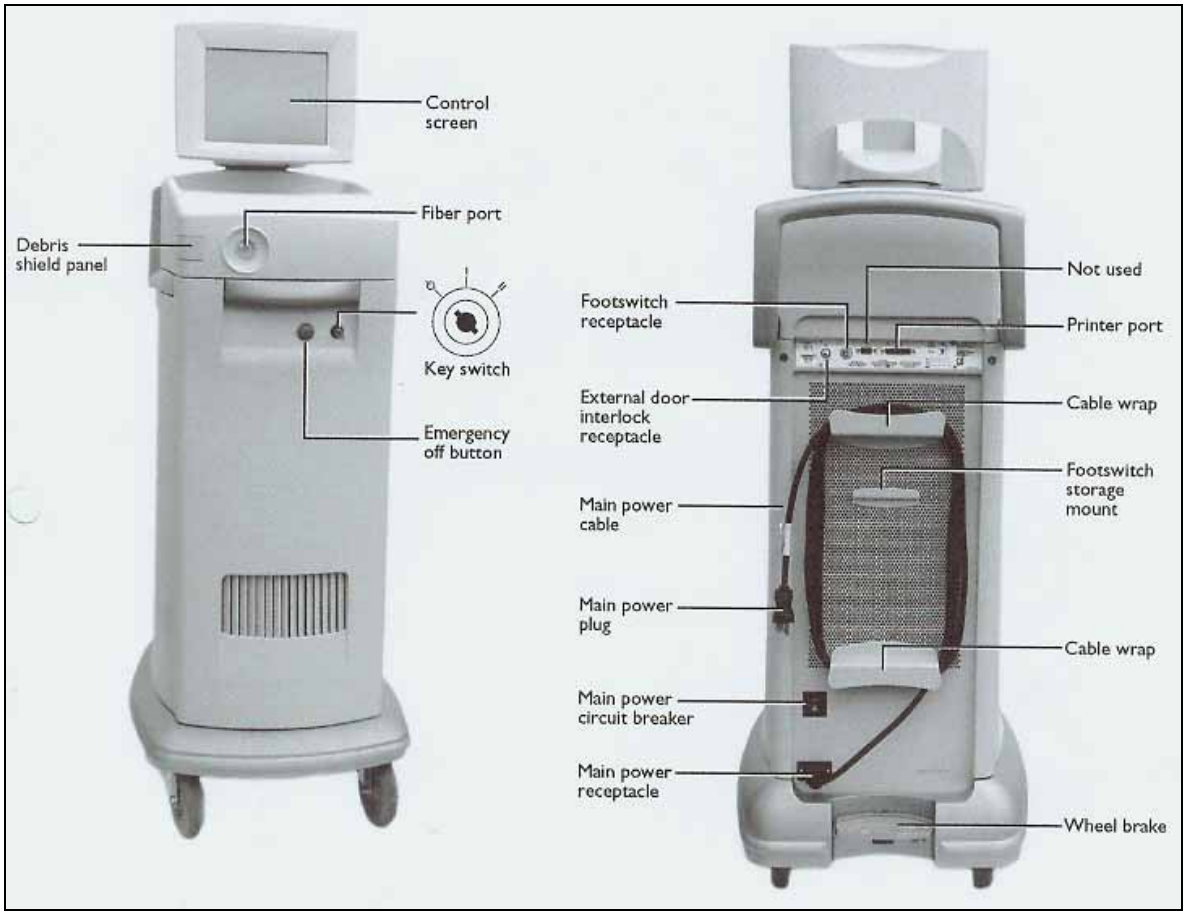
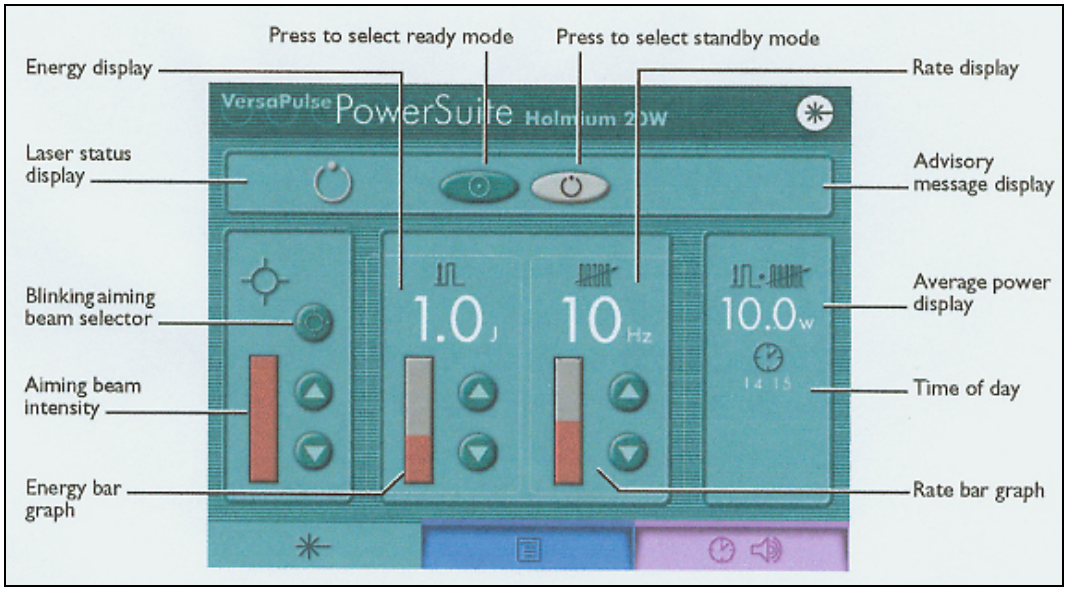
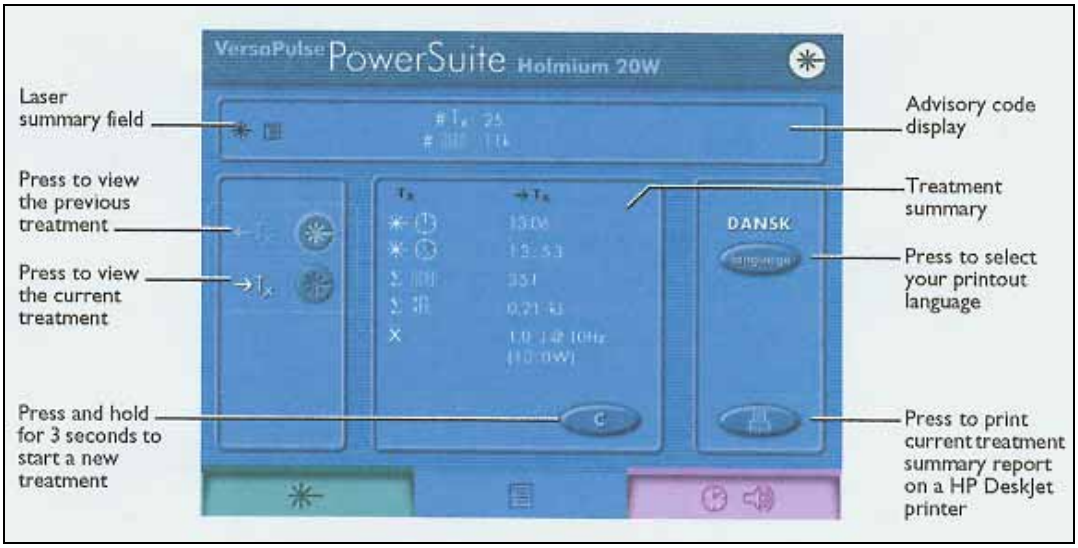
VersaPulse PowerSuite Holmium 20 Watt laser

All View



Control Screen View





Control Screen tabs

Tabs at the bottom of the control screen provide access to the following functions:

Tab	Functions
Treatment	Select ready or standby mode
	Set the laser energy (joules)
	Set the pulse rate (hertz)
	View average power in watts
	Set the aiming beam intensity
	Select a blinking or continuous aiming beam
	View any advisory message
	View time of day
Summary	View cumulative treatments and pulses
	View summary of either current or previous treatment
	View treatment start and end times, number of pulses, total energy delivered to tissue, and average laser parameters
	Start a new treatment
	Print treatment summary report-view every laser parameter setting used during the treatment for a complete case analysis
Options	Select the English or icon viewing mode
	Set the date and time
	Set the laser beep volume to suit your operating environment
	Select 24hour or 12 hour (AM/PM) format

Troubleshooting Guide

If the instrument fails to operate properly, this troubleshooting guide will help you to locate and correct the malfunction. First, check the following items:

- Electrical power source - Verify that the electrical disconnect switch, the circuit breaker, is turned on.
- Laser console electrical – Verify that the laser is on and properly connected to an electrical service outlet.
- External door interlock – If the external door interlock is used in conjunction with a remote switch, verify that the external door interlock plug is inserted in the external door interlock receptacle. Close the interlocked door.

Symptom	Probable Cause	Suggestion
The laser does not turn on. The control screen does not illuminate.	The laser is not plugged in.	Plug in the laser
	The laser main power circuit breaker is in the off (down) position.	Place the laser main power circuit breaker in the on (up) position, and wait 5 seconds before turning the key switch.
	The building power (main electrical service) is turned off.	Turn on the building power.
	The electrical outlet is defective.	Use another outlet, or have the outlet professionally tested and repaired, if necessary.
Inadequate or no aiming beam.	The aiming beam is off or set to low intensity	Adjust the aiming beam intensity.
	The delivery system optical fiber is defective.	Replace the delivery system.
	The endoscopic camera light is too bright (when using an endoscopic camera with the delivery system).	Lower the intensity of the camera light.
	The debris shield is blown.	Inspect and, if necessary, replace the debris shield as instructed in the “User Maintenance” section of the manual. Note – If your debris shield requires replacement, you should also replace your delivery system optical fiber; the debris shield is typically blown by failed fibers.
	The aiming beam is malfunctioning.	Contact your local Lumenis service representative.
No laser power from end of optical	The delivery system optical fiber is defective.	Replace the delivery system.

fiber.	The debris shield is blown.	Inspect and, if necessary, replace the debris shield as instructed in the “User Maintenance” section of this manual. Note – If your debris shield requires replacement, you should also replace your delivery system optical fiber; the debris shield is typically blown by failed fibers.
	The laser is malfunctioning.	Contact your local Lumenis service representative.
“Attach fiber” advisory message appears on the control screen.	The delivery system laser connector is not properly connected to the laser.	Connect the delivery system as instructed in the “connection Instructions” section of this manual.
“Attach footpedal” advisory message appears on the control screen.	The footswitch is not properly connected to the laser.	Connect the footswitch as instructed in the “Connection Instructions” section of this manual.
“Check interlock” advisory message appears on the control screen.	The interlock door is open, or the interlock plug is not properly inserted.	Close the interlock door, or insert the interlock plug.
“Insert debris shield” advisory message appears on the control screen.	The debris shield is missing or is not properly inserted.	Insert the debris shield as instructed in the “User Maintenance” section of this manual.
⚠ ≤1.5J or ⚠ Case saver	The laser is in CaseSaver mode. The maximum energy of 2.5 Joules per pulse is reduced to 1.5 joules per pulse.	When you finish the procedure, schedule a service call with your local Lumenis service representative.
⚠ Or ⚠ Service Soon	The laser is in Service soon mode. Approximately five or less treatments remain before service is required.	Schedule a service call with your local Lumenis service representative.
⚠ or ⚠ Service Required	The laser is malfunctioning	Press *ready* or ⊙ to clear the message. If the condition continues, turn off the laser for five seconds, then turn it back on. If the message reappears, record the advisory code from the summary screen and contact your local Lumenis service representative.

⚠ or ⚠ Overheating	The laser was used at a high power of an extended amount of time.	Wait until the message clears. Press *ready* or ⊙, and continue to use the laser. Pause occasionally during treatment to allow the laser to cool off. Note – If the laser overheats, do not turn off the laser. Leaving the laser on lets the internal cooling system quickly cool the laser. As the laser cools down, listen for the internal fan to slow down to the normal operating speed.
	The air flow is restricted.	Verify that the laser is at least 50 centimeters from walls, furniture, or other equipment.
	The treatment room air temperature is too high.	Verify that the treatment room temperature is between 10℃ and 30 ℃.
⚠ >150% or ⚠ Energy high	The energy delivered is more than 50% higher than the selected level.	Press *ready* or ⊙ to clear the message. If the condition continues, turn off the laser for five seconds, then turn it back on. If the condition persists, contact your local Lumenis service representative.
⚠ <50% or ⚠ Energy low	The energy delivered is less than 50% of the selected level.	Press *ready* or ⊙ to clear the message. If the condition continues, turn off the laser for five seconds, then turn it back on. If the condition persists, contact your local Lumenis service representative.
⚠ or ⚠ Rate high	The pulse rate delivered is more than 50% higher than the selected level.	Press *ready* or ⊙ to clear the message. If the condition continues, turn off the laser for five seconds, then turn it back on. If the condition persists, contact your local Lumenis service representative.
⚠ >120% or ⚠ Rate 20% high	The pulse rate delivered is at least 20% more than the selected level.	Press *ready* or ⊙ to clear the message. If the condition continues, turn off the laser for five seconds, then turn it back on. If the condition persists, contact your local Lumenis service representative.
⚠ <50% or	The pulse rate delivered is less than 50% of the selected level.	Press *ready* or ⊙ to clear the message. If the condition continues, turn off the laser for five seconds, then turn it back on. If the condition

⚠ Rate low		persists, contact your local Lumenis service representative.
⚠ <80% or ⚠ Rate <80%	The pulse rate delivered is less than 80% of the selected level	Press *ready* or ⊙ to clear the message. If the condition continues, turn off the laser for five seconds, then turn it back on. If the condition persists, contact your local Lumenis service representative.

User Maintenance

Annual laser maintenance

Preventative maintenance, safety, power, and calibration check should be performed annually by a Lumenis-certified service engineer to ensure proper laser performance.

Laser repair

All laser repairs should be performed by a Lumenis-certified service engineer. For training and information, contact your local Lumenis representative.

Clean the external surface of the laser console

Use a cloth dampened with a noncaustic cleaning solution, such as soap and water, isopropyl alcohol, or a “hospital - grade” disinfectant, to wipe the external surfaces of the laser console. Dry with a clean cloth, or allow to air dry.

Clean the laser control screen

Use a soft cloth to apply antistatic glass or plastic cleaner to the laser control screen.

Inspecting the debris shield

If you hear an abnormal popping sound while delivering the treatment beam, accompanied by a dramatic reduction in treatment effect, the debris shield and the optical fiber have probably failed; you should immediately stop treatment and inspect both the debris shield and the fiber.

The debris shield is replaceable part that protects the laser’s optical components from damage by a failed delivery system. The debris shield is like a fuse: you only need to replace it if inspection reveals that it is blown.

To inspect the debris shield:

1. Remove the debris shield panel on the laser console.
2. Grasp the debris shield handle, and pull the shield out of the receptacle. (Do not touch the debris shield optic: finger oil may damage the delicate coatings.)
3. Hold the debris shield toward a light source and look through it, The optic should appear translucent, smooth, bright, and free of any burn marks, scratches, dust, or fingerprints. If the optic appears blown, replace the debris shield. (The debris shield is usually blown by a failed fiber; therefore, always replace your fiber whenever you replace your debris shield.)
4. If the debris shield is not blown, reinsert the debris shield into the debris shield receptacle and replace the panel. Attach a new fiber to the laser and resume treatment. If the abnormal popping sound and decrease in energy persist, contact your local Lumenis service representative.

5.0 TROUBLESHOOTING

5.1 OVERVIEW

5.1.1 Serviec philosophy

The VersaPulse PowerSuite Holmium 20 Watt laser is designed to require little adjustment or calibration, and to detect and report hardware malfunctions by fault code or error message, displayed on the LCD color display. In most cases field failures are repaired by changing out a Field Replaceable Unit (FRU). FRU's are built specifically to support field repair, and consist of a part or group of parts determined to suitable for field replacement. When a part fails that is a part of a FRU, normally the FRU is replaced, not the individual part.

Corrective and preventive maintenance must only be a accomplished by a Service Engineer who has completed Lumenis certification service training on the VersaPulse PowerSuite Holmium 20 Watt laser.

The entire optical path is enclosed inside the laser head. Removing the dust cover exposes the interior to foreign matter (i.e. dust, contaminants and etc). Minimize this exposure by removing the cover only when necessary, using a clear plastic cover over the head while the dust cover is off, and getting the dust cover back on as soon as maintenance inside the head is complete.

After power up, and before the VersaPulse PowerSuite Holmium 20 Watt laser moves to its standby condition, the software performs a series of self test. Self test failures result in fault code or error messages displayed on the LCD color touchscreen display. These fault codes provide an indication of what malfunction was detected, which should point to a specific area of the system for further investigation. Explanation of the fault codes are include in this section. Most hardware malfunctions will be detected at this time.

During normal operation the software continues to monitor for system malfunctions, and to report any detected malfunctions by fault code or error message at the LCD color touchscreen display.

Some fault codes are "Logged" in a special service screen.

The VersaPulse PowerSuite Holmium 20 Watt laser has a series of service software routines available to the service engineer. The routines are contained in the software EPROM, and are activated by moving a switch on the Controller PCB(not accessible to the user). These routines facilitate calibration and troubleshooting. The routines are described in detail later in this section

A service attenuator is mounted in the optics bench assembly and is placed in the beam path by enabling SW4 on the Controller PCB. The service attenuator can be used during servicing to decrease the power of the treatment beam before it enters the fiber focus assembly. This can

pervert damage to an attached fiber and/or the blast shield when the laser is fired before the fiber focus alignment has been confirmed.

The microprocessor circuit includes a four digit, 5x7 matrix LED display mounted on the Controller PCB. The software can use this display to indicate status or type of fault information to the service engineer.

5.1.2 Safety Precautions

Lethal Voltages and Ho:YAG laser emissions are the primary dangers to the general safety precautions which always apply when working on electronics and lasers, the Servicing Engineer must be aware of the following specific precautions:

Only Lumenis certified VersaPulse PowerSuite Holmium 20 Watt laser Service Engineers should attempt any service on this system

Even with the keyswitch in the “OFF” position there are potentially lethal voltages present inside the console.

Storage capacitors inside the system are capable of holding a lethal charge, ever after power has been removed from the unit.

Do not touch the Ho:YAG Cavity Module – IT IS A SHOCK HAZARD. The Ho:YAG Cavity Module is electrically isolated from the chassis ground and connected to the secondary of a transformer to develop an electrical field around the flashlamps. The Ho:YAG Cavity Module is located in the laser head.

The Ho:YAG laser light is invisible to the human eye. Because the Ho:YAG energy can not be seen, there is no visible indication of the primary or reflected beam. Eye protection that attenuates the Ho:YAG wavelength to a safe level must be worn by all persons in the area of the laser system whenever the laser is being serviced.

The Ho:YAG laser light and its reflections are potential burn hazards and can ignite flammable materials. Use extreme caution when operating the system with covers opened or removed. The covers contain the beam and reflections safely within the console. Only those persons required should be present during servicing, and eye protection that safely attenuates the Ho:YAG wavelength must be worn by all present.

The Ho:YAG laser light and its reflections are potential hazards to the eye. Use extreme caution when operating the system with covers opened or removed. The covers contain the beam and reflections safely within the console. Only those person required should be present during servicing and eye protection that safely attenuates the Ho:YAG wavelength should be worn by all those present.

5.2 INTERIOR ACCESS & PARTS LOCATION

Interior access is gained through the front cover (door), which is hinged on the right side. Once the front cover is opened, the top cover can be removed. Once the top cover is removed the two side panels can be removed.

Open the front cover to access the DC power supply (mounted inside the door), to access the Controller PCB, or the remove the top cover or either side cover.

To open the front cover, insert the special tool through the hole on the bottom left of the front cover. Push up on the tab inside the hole to release the cover (it is hinged on the right side).

Remove the top cover to access the laser head (optics bench), to access the coolant fill reservoir or to remove either side cover.

To remove the top cover, first open the front cover, then remove the two screws located as shown in the drawing on the succeeding pages.

Remove optic bench cover to access the Attenuator PCB, Optics Bench PCB, Servo Motor PCB and all of the optical/mechanical components. Removing the cover exposes the optics bench to airborne contamination. The optics that operate on the Ho:YAG beam are particularly susceptible to damage associated with optics surface contamination. Remove this cover only when necessary. If the cover must be removed, be careful to minimize exposure of the optics bench interior to external contamination.

To remove the optics bench cover, loosen the screws located along the bottom edge of three sides, then lift the cover up.

Remove the right side cover to access the fuses, AC Control PCB, main contactor, the circuit breaker, HVPS, Tachometer PCB, and to access the interior of the enclosure.

To remove the right side cover, open the front cover, remove the top cover, remove the single screw that secures the cover at the bottom just in front of the rear wheel, then remove the six screws along the top and front of the cover (three along the top, three along the front). The cover can then be lifted off of the frame.

Remove the left side cover to access most of the cooling system components.

To remove the left side cover, open the front cover, remove the top cover, remove the single screw that secures the cover at the bottom, just in front of the rear wheel, remove the six screws along the top and front of the cover (three along the top, three along the front), then carefully pull the cover off.

5.3 SERVICE MODE

The VersaPulse PowerSuite Holmium 20 Watt includes “service mode” software routines. Service mode provides the Servicing Engineer with a number of troubleshooting and maintenance aids, commonly referred to as service screens. Some system faults are ignored in service mode (see 5.4.3).

To enter into service mode, the microprocessor must see an OFF to ON transition of the Controller PCB SW2. SW2 is located on the left side of the Controller PCB. Note that if the switch is left on when the system is powered up, it will not enter into service mode (no OFF to ON transition). If the microprocessor is halted (some fault are handled by halting the microprocessor) the service switch will not work – restart the microprocessor (press the reset switch SW5 on the Controller PCB) then toggle the service switch OFF to ON.

5.4 FAULT ISOLATION

Failures/malfunctions fall into the following general categories:

The system fails to turn on properly, or shuts off when it should not. See section 5.4.1.

The system turns on, by the Control Panel display and/or operating controls do not respond properly, and no fault code is displayed. See section 5.4.2.

During power up tests, or during operation, the system displays one or more error codes. See section 5.4.3.

During power up self tests the system fails to pass autocalibration See Section 5.4.4.

5.4.1 Turn On and Shut Down Fault Isolation

System “turn-on” problems occur when the system fails to turn on and stay on with activation of the key switch. System “Shutdown” refers to the system main contactor de-energizing after the system has successfully turn on.

If the system fails to turn on, determine if there is power to the unit and through the circuit breaker to the main contactor and isolation transformer. Determine if the main contactor is energizing when the keyswitch is held in the start position (do the system fan and pump start running?). If not, check the circuit breaker, isolation transformer thermal switch and fuses F8/F9 and F12.

If the system shuts down after being turned on, and the circuit breaker is not tripping, use the Interlock schematic in Section 8 to troubleshoot the main contactor interlock loop. Note that the software and microprocessor can turn off the main contactor. The 24V DC loop to the main contactor can be broken by the thermal switch in the isolation transformer, the keyswitch, hold on relay K2, or the fuse F12.

If the circuit breaker is tripping, check for proper transformer tapping. If the tripping is associated, with firing (or charging of the main capacitor), it is probable associated with the HVPS. If not, attempt to isolate the tripping to one of the isolation transformer secondary loads by removing fuses (F8 or F9) until the circuit breaker no longer trip (smart fan fuse, pump fuse, P/S fuse, then interlock loop fuse).

5.4.2 ”No Fault Reported” Fault Isolation

Some system malfunction cannot be reported at the Control Panel. These include those malfunctions which interfere with the operation of the microprocessor, malfunctions in the hardware that drives the display used to report errors, and miscellaneous circuits/functions which are not directly monitored/tested by the software

If the malfunction is associated with a particular function (e.g. the system doesn’t respond to the footswitch, or to some front panel control), troubleshoot that function, referring to the circuit descriptions in Section 4.

If the system turns on, but the malfunction is more general (e.g. the self test sequence doesn’t run, Control Panel does not respond) check for proper DC power supply voltages, isolation transformer tapping, interconnection problems, or for some problem with the microprocessor (is it running?)/ Control Panel interface. If the problem cannot isolated to a particular circuit, replace the CPU PCB.

5.4.3 ”Fault Code Reported” Fault Isolation

The microprocessor monitors the system to detect and respond to various fault conditions. When a fault is detected, the microprocessor displays the fault directly on the CPU PCB (as a four digit message). The microprocessor updates the touch screen to display the fault code and any accompanying message at the touch screen. Multiple faults are displayed sequentially, and repeatedly.

These fault conditions can be informational, clearable, or permanent.

> Informational faults notify the user of some detected abnormal condition that is not significant enough to interfere with system operation. An advisory message is displayed on the touch screen and the system continues to operate.
>
> Clearable faults interrupt system operation and force the system to STANDBY, but have the potential to be cleared by some user action. Some clearable faults include messages to indicate an action required by the user, e.g. “ATTACH FIBER” appears on the touch screen if there is no fiber attached. Other clearable faults advise of some detected abnormal condition, but require no further action by the user other than selecting READY to clear the error. Finally, the coolant resistivity and overtemperature errors will not clear until that parameter falls back in to acceptable limits. The user can’t clear these faults directly. Note

that a clearable fault will return if the condition that caused it occurs again or is still active.

Permanent faults place the system in a safe, non-firing condition that cannot be cleared without restarting the system. Restarting the system will clear the fault, but if the detected condition is still present, the fault will occur again.

Some faults are ignored in service mode to aid in troubleshooting. Some faults are only checked during the self test sequence that occurs at start up. Such faults are so identified in the description of the fault.

Begin by setting a detailed understanding of the symptoms. For example, does the fault appear during self testing or during normal operation; Does the fault occur only when firing; Only at certain energy or pulse settings; is the fault easily repeatable or is it intermittent? It is always worthwhile to check for proper mains input, proper transformer tapping, proper DC voltage supply outputs, and to perform a careful visual inspection for loose connections and visual indications of problems.

The following list defines the fault codes/messages and provides troubleshooting information for each.

A: How cleared: P=Permanent; R=Press Ready to clear
B: Error Recognized in Service Mode: Y=Yes; N=No

Code	A	B	Description
0	P	Y	Null Event
11	P	Y	DAC/ADC Test Failed
12	P	N	ADC timed out
102	P	Y	CRC test failed
104	P	Y	Data flow error
201	P	N	Shutter test failed
202	R	N	Shutter not closed
203	R	N	Shutter not open
204	P	N	Both shutter sensors unblocked
205	P	N	Both shutter sensors blocked
303	R	N	Energy to high (>50%)
304	R	N	Energy too low (<50%)
353	R	N	Pulse rate too high
354	R	N	Pulse rate too low
401	R	N	Footswitch improperly depressed
402	P	Y	Footswitch failed test
403	R	Y	Footswitch bouncing
404	R	Y	Footswitch disconnected
405	R	Y	Footswitch broken
406	R	Y	Footswitch EPLD error

431	R	N	External interlock plug is removed
441	R	N	Debris shield is removed from the system
451	R	N	Fiber not attached
452	R	N	No water flow
500	P	Y	HVPS B+ out of tolerance
501	P	Y	HVPS cap bank dump error
502	P	Y	HVPS cap bank volts is greater than 825V
505	P	Y	HVPS cap bank unbalanced
506	P	Y	HVPS AC peak is less than 100V
507	R	Y	Lamp1 pump energy is too high
508	R	Y	Lamp1 pump current is too high
509	R	Y	Lamp2 pump energy is too high
510	R	Y	Lamp2 pump current is too high
511	R	Y	CPU activated crowbar
513	R	Y	ASPM2 over-current factor
515	R	Y	Lamp1 current sense error
516	R	Y	Lamp2 current sense error
517	P	Y	HVPS crowbar SCR inadvertent fire
518	P	Y	HVPS-CPU cable error
519	P	Y	Lamp start error
553	R	N	HVPS lamp 1 simmer not enabled
555	R	Y	HVPS crowbar test failed
556	R	Y	HVPS DAC/ADC test failed
557	R	Y	HVPS test failed
601	R	Y	+5V DC is out of specification
602	R	Y	+15V DC is out of specification
603	R	Y	-15V DC is out of specification
701	R	Y	Coolant temperature too high
702	R	Y	Coolant temperature too low
703	R	N	Coolant conductivity too high
704	P	Y	Fan speed error
801	P	N	Inadvertent exposure test failed
802	R	Y	Unexpected laser light
901	P	N	No good lasers left
902	P	N	Laser not calibrated
903	P	Y	Laser calibration failure
980	R	N	Time out on printer
981	R	N	Printer out of paper
982	R	N	Printer not connected
951	R	N	Auto calibration disabled
955	R	N	Ho:YAG lamp weak
956	R	Y	Burn-in active
958	P	N	Safety system test failed

959	R	N	Energy 20% high
960	R	N	Energy 20% low
961	R	N	Rate 20% low
962	R	N	Rate 20% low
980(?)	R	N	Case Savor mode active
990	P	Y	Time base frequency <>1KHz

5.5 TEST POINTS & LED ARRANGEMENT

5.5.1 Test Points

CONTROLLER PCB:

Test Points#	Name on PCB	Description
TP1	MNZER	Analog output of the autozero amplifier of the main pyro signal
TP2	MNINT	Analog output of the main energy integrator
TP3	GND	System ground, both analog and digital
TP4	GND	System ground, both analog and digital
TP5	MNERG	Analog output of the main peak-hold integrated energy signal
TP6	MNDIF	Differential analog receiver of the main pyro signal from the Laserdeck PCB
TP7	SFDIF	Differential analog receiver of the safety pyro signal from the Laserdeck PCB
TP8	SFZER	Analog output of the autozero amplifier of the safety pyro signal
TP9	SFINT	Analog output of the safety energy integrator
TP10	SNERG	Analog output of the safety peak-hold integrated energy signal
TP11	!FIRE1	Fire pulse#1 output to the HVPS Controller
TP12	!FIRE2	Fire pulse#2 output to the HVPS Controller
TP13	FS#HP_DOWN	De-bounced footswitch or handswitch signal
TP14	!PS-IRQ	The interrupt input signal from the HVPS
TP15	GND	System ground, both analog and digital
TP16	INADV-EXP	The inadvertent laser pulse signal from the safety EPLD
TP17	!NO-FIRE	The CPU No Fire signal output
TP18	!WDT-ERR	The watchdog error indication
TP19	EHI	The laser energy>50% over energy high signal to the safety EPLD
TP20	SFVM	Analog output of the safety energy track and hold amplifier
TP21	GND	System ground, both analog and digital
TP22	CROWBAR	Crowbar signal from the CPU
TP23	16MHZ	16MHZ clock signal

TP24	MNVM	Analog output of the main energy track and hold amplifier
TP25	SCP1	Spare test point1 output for debugging purposes
TP26	SCP2	Spare test point2 output for debugging purposes
TP27	1.8432MHZ	1.8432MHZ clock signal
TP28	GND	System ground, both analog and digital
TP28A	SF-IRQ	Safety EPLD interrupt output
TP29	LCD-PWR	LCD backlight power supply voltage(13V)
TP30	GND	System ground, both analog and digital
TP31	6.144MHz	6.144MHz clock signal
TP32	+3.3v	Plus 3.3 volt power supply
TP33	WREST	Water resistivity signal. 1V=1meg. 2V=500k and etc
TP34	GND	System ground, both analog and digital
TP35	VAC	Mains voltage analog voltage indication from the AC control PCB
TP36	GND	Analog output of the safety energy integrator
TP36A	NVVCC	Non-volatile RAM VCC
TP37	WAVE	Analog output of the DAC channel used for streaming audio
TP38	SF-DAC	Analog voltage output of the safety command DAC
TP39	WTEMP	Water temperature signal
TP40	+5V	+5V low voltage power supply
TP41	-5V	-5V low voltage power supply
TP42	+15V	+15V low voltage power supply
TP43	-15V	-15V low voltage power supply
TP44	GND	System ground, both analog and digital

PYRO PCB:

Test Points#	Name on PCB	Description
TP1	SPREB	Second op amp stage output from the safety pyro
TP2	SPREA	First op amp stage output from the safety pyro
TP3	GND	Analog ground
TP4	MPREB	Second op amp stage output from the main pyro
TP5	MPREA	First op amp stage output from the main pyro
TP6	GND	Analog ground

AC CONTROL PCB:

Test Points#	Name on PCB	Description
TP1	GND	Ground
TP2	GND	Ground

LASER DECK PCB:

Test Points#	Name on PCB	Description
TP1	PWM	The PWM drive gate signal to the safety shutter MOSFET
TP2	PGND	The safety shutter circuitry 24V ground return

TP3	DGND	Digital ground
TP4	GTMIN-	The laser pulse greater than minimum power signal
TP5	AGND	Analog ground
TP6	DGND	Digital ground

HIGH VOLTAGE POWER SUPPLY CONTROLLER PCB:

Test Points#	Name on PCB	Description
TP1	B+CT	Center tap of the B+ capacitor bank
TP2	STR_DRAIN	The starter MOSFET drain voltage
TP3	STR_GATE	The starter MOSFET gate voltage
TP4	KEY24V	The 24V DC from the system low voltage power supply
TP5	GND	System ground, both analog and digital
TP6	GND	System ground, both analog and digital
TP7	STR_DAC	The analog output of the starter DAC/op amp circuit
TP8	SS_GATE	The softstart MOSFET gate voltage. +5V=close softstart relay K1 on AC terminal PCB
TP9	GND	System ground, both analog and digital
TP10	PK_LINE	Mains voltage peak detector..01V/V
TP11	UNBALANCE	B+ cap bank voltage is imbalanced between the upper and lower bank
TP12	0.01_RECT_LINE	B+ cap bank indicator..01V/V
TP13	CT_OPT	B+ cap bank voltage center tap
TP14	SIM_OK1-	Lamp #1 simmer is OK
TP15	-LAMP2	Lamp #2 current at 100A/V
TP16	-20VUR	Unregulated –20V for the simmer controllers
TP17	-5VUR	+15V as referenced from the –20VUR supply
TP18	SIM_OK2-	Lamp #2 simmer is OK
TP19	I_GAIN1	Digital output control bit for the lamp 1 current regulator path.0=50A/V, 1=20A/V
TP20	I2	Lamp #2 current as per I-GAIN1 control bit.0=50A/V, 1=20A/v
TP21	I_GAIN2	Digital output control bit for the lamp 2 current regulator path.0=50A/V, 1=20A/V
TP22	-LAMP1	Lamp #1 current at 100A/V
TP23	2XI2	Lamp #2 current at 50A/V
TP24	I1	Lamp #1 current as per I-GAIN1 control bit.0=50A/V, 1=20A/V
TP25	0.01VLAMP2	Lamp #2 voltage at .01V/V
TP26	0.01VLAMP1	Lamp #1 voltage at .01V/V
TP27	-5V	-5V supply
TP28	+5V	+5V supply
TP28	+15V	+15V supply

TP29	+3.3V	+3.3V supply
TP30	2XI1	Lamp #1 current at 50A/V
TP31	-15V	-15V supply
TP32	AUTO_ZERO2-	Digital output control bit for the lamp 2 integrator autozero.0=zeroed, 1=nonzeroed
TP33	AUTO_ZERO1-	Digital output control bit for lamp 1 integrator autozero.0=zeroed, 1=nonzeroed
TP34	+5REF	+5V reference
TP35	GND	System ground, both analog and digital
TP36	E_GAIN2	Digital output control bit for the lamp 2 integrator gain. 0=15J/V, 1=30J/V
TP37	M2	Instantaneous peak power across lamp 2 @50KVA/V
TP38	GND	System ground, both analog and digital
TP39	E_GAIN1	Digital output control bit for the lamp 1 integrator gain. 0=15J/V, 1=30J/V
TP40	M1	Instantaneous peak power across lamp 1 @50KVA/V
TP41	+15V	+15V supply
TP42	GND	System ground, both analog and digital
TP43	ENG_INT2	Digital output control bit for lamp 2 integrator reset.0=reset, 1=integrate
TP44	P2	Instantaneous peak power across lamp 2 @40KVA/V
TP45	ENG_INT1-	Digital output control bit for the lamp 1 integrator reset.0=reset,1=integrate
TP46	P1	Instantaneous peak power across lamp 1 @40KVA/V
TP47	PCMD	Mains power draw command .250W/V
TP48	VCMD	B+ cap bank command voltage ..01V/V
TP49	CMD1	Lamp #1 energy command. 15J/V
TP50	PS-IRQ	HVPS error interrupt output to the system controller.0=error
TP51	E2	Lamp #2 accumulated energy. 15J/V
TP52	E1	Lamp #1 accumulated energy. 15J/V
TP53	CMD2	Lamp #2 energy command. 15J/V
TP54	E_MAX2	Output of the maximum lamp 2 energy comparator
TP55	I_AT_CMD2	Output of the lamp 2 current control comparator
TP56	E_AT_CMD2	Output of the lamp 2 energy control comparator
TP57	E_MAX1	Output of the maximum lamp 1 energy comparator
TP58	I_MAX2	Output of the maximum lamp 2 current comparator
TP59	I_MAX1	Output of the maximum lamp 1 current comparator
TP60	I2MAXREF	Lamp 2 maximum current DAC output.120A/V
TP61	I1MAXREF	Lamp 1 maximum current DAC output.120A/V
TP62	I_AT_CMD1	Output of the lamp 1 current control comparator
TP63	0.01B+	B+ cap bank voltage at .01V/V.Used for boost regulator comparators
TP64	E2MAXREF	Lamp2 maximum energy. DAC output.30J/V

TP65	E1MAXREF	Lamp1 maximum energy. DAC output.30J/V
TP66	E_AT_CMD1	Output of the lamp 1 energy control comparator
TP67	GND	System ground, both analog and digital
TP68	BST_LEM	Boost regulator current sensor output.10A/V
TP69	B+PKL	Output of the B+ voltage > mains voltage peak line comparator
TP70	B_0.7PKL	Output of the B+ voltage >.7* mains voltage peak line comparator
TP71	B+>825V	Output of the B+ voltage > 825V comparator
TP72	PKL>100V-	Output of the peak line >100V peak comparator
TP73	GND	System ground, both analog and digital
TP74	GND	System ground, both analog and digital
TP75	BOOST_PWM	Gate drive output of the PFC controller U57
TP76	LEM_X4	Boost regulator current sensor output -2.5A/V
TP77	VFFF_DET	Voltage feed forward to the PFC controller U57
TP78	CNTL	Control voltage feedback to the PFC controller U57
TP79	ERROR_2	B+ voltage error amplifier * power command error
TP80	-5V/P	B+ voltage command divided by power command
TP81	ERROR_1	B+ voltage error amplifier
TP82	E+VCMD	B+ voltage and B+ command diff amp with gain of 200
TP83	LEM_BAD	Boost LEM current sensor failure comparator output
TP84	B+>1.02VCMD	Output of the B+ voltage > 1.02*B+ command comparator
TP85	+5REF/P	+5V reference divided by the mains power command DAC
TP86	MINUS-VCMD	B+ cap bank command voltage. -.01V/V
TP87	+7.5V	+7.5V reference from the PFC controller U57
TP88	GND	System ground, both analog and digital
TP89	0.01B+	B+ cap bank voltage at .01V/V.Used for boost regulator command control loop
TP90	DUMP_FAULT	Output of the B+ cap bank dump control fault comparator
TP91	BOOST_EN	Digital output enable bit to the PFC controller U57. 0= enable, 1=disabled
TP92	IVAC	Mains voltage to current input to the PFC controller U57
TP93	CONN_OK-	CPU to HVPS ribbon cable connected input. 0=connected
TP94	+20V	+20V supply
TP95	LOCAL_RST-	Output of the Local reset chip U61.0= reset HVPS
TP96	GND	System ground, both analog and digital
TP97	CLK125K	125KHz clock input from the EPLD U59
TP98	CLK20M	20MHz clock input to the EPLD U59
TP99	GND	System ground, both analog and digital

5.5.2 LEDs

CONTROLLER PCB

LED	Color	Name on PCB	Description
LED1	GREED	FIRE1	Final laser #1 fire pulse output to the HVPS
LED2	GREEN	FIRE2	Final laser #2 fire pulse output to the HVPS
LED4	GREEN	PS_IRQ	The interrupt return signal from the HVPS
LED5	RED	PS_IRQ	The interrupt return signal from the HVPS
LED6	GREEN	NO_FIRE	The CPU No Fire indication
LED7	RED	WDT_ERR	The watchdog error indication
LED8	GREEN	EHI	The laser energy>50% over energy high signal from the safety EPLD
LED9	RED	SHUT_OPEN1	Indicates that the safety shutter open-opto is blocked
LED9	GREEN	SHUT_CLOSED1	Indicates that the safety shutter closed-opto is blocked
LED10	RED	ATTEN_OPEN1	Indicates that the laser attenuator 1 open-opto is blocked.(Unused is SOS 20W)
LED10	GREEN	ATTEN_CLOSED	Indicates that the laser attenuator 1 closed-opto is blocked.(Unused in SOS 20W)
LED11	RED	CROWBAR	Indicates when the system is sending a crowbar drive signal to the laser power supply. The LED blinks on every time the crowbar is fired. The crowbar is fired. This LED will also blink on during power on selftest of the laser power supply.
LED12	RED	SHUT_OPEN2	Indicates that shutter #2 open-opto is blocked.(Unused in SOS 20W)
LED12	GREEN	SHUT_CLOSED2	Indicates that the shutter#2 closed-opto is blocked (Unused in SOS 20W)
LED13	RED	ATTEN_OPEN2	Indicates that the laser attenuator #2open-opto is blocked.(Unused in SOS 20W)
LED13	GREEN	ATTEN_CLOSED2	Indicates that the laser attenuator #2 closed-opto is blocked.(Unused in SOS 20W)
LED14	GREEN	FSNC	Indicates that the normally closed contact in the footswitch is closed
LED15	GREEN	FSNO	Indicates that the normally open contact in the footswitch is closed
LED16	GREEN	FS#HP_DOWN	Debounced footswitch or handpiece switch indication
LED17	GREEN	HSNC	Indicates that the normally closed contact in handswitch is closed
LED18	GREEN	HSNO	Indicates that the normally open contact in the handswitch is closed
LED19	GREEN	CDRH	Indicates when the remote interlock connector is inserted in the connector. If the interlock is used in operating room, this indicates that the remote interlock is closed.

LED20	GREEN	FIBER	The laser fiber optic fully inserted indication
LED21	GREEN	BLAST	The laser fiber blastshield inserted indication
LED22	GREEN	FLOW	Indicates sufficient water flow for the laser cooling system
LED23	GREEN	PLUS 5V	The plus 5V power indication
LED24	GREEN	PLUS 15V	The plus 15V power indication
LED25	GREEN	MINUS 15V	The -15V power indication

HIGH VOLTAGE POWER SUPPLY

LED	Color	Name on PCB	Description
LED1	YELLOW	T_CAP	B+ cap bank upper half dump/balance indicator
LED2	YELLOW	B_CAP	B+ cap bank lower half dump/balance indicator
LED3	RED	STR_DRV	Gate drive input to the lamp starter MOSFET
LED4	YELLOW	B+_GT_100_PK	B+ cap bank voltage>100% of main voltage peak
LED5	YELLOW	B+_GT_1.02_CMND	B+ cap bank voltage>1.02*command voltage
LED6	YELLOW	B+_GT_70_PK	B+ cap bank voltage is greater>70% of main voltage peak
LED7	YELLOW	PKLIN_GT_100V	Mains peak line>100V peak
LED8	RED	B+_GT_825V	B+ cap bank voltage>70% of main peak voltage
LED9	YELLOW	SS_RELAY	Gate drive input to the soft start relay control MOSFET
LED10	RED	BOOST_FAULT-	Boost function fault indicator
LED10	GREEN	BOOST_EN-	Boost function enabled indicator
LED11	RED	CROWBAR_LED	Crowbar indication
LED11	GREEN(?)	BOOST_OUT	Boost function gate drive indicator
LED12	GREEN	LAMP1_FIRE	Lamp #1 fire pulse drive to the IGBT driver
LED13	RED	DUMP_FAULT-	Indicator of the B+ cap bank dump control fault
LED14	RED	UNBALANCE-	B+ cap bank voltage is imbalanced between the upper and lower bank
LED15	GREEN	LAMP2_FIRE	Lamp #2 fire pulse drive to the IGBT driver

LASER DECK PCB:

LED	Color	Name on PCB	Description
LED1	GREEN	PWM	Shutter MOSFET GATE DAIVE
LED2	GREEN	D+5V	Laser diode +5V indicator
LED3	GREEN	>_MIN	Laser pulse greater than minimum energy indicator

AC CONTROL PCB LEDs

LED	Color	Name on PCB
LED1	Red	390V AC
LED2	Grn	115V

LED3	Grn	230V
LED4	Grn	Soft start
LED5	Grn	CPU hold relay
LED6	Grn	(Key in) Start (Position)
LED7	Grn	(Key in) Run (Position)
LED8	Grn	Transformer Thermostat OK
LED9	Grn	Emergency Stop OK
LED10	Grn	24V DC

5.6 REMOVE/REPLACE PROCEDURE

This section provide procedures in the removing and replacement of major components in the VersaPulse PowerSuit Holmium 20 Watt laser. Prior to removing/replacing any components in the system, the covers must be opened or removed (i.e., side cover). Refer to section 5.2 for the removal of any of the covers. *Be sure all ESD protocol are observed when removing/replacing any electronic component. Also, when removing/replacing any optical components, be sure it is free of any contaminants.*

5.6.1 Flashlamp Replacement

1. Turn the system off and disconnect the AC power cord from the AC power source.

2. Open the front door, remove the top and optics bench cover from the laser.

3. Drain the coolant. (Refer to subtopic 5.6.4).

4. Measure B+ capacitor charge

   CAUTION: Do not touch the flashlamp wire or laser pod terminals unless the B+ charge is at 0V DC. This typically takes 2 minutes after disconnecting the power cord from the AC power source.

5. Disconnect the flashlamp wires from the terminal block

   Support the wire at the flashlamp end and carefully straighten out the red wire at the opposite end. If the wire is not supported at the flashlamp, the flashlamp may break.

6. Remove the flashlamp (s)

   a. Remove the cavity assembly, if not already removed.

      Be careful to note the location of the two cavity assembly O-rings between the cavity and the manifold.

b. Remove the insulated end blocks surrounding the flashlamp ends. This releases the pressure from the O-rings.

c. Put on latex gloves and clean the red wire of the old flashlamp with methanol and lens tissue.

    This step MUST BE PERFORMED to prevent contamination from being dragged and deposited inside the cavity flow tube.

d. Carefully slide the flashlamp out of the cavity assembly in the direction of the black wire.

Take caution to locate the O-rings. Note the position of the O-ring on the black end of the old flashlamp. Locate the loose O-ring and place it on the new flashlamp at approximately the same location as the old flashlamp. Remove the other O-ring from the old flashlamp.

7. install the new flashlamp

    a. Carefully straighten the red wire on the new flashlamp and clean the entire flashlamp with methanol and lens tissue. Be sure to wipe the flashlamp several times and each time using a new lens tissue paper.

    b. Carefully insert the red wire into the cavity assembly until the flashlamp is visually centered within the cavity.

        NOTE: The brick are bi-directional. Install the remaining O-ring on the flashlamp.

    c. Install the insulated end blocks keeping the flashlamp visually centered within the cavity assembly.

    d. Replace the cavity assembly on the laser pod and attach the flashlamp wire to the terminal block.

8. Add coolant and check for leaks, specifically in the cavity assembly area.

9. Perform the “Resonator” and “Fiber” alignment procedures, then check the flashlamp calibration values.

10. Reinstall all the cover and front door.

5.6.2 Controller PCB Replacement

1. Turn the system off and disconnect the AC power source.

2. Open the front cover. (Refer to Fig.5.1)

3. Remove all electrical connection from the Controller PCB.

4. Remove the five nuts securing the Controller PCB to the standoffs and remove the Controller PCB.

5. Install the new Controller PCB and secure it in place using the five nuts that was just removed.

   CAUTION: Besure ESD protocols are observed when handing the new Controller PCB, otherwise server damage to the Controller PCB may occur.

6. Reconnect all the electrical connections.

7. Verify the three switches (i.e., service, auto cal and service attenuator) on the Controller PCB are in the proper positions (autocal disabled).

8. Turn the laser on and perform the calibration procedures in Section 3 of the Service Manual.

9. Verify the laser is operating properly.

10. Perform the Operation and Safety Procedure in Section 3.

5.6.3 Water filter Replacement

1. Drain the laser completely.

2. Remove the old filter and install the new one.

   Note: Verify the O-ring is in the filter basket.

3. Re-fill the laser with new distilled water.

5.7 TROUBLESHOOTING

The following is a general check list and troubleshooting guide for the VersaPulse PowerSuite Holmium 20 Watt trained service engineer. Procedures referenced in this section for adjustments, alignments, calibrations and checks are provided in Section 3.

If any of the following components have been adjusted or replaced, perform the related adjustments, alignments, calibrations, and checks.

OPTICS & OPTICS RELATED COMPONENTS

1. Lamp, Rod, HR, OC, or Cavity:

    Cavity Alignment
    Fiber Alignment
    Check Autocalibration Values
    Perform Operational and Safety Checks

2. Blastshield Optic:

    Check Autocalibration Values
    Perform Operational and Safety Checks

3. Aiming Diode Laser, Aim Beam Mirror, Beam Combiner Optic:

    Aiming Laser Alignment
    Check Autocalibration Values
    Perform Operational and Safety Checks

PCBs

Optics Bench PCB:

    Pyro Imaging Mirror Alignment
    Main and Safety Energy Pre-Amp Calibration
    CPU Energy Monitor Calibration
    Check Autocalibration Values
    Perform Operational and Safety Checks

Controller PCB:

    CPU Energy Monitor Calibration
    Check Autocalibration Values
    Perform Operational and Safety Checks

Fan Speed Controller PCB:

    Fan Idle Speed Adjustment
    Perform Operational and Safety Checks

POWER SUPPLY

HVPS:

    Check Autocalibration

Perform Operational and Safety Checks

LVPS:

Output Voltage Adjustment
Perform Operational and Safety Checks

OTHER COMPONENTS

Fan Motor/Impeller, Pump Motor, Pump Head, Waterflow Switch, Water Temp Sensors, Filters (DI, particle, air) and General Plumbing:

Fan Idle Speed Adjustment
Perform Operational and Safety Checks

Display

Check Autocalibration Values
Perform Operational and Safety Checks

The following are common faults which may occur during the operation of the laser.

TEMPERATURE

1. The overheating fault is displayed on the LCD screen.

   a. Verify that the coolant is at its proper lever. (The water reservoir should be between one-half full.

   b. Perform the Fan Speed Controller Adjustment in Section 3.3.2.

   c. Verify that the water particle filter is clean. If the filter is dirty or discolored (brown), drain the laser and replace the particle filter and DI cartridge.

   d. Check the cleanliness of the screen on the bottom of the laser. A dirty screen will restrict air flow.

   e. Verify that there is adequate space at the bottom & sides of the system when it is in use. (There may be other carts or equipment in the operating theater next to the VersaPulse PowerSuite reducing the air flow to the laser).

   f. Verify that the ambient temperature of the operating environment is blow 22 ℃。

g. Verify that water hoses are not bent, kinked, or otherwise damaged.

h. Check lamp calibration values. (Higher lamp energies or cal points means more energy must be dumped into the lamps creating more heat.)

If all of the above items are checked and found to be normal yet, the laser still overheats, it may be possible that the water pump head is worn and not moving the water quickly enough or there may be some flow restriction. Or everything may be normal but the system just need to be left on so the laser would cool down. If the laser overheats, *do not turn it off!* Let it run and it will cool down.

BLASTSHIELD

The following section will address the subject of “blown blastshields” and the causes for this problem.

Laser energy is focused at the center of the proximal endface of the fiber. Due to the causes listed in the following topics, the fiber endface will tend to absorb or scatter more laser energy than it transmits. During laser operation, the temperature of the fiber endface will increase. When the temperature exceeds the energy handling capacity of the fiber, the heat generates a violent reaction within the fiber and fiber endface “explodes”.

This small scale “explosion” ejects sparks, hot gases, and debris away from the fiber endface. While most of the debris is sent out of the lens cell vents, some of the debris is directed toward the blastshield. The blastshield sacrifices itself in the explosion, and in doing so, protects the fiber focus lens from damage. The blastshield is now “blown”, and each additional laser pulse will create another explosion. The fiber and blastshield need to be replace before any further laser operation takes place.

It is recommended that all customers carry additional fiber delivery devices and a spare blastshield FRU.

1. The system is blowing blastshields.

    a. Visually inspect Blastshield Optic for contamination or signs of damage. Replace if necessary.

    b. Verify fiber alignment. (See Section 3 for details)

    c. Interview the customer to determine system usage to calculate the failure rate and to collect other important information. Ask the following questions:

        What type of fiber delivery device was in use at the time?

- Who is the manufacturer?
- How many times was this device used / sterilized?
- How much energy was put into the device?
- Could the failure be handling or procedure related?

If the blastshield glass was known to be new or clean at the time, the optical alignment checks out to be normal, the fiber was new and was being properly used, yet the system continues to consume blastshields at a high rate, check for contamination on the fiber focus lens.

d. Verify system transmission.

(Power out of fiber)
(Power out of OC)
≥85%

FIBER ENDFACE

1. The fiber endface explodes:

The fiber may have been previously used or autoclaved (high temperature sterilized) and/or its lifetime or wear rating has been exceeded. This is probably most common with VersaLinks and SlimLine Bare Fibers that are used more than once.

The fiber (SMA end) may be damaged or contaminated which is most commonly associated with improper handling of the fiber or firing through a blown blastshield.

Contamination on blastshield may be scattering or unfocusing laser energy at the fiber endface. Typically, the causes are a fingerprint on the blastshield glass, the glass has been previously cleaned or not thoroughly cleaned, or the glass has suffered an earlier blast.

The laser optical alignment (on one or more channels) is not centered and / or peaked as measured with, respectively, the 10mm Test Aperture and the Transimpedance Detector.

Contamination of fiber focus lens may be scattering or unfocusing laser energy at the fiber endface. This is usually caused by multiple explosions where a small percentage of the debris may be making its way to the fiber focus lens.

It is necessary to perform the Operational and Safety Checks found at the end of Section 3 after the servicing and repair of the laser.