



## Jewel Laser Operating Manual



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# CONTENTS

<b>1. INTRODUCTION.....</b>	<b>4</b>
<b>2. SAFETY .....</b>	<b>5</b>
LASER SAFETY .....	6
ELECTRICAL SAFETY.....	7
<i>Safety Labels and Locations .....</i>	<i>8</i>
ENVIRONMENTAL CONDITIONS.....	10
<b>3. SYSTEM OVERVIEW .....</b>	<b>12</b>
JEWEL LASER BLOCK DIAGRAM.....	12
<i>Jewel Power Adapter .....</i>	<i>12</i>
JEWEL LASER DESCRIPTION .....	13
LASER FEATURES .....	13
<b>4. JEWEL LASER SETUP.....</b>	<b>15</b>
UNPACKING LASER .....	15
<i>System Inventory.....</i>	<i>15</i>
SYSTEM SETUP .....	16
COMMUNICATION - USB.....	16
<i>Driver Installation (Windows XP).....</i>	<i>16</i>
<i>Driver Installation (Windows 7).....</i>	<i>17</i>
<i>Driver Installation (Windows 8/10) .....</i>	<i>17</i>
<b>5. JEWEL LASER APPLICATION .....</b>	<b>19</b>
JEWEL LASER APPLICATION OVERVIEW .....	19
<i>Getting Started .....</i>	<i>19</i>
LASER OPERATION CONTROL.....	20
<b>6. LASER OPERATION.....</b>	<b>22</b>
MANUAL SHUTTER OPERATION .....	22
<i>Laser head connectors.....</i>	<i>23</i>
<i>Laser status connectors .....</i>	<i>24</i>
INITIAL POWER ON .....	24
POWER OFF.....	24
<b>7. DEVICE COMMANDS .....</b>	<b>25</b>
COMMAND TYPES .....	25
<b>8. MAINTENANCE.....</b>	<b>31</b>
SERVICE PROCEDURES.....	31
<b>9. TROUBLE-SHOOTING.....</b>	<b>32</b>
<i>No Laser Output .....</i>	<i>32</i>
<i>Energy is Low .....</i>	<i>32</i>
<b>10. SPECIFICATIONS .....</b>	<b>33</b>
<b>11. CABLES AND CONNECTIONS .....</b>	<b>35</b>
<b>12. MECHANICAL INTERFACE DRAWINGS .....</b>	<b>37</b>

<b>13. CUSTOMER SERVICE .....</b>	<b>41</b>
WARRANTY .....	41
FEEDBACK.....	41
<b>14. APPENDIX A - DICHROIC MODULE.....</b>	<b>42</b>
OVERVIEW .....	42
CONFIGURATIONS.....	42
SPECIFICATIONS.....	42
<b>15. APPENDIX B – CE/UKCA DECLARATION.....</b>	<b>43</b>

# 1. INTRODUCTION

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This manual contains the information necessary to operate and maintain the Quantum Composers Jewel Laser. It provides information for setup and installation, operation, service, preventive maintenance, and troubleshooting (fault isolation). Generally, each topic has its own section and no section assumes knowledge of information from other sections.

This laser is truly “turn-key” and has been shipped fully functional. Only minor adjustments are necessary after installation. The connections are sized, keyed or labeled to increase the simplicity of installation.

## **Technical Support**

For questions or comments about operating the Jewel Laser the Quantum Composers technical staff can be reached via one of the following methods:

- Phone - (406) 582-0227
- Fax - (406) 582-0237
- Internet - [www.quantumcomposers.com](http://www.quantumcomposers.com)

## **Warranty**

The Jewel Laser has a one-year limited warranty from the date of delivery. This warranty covers defects in materials and workmanship. Quantum Composers will repair or replace any defective unit. Contact the Quantum Composers Service Dept. for information on obtaining warranty service.

## **Package Contents**

The box you receive should contain the following:

- Jewel Laser
- Safety Key
- Shorting Jumper (Rmt Intlk)
- Power Supply, with AC Power Cord
- User's Manual and Control Software on Disk

Contact Quantum Composers (406) 582-0227 if any parts are missing.

## 2. SAFETY

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This product complies with safety standards EN61010-1:2010(3<sup>rd</sup> edition), EN60825-1:2007, and CDRH21 CFR 1040.10(d). Do not install substitute parts or perform any unauthorized modification to this product. Return the product to manufacturer for service or repair to ensure that all safety features are maintained.


Do not operate this product beyond its specifications.





**Caution labels, in accordance with CDRH and CE requirements, are prominently displayed on the Laser Optical Assembly and Laser Power Supply. The maximum ratings indicated on the system labels are in excess of the normal operating parameters. Please refer to the Data Summary Sheet for specific information pertaining to your system.**



**The laser produces laser radiation, which is hazardous to eyes and skin, can cause burning and fires and can vaporize substances. This chapter contains essential information and user guidance about these hazards.**

SYMBOL	DEFINITION OF SYMBOL
	<p><b>CAUTION:</b> Calls attention to a procedure, practice, or condition that could cause damage to the product, or cause bodily injury to the user. Refer to accompanying documentation.</p> <p><b>ATTENTION:</b> Ce symbole signale une procédure, une méthode ou une condition qui peut endommager le produit ou blesser l'utilisateur. Se référer à la documentation jointe.</p> <p><b>ACHTUNG!:</b> Beachten Sie Verfahren, Praktiken oder Zustände, die das Produkt beschädigen oder zu Verletzungen führen können. Lesen Sie die beigefugte Dokumentation.</p> <p><b>ATTENZIONE:</b> Porre estrema cautela alla procedura, uso o condizioni che potrebbero danneggiare il prodotto o l'utilizzatore. Far riferimento alla documentazione inviata insieme al prodotto.</p> <p><b>ADVERTENCIA:</b> Llama la atención sobre un procedimiento, práctica, o condición que podría causar daño al producto o puede herir al usuario. Consulte la documentación que acompaña.</p>

	<p><b>CAUTION:</b> Risk of Electric Shock.</p> <p><b>ATTENTION:</b> Risque d'électrocution.</p> <p><b>ACHTUNG!:</b> Gefahr durch Stromschlag.</p> <p><b>ATTENZIONE:</b> Rischio di shock elettrico.</p> <p><b>ADVERTENCIA:</b> Riesgo de choque eléctrico</p>
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	<p>CAUTION: Risk of exposure to hazardous laser radiation.</p> <p>ATTENTION: Risque d'exposition à un rayonnement laser dangereux.</p> <p>ACHTUNG!: Gefahr durch gefährliche Laserstrahlung.</p> <p>ATTENZIONE: Rischio di esposizione a pericolose radiazioni laser.</p> <p>ADVERTENCIA: Riesgo de exposición a la radiación peligrosa del láser.</p>
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## LASER SAFETY

### VISIBLE AND/OR INVISIBLE LASER RADIATION



**CAUTION: The Jewel Laser is a Class 4 OEM laser. Its output beam is, by definition, a safety and fire hazard. Precautions must be taken to prevent accidental exposure to both direct and reflected beams.**

#### Precautions for Safe Operation of Class 4 OEM Lasers:

- **DO NOT** remove the protective covers from the Laser Head. No user serviceable components are inside. Exposure to laser radiation when covers removed.
- Avoid looking directly at the laser output beam.
- Do not wear reflective jewelry while using the laser, as it might cause inadvertent hazardous reflections.
- Use protective eyewear at all times. Consult the ANSI, ACGIH, or OSHA standards listed at the end of this section for guidance on goggles and safety matters. For customers outside of the US please contact the appropriate national agency for regulations and standards related to personal protective equipment.
- Operate the laser at the lowest possible beam intensity, given the requirements of the intended application.
- Increase the beam diameter wherever possible to reduce beam intensity and thus reduce the hazard.
- Avoid blocking the laser beam with any part of the body.
- Use an IR detector or energy detector to verify that the laser beam is off, before working in front of the laser.
- Establish a controlled access area for laser operation. Limit access to those trained in the principles of laser safety.
- Maintain a high ambient light level in the laser operation area so the eye pupil remains constricted, thus reducing the possibility of hazardous exposure.
- Post prominent warning signs near the laser operation area.

- Provide enclosures for the beam path whenever possible.
- Set up an energy absorber to capture the laser beam, preventing unnecessary reflections or scattering.



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

- Follow the instructions within this manual carefully to ensure the safe operation of your laser. At all times during laser operation, maintenance, or servicing, avoid unnecessary exposure to laser or collateral radiation that exceeds the accessible emission limits listed in "Performance Standards for Laser Products," United States Code of Federal Regulations, 21 CFR 1040.10(d). This information is also available in EN60825-1:2007, Section 8.2, titled "Measurements of Laser Radiation for Determining Classification."
- Preventative Maintenance for Safety: Preventative maintenance is required to ensure the laser remains in compliance with Center for Devices and Radiological Health (CDRH) Regulations and European Norm (EN) requirements. This laser product complies with Title 21 of the United States Code of Federal Regulations, Chapter 1, Subchapter J, Parts 1040.10, as applicable, and with EN60825-1:2007, Part 1 for a Class 4 laser, as applicable. To maintain compliance, verify the operation of all features listed below, either annually or whenever the product has been subjected to adverse environmental conditions, which may have affected these features and functions.
  - Verify that removing the remote interlock connector prevents laser operation. This connector is located on the end cap of the laser.
  - Verify that the laser will operate only with the key switch in the ON position and the key can only be removed when the switch is in the OFF position.
  - Verify that a time delay exists between turning on the Key Switch and the start of laser firing. The time delay must be long enough to allow action to be taken to avoid exposure to laser radiation.
- Please follow all local jurisdictional safety requirements for your area.

## ELECTRICAL SAFETY



**CAUTION: Both the Laser Optics Assembly and Laser Power Supply contain electrical circuits operating at lethal voltage and current levels. Always unplug the system Mains connection and wait at least one (1) minute to allow capacitors to discharge before servicing any part of the laser system.**

Consult with the Quantum Composers if repair of the laser electronics is required. Only those trained in high voltage, high current electronics, and who understand the laser circuitry, should be

allowed to service and repair the laser electronics. If any such action is required, it is recommended that you contact the Quantum Composers for details.

## **Sources of Laser Safety Standards**

### **"Safe Use of Lasers" (Z136.1)**

American National Standards Institute (ANSI)  
11th West 42nd Street  
New York, NY 10036 USA  
Phone: (212) 642-4900

### **"A Guide for Control of Laser Hazards"**

American Conference of Governmental and Industrial Hygienists (ACGIH)  
6500 Glenway Avenue, Bldg. D-7  
Cincinnati, OH 45211 USA  
Phone: (513) 661-7881

### **Occupational Safety and Health Administration**

U.S. Department of Labor  
200 Constitution Avenue N.W.  
Washington, DC 20210 USA  
Phone: (202) 523-8148

### **"Safety of Laser Products" (EN60825-1:1994)**

Global Engineering Documents  
15 Iverness Way East  
Englewood, CO 80112-5704 USA  
Phone: (303) 792-2181

## **SAFETY LABELS AND LOCATIONS**

Figure 1 and Figure 2 show the safety, model number, serial number and origination labels, and their locations on the Jewel Laser. 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 the manufacturer for a replacement.



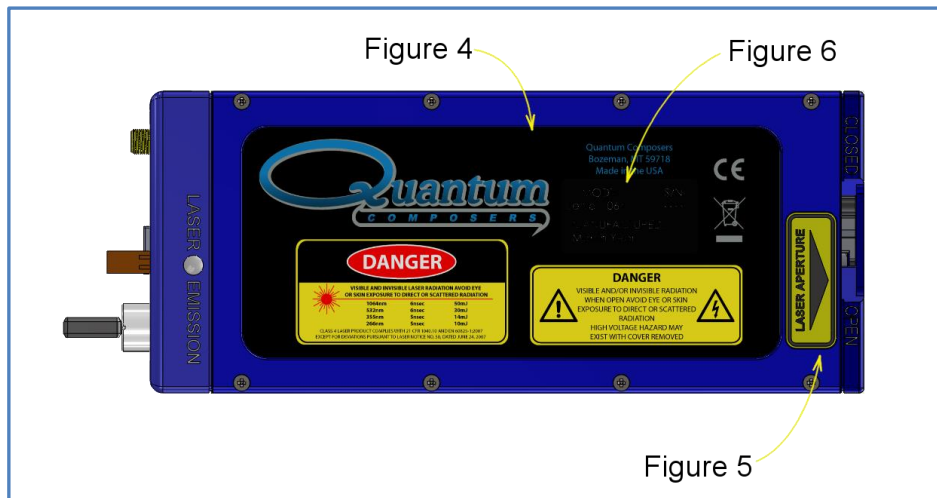


Figure 1: Safety Labels - Jewel 1064nm ONLY

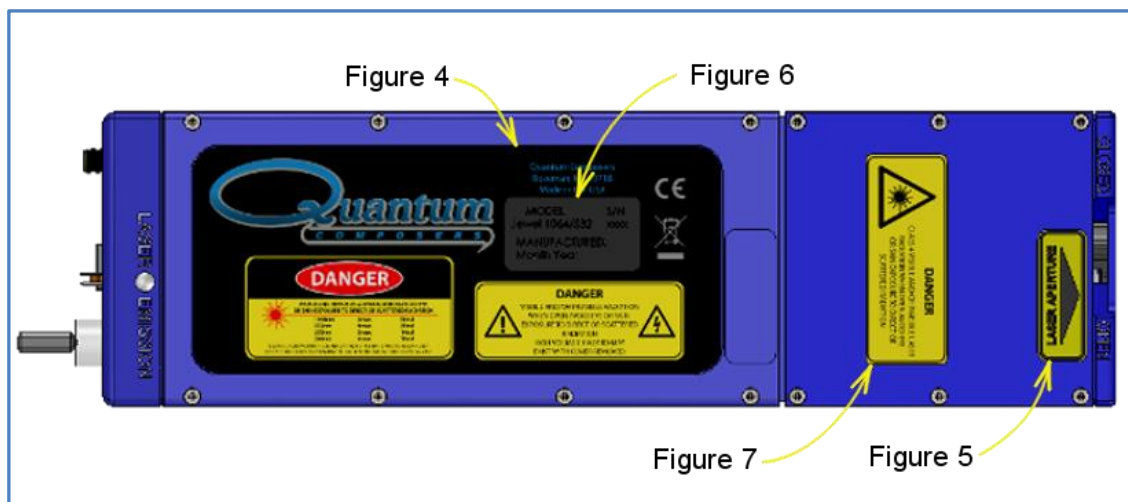


Figure 2: Safety Labels - Jewel 1064, 532, 355, 266nm

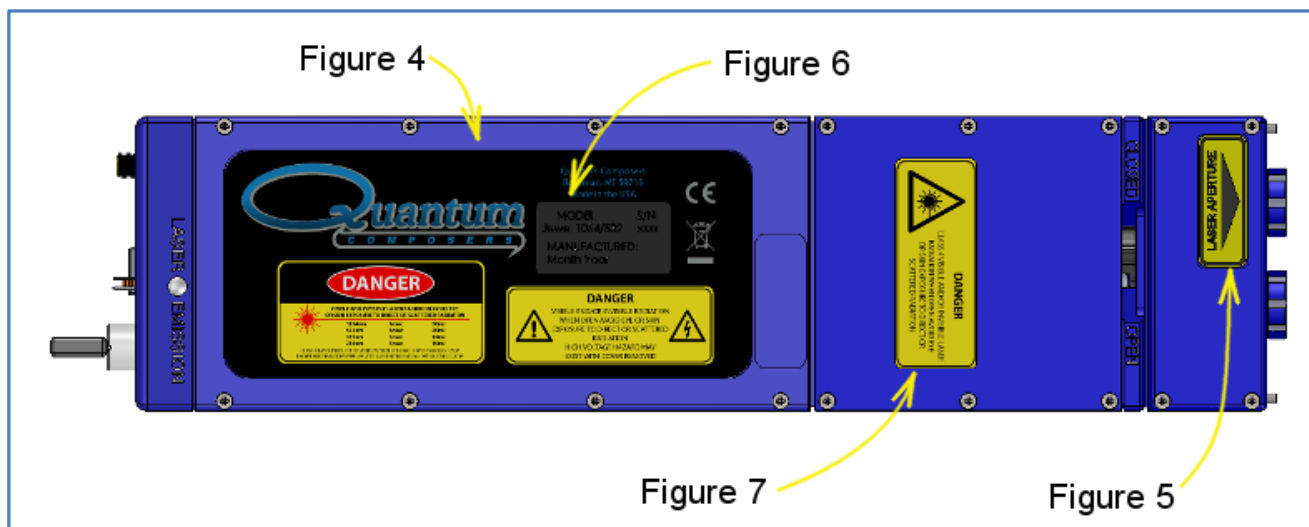


Figure 3 Safety Labels - Jewel 532nm OR 355nm OR 266nm ONLY

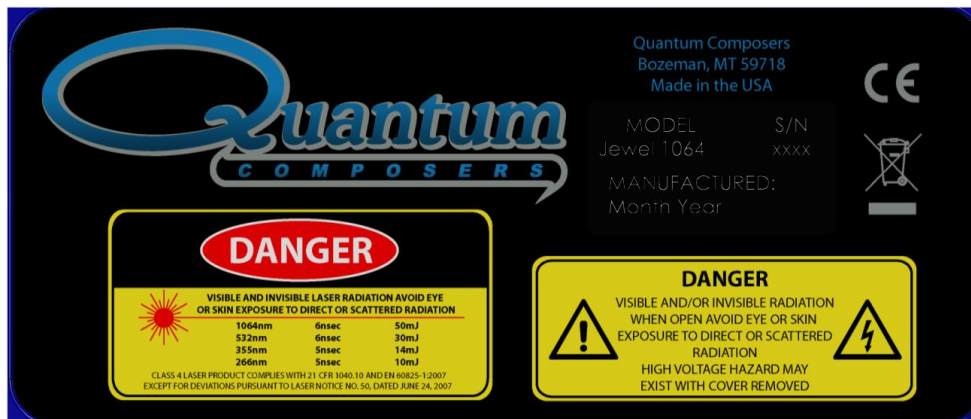


Figure 4 Energy & Cover Label



Figure 5 Laser Aperture Label

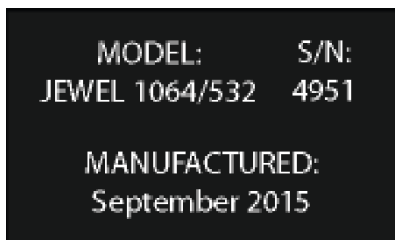


Figure 6 Model, Serial Number & Date of Mfg

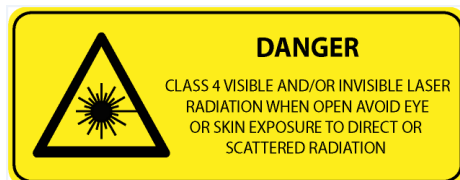


Figure 7 Cover Removed

## ENVIRONMENTAL CONDITIONS

- Indoor use only
- Ordinary Protection: This product is NOT protected against the harmful ingress of moisture.
- Class III Equipment (external 36VDC SELV power supply)
- Pollution Degree 2
- Installation (overvoltage) Category II for transient over-voltages
- Maximum Relative Humidity: <80% RH, non-condensing
- Operating temperature range of 15° C to 30° C

- Storage and transportation temperature of -10° C to 50° C
- Maximum altitude: 3000 m (9843 ft.)
- This equipment is suitable for continuous operation.

Technical specifications including electrical ratings and weight are included within the manual. See the Table of Contents to locate the specifications and other product information

### 3. SYSTEM OVERVIEW

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#### JEWEL LASER BLOCK DIAGRAM

Figure 8 shows the laser system block diagram, which consists of the Jewel Laser, a personal computer, and a power supply.

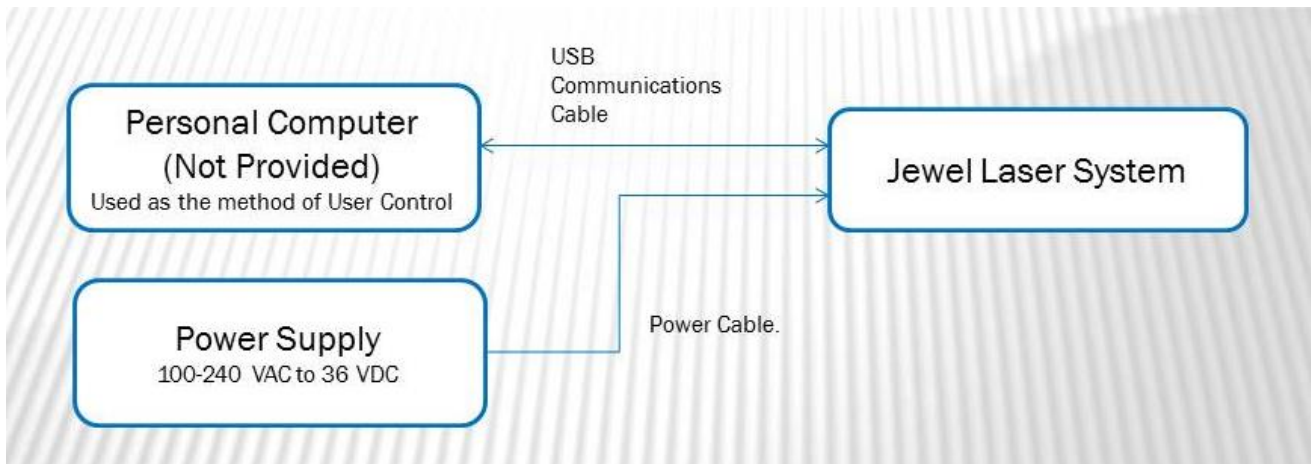


Figure 8 - System Block Diagram

#### JEWEL POWER ADAPTER

The power adapter for the Jewel Laser is a typical laptop style power adapter. It accepts inputs of 100-240 VAC and 50-60 Hz, and outputs 36 VDC, 1.6A (See Figure 9). In the event of power supply failure, contact your local distributor, or replace with an identical/similar power supply that is approved for the country of use and is properly rated per the specifications detailed in Section 10 of this manual.



Figure 9 Power Supply

## JEWEL LASER DESCRIPTION

The Jewel is a conductively cooled 1064/532/355/266nm diode pump laser with output energy pulses up to 15mJ and rep rates up to 50Hz. It is a self-contained laser head, including the diode and Q-switch drivers.

## LASER FEATURES

The laser features (Figure 10 and Figure 11) are indicated below.

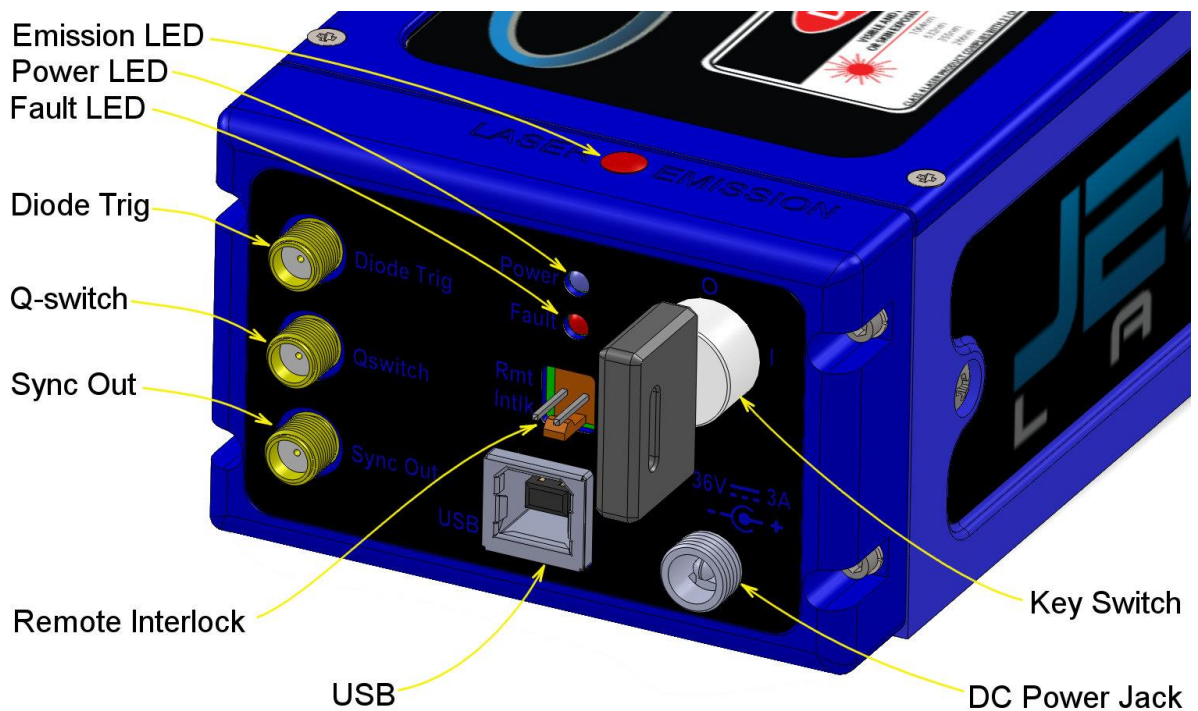


Figure 10 Jewel Connection Panel

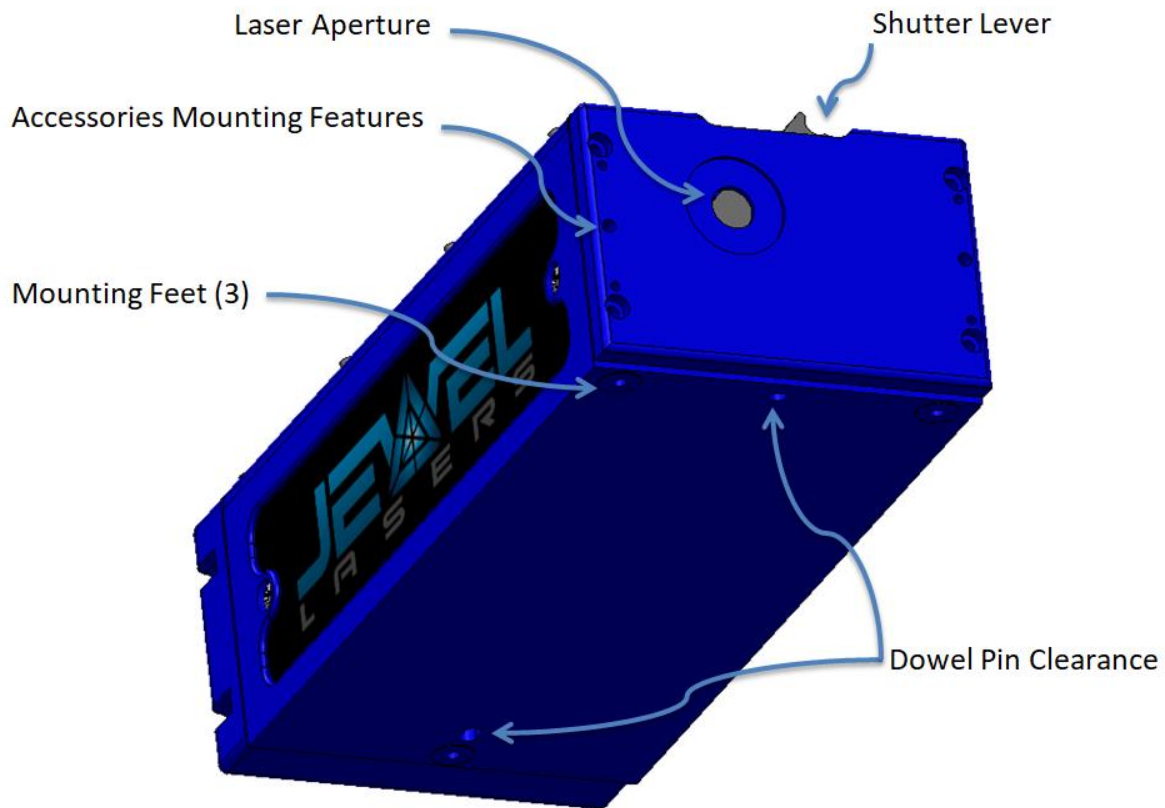


Figure 11 - Laser Features

1. The laser resonator is a highly efficient diode pumped laser (20Hz less than 5W) with a fundamental output wavelength of 1064nm. The monolithic structure is machined from a single block of stress-relieved aircraft grade aluminum. Resonator mirrors are hard-mounted to the machined resonator bench resulting in an extremely stiff, rugged resonator which is much less sensitive to misalignment.
2. Systems with output harmonics, 532/355/266nm, have an attached nonlinear optics module (NLO). The 1064nm output of the laser enters the integral nonlinear module. Harmonic generation is performed using non-linear crystal(s). The crystal temperature is tightly regulated by mounting the crystals inside a temperature controlled oven assembly. The output is collinear, with all wavelengths exiting the same aperture.
3. An optional dichroic module can be attached to “scrape” residual wavelengths from the output beams allowing single wavelength output.

## 4. JEWEL LASER SETUP

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### UNPACKING LASER

The laser has been carefully packaged for shipment. If the container arrives damaged in any way, please contact the shipper's agent to be present for the unpacking. Inspect each unit as it is unpacked, looking for dents, scratches, or other damage. If damage is evident, immediately file a claim against the carrier and notify the manufacturer.

It is recommended that the shipping container be kept for possible shipping should the unit require repair or maintenance services. If a damage claim has been filed the container will be needed to prove shipping damage.

The laser is a turnkey system, designed so that a field service engineer is not required to get the system up and operating properly. The system has undergone extensive testing to verify its conformance to the specifications, prior to delivery.

Before operating the laser, however, it is important to fully understand its main features and controls.



**CAUTION: Do not power up the system before thoroughly reading the system description. Use of the controls or adjustments, or performance of procedures other than those specified in this user's manual may result in hazardous radiation exposure, laser system damage or result in voiding the warranty. Please do not connect the main power until you verify the power switch is in the OFF position.**

### SYSTEM INVENTORY

The Jewel Laser consists of the following items. Verify that all listed items are present in the shipping container. If there are any shortages or discrepancies, contact Quantum Composers immediately.

- Jewel Laser
- Safety Key
- Shorting Jumper (External Intlk / Rmt Intlk)
- Power Supply with Power Cord
- User's Manual and Control Software on Disk
- Acceptance Test Results



## SYSTEM SETUP



**CAUTION:** When utilizing the Remote Interlock capability, use an isolated contact closure such as a relay to avoid generating undesirable ground loops.



**CAUTION:** Ensure that the system is connected to the proper Mains voltage. The voltage rating is marked on the Laser Power Supply. Operating the system at the incorrect voltage may result in damage to the unit.



**CAUTION:** Ensure that the Mains power outlet is properly grounded. Poor ground quality could result in exposure to electrical shock.

- Set up laser beam line, with appropriate optics and/or beam dump(s).
- Set up remote interlock, as needed.
- Mount Jewel laser to an appropriate, heat sinking surface.
  - Apply thermal material between the unit's bottom, mid-section and the mounting surface of the heat sink.
    - DO NOT apply thermal material to mounting feet or alignment pins.
    - Note: The Jewel will operate without a heat sink, but its duty cycle will be greatly reduced.
  - The heat sink must dissipate 4 watts, at a maximum of 35° C, on the bottom surface of the laser head (See Interface Drawings).
- Attach a USB cable from the port of the computer to the port on the Laser Endcap.
- Attach Power Supply DC cord to the Jewel laser head.
- Attach Power Supply AC cord to a proper Mains outlet.

## COMMUNICATION - USB

The Jewel laser provides a standard USB connection for remote communications. When the Jewel is connected to a remote computer via the USB connection, the computer will recognize the unit as a "QC-LASER". Drivers will need to be installed for the remote computer to interface to the Jewel laser. Drivers are included on the provided CD. Once the drivers have been installed, the Jewel laser will show up in the Device Manager as a USB to Serial Port Adapter. The Jewel laser can then be communicated with by either the included Jewel Laser application, or by using any generic communication terminal program. The unit is baud rate independent, so any speed can be selected. Typically a rate of 115,200bps can be used.

## DRIVER INSTALLATION (WINDOWS XP)

1. Plug the Jewel into the computer using a USB cable. Make sure the unit is powered on.
2. The computer will display a message indicating it has found new hardware: "QC-LASER".



3. The new hardware wizard will launch. Check the “Install from a list or specific location” option and click next.
4. Select “Search for the best driver in these locations” and check the option to “Include this location in the search”. Click the browse button and locate the folder on the CD where the Jewel drivers are located. Click next.
5. A message window will launch asking if you want to continue installing this driver. Select the “Continue Anyway” button.
6. It should now indicate that it is installing a driver for a “QC-LASER USB Communications Port”.
7. Once the process is finished, a message will indicate that the drivers have been successfully installed.
8. You can now communicate with the Jewel using either the included Jewel application or by using any generic communication terminal program. You can view the Com Port number assigned to the Jewel in your computers device manager under Ports.

## **DRIVER INSTALLATION (WINDOWS 7)**

1. Plug the Jewel into the computer using a USB cable. Make sure the unit is powered on.
2. A message will pop up on the computer indicating it has found new hardware and is installing device driver software.
3. A message will indicate that the device drivers have not been successfully installed. The Action Center may then launch with a list of options. Close the Action Center and do not launch any of the actions.
4. Go to your computers Device Manager. This can be done by one of two ways. a) Right click on the desktop “Computer” icon and select properties. Select Device Manager on the left toolbar. b) Navigate to Control Panel and then Device Manager.
5. In Device Manager you should see a device under the Other Devices called the QC-LASER. There will be a yellow exclamation point next to it.
6. Right click on the QC-LASER and select update driver software.
7. Select “Browse My Computer” for driver software and browse to the location of the USB drivers for the Jewel. The location is typically found on the software CD. It will contain a file called “Jewelcdc.inf”. Select the folder in which the file resides, not the file itself. Click next.
8. Windows will then indicate a warning window that the drivers are not verified. Select “Install this driver software anyway”.
9. A message will then indicate that the drivers have been successfully updated and a QC-LASER USB Communication Port is now available.
10. You can now communicate with the Jewel using either the included Jewel Laser application or by using any generic communication terminal program. You can view the Com Port number assigned to the Jewel in your computers device manager under Ports.

## **DRIVER INSTALLATION (WINDOWS 8/10)**

When connecting the Jewel laser to a computer running Windows version 8 or 10, the operating system may already have a default driver for the Jewel laser. The default driver will be a generic

USB to serial port driver. If this does happen, then there are no additional drivers required. If the operating system does not install a default driver, then refer to the steps for installing a driver in Windows 7.

## 5. JEWEL LASER APPLICATION

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### JEWEL LASER APPLICATION OVERVIEW

The Jewel can easily be interfaced by means of the included Jewel application. On standard models, a USB cable and a port with USB 1.1 capabilities or greater ( 2.0 or greater recommended) are required to communicate with the unit. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

### GETTING STARTED

- Attach a USB cable from the port of the computer to the port on the Laser Endcap.
- Power up the Jewel laser head.
- Start the Jewel software.
- The Jewel Laser application startup screen will be displayed as shown in Figure 12.
  - This application has been designed as a graphical user interface for ease of use. It includes a Command Terminal section that can be used to manually send and receive commands, to and from the laser system.
  - The software allows you to control the basic functions of the laser. The user can pick energy level, firing mode and frequency.
  - The software provides a system status indicator for the major interlocks and faults. Note – A fault will require the laser to be disabled. User must determine cause of fault, deal with it appropriately, and re-enable laser to Fire.
  - The System Information section displays the Jewel serial number as well as firmware and gate array versions.
- Select and enter control parameters on the Jewel software panel.
- Enable and Fire.
  - Note: See below for detailed information on laser operation.

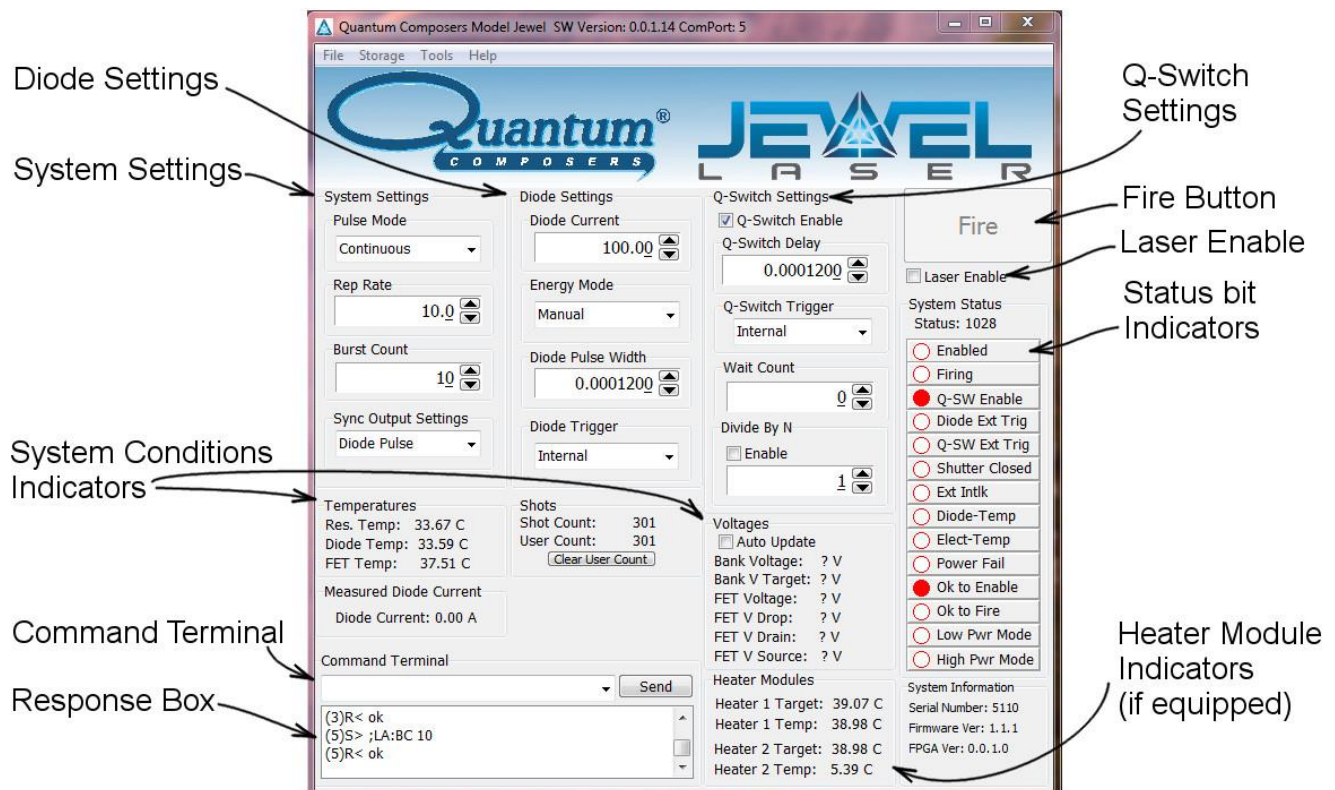


Figure 12 Jewel Software Application Main Window

## LASER OPERATION CONTROL

The user is responsible for ensuring a suitable beam path and appropriate beam dumps are provided, before firing the laser.

1. Pulse Mode – Options are continuous, single shot or burst.
  - a. Continuous mode – The laser will fire continuously from the time the Fire button is pressed until the Stop button is pressed. The pulses per second are controlled with the Rep Rate parameter, under System Settings.
  - b. Single Shot – The laser will output 1 single laser pulse when the Fire button is pressed.
  - c. Burst mode - The laser will output the number of laser pulses specified by the Burst Count parameter, under System Settings. The laser will stop firing at the end of the burst.
2. Diode Current – Current, in Amps, per pulse sent to the laser diode. See the system ATP document for the optimal value.
  - a. System alignment should typically be done at diode current levels 10 to 20 Amps below the optimum setting.

3. Diode Pulse Width – In  $\mu\text{sec}$  it is the width of the diode current pulse. See the system ATP document for the optimal value.
4. Diode Trigger- The diode can be internally or externally triggered. Default is internal trigger.
5. Qswitch Enable – This box must be checked for normal operation. When not selected, the qswitch will not function preventing output from the laser head.
6. Qswitch Delay – In  $\mu\text{sec}$  it is the delay from the start of the diode pulse. See the system ATP document for the optimal value.
7. Qswitch Trigger – The Qswitch can be internally or externally triggered. Default is internal trigger.
8. Wait Count – This setting is in pulses and represents the number of diode pulses before the qswitch is triggered. For example, a setting of 3 would pulse the diode 3 times the qswitch would function on the 4<sup>th</sup> diode pulse. This parameter is applied to all Pulse Modes.
9. Divide By N – This parameter will set the qswitch to function on every XX diode pulse. For example, a divide by value of 2 will trigger the qswitch on every 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup>... diode pulse.
10. Fire button – Selecting the fire button will start laser output. NOTE: the laser must be enabled before the Fire button becomes active.

## 6. LASER OPERATION

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The laser has undergone extensive testing to verify its conformance to the specifications prior to delivery.

Once the laser has been set up as outlined in the previous chapter, it is ready to operate. Turn the Key Switch ON. After approximately 10 seconds the laser is initialized and ready for operator control. See summary Data Sheets included with our laser for factory preset operating parameters.



**CAUTION: Below is a list of guidelines, which apply to all Quantum Composers' laser systems. These guidelines should be followed whenever possible, to avoid laser damage.**

- Operate the laser in a dust-free environment, and keep the Laser Optics covered when not in use. This protects the output aperture against dust and particulate.
- The Laser Optics Assembly is sealed with careful attention to use of low outgassing materials. Silicone and similar sealing, bonding or insulating materials should not be used in close proximity to the Laser Optics because these substances will outgas, and could contaminate the output window, causing laser damage.
- Avoid back reflections. Back reflections of even a small percentage of the output energy can promote damage to optical components in the Laser Head. For example, an uncoated convex lens or a glass disk calorimeter will reflect about 4% of the incident energy. While the reflection may seem harmless, it can perturb the resonator operation to the extent that the near field beam intensity profile is degraded, and may promote optical damage. It may also affect the resonator hold-off, which can cause prelasing and catastrophic optical damage. In some cases, even anti-reflection coated glass optics can reflect enough energy to promote damage to laser optics. It is best to use only quality optics coated for the operating wavelength.



**CAUTION: To avoid laser damage, minimize back reflections of the output beam. When reflections are unavoidable, direct them away from the optical axis of the system by canting the optics off-axis. Failure to do so can cause laser damage and void the warranty.**

### MANUAL SHUTTER OPERATION

The Jewel Laser utilizes a manual shutter, located at the output of the laser head (see Figure 13). The shutter blocks laser output when in the CLOSED position. An internal switch prevents the laser from firing. The switch is satisfied only when the lever is fully in the OPEN position.

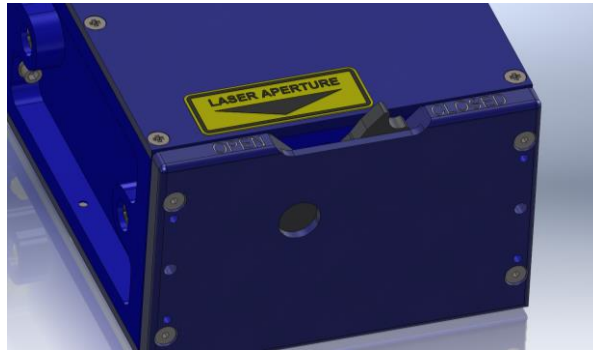


Figure 13 Jewel Shutter Lever

## LASER HEAD CONNECTORS

The laser head connector panel is shown in Figure 14.



Figure 14 Jewel Connections

1. Remote Interlock (Rmt Intlk) – requires switch closure for laser to fire. Indicates Fault when circuit is not satisfied.
2. Diode Trig – SMA connector for Diode Input Trigger
3. Qswitch – SMA connector for Qswitch Input Trigger
4. Sync Out – SMA connector – User selectable output signal. Can independently output Diode signal, Qswitch signal or both signals simultaneously.



5. USB – Communication Connection
6. Power Connector – Center pin positive connector matches included AC/DC power supply.

### **LASER STATUS CONNECTORS**

1. Power LED – Illuminated when Key Switch is ON
2. Fault – Illuminated when laser fault exists. Laser will not fire when FAULT LED is illuminated.
3. Laser Emission – LED is illuminated any time the laser is enabled (ready to fire) or when actively lasing.

### **INITIAL POWER ON**

#### Power-On Checklist

- ☐ Verify cable connections are correct.
- ☐ Apply power to laser power supply.
- ☐ Rotate key switch clockwise to turn on the Jewel Laser.
- ☐ Open Jewel Control Software.

The laser will be ready to operate after approximately 2 minutes. When harmonic module is attached, best laser performance will require 10 minutes of warm-up time.

### **POWER OFF**

#### Power-Off Checklist

- ☐ Stop laser Fire, via software.
- ☐ Close Jewel Control Software.
- ☐ Power down Jewel Laser.



## 7. DEVICE COMMANDS

---

### Device Command Format

All commands use ASCII characters and are composed of the following fields:

<Prefix><Address>< Delimiter ><Command String>[Parameters]<Terminator>

Field	Description
<b>Prefix</b>	Single semicolon character ";", must precede all commands. All devices will reset their command input buffer when the prefix is received.
<b>Address</b>	2 ASCII characters. Each device has a unique address which is programmed into its firmware. See the table below for a list of addresses.
<b>Delimiter</b>	Single colon character ":", must follow device address.
<b>Command String</b>	Commands are specific to each device -- see the following sections for the commands that each device supports.
<b>Parameters</b>	(optional field) Some commands may not require a parameter. For Query commands immediately follow the command string with the question mark character "?". For non-query commands immediately follow the command string with a single space character " " followed by the parameter. Multiple commands are separated by commas.
<b>Terminator</b>	ASCII carriage return character (ODh). The receiving device does not process any commands until the terminator is received.

### Device Addresses

Address	Device
LA	Laser

### COMMAND TYPES

There are two types of commands -- those that set a value or initiate an action (control commands), and those that request information (query commands). Each device must respond in the proper manner to each type of command.

#### Control Commands

A device must always parse a control command and return a response immediately.

- If the command is a recognized command and the parameter is valid, then the device returns an "OK<CR>".

- If the command is not recognized, then the device responds with a "?1<CR>".
- If the command is recognized, but the parameter value is missing or invalid, then the device responds with a "?4" or "?5".
- If a control command is received while the device is in the midst of executing a previous command, and the commands are mutually exclusive (cannot be executed in parallel), then the previous command is aborted and the new one executed. It is up to the host controller (the PC) to poll the device and make sure the previous command has finished, if that is needed.

## Query Commands

Query commands return a value to the PC as soon as the command is parsed and executed. The value returned will depend on the command. The response is always terminated with a "<CR><LF>". If a query command is not recognized by the device, then a "?1" is returned.

## Error Codes

- ?1 Command not recognized.
- ?2 Missing command keyword. If command requires keyword.
- ?3 Invalid command keyword. If command requires keyword.
- ?4 Missing parameter.
- ?5 Invalid parameter.
- ?6 Query only, command needs a question mark.
- ?7 Invalid query, command does not have a query function.
- ?8 Command unavailable in current system state.

## Jewel Command Examples

Below are a few example commands and queries. A <CR> indicates the carriage return value appended:

Set pulse mode to burst:

Command to send:	;LA:PM 2<CR>
Response:	OK<CR>

Set laser burst count to 123:

Command to send:	;LA:BC 123<CR>
Response:	OK<CR>

Set Rep Rate

Command to send:	;LA:RR 5<cr> sets rep rate to 5 Hz
Response:	OK<CR>

Enable laser:

Command to send:	;LA:EN 1<CR>
Response:	OK<CR>

Fire laser:

Command to send: ;LA:FL 1<CR>  
 Response: OK<CR>

Query system status:

Command to send: ;LA:SS?<CR>  
 Response: 3078<CR>  
 (3078 decimal, when converted to bytes, means: Laser enabled, Laser firing, Q-Switch enabled, Ok to enable and OK to fire)

### Communications Timeout Safety Feature

The laser has a safety feature that will stop firing the laser if communication is not initiated in a 3-second period. This prevents the laser from firing unattended if the user application has locked up or a commutation cable has become disconnected. Any command or query can be sent to prevent the timeout from happening.

### Laser Operation Commands

BC # BC?	Burst Count. Sets the number of laser shots to be fired when firing mode is set to burst. Parameters are from 1-65535. Default is 10. A query will return the currently set burst count.
BV?	Bank Voltage. Returns the current diode driver bank voltage.
DC # DC? DC:MIN? DC:MAX?	Diode Current. Sets the diode current value. Parameter is in amps. A query returns the currently set diode current. A MIN and MAX query return the limits of the current setting.
DE # DE?	Divide by N Enable. This enables or disables the diode to q-sw pulse number state. 0 = Disabled, 1 = Enabled. (Default: 0). A query returns the current state.
DN # DN?	Divide by N Value. This sets the divide by N value. The value is a divisor of the number of q-sw pulses for every N number of diode pulses. For example, setting to 10 will give 1 q-sw pulse for every 10 laser diode pulses. A query returns the current value.
DT # DT?	Diode Trigger Mode. Set the laser to operate in either internal or external diode trigger mode. When set to external mode, a trigger signal present on the external diode trigger sma connection will trigger the firing of the laser diode. 0 = internal, 1 = external, default = internal. A query returns the current trigger state.
DW # DW? DW:MIN? DW:MAX?	Diode Width. This sets the diode pulse width. Values are in seconds. Typical values may range from 0.1 to 0.2 seconds. The laser optimal diode width will be specified in the laser performance ATP report. A query returns the current value. A MIN and MAX query return the limits of the setting.
EC # EC?	Echo. Parameters: 0=echo characters off (Default: 0), 1=echo characters on. EC? returns echo state.

EM # EM?	Energy Mode. This is a quick way to increase or decrease the laser energy to either max or by half. Useful for alignment purposes. This will automatically either increase the laser diode current to max or reduce it to a level that gives roughly half of maximum energy output. Parameters are: 0 = manual mode, 1 = Low power, 2 = High power. A query returns the current state. If the diode current is adjusted by using the DC command, then the power mode will automatically go back to manual. Default mode is high power.
EN # EN?	Enable. This will enable or disable the laser. The laser must first be enabled before firing. 0 = Disabled, 1 = Enabled. (Default: 0). A query returns the current enable state.
FL # FL?	Fire Laser. Starts the laser pulsing. 0 = Stop Firing Laser, place laser in idle state. 1 = Fire laser. A query returns the current firing state.
FT? FT:MAX?	FET temperature in degrees C.
FV?	FET Voltage in Volts.
ID?	System ID – QC, model #, serial # (5 digits),FW version#-GA version (##-##) (ex. QC,Jewel,00101,1.0-0.0.0.8). Query only.
IM?	Diode current measurement, in Amps.
LS?	Latched Status. Returns the latched system status. Cleared upon read. See SS? query for details.
PE #.# PE? PE:MIN? PE:MAX?	Sets pulse period in seconds. A query returns the current period value. A MIN and MAX query will return the limits for the setting.
PM # PM?	Mode. Sets the laser firing mode, 0 = continuous, 1 = single shot, 2 = burst. (Default: 0). A query returns the currently set mode.
QD #.# QD? QD:MIN? QD:MAX?	Sets Q-Switch delay (from diode pulse rising edge) in seconds. A query returns the current delay value. A MIN and MAX query will return the limits for the setting.
QE # QE?	Q-Switch Enable. Enables normal Qswitch operation. 0 – Disables normal operation, 1 – Enables normal operation.
QT # QT?	Q-Switch trigger mode. Set the laser to operate in either internal or external q-switch trigger mode. When set to external mode, a trigger signal present on the external q-switch sma connection will trigger the firing of the q-switch. 0 = internal, 1 = external, default = internal. A query returns the current trigger state.
QW # QW?	Q-Switch Wait. The number of diode pulses that the q-switch will wait before activating. A zero will disable the wait. (Range 0 – 65535)
RC #	Recall settings from user bin 1-6. 0 = recall factory defaults.

RC?							
RR #.# RR? RR:MIN? RR:MAX?	Repetition Rate. This sets the rate at which the laser will fire at. Values are from 1-50Hz (Default: 20 Hz). A query will return the current rate. A MIN and MAX query will return the limits for the setting.						
RS	Reset. Resets the system.						
SC?	System shot count, since factory build.						
SS?	System Status – Query Only. Returns the current system state. Value is a 16 bit decimal value with each bit position corresponding to a system state (See Table below, bits 0-15).						
15	14	13	12	11	10	9	8
Spare	Spare	High Power Mode	Low Power Mode	Ready to Fire	Ready to Enable	Power Failure	Electrical Over Temp (FET)
7	6	5	4	3	2	1	0
Resonator Over Temp	External Interlock	Shutter Closed	Q-Switch External Trigger	Diode External Trigger	Q-Switch Enabled	Laser Active	Laser Enabled
SV # SV?	Save settings to user bin 1-6.						
SY # SY?	Sync Output Mode. 0 = off, 1 = LD pulse, 2 = QSW pulse, 3 = LD/QSW.						
TA? TA:MIN? TA:MAX?	Resonator thermistor temperature in degrees C. A MIN and MAX query will return the limits for the setting.						
TB? TB:MIN? TB:MAX?	Diode thermistor temperature in degrees C. A MIN and MAX query will return the limits for the setting.						
UC # UC?	User shot count. Saved shot count. Can be cleared on command by issuing a 0 after command. Can also be preset by sending any number up to 32 bit.						

### Harmonic Module Heater Commands (Note: Applicable if Installed)

H1?	Heater 1 installed (0 = No, 1 = Yes)
H1:SP?	Heater 1 setpoint. Target heater setting, in degrees C.
H1:ST?	Heater 1 Status byte (See Table Below).
H1:TP?	Heater 1 temperature. Active temperature of the heater in degrees C.
H1:VN?	Heater 1 controller firmware version.
H2?	Heater 2 installed (0 = No, 1 = Yes)
H2:SP?	Heater 2 setpoint. Target heater setting, in degrees C.
H2:ST?	Heater 2 Status byte (See Table Below).
H2:TP?	Heater 2 temperature. Active temperature of the heater in degrees C.

H2:VN?		Heater 2 controller firmware version.					
7	6	5	4	3	2	1	0
spare	spare	spare	Temp reading out of range	Temp too high	At Target Temp	Temperature settling	Temp Control Enabled

## 8. MAINTENANCE

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### SERVICE PROCEDURES

#### No User-Serviceable Parts Inside

If service is required, contact the vendor for more information.

## 9. TROUBLE-SHOOTING

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The JEWEL LASER control electronics are 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 electrical and optical damage.

### NO LASER OUTPUT

1. Check Fault and Interlock Conditions: Query status information using commands listed in the command set. Refer to status to determine if a fault or interlock conditions exists.
2. Check Cables: With the main power OFF and unplugged, check all electrical connections between the Laser Optics Assembly and the Laser Power Supply. Make sure all connections are secured. If any of the cables are not installed properly, the system will not function.
3. Check Shutter Position: The shutter is manually controlled and is located on the side of the laser head. The laser will fire only when the shutter arm is in the open position.
4. Check Energy Setting: Refer to the data parameters supplied in the Data Summary Sheet and make sure the parameters are not set below the lasing threshold. Correct if necessary.
5. Check Q-Switch Settings: Verify that the Q-Switch is enabled.
6. Check Diode and Qswitch triggers. Ensure they are correct for internal triggering or external triggering.

### ENERGY IS LOW

1. Resonator Misaligned: If beam quality has degraded, it may suggest that the resonator needs realignment. Contact Quantum Composers for more details.
2. Incorrect Qswitch delay – Qswitch delay typically matches the Diode Pulse Width. Correct value if necessary.

Contact the Quantum Composers for any repair actions necessary beyond those described in this manual. Attempts to adjust, repair or replace any portion of the laser system may cause additional problems and void the warranty.



## 10. SPECIFICATIONS

JEWEL SPECIFICATIONS					
OUTPUT ENERGY [mJ] 1					
	Configurations	1064nm	532nm	355nm	266nm
	1064	≥ 10			
	1064/532	≥ 5	≥ 4		
	1064/532/355	≥ 4	≥ 2.5	≥ 2.0	
	1064/532/266	≥ 5	≥ 2.5		≥ 1.0
REP RATE (Hz)					
		1 to 20Hz Nominal 20-50Hz (8)			
NEAR FIELD BEAM DIAMETER [mm] 2					
		2.0 ± 0.5	2.0 ± 0.5	1.5 ± 0.5	1.5 ± 0.5
BEAM DIVERGENCE [mrad] 3					
		≤ 6.0	≤ 5.0	≤ 4.0	≤ 4.0
RMS STABILITY [%] 4					
		≤ 2.5	≤ 3.5	≤ 5.0	≤ 5.0
ENERGY VARIANCE [%] 5					
		≤ 5.0	≤ 7.0	≤ 10.0	≤ 10.0
PULSEWIDTH [ns] 6					
		< 12	< 11	< 10	< 10
TIMING JITTER [ns]					
		2			
TRANSVERSE MODE					
		MULTI-MODE			
POINTING STABILITY [μRAD] 7					
		≤ 200			
ENERGY DRIFT [%]					
		≤ 10 over 5 minutes			
POLARIZATION					
		150:1 for linear outputs			
DIODE LIFETIME					

		100,000,000 pulses
WARM-UP - POWER ON TO READY		
		10 min
TEMPERATURE [°C]		
	OPERATING	15 to 30
	STORAGE	-10 to 50
SIZE		
	inches	3.25 X 7.10 X 2.38
	mm	(82 x 180 x 60)
POWER REQUIREMENTS		
		36-40VDC @ 0.5A (20W Max) @ 20Hz 36-40VDC @ 0.8A (30W Max) @ 50Hz
DIODE DRIVER & CONTROLLER		
		Integrated with Laser
NOTES:		
1 Nominal factory configuration. For OEM applications energies can be optimized to favor a specific wavelength, which in some cases can double the specified energy.		
2 Beam widths are measured at the output window of the laser. Beam widths are measured using the second moment energy distribution.		
3 Beam divergence is full angle. Beam divergence is determined by measuring the widths of the transformed beam by an aberration-free focusing element, one focal length away from the rear principle plane of the element.		
4 RMS stability is defined as: (standard deviation)/(mean). RMS Stability is measured using the full laser beam for 200 shots at 20 Hz operation.		
5 Energy Variance is defined as: (max-min)/(2*mean). Energy Stability is measured using 98% of the pulses of the full laser beam for any 100 shot interval, after the initial 100 shot stabilization from turn-on, up to 1000 shots of 20 Hz operation.		
6 Pulsewidth is measured at 20 Hz PRF. The energy shall be within +/- 10% of the specified energy when pulse width is measured. Pulsewidth is calculated from the full-width half-maximum (FWHM) of the waveform		
7 Pointing stability is measured on the 1064 nm laser output. It is measured as the angular shift between the centroid of the beam for the 1st pulse and the centroid of the beam exhibiting the strongest angular shift within the first 1000 consecutive shots at 20 Hz operation. Measurement is far field, measured with an aberration-free focusing element, one focal length away from the rear principle plane of the element.		
8 Proper heat sinking required. Long term drift may exceed specifications. Contact factory for details.		

# 11. CABLES AND CONNECTIONS

## USB Cable

USB cable: Standard-A plug and Standard-B plug. A fully molded and shielded USB cable must be used with the Jewel laser to ensure compliance with all CE requirements. The cable must not allow access to the shielding portion of the cable through the outer sheathing i.e. no mold holes in the outer sheathing. Tripp Lite U022 series cables are recommended.

## External Triggers

The laser can be externally triggered when critical timing synchronization between other devices is required. The diode and the qswitch can each be externally triggered. When externally triggering the qswitch, it is imperative that correct timing between the diode pulse and the qswitch is maintained in order to maintain optimal laser performance. Optimal qswitch delay values can be found on the laser ATP document.

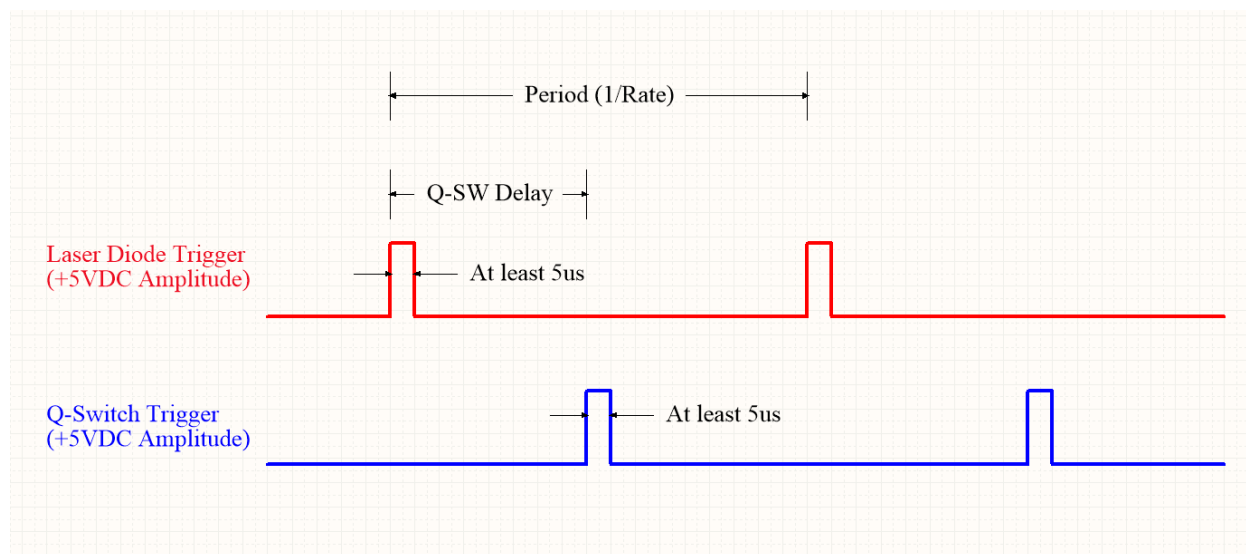


Figure 15 External Trigger Timing

External Trigger Specifications			
	Minimum	Typical	Maximum
Voltage Input Range	0-1V (Low level)	5V	2.5-5.5V (High level)
Pulse Width	5us	10us	100us
Connector Type	SMA Female Jack		
Insertion Delay (QSW trigger to light out)		435ns	
Trigger Jitter (QSW trigger to light out)		3.7ns (p-p)	

## Sync Output

The sync output connector provides a signal that can either represent the diode pulse, qswitch pulse or a combination of both. When set to both diode and qswitch, the rising edge of the pulse represents when the diode pulse starts and the falling edge when the qswitch pulse starts.

Sync Out Specifications	
Voltage Output Range	5V (+/-100mV)
Connector Type	SMA Female Jack
Insertion Delay	60ns
Jitter (Ext diode)	560ps
Jitter (Ext QSW)	460ps

## Remote Interlock

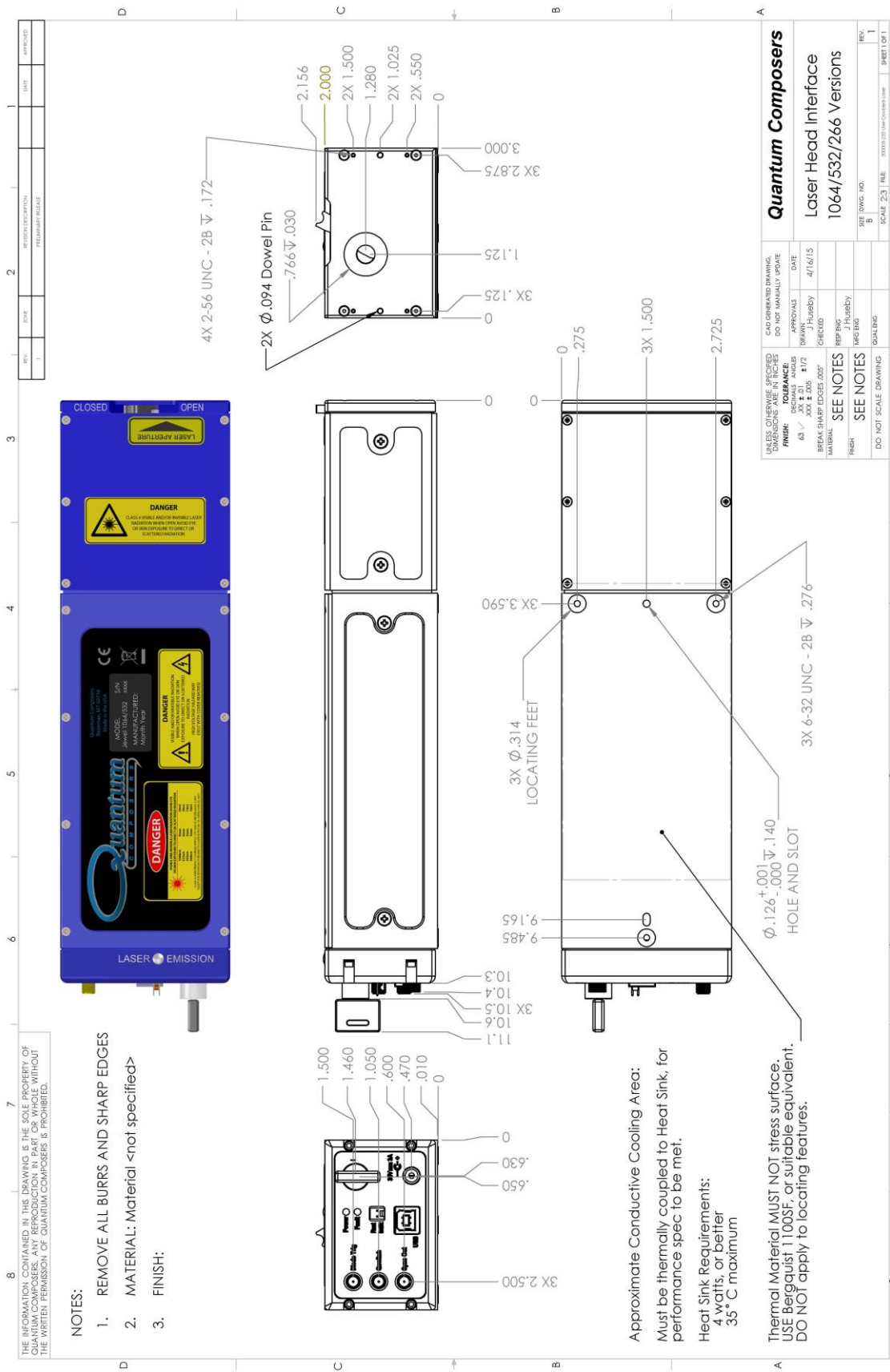
The remote interlock comes with a shorting jumper attached. Once this jumper is removed, the laser will stop firing and cannot be fired again until it is replaced. An external connection can be made to external door switches or system cover interlocks. This connection requires a contact closure to allow the laser to operate.

Remote Interlock Specifications	
Connection type	Contact closure
Connector Type	Molex #0022013027
Pin Types	Molex #0008500114

## 12. MECHANICAL INTERFACE DRAWINGS

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## 13. CUSTOMER SERVICE

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### WARRANTY

The manufacturer warrants the lasers it produces to be free from defects in materials and workmanship for one year following the date of shipment. Laser optics are warrantied for 90 days following the date of shipment provided that operating instructions are properly followed. This warranty is limited to the original purchaser of the laser and is not transferable.

During the one year 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 Quantum Composers. All replaced parts and products become the property of the manufacturer.

This warranty does NOT extend to any lasers which have been damaged as a result of accident, misuse, abuse (such as use of incorrect input voltages, improper or insufficient ventilation, failure to follow the operating instructions provided by the manufacturer, or other contingencies beyond our control), or as a result of service or modification by anyone other than the manufacturer.

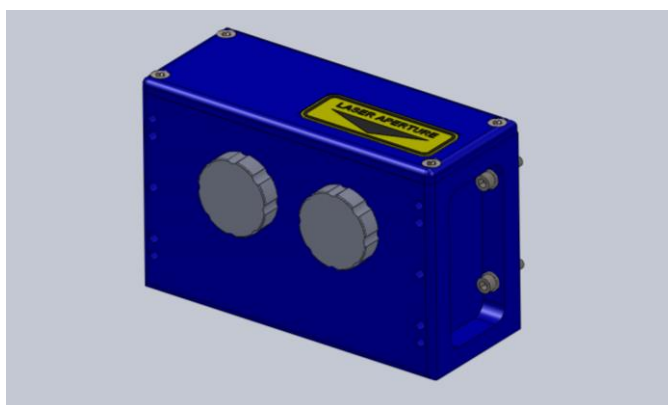
### FEEDBACK

We welcome your feedback regarding the use and performance of our laser system. Product improvements and refinements come about from these contacts; continually improve our product reliability, performance and customer satisfaction.

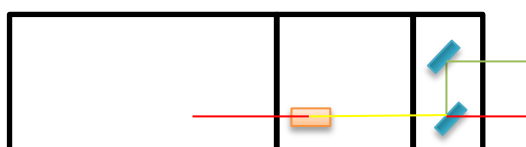
## 14. APPENDIX A - DICHOIC MODULE

### OVERVIEW

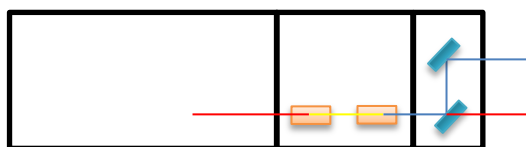
The Dichroic Module is a self-contained wavelength separator that can be added to the output end of the Jewel. It can accurately separate laser light to transmit precisely 266, 355, or 532nm. The light being separated is offset from the normal beam path by 1.039" (26.4 mm), and exits through the port under the laser aperture label. The residual wavelengths continue along the normal beam path and can be dumped into the port cap or accessed. Each port is .535"-40 threaded to accommodate a plug or other accessory.



### CONFIGURATIONS



Jewel Visible **532nm** with Dichroic  
Plus collinear residual **1064nm**  
Residual may be dumped or accessed



Jewel UV **266nm or 355nm** with Dichroic  
Plus collinear residual **1064nm and 532nm**  
Residual may be dumped or accessed

### SPECIFICATIONS

Module Wavelength	266	355	532
Transmission	94.1%	94.1%	94.1%
Residual Energy	.01%	.01%	.01%
Spectral Purity	>98%	>98%	>99%

## 15. APPENDIX B – CE/UKCA DECLARATION



### MANUFACTURERS DECLARATION OF CONFORMITY

Application of Council Directive(s) EMC Directive 2004/108/EC  
Low Voltage Directive 2006/95/EC

Manufacturer's Name Quantum Composers, Inc.

Manufacturer's Address 212 Discovery Drive  
Bozeman, Montana 59718

Model Name Jewel Laser


Year of Manufacture 2015

Conformance to EN 61326-1:2013  
EN 60825-1:2007  
EN 50581:2012

*We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).*

Location Bozeman, Montana Representative Name Paula Carstensen

Date October 6, 2015 Title General Manager

  
(Signature)