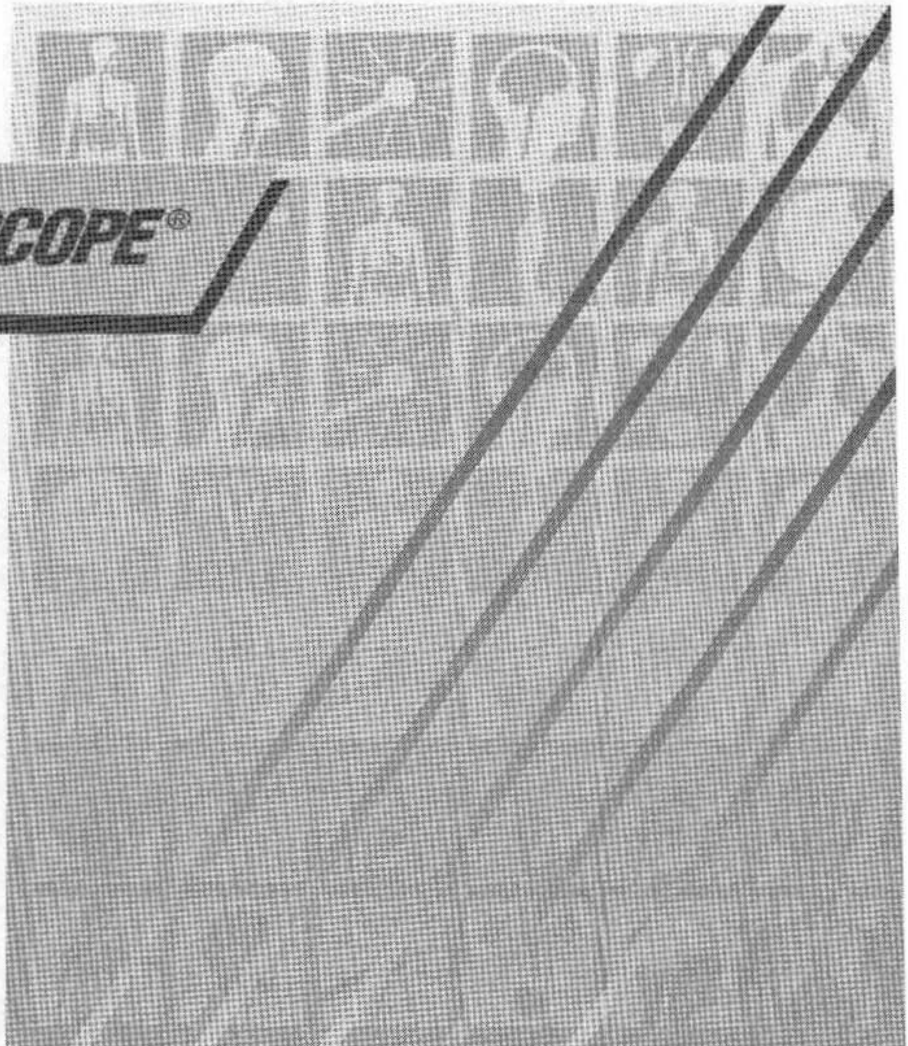


LASERSCOPE®

600 SERIES

SERVICE MANUAL

Table of Contents

Section 3: . . .System Overview, Installation and Operation

Section 5: . . . . Electronics

Section 6: . . . . .Laser and Optics

Section 7: . . . . .Dye Circulation System

Section 8: System Interlocks and Error Codes

List of Figures

List of Tables

Section 1: Introduction

Reader Audience

The 600 Series Dye Module is designed to be used in conjunction with a KTP pump laser in Photodynamic Therapy.* This document is the service and reference manual for the Dye Module. The information contained in this manual is intended for use by Laserscope service engineers and by those individuals who have completed the Laserscope biomedical training course with certification at the factory site.

The owner/operator is not authorized to remove any of the fixed covers or modules from the system, except as described in the Operator Manual for the completion of routine maintenance tasks. Removal of any of these covers or modules will be considered unauthorized modification or misuse of the instrument and will void Laserscope's warranty. Laserscope will not be liable for problems arising from repairs made by unauthorized personnel.

* In the United States, the 600 Series Dye Module has been approved for investigational use in Photodynamic Therapy.

Uses of the Manual

This manual is a comprehensive tool that serves as a reference or as a guide in troubleshooting the various sub-systems of the 600 Series Dye Module. Sections of this manual identify and describe the major assemblies, summarize their operation, point out fault conditions, discuss troubleshooting steps, and list requirememts for periodic maintenance.

The 600 Series Dye Module exists in several versions. This manual is specifically designed for use with the World version Dye Module. Where differences occur between the High and Low Power versions, these are noted in the text. For information about other versions of the Dye Module, contact your Laserscope representative or local Distributor.

As product upgrades and revisions are made for increased safety, higher performance and greater user convenience, addendums will be made available to keep this manual up to date.

Section 2: Safety

Introduction

Before attempting to service the 600 Series Dye Module, first thoroughly read and understand this service manual. This and the 600 Series Dye Module Operator Manual provide important information regarding the installation, operation and service of the Dye Module. Information on the installation, operation and service of the laser system is provided in the KTP/532® Surgical Laser System Operator and Service Manuals.

WARNING

Use of Dye Module controls or adjustment to controls to perform procedures other than those specified herein may result in hazardous radiation exposure.

Hazards and Precautions

The principal hazard associated with use of the 600 Series Dye Module is eye injury.

The cornea, lens and ocular media of the eye are largely transparent to visible (380-780 nm) and near infrared

(780-1200 nm) laser light. This light passes through these regions of the eye and is readily absorbed by pigmented tissues: the retina and choroid layers at the back of the eye. Laser energy is converted to heat in these regions and, if the energy is great enough, will cause irreversible retinal damage. The degree of damage is dependent on the laser beam power, the focusing ability of the lens and the duration of exposure.

Precautions against eye injury should include protective eyewear for anyone in the near vicinity of the laser beam. Protective eyewear should always be worn when servicing the Dye Module if the Dye Module is connected to the pump laser.

The recommended protective eyewear is provided with the 600 Series Dye Module. These goggles and spectacles have a minimum optical density rating of 4.0, and are suitable for use at up to 8.0 watts of power at wavelengths from 600 - 699 nm.

Note:
Different eyewear is required for use with the KTP/532 Surgical Laser System. Refer to the Operator Manual for the surgical laser to obtain detailed information about the eyewear needed for the 532 nm wavelength.

Safety Standards

The American National Standards Institute (ANSI), in The Safe Use of Lasers in Health Care Facilities (Z136.3) and The Safe Use of Lasers (Z136.1), has specified control measures to protect the operators, attendants and patients involved in the use of lasers. Standards are also provided by the U.S. Food and Drug Administration's Center for Devices and Radiological Health (CDRH).

Any individual involved in the operation or servicing of a laser should read, and thoroughly understand, the standards provided by ANSI, CDRH and other organizations.

Laser Area and Operating Room

Precaution against unsafe laser energy exposure mandates that a Class IV Laser Controlled Area be established by the facility and managed by trained personnel, under the guidelines provided by the U.S. Center for Devices and Radiological Health (CDRH).

For information and recommendations concerning laser area and operating room safety precautions, please refer to the KTP/532 Surgical Laser System Operator's Manual.

Safety Interlocks

The 600 Series Dye Module and the KTP/532 Surgical Laser System have been designed to include various safety interlocks. ANSI and CDRH standards require that such interlocks be incorporated into any laser or laser system used within the United States. The 600 Series Dye Module meets or exceeds these safety requirements. The safety interlocks provided in the 600 Series Dye Module are described in Section 5, Electronics, and Section 8, System Interlocks and Error Codes.

Labeling

Certain labeling, mandated by Title 21 of U.S. Code of Federal Regulations (21 CFR 1040.10 - 1040.11), has been affixed to the 600 Series Dye Module. This labeling includes identification of the manufacturer, the laser class, laser apertures, electrical specifications and appropriate warning and caution statements. Figure 2.1 shows the location of this labeling on the 600 Series Dye Module. Figure 2.2 illustrates individual label details.

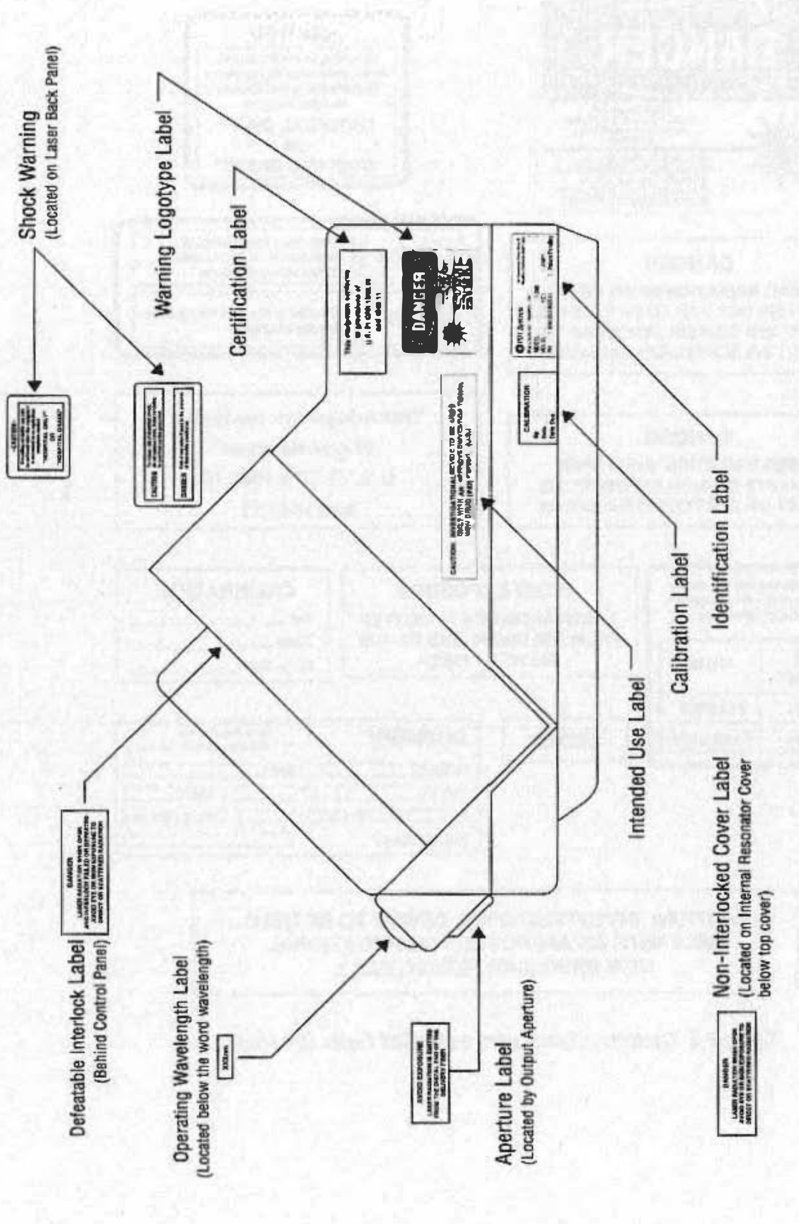


Figure 2.1 *The location sites of all labels on the 600 Series Dye Module.*

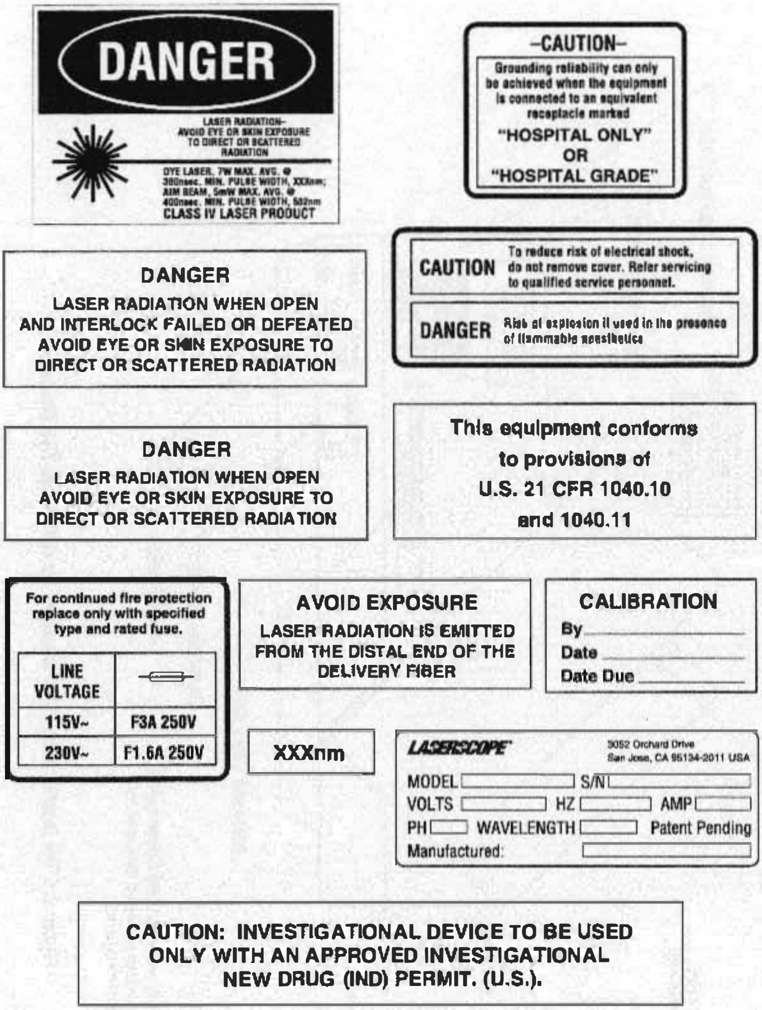


Figure 2.2 Contents of labels used on the 600 Series Dye Module.

Precautions to Observe During Servicing

Connecting the Dye Module to an AC power source after removing the cover panels will allow exposure to high voltages. Practice common sense when placing hands inside the cabinet, and do not allow foreign objects to fall inside.

WARNING

When servicing the system, do not wear jewelry (e.g., rings, chains, etc.) or clothing that might pass into the laser beam path (e.g., neckties, scarves, etc.)

Eye Injury

Visible light and near infrared laser energy passes through the transparent components of the eye (the cornea, lens, aqueous and vitreous humor) and is focused on the retina. This light can cause an accidental retinal burn, the degree of damage of which will depend on the power of the beam, the focus of the lens, and the duration of the exposure. Precautions against eye injury should include always wearing the safety eyewear recommended.

Burns

Irradiating tissue accidentally will result in a burn, regardless of the wavelength. Care and precision in aiming and firing the laser are of paramount importance.

Ignition of Flammable Materials

Many kinds of material can be ignited by the laser beam. Use of non-flammable materials is recommended.

Electrical

Electrical hazards with a laser are the same as with any electrical appliance. Carefully plug the unit into the wall outlet. Make sure the area is free of water and hands are dry. Always disconnect the laser by grasping the plug and not the power cord. Examine the electrical cord routinely, and repair and/or replace as needed.

Additional Hazards to Consider

Components of a Safe Laser Program

The surgical laser has the ability to be a very useful surgical instrument. It can also be quite dangerous if used improperly.

The KTP/532 Surgical Laser System is classified as Class

IV by both the American National Standards Institute (ANSI) and the FDA's Center for Devices and Radiological Health. Class IV means that the laser is capable of producing severe damage to both skin and eye tissues.

The 600 Series Dye Module is also classified as Class IV. However, it does not generate laser energy independently of the pump laser, so it does not produce laser light unless it is connected to the KTP laser system.

Electrical Hazards

Laser systems are designed to be free from electrical danger to the user. High voltages are fully contained within the equipment and systems are fused or protected with circuit breakers. None the less, no user should operate the system if they suspect any electrical problem. If any protective housing is loose or missing, the system should be unplugged and service personnel alerted. Liquids should never be placed upon or hung above any laser system. If a system is splashed with liquids by accident, the user should unplug the system until it can be determined whether any liquid got inside the laser system. If any electrical cord is damaged, it should be replaced immediately, and in a medical environment, should be capable of meeting Underwriter's Laboratory Standard #544 leakage current requirements as a minimum.

Skin Hazards

The potential for skin injury is mainly to those in the immediate lasing field. These accidents are usually minor and can always be avoided by never firing the laser until the entire path of the laser beam is determined to be safe. To prevent the possibility of an accident, always observe the beam path carefully prior to firing the laser.

Eye Hazards

Information about eye hazards and protection can be found in the Safety Section of the KTP/532 Surgical Laser System Operator Manual.

Introduction

The 600 Series Dye Module is used for Photodynamic Therapy (PDT)* and requires the KTP/532 Surgical Laser System to provide the optical power necessary to operate. The complete Dye Module and surgical laser system have three principal components:

- 600 Series Dye Module
- KTP/532 Surgical Laser
- Fiberoptic Delivery System

The 532 nm output from the surgical laser is delivered to the 600 Series Dye Module via the Fiberoptic Interface Cable. The Dye Module controls the operation and power of the surgical laser via a two-meter Control Cable. The Fiberoptic Delivery System connects directly to the 600 Series Dye Module through the PDT Delivery Device Port. Figure 2.3 shows the components of this system and how they are connected.

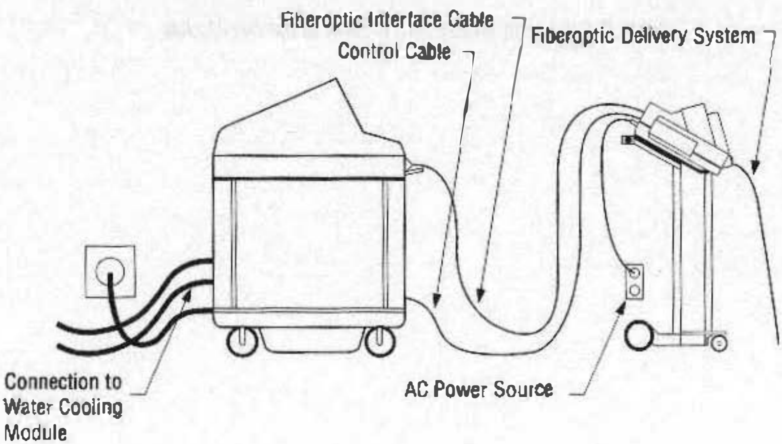


Figure 2.3 Dye Module and Surgical Laser Connections.

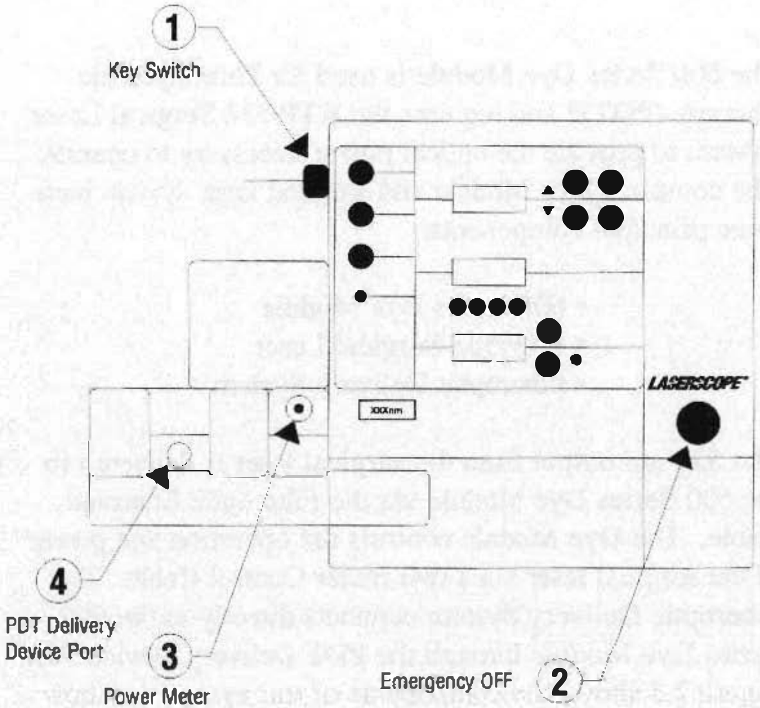
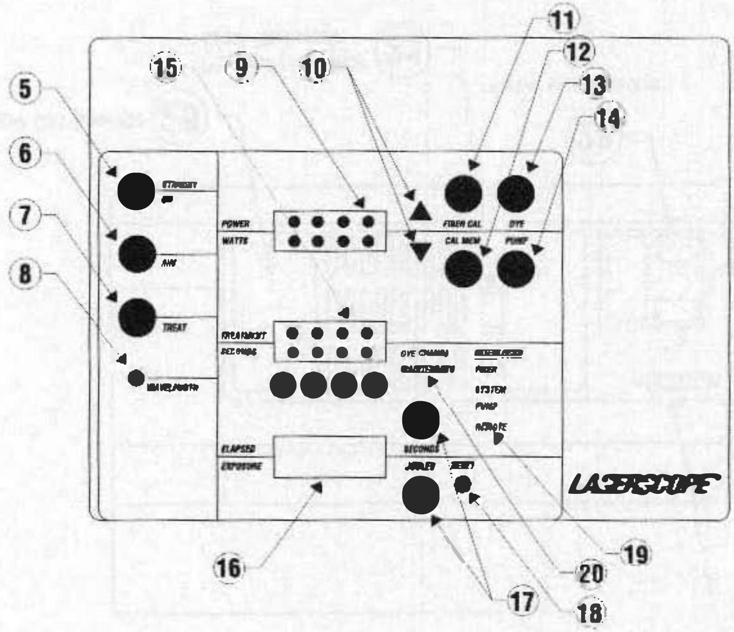


Figure 2.4 Features located on the Front of the Dye Module.



5 Standby/ON
6 Aim
7 Treat
8 Wavelength
9 Power/Watts
10 Power Control
11 Fiber Cal Mode
12 Cal Mem Mode
13 Dye Mode
14 Pump Mode
15 Treatment/Seconds Display
16 Elapsed Exposure Display
17 Seconds/Joules Buttons
18 Reset Keys
19 Interlock Fault Messages
20 Dye Change & Maintenance Warning Messages

***Figure 2. 5** Control Panel details and illuminating message screens.*

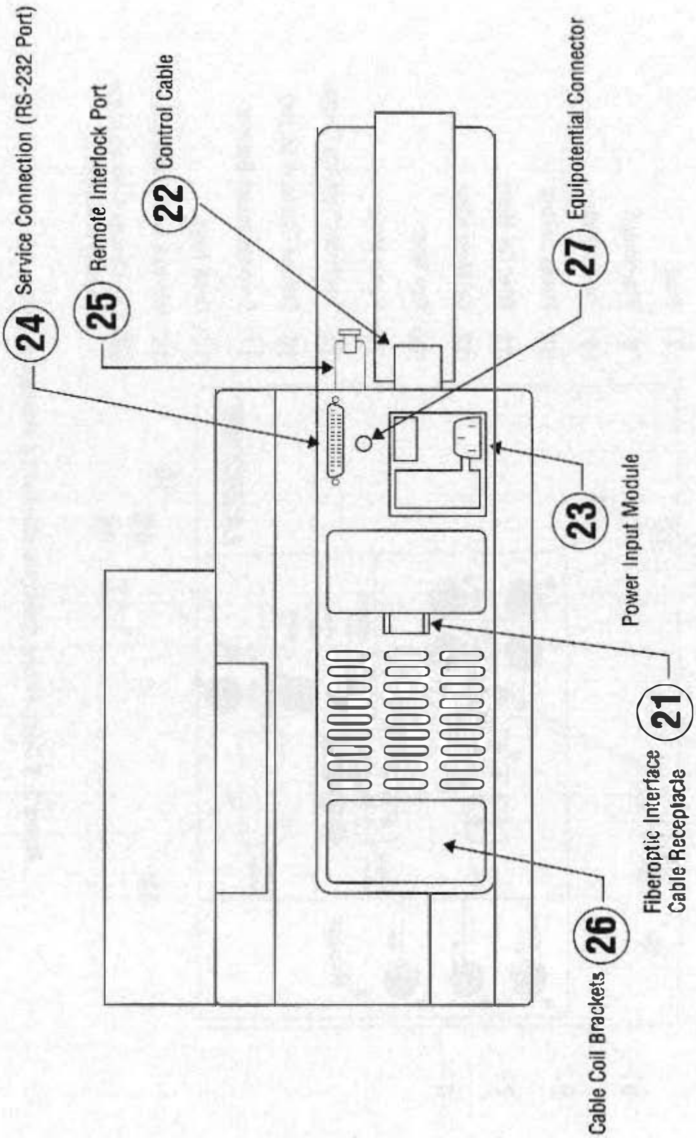


Figure 2.6 Features located on the back of the Dye Module.

Section 3: System Overview, Installation and Operation

Introduction

The 600 Series Dye Module is used for Photodynamic Therapy (PDT)* and requires the KTP/532 Surgical Laser System to provide the optical power necessary to operate. The complete Dye Module and surgical laser system have three principal components:

- 600 Series Dye Module
- KTP/532 Surgical Laser
- Fiberoptic Delivery System

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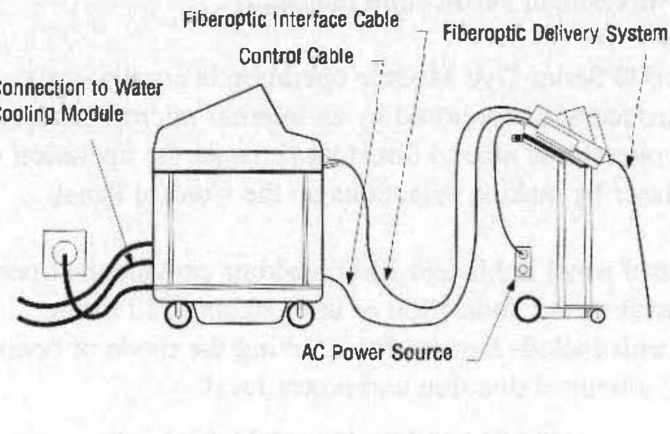

Figure 3.1 Dye Module and Surgical Laser Connections

System Components

The main components of the complete system are described in the following sections.

600 Series Dye Module

The 600 Series Dye Module converts 532 nm laser energy from the surgical laser system to a different wavelength in the range of 600-699 nm. Special features of the Dye Module facilitate its use in a clinical environment. These features include:

- Built-in power meter for measuring the delivered energy at the fiber tip.
- Exposure controller for controlling the treatment duration, with a visual display of elapsed time or elapsed energy delivered through the fiber.
- Wavelength verification indicator.

The 600 Series Dye Module operation is continuously controlled and monitored by an internal microprocessor. The operator is able to direct and change the operation of the laser by making selections on the Control Panel.

Control panel lights and LED readouts provide the operator with a clear indication of laser status at all times. Controls include buttons for selecting the mode of operation, treatment duration and power level.

The Control Panel displays various interlock, maintenance and HELP (or "H") messages designed to provide the operator with feedback regarding the status of the laser. These displays only illuminate when an interlock fault occurs or when a maintenance issue or system malfunction requires attention. For more information, see Section 8, System Interlocks and Error Codes.

The Dye Module is lightweight and portable, and may be ordered with a custom designed cart and/or a custom shelf for mounting on top of the KTP/532 Surgical Laser. The cart has large drawers for storage of manuals, protective eyewear, power cords, interface cables, treatment fibers, and other accessories.

Rubber wheels are provided for added mobility. If desired, the laser may be removed from its cart and placed on a table top or mounted on top of the KTP/532 Surgical Laser System with a specially-designed shelf. Two thumb screws secure the Dye Module to the cart or the shelf.

KTP/532 Surgical Laser

The KTP/532 Surgical Laser is used as a pump source, providing the Dye Module with the optical power necessary to operate. Special features, operating instructions, and safety precautions for the laser are presented in the KTP/532 Surgical Laser System Operator Manual. Service information can be found in the KTP/532 Surgical Laser System Service Manual.

Fiberoptic Delivery System

The PDT Fiberoptic Delivery System delivers light from the Dye Module and evenly distributes it over the area being treated. The delivery system is a fiberoptic device with a special connector. This connector is designed to fit the PDT Delivery Device Port on the 600 Series Dye Module.

PDT fibers are available from Laserscope and other manufacturers. Types of PDT fibers include Cylindrical Diffusers, Spherical Diffusers, and Microlens Fibers. These fibers allow for treatment of a single area. A Fiber Splitter can be attached to the delivery system if multiple areas require treatment during a single session. The splitter allows the Dye Module output to be delivered evenly to two or more PDT fibers.

Product Specifications

The 600 Series Dye Module is a Class IV laser system under the guidelines provided by the U.S. Center for Devices and Radiological Health (CDRH). This classification identifies the Dye Module as an instrument that permits human exposure during operation to levels of laser radiation in excess of certain accessible emission limits as defined by the CDRH and provided in the U.S. Code of Federal Regulations (21 CFR 1040.10). Table 3.1 shows the product specifications for the 600 Series Dye Module.

Intended Use	Photodynamic Therapy
600 Series Dye Module	Quasi-CW (25 kHz)
Pump Laser System	KTP/532 Surgical Laser (with water cooling module)
600 Series Dye Module Performance	
Maximum Average Power	
High Power Module	7.0w +/- 15% at 630 nm with 30w pump laser power at 532 nm
Low Power Module	3.2w +/- 15% at 630 nm with 16w pump laser power at 532 nm
Aim Beam	<5 mW at 532 nm
Equipment Classification	-Class IV -Type BF -Ordinary -Continuous -Equipment not suitable for use in the presence of a flammable anaesthetic mixture or with oxygen or nitrous oxide.
Wavelengths	630, 652, 660, and 664 nm +/- 3 nm (each wavelength requires a specific Wavelength Verification Unit and adjustment of the Birefringence Filter)*
Beam Divergence	1.6° +/- .2°
Pulse Duration	380 - 780 nsec

Table 3.1 Product Specifications for the 600 Series Dye Module

600 Series Dye Module Cooling	Air-cooled
Dye Cartridge	Removable, operator-replacable self-contained dye cartridge; 0.75 liter minimum capacity.
Dye Module Electrical Requirements	Voltage: 115/230VAC Cycles: 50 - 60 Hz Rated Current: 1A at 230V and 2A at 115V, Single Phase Grounded input and hospital grade cord where required.
Delivery Systems	200 micron core or greater, designed for use in Photodynamic Therapy (PDT). Only those fibers approved by Laserscope may be used with the 600 Series Dye Module.
600 Series Dye Module Dimensions	
Height	11 inches
Width	20 inches
Depth	18 inches
Weight	54 lbs.
Cart Dimensions	
Height	39 inches
Width	21 inches
Depth	21 inches
Weight	80 lbs.

***Table 3.1** Product Specifications for the 600 Series Dye Module (cont.)*

System Installation

This section provides a general guideline for the installation of the 600 Series Dye Module. The KTP/532 Surgical Laser System used with the 600 Series Dye Module has specific electrical requirements. Consult the KTP/532 Operator or Service Manual for a list of these requirements. It is the customer's responsibility to satisfy these requirements prior to the installation of the system. Failure to fulfill these requirements can result in intermittent operation and can damage the laser systems. Read the following information carefully.

Space Requirements

The space requirements for the 600 Series Dye Module are shown in Table 3.2.

Dye Module	
Height	11 inches
Width	20 inches
Length	18 inches
Weight	54 pounds
(Dimensions are without cart)	

Table 3.2 Dye Module Space Requirements

For space requirements for the KTP/532 Surgical Laser System, consult the laser Operator Manual.

Power connections must be within a radius of six feet from where the surgical laser console will be positioned in the treatment room. The surgical laser console, in turn, must be able to be positioned not more than seven feet from the center line of the treatment table.

Special Power Requirements

There are no special requirements for the 600 Series Dye Module. Refer to Table 3.1 for Dye Module electrical needs. There are, however, special power requirements for the KTP/532 Surgical Laser System. Refer to the laser system Operator or Service Manual for the power requirements appropriate to the system and the country

NOTE

All units are equipped with a multi-tap isolation transformer allowing them to be reconfigured for other operating voltages. Contact Laserscope Customer Response Center for information regarding specific voltage requirements for your system and your country.

Environmental Requirements

The recommended room temperature range is 65° to 80o F.

Table 3.3 shows the water requirements for external cooling. External water cooling of the KTP/532 Surgical Laser System is required for efficient operation when pumping the Dye Module for long treatment periods. An External Water Cooling Module, PN# 10-4611, is required for all 800 Series Surgical Laser Systems.

Maximum Temperature	.80°
Minimum Pressure	.25 PSI
Maximum Pressure	.65 PSI
Minimum Flow Rate Required	.2 GPM

Table 3.3 Water Requirements for External Cooling

WARNING

Always exercise caution when lifting and moving the Dye Module.

Moving the Dye Module

The 600 Series Dye Module is lightweight and portable, and it can be positioned conveniently near the treatment area, on a table top, cart, or mounted on top of the surgical laser.

However, although the 600 Series Dye Module is lightweight, do not attempt to carry it alone. Always obtain assistance in transferring the laser to and from the cart. Before moving the module, complete the following:

1. Verify that the Dye Module key switch is OFF.

2. Verify that all accessories and cables are disconnected and properly stored. Unplug and secure power cord in cart. Disconnect Fiberoptic Interface Cable from the surgical laser. Replace the red protective cap, and wrap the cable around the coiling bracket on the rear of the Dye Module. Disconnect the Control Cable and the PDT fiber.

3. Transfer the 600 Series Dye Module to the cart and secure it using the thumb screws provided under the cart or shelf pedestal.

4. Roll the Dye Module and cart to the desired location.

5. Alternatively, the Dye Module may be mounted on top of the surgical laser and secured with a specially-designed shelf and moved with the surgical system.

6. If a mounting surface other than the custom-designed cart or surgical laser is used, it must be larger than the Dye Module's base, with a level and non-slippery surface. If placed on a cart, the cart should have wheel locks to prevent uncontrolled motions of the Dye Module.

Control Panel and System Features

The 600 Series Dye Module controls are functionally arranged on the colored membrane touch panel. All operations are performed by pressing the appropriate buttons.

Figure 3.2 identifies the features and controls located on the front of the Dye Module. Figure 3.3 shows the control panel details and the illuminating message screens. Figure 3.4 shows the features and controls located on the back of the Dye Module.

The controls and features are described below. Refer to Figures 3.2, 3.3 and 3.4 for the location of each.

Key Switch (1)

The Key Switch supplies electrical power to the Dye Module when turned clockwise. The key switch activates the power supply, microprocessor, and all safety interlocks. Interlock faults will be illuminated on the control panel only when they occur. The POWER/WATTS/SECONDS display is illuminated when the key switch is activated, but no value is displayed: (......). The key switch also turns the Dye Module off (counter-clockwise turn).

Emergency OFF (2)

The Emergency OFF button is intended to be used in instances where immediate interruption of laser operation is desired. Pressing this button interrupts all lasing and all electrical processes, returning the Dye Module to the KEY ON status.

Power Meter (3)

The Power Meter allows measurement of power output at the fiber tip when FIBER CAL mode is selected. The power meter is designed using an integrating sphere to allow measurement of diffusing and forward illuminating PDT fibers. The power meter also allows setting of the calibration factor when the CAL MEM selector is chosen.

PDT Delivery Device Port (4)

PDT fibers are connected to the Dye Module via the PDT Delivery Device Port. Always slide the black protective cover over the fiber port of the Dye Module when fibers are not connected. Make sure that the glass Calibration Pod (Cal Pod) Insert is removed prior to closing cover to avoid damage.

Standby/On (5)

Pressing the STANDBY/ON button activates the dye pump, begins dye circulation, starts the cooling fan, and activates the initialization sequence of the Dye Module. However, no laser beam is transmitted in this mode. The LED displays will illuminate (POWER/WATTS, TREATMENT/SECONDS, and ELAPSED EXPOSURE).

At startup, a short initialization period will occur during which the ELAPSED EXPOSURE counter will count

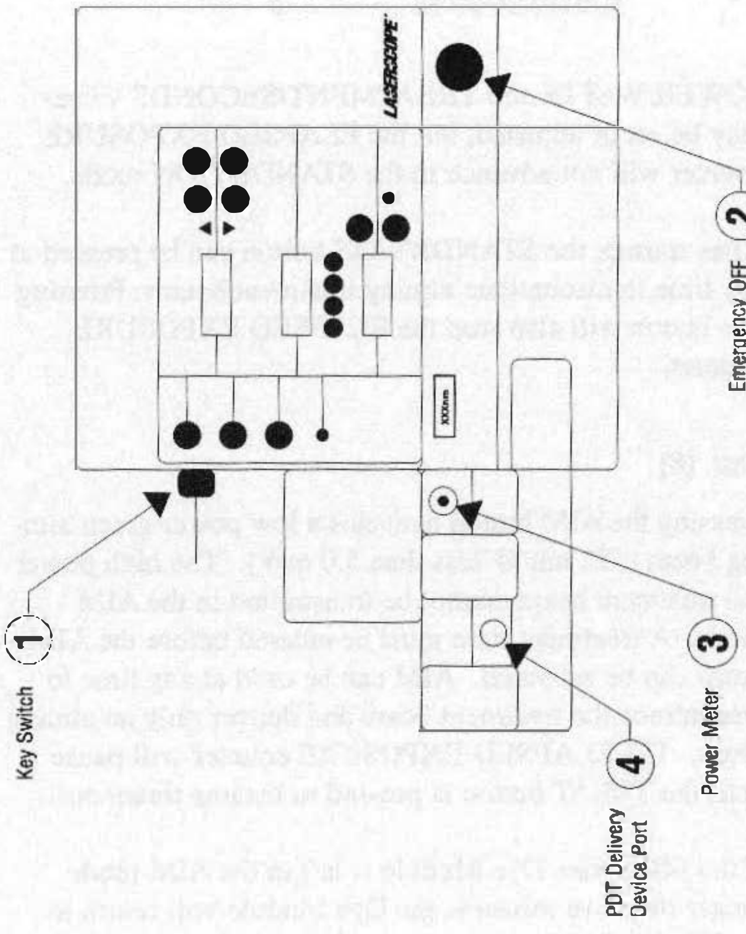

Figure 3.2 Features located on the Front of the Dye Module.

down the time remaining before the Dye Module can be used. Following this warm-up period (maximum of 66 seconds), the LED readouts will display the following values:

POWER/WATTS 0.10
TREATMENT/SECONDS 0
ELAPSED EXPOSURE 0

POWER/WATTS and TREATMENT/SECONDS values may be set or adjusted, but the ELAPSED EXPOSURE counter will not advance in the STANDBY/ON mode.

After startup, the STANDBY/ON button can be pressed at any time to discontinue aiming treatment beams. Pressing this button will also stop the ELAPSED EXPOSURE counter.

Aim (6)

Pressing the AIM button activates a low power green aiming beam (532 nm @ less than 5.0 mW). The high power red treatment beam cannot be transmitted in the AIM mode. A treatment time must be entered before the AIM beam can be activated. AIM can be used at any time to discontinue the treatment beam and deliver only an aiming beam. The ELAPSED EXPOSURE counter will pause until the TREAT button is pressed to resume treatment.

If the 600 Series Dye Module is left in the AIM mode longer than five minutes, the Dye Module will return to the STANDBY/ON mode.

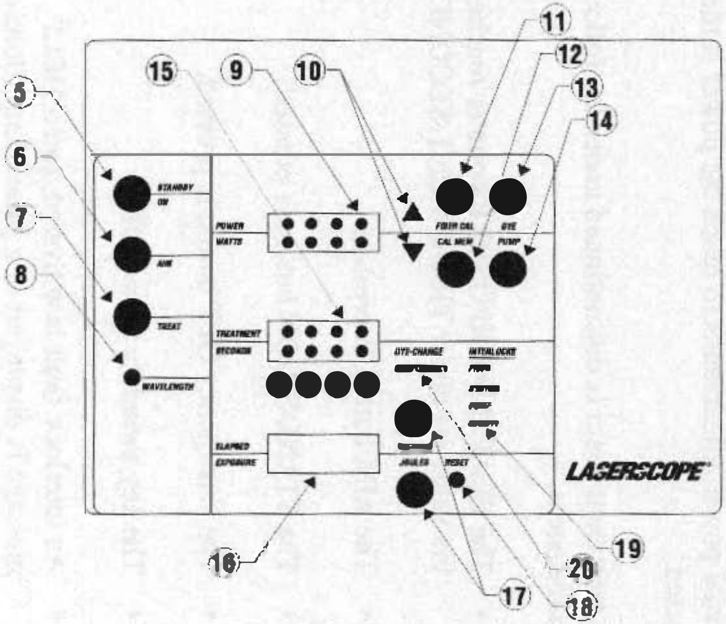

Figure 3.3 Control Panel details and illuminating message screens

5. STANDBY/ON
6. AIM
7. TREAT
8. WAVELENGTH
9. POWER/WATTS DISPLAY
10. POWER CONTROL ARROW KEYS
11. FIBER CAL MODE SELECTOR
12. CAL MEM MODE SELECTOR
13. DYE MODE SELECTOR
14. PUMP MODE SELECTOR
15. TREATMENT/SECONDS DISPLAY
16. ELAPSED EXPOSURE DISPLAY
17. SECONDS/JOULES BUTTONS
18. RESET KEYS
19. INTERLOCK FAULT MESSAGES
20. DYE CHANGE AND MAINTENANCE WARNING MESSAGES

Treat (7)

TREAT opens the Dye Module shutter, allowing the treatment beam to be transmitted. TREAT will only operate if the AIM mode has first been activated and treatment time has been set. The treatment POWER should also be set prior to selecting TREAT or the default value of 0.10 watts will be used.

An approximate three second delay prior to treatment beam emission will occur as required by U.S. 21 CFR 1040.10. The TREAT light will flash on and off during this delay. The delay will be extended to as long as five seconds if the system requires additional time to complete internal power adjustments to reach the power setting selected.

The treatment beam is discontinued under the following circumstances:

- The ELAPSED EXPOSURE counter reaches the value set under TREATMENT/SECONDS.
- The AIM button is pressed.
- The STANDBY/ON button is pressed.
- The Emergency OFF button is pressed.
- The key switch is turned OFF.
- An interlock fault is activated, and a HELP message is displayed or a panel lamp illuminated.

Wavelength (8)

The WAVELENGTH light indicates verification of the specified treatment wavelength. It illuminates continuously when the 600 Series Dye Module output is within +/- 3 nm of the specified wavelength. If the wavelength indicator light is flashing prior to, or during treatment, an H15 Error Code will be displayed. This Error Code can be overridden by pressing STANDBY. However, the wavelength should be checked by an appropriate wavelength verification device. See Section 6, Laser and Optics, for detailed instructions.

Power/Watts Display (9)

POWER/WATTS displays any of the four possible power outputs of the combined laser system: FIBER CAL, CAL MEM, DYE and PUMP. It displays the selected power in watts. To display any one of the desired power outputs, the appropriate power parameter button should be pushed. The power can then be adjusted in all modes, except PUMP, by pressing the UP and DOWN arrow keys.

The Dye Module must be in the FIBER CAL mode to display the total power emitted from the PDT fiber. The fiber must be inserted into the internal power meter.

The POWER/WATTS display window is also used to warn the operator of a possible system problem. An error or Help Code associated with the system malfunction will appear in the POWER/WATTS display window. Help Codes are a series of alphanumeric codes (e.g., H03) that assist the operator in diagnosing system errors or faults.

See Section 8, System Interlocks and Error Codes, for more information.

Power Control Arrow Keys (10)

The Power Control Arrow Keys control power in 0.01 watt increments over the range of 0.10 through 3.2 watts (7.0 watts for High Power Module). These arrow keys can be used to make power adjustments in the FIBER CAL, CAL MEM and DYE modes, but they are not active in the PUMP mode.

Arrow keys may also be used to adjust power in the STANDBY/ON, AIM and TREAT modes. Pressing the UP arrow key increases power, and pressing the DOWN arrow key decreases power. The speed with which the power adjusts increases when an arrow key is pressed and held down. This allows for rapid, large power adjustments.

Pressing both UP and DOWN arrow keys at startup (in the KEY ON mode) will initiate a lamp test command, illuminating every message and LED in the Dye Module display.

FIBER CAL Mode Selector (11)

FIBER CAL activates the internal power meter, allowing the output power of the fiber to be measured and calibrated. When the Dye Module is in the FIBER CAL display mode, the ELAPSED EXPOSURE display will not advance. FIBER CAL is used to measure the power delivered from the fiber. This mode should not be selected while the distal fiber tip is anywhere but in the internal or an external power meter.

When FIBER CAL is selected and an external power meter is used, the Dye Module will return to STANDBY after five seconds automatically, or when STANDBY is selected.

When the internal power meter is used, the Dye Module will remain in TREAT as long as the power meter detects light. To return to STANDBY, press the STANDBY button. If the fiber is removed from the Calibration Pod Insert while the Dye Module is in the TREAT mode, the Dye Module will immediately return to STANDBY as a safety precaution. The ELAPSED EXPOSURE counter will not advance in the FIBER CAL mode, irrespective of which power meter is used.

CAL MEM Mode Selector (12)

CAL MEM displays an estimate of the PDT fiber power delivery during treatment. CAL MEM is used to retain in memory the calibration factor between the 600 Series Dye Module output and the power output of the delivery device. Once this value has been determined, the laser can adjust delivered power out of the PDT fiber during treatment using this memorized calibration factor.

In the CAL MEM mode, the fiber power output is only a calculated value, not an actual real time reading.

The calibration factor is maintained as long as the same

PDT fiber is connected to the PDT Delivery Device Port. When the fiber is disconnected, the calibration factor is lost.

DYE Mode Selector (13)

DYE mode displays the selected power of the 600 Series Dye Module which is delivered into the PDT fiber. This value does not account for transmission losses of the specific delivery device.

PUMP Mode Selector (14)

PUMP mode displays the required 532 nm power input of the surgical pump laser into the 600 Series Dye Module for proper operation. The PUMP mode display is active for three seconds, and then returns to the previously selected mode.

Treatment/Seconds Display (15)

TREATMENT/SECONDS displays the desired treatment duration in seconds. At startup, a "0" is displayed. To set treatment time, press the appropriate TREATMENT/SECONDS control buttons. Treatment time may be adjusted in either STANDBY/ON or AIM modes.

Elapsed Exposure Display (16)

ELAPSED EXPOSURE displays the treatment parameters in either seconds elapsed or energy delivered in joules, as selected by the operator. The counter may be reset to zero by pressing the RESET button when in the STANDBY/ON mode.

The counter begins advancing only in TREAT mode. In order for the JOULES counter to display the energy delivered out of the fiber during treatment, the fiber must be calibrated. If the Dye Module is operated without fiber calibration, no joule value will be displayed.

The ELAPSED EXPOSURE counter will stop under the following circumstances:

- Counter reaches the value set under TREATMENT/SECONDS.
- The AIM button is pressed.
- The STANDBY/ON button is pressed.
- An interlock fault is detected.
- The treatment fiber is inserted into the power meter.

Seconds/Joules Button (17)

The SECONDS/JOULES button allows the operator to select the parameter to be displayed in the ELAPSED EXPOSURE display window during treatment; either SECONDS of time elapsed, or JOULES of energy delivered. The JOULES button must be pressed twice in order to access the JOULES display

Reset Key (18)

The Reset Key is used to reset ELAPSED EXPOSURE counter to zero when in the STANDBY/ON mode.

Interlock Fault Messages (19)

Interlock Fault Messages illuminate to advise the operator of the safety and performance interlock status. The interlock self-test activates when the Dye Module key switch is turned on. If one or more interlock faults occur during the test, or at any time during system operation, the word INTERLOCK will appear, and the specific interlock requiring attention will illuminate (FIBER, SYSTEM, PUMP or REMOTE).

The Dye Module will not go into the AIM or TREAT mode if there is an interlock fault. A detailed description of each interlock is provided in Section 5, Electronics and the different interlock fault codes are described in Section 8, System Interlocks and Error Codes.

Dye Change and Maintenance Warning Messages (20)

Dye Change and Maintenance Warning messages will illuminate to advise the operator of periodic dye change or maintenance requirements. Dye Change and Maintenance procedures are detailed in Sections 7 and 9 of this manual.

Connecting the System

Cable Connections

The 532 nm output from the surgical laser is transmitted to the 600 Series Dye Module via the Fiberoptic Interface Cable. The Dye Module controls the operation and power of the surgical laser via a two-meter Control Cable. The Fiberoptic Delivery System connects directly to the 600 Series Dye Module Delivery Device Port (See Figure 3.2, #4). The cable connections are achieved via the cables listed below. Refer to Figure 3.1 at the beginning of this section for an illustration of the components of the system and how they are connected.

Fiberoptic Interface Cable Receptacle (21)

The Fiberoptic Interface Cable optically connects the 600 Series Dye Module to the surgical laser to transfer the 532 nm wavelength light used as a pump source. It is permanently connected to the 600 Series Dye Module, and connects to the Delivery Device Port of the KTP/532 Surgical Laser System during setup (For those systems with two Delivery Device Ports, the Fiberoptic Interface Cable connects to Port 1). When disconnected from the surgical laser, the Fiberoptic Interface Cable can be coiled onto the special bracket provided for storage. (See Figure 3.4, #26).

Control Cable (22)

The Control Cable replaces the surgical laser footswitch, and allows the 600 Series Dye Module to control the operation and power of the surgical laser. This cable is connected to the footswitch receptacle of the KTP/532 Surgical Laser System.

Power Cord Receptacle (23)

The Power Cord connects the 600 Series Dye Module to the appropriate voltage wall power outlet.

Service Connection (RS 232 Port) (24)

The Service Connection allows computer connection to the Dye Module for service, diagnostic and calibration purposes. It is reserved for use by qualified Laserscope service personnel.

Remote Interlock Port (25)

The Remote Interlock Port allows connection of a remote interlock cable to the 600 Series Dye Module. If this cable is connected to the laser area entry door, opening the door will cause the laser to return automatically to STANDBY/ON and cause a Help Code to be displayed.

Cable Coil Brackets (26)

Cable Coil Brackets allow for convenient coiling of the Fiberoptic Interface Cable for storage.

System Connection Procedure

The procedure outlined below should be followed when connecting the 600 Series Dye Module and the KTP/532 Surgical Laser System.

1. Verify that the key switches of both the surgical laser and the 600 Series Dye Module are OFF.

2. Verify that the circuit breaker of the surgical laser is OFF.

3. Plug the KTP/532 Surgical Laser System into an appropriate power outlet (voltage, phase, and current) as recommended by the KTP/532 Surgical Laser System Operator Manual.

4. For reliable and efficient operation of the 600 Series

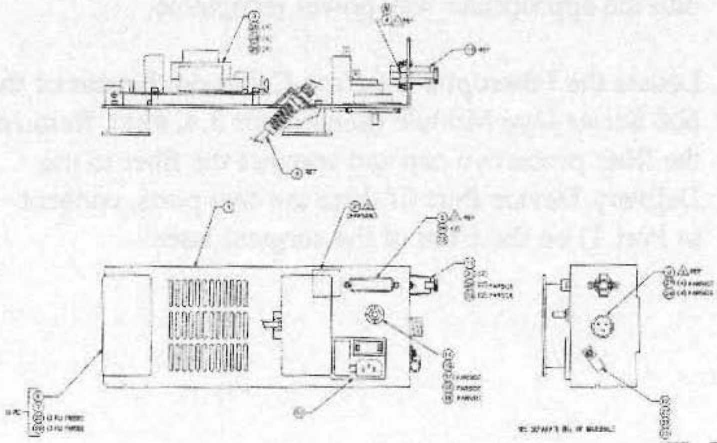

Figure 3.4 Rear View - 600 Series Dye Module

Dye Module in PDT procedures, the External Water Cooling Module is required. Connect cooling water hoses and turn water on before proceeding to the next steps in installation.

5. Disconnect the footswitch of the KTP/532 Surgical Laser System.

6. Attach the 600 Series Dye Module Control Cable to the footswitch receptacle of the surgical laser. Plug the other end of the Control Cable into the connector marked "Control Cable" on the back of the 600 Series Dye Module.

7. Verify that the Dye Module input power voltage is set for 115 or 230 volts, depending upon configuration (Back Panel Input Power - see Figure 3.4, #23). If voltage displayed is not correct, refer to Section 5, Electronics to reset input power. Plug the Dye Module into the appropriate wall power receptacle.

8. Locate the Fiberoptic Interface Cable on the rear of the 600 Series Dye Module (See Figure 3.4, #21). Remove the fiber protective cap and connect the fiber to the Delivery Device Port (if there are two ports, connect to Port 1) on the front of the surgical laser.

System Operation

Turning the Systems On

The procedure outlined below should be followed when turning on the 600 Series Dye Module and KTP/532 Surgical Laser System:

1. Verify that the 600 Series Dye Module and the KTP/532 Surgical Laser Systems have been properly connected. See System Connection in this section of the manual. Verify that cooling water hoses are connected and that the cooling water is turned on.

2. Turn the surgical laser system circuit breaker ON.

3. Turn the surgical laser system key switch ON.

4. After the system has powered up, press the surgical laser STANDBY/ON button. A brief warm-up period will elapse during which the surgical laser display will count down the remaining time until the laser is READY.

5. At the end of the warm-up period, the surgical laser display will show "System Status: STANDBY" along with the power setting in watts.

6. The surgical laser is equipped with device signature recognition. When the 600 Series Dye Module Fiberoptic Interface Cable is connected to Delivery

Device Port I of the surgical laser, the operating para meters will automatically be set to the following:

AIM beam	Green/High
POWER	30/16 watts
WAVELENGTH	KTP/532
DURATION	Continuous
AUTOMATIC EYE SAFETY FILTER	Disabled/Off

7. Press the READY button on the surgical laser.

8. Turn the 600 Series Dye Module key switch to ON (signified by the symbol "I" on the panel near the switch). A FIBER interlock message will normally display if you have not yet connected a PDT fiber to the Dye Module. Any other interlock message at this time is a fault. Check Section 8, System Interlocks and Error Codes, to remedy the fault before proceeding.

9. Press the STANDBY/ON button. A 66-second warm-up period will elapse during which the ELAPSED EXPOSURE counter will count down the time remaining.

Calibrating the PDT Treatment Fiber Output Power

The procedure outlined below should be followed when

CAUTION

Be careful when selecting RESET if a treatment has been interrupted or is paused. The loss of valuable treatment data may result.

calibrating the PDT Fiber Output Power. This procedure should always be performed: (1) prior to every use of a PDT fiber, and (2) after disconnection and reconnection of a PDT fiber.

1. The system will initialize in the DYE mode. Using the UP and DOWN arrow keys, set the power on the Dye Module to "1 watt" to calibrate the treatment fiber ouput.

2. If you have not already done so, attach a PDT fiber to the Dye Module PDT Delivery Device Port.

3. Press the FIBER CAL butto

4. Insert a sterile Cal Pod (Calibration Pod) Insert into the internal power meter until it stops. See Figure 3.5. Carefully insert the distal end of the PDT fiber approximately 5.5 inches (13 mm) into the Cal Pod Insert. Avoid touching the fiber tip to any surface except the inside of the Cal Pod Insert. Doing so will contami-

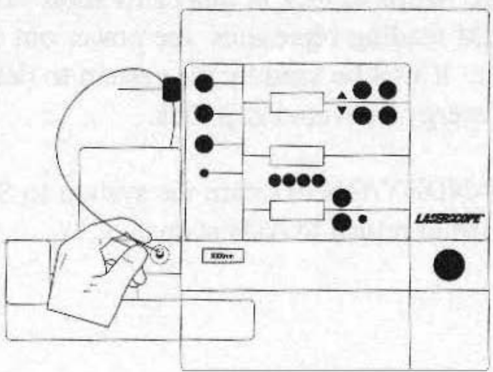

Figure 3.5 Calibration Pod

> **WARNING**
> **Protective eyewear must be worn by everyone present in the laser area before proceeding to the next steps. The recommended protective eyewear is provided with the 600 Series Dye Module. These goggles and spectacles have a minimum optical density rating of 4.0, and are suitable for use at up to 8.0 watts of power at wavelengths from 600 - 699 nm.**

nate the fiber and its power delivery capabilities.

5. Hold the distal tip of the PDT fiber inside of the Cal Pod, press AIM and then press TREAT. Laser light will enter the Cal Pod after a three second delay and a power value will be shown on the Display Panel. Move the fiber tip slightly inside the Cal Pod to obtain the highest value possible.

6. Press CAL MEM to lock in this calibration value. The CAL MEM reading represents the power out of the PDT fiber. It will be used by the system to determine the total energy delivered in joules.

7. Press STANDBY/ON to return the system to STAND BY, or AIM to return to AIM status.

Adjusting the Dye Module Power

After the output power of the PDT fiber is calibrated, the Dye Module power should be adjusted to the desired treatment power. This adjustment is made as follows:

1. The 600 Series Dye Module treatment power may be displayed and adjusted in the STANDBY/ON, AIM or TREAT mode. Set the Dye Module to one of these three modes.

2. Adjust the treatment power to the desired setting using the UP and DOWN arrow keys. The speed with which the power adjusts increases when an arrow key is pressed and held down. This feature allows for large, rapid power adjustments

Setting the Treatment Time and Dose

The treatment time and dose are set using the following procedure:

1. If there is any value other than 0000 displayed in the ELAPSED EXPOSURE window, press the RESET button to cancel the current display and reset to 0000. RESET will erase any value displayed in the ELAPSED EXPOSURE readout and will set the counter back to zero.

2. Set the desired treatment time in seconds from 0 to 9999 by pressing the four TREATMENT/SECONDS control buttons located below the display window.

3. Choose the ELAPSED EXPOSURE parameter you want displayed during treatment by pressing either the SECONDS or JOULES button. (The JOULES display is only active if the PDT fiber has been calibrated.)

Activating the AIM Beam

To activate the AIM beam, press AIM, launching the low power green aiming beam (532 nm at < 5.0 mW) into the treatment fiber. The AIM beam will not activate until a treatment time has been selected.

Due to the low power, protective eyewear specifically for the 532 nm wavelength is not required.

The AIM beam may be used to examine the condition of the treatment fiber and to identify the area to be treated. The AIM beam power will not be displayed.

Treatment

When treating an area, the procedure outlined below should be followed:

1. Position the PDT fiber at the treatment site, as specified by the clinical protocol.

2. Press TREAT to start the treatment cycle of the Dye Module. There will be a three second delay prior to emission of the laser treatment beam.

3. Treatment will stop automatically when the preset

treatment time (in seconds) is completed. The TREAT indicator light will illuminate continuously during a treatment.

4. The treatment beam will be discontinued under any of the following circumstances:

   - The ELAPSED EXPOSURE counter reaches the value preset under TREAT-MENT/SECONDS.
   - The AIM button is pressed.
   - The STANDBY/ON button is pressed.
   - The OFF button is pressed.
   - The key switch is turned OFF.
   - An interlock fault is activated, and a Help Code is indicated.

Turning the Systems Off

The shut down procedure for the Dye Module and surgical laser system is as follows:

1. Turn the 600 Series Dye Module key switch to OFF. OFF is signified by the symbol "O" on the panel near the key switch.

2. Turn the surgical laser key switch to OFF.

3. Disconnect the PDT fiber and discard appropriately.

4. Disconnect the 600 Series Dye Module Fiberoptic Interface Cable from the Delivery Device Port of the surgical laser and replace the protective cap. Store the cable by coiling it around the bracket in the rear of the Dye Module.

5. Disconnect the 600 Series Dye Module Control Cable and store appropriately.

6. Reconnect the footswitch of the surgical laser system if the surgical system is to be used as a surgical device.

7. Turn off the rear circuit breaker on the KTP/532 Surgical Laser System.

8. Disconnect both the 600 Series Dye Module and surgical laser power cords from their respective wall power receptacles.

9. Turn off the water supply to the water cooling system of the surgical laser.

10. Disconnect the water hoses from the water supply and drain.

Section 4: Servicing Overview

Introduction

Section 3 of this manual provided a description of the external components of the 600 Series Dye Module and gave operating instructions for its use. In this section, a brief discussion of Dye Module internal functions is presented, along with an overview of the components which constitute the Resonator. Neither the Electronics nor the Dye Circulation components are covered in this section. For descriptions of components and processes that fall into these categories, see Sections 5 and 7, respectively.

The Dye Module unit is very compact, the components are "layered," and no single view will show the entire system or interconnections. Figure 4.1 illustrates the Dye Module internals from various perspectives and gives an indication of the accessibility of different components.

System Overview

A brief outline of how the Dye Module operates is provided below. For more details about any of these processes, refer to the specific section in this manual addressing that area.

AC Power

When the power cord located on the back of the Dye Module unit is plugged into an AC outlet, +5v, +15v, -15v and -5v (not used) will be supplied to the Low Voltage

Power Supply. When the key switch is turned on, these voltages will be supplied to the Power Circuit Board. The Power PCB then provides the low voltages to the system components. Two transformers located on the Power PCB convert AC power to DC.

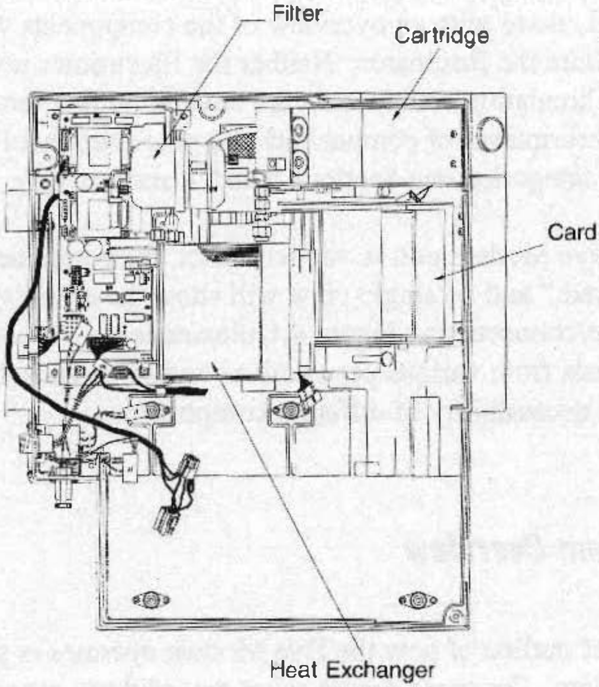

Figure 4.1: Dye Module Internals

Microprocessor

The main controlling element of the Dye Module is a microprocessor-based computer located on the CPU Circuit Board, one of the circuit boards located in the card cage and plugged into the Mother Board.

The main functions of the microprocessor include:

- Operating the system
- Monitoring all system functions
- Maintaining diagnostic information for service use

The microprocessor can be accessed for service purposes through the RS 232 Port on the right front panel of the Dye Module. A step-by-step description of how to access the computer via this Port is given in Section 9, Preventive Maintenance.

System Startup

Inserting the key and turning the key switch on will engage the J1 Connector which will turn on the Low Voltage Power Supply and power up the Power PCB. The microprocessor and all of the safety interlocks will also activate. If there are any interlock faults at this time, they will be illuminated on the control panel. (For more information about Interlocks and Interlock faults, see Section 5, Electronics, and Section 8, Interlocks and Error Codes.) The POWER/WATTS/SECONDS display will also illuminate but no values will be shown.

Powering Up

Pressing the STANDBY/ON button will trigger two white relays (A3 and A4) on the Power PCB. This will cause the dye pump to activate, the cooling fan to start up, and the dye circulation to begin. The computer will also begin an initialization sequence. During the initialization sequence, the ELAPSED EXPOSURE counter will count down the time before the Dye Module can be used (66 seconds maximum). The LED displays will also illuminate at this time. If the powering up sequence is successful, treatment parameters can then be set.

Resonator Assembly

The Resonator Assembly is a flat metal where the 532 nm laser energy received from the pump laser via the Pump Fiber is converted to the 630 nm +/- 3 nm wavelength needed for dye lasing. The dye laser beam is then channeled to the delivery device for treatment. The path along which the laser Aim and Treatment beams travel is described later in this section.

The train for the KTP optic is divided into two sections, referred to as the first and second train. All of the various optical components along the laser beam path must be precisely aligned in order to generate the greatest stable power for transmission to the delivery device. If these components are not precisely aligned, the unit will demonstrate low power and will require an alignment procedure to achieve adequate power. If less than 3.2 watts (4.4 watts in Service Mode) is generated during the system initialization procedure, an H12 fault will be generated. The Alignment Procedure as well as other possible reasons for low power problems are described in Section 6, Laser and Optics.

Dye Circulation

The dye solution is stored in the Dye Cartridge or Reservoir. Once the Dye Module is placed in STAND-BY/ON, the Dye Pump will be activated and the dye in the reservoir will be constantly circulated through the pump and through the Dye Cell Assembly. See Figure 4.2 for Dye Circulation process.

As the KTP laser energy from the pump laser travels down the laser path, it reaches the Dye Cell Assembly where it is absorbed by the constant circulation of organic dye being pumped through the dye cell. These dye molecules are fluorescent . They can absorb light at a shorter

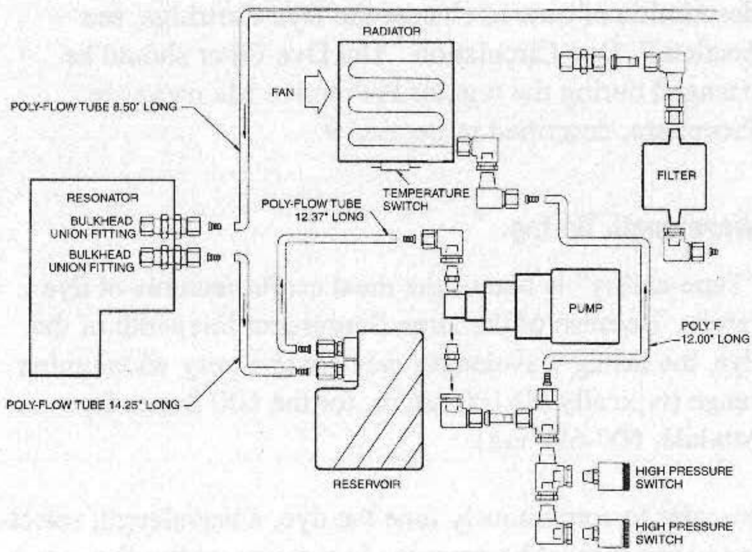

Figure 4.2: Dye Circulation

wavelength (the 532 nm of KTP) and almost immediately fluoresce or emit light at a longer wavelength (the 600-699 nm needed for Photodynamic Therapy).

Because the dye is continuously flowing through the dye cell, each molecule is exposed to the pump light for a brief instant during which time stimulated emission occurs. This light must be intense to produce the necessary population inversion for lasing.

The resultant light oscillates back and forth between the High Reflector and the Output Coupler, passing through the Dye Cell Assembly repeatedly.

For more information on Dye Circulation and for a description of how to change the Dye Cartridge, see Section 7, Dye Circulation. The Dye Filter should be changed during the regular Preventive Maintenance Procedure, described in Section 9.

Wavelength Tuning

"Tune-ability" is one of the most useful features of dye lasers. Because of the large fluorescent linewidth of the dye, the lasing wavelength may cover a very wide tuning range (typically 50-100 nm or, for the 600 Series Dye Module, 600-699 nm).

In order to continuously tune the dye, a wavelength selecting element must be present. In the case of the Dye Module, this element is the Birefringent Filter. The wavelength that is emitted from the Dye Cell Assembly is a result of the chemical composition of the particular dye used and the wavelength characteristics of the pump laser. For the 600 Series, the wavelength conversion ratio is approximately 25-33% (e.g., 16 watts of KTP in = 4-5 watts of 630 nm out). The Birefringence Filter consists of a quartz crystal plate mounted at Brewsters angle within the dye cavity and rotated on its axis to tune the dye laser beam to a specific wavelength, in this case 630 nm +/- 3 nm. The Bandpass Filter determines the wavelength selected. To select a different wavelength, a different Bandpass Filter must be installed. Currently, there are four possible wavelength options available on the World Dye Module version. These include: 630, 652, 660 and 664.

The Red Detector and Wavelength Verification Detector monitor and verify that the wavelength emerging from the Birefringence Filter is the wavelength specified. If the wavelength detected is not within the acceptable range, a fault will be generated (H15). This fault can, however, be overridden by pressing the Standby/On button.

Cooling System

The cooling system for the 600 Series Dye Module consists of a Fan powered by the Power PCB that constantly blows room-temperature air against the Heat Exchanger as the dye circulates through it. The fan automatically turns on when the Standby/On button is pressed.

The Dye Reservoir holds approximately 1.8 liters of dye solution. A motor driven pump, which receives power from the AC Power PCB, forces the dye solution to circulate from the Dye Reservoir to the Heat Exchanger and Output Filter, then through the cavity and the Dye Cell Assembly, and back to the Reservoir. (Refer To Figure 4.2 for an illustration of the dye circulation process.) The dye constantly circulates in this manner as long as the Dye Module is in STANDBY/ON, AIM, or TREAT status.

If the dye pressure is either too high (above 60 psi) or too low (below 25 psi), a high or low pressure switch will be triggered, sending a signal to the DC Power PCB and, via the P8 Connector and the J2 multicolored cable, to the CPU microprocessor. An Interlock fault (H02) will be generated and the system will shut down until the dye solution returns to an acceptable temperature.

For more information about Cooling System components, see Section 7, Dye Circulation.

Calibration Sphere

The 600 Series Dye Module has an internal Calibration Sphere which is permanently connected to the console. It is used to calibrate the delivery devices in order to compensate for power loss during laser beam transmission from the Fiber Coupler to the patient. Typical delivery device power loss may range from 10% to 15%. For details about calibrating a delivery device, see Section 3 of this manual.

RS 232 Port

The RS 232 Port located on the right front panel of the Dye Module allows direct access to the Dye Module microprocessor for service and diagnostic information. Laptop interface signals travel via J3 (blue, gray, and black) wires to the RS 232 Port.
The information available via the laptop connection includes:

- Number and dates of dye changes
- Date when next maintenance is due
- Dye life
- Number of seconds system has been in operation (since last maintenance)

Directions for accessing the Dye Module microprocessor via the RS 232 Port can be found in Section 9, Preventive Maintenance.

Access for Servicing

To access the laser resonator and system components, remove the top cover.

The components of the Dye Module are layered and are not all immediately accessible. Please refer to Figure 4.1 for an indication of component accessibility.

To enter Service Mode, press the service button on the DC PCB.

System Description

Introduction

The Dye Module does not generate its own laser energy. However, it does convert the KTP/532 nm laser energy that it receives from the pump laser into the 630 nm laser energy of the dye laser. This conversion is accomplished through the following process.

Laser Beam Paths

The KTP energy enters the Dye Module through the Fiber Input Mount and continues to the Pump Turning Mirror where it is split and separates into two paths:

- A path for the aim beam (1% of the laser energy)
- A path for the Treatment beam

The paths of the AIM and Treatment beams are illustrated in Figure 4.3.

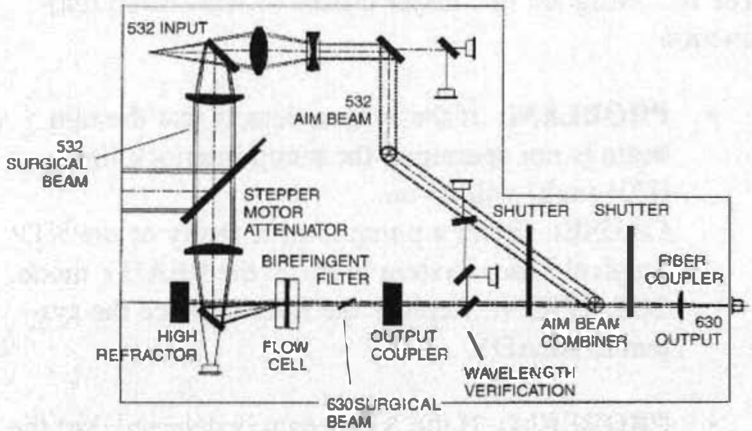

Figure 4.3: Beam Path

A Path for the Aim Beam

After the original beam has been split into an AIM beam and a TREATMENT beam, the AIM beam is then split again at the Beam Splitter located next to the Pump Detector. Most of the beam continues to the First AIM Beam Tower, but a small amount of KTP light passes through to the AIM Detector and the PUMP (green) Detector.

These detectors make sure that the green light of the AIM beam is delivered before any further operation of the system is permitted. If these detectors do not receive the AIM beam light, they will signal the Analog Input PCB which will convert the message to digital signals and relay them to the CPU Board via the Mother Board. The result: neither the AIM nor the Treatment beam will function.

The following are two major causes of AIM beam malfunction:

- **PROBLEM:** If the system detects that the aim beam is not operating, the pump interlock light (H04 fault) will go on.
  CAUSE: Either a pump fiber is faulty or the KTP Surgical Laser System is not in the READY mode.
  SOLUTION: Replace the fiber or place the system in READY.

- **PROBLEM:** If the AIM beam is detected, but the full pump power is not turned on, the system will generate an H14 fault.
  CAUSE: This usually is caused by not properly attaching the control cable.
  SOLUTION: Reattach the control cable.

The AIM beam path proceeds as follows (Refer to Figure 4.3):

1. The KTP aim beam is first reflected to the first of two AIm Mirror Towers (Transmitter).

2. Next, the beam is reflected across to the second Aim Mirror Tower (Receiver) where the beam is then coupled above the Treatment beam.

3. Finally, the two beams are focused down into the Fiber Lens Assembly and Fiber Coupler.

A Path for the Surgical Beam

In the second KTP path (Treatment or ACTIVE mode):

1. The TREATMENT beam is reflected off the Pump Turning Mirror and then enters the 60 mm Condensing/Collimating Lens which condenses the energy into a tighter beam.

2. The beam then exits the Condensing/Collimating lens and travels through the Stepper Motor/Attenuator Assembly—a mechanical aperture that determines the amount of KTP power being sent to the Dye Cell. The amount of laser energy traveling through the Stepper Motor/Attenuator Assembly at any time is determined by the position of the Attenuator blades (number of steps open or closed).

3. The beam then travels through the 75 mm Condensing Lens which is set at its focal distance from the dye cell. The two condensing lens assemblies are used to help establish the correct location and height of the beam so it can be focused on to the dye cell.

4. Next, the beam strikes the Flow Cell Assembly and 90 Degree Turning Mirror where it is deflected and focused onto the center of the Dye Cell Assembly.

5. The 532 nm beam is then absorbed by the flowing dye molecules circulating through the Dye Cell Assembly. The dye fluoresces, and a 630 nm beam is emitted. This beam is reflected back and forth between the High Reflector and the Output Coupler,

NOTE

The two condensing lens assemblies look identical. If they are removed at the same time, be sure to replace them in the proper order (they are not interchangeable). To determine which is the 60mm and which is the 75 mm lens, focus both on an object. The lens that needs to be held further away to get a good focal point is the 75 mm lens. When replacing these lenses, the curved sides of the optics should always be facing each other.

passing through the Dye Cell Assembly repeatedly.

6. The beam also passes through the Birefringent and Bandpass Filters which ascertain and determine the wavelength of the beam. It then passes through the Wavelength Verification Detector where the wave length is verified.

7. Finally, the Treatment beam is coupled with the Aim Beam and focused down into the Fiber Lens Assembly and the Fiber Coupler.

If the Treatment Beam is not properly aligned at every point in its journey, the Dye Module will have low power problems. These are discussed in Section 6, Laser and Optics.

Resonator Components

The following pages describe the various components and assemblies of the Resonator and some of their potential problems . Figure 4.4 illustrates the Resonator and its

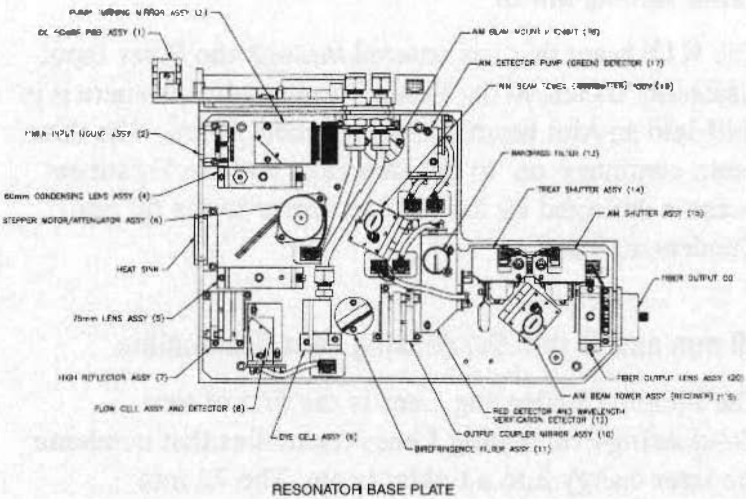

Figure 4.4: *Resonator and its Components*

components. Dye Circulation and Electronics components are not included in this section. For information about these components, see Sections 5 and 7, respectively.

Fiber Input Mount Assembly

The Fiber Input Mount Assembly physically connects the pump fiber which carries the KTP laser energy from the pump laser to the Dye Module. The pump fiber is connected to the Fiber Input Mount Assembly. When the STANDBY/ON button is pressed, laser energy travels from the pump laser, through the Pump Fiber, and into the Fiber Input Mount Assembly.

Pump Turning Mirror

The KTP beam that has entered through the Fiber Input Assembly travels to the Pump Turning Mirror where it is split into an Aim beam and a Treatment beam. The Aim beam continues on to the Detectors and the Treatment beam is deflected by the turning mirror to the 60 mm Condensing Lens.

60 mm and 75 mm Condensing Lens Assemblies

The 60 mm Condensing Lens is the first of two Condensing/Collimating Lens Assemblies that condense the laser energy into a tighter beam. The 75 mm Condensing Lens is the second Assembly which acts both as a focus for the beam and helps to position the beam to hit the center of the Dye Cell.

Stepper Motor/Attenuator Assembly

The condensed treatment beam exits the 60 mm Condensing Lens and travels through the Stepper Motor/Attenuator Assembly on its way to the 75 mm Condensing Lens. The Stepper Motor/Attenuator determines the amount of KTP energy that passes through the Attenuator by the open or closed position of the Attenuator blades. A wide open Attenuator (one which allows the most laser energy to pass through) is about 800-900 steps. To open the Attenuator blades wide, set the Treatment seconds to 800 by pressing the Power UP Arrow. If you hear grinding, stop. This means that the Attenuator blades are already fully open and continued attempts to open them further could cause them to lock.

To get accurate lasing power, the Attenuator blades must respond precisely to the microprocessor "instructions." A Stability Test described in Section 9 will determine the accuracy of the Attenuator vis-a-vis the requested treatment setting. If there is a problem with the Attenuator, an H05 fault will be generated.

Flow Cell Assembly and 90 Degree Turning Mirror

The treatment beam enters the Flow Cell Assembly and is deflected by the 90 Degree Turning Mirror once it leaves the 75 mm Condensing Lens. The beam is then focused onto the center of the Dye Cell.

Dye Cell Assembly

The dye solution from the dye reservoir is constantly pumped through this Dye Cell Assembly. As the KTP beam passes through the center of the dye cell, it is absorbed by the flowing dye molecules. The dye then fluoresces, and a 630 nm beam suitable for dye lasing is emitted. This beam passes through the dye cell repeatedly as it reflects back and forth between the High Reflector and the Output Coupler.

Birefringent Filter

The Birefringent Filter determines the wavelength of the laser beam. It consists of a quartz plate mounted at Brewsters angle within the dye cavity to create a polarization of the intercavity light. The optical axis of the Birefringent Filter is aligned so that the crystal is at Brewsters angle to the optical axis of the dye laser.

The laser beam passes back and forth through the Birefringent Filter just as it does through the Dye Cell Assembly in its oscillation between the High Reflector Assembly and the Output Coupler.

High Reflector and Output Coupler Mirror Assemblies

The High Reflector Assembly acts with the Output Coupler to reflect the treatment beam back and forth through the Dye Cell and the Birefringent Filter.

Red Detector, Wavelength Verification Detector and Bandpass Filter

After being reflected back and forth through the High Reflector and the Output Coupler, the treatment beam passes through the Red Detector and the Wavelength Verification Detector which monitor and verify the wavelength of the beam before it is coupled with the Aim Beam and continues on to the Fiber Lens Assembly. If the specified wavelength is not detected, a signal will travel to the microprocessor via the Analog Input and Mother PCBs, and a fault will be generated. The **Bandpass Filter** is also located within this housing. It specifies the wavelength of the laser beam that is emitted. To change the wavelength, replace this filter.

AIM and TREAT Shutters

The Dye Module has two shutters, one for the AIM Beam and one for the TREATMENT beam.

The shutters must be open for the laser light to pass through to the Fiber Lens Assembly and the Fiber Coupler. Each shutter can only be either open or closed—there are no gradations.

In the STANDBY/ON status, both AIM and TREAT shutters are closed. To open the AIM shutter, the AIM button must be pressed. This sends a signal from the Control Panel PCB to the microprocessor. Through the Mother Board, a signal is then sent to the Analog Input PCB which registers the information and sends it to the AIM Solenoid located on the Resonator PCB. A detector switch located on the shutter signals to the microprocessor that the requested position has been achieved.

To open the TREAT shutter and use the Treatment Beam, press the TREAT button. The same process will occur. The TREAT shutter cannot be opened or the Treatment beam activated unless the AIM shutter has first been opened and the AIM beam activated.

If there are problems with one of the shutters, try switching them (they are identical) to see if the problem travels with the shutter. If it does, replace that shutter. If it does not, the problem may lie with the T2 Transformer.

If the system detects problems with either of the shutters, faults will be generated (H19/AIM Solenoid Failure, H20/TREAT Solenoid Failure).

Pump Detector and Aim Detector

When the AIM beam leaves the Pump Turning Mirror, it hits a Beam Splitter which splits a small amount of the Aim beam off to travel to the Pump (Green) Detector and the Aim Detector. If these Detectors do not detect this beam, a signal will be sent to the Analog Input PCB where it will be converted to a digital signal and relayed to the CPU microprocessor via the Mother Board.

A Pump Interlock (H04) fault will be generated if no Aim beam is detected. If an Aim beam is detected but full pump power is not being achieved, an H14 fault will be generated.

The Dye Module will not emit a treatment beam until these detectors "detect" the aim beam light.

Aim Beam Towers (Transmitter and Receiver)

The Aim Beam travels to the first Aim Beam Tower (Transmitter) where it is deflected to the second Aim Beam Tower (Receiver). At the Receiving Aim Beam Tower, the Aim beam is coupled with the Treatment beam.

Fiber Lens Assembly and Fiber Coupler

The Aim and Treatment beams then pass through the Fiber Lens Assembly where they are focused and aligned into the delivery device fiber. Figure 4.5 provides an illustration of the beam alignment process.

Components of the Dye Module not discussed in this section can be found either in the Electronics Section (Section 5) or the Dye Circulation Section (Section 7). Procedures to correct low power problems and to realign the laser are discussed in the Laser and Optics Section (Section 6).

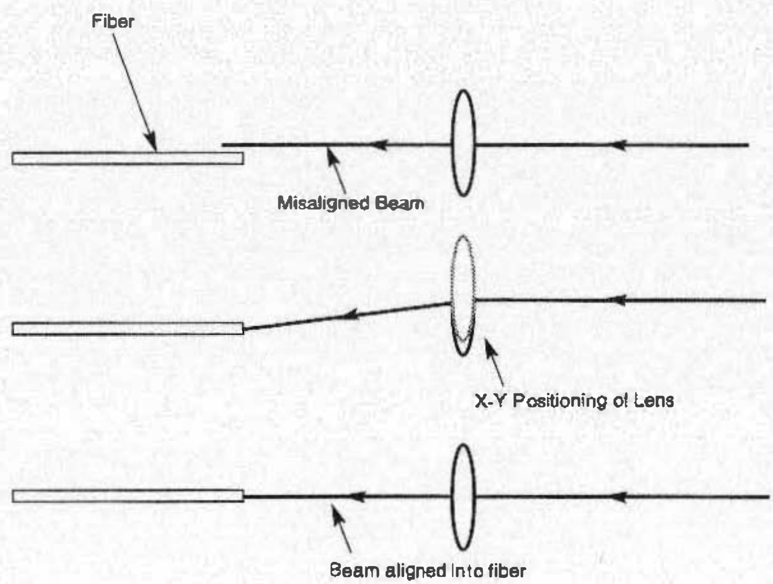

Figure 4.5: Fiber Alignment

Section 5: Electronics

Introduction

The Dye Module depends upon the pump laser for laser energy, but it supplies its own electrical energy through a power cord located at the back of the unit and connected to an AC outlet. If there is a general failure of the Dye Module electrical system, first check that the AC line input fuses (on the back of the Dye Module) are working and that the system is configured properly for the fuses, then check the power cord and the AC source.

When the power cord is plugged in and the circuit breaker switch is turned on, the AC power source will supply power to the AC Power PCB.

Once the key switch is turned on, the AC Power PCB routes AC power to the Low Voltage Power Supply. The Low Voltage Power Supply converts the AC voltage to VDC and supplies the DC Power Board.

When the Standby/On button is pressed, the AC and DC Power Boards supply voltages to the following system components:

- The Dye Pump runs on AC power from the AC Power Board.
- A transformer and bridge rectifier on the AC Power Board supply DC power directly to the Stepper Motor and Fan.
- All other system components receive power from the DC Power Board.

An interconnect diagram of the Dye Module electronics system is illustrated in Figure 5.1. A wiring diagram is shown in Figure 5.2.

AC Configuration

The U.S. and Canadian Dye Module laser units require a 50-60 Hz, single phase, 115/230 VAC input which goes to the Low Voltage Power Supply. For units outside of the U.S. and Canada, the standards will vary according to national specifications. The Procedure to configure the Dye Module to operate at 115 VAC or 230 VAC is described at the end of this section.

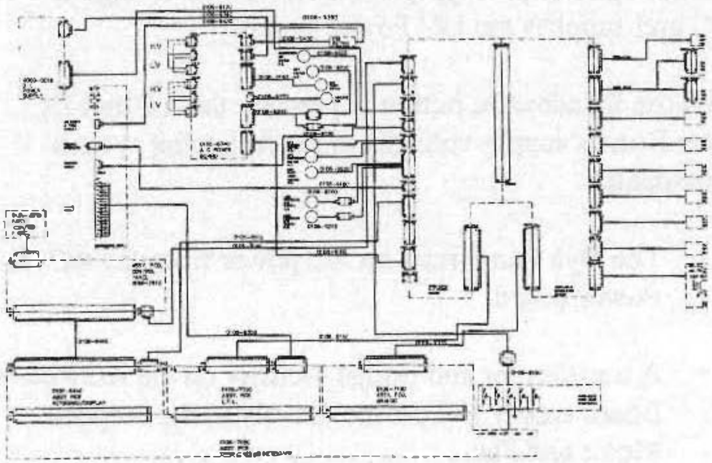

Figure 5.1: Dye Module Electronics System

Subassemblies

The major electronic subassemblies of the Model 600 Dye Module System consist of the following:

- **Low Voltage Power Supply (LVPS).** The LVPS receives power from the AC Power Board and supplies voltages to the DC Power PCB which, in turn, routes power to various system components.
- **Eight major PCBs.** Eight PCBs provide the circuitry and microprocessor support for the Dye Module:

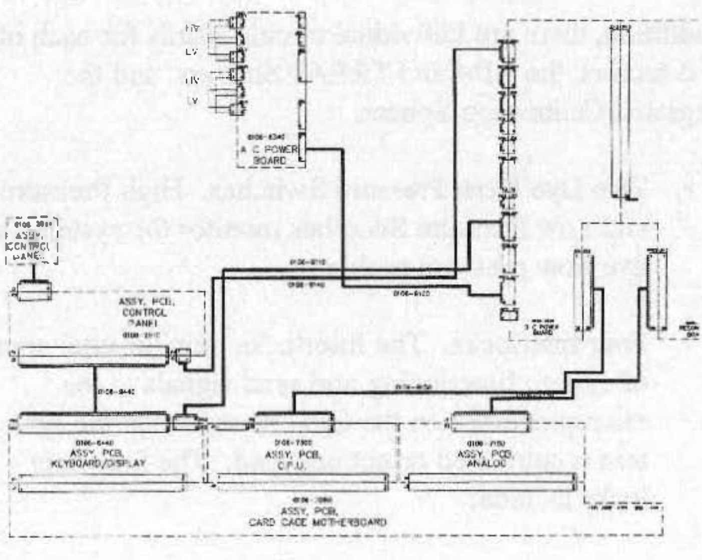

Figure 5.2: Dye Module Wiring Diagram

1. Analog Input PCB

2. CPU PCB

3. Keyboard Display PCB

4. Mother PCB

5. Resonator PCB

6. AC Power PCB

7. DC Power PCB

8. Control Panel PCB

In addition, there are individual circuit boards for each of the detectors, the AIM and TREAT Shutters, and the Integrated Calibration Sphere.

- Two Dye Flow Pressure Switches. High Pressure and Low Pressure Switches monitor the system for dye flow pressure problems.

- Four Interlocks. The Interlocks monitor vital areas of system functioning and send signals to the microprocessor on the CPU Board when the system is subverted or not engaged. The four inter locks include:

1. System Interlock
2. Remote Interlock
3. Pump Interlock
4. Fiber Interlock

- One Transformer. One transformer located on the AC Power PCB converts AC power via a bridge rectifier to DC power between +13 and +15 volts. The transformer supplies the Stepper Motor and the Fan.

- Six Detectors. Six detectors monitor the power levels of the Aim and Treatment beams and the Calibration Sphere:

  1. Red Detector
  2. Pump (Green) Detector
  3. Aim Detector
  4. Pump Detector
  5. Wavelength Detector
  6. Sphere Detector

Each of these subassemblies is described in more detail on the following pages.

Low Voltage Power Supply (LVPS)

Location. The Low Voltage Power Supply (LVPS) is positioned vertically toward the back of the Dye Module facing the AC Power PCB. Refer to Figure 4.1 for exact location.

Function. The Low Voltage Power Supply generates + 5 (4.8 to 5.2 VDC), +15 (14.4 to 15.6 VDC), -15 (-14.4 to -15.6 VDC) and -5 (not used) voltages and supplies them to the DC Power PCB. Voltage measurements can be taken either from the P2 Connector on the LVPS or from the top of the PD9 Connector on the DC Power PCB. (Refer to Figure 5.2.) The wiring for each is as follows:

Measurement at P2/J2 of LVPS

- For +5 VDC, measure at red wire (+), pin 2, and black wire (grnd.), pin 4.
- For +15 VDC, measure at orange wire (+), pin 6, and black wire (grnd.), pin 7.
- For -15 VDC, measure at violet wire (-), pin 8, and black wire (grnd.), pin 7.

Measurement at PD9 of DC Power Board

- For +5 VDC, measure at red wire (+), pin 6, and black wire (grnd.), pin 5.
- For +15 VDC, measure at orange wire (+), pin 3,

and black wire (grnd.), pin 2.

- For -15 VDC, measure at violet wire (-), pin 1, and black wire (grnd.), pin 2.

Problems. If there are problems with the power supplied to the various moving parts and assemblies, the cause may originate in the Low Voltage Power Supply. Adjusting the +5 voltage pot on the LVPS will adjust all of the voltages, so if the LVPS is suspected as the cause of a problem or if the voltages are not within the indicated range, try adjusting the +5 voltage pot (See Figure 5.3). If the voltages are still not within spec, replace the LVPS to see if the power problem disappears.

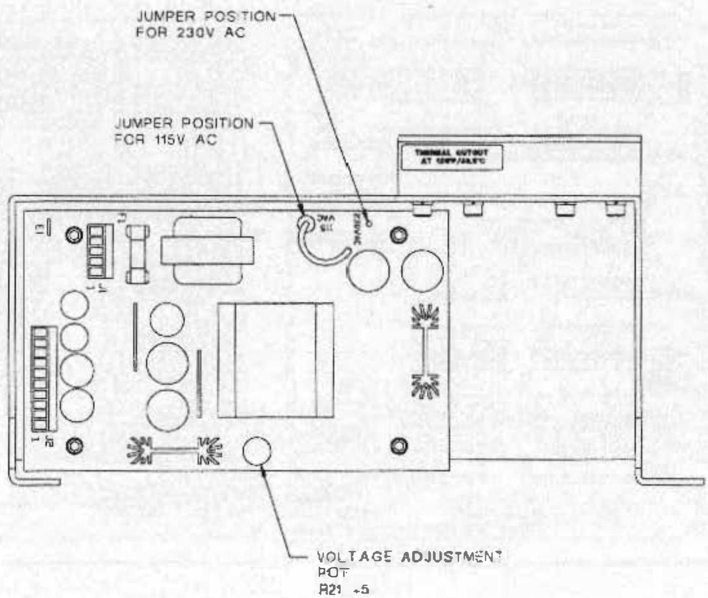

Figure 5.3: Low Voltage Power Supply

Adjusting the LVPS. The +5 VDC is adjusted at the variable resistor located at R21 at the back of the LVPS (shown in Figure 5.4). Adjusting the +5 VDC will also affect the +15 and -15 voltages. If the +5 VDC is adjusted, therefore, be sure that all three voltages are in spec.

Circuit Boards

Analog Input PCB

Location. Removing the top cover of the Dye Module reveals the Analog Input PCB located in the card cage below the Keyboard Display PCB and the CPU PCB. These circuit boards are all plugged into the Mother PCB

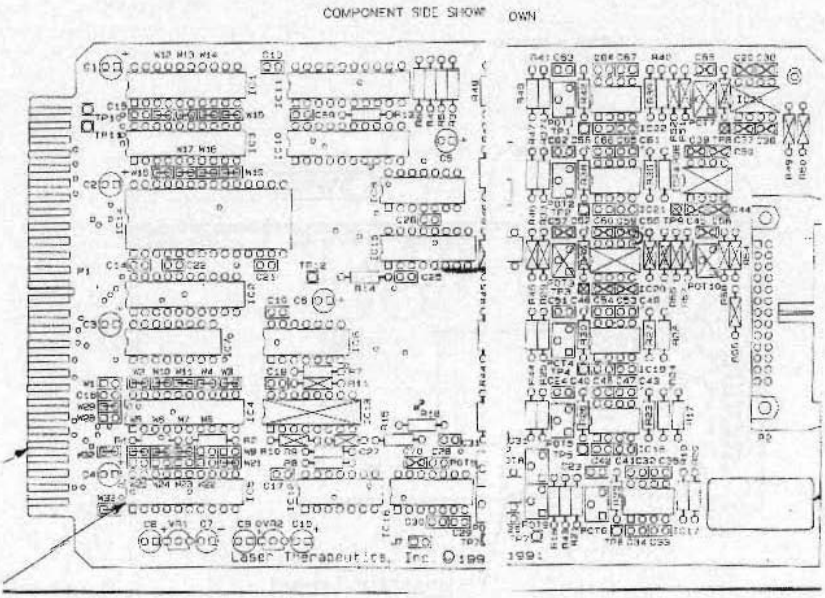

Figure 5.4: Analog Input PCB

which serves as the communicating link between the three (See Figure 5.4). To remove, simply pull out of the card cage.

Function. The Analog Input PCB receives the detector analog voltage readings from the Resonator PCB, converts them to digital signals and then sends the digital data to the CPU Board and the microprocessor, via the Mother Board. It also regulates the +15v and -15v that it receives from the Mother Board to +12v and -12v for the Detectors.

The dedicated op-amp drive circuits for the Detectors are located on the Analog Input PCB.

Voltage measurements and adjustments for the detector monitor circuits are made on this PCB. See Figure 5.4 for adjustment locations.

TP1-TP9 are the measurement test points used when zeroing and adjusting voltages for the detector control circuits. The voltage adjustments are made at the blue potentiometers labeled POT1 - POT9 (Pots 3, 7 and 10 are not used). Pots 8 and 9 are reference level adjustments. They determine the threshold at which the system detects the Aim and Treatment beams. See Figure 5.4 for a schematic of the Analog Input PCB.

To check the voltage measurements, an extender card (Standard Bus Card PN # 5400-0220) will be needed. Make sure the analog ground (AGND) instead of the digital ground (GND) is used when taking the detector voltage measures at TPI-TP9.

Voltage test points, adjustment pots, and specifications for each of the detector monitor circuits and the reference level adjustments are as follows:

Red Detector:
Test Point: TP2
Adjustment: POT2

Specification:
Low Power: 1 V/W (e.g., 5.0 VDC at 5 watts)
High Power: 2 V/W (e.g., 10.0 VDC at 5 watts)

Pump Detector:
Test Point: TP1
Adjustment: POT1
Specification: 0.25 V/W (e.g., 7.5 VDC at 30 watts)

AIM Detector:
Test Point: TP7
Adjustment: POT9
Specification: Adjusted to maximum

Pump (Green)Detector:
Test Point: TP6
Adjustment: POT6
Specification: 0.25 V/W (e.g., 7.5 VDC at 30 watts)

Sphere Detector:
Test Point: TP5
Adjustment: POT5
Specification:
Low Power: 1 V/W (e.g., 5.0 VDC at 5 watts)
High Power: 2 V/W (e.g., 10.0 VDC at 5 watts)

Wavelength Detector:
Test Point: TP4
Adjustment: POT4
Specification:
Low Power: 1 V/W (e.g., 5.0 VDC at 5 watts and within 5% of Red Detector)
High Power: 2 V/W (e.g., 10.0 VDC at 5 watts and within 5% of Red Detector)

PumpOn Threshold:
Test Point: U16, pin 9
Adjustment: POT8
Specification: Adjust to 1.0 volt DC

Aim Threshold:
Test Point: U16, pin 5
Adjustment: POT9
Specification: Adjust to 0.4 volts DC

Problems. If the voltage measurements at the detectors are incorrect, check the voltage test points on the Analog Input PCB to see if there is any output. If voltage values are off, try to adjust them to bring output readings back to specification.

Keyboard Display PCB

Location. The Keyboard Display PCB is located in the card cage above the CPU PCB and is plugged into the Mother PCB which acts as the communicating link (Refer to Figure 5.4). To remove, simply unplug from the Mother Board and pull out of the card cage.

Function. The Keyboard Display PCB sends the encoded/decoded LED control signals via the P2 connector to the Control Panel PCB (the display panel membrane located in the front panel of the Dye Module system).

Problems. If the LED displays are not lighting up, then the problem may be either with the Control Panel PCB or the Keyboard Display PCB. If replacing the Control Panel PCB doesn't correct the problem, replace the Keyboard Display PCB.

CPU PCB

Location. The CPU PCB is located in the card cage between the Keyboard Display PCB and the Analog Input PCB and is plugged into the Mother Board which acts as a communicating link (Refer to Figure 5.4).

Function. The microprocessor for the Dye Module is located on the CPU PCB. (See Figure 5.5.) Through it, the system functioning is monitored and controlled, and diagnostic information is maintained. All signals to and from the microprocessor travel via either the Mother Board or the J2 multicolored cable to the DC Power PCB.

The computer interface for the service laptop is accessed through the CPU PCB. The laptop interface signals travel via the J3 (blue, gray and black) wires to the RS 232 Port at the back of the Dye Module System.

A 3-volt NI-CAD battery is located on the back of the CPU Board. It provides a power source for the memory chips that store system status information used in field service mode. This battery is soldered to the board. If it should fail, the entire CPU Board will need to be replaced.

Problems. If any problems are experienced with the microprocessor connection or software, the fault is probably with the CPU PCB. To check a suspect CPU PCB, replace the Board and see if the problem disappears.

Mother PCB

Location. The Mother PCB is located at the base of the card cage. The Keyboard Display, CPU and Analog Input PCBs are all plugged into the Mother PCB (Refer to Figure 5.4).

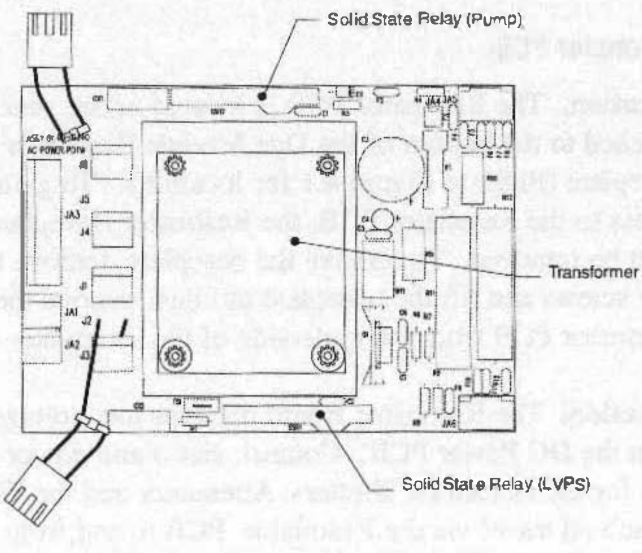

Figure 5.5: AC Power PCB

Function. The Mother PCB connects the Analog, Keyboard, and CPU PCBs and acts as the communicating link between the three. The Mother Board also supplies these three boards with low voltages received from the DC Power PCB.

Problems. Problems with the communication between the three boards plugged into the Mother Board could be caused by a faulty Mother PCB. Power failure in the three boards could also be caused by a faulty Mother PCB. Power failure of all four PCBs could be caused by breaks in the individual wires going to the EMI Filters to supply power to the card cage. To check, measure the voltages at the input side of the EMI Filters and then on the affected PCB. To replace the Mother Board, the card cage itself must be replaced.

Resonator PCB

Location. The Resonator PCB is located under and attached to the bottom of the Dye Module Resonator Baseplate (Refer to Figure 4.1 for location). To gain access to the Resonator PCB, the Resonator Baseplate must be removed. To remove the baseplate, remove the four screws and lift the baseplate up; then remove the Resonator PCB from the underside of the Baseplate.

Function. The Resonator Board receives low voltages from the DC Power PCB. Control, status and power signals for the Detectors, Shutters, Attenuator and the Fiber Switch all travel via the Resonator PCB to and from the Analog Input PCB and the DC Power PCB. The six Detectors are connected to the Resonator PCB.

Problems. Any problems involving signals for the Detectors, Shutters, Attenuator, or Fiber Coupler could be the result of a faulty Resonator PCB. To check, replace the Resonator Board.

AC Power PCB

Location. The AC Power PCB is located along the back of the Dye Module. It is positioned vertically facing the Low Voltage Power Supply (Refer to Figure 4.1 for location). To remove, unscrew the four screws located at the base.

Function: The AC Power PCB performs several functions (See Figure 5.5):

- It receives high voltage from the AC Entry Module and routes it to the Low Voltage Power Supply AC Input when the key switch is turned on.

- The AC Power PCB supplies AC power via a solid state relay to the dye pump (PA3 Connector).

- One transformer is located on the AC Power PCB. It converts (via a bridge rectifier) AC voltage to between +13 and +15 DC volts, and supplies power to the Stepper Motor via the DC Power and Resonator PCBs, the Fan (PA4 Connector), and the Key Switch and Emergency OFF button (PA5 Connector) .

- There are two solid state relays (SSR1 and SSR2) located on the AC Power PCB. SSR1 causes the LVPS automatically to engage when the key switch is turned on, and SSR2 turns on the dye pump when the STANDBY/ON button is pressed.

DC Power Board

Location. A schematic of the DC Power PCB is illustrated in Figure 5.6. The DC Power Board is positioned vertically at right angles to the AC Power PCB and the Low Voltage Power Supply (refer to Figure 4.1 for location).

Function. The DC Power Board has several functions. These include the following:

- The DC Power PCB supplies DC voltages to the Mother Board, the Resonator Board, the Interlock Switches, and the Footswitch.

- The DC Power PCB receives control signals from the CPU PCB and sends drive signals to the AC Power Board to activate the Stepper Motor, Dye Pump, and Fan (via the PD11 Connector).

- The DC Power Board also monitors the following and sends status signals to the CPU Board via the PD4 Connector:

- The Remote Interlock (via the PD3 Connector)

- The Dye Change and Dye Cartridge Switches (via the PD6 Connector)

- The Footswitch (via the PD1 Connector)

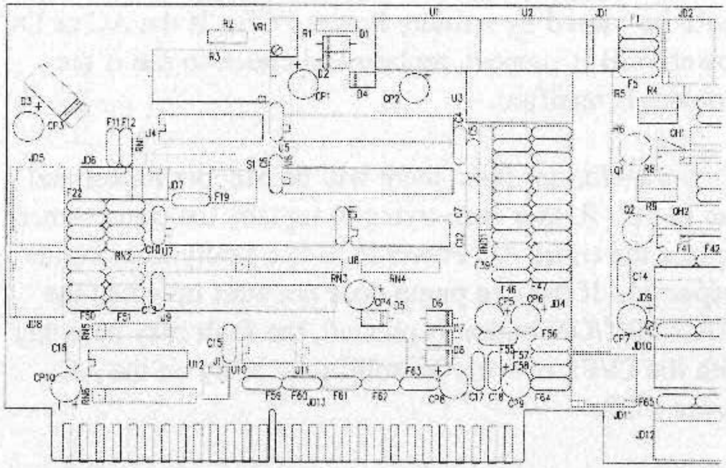

Figure 5.6 *DC Power PCB*

- The Temperature and Low and High Pressure Switches (via the PD5 Connector)
- The Fiber Coupler Switch, Shutter Switches, and Attenuator Switch (relayed via the Resonator Board)
- Voltage measurements for the LVPS (+5v, +15v, and -15v) can be measured on the DC Power Board (refer to LVPS description in this section).
- Service Mode can be entered by pressing a red ser vice button located on the DC Power PCB.

Problems. Because the AC and DC Power PCBs provide, either directly or indirectly, the voltage supply for all of the circuit boards and the moving parts of the Dye

Module, any power problems associated with these areas could be caused by a faulty Power PCB. If the AC or DC Power PCB is suspect, replace and check to see if the problem is rectified.

If the transformer fails, there will be Stepper Motor and Fan faults. Rather than trying to replace the transformer, replace the entire AC Power PCB if a faulty transformer is suspected. If the dye pump does not start up when the STANDBY/ON button is pressed, the fault may be either with the LVPS or with the solid state relay on the AC Power PCB.

Control Panel PCB

Location. The Control Panel PCB is located on the front display panel of the Dye Module. It is the membrane that is pressed to activate the different Dye Module key functions. Removing the Control Panel PCB will involve removing the front panel (five bolts), unscrewing the four screws of the Control Panel PCB and disconnecting the ground wire and cable, and pulling the PCB through the front panel area.

Function. Like the Keyboard Display PCB, the Control Panel PCB sends control signals to the Dye Module LED display panel. It contains all the LED arrays for the display panel.

Problems. Any problem with the LEDs should first be checked at the Control Panel PCB. To check the LEDs, press simultaneously the Power Up and Power Down buttons (green buttons). This will light all the LEDs on the display.

- If a LED segment does not light, replace the Control Panel PCB.

- If a LED array does not light, check the Control Panel PCB voltages at P3. You should read +5v (red wire), +15v (orange wire), and -15v (vio let wire). If these values are more than 10% off, check the voltages at PD12 on the DC Power PCB.

- If the voltages are OK but a panel of LEDs still does not light, replace the Keyboard Display PCB. Circuit Board Interconnects

Low voltages (+5v, +15v, and -15v) are received by the DC Power PCB from the LVPS. Voltages are distributed by the AC and DC Power Boards to the system compo- nents. Control signals for the components are sent and received by the DC and CPU Power Boards.

The DC Power PCB plugs into the Resonator PCB at the JD13/JR12 Connector. It supplies +5, +15, and -15 DC voltages to the Control Panel PCB via the PD12 Connector and to the Mother PCB via the PD10 Connector. The Mother Board then supplies voltages to and serves as the interconnect between the Analog Input PCB, the Keyboard Display PCB, and the CPU PCB. If there is a power failure with all of these boards, check for broken wires at the Card Cage at the point just before the wires connect to the individual EMI filters.

Control signals are sent between circuit boards via the following connectors:

- The DC Power Board to the CPU Board via the PD4 to P2 Connection.
- The Control Panel and Keyboard Display PCBs via the P2 to PK2 Connection.
- The Resonator and Analog Input PCBs via the PR13 to J2 Connection.

See Figure 5.7 for the interconnect diagram of the PCB subassemblies.

Interlocks

There are four interlocks in the 600 Series Dye Module. These are:

- SYSTEM Interlock
- FIBER Interlock
- REMOTE Interlock
- PUMP Interlock

The general function of the interlocks is to safeguard vital aspects of the Dye Module and to signal when one of these vital areas has been defeated. (More detailed information about the Interlocks can be found in Section 8, Interlocks and Error Codes.) If none of the Interlocks is

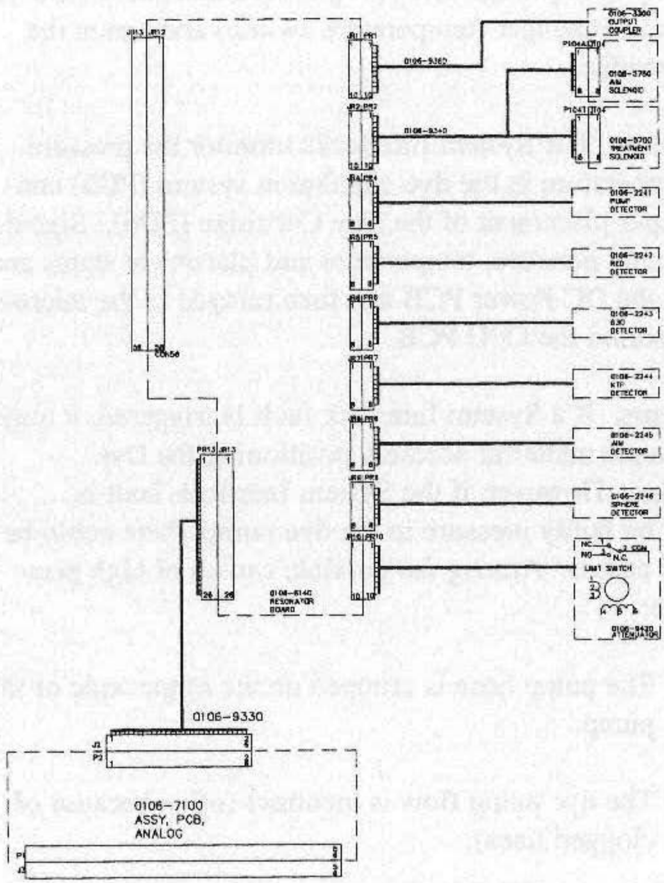

Figure 5.7: Interconnect Diagram of PCB Subassemblies

sending signals, the problem may be a faulty DC Power PCB.

System Interlocks

Location. There are four System Interlock switches: two at the dye pump (high and low pressure indicators), one at the Heat Exchanger (temperature switch) and one at the dye cartridge.

Function. The System Interlocks monitor the pressure and temperature in the dye circulation system (PD5) and the proper placement of the Dye Cartridge (PD6). Signals concerning pressure, temperature and placement status are sent to the DC Power PCB and then relayed to the microprocessor on the CPU PCB.

Problems. If a System Interlock fault is triggered, it may be a simple matter of securely positioning the Dye Cartridge. However, if the System Interlock fault is caused by faulty pressure in the dye pump, there could be several causes. Among the possible causes of high pressure are:

- The pump hose is crimped on the output side of the pump.
- The dye pump flow is incorrect (often because of clogged lines).

Low pressure problems could be caused by:

- Leaks in the hoses connecting to the pump.
- Low fluid level.
- Pump failure.

Possible causes of high temperature problems include:

- The Fan is not operating properly and the dye solution is overheating.
- The laser has been operating in high power for too long without pause.
- The room in which the Dye Module is operating is not properly air-conditioned.

It is also always possible that the problem could be due to a faulty switch (See Section 7, Dye Circulation, for the procedure on changing a High or Low Pressure Switch).

Fiber Interlock

Location. There are two Fiber Interlock switches and both must be sending the same signal to the microprocessor for the system to function. The Fiber Interlock Switches are not immediately visible. They are recessed within the Fiber Output Coupler (See Figure 5.8).

Function. The Fiber Interlock monitors whether or not a delivery device has been attached and relays this information to the microprocessor. If there is an attempt to put the system in Aim or Treat mode when a delivery device has not been attached, an Interlock fault will be generated. Until the fault is cleared, the system will not emit laser energy.

Problem. The problem is usually that a delivery device fiber has not been connected to the Dye Module and there is an attempt to operate the system The usual solution is to connect a delivery device. However, if the fault signal continues even if a device is attached or if no fault is signaled when a delivery device is not attached and the system is made ACTIVE, then one or both switches may be faulty. Either replace the Fiber Output Coupler to see if the problem is corrected or check for voltage output at the JR1/PR1 Connector on the Resonator PCB.

If the switches are not defective, check the JR1 cable from the Output Coupler to the Resonator PCB.

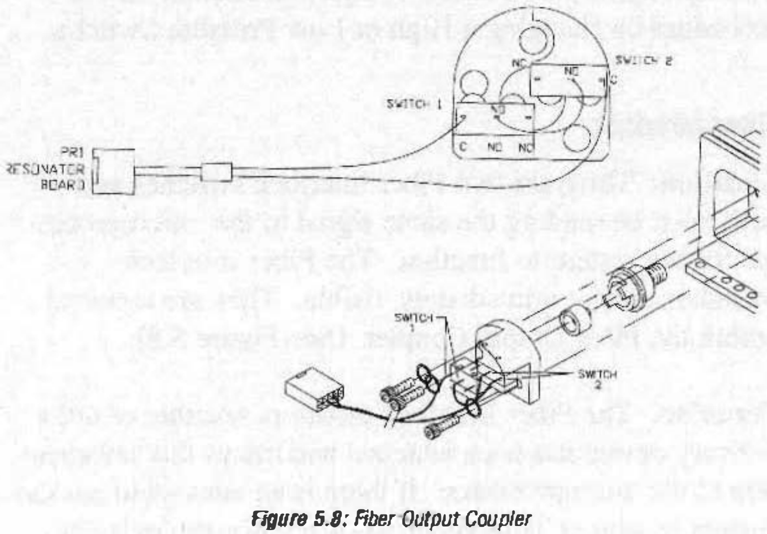

Figure 5.8: Fiber Output Coupler

Remote Interlock

Location. The Remote Interlock socket is installed on the back of the Dye Module (Refer to Figure 3.5).

Function. The Remote Interlock is a safety feature required by the FDA on all lasers. This interlock switch is usually connected to an entry door so that, if the door is opened, the Remote Interlock will be opened and lasing energy will cease until the door is closed.

The Remote Interlock is an option and is used at the customer's discretion. It is mounted with a shorting plug attached on the back of the Dye Module unit.

Problem. If the Remote Interlock malfunctions, check the PD3 Connector to the DC Power PCB.

Pump Interlock

Location. The Pump Interlock does not have a physical switch. The Interlock is achieved using the photodiodes of the Aim and Pump (Green) Detectors to detect the presence of a KTP signal reaching the Dye Module. The presence of this signal ensures that the fiberoptic and pump laser are correctly installed and functioning.

Function. The Pump Interlock monitors the laser light entering from the KTP Surgical Pump Laser to the Dye Module and sends information to the microprocessor which generates a fault if the power is not within the specified range.

If the Pump Interlock fault is triggered during STAND-BY/ON, the AIM and TREAT modes cannot be achieved. If the Pump Interlock fault is triggered during AIM or TREAT, the laser will automatically return to STAND-BY/ON.

Problem. The Pump Interlock fault usually indicates that the Fiber Interface Cable attaching the Dye Module to the pump laser is not connected properly and the fault can usually be rectified by reconnecting the cable.

Detectors

Locations. The 600 Series Dye Module has six detectors whose general functions are to monitor aspects of the laser and signal when there is a problem. These detectors include (See Figure 5.9 for detector locations):

- Red Detector
- Pump (Green) Detector
- Aim Detector
- Pump Detector
- Sphere Detector
- Fiber Detector

Functions. The following describes the functions of the various detectors:

- Red Detector. The Red Detector monitors the wavelength of the pump laser surgical beam and sends this information to the microprocessor. If the monitored wavelength is not within +/- 3 nm of the wavelength setting, a light is displayed.

- Pump (Green) Detector. The Pump (Green) Detector monitors the supplied KTP power from the pump laser and sends this information to the microprocessor. The computer compares the Pump Detector reading with the power listed on the Control Panel. When the two readings are not in line, a light will be displayed.

- AIM Detector. The Aim Detector monitors whether or not the Aim beam is functioning and sends this information to the computer. If the Aim Beam is not detected, a light will be displayed.

- Pump Detector. The Pump Detector monitors the KTP power going through the dye cell and sends this information to the microprocessor which then compares it to the dye life records. If the dye is over the wattage life allowed, a light will be dis played.

- Sphere Detector. The Sphere Detector monitors the light transmitted through the fiber and sends this information to the microprocessor which compares it to the system's calibration memory.

- Wavelength Detector. The Wavelength Detector also monitors the wavelength and verifies that it is the wavelength recognized by the Red Detector. The computer displays a light if the wavelength is not the specified wavelength.

Problems. When troubleshooting detector faults, first check the voltage readings at the detector PCB test points on the Analog Input PCB (See Figure 5.4 and Analog Input PCB description in this section). Increase and decrease the power settings on the Dye Module Control Panel. You should see the voltage readings increase and decrease with the changes in laser power. If the readings do not alter with the change in laser power, check the following:

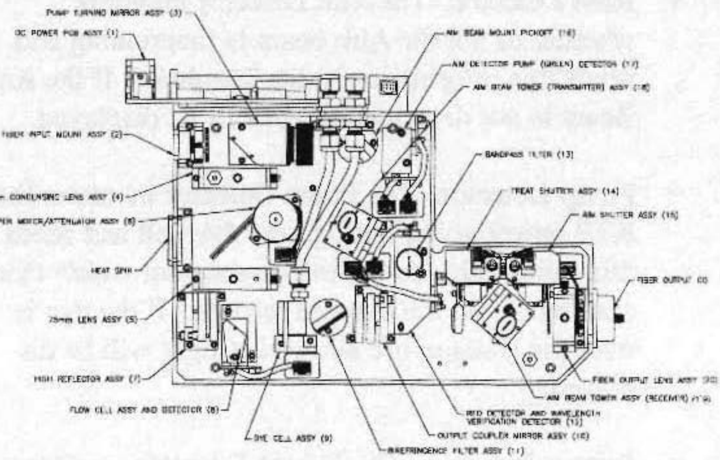

Figure 5.9: Resonator

- Determine whether the fault is coming from the Detector or the Analog Input PCB. Swap the cable connecting the suspect detector to the Analog Input Board to see if the fault condition stays the same or travels to the new location.

- If the Analog Input PCB is suspect, check the voltage test points on the Analog Input PCB to see if there is any output. If there is not, replace the Analog Input PCB.

- If the voltage values are off, first try adjusting them to bring output readings back to specification before replacing the Analog Input PCB. Also, check the VR 1 (+12v) and VR 2 (-12v) analog voltage regulators (Refer to Figure 5.4). If necessary, these can be adjusted by adjusting the +5 voltage pot on the LVPS (refer to Figure 5.3).

The voltage test points, pot adjustment locations, and measurement specifications for each of the detector control circuits are listed under the Analog Input PCB description.

The detector zero and voltage values should be checked at the Analog PCB during each Preventive Maintenance Procedure for the Dye Module system.

AC Voltage Configuration

The 600 Series Dye Module can be configured to operate at either 115 VAC or 230 VAC. The following procedure describes how to configure the system for operation at either power level.

Configuration for 115 VAC Operation

1. Check that the voltage select jumper on the Low Voltage Power Supply is in the 115 VAC position (refer to Figure 5.3).

2. The voltage select jumpers on the AC Power PCB should be configured as follows: J2 to J3 and J5 to J6 (refer to Figure 5.7).

3. Make sure that the AC line input fuses are type 3AG, 3 amp (Laserscope Part Number: 4310-0006).

Configuration for 230 VAC Operation

1. Move the voltage select jumper on the Low Voltage Power Supply to the 230 VAC position (refer to Figure 5.3).

2. The voltage select jumpers on the AC Power PCB should be configured as follows: J2 to J1 and J5 to J4 (refer to Figure 5.7).

3. Make sure that the AC line input fuses are type 5 X 20mm, 1.6 amp (Laserscope Part Number: 4310-0010).

Section 6: Laser and Optics

Introduction

The maximum average output power for the Dye Module is specified as 7.0 watts (High Power Module) or 3.2 watts (Low Power Module) for wavelengths ranging from 600-699 nm. The ability of the output power to meet this specification can be affected by several conditions. In the event that the Dye Module does not reach 7.0/3.2 watts in Application Mode (or 9.0/4.2 watts in Service Mode), check the following:

- Power being received by the Dye Module from the pump laser is 30/16 watts.
- Cable that connects the Dye Module to the KTP Surgical Laser System (the Fiber Interface Cable/ Pump Fiber) is not damaged.
- Life of the dye cartridge and/or dye filter has not expired.
- Optics are in good condition.
- Resonator is in alignment.
- Detectors are in calibration.

This section includes information about and/or procedures for the following :

- Possible causes of Low Power Problems
- Instructions for Dye Module Resonator Alignment
- Instructions for Fiber Coupler Alignment
- Instructions for Detector Calibration

Low Power Problems

Low power can be caused by any number of problems. Before performing a full alignment procedure, there are several other system conditions that should be checked.

Power from the Pump Laser

Using a power meter, verify that 30/16 watts of KTP pump laser energy can be sent to the Dye Module. If the KTP power is low, check the KTP Surgical Laser System resonator powers. Use an oscilloscope and fast photo diode to ascertain that the pulse width parameter on the pump laser is between 450 - 600 ns (550 - 600 ns for Low Power Modules). If the pulse width cannot be set between these parameters, the pump laser may need alignment (See Surgical Laser Service Manual for laser alignment instructions).

Connecting Cables

Once it has been determined that the power from the pump laser is adequate, connect the Dye Module to the laser with the Fiber Interface/Pump Cable and the Connector Cable. Disconnect the footswitch cable on the pump laser and attach the Connector Cable. Visually inspect the cables for any damage, and make sure the connection at the pump laser is secure.

Dye Cartridge/Filter Change

Using an IBM compatible computer (See Preventive Maintenance Procedure in Section 9 for laptop connection and usage with the Dye Module System), check the watt hours remaining in the life of the dye cartridge. If needed, replace the dye cartridge. In some cases the dye filter will also require replacement, particularly if dye contamination is suspected (e.g., power was adequate one day and dropped dramatically the next). A detailed description of the Dye Change Procedure for the Dye Cartridge is given in Section 7, Dye Circulation. The Procedure for changing the Dye Filter is described in Section 9, Preventive Maintenance.

Defective Optics

In a laser system, the optical coatings will sometimes degrade over a period of time. This can cause two major problems: low power and/or a noisy or unstable laser. It does not take much time or effort to inspect and clean these optics because the mounts for the optics are extremely rigid. (This means that when an optic is removed,

> **NOTE**
> **Only work with one optic at a time.**

cleaned and then put back, it should still be close to 100% aligned.)

To inspect an optic, remove the suspect optic and closely examine it under a strong light. Mark the top edge of the optic so there is a reference to show how it was seated. You have to turn it at different angles, because coatings will sometimes develop "bleached-out" spots that are extremely difficult to see. If the optic has bleached spots or a blatantly burnt spot on the surface, you can try to clean it and then rotate it in its holder so that the laser beam passes through a new spot on the optic. But if the bleached or burned spot is in a position where the beam will always pass through it, you must change the optic.

To clean the optic, use Lens Cleaning tissue and a solution of methanol and acetone. Hold a sheet of the lens tissue by one corner and put a drop of acetone in the center of the sheet. Fold the sheet and drag it across the surface of the optic, then discard the sheet. Inspect the optic, and if more cleaning is necessary, repeat the above.

To replace the optic, put the new optic in the Mount or put a new Fixed Optic Assembly in the Resonator Baseplate. Adjust using the X and Y adjustments on the Assembly until a clean spot (one without satellites) is

> **NOTE**
> **Damaged optics should only be rotated as a temporary measure when new optics are not avaiable.**

> **NOTE**
> **When cleaning optics, never apply pressure to the coating. Cleaning should only consist of dragging the wet tissue across the optical surface.**

achieved. Check the power capability. If power is now within the acceptable range, an alignment is not necessary.

Calibration

To check calibration, set the Dye Module power to 1 watt, connect a PDT fiber to the Dye Module's PDT Delivery Device Port and insert the fiber tip into the integrating sphere of the NIST traceable standard to get a reading. Next, put the Dye Module into FIBER CAL mode, insert the fiber tip into the calibration insert in the Dye Module Calibration Sphere, and press the Aim and Treat buttons on the Dye Module Control Panel. Once the reading has stabilized, press CAL MEM.

The laser power reading using the Calibration Sphere should be within 15% of the standard NIST measurement. If it is not within this range, the power measurement error is excessive and the unit should be calibrated as described at the end of this section.

Replacing the Pump Fiber

If the Pump Fiber is defective, it will need to be replaced and a full Alignment Procedure will be required. It is not possible to test the Pump Fiber while it is connected to the

CAUTION
Before removing the Pump Fiber, be certain that the Power Cord has been disconnected.

Dye Module because of lack of space, so even if the Pump Fiber is found to be good after it is removed and tested, an Alignment Procedure will have to be performed after the Fiber is reinserted.

To test or replace the Pump Fiber, unscrew the Fiber inside the Pump Fiber Mount Assembly. There are 2 screws on the inside of the back panel. Loosen these for easier access. Unscrew the strain relief which is mounted to the back plate and pull the Pump Fiber through. To test, set Dye Module to AIM mode and focus beam against wall to check size of Fiber against a known good Fiber. To measure the Pump Fiber, measure the Fiber transmission using a power meter, then compare with the power setting. If Fiber is defective, replace (400 µm fiber for High Power/300µm fiber for Low Power) and realign the

Dye Module. If Fiber is not defective, reinsert and realign the Dye Module.

Realignment

If the Dye Module continues to have low power problems, an alignment of the Dye Module as described on the following pages will be necessary. For realignment procedure refer to document #0106-3330. Realignment should only be done by Laserscope-trained personnel.

Detector Calibration

The Following gives step-by-step description of the procedure for calibrating the Dye Module detectors. This procedure is necessary whenever there is a substantial discrepancy between the selected power and the actual power.

Power Validation Requirements

In order to validate the power measurement system in the 600 Series Dye Module prior to use, the system should always be calibrated using a power measurement standard traceable to NIST (National Institute of Standards Technology). The nature of Photodynamic Therapy requires that the fiberoptic delivery device radiate light uniformaly into large volumes. A power meter that employs an integrating sphere for power measurement is required to properly validate the system. A flat detector is inadequate and its use will result in erroneous calibration.

The general calibration procedure requires that the PDT fiber be connected to the Dye Module's PDT Delivery Device Port, and the fiber tip inserted into the integrating sphere of the standard. The reading from the NIST traceable standard is compared to the reading obrained by inserting the fiber tip into the calibration insert in the Calibration Sphere of the Dye Module. The Dye Module must be in the FIBER CAL mode to activate the integrating sphere for power measurement.

The laser power reading should be within 15% of the standard measurement. If it is not within this range, the power measurement error is excessive and the unit should be calibrated. The procedure to perform this calibration is described on the following pages.

Required Equipment

The following equipment will be required to perform the calibration procedure:

1. Digital Voltmeter (DVM): Fluke DVM Model 75, 85, or equivalent.

2. External Power Meter: Integrating Sphere Power Meter, UDT Model 2025 with Integrating Sphere, UDT Model S370, or equivalent.

3. Spectroscope: Optometrics USA Model DMC1-035, or equivalent.

4. Fiber Bypass Connector: Laserscope or SMA-905.

5. Extender PCB (Standard Bus Card PN# 5400-0220).

Analog Input Board Calibration

The Analog Input Board has five active channels: ADC1, ADC2, ADC4, ADC5, and ADC8. These are switched under software control to a single A to D converter. The outputs of each channel must be adjusted to zero to null any offsets of the detectors for than channel.

In addition, the PUMP/ON and AIM thresholds must be adjusted.

Before starting the calibration procedure, prepare the system as follows:

1. Turn the Dye Module OFF.

2. Connect the Fiberoptic Interface Cable from the Dye Module to the surgical laser.

3. Place the Analog Input Board on an extender.

4. Turn the system ON and access SERVICE mode by pushing the Service Button (S1) located on the DC Power PCB. The Dye Pump should turn on and stay on until the curtains on the Stepper Motor/Attenuator are completely closed.

5. When the pump turns off, press the ON/STANDBY button on the front panel. Verify that the Dye Pump turns on and the Dye Module does not start a warm-up cycle

6. Place the negative probe to Pin 7 of IC14 on Analog Input Board or analog ground location on the Extender PCB (Refer to Doc.# 0106-7180). With a DVM, adjust the PUMP/ON and AIM thresholds and t he ADCI- ADC8 offsets as described in the following sections.

PUMP/ON and AIM Thresholds

Adjust the PUMP/ON and AIM thresholds as follows:

1. The PUMP?ON threshold: Adjust Pot 8 until IC16, Pin 9 equals 1.0 volt, DC.

2. The AIM threshold: Adjust Pot 9 until IC16, Pin 5 equals 0.4 volts, DC.

ADC1-ADC8 Offset Adjust

With the surgical laser set to STANDBY and the Dye Module in the SERVICE mode, adjust the following offsets on the Analog Input PCB of the Dye Module:

1. Pot 1 until TP1 equals 0 volts, DC.

2. Pot 2 until TP2 equals 0 volts, DC.

3. Pot 4 until TP4 equals 0 volts, DC.

4. Pot 5 until TP5 equals 0 volts, DC.

5. Pot 6 until TP6 equals 0 volts, DC.

Detector Gain Adjustments

This calibration involves adjusting five detector boards located in the resonator assembly and one on the integrating sphere. Listed below are the six detectors and their power/voltage relationships, followed by the adjustment procedure.

All adjustments are made on the individual Detector PCBs, but they are measured on the Analog Input PCB (See Figure 6.6).

Before adjusting the detectors, perform the following:

1. Remove the dust cover from the Dye Module Resonator.

2. Connect the footswitch to the surgical laser.

3. Set TREATMENT/SECONDS to 100 seconds. (Stepper Motor/Attenuator will open/close 100 steps when the Power Control buttons are pressed.)

4. Push up button eight times. (Note that the elapsed time is 800 seconds.)

Pump (Green) Detector: 0.25 Volts/Watt*

1. Set the surgical laser to deliver 30/16 watts (uncalibrated).

* Note: Older Dye Systems have a .5 volts/watt on KTP detector. If you areunsure, please consult Laserscope's Technical Support Group.

2. Put the surgical laser in READY mode and press the footswitch.

3. Adjust the Pump (green) Detector gain potentiometer until the DVM reads 4.0 volts, DC (16 watts) or (30 watts at 7.5 volts) at TP6 of the Analog Input PCB. (Refer to Doc#0106-7180.)

Pump Detector: 0.25 Volts/Watt

1. Set the surgical laser to deliver 16 watts (uncalibrated).

2. Put the surgical laser in READY mode and press the footswitch.

3, Adjust the Pump Detector gain potentiometer until the DVM reads 4.0 volts, DC (16 watts) or (30 watts at 7.5 volts) at TP1 of the Analog Input PCB.

High Power Dye Module: 1 Volt/Watt*

1. Defeat the FIBER Interlock with the Fiber Bypass Connector, and place a power meter at the PDT Delivery Device Port.

2. Position the External Power Meter at the PDT Delivery Device Port.

3. Open both the AIM and TREAT shutters by pressing

* Note: Older dye laser systems have a 2 volts/watt configuration on the red detectors. If you are unsure on your system's configuration, please consult Laserscope's Technical Support Group.

AIM, then TREAT. The power could exceed 4 watts at this point.

4. Adjust the Power Control Down button until the power on the External Power Meter reads 2 to 3 watts.

5. Monitor the Red Detector output at TP2 of the Analog Input PCB, and adjust the gain potentiometer until the DVM reads 1 to 1 the External Power Meter reading (2.4volts DC for 2.4 watts).

6. Using the Spectroscope, verify that the wavelength is 6XX nm ± 3 nm.

7. Adjust Bandpass Filter to peak, or maximize 6XX nm Detector output.

8. Adjust the Wavelength Detector output, measured at TP4 to equal the Red Detector, measured at TP2.

Aim Detector

1. Set the surgical laser to deliver 16 watts (uncalibrated), and the AIM beam to HIGH.

2. Put the surgical laser in READY mode.

3. Adjust the Aim Detector output of the Dye Module to maximum while the Dye Module is in STANDBY mode.

Sphere Detector*: 1 Volts/Watt

1. Turn the Dye Module OFF.

2. Remove the Calibration Sphere Assembly from the Dye Module.

3. Connect the Interface Control Cable to the Surgical Laser.

4. Turn the Dye Module ON, and press ON/STANDBY.

5. Defeat the FIBER Interlock with the Fiber Bypass Connector, and place the Calibration Sphere Assembly at the PDT Delivery Device Port.

6. Set the Dye Module power to 1 watt and press the FIBER-CAL button.

7. Press the AIM button, then press the TREAT button.

8. Adjust the gain pot on the Sphere Detector PCB until the display reads 1 watt.

9. Re-install the Calibration Sphere Assembly.

* Note: Older dye laser systems have a 2 volts/watt configuration on the red detectors. If you are unsure on your system's configuration, please consult Laserscope's Technical Support Group.

Section 7:
Dye Circulation System

Introduction

The 600 Series Dye Module Dye Circulation System performs several functions:

- It maintains the dye solvent at a constant temperature.
- It regulates the dye pressure within safe operating limits.
- It provides a clean source of the dye medium.

The Dye Module Circulation System consists of the following main subassemblies:

- Reservoir (Dye Cartridge)
- Heat Exchanger and Fan
- Pump
- Pressure Interlocks
- Filter

Figure 7.1 shows the circulation subassembly interconnections. It also illustrates the dye flow as it is pumped from the Reservoir; travels through the Pump, Heat Exchanger, and Filter to the Dye Cell Assembly in the Resonator; and then returns to the Dye Reservoir.

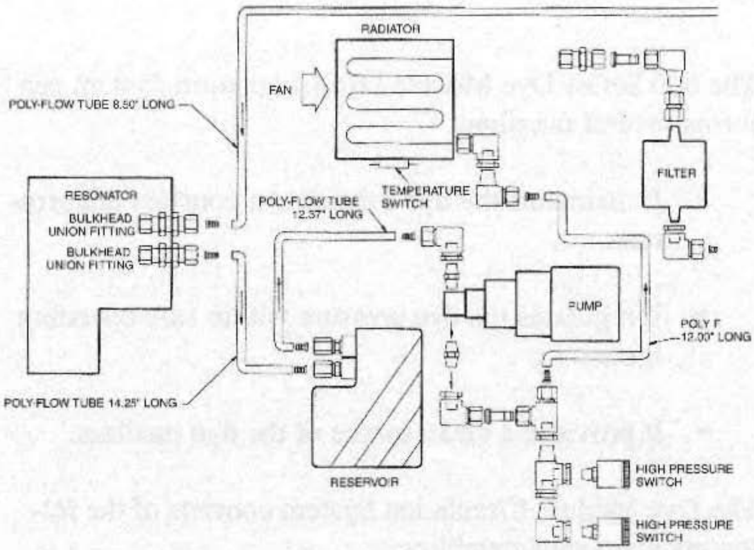

Figure 7.1: Dye Circulation

Dye Module Circulation Description

Reservoir (Dye Cartridge)

The Reservoir (or Dye Cartridge) is a Teflon container which has a capacity of 700 milliliters. The supply of dye is maintained in the Reservoir and is constantly being recirculated by the Pump. The reservoir is fitted with two stainless steel quick disconnect fittings which allow dye to flow only when the cartridge is attached. Because of the valve-like action of these fittings, there is minimum dye spillage when the cartridge is removed.

Attached to each of these fittings on the inside of the dye cartridge is a Teflon tube which will suction the dye from the bottom of the cartridge. As a result, it is not necessary to have the Dye Cartridge filled to the top.

The Dye Module software is programmed to require that the dye cartridge be replaced after 800 watt hours of use. Since the KTP Surgical Laser System pumps the Dye Module with 30/16 watts, this would equate to 27/50 hours of use per dye cartridge (800 watt hours = approximately 30 watts pump for 27 hours or 16 watts pump for 50 hours).

When the microporcessor has determined that the 800 watt hour limit has been reached, a "Dye Change" warning message will flash on the keyboard display. However, even if the Dye Cartridge is not changed, the operator can continue to use the system.*

Once 960 watt hours have been reached, the Dye Module will display an H06 fault. This fault can be cleared by pressing the STANDBY key. H06 fault signals will continue to appear each time the Dye Module is activated, but they can be cleared each time by pressing the STANDBY key and the system will continue to operate.

When 1120 watt hours have been reached, an H07 fault will be displayed. If this fault is signaled while the Dye Module is in use, the operator will be able to continue the current procedure without a system shutdown. However,

*Note: Replacing the Dye Cartridge is an easy procedure and is routinely performed by the system operator.

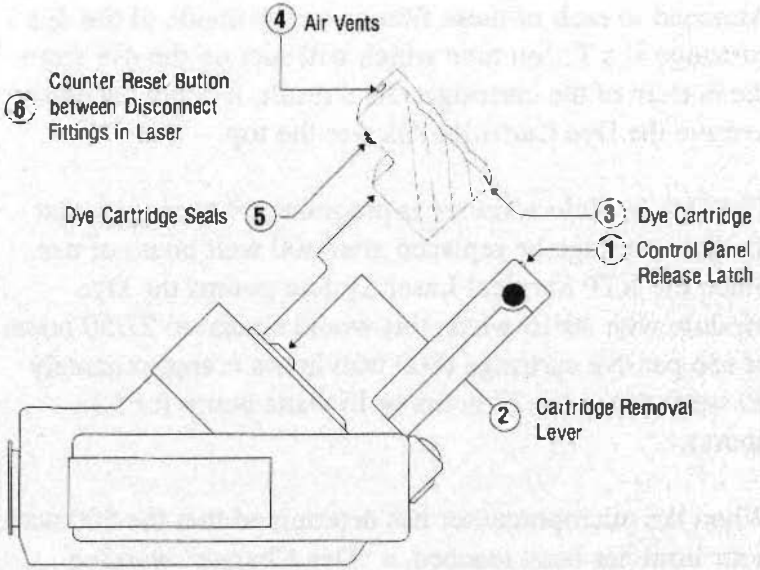

Figure 7.2 Dye Cartridge Assembly.

once the Dye Module has been turned off, the system cannot be reactivated until the Dye Cartridge has been changed.

The system keeps track of dye changes by monitoring the depression of a microswitch located between the two Dye Cartridge fittings on the dye bracket holder assembly. This switch is pressed manually when a cartridge is replaced. See Figure 7.2 for reference. A step-by-step procedure for cartridge replacement is included at the end of this section.

After 800 watt hours have elapsed since the second Dye Cartridge has been changed, a “Maintenance Due” message will be displayed. An H08 fault will be displayed once the watt-hour limit reaches 960, but the fault can be cleared by pressing the STANDBY key.

After 1120 watt hours have been reached since the second Dye Cartridge change, an H09 fault will be displayed. If this fault occurs during use, the system will continue to operate for the current procedure. However, once the system has been turned off, it cannot be reactivated until a maintenance procedure is performed.

The only method to clear the H09 fault (besides performing maintenance) is to interface with the Dye Module's computer via the RS 232 port on the back of the system, have the correct diagnostic software, and understand the commands to clear the fault. See Section 9 for procedures on using the diagnostic software.

The "Maintenance Due" message will also be displayed automatically when 6 months have passed from the installation date. This is regardless of the number of dye changes or watt hours accumulated. Again, the only method of clearing this fault is to interface with the Dye Module using the diagnostic software and to reset the 6 month counter.

Heat Exchanger and Fan

The Heat Exchanger in the Dye Module is much like the radiator used in an automobile. The dye solution is pumped through the Heat Exchanger which is fitted with cooling fins to dispose of the heat generated within the dye solution. A Fan which is mounted on the reverse side of the bracket that holds the Heat Exchanger also assists in the cooling process. The Fan and Pump are both activated when the ON/STANDBY key is pressed.

A temperature switch (thermal cut out) located on the Heat Exchanger (refer to Figure 7.1) monitors the temperature of the dye solution and sends this information to the microprocessor via the DC Power Board. An H01 fault is generated when the temperature reaches above 120° F.

Pump

The pump has an output of 2 liters per minute. Two pressure switches (Refer to Figure 7.1 for location) monitor the pump and dye flow pressure.

Pressure Interlocks

The two pressure interlocks that monitor the dye flow pressure include:

- **A Low Pressure Switch** that is activated when pressure reaches 25 psi + 1- 2 psi.

- **A High Pressure Switch** that is activated when pressure reaches 60 psi + 1- 2 psi.

When the system is off, the High Pressure Switch should be closed and the Low Pressure Switch should be open. When the system is operating and the pump is running, both switches should be closed. If either switch is open while the pump is on, an H02 fault will be generated.

To check whether the switches are operating correctly,

Note:
While both switches are identical in appearance THEY ARE NOT identical in function. Careful attention must be paid when replacing them.

measure the voltages at the PD5/JD5 Connector on the DC Power Board at green wire (pin 7), blk/green wire (pin 8), blue wire (pin 9), and blk/blue wire (pin 10). See Figure 7.3 for a wiring detail of the pressure interlocks. The voltages at these points should all be the same. If they are not, the switches may need to be replaced.

There are three terminal connections on each switch: Closed (C), Normally Closed (NC), and Normally Open (NO).

- The Low Pressure Switch is wired to the C and NO terminals.
- The High Pressure Switch is wired to the C and NC terminals.

If these switches are replaced incorrectly, faults will be generated if the wiring is incorrect.

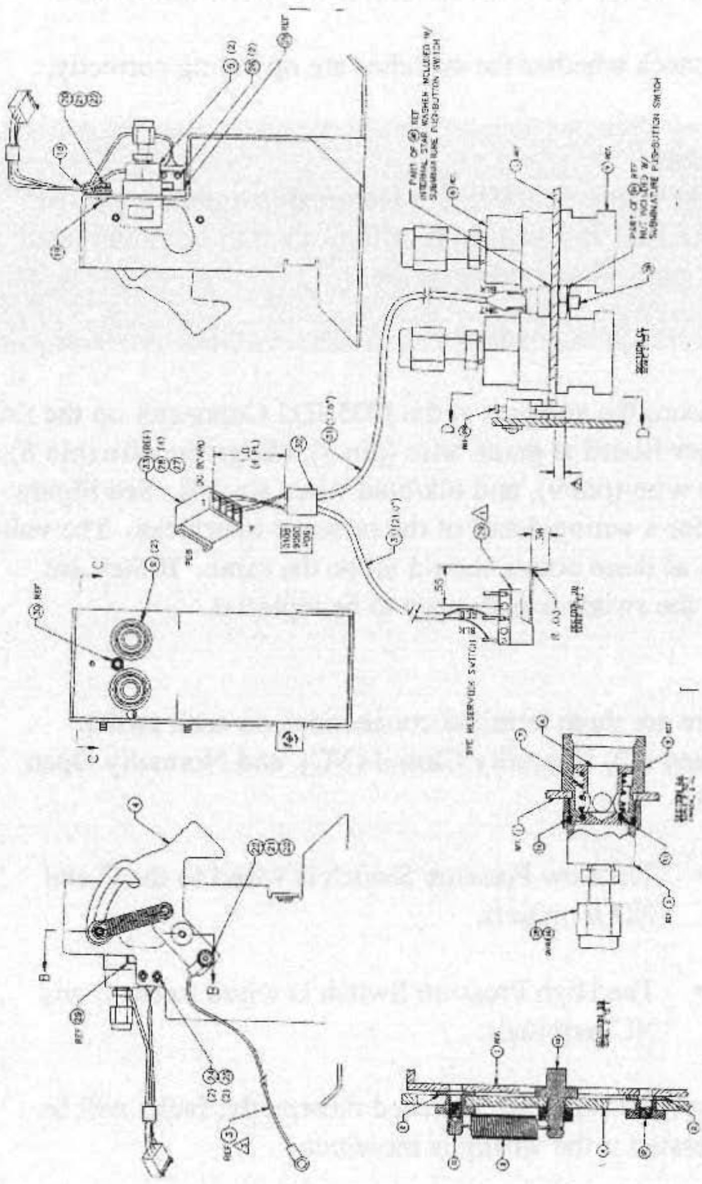

Figure 7.3 High/Low Pressure Switch Wiring.

CAUTION

When changing the Dye Cartridge, always wear the protective gloves provided, and clean up any spillage with the wipes provided with the replacement dye cartridge. Avoid dye contact with skin, eyes, and clothing. When the dye change is complete, all contents (old dye cartridge, gloves, used wipes, etc.) should be placed in the sealed bag and shipping container provided, and returned to Laserscope for proper disposal.

Filter

A 0.2 micron filter is located on the output side of the Dye Cartridge. It is used to filter out any particulate in the cooling loop. This filter should be changed during a scheduled Preventive Maintenance call.

If the Dye Module output is less than 7.0/3.2 watts at the time of the Preventive Maintenance, the circulation system will need to be flushed. If, after general alignment of the Resonator, the power is still below 7.0/3.2 watts, it can be assumed that the dye solution is contaminated.

The procedure for performing the system flush is included in Section 9, Preventive Maintenance.

Changing The Dye Cartridge

The procedure outlined on the following pages should be followed whenever the Dye Cartridge is changed. Refer to Figure 7.4 for an illustration of the Dye Cartridge Replacement.

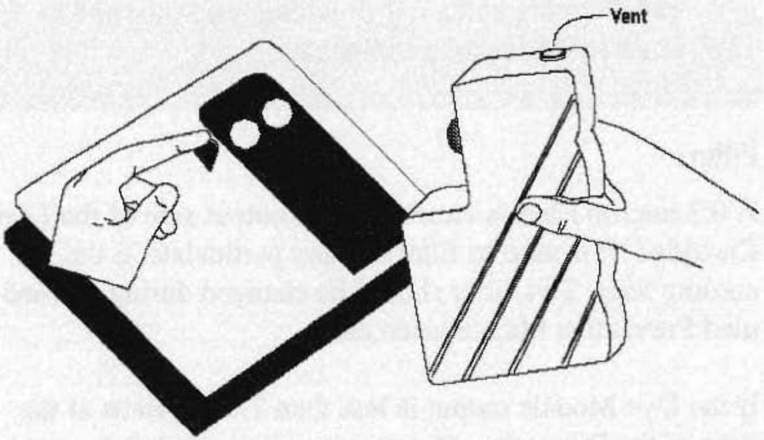

Figure 7.4 Dye Cartridge Replacement

Dye Change Procedure

To change the Dye Cartridge:

1. Verify that the 600 Series Dye Module is in the KEY OFF position.

2. Verify that the pump laser is OFF or in STANDBY.

3. Press the Control Panel Release Latch (1) and swing the control panel forward.

4. Press the red Cartridge Removal Lever (2) located alongside the dye cartridge, downward in a direction parallel to the surface of the dye cartridge and remove the old dye cartridge (3). Close the Top Vent Cap (4) on the old cartridge to prevent dye from leaking during shipment.

5. The used dye cartridge should be returned to Laserscope in the packaging provided with the new cartridge for proper disposal.

6. Remove the protective shipping caps from the new dye cartridge. Inspect the Dye Cartridge Seals (5) on the new cartridge for any sign of damage (such as cuts, scratches, nicks). If any visible defects are found, the cartridge should not be used. A defective cartridge should be replaced or sent back to Laserscope for repair or exchange.

7. Turn on Mains Power Switch.

8. Turn the Dye Module to the KEY ON position but do not press STANDBY/ON.

9. The power display on the Control Panel will display four dots (....) and the system inter-locks will be dis played.

10. Locate the small black Counter Reset Button between

the two disconnect fittings in the laser. Press once to signal the internal microprocessor that the dye cartridge has been replaced. If the DYE CHANGE warning lamp was illuminated on the control panel, it should now be extinguished.

11. Turn the laser to the KEY OFF position.

12. Open the vent cap on the new dye cartridge.

13. Insert the new dye cartridge into position.

14. Firmly press the new unit into place until the dye cartridge is fully seated. (Do not use excessive force to insert the cartridge.)

15. The fit of the new cartridge should be verified by gently tugging on the cartridge after the new unit is in place. The cartridge should remain solidly engaged. (No twisting or side play should be evident.)

16. Close the control panel cover and latch into place by pressing firmly on the cover until it locks into place. The system is now ready for use.

Section 8: System Interlocks and Error Codes

Introduction

The 600 Series Dye Module has circuitry that automatically monitors system functioning and alerts the microprocessor when a problem occurs or a necessary condition is not satisfied.

In turn, the microprocessor will send the appropriate signal, and an Interlock light on the front panel will flash and/or an Error Code will appear in the Power/Watts Display (refer to Figure 3.4). Depending upon the seriousness of the problem, the system will:

- Display the Error Code but continue to function.
- Display the Error Code and go to Standby for correction.
- Display the Error Code and shut down until the problem is resolved.

Table 8.1 lists the Error Codes with a brief indication of the problem condition.

CODE	PROBLEM CONDITION
H01	SYSTEM Interlock
H03	REMOTE Interlock
H04	PUMP/KTP AIM Interlock
H05	Attenuator
H06	Dye Life Warning
H07	Dye Life Limit
H08	Maintenance Warning
H09	Maintenance Limit
H10	Power Stabilization
H11	Power Drift exceeds 15%
H12	Low Maximum Power
H13	Treatment Time Not Set
H14	Control Cable Connection/No KTP
H15	Wavelength Out Of Spec
H16	FIBER Interlock
H17	ROM Test Failure
H18	RAM Test Failure
H19	AIM Solenoid Failure
H20	TREAT Solenoid Failure
H21	Control Cable Connection/ Hardware Initialization
H22	System Power Interrupt
H23	Time Clock
H24	Jumper Not Connected/ No Real Time Clock

Table 8.1: *Error Code*

On the following pages, each Error Code is listed separately and discussed in detail. Information is provided regarding: (1) probable cause(s) of the fault, (2) troubleshooting suggestions, and (3) other sections of the manual where related information can be found.

Code: H01

Problem:

SYSTEM Interlock

Cause:

There are two possible causes of an H01 Fault.

1. The Reservoir or Dye Cartridge is not seated properly and the Interlock switch at the Dye Cartridge is open.

2. The Temperature Switch on the Heat Exchanger has opened because the dye solution has exceeded 120° F.

Troubleshooting:

1. First, check to make sure the Dye Cartridge is securely seated.

2. Next, check that there are no obstructions clogging the air vents and causing the system to overheat. Other possible causes of overheating include:

   •The fan is not operating adequately and the dye is overheating. Make sure the fan turns on when the STANDBY button is pressed. Check the JA4 connection to see if power is reaching the fan and replace AC Power Board if it is not.

•The laser has been in high power operation for too long without pause and the system is overheating.

•The Dye Module has been operating in a room without adequate air conditioning.

3. If it is determined that the Reservoir is securely placed and the dye solution is not overheating, then check for a malfunction in either the Dye Cartridge switch or the Temperature switch by replacing one and then the other to see if the problem is rectified.

Cross Reference:

- See Section 7: Dye Circulation for information about the Dye Cartridge.

- See Section 5: Electronics for information about the Temperature Switch.

Code: H02

Problem:

SYSTEM Interlock

Cause:

There is a fluid system failure which could be caused by three conditions:

- The pump is not turning on when the STANDBY button is pressed.
- The pump pressure, when operating, is above 65 psi and the High Pressure Switch has opened.
- The pump pressure, when operating is below 25 psi and the Low Pressure Switch is open.

Troubleshooting:

1. First, check to see that the pump is turning on when the STANDBY button is pressed. If it is not:
   - Check the PA3 Connector to the AC Power Board to see if power is being received. If there is no power reaching the pump, replace the AC Power PCB.
   - If power is being transmitted but the pump motor is not starting, replace the pump.

- If the pump seems to be operating properly, check for a malfunction of the Low Pressure switch by replacing the switch to see if the problem disappears.

2. If the pump is operating, but the H02 Fault continues, there is a problem with either high or low pressure. To determine which is the problem condition, use an oscillo scope to measure at U7, pin 3 (high pressure) or pin 4 (low pressure) on the DC Power Board. For high pressure, first measure with the pump off and then with the pump turned on (the measurement should not change states). For low pressure, measure with the pump off, then turn the pump on (the measurement should change states immediately).

3. For high pressure problems, check for crimps or blockages in the pump hoses.

4. For low pressure problems, check for leaks in the hoses.

5. If a malfunctioning high or low pressure switch is suspected, replace the switch.

Cross Reference:

- See Section 7: Dye Circulation for more information about the dye pump and high and low pressure switches.

Code: H03

Problem:

REMOTE Interlock

Cause:

This is caused when the Remote Interlock is open either because the Remote Interlock string is not complete (e.g., the door that the Remote Interlock is connected to is open) or because the remote override connector is not in place. The Interlock will self-clear when the remote string is satisfied or the remote override connector is in place.

Troubleshooting:

1. Check the Remote Interlock connection to make sure it is properly attached to the door and to the Dye Module.

2. If a malfunctioning Interlock is suspected, measure at U7-14 on the DC Power Board.

Cross Reference:

- See Section 5: Electronics for more information on the Remote Interlock.

Code: H04

Problem:

PUMP/KTP AIM Interlock

Cause:

The photodiodes in the Dye Module are not detecting any KTP Aim beam laser energy coming from the pump laser. This condition could have several causes:

- The Fiberoptic Interface Cable is not connected or is damaged.
- The pump laser is not in READY.
- The AIM beam intensity of the pump laser is too low to be detected by the Dye Module Aim Detector.

This Interlock will self-clear when the pump laser is properly online.

Troubleshooting:

1. Check the Fiberoptic Cable from the Dye Module to the pump laser for damage and/ or proper connection.
2. Make sure the pump laser is in READY and that it can transmit sufficient power to the Dye Module.

3. Check for defective Dye Module Aim Detector by measuring voltage output. Also check that threshold is .4 watts.

Cross Reference:

- See Section 5: Electronics for information about the Aim Detector and Aim threshold.

Code: H05

Problem:

Attenuator

Cause:

The Attenuator Switch is always open unless the Attenuator blades are fully closed, at which point the switch closes. The H05 fault indicates that the Attenuator blades are either not opening or not closing completely as requested.

Troubleshooting:

1. Most likely, the problem will be a faulty Attenuator/Stepper Motor Assembly. Sometimes the Attenuator blades stick if they have been opened too wide or the Stepper Motor has continued to run after the blades were fully open. Before replacing the Attenuator, check the blades manually by adjusting the worm gear screw until the blades go through their full travel, then testing the Attenuator to see if the problem disappears. If the problem continues, replace the Attenuator.

2. If replacing the Attenuator doesn't solve the problem, check the connection to the Resonator PCB at JR10. Particularly, check for bent pins at the connection. If there is a bent pin, it can usually be bent back into place. If necessary, replace the Resonator PCB.

Cross References:

- See Section 4: System Description for more information on the Attenuator and Attenuator Switch.

- See Section 5: Electronics for wiring diagram of Attenuator Switch.

Code: H06

Problem:

Dye Life Warning

Cause:

The dye requires changing. It is 10 hours over the allowable limit or 6 months since the last dye change. This fault can be overridden by pressing STANDBY, allowing an additional 10 hours before system lockout.

Troubleshooting:

1. Change the Dye Cartridge.

2. If it is determined that the Dye Cartridge does not need to be changed, there may be a problem with the Reset switch. Check at the PD6/JD6 Connector on the DC Power Board, black wire (grnd), pin 1 and white wire, pin 2.

Cross Reference:

- See Section 7: Dye Circulation for more information about the Dye Cartridge and Dye Change procedure.

Code: H07

Problem:

Dye Life Limit

Cause:

The dye requires changing. It is 20 hours over the allowable limit. The H07 fault can be overridden to allow use during the current procedure by pressing STANDBY. However, at the next startup cycle, user will be prevented from using system.

Troubleshooting:

1. Change the Dye Cartridge.

2. If it is determined that the Dye Cartridge does not need to be changed, there may be a problem with the Reset switch. Check at the PD6/JD6 Connector on the DC Power Board, black wire (grnd), pin 1 and white wire, pin 2.

Cross Reference:

- See Section 7: Dye Circulation for more information about the Dye Cartridge and Dye Change procedure.

Code: H08

Problem:

Maintenance Warning

Cause:

The system requires service. Either it is 10 hours over allowable limit, 6 months since last service, or it is the second Dye Cartridge change. The H08 fault can be overridden by pressing STANDBY, allowing an additional 10 hours of use before system lockout.

Troubleshooting:

1. Perform Preventive Maintenance procedure.

Cross Reference:

- See Section 9: Preventive Maintenance for information on how to perform a Preventive Maintennance Procedure.

Code: H09

Problem:

Maintenance Limit

Cause:

The system requires service. It is 20 hours over the allowable limit. The H09 fault can be overridden to allow use during the current procedure by pressing STANDBY. However, next startup cycle, the user will be prevented from using the system.

Troubleshooting:

1. Perform a Preventive Maintenance procedure.

Cross Reference:

- See Section 9: Preventive Maintenance for information on performing a Preventive Maintenance procedure.

Code: H10

Problem:

Power Stabilization

Cause:

The laser cannot adjust to selected power in 5 seconds time. The microprocessor is comparing the selected power setting with the reading from the Pump (Green) Detector and finds that there is more than a 15% variance.

Troubleshooting:

1. First check the Control and Fiberoptic Interface Cables to make sure they are properly connected and undamaged.

2. The problem may be with either the pump laser or the Dye Module. Determine which is the source of the malfunction.

3. If the Dye Module is unable to reach full power, the problem may be damaged or dirty optics or the Resonator may need alignment.

4. If the problem developed "overnight," then it could be the result of dye contamination and the dye would need to be flushed and the filter replaced.

5. If the Dye Module is unable to adjust to a power

change, then the problem could be with the Attenuator blades or Stepper Motor. Replace the Attenuator/Stepper Motor Assembly to see if the problem disappears.

6. If it is determined that both pump laser and Dye Module are functioning normally, check the Pump (Green) Detector reading for possible detector malfunction.

Cross Reference:

- See Section 6: Laser and Optics for information on low power problems and the Resonator alignment procedure

- See Section 9: Preventive Maintenance for information on the dye flush and filter change procedure.

- See Section 5: Electronics for information on the Pump (Green) Detector.

Code: H11

Problem:

Power drift in excess of 15%.

Cause:

The actual dye laser power is not within 15% of the selected power. The microprocessor is comparing the selected power setting with the reading from the Pump (Green) Detector and finds that there is more than a 15% variance.

Troubleshooting:

1. The problem may be with either the pump laser or the Dye Module. Determine which is the source of the malfunction.

2. If the Dye Module is unable to reach full power, the problem may be damaged or dirty optics or the Resonator may need alignment.

3. If the problem developed "overnight," then it could be the result of dye contamination and the dye would need to be flushed and the filter replaced

4. If the Dye Module is unable to adjust to a power change, then the problem could be with the Attenuator blades or Stepper Motor. Replace the Attenuator/Stepper Motor Assembly to see if the problem disappears.

5. If it is determined that both pump laser and Dye Module are functioning normally, check the Pump (Green) Detector reading for possible detector malfunction.

Cross Reference:

- See Section 6: Laser and Optics for information on low power problems and the Resonator alignment procedure.

- See Section 9: Preventive Maintenance for information on the dye flush and filter change procedure.

- See Section 5: Electronics for information on the Pump (Green) Detector.

Code: H12

Problem:

Low Maximum Power

Cause:

The Dye Module does not reach 7.0/3.2 watts (Application Mode) or 9.0/4.2 watts (Service Mode). The microprocessor notes that the maximum power achieved is under the maximum power setting.

Troubleshooting:

1. First check output of pump laser to make sure 30/16 watts of pump laser energy are being transmitted to Dye Module.

2. If there is no problem with the pump laser, check Dye Module for low power problems such as cable connection to the pump laser, dye life of the cartridge or dye contamination, and dirty or damaged optics.

3. If none of these is the cause of the low power, then the Resonator is out of alignment and needs to be realigned.

4. If it is determined that both pump laser and Dye Module are functioning normally, check the Pump (Green) Detector reading for possible detector malfunction.

Cross Reference:

- See Section 6: Laser and Optics for information on low power problems and the Resonator alignment procedure.

- See Section 9: Preventive Maintenance for information on the dye flush and filter change procedure.

- See Section 5: Electronics for information on the Pump (Green) Detector.

Code: H13

Problem:

Treatment time not set.

Cause:

The Treatment Time on the Dye Module has to be set before the module can be put into AIM mode.

Troubleshooting:

This is an informational message for the operator. It does not indicate a service problem. The error will self-clear once the treatment time is set.

Cross Reference:

- See Section 3: System Overview, Installation, and Operation for information on operating requirements and specifications.

Code: H14

Problem:

Control Cable or Fiberoptic Cable Connection/ No KTP

Cause:

The pump laser power does not reach the Dye Module when requested. The Pump Detector is not reading any laser light coming from the pump laser.

Troubleshooting:

1. Check the Control Cable and the Fiberoptic Cable for connection and damage.

2. If there is nothing wrong with the cables, check the pump laser for power capability. When the pump laser is emitting KTP light, the pump laser screen should indicate that it is active.

3. If pump laser is functioning properly, check Dye Module Pump Detector reading and make sure Pump threshold is 1.0 watt.

Cross Reference:

- See Section 3: System Overview, Installation, and Operation for information about the Control and Fiberoptic Cables.

- See Section 5: Electronics for information about the Pump Detector and Pump threshold.

Code: H15

Problem:

Wavelength out of specification.

Cause:

The wavelength as detected by the Red Detector and Wavelength Verification Detector is not within +/- 3 nm of the specified wavelength.

This fault can be overridden by pressing STANDBY.

Troubleshooting:

1. Check the wavelength at the aim shutter using a Spectroscope. If the wavelength is out of spec, tune it by Birefringence Filter.

2. If the wavelength is not out of specification, the Red Detector may be malfunctioning. Replace the Wavelength Verification Unit, making sure that it is being replaced with a unit of the appropriate wavelength.

Cross Reference:

- See Section 4: System Description and Section 6: Laser and Optics for more information about the Birefringence Filter and the Wavelength Verification Unit.

Code: H16

Problem:

Fiber Interlock fault

Cause:

There has been an attempt to put the system into TREAT mode without first connecting a delivery fiber.

Troubleshooting:

1. Connect a delivery fiber and check the connector to make sure it is not damaged.

2. If a known good fiber is connected and the problem continues, check for faulty Output Coupler Switches by replacing the Coupler to see if the problem is resolved.

Cross Reference:

- See Section 5: Electronics for more information about the Fiber Interlock.

Code: H17

Problem:

ROM test failure.

Cause:

During the start-up self-test, the EPROM on the CPU Board malfunctions.

Troubleshooting:

1. Replace CPU Board or replace EPROM (U8) on the CPU Board.

Cross Reference:

- See Section 5: Electronics for information about the CPU Board and location of the EPROM.

Code: H18

Problem:

RAM test failure.

Cause:

During the start-up self-test, the Dye Module fails the RAM test.

Troubleshooting:

1. Replace the CPU Board or the Ram chip on the CPU Board.

Cross Reference:

- See Section 5: Electronics for information about the CPU Board and the location of the Ram chip.

Code: H19

Problem:

AIM Solenoid failure.

Cause:

The AIM shutter is either not opening or not closing as requested.

Troubleshooting:

1. Visually check position of the shutter optical switches. The shutter should be adjusted so that when open, switch one is blocked, and when closed, switch two is blocked. (This is exactly the opposite of the TREAT Solenoid.) If it is out of adjustment, loosen Solenoid mounting screws and move until position is correct.

2. If position is correct, check shutter cable for broken wires and replace if necessary.

3. If replacing the cable does not correct the problem, replace the entire assembly.

Cross Reference:

- See Section 4: System Description for information about the Aim Solenoid Assembly.

Code: H20

Problem:

TREAT Solenoid failure.

Cause:

The TREAT shutter for the optical switches is either not opening or not closing as requested.

Troubleshooting:

1. Visually check position of the shutter optical switches The shutter should be adjusted so that when closed, switch one is blocked, and when open, switch two is blocked. (This is exactly the opposite of the AIM Solenoid.) If it is out of adjustment, loosen Solenoid mounting screws and move until position is correct.

2. If position is correct, check shutter cable for broken wires and replace if necessary.

3. If replacing the cable does not correct the problem, replace the entire assembly.

Cross Reference:

- See Section 4: System Description for information about the TREAT Solenoid Assembly.

Code: H21

Problem:

Control Cable connection/Hardware Initialization Failure.

Cause:

During the start-up circuit check, computer notes that the NMI/RESET cable between the keyboard and the DC Power Board is not connected.

Troubleshooting:

1. Check the cable connection between the Keyboard Display PCB (JK3/PK3) and the DC Power PCB (JD8/PD8). If necessary, replace the cable.

2. If the cable and connection are OK, replace the DC Power PCB. If that does not solve the problem, replace the Keyboard Display PCB.

Cross Reference:

- See Section 5: Electronics for information about the DC Power Board, Keyboard Display Board and wiring diagram of connection.

Code: H22

Problem:

System power interrupt

Cause:

The system power has been interrupted before the treatment time was completed.

This fault can be cleared by pressing the Up, Down and STANDBY buttons simultaneously.

Troubleshooting:

This fault is caused by someone turning off the Dye Module or hitting the Emergency OFF button while the system is in treatment mode. It does not indicate a service problem.

Code: H23

Problem:

Time Clock

Cause:

The Real Time Clock has reached the end of time out, and the system is still emitting laser light.

Troubleshooting:

1. Replace the CPU PCB.

Cross Reference:

- See Section 5: Electronics for information about the different circuit boards and their interconnections.

Code: H24

Problem:

Jumper for Real Time Clock not connected.

Cause:

The jumper for the Real Time Clock is not connected to the CPU Board.

Troubleshooting:

1. Connect the jumper pins 3 and 4 at J17.

Cross Reference:

- See Section 5: Electronics for information about the various circuit boards and their interconnections.