Quantel

User Manual *EverGreen*

Version C | # DOC00115 December 2, 2015

Part Numbers: EVG00070, EVG00145, EVG00200

EverGreen

BIG SKY LASER SERIES

CE

Rugged ▪ Reliable ▪ Designed for PIV

EverGreen User Manual

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EverGreen

BIG SKY LASER SERIES

User Manual

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Version C

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Part Numbers

EVG00070

EVG00145

EVG00200

USER MANUAL

Authorization Memorandum

I have carefully assessed the User Manual for the EverGreen. This document has been completed in accordance with the requirements of Quantel.

MANAGEMENT CERTIFICATION

Patrick Quero, December 2, 2015

Quality Director & Regulatory Affairs - Quantel Group

This manual is provided in digital form to conserve paper.
If you need to print this document, please remember to select two-sided printing to help keep paper use to a minimum.

CONTENTS

LASER SAFETY

1.0 Hazard Information

Hazard information includes terms, symbols and instructions used in this manual or on the equipment to alert operating and service personnel to the recommended precautions in the care, use and handling of Class IV laser equipment.

2.0 Terms & Warning Symbols

DANGER	Imminent hazards which, if not avoided, will result in serious injury or death.
WARNING	Potential hazards which, if not avoided, could result in serious injury or death.
CAUTION	Potential hazards which, if not avoided, could result in minor or moderate injury.
CAUTION	Potential hazards which, if not avoided, could result in product damage.
NOTE	Points of particular interest for more efficient or convenient equipment operation; additional information or explanation concerning the subject under discussion.
WARNING: LASER RADIATION	Avoid exposure of eyes or skin to direct or diffused laser radiation. Permanent eye damage or blindness may occur.
WARNING: HIGH VOLTAGE	Electric shocks and burns from capacitor discharge or power circuits could lead to serious injury or even death.

3.0 Acronyms and Abbreviations

AEL: Accessible Emission Limits

BNC: Bayonet Neill-Concelman RF connector often used with coaxial cable

ICE: Integrated Cooling and Electronics (Laser Power Supply)

I/O: Input/Output

LASER: Light Amplification by Stimulated Emission of Radiation

PIV: Particle Image Velocimetry

PRF: Pulse Repetition Frequency

Dimensions listed in this manual are:
[SI Metric mm] U.S. Standard Units inches.

4.0 General Hazards

The following descriptions are of general hazards and unsafe practices that may result in product damage, severe injury, or death. Other more specific warnings and cautions are presented as appropriate throughout this manual.

	**DANGER Serious Personal Injury**	This Class IV laser emits 532 nm visible laser radiation. Do not allow laser radiation to enter the eye by viewing direct or reflected laser energy. Laser radiation may be reflected from various surfaces; care should be taken to avoid inadvertent reflection of laser energy while working with the laser. Wear appropriate protective eye-wear when working in an area with an exposed laser beam. Avoid looking directly into the laser output aperture or reflections of the beam from other surfaces.
	**DANGER Serious Personal Injury**	This product is not intended for use in explosive, or potentially explosive, atmospheres.
	**WARNING Serious Personal Injury**	U.S. customers should refer to and follow the laser safety precautions described in the American National Standards Institute (ANSI) Z136.1-2014 document, Safe Use of Lasers. Procedures listed in this Standard include the appointment of a Laser Safety Officer (LSO), operation of the product in an area of limited access by trained personnel, servicing of equipment only by trained and authorized personnel, and posting of signs warning of the potential hazards. European customers should appoint a Laser Safety Officer (LSO) who should refer to and follow the laser safety precautions described in EN 60825-1,2007 – Safety of Laser Products
	**WARNING Serious Personal Injury**	Materials processing with a laser can generate air contaminants such as vapors, fumes, and/or particles that may be noxious, toxic, or even fatal. Material Safety Data Sheets (MSDS) for materials being processed should be thoroughly evaluated and the adequacy of provisions for fume extraction, filtering, and venting should be carefully considered. Review the following references for further information on exposure criteria: ANSI Z136.1-2014, Safe Use of Lasers, section 7.3. U.S. Government's Code of Federal Regulations: 29 CFR1910, Subpart Z. Threshold Limit Values (TLVs) published by the American Conference of Governmental Industrial Hygienists (ACGIH). It may be necessary to consult with local governmental agencies regarding restrictions on the venting of processing vapors.

5.0 Other Hazards

The following hazards may be considered typical for this product:

- Risk of exposure to hazardous laser energy and injury through failure to follow appropriate laser safety procedures.
- Risk of exposure to hazardous laser energy through unauthorized removal of protective covers.
- Risk of exposure to hazardous or lethal voltages through unauthorized removal of protective covers.
- Risk of injury when lifting or moving the unit.

6.0 Safe Operation of the Laser

1. Never look at the direct beam from the laser or one of its reflections. No visual alignment should be made when the electric power supply of the laser is ON. Permanent eye damage or blindness may result.
2. Always wear appropriate protective eyewear. Refer to **Protective Eyewear on page 8** for important wavelength information. Refer to **Additional Safety Information on page 8** for additional standards information.
3. Prevent exposing any part of the body to the beam. Never block the laser beam with any part of the body.
4. Limit work area access to the required personnel only. Only use the laser in supervised areas, which are clearly marked and have supervised access.
5. Remove all objects with a reflecting or shiny surface from the work area, as well as all flammable materials.
6. Do not wear reflective jewelry while using the laser, as it may cause hazardous reflections.
7. Maintain a high level of ambient lighting in the laser operation area so the eye pupil remains constricted, reducing the possibility of hazardous exposure.
8. Place warning signs at all work area accesses. The signs must be appropriate and clearly visible. It is recommended that work area accesses be interconnected to the Laser Remote Interlock.
9. During normal operation, the laser area (work area) must be marked off by screens, walls or other means that ensure that laser beams outside the area are less than the AEL (class 1 type laser). These screens must **not** be covered by materials that may reflect the laser wavelength. They must not be flammable, nor may they, when exposed to the direct laser beam (even only for several seconds), allow laser radiation greater than the AEL limit to pass. A warning area limited by barriers is necessary to warn all people of the potential risk that lies within the laser area.
10. Only qualified people may operate the laser. When not in use, the laser must be completely inoperable. This may be done by removing the laser key, for example. It must be impossible for unauthorized people to operate the laser.
11. Aiming laser radiation at individuals, vehicles, aircraft or any other flying object is prohibited by federal regulations.
12. Due to the risk of electric shock, the power supply must be switched off and disconnected from the Laser Head prior to any maintenance operation. Electric shocks or burns resulting from the power supply may cause serious injury or death.
13. Operate the laser at the lowest possible beam intensity, given the requirements of the intended application.
14. Increase the beam diameter wherever possible to reduce beam intensity and thus reduce the hazard.
15. Use an IR detector or energy detector to verify that the laser beam is off before working in front of the laser.
16. Provide enclosures for the beam path whenever possible.
17. Set up an energy absorber to capture the laser beam, preventing unnecessary reflections or scattering.

7.0 Protective Eyewear

Always wear appropriate protective eyewear when operating the laser.

Choose eye protection that is suited to the operation of the laser, taking into consideration emission wavelength, power/energy, and viewing conditions. See energy density ratings, safety reference EN 207, and OSHA's online technical manual for information on selecting proper eye protection.

EverGreen Information for Protective Eyewear Selection

Wavelength (nm)	Maximum Energy Density (J/m^2)
1064	49340
532	29605
266	1480

8.0 Additional Safety Information

There are several public resources for good laser safety information.

United States

- The American National Standards Institute (ANSI) Z136.1-2014 document Safe Use of Lasers prescribes procedures intended to promote safety in using lasers. The document describes practices such as the appointment of a Laser Safety Officer (LSO), operation of the equipment only by trained personnel and in an area of limited access, equipment servicing only by trained and authorized personnel, and appropriate use of warning signs to increase awareness of potential hazards.
- The Occupational Safety and Health Administration (OSHA) provides an online Technical Manual (located at www.osha.gov/dts/osta/otm/otm_iii/otm_iii_6.html). Specifically, Section III, Chapter 6 and Appendix III contain specific laser safety information.
- The Laser Institute of America (LIA) has a comprehensive web site (located at www.laserinstitute.org).

Europe

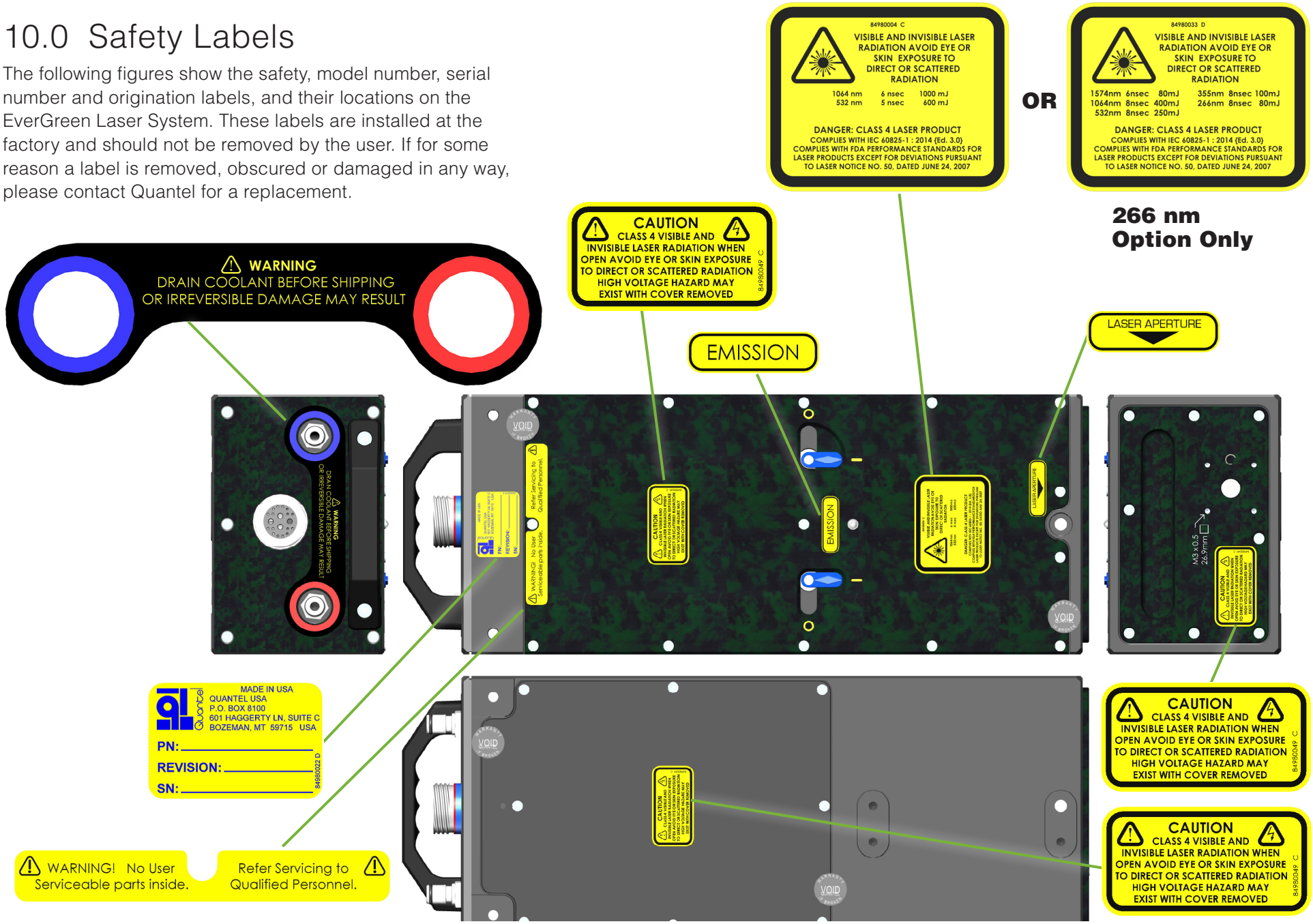
- Norm EN 60825-1 - Safety of laser products, Part 1: Equipment classification, requirements and user guide
- Norm EN 207 - Personal eye protection - Filters and eye protectors against laser radiation
- Norm EN 208 - Personal eye protection - Eye protector for adjustment work on lasers and lasers systems

9.0 Disposal

This product contains material that is considered hazardous industrial waste. If for any reason a laser is rendered unusable and is not repairable, Quantel recommends that disposal of the system follow all appropriate guidelines for such hazardous waste to prevent environmental degradation. This product, must be disposed of separately from domestic household waste.

10.0 Safety Labels

The following figures show the safety, model number, serial number and origination labels, and their locations on the EverGreen Laser System. These labels are installed at the factory and should not be removed by the user. If for some reason a label is removed, obscured or damaged in any way, please contact Quantel for a replacement.



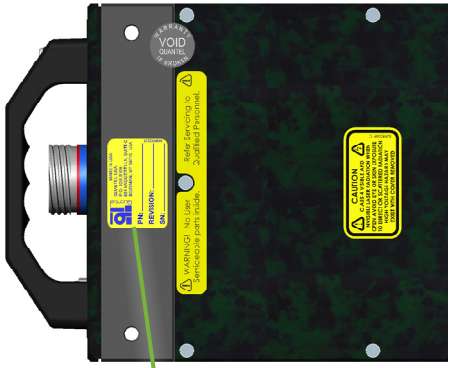
11.0 Part/Serial Numbers

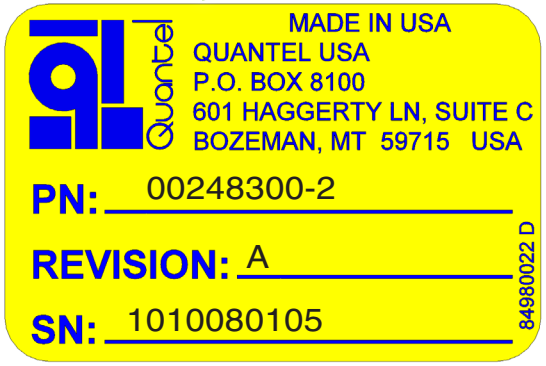
The EverGreen Laser System has three labels with product serial numbers and information.

System Origination Label
(located on the ICE - Laser Power Supply)

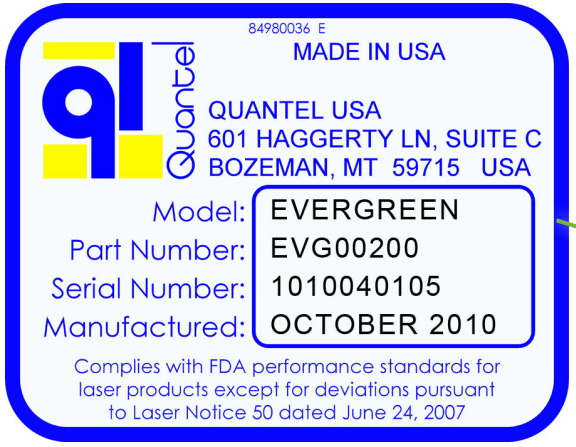
Power Supply Part Number Label (located on the ICE - Laser Power Supply)

Laser Head Part Number Label
(located on the Laser Head)

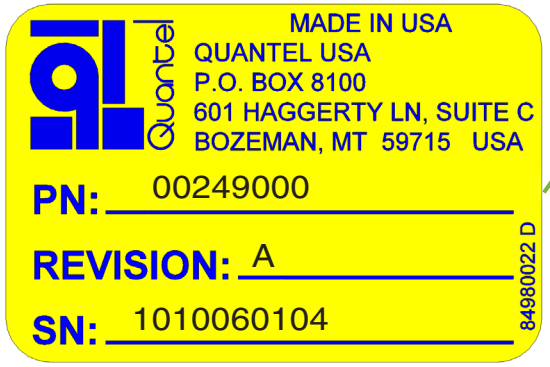




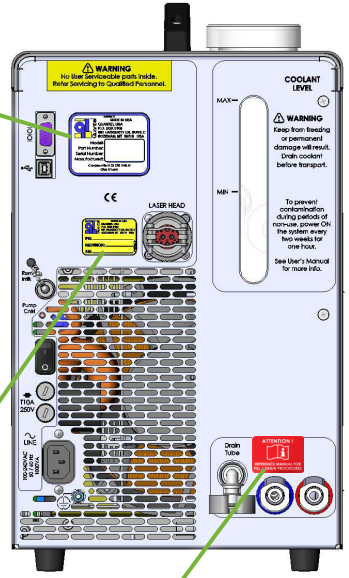
LASER HEAD PART NUMBER LABEL



SYSTEM ORIGINATION LABEL



POWER SUPPLY PART NUMBER LABEL



Note: The cooling system requires a different fill/drain process than that used in previous models. Use the proper procedure.

SETUP

1.0 Priming the Cooling System

CAUTION: Do NOT operate the system until the pump is primed! Operating the pump without coolant damages the pump. Only distilled water with 1MΩ-cm to 5MΩ-cm resistivity is approved for use with the laser system.

1. Place the ICE in the normal operating orientation in a location where spilled coolant may easily be cleaned up. A small amount of coolant may spill during the filling process.
2. Remove the drain tube from its storage location on the ICE rear panel. Remove the protective cap from the drain tube. Remove the plastic shipping covers from the coolant ports on the ICE rear panel. Keep these for reuse.
3. Connect one end of the drain tube to the ICE inlet port. Connect the other end of the drain tube to the ICE outlet port to form a loop.
4. Remove the reservoir cap. Add coolant to the reservoir until the MAX fill line is reached. Coolant should enter the looped tube connected to the ICE rear panel ports. This will prime the pump.
5. Connect the AC Mains power cord to properly grounded 100-240 VAC, 50/60 Hz power.

CAUTION: Ensure the system is connected to the proper voltage. The voltage rating is marked on the ICE back panel. Operating the system at the incorrect voltage may damage the system.

6. Turn ON the ICE AC Mains power switch. “I” is ON, “0” is OFF.
7. Press the green **Pump Cntrl** button located on the ICE rear panel to operate the pump and circulate the coolant for about 2 seconds. Listen for the sound of the pump operating smoothly.

CAUTION: Do not operate the pump if it is making a “buzzing” or “clattering” sound. This indicates no coolant in the pump. If this happens, tip the ICE to lower the coolant loop further before operating the pump again.

8. With coolant primed and the pump operating smoothly, press and hold the **Pump Cntrl** button to circulate the coolant for several seconds.
9. Turn OFF AC power.
10. Simultaneously disconnect both ends of the drain tube from the ICE rear panel.

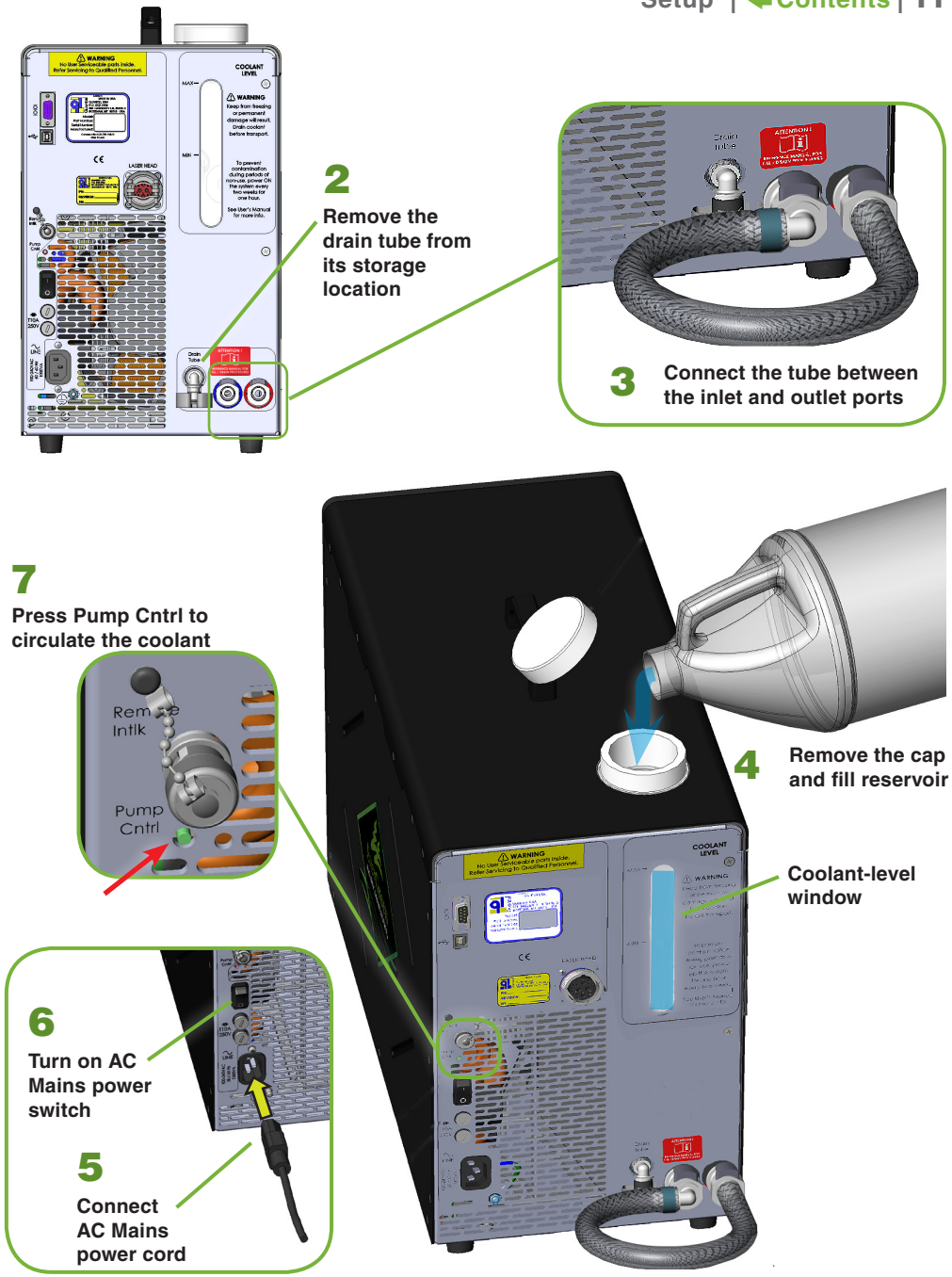


Figure 1: Priming the Cooling System

2.0 Connecting the System

CAUTION: Do not operate the laser system before thoroughly reading the instructions. Ensure you have completed **Priming the Cooling System on page 11**. Always follow laser safety precautions.

1. Verify that the Key Switch on the ICE front panel is turned OFF. Verify the AC Mains power switch is OFF.
2. Connect the AC Mains power cable from the ICE back panel to properly grounded 100-240 VAC, 50/60 Hz power.

CAUTION: Ensure the system is connected to the proper voltage. The voltage rating is marked on the ICE back panel. Operating the system at the incorrect voltage may damage the system.

3. Connect the I/O cable between the ICE rear panel and the Laser Head. All connectors are unique and keyed to ensure proper connection.

CAUTION: These connections carry high voltage and high current. Ensure that the connectors are fully inserted and the collars or screw locks are fully engaged or interlock faults may result.

4. Remove the blue plastic shipping covers from the coolant ports on the Laser Head. Keep them for reuse.
5. Connect the coolant tubes between the back panel of the ICE and the Laser Head. Connect red to red and blue to blue. Coolant flows from the ICE into the Laser Head via the blue tube and returns to the ICE via the red tube.
6. Prior to operation, you must completely fill and purge air from the cooling system. See **Circulating Coolant to the Laser Head on page 13** for details.

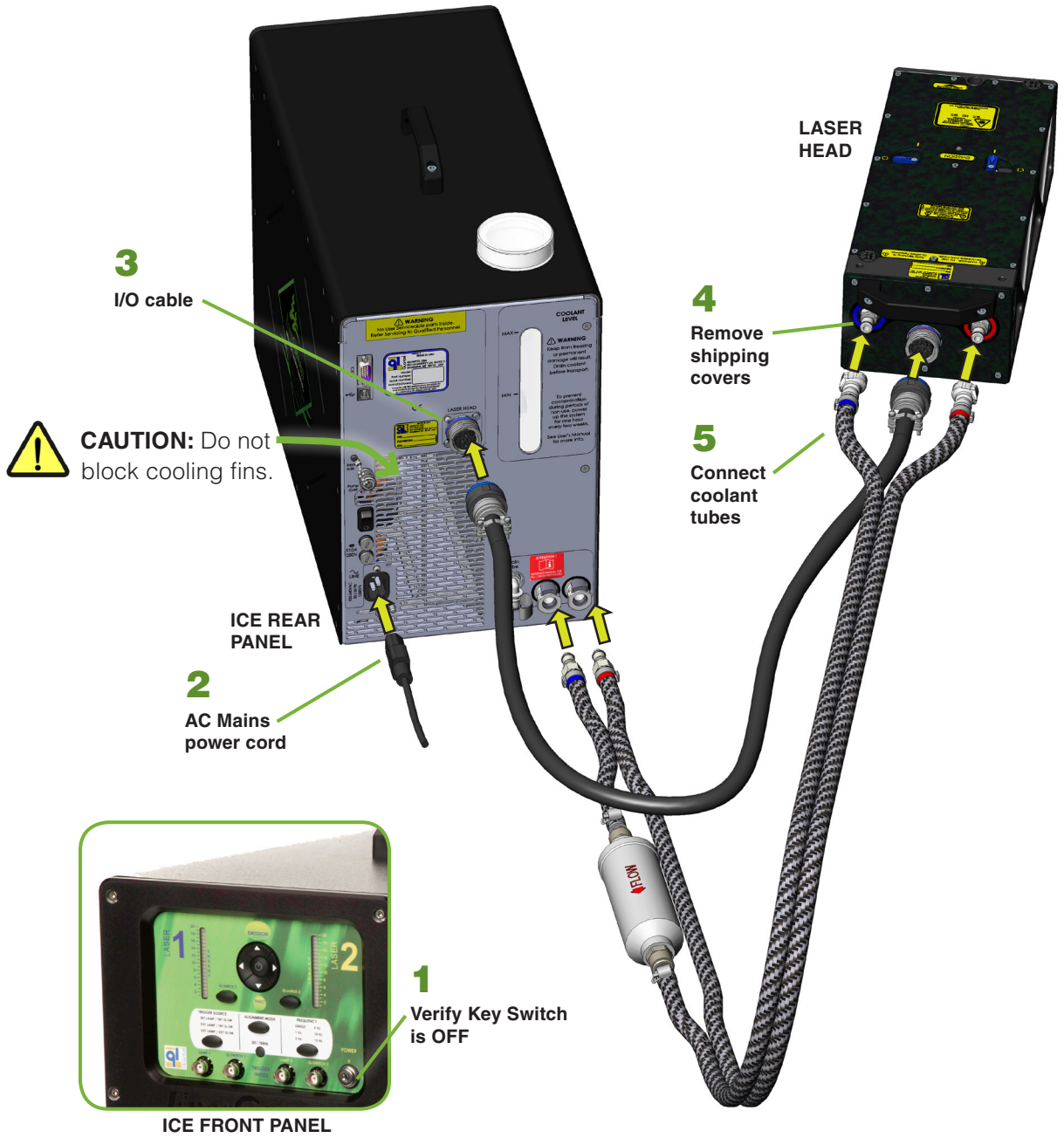


Figure 2: Laser Head Connected to ICE

3.0 Circulating Coolant to the Laser Head

CAUTION: Ensure that you have primed the coolant system before continuing (see **Priming the Cooling System on page 11**). Only distilled water with 1MΩ-cm to 5MΩ-cm resistivity is approved for use with the laser system. Do not operate the system without properly filled coolant or system damage may result.

Always drain the system before shipping or storage. See **Draining the Coolant on page 40**.

1. Refill the coolant reservoir to the line marked MAX.
2. Turn ON the AC Mains power switch.
3. Turn ON the Key Switch located on the ICE front panel. The pump inside the ICE turns on and coolant flow begins. The coolant tubes begin filling with coolant which lowers the fluid level in the reservoir. Add additional coolant as needed to refill the reservoir to the MAX level.

Note: After a 2 second attempt, the pump shuts off if the coolant is below the MIN level mark. The pump automatically restarts after a 5 second shutoff period. After three attempts, if coolant is not flowing, the pump is disabled until a retry command is sent via the serial interface or until the power is cycled OFF and then ON.

4. Use the Key Switch to cycle the power off and then on again several times to intermittently circulate the coolant. This helps to remove air bubbles.
5. Tip the Laser Head vertically while coolant is circulating to aid in purging air bubbles from it.
6. Verify that there are no air bubbles in the coolant tubes.
7. Add more coolant as needed to refill the reservoir to MAX level.
8. Replace the reservoir cap.
9. The system is now ready for Laser Head Mounting. See **Mounting on page 14**.

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

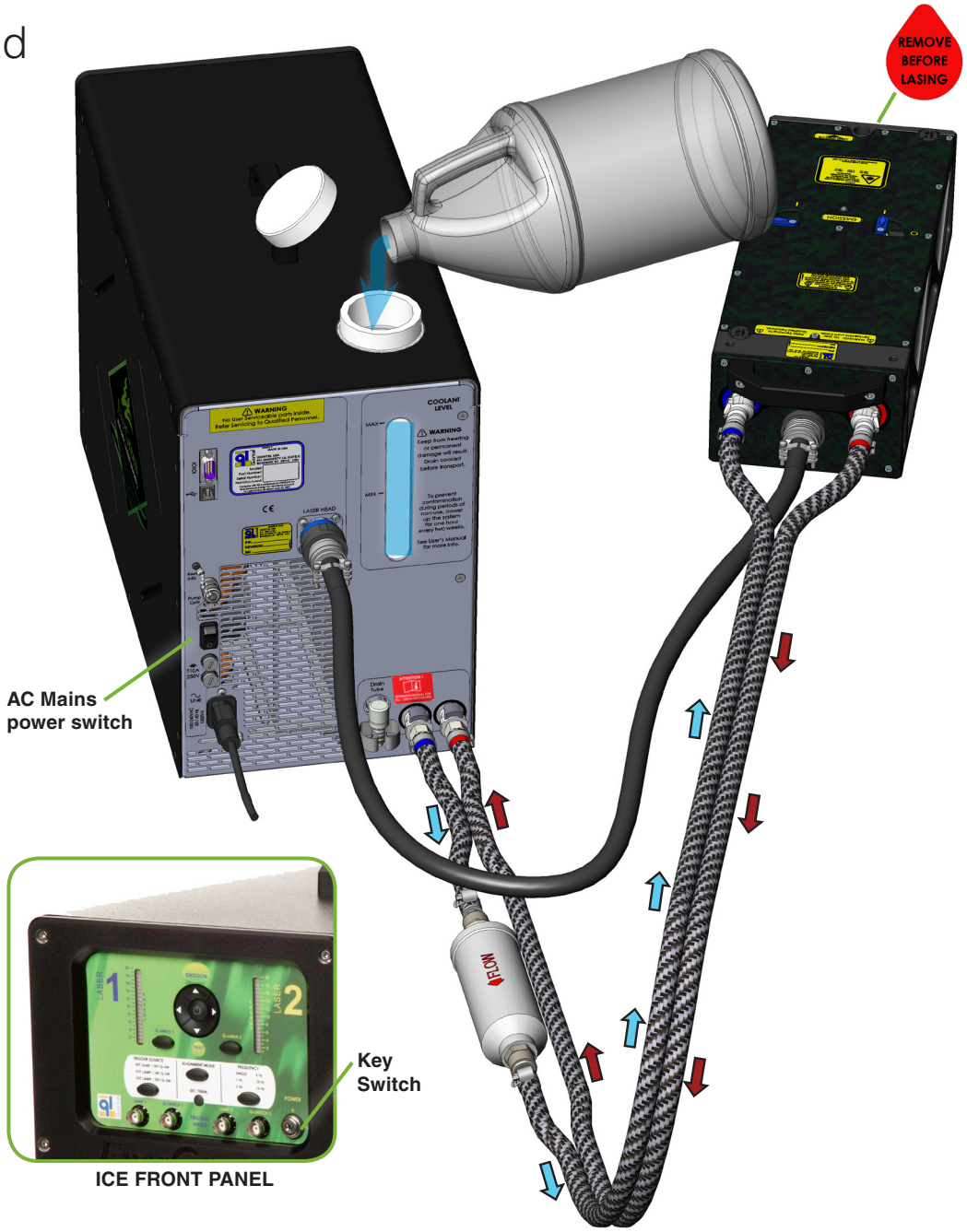
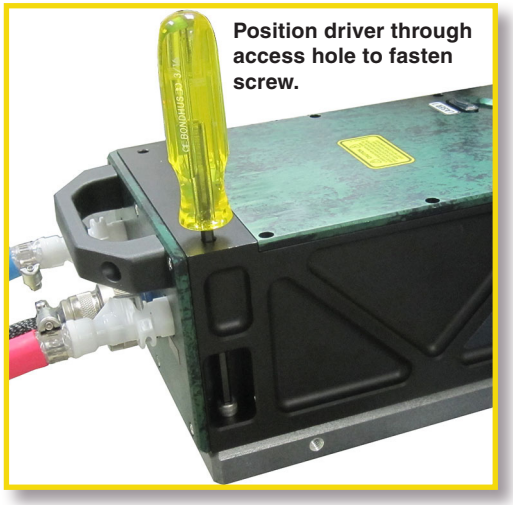


Figure 3: Laser Head Connections

4.0 Mounting

1. Use three M6 socket-head cap screws (or 1/4-20) at the mounting locations indicated to secure the Laser Head to a flat mounting surface. It is important that the mounting surface be flat, to prevent distortion. See page 15 for additional mounting hole locations.
2. Remove the protective sticker from the Laser Head aperture. Protective stickers must also be removed from any modules before their first use. The system is now ready for operation.

Useful Attachment Information: The **Center of Gravity** (COG) ⊕ and **Beam Output Aperture** locations are highlighted in the illustration. **Mass** is 15.5 lb [7.0 kg].



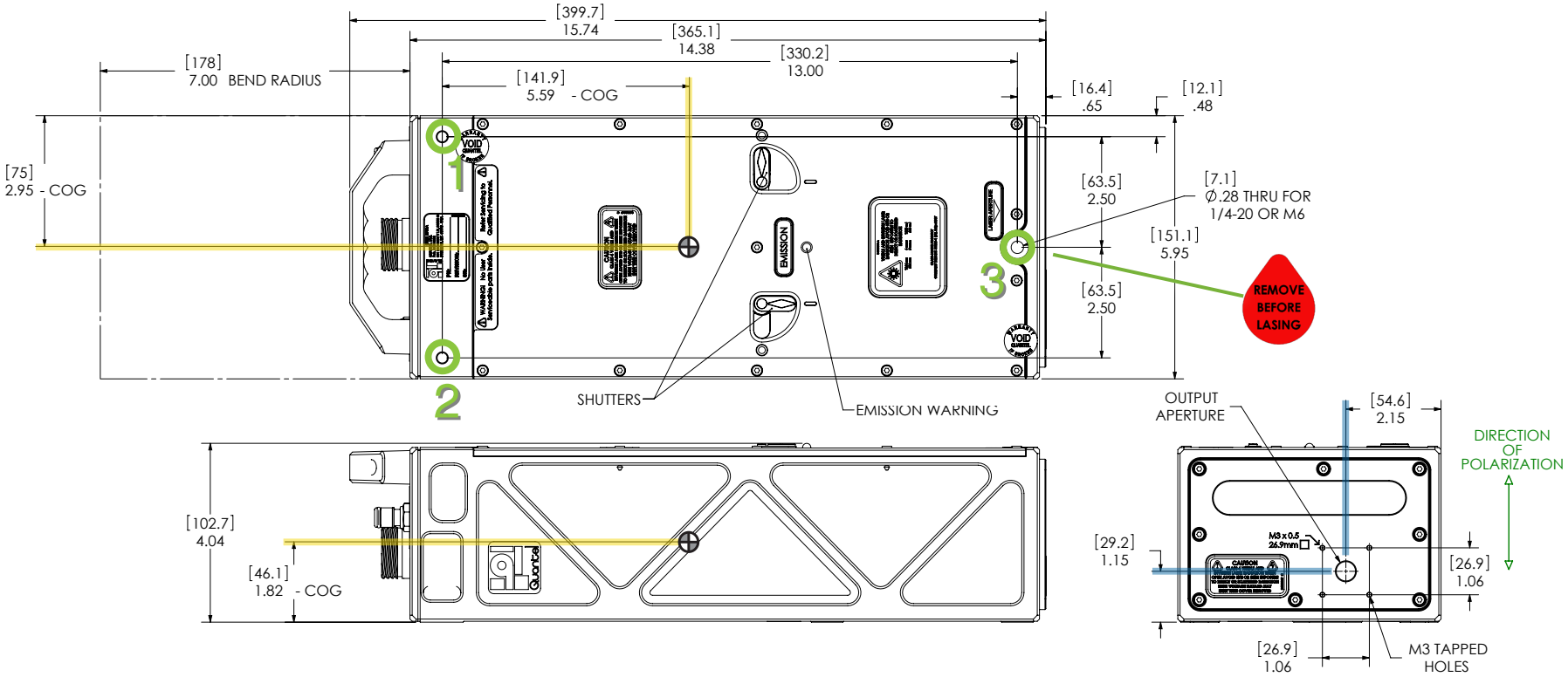


Figure 4: Laser Head Mounting Holes

5.0 Additional Mounting Information

Three optional tapped 1/4-20 mounting holes are provided on the bottom of the Laser Head.

Lenses and equipment may be attached to front of the Laser Head using the four M3 X 0.50 holes surrounding the Beam Output Aperture.

Make sure to remove the protective sticker from the Laser Head aperture before lasing.

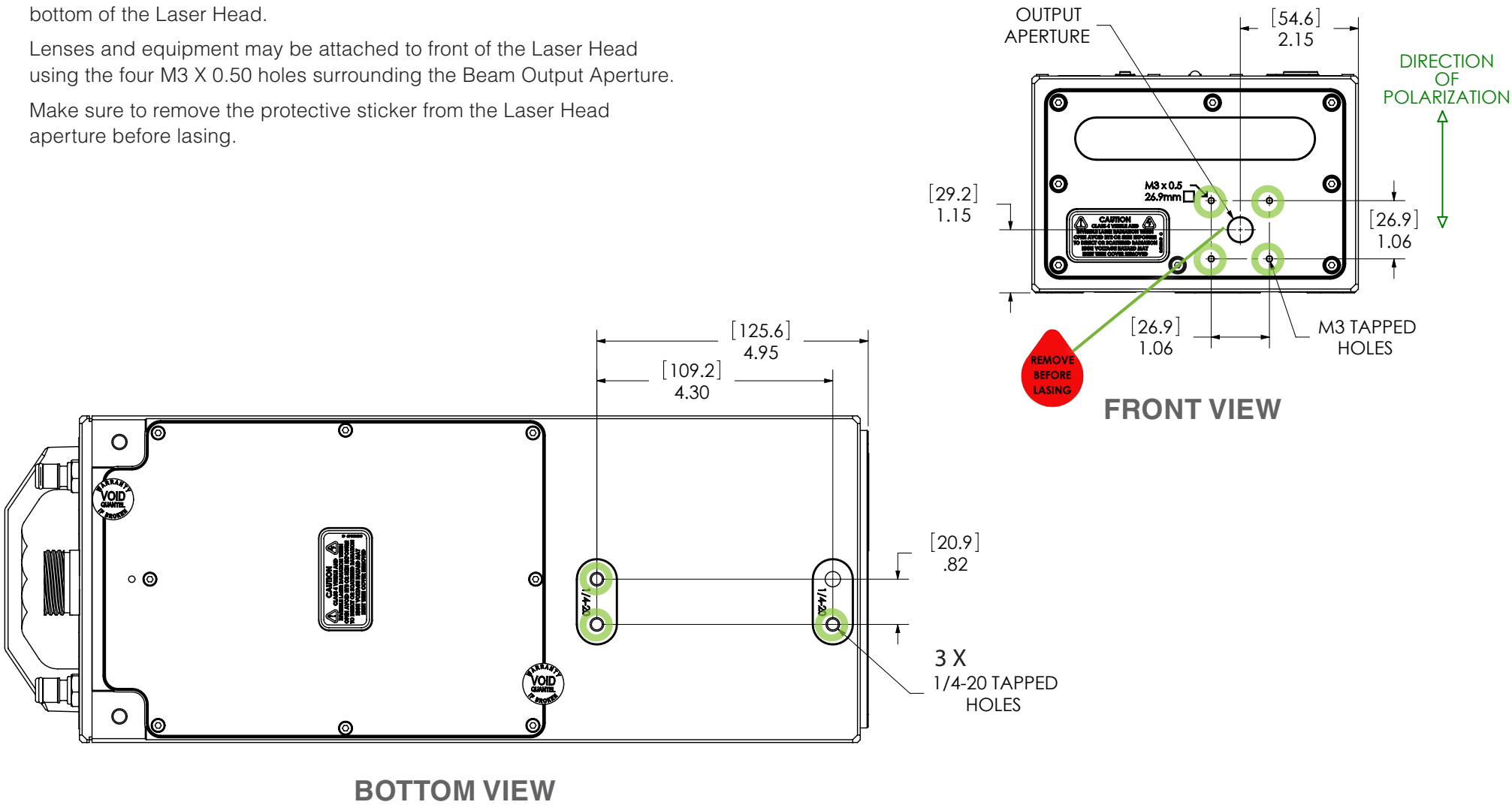


Figure 5: Additional Laser Head Mounting Information

FUNCTIONS

1.0 Control Panel

Before operating the laser, it is important to fully understand its features and controls. The last used settings are saved during the transition from “Run” to “Stop”.

Key Switch	Applies power to the ICE. The Power Indicator, directly above the Key Switch, is lit when power is ON.
Trigger Source	Press to select Internal Lamp & Internal Q-Switch trigger, External Lamp & Internal Q-Switch trigger, or External Lamp & External Q-Switch trigger modes. The selected trigger source applies to both lasers.
Run/Stop button	Press the center button on the Energy Selector to enter the laser Run Mode. The indicator on the button is lit when in Run Mode. Press the center button again for laser Stop Mode. The indicator light turns off. Emission Warning appears lit when in Run Mode.
Alignment Mode	Press button to turn ON low energy mode. The indicator to the right of the button is lit when Alignment Mode is ON. This feature is useful for aligning the laser output to external optics. Alignment Mode extends the Q-Switch Delay and lowers the lamp energy to its minimum value to operate the laser just below the lasing threshold. Increase the energy of each laser to the desired intensity by using the Energy Selector buttons. When Alignment Mode is deselected, the Q-Switch delay returns to the optimized setting. If the energy settings were not adjusted while in Alignment Mode, they return to their original settings. For safety, the Q-Switches are DISABLED upon exiting Alignment Mode. Alignment Mode is not available when the Q-Switch trigger source is set to External.  **Caution:** Wear eye protection. Follow safety precautions as though the system is capable of lasing at anytime.
50 Ω Termination button	Press button to turn ON 50 Ω Trigger Input Termination. The indicator to the right of the button is lit when 50 Ω termination is selected. When the indicator is OFF the trigger inputs are high impedance.
Frequency button	Press to select the internal flashlamp frequency. This button is only valid when Internal Lamp Trigger is selected. Laser is optimized at 15 Hz.
Single Mode	Press the Frequency button to select Single Mode. When Internal Lamp Trigger setting is selected, the flashlamps operate at 15 Hz and both Single and 15 Hz indicators are lit. To fire a single laser output pulse, press the corresponding Q-Switch button. The selected laser will emit one pulse. When in External Lamp Trigger & Internal Q-Switch Trigger mode, only the Single indicator is lit. Press either (or both) Q-Switch buttons to emit a single laser pulse. When an External Lamp Trigger is provided, a single Q-Switch trigger is gated to the selected laser. Single Shot is not available when in External Lamp / External Q-Switch Trigger setting.
Q-Switch 1 Q-Switch 2 buttons	Press to fire/enable the selected laser Q-Switch. The indicator adjacent to the button is lit when Q-Switching is activated. When enabled, if the laser system is in Stop Mode and the shutters are open, the selected laser will begin lasing within two seconds when entering Run mode (if a Q-Switch trigger is present).
Energy Selector	Press the Left button on the Energy Selector to choose Laser 1; press the Right button to choose Laser 2. The corresponding indicator is lit to identify which laser is selected. Press the Up button on the navigation switch to increase the selected laser energy setting. Press the Down button to decrease the selected laser energy setting. Both Laser Selection Indicators will flash if the Control Panel has been locked out.

1.0 Control Panel (Continued)

Laser 1 Energy level	The level indicator displays the energy setting for Laser 1. Setting 1 is the minimum energy. Setting 20 is the maximum energy. In Stop Mode, a single LED in the level indicator is lit to indicate the energy setting. In Run Mode, the entire level indicator is illuminated up to the setpoint. Use the up and down arrows on the Energy Selector to raise and lower the setpoint.
Laser 2 Energy level	The level indicator displays the energy setting for Laser 2. Setting 1 is the minimum energy. Setting 20 is the maximum energy. In Stop Mode, a single LED in the level indicator is lit to indicate the energy setting. In Run Mode, the entire level indicator is illuminated up to the setpoint. Use the up and down arrows on the Energy Selector to raise and lower the setpoint.
Emission Warning	Indicator is ON when in Run Mode. Indicator is solidly illuminated when Q-Switches are disabled. Indicator flashes at 1 Hz if either Q-Switch is enabled or if Single Shot is selected, to indicate the system is capable of lasing.
Fault indicator	Indicator is ON if system hardware or software fault is present. Once the fault has cleared the indicator will turn OFF. Refer to the Status Word Definition Table for a list of faults.
Trigger inputs	BNC connectors for external flashlamp and Q-Switch trigger inputs for Lasers 1 and 2. Triggers are only valid when the an external Trigger Source is selected (for example: External Lamp, or External Q-Switch. See **External Trigger Requirements** section for details.
Beeper	The ICE produces an audible warning to indicate a change of state. A **single short beep** is emitted at power up. A **single short beep** is also sounded at an operational mode change (STOP → RUN, RUN → STOP). A **double beep** is emitted if the change of state can result in lasing. If the Q-Switches are enabled prior to RUN, a double beep will sound when going to RUN. If the laser system is already in RUN Mode and the Q-Switches are then enabled, the beeper will sound with a double beep at that time. Finally, if the Laser is configured for Single Shot operation, a double beep will be produced every time the Q-Switch Button is pressed to produce a single laser pulse.

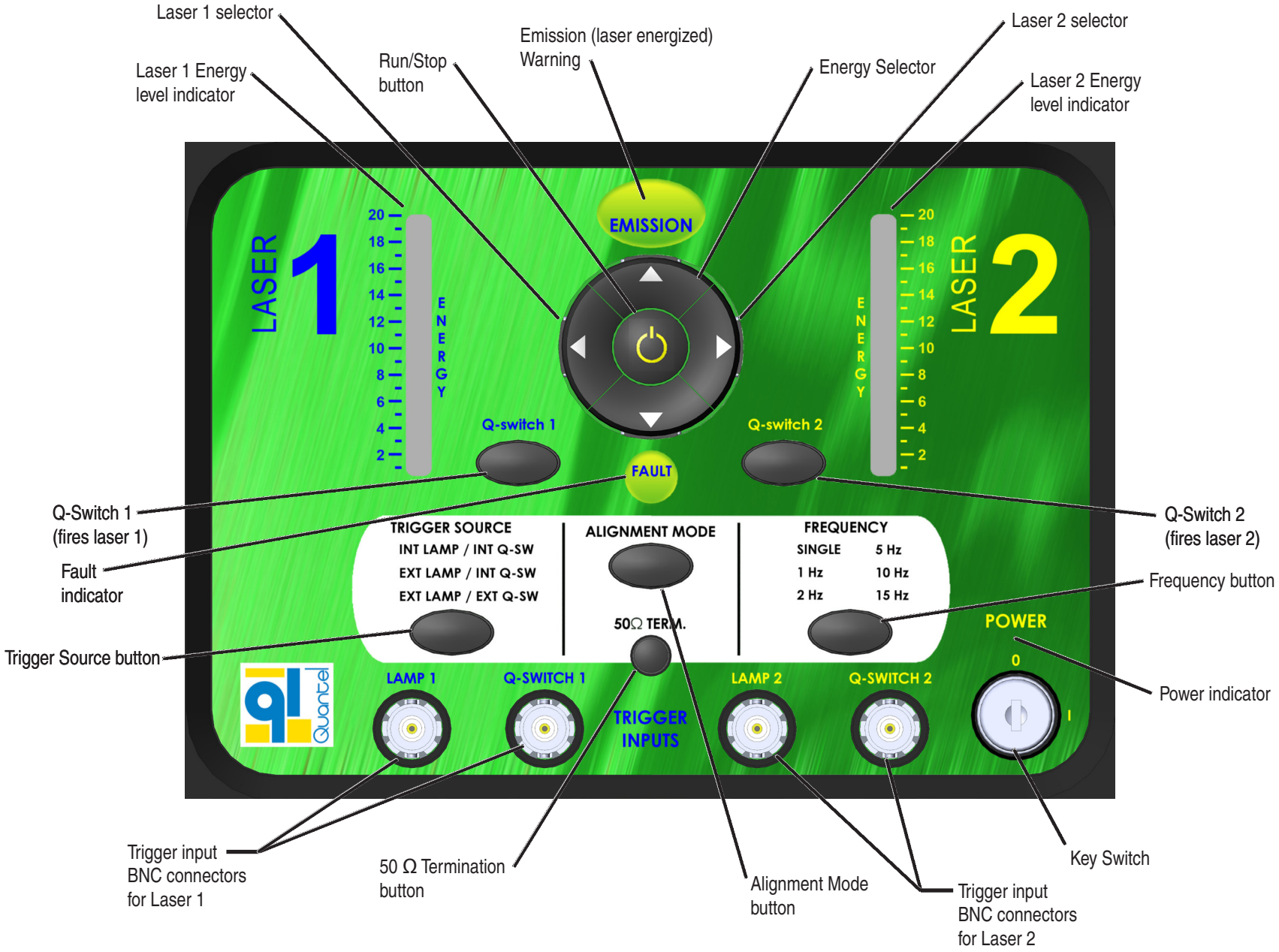


Figure 6: ICE (Laser Power Supply) Front CONTROL Panel

2.0 ICE Rear Panel

Mains Power switch	Provides Mains Power to the ICE.
Mains fuses	5 X 20 mm, 10A, 250V T-LAG. Replace with Bussmann S505-10-R or equivalent.
RS-232 serial interface	Connect to an external computer RS-232 serial port to remotely control the laser system. See the **Software section** of this manual for details.
USB interface	Reserved for firmware updates.
Remote interlock	CDRH required external interlock connection, stops laser radiation when opened. Connect it to an emergency stop switch, laser lab door switch, or other safety switch to reduce likelihood of accidental laser beam exposure. The system ships with a shorting connector installed. The Remote Interlock input connector must be shorted using an isolated switch closure (such as a relay) rated at least +12 VDC at 10mA to satisfy the interlock. Opening the connection trips the interlock and disables the laser.
Laser Head I/O connection	Electrical Interface connection between the Laser Head and ICE. **Do not** connect or disconnect the I/O Cable with the power ON.
System AC Mains Power input.	Connect to 100-240 VAC, 50-60 Hz, single phase power.
Pump Control switch	See the **Setup section** of this manual
Coolant level window	Visually inspect to verify the coolant level is above the minimum line and below the maximum fill line.
Coolant ports	Coolant connections to Laser Head. The blue port is the “cold” coolant output from the Laser Power Supply to the Laser Head. The red port is the “hot” coolant return from the Laser Head, back to the Laser Power Supply.
Drain tube storage	Drain the coolant prior to shipping or maintenance. See the **Maintenance section** for details.

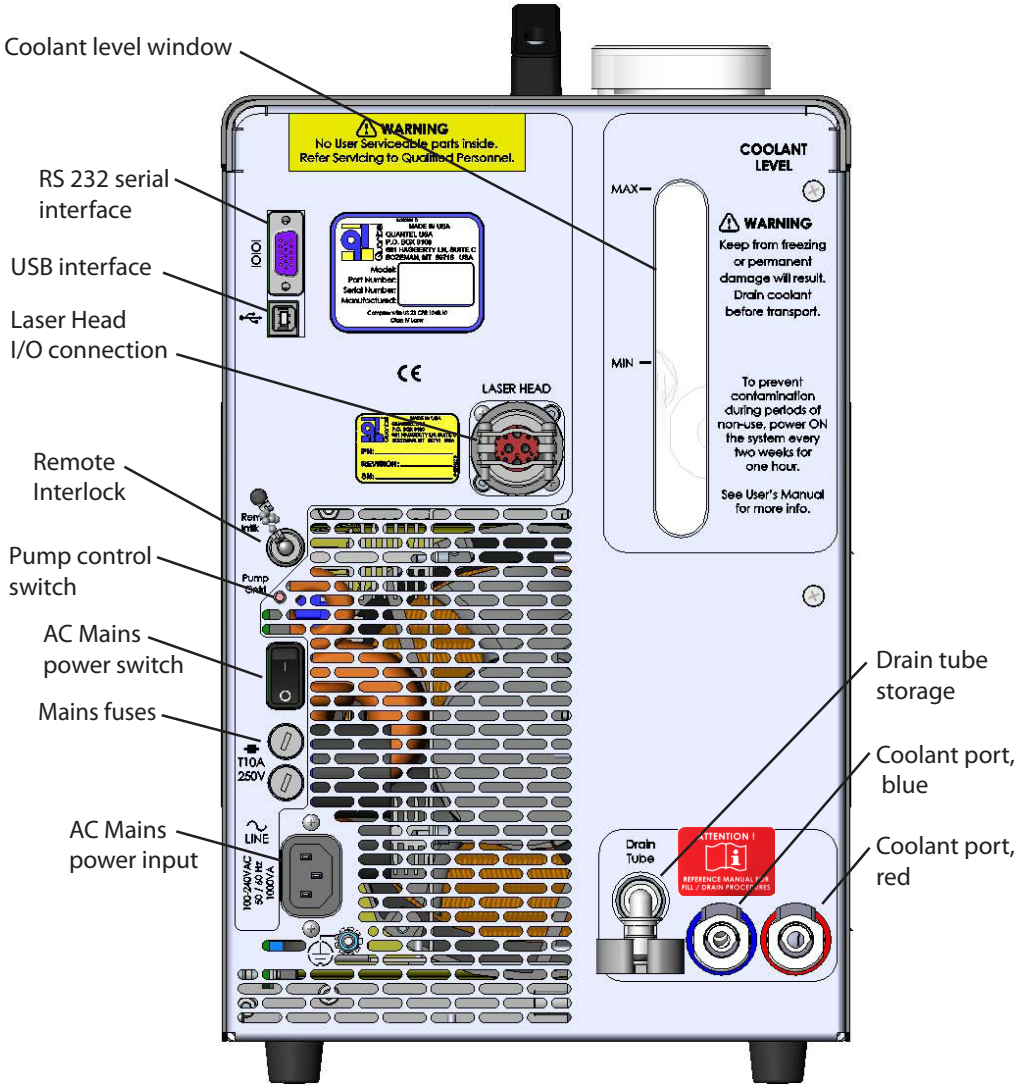
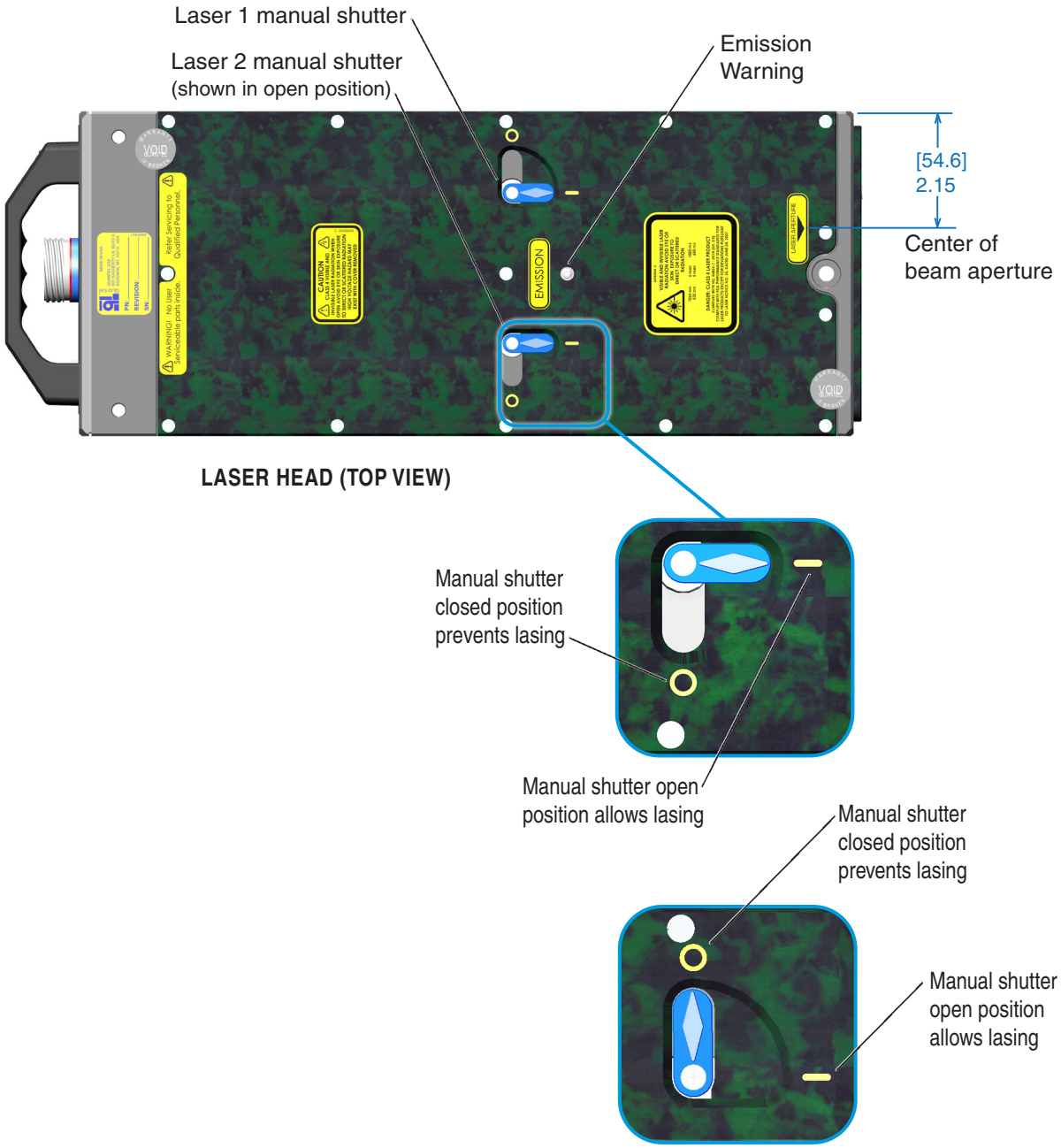


Figure 7: ICE (Laser Power Supply) Rear Panel

3.0 Laser Head

Emission Warning	The Emission Warning is ON when the laser is in Run Mode. • Solid illumination means that high voltage is enabled and the flash lamps are active. • Flashing at 1 Hz rate means that a Q-Switch is enabled; or if Single Shot is selected, indicates the system is capable of lasing.
Manual Shutters **Caution:** If a shutter is in the OPEN "|" position, it should be assumed that the laser is capable of lasing, regardless of the status of the Emission Warning.	Closing the manual shutters prevents lasing. Laser 1 and Laser 2 have separate manual shutters. To OPEN the shutter, rotate the shutter handle to align with the "|". To CLOSE the shutter and block the laser output, rotate the handle to align with the "O".



LASER HEAD (TOP VIEW)

OPERATION

1.0 Safety

CAUTION: Follow all safety procedures described in the Safety section of this manual.

CAUTION: Wear eye protection. Follow safety precautions as though the system is capable of lasing at anytime.

2.0 Remote Interlock

This BNC Connector provides an interface for an external safety shutdown switch. The Remote Interlock can be connected to a lab door or other system outputs for safety purposes. When using the Remote Interlock, only an isolated switch, such as a relay, should be used in order to avoid ground loops. If external safety switches are used, it is important that they are connected in series.

The Remote Interlock connection must be completed in order to operate the laser. If an open circuit occurs, the ICE high voltage is disabled and the Fault indicator is illuminated.

The system is shipped with the BNC shorting cap attached on this connector. Leave this connector in place if this function is not needed.

3.0 Manual shutter

CAUTION: If the Manual Shutter is in the OPEN "|" position, it should be assumed that the laser is capable of lasing, regardless of the status of the Emission Warning.

Closing the Manual Shutter prevents lasing. Laser 1 and Laser 2 have separate manual shutters. The shutter is closed and prevents lasing when the handle is in the "0" position.

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

4.0 Mains Power Switch

The Mains Power switch is on the ICE back panel. Turn the Mains Power switch ON "|" to supply AC mains power to the system.

5.0 Key Switch

Turn the Key Switch to ON "|" to apply main AC power to the ICE. The power indicator illuminates to show that AC power is ON. The key is not removable when in the ON position. After approximately 10 seconds, the laser is initialized and ready for operator control.

6.0 Alignment Mode

Select the Alignment Mode by pressing the button to toggle between the following:

- **ON:** Low laser energy output setting. (Verify that the indicator light to the left of the Alignment button shows lit.)
- **OFF:** Normal laser energy output. (The indicator light to the left of the Alignment button is OFF.)

7.0 Termination

Select the Trigger Termination impedance setting by pressing the button to toggle the 50 Ω Termination setting on or off.

- **ON:** Indicator light appears lit to show that 50 Ω Termination is selected.
- **OFF:** Indicator light is off. High impedance trigger termination is selected.

8.0 Stored Settings

The Laser Power Supply remembers the operational settings last used when transitioning from Run to Stop Mode. When the Key Switch is turned ON, the system will automatically configure to these settings.

The user can recall the factory configured operational settings by simultaneously holding down the Q-Switch #1 and Alignment Mode buttons while turning the Key Switch ON. The ICE will beep 3 times to indicate that the factory settings have been loaded.

9.0 Modes of Operation

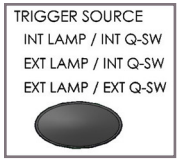
The following modes of operation are available:

- Manual operation using the ICE Control Panel.
- Remote operation using an external computer connected to the ICE via RS-232.

10.0 Manual Operation

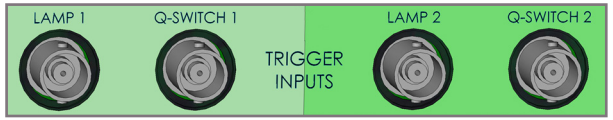
To operate the EverGreen Laser System manually, use the controls on the Laser Power Supply Control Panel.

TRIGGER SOURCE

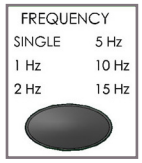


Choose the Trigger Source by pressing the button to select the desired option. The indicator light shows which option is selected. The following trigger options are available.

- **Internal Lamp / Internal Q-Switch:** The ICE produces all trigger generation and timing. Any external signals into the Trigger Input BNCs are ignored.
- **External Lamp / Internal Q-Switch:** The flashlamp trigger sources for Laser 1 and Laser 2 are generated by an external trigger provided by the user. The lamp trigger frequency is limited by the ICE. If an external trigger event occurs before the minimum allowed period (1/PRFMAX), the trigger is ignored. Internal Q-Switch trigger generation and timing is controlled by the ICE. No external Q-Switch trigger is required. If an external Q-Switch trigger is present, it is ignored. Refer to the **External Trigger Requirements** section for trigger pulse requirements.
- **External Lamp / External Q-Switch:** The flashlamp and Q-Switch trigger sources for Laser 1 and Laser 2 are generated by an external trigger provided by the user. The user is responsible for all frequency control, timing, and delays. The lamp trigger frequency is limited by the ICE. If an external trigger event occurs before the minimum allowed period (1/PRFMAX), the trigger is ignored. See the Laser Data sheet provided with your laser to determine the correct Q-Switch delays. Refer to the **External Trigger Requirements** section for trigger pulse requirements.



FREQUENCY SELECT



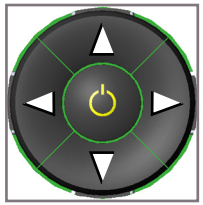
Choose the internal flashlamp frequency by pressing the button to advance to the desired setting. Frequency select is not available when the Trigger Source is in External Lamp/External Q-Switch Mode.

- **1 Hz**
- **2 Hz**
- **5 Hz**
- **10 Hz**
- **15 Hz** (Laser is optimized at 15 Hz)
- **Single:** When Internal Lamp Trigger setting is selected, the flashlamps operate at 15 Hz and both Single and 15 Hz indicators are lit. To generate a single laser output pulse, press either Q-Switch button. The selected laser will emit one pulse.

  When in External Lamp Trigger & Internal Q-Switch Trigger, only the Single indicator is lit. Press either (or both) Q-Switch buttons to activate the Single Shot function. When an External Lamp Trigger is provided, a single Q-Switch trigger will be gated to the selected laser. Single Shot is not valid when in External Lamp / External Q-Switch Trigger setting.

ENERGY SELECTOR

To adjust the Laser Energy:



- Press the left or right button on the Energy Selector to choose Laser 1 of Laser 2. An indicator adjacent to the button will light to identify which laser is selected.
- Press the Up button on the Energy Selector navigation switch to increase the laser output energy for the selected laser. Press the Down button to decrease the laser output energy. The Energy level indicator for that laser displays the relative energy setting. Level 1 is the minimum value. Level 20 is the maximum value. To scan to the desired setting, press and hold the energy adjustment button.

RUN/STOP

Main laser system control:

- **RUN:** To run the laser system (enable high voltage and begin flashing the flashlamps if a trigger is present), press the center Run/Stop button on the Energy Selector. If no faults are present and the system is able to enter Run Mode, the Power symbol on the center Run/Stop button will light, the Emission Warning will light, the Energy level indicators will illuminate to the setpoints, and the beeper will sound.

  The Emission Warning shows one of the following:

  ON solid if Q-Switches are disabled.

  Flashing at 1 Hz rate if either Q-Switch is enabled or if Single Shot is selected, to indicate the system is capable of lasing.

- **STOP:** To transition from Run to Stop Mode, press the center Run/Stop button on the Energy Selector navigation switch. The Power legend on the Run/Stop button and the Emission Warning will extinguish. The Energy level indicators show a single LED to indicate the energy setpoint. The beeper emits a single short beep to indicate the mode change.

Q-SWITCH ENABLE

The Q-Switch buttons control Q-Switch activation. If the system is in Stop Mode and a Q-Switch button is set to ON, the selected laser will begin lasing within two seconds upon entering Run Mode. If the system is in Run Mode with the Q-Switch button OFF, the laser will not lase until the Q-Switch button is toggled ON.

- **Q-Switch 1**: Press to enable Laser #1 Q-Switch. The indicator adjacent to the button is lit when Q-Switching is activated. When enabled, if the laser system is in Stop Mode and the shutters are open, Laser #1 will begin lasing within two seconds when entering Run mode (if a Q-Switch trigger is present).

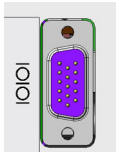
- **Q-Switch 2**: Press to enable Laser #2 Q-Switch. The indicator adjacent to the button is lit when Q-Switching is activated. When enabled, if the laser system is in Stop Mode and the shutters are open, Laser #2 will begin lasing within two seconds when entering Run mode (if a Q-Switch trigger is present).

INTERNAL LAMP TRIGGER DELAY

The EverGreen Laser System is shipped with an internal delay of 100 µsec from Laser 1 to Laser 2 output.

See the **Software starting on page 25** for more detail.

11.0 Remote Operation



The EverGreen Laser System can be controlled by a remote computer using the standard RS-232 serial interface. The serial interface connector (DE-9S D-sub) is located on the rear panel of the ICE. Refer to **Software starting on page 25** for details.

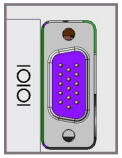
SOFTWARE

1.0 General Information

EXTERNAL CONTROL INTERFACE

The primary communications and control is via the RS-232 port located on the ICE back panel. The serial communications configuration is:

- 57600 baud
- 1 start bit
- 8 data bits
- even parity
- 1 stop bit
- no flow control



Serial Protocol

1. The laser system must acknowledge each communications packet it receives from a host computer. If the command is not valid or recognized, then it will respond (as defined later in this section) and ignore the erroneous command.
2. Only the host initiates communications. Any change of state due to an interlock, fault or error latches the Cause of State Change in the laser system until it has been queried at least once from the host.
3. This information is latched in the Status Word. Once the fault is cleared the hardware is capable of changing modes, regardless of whether the Status Word has been queried or not.

Command Structure

1. The command structure format is **$name data<CR>** where:
   - **“$”** is the attention command indicating a command follows.
   - **“name”** is the command name. Commands are not abbreviated, but only the first five characters are used. No spaces are allowed between the $ and the name.
   - **“data”** is the value associated with “name”. Each command dictates the type of data acceptable (string, integer, floating point). There must be a space between “name” and “data”. Certain commands are stand-alone and do not require data.
   - **“<CR>”** (carriage return) indicates the end of the command packet (command terminator).
2. Commands are not processed until the command terminator is received.
3. If an error is made and identified prior to sending the command terminator, sending a new “$” will reset the input buffer and allow a new command to be sent.
4. The keyboard “backspace” is a valid method to correct an error in entering a command.
5. Commands are not case sensitive.

6. $Echo 1 turns echoing ON; $Echo 0 turns echoing OFF. With echoing ON (1), the laser system will echo back all characters it receives. The <CR> is echoed followed by LF (Line Feed). With echo OFF (0), no characters are echoed.
7. Regardless of the echo status, the laser system will always respond to any complete command it receives with one of the following acknowledgement packets.
   - $name data -- the command was recognized, determined to be valid, and carried out successfully.
   - $Bad Command -- the command itself was not recognized.
   - $Bad Value -- the command was recognized, but data was not valid.
   - $Out of Range -- the data format is valid, but the data is not in a valid range.
8. A non-identified command or not-valid value results in the laser system ignoring the command. In general, only one command can be processed per message. Some special commands can accept a Hex value representing multiple simultaneous commands.
9. To query the current value of any valid command, replace the data value with "?" for example: $name ?<CR>. The response displays the current value as expected, for example: $name "data" -- where "data" is the current value.
10. When a command is of a binary type (ON or OFF), a value of "1" represents ON or TRUE; a value of "0" represents OFF or FALSE.

Byte Order

If necessary, Hex bytes can be used to represent integers. Each multiple byte integer value defined within the protocol is transmitted in network byte order (Big Endian) with the most significant byte (MSb) first and the least significant byte (LSb) second.

Response Timeout

The host computer can expect an Acknowledgement Packet from the laser system within 5 seconds. An exception to this is the File Transfer messages. Operations occurring on files, which are stored in flash memory, can take more than 30 seconds to complete.

2.0 Operational Commands

Function	Operation	Command	Valid Input	Description
System Control	Run	RUN		Attempt to enter Run mode
	Stop	STOP		Enter Stop mode
	NLO Oven Control	OVEN1	0, 1, ?	NLO Oven #1 Control. 0 = OFF, 1 = ON. Default is ON.
	Coolant Pump Control	PUMP	0, 1, ?	Pump Control. 0 = OFF, 1 = ON
	Front Control Panel Lockout	LOCK	0, 1, ?	Front Panel Lockout. When active, only the Run/Stop button is active. If panel lockout is active the right and left arrows will flash simultaneously at 1 Hz rate. 0 = OFF, 1 = ON (Lock)
	Serial Communications Echo	ECHO	0, 1, ?	Echo command. With echoing ON, the Laser Controller will echo back all characters it receives. 0 = OFF, 1 = ON
	Desired Operational State	STATE	00-FF	Sets operational state with a single command. Refer to **Status Word Definition**.
Trigger	Trigger Source Select	TRIG	II, EI, EE, ?	Trigger Source Setting. II = INT/INT, EI = EXT/INT, EE = EXT/EXT
	Trigger Input Termination	TERM	0, 1, ?	50 Ω trigger input termination control. 0 = OFF, 1 = ON
Flashlamp	Lamp Frequency Select	FREQ	SS, 1, 2, 5, 10, 15, ?	Internal Lamp Frequency Setting. SS = Single Shot, 1 = 1 Hz, 2 = 2 Hz, 5 = 5 Hz, 10 = 10 Hz, 15 = 15 Hz. Both lamps operate at the same selected frequency. They cannot be independently set.
	Alignment Mode	AMON	0, 1, ?	Alignment Mode Control. 0 = OFF, 1 = ON, ? = Status Query
	Internal Lamp Delay	PIVDLY	0-255, ?	Timing delay in microseconds from rising edge of Lamp Trigger #1 to rising edge of Lamp Trigger #2. Only valid in Internal Lamp Trigger mode. 1 µsec resolution. Lamp Trigger #1 will always occur first when in internal Lamp Trigger mode.
	Alternate Internal Lamp Trigger	DLYALT	0, 1, ?	Sets delay between Internal Lamp Trigger #1 and Internal Lamp Trigger #2 to be ½ of set period. 0 = OFF, 1 = ON. If DLYALT is active, PIVDLY is ignored. Example: With PRF set to 10 Hz and DLYALT active, timing separation between Lamp #1 and Lamp #2 is 50 msec.
Energy Control	Laser #1 Voltage Adjust	L1VSET	1-20, ?	Laser #1 Setpoint. Discrete integer from 1 to 20; 1 is the minimum voltage setting, 20 is the maximum voltage setting.
	Laser #2 Voltage Adjust	L2VSET	1-20, ?	Laser #2 Setpoint. Discrete integer from 1 to 20; 1 is the minimum voltage setting, 20 is the maximum voltage setting.

Function	Operation	Command	Valid Input	Description
Q-Switch	Q-Switch #1 Enable	QSW1	0,1, ?	Internal Q-Switch #1 trigger enable. 0 = OFF, 1 = ON
	Q-Switch #2 Enable	QSW2	0,1, ?	Internal Q-Switch #2 trigger enable. 0 = OFF, 1 = ON
	Laser #1 Q-Switch Delay	Q1DLY	0-255, ?	Q-Switch #1 delay with respect to Lamp #1 Trigger rising edge, in microseconds. 1 µsec resolution.
	Laser #2 Q-Switch Delay	Q2DLY	0-255, ?	Q-Switch #2 delay with respect to Lamp #2 trigger rising edge, in microseconds. 1 µsec resolution.
	Q-Switch #1 Single Shot	Q1SS	0,1, ?	When in Single Shot setting, allows the next single Q-Switch #1 trigger after the command is received. 0=cancel, 1=activate.
	Q-Switch #2 Single Shot	Q2SS	0,1, ?	When in Single Shot setting, allows the next single Q-Switch #2 trigger after the command is received. 0=cancel, 1=activate.
System Status	System Total On Time	HOURS	?	Total Time-On counter. Report in hour:minute format.
	System Total HV On Time	RHOURS	?	Total hours in Run Mode. Report in hour:minute format.
	System Total Lamp Shot Counter	SSHOT	?	System Lamp Shot count. 1 shot resolution.
	Resetable Lamp Shot Counter	USHOT	00, ?	User resetable Lamp shot count. 00 = reset. 1 shot resolution.
	Laser Head Serial Number	LSERIAL	?	Laser Head serial number; 10 digit.
	Power Supply Serial Number	PSERIAL	?	Power Supply serial number; 10 digit.
	System Serial Number	SSERIAL	?	System serial number; 10 digit.
	Power Supply Firmware Version	PSVERS	?	Power Supply firmware version.
	Laser Firmware Version	LVERS	?	LaserBrain firmware version.
	Laser Head Temperature	LTEMP	?	Laser Head temperature. Floating point number in °C.
	NLO Oven Temperature (actual)	TEMPF	?	Oven temperature feedback. Floating point number in °C.
	NLO Oven Temperature Setpoint	TEMPS	?	Oven Temperature setpoint. Floating point number in °C.
	Status	STATUS	?	Returns current operational state, warning, interlock status, and fault bytes in HEX format. Refer to **Status Word Definition**.
	Current Operational State	STATE	?	Queries operational state. Refer to **Status Word Definition**.
	Event Log	LOG	?	Recalls last 256 stored Status events. Sequence of each record is Time Stamp, SShots, Status Word.

3.0 Status Word Definition

The Status Word response provides the user with the current state of the laser system, as well as interlock status, warning and fault code status, and other pertinent system parameters.

The Status Word format is SB AA BB CC DD where,

- SB is the State Byte
- AA is the Warning Byte
- BB is Interlock Byte (Fault Byle #1)
- CC is Fault Byte #2
- DD is Fault Byte #3.

The bytes are represented in Hexadecimal format in the following order:

- [S7 S6 S5 S4] [S3 S2 S1 S0] [A7 A6 A5 A4] … [D7 D6 D5 D4] [D3 D2 D1 D0]
- S7 is the Most Significant Bit (MSb) and D0 is the Least Significant Bit (MSb)

Byte	Bit	Status	State	
			0	**1**
MSb	S7	Run	Stop	Run
	S6	Lamp Trigger Source	Internal	External
	S5	Q-Switch Trigger Source	Internal	External
STATE	S4	Q-Switch #2	Disabled	Enabled
	S3	Q-Switch #1	Disabled	Enabled
	S2	Alignment Mode	Disabled	Enabled
	S1	50 Ω Trigger Termination	Disabled	Enabled
	S0	Panel Lockout	Disabled	Enabled
	A7	NLO Oven	**Enabled**	**Disabled**
	A6	Power Cycle	No	Yes
	A5	Reserved	No Action	No Action
WARNING	A4	Reserved	No Action	No Action
	A3	External Lamp PRF	OK	PRF High
	A2	NLO Oven Temperature	OK	Warning
	A1	Laser Head Temperature	OK	Warning
	A0	Reserved	No Action	No Action

Byte	Bit	Status	State	
			0	1
HARDWARE INTERLOCK (FAULT #1)	B7	Heat Exchanger Overtemp Interlock	OK	Overtemp
	B6	Charger Magnetics Overtemp Interlock	OK	Overtemp
	B5	Charger Heatsink Overtemp Interlock	OK	Overtemp
	B4	IGBT Heatsink Overtemp Interlock	OK	Overtemp
	B3	Coolant Level Interlock	OK	Low Level
	B2	Coolant Flow Interlock	OK	Low Flow
	B1	Remote Interlock	OK	Open
	B0	System Interlock	OK	Open
FAULT #2	C7	Charger Voltage	OK	Fault
	C6	Laser #2 Voltage	OK	Fault
	C5	Laser #1 Voltage	OK	Fault
	C4	Simmer #2	OK	Fault
	C3	Simmer #1	OK	Fault
	C2	NLO Oven	OK	Fault
	C1	Laser Head Temperature	OK	Fault
	C0	Flow Switch Function	OK	Fault
FAULT #3	D7	Reserved	No action	No action
	D6	Reserved	No action	No action
	D5	Controller Memory Self Test	OK	Fault
	D4	LaserBrain Self Test	OK	Fault
	D3	CAN Bus	OK	Fault
	D2	SPI Bus	OK	Fault
	D1	Watchdog Timer Time Out	No	Yes
LSb	D0	Reserved	No Action	No Action

TECHNICAL SPECIFICATIONS

Quantel reserves the right to modify the specifications without notice.

The EverGreen is rugged, reliable, and built for PIV applications.

Laser Classification: IV

1.0 Specifications

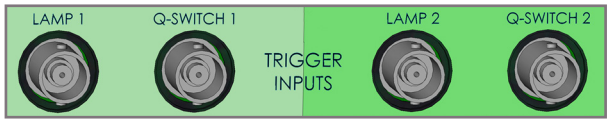
Operational temperature range:	18ºC - 28ºC
Storage temperature range:	5ºC - 50ºC
Laser Head mass:	15.5 lb [7.0 kg]
ICE weight:	Empty: 35 lb[15.9 kg] Full: 40 lb[18.1 kg]
Laser pulse width:	(FWHM) less than or equal to 10 nanoseconds at nominal energy
Coolant:	distilled water
Triggers	5V nominal into 50 Ω or 5V nominal into high-impedance; user selectable
Laser Head operation:	Laser head assembly can operate in any orientation
Power requirements:	100-240 VAC, 50-60 Hz
Laser Head sealing: Power supply sealing	sealed to IP 67 specification sealed to IP 21 specification
Laser vibration compliance:	MIL-STD-810F Procedure 1 Category 10
Shipping compliance:	FedEx Testing for Packaged Products up to 150 lbs.

MODEL	EverGreen 70	EverGreen 145	EverGreen 200	EverGreen 25100	EverGreen 30266
Energy (mJ)*	70	145	200	100	30
Wavelength (nm)	532				266
Pulse repetition rate (Hz)	15			25	15
Pulse-to-pulse Energy stability (% RMS)	< 2.5	< 2			< 3
Pulse width (ns)**	≤ 11	≤ 10			
Near field beam diameter (mm)	< 5.0	< 6.35	< 6.35	< 5.0	< 6.35
Near field beam profile	Flat-top, Uniform				
Spectral purity (%)***	> 98				N/A, 266 nm collinear with residual 532 nm
Beam divergence (mrad)	< 4				
Shot to shot pointing stability (µrad)	< 100				
Far field beam overlap (µrad)	± 100				
Near field beam overlap (µm)	± 100				
Polarization	linearly polarized				

All specifications are at 15 Hz or 25 Hz

* Double pulsed system: energy given for each pulse ** FWHM at nominal energy *** Full angle containing 86.5% energy

2.0 External Trigger Requirements



External Trigger Inputs

The user is responsible for all frequency control, timing, and delays when using external triggers. The lamp trigger frequency is limited by the ICE. If an external trigger event occurs before the minimum allowed period (1/PRFMAX), the trigger is ignored. See the Laser Data sheet provided with your laser to determine the correct Q-Switch delays.

Signal Requirements

The external signal rising edge initiates the trigger with a pulse width defined by the software LPW variable. The signal must supply a pulse with the following characteristics:

- Amplitude: +5V, acceptable range: 3.0V-5.0V
- Pulse-width: 10 µsec minimum

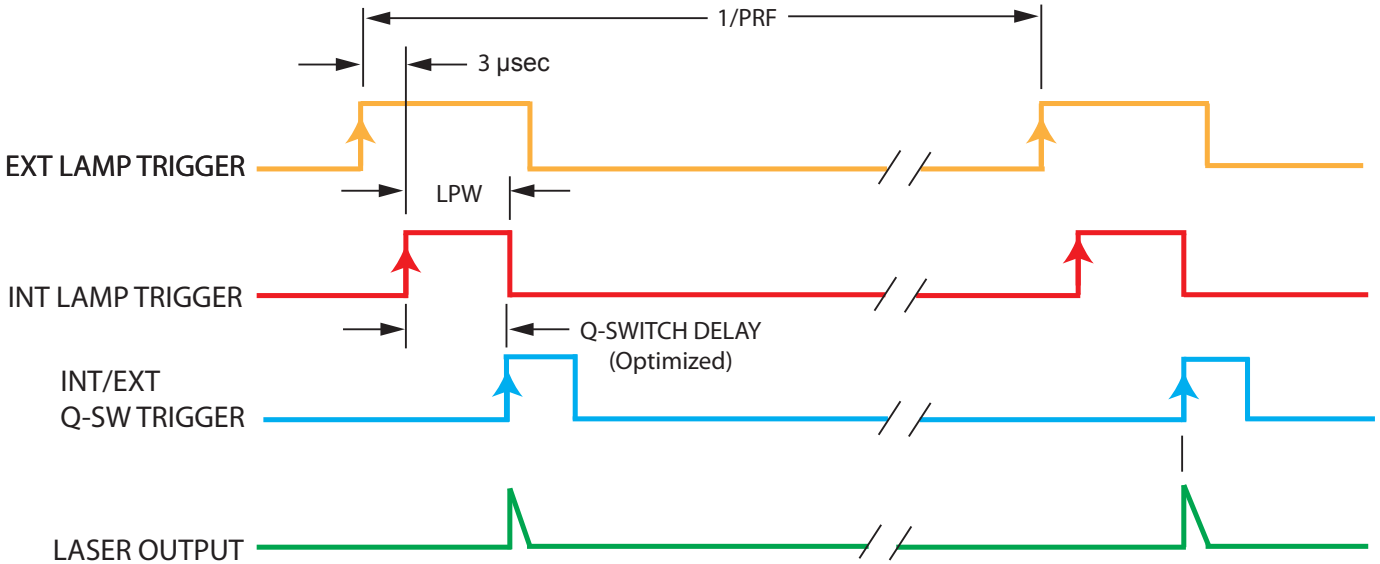


Figure 8: Trigger Timing Diagram

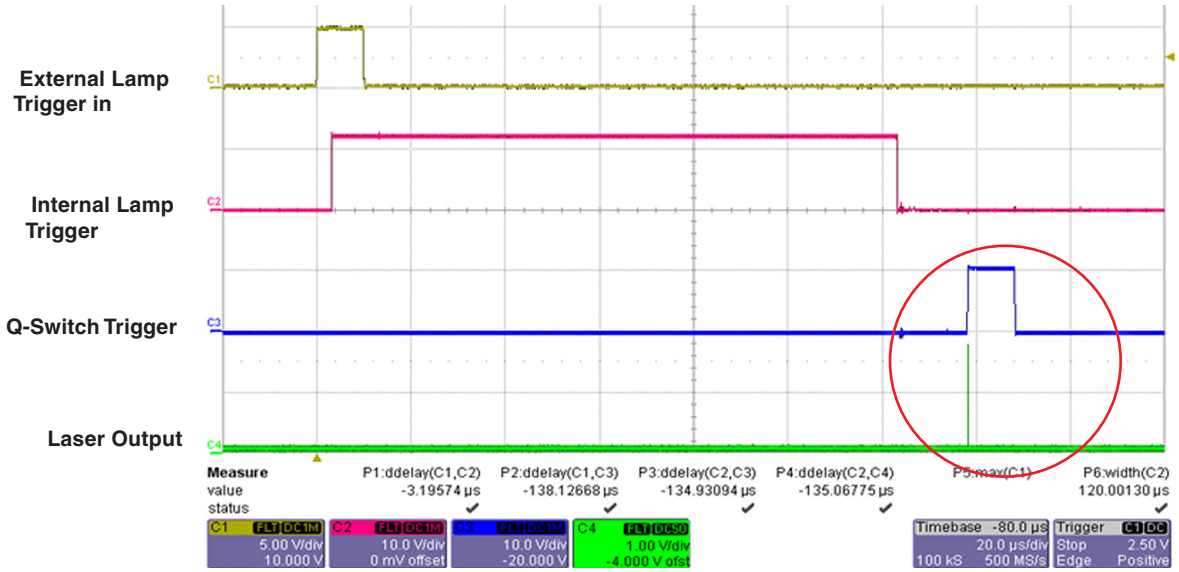


Figure 9: Typical Waveforms and Delays

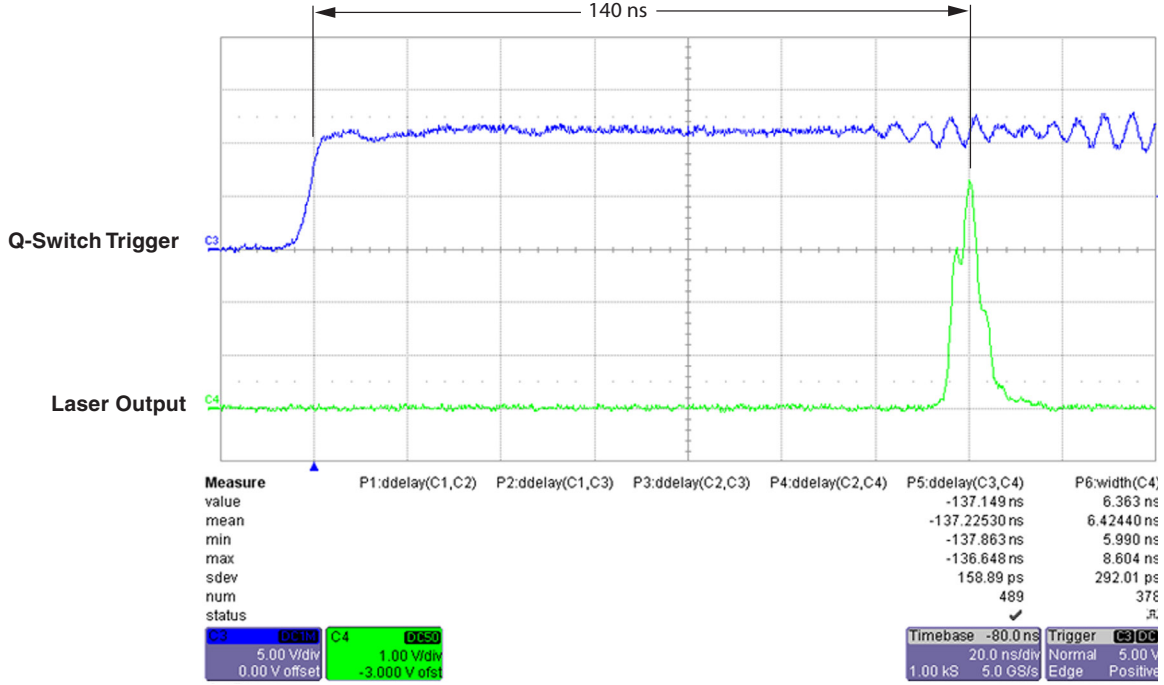


Figure 10: Typical Delay from Q-Switch Trigger to Light Out

3.0 Operating with PIV Delays Shorter than 6 µs

Operating with PIV delays shorter than 6µs (Process)

Technical Note
Distribution: Internal & External

The EverGreen PIV Laser System can be operated in three different trigger modes: Internal Lamp / Internal Q-Switch (INT/INT), External Lamp / Internal Q-Switch (EXT/INT), and External Lamp / External Q-Switch (EXT/EXT).
Refer to the User Manual for additional details not covered in this Technical Note.

When in INT/INT mode, all trigger timing is generated by the EverGreen Laser Controller. The system is configured at the factory with a 10 µsec delay between Laser #1 and Laser #2. This delay can be adjusted via the serial interface, from 0 µsec to 255 µsec, in 1 µsec increments. If the delay is set to 0, there is a possibility that the optical pulses for both lasers will temporally overlap, producing 1064 nm back-conversion in the doubling crystal, resulting in energy loss at 532 nm.

When operating in EXT/INT trigger mode, the user supplies the flashlamp triggers to control laser timing. The Q-Switch triggers are generated internally by the EverGreen Laser Controller. The EverGreen Laser Controller validates and synchronizes the external flashlamp triggers to the internal lamp triggers; a process that takes approximately 3 µsec. Optimum Q-Switch delay with respect to internal flashlamp trigger is 135 µsec. Therefore, when operating in EXT/INT mode, the laser will emit an optical pulse 138 µsec after the rising edge of each external lamp trigger (3 µsec processing time + 135 µsec Q-Switch delay).

When in EXT/EXT mode, the user supplies both flashlamp and Q-Switch triggers. The Q-Switch triggers are not managed by the EverGreen Laser Controller, so no additional delays are introduced. Optimal delay between lamp trigger and Q-Switch trigger, when operating in External Lamp /External Q-Switch mode is 138 µsec.

For PIV delays shorter than 6 µsec, the EverGreen Laser Controller does not have adequate time to validate the external lamp trigger for Laser #1 and still detect the rising edge of the external lamp trigger for Laser #2. The result is that Laser #2 stops lasing at these short PIV delays.

To operate at PIV delays below 6 µsec, the following procedure is recommended. If sub-microsecond PIV delays are desired, the external trigger source must be capable of controlling timing delays in the nsec range. Use a photo-diode connected to an oscilloscope to monitor and adjust the optical pulse spacing.

1. Set the external delay between Laser #1 lamp trigger and Laser #2 lamp trigger to 10 µsec. This fixed delay will ensure that the EverGreen Laser Controller has time to adequately process both external lamp triggers.

2. Add 5 µsec to the Q-Switch delay for Laser #1. This means Laser #1 will now be Q-Switched 143 µsec after the rising edge of lamp #1 trigger.

3. Subtract 5 µsec from the Q-Switch delay for Laser #2. This means Laser #2 will now be Q-Switched 133 µsec after the rising edge of lamp #2 trigger.

4. This process effectively temporally overlaps the two optical pulses. Adjust the Q-Switch delays for each laser by 10ths or 100ths of a µsec to achieve the desired PIV delay.

Adjusting the Q-Switch delays +/- 5 µsec will have minimal impact on the energy or brightness of the 532 nm output. However, if there is a noticeable difference in intensity between the two laser pulses, adjust the voltage settings of the two lasers to compensate for the imbalance.

4.0 266 nm Option

Quantel provides an option to purchase an EverGreen + UV system that emits either ONLY 532 nm light or both 532 and 266 nm light.

Emitted Wavelengths and Polarity

- 532 nm and 266 nm light are collinear.
- 532 nm light is polarized vertically.
- 266 nm light is polarized horizontally.

Controlling the 266 nm Feature

The amber push-button on the side of the Laser Head turns ON/OFF the 266 nm feature.

Button OUT: The laser emits ONLY 532 nm light when the button is out. In this state the button is not illuminated.

Button IN: The laser emits both 532 nm AND 266 nm light when the push-button is IN. In this state the button is illuminated.

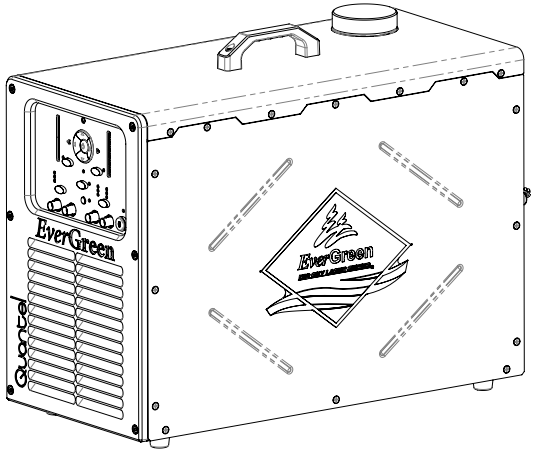
Energy stability

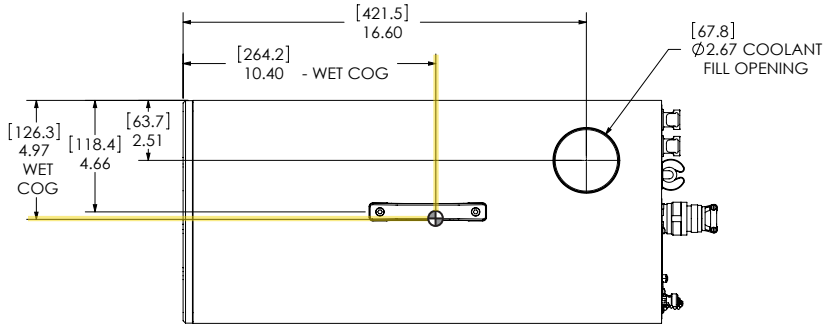
Wait approximately 5 minutes after using the push-button to change between the ONLY 532 nm condition and the 532 AND 266 nm operation, for thermal stability and optimal laser performance.

Push button IN to select 532 AND 266 nm operation.

Button illuminates when 532 AND 266 nm mode is selected.

5.0 Dimensioned Drawing, ICE

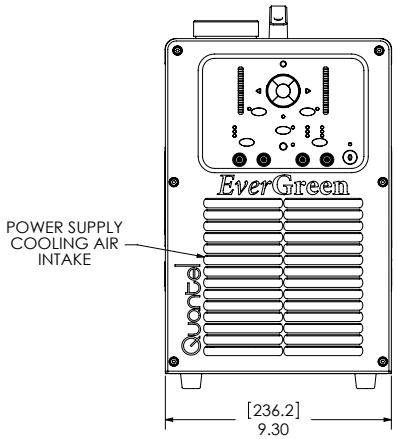


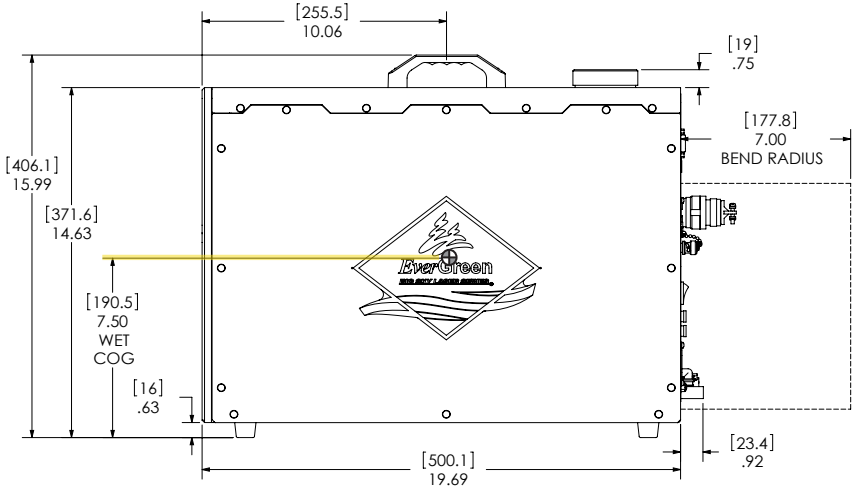


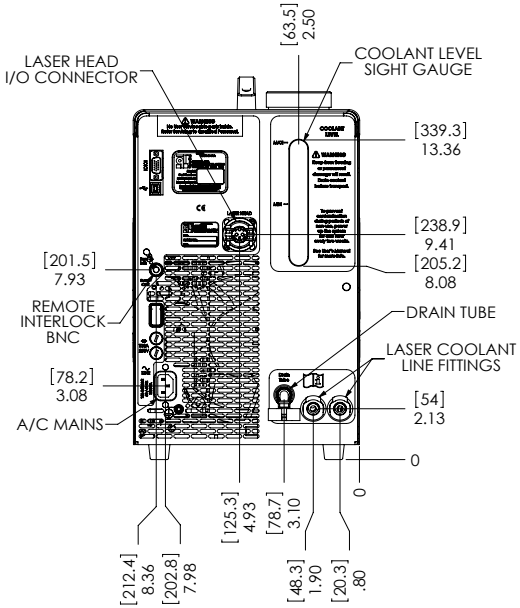
WEIGHT:

Without coolant: 35 lb
15.9 kg

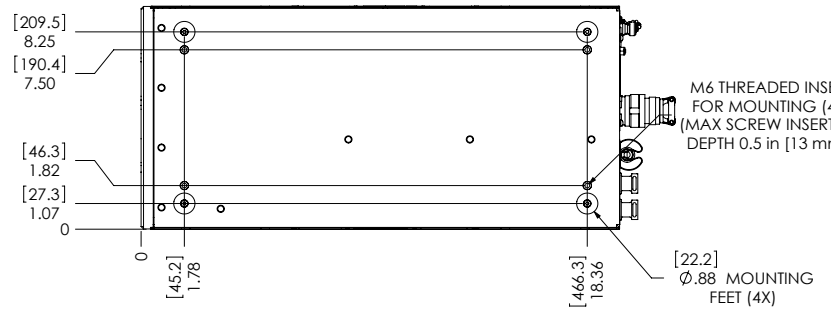
With coolant: 40 lb
18.1 kg



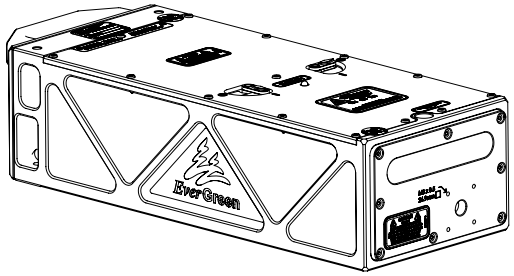




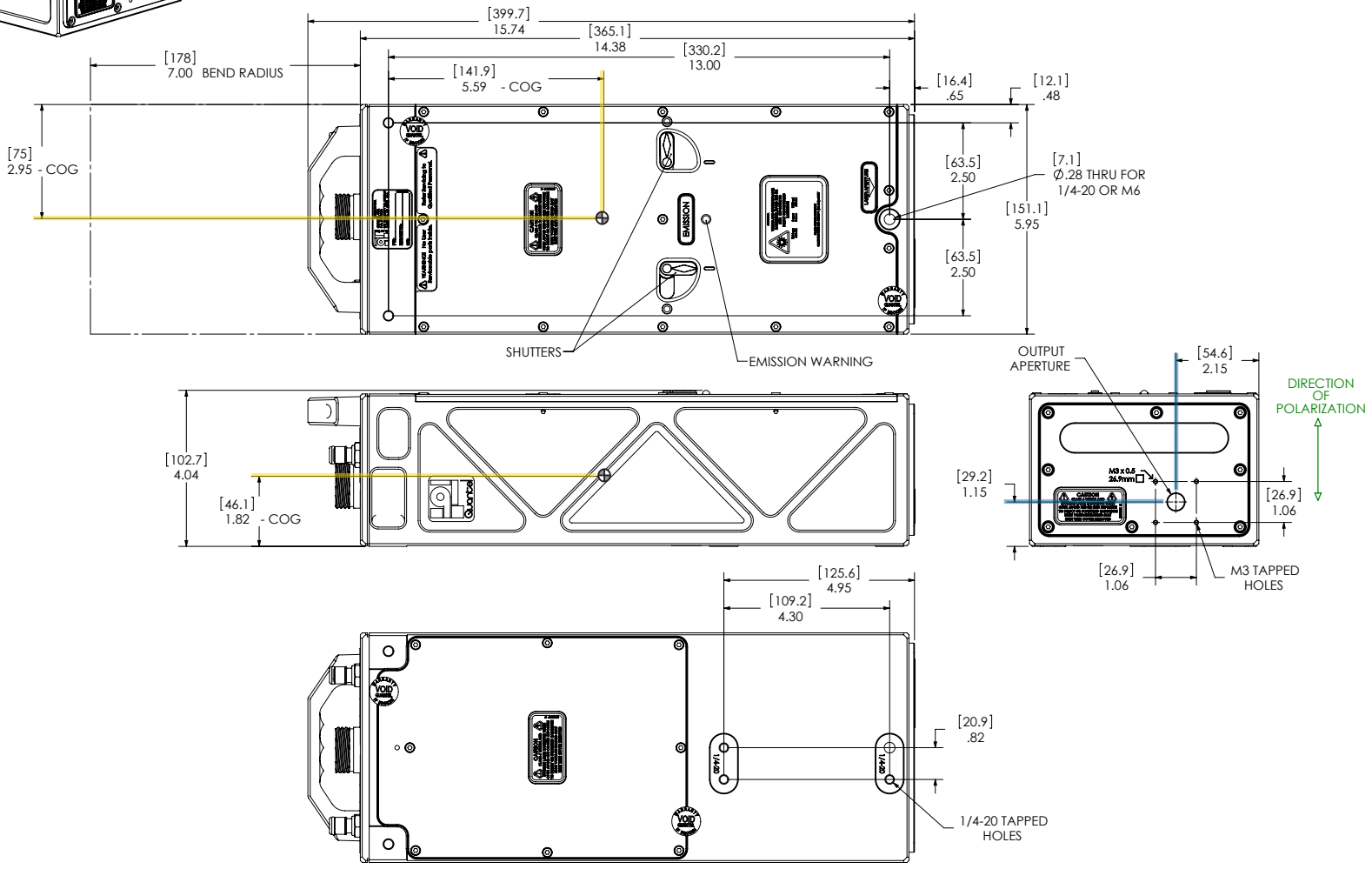
LASER CONTROL PANEL



6.0 Dimensioned Drawing, Laser Head



WEIGHT:
15.5 lb
7.0 kg



MASS: 15.5 lb [7.0 kg]

MAINTENANCE

The EverGreen system is designed to provide years of reliable performance given proper handling and maintenance.

- Visually inspect the EverGreen monthly for coolant leaks, abnormal noises, and damage to connectors and coolant ports.
- Quantel requires that you power ON the system every two weeks for one hour to circulate the coolant through the system. This will prevent the growth of biological contaminants in the coolant system and maintain coolant properties.
- If the system is to remain unused or stored for periods of time longer than six months, it is highly recommended that you completely drain the coolant from the system.

1.0 Replacing the De-Ionizing (DI) Filter Cartridge

CAUTION: Before proceeding, switch the Key Switch to the OFF position. Switch OFF the AC Mains Power and unplug the AC power cord.

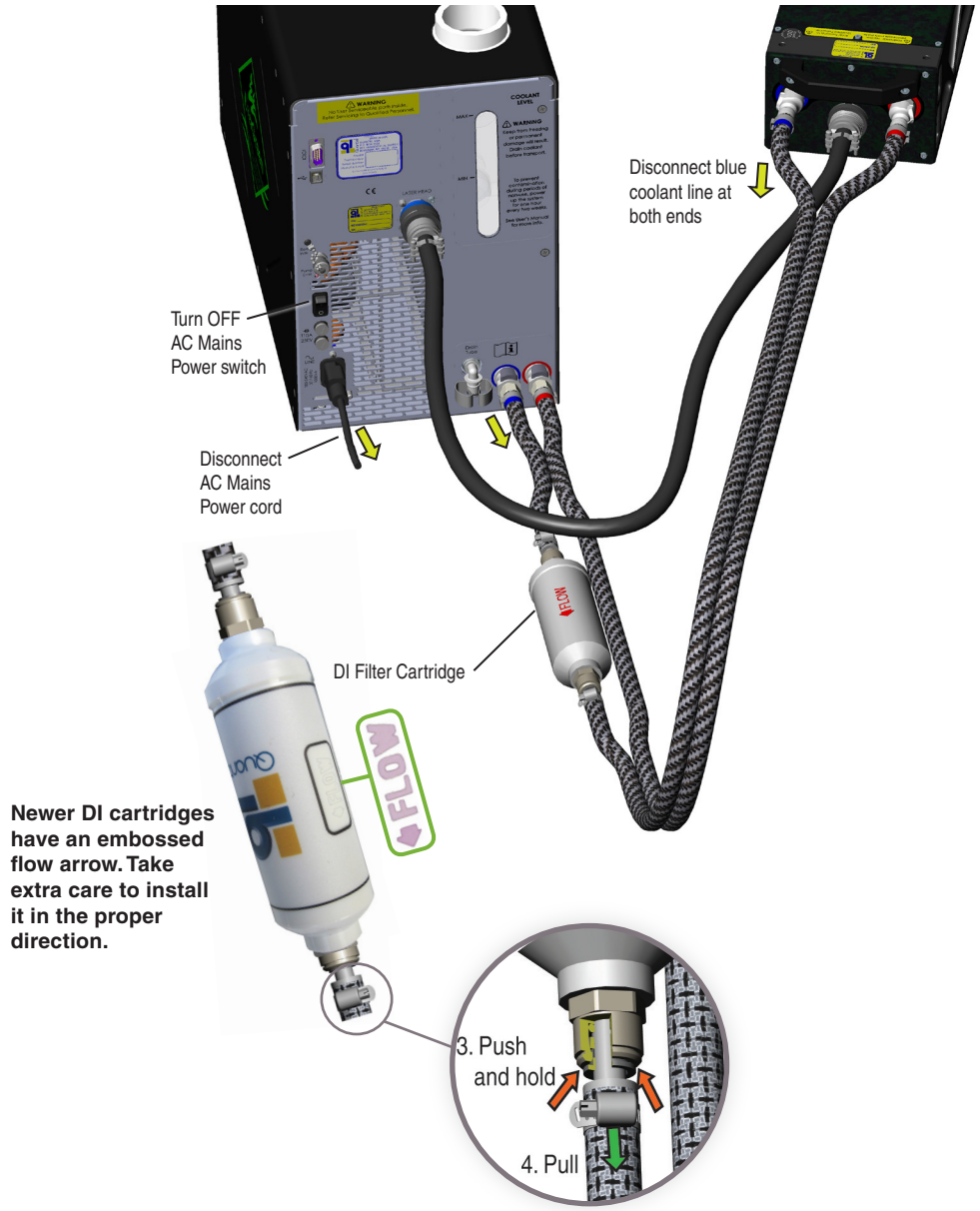
The DI Filter Cartridge must be replaced every six months. Use the following procedure to change the cartridge:

1. Disconnect the blue coolant tube from the back of the ICE and the Laser Head. Drain the coolant from the blue tube into an appropriate container.
2. Locate the DI Filter Cartridge. Note the flow arrow direction before removing.
3. Press the gray collet against the tan body fitting of the DI cartridge in the direction shown with orange arrows. Firmly hold the collet in this position while pulling on the coolant tube in the direction shown with the green arrow to remove the filter.

CAUTION: Failure to follow this process causes the collet teeth to damage the surface of the O-ring of the internal coolant tube fitting.

4. Orient the new cartridge flow arrow in the correct direction (away from the ICE). Then one at a time, push the tube stems into the cartridge fittings, until the tube stem presses fully against the internal stop.
5. Test the cartridge installation by attempting to pull the coolant tubes out of the cartridge. Ensure that the tube stem is fully inserted before continuing to the next step.
6. Reconnect the blue coolant tube to the back of the ICE and Laser Head.
7. Add distilled water to the reservoir to refill it.

Note:
The DI Cartridge Kit is part number 88800053 should you need to order a replacement.



Newer DI cartridges have an embossed flow arrow. Take extra care to install it in the proper direction.

2.0 Draining the Coolant

Use the following procedures to drain the coolant from the ICE, the Laser Head and the coolant tubes whenever:

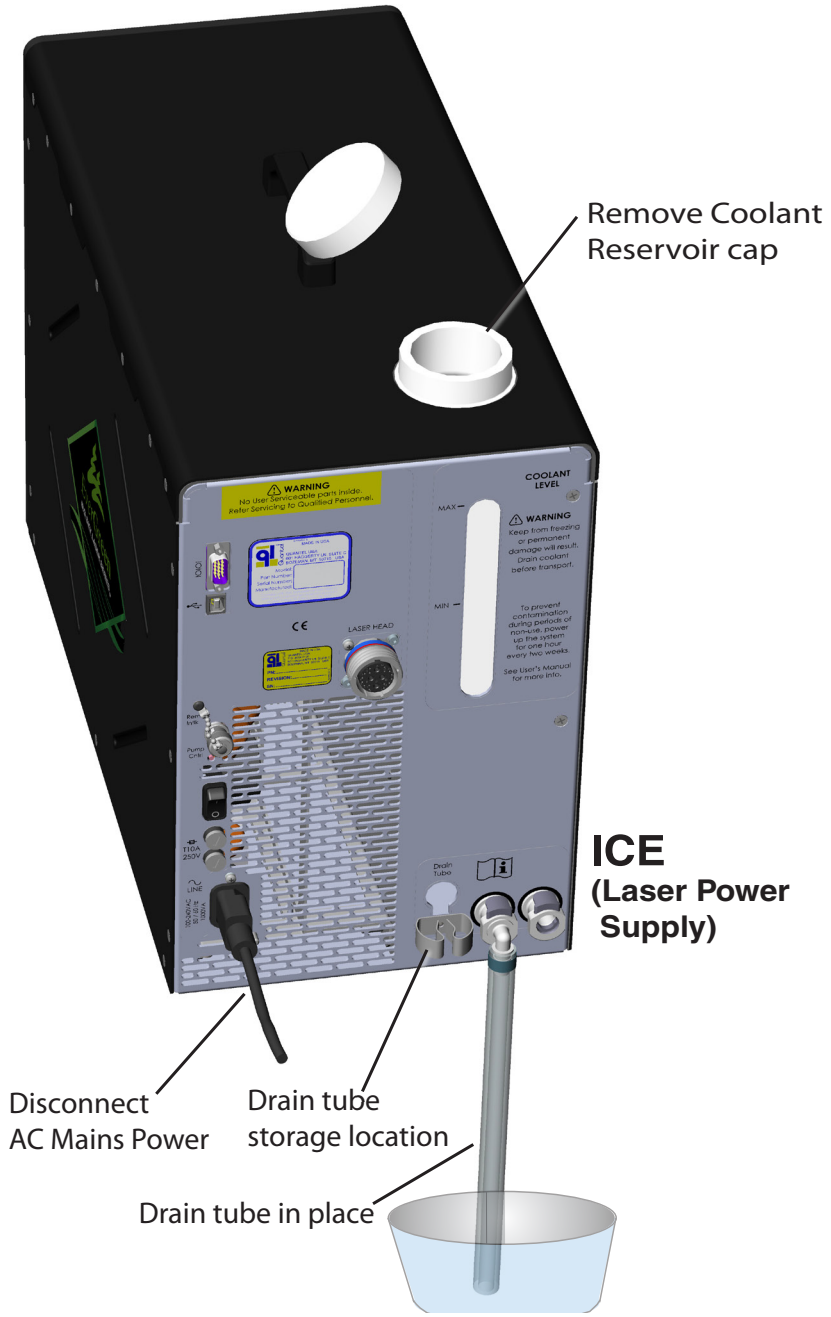
- it is to be shipped.
- it will remain unused or stored for periods of time longer than six months.

Draining the ICE

1. Have a container ready to hold the drained fluid.
2. Disconnect the AC power cord. This is an important step to prevent the pump from operating.

CAUTION: Do not use the pump when draining the system. Operating the pump without sufficient coolant will damage the pump.

3. Disconnect the red and blue coolant tubes from the back of the ICE and the Laser Head. Drain the coolant from the tubes into the container. See **Draining the Coolant Tubes on page 41**.
4. Remove the drain tube from its storage location inside the ICE rear panel.
5. Remove the protective cap from the drain tube.
6. Position the container below the fittings. Place the end of the drain tube into the container. Be ready as coolant will flow from the tube immediately when it is connected to the port.
7. Connect the drain tube to the blue port on the ICE rear panel.
8. Remove the cap from the coolant reservoir.
9. Allow coolant to drain by gravity flow only, until coolant stops flowing from the tube.
10. Disconnect the drain tube and connect it to the red port on the ICE.
11. Drain coolant from the red return side of the coolant system using gravity flow only. Do NOT blow into the reservoir.
12. Disconnect the drain tube.
13. Reinstall the protective cap on the drain tube to prevent damage to the O-ring during storage.
14. Return the drain tube to its storage location.



Draining the Laser Head

1. Lift the Laser Head and tip it to drain the cooling fluid from the interior cavities into a container. Rotate the Laser Head as it is tipped to ensure complete drainage.
2. For thorough draining, low-pressure dry Nitrogen may be blown through the Laser Head.

Draining the Coolant Tubes

1. Have a container ready to hold the drained fluid. Have a second person available to assist with this procedure.
2. Remove the drain tube from its storage location on the ICE.
3. Insert the drain tube into the female connector on the blue coolant tube.
4. Place the free end of the drain tube in the container. Have the second person hold this end in place, or use tape to secure it.
5. Depress the spring-loaded fitting on the male end of the blue coolant tube to allow the fluid to drain. With this fitting end depressed, raise this end of the tube, sliding along the tube to fully drain the coolant tube.
6. Repeat this process to drain the red coolant tube.

3.0 Flashlamp

Contact Quantel or an authorized distributor for instructions on returning the Laser Head for flashlamp replacement.

TROUBLESHOOTING

The ICE is designed to control the laser and warn the user of problems that may occur. The microprocessor-based system monitors the laser system and automatically shuts down if a fault occurs. Software limits have been factory selected to protect the laser system against damage.

www.quantel-laser.com

Contact Us

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service@quantel.fr

QUANTEL USA (North America)
601 Haggerty Lane
Bozeman, MT 59715 – USA
Service toll free: +1-800-914-8216
Fax: +1-406-522-2007
CustomerService@quantelusa.com

1.0 Interlocks

There are hardware and software controlled interlocks, which if activated will not allow the laser to operate until the condition is corrected. If any of the interlocks are not satisfied, the fault light will be illuminated.

Remote Interlock: Located on the back panel of the ICE. The contacts on this connector must be shorted to close the interlock. Check that the shorting connector is in place or that the user interlock cabling is properly shorting these contacts.

Flow Interlock: This interlock ensures that coolant is flowing through the Laser Head. If a coolant interlock fault occurs, verify the coolant flow is proper by checking for coolant turbulence in the reservoir. Also check for pinched cooling tubes or other flow obstructions. A pump motor failure will be evident by touching the ICE near the bottom and noting the lack of vibration. Press the Pump Ctrl button on the ICE back panel to confirm and note whether or not the pump starts. This will confirm that the pump is not operating.

Temperature Interlock: This interlock ensures that the coolant temperature does not exceed an acceptable level. The sensor is located on the heat exchanger inside the ICE. This switch will open if coolant temperature exceeds 65.5°C (150°F).

External I/O Cable Interlock: The cable between the ICE and Laser Head is interlocked to ensure that high voltage cannot be enabled if the cable is not properly or completely installed.

2.0 Diagnosing Problems

Problem	Possible Cause	Solution/Suggestion
No System Power	No power connected	Check the simple things first – make sure the power cord is plugged into the outlet and making connection to the back of the ICE. Verify that the circuit breaker is allowing power to the outlet.
	Mains Power switch is OFF	Verify that the Mains Power is ON by pressing the switch on the back of the ICE toward the ON "|" position. Use 5 X 20 mm, 10A, 250V T-LAG fuses, Bussmann S505-10-R or equivalent.
	Key Switch is OFF	Verfiy that the Key Switch is ON by turning the key on the front of the ICE to the ON "|" position.
	System fuses	Check both fuses located on the back of the ICE. If necessary, replace the fuses.
No Laser Output	System Fault condition	If the Fault indicator is continuously illuminated a fault exists. A fault locks out use of the laser system until it is corrected. If the fault light is blinking a warning state exists. A warning indicates a system state that should be corrected, but the laser system will continue to function. "Enter STATUS using a computer connected to your laser system RS-232 port to determine the system status. Refer to **Status Word Definition** in the Software section of this manual to determine the issue.
	Cables not connected	With the main power OFF and the system unplugged, check all electrical connections between the Laser Head and the ICE. Make sure all connections are secured. If any of the cables are not installed properly, the system will not function.
	Shutter is Closed	The shutters are manually controlled and are located on the Laser Head. Check that the shutters are open.
	Energy Level setting	Refer to the Technical Specifications. Make sure the input energy is not set below the lasing threshold. Correct if necessary.
	Q-Switch not Enabled	Verify that the Q-Switches are enabled and properly functioning. Enter STATUS using a computer connected to your laser system RS-232 port to determine the system status.

Problem	Possible Cause	Solution/Suggestion
Energy is Low	Flashlamp degradation	These changes are normal over time and after shot accumulation (>100 million). The pump energy can be increased to compensate for lamp degradation. However, excessive input energy (voltage) to the lamp must be avoided since pre-lasing and optics damage may result. If significant lamp degradation is suspected, contact Quantel customer service to correct this issue.
	Coolant degradation	Operating the laser system with contaminated coolant can adversely effect energy. Inspect the coolant for clarity. The coolant should be very clear and free from contaminants. There should be no large particulate or organic contaminants in the coolant. Black particulate is a sign of pump wear. Green or brown color is a sign of organic substances growing in the cooling system. If contaminated coolant is suspected, the cooling system must be purged and properly cleaned prior to operating the laser. Please consult Quantel for instructions on how to clean your cooling system if you suspect organically contaminated coolant.
	Resonator misaligned	If beam quality has degraded, it may suggest that the resonator needs realignment. Contact Quantel for more details.
Lamp Does Not Flash	Simmer problem: Lamp will not simmer or is difficult to simmer.	Check to see that the Laser Energy Level flickers indicating the lamp is simmering when Laser Emission is enabled. If it is not, either ionized, or contaminated coolant, or flashlamp degradation may be the cause. Coolant should have a resistivity of 100kΩ-cm to 5MΩ-cm for proper operation. If coolant resistivity is less than 100kΩ-cm, replace the coolant. If the lamp still does not simmer contact Quantel customer service to correct this issue.
	External Lamp Trigger setting	External trigger is either not connected or is not adequate to drive the 50Ω input. Set the Trigger input for internal control (1, 2, 5, 10 or 20 Hz) and check to see if the flashlamp will flash. If the lamps flash when set to internal trigger, but not when set to external trigger, check to see if 50Ω Trigger Termination is selected. If it is, deselect 50Ω Trigger Termination and see if that resolves the problem.

WARRANTY INFORMATION

We at Quantel are proud of our specialty laser systems. Our manufacturing and quality control processes emphasize consistency, stability, ruggedness, reliability and performance. We strive to make reliable laser systems and to provide superior customer support.

Should there be a problem with operation or failure of any kind, please have your **serial numbers** ready and then call:

Quantel Service Center France
33-1-6929-1610 (International)

Quantel toll-free customer service hotline
1-800-914-8216 (inside the U.S. & Canada)

We will do our best to get your system fully operational as quickly as possible.

Feedback

We welcome your feedback regarding your use, the performance of the laser system and these manuals. Product improvements and refinements come about from your input as we strive to continually improve our product reliability, performance and customer satisfaction.

International customers, please call our service center in France at 33-1-6929-1610. Within the United States and Canada, call our toll free number: 1-800-914-8216.

You can also visit us online at:
www.quantel-laser.com.

Warranty

Quantel warrants the EverGreen Laser it manufactures and produces to be free from defects in materials and workmanship for twenty-four (24) months following the date of shipment provided that all operating instructions are properly followed. Flashlamps are warranted for 100 million shots or twenty-four (24) months, whichever comes first. Consumables (filters, distilled water) are excluded. This warranty is limited to the original purchaser of the laser and is not transferable.

(a) During the 24-month warranty period, we will repair or replace, at our option, any defective products or parts at no additional charge, provided that the product is returned, shipping prepaid, to the Quantel facility. All replaced parts and products become the property of Quantel.

(b) This warranty is the only warranty made by Quantel with respect to the goods delivered hereunder and no representative or person is authorized to bind Quantel for any obligations or liabilities beyond this warranty in connection with the sale of Quantel's goods.

(c) Remedies are available only if Quantel is notified in writing by the Buyer promptly upon discovery of any defects and in any event within the warranty period for the individual goods, whereby Seller's examination of such goods discloses to Quantel's satisfaction that such defects actually exist and the goods have not been (i) repaired, worked on or altered by persons not authorized by Quantel so as, in Quantel's sole judgment to effect the stability, reliability or proper operation of such goods; (ii) subject to misuse, negligence, abuse or accident; or (iii) connected, installed, used or adjusted otherwise than in accordance with the instructions furnished by Quantel or normal usage.

(d) All goods that the Buyer considers defective shall be returned, freight and insurance prepaid, to Quantel's office, as designated on the face hereof. Quantel shall not be liable for additional transportation costs arising from the goods having to be shipped to a location remote from the original one. Buyer shall obtain return authorization from Quantel before returning any goods. Quantel shall not bear responsibility for damage or loss to goods not properly prepared for transportation.

(e) If it is found Quantel's goods have been returned without cause and are still serviceable, Buyer will be notified and the goods returned at Buyer's expense, freight collect. In addition, a charge for testing and examination and/or for reimbursement of shipment costs paid by Quantel under subsection (d) above, may, at Quantel's sole discretion, be made on goods so returned which such charges shall also be payable by the Buyer.

(f) The foregoing warranty is exclusive and in lieu of all other warranties whether written, oral or implied, including any warranty of merchantability or fitness for a particular purpose, and shall be the Buyer's sole remedy and Quantel's sole liability on contract or warrant or otherwise for the product.

(g) This warranty shall not apply in the event that the original device identification markings have been removed, defaced or altered, or if any parts have been substituted or modified without the express consent of Quantel.

(h) This warranty will not apply if the customer's general account at Quantel is delinquent in whole or in part.

Quantel's liability under, for breach of, or arising out of this agreement and/or sale will be limited to repair or replacement of any defective goods or a refund of the purchase price of the goods, at Quantel's sole discretion. In no event will Quantel be liable for costs of procurement of substituted goods by buyer, nor will Quantel be liable for any special, consequential, incidental or other damages (including without limitation loss of profit) whether or not Quantel has been advised of the possibility of such loss, however caused, whether for breach or repudiation of contract, breach of warranty, negligence or otherwise.

CERTIFICATES

CE Certificate of Conformance

By affixing the CE marking, Quantel assures that the EverGreen meets all the essential requirements of all applicable European Union (EU) directives required for market placement in the European Economic Area (EEA).

Declaration of Conformity

Conforming to standards according to ISO/IEC Guide 22 and EN 45014. See the Certificate of Conformance for Electromagnetic Compatibility (EMC), electrical and laser safety standards, and requirements applicable to the CE certification mark of the EverGreen.

CE

BACL
Bay Area Compliance Labs Corp.

Bay Area Compliance Laboratories Corp.
1274 Anvilwood Ave., Sunnyvale, CA 94089 (USA)
Phone: (408) 732-9162, Fax: (408) 732-9164
www.backorp.com

ATTESTATION OF CONFORMITY

Date of Issue: 2010-09-15 Attestation Number:R1007201

Bay Area Compliance Laboratories Corp. (BACL) hereby declares that testing has been completed and reports have been generated for;

Product: **Laser System**

Model: **EverGreen PIV**

Applicant: Quantel USA
601 Haggerty Lane, Suite C
Bozeman, Montana 59715, USA

That this product has been assessed and found to comply against the following Standards;

EN 55011:2007 + A1:2007, EN 61326-1:2006, & EN 61010-1:2001

The aforementioned standard(s) is/are one of several standards that are required under the EMC & LVD Directive(s);
Directive 2004/108/EC Electromagnetic Compatibility (as amended)
Directive 2006/95/EC Low Voltage
Additional standard(s) may be required to fulfill the EMC & LVD Directive(s).
Application of the CE Mark is permitted only after all applicable requirements are met in accordance with the European Union Rules, including the manufacturer's issuance of a "Declaration of Conformity."
Additional guidelines can be found at:
LVD Directive website: http://ec.europa.eu/enterprise/electr_equipment/lv/index.htm,
EMC Directive website: http://ec.europa.eu/enterprise/electr_equipment/emc/index.htm
This attestation is specific to the standard(s) stated above and compliance with additional standards and/or directives may be required.

Attestation by: John Chan
Certification Manager

Signature

2010-09-15
Date

CI012-F

Quantel USA
601 Haggerty Lane, Suite C
Bozeman, MT 59715 (USA)
Phone: 406-586-0131
www.quantel-laser.com

Certificate of Compliance

Date of Issue: 2015-03-20

Quantel USA hereby declares that testing has been completed and reports generated for;

Product: Class 4 Laser System

Model: EverGreen 70/145/200

That this product has been assessed and found to comply against the following Standards:

IEC 60825-1: 2007-03 Safety of laser products, Equipment classification and requirements

Attestation by: Kim Bares
Director of Engineering (Quantel USA)

Signature

2015-03-20
Date

www.quantel-laser.com