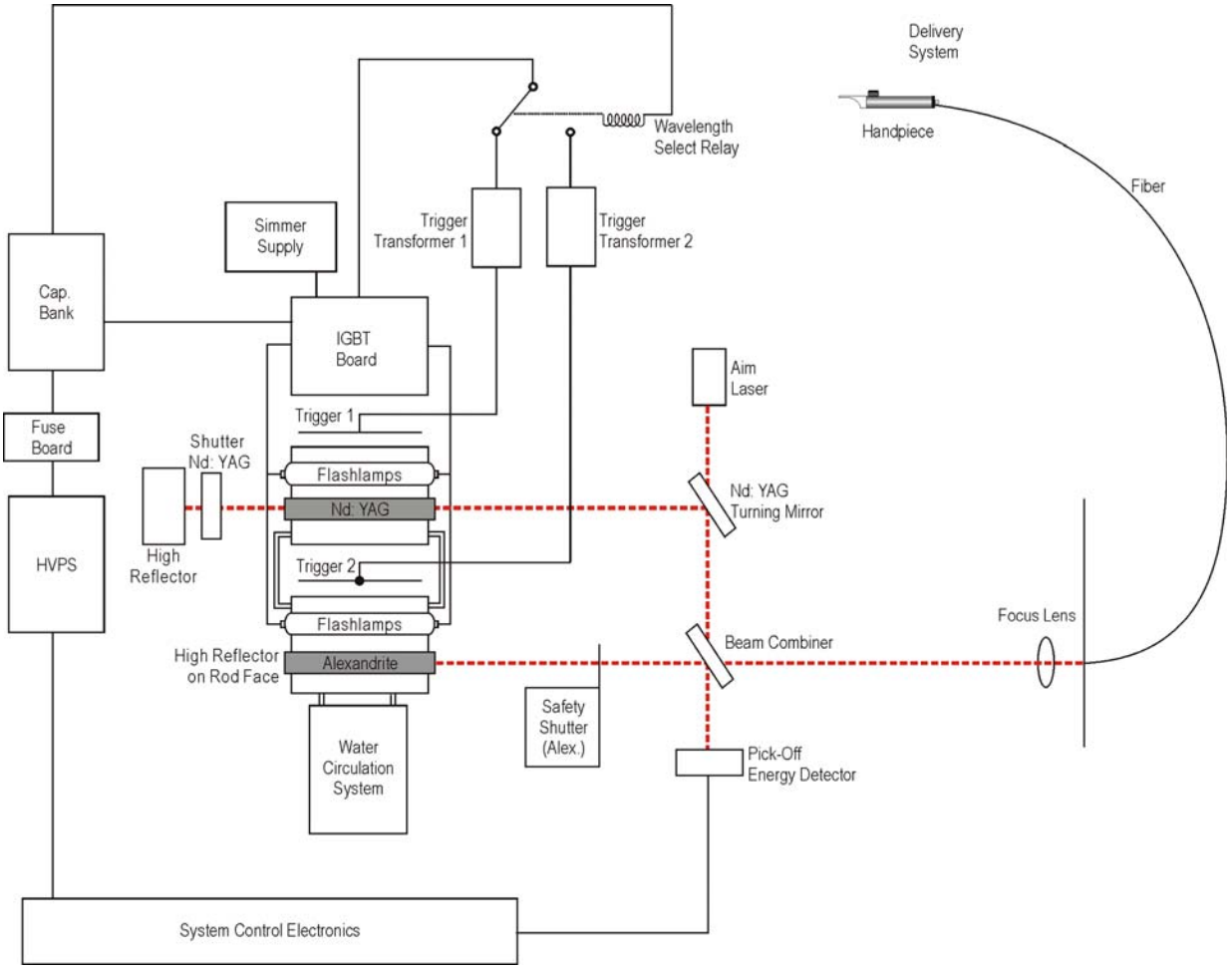

Figure 2A–System Block Diagram, Apogee Elite

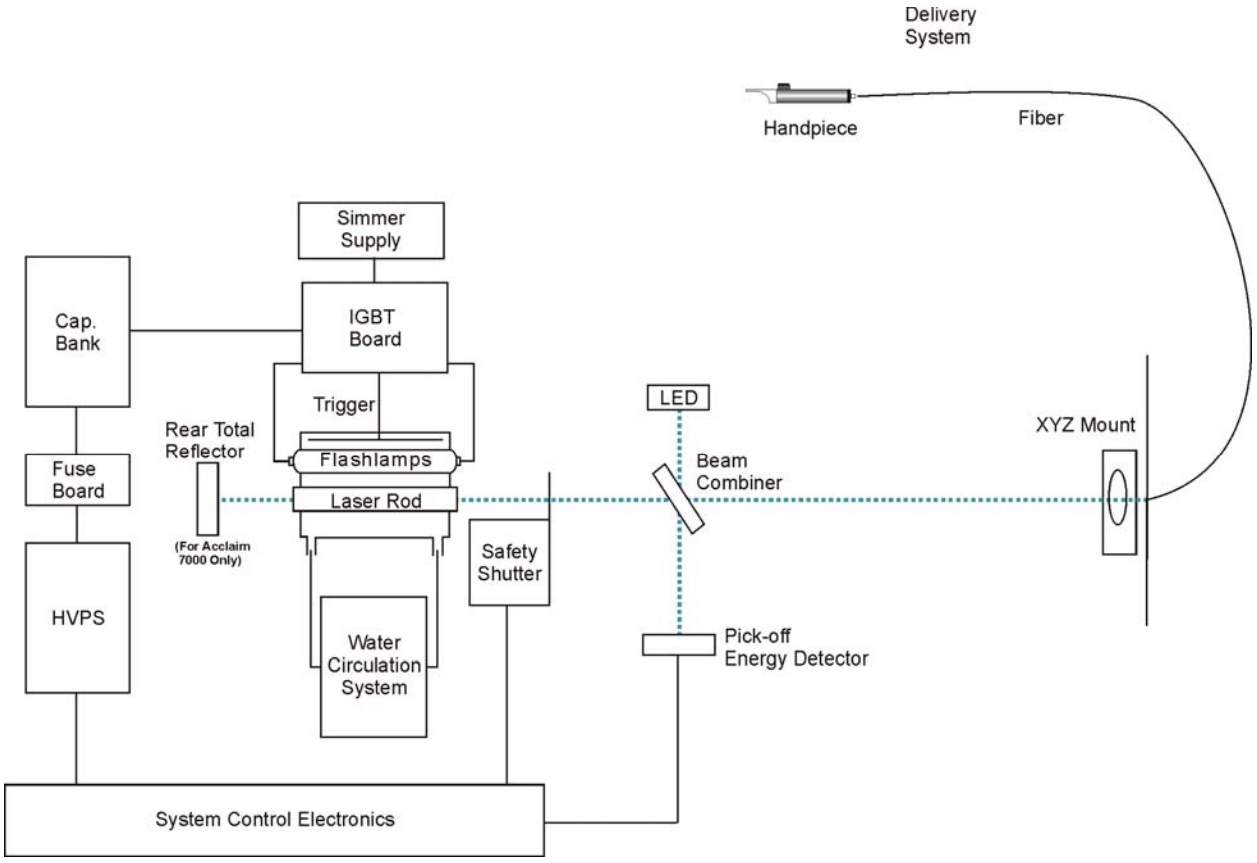

Figure 2B–Block Diagram, Apogee 5500/Acclaim 7000

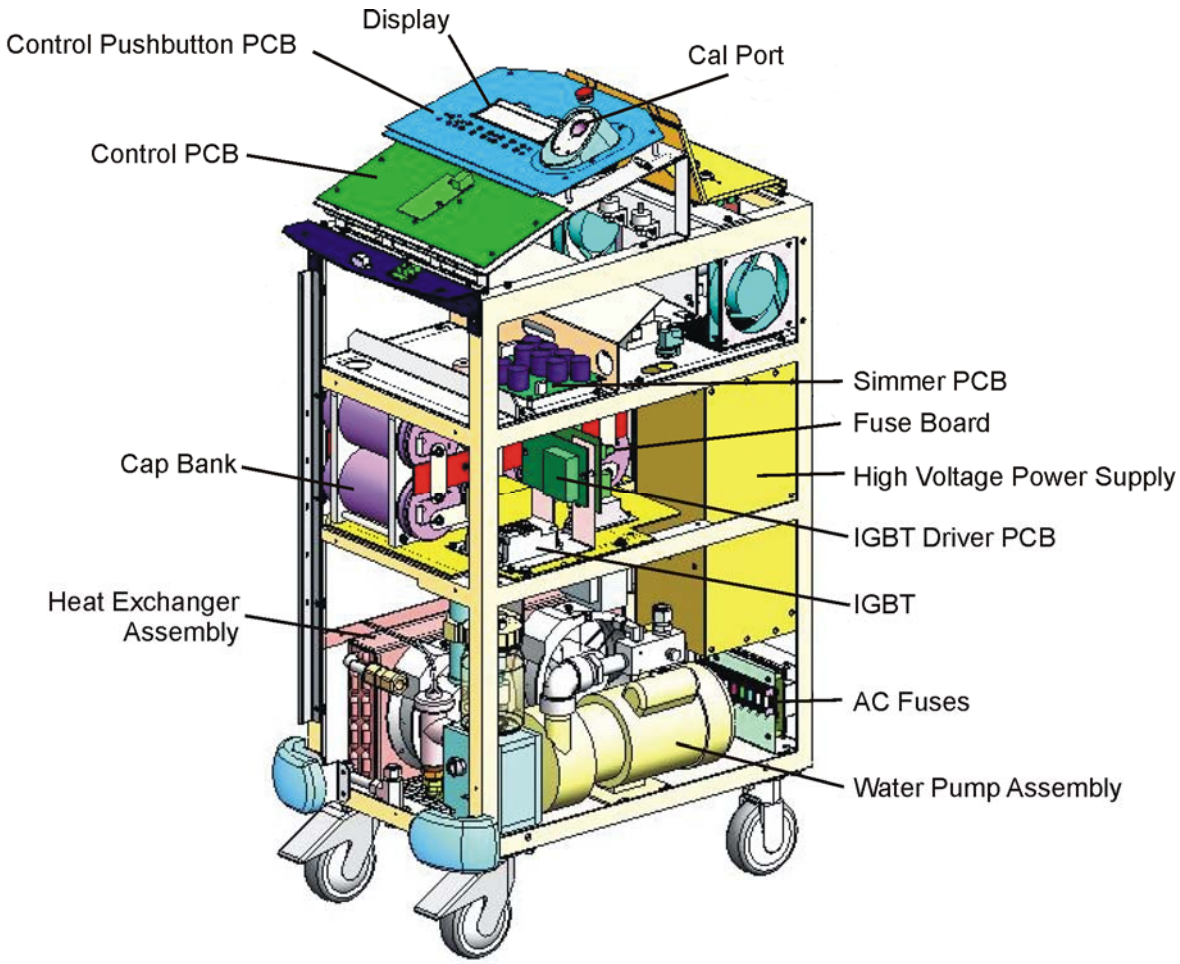

Figure 2C–Main Components

High Voltage Power Supply

The High Voltage Power Supply (HVPS) is a modular inverter capacitor charging power supply. This device accomplishes the primary energy conversion for the laser. It converts input power of 220 VAC, 50 or 60 Hz, to a controlled, high-voltage direct current. A software controlled low-voltage analog signal is used to set the appropriate HVPS output voltage level during laser operation. When enabled, the power supply charges the capacitor bank through the capacitor bank fuses. The laser control board also inhibits, enables and regulates high voltage output level depending on the state of the laser.

The maximum voltage is 900 V and the charge rate is approximately 3700 joules/second. For demonstration purposes, the system can be run on 120 VAC 15A Service. To make this change, please contact Cynosure Service.

Fuse Board

WARNING: High Voltage Danger! In the event of fuse failure, the capacitor bank may retain dangerous energy levels at high voltages. Please approach and handle with extreme caution.

The fuse board contains six 25-amp, 600-volt, Slo-Blow type fuses. Four of these fuses are connected to a pair of high voltage storage capacitors. The fuse board is designed to protect the storage capacitors against any excessive current draw that may occur with a short, such as a flashlamp or another capacitor shorting to ground.

Capacitor Bank

WARNING: High Voltage Danger! The capacitor bank stores dangerous voltage and energy levels during laser operation. Please handle with extreme caution.

The capacitor bank, see **Figure 3**, consists of eight 10,000 µF, 450-volt capacitors coupled together in a series/parallel configuration to provide a 900-volt, 8-kilojoule energy source. This large amount of stored energy must be regarded carefully.

Only a fraction of this stored energy is drained off for a given laser pulse. In a fault condition, the stored energy is discharged through the dump resistors to ground.

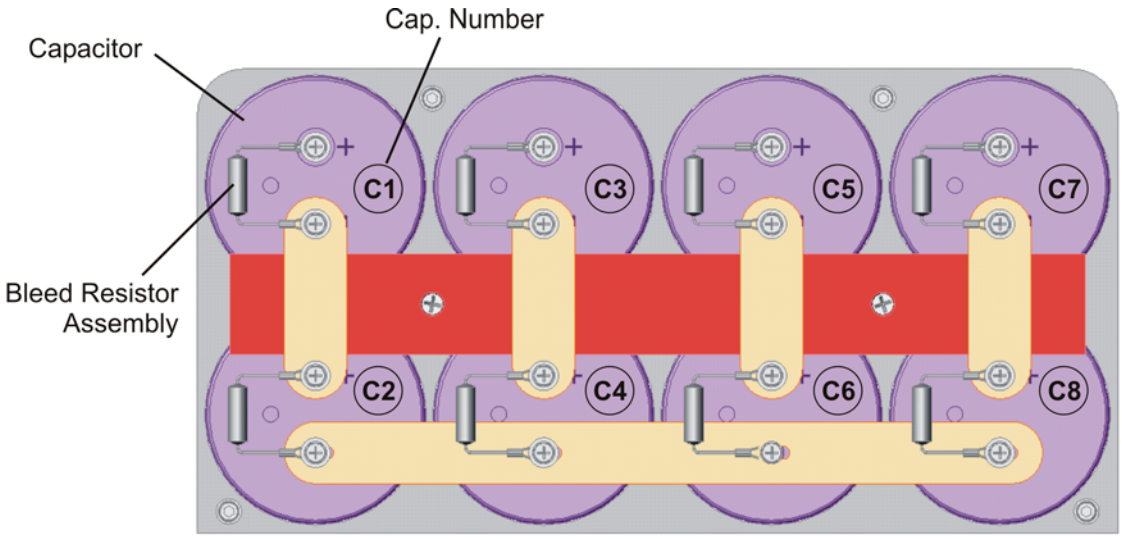

Figure 3–Capacitor Bank Assembly

High Voltage Subsystem and Flashlamp Drive Circuit

The high voltage subsystem stores the electrical energy in a eight capacitor, 900-volt, 10-kilojoule energy source and delivers it to the flashlamps. This subsystem is comprised of the HVPS, the capacitor bank or the pulse forming network (PFN) and the IGBT. See **Figures 4A and 4B**.

WARNING: Exercise extreme caution while working in the high voltage subsystem. High voltage may be present at any time! Electrical shock or burns can occur. Limit access to factory-trained personnel.

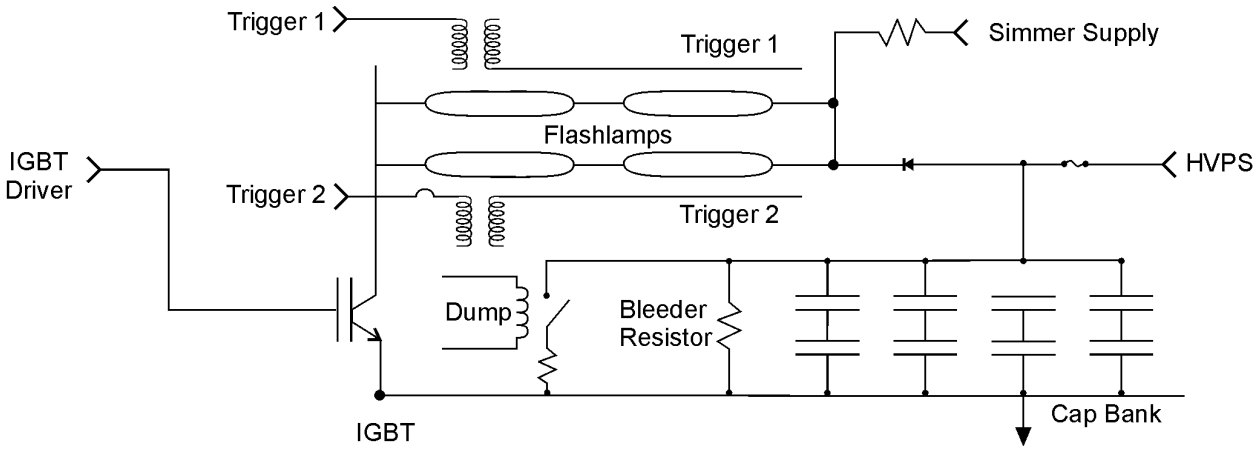

Figure 4A–High Voltage Subsystem, Apogee Elite

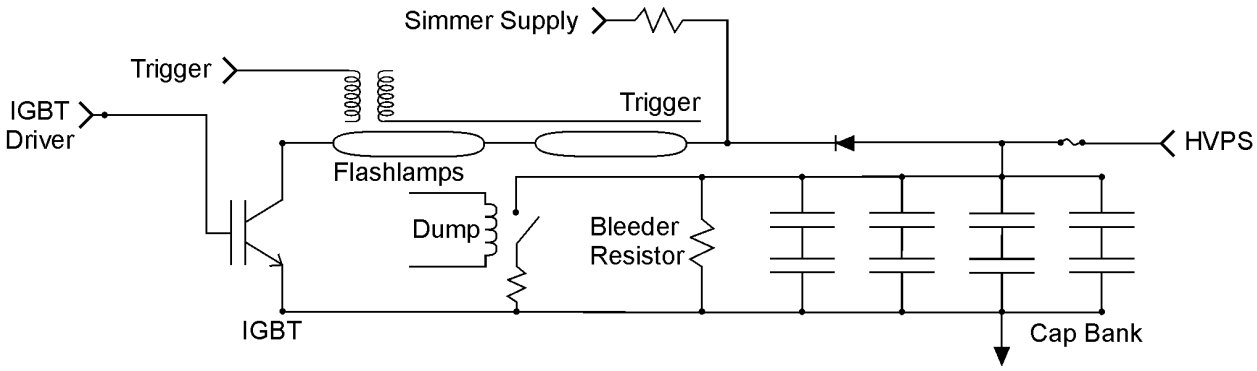

Figure 4B–High Voltage Subsystem, Apogee 5500/Acclaim 7000

IGBT Driver Board

The primary function of the Integrated Gate Bipolar Transistor (IGBT) driver board is to control, monitor and report operation of the IGBT using fiber optic input and outputs. For example, if an optical pulse of 5 milliseconds is received by the IGBT driver board from the laser control board, the driver board will generate an electrical gate pulse for 5 msec, which then turns on the IGBT device for 5 msec. Optical transmitters on the board relay status signals back to the laser control board that indicate proper function and will detect any fault in operation. These faults are monitored by the system control electronics.

IGBT and Snubber Module

The Integrated Gate Bipolar Transistor (IGBT) is a high voltage, high current switching device that controls the current flow through the flashlamps. When turned on, a ground path from the "+" capacitor bank through the flashlamps to the "–" of the capacitor bank is completed, allowing current to flow. See **Figure 5** diagram. The IGBT used in the Apogee Elite/Apogee 5500/Acclaim 7000 is a single IGBT module. High voltage is always on the flashlamps and the collector of the IGBT, therefore use extreme caution when high voltage is present.

The snubber module functions as a resistor capacitor diode (RCD) clamp. When the IGBT is turned off, the snubber diode is forward biased and the snubber is activated. The energy trapped in the stray inductance of the PFN is absorbed by the snubber capacitor. When the IGBT is turned on, the snubber capacitor that was charged to bus voltage has a discharge path through the forward-biased, free-wheel diode, the IGBT and the snubber resistor. This reduces the reverse recovery voltage transient, protecting the IGBT from harmful voltage spikes.

Refer to **Figure 6** for an overview of the components of the IGBT plate assembly.

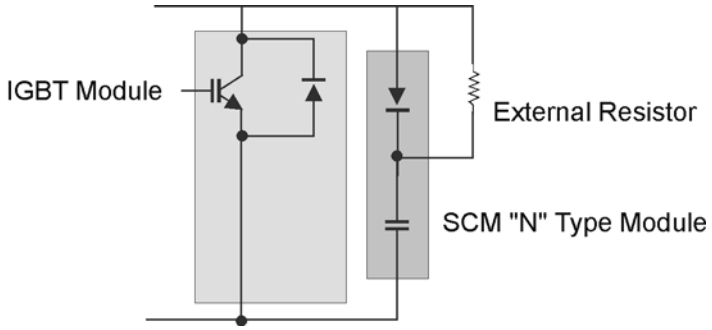

Figure 5–Snubber Module Across an IGBT

Simmer Board and Trigger Transformer

The simmer board provides a low level (~100 mA) DC current through the flashlamps. This preionization of the flashlamps improves pulse-to-pulse stability and increases flashlamp lifetime. Simmer is initiated on the simmer board by sending a low energy trigger pulse to the trigger transformer. The transformer steps up this signal to a high voltage trigger pulse on the pump chamber. This high voltage pulse ionizes the gas near the flashlamp electrodes by capacitively coupling through the flashlamps glass envelope. Once breakdown is achieved, a low power DC current from the simmer board is maintained through the simmer ballast resistor allowing continuous current flow through the lamps. A current sensing circuit on the simmer board verifies that this current is present. An optical transmitter located on the simmer board will then turn on, sending an optical signal to the laser control board as an indication of simmer status.

Wavelength selection on the Apogee Elite laser is done using a relay to select two separate trigger transformers. When the relay is in default mode—inactive, the Nd: YAG head trigger transformer is connected. When the Alexandrite wavelength is chosen, the capacitor bank is dumped, the trigger select relay activated, and the simmer started through the Alexandrite head.

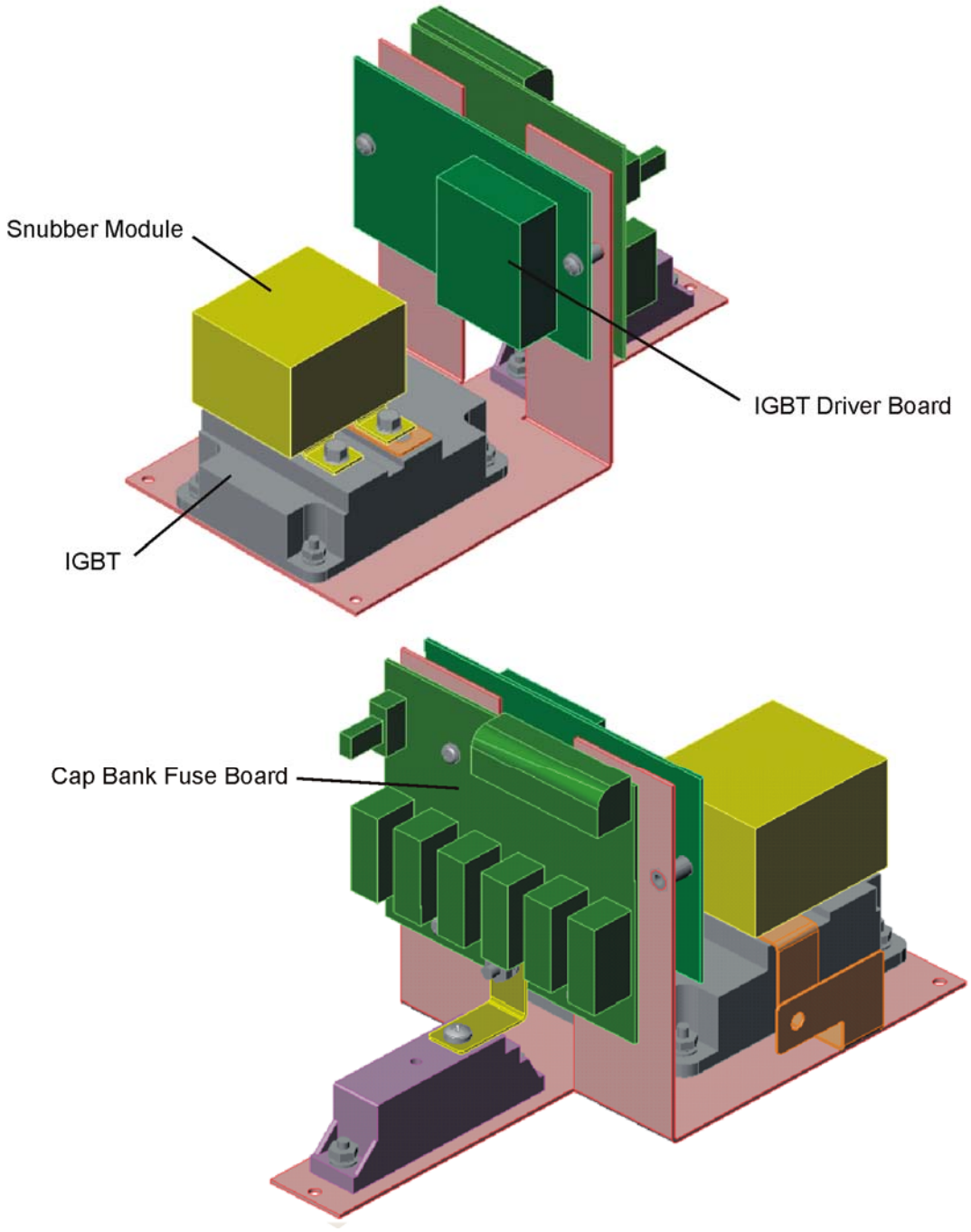

Figure 6–IGBT Plate Assembly

System Control Electronics

The system control electronics, see **Figure 7,** consists of a laser control board, microprocessor, hardware, software and associated wiring. This system switches the laser on and off, produces pulses at the proper times, regulates pulse energy, ensures safety, provides appropriate controls and status displays to the operator, and operates a variety of auxiliary subsystems, e.g., the water circulation pump. The major components of the system control electronics and their functions are detailed below.

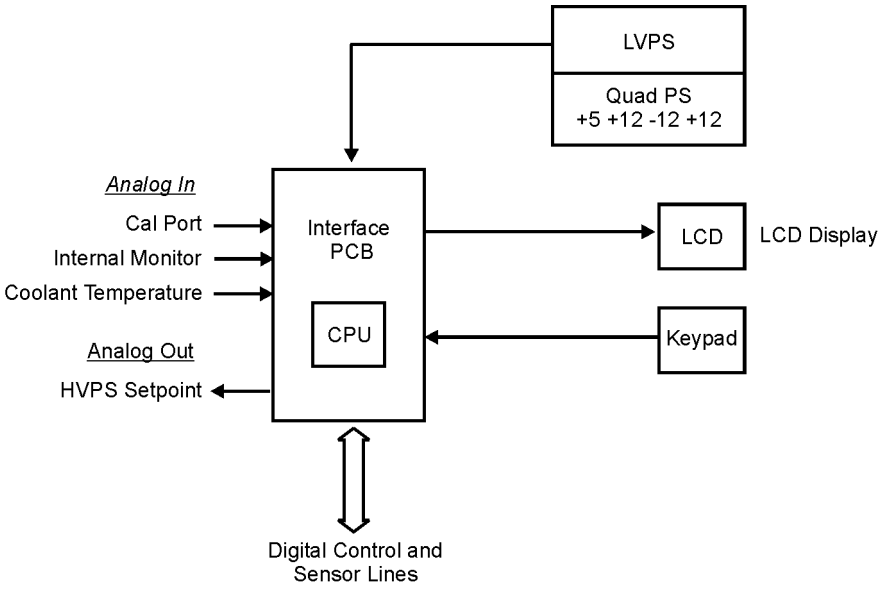

Figure 7–System Control Electronics

Laser Control Board

The laser control board includes the microcontroller, as well as the digital and analog circuits to control laser operation. The Control PCB for all three lasers is the same. Jumpers are used to select for differences specific to a particular laser system.

The optical detectors for the internal monitor and the cal port reside on the front edge of the control electronics PCB. The cal port detector is mounted direct to the control electronics PCB, and is connected to the pick-off assembly. This configuration ensures that the fiber is not affected when the Control Electronics PCB is lifted up for service access. **NOTE:** On the Apogee Elite system two detectors are used.

Microcontroller

The microcontroller is mounted on the laser control board. The software is on the board in flash memory, which can be updated through a serial port.

High Voltage Control Circuit

The microcontroller sets the HVPS by writing a programming voltage to DAC U19. U21A and B, along with pots VR7 and 11, convert the programming voltage to a range of 0 to 9 volts at TP36, which corresponds to a HVPS output of 0 to 900 volts. The microcontroller also sets the HVPSEN signal to enable the HVPS.

The microcontroller reads the actual high voltage through U21C and VR5. The signal at TP38 is a 0-5 volt signal that represents 0 to 900 volts at the HVPS. If the actual voltage is more than 20 volts less than the programmed voltage, the laser will display a power supply fault.

IGBT Control Circuit

The software controls the pulse timing to the IGBT control board through U17B. It monitors IGBT faults and status through DR1, 6 and 7.

Temperature Control Circuit

A solid-state temperature sensor measures the water temperature. U20C converts the temperature to a voltage as follows: 0 to 5 V = 0 to 100 °C. This voltage is read by the microcontroller through the A/D converter U7. The microcontroller then uses this information to regulate the temperature and check for faults.

Energy Regulation Circuit

The software reads the laser head energy through RX1 and U8a, and the cal port energy through RX2 and U20D. It uses this information to adjust the HVPS to maintain the laser energy.

Handpiece Selection Board

The handpiece selection PCB is located on the upper front dress panel next to the cal port. This board interfaces with the laser control board and provides information as to which handpiece is connected to the laser's delivery fiber. The finger switch signal is also transmitted through this board.

Laser Head(s)

The laser head or pump chamber is the diffuse reflector that couples the light energy from the flashlamps into the solid state laser crystal. This assembly consists of a two-piece main body and end plates that secure and seal the precision glass flow tubes. The flashlamp and rod keepers are secured to the end plates to provide fluid seals. The upper half of the pump chamber can be removed for a visual inspection of the diffuse reflective coating and flow tubes. The laser head is not considered a field serviceable item and must be replaced as an assembly.

Flashlamps

The two flashlamps (per head) emit brief, intense bursts of white light when excited by pulses of electrical current. This intense light provides the pump energy source for the lasing medium. The anode or positive lead is identified by a crimp lug on the wire. Always use finger cots when handling or cleaning the flashlamps.

Laser Rod

The Alexandrite crystal in the Apogee 5500 and the Neodymium:YAG crystal in the Acclaim 7000 is the active medium that is pumped by the flashlamps. The Apogee Elite system has two heads to attain both wavelengths. The Alexandrite rod ends are coated for maximum and partial reflectivity @ 755 nm. There are no external optics required for lasing action. The Nd:YAG rod has an anti-reflective (AR) coating @ 1064 nm at one end and is uncoated on the other end. An external maximum reflector is used to complete the optical cavity.

CAUTION: Damage to both the coated or uncoated surfaces can occur from a single speck of dust or smudge resulting in poor laser performance or further system damage. Be extremely careful when handling these fragile, expensive crystals.

Rear Total Reflector, Nd: YAG

NOTE: This section is for Nd: YAG lasers only.

The rear total (max) reflector, is the back half of the optical cavity see **Figures 8A, 8B** and **8C**. It reflects all 1064nm light that strikes the mirror face. The mirror, when mounted, tilts on two orthogonal axes. For the laser to function properly, it must be absolutely parallel to the front partial reflector (uncoated surface of the Nd:YAG rod), and perpendicular to the axis of the Nd:YAG rod. This reflector may require adjustment after replacement of the flashlamps or pump chamber.

Safety Shutter

The safety shutter, see **Figures 8B** and **8C**, physically blocks the laser beam until the shutter solenoid is activated. A sensor located on the shutter assembly is used to determine the correct position of the shutter blade at all times. The microprocessor monitors the shutter state to ensure laser safety.

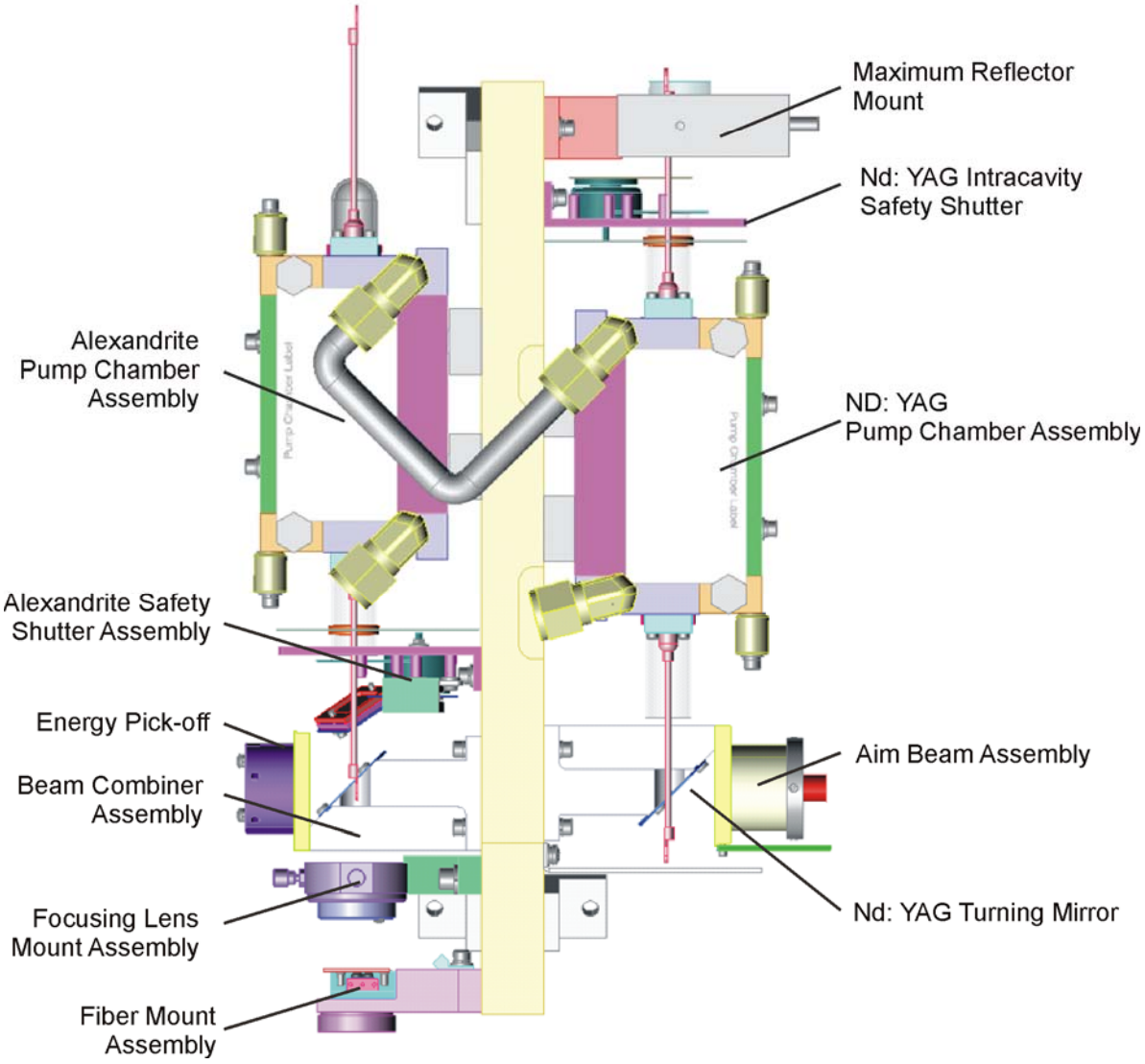

Figure 8A–Resonator Rail, Apogee Elite

Beam Path: Energy Monitor/Beam Combiner

The energy monitor uses a coated beam combiner that samples a small portion of the laser beam. This fraction of resonator energy is sent to and calibrated at the laser control board maintaining the energy level continuously in a closed loop operation. The monitor (also called an energy pick-off) and beam combiner assemblies are different for the Apogee Elite lasers and the Apogee 5500/Acclaim 7000 lasers.

The Apogee Elite beam combiner, see **Figure 8A**, has a different pick-off assembly and placement of the aiming source, a red laser diode. The Nd:YAG and Alexandrite beams are combined at the beam combiner and directed to the same focus lens and laser fiber. The beam that is reflected from this turning mirror is the signal sent to the pick-off. The aim beam is folded into the beam path at the Nd: YAG turning mirror.

The Apogee 5500/Acclaim 7000 beam combiner, see **Figures 8B** and **8C**, reflects the aiming LED so that it is coincident with the laser beam onto the proximal end of the delivery fiber.

Aiming Source: LED and Laser

For the Apogee 5500/Acclaim 7000 systems, the light emitting diode (LED) produces a low-power, visible source of blue-green light for aiming the laser beam. The LED sits in an adjustable mount. The red diode laser (635 nm) is mounted to the YAG turning mirror and has its own separate adjustments. For information on aligning, refer to the *Final Test and Calibration Procedure*

XYZ Mount

The XYZ mount contains a focusing lens, see **Figures 8A, 8B** and **8B**, that collects the light emitted from the laser rod and aiming LED, and couples it into the input or proximal end of the optical fiber. The X and Y adjustments on the fiber-focusing lens center the lens focal point on the fiber core. The Z adjustment positions the focal plane relative to the end of the fiber.

The XYZ mount may require field adjustments after shipment or after service involving repair or replacement of optical components.

Realign the XYZ each time the lens is replaced.

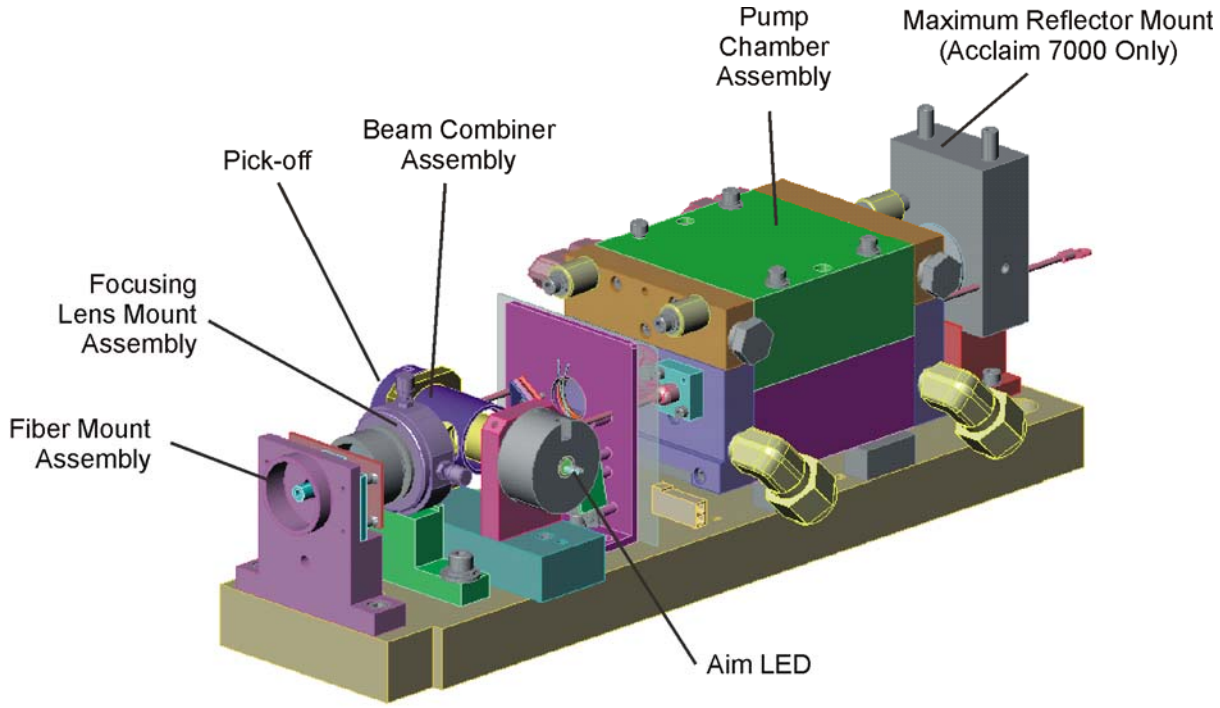

Figure 8B–Resonator Rail, Apogee 5500/Acclaim 7000, Isometric View

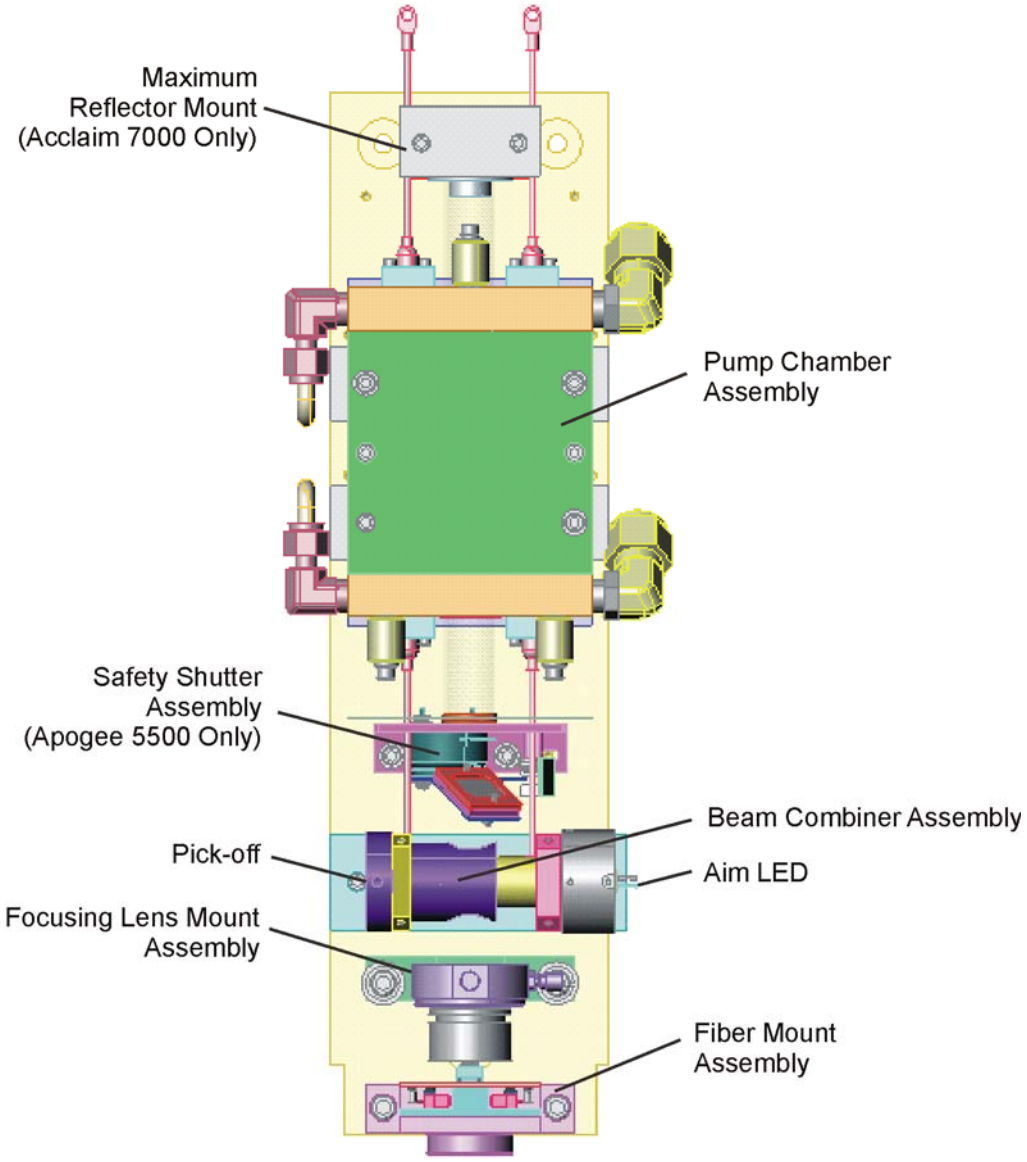

Figure 8C–Resonator Rail, Apogee 5500/Acclaim 7000, Top View

Delivery System

Approximately 80% of the energy, which has been coupled into the fiber, reaches the distal or output end of the fiber and enters the handpiece. The handpiece images the light from the fiber into a magnified spot of a specific diameter. The handpiece incorporates a push-button switch for firing the laser, as well as an electrical means of providing identification of the spot diameter to the laser control system. Refer to **Figure 9** for an overview of delivery system components.

Trigger Switches

When the laser system is in ready mode and the delay has passed, activate the laser beam by pressing one of the following trigger switches:

- The finger switch, is an electrical push button on the handpiece.
- The foot switch is a pneumatic switch. To connect it, insert the foot switch port on the rear of the laser.

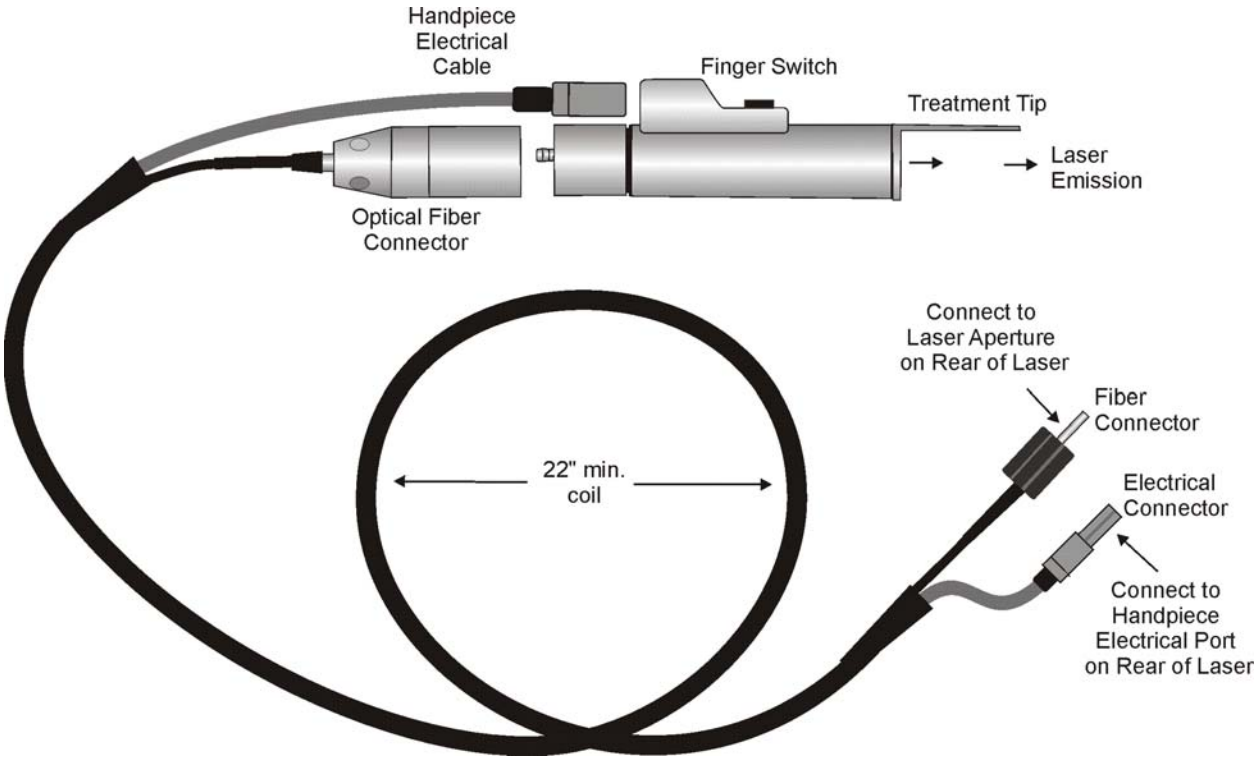

Figure 9–Delivery System

Cal Port

The lasers utilize an integrating sphere with a small aperture that is used for fiber optic sampling of a portion of the lasers delivered energy—a true energy meter. This fiber optic is connected to the laser control PCB.

A sapphire window is used to protect the Opal glass diffuser against damage from dirt and debris. This window should be cleaned periodically to ensure consistent and accurate measurement of laser energies.

When the handpiece is inserted into the cal port, two series wired micro-switches detect the presence of the handpiece, and this switch closure is detected and monitored by the laser control PCB.

Refer to **Figure 10** for an overview of the cal port components.

CAUTION: Overheating of the cal port is a concern and should be avoided. For this reason the software of the laser only allows a maximum of twenty, consistent laser pulses at a time into the cal port.

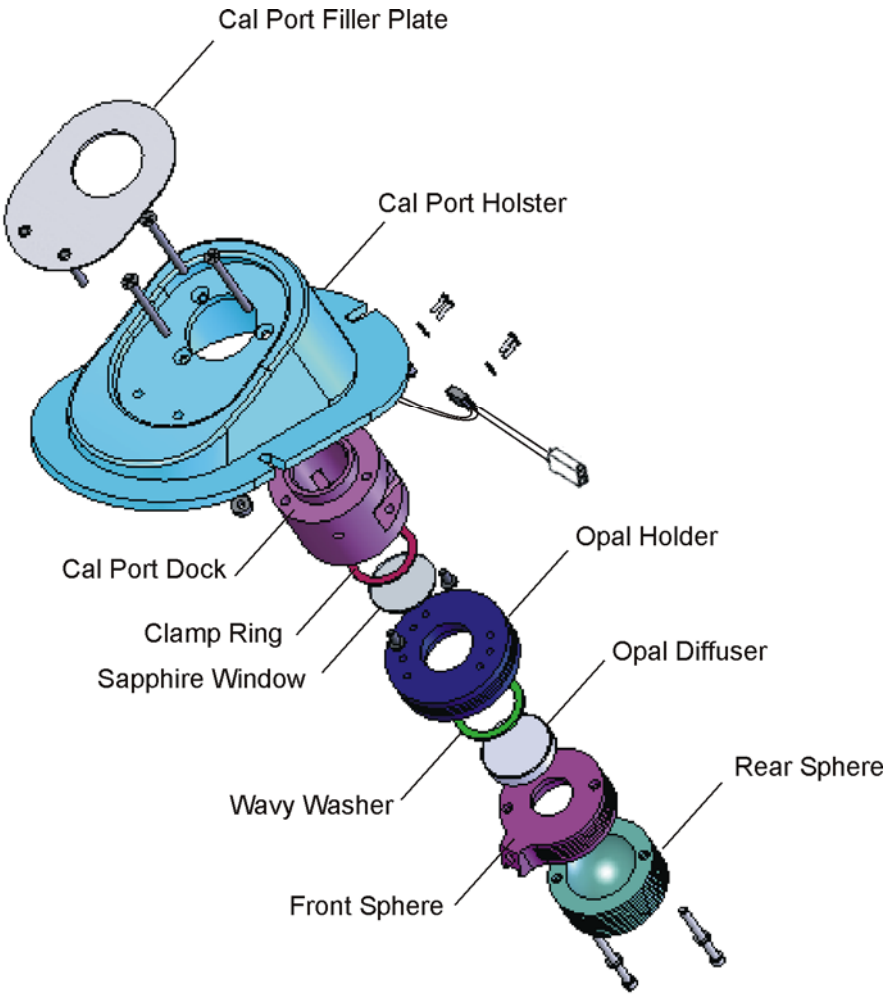

Figure 10–Cal Port Assembly

Coolant Circulation System

The water circulation system, as diagrammed in **Figure 11**, maintains the flashlamps, rod and laser head at a temperature of 65 °C.

The water pump circulates the deionized water through the laser head, heat exchanger and a flow switch. A bypass loop contains a deionizer cartridge that helps maintain low electrical conductivity of the coolant.

A heater is incorporated into the coolant systems of all three lasers, but the Alexandrite laser require a warm up period before laser operation. **NOTE:** When turned on the Apogee Elite defaults to Nd: YAG laser mode, which requires no warm up period.

Level switches located in the upper reservoir are used to provide water level status information to the systems control electronics. The upper level switch indicates when water must be added. The lower level switch, when activated, will not allow laser operation until water is added.

The solid-state temperature sensor measures the water temperature and provides temperature information back to the microcontroller, as described in “Temperature Control Circuit,” on page 22. This sensor must be recalibrated when replaced or when the Laser Control PCB. is replaced. See *Final Test and Calibration Procedure* for calibration information.

NOTE: When adding water use <u>deionized or distilled water</u> only.

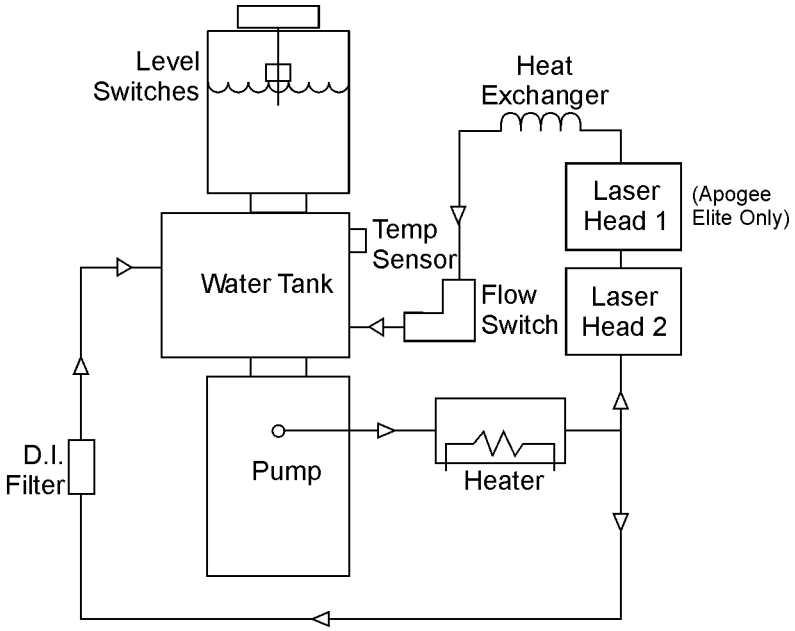

Figure 11–Coolant Flow Diagram

Section 4 INSTALLATION

Installation of the Apogee Elite/Apogee 5500/Acclaim 7000 laser systems should be performed by factory-trained, authorized personal only.

Facility environmental and electrical requirements are outlined in the *Operator's Manual.*

The Installation Procedure, details the proper installation procedure for these lasers and it should be followed completely. A copy of the completed *Installation Data Report (IDR)* must be faxed back to Cynosure upon completion of the installation.

This page has been intentionally left blank.

Section 5 ROUTINE MAINTENANCE

In order to ensure proper operation of the Apogee Elite/Apogee 5500/Acclaim 7000 laser systems, Cynosure recommends that yearly routine maintenance be performed by factory-trained authorized personal.

This maintenance should include the following operations:

- A visual inspection of the lasers overall condition and appearance. The laser should be clean and in a clean environment. Inspect all optical components for dust or damage, including the laser resonator, beam combiner, focusing lens, delivery fiber and handpieces. Replace any component as necessary.
- Flushing of the coolant system and replacement of the deionizer cartridge. Inspect plumbing and tube fittings for leaks.
- Inspection and replacement of the air filter.
- Calibration verification of the water temperature sensor. Check for proper operation of the temperature regulation circuit as controlled by the heater and heat exchanger fans.
- Calibration verification of factory set points, such as the one shot gate signal, pulse widths, repetition rates, etc.
- Check laser resonator performance as determined by slope efficiency.
- Fiber alignment and fiber coupling efficiency.
- Inspection and calibration verification of the cal port.
- Inspection and cleaning of the high voltage power supply.

Detailed procedures and specifications for the above mentioned items, as well as all factory presets can be found in the *Final Test and Calibration Procedure.*

This page has been intentionally left blank.

Removing the Dress Panels

This section of the technical guide details how to remove the dress panels for accessing and servicing internal components.

For most common service procedures, such as accessing the control electronics or laser resonator, it is only necessary to remove the side rails and raise the top cover. The resonator is located under the top plate that is secured to the laser chassis.

Exercise care when removing any of the dress panels. Handle all painted items carefully to avoid scratching or damaging them. Always store panels away from work area until service is complete.

WARNING: Even when the laser is off and the AC line cord is disconnected, DC voltages on various laser components, such as capacitors may exist. This can present a potentially fatal electrical hazard during service procedures. Proceed with caution!

Take the following precautions to avoid an electrical shock during servicing:

- Always turn the laser off and disconnect the AC line cord from the receptacle before removing the protective housing of the laser system.
- With the laser off, allow the dump resistors to dissipate the energy in the pulse forming network's capacitors to a safe level (approximately 45 seconds). Monitor the voltage on the capacitors with a DVM probe to ensure it is at a safe level.
- If it is necessary to test or adjust any electrical component while the system power is on, be careful not to touch any electrical components. Use only appropriate probes or insulated tools.
- Become familiar with the electrical schematics and layout of the system before attempting to service the laser.

If the AC must be connected during service routines, exercise caution around mains connected components, such as power supply feeds, circuit breakers, key switches, etc. A remote interlock fault condition will reduce high voltage electrical hazards. This fault condition disables the high voltage power supply control and simmer circuits, as well as ensuring that the dump relay is closed (grounding the potential of the pulse forming network). When possible, remove the remote interlock plug during "live" service routines.

Removing the Top Cover

1. Disconnect the AC line cord from the receptacle.
2. Remove the four screws that attach the top cover to the top of the laser chassis.
   NOTE: Two screws are located behind the front door and two screws are located on the rear panel of the laser.
3. Carefully lift the cover off the top of the laser.

Accessing the Laser Resonator

1. Remove the top cover, as detailed in the previous section.
2. Lift the top control/display panel to the stops exposing the resonator rail.
   NOTE: For ease of serviceability, a piano hinge allows access to the upper chassis.

Removing the Side Panels

1. Remove the two screws, located on the rear of the laser, that attach each side panel to the laser.
2. Slide each panel toward the rear of the laser, and then lift panel off of the laser.

Removing the SMA Access Panel

1. Unscrew the plastic SMA trim nut.
2. Remove the two screws holding the rear control panel to the main chassis.
3. Slide the rear control panel to the side in order to clear the resonator.

Removing the Front and Rear Panels

1. Remove the two retaining screws that hold each panel to the laser. **NOTE:** The front panel is located behind the front door.
2. Lift off the front and back panels.

Section 7 SERVICE PROCEDURES–PERFORMANCE

One of the most frequent causes of a service call is for "high voltage power supply limit reached," which is basically a low energy condition. It is important to understand, evaluate and diagnose this problem accurately.

This section includes information on the following topics that should be used to determine the cause of the problem.

- Understanding performance criteria,
- Verifying the resonator performance and fiber coupling efficiency,
- Checking the condition of fiber,
- Checking the condition of the handpiece,
- Checking the condition and alignment of the focusing lens.

Performance Criteria

There are two performance criteria that must be met to define a properly working laser: system performance and resonator performance.

System Performance

System performance is defined from the point of view of the laser operator with a totally assembled laser. The laser must meet all fluence specifications as outlined in the *Operator's Manual*.

Resonator Performance

A separate performance standard for each laser has been established for the resonator output. In order to meet the system performance criteria, the resonator must generate approximately 20% more output to compensate for losses in coupling to the delivery system.

For the Alexandrite lasers, the resonator must be capable of generating a minimum of 55 joules/pulse @ 1Hz or 55 Watts. This is based upon a system performance criteria of 25 J/cm^2 with a 15-mm handpiece, which equals 44 joules/pulse out of the handpiece. Adding a nominal 20% for delivery system losses, this means that the resonator must produce 55 joules/pulse. If the system cannot meet this criterion, the efficiency of the laser must be improved.

For the Nd: YAG lasers, the resonator must be capable of generating a minimum of 78.5 joules/pulse @ 1Hz or 78.5 Watts. This is based upon a system performance criteria of 80 J/cm^2 with a 10-mm handpiece, which equals 62.8 joules/pulse out of the handpiece. Adding a nominal 20% for delivery system losses, this means that the resonator must produce 78.5 joules/pulse. If the system cannot meet this criterion, the efficiency of the laser must be improved.

Checking the Condition of the Fiber

The fiber ends should be inspected to insure that they are round, smooth, clean and slightly recessed. If any chips, dust, corrosion, or obvious concentricity errors are apparent, replace the fiber. Generally, the laser does not cause fiber wear, but at times the ends of the delivery fiber can be chipped due to rough handling.

WARNING: Never look directly into the distal end of the fiber while the laser is on, even when wearing protective eyewear; serious eye injury can occur.

1. Turn off laser if laser is on.
2. Disconnect the fiber by unscrewing the fiber from the handpiece and unscrewing the SMA connector from the laser.
3. Using a 7-10X eye loupe, examine both fiber ends. The ends should be slightly recessed (~0.5 mm), clear of debris and round and smooth. See examples below.

Protruding Fiber

Good Fiber

4. If either fiber end is missing, protruding, dirty, blackened, chipped or rough in appearance, do not use. Replace with a new fiber.
5. Hold one fiber end to a bright source, a ceiling light, sunny window, etc., and look at the other end. The fiber end should be illuminated brightly as compared to when it is not pointed at a light source.

Checking the Condition of the Handpiece

Some optics within the system are more susceptible to damage than others. After a long period of use, certain optics need to be inspected and unless their condition is pristine, replaced. The first optics to inspect are the handpiece lenses. Any dirt or discoloration in the coating surface will affect the handpiece transmission and thus the overall efficiency of the laser.

WARNING: Never look directly into the handpiece while the laser is on, even when wearing protective eyewear; serious eye injury can occur.

1. Turn off laser if laser is on.
2. Disconnect the fiber from handpiece. Remove the treatment tip if attached. Inspect the window and replace if damaged.
3. Examine the condition of the handpiece lenses, by sighting down the barrel. A handpiece in good working order provides a clear, unobstructed view through the lens. See examples below.

Dirty Lenses, Unacceptable

Clean Lenses, Good

4. If the handpiece lenses appear dirty, scratched, discolored, or pitted, then test the laser with a good handpiece and repair or replace the damaged lenses.
5. If handpiece lenses are replaced, verify spot size. If necessary re-spot the actual spot size of the handpiece in accordance with Cynosure's recommended procedures for handpiece repair.

Checking the Focus Lens

Additional optics that are susceptible to wear and optical damage are the focus lens, turning mirror and the beam combiner. It is important when working with these optics that the parts stay clean and free of oils and fingerprints. Follow the procedure for aligning the focusing lens as described in the *Final Test and Calibration Procedure.*

The fiber coupling transmission should be approximately 80% of resonator energy with new or good quality optics.

This page has been intentionally left blank.

Performance Test Sequence/Field Evaluation

1. Perform a system performance check, as defined in the system specifications section of the *Operator's Manual.*
2. Does system meet those system specifications?
   - 2.1 If yes, fill out the *Installation Data Report (IDR)* in the *Installation Procedure.*
   - 2.2 If no, continue this test sequence.
   - 2.3 Inspect fiber and handpiece for any damage.
   - 2.4 If no damage is found, continue this test sequence.
3. Access the resonator as detailed on page 36.
4. Check beam combiner, focusing lens and fiber alignment as detailed in "Checking and Replacing the Focusing Lens" on page 44 and in the *Final Test and Calibration Procedure*.

   If no damage is found, continue this test sequence.
5. Does system meet requirements of "Resonator Performance," on page 37?
6. Check resonator output as detailed in *Final Test and Calibration Procedure*.

   If resonator output acceptable, complete the *Resonator Performance Report*.

   If resonator output unacceptable, continue this test sequence.
7. For the Nd:YAG lasers, check the alignment of the resonator. Realign, and complete the *Resonator Performance Report.*
8. Verify fiber alignment and aim beam adjustment as detailed in the *Final Test and Calibration Procedure*.
9. Verify fiber transmission is at least 80% of resonator energy.
10. Verify the accuracy of the cal port.

Pump Chamber Maintenance

This section of the technical guide describes the maintenance of the pump chamber and includes removing and replacing the flashlamps, cleaning and inspecting the laser rod.

If severe damage to the rod or the rod's reflective coating occurs, then the pump chamber including the rod must be replaced as an assembly. The pump chamber is not considered a field serviceable item.

Removing the Pump Chamber

CAUTION: Before removing the pump chamber, always remove the lasers AC line cord from the wall receptacle. Use a digital volt meter to make certain that there is no voltage present on capacitor bank.

1. Access the resonator as described on page 36.
2. Disconnect the coolant lines from the pump chamber being serviced.
3. Disconnect the two PFN wires from the ceramic standoffs from the pump chamber.
4. Disconnect the red wire from the trigger transformer that is attached to the pump chamber.
5. For Nd:YAG lasers, remove the maximum reflector mount and dust tube, and set them aside.
6. Slide the front dust tube forward into the safety shutter mount.
7. Remove the four 8-32 socket head screws that secure the pump chamber to the resonator rail.
8. Carefully remove the pump chamber from the laser.

Replacing the Flashlamps

Before replacing the flashlamps, always record the flashlamp pulse count on the *Service and Repair Report* along with the voltage at 50W for the Alexandrite laser and 60W for the Nd: YAG laser. Note the location of the crimp lug on the flashlamp wire lead of each lamp. This indicates the anode or "+" electrode of the lamp. See **Figure 12A and 12B** for pump chamber components.

1. Remove the pump chamber as described in the section above.
2. Remove the 4-40 socket head screws and lock washers that secure the flashlamp keepers to the pump chamber.
3. Carefully remove the flashlamp keepers from the lamps.
4. Remove the old lamps, noting the correct position of the flashlamp anode.
5. Clean the new lamps with methanol before installing.
6. Inspect and replace the flashlamp keeper O-rings if necessary.

7. Inspect and clean rod, if necessary, as detailed on page 44.
8. Reverse this section for installation of lamps and pump chamber.

CAUTION: Do not handle the flashlamps with bare fingers. Skin oils can damage the quartz envelope of the lamp. Always use finger cots or cotton gloves.

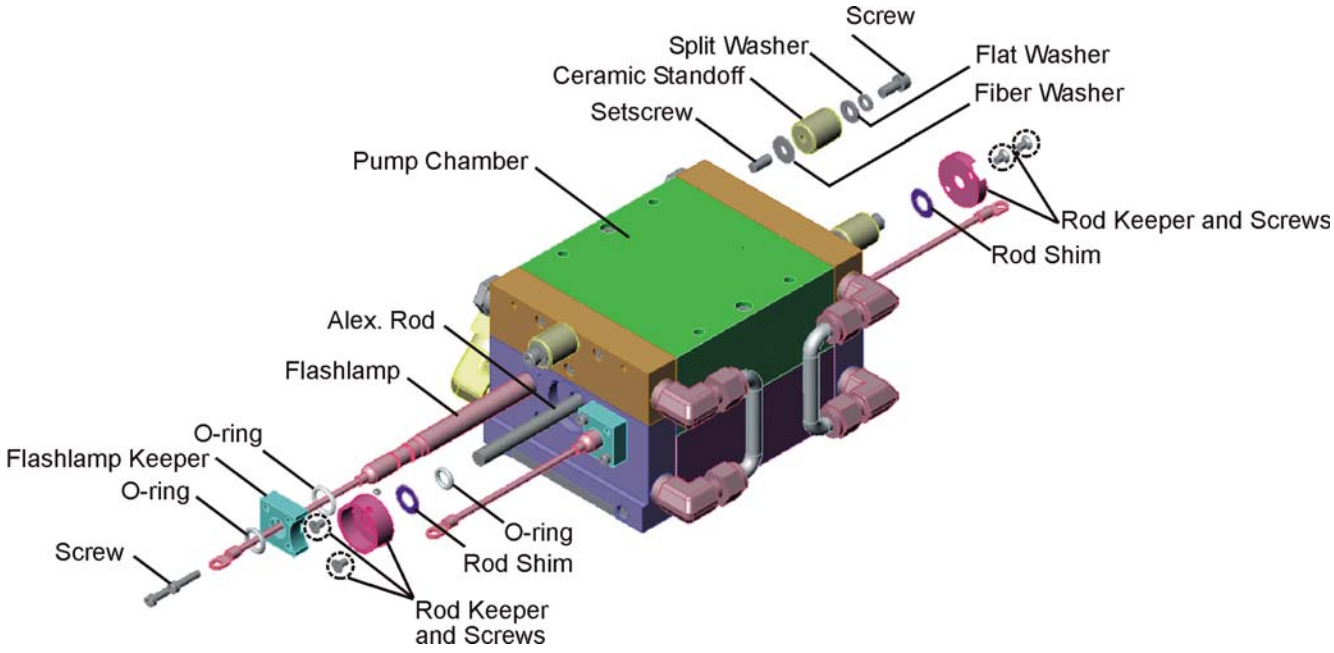

Figure 12A–Pump Chamber, Apogee Elite

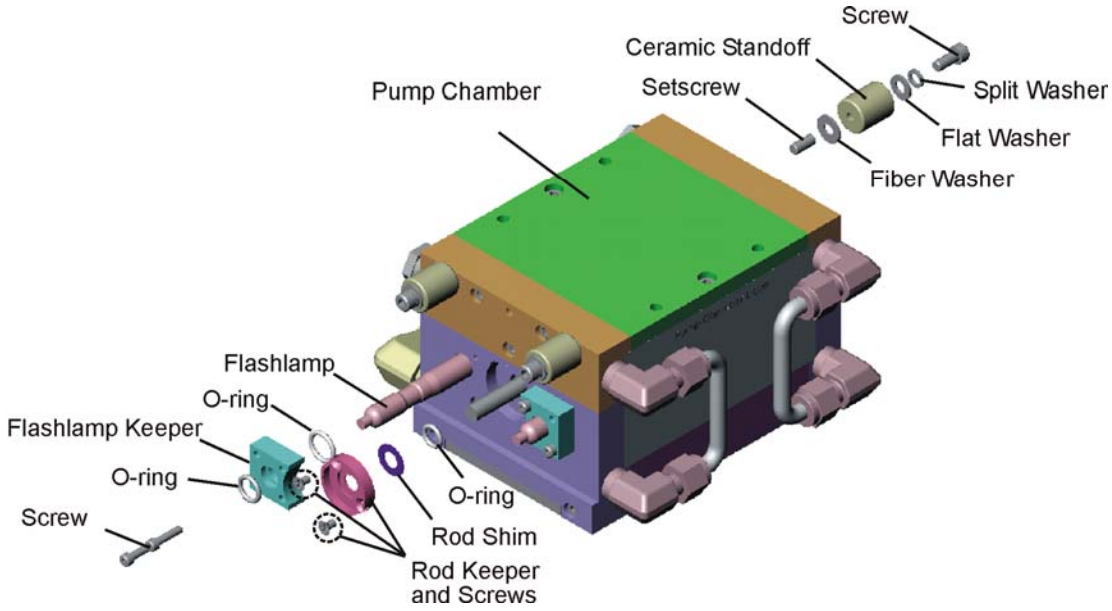

Figure 12B–Pump Chamber, Apogee 5500/Acclaim 7000

Inspecting and Cleaning the Laser Rod

Inspect both surfaces of the rod using at least a 7x eye loupe for scratches, pinholes, burns, etc. If there is any problem with the rod, note the location and severity of damage on the service report.

If dirt is present, clean the end of the rod very carefully as detailed in the steps below. Use only optics grade methanol, or acetone for heavy-duty spots, and tightly wound cotton swabs. Make certain that the cotton swabs do not contain an adhesive.

1. Soak the end of cotton swab with methanol.
2. Shake off any excess methanol from the swab.
3. Using light pressure, move the swab in a circular motion starting in the middle of the rod, and then gradually working outward to the edge of the rod.
4. Dispose of the swab when finished.
5. Reinspect the rod, and repeat as necessary. **NOTE:** Use a new cotton swab each time the rod surface cleaning is repeated.

Checking and Replacing the Focusing Lens

IMPORTANT: At each service call, the focusing lens must be inspected.

1. Verify that the laser is off.
2. Access the resonator as described on page 36.
3. Remove the two 1/4-20 socket head screws that secure the XYZ mount to the resonator rail.
4. Inspect the surface of the focusing lens. Use a bright lamp for inspection. Haze might not be easily detected with poor lighting. Any pitting or discoloration to the antireflection coating constitutes damage and requires that the optic be replaced.
5. Loosen and remove the locking ring with the lens holder key.
6. Wearing finger cots or gloves, clean all parts with methanol and allow them to dry.
7. Carefully drop a new, clean lens into the lens holder. The lens is plano-convex, so orientation is critical. NOTE: The curved side of lens faces the laser resonator.
8. Reinstall the locking ring. Gently blow out any debris or dust. Reinspect the lens for cleanliness.
9. Install the XYZ mount on the rail.
10. Realign the focusing lens as described in the *Final Test and Calibration Procedure*.
11. Verify that fiber transmission is at least 80% of the resonator energy.

Aligning the Resonator

Alexandrite Lasers

The Apogee 5500 Alexandrite Rod, as described on page 23 is coated for maximum and partial reflectivity. No external optics are required for lasing. Alignment is fixed.

Nd: YAG Lasers

The Nd:YAG resonator uses only one external laser optic the maximum reflector. Before aligning, inspect the rod and maximum reflector for damage. Remove the turning mirror mount. For aligning and measuring resonator energy, please refer to the *Final Test and Calibration Procedure*.

Inspecting and Replacing the Resonator Mirror, Nd:YAG

NOTE: This section applies to the Nd: YAG lasers only.

1. Inspect the maximum reflector carefully for burns or other degradation. Use a flashlight and compressed air to aid in the inspection. If any damage is noted, remove the optic with the mount and clean it.
2. Clean the optic carefully using methanol and a lens tissue or cotton swab. If the optic cannot be cleaned, rotate it in the mount to an undamaged area of the optic, otherwise, replace it.
3. Reinspect the mirror carefully for filth, streaks or specs. Use a flashlight and compressed air to aid in the inspection. Clean the optic again if necessary.
4. Install the optic with the mount, and then verify alignment. Align the resonator if necessary.

   For aligning and measuring resonator energy, please refer to the *Final Test and Calibration Procedure.* When making energy measurements, the entire beam profile must fill at least 75% of the detector area. Take a burn to confirm the size of the beam, and to confirm that it is centered on the detector face.

   CAUTION: Be sure that the burn paper is inside a plastic bag to prevent any burn residue and smoke from depositing on the laser rod or other optics.

Aligning the Turning Mirror, Apogee Elite Nd:YAG

The Apogee Elite Nd:YAG resonator uses a tuning mirror and beam combiner to align the Nd: YAG beam to the fiber assembly. Before aligning the mirror, inspect the turning mirror and beam combiner for damage. For aligning and measuring resonator energy, please refer to the *Final Test and Calibration Procedure.*

IMPORTANT: Aligning the turning mirror is a critical function.

Inspecting the Beam Combiner Glass/Removing the Holder

1. Disconnect fiber # 96 from the beam combiner assembly.

   NOTE: For the Apogee 5500/Acclaim 7000 lasers, also disconnect P14 (LED).
2. Loosen the two 8-32 socket head and remove the beam combiner.
3. Loosen the two 4-40 setscrews that secure the pick off holder on the beam combiner assembly. Remove the holder.
4. Inspect the beam combiner glass for any damage, and replace the glass if necessary. Make sure that the new glass is installed in the same orientation.

Replacing the Beam Combiner Glass

CAUTION: Verify calibration of the energy monitor when replacing the beam combiner glass. Recalibrate if necessary, or the laser may operate incorrectly.

Replacing the Glass Only, Apogee Elite

1. Remove the holder as described in the section above.
2. Remove and replace the glass assembly by removing the three holding screws and the wavy washer.
3. Install a new combiner glass and verify alignment of the Nd: YAG laser beam and aiming LED, and then realign if necessary.
4. Reinstall fiber #96 and verify the energy. If necessary, recalibrate as described in the *Final Test and Calibration Procedure.*

   NOTE: The beam combiner is coated on one side only. This coated surface must face the laser rod. A black dot on the glass indicates the uncoated surface. Remove this dot using methanol and a lens tissue or cotton swab before gluing the new glass in place.

Replacing the Glass Only, Apogee 5500/Acclaim 7000

1. Remove the holder as described on page 46.
2. Remove the damaged glass and any adhesive remaining on the holder. Clean with methanol.

   NOTE: The beam combiner is coated on one side only. This coated surface must face the laser rod. A black dot on the glass indicates the uncoated surface. Remove this dot using methanol and a lens tissue or cotton swab before gluing the new glass in place.
3. Use optical grade adhesive to secure the new glass to the holder so that the coated surface is toward the laser rod. Let it dry.
4. Reinstall the holder and glass in the beam combiner mount in the correct orientation.
5. Reverse above steps for installation.
6. Verify alignment of the aim LED, and then realign if necessary.
7. Verify the energy monitor, and if necessary, recalibrate as described in the *Final Test and Calibration Procedure.*

Replacing the Aim LED

If the aim beam is not visible and power is being supplied (only in Ready Mode), the aim LED must be replaced. The LED can be switched on and off by S2 on the Control Logic PCB.

NOTE: On the Apogee Elite system, the aiming beam diode is located on the Nd: YAG turning mirror mount.

1. Disconnect P14 from LED.
2. Loosen the three adjustment screws and remove the LED assembly and holder.
3. Loosen the 4-40 setscrew in the holder to remove the LED assembly.
4. Replace the LED assembly.

   NOTE: If only the LED is provided and not the complete assembly, resolder the new LED making sure that the anode (+) of the LED (long lead) is connected to the red wire.
5. Verify LED alignment and readjust if necessary.

This page has been intentionally left blank.

Section 9 SERVICE PROCEDURES–ELECTRICAL

For most electrical procedures involving the replacement, recalibration and/or test of a component, refer to the *Apogee Elite/Apogee 5500/Acclaim 7000 Final Test and Calibration Procedure* for complete instructions.

Replacing the Front Panel Display/Membrane Switch PCB

1. Turn off the laser power and disconnect the AC from the wall.
2. Remove four screws securing the front panel display to the top control/display plate.
3. Remove the two wires form the emergency stop switch.
4. Disconnect P13 and fiber #97 for the cal port assembly.
5. Remove all connectors from the membrane switch PCB and the display PCB.
6. Using a nut driver, remove the four 4-40 nuts that hold the display PCB, or the eight 4-40 nuts that hold the membrane switch PCB to the front panel plate.
7. Replace the PCB by reversing the above steps.

Replacing and Calibrating the Control Logic PCB

1. Turn off the laser power and disconnect the AC from the wall.
2. Follow the section above to remove the front panel display from the top control plate.
3. Remove all connectors from the PCB. Connectors should be marked, but pin number and harness length should only allow one possibility for connection.
4. Remove the six 4-40 screws that attach the PCB to the sheet metal.
5. Replace the PCB by reversing the above steps.
6. Perform the following sections of the *Final Test and Calibration Procedure*:
   - HVPS Calibration
   - Temperature Settings
   - Calibrating the Energy Monitor
   - Calibrating the Cal Port

Programming the Microcontroller

For updating laser software, follow the instructions found in the *Apogee 5500/Acclaim7000 Software Update Procedure Using a Laptop Computer*.

AC Fuses and AC Relay PCB

The AC fuses and the AC relay PCB are located under the AC distribution plate. The fuse block is next to the AC relay board. The fuse closest to the outside is Fuse 1 (F1). See *System Wiring Diagram* for a description, part number and designation of each fuse and relay. The fuse numbers follow sequentially to the center of the laser: F1 through F9.

Replacing the High Voltage Power Supply

1. Disconnect the laser from the AC service.
2. Disconnect the HV Blocking Diode and GND.
3. Disconnect the control cable from the power supply.
4. Remove the two flat head screws attaching the HVPS to the center post of the main chassis.
5. Completely loosen and move the center post of the frame to the side. It may be necessary to remove the line filter and bracket on systems equipped with these items.
6. Loosen and remove the flat head screw that attaches the shelf of the main capacitor to the chassis. This will allow the shelf to swing to the side slightly allowing the supply to pass by the cables.
7. While supporting the HVPS chassis, remove the remaining two 8-32 Phillips flat head screws, that hold the supply to the main chassis, and then remove the supply.
8. Remove the AC connection.
9. Reverse the above steps when installing a supply.

Calibrating the High Voltage Power Supply

Follow the procedure for testing the high voltage power supply as detailed in the *Final Test and Calibration Procedure.*

Low Voltage Power Supply

There is one low voltage power supply (LVPS) on this system mounted to the upper partition under the laser control PCB. This supply has two +12 V outputs, -12V and 5 V that is used for the logic control and power for the different solenoids.

Adjustment information and procedure on the LVPS can be found in the *Final Test and Calibration Procedure.*

Pin designations can be found on the *System Wiring Diagram*, #105-1847-000.

Replacing the Voltage Selection PCB

1. Disconnect the laser from the wall.
2. Disconnect all wire connectors from the PCB.
3. Remove the four mounting screws from the central portion of the PCB.
4. Replace the PCB and reverse the precious steps. Make sure the correct line voltage is selected.

This page has been intentionally left blank.

Draining the Coolant System

When it becomes necessary to drain the coolant system, use one of the two quick disconnect fluid couplings provided. One is located on the main water reservoir of the water pump assembly. The second is located underneath the front left of the laser system. This drain is attached to the air-to-fluid, heat-exchanger inlet tube and is accessible without removing dress panels.

CAUTION: When the laser is transported or shipped it is important that the coolant system is completely drained to avoid damaging the laser components. Use the quick disconnect underneath the laser for this purpose only.

Draining the Water

1. Place a pan under the front of the laser under the stainless steel quick disconnect.
2. Snap a mating 3/8" quick disconnect fitting into the fitting. This will drain the system.
3. Run the pump for a few seconds by holding the key in START to purge more fluid.
4. Disconnect the quick disconnect fitting.

Replacing the Deionizer (DI) Cartridge

1. Drain the water.
2. Remove the front panel behind the front door.
3. Remove the old deionizer (located next to water pump manifold assembly) by removing the tubing at the fittings and opening the clamp. Remove the old cartridge.
4. Insert a new cartridge and attach the tubing to it. If the cartridge does not have fittings, the fittings must be transferred. Clean the threads of any old Teflon tape, and then place approximately 1.5 turns of new Teflon tape on the male threads turning by hand until tight.

NOTE: Refer to **Figure 13** for an overview of the water pump components as needed. Before performing the following procedures the front and side panels need to be removed to access the components.

Replacing the Water Pump

1. Drain the system.
2. Disconnect all electrical connectors for the following:
   - ♦ heater
   - ♦ temperature switch on manifold
   - ♦ flow switch
   - ♦ temperature sensor
   - ♦ level sensors
   - ♦ water pump AC line
3. Remove the following water lines from the manifold:
   - ♦ 1/2" line to head
   - ♦ 3/8" line to D.I. cartridge
4. Remove the following water lines connected to tank assembly:
   - ♦ 1/2" line to flow switch
   - ♦ 1/4" line from heat D.I. cartridge
5. Remove the four nuts holding the pump plate to the laser chassis. Remove the pump and tank assembly.
6. Unwind the manifold from the pump outlet at the black PVC elbow. Remove the manifold.
7. Unwind the tank assembly from the pump inlet.
8. Clean all pipe threads by removing the Teflon tape. Re-tape the threads with Teflon tape.
9. Reassemble by reversing the previous steps.

Replacing the Flow Switch

1. Drain water from the tank.
2. Unplug P24 from the flow sensor.
3. Disconnect 1/2" tube from the switch. Unscrew the elbow fittings, and detach them from the flow switch.
4. Unscrew the flow switch to remove it.
5. Clean any residual Teflon tape from the threads of the fitting connected to the tank. Rewrap the fitting with Teflon tape.
6. If the wires of the new flow switch have not been terminated with a 2-pin plug, cut the wires from the old switch, and then butt-splice onto the new switch.
7. Replace with a new flow switch. Plug P24 back in.
8. Fill the tank with water. Check for leaks.

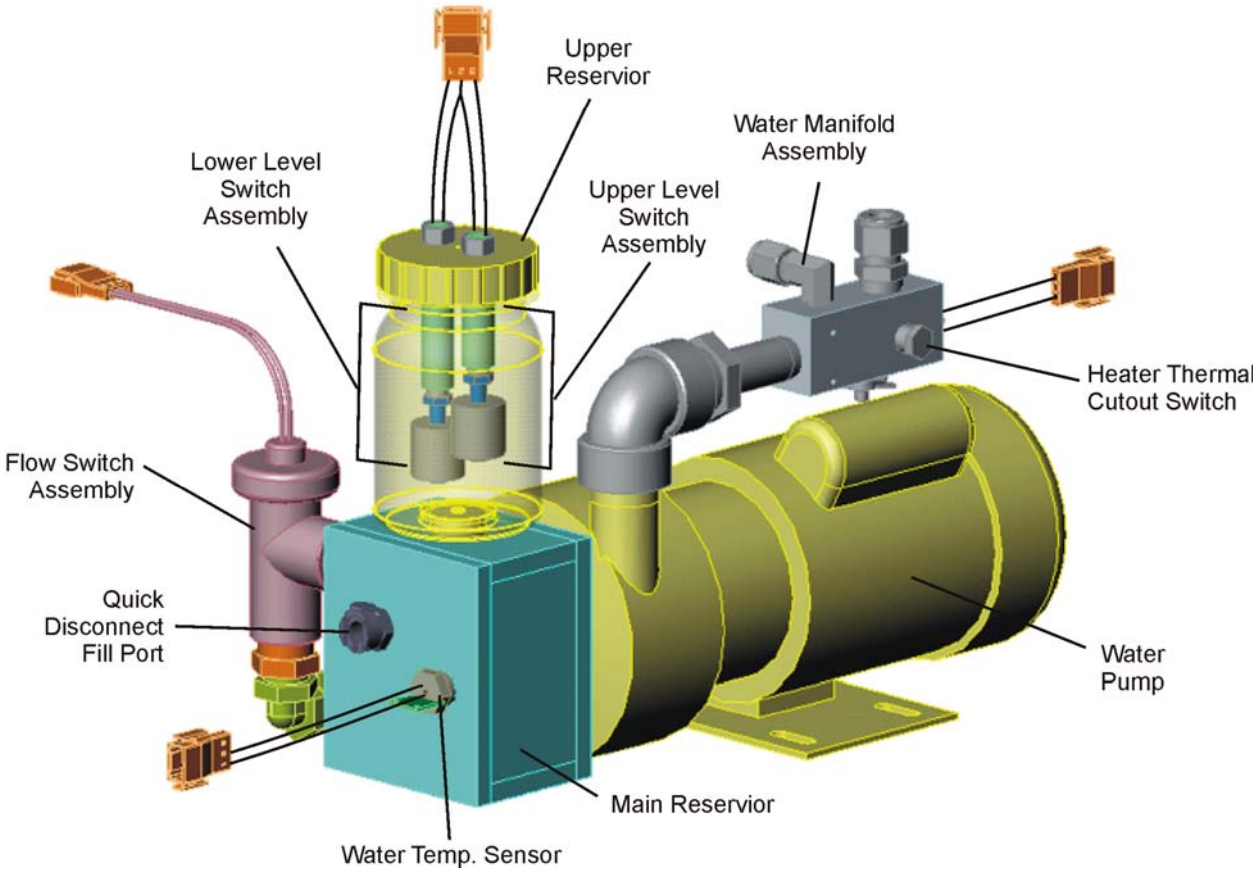

Figure 13–Water Pump Assembly

Replace the Temperature Sensor

1. Drain water from the tank.
2. Unplug P37 from the temperature sensor.
3. Unscrew the temperature switch from the tank.
4. Wrap the threads of the new temperature sensor with Teflon tape.
5. Install the new temperature sensor into the tank.
6. Plug P24 back in.
7. Fill the tank with water. Check for leaks.
8. Recalibrate the temperature as described in the *Final Test and Calibration Procedure.*

This page has been intentionally left blank.

Calibration of the Energy Monitor

Introduction and Overview

The laser is provided with built-in energy meter that allows the operator to calibrate the laser by measuring the actual energy delivered from the handpiece. Energy measurements are obtained by inserting the handpiece into the Cal Port, and then firing the laser. The Front Panel Display indicates the energy per unit area (or fluence in joules per square centimeter, J/cm^2), taking into account the area of the laser focal spot for the handpiece in use.

The Energy Meter consists of the following main components:

- The Cal Port which is built into the front panel. The Cal Port includes an internal switch to sense the presence of the handpiece, which allows the laser to fire while in calibration mode only if a handpiece is inserted.
- A sapphire window protects the internals of the Cal Port and is very damage resistant. It should be cleaned frequently using a tissue or cloth.
- A pinhole within the Cal Port allows only a small fraction of the incident light through a fiber optic cable to an optical sensor.
- The optical sensor receives the laser light incident on it, and produces an electrical signal proportional to the absorbed optical pulse energy.
- The signal is amplified and calibrated at the Laser Control PCB.
- The Front Panel Display shows the selected fluence in $joules/cm^2$.

Schedule for Calibration

Cynosure calibrates the laser's energy meter at the factory prior to shipment. The energy meter should be calibrated once a year by authorized service personnel. Call your local Cynosure representative to arrange for annual calibration by authorized personnel. The energy meter is calibrated by checking that the displayed fluence value corresponds to the actual laser pulse energy as measured by an independent energy meter of known accuracy.

CAUTION: This procedure should be attempted only by qualified authorized personnel, who are familiar with the operation of this laser, are familiar with the operation of the calibration standard, are well-versed in the general methods and techniques of ENERGY/FLUENCE measurements, and have read and thoroughly understood this procedure.

CAUTION: The accuracy of the calibration depends completely upon the measurement of laser pulse energy using a separate instrument as an independent calibration standard. If the independent calibration standard is not accurate or is not used correctly, then the built-in energy meter will also be inaccurate after calibration.

Required Equipment

- An accurate, NIST-traceable, fluence meter for use as a calibration standard. The selected calibration standard must be accurate for the appropriate wavelength and range of pulse energies. The meter's sensor element or input attenuator must withstand, without damage, the range of fluence and peak power per unit area typical of the laser.
- A standard service tool kit, e.g., a #2 Phillips screwdriver and a small flat-blade, potentiometer trimming screwdriver.
- Calibrated oscilloscope, 50 MHz or better, 2-channel (LeCroy 9310, Cynosure # 706-0107-000 TEKSCOPE THS-720 or equivalent)

Calibration Procedure, Apogee 5500/Acclaim 7000 Lasers

Record all calibration data on the *Calibration Accuracy Report*, see "Appendix B" on page 69 for a sample of the form.

NOTE: For the following procedure, the laser's coolant temperature must be at 65 C°.

WARNING: Keep the Cal Port Window clean to ensure proper calibration. Failure to keep the Cal Port Window clean may result in incorrect Energy Meter calibration.

For Apogee 5500 lasers, use the 10-mm handpiece. For the Acclaim 7000 laser, use the 5-mm handpiece.

1. Make certain that the Cal Port optical fiber #97 is attached to the Cal Port assembly and properly inserted into RX2 of the Laser Control PCB.

   CAUTION: The fiber optic must be properly routed and secured.

2. Install the handpiece into the Cal Port. Enter 'Constant Voltage' program. Place system in 5 ms, 1 Hz mode. Adjust the voltage to achieve 35 watts through the handpiece into the power meter.

3. While firing laser, adjust VR1 so that energy reading of the Cal Port as displayed on the computer screen agrees with actual measured power.

4. Exit CV, and enter operating mode. Verify energy meter calibration in the operator's software program. Calibrate and verify each pulse width as listed in the appropriate *Cal Port Accuracy Verification Report*. If the results lie outside of 90-110%, recalibrate the energy meter. If the system passes, calibration is complete only after signing the report.

Calibration Procedure, Apogee Elite Lasers

Record all calibration data on the *Calibration Accuracy Report*, see "Appendix B" on page 69 for a sample of the form.

NOTE: For the following procedure, the laser's coolant temperature must be at 65 C°.

WARNING: Keep the Cal Port Window clean to ensure proper calibration. Failure to keep the Cal Port Window clean may result in incorrect Energy Meter calibration.

For the Apogee Elite laser, use the 7-mm handpiece.

1. Connect the optical receiver cable into RX2 of the Laser Control PCB.

   CAUTION: The fiber optic # 97 must be properly routed and secured.

2. Install the handpiece into the Cal Port. Enter 'Constant Voltage' program. Select a wavelength of 1064 nm (Nd:YAG). Place system in 5 ms, 1 Hz mode. Adjust the voltage to achieve 35 watts through the handpiece into the power meter. Verify meter set to 'NIR' or 'YAG.'

3. While firing laser, adjust VR1 so that the energy reading of the Cal Port displayed on the computer screen agrees with actual measured power. Make note of TP3 final voltage at which Cal Port was set.

4. Make note of the PFN voltage at which the Cal Port was set.

5. Select a wavelength of 755 nm (Alexandrite). Without making any high voltage adjustment, fire laser into the Cal Port, and make note of Cal Port voltage as displayed on the computer monitor screen.

6. Fire into the Ophir and make note of the power meter reading. Verify meter set to 'VIS' or 'ALEX.'

7. Calculate the Alexandrite slope in joules / volt for the Cal Port by dividing the Ophir Power Meter reading by the Cal Port voltage from step 5. Make note of the ratio.

8. Exit the Constant Voltage program and prompt the Testall program.

9. Using a keystroke of "U", enter the ratio as calculated in step 7.

10. Press "x" from Testall program to prompt the Constant Voltage program.

11. Set laser for 755 nm, (Alexandrite) 5.0 msec, 1Hz, PFN Voltage to level noted in step 4.

12. Fire laser into power meter and make note of power reading. Fire laser into the Cal Port and verify that the Cal Port voltage as displayed on the computer screen agrees with the actual energy measurement. Make note of the Cal Port voltage and power reading.

13. Exit CV, and enter operating mode. Verify energy meter calibration in the operator's software program. Calibrate and verify each pulse width listed in the appropriate *Cal Port Accuracy Verification Report*. If the results lie outside of 90-110%, recalibrate the energy meter. If the system passes, calibration is complete only after signing the report.

Section 12 SERVICE PROCEDURES–FINAL CHECK

The section of the technical guide is to make certain that repaired Apogee Elite/Apogee 5500/Acclaim 7000 lasers pass all functional and physical performance requirements before being released back to a customer.

Final Check Procedure

NOTE: If a laser fails a step, record the discrepancy on a *Service & Repair Report*, as well as the corrective action taken.

1. Verify that the system contains distilled water.
2. Turn on the laser with the keyswitch and verify that the front control panel features light.
3. Test the automatic energy regulation and slope efficiency of the laser.
4. Verify that laser meets all system performance specifications for maximum fluence and rep. rates for each handpiece provided.

This page has been intentionally left blank.

Troubleshooting

There are two types of faults the user may encounter while operating the laser system.

Operational Faults

These faults are operational errors, often caused by improper operation or state of the laser. For example, an attempt to fire the laser without a fiber present is a fault. The operator can usually correct this type of fault. These faults will generate a fault code that will appear on the front display panel as shown in the following table.

Operational Fault Codes

Fault Code/Fault Description	Cause of Failure/Solution
W01:Open Interlock; Check Interlock	Check whether external interlock is open. Check for bad electrical connection. Replace if necessary. See *System Wiring Diagram*.
W02:No Fiber; Connect Fiber	Fiber interlock is open. Install a fiber, then press any key to continue. Check fiber interlock switches in cal port, replace if necessary.
W03:No Lamp Simmer; Press Standby	If lamps are not simmering in Standby Mode, check that both lamps flicker. If not, check lamps and simmer circuit. If lamps are simmering, check that the ends of fiber 90 are smooth and shiny. Verify fiber 90 is securely connected at DR4 on Interface PCB and CR1 Simmer PCB.
W04: Reserved	
W05:Low Water; Add Water	Add distilled water to fill level. If fault persists, check for loose electrical connection and functionality of level switches.
W06: Reserved	
W07:Power Supply Warning; Press Standby	High Voltage max. not reached after three seconds. Turn system off, then on, to test recurrence. If still fault, replace HVPS and recalibrate it.
W08:Power Supply Warning; Cycle Power	Turn system off, then on, to test recurrence. If still fault, replace HVPS and recalibrate it.
W09:Power Supply Warning; Press Standby	Cap bank not charged going to READY mode. Check for high voltage. Verify accuracy of HV setting and read back setting.
W10: Reserved	
W11:No Handpiece; Install Handpiece	No handpiece is connected.
W12:Handpiece Change Sensed	Handpiece was changed in ready or calibration modes.

Operational Fault Codes (Cont.)

Fault Code/Fault Description	Cause of Failure/Solution
W13:Check Fiber and Handpiece	Fiber transmission less than 50% Verify energy monitor and cal port calibrations. Verify fiber transmission.
W14: Reserved	
W15:Calibration Failed; Call Service	Resonator not producing adequate power to complete calibration, or transmission level of the fiber is below 50%. Verify resonator performance and/or transmission level.
W16:Calibration Failed, Call Service	Resonator not producing adequate power to complete calibration, or transmission level of the fiber is below 50%. Verify resonator performance and/or transmission level.
W17:Check Fiber and Handpiece	Energy measured at monitor, but not at cal port when required. Verify fiber transmission.
W18:Fluence Meter Error; Call Service	Cal port voltage too high. Recalibrate cal port.
W19:Internal Meter Error; Call Service	Monitor voltage too high. Recalibrate monitor. Verify fiber transmission.
W20:Energy Out of Range; Press Standby	Energy exceeds or is less than setting by 18% or more.
W21:Handpiece Removed; Standby and CAL	Handpiece was removed during calibration.
W22:Unable to Reach Fluence; Decrease	HVPS limit reached before max. handpiece energy reached. Verify resonator performance. Verify fiber transmission.
W23:Invalid Handpiece; Change Handpiece	The handpiece sensed cannot be used. Install an appropriate handpiece
W24 Reserved	

Critical Faults

Critical Faults will cause the laser system to stop operating and to generate a fault code that appears on the front display panel. Contact Cynosure Service if necessary.

Critical Fault Codes

Fault Code/Fault Description	To Clear Message
E01:Water Flow Fault; Cycle Power	Cycle Power
E02:Shutter Fault; Press Standby	Press Standby Key (◌)
E03:Shutter Fault, Press Standby	Press Standby Key (◌)
E04:Fuse Open; Call Service	Press Standby Key (◌)
E04:Fuse Open; Call Service	Press Standby Key (◌)
E06:Power Up Check Failed; Call Service	Cycle Power
E07:High Voltage Fault; Press Standby	Press Standby Key (◌)
E08:High Voltage Fault; Cycle power	Cycle Power
E09:Coolant Over Temp; Let Laser Cool	Self Clearing
E10:Coolant Sensor Fault; Call Service	Self Clearing
E11:Flow Error; Call Service	Self Clearing
E12:Shutter Fault YAG, Press Standby	Press Standby Key (◌)
E13:Shutter Fault YAG, Press Standby	Press Standby Key (◌)

Self Test

During startup, the lasers run a self test. If any critical area fails the self test or fails during operation, a system fault and a fault code appears on the display. See “Critical Faults” on page 65 for fault code definitions.

Miscellaneous Troubleshooting

Problem	Possible Cause	Solution
Laser does not start.	Power is not properly connected.	Connect power cables. Check that laser’s main circuit breaker is in the on position.
	The keyswitch is OFF.	Turn the keyswitch to START and let it return to ON.
Laser will not go into Standby Mode.	Lasers not up to operating temperature.	Allow laser to run until WARM UP message is off.
	Check that no other fault messages are displayed.	Correct any conditions as indicated by fault messages.
	Standby Key (◯) not activated or not working.	Press Standby Key (◯).
Laser will not enter Ready Mode.	Operator switch activated.	Check that finger switch or foot switch is not being pressed.
	Ready Key (⊙) not activated or not working.	Press Ready Key (⊙).
Ready LED lit, but laser will not fire outside of Cal Port.	Laser not properly calibrated as indicated by Front Panel Display	Recalibrate Laser.
	Fiber cable not connected.	Check that handpiece fiber cable is properly connected.
	Foot switch not connected.	Check that foot switch connector is properly inserted into foot switch receptacle.

NOTE: If any problems occur that are not covered in the troubleshooting chart, or the suggested solutions do not work, call the Cynosure Service Department at (888) 523-2233, FAX (978) 256-6556 or Service FAX at (978) 256-4888.

Attaching a Laptop Computer

For communication and diagnosis of the laser, a laptop computer with a Windows DB9 to DB9 Null-modem serial cable (pins 2-3 swapped), and HyperTerminal or an equivalent serial terminal program is needed.

NOTE: The following section is for setting up HyperTerminal the first time only. Other RS232 terminal programs should be setup using the same parameters.

HyperTerminal Setup

1. Start HyperTerminal program (from start menu–programs–accessories–communications).
2. Set ‘CONNECT USING’ to ‘DIRECT TO COM1:’ or the com port being used. Click OK.
3. Set ‘Bits per second’ (BAUD) to 38400.
4. Set ‘Data bits’ to 8.
5. Set ‘Parity’ to NONE.
6. Set ‘Stop bits’ to 1.
7. Set ‘flow control’ to NONE. Click OK.

NOTE: HyperTerminal should be running and the laser status should be displaying on the computer.

This page has been intentionally left blank.

Apogee Elite/Apogee 5500 Alexandrite Lasers **Calibration Accuracy Report**

Tester: ______ **Unit #** ______ **Unit Type:** ______ **Date:** ______

Pulse Width: **20** **Handpiece:** **10 mm** **Meter Mfg. Serial No./Cal. Due Date:** ______

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
Cap Bank	System Settings		External Meter	Allowed Power Range (Watts)			
VDC	Rep Rate (Hz)	Fluence (J/cm²)	Power (W)	90% Min.	100%	110% Max	Col. 4 pwr. > Col. 5 and < Col. 7 (P/F)
	1	7		4.9	5.50	6.0	
	1	50		35.3	39.27	43.2	
	1.5	7		7.4	8.25	9.1	
	1.5	40		42.4	47.12	51.8	

This page has been intentionally left blank.