MicroJewel Laser Operating Manual

CONTENTS

1. INTRODUCTION

This manual contains the information necessary to operate and maintain the Quantum Composers MicroJewel 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 MicroJewel 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

Warranty

The MicroJewel 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:

- MicroJewel Laser with attached cables
- Safety Key
- Shorting Jumper (Rmt Intlk)
- Power Supply, with AC Power Cord
- User's Manual and Control Software on USB drive

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

2. SAFETY

This product complies with safety standards EN 61010-1:2010, EN 60825-1:2014, and CDRH 21 C.F.R. 1040.10 (2010). 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
	CAUTION: 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. ATTENTION: 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. ACHTUNG!: Beachten Sie Verfahren, Praktiken oder Zustände, die das Produkt beschädigen oder zu Verletzungen fuhren können. Lesen Sie die deigefugte Dokumentation. ATTENZIONE: Porre estrema cautela alla procedura, uso o condizioni che potrebbero danneggiare il prodotto o l'utilizzatore. Far riferimento alla documentazione inviata insieme al prodotto. ADVERTENCIA: Llama la atención sobre un procedimiento, práctica, o condición que podría causar daño al producto o puede herir al usario. Consulte la documentación que acompaña.

	CAUTION: Risk of exposure to hazardous laser radiation. ATTENTION: Risque d'exposition à un rayonnement laser dangereux. ACHTUNG!: Gefahr durch gefährliche Laserstrahlung. ATTENZIONE: Rischio di esposizione a pericolose radiazioni laser. ADVERTENCIA: Riesgo de exposición a la radiación peligrosa del láser.

LASER SAFETY

VISIBLE AND/OR INVISIBLE LASER RADIATION

CAUTION: The MicroJewel 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.

- 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 C.F.R. 1040.10. This information is also available in EN 60825-1:2014, 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 EN 60825-1:2014, 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.

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" (EN 60825-1:2014)
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 serial number and aperture labels, and their locations on the MicroJewel Laser. Figure 3 shows the safety, model number, serial number, and origination labels and their locations on the MicroJewel Control Box. 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.
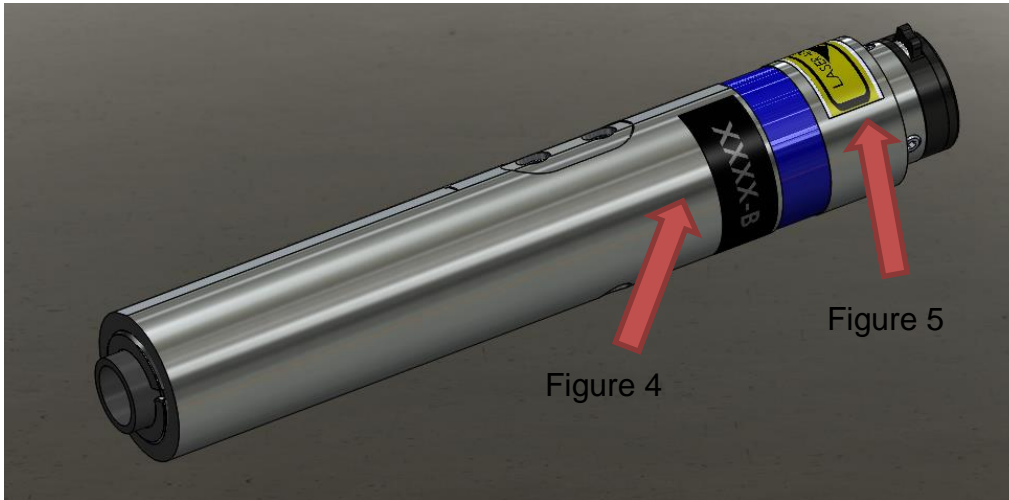
Figure 1: Safety Labels - MicroJewel 1064nm ONLY
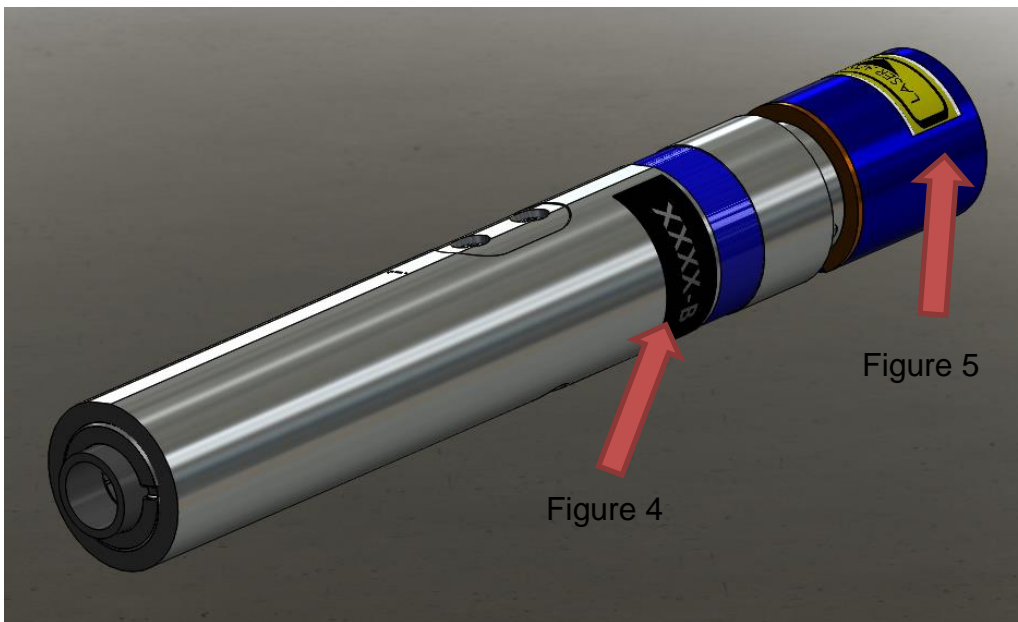
Figure 2: Safety Labels - MicroJewel 1064, 532nm

Figure 6

Figure 7

Figure 3: Safety Labels - MicroJewel Control Box

Figure 4: MicroJewel Serial Label

Figure 5: Laser Aperture Label

VISIBLE AND INVISIBLE LASER RADIATION AVOID EYE
OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION

1064nm	6nsec	50mJ
532nm	6nsec	30mJ
355nm	5nsec	14mJ
266nm	5nsec	10mJ

CLASS 4 LASER PRODUCT COMPLIES WITH 21 CFR 1040.10 AND EN 60825-1:2007
EXCEPT FOR DEVIATIONS PURSUANT TO LASER NOTICE NO. 50, DATED JUNE 24, 2007

Quantum Composers
Bozeman, MT 59718
Made in the USA
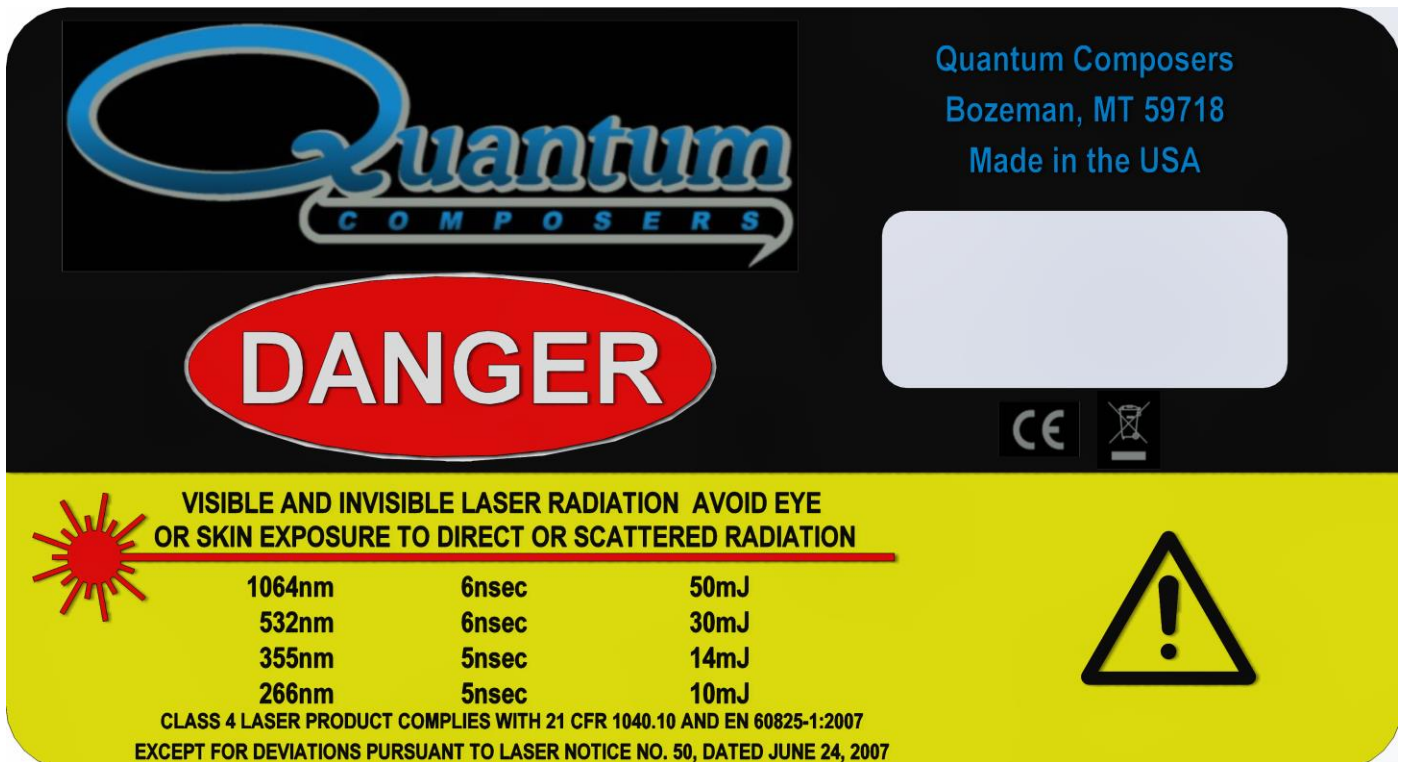
Figure 6: Safety and origination label

MODEL: S/N:
microJewel   XXXX-A

MANUFACTURED:
NOVEMBER 2016

Figure 7: Model and serial number label

3. SYSTEM OVERVIEW

MICROJEWEL LASER BLOCK DIAGRAM

Figure 8 shows the laser system block diagram, which consists of the MicroJewel Laser, a personal computer, and a power supply.
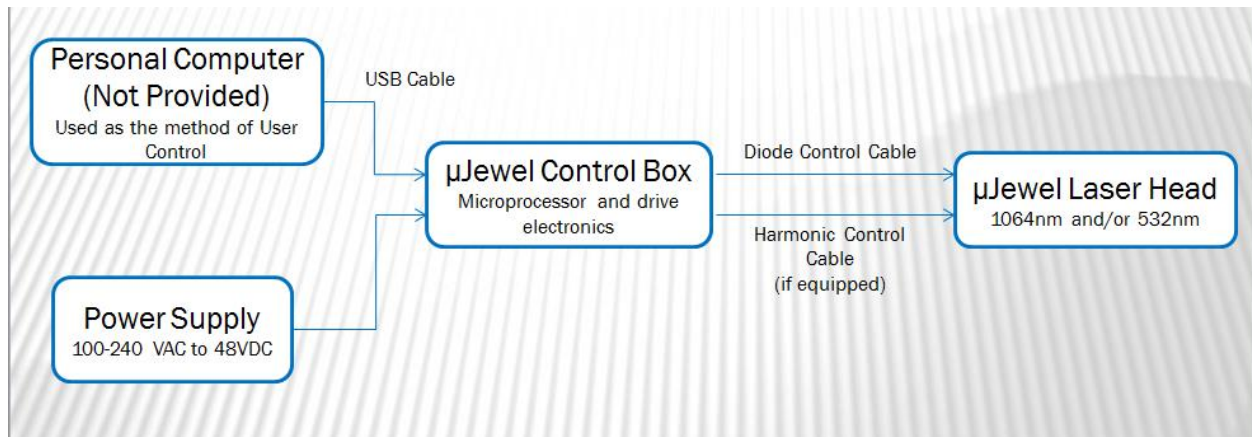
Figure 8: System Block Diagram

MICROJEWEL LASER DESCRIPTION

The MicroJewel is a small, compact, conductively cooled 1064/532nm diode pumped laser with output energy pulses up to 8mJ and pulse rates up to 5Hz. The MicroJewel laser head is connected by cables to a main control box that contains control and diode driving. The MicroJewel control box is powered by an external laptop style power supply (100-240 VAC and 50-60 Hz, and outputs 48 VDC, 1.6A).

LASER COMPONENTS

The MicroJewel is comprised of 3 main components: the laser controller box, power supply, and laser head with attached cables (Figure 9: Power Supply, Figure 10, and Figure 11). These components are shown below.

Figure 9: Power Supply

Figure 10: MicroJewel Control Box
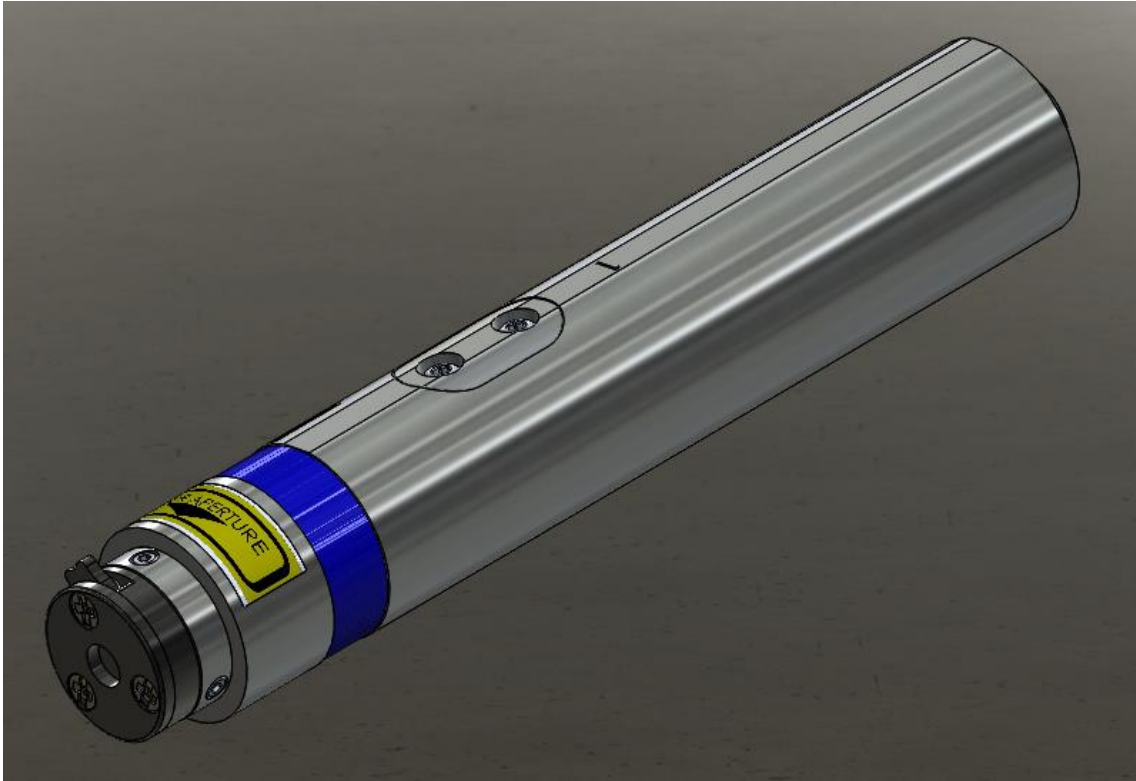
Figure 11: MicroJewel Laser Head 1064 nm
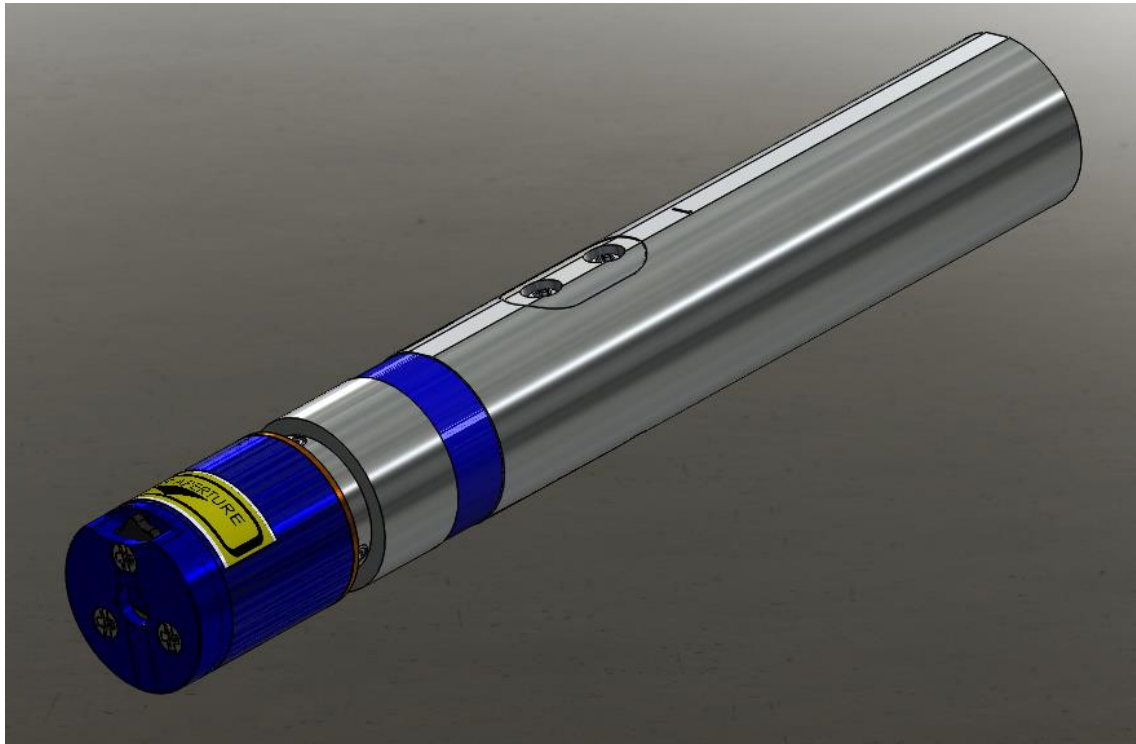
Figure 12: MicroJewel Laser Head 532 nm

1. The laser resonator is a highly efficient diode pumped laser (5Hz 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 then other laser resonators.
2. Systems with output harmonics, 532nm, 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.

4. MICROJEWEL LASER SETUP

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 my 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 MicroJewel 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.

- MicroJewel Laser and Control Box with attached cables.
- Safety Key
- Shorting Jumper (Remote Interlock)
- 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 the Mains power outlet that the Laser Power Supply connects to 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.
- The MicroJewel laser must be mounted to an appropriate, heat sinking surface (See Interface Drawings).
  - Apply thermal material between the unit's round profile and mounting surface of the heat sink (See Interface Drawings).
    - Note: The MicroJewel will operate without a heat sink, but its duty cycle and pulse rate will be greatly reduced. Contact manufacturer for further details.
  - To operate continually, the heat sink must dissipate 2 watts, at a maximum of 30° C, on the external round surface of the laser head (See Interface Drawings). All MicroJewel lasers will be shipped with one of the standard heat sinks shown in the Interface Drawings section.
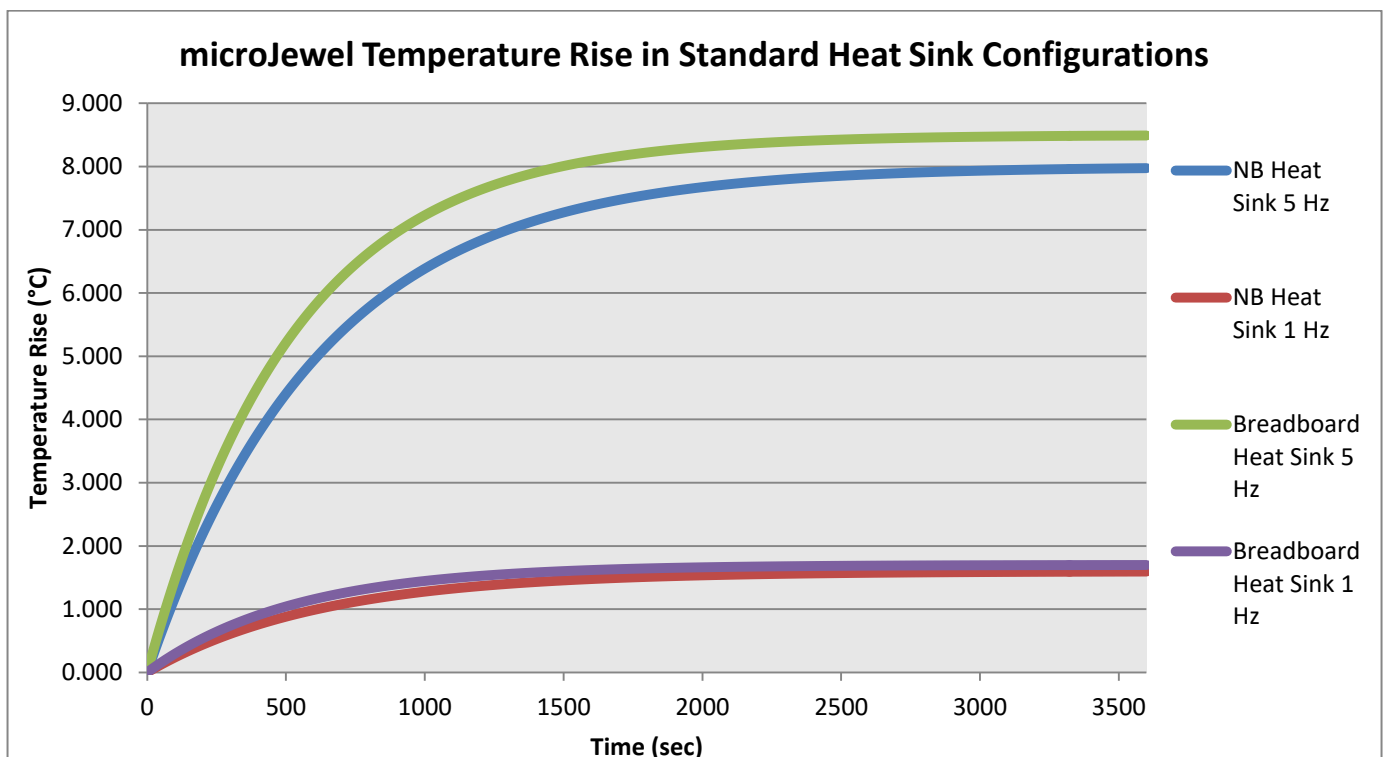
Figure 13: microJewel Temperature Rise in Standard Heat Sink Configurations

Rep Rate	Power Dissipation
1 Hz	≥ 0.4 watts
5 Hz	≥ 2.0 watts

- Attach a USB cable from the port of the computer to the port on the control box.
- Attach Power Supply DC cord to the MicroJewel laser control box.
- Attach Power Supply AC cord to a proper Mains outlet.

COMMUNICATION - USB

The MicroJewel laser provides a standard USB connection for remote communications.   When the MicroJewel 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 MicroJewel laser. Drivers are included on the provided CD. Once the drivers have been installed, the MicroJewel laser will show up in the Device Manager as a USB to Serial Port Adapter. The MicroJewel laser can then be communicated with by either the included MicroJewel 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 MicroJewel 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 MicroJewel 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 MicroJewel using either the included MicroJewel application or by using any generic communication terminal program. You can view the Com Port number assigned to the MicroJewel in your computers device manager under Ports.

DRIVER INSTALLATION (WINDOWS 7)

1. Plug the MicroJewel 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 MicroJewel. The location is typically found on the software CD. It will contain a file called "MicroJewelcdc.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 MicroJewel using either the included MicroJewel Laser application or by using any generic communication terminal program. You can view the Com Port number assigned to the MicroJewel in your computers device manager under Ports.

5. MICROJEWEL LASER APPLICATION

MICROJEWEL LASER APPLICATION OVERVIEW

The MicroJewel can easily be interfaced by means of the included MicroJewel 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 control box.
- Plug in the DC power supply to the control box and connect the DC supply to an AC source.
- Power up the MicroJewel laser head by turning on the key switch. The power LED will illuminate.

- Start the MicroJewel software.

- The MicroJewel Laser application will be displayed as shown in Figure 14.

  - 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 Pulse Mode, Pulse Rate (Rep Rate) and Burst Count.

  - The software provides system status indicators for the current state of the laser as well as any major interlocks and faults.
    Note – Depending on the type of fault, the laser may be disabled or stopped. In either case, the user must resolve the fault condition before re-enabling or firing the laser.

  - The System Information section displays the MicroJewel serial number as well as firmware versions.

- Select and enter control parameters on the MicroJewel software panel.
- Enable and Fire.
  - Note: See below for detailed information on laser operation.
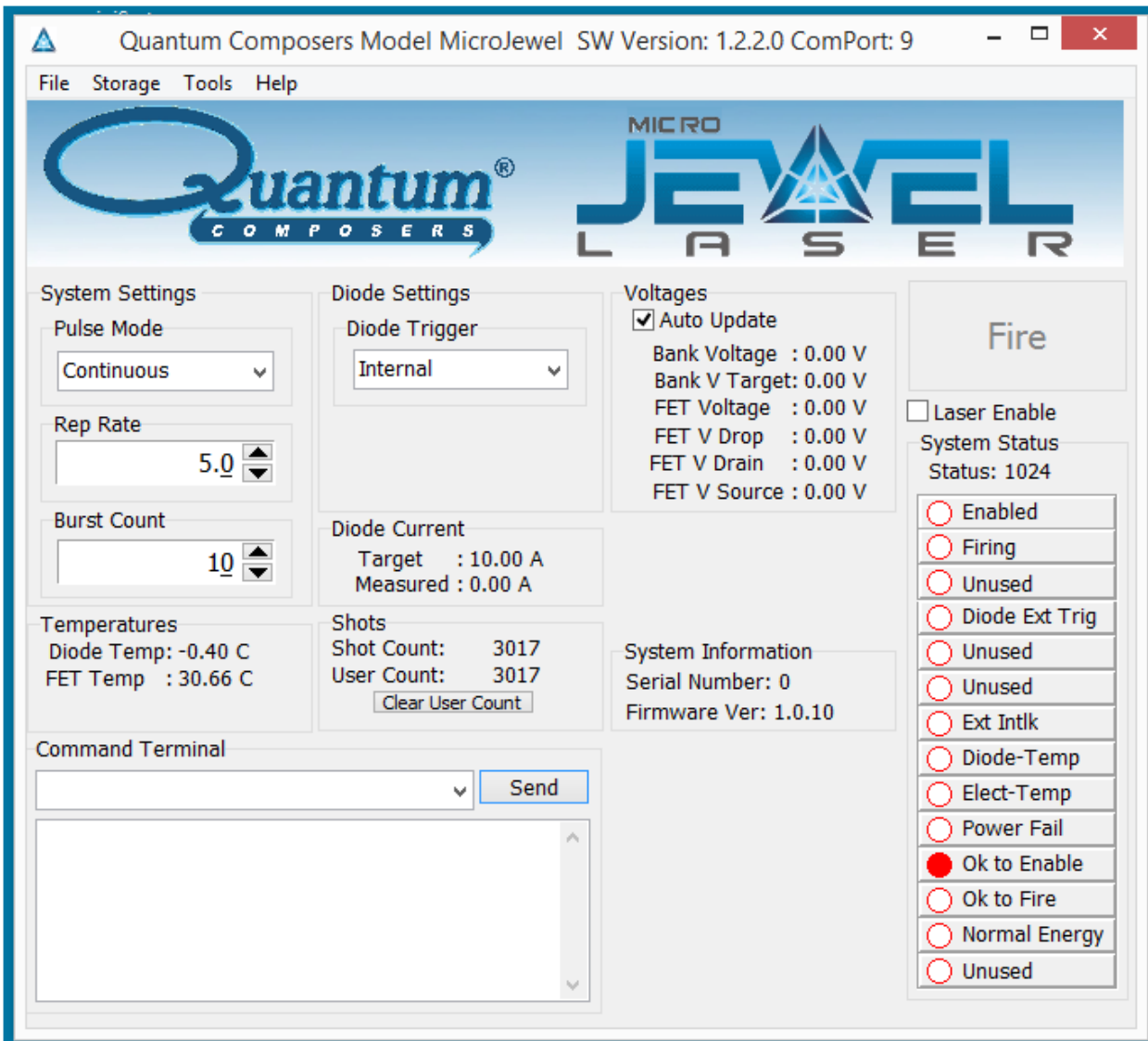
Figure 14: MicroJewel Software Application Main Window

LASER OPERATION CONTROLS

The user is responsible for ensuring a suitable beam path and appropriate beam dumps are in place 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 Trigger - The diode can be internally or externally triggered. Default is internal trigger. When in external trigger mode, the laser will fire once for every trigger input. Pulse modes or burst counts do not apply when in external trigger mode. When in external trigger mode, the fire command must be issued to arm the laser to accept external trigger signals.

3. Laser Enable – This enables the laser and readies it for firing. Note: there will be an 8 second delay between when the laser is first enabled and the laser is able to fire.

4. Fire button – Selecting the fire button will start laser output. NOTE: the laser must be enabled before the Fire button becomes active.

LASER STATUS

The status of the laser can be determined by monitoring the following items:

1. System Status – The system status reports various conditions of the laser. These status "bits" can be used to determine if there is a fault or what enable or firing state the laser is in.

2. Temperatures – Critical temperatures of the laser are reported here. If any of these temperatures reach pre-set limits, a fault will occur.

3. Measured Diode Current – This reports the actual measured pulse current of the laser diode. This current should report within ~5% of the set diode current value.

4. Voltages – This reports various voltages in the system for diagnostic purposes only.

5. Heater Modules (if installed) – This reports the target and the actual temperature of the harmonic module. Optimal laser performance is achieved once the two values are within 0.5 degrees of one another.

6. Shots – This reports the total number of shots on the diode since it left the factory as well as a user shot count that can be cleared by the user.

6. LASER OPERATION

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 2 minutes the laser is initialized and ready for operator control. If the laser includes a harmonic module (for 532nm for example), the laser may take up to 15 minutes to reach optimal temperature for the harmonic crystals. The laser can be fired before this time, but performance may suffer. 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 MicroJewel Laser utilizes a manual shutter, located at the output of the laser head (see Figure 15). The shutter blocks laser output when in the CLOSED position.
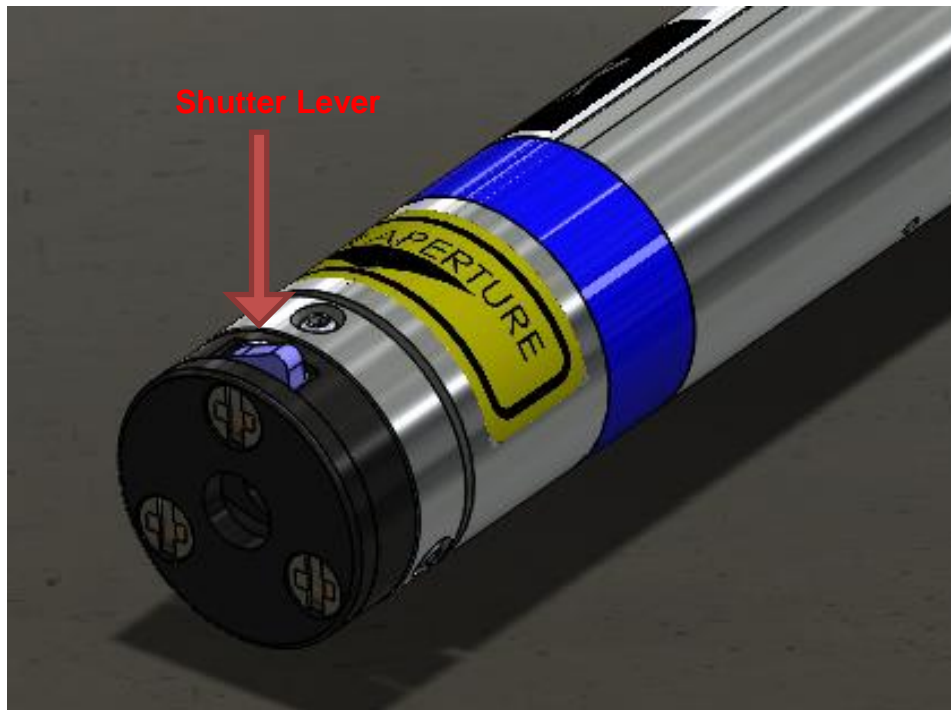
Figure 15: MicroJewel Shutter Lever, 1064 nm
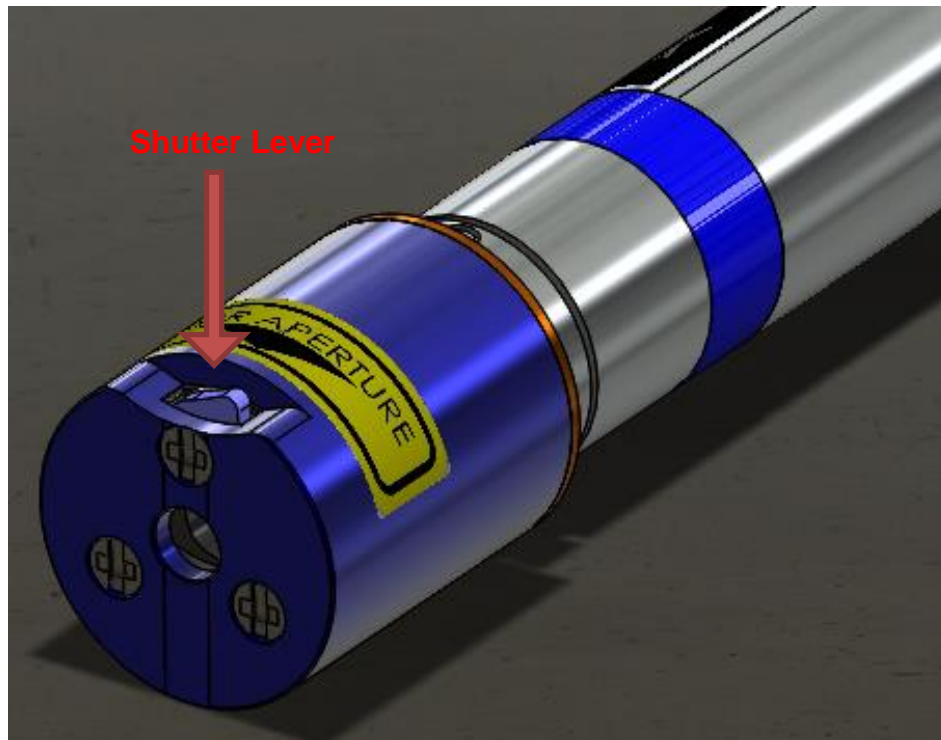
Figure 16: MicroJewel Shutter Lever, 532 nm

LASER CONTROLLER INTERFACE CONNECTORS

The laser controller connector panel is shown in Figure 17.
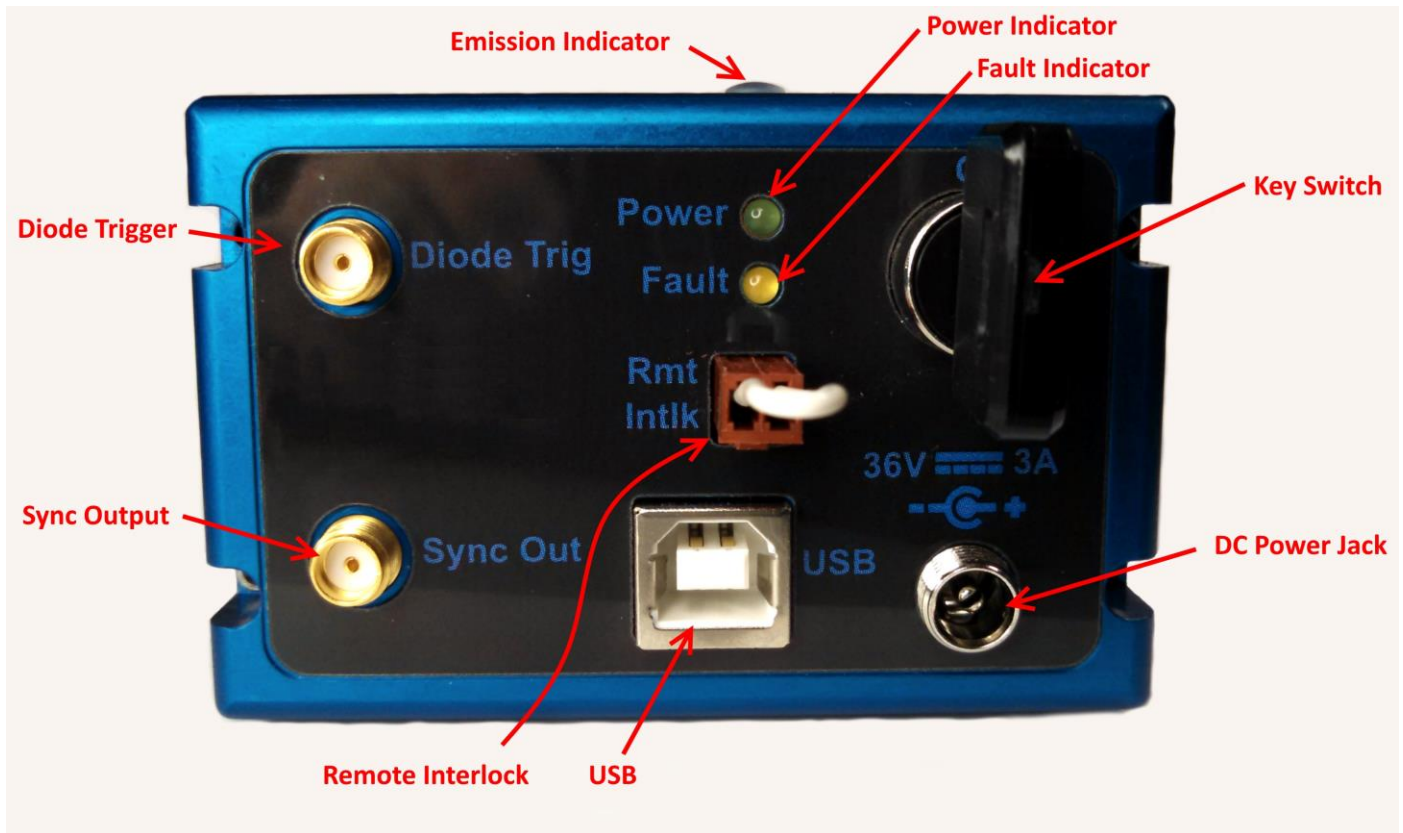
Figure 17: MicroJewel Connections

1. Remote Interlock (Rmt Intlk) – requires switch closure for laser to fire. Indicates Fault when circuit is not satisfied. If not using an external switch, then leave shorting jumper attached.

2. Diode Trig – SMA connector for Diode Input Trigger

3. Sync Out – SMA connector that outputs a pulse representative of the laser diode pulse.

4. USB – Communication Connection

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

LASER STATUS LED'S

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.

LASER CONTROLLER LASER HEAD CONNECTORS

The laser controller connections to the laser head are shown in Figure 18: MicroJewel Laser Head Connections.
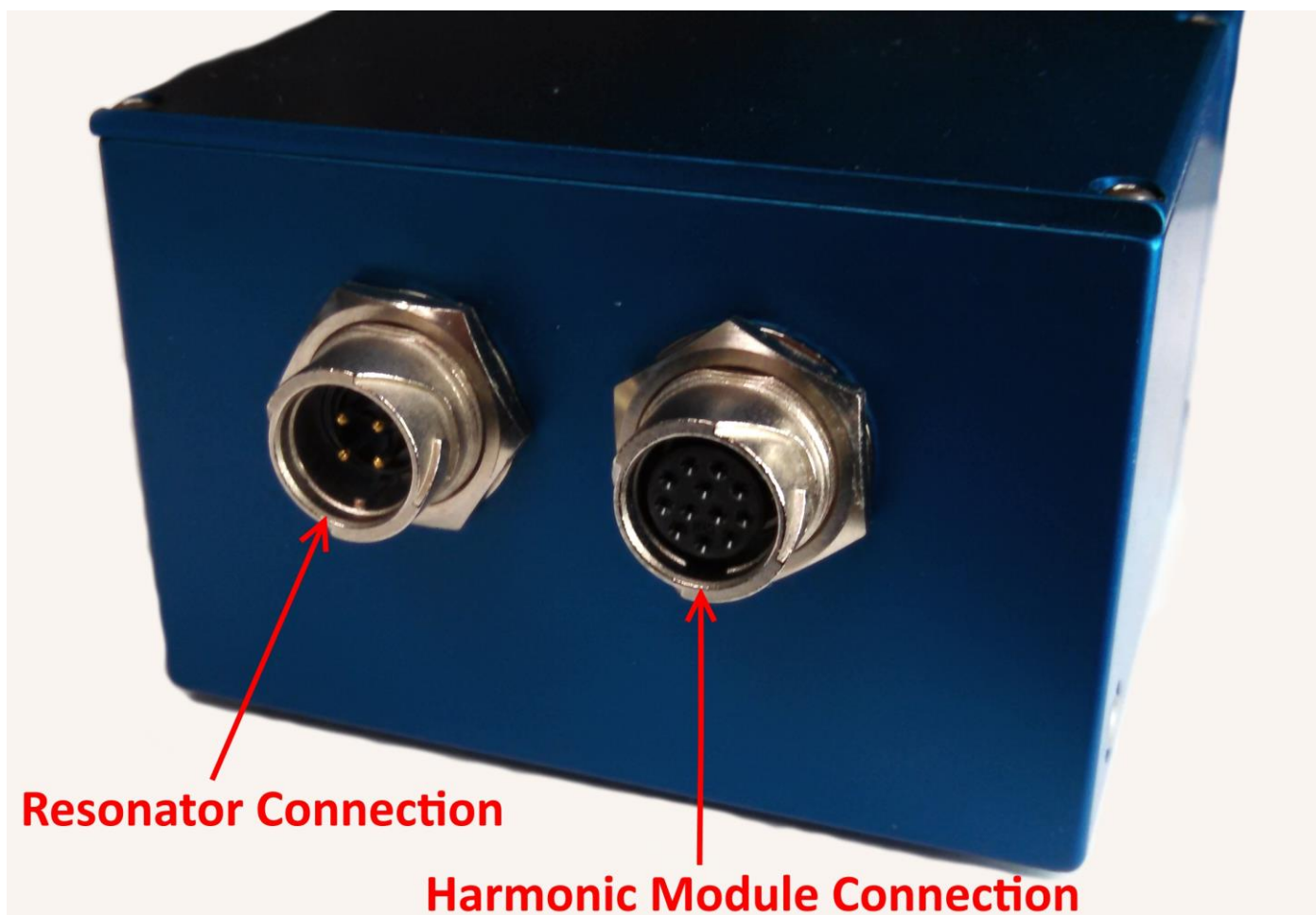
Figure 18: MicroJewel Laser Head Connections

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 MicroJewel Laser.

☐ Open MicroJewel Control Software.

The laser will be ready to operate after approximately 2 minutes. When the harmonic module is attached, best laser performance will require 15 minutes of warm-up time.

POWER OFF

Power-Off Checklist

☐ Stop laser Fire, via software.

☐ Close MicroJewel Control Software.

☐ Power down MicroJewel Laser.

7. COMMUNICATIONS

The microJewel has a standard USB port for communications. An optional RS-232 port can be installed on request. Contact the factory for options. All system parameters can be set and retrieved over either computer interface using a simple command language. The command sequence is controlled by a software handshake. A response of "ok" or "?n" in case of an error is returned after every command. To ensure reliable communications, it is important to wait until a response from the previous command is received before sending the next command.

USB INTERFACE OVERVIEW

The USB port is located on the back of the microJewel control box and uses a USB-B type connector with the following pinout (as viewed from the back of the unit):

Pin Number	Name	Description
1	+5 VDC	Vbus
2	D-	Data -
3	D+	Data +
4	Ground	Power Return

RS-232 INTERFACE OVERVIEW

The optional serial port is located on the control box. Please contact the factory for the type of connections available.

The serial port parameters should be set as follows:

Baud Rate	57600
Data Bits	8
Parity	Even
Stop Bits	1

Device Command Format

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

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

Field   **Description**
Prefix   Single semicolon character ";", must precede all commands. All devices will reset their command input buffer when the prefix is received.
Address   2 ASCII characters. Each device has a unique address which is programmed into its firmware. See the table below for a list of addresses.

Delimiter	Single colon character ":", must follow device address.
Command String	Commands are specific to each device -- see the following sections for the commands that each device supports.
Parameters	(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.
Terminator	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><LF>".
- If the command is not recognized, then the device responds with a "?1<CR><LF>".
- 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.

MicroJewel Command Examples

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

Set pulse mode to burst:

       Command to send: ;LA:PM 2<CR><LF>

       Response: ok<CR><LF>

Set laser burst count to 123:

       Command to send: ;LA:BC 123<CR><LF>

       Response: ok<CR><LF>

Set Rep Rate

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

       Response: ok<CR><LF>

Enable laser:

       Command to send: ;LA:EN 1<CR><LF>

       Response: ok<CR><LF>

Fire laser:

       Command to send: ;LA:FL 1<CR><LF>

       Response: ok<CR><LF>

Query system status:

       Command to send: ;LA:SS?<CR><LF>

       Response: 3075<CR><LF>

              (3075 decimal, when converted to bytes, means: Laser enabled, Laser firing, ok to enable and ok to fire)

Communications Timeout Safety Feature

The laser has a safety feature that will stop firing the laser if the any 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?	Diode Current. Queries the diode current setting for the laser. This is a factory set value and cannot be changed.

Command	Description
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.
EC # EC?	Echo. Parameters: 0=echo characters off (Default: 0), 1=echo characters on. EC? returns echo state.
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,MicroJewel,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.
RC # RC?	Recall settings from user bin 1-6. 0 = recall factory defaults.
RR #.# RR? RR:MIN? RR:MAX?	Repetition Rate. This sets the rate at which the laser will fire at. Values are from 1-30 Hz. (Default: 1 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
7	6	5	4	3	2	1	0
Resonator Over	External Interlock	Reserved	Reserved	Diode External	Reserved	Laser Active	Laser Enabled

Temp				Trigger			
SV # SV?	Save settings to user bin 1-6.						
TR? TR:MAX?	Resonator thermistor temperature in degrees C. A MAX query will return the limit 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)

H0?	Heater installed (0 = No, 1 = Yes)
H0:SP?	Heater setpoint. Target heater setting, in degrees C.
H0:TP?	Heater temperature. Active temperature of the heater in degrees C

8. MAINTENANCE

SERVICE PROCEDURES

No User-Serviceable Parts Inside

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

9. TROUBLE-SHOOTING

The MicroJewel 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 head and the laser control box. Make sure all connections are secured. If any of the cables are not installed properly, the system will not function.
3. Check Shutter Position. Make sure the shutter is in the open position.

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.

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

micro JEWEL SPECIFICATIONS		
OUTPUT ENERGY [mJ]1		
Configurations	1064nm	532nm
1064	≥ 7.5	
1064/532	≥ 3	≥ 2.5
REP RATE (Hz)		
	1 to 30Hz (Nominal) 30-50Hz (8)	
NEAR FIELD BEAM DIAMETER [mm] 2		
	1.25 ± 0.5	1.25 ± 0.5
BEAM DIVERGENCE [mrad] 3		
	≤ 6.0	≤ 5.0
RMS STABILITY [%] 4		
	≤ 2.5	≤ 3.5
ENERGY VARIANCE [%] 5		
	≤ 5.0	≤ 7.0
PULSEWIDTH [ns] 6		
	6 ± 2	6 ± 2
TIMING JITTER [us]		
	1 RMS	
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		
	15 min	

TEMPERATURE [°C]	
OPERATING	15 to 30
STORAGE	-10 to 50

RESONATOR SIZE	
inches	1064nm 3.56" L .63" Dia; 532nm 4.32" L .63" Dia
mm	1064nm 90.5 mm L 16mm Dia ; 532nm 110mm L 16mm Dia

POWER REQUIREMENTS	
	40-50VDC (48 V Nominal) @ 0.5A (20W Max) @ 20Hz 40-50VDC (48 V Nominal) @ 0.8A (30W Max) @ 50Hz

DIODE DRIVER & CONTROLLER	
inches	3.65 x 3.00 x 1.96
mm	(95.6 x 76.2 x 49.8)

CABLE LENGTH	
inches	24
cm	61

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 1000 shots after a 100 shot turn-on at 5 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 5 Hz operation.

6 Pulsewidth is measured at 5 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 theangular 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 5 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 CONNECTION PINOUT

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.

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		100us	
Jitter		2us p-p	

Sync Output

The sync output connector provides a signal that represents the diode pulse.

Sync Out Specifications	
Voltage Output Range	5V (+/-100mV)
Connector Type	SMA Female Jack
Insertion Delay	2us
Jitter	60us p-p

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

MicroJewel- 1064 nm

MicroJewel- 532nm

Polarization with respect to reference

SCALE 1:1

Laser Aperture

532 nm Polarization Reference

$\emptyset .625^{+.000}_{-.002}$

3/16" $\emptyset$ Heater Controller Wire Bundle

3/16" $\emptyset$ Laser Wire Bundle

4.23
3.46
2.750
2.33
1.525
.900
0
.02'
0

Conductive Cooling Area Hi Rate

Conductive Cooling Area STD Rate

Must be thermally coupled to Heat Sink for performance spec to be met. Must have clearance for heater interface wire bundle.

Heat Sink Requirements:
see manual
30° C maximum

Thermal Material MUST NOT stress surface.
USE Bergquist 1100SF, Bergquist 2200SF or suitable equivalent.

Quantum Composers

MicroJewel
SHG Laser, 532nm

300005-500

ZONE	REV	REVISION DESCRIPTION	DATE	APPROVED
	1	PRELIMINARY RELEASE		
	2	CHNG'D RESONATOR DIA FRM .50	11/12/2018	
	3	CHNG'D HI RATE COOLING AREA	6/29/2021	J Visser

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Quantum Composers

uJewel Ctrlr

USB

SIZE B | DWG. NO. 300005-753 | REV. 1

SCALE 3:4 | SHEET 1 OF 1

CAD GENERATED DRAWING, DO NOT MANUALLY UPDATE

APPROVALS | DATE
DRAWN J Visser | 2/19/2021
CHECKED
REF ENG J Visser | 2/19/2021
THIRD ANGLE PROJECTION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCE:
FINISH: DECIMALS ANGLES
63 √   .XX ±.01   ±1/2
.XXX ±.005
BREAK SHARP EDGES .005"
MATERIAL SEE NOTES
FINISH SEE NOTES
DO NOT SCALE DRAWING

ZONE	REV	REVISION DESCRIPTION	DATE	APPROVED
	1	PRELIMINARY RELEASE		

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF QUANTUM COMPOSERS. ANY REPRODUCTION IN PART OR WHOLE WITHOUT THE WRITTEN PERMISSION OF QUANTUM COMPOSERS IS PROHIBITED.

DANGER

LASER EMISSION

1.95
1.18
0
2.00
1.00
0

.42
0
2.96
3.12
3.15
3.82

2X .25
.750
1.500
2.250
2X 2.75
0
2X .25
2X .300
2.050
2X 2.15
3X Ø .312 RUBBER FEET
3X 4-40 UNC - 2B ▽ .224
Ø .250 MOUNTING FEET

1.46
1.42
.56
.43
.010
0
.05
0
.63
.65
2.50

Power
Fault
Gate Trig
Sync Out
USB

Optical Table Heat Sink
Mechanical Interface

microJewel must be thermally coupled to
Heat Sink for performance spec to be met.

Thermal material MUST NOT stress surface.
USE Bergquist 2200SF .020" thk, Bergquist 1100SF,
or equivalent.

FRONT

SIDE

BOTTOM

2X Ø .266 THRU

8-32 UNC - 2B THRU ALL

2X 4-40 UNC - 2B THRU
BOTTOM HALF

2X THRU HOLE FOR 1/4-20 UNC SHC SCREWS

8-32 THRD THRU

Quantum Composers

microJewel 1064nm
w/ heat sink

300005-523

Narrow Body Heat Sink
Mechanical Interface

microJewel must be thermally coupled to
Heat Sink for performance spec to be met.

Thermal material MUST NOT stress surface.
USE Bergquist 3004SF .010" thk, Bergquist 11005F,
or equivalent.

FRONT

SIDE

BOTTOM

2X C'BORE FOR #4 SHC SCREW

8-32 THRU
.22 MAX SCREW DPTH

MOUNT FACE
FLUSH W/ HEAT SINK

2X Ø .129 THRU
⌴ Ø .219 FAR SIDE

8-32 UNC - 28 ▽ .22 MAX

1/4" DIA POWER
CABLE EXITS HERE

Quantum Composers

microJewel Narrow Body
Heat Sink

300005-669

13. CUSTOMER SERVICE

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.