LIGHTSheer™

DIODE LASER SYSTEM

SERVICE MANUAL

COHERENT | Palomar

12-01000-00.AA

CONFIDENTIAL

1.0 General Information

1.1 Use of This Manual

This manual contains service instructions for the LightSheer™ model Diode Laser system. The content of this manual is intended solely for use by Star Medical Technologies and its authorized service agents. Star Medical Technologies can not be responsible for service attempted by others, and the use of this manual by others is not permitted. There are no User Serviceable parts inside. **CAUTION**-Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

1.2 LightSheer Configurations

One LightSheer™ model with two voltage configurations exists today. A model configured to operate on 110Vac ± 10% @ 8 Amps and a model configured to operate on 220Vac ± 10% @ 4 Amps. There is no operational difference between the two, although the circuit breakers and voltage configuration switch settings change. Check the rear panel label for the specific voltage range of the system.

1.3 Approvals and Warning Labels

The LightSheer™ diode laser system is designed and tested in accordance with Star Medical Technologies procedures. A certified ISO 9001 and CE 0044 company.

Danger and Warning Labels (laser information, high voltage, and voltage configuration) are located on the rear panel of the Upper Console. The Laser Aperture label is located on the distal end of the handpiece. Note: the laser aperture label may be scrubbed off with aggressive cleaning and if missing, should be replaced.

The LightSheer Diode Laser System meets the definition of year 2000 compliant for the purpose of FDA product status reporting. All laser systems manufactured and currently manufactured will work during, from, into and between the twentieth and twenty-first centuries for the expected lifetime of the product. Note: the life-time of the product is currently limited to about 5 years by an on-board, non-rechargable battery that is not user servicable. Therefore, proper operation of the LightSheer with respect to the year 2000 bug beyond the year 2010 is not relevant to this product.

The LightSheer Diode Laser System has been tested to 5 years beyond its expected lifetime (up to the year 2010) for proper functionality with repect to year 2000 compliance.

1.4 Safety

1. Laser - The LightSheer™ is a Class 4 laser system which contains Infra-Red (IR) emitting diode lasers at a wavelength of approximately 800 nm. This infrared radiation is invisible to the human eye, yet is readily transmitted through the cornea and focused on the retina. Even brief exposure to this laser may cause permanent eye damage. All persons during any service activity must wear proper laser safety eyewear (OD +5 @ 790-830 nm).

2. Chemical - A number of hazardous chemicals are used in the operation and service of the laser. Please refer to the specific MSDS for each specific substance: ethylene glycol, acetone, methanol, LocTite, and silicone rubber (RTV). An MSDS for each specific substance is available upon request from Star Medical Technologies.

3. Electrical - The LightSheer™ Diode Laser uses high-voltage internal components which have the potential to cause serious injury or fatal electrical shock. It is possible for the high voltage components to retain a charge for some period of time even after the laser has been turned off.

   No part of the exterior housing, except the calibration/storage port insert, should be removed except by trained and authorized laser technicians. Do not soak or spray the laser console or handpiece in fluids because this can result in damage to the equipment and electrical shock. Do not operate the unit if the power cord is frayed or otherwise damaged.

Opening the exterior housings may cause exposure to hazardous optical radiation and electrical voltage, even after the laser has been turned off. No part of the exterior housing, except the calibration/storage port insert, should be removed except by trained and authorized laser technicians.

4. Fire hazards - The potential for fire hazards exists because the absorption of laser energy may raise the temperature of any material. While this principle is the basis of many useful medical and surgical applications, it requires that precautions be taken against igniting combustible materials. For the LightSheer™ Diode Laser, the following precautions should be taken:

   Allow any flammable liquids used for cleaning the skin, such as alcohol, to fully evaporate before treatment.

   Anesthetics administered topically or by inhalation must be approved as nonflammable.

   Exercise particular care in the use of oxygen which can accelerate the combustion of any flammable material.

Avoid using combustible materials, such as gauze and drapes, in the treatment area. When required, these materials may be made more fire resistant by keeping them moist with water. Clothing should be kept well away from the area of treatment.

Do not operate the laser with any cover or drape over the laser.

DANGER

Do not operate the laser in the presence of flammable liquids (such as alcohol or acetone) or flammable gases (such as ether).

2.0 Calibration, Maintenance and System Checks

2.1 Periodic Maintenance

1. Action Checklist

Perform Visual Inspection

1. Visually inspect the exterior for damage, loose hardware, or signs of wear. Pay special attention to the power cord and cord connector, the footswitch and hose, the door hardware, the calibration port glass, the handpiece, the front switches, and the display assembly.

2. Remove the front cover from the Lower Console (LC) and inspect for loose power supply mount hardware and electrical connections. Reinstall the front cover.

3. Remove the access panel from the Upper Console (UC) and inspect for loose hardware, coolant leakage, and electrical connections. Reinstall the access panel.

Check/Clean Air Vents

1. For the Lower Console (LC), check the bottom and rear air vents for any build up of dust or debris. Remove dust and debris by wiping with a dampened cloth or by vacuum.

2. For the Upper Console (UC), check the side and rear air vents for any build up of dust or debris. Remove dust and debris by wiping with a damp cloth or by vacuum.

Check/Replace Coolant Filter

1. Remove the Access Panel and check the date label on the coolant filter. (Some filters may not have a date label attached. If no label is attached, contact Star Medical Technologies to determine the age of the system).

2. If today's date is 12 ± 3 months from either the date label on the filter or the age of the laser, replace the coolant filter.

Change Coolant

It has not been determined if the coolant needs to be changed/flushed at a regular basis. At a minimum, the coolant level should be topped off (fill to the neck of the reservoir) at each service event.

Clean Console Exterior

Using a soft cotton cloth dampened with a general purpose detergent cleaner, wipe down the exterior of the console.

Clean Handpiece and Umbilical Cord

Using a soft cotton cloth dampened with a general purpose detergent cleaner, wipe down the handpiece and umbilical cord.

Clean Energy Detector Window

The protective window above the energy meter must be kept clean for accurate energy calibration. The window is cleaned by (1) turning the access screw on the top of the console a quarter turn counter-clockwise, (2) removing the calibration port insert, (3) cleaning the window in the same manner as the handpiece tip or with common glass cleaners, taking care to remove any haze remaining from the cleaning solution by wiping with a clean, dry towel, (4) carefully reinstalling the calibration port insert, and (5) tightening the access screw with a quarter turn clockwise.

Check for Proper Form and Fit

1. Check to see that the display swivels and tilts.

2. Verify that the handpiece fits inside the door pocket.

3. Verify that the umbilical cord is not too long or too short.

4. Verify that the door latch mechanism works.

5. Verify that the console latch mechanism works.

Perform Operational and Safety Check Out

Go to Section 2.2 of the Service Manual and perform the Operational and Safety Check Out procedure.

2.2 Operational and Safety Check Out

The Operational and Safety Check Out procedure should be performed at the completion of each service call to verify proper operation of the laser system.

Time Boot Sequence

Turn system on, start clock (stopwatch). The system should display the Start Screen in 90 seconds or less.

Check Safety Circuits

1. Push the Emergency Stop button in and verify that the message "Emergency Stop button has been depressed" appears on the display. Rotate the button to reset and verify the message disappears.

2. Turn the Key switch and verify that the Key icon with directional arrow appears on the display. Rotate the key clock-wise and counter clock-wise.

3. Remove the Interlock plug from the rear panel and verify that the Interlock screen appears on the display. Replace the interlock plug.

4. Lift Handpiece from holster and verify that the Handpiece icon is displayed along with the down arrow. Replace the handpiece in the holster and verify that the icon disappears.

5. When the Footswitch icon and down arrow appears on the display step on the footswitch (hold it down) and verify that the icon disappears. Also, listen to the footswitch pressure sensor at the rear panel to hear a "click" when the pedal is depressed.

6. Verify that the Handpiece Trigger icon is displayed. When the trigger is pulled and held down, the system will fire 4 calibration shots and deliver a "beep" with each shot.

7. Place the Handpiece in the holster, step on the Footswitch, and pull the Trigger.

8. Verify that the calibration test passes (User screen is displayed and a maximum fluence of 40J/cm^2 can be selected.)

9. Turn the key, then push the Quit button on the display. Wait a moment and verify that the "Turn off System at Rear of Console" message appears.

10. Turn the Main Breaker off and verify that the system shuts off.

Measure/Verify Delivered Energy

Caution - the following procedure involves firing the laser and delivering hazardous levels of optical radiation. Verify that the laser is located in a Class 4 Laser Controlled Area and that all persons present are wearing proper laser safety eyewear. Do not fire the laser in the presence of flammable liquids or gasses.

From the User screen, select ChillTip = OFF, pulse width in Auto Mode, Fluence (from the table below) and go to Ready. Direct the output of the handpiece into the external detector head (keep the sapphire tip approximately 1/4" above the detector head surface) and step on the footswitch. Pull the trigger to deliver laser pulses. Delivered pulse energies should fall into the ranges listed below.

Request Fluence = 10 J/cm^2: Measure 6.89 – 9.32 J (8.1 J nominal)
Request Fluence = 25 J/cm^2: Measure 17.2 – 23.3 J (20.25 J nominal)
Request Fluence = 40 J/cm^2: Measure 27.5 – 37.3 J (32.4 J nominal)

Calculate the delivered pulse energies by averaging 5 shots from each range.

From the main user screen, select ChillTip = OFF, pulse width in 30 ms Mode, Fluence (from the table below) and go to Ready. Direct the output of the handpiece into the external detector head (keep the sapphire tip approximately 1/4" (6 mm) above the detector head surface) and step on the footswitch. Pull the trigger to deliver laser pulses. Delivered pulse energies should fall into the ranges listed below.

Request Fluence = 10 J/cm^2: Measure 6.89 – 9.32 J (8.1 J nominal)
Request Fluence = 25 J/cm^2: Measure 17.2 – 23.3 J (20.25 J nominal)
Request Fluence = 40 J/cm^2: Measure 27.5 – 37.3 J (32.4 J nominal)

If any of the pulses fall outside the listed ranges, calibration is required. See the Calibration Procedure in Section 2.3.

There may be additional work to be done on this procedure.

2.3 Calibration Procedure

If the delivered pulse energy differs by more than ±15% of requested energy (requested energy equals displayed FLUENCE x 0.810), verify that the Energy Detector Window and Handpiece Tip are clean and perform another system calibration. If the delivered pulse energy still differs by more than ±15% of requested energy, perform the calibration procedure listed below.

Caution - the following procedure involves firing the laser and delivering hazardous levels of optical radiation. Verify that the laser is located in a Class 4 Laser Controlled Area and that all persons present are wearing proper laser safety eyewear. Do not fire the laser in the presence of flammable liquids or gasses.

Calibration Set-Up

1. Ensure that the LightSheer system is turned off and the power cord is disconnected.

2. Use glass cleaner and lens tissue to clean the handpiece tip. If the tip does not appear to be clean (i.e. can see residue) on the exterior surface or if the sapphire lens is internally contaminated or fractured, replace the Handpiece/Umbilical assembly.

3. Remove calibration pocket after loosening the quarter-turn fastener.

4. Thoroughly clean the protective window above the energy meter with glass cleaner and lens tissue. Blow out any particles with compressed air or nitrogen.

5. Re-install the calibration pocket and tighten the quarter-turn fastener.

6. Turn power on to the external energy meter display with its rear panel rocker switch. Instructions for setting up the Molectron Energy Meter are in Section 6.

Calibrate the System

1. Turn on the LightSheer main power at rear of lower console and place the laser in Service Mode. Refer to section 3.9 of the Service Manual.

2. Press the [D] button to enter the Diagnostic screen. Turn the ChillTip OFF.

3. Set the current on channel A to 2.100 Volts by pressing the [Current SP A] field and entering the 2.100 from the pop-up menu. This setting corresponds to 21 A.

   Set Current SP A to 2.100 Volts: _____ (check to confirm)

4. Set the current on channel B to 2.100 Volts by pressing the [D] [Current SP B] field and entering the 2.100 from the pop-up menu. This setting corresponds to 21 A.

   Set Current SP B to 2.100 Volts: _____ (check to confirm)

5. Set the pulsewidth to 0.030 s by pressing the pulsewidth field and entering the value from the pop-up menu.

   Set Pulse Width to 0.030 s: _____ (check to confirm)

6. Ensure that the handpiece is fully seated in the calibration port on the LightSheer™ system.

7. Fire a single pulse into the calibration port while keeping the handpiece fully seated and immediately read the peak voltage on the energy meter readout. To fire from the Diagnostic screen, depress the footswitch, wait for the shutter to come fully open (the shutter motor is audible unless the electronic shutter retrofit has been performed), depress and hold the handpiece trigger, and press the Trigger button on the screen. Repeat for (4) more shots, immediately recording the energy meter peak voltage after each shot. (With software versions of 0.19 and higher, the energy meter peak voltage is recorded at the end of the event line in the diagnostic screen.)

   Internal Energy Meter Measurements (Record):

   Pulse 1 Voltage: _____ V (X.XXX)
   Pulse 2 Voltage: _____ V (X.XXX)
   Pulse 3 Voltage: _____ V (X.XXX)
   Pulse 4 Voltage: _____ V (X.XXX)
   Pulse 5 Voltage: _____ V (X.XXX)

   If the voltage readings appear to be unstable, verify that the ChillTip = OFF and that there is no condensation on the sapphire tip. Repeat the measurements.

8. Compute and record the average energy meter voltage for the five shots. The average is the sum of the five shots divided by 5. If the voltage average is not between 3.75 – 4.75 V, see the Energy Detector Assembly change procedure.

   Avg. Voltage: _____ V (X.XXX, average = sum of above 5 voltages / 5.0)

9. Compute and record the minus 5% deviation limit from the average by multiplying the average voltage by 0.95.

   Low Voltage Limit: _____ V (X.XXX, low limit = 0.95*average voltage)

10. Compute and record the plus 5% deviation limit from the average by multiplying the average voltage by 1.05.

    High Voltage Limit: _____ V (X.XXX, high limit = 1.05*average voltage)

11. Confirm that all five voltages fall between the minus 5% and the plus 5% deviation limits. If any single shot is not within this range, see Section 4, Troubleshooting.

    Avg. Voltage greater than 3.75 V and less than 4.75 V: _____

    All five pulse voltages greater than the Low Voltage Limit: _____

    All five pulse voltages less than the High Voltage Limit: _____

12. Hold the tip of the handpiece from 1/4" (6 mm) to 1/2" (12 mm) above the surface of the external energy detector head.

13. Repeat the following steps five times: Zero the external energy meter display by pressing the "Zero" button. Fire a single pulse into the external energy meter probe. Record the pulse energy in Joules from the external energy meter display.

    External Energy Meter Measurements:

    Pulse 1 Energy: _____ J (XX.X)
    Pulse 2 Energy: _____ J (XX.X)
    Pulse 3 Energy: _____ J (XX.X)
    Pulse 4 Energy: _____ J (XX.X)
    Pulse 5 Energy: _____ J (XX.X)

    Note: If the Molectron Energy Meter yields strange values (either all unusually high or low) see Section 6 for instructions on setting up the meter.

    If the energy readings appear to be unstable, verify that the ChillTip = OFF and that there is no condensation on the sapphire tip. Repeat the measurements.

14. Compute and record the average shot energy in Joules for the five shots. The average is the sum of the five energies divided by 5. If the average shot energy is not between 26 – 36 J, see Section 4, Troubleshooting.

    Avg. Energy: _____ J (XX.XX, average = sum of above 5 energies / 5.0)

    Avg. Energy greater than 26 J and less than 36 J: _____ (yes, pass)

15. Compute and record the minus 10% deviation limit from the average by multiplying the average pulse energy by 0.90.

    Low Energy Limit: _____ J (XX.XX, low limit = 0.90*average energy)

16. Compute and record the plus 10% deviation limit from the average by multiplying the average pulse energy by 1.10.

    High Energy Limit: _____ J (XX.XX, high limit = 1.10*average energy)

17. Confirm that all five pulse energies fall between these minus 10% and plus 10% deviation limits. If any single shot is not within this range, see Section 4, Troubleshooting.

    All five pulse energies greater than the Low Energy Limit:_____ (yes, pass)

    All five pulse energies less than the High Energy Limit:_____ (yes, pass)

18. Compute and record the calibration coefficient of the on-board energy meter. The coefficient has the units of $J/cm^2/V$ and is given by the following formula: (Avg Pulse Energy in Joules) / (Avg Voltage) / (0.81 cm^2).

    Coefficient = Average Energy / 0.81 / Average Voltage)

    Coefficient: _____ J/cm2/V (X.XXX)

    Record the Coefficient on the Service Report.

19. Confirm that the calibration coefficient just calculated is between 7.6 and 11.0 $J/cm^2/V$. If not, repeat this procedure.

    Coefficient greater than 7.6 and less than 11.0 J/cm2/V: _____ (yes, pass)

20. Press the [Return] button to exit the Diagnostic screen.

21. Press the [S] button to enter the Setup Screen.

22. Enter the calibration coefficient (obtained in step 18) into the Detector field by pressing on the field to pop-up the numeric entry menu.

23. Press [Return] to exit the Setup Screen.

24. Place the handpiece in the holster, depress the footswitch and pull the trigger. The system will perform a system calibration. If prompted for a cleaning, lift handpiece from pocket, release footswitch, replace handpiece in pocket and

depress footswitch. Follow the screen prompts for another calibration. If more than one cleaning prompt occurs, go to the beginning of this procedure and repeat.

25. From the treatment screen, press the [S] button to enter the Setup Screen.

26. Record the Headroom Auto Mode and Headroom 30 ms Mode values on the Service Report.

    Headroom Auto Mode: _____ (X.XX)

    Headroom 30 ms Mode: _____ (X.XX)

27. Confirm that the "Headroom Auto" is greater than 1.20 and "Headroom 30 ms" is greater than 1.20 and check Pass on the Energy Meter Calibration Data Sheet. If not, see Section 4, Troubleshooting.

    Headroom Auto Mode greater than 1.20: _____ (yes, pass)

    Headroom 30 ms Mode greater than 1.20: _____ (yes, pass)

    Note: the Headroom values of 1.20 is a shipping specification for a new system.

28. Press [Return] to return to the Startup Screen.

29. Turn off the key and press the Quit button and follow the screen prompts to turn off power to the system.

3.0 Theory of Operation

3.1 Overview

Based on diode laser technology, the LightSheer™ Diode Laser System produces pulsed infrared light intended for hair removal and the treatment of leg veins. The laser system consists of a two-part console, a footswitch, and a handpiece connected to the console with an umbilical. Laser light is generated in the handpiece by the laser diode arrays and exits at the sapphire tip that also serves as a skin cooler. A microprocessor-based controller (microcontroller) monitors the system, provides fault checking, and controls the laser operation. The operator interacts with the controller via a touch-screen display located on the top of the console

Like all pulsed lasers, the LightSheer™ produces a pulse of coherent light with a specific wavelength. The LightSheer™ wavelength is nominally 800 nanometers, in the near infrared region of the spectrum just beyond the visible range. For the intended medical applications, the most important pulse characteristics are (1) the fluence, expressed in Joules per square centimeter, which is the amount of optical energy delivered to a given area of skin, and (2) the duration or pulse width, expressed in milliseconds. The fluence is the most relevant single measure of exposure dose. Other key laser parameters are the pulse repetition frequency in pulses per second and peak power in watts.

The general functions of the system components are described in this section. Operation of the laser, including proper use of these components, and the installation of the system is described in the User Manual.

3.2 Power Conditioning

The components used in the power conditioning system consist of (1) the power cord, (2) the power input module, (3) a circuit breaker that also acts as the main switch, (4) a terminal block which connects the (5) voltage selector switch with the (6) isolation transformer, and (7) the low voltage power supplies which converts line voltage alternating current into low voltage direct current for use by the control electronics, the user interface, the laser (diodes), the laser power supply, and the cooling system.

Input Voltage - the laser requires power from a standard wall outlet to be in the range for which the system was built. The two voltage ranges are: 110 ± 10% Vac @ 8 Amps or 220 ± 10% Vac @ 4 Amps. The power can be either 50 Hz or 60 Hz.

Circuit Breaker - depending upon the voltage range for which the laser was built, either a 4 Amp breaker (for 220 Vac systems) or an 8 Amp breaker (for 110 Vac systems) will be installed. The circuit breaker also functions as the mains disconnect, or the on/off switch.

Voltage Selector Switch - a voltage selector switch is incorporated into the system and should be set to the closest value to match input voltage. The voltage selector switch must be properly set to insure that the input to the primary side of the isolation transformer is correct.

Isolation Transformer - the transformer, and auto transformer, is wound with multiple input taps on the primary side and if the mains voltage is correct and the voltage selector switch is set to match mains voltage, the transformer secondary voltage will be approximately 120 Vac. The isolation transformer output is directly connected to the Low Voltage Power Supplies.

Low Voltage Power Supplies - a bank of six low voltage power supplies is incorporated into the system to convert 120 Vac into low voltage direct current. Each low voltage power supply serves some load. The outputs of each supply and the load it serves are listed below:

Low Voltage Power Supply	Load
PS1 - 24 Vdc (adjusted to 16 Vdc) @ 2A PS2 - 48 Vdc @ 2A PS3 - 48 Vdc @ 2A	The outputs of PS1, PS2 and PS3 are in series for a combined output of 112 Vdc to charge the Cap Bank
PS4 - +5 @ 3 A, ± 12 Vdc @ 2 A	Computer, display, and Main boards
PS5 - 12 Vdc @ 12 A	Main TEC, LC fan
PS6 - 12 Vdc @ 8 A	Pump, UC fan, and ChillTip Cooler

3.3 Control Electronics

The components used in the control electronics system consist of (1) an i486™ based single board computer module with a display interface, 64 megabytes of random access memory, an I/O board containing A/D and D/A circuitry, a disk drive controller and keyboard interface, (2) a hard disk drive for storage of the computers operating system, program files, and laser configuration data, and (3) the Main board assembly (top and bottom) which communicate with the I/O board and distribute power and signals to the rest of the system components.

Single Board Computer Assembly - the computer is a PC style computer responsible for controlling the entire LightSheer system. The assembly consists of a Intel® i486™ microprocessor, a super VGA display controller, two 32 megabyte random access memory boards, a Diamond-MM™ I/O board containing input/output ports, A/D and D/A circuitry, an IDE disk drive controller and keyboard interface. The computer's configuration is held in battery backed-up CMOS. The computer

assembly gets power from the Main-Top Board and is mounted to the top of the Upper Monolith Assembly.

Hard Drive - a 3.2 Gigabyte fixed disk is utilized for storage of the computer's operating system (Microsoft-DOS®), device drivers, program files (Microsoft-Windows '95™ Shell and LightSheer™ program), and laser configuration data (current limits, repetition rate limits, and detector calibration coefficients). Activity file(s) are also stored on the hard drive which logs each event (such as turn on, calibration shots, pulses delivered, and errors detected). Each activity LOGFILE contains the last 10,000 events. The Hard Drive is mounted to the Top Cover Assembly.

Main Board (Top and Bottom) Assembly - the Main board assembly is the primary interface between the Computer assembly's I/O board and the rest of the system components. The board distributes signals and power and is mounted on the front right of the Upper Monolith Assembly.

3.4 User Interface

The components of the User Interface consist of (1) a back-lit color LCD display panel with infrared (IR) touch screen, (2) a keyswitch and emergency stop switch, (3) the footswitch, and (4) a remote interlock plug.

LCD Display - a back-lit active-matrix flat panel color LCD (Liquid Crystal Display) is housed in the Display Panel Assembly and is the visual interface for the operation of the laser system. Laying over the top surface of the LCD Display is an infrared (IR) touch screen. Areas or zones of the touch screen are defined by XY coordinates and any interruption that falls within a specified zone are interpreted by software. The touch screen is connected to the Main-Top Board.

Switches (Key and Emergency Stop) - the Key and Emergency Stop switches are located on the exterior of the Front Door Assembly and are primary safety features. The laser cannot be operated without the Key. Both the Key and the Emergency Stop Switches are required to enable the Laser Power Supply to deliver current to the FET Board. If at any time the Emergency Stop Switch is depressed, the Laser Power Supply will be disconnected from the FET Board and Handpiece preventing the laser from firing.

Footswitch - a pump style pneumatic footswitch is incorporated into the system for both safety and simplicity. Depressing the footswitch increases air pressure in the footswitch hose, activating a pressure switch. When the pressure switch opens, the system will command the Shutter to open.

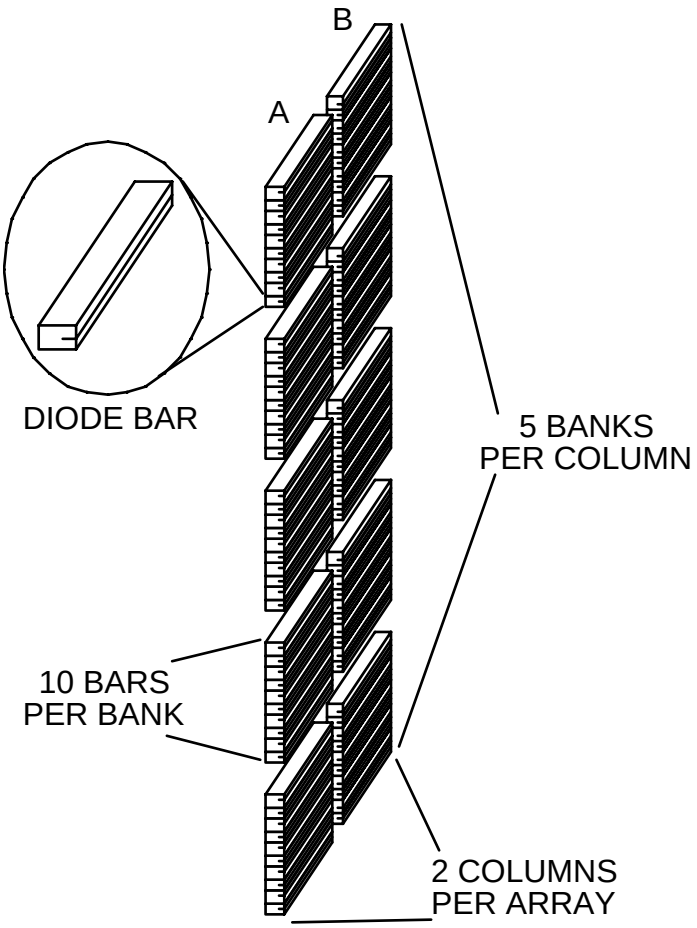
Remote Interlock Plug - a headphone style remote interlock connector is installed at the rear panel of the Upper Console and can be used as a safety feature to disconnect

the Laser Power Supply from the FET Board and Handpiece preventing the laser from firing. Normally a (shorted) plug is installed in the jack, although a customer may choose to connect the plug to a treatment room door switch.

3.5 Laser and Delivery System

The diode lasers are incorporated into an optical delivery system located in the handpiece. The components of the handpiece consist of (1) a liquid cooled, micro-lensed diode laser array module followed by a (2) motor driven mechanical blade shutter with position limit switches (This would only apply to Light Sheers with the mechanical shutter. To the later model Light Sheer or retrofits that have the electronic shutter this would not apply.) with a (3) fresnel lens and a (4) highly reflective light guide (condenser) to direct the radiation to a (5) liquid cooled sapphire tip, and a (6) trigger mechanism to deliver laser pulses, a (7) heat exchanger to cool the diode arrays in contact with the hot side of the (8) thermo-electric cooler which cools the sapphire tip in a closed-loop plumbing system by circulating the liquid with the assistance of a (9) small pump. The temperature of the sapphire tip is monitored and controlled to 4 $\pm$2 degrees C by a temperature controller.

Diode Laser Array - the Diode Laser Array consists of two parallel columns (side A and side B) of five banks of diode modules each. Each diode module consists of ten diode bars, and each bar contains many diode lasers. Each diode bar is covered by a microlens to collimate the laser beams. The array is mounted to the Backplane Heat Exchanger for cooling. NOTE- Configuration and number of bars subject to change without notice.

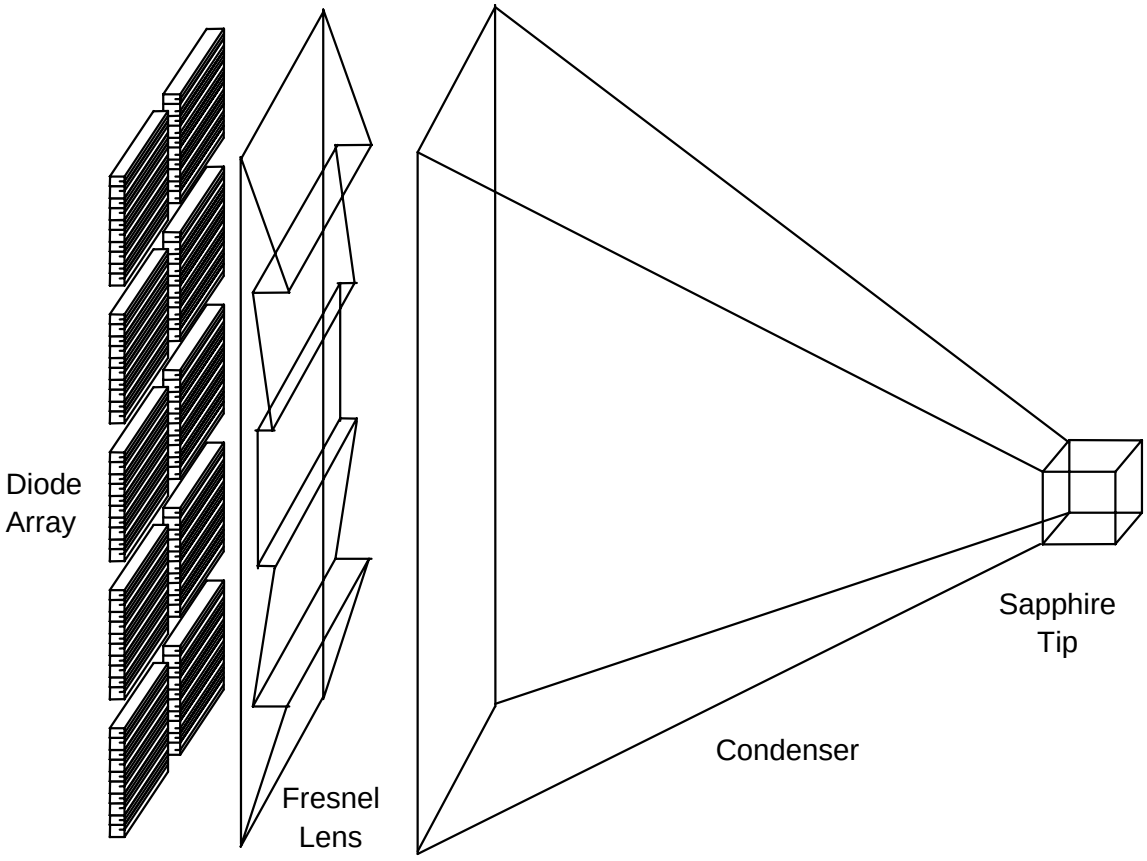


Mechanical Shutter - a motor drive Shutter (metal blade) is located between the Diode Laser Array and the ChillTip™ and will prevent laser exposure when closed. The mechanical shutter will drive out of the beam path when the laser is in the Treatment Mode and the Footswitch is depressed. Limit switches detect the position of the blade to be open or closed.

Note: Some handpieces have an electronic shutter installed and do not require the use of the motor drive or limit switches.

Fresnel Lens - a fresnel lens is used to collect the collimated laser light from the Diode Laser Array and direct the light towards the sapphire tip.

Condenser - a highly polished gold plated wave guide (condenser) is used to redirect any scattered laser light from the fresnel lens and deliver it to the sapphire tip.

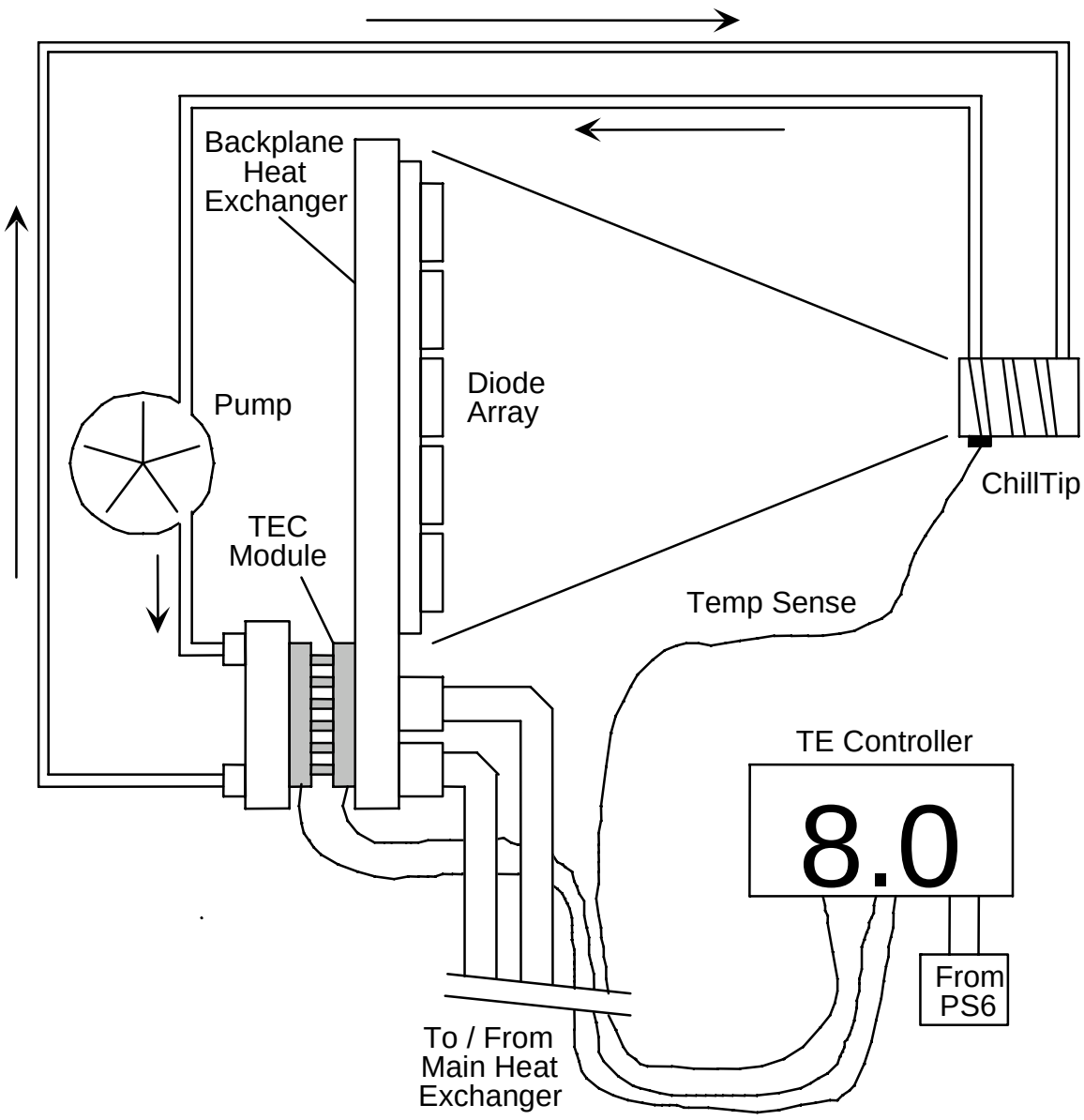


Sapphire Tip (ChillTip™) - the ChillTip™, a 9 mm x 9 mm square lens made of sapphire, is the output aperture of the Handpiece. Laser light is transmitted through the tip to the patient skin. To prevent tissue damage, the tip is wrapped in a cooling loop to maintain a tip temperature in the range of 4 $\pm$2 degrees C.

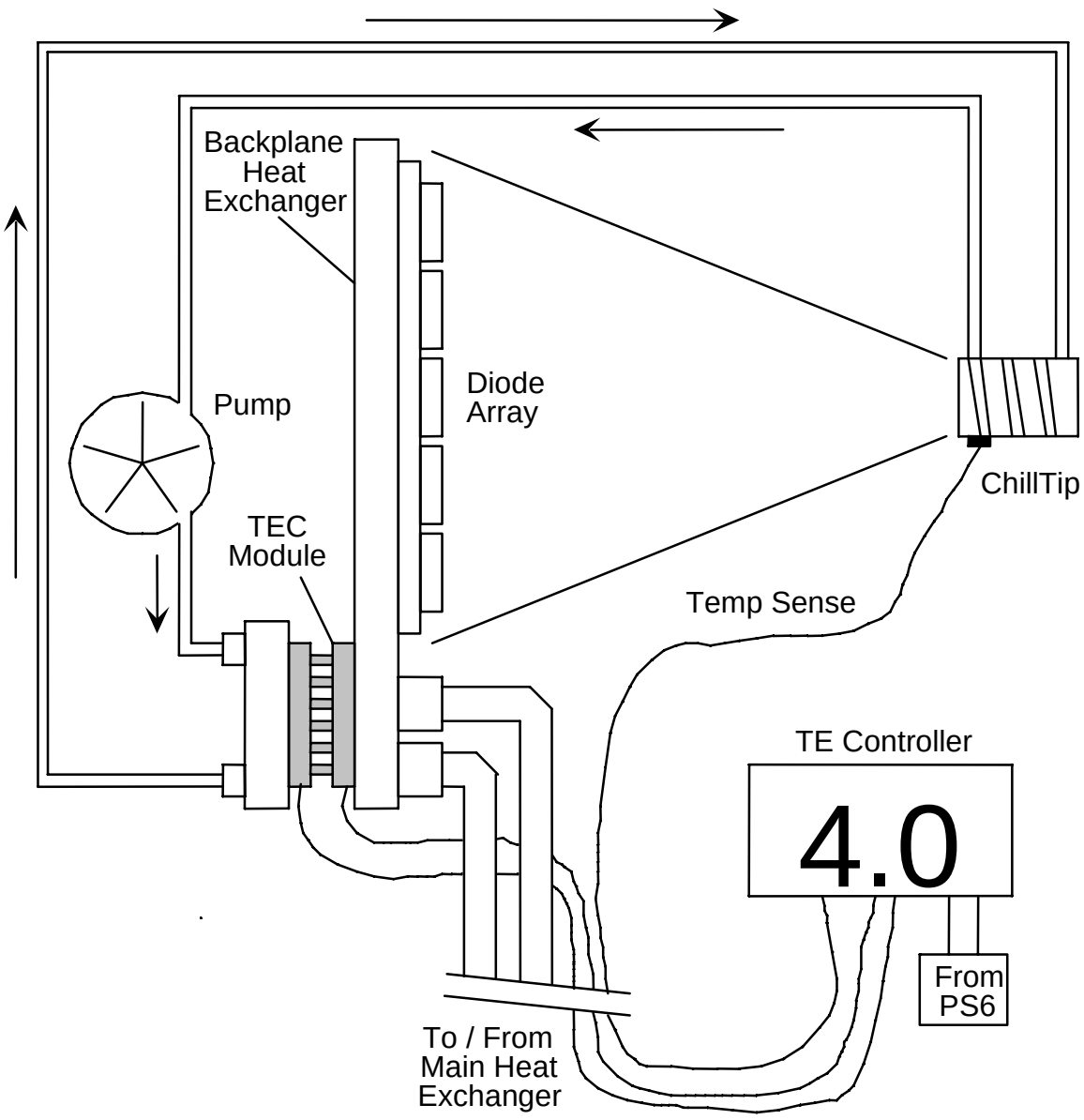
Trigger - a trigger switch is pulled to command the laser to fire. The trigger switch is active when the laser is in the Treatment Mode and the Shutter is open (footswitch down). As long as no faults are detected and the footswitch remains depressed, the laser will fire at a rate of one shot per second when the trigger is depressed and held.

Backplane Heat Exchanger - the laser diode array and the hot side of the ChillTip™ Thermo-Electric Cooler are mounted to the backplane heat exchanger. Coolant from the Main Cooling loop is pumped through the backplane to remove heat.

Thermo-Electric Cooler (a Peltier device) - the Thermo-Electric Cooler is a two sided ceramic device where one side gets hot drawing heat from the other side (which gets cold) as a current is passed through. The cold side is used in a small closed loop cooling circuit to cool the ChillTip™.



Cooling Loop w/Standard Chill Tip™



Cooling Loop w/Calibrated Chill Tip™

TEC Controller - located on top of the Upper Monolith Assembly, the TEC Controller (right hand side) is programmed to maintain a ChillTip™ temperature in the range of 4 ±2 degrees C. The temperature of the ChillTip™ is monitored, and if it gets warmer than the set point temperature of 4 degrees C (8 degrees C on older models), it allows current to flow through the Thermo-Electric Cooler.

Pump (ChillTip) - a small liquid pump is located in the Handpiece to move the coolant from the cold side of the Thermo-Electric Cooler to the ChillTip™ and back.

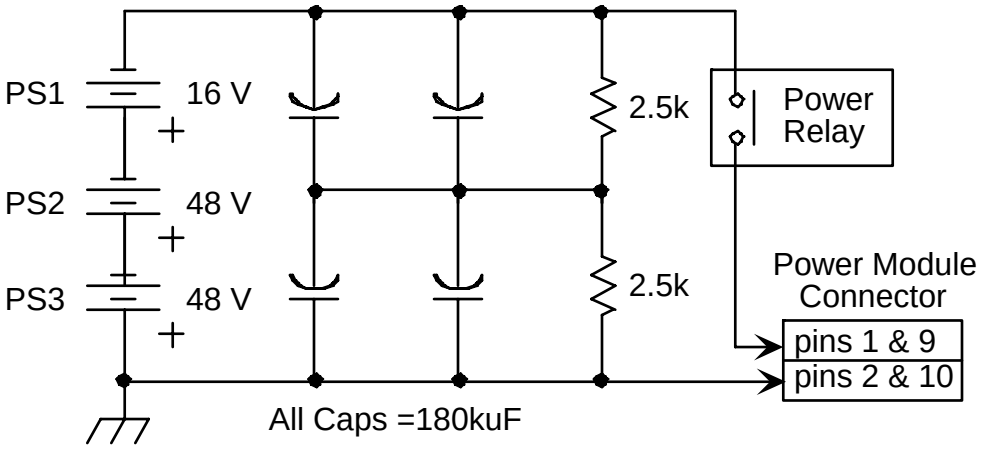
3.6 Laser Power Supply

The laser power supply consists of (1) the combined [summed] outputs of PS1, PS2, and PS3, a (2) balanced series-parallel capacitor bank which acts as a current source, a (3) computer controlled power relay allowing a controllable connect/disconnect of the capacitor bank with the (4) FET [Field Effect Transistor] Board that contains the FETs that regulate the amount of current flow from the capacitor bank to the diode laser array. The length of time current is allowed to flow (laser pulse width) is controlled by a programmable timer circuit.

PS1 + PS2 + PS3 - the outputs of PS1, PS2 and PS3 are connected in series to generate 112 Vdc @ 2 A_{rms} (negative with respect to ground) and stored in the capacitor bank.

Capacitor Bank - a balanced series-parallel capacitor bank is utilized to store energy for the Diode Laser Array. The capacitor bank consists of four 180k microfarad capacitors. The capacitors are charged anytime the Lower Console is energized (plugged in and breaker on). The energy stored on the capacitor bank can be calculated using the formula: $J = 1/2\ C\ V^2$, where C = 0.18 and V = 112. The capacitor bank is the current source for the laser diodes.

Power Relay - the function of the power relay is to deliver energy stored on the capacitor bank to reach the FET Board via the J2/P2 Connector.



FET Board - the FET Board is mounted to the FETs (Field Effect Transistors) which are mounted to the main heat exchanger of the Upper Monolith Assembly. A control voltage to the gate of the FET will allow a measured amount of current to pass from drain to source. Current passes from the Capacitor Bank, through the FET,

to the Diode Laser Array. The length of time that the FET is ON (passing current) defines the width of the laser pulse.

3.7 Cooling System

The components in the cooling system consist of (1) liquid coolant that is circulated to the handpiece by means of a (2) pump through the cold side of a (3) thermo-electric cooler module which is mounted to the (4) heat exchanger that is cooled by ambient air forced across the heat exchanger by a (5) muffin fan. The temperature of the coolant is monitored and controlled to 19 degrees C by a temperature controller.

Coolant - a mixture of 20% ethylene glycol (Prestone® anti-freeze) and 80% water used in both the main cooling loop and the ChillTip™ cooling loop.

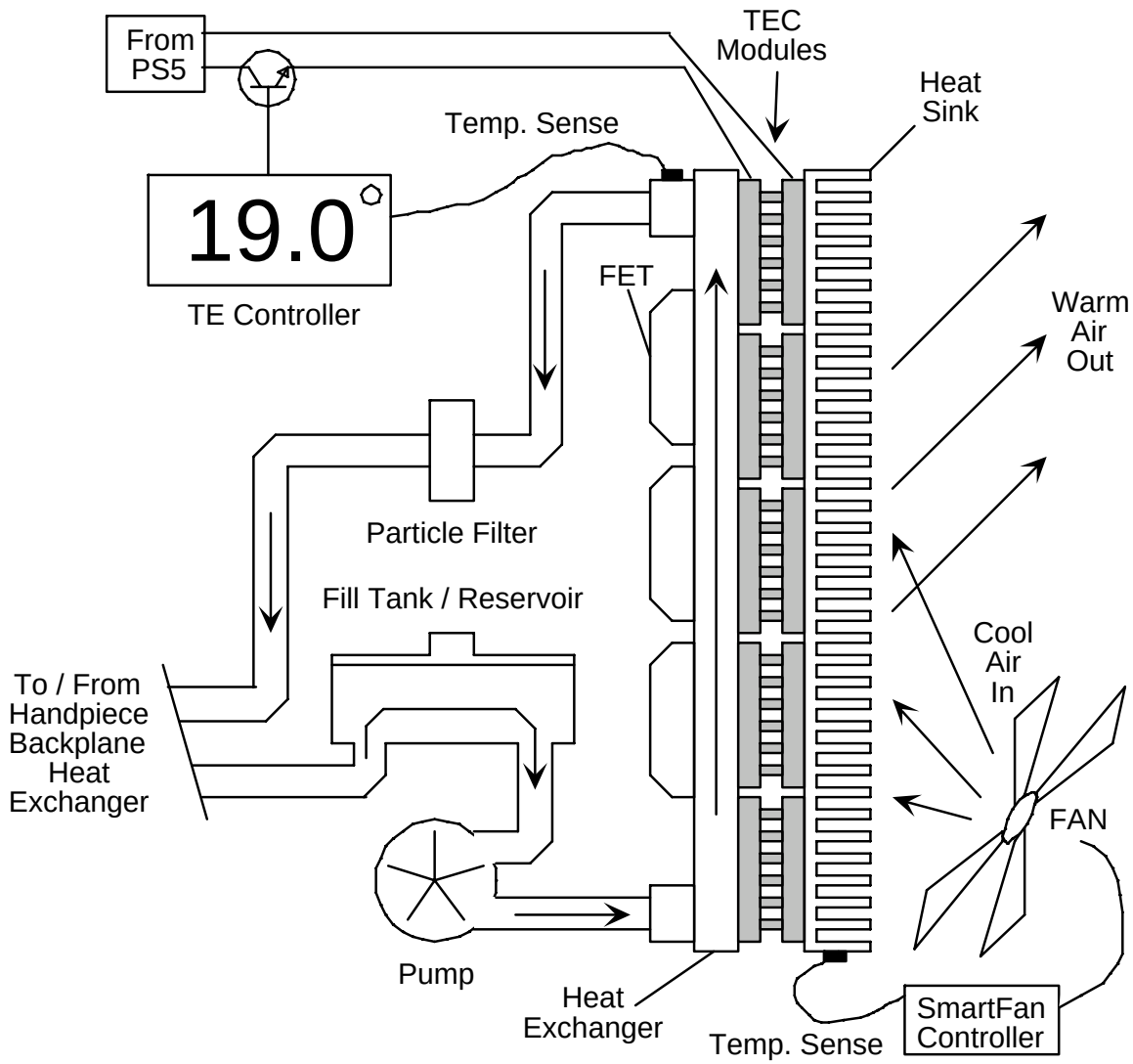
Pump - a constant flow rate pump is incorporated to force the liquid coolant through the main heat exchanger, through a particle filter, to the Backplane Heat Exchanger located in the Handpiece. A fill tank/reservoir is located just above the pump.

Thermo-Electric Cooler (a Peltier device) - the Thermo-Electric Cooler is a two sided ceramic device where one side gets hot drawing heat from the other side (which gets cold) as a current is passed through. A number of Thermo-Electric Coolers are used in the main heat exchange. The cold side is used in the main closed loop cooling circuit to cool the FETs and the Backplane Heat Exchanger in the Handpiece.

Temperature Controller - located on top of the Upper Monolith Assembly, the temperature controller (left hand side) is programmed to maintain a coolant temperature of 19 degrees C. The temperature of the coolant is monitored, and when it gets warmer than the setpoint temperature of 19 degrees C, it allows current to flow through the Thermo-Electric Cooler.

Heat Exchanger - the liquid coolant flows through a metal heat exchanger where heat is absorbed by the metal and transferred from the cold side of the Thermo-Electric Coolers to the hot side.

Fan - a large muffin fan draws ambient air into the rear of the Upper Console and forces it through an aluminum heat sink attached to the hot side of the Thermo-Electric Coolers.



3.8 User Software

The User software is stored on the hard drive and is set up as the “boot” program so that upon system turn on, the microcontroller will grab the program files from the hard drive and load them into memory. The program will begin to run under the Microsoft Windows shell.

After startup and calibration, the microcontroller displays the treatment screen which provides system information and allows the operator to set laser parameters, control the skin cooler (ChillTip™), and reset the shot counter. The screen features are described here.

ChillTip™

The ChillTip button toggles the cooling on and off to the sapphire tip. When first turned on, the ChillTip requires less than one minute to cool to its operating temperature, during which time the "Cooling" message is displayed on the screen. The laser cannot be fired if the ChillTip is on but not at operating temperature. For safety, the ChillTip is on by default and a confirmation screen appears when the ChillTip is turned off. In addition, if the ChillTip is off, the "OFF" indicator flashes red as a warning to the user.

Opti-Pulse™

The Opti-Pulse button controls the laser's temporal pulse width. Opti-Pulse has two user selectable modes: "Auto" and "30 ms". In "Auto" mode, the microcontroller selects the minimum pulse width allowable at a given fluence (equal to the fluence divided by two, in milliseconds). In "30 ms" mode, the pulse width is fixed at 30 ms, independent of the fluence setting.

Fluence

The fluence setting in J/cm^2 is displayed on a digital indicator near the center of the screen. To adjust the fluence, press the adjacent up and down arrows to increase or decrease the setting. The standard fluence range is 10-40 J/cm^2 and the default fluence is the value last used for treatment.

Status Indicator

The laser status indicator is located on the bottom of the treatment screen and has three states: "Cooling", "Standby", and "Ready". When the ChillTip is on but not at its operating temperature (above its setpoint temperature), the status indicator shows "Cooling". When the system is ready for use and the footswitch is not depressed, "Standby" is displayed. Depressing the footswitch causes the shutter to open, and when sensed to be fully open, the status message changes to "Ready". Whenever the system is "Ready", pulling the handpiece trigger will result in laser emission.

Shot Counter

Useful for recording the number of pulses in a treatment, the shot counter in the upper right corner of the treatment screen tallies each laser pulse. A reset button is located adjacent to the digital indicator. Pressing the reset button clears the present shot counter value and returns the count to "0000". Pressing the numbers themselves will reveal the total shots fired on the system. This value is not re-settable. Pressing the numbers again will return the system to the original setting. (NOTE- This is only available on software version V0.19.)

User Calibration

From the treatment screen, the operator can perform a calibration of the laser energy by inserting the handpiece into the holster, depressing the footswitch, waiting for the "Ready" indicator, and pulling the trigger. At that point, the calibration screen will appear and a four shot calibration will occur.

3.9 Service Software

The Service software is nested within the User software and by default, is not activated. System and laser parameters are accessible from the service screens. Access to and use of the Service routines is to be strictly limited to trained service personnel.

Caution - Do not instruct users or non-trained technical personnel to access or utilize these routines. Mis-calibration, laser damage, and/or a non-functional system may result from improper settings of the service screens!

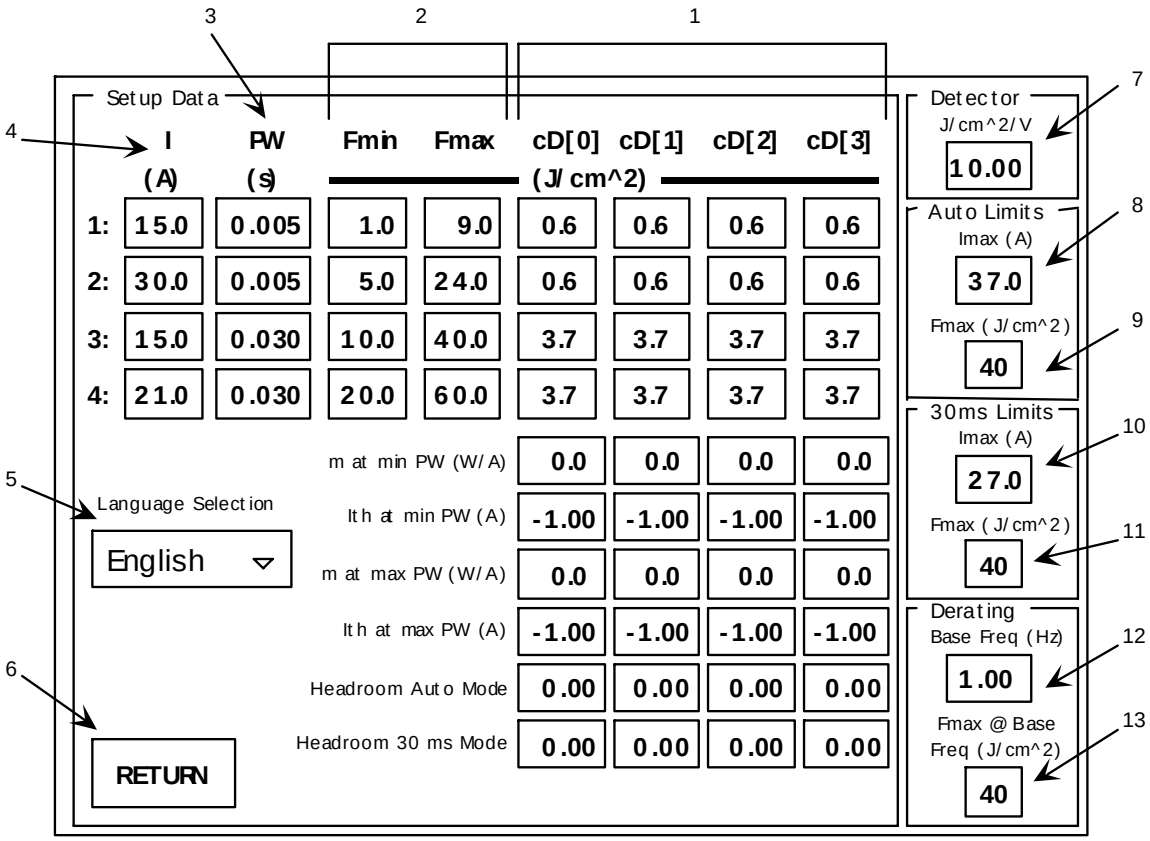
Access to Service Software

There are two methods to activate Service software:

(1) Upon system turn on, the microcontroller will look at the Main-Bottom board configuration switch, SW1-1, to see if it is open (OFF, reset) or closed (ON, set). If the bit is set, the service routines will be activated, as indicated by the letters [D], [S], and [Q] scattered around the display. Selecting [D] or [S] will get into the two useful service screens. Pressing [Q] locks the computer up - so don't press it. If the switch method is employed to enter Service software, verify that the switch position is returned to its default position so that there is no chance the user can get into Service software.

(2) Depress the emergency stop switch, then play the three note "Mary had a little lamb" song near the bottom of the display and wait a second. A new screen with the options "Normal Operation", "Service", "Demo", and "Service & Demo" will appear on the display. Select "Service". Once "Service" has been selected play the three note "Twinkle Twinkle Little Star". The normal screen will return with the letters scattered as described above. To leave Service software is this method is employed, either quit and turn off the system as normal or depress the emergency stop switch, play the three note "Mary had a little lamb" song near the bottom of the display and wait a second. A new screen with the options "Normal Operation", "Service", "Demo", and "Service & Demo" will appear on the display. Select "Normal Operation" and play "twinkle, twinkle, little star" near the bottom of the display. The system will return to the normal User software.

The [S]etup Screen and [D]iagnostic Screen with a description of fields and default values are shown in the following figures.

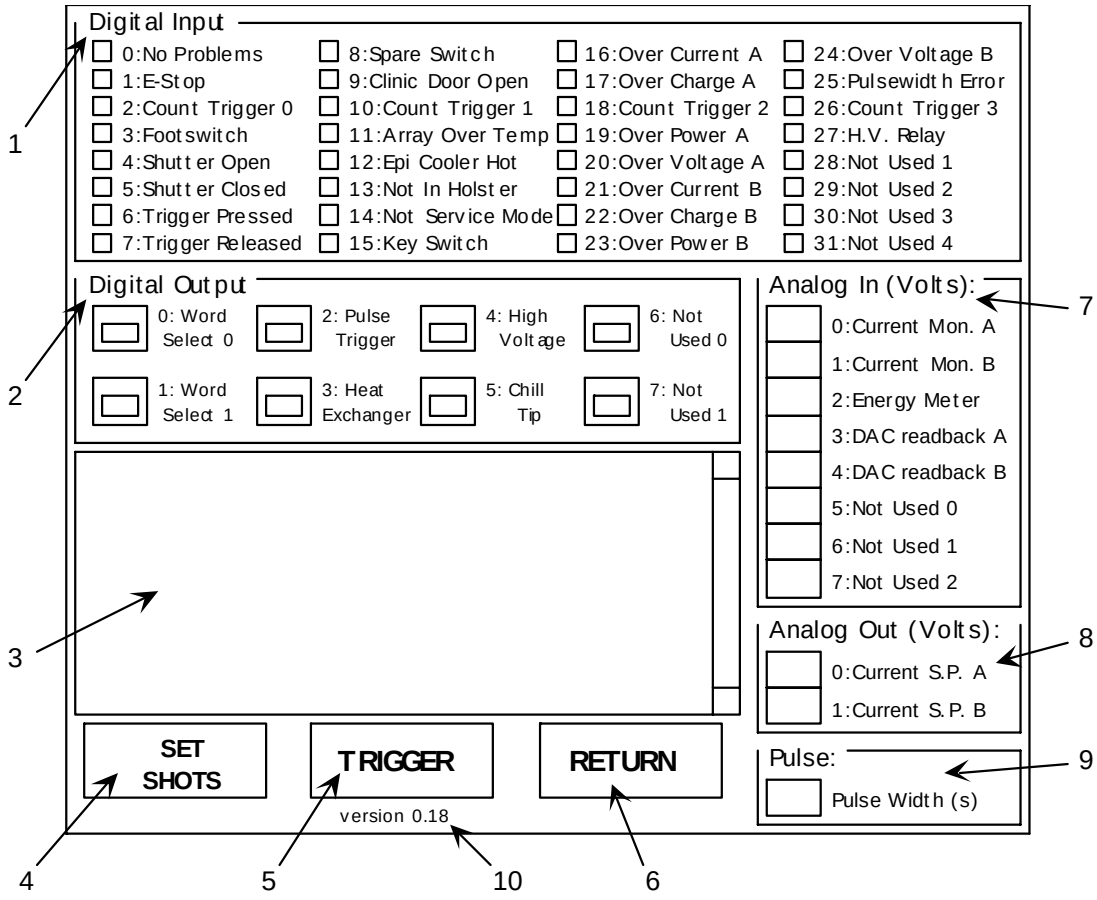


Setup Screen

Setup Screen Field Descriptions:

1. Results of recent calibration.
☆2. Acceptable fluence range for the four shot calibration measurements.
☆3. Pulsewidth set points for the four shot calibration.
☆4. Current set points for the four shot calibration.
5. Language selection.
6. Return to the previous screen.
7. Power meter sensitivity (from the manual calibration procedure, Section 2)
☆8. Maximum diode current allowed in Auto mode.
☆9. Maximum fluence set point allowed in treatment screen in Auto mode.
☆10. Maximum diode current allowed in 30 ms mode.
☆11. Maximum fluence set point allowed in treatment screen in 30 ms mode.
☆12. Maximum pulse rate frequency of system.
☆13. Fluence above which pulse rate frequency is reduced to limit avg. power.

Note - Items listed above with a ☆ should retain the default value shown in the figure and must never be altered!



Diagnostic Screen

Diagnostic Screen Field Descriptions:

1. Digital Input Status (a ✓ mark indicates that the status bit is active).
2. Digital Output Control (toggle to turn on or off).
3. Event Screen - Record of the last 10 shots.
4. Access to cumulative shot counter reset.
5. Screen Trigger (depress footswitch, pull handpiece trigger, then press Screen Trigger button to fire laser).
6. Return to the previous screen.
7. Analog Voltage Measurements (as measured by system ADC circuitry).
8. Analog Output Command to Diode Arrays (volts x 10 = amps)
9. Pulse Width Command
10. Software Version Number

3.10 Demo Software


DANGER

Prior to operating the system in Demo Mode the power to the arrays must be disabled by disconnecting the power to the arrays at the FET driver board.

DO NOT OPERATE THE SYSTEM IN DEMO MODE UNLESS THE POWER TO THE ARRAYS HAS BEEN DISCONNECTED.

To operate the laser in Demo software, gain access to the Service mode screen as described in Section 3.9 (2) and select "Demo" mode. Operating the system in demo mode simulates complete operation of the system *without* firing any laser shots. The system will turn on normally and prompt the user to perform the normal start up sequence. The system will perform the four shot calibration without laser emission and mock treatments can be made. Return the system to normal operation (User software) as described in Section 3.9.

3.11 Service and Demo Software

This operating mode is not used.

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4.0 Troubleshooting

4.1 Overview

The LightSheer™ Diode Laser Systems is designed to require little adjustment or calibration, and to detect and report hardware malfunctions by Fault Code or error Messages displayed on the screen. In most cases field failures are repaired by changing out assemblies, or groups of parts.

Corrective and preventive maintenance must only be performed by a Service Technician who has completed a Certified Training Course on the LightSheer™ Diode Laser System.

4.2 Form and Fit, Mechanical Problems

Covers, Handle, or Skirt Dented or Damaged

Dented or damaged covers and handles are generally a sign of improper handling or rough transportation and are typically not covered under system warranty.

Upper Console (UC) and Lower Console (LC) Do not Mate

Note: this is more common with the “old latch” style (pin and 2 latch).

1. Verify that the UC and LC have the same serial number (although this is not necessarily always the case). Height adjustment pads are located on the LC. Adjust as required.

2. Verify proper orientation of both UC and LC (front of UC lines up with front of LC). In other words, the UC and LC only mate in one orientation.

3. Verify that J2/P2 Module Power Connector alignment posts are not bent, broken, or missing. Repair or replace alignment posts as required.

4. Verify that J2/P2 Module Power Connector is not damaged (check for broken plastic connectors, pushed pins, etc.). Repair or replace as required.

5. Check console latch for proper operation.

Castor Off or System Rocks on Level Ground

Tighten any loose castors. Replace any bent, broken or missing castors.

Display Won't Stay in Position

Replace the display assembly.

Handpiece Doesn't Fit in Door Pocket

1. Verify that the umbilical cord is properly wrapped in door.
2. Check to see that the handpiece covers are not damaged.
3. Verify that the handpiece wrist strap is not in the way.
4. Examine the door pocket and verify that it is not damaged.
5. Verify that the umbilical is not too long or too short (see below).
6. The handpiece is not fully inserted in the door pocket.

Handpiece Doesn't Fit in Holster

1. Check to see that the handpiece covers are not damaged.
2. Verify that the handpiece wrist strap is not in the way.
3. Is the holster damaged or incorrectly installed?

Umbilical Too Long or Too Short

Remove access panel from UC, cut umbilical tie wrap, slide umbilical cord in or out (depending upon problem), attach new tie wrap, reinstall access panel. Verify that the cooling hoses are not kinked or twisted. Each hose should only have one continuous bend.

Front Door Won't Close or Latch Closed

1. Are the handpiece and umbilical properly installed in the door pocket?
2. Door latch broken? Repair or replace it.
3. Door hinges broken or have loose hardware? Repair or replace broken parts.
4. Is the key or a key chain in the way?

5. Wrist strap in the way?

Front Door Drops Open

Airpot(s) require adjustment or replacement. Adjust vent at rear of airpot. Hinges not attached to door or hinges broken. Repair or replace as required.

Key/Emergency Stop Switches Mounts Loose

Remove front door assembly and tighten mounting hardware.

Footswitch Damaged

Replace it.

4.3 Turn-on Problems

No Power at Outlet

This is not a problem with the laser. The customer needs to rectify the situation. Either the outlet is not connected or is dead. Check for a wall switch or circuit breaker for the outlet.

Mains Voltage Incorrect

This is not a problem with the laser. The customer needs to rectify the situation. If the voltage is outside the specified tolerance, try another outlet. Make sure that a 110 Vac system is not plugged into a 220 Vac outlet or that a 220 Vac system is not plugged into a 110 Vac outlet. Incorrect selection of outlet voltage will only result in the tripping of the main circuit breaker switch.

Power Cord not Properly Connected

The power cord must be firmly seated in the socket at the rear of the laser. Some of the cord sockets have a clamping type cord keeper. If a cord keeper is available, make sure it is used. Otherwise, make sure the cord is fully inserted into the socket.

Voltage Selection Incorrect

There are two types of voltage selectors so first identify which style. Look below the power cord connector. The original (older) style is a red slider, which allows selections of 115 or 230 Vac. The current (newer) style is a black rotary, which give a few more selections of 100, 120, 200, 220, 240 Vac. Measure main voltage and set the switch to the closest value.

Circuit Breaker Tripping

The circuit breaker should never trip during normal laser operation. If the breaker consistently trips while the laser is in use, verify the current rating of the breaker. Possibly a 4 amp breaker is installed (as it should be on a 220 Vac system) AND the laser is incorrectly configured to operate on 110 Vac.

If the breaker will not stay on when first turned on, make sure to hold the breaker in the ON position for a few seconds and verify that the breaker is firmly placed in the ON position.

If the breaker will not stay and latch even if held, there must be an internal short circuit. Troubleshoot the power conditioning circuit in the Lower Console.

If the breaker rating is correct and is able to remain on for some time, there must be an internal short circuit with a secondary load. Isolate the loads to determine the cause of the over current condition.

4.4 Boot-up Problems

System Losing Power and/or Re-booting

1. Check the connector between the upper and lower console. If there are any foreign objects such as foam, remove them and check the pins for damage.

2. Check the 5V power line (TP3 and TP2). This should be 5.0-5.1V. If it is not then check the following.

    a. Check the voltage drop for the ground and 5V line. It should be no greater than 80 mV. This is done by:

        1. Using a voltmeter connect the two leads to the ground (TP1) and the white with black strip line in the lower console ground wire.

        2. Using a voltmeter connect the two lead to the 5V (TP2) and the red wire in the lower console 5V power supply.

        3. If either voltage drop is greater then 80 mV, replace the connection pins. It may be the pin connection in the Main Bottom board (J10) pins or the pin connections in the lower console.

CMOS Data Corrupt

The CMOS data is incorrect or has been corrupted. Refer to Section 6.6, CMOS Configuration.

Operating System Missing or Not Found or Missing or Corrupt File

The hard disk is disconnected or has crashed. Refer to Section 6.7, Rebuild Hard Drive.

System Always in Service (small letters scattered around an otherwise normal display)

Switch SW1-1 on the Main-Bottom board is incorrectly set. Remove the access panel on the UC to locate the switch. The switch should normally be OFF.

Blank Display

The display has failed or become disconnected or the display driver board has failed or the computer is dead.

4.5 Start-up Problems

Display Buttons Not Recognized

J3 on the Main-Top board may be disconnected or the touch panel is damaged.

Keyswitch Operation Not Detected

The Keyswitch has failed, a wire in the harness is broken or disconnected, or J8 on the Main-Bottom board is disconnectedor plugged in incorrectly.

Emergency Stop Switch In

Rotate the e-stop switch clockwise so that it “pops” out.

Handpiece-in-Holster Not Detected

1. The handpiece is not properly seated in the holster.
2. J5 on the Main-Bottom board is disconnected.
3. The proximity sensor has failed.

Footswitch Not Detected

1. The footswitch is not depressed.

2. The footswitch hose is not connected to the rear of the UC.

3. The footswitch hose was attached while being depressed.

4. J9 on the Main-Bottom board is disconnected.

5. A wire is broken or the pressure microswitch has failed.

System Stuck in Cooling or Tip Doesn't Get Cold

Coolant level low, J12 on Main-Bottom board not connected, (one of the) low voltage power supplies has failed, Thermo-Electric Controller not properly set-up or has failed, J4 on the Main-Bottom board not connected, TEC in handpiece has failed, J14 on the Main-Bottom board not connected, or check below.

1. Check on the temperature on the main heat exchanger controller. Check to see if it is set to 19˚ C.

2. If the controller is blank check to see if there is any power by checking (J3 pin 2): 12V. If it is not 12V there may be something wrong with the board, and it may need replacing.

3. If the controller indicates a "fail input", check the connections, there may be a wire loose or broken. Turn off the system and fix the problem and restart the system.

4. Check on the Epi Temperature controller. Check to see if it is set to 4 degrees C (This is for software V0.19. Any version prior to that would have a setting of 8 degrees C).

5. If the controller is blank, check to see if there is any power by checking (J4 pin 3,4) both should be 12V.

6. If the controller indicates a "fail input", check the connections, there may be a wire loose or broken. Turn off the system and fix the problem and restart the system.

7. If both controllers are fine, but the Epi controller reads extremely high or low temperature (greater then 30 degrees C), check the resistance between (J16 pin 1 & 2). It should read approximately 114 ohms.

8. At the same time, wiggle the hand piece and check the resistance on the meter. If the resistance fluctuates widely, there may be a short in the umbilical or a connector problem inside the handpiece. This can cause the controller to think that the "ChillTip" is too hot.

4.6 Operational Problems

Calibration Check Sum.

1. The software has been corrupted by a possible improper shutdown or a separation and reconnection of the of the upper and lower consoles while the system is still on.

2. Reload new software on to the system and re-enter the calibration coefficient in the [S]et up screen.

Multiple Errors While Performing Calibration

1. This may occur if one or more of boards are not plugged in or if there are loose connections.

2. Connect any loose wires or cables and restart the system. Most if not all of the error messages should go away.

Over Current A/B, Over Charge A/B, Over Power A/B or Over Voltage A/B (while performing Calibration)

If it is determined that the diamond board and/or its connections are fine, check the following:

1. Turn off the system and check all the screws on the FET board to see if they are tight, if they are loose tighten them. Check to see if there are any loose or broken wire(s) which may be shorting to ground. Fix any obvious problems and restart the system. If the problem persists…

2. Go into Service mode and touch [D] to get into the diagnostic screen.

3. Check the FET board using a Voltmeter. Hook the black clip of the meter to (TP7).

4. Turn on the key switch and with the red lead, touch the fuse (F1) on both sides. It should read (-112V). If it does not, the fuse is bad and needs to be replaced.

5. If the fuse is good, turn on the high voltage bit and touch the red lead to (Q10). It should read (-112V) also.

6. If the above tests are good, move the black clip to (TP8).

7. With the red LEAD, test the (U4 - pin 4), (U4 - pin 11), and (U13 – pin 8), they should read, +12V, –12V, and + 5V respectively.

8. If one or all of these tests fails, the board may need to be replaced.

9. Take the FET board off and test the FET itself. The resistance between the top of the FET and the bottom should be infinite. Check all the FETs, replace any that are bad, and put the FET board back on and restart the system.

10. Check to see if the MAIN BOTTOM board is getting the power it needs. Using a Voltmeter, attach the negative LEAD to (TP3) on the MAIN TOP board, then measure the following dc voltages:

    (J10 pin 2) : 12V
    (J10 pin 3) : -12V
    (J10 pin 4) : 12V
    (J10 pin 6) : 5V
    (J10 pin 8) : 12V

11. If you do not get the above reading, there is a problem with the connection between the lower and upper console. Fix the problem and restart the system.

4.7 Handpiece Problems

Sapphire Tip Fractured

Review Pre-Op procedures (shave patient immediately prior to treatment). Clean tip frequently. Don't drop the handpiece (use the wrist strap). Replace the handpiece/umbilical assembly.

Trigger Switch Doesn't Work

Trigger switch in handpiece broken or disconnected.

1. Check for continuity on the leads at the J14connector (J16 on systems without the electronic shutter) on Main-Bottom board.

2. A damaged trigger or trigger switch will require the replacement of the hand piece/umbilical assembly.

Shutter Not Moving/Moving Too Slow (Mechanical Shutter Only)

Shutter mechanism damaged or broken, shutter motor not connected, J14 (J16 on systems without the electronic shutter) on Main-Bottom board not connected.

1. The shutter may have failed to open. To test this, restart the system and go through the calibration procedure, but when pressing the foot switch, hold it for 1 second, release and immediately press it again. You may have to repeat this step several times then hold the foot switch down. If this works and the system allows you to finish calibrating, there is a problem with the shutter. It is taking too long to open.

2. The shutter may fail to close. The system may allow you to calibrate, but when you are finished, and released the foot switch, it will give you a system fault. This may also occur while the authorized user is treating a patient. Ask the authorized user if he/she remembers when the system fault occurred. If the authorized user indicated that the problem occurred when he/she released the foot switch, it could be the shutter failing to close.

ChillTip™ Not Cold

When the system is turned on, is the hand piece pump running? Does the handpiece vibrate?. If not check to see if power is getting to the handpiece. Check the following with a DVM:

(J12 pin 3) : 12V
(J12 pin 4) : 12V
(J14 pin 1) : 12V
(J14 pin 2) : 12V
(J14 pin 6) : 5V
(J14 pin 8) : 2V
(J14 pin 10) : 5V

Also see “System Stuck in Cooling or Tip Doesn’t Get Cold” above.

4.8 Fault Codes

If multiple fault codes are displayed, it generally indicates that a connector or wire harness is not fully seated or has become disconnected. One to five fault codes may be

displayed on the screen at one time. Therefore, the possibility may exist where more than five faults have occurred.

E1	Bios Memory Failure	It is doubtful if this error can be displayed.
E2	IO Board Failure	It is doubtful if this error can be displayed.
E3	Calibration Checksum Failure	Displayed after first software progress bar.
E4	Shutter Failed to Open	(or moving too slow)
E5	Shutter Failed to Close	(or moving too slow)
E6	Over Current A	E6 through E13 may occur during or after the 4 shot calibration.
E7	Over Current B	
E8	Over Charge A	
E9	Over Charge B	
E10	Over Power A	
E11	Over Power B	
E12	Over Voltage A	
E13	Over Voltage B	
E14	Pulsewidth Error	
E15	Calibration out of range	R7 on Main-Top not properly set.
E16	Calibration not self-consistent	Clean the ChillTip and cal port window.
E17	Calibration inconsistent	Clean the ChillTip and cal port window.
E18	Current Tolerance	Only after firing a shot.
E19	Energy Low	
E20	DAC Readback A	Only prior to firing a shot.
E21	DAC Readback B	Only prior to firing a shot.

5.0 Remove/Replace Procedures

5.1 Separate Upper Console (UC) from Lower Console (LC)

1. Turn the keyswitch off, press “Quit” and follow the screen instructions to power down the system with the main power rocker switch.

2. Fold down the touch-screen to protect it.

3. Secure the handpiece in the storage compartment on the front of the console. The umbilical should be wrapped two times around the outside of the handpiece pocket.

4. Unplug the power cord from the wall socket.

5. Unplug the remote interlock connector if a special (i.e., non-factory) connector has been installed.

6. Pull the console release latch located in the rear between the upper and lower console halves. This will unlatch the two consoles.

7. Pulling straight up by the handrails, lift the upper console from the lower. Because the upper console weighs approximately 50 pounds, it is recommended that two people perform the lifting for safety and to prevent possible inadvertent damage to the instrument.

5.2 Upper Console

Access Panel Removal

1. Open the front door.

2. Locate the access panel mount screws (x8). The screws are around the perimeter of the panel.

3. Remove the #8-32x1/4” screws with 3/32” hex wrench.

4. Pull the access panel back and lift out of the front door assembly.

Access Panel Replacement

1. Clean any dried excess LocTite® from the access panel mounting screw holes with acetone.

2. Verify that the Calibration Port drain hose is routed at the bottom right of the front door assembly. Relocate as required.

3. Verify that the Handpiece Umbilical Cord is anchored at the bottom left of the front door assembly with a tie-wrap. Tie-wrap as required.

4. Verify that no wires or cable harness are within the perimeter of the access panel. Relocate as required.

5. Place the access panel in the front door assembly and push forward.

6. Add one drop of LocTite 242 to each of the #8-32x1/4" access panel mount screws just prior to installing each screw.

7. Install mounting screws (x8) and tighten.

Front Door Assembly Removal

1. With UC on a table or counter, remove Access Panel.

2. Place "bubble-wrap" or other suitable cushion material below front door.

3. Remove the handpiece and unwind the umbilical cord from the inside front door.

4. Locate and remove the umbilical cord keeper bracket.

5. Locate and remove left (x3) and right (x3) side hinge mounting screws (#8-32x3/8") with 3/32" hex wrench. Let the front door come down to rest on the cushion material.

6. Locate and disconnect the J8 cable from the Main-Bottom board.

7. Locate and remove (x10) front door assembly mounting screws (#8-32x3/8") around the left, top and right perimeter using 3/32" hex wrench.

8. Cut the tie-wrap that secures the Handpiece Umbilical Cord to the bottom inside front door.

9. Locate and verify that the Calibration Port drain hose is free.

10. Carefully pull the front door assembly away from the UC, feeding the Handpiece/Umbilical Assembly through the center opening of the front door assembly.

Front Door Assembly Replacement

1. Clean any dried excess LocTite from the front door assembly screw mounting holes with acetone.

2. Carefully feed the handpiece/umbilical assembly through the center opening of the front door assembly.

3. Route the Calibration Port drain hose to the bottom right of the front door assembly.

4. Attach the Handpiece Umbilical Cord to the bottom left of the front door assembly with a tie-wrap, but leave the tie-wrap loose. Use old tie-wrap marking for placement of umbilical.

5. Route all wires, handpiece tubing and cable harness away from the perimeter of the front door assembly.

6. Locate and connect the J8 cable to the Main-Bottom board.

7. Add one drop of LocTite 242 to each screw prior to installation.

8. Install (x10) front door assembly mounting screws (#8-32x3/8") around the left, top and right perimeter using 3/32" hex wrench.

9. Install left (x3) and right (x3) side hinge mounting screws (#8-32x3/8") with 3/32" hex wrench.

10. Wind the umbilical cord inside the front door and place the handpiece in the pocket. Verify that the umbilical cord does not protrude outside the bounds of the front door. Lengthen or shorten as required.

11. Anchor the umbilical cord by tightening the tie-wrap.

12. Remove the handpiece and unwind the umbilical cord.

13. Install the umbilical cord keeper bracket.

14. Wind the umbilical cord inside the front door and place the handpiece in the pocket.

15. Verify that the front door opens and closes without interference.

16. Replace Access Panel.

Key/Emergency Stop Switch Assembly

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Remove the wired end of the switch assemblies.

4. With an adjustable wrench, loosen or tighten the panel mount hardware.

Top Cover Assembly Removal

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Fold the display panel down to cover the Calibration Port.

4. Locate and disconnect the J2 and J3 (this one is glued) cables from the Main-Top board and route them out and above the monolith frame cutout.

5. Locate and disconnect the J5 cable from the Main-Bottom board and route it out and above the monolith frame cutout.

6. Locate and disconnect the Hard Drive ribbon cable from the main Computer board. This connector is hot glued.

7. Locate and disconnect the grounding wire from the frame ground stud on the upper left monolith. (The second ground wire goes to the handpiece). Use a 5/16” hex socket wrench.

8. Locate the Calibration Port drain hose and route it out and above the cutout at the top center of the monolith frame.

9. Locate the (x1) left and (x1) right top cover assembly frame mount screws (#10-32x1/4”). The screws are just inside the front door assembly cutout. Remove both screws with a 1/8” hex wrench.

10. Locate (x2) top cover assembly mounting screws at the rear of the UC. The screws are located just above the UC air intake screen. Remove both screws with a 1/8” hex wrench.

11. Slide the top cover assembly toward the front of the UC, then tilt the top cover assembly up with the pivot point at the rear.

12. Locate and disconnect the cables (x2) from the Display Driver board located on the Main Computer board. The connectors are CN1 and CN3. The CN1 connector is hot glued.

13. Lift and separate the top cover assembly from the UC.

Top Cover Assembly Replacement

1. Lower the top cover assembly on the top rear of UC.

2. Route the cables (x2) from the Display and connect to the Driver board located on the Main Computer board. The “push-on” connector needs to be hot glued.

3. Route the J2 (energy detector) cable, the J3 (touch panel) cable, the J5 (holster proximity switch) cable, and the Calibration Port drain hose through the monolith frame top center cutout.

4. Route the display panel ground wire along the left side toward the front of the UC.

5. Lay the top cover assembly down on the UC, allowing the mid-point screws to fall into the slotted holes. Slide the top cover assembly back.

6. Place a drop of LocTite 242 on each screw thread and install the (x1) left and (x1) right top cover assembly frame mount screws (#10-32x1/4”). Use a 1/8” hex wrench.

7. Place a drop of LocTite 242 on each screw thread and install the (x2) top cover assembly mounting screws at the rear of the UC. Use a 1/8” hex wrench.

8. Attach the grounding wire to the frame ground stud on the upper left monolith. (The second ground wire goes to the handpiece). Use a 5/16” hex socket wrench.

9. Connect the Hard Drive ribbon cable to the main Computer board. Make sure pin 1 (red stripe) is toward the center of the monolith. This connector is hot glued.

10. Connect the J5 cable to the Main-Bottom board.

11. Connect the J2 and J3 (this one is glued) cables to the Main-Top board.

12. Replace the Front Door Assembly.

13. Replace the Access Panel.

Energy Detector Assembly

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Remove the Top Cover Assembly.

4. Remove and replace the Detector Assembly.

5. Replace the Top Cover Assembly.

6. Calibrate the Energy Detector

   A. Attach voltmeter clips to +5V and GND test points on main bottom board. Voltmeter should read 5.05V ±0.05 after application has booted. If not, adjust potentiometer on PS4 in the Lower Console so that it does and add a small amount of corona dope to the potentiometer on PS4 in the Lower Console.

   Note: The handpiece must be in calibration port for the entire procedure.

   B. Check to see if all connectors to PC board are plugged in.

   C. Plug in key/emergency switch to Main-Bottom board. Make sure that emergency and key switches are in OFF position.

   D. Connect foot switch and install remote interlock plug.

   E. Turn power on.

   F. Place the system in Service software and press [D] on the screen. In diagnostic screen, turn on the heat exchanger.

   G. Turn the key switch ON. If it is in ON position cycle it.

   H. In diagnostic screen, turn on the “high voltage” bit.

I. Set pulse width to .005 (5 mS). Set current of both arrays to 0.500 (5A). Observe that monitor currents are 0.

Warning: the handpiece must be in the calibration port .

J. Press down the foot switch, pull the trigger, and touch the TRIGGER button on the screen. The buzzer should sound.

K. Read the value of laser monitor currents immediately. It displays in volts and should read 0.5V for both channels.

L. If the laser current monitor reads 0, check to see if the laser is connected. If the laser is connected, stop. (Laser may be in "Demo" mode). If the laser is not connected, turn the key to OFF position, connect the laser, turn the key back ON, and repeat this step.

M. If the value current monitor is OK, increase the current setpoint to 1.5 (15A) and then 2.5 (25A). Observe current monitor for each setpoints. They should be within 0.15V of set point.

N. Confirm that at these current settings there is some voltage on energy meter. If not, check the energy meter connector (J2 on TOP board).

O. Adjust the energy meter output reading.

P. Increase the pulse width to 0.020 (20 mS), and fire. Read the energy meter output immediately.

Q. Adjust R7 on Main-Top board and fire the laser until the energy meter reading is about 3.8V (~40J/cm^2). Use your judgment of how much you need to adjust R7 each time before firing.

R. Add a small amount of Corona Dope to R7 following adjustment.

S. Put system back to normal mode by resetting the service bit on Main-Bottom board (SW1-1).

T. Turn off key switch.

U. Press return and then QUIT button on the screen and follow the message.

7. Replace the Front Door Assembly.

8. Replace the Access Panel.

Energy Detector Window

1. Remove the Access Panel.
2. Remove the Front Door Assembly.
3. Remove the Top Cover Assembly.
4. Remove the Detector Assembly.
5. Hold the Top Cover Assembly over a garbage can and break the glass. Scrap any glass chips and old glue from the perimeter of the window.
6. Glue the new window in place Dow/Corning RTV Sealant #732.
7. Replace the Detector Assembly.
8. Replace the Top Cover Assembly.
9. Replace the Front Door Assembly.
10. Replace the Access Panel.

Handpiece Proximity Detector

1. Remove the Access Panel.
2. Remove the Front Door Assembly.
3. Remove the Top Cover Assembly.
4. Remove and replace the Proximity Detector. Use Dow/Corning RTV Sealant #732 to seal the gap around the detector and the hole in the calibration port area.
5. Replace the Top Cover Assembly.
6. Replace the Front Door Assembly.
7. Replace the Access Panel.

Display Panel Assembly

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Remove the Top Cover Assembly.

4. Turn the Top Cover over and looking from below, locate the external snap ring. With a Snap Ring pliers, remove the snap ring. Pull the white bushing out and over the cables.

5. Lift the Display out the top allowing the cables to follow.

6. Insert the cables from the new Display Panel through the hole in the top cover.

7. Install the bushing over the cables and slide up into the base of the Display Panel, then install the snap ring.

8. Replace the Top Cover Assembly.

9. Replace the Front Door Assembly.

10. Replace the Access Panel.

Hard Drive (Software Preloaded)

Note - this procedure can be used for a pre-loaded hard drive that was special ordered for the serial number of the laser system it is being installed in. The specific calibration coefficient can be loaded on to the hard drive at the factory if the serial number of the system is known. **Always check that the software has the proper calibration coefficient in place before operating the system.** (See section 2-3 of this manual.)

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Remove the Top Cover Assembly.

4. Remove and replace the Hard Drive.

5. Replace the Top Cover Assembly.

6. Replace the Front Door Assembly.

7. Replace the Access Panel.

8. Confirm, reload or recalculate the Calibration Coefficient specific to the system. (see Calibration Procedure, Section 2.3)

Remove Upper Monolith Assembly

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Remove the Top Cover Assembly.

4. On the FET Board, locate and disconnect J1.

5. On the Main-Bottom Board, locate and disconnect J9, J10 and J13.

6. Locate and disconnect the ORG - RED (x3) cable for the main TEC.

7. At each bottom corner of the Monolith Assembly, locate and remove the screws (x4) with a 9/64” hex wrench and flat washers.

8. Remove both memory boards from the computer to reveal one of the three screws attaching the monolith to the plenum. Using a Phillips head screwdriver remove all three screws.

8. Grasp the Monolith Assembly at the top frame and carefully lift the assembly up and out of the UC.

Replace the Monolith Assembly

1. Use the glue gun to glue the flat washer to the mount screw for each rear screw (x2).

2. Install the two rear mount screws leaving the flat washer above the base by 1/8”.

3. Grasp the Monolith Assembly at the top frame and carefully place the assembly into the UC, sliding the slotted rear holes under the mount screws.

4. Install the two front mount screws and tighten the two rear screws.

5. On the FET Board, reconnect J1.

6. On the Main-Bottom Board, reconnect J9, J10 and J13.

7. Connect the ORG - RED (x3) cable for the main TEC.

8. Replace the Top Cover Assembly.

9. Replace the Front Door Assembly.

10. Replace the Access Panel.

Change Handpiece/Umbilical Assembly

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Remove the Top Cover Assembly.

4. Remove the Upper Monolith Assembly.

5. On the FET Board, locate and remove J2.

6. On the Main-Bottom Board, locate and remove J12 and J14.

7. Disconnect the ground wire from ground stud on the left side of monolith frame.

8. Put on some latex or nitrile gloves, get a bucket and disconnect the coolant lines. Wipe up any spilled coolant.

9. Carefully set the old Handpiece/Umbilical Assembly aside.

10. Change the filter if it is 12 ± 3 months old.

11. Handling the new Handpiece/Umbilical Assembly with great care, attach the coolant hoses. Flow direction does not matter.

12. On the FET Board, reconnect J2.

13. On the Main-Bottom Board, reconnect J12 and J14.

14. Replace the Upper Monolith Assembly.

15. Remove the Coolant Reservoir plug and add coolant.

16. Fill to the neck of the reservoir, place Teflon® tape on plug and install plug. See the Filling Procedure.

17. Replace the Top Cover Assembly.

18. Replace the Front Door Assembly.

19. Replace the Access Panel.

20. Turn the system on and check for leaks.

21. In User software, verify the temperature of the ChillTip™.

Coolant Pump

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Remove the Top Cover Assembly.

4. Remove the Upper Monolith Assembly.

5. On the Main-Bottom Board, locate and disconnect J6. Unroute the cable back to the motor.

6. Put on some latex or nitrile gloves, get a bucket and disconnect the coolant lines. Wipe up any spilled coolant.

7. Remove the Coolant Pump mounting screws.

8. Change the filter if it is 12 ± 3 months old.

9. Attach the new Coolant Pump to the Monolith with mounting screws.

10. Route the motor cable back to the Main-Bottom Board reconnect J6.

11. Replace the Monolith Assembly.

12. Remove the Coolant Reservoir plug and add coolant.

13. Fill to the neck of the reservoir, place Teflon® tape on plug and install plug. See the Filling Procedure.

14. Replace the Top Cover Assembly.

15. Replace the Front Door Assembly.

16. Replace the Access Panel.

Temperature Controller

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Remove the Top Cover Assembly.

4. Disconnect the terminal block (lifts up) from the TEC Controller.

5. Remove the TEC Controller from the Monolith frame.

6. Install the new TEC Controller on the Monolith frame.

7. Connect the terminal block.

8. Install the Top Cover Assembly.

9. Connect the Key/Emergency Stop switch cable to J8 on the Main-Bottom Board.

10. Turn the system on, and verify that the setpoint temperature is correct: 19˚ C for the Main TEC (left-hand controller) and 8˚ C for the Epi TEC (right-hand controller).

11. Replace the Front Door Assembly.

12. Replace the Access Panel.

Main Board (Top and Bottom) Assembly

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Locate the J6 and J7 cables on the Main-Bottom Board. Mark the J6 cable as the PUMP and the J7 cable as the FAN.

4. Carefully disconnect all cable connectors from both Main-Top and Main-Bottom Boards.

5. Remove the (x6) mounting screws with a 7/64" hex wrench and 4 stand-offs with a ¼" socket and pull the Main Board Assembly off of the Monolith frame.

6. Install the new Main Board Assembly with the mounting screws using LocTite 242.

7. Reconnect all cable connectors to both Main-Top and Main-Bottom Boards.

8. Replace the Front Door Assembly.

9. Perform the detector calibration procedure as if the energy detector were changed.

10. Replace the Access Panel.

FET Board Removal and Replacement

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Disconnect all cable connectors from the FET Board.

4. Remove the FET (x20) screws (Phillips head).

5. Remove the board mounting screws (x4) with a 7/64" hex wrench and pull the FET Board off of the Monolith frame.

6. Install the new FET Board with the mounting screws using LocTite 242. Do not place LocTite on the FET screws!

7. Install the FET screws. **Caution**, do not over tighten the screws. The FETs will be damaged.

8. Reconnect all cable connectors to the FET Board.

9. Replace the Front Door Assembly.

10. Replace the Access Panel.

Computer Assembly

1. Remove the Access Panel.
2. Remove the Front Door Assembly.
3. Remove the Top Cover Assembly.
4. Disconnect the cables from the Main-Top Board.
5. Remove the mounting screws and lift the board assembly off of the Monolith frame.
6. Place the new board assembly on the Monolith frame and attach with mounting screws and LocTite 242.
7. Add Keyboard/Floppy Drive Cable per FSB#x.
8. Replace the Top Cover Assembly.
9. Replace the Front Door Assembly.
10. Configure CMOS (Refer to Section 6.6, CMOS Configuration)
11. Replace the Access Panel.

Chiller Assembly

1. Remove the Access Panel.
2. Remove the Front Door Assembly.
3. Remove the Top Cover Assembly.
4. Remove the Monolith Assembly.
5. Remove (whatever didn’t come with the assembly).
6. Replace (whatever didn’t come with the assembly).
7. Replace the Monolith Assembly. See the Filling Procedure.

8. Replace the Top Cover Assembly.

9. Replace the Front Door Assembly.

10. Replace the Access Panel.

Remote Interlock/Footswitch Pressure Switch Assembly

1. Remove the Access Panel.

2. Remove the Front Door Assembly.

3. Remove the Top Cover Assembly.

4. Remove the Monolith Assembly.

5. Remove the remote interlock/pressure switch assembly by loosening the rear panel hardware.

6. Install the new pressure switch assembly.

7. Replace the Monolith Assembly.

8. Replace the Top Cover Assembly.

9. Replace the Front Door Assembly.

10. Replace the Access Panel.

P2 Power Module Connector

1. Separate the UC from the LC.

2. Remove the Access Panel, the Front Door Assembly, the Top Cover Assembly, and the Upper Monolith Assembly (The monolith removal may not be necessary if the ground wire pin can be removed from the power module connector.).

3. Disconnect all wire harnesses from inside the UC that come from the Power Module Connector. The ground can be removed by pushing out the pin in the power module connector. **NOTE- The pin should only be removed by using the correct pin extraction tool or the connector could be damaged.**

4. Remove the four outside screws from the latch mechanism.

5. From the wire side of the connector, remove the two small screws and pull the connector out of the latch mechanism. Pull the wire harnesses through the hole.

Airpots/Hinges

1. Remove the Access Panel.
2. Remove the Front Door Assembly.
3. Remove the Top Cover Assembly.
4. Remove the Monolith Assembly.
5. Remove and replace the Airpot/Hinge parts.
6. Adjusted the vents on an Airpot.
7. Replace the Monolith Assembly.
8. Replace the Top Cover Assembly.
9. Replace the Front Door Assembly.
10. Replace the Access Panel.

5.3 Lower Console

Front Door

1. Locate and remove the two top screws (these screws may not be on all systems).
2. Pull the front door off of the LC by prying (with fingertips or a non-metallic tool) it away from the frame at the top, then lift it up and out. Be careful not to chip the paint.

LC Top Removal

1. With the front door off, place a wrench on the J2 Power Module Connector alignment pin brass shoulder nut and twist off the alignment pin on the top. Repeat for the second alignment pin.

2. Carefully pull the J2 Power Module Connector harness up through the hole.

3. Bend the connector over to expose two small Phillips head screws. Remove both screws to detach the metal bracket from the plastic jack.

4. Slide the metal bracket down the wire harness and through the hole. If the metal bracket doesn't fit through the hole, use a pin extractor and remove the pins/wires from the connector.

5. Carefully bend the wire harness on the plastic jack and work it down through the hole.

6. Along the top edge of the LC, locate and remove 12 countersunk Phillips head screws.

7. Lift the LC Top off the frame.

LC Top Replacement

1. Place the LC top on the frame and pre-align the screw holes.

2. Carefully bend the wire harness on the plastic jack and work it up through the hole. Orient the connector so that Pin 1 is left (towards the relay side of the LC).

3. Slide the metal bracket up along the wire harness and through the hole or reinstall the pins/wires in the connector.

4. Place the metal bracket on the bottom of the plastic connector and carefully bend the connector over exposing the bottom screw holes.

5. Install the two small Phillips head screws and place the J2 Power Module Connector in the hole. Verify that Pin 1 is left (towards the relay side of the LC).

6. From the inside bottom, place the brass shoulder nut up through the hole. Place a drop of LocTite on the nut threads and twist the alignment pin on the brass nut. Do not over tighten. Repeat for the other brass nut and alignment pin.

7. With a drop of LocTite 242 on each screw, install the 12 countersunk Phillips head screws.

J2 Power Module Connector

1. Remove the LC Top.

2. Disconnect the wire harness from the low voltage power supplies, the power relay socket, the Cap Bank terminal block (at left, behind power relay) and the ground stud.

3. Connect the new wire harness to the low voltage power supplies, the power relay socket, the terminal block and the ground stud. See the wiring diagram in Section 8.

4. Replace the LC Top.

Power Supply Monolith Removal

1. Remove the LC Top.

2. Disconnect the wire harness from the right side of the Transformer terminal block, the fan connector on the left side and the ground stud.

3. Remove the foam from each side (break free, then lift up and out).

4. Locate and remove two monolith mount screws from each side (x4 screws in total).

5. Lift the Power Supply Monolith up and out of the LC frame.

Power Supply Monolith Replacement

1. Before placing the monolith in the LC, verify that all LC frame hardware is tight. Check all skin screws and castor nuts.

2. With the glue gun, glue the flat washers to the monolith mount screws.

3. Carefully place the Power Supply Monolith into the LC frame from the top. Pre-align the mount screw holes.

4. Place a drop of LocTite 242 on each mount screw. Install the four mount screws.

5. Connect the wire harness to the right side of the Transformer terminal block and the ground stud. See Terminal block wiring diagram in Section 8.

6. Wipe some silicone sealant on each side panel. In between the monolith and the side panel, push the foam down to the bottom.

7. Replace the LC Top.

Low Voltage Power Supply

1. Remove the LC Top.

2. Remove the Power Supply Monolith.

3. Disconnect the power supply wires from the Cap Bank terminal block, the transformer, and the J2 Power Module Connector harness.

4. Locate the power supply lower mount plate. On each side, remove the two mount screws.

5. From the front of the power supplies, locate and remove the five mount screws to separate the power supply assembly from the monolith.

6. Disconnect any remaining wires from the low voltage power supply to be changed, then remove the power supply mount screws from the rear of the mount plate.

7. Attach the new power supply to the mount plate by placing a drop of LocTite 242 on each screw and securing the screws.

8. Connect wires that interconnect the low voltage power supplies.

9. Add a drop of LocTite 242 to each mount plate screw and attach the power supply assembly to the monolith (5 screws on the front, 2 screws on the rear sides).

10. Connect the power supply wires to the Cap Bank terminal block, the transformer, and the J2 Power Module Connector harness.

11. Replace the Power Supply Monolith.

12. Replace the LC Top.

13. Connect the laser to mains and turn the breaker on. Measure/adjust power supply output.

Circuit Breaker, Power Input Module, or Cooling Fan

1. Remove the LC Top.
2. Remove the Power Supply Monolith.
3. Disconnect, swap and reconnect defective component.
4. Replace the Power Supply Monolith.
5. Replace the LC Top.

Power Relay

1. Remove the LC Top.
2. Cut the tie-wrap around the relay socket spring clips.
3. While spreading the socket spring clips outward, gently wiggle the relay from side to side and lift up and out of the socket.
4. Carefully align the relay pins to the socket and push the relay down into the socket. The socket spring clips should lock around the relay.
5. Place a tie-wrap around the spring clips to prevent the relay from working out of the socket.
6. Replace the LC Top.

Castor Removal/Replacement

1. Remove the LC Top.
2. Remove the Power Supply Monolith.
3. From the top, remove the nut from the castor in question. Pull the castor out the bottom.
4. Insert the new castor up from the bottom and apply a small amount of LocTite 242 to the castor threads. Secure the nut.
5. Replace the Power Supply Monolith.

6. Replace the LC Top.

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6.0 Special Procedures

6.1 Thermal Test

TBD. Check temps, TEC current, TEC Controller duty cycle.

6.2 Shutter Speed Test

TBD.

6.3 Pulse Width Test

TBD.

6.4 Make Coolant Mixture

1. Add one part ethylene glycol to four parts distilled water.
2. Mix and place in suitable container.
3. Add one year to the date and write, “Use by [month/next year]” on the bottle.
4. Write “20/80 Ethylene Glycol/Water Mixture” on the bottle.
5. Store as Hazardous Material.

6.5 Coolant Loop Filling Procedure

1. Dilute coolant with water (tap, bottled or distilled) by mixing 20% coolant with 80% water in appropriate container. (Note: Container must be properly marked to identify contents.)
2. Fill the cooler loop.
3. Wrap Teflon® tape counterclockwise around threaded end of square head plug. Fill reservoir with 80/20 mixture of water to coolant to just below the fill spout.
4. Disconnect the pump from the main bottom board and connect it to a 12V power supply.
5. Turn on the power supply and continue to fill reservoir until loop is full. (Note: Loop is full when there are minimal amount of air bubbles flowing through the umbilical coolant tubes.)

6. Using an adjustable wrench, tighten square head plug on top of reservoir.

7. Check the cooling loop for leaks. If leaks are found, turn off the power supply, fix the leaks, and repeat this procedure.

8. Turn off power supply and unplug the pump cable assembly from the power supply and connect it to the Main-Bottom board (TO PUMP).

6.6 CMOS Configuration

1. Remove the Access Panel and locate Keyboard Cable. If Keyboard Cable is present, connect a keyboard and skip to Step #6. Otherwise continue.

2. Remove the Front Door Assembly.

3. Remove the Top Cover Assembly.

4. Add Keyboard/Floppy Drive Cable per FSB#x.

5. Replace the Top Cover Assembly.

6. Connect the Keyboard cable to J5.

7. Hold down the [F2] Key and turn on the computer. Keep the [F2] key depressed until the CMOS Setup Menu is displayed.

8. Press [F9] to default CMOS settings.

9. Press [Enter] to continue.

10. In the Main Menu, set the system time and date keeping the year at 1988. Press [Enter] to move the cursor to the different fields. Note that the system has a 24-hour clock, so it is necessary to add 12 to the hours if it is after noon.

    NOTE: When the date is being reset due to computer battery replacement, the date must be set to the year 1988 in order to insure year 2000 compliance.

11. Using the down arrow, select IDE Adapter 0 Master and press [Enter].

12. At the Autotype Fixed Disk Selection, press [Enter].

13. Press [Esc] to back out of the submenu.

14. Make sure that IDE Adapter 0 Slave, IDE Adapter 1 Master, IDE Adapter 1 Slave are set to none.

15. Press down arrow to select Boot Sequence and press [Enter].

16. Press the down arrow to highlight Setup Prompt, then disable by pressing the [Plus (+)] key.

17. Repeat the above step to disable the Summary Screen.

18. Press [Esc].

19. Press right arrow to select the Advanced Menu.

20. Press the down arrow to select Large Disk Access Mode.

21. Press the [Plus (+)] key to select [Other].

22. Press [Esc].

23. Select Save Changes and Exit and press [Enter].

24. Press [Enter] to continue. System will now reboot.

25. Press [Enter] to continue.

26. Soft boot system by pressing [CTRL ALT DEL] keys simultaneously.

27. Observe flat panel display when system boots up. Confirm color of display, then push “Quit” icon on touch screen.

28. Turn off the system and disconnect the keyboard.

29. Replace the Front Door Assembly.

30. Replace the Access Panel.

6.7 Rebuild Hard Drive

TBD.

6.8 Upgrade Software

TBD.

6.9 Setup Molectron Energy Meter

1. Connect detector head to energy meter console at rear. Attach the power cord.

Note: Do NOT connect or disconnect the detector head from the console while the console is turned on. The "smart detector" technology (EEPROM) built into the PM150-50C detector head will be permanently damaged.

2. Turn the energy meter on.

3. Push the "W" button to select Watts (power).

4. Using the " σ " and "τ " Range buttons, get the display to show a small "3" in the lower left of the LCD and have the decimal point placed at "0.00" (hundredths) then press the "ZERO" button. The display should look like this:

3 0.00 W

5. Push the "J" button to select Joules (energy). The display should look like this:

3 0.00 J

6. Hold the ChillTip 1/4" (6 mm) to 1/2" (12 mm) above the surface of the detector head and fire.

7. Read the measured pulse energy on the LCD.

8. Press "ZERO" and repeat for each measurement.

7.0 Selected Part Numbers

7.1 Specialized Tools and Test Equipment (for FSE)

Coherent P/N	Description	Star P/N
	Laser Safety Eyewear, 790-830 nm, OD 5+	[70-01430-00]
	DVM (Fluke 77 or equiv.)	
	50 MHz Dual Channel Oscilloscope	
	Current Probe (Fluke 80i-110s or equiv.)	
	Thermocouple Module (Fluke 80TK)	
	Surface Temperature Probe (Fluke 80PK-3A)	
	Energy Meter (Molectron EPM-1000)	
	Energy Detector Head (Molectron PM150-50C)	
	Hot Glue Gun	

7.2 Consumables

Coherent P/N	Description	Star P/N
	Methanol (get locally from Fischer Scientific)	
	Acetone (get locally from Fischer Scientific)	
(free issue)	Latex Gloves (specify size)	
3804-0065	Lens Tissue, Kodak	[40-01406-00]
(free issue)	Cotton Swabs	[40-01068-00]
1605-0006	LocTite 242	[70-01522-00]
	Dow/Corning RTV Sealant #732	[70-01226-00]
	Coolant Mixture	
3103-0024	Teflon Tape, 1/4”	
1605-0038	Thermal Compound	
	Glue Gun Glue Sticks	
	Touch-up Paint	[40-01490-00]

7.3 Assemblies and Parts

Coherent P/N	Description	Star P/N
	Upper Console (complete)	
	UC Monolith Assembly (no Handpiece)	[80-00700-02]
	Chiller (stripped monolith)	[80-00700-02]
	Computer/Memory/IO Assembly	[80-00749-01]
	Coolant Pump Assembly	[80-00734-00]
	Handpiece/Umbilical Assembly	[80-00483-01]

	TE Controller, Main, Programmed	[60-00460-00]
	TE Controller, Epi, Programmed	[60-00460-00]
	Front Door Assembly	[80-01244-00]
	Door Handpiece Pocket	[70-00443-00]
	Door Latch	[70-01093-00]
	Key/E-stop Switch Harness (w/2 keys)	[60-01136-00]
5107-0163	Key, Laser	
	Top Cover Assembly (no hard drive)	[80-01293-00]
	Display Assembly	[80-01295-00]
	Hard Drive (preloaded)	[60-01530-00]
	Energy Detector Assembly	[70-00186-00]
	Energy Detector Window	[70-00714-00]
	Holster, Calport	
	Screw, Calport	[70-01526-00]
	Handpiece Proximity Switch Assembly	[60-01135-00]
	Footswitch/Interlock Plug Assembly	[60-01137-00]
	Airpot	[70-00727-01]
	Lower Console Assembly (complete)	
	Circuit Breaker, 8 A	[80-00951-00]
	Circuit Breaker, 4 A	[60-01647-00]
	Power Input Module	[60-00240-00]
	Power Cord, 125V	[60-00274-00]
	Power Cord, 250V	
	Voltage Selector Module	[80-00781-00]
	Power Relay	[60-00238-00]
	Relay Socket	[60-00209-00]
	Capacitor, 180kuF	[60-00197-00]
	Capacitor Bank	[80-00947-01]
	Transformer, Isolation	[60-00872-00]
	Low Voltage Power Supply, PS1	[60-00347-00]
	Low Voltage Power Supply, PS2/PS3	[60-00346-00]
	Low Voltage Power Supply, PS4	[60-00343-00]
	Low Voltage Power Supply, PS5	[60-00345-00]
	Low Voltage Power Supply, PS6	[60-00344-00]
	Castor, Locking	[70-00594-00]
	Castor, Non-locking	[70-00596-00]
	LC Cosmetic Skirt	[70-01393-00]
	Footswitch	[70-00338-00]
	Remote Interlock Plug	[60-00805-00]
5110-0255	Fuse, T3.15A, 250V, 20m	
5110-0065	Fuse, T5A, 250V, 3AG	
	Fuse, T6.3A, 250V, 3AG	
5110-0002	Fuse, T15A, 250V, 3AG	
	FET Board	[60-00172-00]

Main-Top Board	[60-00313-03]
Main-Bottom Board	[50-01793-00]
FET	[60-00618-00]
Assy PCB Electronics UC	[80-00697-03]
Switch Rotary	[80-00781-00]
Relay Switching	[60-00238-00]
Relay Socket	[60-00209-00]
Heat Exchanger Assy	[80-00597-01]
Chiller TE Module Assy	[80-00698-00]
UC Fan Assy	[80-01368-00]
Hinge	[70-00862-00]
Airpot Adapt Bkt.	[70-01389-00]
Tie Rod Bkt.	[70-01388-00]
Fixed LC Front Cover	[70-00350-00]
Assy LC Top Panel	[70-00458-00]
Hook Retainer Hard Anodized	[70-01639-00]
Lower Pad LC	[70-01626-00]
Phenoseal Vinyl Adhesive	[50-01830-00]
Conn rcpt IDC 2-pin 100” pitch	[60-01006-00]
Wire 24AWG White	[60-01005-00]
Resistor cf 5%. 25W	[60-01194-00]
Top Panel Base Silkscreened	[70-01346-00]
Wedge Sensor UC	[70-01124-00]
Screw PH Phillips Type A Tapping	[50-01820-00]
Assy UC Connector	[60-01216-00]
User Manual	[10-01000-00]
Service Manual	

7.4 Description of Parts and Assemblies

Upper Console Assembly (complete)

A fully assembled and tested Upper Console section of the LightSheer.

Lower Console Assembly (complete)

A fully assembled and tested Lower Console section of the LightSheer.

Computer/Memory/IO Assembly

The computer assembly to consist of a main processor board, the Diamond I/O board, the display interface board, and memory boards. This assembly should be programmed (CMOS), pre-configured (jumpers), electronically aligned, and tested. Any cabling to be part of this assembly to be identified. Mounting hardware not required.

Coolant Pump Assembly

A coolant pump assembly to consist of the pump/motor housing, coolant reservoir and all fittings necessary to connect to existing system plumbing. The motor to contain the capacitor upgrade and have power wires cut to length and connectorized. This assembly should be tested. Mounting hardware not required. Add teflon tape and pre-mixed coolant to make a "Pump Swap Kit".

Monolith Frame w/Chiller Assembly

A high level assembly to contain the monolith frame, heat sink, heat exchanger (with TE modules), FETs, and whatever mounting hardware cannot be scavanged from the original monolith.

Handpiece/Umbilical Assembly

An assembled and tested handpiece w/umbilical cord with complete calibration data. May be combined with pre-mixed coolant to form a "Handpiece Swap Kit".

Front Door Assembly

An assembled front door to contain outer door with handpiece pocket, inner door section, mounting hardware, and mounted door latch. The keyswitch/e-stop switch harness could but does not have to be part of this assembly.

FET Board

A configured and tested FET circuit board.

Main Board Assembly

A configured and tested assembly to contain the Main-Top and Main-Bottom circuit boards.

Key/Emergency Stop Switch Harness

A switch harness assembly to contain switch mounting hardware, keys, and pre-wired and connectorized keyswitch and e-stop switch.

Top Cover Assembly

An assembly to contain the top cover, handrail, mounted handpiece sensor, mounted energy detector window, and whatever mounting hardware (for hard drive, energy detector, display, etc.) that cannot be scavanged from original top cover assembly.

Display Panel Assembly

An assembly to contain the LCD display and Touch Screen mounted in the bezel, with cabling cut to length and connectorized. Mounting hardware not required. Display and touch screen functions to be tested.

Hard Drive (preloaded)

A formatted and loaded hard drive containing system, all operating systems, program files and system specific LightSheer calibration data. The SERIAL NUMBER of the LightSheer must be specified when ordering a Hard Drive.

Energy Detector

An assembly to contain a mounted energy detector with wires cut to length and connectorized. This assembly should be tested and shipped with calibration data.

Power Input Module

An assembly to contain the power input module switch with wires cut to length and connectorized. Mounting hardware should be included.

Voltage Selector

A switch harness assembly to contain the voltage selector switch with wires cut to length and connectorized. Mounting hardware should be included.

Footswitch

A pedal in a shroud with tube cut to length and pressure tested.

Castor

An individual part to contain the castor and mounting hardware. Rear Castors lock.

Holster

An individual part to contain holster and locking screw.

LC Cosmetic Skirt

Power Relay

Airpot

Bottle of Coolant

A one-quart (liter) bottle of pre-mixed coolant (20% ethylene glycol and 80% water) with directional squirt tube.

Power Cord

Remote Interlock Plug

Relay Socket

Isolation Transformer

Transformer wires cut to length and ring lugs crimped on.

Circuit Breaker, 8 Amp (for 110 Vac systems only)

Circuit Breaker, 4 Amp (for 220 Vac systems only)

Handpiece Proximity Sensor

A tested assembly to contain a proximity switch with wires cut to length and connectorized. Mounting hardware not required, but glue or RTV may be required to seal the hole.

Footswitch/Interlock Assembly

An assembly to contain a footswitch pressure sensor/microswitch assembly and interlock jack that has wires cut to length and connectorized. The assembly should be tested and should come with panel mounting hardware.

Energy Detector Window

A kit to contain the window and mounting adhesive.

Door Latch

A bag of parts to contain all door latch parts and mounting hardware.

Thermo-Electric Controller

01 Main TE Controller, pre-programmed to 19˚C and tested.
02 ChillTip TE Controller, pre-programmed to 8˚C and tested.

Low Voltage Power Supply, PS1

A pre-adjusted and tested power supply. Mounting hardware not required.

Low Voltage Power Supply, PS2, PS3

A pre-adjusted and tested power supply. Mounting hardware not required.

Low Voltage Power Supply, PS4

A pre-adjusted and tested power supply. Mounting hardware not required.

Low Voltage Power Supply, PS5

A pre-adjusted and tested power supply. Mounting hardware not required.

Low Voltage Power Supply, PS6

A pre-adjusted and tested power supply. Mounting hardware not required.

8.0 Field Service Bulletins

There are no released Field Service Bulletins at this time.

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9.0 Drawings and Schematics

System Block Diagram

Interconnect Diagram

Lower Console Wiring Diagram

Main and FET Board Connections (Mechanical Shutter)

Main and FET Board Connections (Electronic Shutter)

Upper Console Top Cover Assembly

Upper Monolith Assembly

Chiller Assembly

Handpiece Assembly

Lower Console Assembly

Wire/Cable Harness List

Main-Top Board Schematic

Main-Bottom Board Schematic

FET Board Schematic

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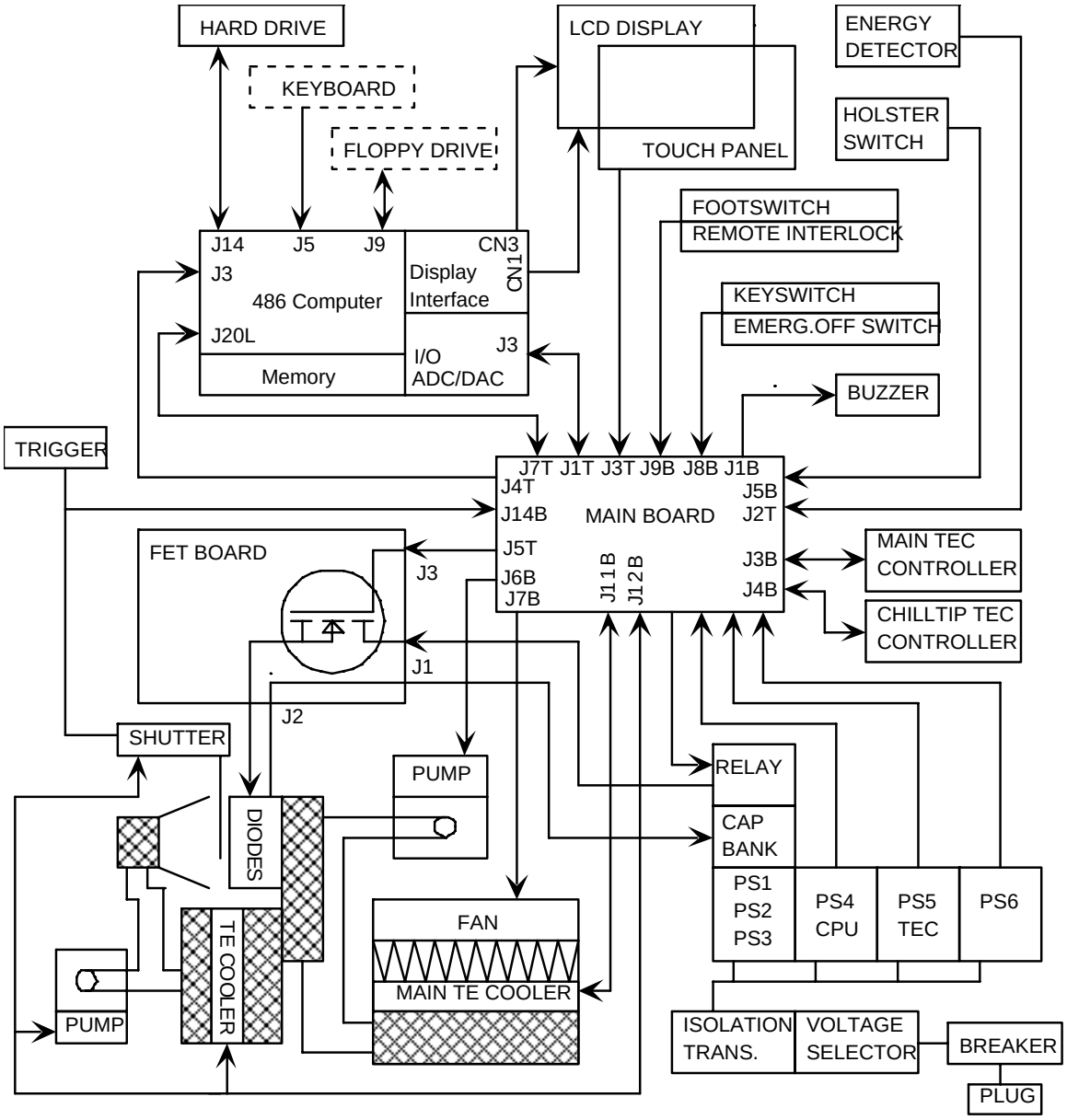
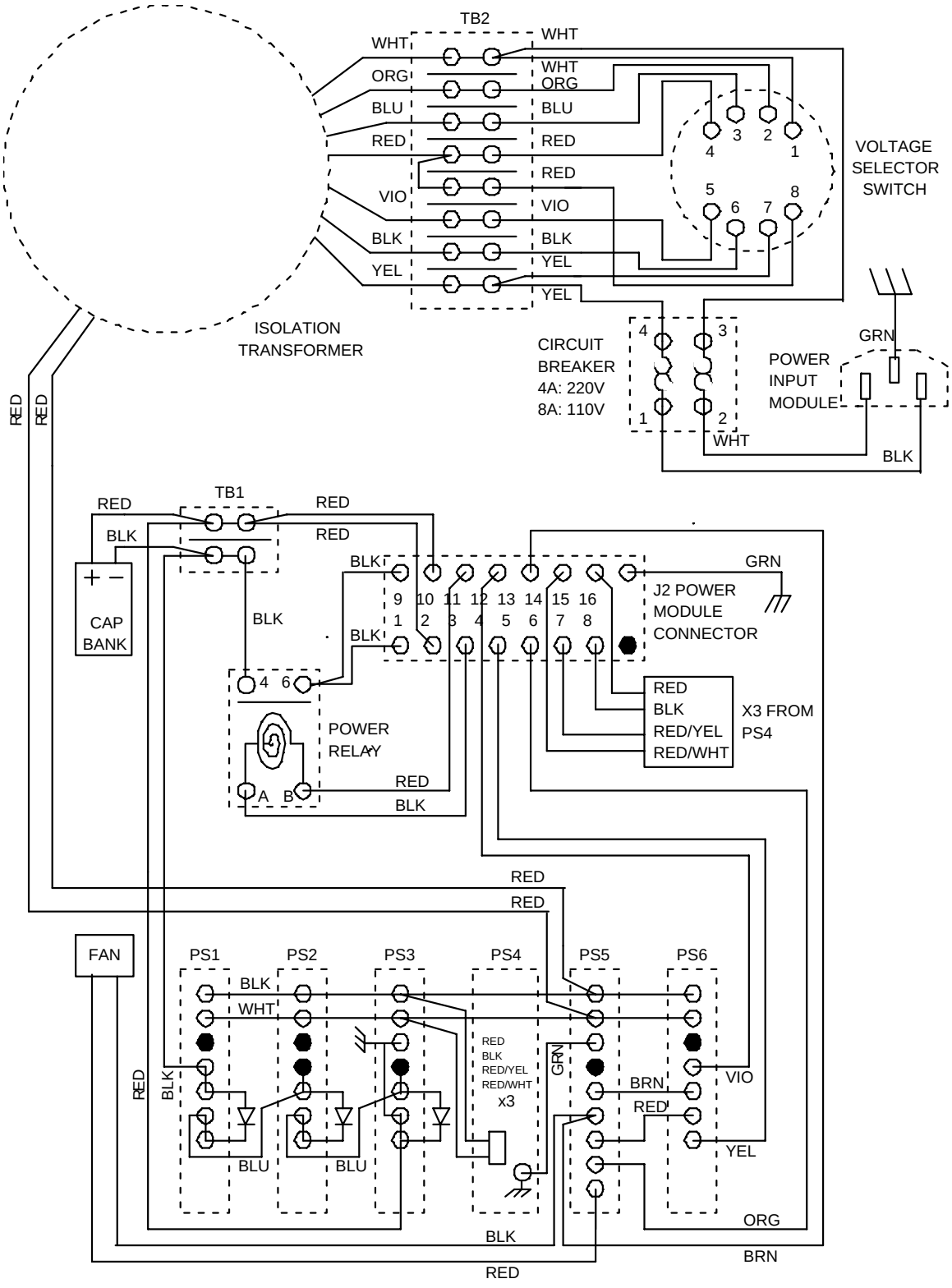
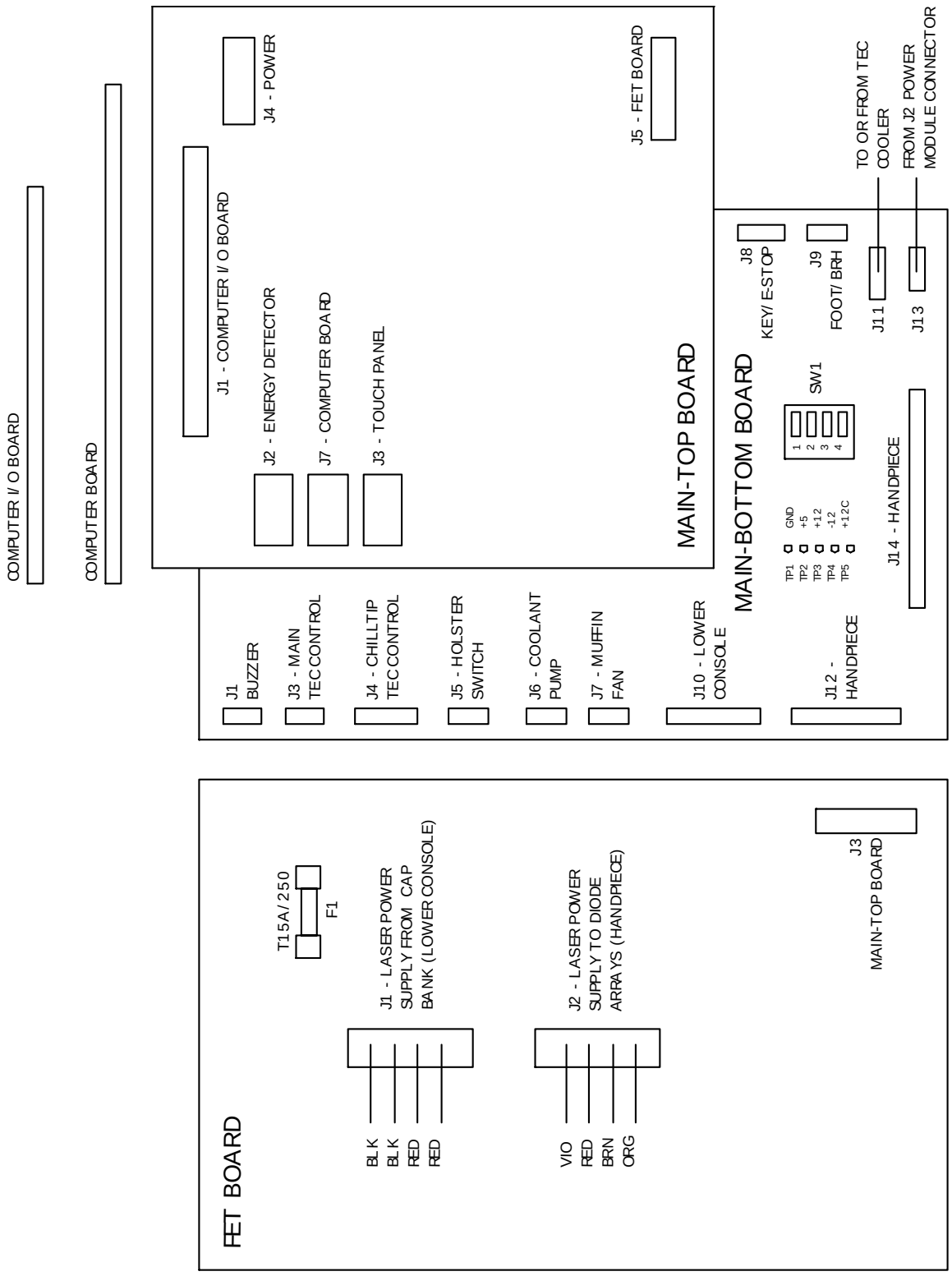
System Block Diagram



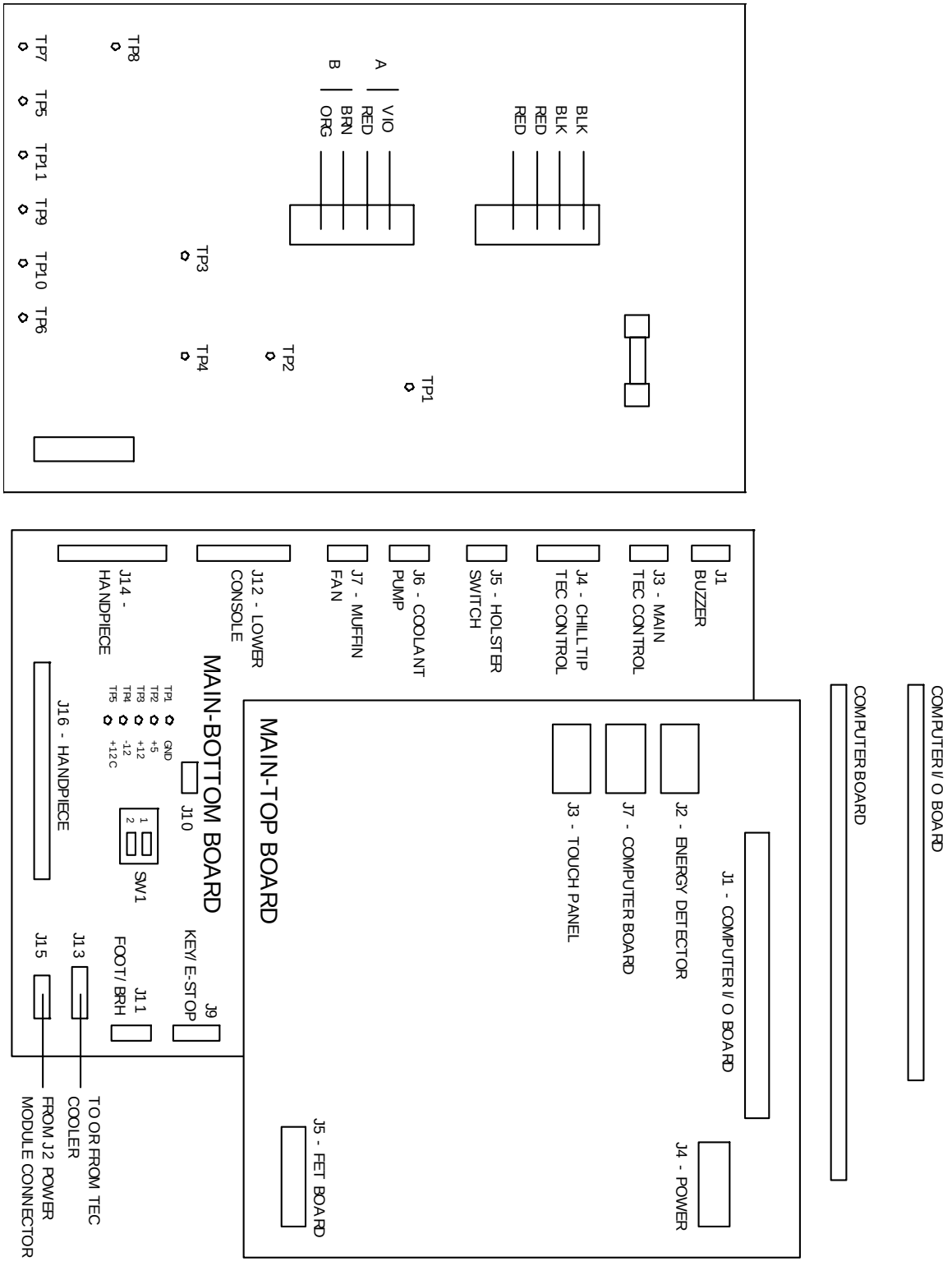
Interconnect Diagram



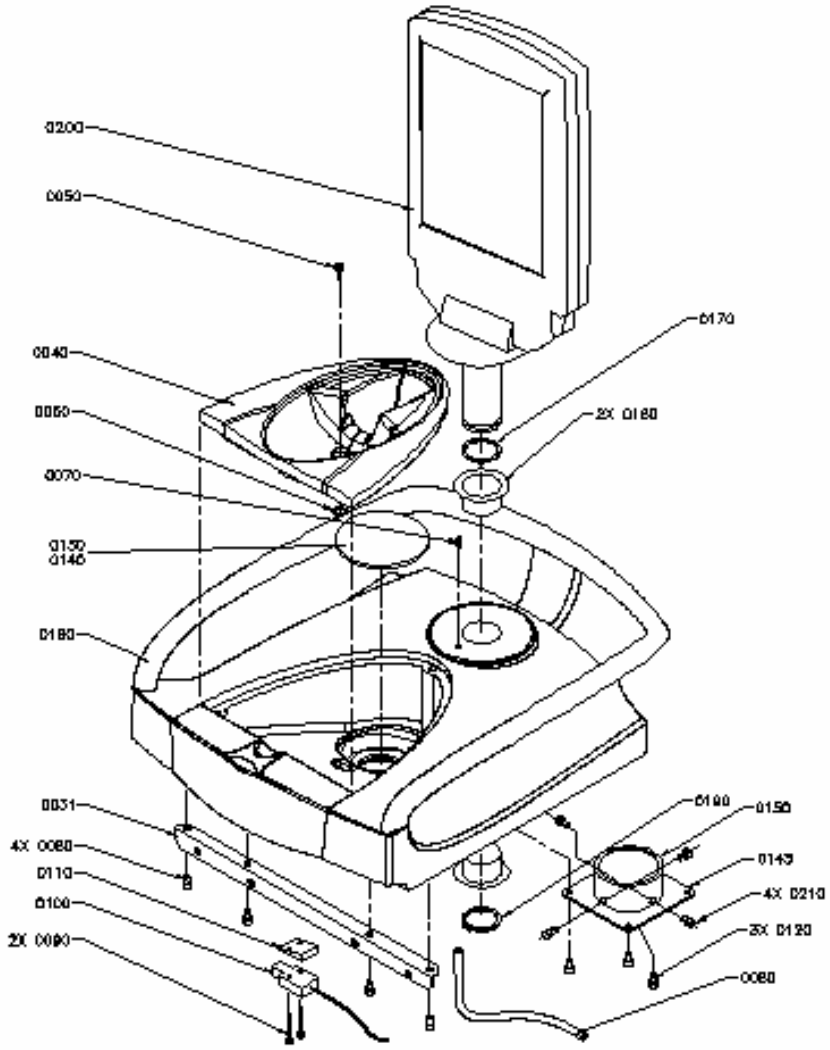
Lower Console Wiring Diagram



Main and FET Board Connections(Mechanical Shutter)



Main and FET Board Connections (Electronic Shutter)



Upper Console Top Cover Assembly

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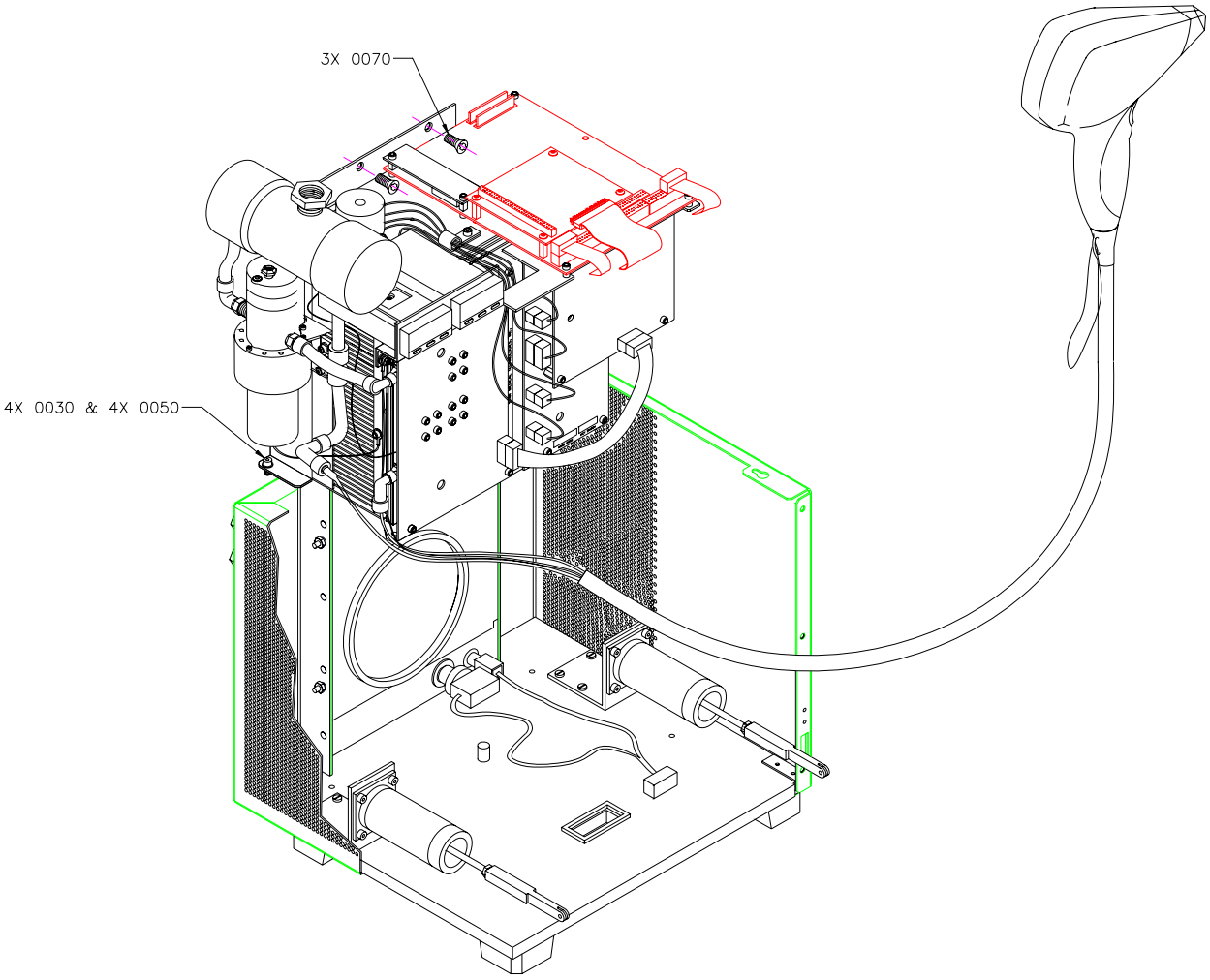
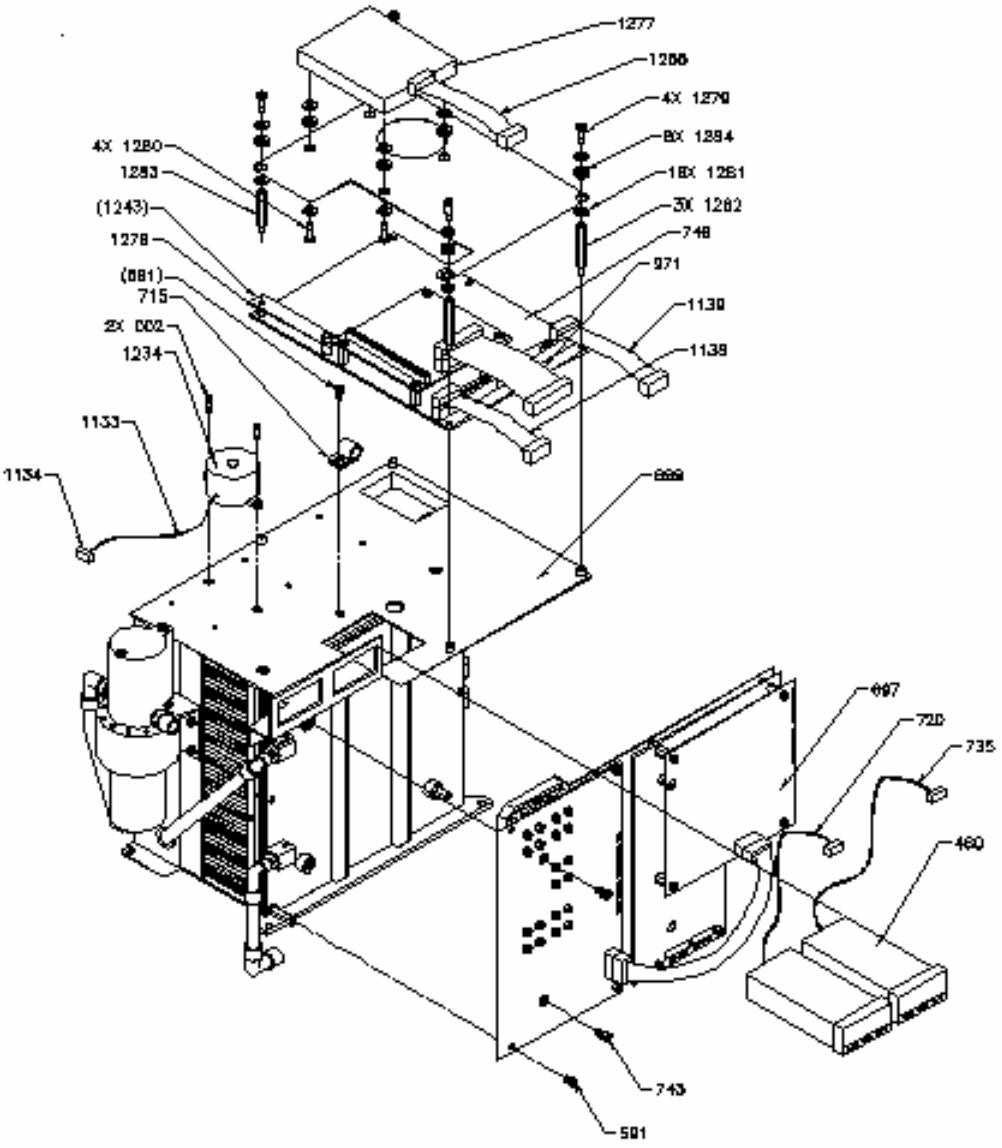


Upper Monolith Assembly



Chiller Assembly

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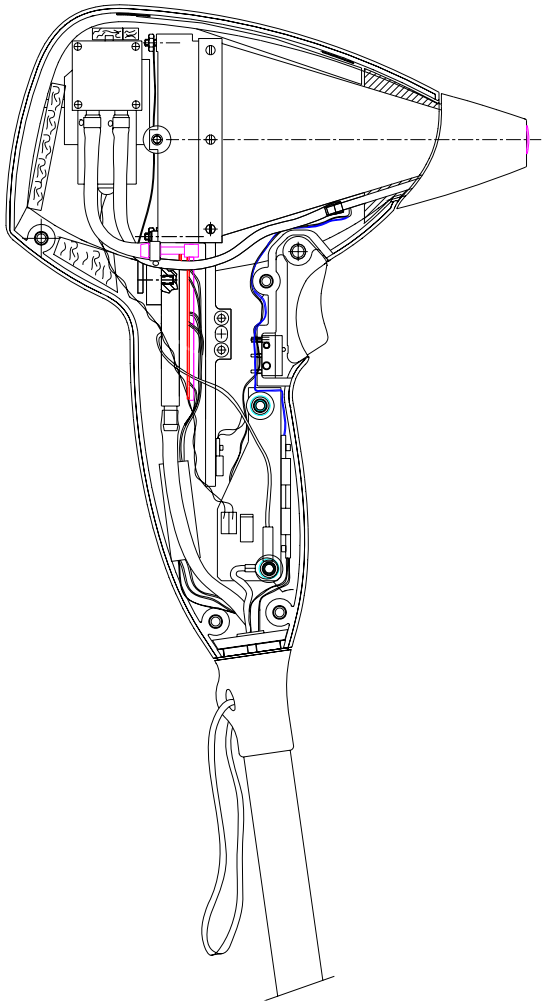

Handpiece Assembly

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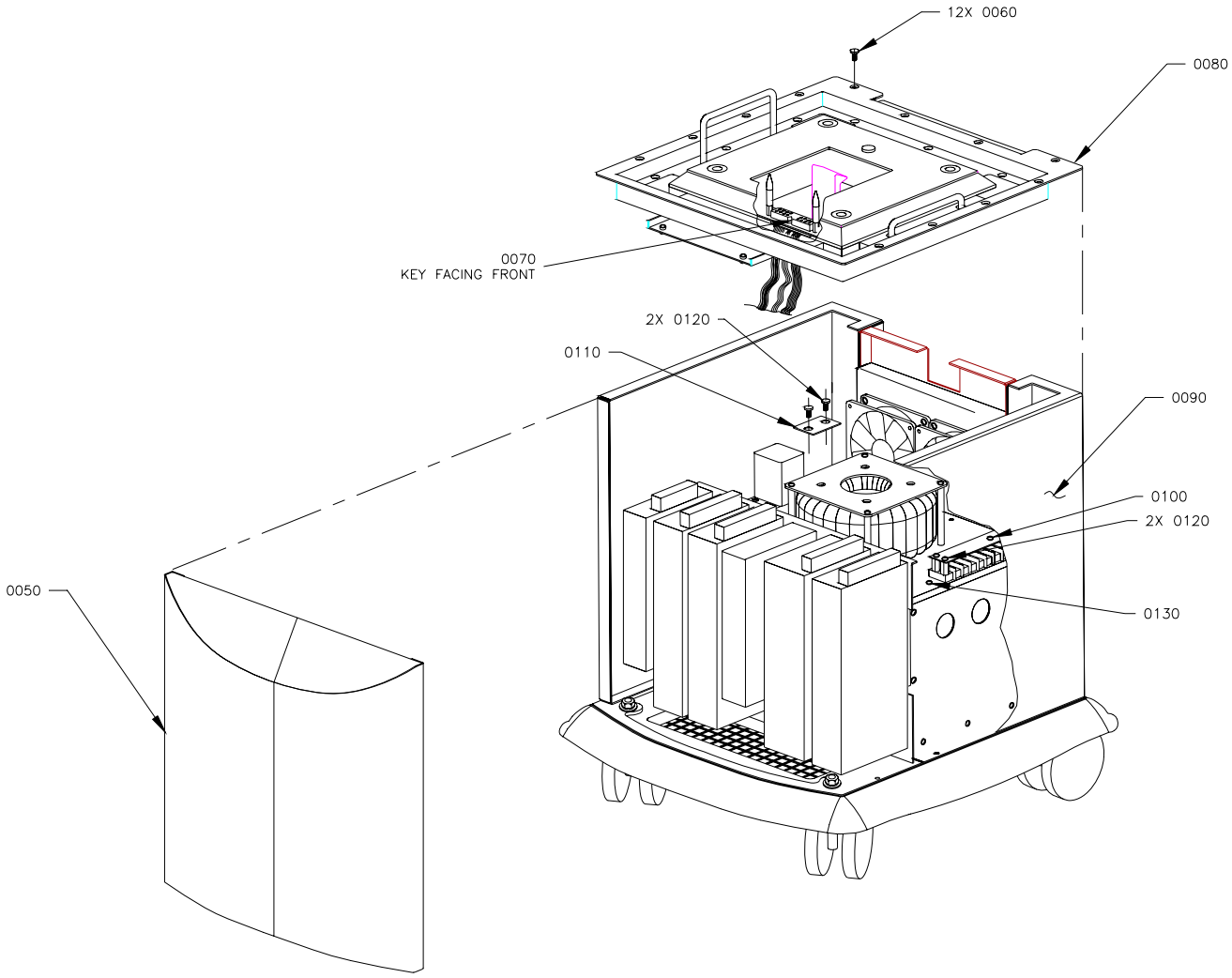

Lower Console Assembly

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Table of Contents

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Please note that while every effort has been made to ensure that the data given is accurate, the information, figures, illustrations, tables, specifications, and schematics are subject to change without notice.

Please direct all inquiries about this manual to:

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