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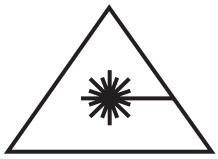
Optical Safety

Because of its special properties, laser light poses safety hazards not associated with light from conventional sources. The safe use of lasers requires that all laser users, and everyone near the laser system, are aware of the dangers involved. The safe use of the laser depends upon the user being familiar with the instrument and the properties of coherent, intense beams of light.



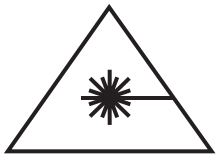
Direct eye contact with the output beam from the laser will cause serious damage and possible blindness.

The greatest concern when using a laser is eye safety. In addition to the main beam, there are often many smaller beams present at various angles near the laser system. These beams are formed by spectral reflections of the main beam at polished surfaces such as lenses or beamsplitters. While weaker than the main beam, such beams may still be sufficiently intense to cause eye damage.

Laser beams are powerful enough to burn skin, clothing or paint. They can ignite volatile substances such as alcohol, gasoline, ether and other solvents, and can damage light-sensitive elements in video cameras, photomultipliers and photodiodes. The laser beam can ignite substances in its path, even at some distance. The beam may also cause damage if contacted indirectly from reflective surfaces. For these reasons, and others, the user is advised to follow the precautions below.

1. Observe all safety precautions in the preinstallation and operator's manual.
2. Extreme caution must be exercised when using solvents in the area of the laser.
3. Limit access to the laser to qualified users who are familiar with laser safety practices and who are aware of the dangers involved.
4. Never look directly into the laser light source or at scattered laser light from any reflective surface. Never sight down the beam into the source.

5. Maintain experimental setups at low heights to prevent inadvertent beam-eye encounter at eye level.
6. As a precaution against accidental exposure to the output beam or its reflection, those using the system should wear laser safety glasses as required by the wavelength being generated.
7. Avoid direct exposure to the laser light. The intensity of the beam can easily cause flesh burns or ignite clothing.
8. Use the laser in an enclosed room. Laser light will remain collimated over long distances and therefore presents a potential hazard if not confined.
9. Post warning signs in the area of the laser beam to alert those present.
10. Advise all using the laser of these precautions. It is good practice to operate the laser in a room with controlled and restricted access.



Laser safety glasses can present a hazard as well as a benefit; while they protect the eye from potentially damaging exposure, they block light at the laser wavelengths, which prevents the operator from seeing the beam. Therefore, use extreme caution even when using safety glasses.

Safety Features and Compliance to Government Requirements

The following features are incorporated into the instrument to conform to several government requirements. The applicable United States Government requirements are contained in 21 CFR, subchapter J, part II administered by the Center for Devices and Radiological Health (CDRH). The European Community requirements for product safety are specified in the Low Voltage Directive (LVD) (published in 73/23/EEC and ammended in 93/68/EEC). The Low Voltage Directive requires that lasers comply with the standard EN 61010-1 “Safety Requirements For Electrical Equipment For Measurement, Control and Laboratory Use” and EN60825-1 “Radiation Safety of Laser Products”. Compliance of this laser with the (LVD) requirements is certified by the CE mark.

Laser Classification

The governmental standards and requirements specify that the laser must be classified according to the output power or energy and the laser wavelength. The Verdi is classified as Class IV based on 21 CFR, subchapter J, part II, section 1040-10 (d). According to the European Community standards, Verdi series ion lasers are classified as Class 4 based on EN 60825-1, clause 9. In this manual the classification will be referred to as Class 4.

Protective Housing

The laser head is enclosed in a protective housing that prevents human access to radiation in excess of the limits of Class I radiation as specified in the Federal Register, July 31, 1975, Part II, Section 1040.10 (f) (1) and Table 1-A/EN 60825-1, clause 4.2 except for the output beam, which is Class IV.

Laser Radiation Emission Indicators

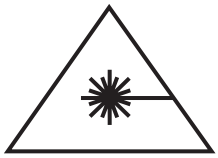
The appropriately labelled lights on both the power supply and the laser head illuminate approximately 30 seconds before laser emission can occur. White lights are used so that they will be seen regardless of the type of safety glasses which might be used [CFR 1040.10(f)(5)/EN 60825-1, clause 4.6].

Beam Attenuator

A beam attenuator, or shutter, prevents contact with laser radiation without the need to switch off the laser [CFR 1040.10 (f)(6)/EN 60825-1, clause 4.7].

Operating Controls

The laser controls are positioned so that the operator is not exposed to laser emission while manipulating the controls [CFR 1040.10(f)(7)/EN 60825-1, clause 4.8].



Use of controls or adjustments or performance of procedures other than those specified in the manual may result in hazardous radiation exposure.

Use of the system in a manner other than that described within this manual may impair the protection provided by the system.

Location of Safety Labels

Refer to Figure 1.1-1 for a description and location of all safety labels. These include warning labels indicating removable or replaceable protective housings, apertures through which laser radiation is emitted and labels of certification and identification [CFR 1040.10(g), CFR 1040.2, and CFR 1010.3/ EN60825-1, Clause 5]].

Electromagnetic Compatibility

The European requirements for Electromagnetic Compliance (EMC) are specified in the EMC Directive (published in 89/336/EEC).

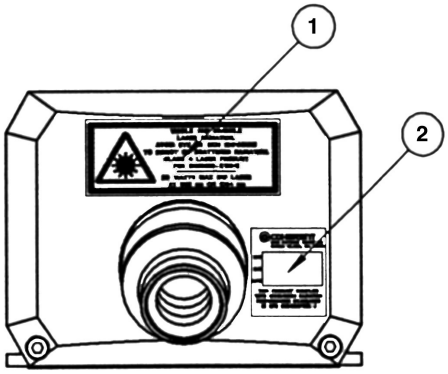
Conformance (EMC) is achieved through compliance with the harmonized standards EN55011 (1991) for emission and ENC50082-1 (1992) for immunity.

The laser meets the emission requirements for Class A, group 1 as specified in EN55011 (1991).

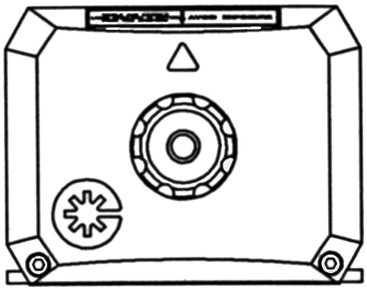
Compliance of this laser with the (EMC) requirements is certified by the CE mark.

LASER HEAD

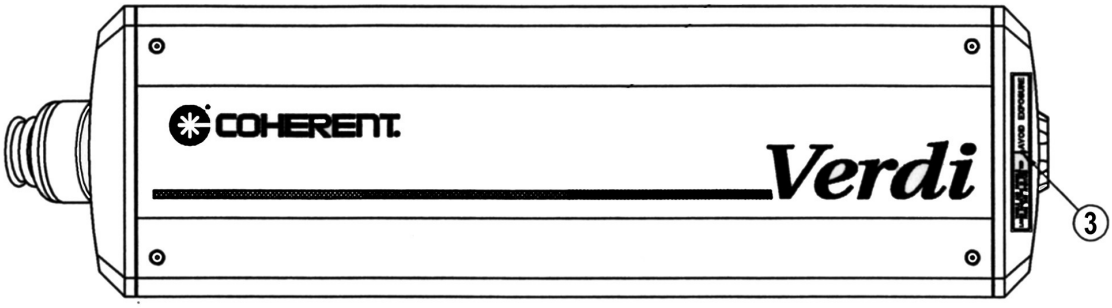
REAR VIEW



FRONT VIEW



TOP VIEW



POWER SUPPLY

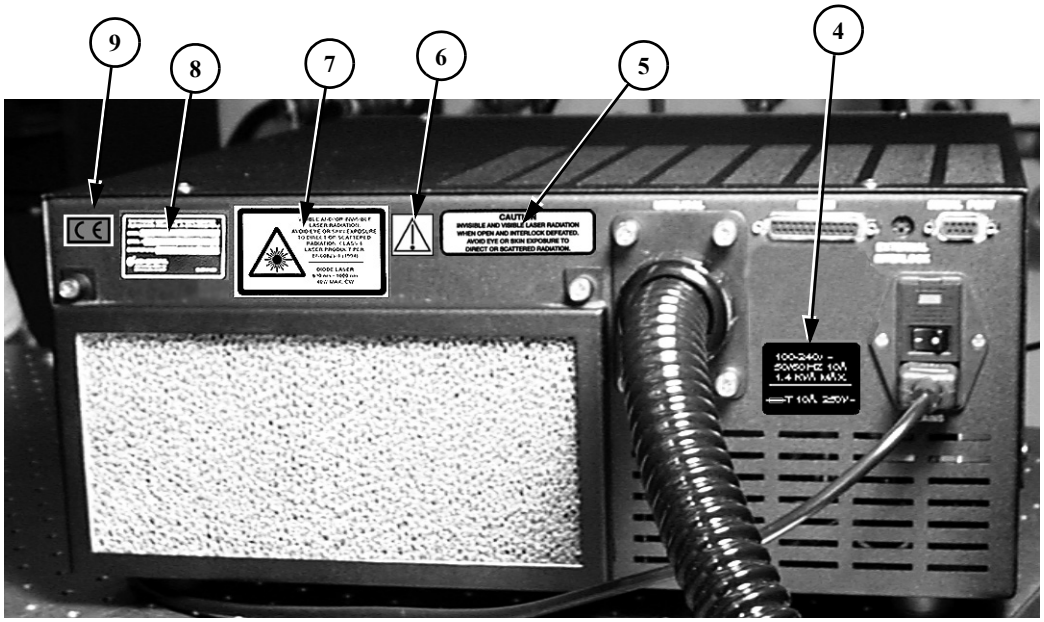
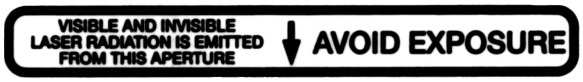


Figure 1.1-1. Safety Features and Labels (Sheet 1 of 3)

1.

2.



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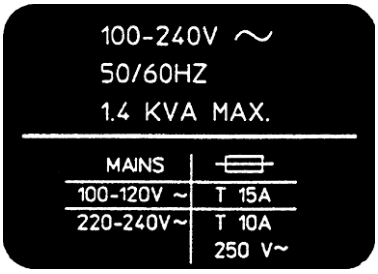

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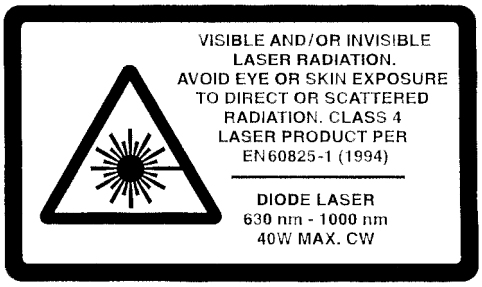
Figure 1.1-1. Safety Features and Labels (Sheet 2 of 3)

6.



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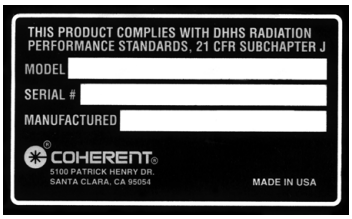

8.

9.

Figure 1.1-1. Safety Features and Labels (Sheet 3 of 3)

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Service Equipment

In addition to the standard maintenance hand tools and cleaning equipment, the following items should always be available:

1. LM-45 power sensor with power meter
2. Computer (laptop or desktop)
3. DC current clamp
4. Signal Interconnect jumper cable (0174-078-00)
5. Board stand-offs for Signal Interconnect board, 3x (0171-629-00)
6. 1 meter fiber optic cable (1005923) with power meter adaptor (0211-024-00 for LM-10 or 0178-668-00 for LM-45)
7. Fiber ferrule nut, 2x (0170-839-00)
8. Serial cable, DTE (6005-0155)
9. Serial cable, DCE (0168-333-00)
10. Fiber optic cable cap, 2x (1404-0169)
11. FAP emission port cap, 2x (1404-0164)
12. FAP shorting clip, 2x (0171-588-00)
13. EPROM removal tool (5402-0169)
14. Mode cup
15. Fiberscope (see “Equipment Needed” on page 5.3-1)
16. Cleanroom swabs/lens tissue
17. Hemostat

Summary of Installation Procedure

The following outline must be followed during a Verdi installation.

Initial Installation Steps

1. Prepare the work space. The surface on which the laser head is to be mounted should be smooth and free of defects (pits, burrs, etc.).
2. Check electricity and facility water if the system is equipped with water-cooled riser/heat sink.
3. Uncrate the laser head and the power supply.
4. Position the laser head and power supply on an optical table. (See Section Three: Installation, of the Operator's Manual for proper lifting techniques and procedures.)
5. If required, connect facility water or chiller to the riser/heat sink.
6. Set the chiller to the appropriate temperature (normally 20°C), turn the water flow on and check for leaks.

V-10 Chiller Connections

The V-10 Verdi laser may be shipped with a Neslab CFT-25 chiller, or a Thermotek chiller. Prior to approximately September 2000, both the laser head riser/heat sink and the FAP-I™ baseplate are water-cooled. (V-10 lasers shipped after September 2000 will have air-cooled FAP-I baseplates, just like the V-2, V-5 and V-8 models. Only the laser head will be water-cooled).

An RS-232 cable connects the Neslab chiller and Verdi power supply, so the chiller can be controlled from the front panel of the Verdi power supply.

For V-10 lasers with water-cooled FAP-I baseplates, and Neslab CFT-25 chillers, the following steps are required to enable RS-232 communication between the chiller and Verdi laser.

1. For V-10 chiller water connections, refer to Figure 1.2-1. The red and blue hoses run between the chiller and the power supply. The quick connect fittings on the red and blue hoses connect to the rear panel of the power supply.

   The smaller plastic tubing is teed into the red and blue hoses,

and connects to the riser/heat sink.

After cooling water connections are made, set the chiller to the appropriate temperature (normally 20°C), turn on the water flow and check for leaks.

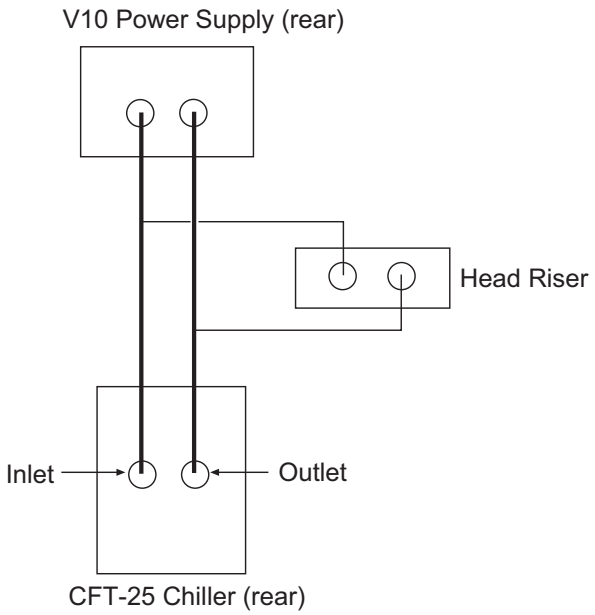

Figure 1.2-1. V-10 Chiller Hook Up

2. Connect the RS-232 cable to the 9-pin RS-232 port on the CFT-25 chiller.
3. Connect the 25-pin chiller port on the rear panel of the power supply.
4. To enable RS-232 communication between the Verdi V-10 power supply and the chiller, the CFT-25 chiller must be put in Remote mode by completing the following steps:
   a. Connect the chiller to facility power and turn the chiller on with the front panel rocker switch. (If the REMOTE LED on the front panel of the chiller is on, the chiller is already in remote mode. Proceed to the procedure titled "Completing the Installation".)

      If the REMOTE LED on the front panel is off, the chiller is in Manual mode. Proceed with steps (b) through (g).

b. Press the NO, down-arrow pushbutton on the chiller front panel, and keep holding it down. While holding it down, also press the NEXT-ENTER pushbuttons. The front panel should now read “tunE”. Release both push-buttons.

c. Press the YES up-arrow. The front panel display will alternate between “r232” and OFF.

d. Press the YES up-arrow. The front panel display should now alternate between “r232” and ON.

e. Press the NEXT-ENTER pushbutton 5 times. The front panel will scroll through a number of additional options (“SenS”, “CooL”, “Hi t”, and “Lo t”). Finally the front panel screen will read “Stor”.

f. Press the YES up-arrow. This saves the RS-232 ON selection.

g. The REMOTE LED should be on, indicating that the RS-232 communication between the chiller and laser is enabled.

Completing the Installation

1. Connect facility power to laser system.
2. Turn system on according to Cold Start procedure in Section Four: Operation, of the Operator’s Manual.
3. When the V-10 laser system is turned on, the front panel display may query “Does this system requires a chiller?” Respond by pressing SELECT to enable RS-232 communication between the chiller and power supply. (If the customer does not wish to enable RS-232 communication between the laser and chiller, respond by pressing EXIT.)
4. For V-10 systems with Neslab chillers only, verify that RS-232 communication between the laser and chiller is enabled. Access the Chiller Setup menu, and press SELECT. Follow the menu instructions to turn the chiller ON, and set the appropriate temperature.

   If the Chiller Setup menu does not exist, enable the RS-232 communication between laser and chiller.

   a.) Put the laser into Service Mode.

b.) Access the Laser Head Setup menu, and scroll to Enable Chiller. Press MENU SELECT. Wait one minute.

c.) Cycle the power supply power OFF and ON. The Chiller Setup menu should now be accessible.

d.) Return the laser to Customer Mode.

5. Conversely, if the customer wishes to disable RS-232 communication between the laser and chiller,

a.) Put the laser into Service Mode.

b.) Access the Laser Head Setup menu and scroll to the Disable Chiller line. Press MENU SELECT. Wait one minute.

c.) Cycle the power OFF and ON. The Chiller Setup should no longer be accessible.

d.) Return the laser to Customer Mode.

6. Verify performance at system specification output power.

7. Verify calibration of internal photocell. See "Photocell Calibration" on page 5.7-1.

8. Complete the Verdi Installation Checklist from the paragraph titled "System Repairs and Installations" and attach to Service Report.

Customer Training

The following Customer training should be provided at the time of installation. These procedures can be found in the Operator's Manual, provided with the system.

1. All turn-on and turn-off procedures:

a. Turn-On (Cold Start)

b. Daily Turn-On (Warm Start)

c. Turn-Off (Daily Use)

d. Turn-Off (Complete Shutdown)

2. Instruct the customer on the functions of the Verdi software and the front panel controls of the power supply.

3. Instruct the customer on the importance of thermal management.

4. Instruct the customer on the removal and replacement of the air filter and the power supply fuses.
5. Instruct the customer on the optimization of the LBO Temperature.
6. Review troubleshooting charts.

System Repairs and Installations

If the system is being installed for the first time, reinstalled, or repaired, the following information should be recorded on the Service Report. This information should be recorded at the specification power of the system.

All systems:

1. LBO temperature set point
2. Vanadate temperature set point
3. Vanadate2 temperature set point (for V-18 units only)
4. Etalon temperature set point
5. Diode #1 temperature set point
6. Diode #1 current (software value)
7. Diode #1 hours

For 2-FAP systems:

8. Diode #2 temperature set point
9. Diode #2 current (software value)
10. Diode #2 hours
11. Diode current delta

Revision History

Version 3.53 of the Verdi software (Rev. B) went into production July 7, 1998. All systems manufactured prior to this date were shipped with Revision "A" software, and were scheduled to be upgraded to Version 5.03 (Rev. C) of the software. Version 5.03 software was put into production in January of 1999. There are approximately 250 laser systems with Rev. B software. The V-8 and V-10 Verdi laser systems began shipping in January of 1999 and therefore all have Version 5.03 of the Verdi software.

On September 16, 1999, Verdi software 6.0 (Rev. D) was released. In addition to the software upgrade, the Viper V-5, V-8, and V-10 models were introduced. Version 7.82 (Rev E) was released January 1, 2003. This version improved LBO optimization for V-8 and V-10 models only. There are approximately 160 lasers in the field with Version 7.82. On September 15, 2003, version 7.93 (Rev F) was released to include all Verdi models with the improved LBO optimization from 7.82, and a second- point photocell calibration was added.

Software version 8.33 was released April of 2004 and introduces the V-18 Verdi. The V-18 adds a second vanadate, along with the removal of *seek for FAP-I optimization on V-18 models only. An on-demand FAP-I temperature optimization is now available.

The most recent software version 8.83 has a new automated LBO temperature algorithm. This version went into effect February of 2005. The diode temperature optimization was refined and improved; see FSB #460 for more information.

Table 1.3-1. Comparison of System Specifications

V-2/V-5/V-6	V-8/V-10/V-18
SYSTEM SPECIFICATIONS AND DATA	
Noise specification: < 0.03% rms Single frequency operation: All at operating power. Output power range: **v3.53 Software** Minimum: 500 mW Maximum: 0.5 W greater than specification. 200mW greater for V-2. **v-5.03 Software or Higher** Minimum: 10 mW Maximum: 0.5 W greater than specification. **Vanadate Set Temperature:** 35°C	**Noise specification:** < 0.03% rms Single frequency operation: All at operating power. Output power range: **v-5.03 Software or Higher (V-8 and V-10)** Minimum: 10 mW Maximum: 0.5 W greater than specification. **Vanadate Set Temperature:** 30°C

Table 1.3-2. Comparison of System Components (Sheet 1 of 3)

V-2/V-5/V-6	V-8/V-10/V-18
POWER SUPPLY CHASSIS	
LxWxH 17.75x17.13x7.72 Smaller power supply mandates an airflow grill in power supply cover, over the Signal Interconnect board (alignment critical). V-2/V-5 noise reduction assembly is positioned horizontally behind the FAP-I assemblies.	LxWxH 17.75x17.13x10.00 Increased power supply height allows for better cooling of the power supply electronics. Circulating air is brought into the power supply through front inlet filter and leaves through the back of the power supply. V-8/V-10/V-18 noise reduction assembly is located between the heatsink and back panel of the power supply.

Table 1.3-2. Comparison of System Components (Sheet 2 of 3)

SYSTEM FAP-I ASSEMBLIES	
V-2: • One 12W FAP-I assembly kit (part #0175-589-00) • Typical IR output power @ 2 W of 532-nm is 10 W • Typical Diode Drive Current: 15 to 21 A **V-5 Uno:** • One 30W FAP-I assembly (part #1037865) • Typical IR output power @ 5W of 532-nm is 18W • Typical Diode Drive Current: 26 to 32 A **V-8:** • Two 18W FAP-I assembly kits (part #0178-501-50) • Typical IR output power @ 8W of 532 nm is 18W/ FAP-I • Typical Diode Drive Current: 19 to 26 A **V-18:** • Two 40W FAP-I assemblies (part #1063072) • Typical IR output power @ 18W of 532 nm is 35 W/FAP-I • Typical Diode Drive Current: 41 to 51 A	**V-5:** • Two 12 W FAP-I assemblies (part #0171-195-50) • Typical IR output power @ 5W of 532 nm is 10W/ FAP-I • Typical Diode Drive Current: 15 to 21 A **V-6:** • One 30W FAP-I assembly (part #1036352) • Typical IR output power @ 6W of 532-nm is 20W • Typical Diode Drive Current: 28 to 34 A **V-10:** • Two 25 W FAP-I assembly kits (part #0175-723-00) • Typical IR output power @ 10W of 532 nm is 18W/FAP-I • Typical Diode Drive Current: 23 to 29 A

Table 1.3-2. Comparison of System Components (Sheet 3 of 3)

V-2/V-5/V-6	V-8/V-10/V-18
SYSTEM COOLING	
Laser Head: Water-cooled head riser recommended if employed as a pump laser for another system.	Laser Head: Water-cooled head riser required.
Power Supply: **V-2:** Air-cooled **V-5:** Air-cooled **V-6:** Air-cooled	Power Supply: **V-10:** Water cooling of power supply required prior to Sept. 2000; otherwise air-cooled **V-8:** Water cooling of power supply required prior to Sept. 2000; otherwise air-cooled **V-18:** Air-cooled
Chiller Hookup (optional): Head riser should be hooked in parallel with system being pumped (See Figure 1.3-1).	Chiller Hookup (optional for **V-8**): **Air-Cooled Power Supply:** Head riser should be connected in parallel with system being pumped (See Figure 1.3-1). **Water-Cooled Power Supply:** Shipped with dedicated chiller. Head riser and power supply should be connected to the chiller in parallel (See Figure 1.3-2).
Chiller Temperature Set Point: 20 to 25°C	**Chiller Temperature Set Point:** 18 to 20°C

Table 1.3-3. Comparison of System Software Versions

VERSION 3.53 (REV. B)	VERSION 5.03 (REV C) OR HIGHER
SOFTWARE	
When the shutter is closed, the system continues to lase at selected 532-nm power.	When the shutter is closed, the diode drive current automatically ramps down, but still produces laser energy (<10mW). This minimizes heating inside the shutter mechanism and the air prism that can occur from this heating.
The diode wavelength optimization routine (*seek) will initiate if the system has been in the Laser On mode for more than three minutes without user interaction.	The diode wavelength optimization routine (*seek) is only enabled if the system is running at 80% or greater output power.
Etalon Mode Recentering (Etalon Capture Mode)[1]: Initiated by hitting the MENU EXIT pushbutton from the Base Menu screen.	Etalon Mode Recentering (Etalon Capture Mode)[1]: Initiated via the Etalon Capture software menu.
Diode Parameters software menu: No equivalent software menu.	Diode Parameters software menu: Provides diagnostic values that can help in troubleshooting the Verdi system. The diode photocell voltage should be approximately 2.5 V when the system is operating at specified output power. The diode photocell voltage is linearly related to the IR output energy from the FAP-I assembly. A voltage that differs significantly from 2.5 V (V < 1 or V > 4) when specification 532 nm output power is requested from the system indicates FAP-I problems.

[1]Functionally, “etalon recentering” should be performed after a large change to an operating parameter has been made. After such an event, the longitudinal mode that experiences the highest gain may have shifted and no longer correspond to the maximum transmission of the etalon. When the Capture Mode is activated, the diode current is temporarily dropped to below the 532 nm lasing threshold and then returned to the previous diode current.

Table 1.3-2b. Comparison of System Software Versions

VERSION 3.53 (REV. B)	VERSION 5.03 (REV C) OR HIGHER
SOFTWARE	
Vanadate TEC Drive: Vanadate is held at the set temperature with the laser system in Standby mode.	Vanadate TEC Drive: When the keyswitch is switched to STANDBY, the Vanadate TEC drive circuit is opened (i.e., the TEC DAC counts will go to zero). When the laser system is keyed to LASER ON, the Vanadate TEC loop will close and enter the Seek mode. This was done to reduce temperature overshoot in the Vanadate crystal at startup.
Speaker Control software Menu: No equivalent software menu; early Verdi did not have a speaker.	Speaker Control software Menu: The speaker alerts user when a fault has occurred. The speaker volume can be changed or the speaker can be turned off completely.
VERSION 6.0 SOFTWARE (REV D)	
Chiller control by V-10 Power Supply. The V-10 submenu can turn the chiller on or off, and also control the set temperature.	
System status is blank on the main display when the laser is locked. Otherwise, “Standby”, “System Warming Up”, “Laser Seeking”, “Shutter Closed”, “Fault Active”, or “RS-232 Key Standby” is displayed. See FSB #373 for details.	
Vanadate drive goes to zero in Standby for V-5Uno, V-6, V-8, and V-10.	
Audible “Low Power” fault and “LBO Optimization” fault will be displayed. See FSB #373.	

Table 1.3-2b. Comparison of System Software Versions

VERSION 7.82 SOFTWARE (REV E)	VERSION 7.93 SOFTWARE (REV F)
Automated LBO optimization added for V-8 and V-10 Only. See FSB #417 for details.	Automated LBO optimization from version 7.82 was extended to include all Verdi and Viper models. See FSB #425 for details.
	Two-point photocell calibration introduced. FSB #425 details procedure.
VERSION 8.33 SOFTWARE (REV G)	**VERSION 8.83 SOFTWARE (REV H)**
Introduction of the V-18 laser system. Software includes a second Vanadate in various operator menus.	Improved auto-LBO temperature algorithm
Removal of *seek for the FAP-I temperature optimization for V-18 models only.	Improved on-demand diode temperature optimization for V-18 only
	Allows for 60-A power supply for V-18 only

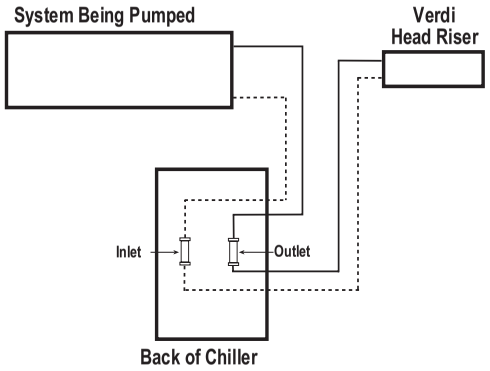

Figure 1.3-1. Proper Hookup of Verdi Laser Head Riser to Shared Chiller, in Parallel

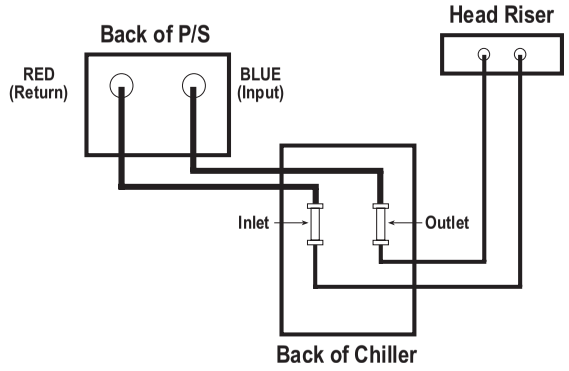

Figure 1.3-2. Proper Hookup of V-10 Laser Head Riser and Power Supply to Dedicated Chiller, in Parallel

Introduction

This section provides a numerical listing of all possible Verdi software fault messages. For each fault, the condition that prompted the fault, the action taken by the software, and a troubleshooting outline is presented. Note that the section starts with faults that do not have a fault number.

All of the circuits in the power supply and head are biased (driven) by low voltages from the Power Piggy board. As a first step in the troubleshooting process, the health of these voltages (± 5 V and ± 12 V) should always be verified. See Table 2.1-1 and Table 2.1-2.

After verifying the health of the low voltages, check the health of the +48 V. This can be accomplished by measuring the voltage on J83 of the Signal Interconnect Board, pins 1 and 2.

Table 2.1-1. Low Voltage Test Points on the Power Distribution Bd

SYSTEM	GROUND	TEST POINTS
V-2 to V-10	TP42 or TP57	+5 V TP39, –5 V TP40 +12 V TP37, –12 V TP38
V-2 to V-6 UNO	TP21	+5V TP46, -5V TP47 +12V TP44, -12V TP45
V-18	TP18 or TP48	+5 V TP41, –5 V TP47 +12 V TP42, –12 V TP43

Table 2.1-2. Low Voltage Test Points on the CPU Board, Top Edge

SYSTEM	GROUND	TEST POINTS
V-2 to V-18 (All)	TP1	+5 V TP2, –5 V TP5 +12 V TP3, –12 V TP4

48 V PS AC Voltage Fault

Definition: The AC fault line from the Lambda/Pioneer Magnetics power supply to the Signal Interconnect board (J88-3) has gone from a low state to a high state. This signal is filtered and inverted on the Signal Interconnect board (U4C) before being sent to the CPU Board (J8-26) via the Display PCB (J28-26).

This signal is acted on by the CPU. If it occurs, the CPU will inhibit writing to the EEPROMs. If J88 (signal interconnect) is disconnected before start-up, you will get all the EEPROM faults and all the range faults. If disconnected after start-up, you will not be able to date EEPROM contents through a power switch cycle.

Action: If this fault occurs, check the following:

1. LED indicators on front of Lambda power supply. There are no indicators on the Pioneer Magnetics power supply. Reference the paragraphs titled "Lambda Power Supply" on page 2.4-4 and "Pioneer Magnetics Power Supply" on page 2.4-5 for more information.
2. Corcom assembly fuse, facility power and breaker.
3. Facility power connection on both the primary and secondary side of the Corcom switch/fuse/filter assembly.
4. Cable/plug connection problems between the Lambda/Pioneer Magnetics power supply, Signal Interconnect board, Display PCB, and the CPU board.

48 V PS DC Voltage Fault

Definition: The DC fault line from the Lambda/Pioneer Magnetics power supply to the Signal Interconnect board (J88-5) has gone from a high state to a low state. This signal is filtered and inverted on the Signal Interconnect board (U4D) before being sent to the CPU Board (J8-28) via the Display PCB (J28-28).

This signal is not currently acted on by the CPU. If it occurs, the CPU will lose power 15 to 40 msec later and no fault will be displayed. The diode current will fall to zero and the shutter will close due to a lack of power.

Action: If this fault occurs, check the following:

1. LED indicators on front of Lambda power supply. There are no indicators on the Pioneer Magnetics power supply. Reference the paragraphs titled "Lambda Power Supply" on page 2.4-4 and "Pioneer Magnetics Power Supply" on page 2.4-5 for more information.
2. Facility power connection on both the primary and secondary side of the Corcom switch/fuse/filter assembly.
3. Cable/plug connection problems between the Lambda/Pioneer Magnetics power supply, Signal Interconnect board, Display PCB, and the CPU board.

48 V PS Temperature Fault

Definition: The temperature fault line from the Lambda/Pioneer Magnetics power supply to the Signal Interconnect board (J88-7) has gone from a high state to a low state. This signal is filtered on the Signal Interconnect board (U4A and U4B) before being sent to the CPU Board (J8-30) via the Display PCB (J28-30).

This signal is not currently acted on by the CPU. If it occurs, the CPU will lose power 15 to 40 msec later and no fault will be displayed. The diode current will fall to zero and the shutter will close due to a lack of power.

Action: If this fault occurs check the following:

1. LED indicators on front of Lambda power supply. There are no indicators on the Pioneer Magnetics power supply. Reference the paragraphs titled "Lambda Power Supply" on page 2.4-4 and "Pioneer Magnetics Power Supply" on page 2.4-5 for more information.
2. Power supply fans are working and the air filter is clean and not obstructed.
3. Facility power voltage and stability.
4. Cable/plug connection problems between the Lambda power supply, Signal Interconnect board, Display PCB, and the CPU board.

Shutter State Mismatch Fault

Definition: The drive state for the shutter solenoid disagrees with the position of the shutter sensor.

If this fault occurs the laser diode current is terminated, the fault message is displayed, and the system shutter is closed.

Action: If this fault message appears, check the following:

1. Verify solenoid wiring, J102 on Head board pins 1 and 2.
2. Verify sensor wiring, J102 on Head board pins 3 and 4.

Laser Head Interlock Fault Fault #1

Definition: The head interlock circuit is open.

If this fault occurs the laser diode current is terminated, the fault message is displayed, and the system shutter is closed.

Action: If this fault message appears, check the following:

1. Verify the interlock connection, J103, on the head board.
2. Verify the LASER EMISSION LED is operational. If the LED fails, a fault will be triggered.

External Interlock Fault
Fault #2

Definition: The external interlock circuit is open.

If this fault occurs the laser diode current is terminated, the fault message is displayed, and the system shutter is closed. Reference the paragraph titled “External Interlock” on page 3.1-3 for more information.

Action: If this fault message appears, check the following:

1. Verify that the interlock defeat is inserted fully in the receptor of the Signal Interconnect board. (If the customer is using an external interlock circuit, verify the power supply circuit with the factory defeat plug.)
2. Verify continuity between the two lower pins on each side of alignment tab of the external interlock plug. See Figure 2.1-1 below.

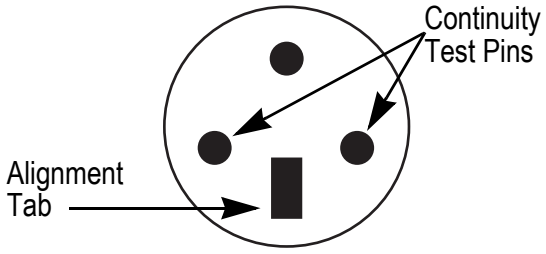

Figure 2.1-1. External Interlock Plug

3. Verify the connections between the Signal Interconnect (J89-4B) and the Display PCB, and the Display PCB and the CPU board (J8-8).

Power Supply Interlock Fault
Fault #3

Definition: The power supply interlock circuit is open.

If this fault occurs the laser diode current is terminated, the fault message is displayed, and the system shutter is closed. Reference the paragraph titled "Power Supply Interlock" on page 3.1-3 for more information.

Action: If this fault message appears, check the following:

1. Verify that power supply cover is properly in place and secure, and/or the mechanical arms of the interlocks on the right-hand side of the power supply have not been damaged.
2. Verify the operation of the power supply interlock and the connection to the Display PCB, J30-1, 2.
3. Verify the connection between the Display PCB (J28-50) and the CPU board (J8-50).

LBO Temperature Fault
Fault #4

Definition: The LBO temperature has moved out of the range: of between –12°C to < 180°C.

If this fault occurs the laser diode current is terminated, the LBO drive voltage is held at the last value previous to the fault, the fault message is displayed, and the system shutter is closed. Reference the paragraph titled "LBO Servo" on page 3.3-11 for more information.

Action: If this fault message appears check the following:

1. Verify the LBO temperature set point.
2. Verify Head connections, J105 and J104, and drive signal connection on the Signal Interconnect board J85 pin 1 and 2.
3. Verify drive signal connections between the Signal Interconnect board (J89-29A, J89-30A) and the Display PCB (P29-29A, P29-30A).
4. Verify drive signal connections between the Display PCB (J24-23A, J24-27A) and the Mother board (P24-23A, P24-27A).
5. Verify servo operation using the troubleshooting procedure titled "LBO Servo Troubleshooting" on page 3.3-13.

LBO Not Locked at Temperature Fault #5

Definition: The keyswitch is in the LASER ON position, but the LBO is not locked at its operational temperature.

If this fault occurs, the laser diode current is terminated, the fault message is displayed, and the system shutter is closed. Reference the paragraph titled "LBO Servo" on page 3.3-11 for more information.

Action: If this fault message appears, check the following:

1. Verify the LBO temperature set point.
2. In the software Status Screen, verify that the LBO heating loop is closed. If status screen reads "open", go to the LBO servo screen and close the loop using the Menu Up/Menu Down pushbutton keys on the front panel of the power supply
3. Wait for the LBO to reach operational temperature, approximately 45 minutes from cold start.
4. Verify servo operation using the troubleshooting procedure titled "LBO Servo Troubleshooting" on page 3.3-13.

Vanadate Temperature Fault Fault #6

Definition: The Vanadate temperature has moved out of the range: of between –12°C and 55°C.

If this fault occurs, the laser diode current is terminated, the Vanadate drive voltage is set to zero, the fault message is displayed, and the system shutter is closed. Reference the paragraph titled "Vanadate and Diode TECs" on page 3.3-1 for more information.

Action: If this fault message appears, check the following:

1. Verify the Vanadate temperature set point, typically 35°C.
2. Verify Head connections (J107 and J104-5, 7) and drive signal connection on the Signal Interconnect board J85-5, 7.
3. Verify drive signal connections between the Signal Interconnect board (J89-5A) and the Display PCB (P29-5A).
4. Verify drive signal connections between the Display PCB and the Mother board (P24-12B).
5. Verify servo operation in the troubleshooting procedure titled "TEC Servo Troubleshooting" on page 3.3-4.

Etalon Temperature Fault Fault #7

Definition: The etalon temperature has moved out of the range: between –12°C to 80°C.

If this fault occurs the laser diode current is terminated, the fault message is displayed, and the system shutter is closed.

Action: If this fault message appears check the following:

1. Environment of laser system, specifically heat fluctuations, humidity, ambient dirt and dust, and any other factors that might affect the functioning of the system.
2. Etalon operating parameters are properly set. If thermistor reading is –273°C, the thermistor is open.
3. Verify the health of the Etalon thermistor. At 25°C, the resistance should be 10 kΩ, J106 pins 3 and 4.
4. Verify laser Head board connections, J104 and J106.
5. Verify the operation of the Etalon drive power signal at the following test points. Reference Table 2.1-3 for typical results.
   a. Laser Head board: J104-3(-), J104-4(+)
   b. Signal Interconnect board: J85-3(-), J85-4(+)

Table 2.1-3. Etalon Drive Voltage

DAC COUNT	VOLTAGE
0	0
1000	0.5
2000	0.8
3000	1.1
4000	1.4

Diode 1 or 2 Temperature Fault Fault # 8/9

Definition: The FAP baseplate temperature has moved out of the range of –12°C to 45°C.

If this fault occurs the laser diode current is terminated, the drive voltage is set to zero, the fault message is displayed, and the system shutter is closed. Reference the paragraph titled "Vanadate and Diode TECs" on page 3.3-1.

Action: If these fault messages appear check the following:

1. Environment of laser system, specifically heat fluctuations, humidity, ambient dirt and dust, and any other factors that might affect the functioning of the system.
2. Power supply fans are working and the air filter is clean and not obstructed.
3. Verify the heat sink temperature.
4. Verify that the cables to the FAP-I are properly connected and that the Diode Temperature set point is properly set.
5. Verify the continuity of the Personality Module cable.
6. Verify the health of the diode (FAP) thermistor. At 25°C the resistance should be 10 kΩ.

   FAP-I #1: 12-pin black molex connector J41, pins 5 and 7.

   FAP-I #2: 12-pin black molex connector J42, pins 5 and 7.
7. Verify servo operation in the troubleshooting procedure titled "TEC Servo Troubleshooting" on page 3.3-4.

Baseplate Temperature Fault Fault #10

Definition: The laser head baseplate temperature has moved out of the range of –12°C to 55°C.

If this fault occurs, the laser diode current is terminated, the fault message is displayed, and the system shutter is closed.

Action: If this fault messages appears, check the following:

1. Laser head is secured properly to a riser/heat sink, and that the heat sink is properly mounted to a thermally conducting surface.
2. Cooling water flow is unobstructed to and from riser/heat sink if so equipped.
3. Baseplate of laser head is clean and damage-free.

4. System operating parameters are properly set.
5. Verify the health of the baseplate thermistor. At 25°C, the resistance across pins 3 and 4 of J107 (on head board) should be 10 kΩ (on V-18 models, it is across pins 3 and 4 of J107A).
6. Verify connectors on head board and +5 V reference voltage, J100 pin 4,TP13 DGnd.

Heat Sink 1 or 2 Temperature Fault Fault #11/12

Definition: The FAP heatsink temperature has moved out of the range of –12°C and 65°C.

If this fault occurs, the laser diode current is terminated, the fault message is displayed, and the system shutter is closed.

Action: If this fault messages appears, check the following:

1. Verify the connection between the FAP assembly and the Mother board; J41-8 diode 1, J42-8 diode 2.
2. Verify the connection between the Mother board (P7-26A diode 1, P7-26B diode 2) and the CPU board.
3. Verify the health of the heat sink thermistor. At 25°C the resistance should be 10 kΩ.

   FAP-I #1, 12-pin black molex connector J41, pins 6 and 8.

   FAP-I #2, 12-pin black molex connector J42, pins 6 and 8.

Diode Over Current Fault Fault #18

Definition: The read current is greater than 32 A in Light Regulation.

Note: No fault is generated in Current Regulation mode.

If this fault occurs, the laser diode current is terminated, the fault message is displayed, and the system shutter is closed.

Action: If this fault message appears, check the following:

1. Verify the anode and cathode connections on the following:
   - The Power Distribution board
   - The primary and secondary side of the Noise Reduction board
   - The FAP assembly

2. Verify the anode-to-FAP case ground connection.
3. Perform the troubleshooting procedure titled "Diode Current Troubleshooting" on page 3.4-3.

Diode 1 or 2 Under Voltage Fault Fault # 19/20

Definition: The voltage across the anode and cathode is less than 0.5 V when the current is greater than 10 A. In the case of a major power supply failure indicated by this fault, check that power is being supplied to the FAPs using a digital volt meter (DVM) or amp clamps. See "FAP-I Current & Voltage (V & I) Calibration" on page 5.6-1. This fault is most often caused by a shorted laser diode or other component in the diode circuit.

Diode 1 or 2 Over Voltage Fault Fault # 21/22

Definition: The voltage across the anode and cathode is greater than 2.0 V (2.2 V in software version 6.01 and above and 2.6 V in software version 8.83 and above) when the current is greater than 10 A. In case of a major power supply failure indicated by this fault, check that the power is being supplied to the FAPs using a digital volt meter (DVM) or amp clamps. See "FAP-I Current & Voltage (V & I) Calibration" on page 5.6-1. The most common cause is an electrically open laser diode or wire in the diode current circuit.

If these faults occur the laser diode current is terminated, the fault message is displayed, and the system shutter is closed.

Action: If these fault messages appear, check the following:

1. Verify the anode and cathode connections on the Power Distribution board, on both the primary and secondary side of the Noise Reduction board, and the FAP assembly.
2. On the Power Distribution board verify that the following currents are in the specified range:

Table 2.1-4. Test Points, Power Distribution Board

SYSTEM	CPU DIODE DRIVE (0 TO 5 V)		DRIVE VOLTAGE (0 TO 2.2 V)	
V-2 to V-10 (Two FAP)	**Diode 1:**	**Diode 2:**	**Diode 1:**	**Diode 2:**
	TP5 (+) TP57 (–)	TP6 (+) TP57 (–)	TP18 (+) TP3 (–)	TP19 (+) TP1 (–)
V-2 to V-6 UNO	**Diode 1:**		**Diode 1:**	
	TP39 (+) TP21 (–)		TP2 (+) TP1 (–)	
V-18 only	**Diode 1:**	**Diode 2:**	**Diode 1:**	**Diode 2:**
	TP37 (+) TP18 (–)	TP26 (+) TP18 (–)	TP6 (+) TP5 (–)	TP7 (+) TP8 (–)

3. Measure and re-calibrate FAP voltage at 10 W IR. The current required to achieve 10 W output from the FAP-I should be determined using a test fiber and power meter.
4. Verify that J1 is connected on the CPU board, and that the laser diode anode is properly grounded to the FAP-I case.

Diode 1 or 2 EEPROM Fault Fault #25/26

Definition: The CPU was unable to read the diode EEPROM. These faults will only occur during a power-up or after a manual reset of the CPU board.

Action: If these fault messages appear, check the following:

1. Power down and restart the system.
2. Verify the connection between the FAP assembly cable and the Mother board.
3. Verify the connection between the Mother board and the CPU board.
4. If the previous conditions are within normal limits, the fault is caused by the failure of the EEPROM. The FAP assembly must be replaced.

Head EEPROM Fault
Fault #27

Definition: The CPU was unable to read the Head board EEPROM. This fault will only occur during a power-up or after a manual reset of the CPU board.

Action: If this fault message appears check the following:

1. Power down and restart the system.
2. Verify the connection between the laser head and the power supply, J108 and J81 on the umbilical, respectively.
3. Verify +5 V reference voltage, J100 pin 4,TP13 digital ground (DGnd).

Power Supply EEPROM Fault
Fault #28

Definition: The CPU was unable to read the power supply EEPROM. This fault will only occur during a power up or after a manual reset of the CPU board.

Note: The Power Supply EEPROM is located on CPU board.

Action: If this fault message appears, check the following:

1. Power down and restart the system.
2. Verify +5 V reference voltage on CPU board, TP2(+) TP1 GND.

Head/PS Mismatch Fault
Fault #29

Definition: The head and power supply are not the same system type. This fault will only occur during a power up and may be related to an EEPROM failure.

Action: If this fault message appears check the following:

1. Verify match of software Head Setup and Power Supply setup menus. Ensure:
   a. That a 2-W head is selected for 1-FAP power supply.
   b. That a 5-W head is selected for 2-FAP power supply.
2. See Head and Power Supply EEPROM fault messages.

LBO Battery Fault
Fault #30

Definition: The battery has failed the power supply battery test.

If this fault occurs, the laser diode current is terminated, the LBO cool-down process is started, the fault message is displayed, and the system shutter is closed.

Action: If this fault messages appears, check the following:

1. Verify that connections between +12 V battery and the Mother board, terminals E1 and E2.
2. Verify the connection between the Mother board (P7) and the CPU board.
3. Inspect battery for visual signs of damage (cracked case, leakage, corrosion, discoloration, etc.).
4. Verify operation of battery charge circuit by attaching a DVM across R8 on the Mother board (R9 on V-18 Mother boards). The polarity of hookup is not important. The voltage read will depend on battery charge; see Table 2.1-6.

   With the facility power on, the voltage across the battery terminals should read between 13 and 14.6 V.

Table 2.1-5. Battery Charge Circuit Voltages

BATTERY STATE	BATTERY VOLTAGE	CHARGE CIRCUIT VOLTAGE
Very Low	9 V to 11 V	245 mV
Low	11 V to 12 V	245 mV to 200 mV
Moderate	12 V to 13 V	160 mV to 100 mV
Fully Charged	13 V to 13.4 V	60 mV to 10 mV
Over Charged	Over 13.4 V	0 mV

Version v-5.03

The following Verdi software faults are new for version v-5.03 or newer.

Shutter State Mismatch Fault Fault 31

Definition: The drive state for the shutter solenoid disagrees with the position of the shutter sensor. This fault is the same as the one in the revision "B" software, only the fault number is new.

If this fault occurs, the laser diode current is terminated, the fault message is displayed, and the system shutter is closed.

Action: If this fault message appears check the following:

1. Verify solenoid wiring, J102 on Head board pins 1 and 2.
2. Verify sensor wiring, J102 on Head board pins 3 and 4.
3. Verify that the shutter arm sits properly in the black U-shaped diode sensor. If the arm binds against the sensor, the diode sensor position should be readjusted by:
    a. Verify that the all screws on solenoid are tight.
    b. Loosen the screw that holds sensor in position.
    c. Slide sensor laterally so the shutter arm rests in the center of the U-shaped bracket.
    d. Tighten screw that holds sensor in position.
4. Verify that 10 to 12 Volts arrives at the Head Board connector J102 (pins 1 and 2) when shutter switch is activated for opening.

CPU PROM Checksum Fault Fault 32

Definition: EEPROM contents have changed since the CPU EEPROM was last updated.

If this fault occurs, the error is displayed and the system will beep. This fault will not cause the system to shut down.

Actions: If this fault message appears, check the following:

1. Press the exit button to clear the fault.
2. If the fault remains, cycle the power.
3. If the fault remains, write down all relevant data (temperature set points and Current Delta) and clear the CPU EEPROM in the EEPROM Diagnostics menu. **The current to the diodes**

must be re-calibrated and the Current Delta re-entered following this procedure.

Head EEPROM Checksum Fault Fault 33

Definition: EEPROM contents have changed since the Head EEPROM was last updated.

If this fault occurs, the error is displayed and the system will beep. This fault will not cause the system to shut down.

Action: If this fault message appears check the following:

1. Press exit button to clear the fault.
2. If the fault remains, cycle the power.
3. If the fault remains, write down all relevant data (temperature set points and head hours) and clear the HEAD EEPROM in the EEPROM Diagnostics menu. **All temperatures and head hours must be re-entered following this procedure and the photocell will need to be re-calibrated.**

Diode #1 EEPROM Checksum Fault Fault 34

Definition: The EEPROM contents have changed since the Diode #1 EEPROM was last updated.

If this fault occurs, the error is displayed and the system will beep. This fault will not cause the system to shut down.

Action: If this fault message appears, check the following:

1. Press the exit button to clear the fault.
2. If the fault remains, cycle the power.
3. If the fault remains, write down all relevant data (all temperature set points and diode hours) and clear the Diode#1 EEPROM in the EEPROM Diagnostics menu. **Diode #1 set temperature and hours must be re-entered following this procedure.**

Diode #2 EEPROM Checksum Fault Fault 35

Definition: EEPROM contents have changed since the Diode #2 EEPROM was last updated.

If this fault occurs, the error is displayed and the system will beep. This fault will not cause the system to shut down.

Action: If this fault message appears, check the following:

1. Press the exit button to clear the fault.
2. If the fault remains, cycle the power.
3. If the fault remains, write down all relevant data (all temperature set points and diode hours) and clear the Diode #2 EEPROM in the EEPROM Diagnostics menu. **The Diode #2 set temperature and hours must be re-entered following this procedure.**

CPU EEPROM Range Fault Fault 36

Definition: A value stored in the CPU EEPROM is out of specified range.

If this fault occurs, the error is displayed and the system will beep. This fault will not cause the system to shut down. In service mode, the software will indicate that the EEPROM location that is out of range. It will also indicate the minimum and maximum allowed and the actual value of the location. This information is sent out via the customer RS-232 port just after the start-up in service mode.

Action: If this fault message appears, check the following:

1. Press the exit button to clear the fault.
2. If the fault remains, cycle the power.
3. If the fault remains, write down all relevant data (temperature set points and Current Delta) and clear the CPU EEPROM in the EEPROM Diagnostics menu. **The current to the diodes must be re-calibrated and the Current Delta re-entered following this procedure.**

Head EEPROM Range Fault Fault 37

Definition: A value stored in the Head EEPROM is out of specified range.

If this fault occurs, the error is displayed and the system will beep. This fault will not cause the system to shut down.

Action: If this fault message appears check the following:

1. Press exit button to clear the fault.
2. If the fault remains, cycle the power.

3. If the fault remains, write down all relevant data (temperature set points and head hours) and clear the Head EEPROM in the EEPROM Diagnostics menu. **All temperatures and head hours must be re-entered following this procedure and the photocell must be re-calibrated.**

Diode #1 EEPROM Range Fault Fault 38

Definition: A value stored in the Diode #1EEPROM is out of specified range.

If this fault occurs, the error is displayed and the system will beep. This fault will not cause the system to shut down.

Action: If this fault message appears, check the following:

1. Press the exit button to clear the fault.
2. If the fault remains, cycle the power.
3. If the fault remains, write down all relevant data (all temperature set points and diode hours) and clear the Diode#1 EEPROM in the EEPROM Diagnostics menu. **The Diode #1 set temperature and hours must be re-entered following this procedure.**

Diode #2 EEPROM Range Fault Fault 39

Definition: A value stored in the Diode #2 EEPROM is out of specified range.

If this fault occurs, the error is displayed and the system will beep. This fault will not cause the system to shut down.

Action: If this fault message appears, check the following:

1. Press the exit button to clear the fault.
2. If the fault remains, cycle the power.
3. If the fault remains, write down all relevant data (all temperature set points and diode hours) and clear the Diode #2 EEPROM in the EEPROM Diagnostics menu. **The Diode #2 set temperature and hours must be re-entered following this procedure.**

Head-Diode Mismatch Fault Fault 40

Definition: The diode initialization does not match the head initialization.

If this fault occurs, the error is displayed and the system will beep. This fault will not cause the system to shut down.

Action: If this fault message appears, check the following:

1. Press the exit button to clear the fault.
2. If the fault remains, cycle the power.

Version v-8.33

The following Verdi software fault is new for version v-8.31 or newer.

Vanadate2 Temperature Fault Fault #47

Definition: The Vanadate2 temperature has moved out of the range: of –12°C to 55°C.

If this fault occurs, the laser diode current is terminated, the Vanadate2 drive voltage is set to zero, the fault message is displayed, and the system shutter is closed.

Action: If this fault message appears, check the following:

1. Verify the Vanadate2 temperature set point, typically 35°C. Reference the paragraph titled “Vanadate and Diode TECs” on page 3.3-1 for more information.
2. Verify the health of the Vanadate2 temperature thermistor. The resistance should be 10 kΩ at 25°C. J107 on the Head board, pins 1 and 2.
3. Verify Vanadate2 TEC drive on the Vanadate2 Driver board:
   a. CPU drive [0 to 5 V]:

      TP3(+), TP1 of CPU board.(–) [2.2 V @ 35°C]

   b. Direction [0 V heating, 5 V cooling]:

      TP4(+), TP1 of CPU board(–)

   c. Power [1.4 ± 0.2 V @ 35°C]

      TP1(+), TP2(–)

4. Verify Head connections (J107 and J104-5, 7) and drive signal connection on the Signal Interconnect board J85-5, 7.
5. Verify drive signal connections between the Signal Interconnect board (J89-5A) and the Display PCB (P29-5A).
6. Verify drive signal connections between the Display PCB and the Mother board (P24-12B).

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Introduction

Troubleshooting steps for specific system faults are listed below:

Locked-Up Front Panel

Symptom: Inability to scroll through display screen menus or access various menus with the MENU SELECT or MENU EXIT pushbuttons.

Cause: Stuck MENU UP or MENU DOWN key on keyboard.

Effect: In both cases, the CPU attempts to process the command (either scroll-up or scroll-down) at the expense of all other commands.

Diagnosis

1. When moving from the default front panel display into a submenu with the select key:
   a. Sub-menus cannot be 'Selected'.
   b. Cannot 'Exit' back to default front panel display.
   c. Cannot scroll down.
2. Without user intervention, upon entering a submenu screen, scrolling occurs through the submenus to RS-232 Baudrate Setup (in Customer Mode) or EEPROM Diagnostics (in the Service Menu).

Action

Replace front panel assembly.

Parts Required:

- Front Panel Assembly, CE: See Parts List
- Front Panel Assembly, non-CE: 0170-632-50

Two chassis designs, CE and non-CE, have been used in production. Before ordering a replacement Front Panel assembly, the version required should be determined.

The Front Panel assembly attaches to the CE chassis via six screws that thread in from the front. The Front Panel assembly mounts to the non-CE chassis via four screws; two that thread from the top and two that thread from the bottom.

If the incorrect version is ordered, the keyboard and display board can be remounted on the correct front plate.

Sticking Relay

Symptom: One of the following will be observed:

a. Temperature servo failure to lock on Vanadate, Vanadate2 (V-18 only), Diode #1, or Diode #2.

b. In Standby, the malfunctioning servo will not lock unless the set temperature of the diode is at the environmental temperature.

c. Repeated Vanadate Temperature Fault, Vanadate2 Temperature Fault (V-18 only), Diode #1 (or #2) Temperature Fault, Overcurrent Fault.

d. Drives are at a maximum, ± 8191 DAC counts, without a change in component temperature.

Cause: Relay on Power Distribution board is stuck in the heating, cooling or open position.

Effect: With the power supply keyswitch in the LASER ON position, the malfunctioning loop will move the drive voltage in the direction required to obtain the set temperature (8191). The servo cannot cool the element and the temperature increases.

Diode 1/2. Temperature shift leads to wavelength shift and Overcurrent Fault.

Vanadate/Vanadate2. Significantly increased temperature although the system can still operate.

Diagnosis

1. Enter the service menu and run the Temperature Servos in the Open Loop mode, verifying whether the servo can heat and cool. This can be verified by observing the displayed temperature on the front panel.
2. While in Open Loop mode, switch the drive from positive to negative values listening for the relay to “click”. This “click” indicates the TEC is switching from heating to cooling or vice-versa. If no sound is audible, the relay is frozen.
3. See “Fault Messages” on page 2.1-1.
   a. Vanadate Temperature Fault, Vanadate2 Temperature Fault (V-18 only)
   b. Diode 1 (or 2) Temperature Fault
   c. Heat Sink 1 (or 2) Temperature Fault

Action

Replace Power Distribution Assembly.

Parts Required: See Parts List

Power Distribution Troubleshooting

Symptom: Since all of the circuits in the power supply and laser head are biased (driven) by low voltages from the Power Distribution board, any fault or multiple faults can indicate a power distribution problem.

If a fault or multiple faults are active, the system may actually have the displayed fault(s). Reference the troubleshooting procedures in Section 2.1 "Fault Messages" for specific fault troubleshooting.

A blank display or system lock-up could also be found with a power distribution problem. If the system has a blank display, begin troubleshooting with the procedure titled "Blank Display" on page 2.2-10.

+48 Voltage Line

If the +48, ±12, or ±5V supply lines are in question, begin troubleshooting the +48V using the following procedure:

1. Measure +48V coming from the AC to DC power supply on the Power Distribution Assembly (PDA). Reference Figure 2.2-1.

V-2 to V-10 (Two FAP):	Use E1 and E2
V-2 to V-6 UNO:	Use E1 and E2
V-18:	Use E2 and E4

   If the voltage is good, there is a sufficient supply of +48V. Continue with the troubleshooting procedure titled "±5 , ±12 Voltage Lines" if the ±5V and ±12V supplies are in question.

   If the voltage is bad, replace the Lambda or Pioneer Magnetics power supply with a Pioneer Magnetics supply. Reference FSB 426 if converting from a Lambda to a Pioneer Magnetics supply.

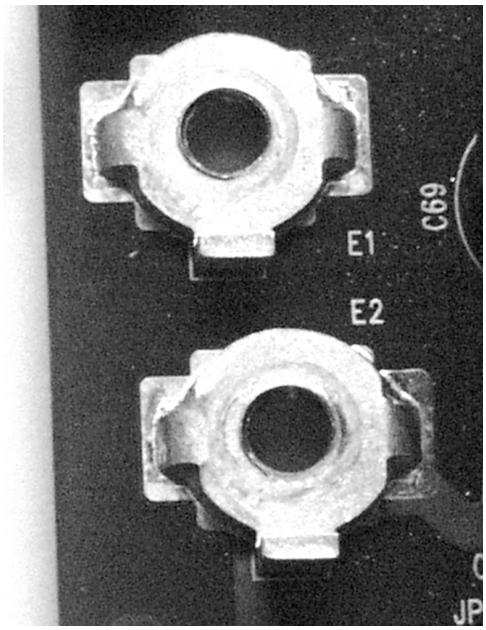

Figure 2.2-1. +48V Input to the Power Distribution Assembly

±5 , ±12 Voltage Lines

The following procedure assumes the +48 voltage line is operating normal as measured in the procedure titled "+48 Voltage Line". If the ±5 and ±12 voltage supplies are in question, use the following procedure, and note there is a 5% tolerance on the ±5V supplies and a 10% tolerance on the ±12V supplies.

1. Measure the voltage in question on the CPU board. Reference Figure 2.2-5 on page 2.2-10 for test point locations. Use TP1 for GND.

   TP2 (+5V) TP5 (-5V)
   TP3 (+12V) TP4 (-12V)

   If the voltage in question is good, continue with the low voltage test point(s) on the headboard in Step 2. Note there is sufficient -5V supply throughout the system.

   If the voltage in question is bad, go to Step 3.

2. Measure the voltage in question on the headboard at the following test point locations. Use TP7 GND and note there is no -5V supply at the headboard.

J100-1 (+)	+12V
J100-2 (+)	-12V
J100-4 (+)	+5V

If the voltage in question is good, there is sufficient voltage supplied throughout the system.

If the voltage in question is bad, go to Step 3..

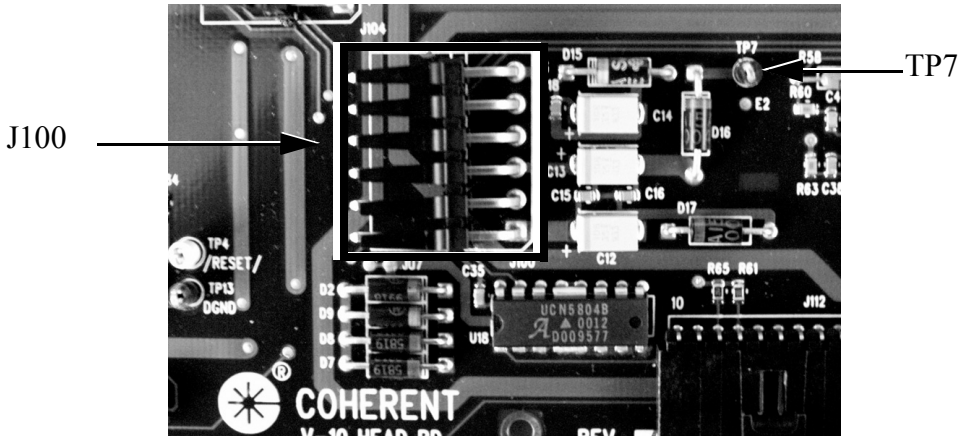

Figure 2.2-2. J100 on the Verdi Headboard

3. Place DVM leads at the voltage in question using the following test points on the Power Distribution board:

If the voltage in question is good, and there is a missing or bad voltage on the CPU board, replace the Front Panel assembly, Mother board, and CPU board.

SYSTEM	GROUND	TEST POINTS
V-2 to V-10	TP42 or TP57	+5 V TP39, –5 V TP40 +12 V TP37, –12 V TP38
V-2 to V-6 UNO	TP21	+5V TP46, -5V TP47 +12V TP44, -12V TP45
V-18	TP18	+5 V TP41, –5 V TP47 +12 V TP42, –12 V TP43

Continued Troubleshooting

The following procedure assumes there is one or more of the low voltage supplies missing from either the CPU or headboard as described in "±5 , ±12 Voltage Lines". One of the printed circuit board or cable assemblies could be draining the supply voltage. Use the following procedure to isolate the problem.

1. Perform the Complete Shutdown procedure in the operators manual.
2. Place DVM leads at the voltage in question using the following test points on the Power Distribution board:

SYSTEM	GROUND	TEST POINTS
V-2 to V-10 (Two FAP)	TP42 or TP57	+5 V TP39, –5 V TP40 +12 V TP37, –12 V TP38
V-2 to V-6 UNO	TP21	+5V TP46, -5V TP47 +12V TP44, -12V TP45
V-18	TP18	+5 V TP41, –5 V TP47 +12 V TP42, –12 V TP43

Wear an ESD wrist strap when handling printed circuit board assemblies to avoid ESD damage. Always remove the wrist strap when AC power is applied.

3. Disconnect J100 at the headboard wearing an ESD wrist strap.
4. Turn AC power on. Several laser head faults will be observed.

   If the voltage in question is good, replace the headboard. Also, inspect the cable assembly between J100 on the headboard and J84 on the Signal Interconnect board. Verify there each pin is electrically isolated from any other pin via continuity check.

   If the voltage in question is bad, continue.
5. Perform the Complete Shutdown procedure in the operators manual.
6. Disconnect J84 at the Signal Interconnect board as shown in Figure 2.2-3.
7. Turn AC power on.

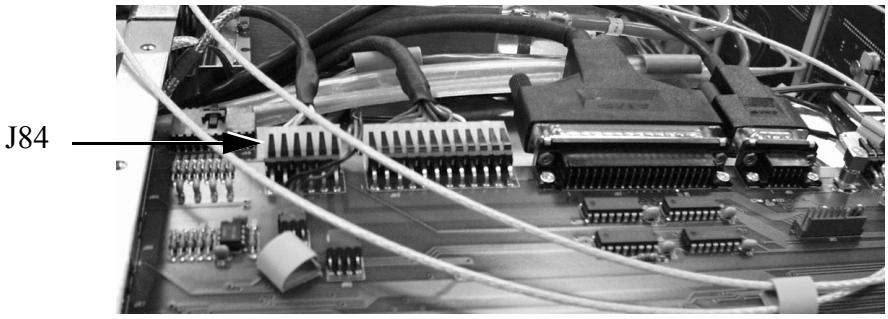

Figure 2.2-3. J84 at the Signal Interconnect Board

If the voltage in question is good, replace the umbilical assembly.

If the voltage in question is bad, continue.

8. Perform the complete shutdown procedure in the operators manual.

9. Remove the CPU board as follows:

   a. Unlock the CPU guide rails as shown in Figure 2.2-4.

   b. Using the board removal tabs, remove the CPU board and place the board in an ESD-safe environment.

10. Turn AC power on.

    If the voltage in question is good, replace the CPU board.

    If the voltage in question is bad, continue.

11. Perform the complete shutdown as described in the operators manual.

12. Disconnect and remove the Front Panel Assembly. Place it in an ESD-safe environment.

13. Turn AC power on.

    If the voltage is good, replace the Front Panel assembly, Signal Interconnect, and Mother boards. Inspect all cable interconnects between the PCBAs and replace as need

    If the voltage is still bad, replace the Power Distribution Assembly.

The low voltage supply troubleshooting is now complete.

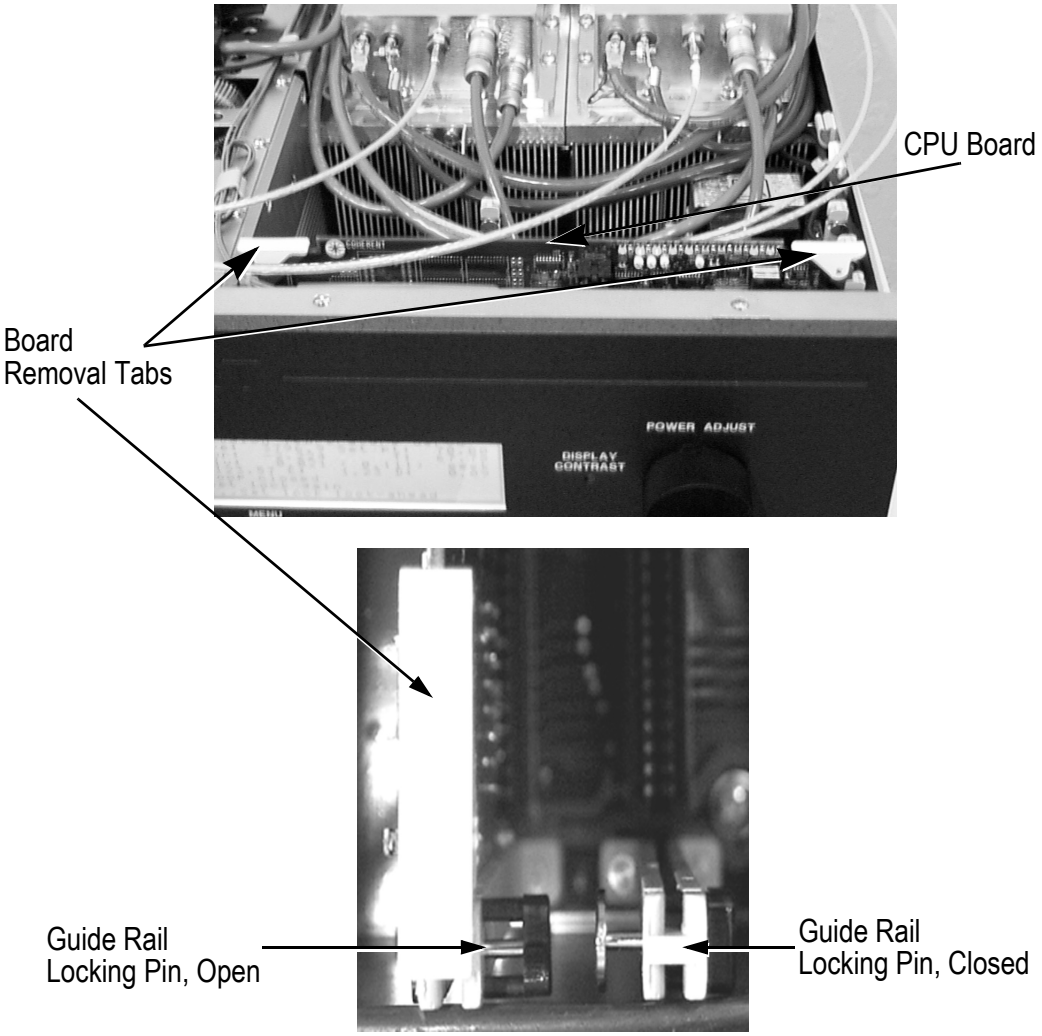

Figure 2.2-4. CPU Board Guide-Rail Locking-Pin Locations

Blank Display

Symptom: With AC power applied, there is a blank display on the front panel of the power supply.

If several faults are verified via RS-232(?FH), there are no proper low voltages being produced by the Power Distribution board and associated circuitry, or the AC to DC power supply is not supplying the +48V. Reference the procedure titled "Power Distribution Troubleshooting" on page 2.2-4 and determine the faulty components.

If all system indicators are working well, such as fans on and no active faults via RS-232, there is a problem with the front panel assembly or the +12V power supply. To isolate the problem, use the following procedure:

1. Measure the low voltage test points on the CPU board. Reference Figure 2.2-5 for test point locations. There is a 5% tolerance on the ±5V and a 10% tolerance on the ±12V.

   If the low voltages are normal, the lamp to the display or associated circuitry is the root cause. Replace the Front Panel assembly.

   If the low voltages are bad, the +12V requires troubleshooting. Reference the procedure titled "Power Distribution Troubleshooting" on page 2.2-4 to isolate the failed assembly.

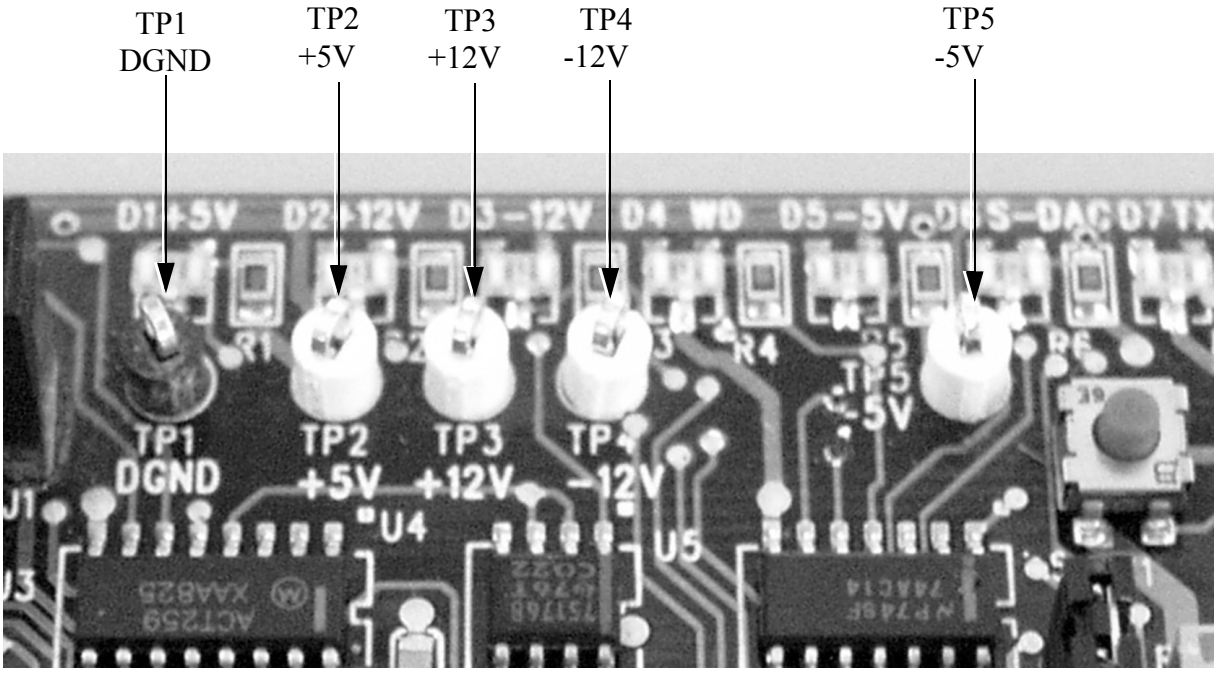

Figure 2.2-5. CPU Board Test Points

Increasing Accessibility

To gain access to the test points and components on the Power Distribution board (for V-2/V-5/V-6 models), the Signal Interconnect board should be raised. The Vanadate2 Driver Board can also be raised using a card extender (0171-529-00). See Figure 3.3-1 on page 3.3-6 for driver board location.

To raise the Signal Interconnect board, proceed as follows:

1. Place the keyswitch to the STANDBY position.
2. Remove the power supply top cover.
3. Jumper JP9 on the CPU board so Service menus can be accessed and press the reset button located on the top edge of the CPU board.

Depending on the problem with the laser system, it may not be possible to collect all of the preliminary data listed below. However, every attempt should be made to characterize the laser system as completely as possible before repairs are made.

4. From the main software window, with the system in the Light Control mode of operation, set the laser to its specification output power (i.e., 5 W, 2 W, etc.).
5. Record the following system data:

All systems:

a. LBO temperature set point
b. Vanadate temperature set point
c. Etalon temperature set point
d. Diode #1 temperature set point
e. Diode #1 current (software value)

For 2-FAP systems:

f. Diode #2 temperature set point
g. Diode #2 current (software value)

h. Vanadate2 temperature set point (V-18 only)

i. Diode current delta

6. Perform the "Turn-off (Complete Shut Down)" procedure located in Section Three of the Operator's Manual. The associated cool-down cycle will take approximately 45 minutes. The front panel display will indicate when the cool-down cycle is complete.

7. After the LBO cool-down cycle is complete, turn the power switch on the power supply rear panel off and disconnect the power cord from facility power.

8. Remove the Signal Interconnect board as follows (refer to Figure 2.3-1):

   a. Remove the screws securing the power supply front panel and gently unplug the assembly.

   b. Remove the external interlock connector, and RS-232 cable if installed, from the back of the Signal Distribution board.

   c. Remove all of the cables along the inner edge of the board, and the three screws which secure the board in place.

      Special care should be noted how the cables are routed in the power supply.

9. Detach and remove the protective cover that goes between the Signal Interconnect board and the Power Distribution board.

10. Install the PCB board stand-offs (two in front and one on outer back corner).

11. Re-install the Signal Interconnect board (see Figure 2.3-2).

12. Attach the jumper cable from the Display board to the Signal Distribution board.

13. Re-install the front panel of the power supply.

14. Reconnect the system to the facility power.

15. Perform the "Turn-on (Cold Start)" procedure located in Section Four of the Operator's Manual.

16. Re-check the system data gathered at the beginning of this procedure. If any set points are not consistent with those readings, re-set them.

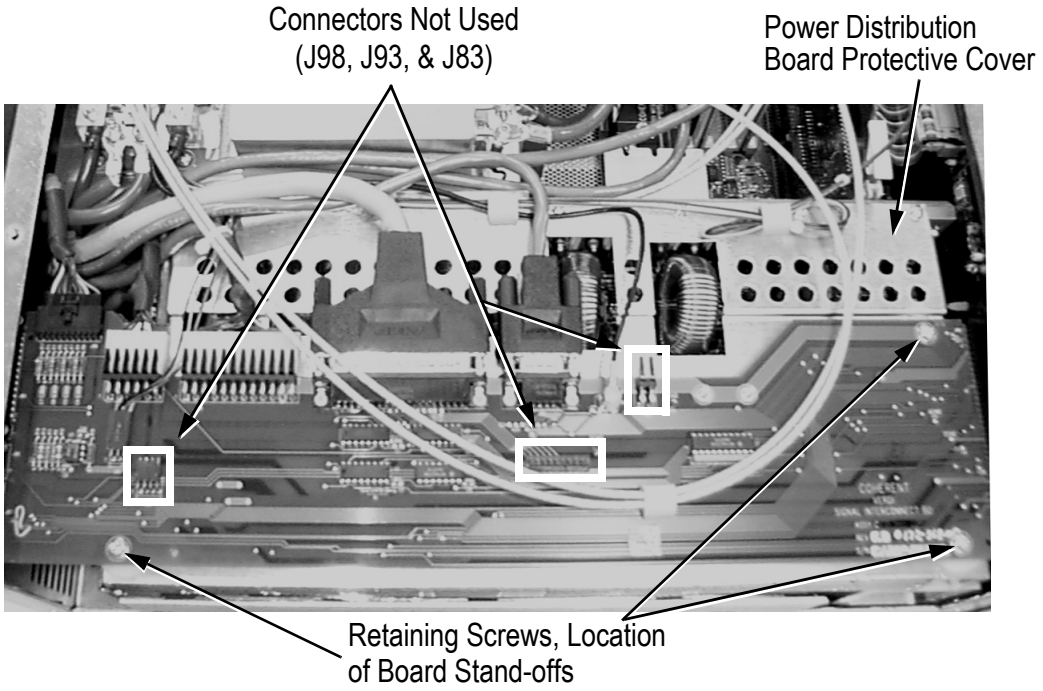

Figure 2.3-1. Signal Distribution Board

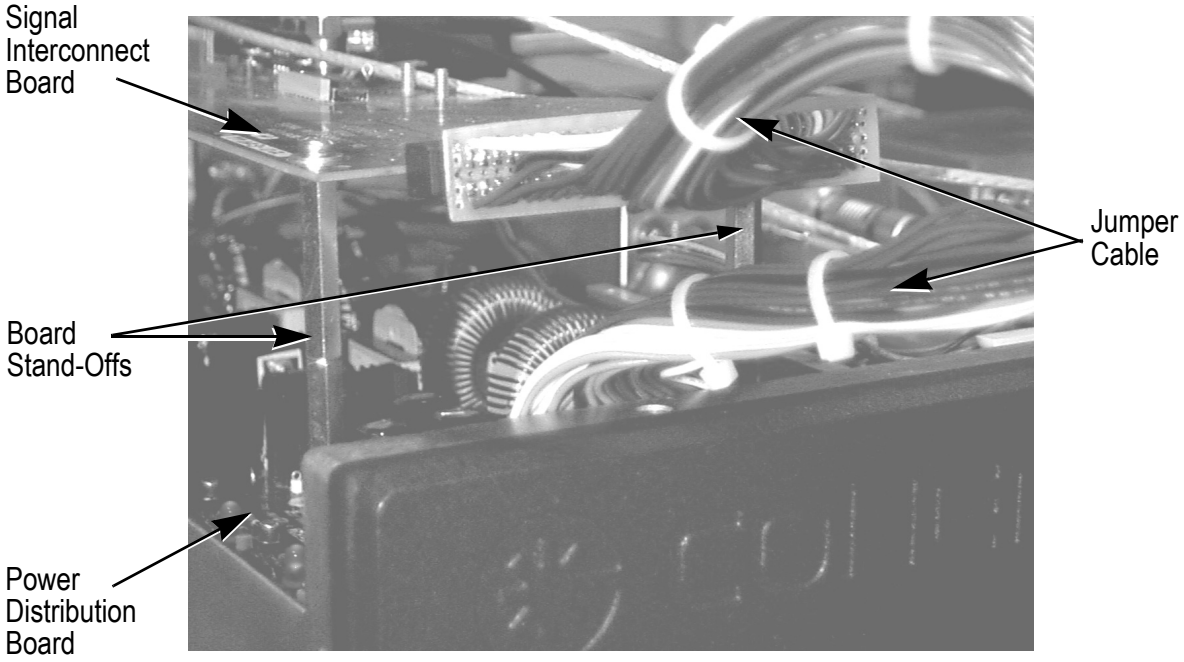

Figure 2.3-2. Signal Interconnect/Display PCB Jumper Cable

All systems:

a. LBO temperature set point

b. Vanadate temperature set point

c. Etalon temperature set point

d. Diode #1 temperature set point

e. Diode #1 current (software value).

For 2-FAP systems:

f. Diode #2 temperature set point.

g. Diode #2 current (software value).

h. Vanadate2 temperature set point (V-18 only)

i. Diode current delta

No new fault messages should be displayed by the system! If a new fault message is encountered, the cause of the fault should be determined before proceeding with the repair of the system.

Introduction

In addition to the LEDs across the top edge of the CPU board, there are LEDs on the Power Distribution board, Mother board, laser Head board and the Lambda 48 V power supply. By monitoring the behavior and state of these indicators, information can be obtained rapidly about the health of many of the laser system critical circuits.

Power Distribution Board

There are three red LEDs on the Power Distribution board, see Figure 2.4-1. The function of each LED is shown in Table 2.4-1.

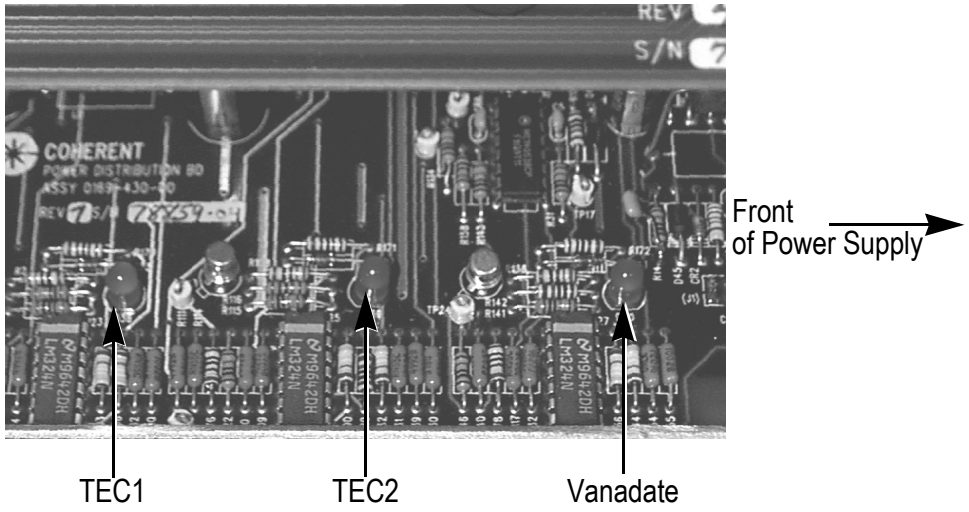

Figure 2.4-1. LEDs on Power Distribution Board

LED # V-2 TO V-10 (TWO FAP)	LED # V-2 TO V-6 UNO	LED # V-18	FUNCTION	ON	OFF
D38	D19	D18	TEC Monitor, FAP #1	Heating	Cooling
D39		D20	TEC Monitor, FAP #2	Heating	Cooling
D40	D25	D24	TEC Monitor, Vanadate	Cooling	Heating

Table 2.4-1. Function of Power Distribution Board LEDs

Vanadate2 Driver Board

There is a second Vanadate Driver Board for V-18 models only. On the Vandate2 Driver, there is D3, a red LED that indicates whether the TEC is heating or cooling. See Table 2.4-1 and Table 2.4-2 for LED functions.

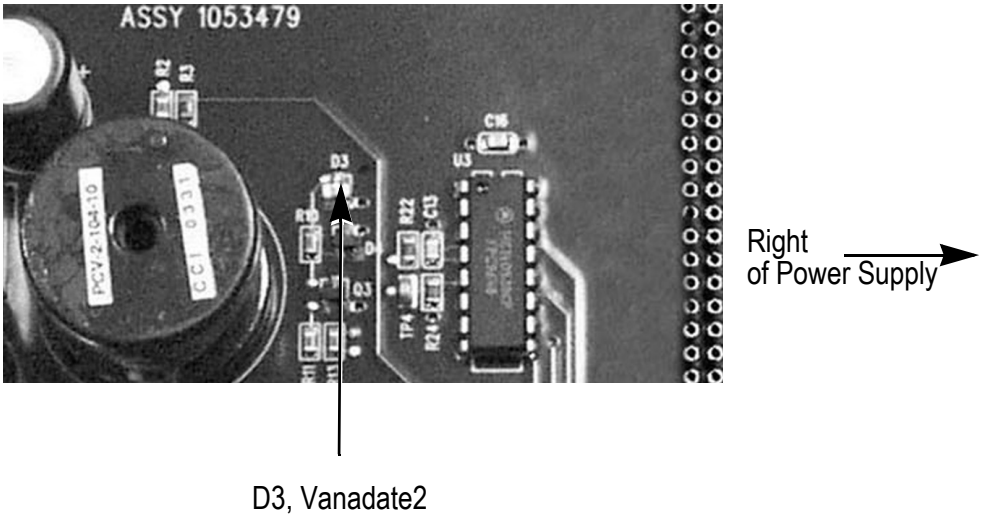

Figure 2.4-2. LED on Vanadate2 Driver Board

LED #	FUNCTION	ON	OFF
D3	TEC Monitor, Vanadate, Vanadate 2 (V-18 models)	Cooling	Heating

Table 2.4-2. Function of Vanadate2 Driver Board LED

Mother Board

There are two LEDs on the Mother board. The green LED, top of Figure 2.4-3, indicates whether the LBO heater/cooling circuit is active. This LED is in front of the CPU board slot on the Mother board.

The rate at which the LED is blinking indicates if there is facility power to the system. If the LED is blinking rapidly, then the facility power to the system has been terminated and the LBO is under going battery cool-down. If the LED is blinking slowly, there is power to the system, and the LBO heater circuit is working properly.

Next to the Verdi backup battery is a yellow LED, bottom of Figure 2.4-3. If the battery is charging, the LED should be on. If the battery is fully charged, the LED will be off.

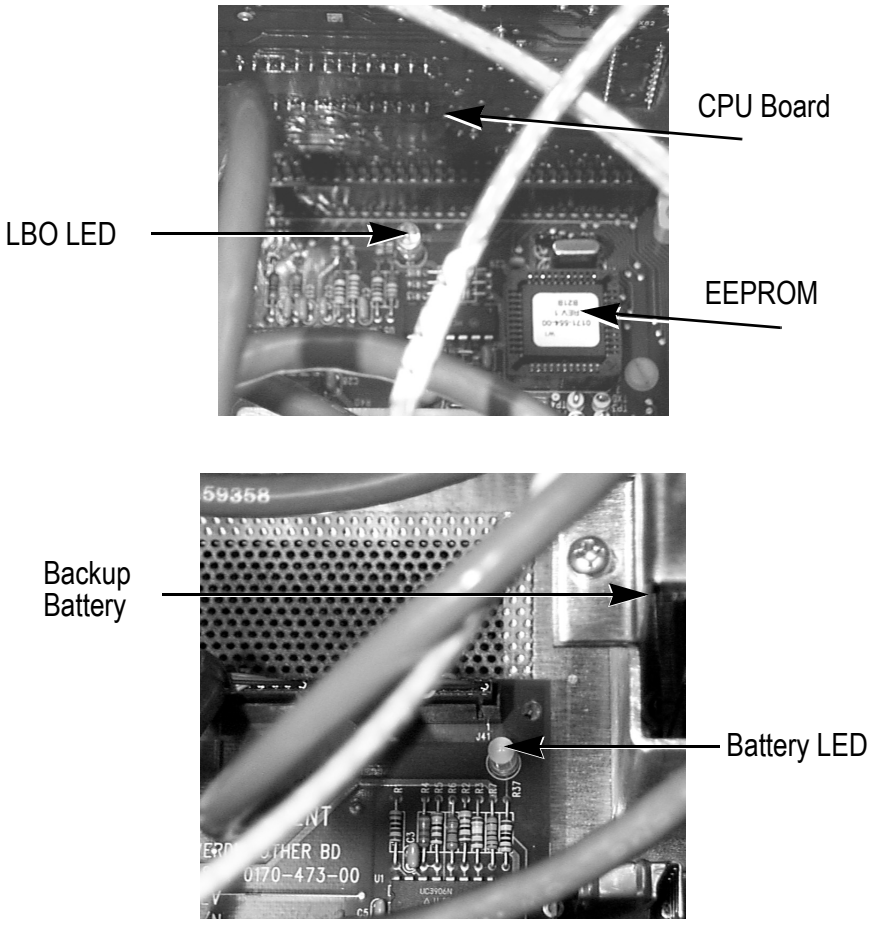

Figure 2.4-3. LBO (Top) and Battery Over-Charged (Bottom) LEDs

Head Board

There are two LEDs on the Verdi Head board—one red and one green (see Figure 2.4-4). Like the LED on the Mother board, these two LEDs monitor the status of the LBO.

If the power to the system is on and there is no drive voltage to the LBO heater, the green diode will be on and the red diode is off. As the heater drive increases from zero, the red LED turns on and gets steadily brighter as the drive voltage (temperature of the LBO) increases. Under normal operating conditions, the green LED will be on.

If the power to the system is switched off, the green LED will turn off leaving only the red LED on. The brighter the red LED, the higher the temperature of the LBO crystal. When the LBO has fully cooled (reached room temperature), the red LED will extinguish.

Note that the green LED will not turn off if the LBO cooling cycle is initiated.

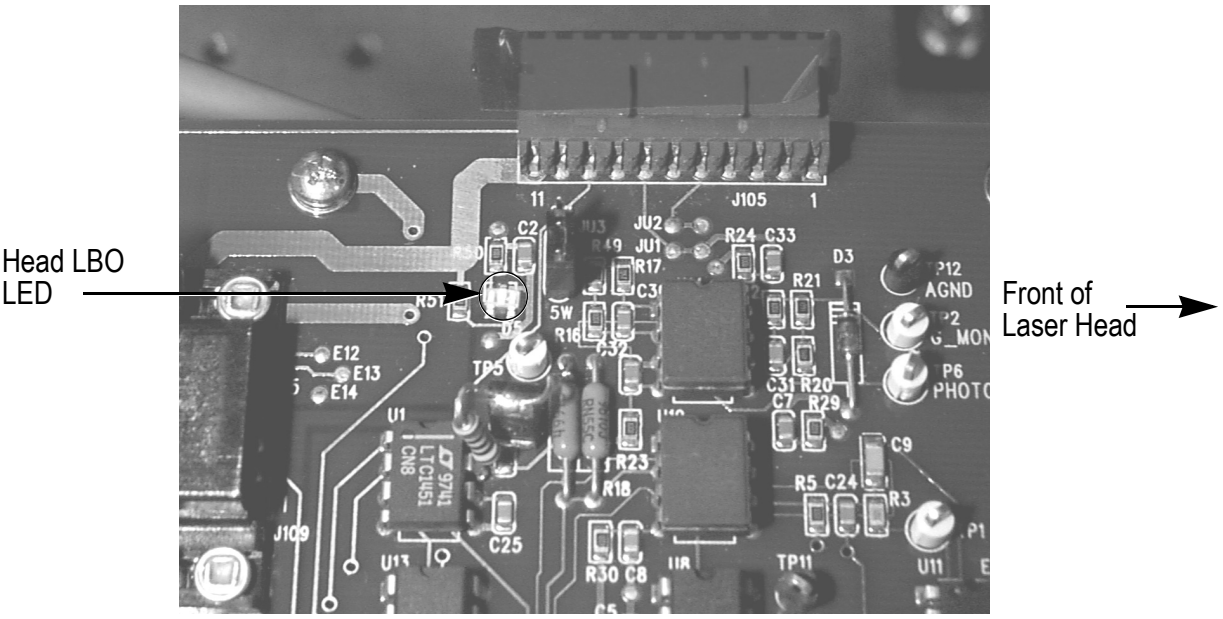

Figure 2.4-4. Laser Head Board LEDs

Lambda Power Supply

There are two green LEDs, one red LED, and a green LED bar graph on the front of the 48 V Lambda power supply (see Figure 2.4-5).

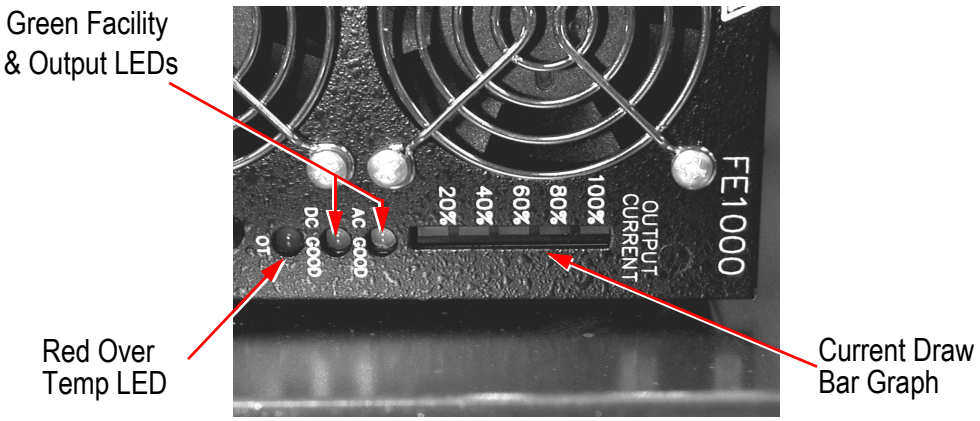

Figure 2.4-5. LEDs on the Front of the Lambda Power Supply

The single red LED indicates if the power supply is over temperature, and should be off under normal operation. The two green LEDs indicate the health of the facility voltage and the low voltages being produced by the power supply. Under normal operating conditions both of these green LEDs should be on. The green LED bar graph indicates the amount of current draw on the power supply. Under normal operating conditions, the current draw to the power supply is less than 20% of its maximum capacity (i.e., no LEDs on). The state of the LEDs can be viewed through the front left hand corner of the power supply when the cover is removed. See Figure 2.4-6.

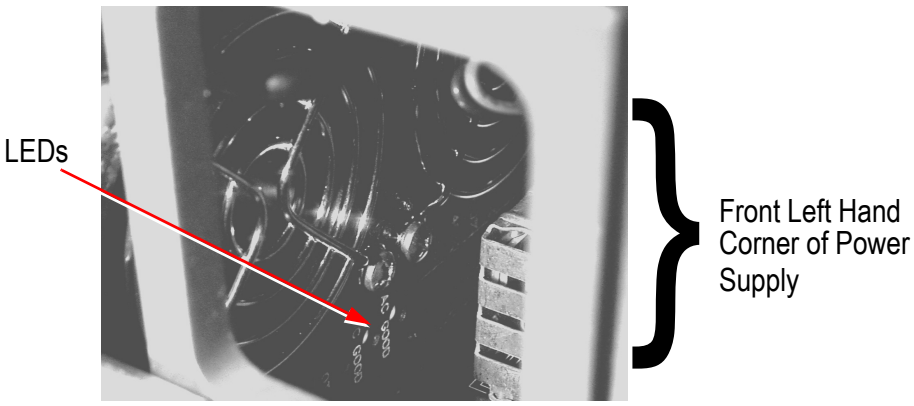

Figure 2.4-6. View of Lambda Power Supply LEDs

Pioneer Magnetics Power Supply

The Pioneer Magnetics supply does not have an over temperature indicator, conditional indicators, nor an output current bar graph as the Lambda supply does. See Figure 2.4-7 for an installed view of the Pioneer Magnetics supply.

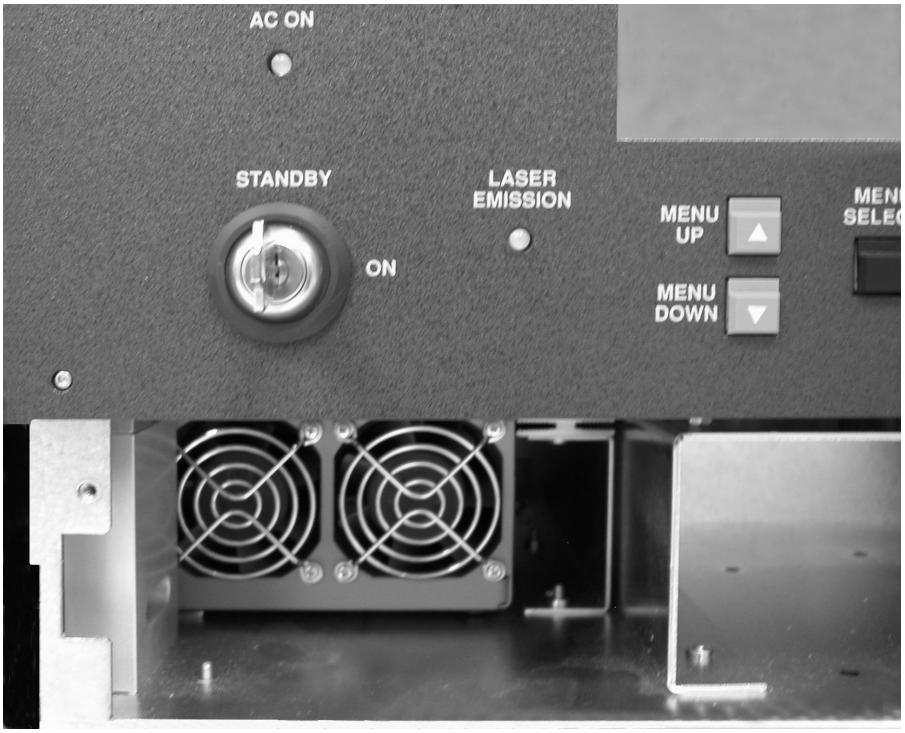

Figure 2.4-7. View of Pioneer Magnetics Power Supply

Interlock Circuits

There are three interlock circuits in the laser system:

- A power supply cover interlock
- An external interlock
- A head interlock

An overview of these interlock circuit paths is shown in Figure 3.1-1. The discussion below starts with an overview of the electronics common to all of the circuits. The three subsections that follow the electronics introduction focus on the individual circuit paths and hardware. This section concludes with a troubleshooting outline.

Electronics

The drive voltage (+5 V) and primary electronics for all three of the interlock circuits are identical, and are located on the CPU board (left hand side of Figure 3.1-1). During normal operation, the interlock switch or jumper connects the drive voltage to ground. In doing so, the switch or jumper places the gate of its MOSFET at the same potential as the source. If the interlock switch or jumper is opened, the potential of the gate raises above that of the source and the FET is forward-biased. This pulls the interlock fault line, connected to the drain of the MOSFET (also biased to +5 V), to ground. This indicates to the CPU that the interlock is open and the laser system shuts down. All three interlock circuit fault lines are monitored by the CPU via multiplexer U10, pin 4 external interlock, pin 5 power supply interlock, pin 8 head interlock.

The state of the interlock fault lines, via the gate input line of the MOSFETs, is sampled by two logic OR gates (also see the keyswitch circuit diagram, Figure 3.2-2). The power supply and external interlock provide input to U47A and the head interlock and keyswitch provide input for U47C. Under normal operation (i.e., no open interlocks and the keyswitch in the ON position), the output of these two OR gates will be a logical 0. The outputs of U47A and C then feed into the U47B, also an OR gate. The output of this final OR gate is labeled POWER_SUPPLY_EN. This signal leaves the CPU board on J1 pin 1 to the Power Distribution board P4 pin 1. On the Power Distribution board, the signal is re-named to PS_DISABLE and controls (i.e., enables or shuts down) the diode drive circuit ICs U15 and U18. See the Diode Drivers circuit diagram.

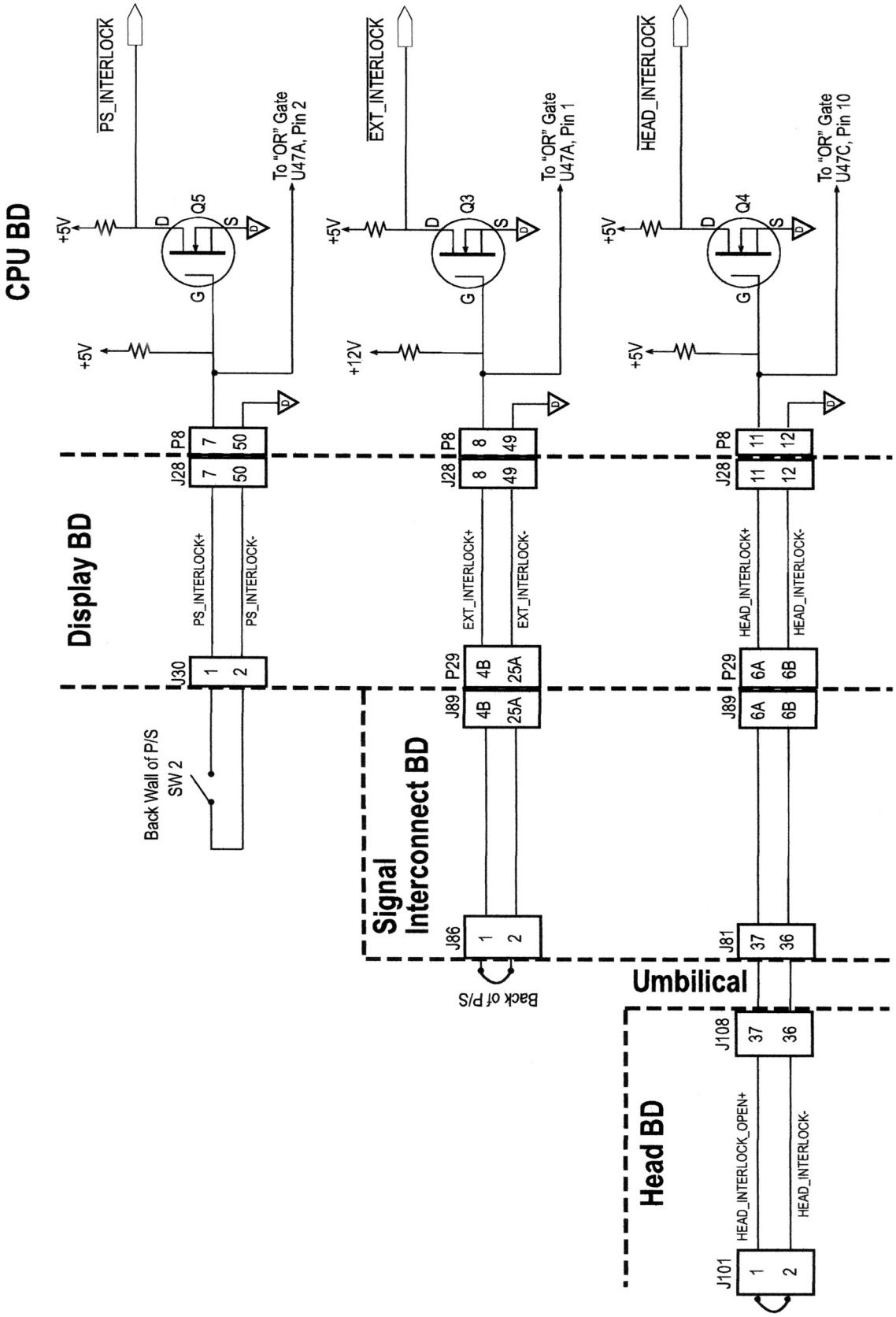
CPU BD
Display BD
Signal Interconnect BD
Umbilical
Head BD
PS_INTERLOCK
EXT_INTERLOCK
HEAD_INTERLOCK
To "OR" Gate U47A, Pin 2
To "OR" Gate U47A, Pin 1
To "OR" Gate U47C, Pin 10
Q5
Q3
Q4
+5V
+12V
D
S
G
P8
J28
P29
J89
J30
J86
J81
J108
J101
PS_INTERLOCK+
PS_INTERLOCK-
EXT_INTERLOCK+
EXT_INTERLOCK-
HEAD_INTERLOCK+
HEAD_INTERLOCK-
HEAD_INTERLOCK_OPEN+
Back Wall of P/S
SW 2
Back of P/S

Table 3.1-1. OR Gate Logic Table

A	B	OUTPUT
0	0	0
0	1	1
1	0	1
1	1	1

Power Supply Interlock

There are two mechanical interlocks in the power supply, but only one of these units is wired into the circuit. The interlocks are located along the back wall of the power supply and are defeated by reinstalling the cover screw directly over the interlock switch. The cabling between the wired interlock and the Display board runs along the left hand wall of the power supply.

External Interlock

The system is provided with two plug connectors for the external interlock. One of these connectors is shorted and should be used when an external interlock is not required by the customer. The second connector is supplied disassembled and should be used by the customer to connect an external interlock circuit to the Verdi laser system.

It is very important that a load not be placed on the electronics by an external interlock circuit. Figure 3.1-2 presents an acceptable external interlock circuit. This circuit utilizes an AC powered double pole single throw relay to form the external interlock circuit.

Head Interlock

During the initial design phase of the laser system, it was thought that a head interlock would be needed. It was later determined that this would not be required since there are no customer serviceable components in the laser head. However, the circuit is active and is jumpered (hard wired) on the system Head board as illustrated in Figure 3.1-1.

Troubleshooting

1. Verify that the +5 V is available on the CPU board and in acceptable range (± 5%).

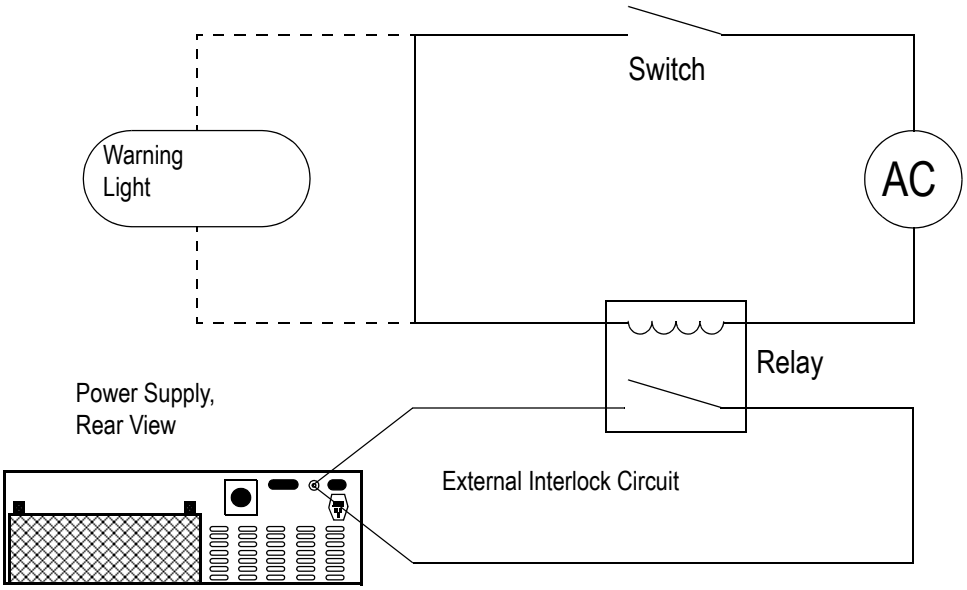

Figure 3.1-2. Example External Interlock Circuit

2. Verify that the switch or jumper is functioning properly. If the fault is due to an external circuit, install the factory-provided external interlock plug to determine if there is a problem with the customer's external circuit.

3. Determine if there is a break in the circuit by tracing the interlock supply voltage through the board/cable connectors.

Introduction

The laser system utilizes a two-position, 8-pin keyswitch. Note that only pins 1 and 3 of the keyswitch are used, and pins 2 and 6 are not present (see Figure 3.2-1). Switching the keyswitch from STANDBY to the LASER ON position enables the diode (FAP) drive circuits. A simplified example of the circuit that performs this task is shown in Figure 3.2-2.

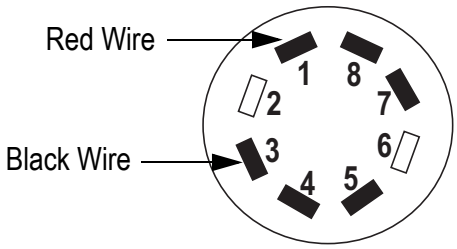

Figure 3.2-1. Pin Numbering on the Back of the Keyswitch

The primary electronics for the keyswitch circuit are located on the CPU board (left hand side of Figure 3.2-2). The drive voltage for the circuit is +5 V. During normal operation (with the keyswitch in the LASER ON position), the circuit drive voltage is connected to ground. This places the gate of FET Q1 at the same potential as its source.

When the keyswitch is moved to the Standby position (i.e., the switch is opened) the potential of the gate raises above that of the source and the FET is forward-biased. This pulls the keyswitch state line, connected to the drain of the MOSFET (also biased to +5 V), to ground. This indicates to the CPU that the keyswitch is in the STANDBY position. The state line is monitored by the CPU via multiplexer U10, pin 7.

To enable or disable the diode (FAP) drive circuits, the state (high or low) of the keyswitch line and the interlock fault lines are monitored by a series of OR gates. The power supply and external interlocks provide input for U47A, while the head and the keyswitch interlocks provide input for U47C (see also the Interlock circuit diagram, Figure 3.1-1). Under normal operation, the output of these two OR gates will be a logical 0. The outputs of U47A and C are then feed into U47B. The output of this OR gate is labeled

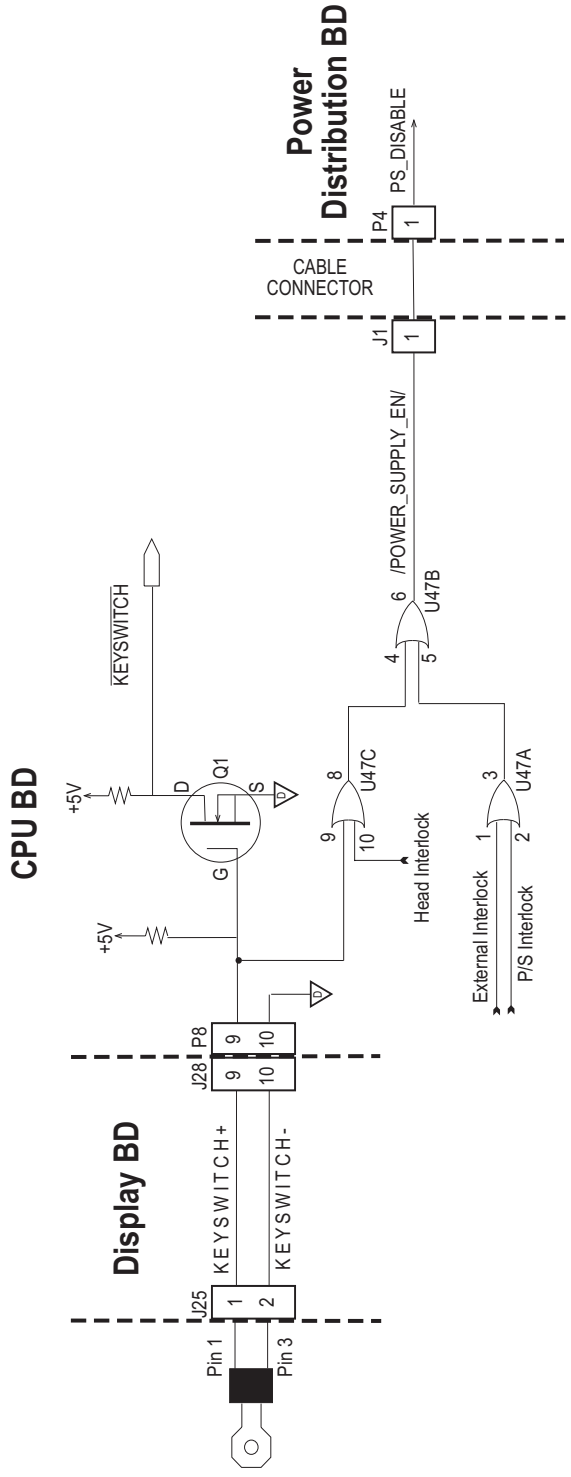

Figure 3.2-2. Keyswitch Circuit and Switch Pin Layout

POWER_SUPPLY_EN. This signal leaves the CPU board on J1 pin 1 to the Power Distribution board P4 pin 1. On the Power Distribution board, the signal is renamed to PS_DISABLE (See Figure 3.2-2).

Troubleshooting

1. Verify that the +5 V is available on the CPU board and in acceptable range (± 5%).
2. Using a DVM, verify that the keyswitch is functioning properly.
3. Verify that the POWER_SUPPLY_EN signal is a logical 0 with the keyswitch in the STANDBY position on both the CPU and Power Distribution boards.

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Introduction

The following presents an overview of the functionality and explanation of the LBO, Vanadate, Vanadate2, and FAP-I TEC (heating/cooling) servo loops.

- The CPU provides a digital drive signal to the Power Distribution or Mother board that corresponds to a drive voltage to the TECs or LBO oven.
- This drive voltage corresponds to a current through the TEC or LBO oven.
- The magnitude of the voltage (or current) determines the temperature of the TEC surfaces, or the temperature of the LBO oven.
- The drive range is ± 8191 DAC counts for the Vanadate and diodes. The sign determines the sense of the voltage across the TEC and therefore which face is hot/cold.
- The LBO is heated by a resistive oven which only has the capability of heating. Therefore, the drive range is 0 to +8191.

Note that some of the subsection titles also include the signal label, given in parenthesis, as it appears on the schematics. For signals that are common to several circuits, "XXX" is substituted for the specific label (component) name (VAN,VAN2, TEC1, or TEC2).

Vanadate and Diode TECs

The following is an overview of the Vanadate and FAP-I TEC circuits. Refer to Figure 3.3-1 for Vanadate2 Driver board location (V-18 supplies only). Also, see Figure 3.3-2 for V-2 to V-10 systems, and Figure 3.3-4 for V-18 systems for block diagrams and test point locations.

Set Temperature

The set temperature is stored in either the head or diode EEPROMs. This value is read into temporary memory and input into the CPU microprocessor.

Thermistor Signal

The resistance through the thermistor corresponds by a logarithmic relationship to the temperature of the element. The thermistor resistance is 10 kΩ at 25°C. A reference voltage of +5 V is used to bias the circuit. The voltage drop across the thermistor is measured and converted to a digital number. The CPU microprocessor converts this digital signal into a temperature that is displayed on the front panel of the power supply.

The Vanadate2 cicuitry is located on the Vanadate2 Driver Board, not the Power Distribution board, and is only used on the V-18. All Vanadate2 test points below are in reference to the Vanadate2 Driver Board. TP1 on CPU Board can be used for ground.

Power Supply_ DAC (XXX_DRIVE)

This value, obtained from a relationship stored in the CPU microprocessor, calibrates (i.e., determines) the drive required by a TEC element. Both the Set Temperature and Thermistor signals are needed for the calculation and are stored in the head or FAP-I EEPROM.

The DAC Voltage signal ranges from 0 to 2.5 V, and can be measured on the following Power Distribution board test points. Vanadate2 voltages (on V-18 models only) must be measured on the Vanadate2 driver board. See Table 3.3-3 on page 3.3-6, Table 3.3-4 on page 3.3-7, Table 3.3-5 on page 3.3-7, or Table 3.3-6 on page 3.3-8 for typical voltages of the respective drive signal.

Table 3.3-1. Test Points for DAC Voltage Signal

SYSTEM	VANADATE #1	VANADATE #2	FAP-I #1	FAP-I #2
V-2 to V-10 (Two FAP)	TP57(-), TP24(+)	—	TP57(-), TP15(+)	TP57(-), TP23(+)
V-2 to V-6 UNO	TP21(-), TP26(+)	—	TP21(-), TP22(+)	
V-18 only	TP18(-), TP38(+)	TP18(-), TP3(+)	TP18(-), TP33(+)	TP18(-), TP35(+)

Direction Signal (XXX_DIR)

The Direction signal, measured on the Power Distribution board or Vanadate2 Driver board (V-18 models only), is used to throw a relay, which determines if the TEC element is heating or cooling. This signal can be a logical high (+5 V) or a logical low (0 V).

Note that the state voltages are opposite for the Vanadate and the FAP-I assembly circuits. Vanadate2 voltages (V-18 models only) must be measured on the Vanadate2 driver board. Use TP18 for AGND on Vanadate2 voltage measurements.

Table 3.3-2. Test Points and Voltage for Direction Signal

	VANADATE #1	VANADATE #2	FAP-I #1	FAP-I #2
Cooling	5 V	5 V	0 V	0 V
Heating	0 V	0 V	5 V	5 V
V-2 to V-10 (Two FAP)	TP57(-), TP36(+)	—	TP57(-), TP17(+)	TP57(-), TP22(+)
V-2 to V-6 UNO	TP21(-), TP24(+)	—	TP21(-), TP27(+)	
V-18 only	TP18(-), TP37(+)	TP18(-), 4(+)	TP18(-), TP39(+)	TP18(-), TP36(+)

Power Signal (XXX_PWR)

The Power Distribution board and Vanadate2 Driver board takes the PowerSupply_DAC voltage and generates a current to the TEC element (Power Signal) being heated or cooled. The magnitude of the current passing through the TEC determines how hard the TEC is working. The various power signals, which can range from –48 to +48 V, can be measured across the following test points shown in Table 3.3-3, Table 3.3-4, Table 3.3-5, or Table 3.3-6.

The maximum drive (8191) would produce an extreme temperature, which is not seen when the system is operating properly.

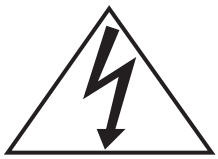
On Startup

For a given TEC, the CPU microprocessor obtains the Thermistor signal from the thermistor and compares this to the Set Temperature. The result of the microprocessor comparison is used to generate the PowerSupply_DAC and direction voltage signals.

On the Power Distribution and Vanadate2 Driver boards, the signals are converted to a power signal that drives current through the TEC, resulting in a change in temperature.

TEC Servo Troubleshooting

The following should be verified when the power supply cannot regulate the temperature of the Vanadate or one of the Diode TECs. Reference Figure 3.3-1 for Vanadate2 driver board location.



Turn the power supply to the OFF position before attaching the Digital Voltmeter (DVM) leads. Ensure the LBO cool-down cycle is initiated each time the power supply is turned on to avoid long cool-down periods.

1. Verify that the +5 V is available on the CPU board and in acceptable range (± 10%).
2. Open the Servo loop by using the MENU DOWN pushbutton to the appropriate menu (Vanadate Temp Servo, Vanadate2 Temp Servo, or Diode1 Temp Servo, Diode2 Temp Servo).
3. Verify that the drive signal from the CPU is present on the Power Distribution board:
   a. Attach a DVM with clip leads to the respective test points listed in Table 3.3-3, Table 3.3-4, Table 3.3-5, or Table 3.3-6.
   b. Change the drive in the respective servo menu and verify the drive signal on the Power Distribution board changes as listed in the respective table.

   If the voltage changes in accordance with the respective drive, go to Step 4.

   If the voltage does not change, replace the CPU board, Mother board, and Front Panel assembly.
4. Verify the direction signal of the respective temperature servo:
   a. Attach a DVM with clip leads to the respective test points as listed in Table 3.3-3, Table 3.3-4, Table 3.3-5, or Table 3.3-6.

b. Manually adjust the drive from negative to positive values (or vice versa) in the respective temp. servo menu and listen for the audible “click” of the relay.

The LEDs on the Power Distribution board will also change from on to off (or vice versa). Reference Table 2.4-1 on page 2.4-2 for LED location and operation.

If the relay and direction voltages are good, go to Step 5.

If there is no audible click, or the LEDs do not come on or go off, then replace the Power Distribution assembly.

5. Verify the Power Signal for the respective temperature servo:

a. Attach a DVM with clip leads to the respective test points as listed in Table 3.3-3, Table 3.3-4, Table 3.3-5, or Table 3.3-6.

Use standard DVM point leads when testing flex circuit connectors at the head board.

b. Manually adjust the drive in the respective temp. servo menu and verify the voltages change in accordance with the respective table.

If the voltage changes in accordance with the drive, the temperature servo is correctly operating.

If the voltage does not change in accordance with the table, replace the printed circuit board assembly (PCBA) after the last known-good test point.

- If the signal is lost in the umbilical, the entire laser head must be replaced.

The values provided in the tables are from a single system, and may therefore vary slightly from the system being serviced.

Table 3.3-3. Vanadate TEC Circuit Drive and Sense Voltages

DAC COUNT	DRIVE SIGNAL (V)	DIRECTION SIGNAL (V)	POWER SIGNAL VOLTAGE (V)			
V2-V10 (TWO FAP)	**PDB (TP57, TP24)**	**PDB (TP57, TP36)**	**PDB (TP54-TP55)**	**SIB (J85, 5-6)**	**HB (J104, 5-6)**	**HB (J107, 5-10)**
V2-V6 UNO	**PDB (TP21, TP26)**	**PDB (TP21, TP24)**	**PDB (TP38, TP48)**	**SIB (J85, 5-6)**	**HB (J104, 5-6)**	**HB (J107, 5-10)**
3000	1.78	0.02	4.4	4.3	4.2	4.2
2000	2.01	0.02	3.1	2.9	2.8	2.8
1000	2.25	0.02	1.2	1.2	1.2	1.2
500	2.37	0.02	0.6	0.6	0.5	0.5
0	2.50	0.2	0	0	0	0
–500	2.37	4.98	–0.5	–0.5	–0.5	–0.5
–1000	2.25	4.98	–2.1	–2.1	–2.0	–2.0
–2000	2.01	4.98	–3.1	–2.9	–2.8	–2.8
–3000	1.78	4.98	–4.4	–4.3	–4.2	–4.2

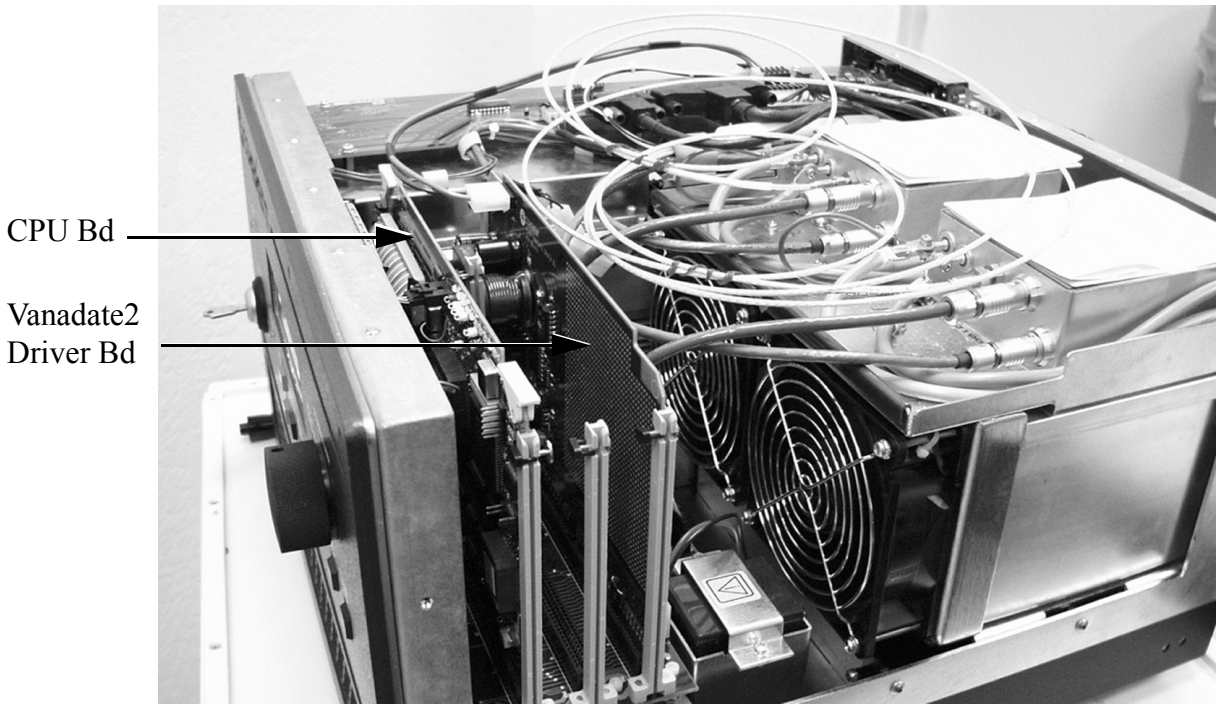


Figure 3.3-1. Vanadate2 Driver Board Location

Table 3.3-4. V-18 Vanadate #1 TEC Circuit Drive and Sense Voltages

DAC COUNT	DRIVE SIGNAL (V)	DIRECTION SIGNAL (V)	POWER SIGNAL VOLTAGE (V)			
	PDB (TP18, 38)	PDB (TP18, 37)	PDB (TP43, 40)	SIB (J85, 5-6)	HB (J104, 5-6)	HB (J107A, 5- 7)
3000	1.7	0.2	5.8	5.3	4.8	4.8
2000	2.0	0.2	3.7	3.5	3.1	3.1
1000	2.3	0.2	2.2	1.7	1.5	1.5
500	2.4	0.2	1.5	1.0	0.8	0.8
0	2.5	0.2	.5	.5	.3	.3
−500	2.4	4.9	−1.5	−1.0	−0.8	−0.8
−1000	2.3	4.9	−2.2	−1.7	−1.5	−1.5
−2000	2.0	4.9	−3.7	−3.5	−3.1	−3.1
−3000	1.7	4.9	−5.8	−5.3	−4.8	−4.8

Table 3.3-5. V-18 Vanadate #2 TEC Circuit Drive and Sense Voltages

DAC COUNT	DRIVE SIGNAL (V)	DIRECTION SIGNAL (V)	POWER SIGNAL VOLTAGE (V)			
	VAN2 (TP18, 3)	VAN2 (TP18, 4)	VAN2 (TP1-2)	SIB (J885, 1- 3)	HB (J104, 7-8)	HB (J107B, 6- 8)
3000	4.8	4.8	5.8	5.3	4.8	4.8
2000	3.1	3.1	3.7	3.5	3.1	3.1
1000	1.5	1.5	2.2	1.7	1.5	1.5
500	0.8	0.8	1.5	1.0	0.8	0.8
0	.3	.3	.5	.5	.3	.3
−500	−0.8	−0.8	−1.5	−1.0	−0.8	−0.8
−1000	−1.5	−1.5	−2.2	−1.7	−1.5	−1.5
−2000	−3.1	−3.1	−3.7	−3.5	−3.1	−3.1
−3000	−4.8	−4.8	−5.8	−5.3	−4.8	−4.8

Table 3.3-6. FAP-I TEC Circuit Drive and Sense Voltages

DAC COUNT	DRIVE SIGNAL (V) PDB		DIRECTION SIGNAL (V) PDB		POWER SIGNAL (V) PDB	
	Diode #1	Diode #2	Diode #1	Diode #2	Diode #1	Diode #2
V-2 TO V-10 (TWO FAP)	TP57, TP15	TP57, TP23	TP57, TP17	TP57, TP22	TP50, TP51	TP52, TP53
V-2 TO V-6 UNO	TP21, TP22		TP21, TP27		TP19, TP15	
V-18	TP18, TP33	TP18, TP35	TP18, TP39	TP18, TP36	TP39, TP18	TP36, TP18
3000	1.7		4.9		23.5	
2000	2.03		4.9		15.1	
1000	2.28		4.9		7.4	
500	2.40		4.9		3.4	
0	2.52		4.9		0	
-500	2.40		0.2		–3.4	
-1000	2.28		0.2		–7.4	
-2000	2.03		0.2		–15.1	
-3000	1.7		0.2		–23.5	

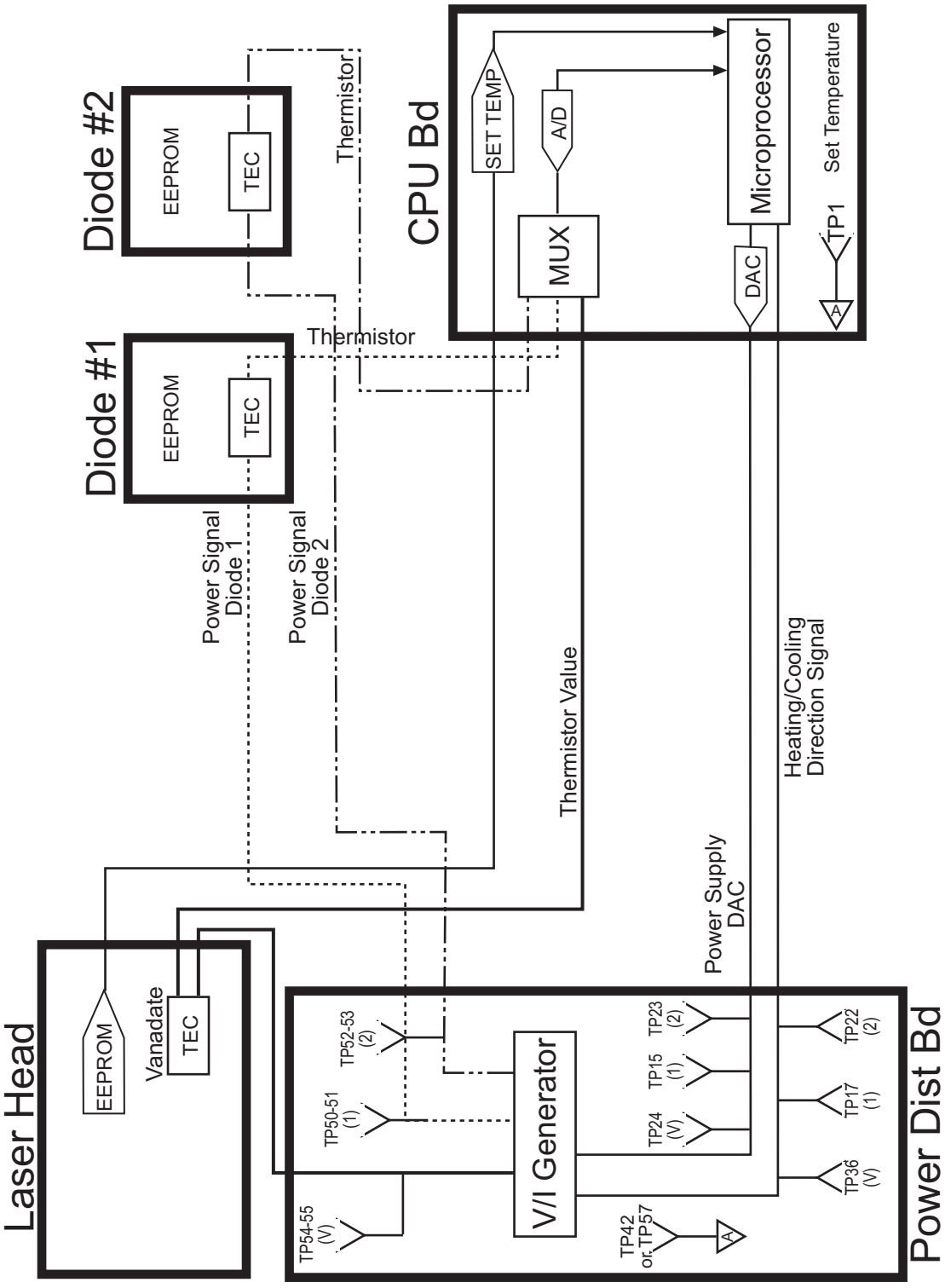


Figure 3.3-2. Vanadate and FAP-I TEC Block Diagram (V-2 to V-10)

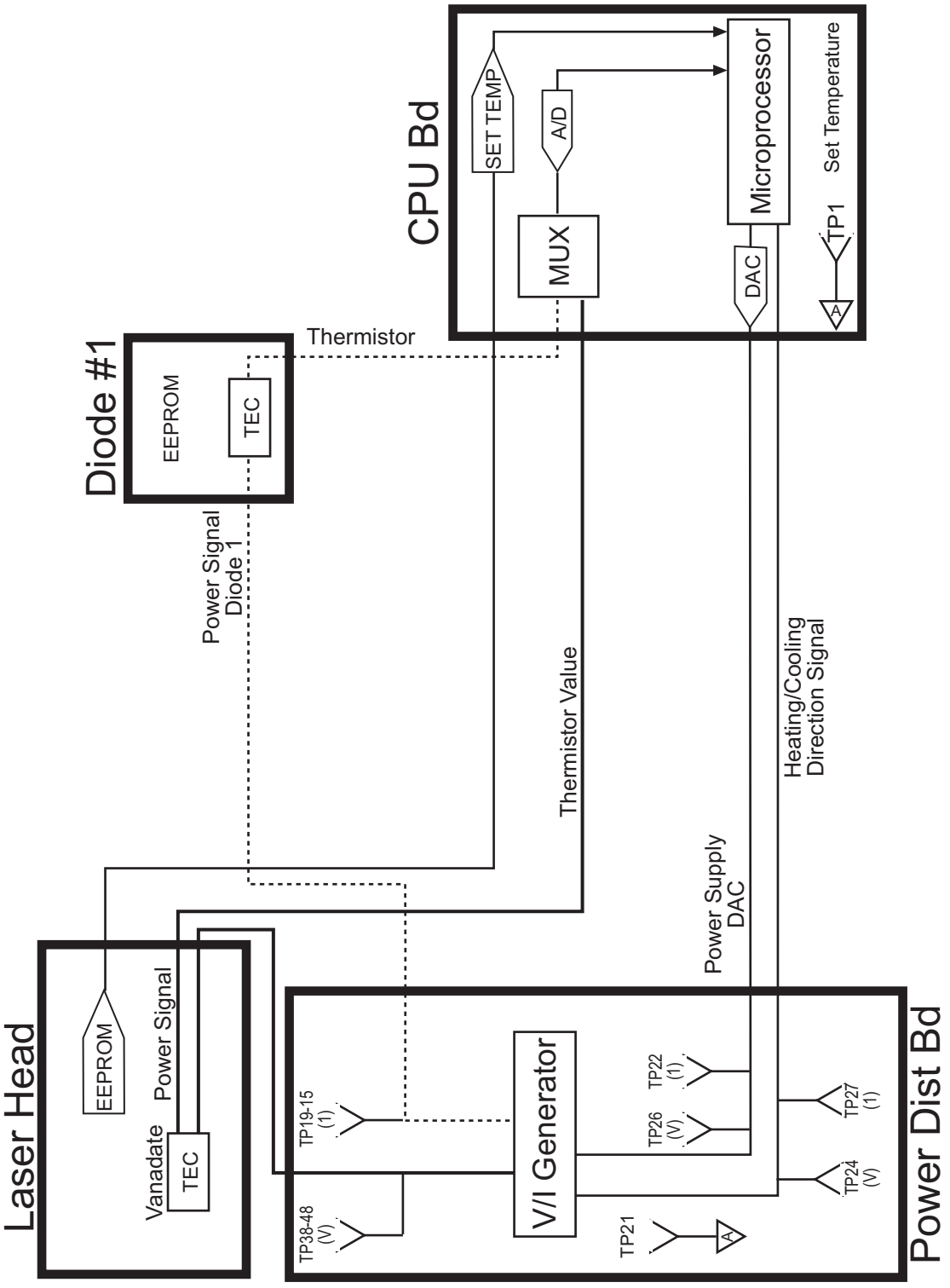


Figure 3.3-3. Vanadate and FAP-I TEC Block Diagram (V-2 to V-6 UNO)

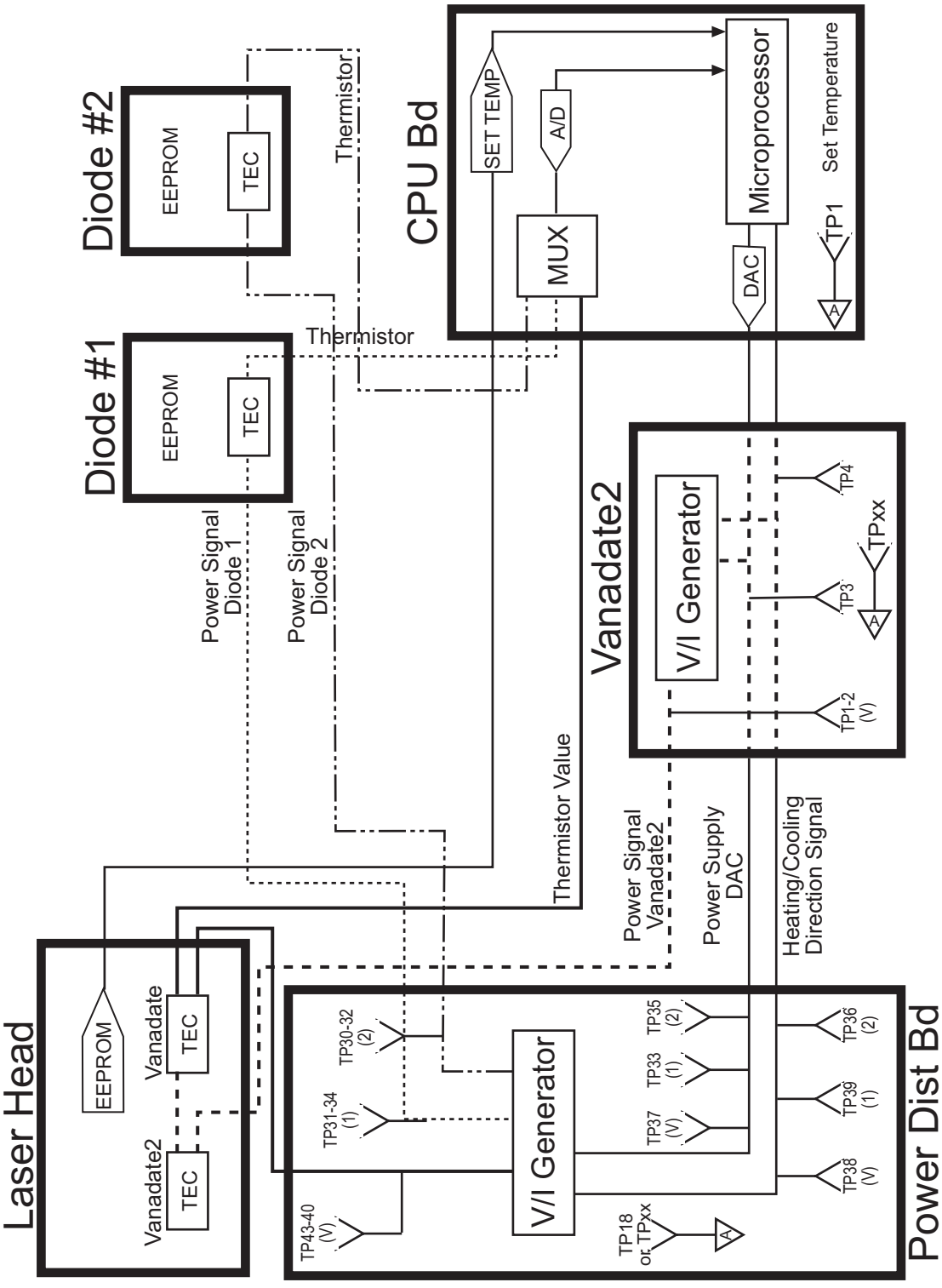


Figure 3.3-4. Vanadate and FAP-I TEC Block Diagram (V-18)

LBO Servo

The following is an overview of the LBO oven circuit. Refer to Figure 3.3-5 for the location of all test points and components.

Set Temperature

The set temperature is stored in the head EEPROM. This value is read into temporary memory and input into the CPU microprocessor.

Thermistor Signal

The resistance through the thermistor corresponds by a logarithmic relationship to the temperature of the LBO oven. The thermistor resistance is 100 kΩ at 25°C. A reference voltage of +5 V is used to bias the circuit. The voltage drop across the thermistor is measured and converted to a digital number. The CPU microprocessor converts this digital signal into a temperature that is displayed on the front panel of the power supply.

Drive Signal (LBO_DRIVE)

The CPU drive signal is based on the actual temperature read from the Thermistor Signal and the Set Temperature stored in an EEPROM on the laser head board.

After passing through a multiplexer, the DAC signal also goes to the LBO microprocessor. Both the CPU and LBO microprocessor Drive signals should range between 0-5 V. The DAC signal then passes through a voltage divider, where it is divided by a factor of 2.5 known as post DAC signal. See Table 3.3-7 for LBO_Drive signal test points on the Mother Board

Table 3.3-7. Test Points and Voltage for Direction Signal

LBO_DRIVE	CPU	LBO EEPROM	POST DAC
V-2 to V-10 Two FAP, UNO	TP5(-), TP7(+)	TP5(-), TP8(+)	TP5(-), TP6(+)
V-18 only	TP6(-), 8(+)	TP6(-), TP10(+)	TP6(-), TP1(+)

LBO Microprocessor

The microprocessor constantly monitors, updates, and stores the LBO_Drive signal supplied by the CPU. If the system power is cut, a signal called AC_GOOD changes state (from 5 to 0 V) and control of the LBO heating is given to the LBO microprocessor. The cool-down cycle is initiated and the battery provides the power to step down the LBO to ambient temperature.

Vicor-Regulated Power Supply (LBO_PWR)

Using the post-divider DAC voltage signal, the Vicor generates a drive voltage that is linearly related to the post-divider DAC voltage signal. A drive signal of 0 to 5 V into the Vicor power supply corresponds to an output LBO Drive voltage of 0 to 40. The magnitude of the signal determines how much current passes through the resistive heater. The greater the current, the greater the heating of the oven, and thus the higher the temperature of the LBO crystal. The LBO_PWR signals can be monitored at the test points listed in Table 3.3-8 for V-2 through V-10 systems, or Table 3.3-9 for V-18 systems.

The Vicor power supply is biased by an 18 V signal from the Power Distribution board when the system has power, and is biased by the internal 12 V battery when the facility power is interrupted.

On Startup

On startup (Power On), the CPU microprocessor checks the In_Control signal voltage. If the LBO microprocessor has been in control of the LBO oven, the signal will be 5 V. If the LBO microprocessor has not been in control of the LBO oven, the signal will be 0 V.

If the In_Control signal is 0 V, the CPU microprocessor will start increasing the LBO Drive DAC in steps of three (or five, depending on the software revision), starting from zero. If the In_Control signal is 5 V, the CPU will raise the Release_Control signal from 0 V to 5 V.

When Release_Control is 5 V, the LBO microprocessor gives control of the LBO Drive DAC (and thus the Vicor reference signal voltage) to the CPU microprocessor. The CPU then takes the LBO read temperature from the thermistor value, compares this against the set temperature and determines the LBO drive DAC that is required.

Battery Cool-Down

On loss of power, the AC_GOOD signal goes from +5 V to 0 V, TTL logical false state. This signals the to LBO microprocessor to take control of the LBO cool-down cycle. The LBO microprocessor uses the last LBO_Drive setting and initiates the cool-down using the battery as the power source.

LBO Servo Troubleshooting

The following should be verified when the power supply cannot regulate the temperature of the LBO:

1. Verify that the +5 V is available on the CPU board and in acceptable range (± 10%).
2. Verify that the +18V is available at TP34 for V-2 to V-10 systems, or TP50 for V-18 systems on the Power Distribution board. Replace the Power Distribution board if the voltage is not available.
3. Open the servo loop in the LBO Temp Servo menu. Manually adjust the drive and verify that the temperature changes accordingly.

   If the LBO temperature does not change accordingly, there is no power voltage reaching the LBO oven. Go to Step 4.
4. Verify that the drive signal from the CPU is present on the Mother board:

   a. Attach a DVM with clip leads to the CPU_Drive test points listed in Table 3.3-8 for V-2 to V-10 systems, or Table 3.3-9 for V-18 systems.

   b. Change the drive in the LBO Temp. Servo menu and verify the drive signal on the Mother board changes as listed in the respective table.

   If the voltage changes in accordance with the respective drive, go to Step 5.

   If the voltage does not change, replace the CPU and Mother boards.
5. Verify that the drive signal from the LBO microprocessor is present on the Mother board:

   a. Attach a DVM with clip leads to the LBO_Drive test points listed in Table 3.3-8 for V-2 to V-10 systems, or Table 3.3-9 for V-18 systems.

b. Change the drive in the LBO Temp. Servo menu and verify the drive signal on the Mother board changes as listed in the respective table.

If the voltage changes in accordance with the respective drive, go to Step 6.

If the voltage does not change, replace the Mother board.

6. Verify the Power Signal for the respective temperature servo:

a. Attach a DVM with clip leads to the LBO_PWR test points as listed in Table 3.3-8 for V-2 to V-10 systems, or Table 3.3-9 for V-18 systems.

Use standard DVM point leads when testing flex circuit connectors at the head board.

b. Manually adjust the drive in the LBO Temp. Servo menu and verify the voltages change in accordance with the respective table.

If the voltage changes in accordance with the drive, the temperature servo is correctly operating.

If the voltage does not change in accordance with the table, replace the printed circuit board assembly (PCBA) after the last known-good test point.

- If the signal is lost in the umbilical, the entire laser head must be replaced.

The values provided in Table 3.3-8 and Table 3.3-9 are from a single system, and as a result may very slightly from the system being serviced. V-18 voltages will have a higher LBO drive post-DAC of 2.5 V maximum.

Power signal voltages can be as high as 48 V for the V-18.

Table 3.3-8. LBO Oven Drive and Power Voltages for V-2 to V10 Systems

DAC COUNT	LBO DRIVE (V) (CPU)	LBO DRIVE (V) (MB)	LBO DRIVE (V) (POST DAC)	POWER SIGNAL VOLTAGE (V)		
	MB (TP5, TP7)	MB (TP5, TP8)	MB (TP5, TP6)	SIB (J85 1-2)	HB (J104 1-2)	HB (J105 10-11)
8191	4.92	5.02	1.81	34.27	34.27	34.27
7000	4.27	4.33	1.73	32.80	32.75	32.75
6000	3.66	3.75	1.48	28.11	28.06	28.06
5000	3.05	3.06	1.24	23.44	23.39	23.39
4000	2.43	2.46	0.98	18.76	18.72	18.71
3000	1.8	1.87	0.73	14.08	14.04	14.04
2000	1.21	1.29	0.49	9.39	9.37	9.37
1000	0.60	0.63	0.24	4.52	4.50	4.50
0	0	0	0	0	0	0

Table 3.3-9. LBO Oven Drive and Power Voltages for V-18 Systems

DAC COUNT	LBO DRIVE (V) (CPU)	LBO DRIVE (V) (MB)	LBO DRIVE (V) (POST DAC)	POWER SIGNAL VOLTAGES (V)		
	MB (TP6, TP8)	MB (TP6, TP10)	MB (TP6, TP1)	SIB (J85 1-2)	HB (J104 1-2)	HB (J105 10-11)
8191	4.92	5.02	2.35	45.2	45.1	45.1
7000	4.27	4.33	2.25	40.1	40.0	40.0
6000	3.66	3.75	1.92	34.4	34.3	34.3
5000	3.05	3.06	1.61	28.6	28.6	28.6
4000	2.43	2.46	1.27	22.9	22.9	22.9
3000	1.8	1.87	0.95	17.2	17.1	17.1
2000	1.21	1.29	0.56	11.5	11.4	11.4
1000	0.60	0.63	0.31	5.7	5.7	5.7
0	0	0	0	0	0	0

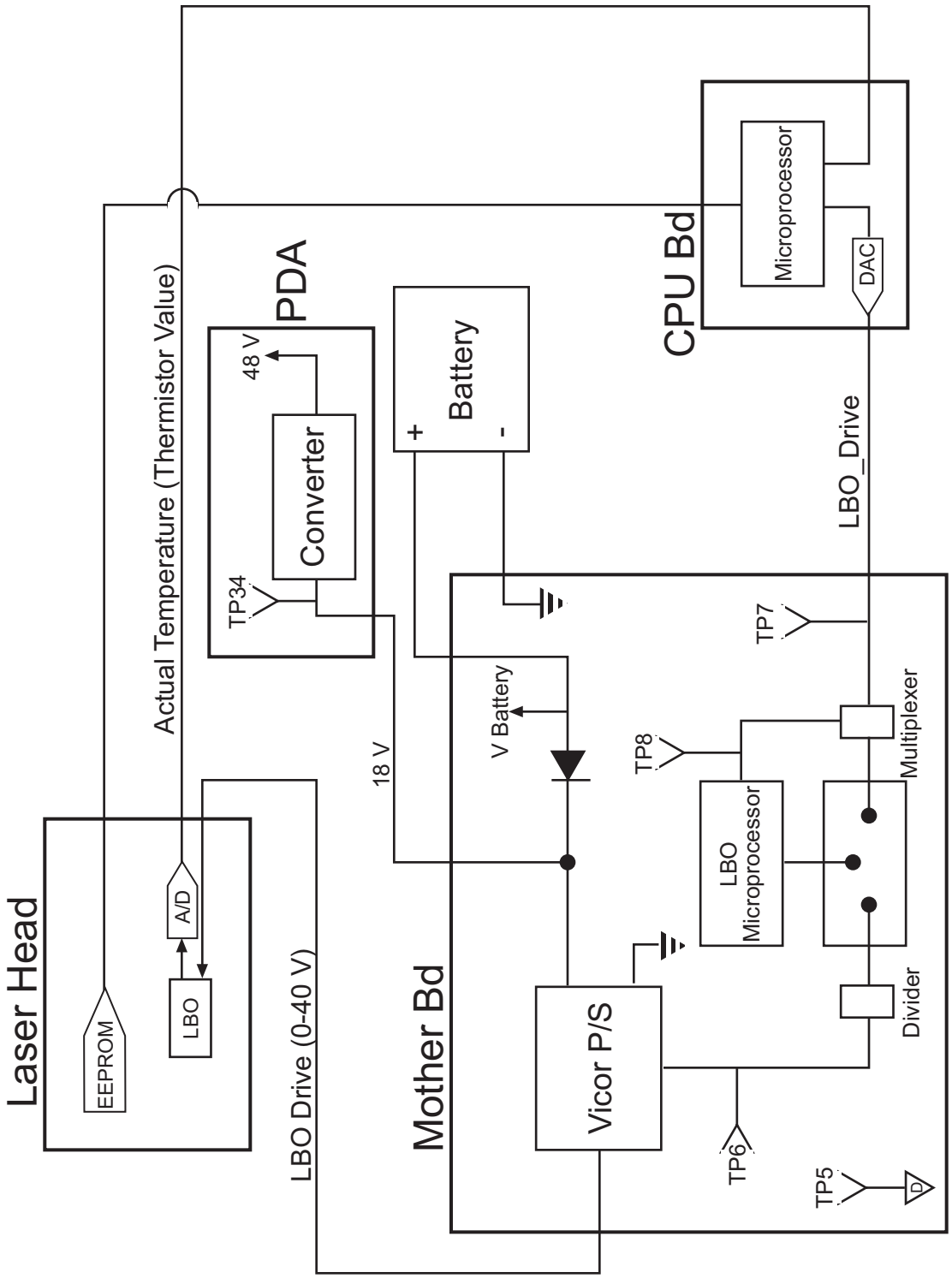


Figure 3.3-5. LBO TEC Block Diagram for V-2 to V-10 Systems

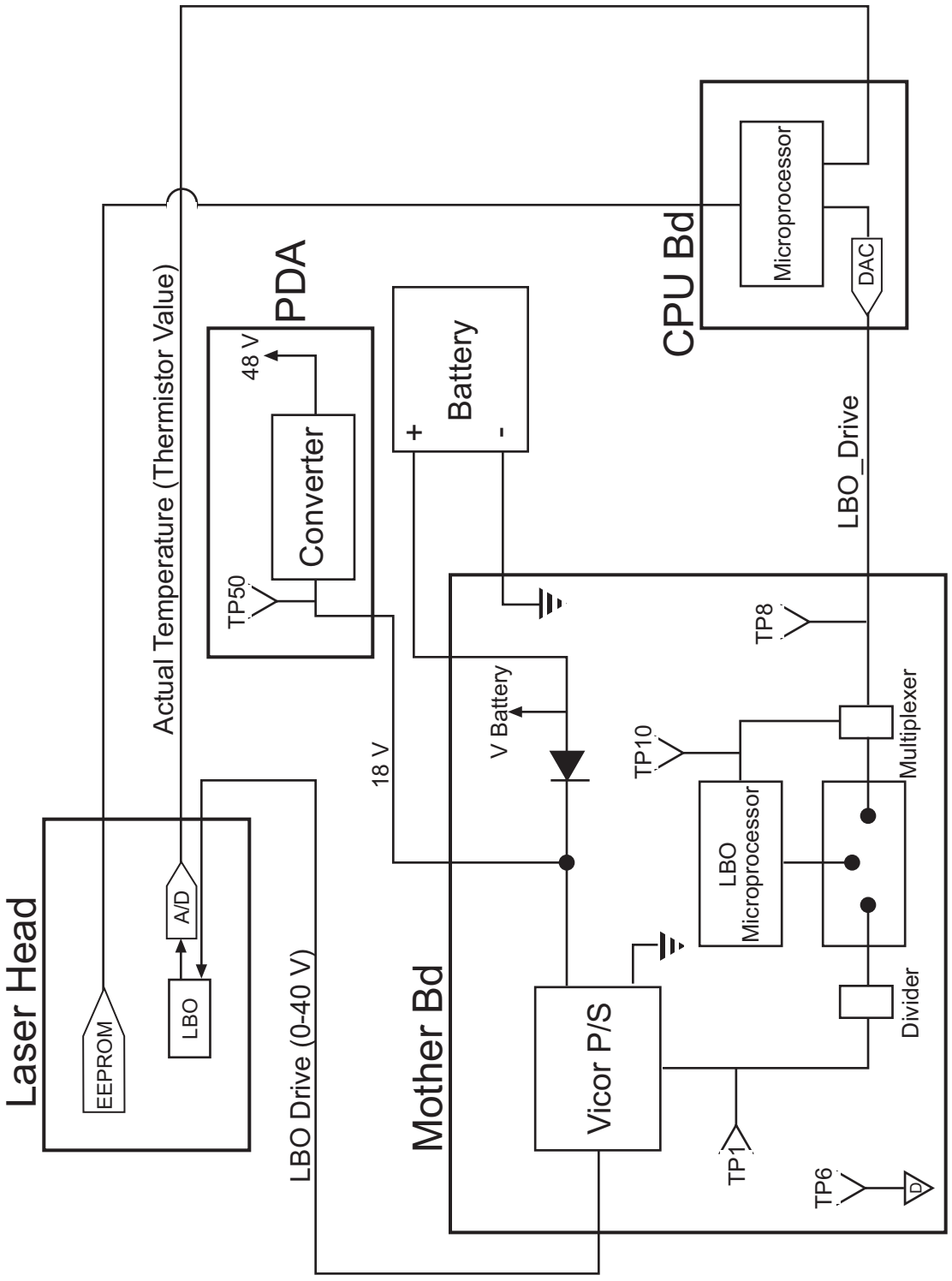


Figure 3.3-6. LBO TEC Block Diagram for V-18 Systems

Introduction

The following presents an overview of the Diode Current Regulation circuit and a description of the hardware light loop. Note that some of the subsection titles also include the signal label, given in parenthesis, as it appears on the schematics.

Power Supply DAC (PS_DAC)

The PS_DAC provides rough control (approximately 97%) of the diode current (fine control is provided by the hardware light loop). This signal ranges from 0 to 5 V, corresponding to 0 to 50 A (0.1 V/1 A). This voltage passes through a comparator circuit where it is summed with the error signal from the green photocell (range of ± 12 V). Note that the V-18 diode drive is 13.75 A/DAC V, therefore 60 A of drive out of 4.3 DAC volts.

Loop Snoop Voltage

The LOOP_SNOOP voltage is a signal that ranges from 0 - 5 V with a center point of 2.2 V. A LOOP_SNOOP voltage of 2.2 V corresponds to a 0 error signal between the desired output power (SDAC) and the actual power (Green Photocell signal). This signal can be read at TP10 on the Display board. Note that a convenient Analog ground connection is not available on the Display board.

Green Photocell Signal

The Green Photocell will have an output voltage that is linearly related to amount of 532 nm radiation being produced by the laser system. When calibrating the photocell, the user is calibrating this linear relation, such that:

Actual Power = (A to D) x (Photocell Calibration Factor)

where:

- **Actual Power** is the power measured on an external meter.
- **A to D** is the digital signal corresponding to the analog voltage on the photocell.
- **Photocell Calibration Factor** is a factor calculated by the Verdi firmware such that future A/D signals can be translated into actual output powers. This output power is displayed in the Servo Status menu.

Serial DAC (SDAC)

This is the serial DAC voltage representing the user desired output power. To regulate/adjust the output power of the system, this voltage is compared to the output voltage of the Green Photocell. The value of the SDAC voltage is calculated from the relation:

SDAC = (Requested Output Power) • (LightLoop Cal. Factor)

This analog signal ranges from 0 to 5 V and is nominally 2.5 V at 5 W.

The Verdi software calculates the LightLoop Calibration Factor during the calibration of the Green Photocell. During the calibration of the photocell, the Requested Output Power is equal to the Actual Output Power and the SDAC voltage can be considered to be correct.

On Startup

The PS_DAC starts at 0 and increases in steps of 0.6 A/second. This signal can be monitored on the Power Distribution board at TP5.

Initially, the Desired Output Power is 5 W or whatever power is asked for on the front panel, and the Actual Output Power is 0 W. As a result, the error signal is large and disables LOOP_SNOOP, because the voltage is greater than 2.6 V.

The upward ramping of the PS_DAC continues until the LOOP_SNOOP voltage is within the range of 1.8 - 2.6 V. Once the LOOP_SNOOP signal is within this range, the Actual Output Power should be close to the Desired Output Power and the PS_DAC voltage is clamped.

The LOOP_SNOOP signal now adds or subtracts current (see Hardware Light Loop explanation below) as necessary to produce a 0 error signal between the Green_Photocell and SDAC comparator.

If the LOOP_SNOOP signal goes out of the 1.8 to 2.6 V range, the PS_DAC is enabled to bring the LOOP_SNOOP signal back into the desired range. The software monitors the LOOP_SNOOP signal to ensure the accuracy of the PS_DAC signal.

Hardware Light Loop

The following key points should be noted about the Hardware Light Loop:

- The Hardware Light Loop is in control of the diode current once the PS_DAC signal is fixed.
- The PS_DAC signal remains fixed as long as the LOOP_SNOOP signal is within 2.2 ± 0.4 V.

The difference between the SDAC and the Green_Photocell signals are sent through a variable gain amplifier, integrator and an error signal is generated (± 12 V range; 0 V equals no error). This error signal is summed with the PS_DAC signal on the Power Distribution board. Note that:

- A positive error signal adds current to PS_DAC.
- A negative error signal subtracts current from PS_DAC.

This results in either an increase or a decrease in the current delivered to the FAP-I assemblies. This voltage signal has the capability of adding ± 2 A on top of the current resulting from the fixed PS_DAC signal and provides the fine control of the diode current.

Diode Current Troubleshooting

The following should be verified if there is no 532 nm output from the Verdi system.

1. Verify that the +5 V is available on the CPU board and in acceptable range (± 10%).
2. Using a current clamp on the cathode (gray) wire, verify that current is reaching the FAP-I.

   If current is being supplied to the FAP-I, use the following procedure:

   a. Verify with a test optical fiber that the FAP-I can produce the power specified in Table 1.3-2 on page 1.3-2 at a value that is within 15% of the rated current for the diode. (The rated current should be listed on the Customer Data Sheet.)

   b. If the FAP-I cannot produce its rated output power (see "Determine Diode Rated Currents" on page 5.5-1), replace the FAP-I.

   If current is not being supplied to the FAP-I:

   a. Check the voltage across Diode1, and Diode2 for two-FAP systems at the Power Distribution board. The voltages should be between 1.5 and 2.2 V. Reference Table 3.4-1 for test point identification.

      If the voltages are good, replace the Noise board and FAP-I assemblies. Also, verify connections between the Power Distribution assembly and Noise board, and between the Noise board and FAP-I assembly.

The power supply may be supplying a limited amount of current to the diodes, therefore continue with the next step to ensure the power supply is providing the requested current amount.

If the voltages are not good, go to the next step.

Table 3.4-1. Test Points for Diode Current

	PDA DIODE 1	PDA DIODE 2
V-2 TO V-10 (TWO FAP)	TP18(-), TP3(+)	TP19(-), TP1(+)
V-2 TO V-6 UNO	TP2(-), TP1(+)	
V-18	E6(-), E5(+)	E7(-), E8(+)

b. Verify Diode1 and Diode2 voltages at the Power Distribution board. The voltage should be 0.1V/A for V-2 to V-10 systems, or 0.13-0.14V/A for V-18 systems. Reference Table 3.4-2 for test point identification.

Table 3.4-2. Test Points for Varying Diode Currents

	PDA DIODE 1	PDA DIODE 2
V-2 TO V-10	TP57(-), TP5(+)	TP57(-), TP6(+)
V-2 TO V-6 UNO	TP21(-), TP39(+)	
V-18	TP18(-), TP19(+)	TP18(-), TP26(+)

c. If the voltages measured in step “b” are inaccurate, replace the CPU and Mother boards, and the Front Panel Display and Power Distribution assemblies.

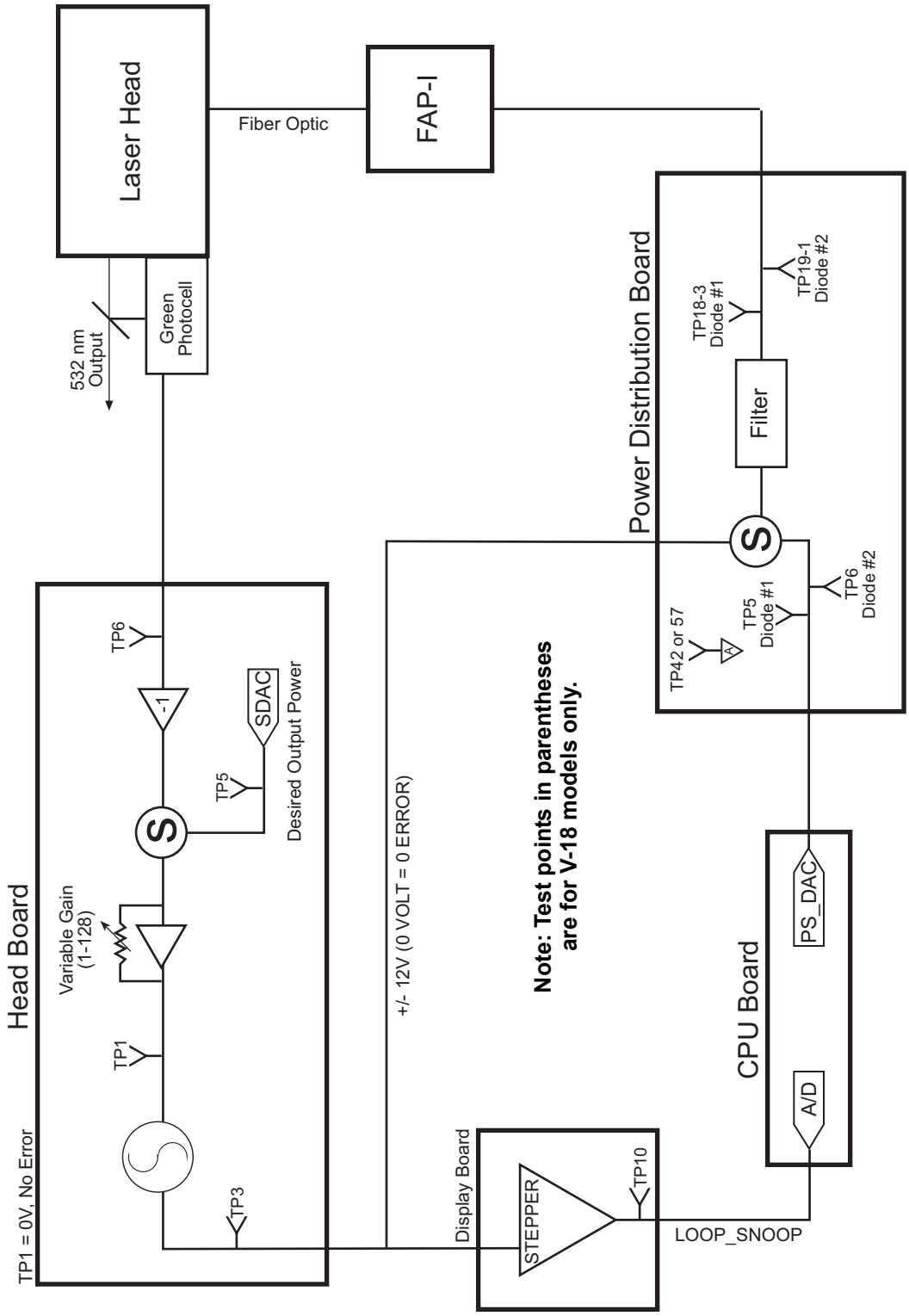


Figure 3.4-1. V-2 to V-10 Diode Current Regulation Circuit

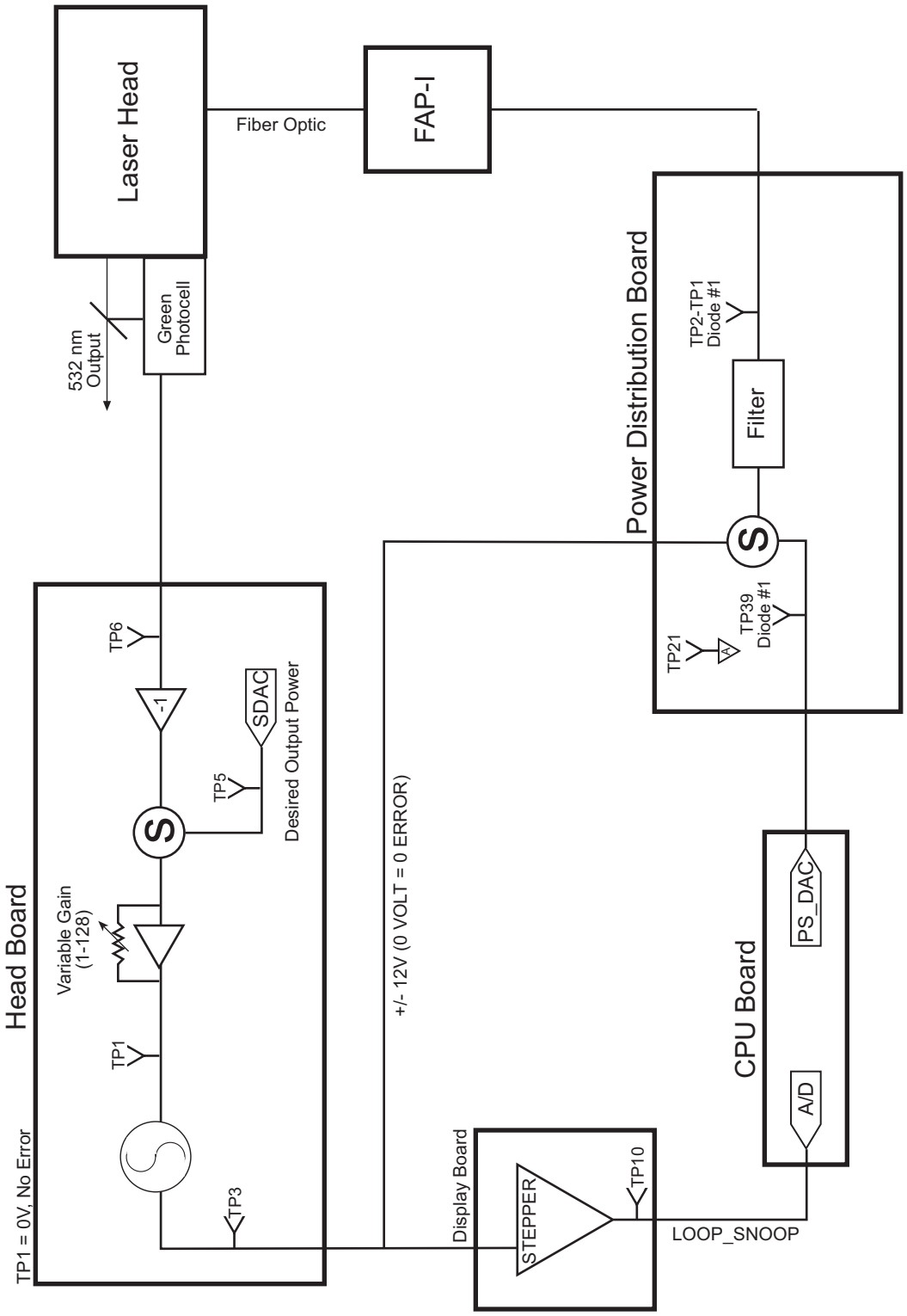


Figure 3.4-2. V-2 to V-6 UNO Diode Current Regulation Circuit

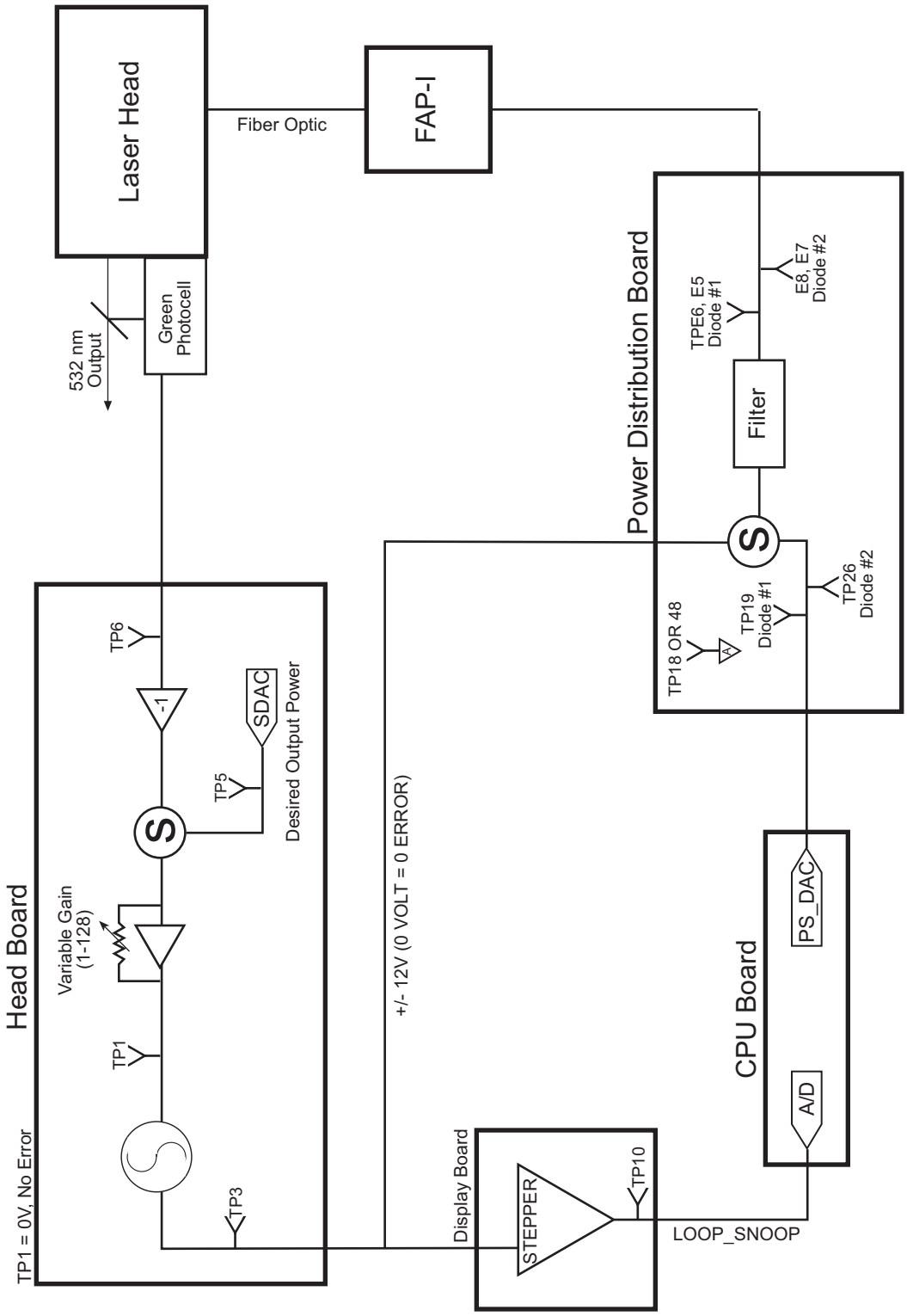


Figure 3.4-3. V-18 Diode Current Regulation Circuit

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Introduction

The following presents an overview of the Verdi noise reduction circuitry. This circuit senses both current and light noise, and attempts to correct for this noise by changing the current through the laser diode.

Definitions

Integrator Signal: Measure of the current delivered from the Power Distribution board to the Laser Diode circuit integrated over 1 msec. This signal measures the low frequency AC noise on the diode current.

Current Sense Signal (I Sense Signal): Measure of the high frequency noise through the system diodes.

Power Signal: Amount of current injected into the circuit. This leads directly to a change in the voltage of the diode cathode, thus changing the overall voltage drop of the circuit. This injected current is pulled from analog ground and pumped into the -2 V supply of the cathode. This essentially changes the current passing through the laser diodes by a small amount.

Circuit Overview

The Power Distribution board (PDB) uses a switching Power Supply (100 kHz) to supply the diodes with the current needed to produce light output. The voltage across the circuit is tightly controlled with a positive (anode) ground. The cathode is held at approximately -2 V. With a constant voltage drop and resistance through the circuit, by Ohm's Law, a constant current must pass through the circuit. Conversely, by slightly changing the voltage drop across the circuit, the current must also change slightly.

Referring to Figure 3.5-1, the first inductor-capacitor (LC) circuit smooths the current pulse train. Prior to this LC circuit a sample of the diode current leaving the PDB is taken and sent through an integrator. This signal is integrated over 1 msec and provides a measure of the average current delivered to the diode. This integrator signal is then summed with an amplified high frequency current sample (I Sense Signal). The summed current passes through a second amplifier, which drives the base of several transistors that inject or remove current from the circuit. This injection or removal of current leads to an increase or decrease in drive current though the diodes, respec-

tively. The net effect is a stabilization of the current passing through the laser diodes, which results in a reduction in the noise on the diode outputs.

Summing of the Integrator and Current Sense Signals

The Integrator and I Sense signals are summed and amplified. The relative weights of these two values are not the same. The Integrator signal is more important than the current sense signal. With no noise on these signals, a small fixed amount of current is injected into the circuit as shown by power signal 1 maintaining a constant voltage drop between the anode and the cathode.

The current for power signal 1 is provided by analog ground. If noise exists on these two signals, additional current is added or subtracted (controlled by a transistor), effectively changing the absolute voltage of the cathode. The absolute voltage leads to a change in the overall voltage drop of the circuit. The change in voltage drop across the circuit leads to a change in the amount of current passing through the laser diode, which minimizes current noise.

Light Loop

The GREEN_PC_LOOP signal can also inject or subtract current via Power Signal 2, which changes the voltage drop across the anode and cathode, and again changes the current passing through the laser diode. These circuit changes minimize laser light noise.

The GREEN_PC_LOOP signal is an AC signal (< 50kHz) and the amount of current injected or removed is based on the amplitude and sign of the AC signal.

Troubleshooting

The following should be verified if the Verdi 532 nm output is found to be unstable and/or noisy.

1. Verify that the +5 V is available on the CPU board and in acceptable range (± 10%).
2. Verify that all temperatures remain stable once the system has reached equilibrium at maximum power.

   If all temperatures remain stable, check the value of TP6 on the Head board. If the observed value is found to be unstable, the head will have to be changed due to a problem with the Photo-cell.

3. If the voltage at TP6 is stable, check TP1.

   If TP1 is unstable, lower the gain in the Verdi LightLoop Test menu.

   Nominal gain values are 8 or 16, but this may need to be lowered if the voltage at TP1 oscillates.

   If reducing the gain does not eliminate the instabilities, change the Head board. If replacing the Head board does not correct the instability, the problem is optical and the entire head must be replaced.

It should be noted that customer complaints of noise are very difficult to define. Important questions to ask are:

1. How are you measuring the noise?
2. At what frequency is the noise?

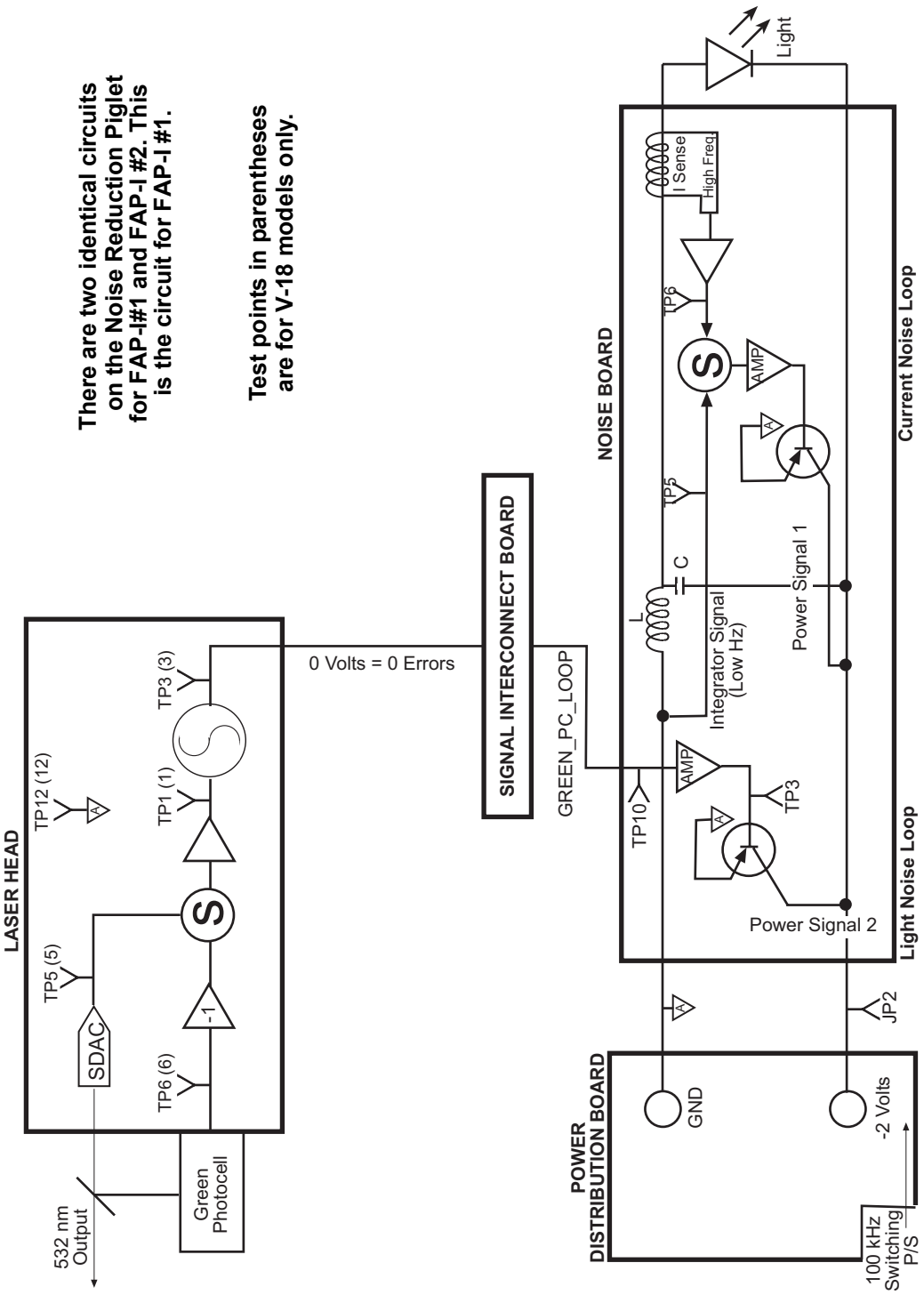


Figure 3.5-1. Noise Reduction Circuit

Introduction

The following service menus were released with Revision "C" (v-5.03) Verdi software. Figure 4.1-1 lists all available menus when the CPU is configured for Service mode.

The submenu "line item arrow" points to the currently active command line. The arrow is scrolled using the MENU UP and MENU DOWN arrow keys located on the power supply front panel. Unless otherwise noted in the menu, all menus can be left without making changes by pressing the MENU EXIT pushbutton on the power supply front panel.

```
5 Watt-Service Base Menu
---> Servo Status
                Laser Status
                FAULT Status
                TemPerature Set Points
               LBO Settings
                LBO Optimization
               Diode Optimization
               LBO TemP Servo
                Vanadate TemP Servo
                … Etalon TemP Servo
                    Etalon Capture
                    Diode 1 TemP Servo
                    Diode 2 TemP Servo
                    Set Diode Current Delta
                    Light/Current Control
                    Thermistor Check
                    Calibrate Photocell
                    Calibrate Diode I & V
                    Lightloop Test
                    Power Supply Setup
                    Laser Head Setup
                    RS 232 Baudrate SetuP
                    EEPROM Diagnostics
                    Speaker Volume
     Diode Parameters
```

Figure 4.1-1. Service Base Menus

Servo Status Screen

Servo:	State	W/Deg C	Drive
Laser:	seek	0.02	0
LBO:	lock	145.21	6584
Vanadate:	lock	35.00	1189
Vanadate2:	lock	35.00	1189
Diode1:	lock	25.17	220
Diode2:	lock	25.00	110

Servo Status Screen: Displays the status of the temperature servo loops and output power. The servo state can be 'open', 'seek', 'lock' or '*seek'.

The servo drive range between 0 to 60,000 for the Laser; 0 to 8191 for the LBO; and ± 8191 for the Vanadate, Etalon and Diodes.

Laser Status Screen

S/W Version:	5.03		
Heatsink #1 T:	21.73 C		
Heatsink #2 T:	22.85 C		
Head	Hrs:	273.55	
DIODE # 1	Hrs:	525.88,	I: 20.50
DIODE # 2	Hrs:	291.64,	I: 21.20

Laser Status: Displays the Software Version, Heatsink Temperatures, Diode and System hours and Diode currents.

The diode current in this menu is an accurate measure of the diode current.

FAULT Status Screen

SYSTEM OK!

Fault Status: If a fault is active, this display provides the status and details of the fault.

TemPerature Set Points

Set Pt:	145.20	Drive:	6601.1
Read T:	145.21	Status:	lock
Set Pwr:	4.00W	Avg I:	0.00A

---> LBO TemPerature

Vanadate TemPerature

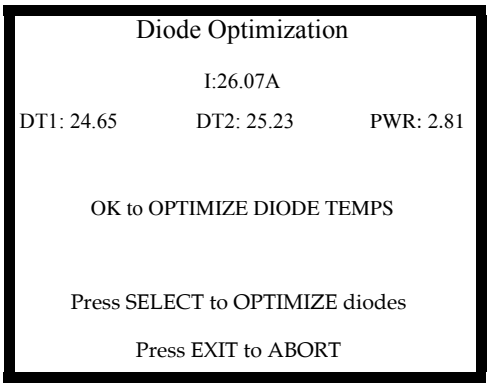
Vanadate 2 TemPerature

Etalon TemPerature

Diode #1 TemPerature

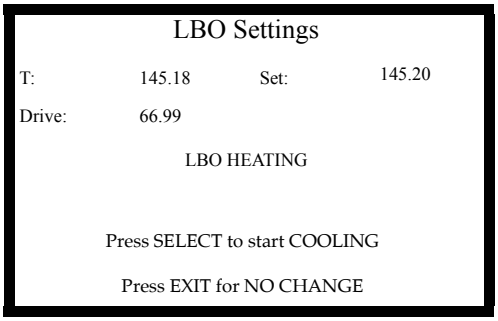
Diode #2 TemPerature

Temperature Set Points: Displays information about the individual temperature servo. When in this menu, the set temperature of the specified servo can be changed via the control knob on the front panel (service menus only).

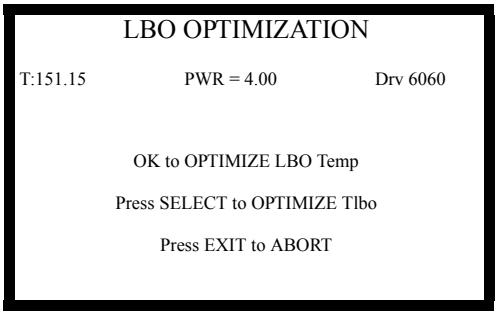


This menu is used to initiate Diode optimization. See Operator's Manual for more information.

Note that this is only available for V-18 models.

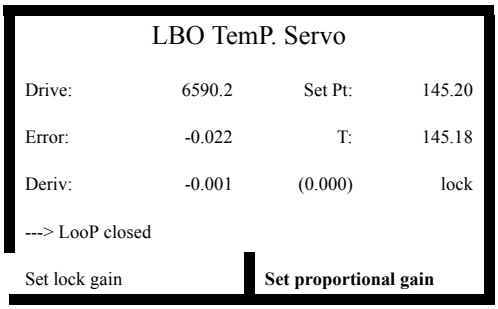


LBO Settings: Menu used to initiate LBO heating or cooling.



LBO Optimization: The LBO temperature can be optimized from this menu. This optimization should be run if the diode current has increased by greater than 10 % from initial shipment values.

Laser must be in Light Loop with all temperature servos locked to run this optimization. Run time can take up to 4 hours.



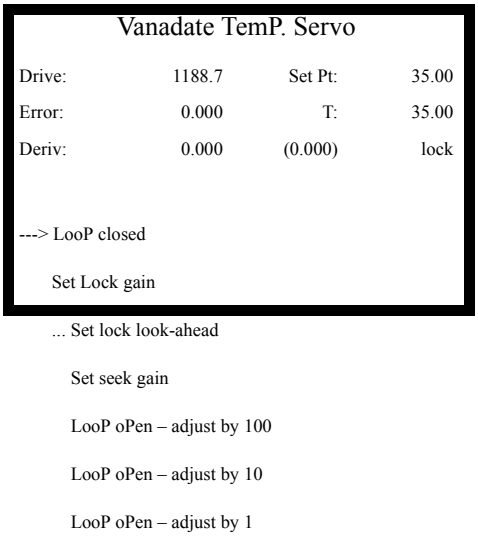
LBO Temperature Servo: Displays information about the LBO Temperature Servo. Set temperature can be adjusted via the control knob on the front panel in this menu (Service menus only).

Menu is used to open the LBO Temperature Servo and manually adjust the drive value.

Open loop is used for troubleshooting purposes.

Bold information text in the menu to the left indicate options on software version 8.83 only.

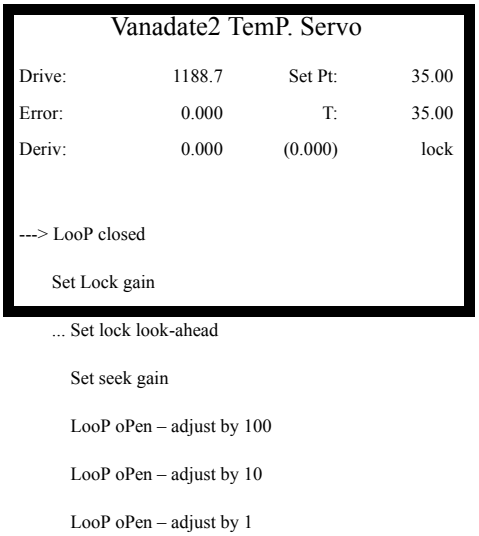
See FSB#460 for more information, including new gain values for software version 8.83.



Vanadate Temperature Servo: Displays information about the Vanadate Temperature Servo. Set temperature can be adjusted via the control knob on the front panel in this menu (Service menus only).

Menu used to open the Vanadate Temperature Servo and manually adjust the drive value.

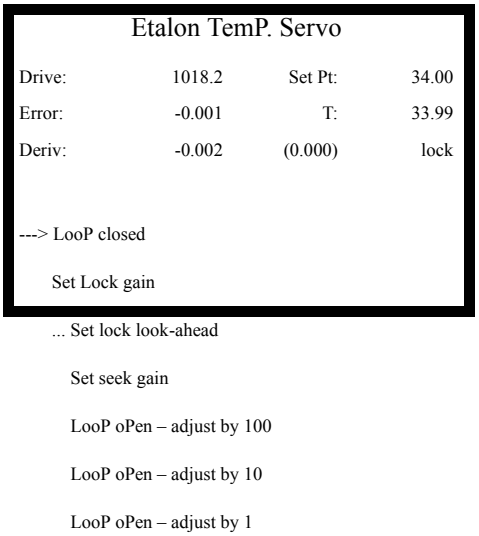
Open loop is used for troubleshooting purposes.



Vanadate2 Temperature Servo (V-18 Only): Displays information about the Vanadate2 Temperature Servo. Set temperature can be adjusted via the control knob on the front panel in this menu (Service menus only).

Menu used to open the Vanadate2 Temperature Servo and manually adjust the drive value.

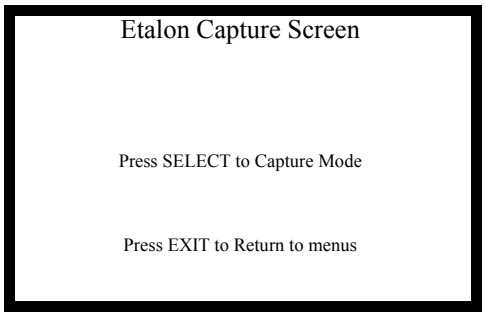
Open loop is used for troubleshooting purposes.



Etalon Temperature Servo: Displays information about the Etalon Temperature Servo. Set temperature can be adjusted via the control knob on the front panel in this menu (Service menus only).

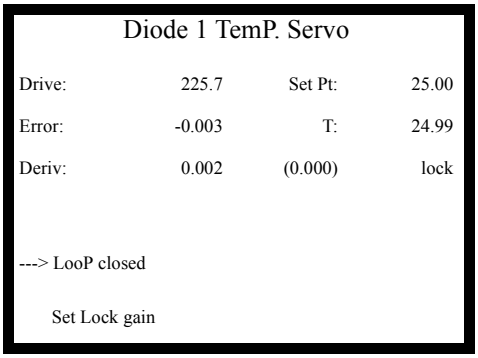
Menu used to open the Etalon Temperature Servo and manually adjust the drive value.

Open loop is used for troubleshooting purposes.



Etalon Capture Screen: This menu is used to "recenter" the etalon, maximizing output power. Functionally, this should be used after large changes in operating parameters. After large changes in the operating parameters the longitudinal mode that experiences the highest gain may have shifted and no longer correspond to the maximum transmission of the etalon.

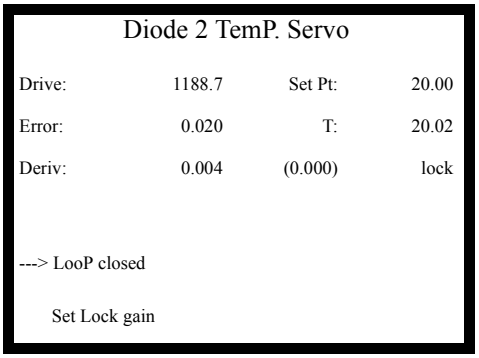
When the Capture Mode is activated the diode current is temporarily dropped to below the 532 nm lasing threshold and then returns to the previous diode current. This allows the highest gain mode in the cavity to reestablish itself.



Diode 1 Temperature Servo: Displays information about the Diode 1 Temperature Servo. Set temperature can be adjusted via the control knob on the front panel in this menu (Service menus only).

Menu used to open the Diode 1 Temperature Servo and manually adjust the drive value.

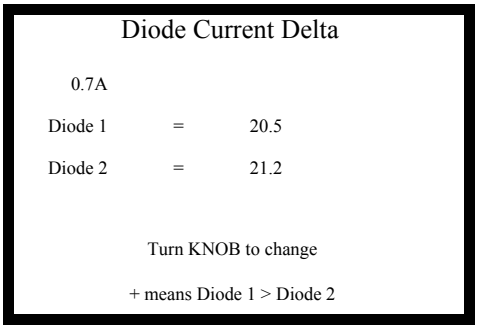
Open loop is used for troubleshooting purposes.



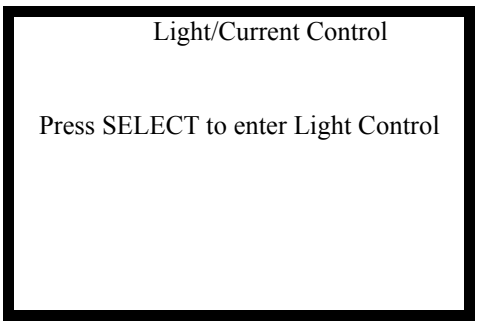
Diode 2 Temperature Servo: Displays information about the Diode 2 Temperature Servo. Set temperature can be adjusted via the control knob on the front panel in this menu (Service menus only).

Menu used to open the Diode 2 Temperature Servo and manually adjust the drive value.

Open loop is used for troubleshooting purposes.



Set Diode Current Delta: Allows the current delta for the two FAP-I assemblies to be set. See the FAP-I replacement procedure for complete information on this procedure.



Light/Current Control: Allows the user to Light or Current Control.

Thermistor Check

13753 ohms 17.93 degrees

DAC = 430 Offset = 0 A/D = 1825

Ret 404

Vanadate

Vanadate2

LBO

Etalon

Diode1

Heatsink1

Diode2

Heatsink2

Thermistor Check: Displays measured temperatures for all thermistors.

Power Calibration

A/D = 3 (2000 100), P = 0.00W

SDAC = 2.50V, LIGHT CAL = 0.25

m = X.XXXXXXXX b = X.XXXXXX L V E D1 D2

SELECT Accepts PT# 1 (Iset, Pset)

Iset = X.XXXA Pset = (X.XXW)

PC Cal Pt#1 (@ X.XXW)

PC Cal Pt# 2 (@0.10W)

Power Calibration: Allows the user to calibrate the Green Photocell with two-point accuracy.
Note: Calibration screen may be for one or two points, depending on the version of the software.

Calibrate Diode I & V

D#1 2.914 = 0.0137 IRead + 2.90

Use knob to set Imegs = 12.0

Push SELECT to accept data point

Set Current: 0.00 Amps

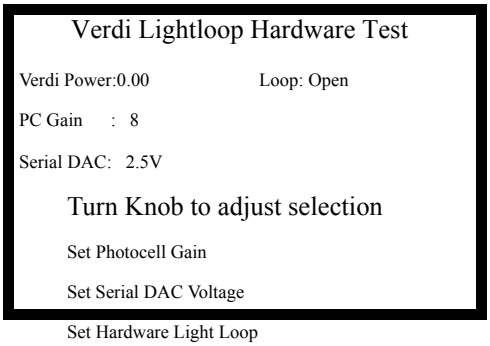
D#1 I Cal PT#1 (@2.00 A)

D#1 V Cal (@19 A)

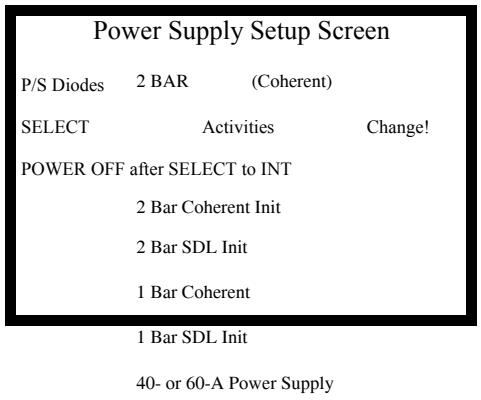
D#2 Cal PT#1 (@2.00 A)

D#2 V Cal (@19 A)

Calibrate Diode I & V: Allows the calibration of current and voltage supplied to the FAP-I assemblies.



Verdi LightLoop Hardware Test: Displays information and allows changes to the photocell gain, serial DAC voltage, and Light Loop setup.

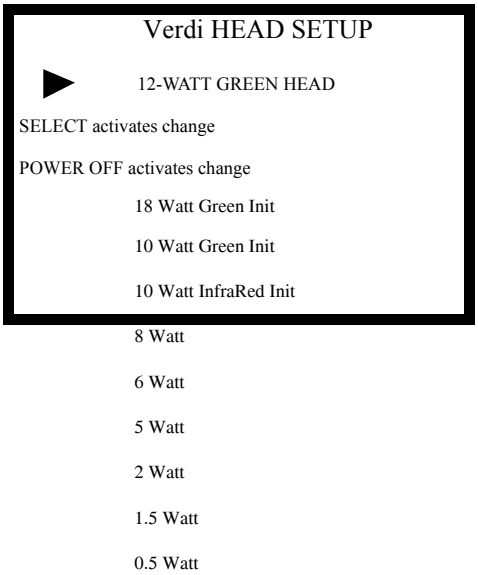


Power Supply Setup: Allows the user to select the diode-type assembly. The selected initialization should only be 1 or 2 bar Coherent, for 1 or 2 FAP Verdi systems.

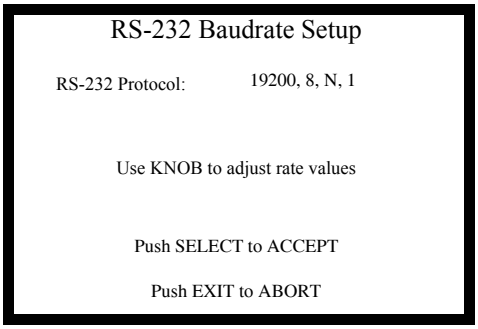
Note: The 8.83 software asks whether the power supply is 40-A or 60-A when it is first turned on after the install. A change from 40 to 60 should only be necessary for a few V-18 models with finned Vicors. Both FAP-I will then need a voltage and current recalibration (see directions below for V-18 FAP-I voltage and current calibration). See FSB#460 for more information.

The software now distinguishes between the power supplies of the V-18 and lower power Verdi in order to have meaningful drive levels:

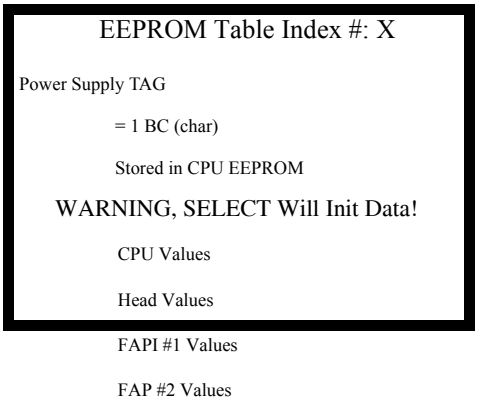
- V-18 with finned Vicors on the PDB have a 60-Amp-per-channel power supply
- V-18 without finned Vicors have a 40-Amp-per-channel power supply
- All lower-power Verdis have a 40-Amp power supply



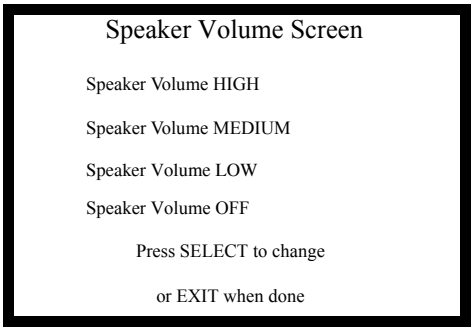
Laser Head Setup: Allows the user to select the Verdi head-type.



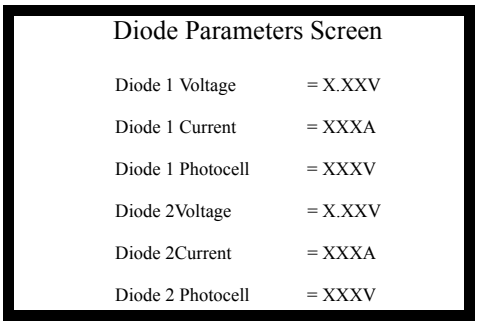
RS-232 Baudrate Setup: Allows adjustment of the baud rate. (factory set to 19, 200) for RS-232 communication.



EEPROM Diagnostics: Allows the user to view and change gain values to the CPU, Head, and FAP assemblies. Extreme caution should be used.



Speaker Volume: Allows the user to control the speaker Volume



Diode Parameters: Displays diode voltage, current, and photocell values for the diode. The diode photocell voltage should be approximately 2.50 V at the maximum-output power-level.

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Introduction

The following presents information required to connect the laser system power supply via RS-232. The connection procedure uses the Windows program, HyperTerminal™. It is assumed that the engineer has read and is comfortable with the RS-232/Software section of the Verdi Operator's Manual.

The type of serial cable required for RS-232 communications can be determined from the part number of the Signal Interconnect board.

P/N 0172-369-00 and 1059124 (both SIBs) require the straight cable (DCE).
P/N 0170-585-00 requires the crossed cable (DTE).

If there is no modem connected or installed in the computer system, Windows may inquire whether you want to install a modem the first time you launch the HyperTerminal program. If this occurs, dismiss the query window by clicking on the "Cancel" button.

Establishing Connection

The HyperTerminal program can be launched using the following procedure.

1. Single click on the Windows Start button and scroll up to "Programs" to activate its pop-up menu.
2. From the Programs menu scroll up to "Accessories" to activate its pop-up menu.
3. Single click on the HyperTerminal folder.
4. From the resulting folder window, select the HyperTerminal program, Hypertrm.exe, by double-clicking on the program icon.

If the program has launched properly, the window shown in Figure 4.2-1 should be displayed. If this is the first time a Verdi connection is to be made, continue with the section titled “First Time Connection Configuration”. If a connection has been made previously, proceed with the section titled “Loading a Connection File”.

Figure 4.2-1. Initial HyperTerminal Window

Loading a Connection File

1. Dismiss the connection description dialog box by clicking on the “cancel” button.
2. From the File menu, select “Open”. From the Open dialog box, select the Verdi communications file by double clicking on it.
3. Press the return key on the keyboard to establish connection. At this point, the Verdi prompt (see Figure 4.2-6), should be displayed in the main window of HyperTerminal program.

First Time Connection Configuration

1. In the connection description dialog box, type the file name "Verdi" and click on the "OK" button.
2. The next step will depend on whether a modem is connected to the computer system being used.
   a. If a modem is installed in (or connected to) the computer, the dialog box illustrated in Figure 4.2-2 will be displayed. Dismiss this window by clicking on Cancel button.

      From the HyperTerminal file menu, select "Properties" to display the dialog box given in Figure 4.2-3.

   b. If the computer is not connected to a modem, the properties dialog box should be displayed, as shown in Figure 4.2-3.

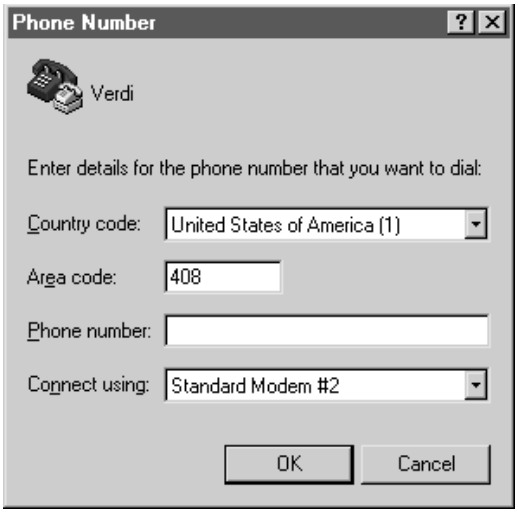

Figure 4.2-2. HyperTerminal Phone Number Dialog Box

3. Configure the "Properties" dialog box as illustrated in Figure 4.2-3, and then click on the "Configure..." button.
4. Set up the communication port as illustrated in Figure 4.2-4 and click on the "OK" button.
5. Click the Settings tab of the properties window, and then click on the ASCII Setup button. Configure the ASCII Setup window as illustrated in Figure 4.2-5 and click on the OK button.

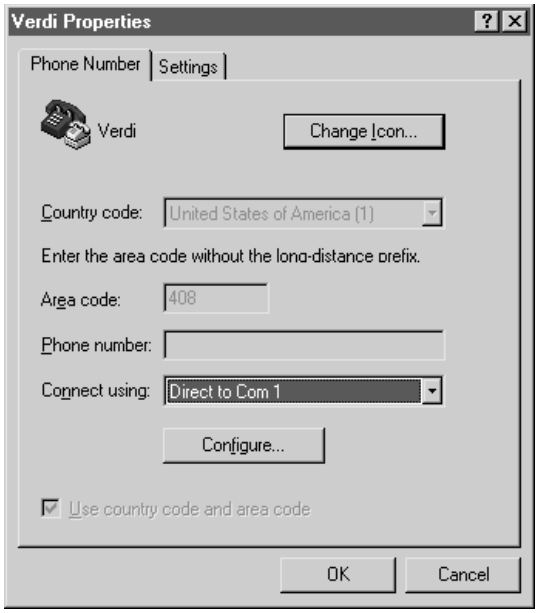

Figure 4.2-3. HyperTerminal Properties Dialog Box

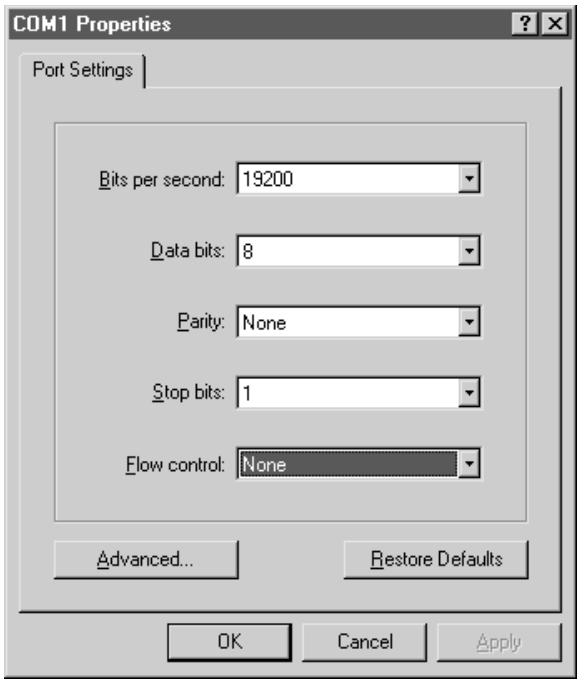

Figure 4.2-4. HyperTerminal Communications Port Dialog Box

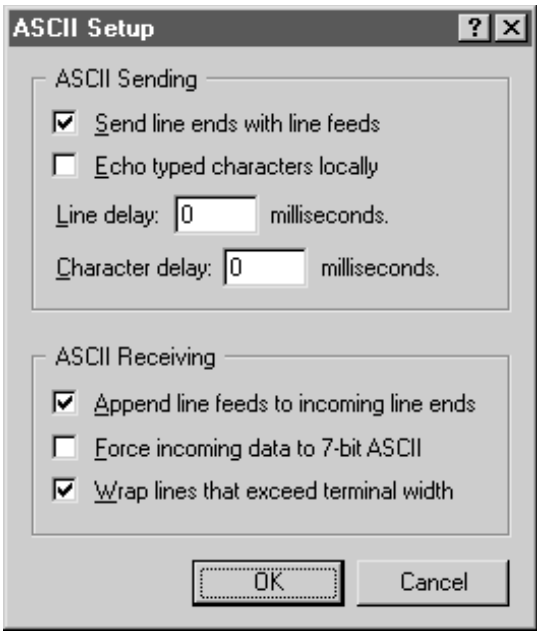

Figure 4.2-5. HyperTerminal ASCII Setup Dialog Box

6. Close the properties window by clicking on the “OK” button.
7. Press the return key on the keyboard to establish connection. At this point, the Verdi should be seen in the main window of HyperTerminal (see Figure 4.2-6).

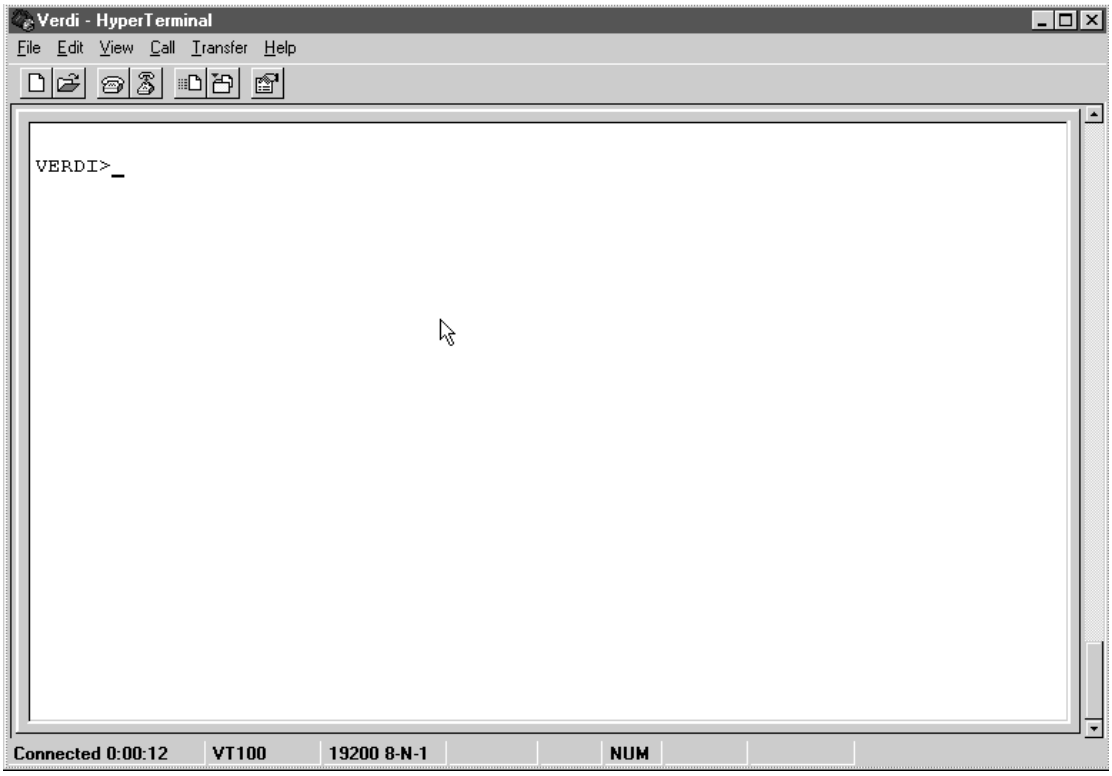

Figure 4.2-6. HyperTerminal Main Window Illustrating Verdi Prompt

Introduction

The following presents the Verdi service RS-232 commands and queries. It is assumed that the engineer has read, and is comfortable with, the RS-232/Software section of the Verdi Operator's Manual.

The type of serial cable required, straight through or crossed, for RS-232 communications can be determined from the part number of the Signal Interconnect board.

Part #0170-585-00 requires the crossed cable (DTE).
Part #0172-369-00, 1059124, or others require the straight cable (DCE).

It is important to inform the customer of the type of RS-232 cable required for the laser system.

Table 4.3-1. Verdi Service RS-232 Commands

COMMAND	ACTION
`CAL DIODE1 CURRENT POINT1=nn.nn` `CD1CP1=nn.nn`	Calibrates the 12 A current point for laser diode #1 to nn.nn amps.
`CAL DIODE1 CURRENT POINT2=nn.nn` `CD1CP2=nn.nn`	Calibrates the 19 A current point for laser diode #1 to nn.nn amps.
`CAL DIODE2 CURRENT POINT1=nn.nn` `CD2CP1=nn.nn`	Calibrates the 12 A current point for laser diode #2 to nn.nn amps.
`CAL DIODE2 CURRENT POINT2=nn.nn` `CD2CP2=nn.nn`	Calibrates the 19 A current point for laser diode #2 to nn.nn amps.
`CALIBRATE DIODE1 VOLTAGE=n.nn` `CD1V=n.nn`	Calibrates the voltage (at 20 A) for laser diode #1 to n.nn volts.
`CALIBRATE DIODE2 VOLTAGE=n.nn` `CD2V=n.nn`	Calibrates the voltage (at 20 A) for laser diode #2 to n.nn volts.

Table 4.3-1. Verdi Service RS-232 Commands (Continued)

COMMAND	ACTION
CALIBRATE PHOTOCELL=nn.nn CP=nn.nn	Calibrates the photocell to specific value, obtained from external meter.
CHILLER	=ON, =XX.X, = OFF
CURRENT=nn.nn C=nn.nn	Sets to current regulation at the specified average diode current.
CURRENT DELTA=n.n CD=n.n	Sets the diode current delta to specified value to n.n.
DIODE1 ACTUAL WAVELENGTH=nnn.nn D1AW=nnnn	Sets the actual wavelength of diode #1 to nnn.nn nanometers. The diode operating temperature is calculated from this value.
DIODE1 DRIVE=nnnn D1D=nnnn	Opens diode #1 temperature servo and set the drive setting to nnnn.
DIODE1 RATED CURRENT=nn.nn D1RC=nn.nn	Sets diode #1 rated current to nn.nn amps.
DIODE1 RATED CURRENT FACTOR=nn.nn D1RCF=nn.nn	Sets diode #1 rated current factor (aging factor) to nn.nn.
DIODE1 TEMP=nn.nn D1T=nn.nn	Sets diode #1 temperature to specified value, nn.nn.
DIODE2 ACTUAL WAVELENGTH=nnn.nn D2AW=nnn.nn	Sets the actual wavelength of diode #2 to nnn.nn nanometers. The diode operating temperature is calculated from this value.
DIODE2 DRIVE=nnnn D2D=nnnn	Opens diode #2 temperature servo and set the drive setting to nnnn.
DIODE2 RATED CURRENT=nn.nn D2RC=nn.nn	Sets diode #2 rated current to nn.nn amps.
DIODE2 RATED CURRENT FACTOR=nn.nn D2RCF=nn.nn	Sets diode #2 rated current factor (aging factor) to nn.nn.
DIODE2 TEMP=nn.nn D2T=nn.nn	Sets diode #2 temperature to specified value, nn.nn.

Table 4.3-1. Verdi Service RS-232 Commands (Continued)

COMMAND	ACTION
ECHO=n E=n	n = 0 turns echo off. Characters transmitted to the laser will not be echoed. n = 1 turns echo on. Characters transmitted to the laser will be echoed. A change in echo mode will take effect with the first command sent after the echo command.
EEPROM:mm=nn EE:mm=nn	Writes byte nn to EEPROM at address mm.  **This command should be used with extreme care.**
ETALON DRIVE=nnnn ED=nnnn	Opens the etalon temperature servo and sets the drive setting to nnnn.
ETALON TEMP=nn.nn ET=nn.nn	Sets the Etalon temperature to a specified value, nn.nn.
LBO DRIVE=nnnn LBOD=nnnn	Opens the LBO temperature servo and sets the drive setting to nnnn.
LBO FAULT=n	N = 0: disables LBO not at temp fault. N = 1: enables LBO not at temp fault. Default sets to "1" upon CPU reset.
LBO TEMP=nn.nn LBOT=nn.nn	Sets LBO temperature to specified value, nn.nn.
LR GAIN=n LRG=n	Sets the light regulation gain (G = 2(n-1))
LR SWITCH=n LRS=n	Sets the light regulation loop switch. 0 = open; 1 = closed
LR DAC=n.nn LRD=n.nn	Sets the light regulation DAC voltage to n.nn.
NOMINAL WAVELENGTH=nnn.nn NW=nnnn	Sets the nominal wavelength for the Verdi to nnn.nn nanometers.
PROMPT=n >=n	If n = 0 turns "Verdi>" prompt off. If n = 1 turns "Verdi>" prompt on.

Table 4.3-1. Verdi Service RS-232 Commands (Continued)

COMMAND	ACTION
`VANADATE DRIVE=nnn` `VD=nnn`	Opens the Vanadate temperature servo and sets the drive setting to nnn.
`VANADATE2 DRIVE=nnn` `V2D=nnn`	Opens the Vanadate2 temperature servo and sets the drive setting to nnn.
`VANADATE TEMP=nn.nn` `VT=nn.nn`	Sets the vanadate temperature to the specified value, nn.nn.
`VANADATE2 TEMP=nn.nn` `V2T=nn.nn`	Sets the vanadate2 temperature to the specified value, nn.nn.

Table 4.3-2. Verdi Service RS-232 Queries

QUERY	ACTION
?BAT VOLTS ?BV	Displays the voltage of the Backup Battery, nn.nn volts.
?DIODE1 ACTUAL WAVELENGTH ?D1AW	Displays the actual wavelength of diode #1, nnn.nn nanometers.
?DIODE1 CURRENT DRIVE ?D1CD	Displays the current drive to diode #1.
?DIODE1 RATED CURRENT ?D1RC	Displays diode #1 rated current, nn.nn amps.
?DIODE1 RATED CURRENT FACTOR ?D1RCF	Displays diode #1 rated current factor, n.n.
?DIODE1 RATED CURRENT MAXIMUM ?D1RCM	Displays diode #1 rated current maximum, nn.nn.
?DIODE1 VOLTAGE ?D1V	Displays the voltage drop across diode #1, n.nn volts.
?DIODE2 ACTUAL WAVELENGTH ?D2AW	Displays the actual wavelength of diode #2, nnn.nn nanometers.
?DIODE2 CURRENT DRIVE ?D2CD	Displays the current drive to diode #2.
?DIODE2 RATED CURRENT ?D2RC	Displays diode #2 rated current, nn.nn amps.
?DIODE2 RATED CURRENT FACTOR ?D2RCF	Displays diode #2 rated current factor, n.n.
?DIODE2 RATED CURRENT MAXIMUM ?D2RCM	Displays diode #2 rated current maximum, nn.nn.
?DIODE2 VOLTAGE ?D2V	Displays the voltage drop across diode #2, n.nn volts.
?CURRENT DELTA ?CD	Displays the diode current delta.
?EEPROMmm ?EEmm	Displays the byte value stored in EEPROM address mm.

Table 4.3-2. Verdi Service RS-232 Queries (Continued)

QUERY	ACTION
?HEAD ID ?HI	Displays the laser head initialization state. V-5G = 5-Watt Head V-2G = 2-Watt Head
?LAMBDA CURRENT ?LC	Returns the current from the Lambda power supply. **Note: This query is only available for v 5.03 or higher and will not apply to the Pioneer Magnetics supply.**
?LBO IN CONTROL ?LBOC	Returns the microprocessor in control of the LBO temperature servo. 1 = CPU micro in control 0 = LBO micro in control
?LBO OPTIMIZER POWER DATA ?LOPD	Returns the string of output powers obtained in the LBO optimization routine. Powers correspond to temperatures given by the lbo optimizer temperature data command.
?LBO OPTIMIZER TEMP DATA ?LOTD	Returns the string of temperatures used in the LBO Optimization routine. Temperatures correspond to output powers given by the LBO optimizer power data command.
?LIGHT LOOP CAL ?LLC	Returns the light loop calibration value. SDAC = Desired output power x LLC
?LIGHT REG DAC SETPOINT ?LRDS	Displays the light regulation DAC set point.
?LIGHT REG GAIN ?LRG	Displays the light regulation gain value.
?LOOP_SNOOP ?LS	Returns the value of the loop snoop voltage signal.
?NOMINAL WAVELENGTH ?NW	Displays the nominal wavelength of the system, nn.nn nanometers. Value should be 808 nm.
?PHOTOCELL CAL ?PCC	Returns the photocell calibration value. Actual Output Power = A/D x PCELL CAL
?POWER SUPPLY ID ?PI	Displays laser head initialization state. 2BC = 2 Bar Coherent; 2BSDL = 2 Bar SDL 1BC = 1 Bar Coherent; 1BSDL = 1 Bar SDL

Table 4.3-2. Verdi Service RS-232 Queries (Continued)

QUERY	ACTION
?SERVICE SWITCH ?SS	Displays the state of the base menus. 0 = Service menus 1 = Customer menus
?SET CURRENT ?SC	Displays the set current in Current mode.
?SYSTEM ID ?SI	Displays system identification. V-5G = 5-Watt System V-2G = 2-Watt System
?THERMISTOR REF ?TR	Displays the thermistor reference voltage for the diodes and heatsinks. Should normally be 2.5 V.
?THERMISTOR REF HEAD ?TRH	Displays the thermistor reference voltage for the Vanadate, etalon and LBO. Should normally be 5.0 V.

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Complete this data sheet before and after proceeding with any Verdi service task. All of the required data is available in the front panel menus, otherwise the RS-232 query is listed in parenthesis.

Introduction

Different models of the Verdi product family are specified to run at different parameters. Table 5.1-1 details the parameters that different models should be operated at when verifying operation.

Table 5.1-1. Verdi FAP & Power Specifications

MODEL	SPECIFIED POWER (W)	FAP-I POWER (W)	TYPICAL FAP CURRENT (A)
V-2	2W	10W	15A to 21A
V-5	5W	10W	15A to 21A
V-5 Uno	5W	18W	26A to 32A
V-6	6W	20W	28A to 34A
V-8	8W	18W	19A to 26A
V-10	10W	18W	19A to 26A
V-18	18W	35W	41A to 51A

Table 5.1-2. Laser Parameters

PARAMETER	MENU	VALUE BEFORE SERVICE	VALUE FOLLOWING SERVICE
Software Version	Laser Status Screen		
Maximum Laser Power	Main Display	Watts	Watts
Diode Current at Maximum Laser Power Diode 1 Diode 2 (if required)	Laser Status Screen	 Amps Amps	 Amps Amps
SHG Temperature	Temperature Set Points	°C	°C
Diode 1 Temperature	Temperature Set Points	°C	°C
Diode 2 Temperature	Temperature Set Points	°C	°C
Vanadate Temperature	Temperature Set Points	°C	°C
Vanadate2 Temperature	Temperature Set Points	°C	°C
Etalon Temperature	Temperature Set Points	°C	°C
Base Plate Temperature	Laser Status Screen	°C	°C
Diode 1 Hours	Laser Status Screen	hours	hours
Diode 2 Hours	Laser Status Screen	hours	hours
Head Hours	Laser Status Screen	hours	hours
D1 Irated	RS-232 (?D1RC)	Amps	Amps
D2 Irated	RS-232 (?D2RC)	Amps	Amps
D1 Irated Maximum	RS-232 (?D1RCM)	Amps	Amps
D2 Irated Maximum	RS-232 (?D2RCM)	Amps	Amps

Introduction

When optimizing for maximum output power of the laser, set the laser to Current mode (Service Mode) and perform the following procedures in order:

1. Set the laser to current mode and check the system for rollover power. The minimum rollover power must be:

Verdi V-2	2.6 Watts
Verdi V-5/V-5 Uno	6.2 Watts
Verdi V-6 Uno	7.2 Watts
Verdi V-8	9.2 Watts
Verdi V-10	11.2 Watts
Verdi V-18	19.5 Watts

2. In light regulation, the laser power must ramp smoothly from 0 to maximum power (2.2, 5.5, 6.5, 8.5, 10.5, 18.5 Watts for each type of Verdi system, respectively) without reaching maximum current.

Continue with the procedure titled "LBO Temperature Optimization" if the system fails to meet the minimum power requirements.

LBO Temperature Optimization

The LBO temperature can be optimized manually or automatically. The manual optimization is preferred during Service visits due to the amount of time (several hours) required to complete an automatic optimization.

Automatic optimization

For automatic optimization, use the following procedure. Otherwise, continue with the procedure titled "Manual Optimization and Checking Rollover Performance"

1. Record the initial LBO set temperature.
2. Go to the Temperature Optimization menu.
3. Press MENU SELECT to initiate the optimization algorithm.

Manual Optimization and Checking Rollover Performance

For manual optimization, use the following procedure to improve rollover performance.

1. Set up an external power meter.
2. Open the shutter.
3. Turn the keyswitch to the LASER ON position.
4. In current control, from the top level menu, use the front panel knob to increase the current to achieve lasing. Continue to increase the current until the laser power begins to decrease with increasing current, rather than increasing with current.
5. Decrease the current slightly until the peak of the power curve is determined. The peak of the power curve is known as roll-over power.

A hysteresis effect will occur in V-18 models, and sometimes in V-8 and V-10 models.

After reaching initial rollover in current mode, reduce the current and verify if the laser power increases. If the power increases, continue to reduce the current until rollover is achieved. Keep turning the current down until the power peaks and begins to decline by a few tenths of a Watt.

At this point, the output power will be on the leading edge of the rollover curve where the output is single longitudinal mode and TEM_{00}. Wait for the servo temperatures to stabilize before continuing with performance or optimization procedures.

See FSB #460 for additional information.

6. Prepare a table similar to Table 5.2-1.

LBO (ACTUAL) TEMPERATURE	CURRENT	LASER POWER

Table 5.2-1. Blank Rollover Table

7. Go to the LBO Temperature Servo menu.
8. Record the LBO set temperature and the rollover power.
9. Search for the maximum laser power by adjusting the LBO temperature in 0.2 degree increments. Allow sufficient time for the LBO temperature to stabilize at each new set point.
10. After the temperature has stabilized, press MENU EXIT twice to access the top level menu.
11. Adjust the current up and down as necessary to find the rollover (maximum) power.
12. Return to the LBO Temperature Servo menu and adjust the temperature to the next set point.
13. Repeat this cycle until the LBO temperature with the highest rollover power is found.
14. Set the new LBO temperature to 0.2ºC below the peak temperature in Step 13.

If the laser fails to meet minimum output power requirements, continue with the procedure titled “Diode Temperature Optimizations”.

Diode Temperature Optimizations

For V-18 units, use the procedure titled “V-18 Diode Temperature Optimization”. All other Verdi models can only be manually optimized. The Diode temperatures may be manually optimized by using the following procedure.

1. Access the Temperature Set Points menu.
2. Scroll to Diode 1 or Diode 2 and begin increasing or decreasing the set temperature in 1ºC increments to maximize output power.
3. Record and plot the diode temperature and rollover power in a graph as illustrated in Figure 5.2-1.
4. Select the new diode temperature that produces maximum power.
5. Optimize the second diode in a two-FAP power supply.

V-18 Diode Temperature Optimization

V-18 Diode temperatures can be optimized automatically or manually. For automatic optimization, use the following procedure:

1. Access the Diode Optimization menu and press MENU SELECT to initiate the optimization routine.

Use the following procedure when manually optimizing V-18 diodes, which is the preferred method during Service visits.

1. Record Diode 1 and Diode 2's set temperature.

   If the original FAP-I assemblies are installed, set the diode temperatures as indicated on the customer data sheet and begin the temperature optimization.

2. In Current mode, determine the rollover power as described in the procedure titled "Manual Optimization and Checking Rollover Performance" on page 5.2-2, Step 1 through Step 5.

   If only threshold lasing can be achieved, reduce the diode temperatures while maintaining the temperature delta. Output powers comparable to the operating power may be achieved at lower diode temperatures.

The diode temperature delta is the difference between the set temperatures of Diode 1 and Diode 2. The temperature delta must be maintained throughout the diode temperature optimization procedure. Use the diode temperature delta as determined from the diode temperatures recorded in Step 1.

3. Decrease Diode 1 and Diode 2 by 1.0ºC.
4. Once both diodes are within 0.2ºC of their set temperature, determine and record the rollover power.
5. Create a table or a graph as illustrated in Figure 5.2-1 and plot the new diode temperature and rollover power.
6. Continue with Step 3 through Step 5 until rollover power levels off or begins to decrease.
7. Return the diode temperatures to their original set points.
8. Begin increasing the temperatures by 1ºC.
9. Continue increasing the diode temperatures by 1ºC. Lasing threshold lasing will eventually be observed, no matter how high the diode current is increased.

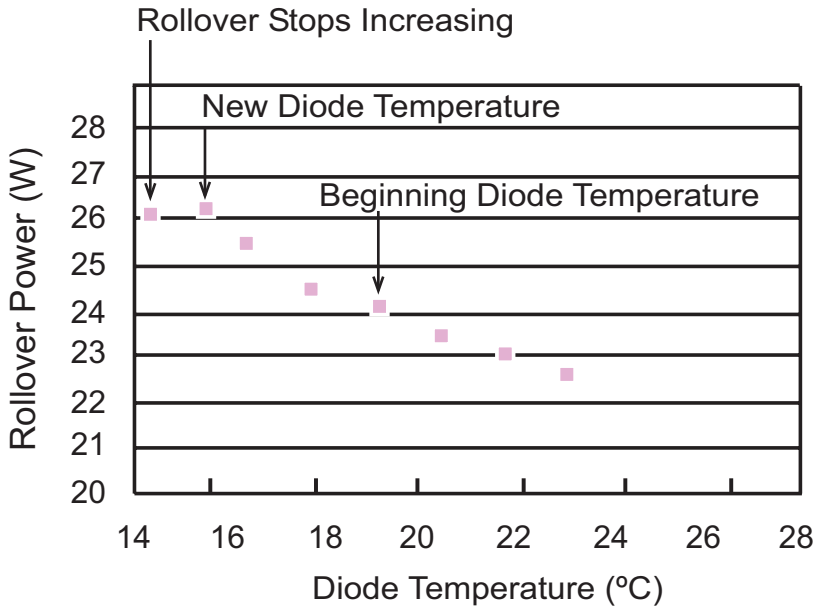


Figure 5.2-1. Diode Temperature Optimization Graph

10. The new diode set temperatures will be the first point on the graph where there is no increase in rollover power, or any increase in rollover power is limited. Reference Figure 5.2-1.

Alternatively, because the efficiency of the laser head decreases with diode temperature, choose the temperature with the most efficient operating current and that still produces minimum rollover power.

If the minimum rollover power cannot be obtained, perform the procedure titled “Determine Diode Rated Currents” on page 5.5-1 and repeat the procedure titled “LBO Temperature Optimization” as necessary to achieve the minimum rollover power.

If power still cannot be recovered, continue with “Optimizing the Etalon”.

Optimizing the Etalon

To optimize the Etalon, perform the following procedure.

1. In current control, slowly increase the current to rollover power. Over pump the laser head until the output decreases by ~1W, then decrease the current to find the rollover.
2. Go to the Etalon Temperature Servo menu. Record the output power corresponding to the current Etalon set temperature.
3. Decrease the Etalon temperature to 35ºC. Wait until the actual temperature is within 0.1ºC of the set temperature.
4. Find and record the rollover power as described in Step 1.
5. Increase the Etalon temperature in 5ºC increments up to 75ºC, or 3ºC increments to 62ºC for the V-18 only. After each increment, optimize the rollover power as described in Step 1 once the actual temperature is within 0.1ºC of the set temperature and record the rollover power as illustrated in Figure 5.2-2.
6. After the 35ºC-75ºC temperature sweep, or 35ºC-62ºC for V-18 only, select the Etalon temperature that corresponds to the maximum rollover power.

   If multiple points have the same maximum rollover power, then select the lowest Etalon temperature that produces maximum rollover.

If power cannot be recovered, there is likely an issue within the laser head.

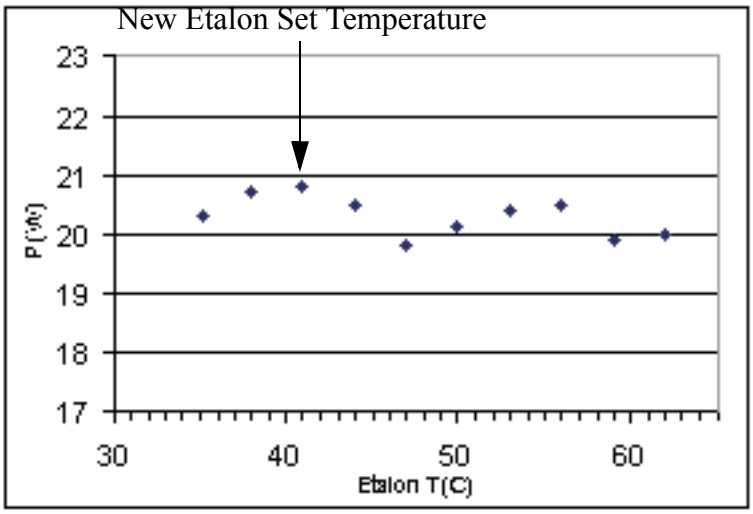


Figure 5.2-2. Etalon Temperature Optimization Graph

Fiber Optic Cleaning

Before performing the cleaning procedure, inspect the fiber optic surface with a fiberscope or magnifier to determine the extent to which the fiber might be damaged or contaminated. Only perform the cleaning procedure if the fiber optic surface shows imperfections, otherwise the procedure may introduce dust, dirt, or potentially induce damage to the fiber optic. Reference the figures titled "Good Fiber" on page 5.3-10, "Bad or Questionable Fibers" on page 5.3-10, and "Guidelines for Fiber Optic Inspection" on page 5.3-11 to determine if the fiber requires cleaning and/or replacement.

The Drop and Drag method is the least abrasive cleaning method and should always be used first to remove imperfections on the fiber optic surface. If the Drop and Drag method will not remove particulates, then the fiber optic surface should be cleaned with a cleanroom swab. The cleanroom swab is most effective; however, a lens tissue with a hemostat may be used as an alternative to the cleanroom swab.

Equipment Needed

The following materials are required to perform this procedure:

- Lens cleaning tissue
- Cleanroom-quality swabs
  (Coherent recommends using Micro Alpha Swab ESD, Part #1488-758E from Cintas at (800) 786-6027)

  Lens tissue and a hemostat may be used as an alternative to the swabs.
- Fresh spectroscopic-grade Methanol
- Fiber microscope (fiberscope), 200X total magnification
- Non-powdered, non-coated Latex (or equivalent) gloves or fingercots

Important: Do not use Acetone! Acetone will dissolve adhesives used in the manufacture of the fiber optic and will destroy the fiber optic cable.

Fiberscope

A recommended cost-effective fiberscope is the OFS 300-200C model with 20X eyepiece and SMA adapter manufactured by Noyes™. See Figure 5.3-1.

Figure 5.3-1. Fiberscope with 20X Eyepiece and SMA Adapter

Procedure

Always wear latex gloves or fingercots (or the equivalent) while performing any of the following procedures. Fingerprints, dust, condensation, and oils from the hand can damage the fiber optic surface.

Drop and Drag Procedure

1. Using a medicine dropper and a new, clean lens tissue, put one drop of Methanol near the center of the lens tissue. See Figure 5.3-2.
2. Holding the fiber vertically so the fiber surface points to the ceiling, carefully place the tissue so the optical surface rubs against the underside of the tissue. See Figure 5.3-3.
3. In a single movement, gently drag the fiber surface against the underside of the wet tissue in a circle, spiraling out, taking care not to go over the same part of the tissue twice. See Figure 5.3-4.

   Drag the fiber out from the saturated part of the tissue to the dry parts of the tissue, which dries the fiber optic surface and prevents Methanol residue.

Figure 5.3-2. Methanol Drop on Lens Tissue

Figure 5.3-3. Placement of the Fiber Optic Against the Lens Tissue

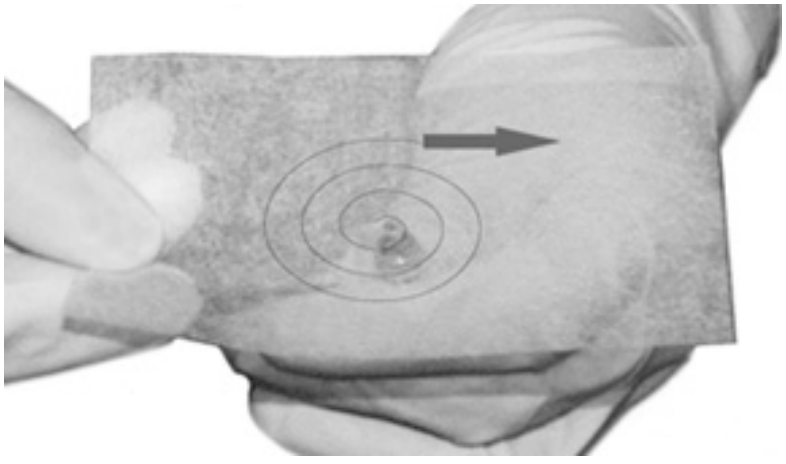


Figure 5.3-4. Movement of Fiber Optic Against Lens Tissue

4. Re-check the fiber with the fiberscope.

   If the fiber surface is now ideal or complies with the acceptable guidelines as illustrated in Figure 5.3-14 on page 5.3-11, immediately install the fiber optic into the FAP-I.

   If the imperfections have not been removed, or if any Methanol residue has been induced (See Figure 5.3-5), continue with the cleanroom swab procedure below.

Methanol residue can cause burn spots or potentially catastrophic damage to the fiber optic and the FAP-I.

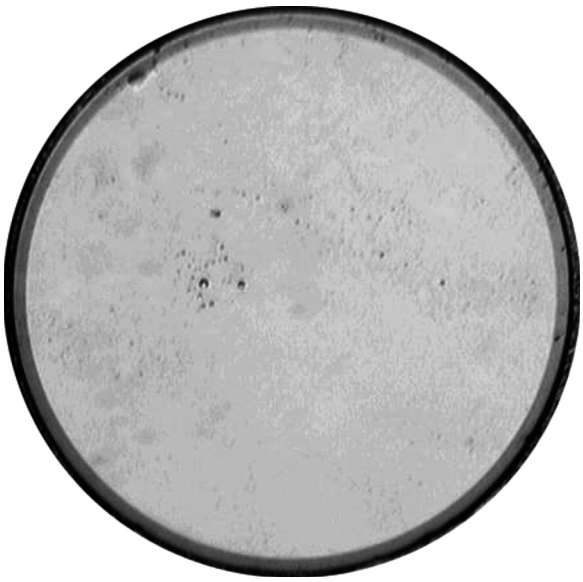


Figure 5.3-5. Methanol Residue

Cleanroom Swab Procedure

Using lens tissue and a hemostat may be substituted for the cleanroom swab procedure. Reference the procedure titled "Alternative Cleaning Procedure" on page 5.3-6 for the alternate method.

1. Using a medicine dropper, put one to two drops of Methanol on the swab (Figure 5.3-6).
2. Vigorously shake off excess Methanol from the swab to prevent Methanol residue.

Only the synthetic cloth should make contact with the fiber optic surface. Do not allow the plastic applicator to touch the fiber surface.

3. Holding the fiber vertically so the fiber surface points to the ceiling, carefully place the base of the swab against the fiber optic surface, taking care not to touch the plastic applicator to the fiber optic surface. See Figure 5.3-7.

Figure 5.3-6. Methanol Drop

4. Drag the swab across the fiber optic surface in a single stroke. **Do not** drag the swab back and forth.
5. Repeat Step 4 using the other side of the swab.
6. Re-check the fiber using the fiberscope.

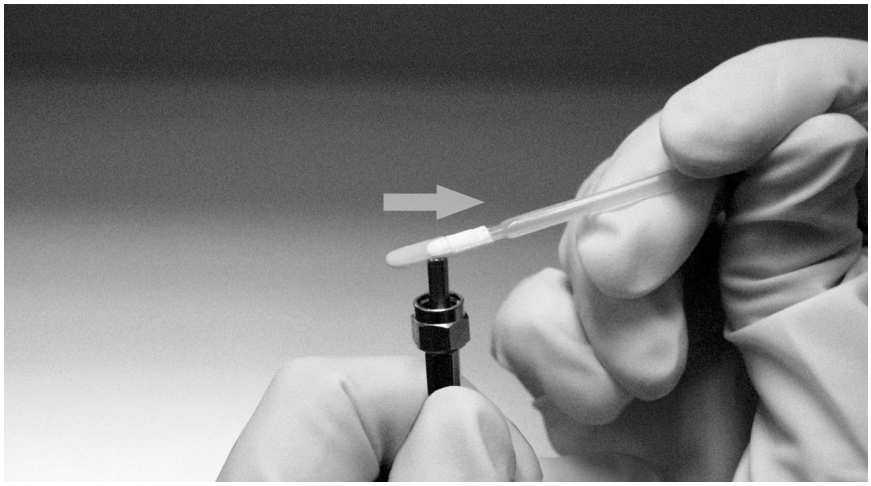


Figure 5.3-7. Placement and Movement of the Swab Against the Fiber Optic Surface

If the fiber surface is now ideal or complies with the acceptable guidelines as illustrated in Figure 5.3-14 on page 5.3-11, immediately install the fiber optic into the FAP-I.

If imperfections remain, repeat the procedure using a new swab.

7. If imperfections still remain, compare the image in the fiberscope with Figure 5.3-14 on page 5.3-11 and determine whether the fiber optic must be replaced. Contact Coherent Service if further guidance is needed.

Alternative Cleaning Procedure

As an alternative to the cleanroom swab procedure, use the following procedure with lens tissue and a hemostat:

1. With one hand on each end of the lens tissue, fold the tissue in half (width wise), three times. Do not touch any part of the lens tissue that will make contact with the fiber optic surface. See Figure 5.3-8.
2. Use a hemostat to fold the tissue in half, lengthwise. Do not touch any part of the lens tissue that will be used to clean the fiber optic surface. See Figure 5.3-9.
3. Attach a hemostat to the lens tissue as shown in Figure 5.3-10.
4. Using a medicine dropper, put two drops of Methanol on the lens tissue.
5. Vigorously shake off excess Methanol from the folded tissue to prevent Methanol residue

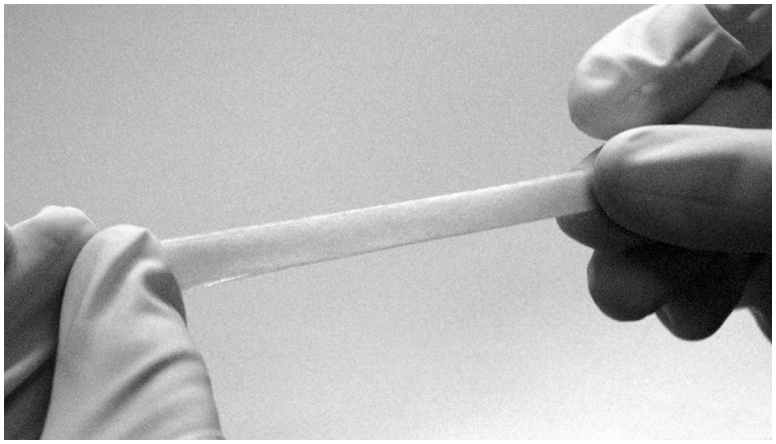


Figure 5.3-8. Folded Lens Tissue (Width wise)

Figure 5.3-9. Folded Lens Tissue (Lengthwise)

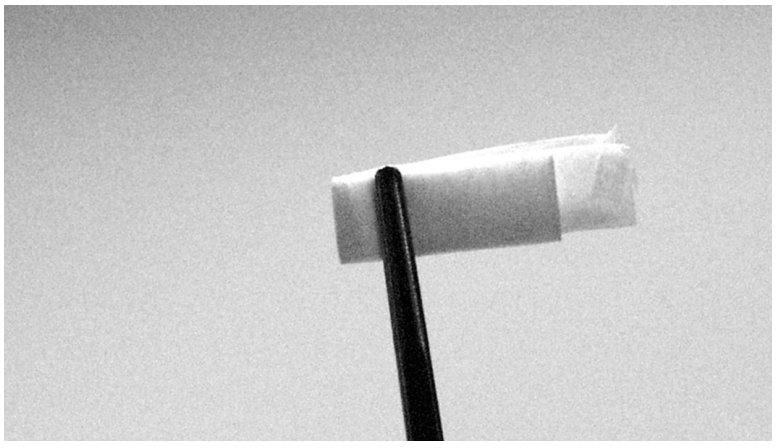


Figure 5.3-10. Hemostat Attached to Properly Folded Lens Tissue

Only the lens tissue should make contact with the fiber optic surface. Do not allow the hemostat to touch the fiber surface.

6. Holding the fiber vertically so the lens surface points to the ceiling, carefully place the base of the wet side of the folded tissue against the fiber optic surface, taking care not to touch the fiber optic with the hemostat. See Figure 5.3-11.
7. Drag the folded tissue across the fiber optic surface in a single stroke. **Do not** drag the swab back and forth.

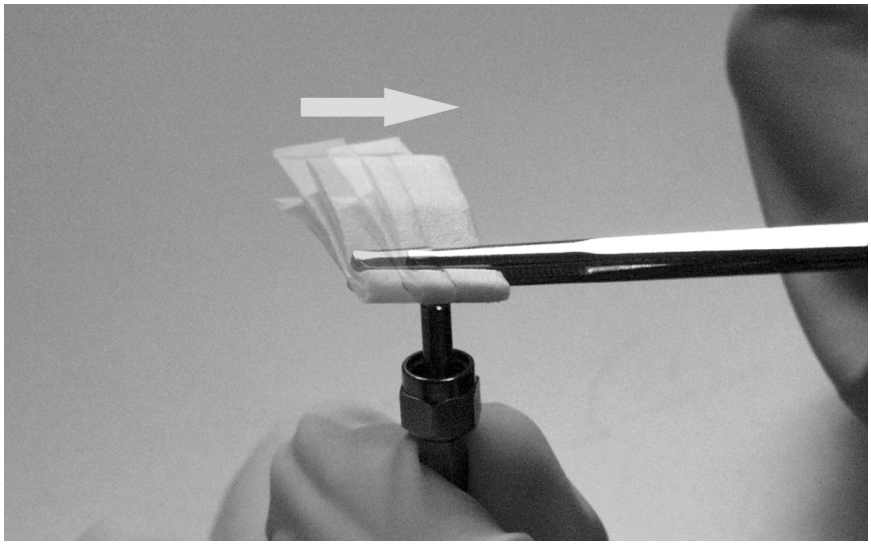


Figure 5.3-11. Placement and Movement of the Folded Tissue Against the Fiber Optic Surface

8. Repeat Step 7 using the other side of the folded tissue.
9. Re-check the fiber using the fiberscope. If imperfections remain, repeat the procedure using a new lens tissue.
10. If imperfections still remain, compare the image in the fiberscope with Figure 5.3-14 and determine whether the fiber optic must be replaced. Contact Coherent Service if further guidance is needed.

    If the fiber surface is now ideal or complies with the guidelines as illustrated in Figure 5.3-14 on page 5.3-11, immediately install the fiber optic into the FAP-I.

Examples of Good and Bad Fibers

Figure 5.3-12 shows an image of the ideal fiber optic surface that can be used successfully in the FAP-I assembly through a fiberscope. Figure 5.3-13 shows images of fibers through a fiberscope with imperfections that can impair the function of the assembly. The image on the left is clearly a damaged fiber. Severely damaged fibers must not be used in the FAP-I assembly or permanent and severe damage to the assembly will occur.

The image on the right shows a fiber that is questionable. If the power output is acceptable, then the fiber can be used with little concern for damaging the assembly. However, if the power output is unstable or not up to acceptable standards, the fiber must be considered damaged and must not be used.

Figure 5.3-14 illustrates further criteria for accepting or rejecting a fiber because of damage. Note that the views shown do not represent the entire surface of the fiber optic. Much of the surface is the metal connector and only the 800-micron core is the actual optical fiber.

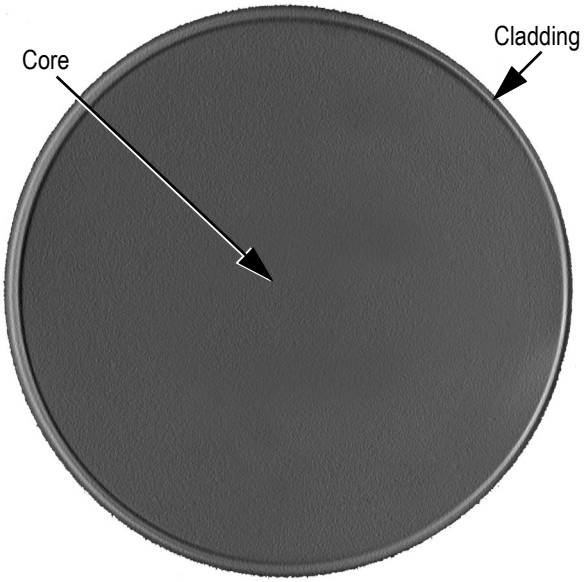
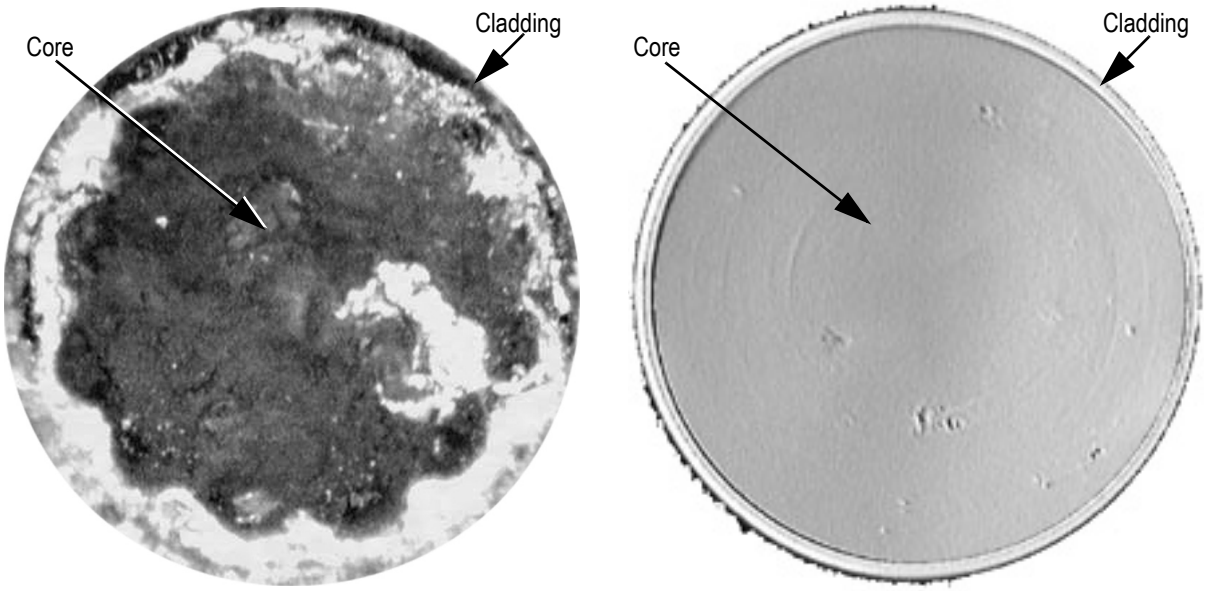


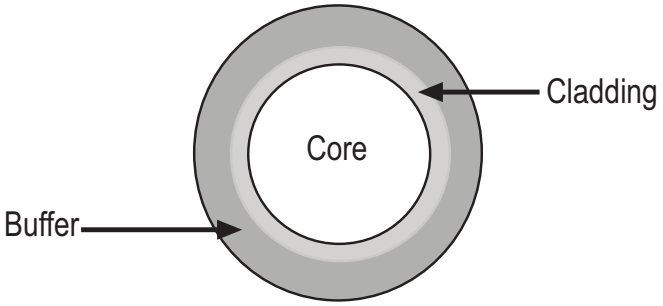
Figure 5.3-12. Good Fiber



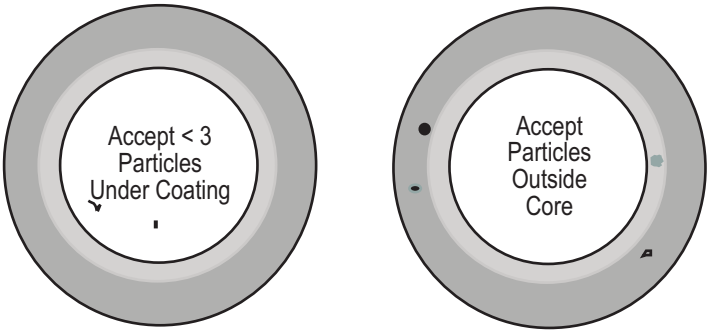
Bad Fiber (Burned)

Questionable Fiber

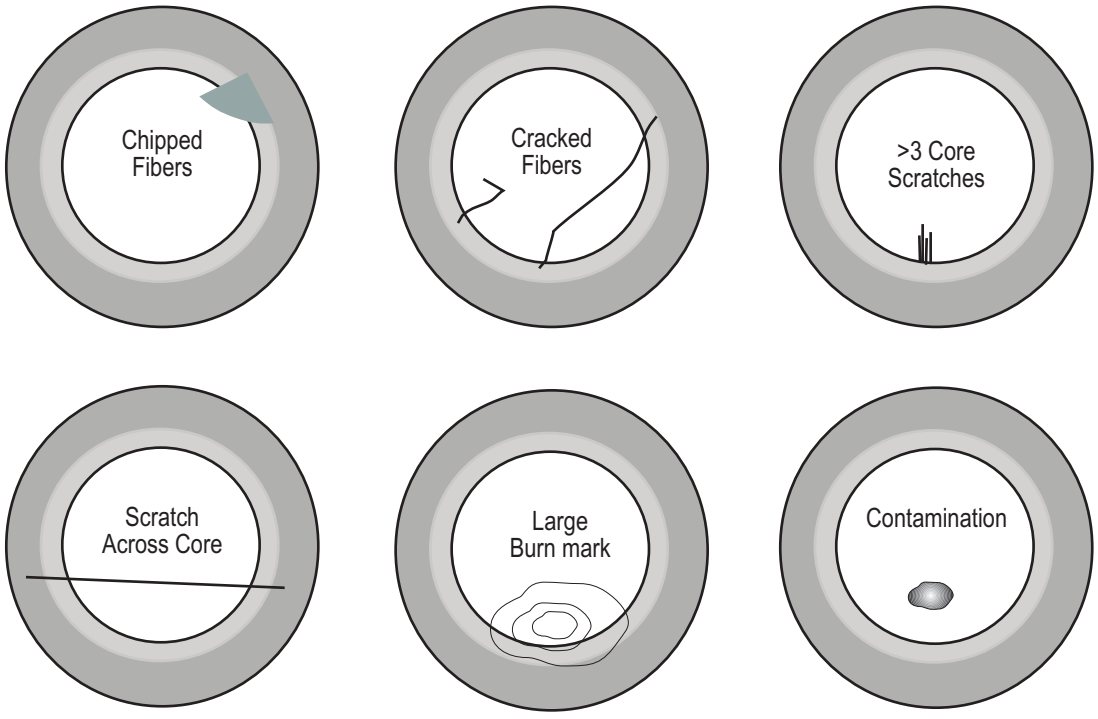
Figure 5.3-13. Bad or Questionable Fibers



IDEAL FIBER



ACCEPTABLE IMPERFECTIONS



CRITERIA FOR REJECTION

Figure 5.3-14. Guidelines for Fiber Optic Inspection

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Introduction

This procedure should be followed when disconnecting the laser head from the power supply for the purpose of installing the laser system into another machine, or when replacing the head or power supply. Figure 5.4-1 gives an overview of the Verdi power supply.

Do not turn the AC power switch to the OFF position or disconnect AC power input until the LBO cool-down cycle is complete.

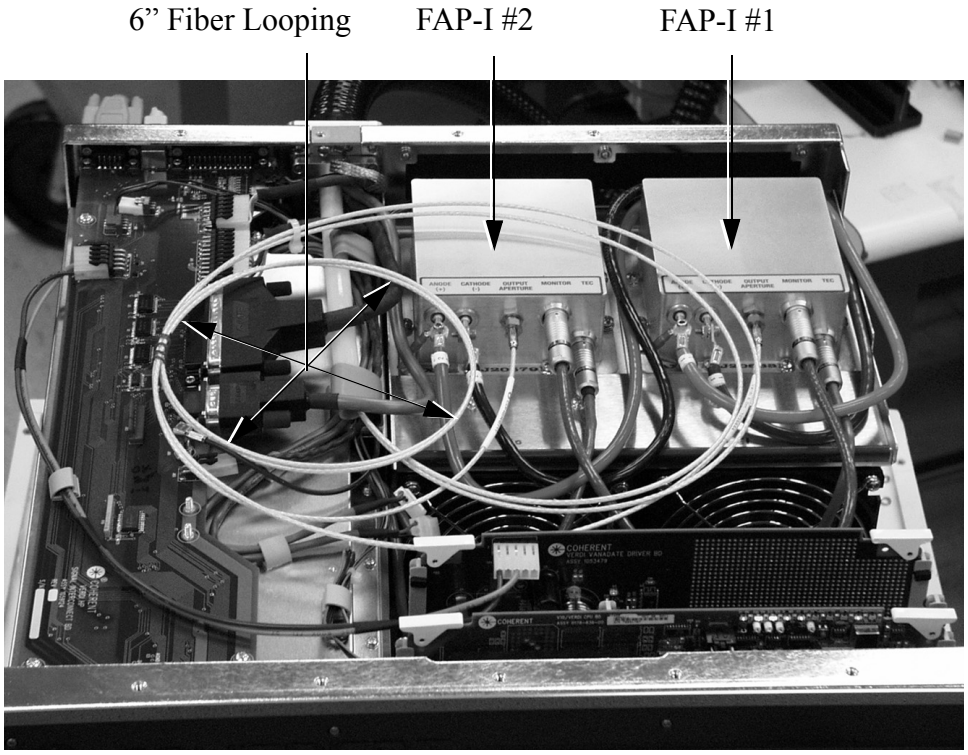

Figure 5.4-1. Location of FAP Assemblies

FAP-I Handling Precautions

A shorting clip (Figure 5.4-2) must be installed between the anode and cathode terminals to avoid inadvertent electro-static discharge (ESD).

- The laser diode assembly can be damaged by improper handling. To avoid ESD, a personal grounding strap must be used at all times.
- When disconnecting the fiber optic cable from the FAP assembly, caps (Figure 5.4-2) should be installed over the FAP optical emission port and the end of the fiber optic cable to protect them from accidental damage or contamination.

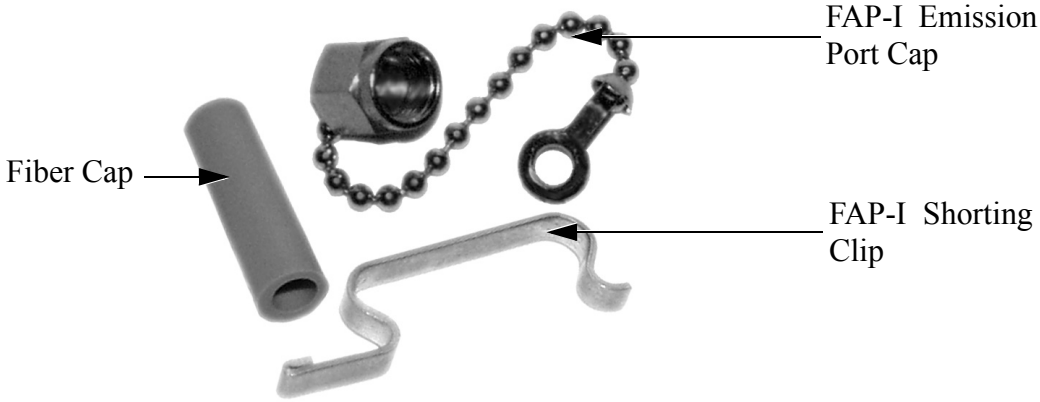

Figure 5.4-2. Fiber Optic and FAP Optical Port Caps

Fiber Cable Handling Precautions

- When removing or installing a fiber optic cable, do not allow the fiber optic cable to rotate while loosening the ferrule connector.
- The end of the fiber optic cable constitutes an optical surface. Do not allow the end of the fiber optic cable to contact any surface including the fingers. To minimize exposure to the environment, the protective plastic cap should be left in place until a connection is made and immediately installed over the fiber end when a connection is disassembled.

- Do not allow the end of the fiber optic cable to contact the diode (FAP-I) assembly. Contact can damage the optical surface.
- Do not install a contaminated or damaged fiber optic cable to the FAP-I. Doing so will cause a failure of the FAP-I.
- Contamination or damage to the fiber optic face can be difficult to detect. Use a fiberscope to check for dust, dirt, cracks, burns, or scratches before the fiber is installed in to a FAP-I assembly. Reference Section 5.3 “Fiber Optic Cleaning” for complete information on fiber inspection and cleaning.

Disconnection

The following sections explain how to disconnect the laser head and the power supply.

The following equipment is required to disconnect and reconnect the Verdi head and power supply:

Personal grounding strap
Fiberscope, 200x magnification
FAP-I Stainless Steal protective cap
Fiber optic protective cap
Allen key set
Blade and Phillips screwdrivers
3/8” wrench
Spectroscopic-grade methanol
Cleanroom Q-tips or lens tissue
Finger cots or latex gloves

Refer to “System Re-integration” on page 5.4-7 for additional equipment required to re-integrate the head and power supply.

Laser Shutdown

1. Turn the keyswitch to the STANDBY position.
2. Access the LBO Settings menu.
3. Press MENU SELECT to initiate LBO cooling. This may take 30 to 45 minutes.
4. When the LBO cool-down is complete (indicated by the temperature of the LBO crystal being cooler than 35°C), turn the AC power switch on the back of the power supply off.

5. Disconnect the power cord.
6. Remove the power supply cover by removing the ten Allen screws along the top edge and seven on each of the right and left sides.

Note that two of the screws on the right-hand side are interlock defeat screws and are larger than the others. These must be returned to those precise positions when performing re-assembly.

Fiber Assembly Removal

Disconnect each of the two fiber optic cables from their FAP assemblies as follows:

1. While firmly holding the fiber optic cable, loosen and remove the ferrule connector securing the fiber optic cable to the laser diode assembly.
2. Note that the ferrule is a cutout nut. Carefully extract the fiber optic cable from the laser diode assembly and remove the ferrule.

   Immediately install the two plastic protective caps, one over the end of the fiber cable (blue) and the second over the FAP-I optical port (Stainless Steel with chain). See Figure 5.4-2.

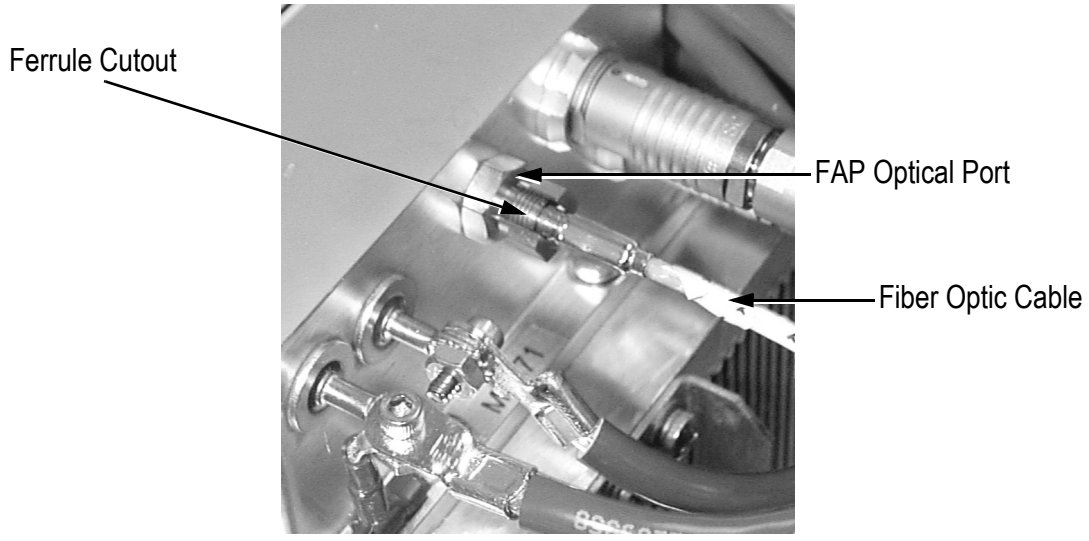

Figure 5.4-3. FAP Fiber Optic Connector.

Umbilical Disconnection

1. Free the fiber optic cables from the two clips that secure them in the power supply (see Figure 5.4-1).

Before disconnecting the umbilical connectors from the Signal Interconnect board it is important to note how they are routed in the power supply. See Figure 5.4-4.

2. Disconnect the umbilical connectors to J81, J82, J84 and J85 on the Signal Interconnect board. (To facilitate getting the connectors through the access port in the back of the power supply, the connectors to J88 and J91 should also be disconnected.)
3. Disconnect the 4 screws from the umbilical bracket on the rear of the power supply.
4. Pull the umbilical back, away from the power supply, until the protective tubing over the fiber optic cables is just to the inner edge of the power supply rear wall (see Figure 5.4-5).
5. Pull connectors P82, P84 and P85 through the access port.
6. Pull P81 through the access port, repositioning P88 as necessary to gain additional space.

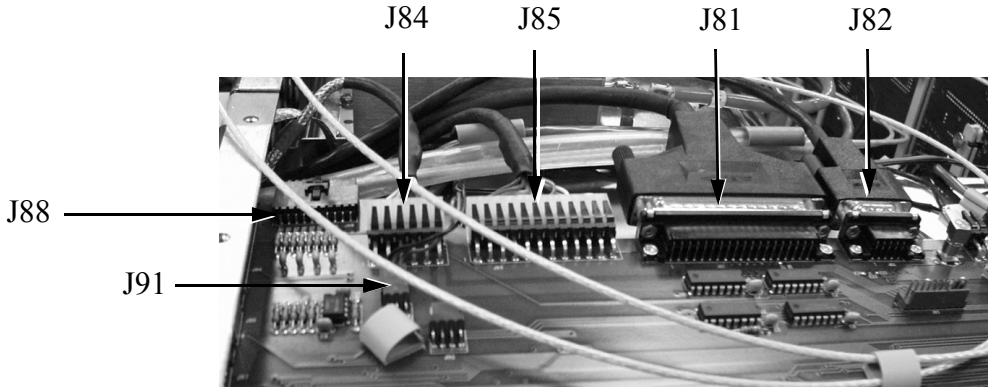

Figure 5.4-4. Connectors on Signal Interconnect Board

7. If desired, the fiber optic cables can be coiled and secured, as shown in Figure 5.4-6. If the head is to be shipped, wrap the coil of fiber optic cables and electrical connectors with cushioning material (such as bubble wrap).

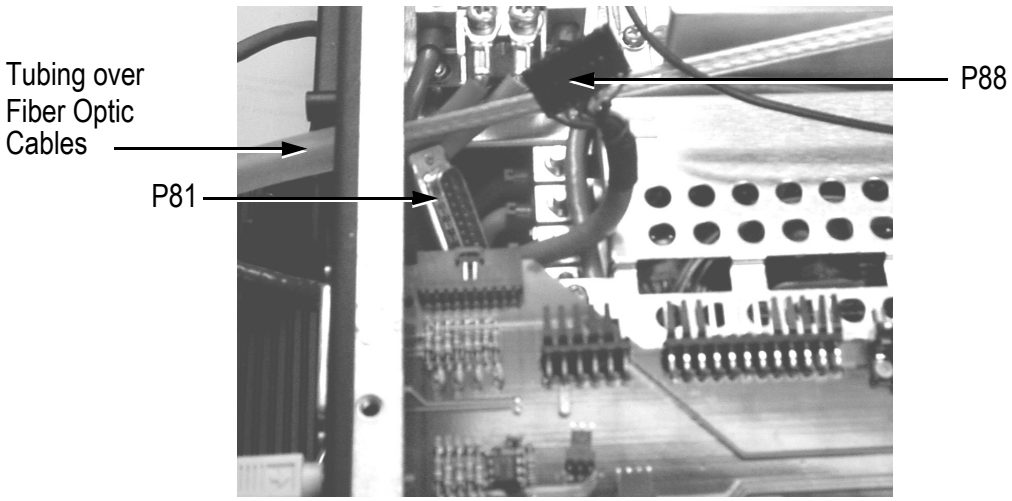

Figure 5.4-5. Manipulating P81 Out of Umbilical Access Port

The minimum coil radius for the fiber optic cables is 3 in. (7.6 cm), 6-in. diameter (15.2 cm diameter). A smaller coil radius could result in damage to the fibers.

Figure 5.4-6. Verdi Umbilical with Fibers Coiled and Cables Secured

Umbilical Reconnection

1. Insert the fiber optic cables through the umbilical access port until the protective plastic tubing is just on the inside of the power supply wall.
2. To insert P81, see Figure 5.4-5. The cable of P88 should be repositioned during this process to obtain the greatest amount of free space.
3. Insert umbilical connectors P82, P84 and P85.
4. Reconnect connectors P81, P82, P84, P85, as well as P88 and P91. (See Figure 5.4-4).
5. The fiber(s) are ready for reconnection. Perform the following procedure:
    b. Inspect and clean the fiber if necessary as described in the procedure titled in Section 5.3 “Fiber Optic Cleaning”.
    c. Remove the protective Stainless Steel cap from the FAP-I emission port.
    d. Carefully insert the fiber optic cable into the ferrule nut, and then insert the ferrule nut and fiber optic cable into the laser diode assembly.
    e. While holding the fiber optic cable securely, finger tighten the ferrule connector.
5. If the head or power supply has been replaced, the system must be re-integrated, continue with the procedure titled “System Re-integration”. If re-integration is not required, replace the power supply cover, connect facility power, turn the system on, and wait for the LBO crystal to reach its setpoint temperature (approximately 30-45 minutes).

The system is now ready for operation.

System Re-integration

If the head or power supply has been replaced, a number of optimization procedures must be completed.

The following equipment may be required to re-integrate the Verdi head and power supply:

Test fiber
Power meter and head (LM-45 or larger)
Power meter adapter to enable fiber optic connection
Computer with RS-232 serial cable
Null modem adapter

System Power Up

1. Jumper JP9 on the CPU board to access the service menus.
2. Reconnect the power supply to facility power.
3. Turn the AC power on and wait for the LBO crystal to reach its setpoint temperature (approximately 30-45 minutes).
4. Clear any faults by pressing the MENU EXIT pushbutton. If eeprom faults cannot be cleared, the eeprom must be reset.

   Do not reset the eeproms unless absolutely necessary. Before resetting the eeproms, record the relevant system information as listed below.

   - When you are ready to reset the eeprom, access the EEPROM Diagnostics screen.
   - Scroll the arrow to the appropriate eeprom, and press the MENU SELECT pushbutton to reset the eeprom.
   - Re-enter the following information:

     a. **FAP eeprom reset.** Record and re-enter FAP temperature and FAP hours. FAP hours must be re-entered via an RS-232 connection, using the following commands:

        `VERDI>ee:34=`[diode 1 hours]
        `VERDI>ee:35=`[diode 2 hours]

        FAP temperatures can be re-entered in the Diode 1 or Diode 2 Temp Servo Status menus.

     b. **Head eeprom reset.** Record and re-enter Vanadate (and Vanadate 2, if necessary), Etalon, and LBO temperatures, and head hours. Head hours can be re-entered using the following RS-232 command:

VERDI>ee:33=(head hours)

Vanadate, Vanadate2 (V-18 only), Etalon, and LBO temperatures can be re-entered in the Vanadate, Vanadate2, Etalon, and LBO Temp Servo Status menus, respectively.

c. **CPU eeprom reset.** Re-calibrate FAP current and voltage. Follow the procedures titled "FAP-I Current & Voltage (V & I) Calibration" on page 5.6-1.

5. Check the Temperature Set Points menu to make sure the LBO, Vanadate, Vanadate2, Etalon, Diode 1 and Diode 2 coincide with the setpoints listed in the customer traveller.
6. Optimize the laser as described in Section 5.2 "System Optimization".
7. Access the Light/Current Control menu and press MENU SELECT to put the laser into current control.
8. Press MENU EXIT to access the top level menu.
9. Recalibrate diode current in the procedure titled "Diode Current Calibration" on page 5.6-1.
10. If necessary, re-calibrate the photocell as described in Section 5.7 "Photocell Calibration".
11. Turn the keyswitch to the STANDBY position.
12. Set CPU board jumper JP9 to Customer mode and press the CPU reset button.
13. Re-install the power supply cover.

The re-integration procedure is now complete.

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FAP-I Evaluation

The ability of the FAP-I to produce full power at 100% of its rated current should always be verified using a test fiber and an external meter. If the FAP-I cannot produce enough pump power at 100% rated current, the diode bar in the assembly may have failed. See Table 5.1-1, "Verdi FAP & Power Specifications," on page 5.1-1 for more information. To verify if the diode(s) have failed, perform the procedure titled "Determine Diode Rated Currents".

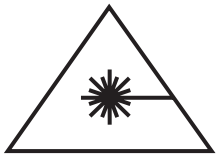
With revision 3.53 (Rev. B) software or higher, the RS-232 software query "?DxPC" will return the voltage on the photocell in the FAP-I assembly. If this voltage is below 0.5 V, it is very likely that the FAP-I has failed. Do not replace the FAP unless this specific test has failed.

Determine Diode Rated Currents

1. Ensure the keyswitch is in the STANDBY position.
2. Disconnect the fiber optic cable from FAP 1. See Figure 5.5-1 on page 5.5-6 for FAP-I location. Immediately install a plastic protective cap on the end of the fiber.
3. Inspect the test fiber in accordance with Section 5.3 "Fiber Optic Cleaning".
4. Connect one end of the test fiber to FAP 1, and connect the other end of the test fiber to a power meter, fitted with an adapter to enable fiber connection.

Step 5 to Step 8 may be omitted for single-FAP lasers.

5. From the top level menu, press MENU SELECT to access the Base Menu.
6. Scroll to Set Diode Current Delta and record the current delta.



If Current Delta is not set appropriate limits, FAP #2 can produce enough IR energy to leak through the laser head cavity and into FAP 1's disconnected fiber optic cable. Use extreme caution.

Current Delta is the average current between both FAPs. Since changing the Current Delta will display an incorrect value on the front panel display, use the Diode Parameters Screen to record *actual* Diode 1 and Diode 2 currents.

7. Use the front panel knob to set a positive current delta, which will set diode 2's amperage less than diode 1 and minimizes asymmetric pumping of the Vanadate crystal (see Table 5.5-1 below).

SYSTEM	CURRENT DELTA
V-2, V-5	10
V-5 Uno, V-6	30
V-8, V-10	30
V-18	50

Table 5.5-1. Current Delta by System

8. Press MENU EXIT twice to return to the top level menu.
9. Turn the keyswitch to the LASER ON position, open the shutter, and slowly increase the current until the external power meter reads the diode-rated power. See Table 1.3-2, "Comparison of System Components," on page 2 for typical diode operating currents.

SYSTEM	DIODE-RATED POWER (IN AMPS)
V-2, V-5	10
V-5 Uno	18
V-6 Uno	20
V-8, V-10	18
V-18	35

Table 5.5-2. Diode-Rated Power and its Related System

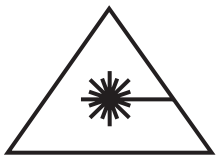
10. Record the current required to reach diode operating power from Diode Parameters Screen Menu and add the overhead current from Table 5.5-3. This is the rated current for diode 1, “d1rc”.

    Adding overhead drive current ensures sufficient current headroom for any progressive decline in the diode-to-head current efficiency. See Table 5.5-3 for the overhead current required for each system.

SYSTEM	DIODE-RATED POWER
V-2	2
V-5 to V-10	4
V-18	8

Table 5.5-3. Overhead and its Related System (in Amps)

11. Turn the keyswitch to the STANDBY position.
12. Disconnect the test fiber and reconnect the system fiber to FAP 1. (If the laser is a single-FAP Verdi, skip Step 13 through Step 23 and proceed to Step 24.)
13. Disconnect the fiber optic cable from FAP 2. Immediately install a plastic protective cap on the end of the fiber.
14. Connect one end of a test fiber to FAP 2, and connect the other end of the test fiber to a power meter, fitted with an adapter to enable fiber connection.
15. From the top level menu, press MENU SELECT to access the Base menu.
16. Scroll to Set Diode Current Delta.



If Current Delta is not set appropriate limits, FAP 1 can produce enough IR energy to leak through the laser head cavity and into FAP 2’s disconnected fiber optic cable. Use extreme caution.

Current Delta is the average current used between both FAPs. Setting Current Delta to appropriate models will display an incorrect value on the front panel display. Use the Diode Parameters Screen to record *actual* Diode 1 and Diode 2 currents.

17. Use the front panel knob to set a negative current delta to the appropriate amperage (see Table 5.5-1). This will set diode 1's amperage less than diode 2 and minimizes asymmetric pumping of the vanadate crystal.
18. Press MENU EXIT twice to return to the top level menu.
19. Turn the keyswitch to the LASER ON position, open the shutter, and slowly increase the current until the external power meter reads the diode rated power, as indicated in Step 9.
20. Record the current required to reach diode operating power from Diode Parameters Screen Menu and add the overhead current from Table 5.5-3. This is the rated current for diode 2, "d2rc".
21. Turn the keyswitch to the STANDBY position.
22. Disconnect the test fiber and reconnect the system fiber to FAP 2.
23. Calculate (d1rc – d2rc). This value is the actual diode Current Delta.
24. If the FAP-I must be replaced, reference the procedure titled "FAP-I Replacement". If the FAP-I assembly is good, continue with Step 25.
25. Establish RS-232 communication between a computer and the laser. (See "RS-232 Connection" on page 4.2-1 for connection details.) Issue the following commands:

    `VERDI>d1rc=`[input value measured in Step 10 for FAP1]

    `VERDI>d2rc=`[input value measured in Step 20 for FAP2]
26. Wait one full minute. Cycle the power off and then on, or press the blue CPU-reset button.
27. Issue the following RS-232 queries:

```
VERDI>?CD
VERDI>?d1rc
VERDI>?d1rcm
VERDI>?d2rc
VERDI>?d2rcm
```

Values of d1rc and d2rc should be equal to the values input in Step 24. Values of d1rcm and d2rcm should be 15% greater than d1rc and d2rc, respectively (See "EEPROM Initialization" on page 5.9-3 for rated current maximum definition). Once values of d1rc and d2rc are input, the CPU automatically calculates d1rcm and d2rcm values.

28. Disconnect the RS-232 connection.

FAP-I Replacement

If a FAP-I requires replacement after evaluation, use the following procedure.

Note: when replacing the FAP-I on V-18 models only, ensure the software is upgraded to software version 8.83 or newer. Contact Coherent customer service for more details and see FSB #460.

Do not turn the power switch off or disconnect the AC power input until the cool-down cycle is complete.

The current to the diode assembly (FAP) is measured with an Amp Clamp, using the cathode (gray) lead.

Diode voltage is measured with a DVM across the FAP anode and cathode.

Preliminary Steps & Data

1. Record all system parameters as recorded in Table 5.1-2, "Laser Parameters," on page 5.1-2.
2. Perform the "Turn-off (Complete Shut Down)" procedure located in Section Three of the Operator's Manual.

Note that the associated cool-down cycle will take approximately 45 minutes. The front panel display will indicate when the cool-down cycle is complete.

3. When the LBO cool-down cycle is complete, turn the power switch on the power supply rear panel off.

Do not disconnect the power cord from the facility power, even though the power switch is off. The facility connection is providing "earth" ground.

4. Remove the top cover of the power supply. Jumper the two pins of JP9 on the CPU board so the Service Menu can be accessed when system is restarted.

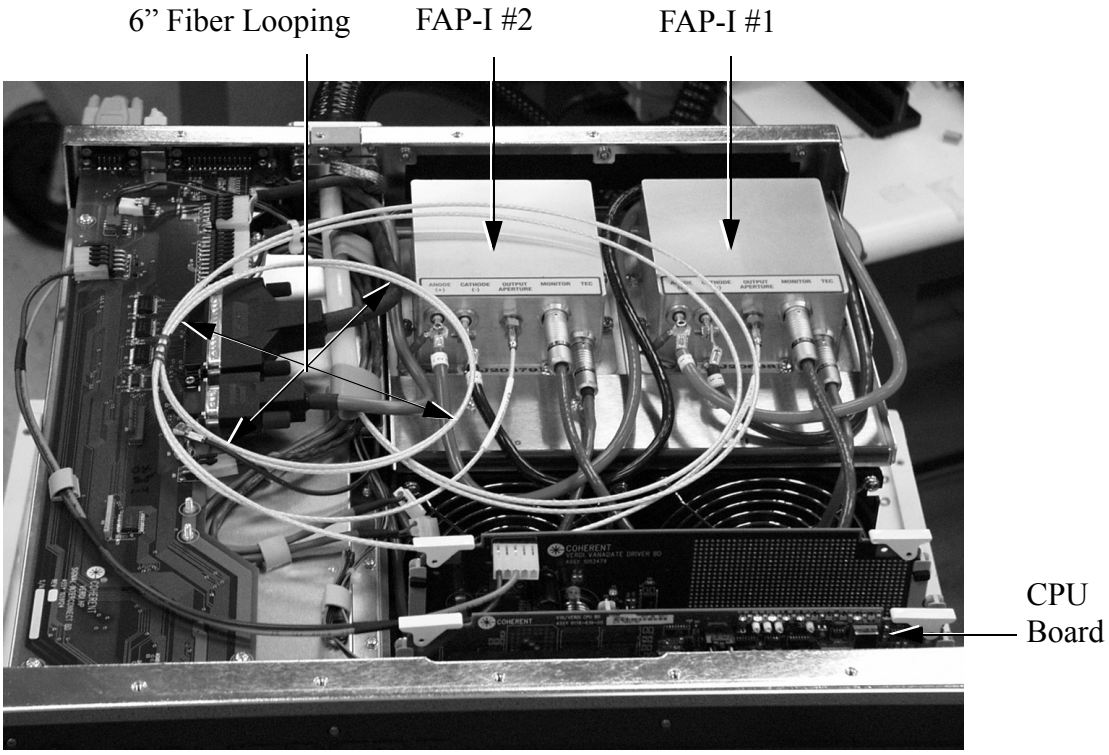


Figure 5.5-1. Location of FAP Assemblies

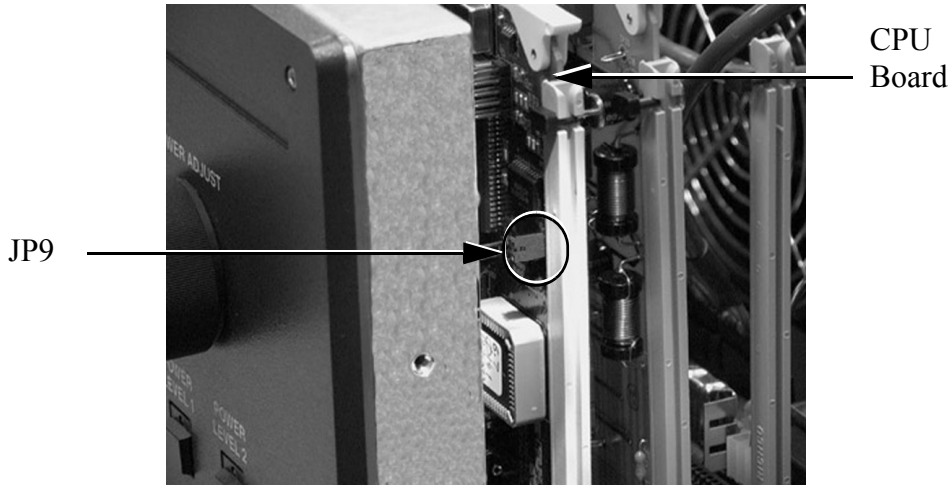


Figure 5.5-2. Location of JP9 on CPU board

FAP Handling Precautions

The laser diode assembly is sensitive to electro-static discharge (ESD) and can be damaged due to improper handling. To avoid ESD damage, a personal grounding strap must be used at all times.

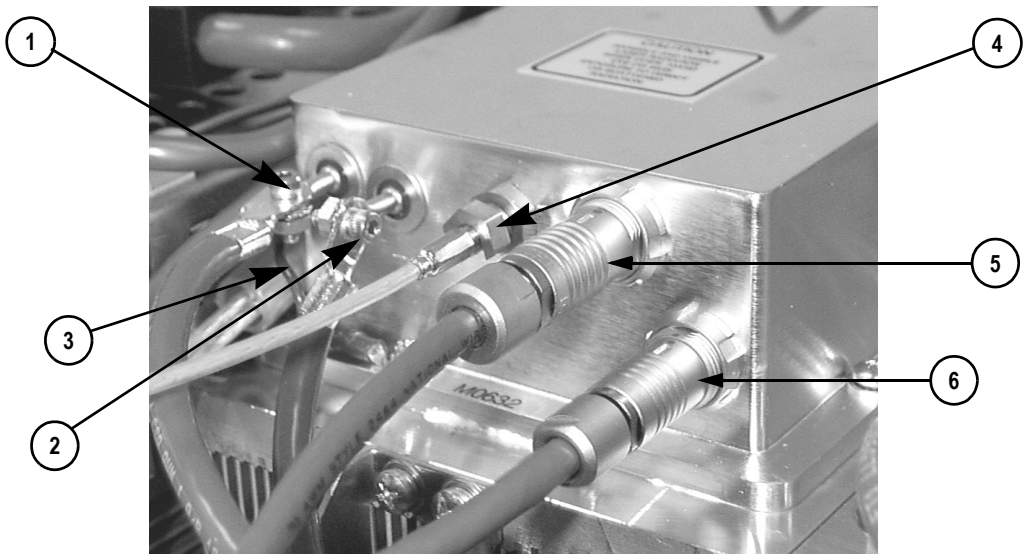
A shorting clip (Figure 5.5-3) must be installed between the anode and cathode terminals to avoid inadvertent ESD before the leads are disconnected from the terminals.

When disconnecting the fiber optic cable from the FAP assembly, a cap (Figure 5.5-3) should be installed over the FAP optical emission port and the end of the fiber optic cable to protect them from accidental damage or contamination.

Figure 5.5-3. Fiber Optic Cap and FAP Anode/Cathode Shorting Clip

Fiber Cable Handling Precautions

1. When removing or installing a fiber optic cable, do not allow the fiber optic cable to rotate while loosening the ferrule connector.
2. The end of the fiber optic cable constitutes an optical surface. Do not allow the end of the fiber optic cable to contact any surface including the fingers.
3. To minimize exposure to the environment, the protective fiber cap should be left in place until a connection is made and immediately installed over the Do not allow the end of the fiber optic cable to contact the diode (FAP) assembly. Contact can damage the optical surface.
4. Do not install a contaminated or damaged fiber optic cable to the FAP. Doing so will cause a failure of the FAP.
5. Contamination or damage to the fiber optic face can be difficult to detect. Use a fiberscope to check for dust, dirt, cracks, burns, or scratches.
6. To ensure that the fiber optic cable is appropriate to be installed, follow the entire inspection and cleaning procedure as detailed in the section titled “Fiber Optic Cleaning” on page 5.3-1.



1. Anode Connector
2. Cathode Connector
3. Case/Anode Ground Jumper
4. Fiber Optic Connector
5. Personality Module, Thermistors, Head Hours Connector
6. TEC Coolers Inputs/Outputs Connector

Figure 5.5-4. FAP Assembly Interface

FAP-I Removal

1. Install shorting clip (Figure 5.5-3) between anode and cathode of FAP assembly to be removed.
2. Disconnect the anode and cathode connectors (Figure 5.5-4).
3. Disconnect the Case/Anode ground jumper from the FAP assembly.

Wear latex finger cots (supplied with the replacement FAP-I) or gloves while handling the fiber optic cable.

4. Disconnect the fiber optic cable as follows:

   a. While firmly holding the fiber optic cable, loosen and remove the ferrule connector securing the fiber optic cable to the laser diode assembly. It may be necessary to use a small wrench to loosen the connector.

   b. Note that the ferrule is cutout (Figure 5.5-5). Carefully extract the fiber optic cable from the laser diode assembly and remove the ferrule.

   c. Immediately install the two plastic protective caps (Figure 5.5-3), one over the end of the fiber cable and the second over the FAP optical port.

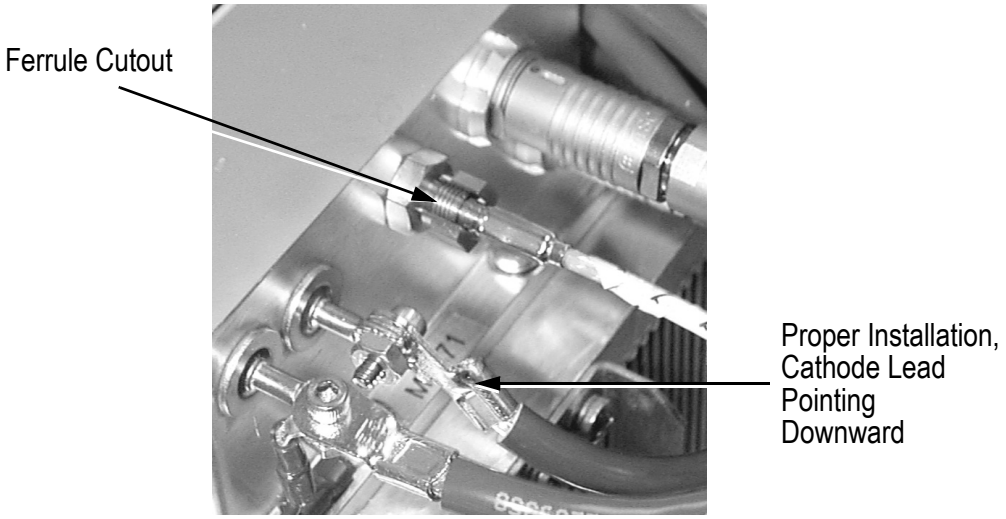


Figure 5.5-5. FAP Fiber Optic Connector

5. Disconnect the Personality module and TEC connectors from the FAP assemblies by pulling back on the outer sleeve and then unplugging the connector.

6. Remove eight screws securing the laser diode assembly to the heat sink (two on each side).

7. Remove the FAP-I assembly from the heat sink on which it rests.

Due to the thermal grease on the bottom of the FAP assembly, it may be necessary to work the assembly loose by rotating (wiggling) it back and forth around its center.

8. Clean the thermal grease from the FAP-I and the mounting surface (methanol or mild cleanser and a soft cloth or paper towels).

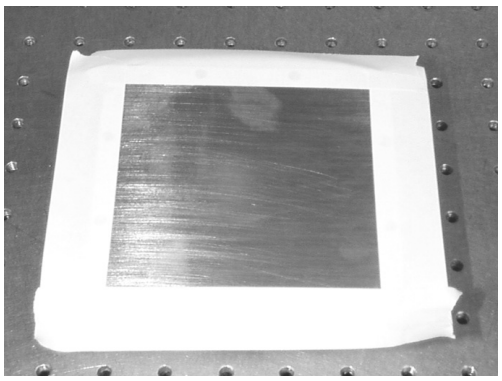


Figure 5.5-6. Preparation of the Replacement FAP Assembly

FAP-I Installation

1. Remove the new laser diode assembly from the shipping container. (Leave the shorting clip and protective plastic cap in place to avoid possible ESD and contamination damage.)
2. Place masking tape over the edges of the FAP-I baseplate as illustrated in Figure 5.5-6.
3. Using a clean metal, plastic, or wooden applicator, apply an even coating of thermal grease to the bottom of the laser diode assembly. The thickness of the grease film should be less than the thickness of the masking tape.
4. Carefully remove the tape from the assembly.
5. Position the FAP assembly on the heat sink.
6. Reattach the Case/Anode ground jumper to the FAP-I baseplate.
7. Secure the FAP-I to the heat sink using the remaining seven mounting screws.

8. Remove any excess thermal grease from around the assembly with methanol-soaked paper towels or cotton swabs.

After connection, the cathode lead (black) should be pointing downwards and the anode lead (red) should be pointing straight out. This is illustrated in Figure 5.5-5. This minimizes the potential of generating/picking-up EM noise.

9. While wearing a personal grounding strap, reconnect the anode and cathode leads. Be sure to reconnect the case/anode ground jumper when connecting the anode lead.
10. Remove the anode/cathode shorting clip.
11. Reconnect the personality module and TEC connectors.
12. Perform the inspection and cleaning procedure to the fiber optic cable surface as detailed in "Fiber Optic Cleaning" on page 5.3-1.
13. Reconnect the fiber optic cable as follows:
    a. Note that the ferrule to connect the fiber optic cable to the laser diode assembly is cutout (Figure 5.5-5). Carefully insert the fiber optic cable into the laser diode assembly.
    b.) While holding the cable secure, tighten the ferrule finger-tight.

Initialization of Diode EEPROM

1. Cycle the AC power on and stop the LBO from heating.
    a. Scroll down to the LBO Settings menu.
    b. Press MENU SELECT.
    c. Press MENU SELECT to initiate cool down cycle.
    d. Press MENU EXIT twice.
2. Establish RS-232 communications with the laser system.
3. Verify the system parameters as recorded from Table 5.1-2, "Laser Parameters," on page 5.1-2.

4. Verify the new FAP-I information:

?NW	(Should be 808.0)
?D1AW	
?D1RCF	(Should be 2%)
?D1RC	
?D1RCM	
?D2AW*	
?D2RCF*	(Should be 2%)
?D2RC*	
?D2RCM*	
?CD*	

Note:

D1 (2) RCM = Diode 1 (2) Rated Current Maximum

D1RCM = [(Rated Current x 115%)] + [(DiodeHours/1000) x (2% x Rated Current)]

Diode current delta is calculated as CD = D1RC – D2RC

The new diode parameters should match those found on the test sheet shipped with the replacement FAP-I assembly. All other parameters should match those initially measured in Table 5.1-2, “Laser Parameters,” on page 5.1-2.

If the values are found to be different, they should be manually reset. Reset system parameters using the initial values from those recorded in the section “Preliminary Steps & Data” on page 5.5-5, values listed from the FAP-I final test sheet (D100357), or calculated/entered with information from the final test data sheet.

If the Diode Rated Current command does not return a value, perform the procedure titled “Determine Diode Rated Currents” on page 5.5-1.

5. Warm up the LBO crystal (this will take approx. 45 minutes).
6. Scroll to LBO Settings Menu and press MENU SELECT twice, then press MENU EXIT.
7. Wait approximately 45 minutes. Once all servos are Locked, verify proper operation of the laser system.

8. Place the laser system in Standby. If the system is a V-18 model, continue immediately to the section titled "V-18 Diode Temperature Optimization" on page 5.2-4. If not, continue to Step 9.
9. Move the jumper from Service to Customer mode.
10. Cycle the AC power or press the blue reset button on top of the CPU board.

This procedure is now complete.

FAP-I Current & Voltage (V & I) Calibration

The FAP-I current and voltage are calibrated in the factory, and there is normally no need to re-calibrate these values. However, the FAP-I current and voltage calibration should be checked when any of the following symptoms/procedures occur:

- Large shifts in current required to obtain a given laser power
- Over- or under-voltage faults are active (Faults 19-22)
- Low current faults are active (Faults 23 and 24)
- EEPROM has been replaced or upgraded.

Measure FAP-I current using an Amp Clamp on the cathode (gray) cable.

Measure FAP-I voltage with a digital voltage meter (DVM) across the anode and cathode.

Diode Current Calibration

1. Switch the laser system from Light control to Current.
   - Press MENU SELECT from the Main Display Menu.
   - Scroll to Light/Current Control Menu
   - Press MENU SELECT and then press MENU SELECT again to enter Current Control mode of operation
   - Press MENU EXIT twice
2. Attach the amp clamp to a DVM and turn the clamp on.
3. Reset the DVM display to zero by adjusting the amp clamp dial.
4. Attach the amp clamp to Diode one's gray wire.
5. Key the laser system to LASER ON.
6. In Service mode, press the MENU SELECT button and scroll to the Calibrate Diode I & V menu.

7. Press MENU SELECT and scroll the arrow to D# 1 I Cal Pt# 1 (@12.00 A for V-2-V-10, @ 20.00 A for V-18).
8. Turn the knob until the current read from the Amp clamp (DVM), is 12.00 A for V-2-V-10, 20.00 A for V-18. Press MENU SELECT to enter the point into calibration memory.
9. Scroll to D# 1 I Cal Pt# 2 (@19.00 A for V-2-V-10, @ 40.00 A for V-18).
10. Use the power supply knob to increase the current to 19.00 A for V-2-V-10, 40.00 A for V-18, as read by the Amp clamp. Press MENU SELECT to store the point.
11. Press MENU SELECT again to recalculate the equation at the top of the screen.

    The offset ($y = mx + b$; b = offset) in this equation should be approximately 2 to 4.

Repeat procedure for the second diode in a 2-diode system.

Move the current clamp and meter to diode 2. All diode 1 references should be read as diode 2.

12. Press the MENU EXIT button twice.

Diode Voltage Calibration

1. Place the current clamp on diode #1 gray wire.
2. Adjust the current until the current clamp reads 20 A.
3. Scroll to the Calibrate Diode I & V menu.
4. Scroll to D#1 V Cal(@20 A).
5. Use the power supply knob to adjust the voltage on the LCD display until it equals the voltage recorded on a volt meter placed across the anode and cathode of diode 1.
6. Press the MENU SELECT pushbutton.

Repeat procedure for the second diode in a 2-diode system.

Move the current clamp and meter to diode 2. All diode 1 references should be read as diode 2.

7. Press MENU EXIT twice. Turn the keyswitch to STANDBY.

Verification of Diode Calibration

1. Wait one full minute after calibrating the diode.
2. Switch the AC power off for at least 5 seconds (the backup battery will start the LBO cool-down), and then turn the power back on. (Or, alternatively, press the blue restart button on the CPU.)
3. Turn the keyswitch to the ON position.
4. After the servo loops have locked, verify the current calibration as follows:
   - Press MENU SELECT
   - Scroll to Light/Current Control Menu
   - Press MENU SELECT and then MENU SELECT again to enter Current Control mode of operation
   - Press MENU EXIT twice
5. The current clamp and external DVM, should be connected to diode 1. Dial up the current until the external meter reads approximately 12 A.
6. Press MENU SELECT, scroll to the Laser Status menu, and press MENU SELECT again.
7. Read the current on Diode 1.

   Compare these values to that read on the current clamp.

   Current tolerance = ± 0.3 A from 12 to 19 A

   Voltage tolerance = ± 0.05 V from 12 to 19 A
8. Press MENU EXIT twice.
9. Dial the current up and check the current displayed against the current clamp at several places between 12 and 20 A.
10. Turn the keyswitch to the STANDBY position.

Repeat the procedure for the second diode in a 2-diode system.

Move the current clamp and meter to diode 2. Read all "diode 1" references as "diode 2".

Light Mode Operation Test

1. Press MENU SELECT and scroll to Light/Current Control menu.
2. Press MENU SELECT to enter Light Control and then press MENU EXIT twice.

Note: The power meter must be "cold" or at room temperature unless using an LM-100 power sensor.

3. Turn the power supply control knob until the system is producing max power (2.2, 5.5, 6.5, 8.5, 10.5, 18.5 W, respective to the type of Verdi system) on an external power meter.
4. Turn the keyswitch to the ON position.
5. Verify that the power on the power meter is within 5% of the displayed value on the power supply LCD screen.
6. Terminate the RS-232 connection to the power supply and disconnect the serial cable.
7. Place the keyswitch to STANDBY.
8. Reset CPU jumper JP9 to Customer mode and press the blue CPU reset button.
9. After the CPU resets, reinstall the power supply top cover.

Introduction

This procedure should be followed when re-calibrating the internal photocell. The photocell will require calibration when:

- Following a head EEPROM reset
- There is a 15% discrepancy between the internal photocell and an external power meter
- Following a head/power supply swap
- Following a software upgrade of one-point photocell calibration to two-point calibration

Photocell Calibration

Current Control

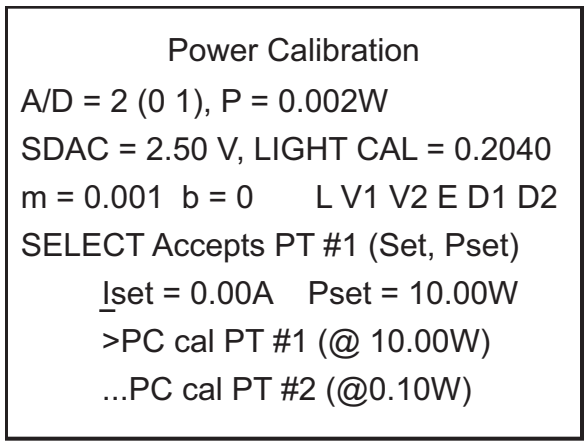
1. Turn the keyswitch to the STANDBY position.
2. Remove the power supply cover.
3. Jumper JP9 on the CPU board to access the service menus.
4. Press the blue CPU reset button.
5. From the top level menu, press MENU SELECT to access the Base Menu.
6. Using the arrow keys, scroll down to “Calibrate Photocell”, and press MENU SELECT.
7. Set up a calibrated external power meter.

Note: The power meter must be “cold” or at room temperature unless using an LM-100 power sensor.

8. Turn the keyswitch to the LASER ON position, and open the laser shutter.

9. Using the front panel knob, increase the laser current until the rated laser power is measured on the external power meter.

Verdi V-2	2.0 Watts
Verdi V-5/V-5 Uno	5.0 Watts
Verdi V-6 Uno	6.0 Watts
Verdi V-8	8.0 Watts
Verdi V-10	10.0 Watts
Verdi V-18	18.0 Watts



m = slope
b = intercept
Iset = current adjust
...PC = calibration at low power
L = LBO
V1 = Vanadate 1
V-2 = Vanadate 2 (V-18 only)
E = etalon
D1, D2 = diodes 1, 2
Pset = power adjust

Figure 5.7-1. Photocell Calibration Menus

10. Move cursor to PC cal PT#1 and arrow pointing at “Iset = ...A” (if not there already).

11. Adjust the current until the power meter reads “Rated Laser Power”, or if the slope of the power curve is steep, then adjust for the power closest to rated that results in stable operation.

If you cannot obtain Operating Power due to the setting of the current (I), push the Power Adjust knob until the cursor moves to "Pset". Then, adjust the power to the current setting (In Figure 5.7-1, the cursor is on "Iset").

12. Verify the A/D count is between 2000 and 2500. If not:
    a. Remove the head cover and locate R55 on the head board. R55 is an adjustable potentiometer, located next to the J105 connector, near the front of the laser head. (Refer to Figure 5.7-2 to locate R55.)
    b. Adjust R55 until the A/D value falls between 2000 and 2500.
    c. Replace the head cover.
13. Once the letters "L V1 V2 E D1 D2" appear on the screen, ensure that the arrow now points to "Pset". (Note: V2 only exists on V-18 models.)
14. Press MENU SELECT to calibrate that point.
15. When the prompt "Push menu down to adjust PT#2" appears, move the cursor to PC cal PT#2.
16. Decrease the current until the power meter reads ~ 0.1 to 0.5 Watts, or until you have about 100 ADC counts. Wait until the letters "L V1 V2 E D1 D2" appear on the screen. (Note: V2 only exists on V-18 models.)
17. Move the arrow to Pset, then adjust Pset to match the power meter reading.

If you cannot obtain Operating Power due to the setting of the current (I), push the Power Adjust knob until the cursor moves to "Iset". (In Figure 5.7-1, the cursor is on "Iset".)

18. Press MENU SELECT to calibrate point #2.

Continue with the procedure titled "Light Mode" to complete the Photocell Calibration.

Light Mode

1. After calibrating PT#2 in current control, you will see prompt: "Menu down to enter light mode." Move cursor down and press MENU SELECT to enter light mode.
2. The current will automatically increase for output, which is close to specified power. The arrow will be positioned at Pset. Wait for the current reading to stop changing and all letters "L V1 V2 E D1 D2" to appear on the screen. (Note: V2 is present in V-18 models only.)

   If you can't get full power, check to see that the SHUTTER OPEN indicator is lit on the shutter pushbutton.
3. Adjust Pset to match the power reading. Press MENU SELECT to calibrate PT#1.
4. Move the cursor down to calibrate PT#2. The current will decrease automatically for an output of ~ 0.10 W. Wait for the current reading to stop changing and all letters "L V1 V2 E D1 D2" to appear on the screen. (Note: V2 is present in V-18 models only.)
5. Adjust Pset to match the power reading.
6. Press MENU SELECT to calibrate PT#2. The Calibration menu will automatically exit to the main menu and the system will be set for 0.10 W in light loop.
7. Check the calibration accuracy at several points. (If an adjustment of power is necessary, go to the Photocell Calibration menu and repeat the entire procedure.)
8. Turn the keyswitch to the STANDBY position.
9. Set CPU jumper JP9 to Customer mode.
10. Press the blue CPU reset button or cycle the AC power.
11. Replace the power supply cover.

The photocell calibration is now complete.

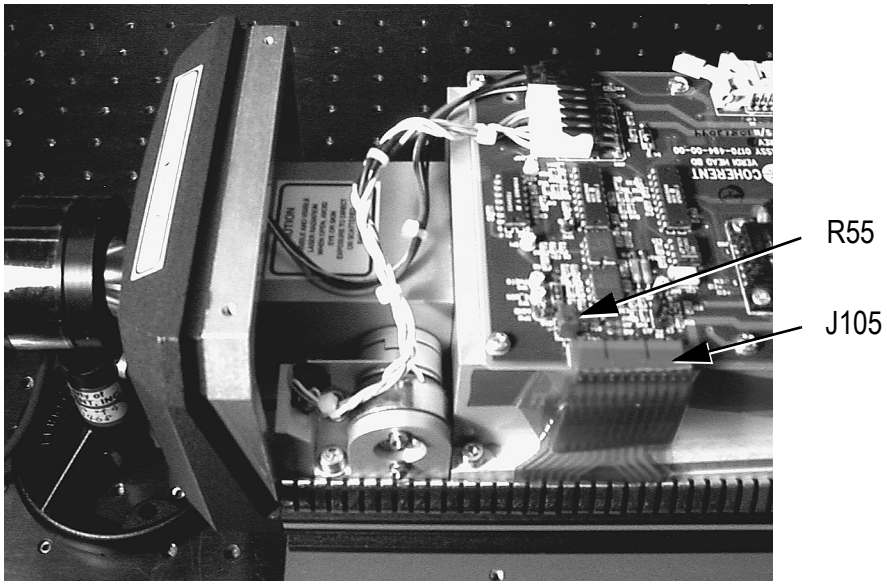


Figure 5.7-2. Position of R55 on the Verdi Head Board

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Introduction

The LBO backup battery in the power supply must be replaced after the fault message, "Battery Low" is displayed on the front panel of the power supply. Failure to do so could result in damage to the system when coupled with an AC power loss.

Do not turn the power switch off or disconnect the AC power input until the LBO cool-down cycle is complete.

Preliminary Steps & Data

1. Place the laser system in Standby mode and remove the top cover of the power supply.
2. Jumper JP9 on the CPU board so the service menus can be accessed and press the blue reset button.
3. After the CPU resets, turn the keyswitch to the LASER ON position.
4. Record the system parameters listed in Table 5.1-2, "Laser Parameters," on page 5.1-2.
5. Perform the "Turn-off (Complete Shut Down)" procedure located in Section Three of the Operator's Manual. The front panel display will indicate when the cool-down cycle is complete.
6. After the LBO cool-down cycle is complete, turn the power switch on the power supply rear panel to the OFF position.
7. Disconnect the power cord from facility power.

Battery Removal and Installation

1. The Verdi backup battery is located towards the front (with respect to the power supply front display) right hand corner of the Verdi power supply.
2. Remove the two Phillips-head screws that secure the battery retaining bracket in place (see Figure 5.8-1) and remove the bracket.

3. Unplug the ground (black) wire, and then the positive (red) wire.
4. Remove the depleted battery and install the replacement. The positive connection should be made before the ground wire is connected.
5. Reinstall the battery retaining bracket and reconnect the laser system to the facility power.

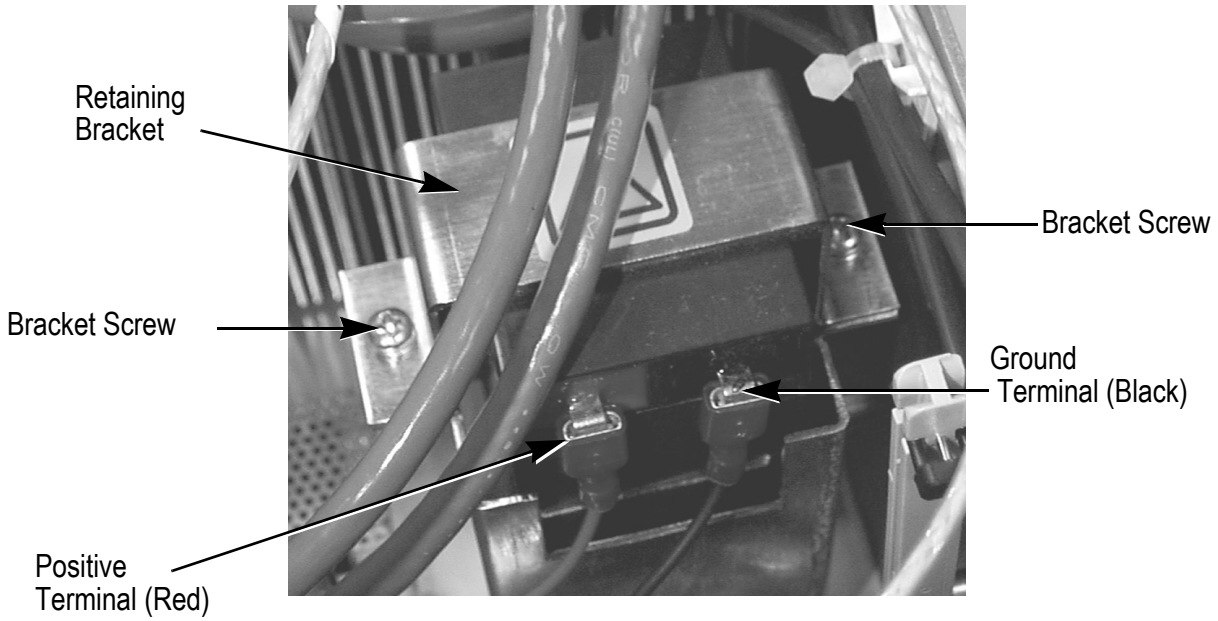
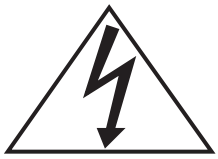


Figure 5.8-1. Power Supply Backup Battery



The charge on the backup battery can be measured across the battery terminals with a digital voltage meter (DVM). AC power to laser system (switch on back panel) be off when measuring battery voltage. A fully charged battery should read between 12 and 13.4 V.

Battery Charge Circuit Verification

After installing the battery, verify the battery charge circuit.

1. Attach a DVM across R8 on the Mother board (R9 on V-18 Mother boards). The polarity of hookup is not important. The voltage read will depend on battery charge; see Table 5.8-1.
2. With the facility power on, the meter should initially read 245 mV and begin counting down. The voltage and speed at which the meter counts down will depend on the initial charge state of the battery (see Table 5.8-1). The voltage across the battery terminals should read between 13 and 14.6 V.

Table 5.8-1. Battery Charge Circuit Voltages

BATTERY STATE	BATTERY VOLTAGE	CHARGE CIRCUIT VOLTAGE
Very Low	9 V to 11 V	245 mV
Low	11 V to 12 V	245 mV to 200 mV
Moderate	12 V to 13 V	160 mV to 100 mV
Fully Charged	13 V to 13.4 V	60 mV to 10 mV
Over Charged	Over 13.4 V	0 mV

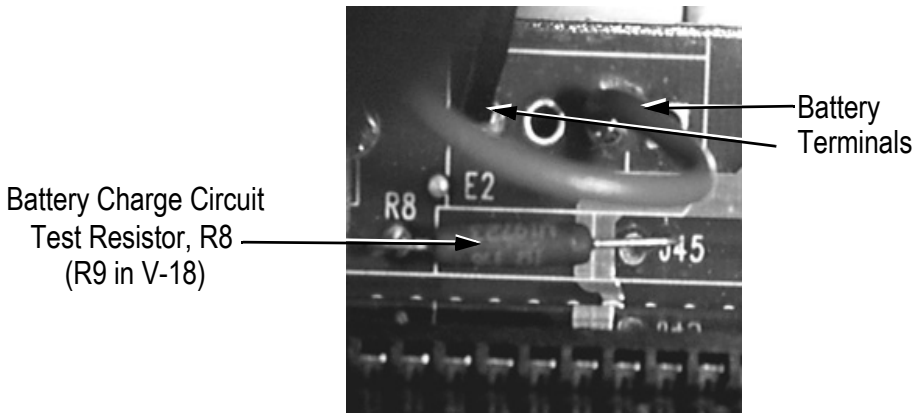


Figure 5.8-2. Location of Battery Charge Circuit Resistor

Verification of Successful Installation

1. Perform the "Turn-on (Cold Start)" procedure located in Section Three of the Operator's Manual. (The "Battery Low" message should no longer be displayed on the power supply front panel.)
2. Verify the system data collected at the beginning of this procedure, as recorded in Table 5.1-2, "Laser Parameters," on page 5.1-2.
3. Turn the keyswitch to the STANDBY position.
4. Reset the CPU jumper to Customer mode of operation and press the blue reset button on the CPU board or cycle AC power.
5. After the CPU resets, re-install the power supply top cover.
6. Verify that the laser is free of system faults, and disconnect serial cable.

This procedure is now complete.

Electrostatic charges as high as 4000 V readily accumulate on the human body and equipment and can easily discharge without detection. Although the electronics features have impressive input protection, permanent damage may occur on devices subjected to high-energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation.

The most common ESD damage occurs while handling the device during installation or use. Please take necessary measures to protect the system from ESD.

Dry air and carpet can create even higher potential for ESD. Precautions must be taken for demonstrations or trade show exhibitions.

Introduction

The following procedure must be followed when upgrading software.

Note: Do not turn the AC power switch to the OFF position or disconnect the AC power input until the cool-down cycle is complete.

Preliminary Steps & Data

When upgrading to software version 8.83, reference FSB #460, paying specific attention to items 4 through 7 on page 2, concerning the power supply, LBO and diode temperature servos.

1. Place the laser system in Standby mode and remove the top cover of the power supply.
2. Jumper JP9 on the CPU board such that service menus can be accessed; and press the blue reset button.
3. After the CPU resets, turn the keyswitch to the LASER ON position.
4. Record the information as noted in Table 5.1-2, "Laser Parameters," on page 5.1-2.
5. Perform the "Turn-off (Complete Shut Down)" procedure located in Section Three of the Operator's Manual. The front panel display will indicate when the cool-down cycle is complete.
6. After the LBO cool-down cycle is complete, turn the power switch on the power supply rear panel to the OFF position and disconnect the power cord from facility power.

EEPROM Removal and Installation

To access the EEPROM, the CPU board must be disconnected and removed from the power supply.

The EEPROM is susceptible to ESD. Wear an ESD wrist strap when performing this procedure.

1. Carefully unplug the ribbon cable connecting the CPU board to the Display board by pushing the two black retaining latches downward (see Figure 5.9-1).
2. Unplug the diode drive cable (J1); see Figure 5.9-1.
3. Unlock the CPU board from the Mother board guide rails by pressing the pins inward.
4. Remove the CPU board by lifting the two white tabs located on the outer edges of the board. See Figure 5.9-2.

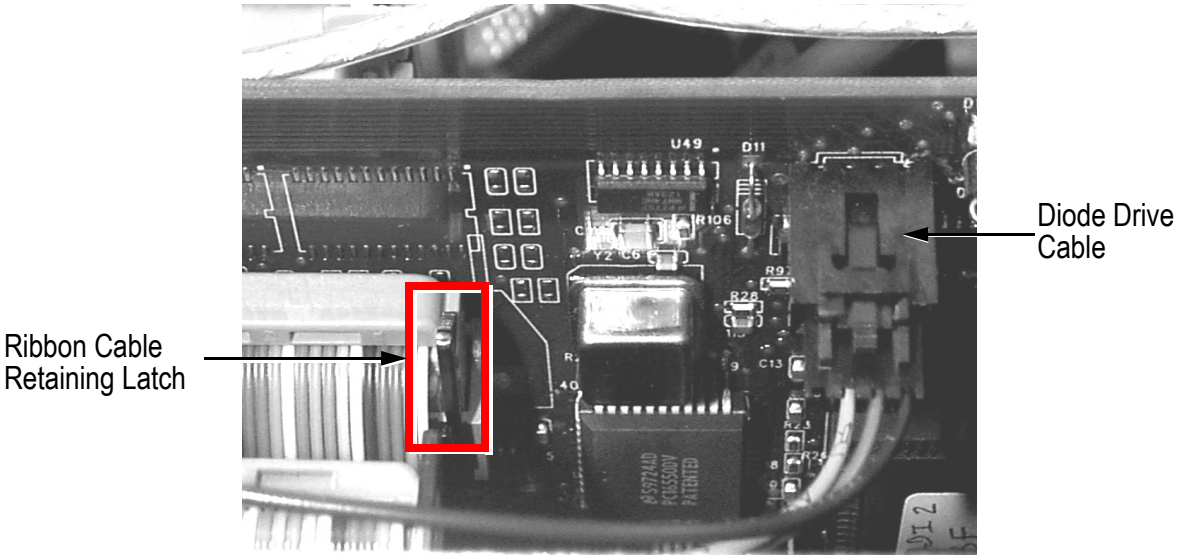


Figure 5.9-1. CPU Board Cable Connectors

5. The EEPROM is located in the lower right-hand corner of the CPU board as illustrated in Figure 5.9-3. Note the orientation of the EEPROM. The slots in the EEPROM socket are used to extract the integrated circuit (IC).
6. Insert the hooked-end of the EEPROM removal tool, illustrated in Figure 5.9-4, into the socket slots.
7. While alternating between the corners of the IC socket, carefully extract the old EEPROM by applying upward pressure.
8. Insert the replacement EEPROM. Note that one edge is beveled. This beveled edge must be installed closest to the outside edge of the CPU board.
9. Re-install the CPU board and re-lock the board to the two guide rails extending from the Mother board.

EEPROM Initialization

Initialize the new EEPROM after installation.

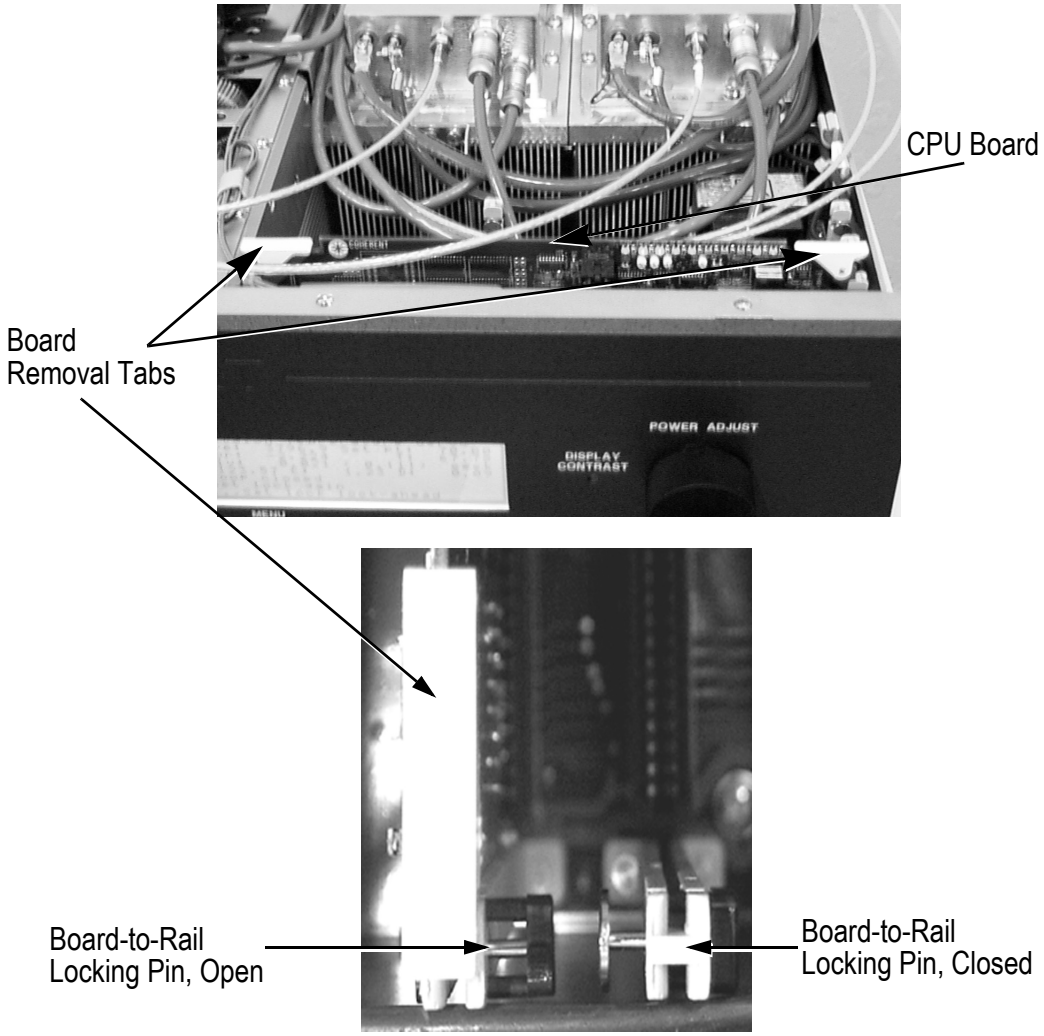


Figure 5.9-2. Verdi CPU Board

1. Power the system on from a cold start.
2. Stop the LBO from heating:
   - Scroll down to LBO Settings menu
   - Press MENU SELECT
   - Press MENU SELECT to initiate cool-down cycle
   - Press MENU EXIT twice
3. Initialize the CPU EEPROM (loads new gain values):
   - Press MENU SELECT

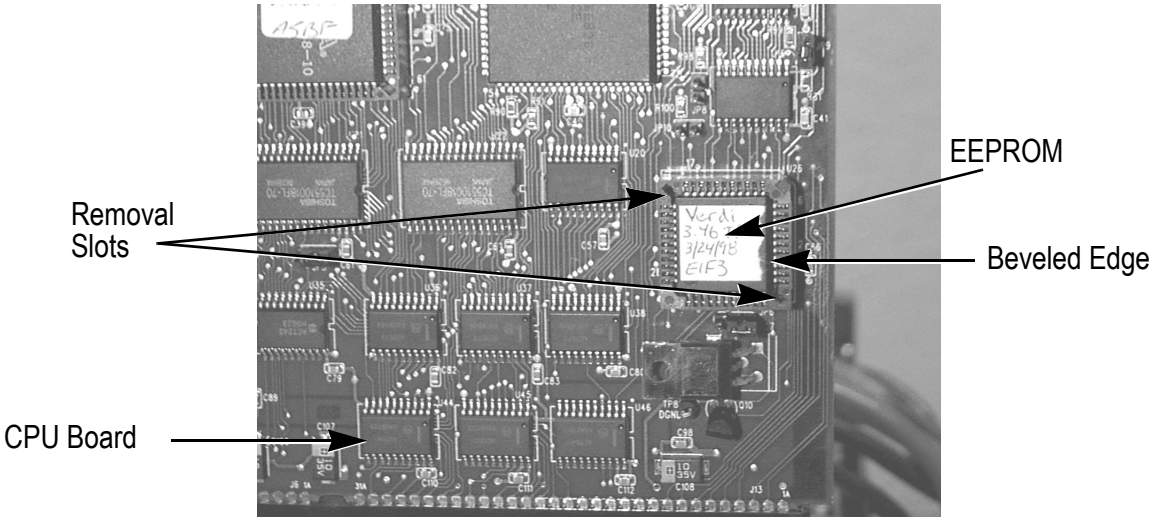


Figure 5.9-3. Location of EEPROM on CPU Board

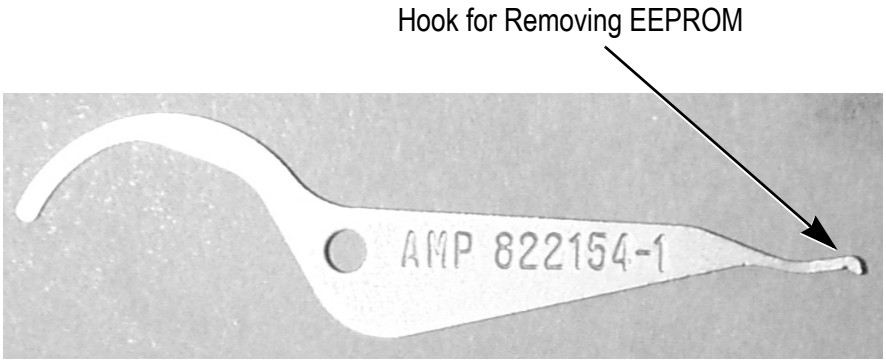


Figure 5.9-4. EEPROM Removal Tool

- Scroll to the EEPROM Diagnostics menu
- Press MENU SELECT
- Scroll the arrow to CPU Values
- Press MENU SELECT
- Press MENU EXIT

4. Wait one minute after step 2 (this gives the CPU time to update the EEPROM).
5. Cycle the AC power off and then on again.
6. Stop the LBO from heating:

- Scroll down to LBO Settings menu
- Press MENU SELECT
- Press MENU SELECT to initiate cool-down cycle
- Press MENU EXIT twice

7. Verify information recorded in Table 5.1-2, "Laser Parameters," on page 5.1-2.
8. Scroll to LBO Settings menu and press MENU SELECT to initialize LBO heating.
9. Allow 45 minutes for the LBO to reach the set temperature. Once all servos are locked, verify proper operation of the laser system.

Diode Calibration

The diodes may require current and voltage calibration (it will be required if the actual current from a current clamp and the display current are not the same). If calibration is required, follow the procedures titled "FAP-I Current & Voltage (V & I) Calibration" on page 5.6-1, which include "Diode Current Calibration", "Diode Voltage Calibration", "Verification of Diode Calibration", and "Light Mode Operation Test".

The EEPROM upgrade procedure is now complete. The system operational parameters at operating power should be recorded on the Service Report. When all data has been recorded, ensure the system is placed back in Customer Mode.

If any fault messages are displayed by the system, the proper corrections should be attempted. If the fault can not be cleared, contact Coherent customer support.

FSBs

Table 6.1-1. Field Service Bulletins

NO.	DATE	TITLE
346	06/19/1998	Establish Database for LBO Self Heating
351	09/28/1998	Verdi Software Revision “B”
353	09/28/1998	Verdi Rectifier Screws
354	10/13/1998	Verdi noise Assembly Transformer Screws
355	12/08/1998	Replacement of Signal Interconnect Board
356	12/08/1998	Revision “B” Software Bugs
362	02/10/1999	Verdi Software Revision “C”
364	03/31/1999	Verdi/Neslab Chiller Fittings
370	09/16/1999	Mother Board Replacement Procedure
371	09/16/1999	New Keyboard Part Number
372	09/16/1999	Verdi Power Distribution board Revision
373	09/16/1999	Introduction of Verdi Software v-6.0 and the Viper Light Show Laser
386	08/23/2000	Thermotek Chillers to Replace Neslab Chillers for Mira, Verdi, Vitesse and Coherent Scotland Product Lines
387	08/23/2000	Release of Version 6.03 Software & Release of Verdi OEM Laser
388	08/23/2000	Solutions for Clogged Water Flow in Verdi V-10 Systems with CFT-25 Chillers
389	08/23/2000	New Part Numbers for Verdi, Vitesse and Avia Fap-I Kits
390	08/23/2000	New Air Cooled Power Supply for the Verdi V-10
407	10/25/2001	Blockage in Water-Cooled Verdi and Vitesse Systems
417	1/22/2003	Release of Version 7.82 Software for High-Power Verdi’s
420	5/14/2003	Calling of Ultrafast Laser Systems: ThermoTek Chiller Issues, Clogged Verdi Baseplates, New Water Manifold, and Cooling Loops.
425	9/15/2003	Release of Version 7.93 Software for High Power Verdi Systems.

Table 6.1-1. Field Service Bulletins

426	10/14/2003	Conversion of Lambda Power Supply to Pioneer Magnetics.
437	09/10/2004	Release of Version 8.33 Software for Verdi
441	11/29/2004	New Design Front Panel for Diode Pumped Products
442	12/06/2004	Possible Faulty Components
446	12/22/2004	T255P Chiller Rev C05 Software Upgrade
450	02/15/2005	New Verdi Ver8 Software
453	03/29/2005	New Style FAP-I Package for Diode Pumped Products
460	05/25/2005	Updated FAP-I Replacement for Verdi (including V-18)
463	08/04/2005	Corrective Action for Verdi CPU Boards
467	09/06/2005	Low Power Verdi Lasers Manufactured with UNO Power Supplies

Introduction

All schematics with their current revisions within the Verdi Platform Service Manual are listed below.

DRAWING TITLE	REVISION	DRAWING NUMBER	SHEETS INCLUDED
Verdi Electrical Block Diagram	A	0171-837-00	2
Verdi Signal Interconnect Diagram	A	0171-838-00	5
POWER DISTRIBUTION BOARDS			
UNO V-2 to V-6	AD	1008454	7
Two-FAP V-2 to V-10, OEM	DF	0169-430-01	9
V-18	AG	1052803	8
Power Piggy Board (All Non-UNO)	CD	0178-523-00	3
CPU BOARDS			
UNO/TWO-FAP V2-V6	AC	0174-924-00	12
V-8, V-10, V-18, OEM	AB	1006411	11
MOTHER BOARDS			
UNO/Two-FAP V-2 to V-10	AB	0171-954-00	4
V-18	AC	1058961	5
OEM	AB	1005581	4

DRAWING TITLE	REVISION	DRAWING NUMBER	SHEETS INCLUDED
SIGNAL INTERCONNECT BOARDS			
UNO/Two-FAP V-2 to V-6, V-8, V-10	AA	0175-201-00	3
V-18	AA	1059124	3
OEM	CB	1006169	3
DISPLAY BOARDS			
All Short Power Supplies	AC	1042908	3
All Tall Power Supplies	AE	1054607	3
KEY BOARDS			
All Short Power Supplies	AA	1057382	2
All Tall Power Supplies	AC	1042244	3
HEAD BOARDS			
UNO/Two-FAP V-2 to V-6, V-8, V-10, OEM	BB	0174-911-00	3
V-18	AB	1059434	3
VANADATE2 DRIVERBOARD			
V-18	AC	1053479	2
NOISE BOARDS			
Noise Filter Board (All)	AB	0171-398-00	2
Noise Filter Piglet (All)	AA	0172-904-00	2
SHUTTER BOARD			
OEM	AA	0176-743-00	2

Introduction

Below, are all spare parts listed within the Verdi Platform Service Manual.

	DESCRIPTION	PART NUMBER	COMMENT
Two-FAP Power Supply	**V-2/V-5/V-6/VIPER CIRCUIT BOARDS**		
	Front Panel Assembly	1065418	
	Power Distribution Assembly	0170-368-51	
	CPU Board	0174-924-50	
	Mother Board	0171-954-50	
	Signal Interconnect Board	0175-201-50	
	Head Board	0174-911-50	
	Power Piggy Board	1042723	
	V-8/V-10/VIPER CIRCUIT BOARDS		
	Front Panel Assembly	1064183	
	Power Distribution Assembly	1051109	
	CPU Board	1046338	
	Mother Board	0171-954-50	
	Signal Interconnect Board	0175-201-50	
	Head Board	0174-911-50	
	Power Piggy Board	1042723	
	V-18 CIRCUIT BOARDS		
	Front Panel Assembly	1064183	
	Power Distribution Assembly	1066656	
	CPU Board	1046339	
	Mother Board	1066659	
	Signal Interconnect Board	1066660	
	Vanadate2 Driver	1066654	
	Headboard	1066662	
	Power Piggy Board	1042723	

	DESCRIPTION	PART NUMBER	COMMENT
UNO PowerSupply	**V-2/V-5/V-6/VIPER CIRCUIT BOARDS**		
	Front Panel Assembly	1065418	
	Power Distribution Assembly	1069537	
	CPU Board	0174-924-50	
	Mother Board	0171-954-50	
	Signal Interconnect Board	0175-201-50	
	Head Board	0174-911-50	
OEM PowerSupply	**VERDI OEM CIRCUIT BOARDS**		
	Display Assembly	1042899	
	Signal Interconnect Board	1006169	
	Shutter Board	0176-743-00	
	CPU Board	1046338	
	Mother Board	1005581	
	Head Board	0174-911-50	
	COMMON CIRCUIT BOARDS		
	Noise Reduction Assembly	0172-905-50	
	REFURBISHED LASER HEADS		
	Refurbished Verdi V-2/Viper Head	R172-417-50	
	Refurbished OEM Verdi V-2 Head	1050201	
	Refurbished Verdi V-5/Viper Head (Two FAP)	R172-416-50	
	Refurbished Verdi V-5/Viper Head (UNO)	1008767	
	Refurbished OEM Verdi V-5 Head	1007594	
	Refurbished Verdi V-6/Viper Head	1037621	
	Refurbished OEM Verdi V6 Head	1037876	

	DESCRIPTION	PART NUMBER	COMMENT
	Refurbished Verdi V-8/Viper Head	R176-099-50	
	Refurbished OEM Verdi V-8 Head	1051776	
	Refurbished Verdi V-10/Viper Head	R175-077-50	
	Refurbished OEM Verdi V-10 Head	1051777	
	Refurbished Verdi V-18 Head	1051758	
	REFURBISHED POWER SUPPLIES		
	Refurbished Power Supply, Verdi V-2/Viper (Two-FAP Power Supply)	R174-525-51	
	Refurbished Power Supply, Verdi V-2 (UNO Power Supply)	1070707	
	Refurbished Power Supply, Viper V-2 (UNO Power Supply)	1070708	
	Refurbished Power Supply, OEM Verdi V-2	1050200	
	Refurbished Power Supply, Verdi V-5/Viper (Two-FAP Power Supply)	R172-525-52	
	Refurbished Power Supply, Verdi V-5 (UNO Power Supply)	1070709	
	Refurbished Power Supply, Viper V-5 (UNO Power Supply)	1070710	
	Refurbished Power Supply, OEM Verdi V-5 UNO	1037881	
	Refurbished Power Supply, OEM Verdi V-5	R174-525-53	
	Refurbished Power Supply, Verdi V-6 (UNO Power Supply)	1070711	
	Refurbished Power Supply, Viper V-6 (UNO Power Supply)	1070712	
	Refurbished Power Supply, OEM Verdi V-6	1037882	
	Refurbished Power Supply, Verdi V-8/Viper	R175-100-50	
	Refurbished Power Supply, OEM Verdi V-8	R175-100-51	
	Refurbished Power Supply, Verdi V-10/Viper (water- cooled)	R174-905-50	

	DESCRIPTION	PART NUMBER	COMMENT
	Refurbished Power Supply, Verdi V-10/Viper (air-cooled)	R178-281-50	
	Refurbished Power Supply, OEM Verdi V-10 (air-cooled)	R174-905-51	
	Refurbished Power Supply, Verdi V-18 (air-cooled)	1068650	
	FRUS AND ASSEMBLIES		
	Shutter Assembly, Solenoid	0171-298-51	
	Pioneer Magnetics Power Supply	4001-0318	
	Battery, 12-volt, rechargeable	4002-0031	
	Fuse, 4 A/250 V	5110-0088	UNO only
	Fuse, 7 A/250 V	5110-0241	UNO only
	Fuse, 10 A/250 volt T-Delay, 0.25” x 1.25”	5110-0072	
	Fuse, 15 A/250 volt T-Delay, 0.25” x 1.25”	5110-0002	
	Power Entry Module Assembly, 2P, ST, 90-Amp	0175-551-00	
	Power Cord, 13 A, 125 VAC, 10-ft	6005-0145	
	Power Cord, 13 A, 125 VAC,10-ft, No plug	6005-0146	
	Water Chiller (Thermotek T255)	1037271	
	SOFTWARE		
	Programmed Software EPROM (for CPU Board)	1055310	Verdi 7.93
	CABLES		
	Cable, PS to Signal Connect BD	0170-602-00	
	Cable, FAP-l to motherboard	0171-494-00	
	Cable, TEC#1, 3P, 24"	0171-495-01	
	Cable, TEC#2, 4P, 18"	0171-495-02	
	Cable, CPU-Display 64 pin RBN	0170-517-00	

DESCRIPTION	PART NUMBER	COMMENT
Cable, Pwr Supply Interlock	0170-759-00	
Cable, Laser Emission	0171-635-00	
Cable, Signal to noise Board	0171-639-00	
CABLE, ASSY AC POWER LINES	1035720	
CABLE, ASSY DC POWER CONNECTION	1035721	
Cable, CPU to Power Distribution Board	0171-641-00	
MECHANICAL		
Top Cover, CE	0171-889-00	
Top Cover, OEM	0174-835-00	
Top Cover, OEM SST	1052113	Stainless Steel
Top Cover, Hatch OEM	0174-836-00	
Top Cover, Hatch OEM SST	1052114	Stainless Steel
Hatch Cover, OEM	0174-836-00	
Air Filter, V2/V5/V6/Viper	0170-382-00	
Air Filter, V8/V10/Viper	0172-568-00	
Ext Interlock Plug	0171-642-00	
Conductively Cooled Riser	0171-530-00	
Water Cooled Riser	0171-531-50	
Convective Cooled Riser (for Viper)	0176-325-00	
Rack mount kit	0172-720-00	
Rack mount kit OEM	0172-720-02	
Head mounting clamps and pins (kit)	0172-826-00	
Front Panel Keys, set of 2	5107-0143	

DESCRIPTION	PART NUMBER	COMMENT
MANUALS		
V-2/V-5/V-6 Preinstallation Manual	0171-796-00	
V-2/V-5/V-6 Operator's Manual	0171-750-00	
V-8/V-10 Preinstallation Manual	0175-452-00	
V-8/V-10 Operator's Manual	0174-929-00	
Viper V-5/V-6 Operator's Manual	0176-180-00	
Viper V-8/V-10 Operator's Manual	0176-181-00	
OEM Verdi Operator's Manual	0178-048-00	
V-18 Operator's Manual	1065343	
FAP-I KITS		
V-2/V-5/Viper/OEM FAP-I Kit	0175-589-00	
V-5 UNO/Viper/OEM FAP-I Kit	1037865	
V-6/Viper/OEM FAP-I KIT	1036352	
V-8/Viper/OEM FAP-I Kit	0178-501-50	
V-10/Viper/OEM FAP-I Kit	0175-723-00	
V-18 FAP-I Kit	1063072	
SERVICE KIT		
Verdi Service Kit (complete)	0174-900-00	
Fiber, SMA-SMA, 1 m	1005923	
Fiber Optic connector, for V-2, V-5	0211-024-00	Phase Out
Fiber Optic connector, for V-8, V-10	0178-668-00	

	DESCRIPTION	PART NUMBER	COMMENT
	WATER FITTINGS		
	Water Cooled Riser/Power Supply Service Kit	1005773	
	Stainless Hose Barbs for Water Riser	2518-0639	
	Thermotek chiller: 1/4” Quick Disconnect Adapter Ftg.	1051825	Female
	Thermotek chiller: 1/4” Quick Disconnect Compression Valve Ftg.	1051826	Male
	Water riser only Quick Disconnect	1042405	Female
	Water riser only Quick Disconnect	1042406	Male
	SHIPPING CRATES		
	V-2/V-5/V-6/Viper Shipping Crate	0171-654-00	
	V-8/V-10/V-18/Viper Shipping Crate	0175-091-00	
	OEM Shipping Crate	0178-008-00	

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