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**Technical Support**

**In the U.S.:**

Should you experience any difficulties with your laser or need any technical information, please go to our web site www.Coherent.com. Should you need further assistance, please contact Coherent Technical Support by e-mail Product.Support@Coherent.com or telephone, 1-800-367-7890 (1-408-764-4557 outside the U.S.). Please be prepared to supply the model and laser head serial number of your laser system also the description of the problem and any attempted corrective steps to the Product Support Engineer responding to your request.

Telephone coverage is available Monday through Friday (except U.S. holidays and company shutdowns). Inquiries received outside of normal office hours will be captured by our automatic answering system and will be quickly returned the next business day.

**Outside the U.S.:**

If you are located outside the U.S., please visit www.Coherent.com for technical assistance, or contact your local Service Representative. Service Representative telephone numbers and addresses can be found on the Coherent web site.

Coherent provides telephone and web-based technical assistance as a service to its customers and assumes no liability for any injury or damage that can occur at the same time with such services. Under no conditions do these support services effect the terms of any warranty agreement between Coherent and the buyer. Operation of any Coherent laser with any of its interlocks defeated is always at the operator's own risk.
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This documentation may contain sections in which particular hazards are defined or special attention is drawn to particular conditions. These sections are indicated with signal words in accordance with ANSI Z-535.6 and safety symbols (pictorial hazard alerts) in accordance with ANSI Z-535.3 and ISO 7010.

Signal Words and Symbols in this Manual

Four signal words are used in this documentation: DANGER, WARNING, CAUTION and NOTICE.

The signal words DANGER, WARNING and CAUTION designate the degree or level of hazard when there is the risk of injury:

---

**DANGER!**
Indicates a hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

---

**WARNING!**
Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

---

**CAUTION!**
Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

---

The signal word “NOTICE” is used when there is the risk of property damage:

---

**NOTICE!**
Indicates information considered important, but not hazard-related.

---

Messages relating to hazards that could result in both personal injury and property damage are considered safety messages and not property damage messages.
Symbols

The signal words DANGER, WARNING, and CAUTION are always emphasized with a safety symbol that indicates a special hazard, regardless of the hazard level:

This symbol is intended to alert the operator to the presence of important operating and maintenance instructions.

This symbol is intended to alert the operator to the danger of exposure to hazardous visible and invisible laser radiation.

This symbol is intended to alert the operator to the presence of dangerous voltages within the product enclosure that may be of sufficient magnitude to constitute a risk of electric shock.

This symbol is intended to alert the operator to the danger of Electro-Static Discharge (ESD) susceptibility.

U.S. Export Control Laws Compliance

It is the policy of Coherent to comply strictly with U.S. export control laws.

Export and re-export of lasers manufactured by Coherent are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components are regulated by the State Department under the International Traffic in Arms Regulations.

The applicable restrictions vary depending on the specific product involved and its destination. In some cases, U.S. law requires that U.S. Government approval be obtained prior to resale, export or re-export of certain articles. When there is uncertainty about the obligations imposed by U.S. law, clarification should be obtained from Coherent or an appropriate U.S. Government agency.
Read this manual carefully before operating the laser for the first time. Special attention should be given to the material in “Section One: Laser Safety” that describes the safety features built into the laser.
SECTION ONE: LASER SAFETY

NOTICE!
This user information is in compliance with section 1040.10 of the CDRH Performance Standards for Laser Products from the Health and Safety Act of 1968.

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

This laser safety section must be reviewed thoroughly prior to operating the Monaco laser system. Safety instructions presented throughout this manual must be followed carefully.

Hazards

Hazards associated with lasers generally fall into the following categories:

- Exposure to laser radiation that may damage the eyes or skin
- Electrical hazards generated in the laser power supply or associated circuits
- Chemical hazards resulting from contact of the laser beam with volatile or flammable substances, or released as a result of laser material processing

The above list is not intended to be exhaustive. Anyone operating the laser must consider the interaction of the laser system with its specific working environment to identify potential hazards.
Optical Safety

Laser light, because of its special qualities, poses safety hazards not associated with light from conventional sources. The safe use of lasers requires all operators, and everyone near the laser system, to be aware of the dangers involved. Users must be familiar with the instrument and the properties of coherent, intense beams of light.

The safety precautions listed below are to be read and observed by anyone working with or near the laser. At all times, ensure that all personnel who operate, maintain or service the laser are protected from accidental or unnecessary exposure to laser radiation exceeding the accessible emission limits listed in ‘Performance Standards for Laser Products,’ United States Code of Federal Regulations, 21 CFR 1040.10(d).

**DANGER!**
*Direct eye contact with the output beam from the laser will cause serious damage and possible blindness.*

The greatest concern when using a laser is eye safety. In addition to the main beam, there are often many smaller beams present at various angles near the laser system. These beams are formed by specular reflections of the main beam at polished surfaces such as lenses or beamsplitters. While weaker than the main beam, such beams may still be sufficiently intense to cause eye damage.

Laser beams are powerful enough to burn skin, clothing or paint even at some distance. They can ignite volatile substances such as alcohol, gasoline, ether and other solvents, and can damage light-sensitive elements in video cameras, photomultipliers and photodiodes. The user is advised to follow the precautions below.

**Recommended Optical Precautions and Guidelines**

1. Observe all safety precautions in this operator’s manual.
2. All personnel should wear laser safety glasses rated to protect against the specific wavelengths being generated. Protective eyewear vendors are listed in the Laser Focus World, Lasers and Optronics, and Photonics Spectra Buyer’s guides. Consult the ANSI, ACGIH, or OSHA standards listed at the end of this section for guidance. Avoid wearing watches, jewelry, or other objects that may reflect or scatter the laser beam.
3. Stay aware of the laser beam path, particularly when external optics are used to steer the beam.
4. Provide enclosures for beam paths whenever possible.
5. Use appropriate energy-absorbing targets for beam blocking.
6. Block the beam before applying tools such as Allen wrenches or ball drivers to external optics.
7. Limit access to the laser to qualified users who are familiar with laser safety practices. When not in use, lasers should be shut down completely and made off-limits to unauthorized personnel.
8. Terminate the laser beam with a light-absorbing material. Laser light can remain collimated over long distances and therefore presents a potential hazard if not confined. It is good practice to operate the laser in an enclosed room.
9. Post warning signs in the area of the laser beam to alert those present.
10. Exercise extreme caution when using solvents in the area of the laser.
11. Never look directly into the laser light source or at scattered laser light from any reflective surface. Never sight down the beam.
12. Set up the laser so that the beam height is either well below or well above eye level.
13. Avoid direct exposure to the laser light. Laser beams can easily cause flesh burns or ignite clothing.
14. Advise all those working with or near the laser of these precautions.

---

**DANGER!**
Laser safety glasses protect the user from eye damage by blocking light at the laser wavelengths. Exercise extreme caution even while wearing safety glasses.

---

**Electrical Safety**

**Recommended Electrical Precautions**
The following precautions must be observed by everyone when working with potentially hazardous electrical circuitry:
1. Disconnect main power lines before working on any electrical equipment when it is not necessary for the equipment to be operating.

2. Do not short or ground the power supply output. Protection against possible hazards requires proper connection of the ground terminal on the power cable, and an adequate external ground. Check these connections at the time of installation, and periodically thereafter.

3. Never work on electrical equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment, and who is competent to administer first aid.

4. When possible, keep one hand away from the equipment to reduce the danger of current flowing through the body if a live circuit is touched accidentally.

5. Always use approved, insulated tools.

6. Special measurement techniques are required for this system. A technician who has a complete understanding of the system operation and associated electronics must select ground references.

Safety Features and Compliance with Government Requirements

The following features are incorporated into the instrument to meet several government requirements. The applicable United States Government requirements are in 21 CFR, Subchapter J, part 1040, administered by the Center for Devices and Radiological Health (CDRH). The European Community requirements for product safety are specified in the Low Voltage Directive (LVD) (published in 73/23/EEC and amended in 93/68/EEC). The Low Voltage Directive requires that lasers comply with the standard EN 61010-1/IEC 61010-1, “Safety Requirements For Electrical Equipment For Measurement, Control and Laboratory Use,” and EN 60825-1/IEC 60825-1, “Safety of Laser Products.” Compliance of this laser with the LVD requirements is certified by the CE mark.

CDRH/IEC 60825-1 Compliance

When used with the Monaco power supply, the Monaco laser head complies with CDRH (21 CFR 1040.10 and 1040.11).

NOTICE
To be CDRH compliant, you must use the Coherent power supply with the laser head, the laser head alone is not CDRH compliant.
Laser Classification

Governmental standards and requirements specify that the laser must be classified according to the output power or energy and the laser wavelength. The Monaco is classified as Class 4 based on 21 CFR, Subchapter J, part 1040, section 1040.10 (d). According to the European Community standards, Monaco lasers are classified as Class 4 based on EN 60825-1, clause 9.

Protective Housing

The laser head is enclosed in a protective housing that prevents human access to radiation in excess of the limits of Class 1 radiation as specified in the 21 CFR, Part 1040 Section 1040.10 (f)(1) and Table 1-A/EN 60825-1/IEC 60825-1 clause 4.2 except for the output beam, which is Class 4.

WARNING!
There are NO serviceable items in the laser head or power supply except those shown in the desiccant replacement procedure. Any opening to break the sealing of the laser head or power supply is not permitted. Do not remove any item from the protective housing except those shown in the desiccant replacement procedure. Opening or breaking the laser head sealing, except as specified in the desiccant replacement procedure, will void the manufacturer’s warranty.

Remote Interlock Connector

The Monaco laser system is equipped with an external interlock connector on the rear panel of the laser Head. The terminals of this connector must be electrically joined for the laser to operate [CFR 1040.10 (f)(3)/ EN 60825-1/IEC 60825-1, Clause 4.4].

Key Control

Operation of the Monaco requires that the power supply keyswitch be in the ON position. The key is removable in the Off position. The system cannot be operated when the key is removed [CFR 1040.10 (f)(4)/ EN 60825-1/IEC 60825-1, Clause 4.5].

Laser Radiation Emission Indicators

The LASER EMISSION indicators on both the power supply and the laser head lights approximately 30 seconds before laser emission can occur. The indicators are visible without exposing the operator to laser emission. White lights are used that are visible while wearing the proper type of safety glasses [CFR 1040.10(f)(5)/ EN 60825-1/IEC 60825-1, clause 4.6].
The Monaco laser system is classified by the United States National Center for Device and Radiological Health (CDRH) as a CLASS 4 laser product. It may emit visible or invisible laser radiation wavelengths of 0.9 to 1.1 μm from the aperture in the front of the laser head.

**Beam Attenuator**

An internal AOM prevents exposure to all laser radiation without removing power from the system [CFR 1040.10 (f)(6)/EN 60825-1/IEC 60825-1, clause 4.7].

**Operating Controls**

The laser is controlled remotely through its Ethernet, RS232, or USB port. Position the control computer so that the operator has no exposure to laser emission while manipulating the controls. [CFR 1040.10(f)(7)/EN 60825-1/IEC 60825-1, clause 4.8]

**Manual Reset Mechanism**

Following an interlock fault or unexpected loss of electrical power, the shutter automatically closes, the laser diodes turn off, and any internally triggered pulsing is disabled. To resume operation clear the fault, turn on the laser diodes, and enable pulsing through the laser’s USB, Ethernet, or RS232 interface. The shutter can be reopened through the laser’s USB, Ethernet, RS232, or I/O interface or by pressing the SHUTTER OPEN button on the power supply front panel [CRF 1040.10(f)(10)/EN 60825-1/IEC 60825-1, clause 4.11].

---

**DANGER!**

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

---

**DANGER!**

Use of the system in a manner other than that described herein may impair the protection provided by the system.

---

**Electromagnetic Compatibility**

The European requirements for Electromagnetic Compliance (EMC) are specified in the EMC Directive (published in 89/336/EEC).
Conformance to EMC requirements is achieved through compliance with the harmonized standards CISPR 11 (EN61326-1:2013) for emission and EN61000-6-1 for immunity.

The laser meets the emission requirements for Class A, Group 1, as specified in CISPR 11 (EN61326-1:2013).

Compliance of this laser with the EMC requirements is certified by the CE mark.

**Waste Electrical and Electronic Equipment (WEEE, 2002)**

The European Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) is represented by a crossed-out garbage container label (see Figure 1-1). The purpose of this directive is to minimize the disposal of WEEE as unsorted municipal waste and to facilitate its separate collection.

![Figure 1-1. Waste Electrical and Electronic Equipment Label](image)

**Location of Safety Labels**

Refer to Figure 1-2 for a description and location of all safety labels. These include warning labels indicating removable or displaceable protective housings, apertures through which laser radiation is emitted and labels of certification and identification [CFR 1040.10(g), CFR 1040.2, and CFR 1010.3/ EN 60825-1/ IEC 60825-1, Clause 5].
Figure 1-2. Safety Features and Labels (Sheet 1 of 3)
1. Aperture Warning

2. Radiation Warning

3. Laser Head Serial Number Identification

4. Caution Mark

5. CE Certification

Figure 1-2. Safety Features and Labels (Sheet 2 of 3)
6. VOLTAGE RATING

7. RADIATION WARNING

8. PATENT LABEL

9. CHINA RoHS

10. POWER SUPPLY SERIAL NUMBER IDENTIFICATION

Figure 1-2. Safety Features and Labels (Sheet 3 of 3)
Sources of Additional Information

The following are sources for additional information on laser safety standards and safety equipment and training.

Laser Safety Standards

*American National Standard for Safe Use of Lasers*
- ANSI Z136 series
- American National Standards Institute (ANSI)
  - [www.ansi.org](http://www.ansi.org)

*A Guide for Control of Laser Hazards*
- American Conference of Governmental and Industrial Hygienists (ACGIH)
  - [www.acgih.org](http://www.acgih.org)

- IEC TR 60825-14
- International Electrotechnical Commission (IEC)
  - [www.iec.ch](http://www.iec.ch)

Equipment and Training

*Laser Focus Buyer’s Guide*
- Laser Focus World
  - [www.laserfocusworld.com](http://www.laserfocusworld.com)

*Photonics Spectra Buyer’s Guide*
- Photonics Spectra
  - [www.photonics.com](http://www.photonics.com)
SECTION TWO: DESCRIPTION AND SPECIFICATIONS

System Description

The Monaco laser system is an ultrafast diode-pumped fiber laser with pulse repetition rates from single shot to 1000 kHz.

Monaco sets superior levels of reliability and cost of ownership, unmatched by other femtosecond lasers. The unique SoloBoard™ electronics interface reduces all laser management to a single head board.

Monaco’s compact laser head is machined from a single block of stress-relieved aluminum. This monolithic structure ensures an optical alignment that is kept during the life of the laser. This head encases all of the optical, electrical, and control elements. There are no umbilicals, no outmoded wiring harnesses between power supply boards, and no remotely located pump diodes. Furthermore the laser head acts as its own clean room environment, thanks to the onboard PureFemto™ cleaning engine that is constantly cleaning the interior of the laser.

The Monaco design and assembly is done under the industry’s most stringent test benchmarks. HALT (Highly Accelerated Life Test) and HASS (Highly Accelerated Stress Screen) standards are the hallmarks of the design philosophy behind the Monaco. All components, as well as the full system, are tested to environmental levels well beyond normal application conditions. This attention to vigorous testing ensures that the Monaco quality and reliability levels are beyond that of any other femtosecond laser.

Figure 2-1. Monaco Laser System
Monaco Laser Head

The optical elements of the laser head include a seed laser, seed acousto-optic modulator (AOM), amplifier, and amplifier acousto-optic modulator (AOM).

The Monaco features several modes of operation for precise control over the output pulses. See “Operating Modes” on page 4-12 for a complete description of seed laser and amplifier functionality. See Figure 2-2 below for the seed laser and amplifier block diagram.

![Laser Head Block Diagram - Seed Laser & Amplifier with AOM](image)

**Figure 2-2. Laser Head Block Diagram - Seed Laser & Amplifier with AOM**

Seed AOM & Microburst

A modelocked seed laser provides a 60 MHz pulse train for subsequent pulse picking and amplification. A fast AOM on the seed laser output allows the 60 MHz pulse train to be divided-down to achieve lower repetition rates, and suitable gating of the seed AOM offers single or microbursts of pulses in the reduced repetition rate pulse-train. The pulse train is then delivered to the amplifier.

User settings allow control of the reduced repetition rate from the seed AOM and the number of pulses in each microburst. This seed microburst allows pulses to be delivered separated by 17 ns. An example of a microburst containing 5 pulses is shown in Figure 2-3.

Amplifier AOM & Laser Output

The pulse train from the seed AOM is further amplified in a high-gain amplifier, which exits the laser through an amplifier AOM. The amplifier AOM allows a wide range of gating, power tuning and pulse selection options. For a full description of these options see “” on page 4-13. The user has multiple options with the seed AOM in conjunction with amplifier AOM.
A Customer Data Sheet is sent with the Monaco system. Specifications for all Coherent products can be found at [www.Coherent.com](http://www.Coherent.com).

**Specifications**

**Table 2-1. Monaco Specifications**

<table>
<thead>
<tr>
<th><strong>PARAMETER</strong></th>
<th><strong>MONACO</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength (nm)</td>
<td>1035 +/- 5</td>
</tr>
<tr>
<td><strong>MONACO 1035-40-1</strong></td>
<td></td>
</tr>
<tr>
<td>Average Output Power (W)</td>
<td>&gt;40 @ 1 MHz</td>
</tr>
<tr>
<td>Energy per Pulse (µJ)</td>
<td>&gt;40 over entire output rep rate range</td>
</tr>
<tr>
<td>Pulse Repetition Rate Range (kHz)</td>
<td>Single Shot to 1 MHz</td>
</tr>
<tr>
<td><strong>COMMON SPECIFICATIONS</strong></td>
<td></td>
</tr>
<tr>
<td>Spatial Mode</td>
<td>TEM$_{00}$ (M$^2$ &lt;1.2)</td>
</tr>
<tr>
<td>Pulse Duration (fs)$^a$</td>
<td>&lt;400$^b$</td>
</tr>
<tr>
<td>Energy in pedestal or pre/post pulses</td>
<td>&lt; 5 %</td>
</tr>
<tr>
<td>Average Power Stability (RMS 2σ over 8 hours)</td>
<td>&lt;2%</td>
</tr>
<tr>
<td>Pulse-to-Pulse Stability (RMS 1σ over 5 min)</td>
<td>&lt;2% at 1 MHz</td>
</tr>
<tr>
<td>Polarization Ratio</td>
<td>&gt;100:1 Vertical</td>
</tr>
<tr>
<td>Beam Diameter 1/e$^2$ (mm)</td>
<td>3.0 ± 0.3$^c$</td>
</tr>
</tbody>
</table>
### Table 2-1. Monaco Specifications (Continued)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam Divergence (mrad, 2Φ)</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>Beam Circularity</td>
<td>&gt;0.9</td>
</tr>
<tr>
<td>Boresight Accuracy (referenced to mounting features on laser head)</td>
<td>±0.5 mm and ±5 mrad</td>
</tr>
</tbody>
</table>

All specifications are subject to change without notice.

a. < 400fs to >10ps for lasers equipped with the pulse-width adjustment option.
b. Based on sech$^2$ deconvolution factor of 0.65 times autocorrelation width.
c. Measured at 1m in front of laser output aperture.

### Table 2-2. Environmental Specifications

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OPERATING SPECIFICATIONS</strong></td>
<td></td>
</tr>
<tr>
<td>Temperature (Non-Condensing):</td>
<td></td>
</tr>
<tr>
<td>Laser Head</td>
<td>+10 to 30°C (50 to 86°F)</td>
</tr>
<tr>
<td>Power Supply</td>
<td>+10 to 30°C (50 to 86°F)</td>
</tr>
<tr>
<td>Relative Humidity:</td>
<td>5 to 65%</td>
</tr>
</tbody>
</table>

| **NON-OPERATING SPECIFICATIONS** | |
| Shipping/Storage Temperature (Non-Condensing): | -20 to +60°C (-4 to 140°F) |

### Table 2-3. Laser System Dimensions

<table>
<thead>
<tr>
<th>POWER SUPPLY</th>
<th>LASER HEAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>37.8 cm (14.9 in.)</td>
</tr>
<tr>
<td>Width</td>
<td>19.3 cm (7.6 in.)</td>
</tr>
<tr>
<td>Height</td>
<td>8.4 cm (3.3 in.)</td>
</tr>
<tr>
<td>Weight</td>
<td>4.5 kg (10.0 lb)</td>
</tr>
</tbody>
</table>

**POWER SUPPLY CABLE LENGTH:** 3 m (10 ft.)
SECTION THREE: INSTALLATION

Receiving and Inspection

Inspect the shipping containers for indication of rough handling or damage. Record any signs of damage on the bill of lading. Report any damage immediately to the shipping carrier and to Coherent Order Administration Department (800-438-6323) or to an authorized Coherent representative.

---

Keep the original shipping containers. The container is necessary if the system is returned to the factory for service. The containers may also be needed to support a shipping damage claim.

---

DANGER!
To prevent injury, Coherent recommends that at least two people unpack and transport the Monaco laser system.

---

Installation

This section describes the Monaco electrical interface and provides quick-start instructions with commands to control the laser. The Monaco continues to be refined before production and any information in this document is subject to change. Refer to future revisions of this manual for updated descriptions of the interface.

---

It is the customer’s responsibility to comply with IEC60825 safety standards during any use of the signals supplied in this document.

---

Hardware Setup

Remove the laser head, power supply and chiller from their shipping crates.

1. Coherent recommends that at least two people unpack and transport the Monaco laser system. The power supply weight is approximately 4.5 kg (10 lb) and the laser head weight is approximately 38.6 kg (85 lb).
2. Arrange the chosen power supply and the laser head into their operating positions in an accessible location, preferably away from heat sources. Confirm the power supply cooling air intake and exhaust (front and back) are not blocked or obstructed (refer to Figure 4-14 and Figure 4-15). Coherent recommends using a kinematic alignment plate to enhance the mounting repeatability of the laser head.

3. Remove the protective plate mounted to the front of the laser over the aperture.

4. Block the laser beam using a beam attenuator.

5. Refer to Figure 3-1 while performing the following instructions.

---

**Figure 3-1. Laser Head Connections**

1. Extended Interface
2. EXT MOD Input
3. Gate 1
4. Gate 2
5. Sync 1
6. Sync 2
7. USB Connector
8. Ethernet Connector
9. RS-232 Connector
10. Chiller RS232
11. External Interlock
12. Power Supply Cable
13. Coolant In
14. Coolant Out
15. Desiccant Cartridge Access
6. Connect the power supply cable to the laser head and to the power supply.

7. Insert the Chiller, Extended Interface, and Interlock cables into the applicable connectors on the laser head.

8. Connect and secure the RS-232 connector from the Chiller/Control/Interlock cable to the chiller RS-232 control. Connect the AC power cord to the rear of the power supply.

9. Connect the power supply AC power cord to building power.

### Table 3-1. Laser System Dimensions

<table>
<thead>
<tr>
<th></th>
<th>Power Supply</th>
<th>Laser Head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>37.8 cm (14.9 in.)</td>
<td>70.5 cm (26 in.)</td>
</tr>
<tr>
<td>Width</td>
<td>19.3 cm (7.6 in.)</td>
<td>37.5 cm (14.8 in.)</td>
</tr>
<tr>
<td>Height</td>
<td>8.4 cm (3.3 in.)</td>
<td>17.5 cm (6.9 in.)</td>
</tr>
<tr>
<td>Weight</td>
<td>4.5 kg (10.0 lb)</td>
<td>38.6 kg (85.0 lb)</td>
</tr>
</tbody>
</table>

**Power Supply Cable Length:** 3 m (10 ft.)

---

**Chiller Setup**

---

**NOTICE!**
If additional external coolant plumbing lines or fittings are required for the chiller, use only plastic fittings and opaque high-quality hose (such as food grade) with no stop valves. To prevent damage, DO NOT use any metal materials (for example brass, stainless steel, or copper).

---

To minimize the pressure drop and maximize the chiller efficiency through the connecting hoses, the chiller should be put as close as possible to the laser head. Coolant lines are best run at or near the same level as the cooling system. For more information, refer to the chiller product manual and the addendum “Thermal Management.”

1. Connect the coolant lines between the chiller and the laser head. Inlet and outlet connections for the coolant hoses must match with the label.

2. Check that fittings are tight to prevent leaks.
NOTICE!
To prevent damage to the Monaco system, use ONLY distilled water (with 20% to 25% CoolFlow) in the chiller’s closed loop system. DO NOT use facility tap or deionized water.

3. Fill the chiller reservoir with the coolant specified in the addendum section “Thermal Management.”

4. Connect the chiller AC power cord to facility power.

Chiller RS-232
Coherent uses a custom cable to connect between the chiller and Monaco head. Although some RS-232 signals are used, most signals are not standard and require a special cable to select the appropriate signals to match the chiller. The TermoTek P307 chiller is recommended. The connector on the laser is a female 9-pin D-Sub. Do not plug this connector into any other equipment.

Monaco Connectors
There are twelve connectors on the back of Monaco laser head to connect equipment. Figure 3-1 shows the location of the connectors.

Computer Interface
A Windows computer is the user interface necessary to operate the Monaco laser system. The Monaco can be connected to the computer through an Ethernet, USB, or RS-232 interface.

RS-232 Connector
The customer RS-232 connection is a standard female 9-pin D-sub (DE-9) connector. A cable with a male connector is required to use this interface. The RS-232 pins shown in Table 3-2 must be connected. The only data rate supported is 19200 Baud.

Table 3-2. RS-232

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL_NAME</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>TxD</td>
<td>Transmit data (RX into laser).</td>
</tr>
<tr>
<td>2</td>
<td>RxD</td>
<td>Receive data (TX from laser).</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Common ground</td>
</tr>
<tr>
<td>1,4,6,7, 8,9</td>
<td></td>
<td>No connection.</td>
</tr>
</tbody>
</table>
USB Connector

This connection uses a standard USB connector on a PC for computer control of the laser. The USB connector uses the industry standard type B receptacle. The USB uses industry standard signal levels and Microsoft's RNDIS protocol.

Ethernet Connector

The Ethernet connector uses the industry standard receptacle for an RJ45 connector (sometimes called an 8P8C connector). It connects to a switch, router or PC using a Cat 5 cable. Once the IP address of the laser is known, a Telnet session can be established to the Monaco using the same commands as the RS-232 or USB connections.

The laser automatically acquires an IP address from a DHCP server if one is provided on the Ethernet network.

If the network does not have a DHCP server (for example, in a tool with a private network), then by default the laser will scan from 192.9.200.1 to 192.9.200.255 to find an unused IP address. This range can be changed with the IPMIN and IPMAX commands, respectively.

The laser can be assigned a static IP address by setting AUTOIP=0 and IP=nn.nn.nn.nn. There are other commands that can be useful to a network administrator for unusual configurations. Type the queries ?HELP NET or ?HELP DHCP to see them all.

The Coherent GUI can display the IP address of the laser as long as the computer is on the same subnet as the laser. To see the IP address, from the GUI Main menu press the CONNECTION button, then the SEARCH button. The Ethernet Discovery screen appears, where the laser IP address can be identified with the corresponding laser serial number in the list. To connect a laser, select the laser you want to connect and press the CONNECT button. This establishes GUI connection with the selected laser and returns the GUI to the Main tab.

Interlocks

The system will not operate with an interlock circuit open. The fault can be cleared when the interlock is closed. The fault must be cleared to restart the laser.

Interlock Connector

The interlock connector is connected to customer equipment for safety, such as to switches on access doors. As long as the interlock connection is made, the laser will operate. A 12 mA current loop supplies power to this connection. A 3-pin ITT connector is used on the Monaco head with the following connections.

The recommended mating plug is ITT Cannon M-XL-3-11M.
The extended interface connector provides an OEM customer interface. Table 3-5 describes how each signal should be managed.

### Extended Interface

#### Table 3-3. Interlock Connector

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL NAME</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EXT_INTERLOCK+</td>
<td>Short to pin 2 to enable diode current; 24 V 12 mA. Short must be less than 100 ohms. Open must be greater than 100k Ω</td>
</tr>
<tr>
<td>2</td>
<td>EXT_INTERLOCK-</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>N/C</td>
<td>Reserved. Do not connect</td>
</tr>
</tbody>
</table>

#### Table 3-4. Extended Interface Connector

<table>
<thead>
<tr>
<th>Connector</th>
<th>Tyco Electronics 5205207-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mating connector</td>
<td>Tyco Electronics 5205208-1</td>
</tr>
</tbody>
</table>

#### Table 3-5. Extended Interface/RS-232 Connector Pinouts

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL_NAME</th>
<th>SIGNAL</th>
<th>DIR</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>Ground</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>+24V</td>
<td>+24 V</td>
<td>Out</td>
<td>4 A fuse - Monaco is able to drive 0.5 A max</td>
</tr>
<tr>
<td>3</td>
<td>EXT_INTERLOCK+</td>
<td>Current loop</td>
<td>Out</td>
<td>Pins 3 and 4 must be connected for the laser to operate. These signals should be connected to customer equipment for safety, such as switches on access doors.</td>
</tr>
<tr>
<td>4</td>
<td>EXT_INTERLOCK-</td>
<td>Current loop</td>
<td>In</td>
<td>–</td>
</tr>
<tr>
<td>5</td>
<td>LASER_READY</td>
<td>TTL</td>
<td>Out</td>
<td>High when laser is ready to pulse.</td>
</tr>
<tr>
<td>6</td>
<td>SYSTEM_STATUS</td>
<td>TTL</td>
<td>Out</td>
<td>High when status is OK. Low when Fault or warning occurs.</td>
</tr>
<tr>
<td>7,8,9,10</td>
<td>Reserved</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>11</td>
<td>Laser Shutdown</td>
<td>TTL</td>
<td>In</td>
<td>Hold low for 2–3 seconds to shutdown the laser. Pulled up through 10 k ohm resistor to 5V.</td>
</tr>
<tr>
<td>12</td>
<td>FF-Interlock</td>
<td>TTL</td>
<td>In</td>
<td>Pulled down through 10 k ohm resistor to ground. Connecting to ground disables laser.</td>
</tr>
</tbody>
</table>
The EXT MOD connection allows modulation of the output beam when in the external modulation mode. External modulation is enabled from the GUI Triggering tab (see Figure 4-4 on page 4-6), or by using the serial command EM=1. The fastest modulation possible is approximately a 200 kHz square wave.

**EX MOD Input**

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL NAME</th>
<th>SIGNAL</th>
<th>DIR</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Shutter Status: OPEN</td>
<td>TTL</td>
<td>Out</td>
<td>Direct connection to shutter (5 V = open)</td>
</tr>
<tr>
<td>14</td>
<td>Shutter Status: CLOSED</td>
<td>TTL</td>
<td>Out</td>
<td>Direct connection to shutter (5 V = closed)</td>
</tr>
<tr>
<td>15</td>
<td>Pulse Energy Control</td>
<td>0-5 V / 10 kΩ</td>
<td>In</td>
<td>Analog Input pulse energy control via AOM2 (relation is not linear). See section 3, below, for details on how to set the mode to use this pin.</td>
</tr>
<tr>
<td>16</td>
<td>GND Pulse Energy Control</td>
<td>Ground</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Shutter Control</td>
<td>TTL</td>
<td>In</td>
<td>Pulled down through 10 k ohm resistor to ground. Ground closes shutter.</td>
</tr>
<tr>
<td>18</td>
<td>GND Shutter Control</td>
<td>Ground</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Pulse Picker Enable</td>
<td>TTL</td>
<td>In</td>
<td>Pulled down through 10 k ohm to ground. High to allow control of the AOM2 pulse picker. Low to disable the AOM2 pulse picker. Output laser pulses stop when the AOM2 pulse picker is disabled.</td>
</tr>
<tr>
<td>20</td>
<td>GND Pulse Picker Enable</td>
<td>Ground</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>21,22,23,24,25</td>
<td>Reserved</td>
<td>No connection.</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Connector</th>
<th>HD-BNC Amphenol 034-1030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mating connector</td>
<td>Amphenol 034-5017</td>
</tr>
<tr>
<td>HD-BNC to BNC Adaptor</td>
<td>APH-BNCJ-HDNBNCP</td>
</tr>
<tr>
<td>HD-BNC to BNC cable 12&quot;</td>
<td>Amphenol 095-666-44815</td>
</tr>
</tbody>
</table>
Sync 1 and Sync 2

The sync connection allows synchronizing external events with the laser output by providing output signals which are synchronous with the laser pulses. The output signal is a fixed delay from laser pulse and 50 ns wide. The signals from both connectors are the same.

<table>
<thead>
<tr>
<th>Connector</th>
<th>HD-BNC Amphenol 034-1030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mating Connector</td>
<td>HD-BNC Amphenol 034-5017</td>
</tr>
<tr>
<td>HD-BNC to BNC Adaptor</td>
<td>APH-BNCJ-HDBNCP</td>
</tr>
<tr>
<td>HD-BNC to BNC Cable 12&quot;</td>
<td>Amphenol 095-666-44815</td>
</tr>
</tbody>
</table>

Signal levels/Impedance. Source is four parallel 74ACT541 drivers at 5.0 V. Designed to drive a 75 Ω line.

Gate 1 and Gate 2

The gate input connection provides external pulse control. Gate 1 is used to control the duration of a string of pulses. If the Pulse Mode is set to 1, laser pulses will be produced as long as the Gate 1 signal is high. Gate 2 is a spare for future use.

<table>
<thead>
<tr>
<th>Connector</th>
<th>HD-BNC Amphenol 034-1030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mating Connector</td>
<td>HD-BNC Amphenol 034-5017</td>
</tr>
<tr>
<td>HD-BNC to BNC Adaptor</td>
<td>APH-BNCJ-HDBNCP</td>
</tr>
<tr>
<td>HD-BNC to BNC Cable 12&quot;</td>
<td>Amphenol 095-666-44815</td>
</tr>
</tbody>
</table>

Signal levels/Impedance: 3.3 V to 5.0 V is a high input, 0 to 0.5 V low input. 100 Ω series resistor.
The umbilical connection between the power supply and head uses a 7W2 D-sub connector with the pinout shown in Table 3-10 below. The power supply has a receptacle, the laser has a plug. One or two LEDs may be wired in series with the key switch to provide an emission indication.

### Table 3-9. Power Supply Connector

<table>
<thead>
<tr>
<th>Connector</th>
<th>Norcomp 680S7W2203L401</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mating Connector</td>
<td>Norcomp 680S7W2103L401</td>
</tr>
</tbody>
</table>

### Table 3-10. Power Supply Cable

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL NAME</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>KEY_SW+</td>
<td>CDRH keyswitch input and emission indicator drive. Short to pin 5 indicates key is in the enabled position. Open indicates key off. Short must be less than 100 Ω. Open must be greater than 100 kΩ. 12 mA and 24 V.</td>
</tr>
<tr>
<td>2</td>
<td>SHUTTER LED+</td>
<td>Shutter position indicating LED is on when the shutter is open. Drive is 12 V at 3 kΩ when shutter is open. This is the LED anode connection.</td>
</tr>
<tr>
<td>3</td>
<td>SHUTTER BUTTON</td>
<td>Short this pin to pin 4 to request a change in the shutter state from open to close or close to open. 10 kΩ pull-up to 3.3 V. 511 Ω series resistance.</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>Shutter indicating LED cathode connection and reference for the shutter button.</td>
</tr>
</tbody>
</table>
Table 3-10. Power Supply Cable (Continued)

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL NAME</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>KEY_SW-</td>
<td>Key_SW- signal passes through an optocoupler to ground. This is used to sense the position of the keyswitch. The optocoupler output signal is then passed on to the microcontroller and safety circuits.</td>
</tr>
<tr>
<td>A1</td>
<td>48V</td>
<td>10 AWG wire recommended for connecting directly to the +48 V output of the power supply.</td>
</tr>
<tr>
<td>A2</td>
<td>GROUND_RETURN</td>
<td>10 AWG wire recommended for connecting directly to the Ground return of the power supply.</td>
</tr>
<tr>
<td>Shield</td>
<td>Chassis GND</td>
<td>Chassis connection for shielding.</td>
</tr>
</tbody>
</table>
Figure 3-4. Monaco Laser Head Dimensions
1. Exhaust Holes
2. Air Intake

*Figure 3-5. Monaco Power Supply Dimensions*
SECTION FOUR: OPERATION

DANGER!
To prevent injury or damage, the laser output must be blocked or pointed at a specified target. All personnel in the area must be wearing laser safety eyewear.

DANGER!
To prevent injury or damage, never move the laser head while the laser diodes are ON or the keyswitch on the power supply is enabled.

Operating States

This section describes the operation of the laser through the Coherent GUI program. The program is supplied on a USB drive included in the accessory kit. Refer to “Coherent GUI Installation” on page 5-1 for instructions on installing the program on the computer. Table 4-1 summarizes the operating states of the Monaco laser system.

Table 4-1. Operating States

<table>
<thead>
<tr>
<th>STATE</th>
<th>SWITCH POSITION</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>• Power Switch (rear panel): Off.</td>
<td>All functions off.</td>
</tr>
<tr>
<td></td>
<td>• All other switches: Any position.</td>
<td></td>
</tr>
<tr>
<td>STANDBY</td>
<td>• Power Switch (rear panel): On.</td>
<td>Temperature servos on.</td>
</tr>
<tr>
<td></td>
<td>• Key switch: STANDBY.</td>
<td>Current to laser diodes off.</td>
</tr>
<tr>
<td>LASER ENABLED</td>
<td>• Power Switch (rear panel): On.</td>
<td>Temperature servos on.</td>
</tr>
<tr>
<td></td>
<td>• Key switch: LASER ENABLE.</td>
<td>Current to laser diodes can be on or off.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pulsing can be on or off.</td>
</tr>
</tbody>
</table>
Laser Control
Coherent GUI

WARNING!
To prevent injury or damage, the laser output must be blocked or pointed at a specified target. All personnel in the area must be wearing laser safety eyewear.

Initial Start-up Procedure

To start the Monaco laser system, follow each of the steps in the order listed. If the power switch on the rear panel has been shut off, the Initial Start-up procedure must be used. Refer to Table 4-1 for more information.

After a complete shut down, the warm up time may take up to 40 minutes while the chiller temperature stabilizes to the set values. If a fault or system message occurs during either startup or operation, refer to “Fault Handling” on page 4-23.

Preliminary Steps

1. The chiller reservoir must be filled with distilled water mixed with Coolflow at 28% volume, the coolant lines are connected, the chiller AC switch is in the ON position, and the coolant is flowing.

2. Set the power supply keyswitch to the Standby position.

3. Set the power switch on the power supply rear panel to the ON position. The AC power indicator will illuminate.

4. Allow at least 40 minutes for the temperature servos and the chiller to get to operating temperature.

5. Wait for the emission LED to light on the power supply front panel.

6. Install/open the Coherent Monaco GUI on a PC.

After the preliminary steps of the Initial Start-up procedure have been completed, perform the Standby Start-up procedure below to complete the Initial Start-up.

---

1. If the indicator does not illuminate, refer to “Section Seven: Service and Maintenance” for more information.
Standby Start-up Procedure

For normal operation of the Monaco, Coherent recommends using the Standby Start-up procedure listed below to turn on the laser. Before restarting the laser after a Standby Shut-down has been performed, the rear panel power switch must be in the ON position and chiller temperature must be locked and stable\(^1\).

Refer to “Fault Handling” on page 4-23 if a fault message occurs during the start-up or normal operation.

1. Check that the coolant level in the chiller reservoir is full.
2. Block the laser beam using an appropriate beam attenuator.
3. Set up Communication (see Figure 4-1). On the GUI **Main menu tab**, in the Connection to Laser panel, select the CONNECTION button to open the Connection Options window.

![Monaco GUI for SNTesterDev2](image_url)

1. Main menu tab on the Coherent Monaco GUI
2. CONNECTION button

**Figure 4-1. Connecting GUI to Laser**

\(^1\) Laser in the standby state with main AC power on as described in Table 4-1.
4. In the Connection Options window select one of the following methods to set up the laser communication connection, then click the OK button (see Figure 4-2):

- RS232 Port or
- Ethernet Port or
- Modem port or
- USB Port

The Offline Mode enables review of Logdata files (See “Logging” on page 5-18). The Power Meter mode enables communication with an external power meter (See “Power Meter” on page 5-19).

---

1. For example, if an RS232 cable is used between the control computer and the laser, select RS232. The specific COM port can be selected from the menu if it is known, or check “Search All Ports.”
5. Set the power supply keyswitch to the ON position.

6. From the Main menu tab, select the Triggering tab to set up the preferred AOM Pulse Mode (see See “” on page 4-13).
7. On the Triggering tab, in the Triggering Setup panel, make the following selections (see Figure 4-4):

a.) Select Pulsing Enabled (this is a duplicate function to the Pulsing On/Off button on the Main tab).

b.) Select the External Triggering button if Gated or Burst Mode is desired (See “Gated Mode” on page 4-15).

c.) Select the External Energy Control button to adjust pulse energy (through EXT MOD Input port, see Figure 4-13).

d.) Select the Burst Mode button if Burst Mode is desired (See “Burst Mode” on page 4-16).

e.) Select the Divided Mode button if Divided Mode is desired (See “Divided Mode” on page 4-15).

f.) Enter a Burst Length value (if Burst Mode is selected).

g.) Enter a Frequency Divider value (if Divided Mode is enabled).

Figure 4-4. Triggering Tab Selections

a. Pulsing Enabled  

b. External Triggering (enables Gated/Burst Modes)  

c. External Energy Control  

d. Burst Mode enable (requires External Triggering)  

e. Divided Mode enable  

f. Burst Length (requires Burst Mode)  

g. Frequency Divider (enables Divided Mode)
8. On the Main menu tab, in the Laser Output panel at the bottom of the screen, make the following selections (see Figure 4-5):

a.) From the Amplifier Rep Rate (kHz) drop down menu select the amplifier repetition rate (in kHz) and number of pulses in each microburst.

b.) For lasers with the variable pulse option, select the Pulse Width in femtoseconds (or picoseconds) if applicable,

Figure 4-5. Laser Output Panel Selections
9. Check that pulsing is turned on. On the Main menu tab, in the Pulsing panel, select the Switch On button (see Figure 4-6). Note that when pulsing is turned off, there is no laser output. This function allows output to be quickly switched on and off without requiring the laser to go through start up.

![Image of the Pulsing SWITCH ON button](Figure 4-6. Pulsing SWITCH ON Button)
10. Start the laser. On the Main menu tab, in the System Status panel, select the START button and wait for the System Status message “Laser On” to appear (see Figure 4-7).

1. START button

*Figure 4-7. START (the Laser) Button*
11. Open the shutter. On the Main menu tab, in the Shutter panel, select the OPEN button (see Figure 4-8). A message asks you to confirm that you want to open the shutter, and gives the option of not asking again.

12. Select the OK button. The status changes to “Shutter Open” and the shutter indicator lights.

1. Shutter OPEN button
2. System Status Indication

Figure 4-8. Shutter OPEN Button and System Status
Standby/ Shut Down

During normal operation the Monaco system can be put in Standby mode through the Coherent GUI. Using Standby mode eliminates the time necessary for warm up during the Initial Power-up procedure. To put the laser into Standby mode, do the following:

1. **Disable the AOM.** On the Main menu tab, in the Pulsing panel, change to OFF. The pulsing status indicator light goes out.

2. **Stop lasing.** On the Main menu tab, in the System Status panel, select the STOP button. The status reads “Laser Off” and the system status indicator light goes out.

3. Turn the keyswitch to the STANDBY position. (The key can be removed for safety.)

4. For the chiller, leave the AC Main Power switch on the back of the power supply in the ON position. The chiller can remain in the ON position and running.

Complete System Shut Down

Use this procedure when doing system maintenance or repair. To remove all electrical power from the Monaco, complete the previous Standby/Shut-down procedure, then do the following additional steps:

1. **Monaco laser:** Turn off the AC Main Power switch on the power supply rear panel.

2. **Chiller:** Turn off the AC Main Power to the chiller. Complete shut down of the laser can take up to two minutes. After complete shut down there is no connection to the Coherent GUI.
The Monaco laser system makes available several operating modes that can be used in different combinations. Through control of the Monaco’s seed AOM and amplifier AOM components, the pulse repetition rate, pulse width, and pulse energy can be adjusted from the Coherent GUI or by serial command. Table 4-2 below is a summary of the Monaco Operating Modes and the user selectable parameters to configure them.

Monaco lasers use patented techniques to maintain thermal equilibrium for the laser gain media and other optical components.

**Operating Modes**

The Monaco laser system makes available several operating modes that can be used in different combinations. Through control of the Monaco’s seed AOM and amplifier AOM components, the pulse repetition rate, pulse width, and pulse energy can be adjusted from the Coherent GUI or by serial command. Table 4-2 below is a summary of the Monaco Operating Modes and the user selectable parameters to configure them.

Monaco lasers use patented techniques to maintain thermal equilibrium for the laser gain media and other optical components.

**Figure 4-9. Laser Schematic and Laser Repetition Rates**

**Table 4-2. Monaco Operating Modes**

<table>
<thead>
<tr>
<th>PULSE MODE</th>
<th>SEED AOM</th>
<th>AMPLIFIER AOM</th>
<th>PULSING PARAMETER REQUIRED SET UP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous/ Microburst Figure 4-10</td>
<td>Sets ARR and number of pulses in microburst</td>
<td>Not used</td>
<td>Amplifier Repetition Rate (ARR) Microburst Pulses</td>
</tr>
<tr>
<td>Gated Figure 4-12</td>
<td>Sets ARR and number of pulses in microburst</td>
<td>Gates output On and Off</td>
<td>Amplifier Repetition Rate (ARR) Microburst Pulses</td>
</tr>
<tr>
<td>Divided</td>
<td>Sets ARR and number of pulses in microburst</td>
<td>Divides down ARR by factor RRD</td>
<td>Amplifier Repetition Rate (ARR) Microburst Pulses</td>
</tr>
</tbody>
</table>

Table 4-2. Monaco Operating Modes
Microburst mode groups multiple pulses into a short time window. The separation between pulses in the microburst is determined by the 60MHz seed laser repetition rate (SRR) and is approximately 17 nsec (see Figure 4-9 on page 4-12). The maximum energy for each pulse in the microburst is limited to 40uJ. The number of pulses in each microburst can be chosen from the values in the Coherent GUI amplifier rep rate drop down menu (see “Laser Output Panel Selections” on page 4-7). If a microburst contains only one pulse it is simply a continuous stream of single pulses at the amplifier repetition rate (ARR). The amplifier repetition rate is adjusted to maintain the maximum 40 W average power out of the laser. For example, at a 1 MHz amplifier repetition rate, changing the number of microburst pulses from 1 to 2 will decrease the amplifier repetition rate to 500kHz maintaining 40W output power. The repetition rate and the number of pulses in a microburst can be specified using the Coherent GUI drop down table (see Figure 4-5 on page 4-7), or through the serial command SET. If the SET command is used (see “SET Command” on page 6-17), the amplifier repetition rate and pulses per microburst entered must be limited to the values displayed in the GUI drop down menu. See Figure 4-10 below for an illustration of microburst mode.

<table>
<thead>
<tr>
<th>PULSE MODE</th>
<th>SEED AOM</th>
<th>AMPLIFIER AOM</th>
<th>PULSING PARAMETER REQUIRED SET UP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divided and Gated</td>
<td>Sets ARR and number of pulses in microburst</td>
<td>Divides down ARR by factor RDD Gates output On and Off</td>
<td>Amplifier Repetition Rate (ARR) Microburst Pulses Repetition Rate Divisor (RRD)</td>
</tr>
<tr>
<td>Burst</td>
<td>Sets ARR and pulse number in microburst</td>
<td>Sets BP pulses in burst output</td>
<td>Amplifier Repetition Rate (ARR) Microburst Pulses Burst Pulses Setting (BP)</td>
</tr>
<tr>
<td>Burst and Divided</td>
<td>Sets ARR and pulse number in microburst</td>
<td>Sets BP pulses in burst output Divides down ARR by factor RDD</td>
<td>Amplifier Repetition Rate (ARR) Microburst Pulses Burst Pulses Setting (BP) Repetition Rate Divisor (RRD)</td>
</tr>
</tbody>
</table>
AOM Pulse Modes

There are several laser AOM Pulse Mode options available for operating the Monaco laser system. By making use of the amplifier acousto-optic modulator (AOM) the laser output can be adjusted in different ways:

Continuous (Pulse) Mode

The Monaco laser can be operated at a steady pulse (or microburst) repetition rate (PRF) up to a maximum of 1 MHz. The amplifier repetition rate can be selected through the Coherent GUI Main menu (see Figure 4-5 on page 4-7), or through the serial command SET.
**Gated Mode**

Gated Mode enables pulsing by applying a TTL signal externally through the Gate 1 port on the rear of the laser head. (See “Sync 1 and Sync 2” on page 3-8). As in Continuous Mode the amplifier repetition rate can be selected through the Coherent GUI Main menu or through the serial command SET. In Gated Mode, TTL high enables output pulses and TTL low inhibits output pulses (see Figure 4-12). To utilize Gated Mode the External Triggering button is selected from the GUI Triggering Menu (see Figure 4-4 on page 4-6), or by entering the serial command PM=1.

![Gated Mode Diagram](image)

**Figure 4-12. Gated Mode**

**Divided Mode**

Divided Mode enables Monaco laser output at lower pulse repetition rates by using the AOM to reduce the output laser pulse (or microburst) repetition rate by a frequency/rep rate divisor (RRD) chosen by the user. For example, for an amplifier laser pulse repetition rate of 1MHz and setting the divisor to 4, the output repetition rate would be 250kHz. To utilize Divided Mode, the Divided Mode button is selected from the Triggering Menu (see “Triggering Tab Selections” on page 4-6), or by entering the serial command PM=2. The divisor can be specified by choosing a frequency divider through the GUI Triggering menu (see “Triggering Tab Selections” on page 4-6), or by the serial command RRD. The value for the divisor can be from 1 - 65,535.
Divided and Gated Mode

Divided and Gated Mode enables pulsing by applying a TTL signal externally through the Gate 1 port similar to Gated Mode, and at a lower output pulse repetition rate similar to Divided Mode. To utilize Divided and Gated Mode both the External Triggering button and the Divided Mode button from the GUI Triggering Menu must be selected, or by using the serial command PM=3. Again the divisor can be specified by choosing a frequency divider through the GUI Triggering menu, or by the serial command RRD. The value for the divisor can be from 1 - 65,535.

Burst Mode

The Monaco laser can emit a number (1–1,000,000) of laser pulses (or microbursts) in a burst configuration at a specified repetition rate. In Burst Mode the number of pulses emitted in a burst is controlled by the Burst Pulses (BP) setting. To utilize Burst Mode the External Triggering and Burst Mode buttons are selected from the Triggering Menu (see “Triggering Tab Selections” on page 4-6), or by entering the serial command PM=4. The repetition rate and the number of pulses in a burst can be specified using the Coherent GUI, or through the serial command SET and BP, respectively. Each burst is initiated by the transition from TTL low to TTL high similar to Gated Mode shown in Figure 4-12. The burst will continue until the specified number of pulses is generated if the Gate 1 signal (see “Laser Head Rear Features” on page 4-24) remains TTL high. A burst can be shortened by a transition from TTL high back to TTL low. If a burst is allowed to continue for the specified number of pulses, the Gate 1 signal must be reset from TTL high to TTL low before initiating the next burst.

Burst and Divided Mode

In Burst and Divided Mode the number of pulses (or microbursts) emitted in a burst is initiated by the Gate 1 TTL signal and controlled by the Burst Pulses (BP) setting similar to Burst Mode, and at a lower output pulse repetition rate similar to Divided Mode. To utilize Burst and Divided Mode the External Triggering, Burst Mode and Divided Mode buttons from the GUI Triggering Menu must be selected (see “Triggering Tab Selections” on page 4-6), or by using the serial command PM=5. As in Divided Mode the divisor can be specified by choosing a frequency divider through the GUI Triggering menu, or by the serial command RRD. The value for the divisor can be from 1 - 65,535.
This section contains a subset of Monaco serial commands. They are supplied here as a guide to start using the Monaco. There are two types of instructions to communicate with the Monaco: commands that set the values of laser operating parameters and queries that request the laser to return the value of an operating parameter.

For initial setup of the laser, Coherent recommends use of the Coherent GUI which eliminates the need to type these serial commands.

The ?HELP command supplies a list of all possible commands. To get a sublist of all commands containing a specific key word, enter ?HELP <keyword>.

### Table 4-3. Basic Serial Commands (Sheet 1 of 4)

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>BRIEF DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>?ARR</td>
<td>AMPLIFIER REP RATE</td>
<td>Returns the laser amplifier repetition rate (in kilohertz).</td>
</tr>
<tr>
<td>BP</td>
<td>BURST PULSES</td>
<td>Number of pulses in a burst.</td>
</tr>
<tr>
<td>?BP</td>
<td>PRINT BURST PULSES</td>
<td>Returns number of pulses in a burst.</td>
</tr>
<tr>
<td>CHEN</td>
<td>CHILLER ENABLE</td>
<td>CHEN=1 turns on the chiller CHEN=0 turns off the chiller</td>
</tr>
<tr>
<td>EM</td>
<td>EXTERNAL MODULATION</td>
<td>EM=1 enables external modulation through the EXT MOD Input port EM=0 turns off external modulation</td>
</tr>
<tr>
<td>?EM</td>
<td>PRINT EXT MODULATION</td>
<td>Returns external modulation status.</td>
</tr>
<tr>
<td>?F</td>
<td>PRINT FAULTS</td>
<td>Displays a list of faults, if present. Use the ?FNAME command to show a description of a particular fault. If a fault is present, it will turn off the laser.</td>
</tr>
<tr>
<td>FACK</td>
<td>ACKNOWLEDGE FAULTS</td>
<td>Send ‘FACK=1’ to acknowledge faults and return the laser to a ready state if the fault condition is lifted.</td>
</tr>
<tr>
<td>?FNAME</td>
<td>PRINT FAULT NAME</td>
<td>For example, send ‘?FNAME 4’ to get the description for fault 4.</td>
</tr>
<tr>
<td>?HELP</td>
<td>PRINT HELP</td>
<td>Shows a list of all commands or a subset if a keyword is used. For example, ‘?HELP PULSE’ shows all PULSE related commands.</td>
</tr>
<tr>
<td>?HV</td>
<td>PRINT HARDWARE VERSION</td>
<td>Displays the internal revision level of major hardware components.</td>
</tr>
<tr>
<td>?IRE</td>
<td>PRINT IR ENERGY</td>
<td>Returns the laser pulse energy in μJ.</td>
</tr>
<tr>
<td>?IRPOUT</td>
<td>PRINT IR POWER</td>
<td>Returns laser average power in W.</td>
</tr>
</tbody>
</table>
### Table 4-3. Basic Serial Commands (Sheet 2 of 4)

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>BRIEF DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
</table>
| ?K      | PRINT KEYSWITCH   | Returns laser enable keyswitch state  
|         |                   | 1 = Laser Enabled  
|         |                   | 0 = Laser in Standby (laser diodes cannot be turned on) |
| L       | LASER ENABLE      | L=1 turns on laser  
|         |                   | L=0 turns off laser |
| ?L      | PRINT LASER STATE | Returns laser state. For example:  
|         |                   | 0 if the laser is in (STANDBY)  
|         |                   | 1 if the laser is in ON  
|         |                   | 2 if the laser is in STANDBY because FAULT occurred |
| ?LNAME  | PRINT STATE DESCRIPTION | For example, send ‘?LNAME 1’ to get the description of state 1. |
| ?LM     | PRINT LASER MODEL INFO | Returns laser model |
| ?ORR    | PRINT OUTPUT REP RATE | Returns the laser pulse or microburst output repetition rate in Hz. |
| PC      | PULSE CONTROL     | Enable or disable laser pulsing.  
|         |                   | PC=1 enables laser pulsing  
|         |                   | PC=0 disables laser pulsing |
| ?PC     | PRINT PULSE CONTROL | Returns the state of laser pulse control.  
|         |                   | 1 = laser pulsing on  
|         |                   | 0 = laser pulsing off |
| PM      | PULSE MODE        | Sets the AOM Pulse Mode.  
|         |                   | PM=0 for Continuous pulsing.  
|         |                   | PM=1 for Gated mode  
|         |                   | PM=2 for Divided mode  
|         |                   | PM=3 for Divided and Gated mode  
|         |                   | PM=4 for Burst mode  
|         |                   | PM=5 for Burst and Divided mode |
| ?PM     | PRINT PULSE MODE  | Returns the AOM Pulse mode.  
|         |                   | 0 = Continuous pulsing  
|         |                   | 1 = Gated mode  
|         |                   | 2 = Divided mode  
|         |                   | 3 = Divided and Gated mode  
|         |                   | 4 = Burst mode  
<p>|         |                   | 5 = Burst and Divided mode |
| RL      | SET PULSE LEVEL   | Sets pulse energy percent, from 0 to 100. |
| ?RL     | PRINT PULSE LEVEL | Returns the current pulse energy level percent setting. |</p>
<table>
<thead>
<tr>
<th>COMMAND</th>
<th>BRIEF DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>?RR</td>
<td>PRINT REP RATE</td>
<td>Returns the laser pulse or microburst output repetition rate in Hz.</td>
</tr>
<tr>
<td>RRD</td>
<td>SET REP RATE DIVISOR</td>
<td>Allows the amplifier laser pulse repetition rate (configured using the SET command below) to be divided by an integer. For example, to divide the repetition rate by 4, enter RRD=4. Range is from 1 - 65,535.</td>
</tr>
<tr>
<td>?RRD</td>
<td>PRINT REP RATE DIVISOR</td>
<td>Returns the laser pulse repetition rate divisor.</td>
</tr>
</tbody>
</table>
| S       | SHUTTER           | S=1 opens the shutter  
S=0 closes the shutter |
| ?S      | PRINT SHUTTER     | Returns the state of the shutter  
1 = shutter is open  
0 = shutter is closed |
| SET     | SET LASER PARAMETERS | Sets up to 4 laser parameters simultaneously: amplifier repetition rate (ARR), pulse width (PW), repetition rate divisor (RRD), and number of pulses per microburst. The command is of the form SET=w,x,y,z where w is the requested amplifier repetition rate in kHz, x is the pulse width in femtoseconds, y is the repetition rate divisor (RRD), and z is the number of pulses per microburst. Values for the amplifier repetition rate must be chosen from those in the GUI Amplifier Rep Rate drop down menu. Missing parameters are left unchanged e.g. “SET=ARR,,RRD,“ will leave PW and microburst pulses unchanged. For a full description of the SET command, see “SET Command“ on page 6-17. |
| ?SET    | PRINTS THE LASER PARAMETER SETTINGS | Returns the provide the current values for the laser parameters: amplifier repetition rate (ARR) in kHz, pulse width (PW) in femtoseconds, repetition rate divisor (RRD), and number of pulses per microburst (e.g. “1000,400,2,1”). |
| SSP     | SESAM SPOT        | For example, use ‘SSP=+’ to shift to the next available spot. |
| ?SSP    | PRINT SESAM SPOT  | Returns current SESAM spot position. |
| ?SSPH   | PRINT SESAM SPOT HOURS | Returns current SESAM spot hours. |
| ?ST     | PRINT LASER STATE NAME | Returns the name of the current laser state such as “Standby”, “Ready”, “Fault” or “On” when the laser reaches those steady state conditions. It can also return transient laser states, such as diode current ramping up or down. The ?L command is a short form of this command. |
| ?SV     | PRINT SOFTWARE VERSION | Displays the revision level of major software components. |
### Table 4-3. Basic Serial Commands (Sheet 4 of 4)

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>BRIEF DESCRIPTION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>?W</td>
<td>PRINT WARNINGS</td>
<td>Displays a list of warnings, if present. Then use the ?WNAME command to show a description of a particular warning. Warnings will not turn off the laser.</td>
</tr>
<tr>
<td>?WNAME</td>
<td>PRINT WARNING NAME</td>
<td>For example send ‘?WNAME 500’ to get the description for warning 500.</td>
</tr>
</tbody>
</table>
Example Command Sequence

The following are examples of how serial commands can be used to control the laser. This sample is not intended for use without a full knowledge and understanding of commands appropriate for the process being performed by the operator. Changes may be required. It is the customer’s responsibility to comply with IEC60825 safety standards when using these commands.

Startup for Normal Operation

The following serial commands are an example to startup the laser for normal operation in Continuous (Pulse) mode (for a description of Pulse Modes, see “” on page 4-13).

Table 4-4. Startup Commands

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>LASER RESPONSE</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEN=1</td>
<td></td>
<td>Enable the chiller. For the most stable laser operation, the chiller should be enabled several minutes before turning on the laser.</td>
</tr>
<tr>
<td>?K</td>
<td>1</td>
<td>Check if keyswitch is on (1 = keyswitch on).</td>
</tr>
<tr>
<td>?F</td>
<td>SYSTEM OK</td>
<td>Check if there are faults.</td>
</tr>
<tr>
<td>?W</td>
<td>SYSTEM OK</td>
<td>Check if there are warnings.</td>
</tr>
<tr>
<td>S=0</td>
<td></td>
<td>Closes shutter.</td>
</tr>
<tr>
<td>?S</td>
<td>0</td>
<td>Check if shutter is closed (0 = closed).</td>
</tr>
<tr>
<td>PM=0</td>
<td></td>
<td>Setup Continuous pulsing.</td>
</tr>
<tr>
<td>?PM</td>
<td>0</td>
<td>Check the AOM pulse mode (0 = Continuous mode).</td>
</tr>
<tr>
<td>L=1</td>
<td></td>
<td>Turn on diodes. They will typically ramp to their set current within 30 seconds.</td>
</tr>
<tr>
<td>?ST</td>
<td>ON</td>
<td>This query may be repeated until “On” is returned, which indicates the diodes have completed ramping to their set point. This query may also return the descriptions of other intermediate states. Note that if the laser is cold from a power off state, it may take some time to become thermally stable and reach a steady state.</td>
</tr>
<tr>
<td>PC=1</td>
<td></td>
<td>Turn on pulses.</td>
</tr>
<tr>
<td>S=1</td>
<td></td>
<td>Open the shutter</td>
</tr>
<tr>
<td>?S</td>
<td>1</td>
<td>Check the shutter state (1 = open).</td>
</tr>
</tbody>
</table>
Monitoring While Operating

The following commands can be issued periodically while the laser is operating.

Table 4-5. Periodic-Issue Commands

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>EXPECTED REPLY</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>?F</td>
<td>SYSTEM OK</td>
<td>This command replies with a list of numbers if a fault exists. The ?FNAME n command can be used to describe the fault condition “n” if it exists. The laser will automatically go to a standby state whenever there is a fault condition. Most faults are cleared with the FACK=1 command if the fault condition is lifted.</td>
</tr>
<tr>
<td>?W</td>
<td>SYSTEM OK</td>
<td>Same as ?F except for warnings. Warnings do not change the state of the laser. It continues to operate.</td>
</tr>
</tbody>
</table>

Shutdown

The following commands can be issued to shut down the laser.

Table 4-6. Laser Shutdown Commands

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>EXPECTED REPLY</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>S=0</td>
<td></td>
<td>Close the shutter and turn off pulsing.</td>
</tr>
<tr>
<td>?S</td>
<td>0</td>
<td>Check the shutter state (0 = closed)</td>
</tr>
<tr>
<td>L=0</td>
<td></td>
<td>Turn off diodes.</td>
</tr>
<tr>
<td>?ST</td>
<td>Ready</td>
<td>Repeat this command every few seconds while diodes are turning off and wait for the ‘Ready’ reply. This command will also return the descriptions of other intermediate states.</td>
</tr>
</tbody>
</table>
**Fault Handling**

If a fault condition occurs, the fault indicator on the Main menu tab of the GUI changes from green to red and displays the fault number and description. When a fault occurs, the laser shuts down and goes into Standby state. See Table 7-1 on page 7-2 for a list of system faults and troubleshooting procedures.

To return the system to normal operation first correct the condition that caused the fault, and then acknowledge the fault condition by clicking the Clear button on the System Fault panel in the GUI. The fault condition can also be acknowledged using the FACK=1 serial command.

Warning messages are also displayed in the System Faults panel on the Main menu tab of the GUI. Unlike fault conditions, warnings do not shut down the laser. Warnings do not need to be acknowledged to restart or continue normal laser operation.

**Table 4-7. Fault States**

<table>
<thead>
<tr>
<th>State</th>
<th>Switch Position</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LASER OFF</strong></td>
<td>• Power Switch (rear panel): ON</td>
<td>Seed laser off.</td>
</tr>
<tr>
<td><strong>FAULT</strong></td>
<td>• Keyswitch: ENABLE</td>
<td>Temperature servos on.</td>
</tr>
<tr>
<td></td>
<td>• Current = OFF</td>
<td></td>
</tr>
<tr>
<td><strong>STARTING</strong></td>
<td>• Power Switch (rear panel): ON</td>
<td>Seed laser current ramping.</td>
</tr>
<tr>
<td><strong>FAULT</strong></td>
<td>• Keyswitch: ENABLE</td>
<td>Temperature servos on.</td>
</tr>
<tr>
<td></td>
<td>• Current = 0 %</td>
<td>High current disabled.</td>
</tr>
</tbody>
</table>
Controls and Indicators

1. Extended Interface
2. EXT MOD Input
3. Gate 1
4. Gate 2
5. Sync 1
6. Sync 2
7. USB Connector
8. Ethernet Connector
9. RS-232 Connector
10. Chiller RS232
11. External Interlock
12. Power Supply Cable
13. Coolant In
14. Coolant Out
15. Desiccant Cartridge Access

Figure 4-13. Laser Head Rear Features

Table 4-8. Laser Head Features

<table>
<thead>
<tr>
<th>ITEM</th>
<th>CONTROL</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Extended Interface</td>
<td>The extended interface connector provides extra signals that are compatible with other OEM laser systems. This is described in detail in Table 3-5 on page 3-6.</td>
</tr>
<tr>
<td>2</td>
<td>Ext MOD Input</td>
<td>Input to modulate output beam when in the external modulation mode (EM=1). See “Fault Handling” for details on how to set the mode to use this signal.</td>
</tr>
</tbody>
</table>
Table 4-8. Laser Head Features (Continued)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>CONTROL</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Gate 1</td>
<td>Input to control pulsing. Gate 1 is used to control the duration of a string of pulses. That is, if the AOM Pulse Mode is set to Gated mode (PM=1), laser pulses are produced as long as the Gate 1 signal is high. Gate 1 also has a function in Divided Gate mode (PM=3). That is, a pulse rate is produced that is the fixed amplifier pulse rate divided by an integer.</td>
</tr>
<tr>
<td>4</td>
<td>Gate 2</td>
<td>Gate 2 is a spare for future use. It is connected to internal timing circuits but has no function currently.</td>
</tr>
<tr>
<td>5</td>
<td>Sync 1</td>
<td>Output signal with a fixed delay from laser pulse and 40 nS wide. Intended to be synchronous with the output laser pulses.</td>
</tr>
<tr>
<td>6</td>
<td>Sync 2</td>
<td>Same signal as Sync 1.</td>
</tr>
<tr>
<td>7</td>
<td>USB Connector</td>
<td>The USB connector uses the industry standard Type B receptacle. Industry standard USB signal levels and Microsoft's RNDIS protocol are used. It can be connected to a standard USB connector on a PC to control the laser from, for example, the supplied Coherent GUI.</td>
</tr>
<tr>
<td>8</td>
<td>Ethernet Connector</td>
<td>The Ethernet connector uses the industry standard receptacle for an RJ45 connector (sometimes called an 8P8C connector). It can be connected to a switch, router or PC using Cat5 cable. A PC connection requires a cross-over cable wiring. Once the IP address of the laser is known, a Telnet session can be established to the laser and the same commands used with the RS232 or USB connections can control the laser.</td>
</tr>
<tr>
<td>9</td>
<td>RS-232 Connector</td>
<td>The customer RS232 connection is a standard female 9-pin D-sub (DE-9) connector. A cable with a male connector is needed to use this interface. Only 19200 Baud is supported.</td>
</tr>
<tr>
<td>10</td>
<td>Chiller</td>
<td>RS232 communication between the laser and the chiller is required.</td>
</tr>
<tr>
<td>11</td>
<td>External Interlock</td>
<td>The interlock connector can be connected to customer equipment for safety, such as to switches on access doors. As long as the interlock connection is made, the laser will operate. A 12 mA current loop supplies power to this connection.</td>
</tr>
<tr>
<td>12</td>
<td>Power Supply Cable</td>
<td>Carries power and various signals between the power supply and the laser head.</td>
</tr>
<tr>
<td>13</td>
<td>Coolant In</td>
<td>Inlet connector for coolant from the chiller.</td>
</tr>
<tr>
<td>14</td>
<td>Coolant Out</td>
<td>Outlet connector for coolant to the chiller.</td>
</tr>
<tr>
<td>15</td>
<td>Desiccant Cartridge Access</td>
<td>Access cover to expose the desiccant housing. Check the relative humidity reading on the Temperature menu tab screen and replace the desiccant if &gt;10%.</td>
</tr>
</tbody>
</table>
1. Cooling Fans
2. Keyswitch
3. AC ON Indicator

Figure 4-14. Power Supply Front Panel Controls and Indicators

Table 4-9. Power Supply Front Panel Controls and Indicators

<table>
<thead>
<tr>
<th>ITEM</th>
<th>CONTROL</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cooling Fans</td>
<td>Inlet for cooling air for the power supply.</td>
</tr>
<tr>
<td>2</td>
<td>Keyswitch</td>
<td>Places the laser in either the Standby or On (Enable) state. The key can be removed when in Standby position to prevent unauthorized operation. It cannot be removed when in the On position.</td>
</tr>
<tr>
<td>3</td>
<td>Power Indicator (AC On)</td>
<td>LED lights when the AC electrical power is applied to the power supply.</td>
</tr>
<tr>
<td>4</td>
<td>Emission Indicator</td>
<td>Lights when laser emission is possible.</td>
</tr>
<tr>
<td>5</td>
<td>Shutter Indicator</td>
<td>This LED indicates when the shutter is open. Push the button to change shutter state.</td>
</tr>
</tbody>
</table>
Figure 4-15. Power Supply Rear Panel Controls and Indicators

Table 4-10. Power Supply Rear Panel Controls and Indicators

<table>
<thead>
<tr>
<th>ITEM</th>
<th>CONTROL</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power On/Off Switch</td>
<td>Applies/removes all AC electrical power to the laser. Refer to “Complete System Shut Down” to avoid possible damage to the system.</td>
</tr>
<tr>
<td>2</td>
<td>Power Supply Cable Connection</td>
<td>Carries power and various signals between the power supply and the laser head.</td>
</tr>
<tr>
<td>3</td>
<td>AC Mains Power Cord</td>
<td>Connects the power supply to AC facility power.</td>
</tr>
</tbody>
</table>
SECTION FIVE: GRAPHICAL USER INTERFACE

Monaco Computer Interface

The user interface for the Monaco laser system is provided through an external computer. This section provides information on how to connect to that computer and how to use the laser control instructions to operate the Monaco laser system. Instructions are sent to the laser through a terminal interface program using an RS-232, USB, or Ethernet connection.

There are two types of instructions used to communicate with the laser: commands that set the values of operating parameters, and queries that return status information to the user. The instruction set is sufficient to support user-written programs.

The simplest and most intuitive way to interact with the Monaco laser is with the Coherent Graphical User Interface (GUI). The Coherent GUI is a PC based application that uses commands and queries to interact with the Monaco. The instructions below explain how to set up the Coherent GUI on an external computer.

Coherent GUI Installation

The required installation file can be obtained from the USB drive, included in the accessories kit. Put in the USB drive and select ‘Setup.exe’ to execute the Coherent GUI installation.

The files can be downloaded on the control Windows PC with an active Internet connection by visiting the Coherent GUI web page at:

Microsoft Components

Select the “Accept” button as indicated in the menu form, and shown in Figure 5-1.

![Microsoft Software License](image)

**Figure 5-1. Microsoft Software License**

The setup program will install the required files, as shown in Figure 5-2.

![Installing SQL](image)

**Figure 5-2. Installing SQL**
Coherent GUI Setup

The Coherent GUI is installed after the components from Microsoft have been installed. If the required components are already installed on the computer then the Coherent GUI setup program will start at the “GUI Setup Wizard” menu form as shown in Figure 5-3.

Figure 5-3. GUI Setup Installation
GUI Menu Tabs  
The Coherent GUI for the Monaco has seven menu tabs.
- **Main** - Contains the command panels for primary operation of the laser system.
- **Temperature** - Information about the temperature servos and chiller and baseplate temperatures.
- **Details** - Displays the current status of all data ported through the GUI connection.
- **Triggering** - Configures the laser trigger parameters.
- **Prompt** - A COMMAND Prompt window that enables the user to query and send commands.
- **About** - Provides Coherent GUI information, access to the Monaco web page, and other features.

![GUI Menu Tabs Diagram](image)

**Figure 5-4. Main Menu Tab**
Main Menu Tab

The Coherent GUI Main menu tab provides an overview of laser status and includes panels for primary operation of the laser system. See Figure 5-4 above.

1. **Menu Tabs** - Name of tab under discussion.

2. **Connection to Laser** Panel - Displays the communication status between the control computer and laser, the active communication port, and setting options through the CONNECTION button.

3. **Keyswitch Panel** - Displays the keyswitch status.

4. **Shutter Panel** - Displays the state of the shutter and allows the shutter to be opened or closed.

5. **Diodes Panel** - Switches the Diodes on or off, indicates status.

6. **Pulsing Panel** - Switches the pulses on or off, indicates status.

7. **System Faults Panel** - Lists any active faults or warnings and provides the option to clear faults that have been addressed.

8. **System Status Panel** - Switches the laser on and off, indicates status.

9. **Laser Output Panel** - Displays the average power, pulse energy, enables the pulse parameters, and current adjustments.

10. **Settings Form** - Launches Coherent GUI Settings screen. Login and Update setting
GUI Connection Panel

The Connection to Laser panel on the Main tab allows the user to select a connection method between the laser and the control PC. By clicking the CONNECTION button in the panel, a Connection Options screen pops up as shown in Figure 5-5 below.

There are three available connection options that can be set up from the Connection Options screen: RS-232, Ethernet, and USB. The preferred connection modes are Ethernet and USB, which allow fast connection and data transfer between the laser and GUI (control PC). Check that proper cable connection is established before making selection in the Connection Options screen and clicking the OK button. The connection process may take a few minutes. See “RS-232 Connection” on page 5-12, “Ethernet Connection” on page 5-13, and “USB Connection” on page 5-14 for more information on these connection options.

This panel also provides options to connect the GUI to a simulator or to Offline mode in which no connection to a real laser is required. The GUI can also be connected to a power meter only.
Temperature Menu Tab

The Temperature menu tab displays the chiller temperature, base-plate temperature, and humidity inside the laser head (see Figure 5-6 below).

The chart buttons open new windows to display system parameters in real time. These screens are highly configurable using the buttons on the screens. Configurable features include the graph scale; hiding old data; exporting the graph; showing or hiding the statistics panel; showing older data, more recent data, or the latest data; and zoom out. Using the dropdown menu, the chart can be set to examine a myriad of data captured by the data logger.

Figure 5-6. Temperature Menu Tab
Triggering Menu Tab

The Triggering menu tab, shown in Figure 5-7 below, provides selection and modification of the laser pulse mode. The drop down menus permit the user to select the AOM Pulse Mode and the number of pulses in a burst (Burst Length). The different operating modes supported by the Monaco are described in “” on page 4-13.

![Monaco GUI for SN:TesterDev2]

Figure 5-7. Triggering Menu Tab
Details Menu Tab

The Details menu tab displays the current status of all the data ported through RS232, USB, or Ethernet. See Figure 5-8 below.

![Figure 5-8. Details Menu Tab](image-url)
Prompt Menu Tab

The **Prompt Menu** tab provides a command line for entering commands into the system. See Figure 5-9 below. For a description of available commands, see “RS-232 Commands and Queries” on page 6-7.

![Prompt Menu Tab](image)

*Figure 5-9. Prompt Menu Tab*
About Menu Tab

The About menu tab shows the version and build date of the Coherent GUI. It also provides links to the Monaco and Laser web pages, the GUI and Laser Operator’s manuals, and direct email access to the GUI developer.
RS-232 Connection

The RS-232 interface does not support either hardware or software flow control. Any instruction to the laser consists of a command or query written as a string of ASCII characters and terminated by a carriage return (\texttt{<CR>}) and linefeed (\texttt{<LF>}) or a semicolon (;). For proper handshaking, communication programs should wait until the \texttt{<CR><LF>} has been returned from the laser before sending the next instruction.

Although RS-232 is a common industry standard, it is an unbalanced connection that is more susceptible to noise and is not robust in a factory environment. When using RS-232, the following are required to maintain good signal integrity:

1. Use only shielded cables. The shield must be connected between the two ends of the cable.
2. Keep cable length to 15 meters or less. The shorter it is, the better.
3. Check that the equipment at both ends of the cable is very well grounded. Because RS-232 is unbalanced, a small voltage difference between equipment can be interpreted as a different value at the receiver.
4. Avoid running the cable in a way that magnetic coupling can occur with other equipment.

The RS-232 connector uses three pins of the 9-pin D-type connector on the rear of the laser head, as shown in Figure 5-11.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig5-11.png}
\caption{RS-232 Pin Configurations}
\end{figure}
Figure 5-12 shows a basic example of interacting with the Monaco via the RS-232 interface using a serial interface program.

![Figure 5-12. Serial Interface Program](image)

**Ethernet Connection**

The Monaco includes a Telnet server which listens for connections on port 23. The Coherent GUI can use Telnet to interact with the Monaco.

The Monaco Ethernet port can be connected either to a network or it can be connected directly to a computer using an Ethernet cable. The Monaco supports multiple, simultaneous Telnet connections from multiple computers.

The Monaco registers a host name on the network to allow connections to be established. The default host name is the product type, followed by an underscore, followed by the laser serial number. Figure 5-13 below shows an example of a telnet connection being established to Monaco laser serial number 1234.
USB Connection

The USB interface to the laser uses the RNDIS standard. RNDIS is a Microsoft standard that implements a virtual Ethernet connection on top of a USB connection. RNDIS is supported only by Microsoft Windows XP or later.

The Coherent GUI must be installed before using the USB connection to the laser. After plugging in the USB cable, a device called “Coherent Datalogger” should appear on the system, as shown in Figure 5-14 (in Windows 7).

The virtual connection will also appear in the network connections as “Unidentified network”, as shown in Figure 5-15.

Figure 5-13. Telnet Connection
Once Windows has configured the USB driver, the Monaco can be accessed on IP number 169.254.21.151 as shown in Figure 5-16.

This IP number can be used to establish telnet connections, as shown in Figure 5-17, or to connect to the Monaco using a web browser.
Figure 5-16. IP Number

Figure 5-17. Telnet Connection
Web Server

The Monaco laser includes a web server that can be accessed through the Ethernet or USB connections as shown in Figure 5-18 below. To access the web server, simply open a web browser and enter either the IP address or host name of the laser into the web server address bar.

The web server allows the basic functions of the laser to be monitored and adjusted.

![Web Server Screenshot](image)

**Figure 5-18. Web Server**
GUI Configuration

To change general settings of the Coherent GUI, click on the Adjust Settings icon at the bottom of the Main menu tab (see Figure 5-4).

Logging

The **Logging** menu tab allows you to set the data polling frequency period and the Database period as well as select which data parameters to log.

1. Select Adjust Settings icon at the bottom of the GUI screen.
2. Select the **Logging** menu tab on the Coherent GUI Settings screen.
3. To limit the amount of data stored in the data logger, check the “Trim old data” check box and set the time duration limits accordingly.
4. To save datalogger storage space, check the “Do not log duplicate data” check box as shown in Figure 5-19.

![Figure 5-19. Logging Menu Tab](image)

5. Set the data polling frequency by entering a value (m) in the Period (Secs) box. This sets the time period in seconds at which the GUI reads and displays laser parameters. The default value of m is 5; if m is set to zero, the GUI will read the data at the maximum rate.
6. Set the data storing frequency by entering a value \((n)\) in seconds in the Database Period box. This sets the time period in seconds at which the datalogger saves the laser parameters. The default value on \(n\) is 30; if \(n\) is set to zero, the GUI will save the data at the maximum rate.

With the data reading period set to \(m\) and the database period set to \(n\), the datalogger will store laser parameters at a rate of \(n \times m\) seconds.

Low set values of \(m\) and \(n\) may drastically increase the demand for storage space and slow down the speed of data display; high set values may risk skipping data information for brief or intermittent events.

7. Select the parameters to record and monitor in the “Log these params” panel.

By default all available laser parameters are logged. To save storage space, the user may choose to log only specific parameters. The DOUBLE ARROW buttons simultaneously transfer all parameters between the “Do not log these params” panel and the “Log these params” panel. The SINGLE ARROW buttons allow only selected laser parameters to be moved between the two panels.

Note: You can make multiple selections by holding down the CTRL key while making selections or the Shift key for selections in sequence. After making the selection(s), press the SINGLE ARROW button.

**Power Meter**

The following instructions for establishing communication with the FieldMaster power meter are specific to the FieldMaster. However, the method used to establish communication for other types of power meters is similar to this method.

1. Connect an RS-232 cable between the power meter and the computer.
2. Check the power meter is ON.
3. Click on the Adjust Settings icon at the bottom of the GUI screen.
4. Click on the **Power Meter** menu tab.
5. The “Use External Power Meter” check box must be checked as shown in Figure 5-20 below.
6. From the COM port dropdown menu, choose the COM port corresponding to the port you connected to the power meter.

7. From the Type dropdown menu, choose the power meter type corresponding to the power meter you are using.

8. From the Channel dropdown menu, choose the channel corresponding to the power meter channel you are using: A or B.

9. From the Terminator dropdown menu, choose the terminator setting that matches the setting on the power meter console.

10. Determine if communication with the power meter has been established by clicking on the Test Connection button.

Figure 5-20. Power Meter Settings
Log File

Log files can be sent to the Coherent product support for diagnostic help. The complete laser signal dataset is saved in a .sdf file. To save the log file, proceed as follows:

1. Click on the Adjust Settings icon at the bottom of the GUI screen.
2. Click on the Log File menu tab as shown in Figure 5-21 below.

3. The log file may contain datasets for multiple laser heads and can become quite large. To locate the current log file “LogData.sdf” on the local PC, click on the OPEN FOLDER button.

The user may create a new data log file and save the current one by closing the GUI application and then renaming the current data file (e.g. LogData-sn12345.sdf). When the GUI is reopened, a new log file is created with the default file name “LogData.sdf,” and the old data file is saved with the new name.

To analyze data from a particular laser listed in the panel, select the serial number of the laser and click the CONNECT OFFLINE button. Then go back to the GUI Main menu and select the parameter(s).
Updates

The **Update** menu tab provides the option of checking for GUI software updates. By default the GUI is set to automatically query the website [www.Coherent.com/gui](http://www.Coherent.com/gui) for new versions. You can also get updates by pressing the CHECK NOW button. To prevent the GUI from checking for automatic updates when starting, click on the “Don’t check for updates when starting” check box. See Figure 5-22, below.

![Figure 5-22. Update Settings](image-url)
SECTION SIX: SERIAL COMMAND INTERFACE

Instruction Syntax

There are two types of instructions used in serial software command communication with the Monaco lasers:

- Commands which set the values of laser operating parameters
- Queries which request the laser to return the value of an operating parameter

Any instruction to the laser consists of a command or query written as a string of ASCII characters and terminated by a carriage return and line feed (<CR><LF>).

For example:

```
CPT = 10<CR><LF>
```

Sets the current of the pump diode to 10%.

```
?B<CR><LF>
```

Requests the laser to return the baudrate of the serial port.

The laser will always respond to a command with a carriage return and a line feed. It responds to a query with the requested data followed by a carriage return and a line feed. Table 6-1 lists the possible responses from the laser.

**For proper handshaking, communication programs should wait until the <CR><LF> has been returned from the laser before sending the next instruction.**

ECHO Mode

The Monaco provides an “echo” mode in which each character transmitted to the laser is echoed to the host. This feature can be turned on or off using the ECHO command (E=0 for off, E=1 for on).

PROMPT Mode

The Monaco provides a “prompt” mode for terminal operation in which the laser returns; “Monaco>” after each command. This feature can be turned on or off using the PROMPT command (>=0 for off, >=1 for on).
**Table 6-1. Computer Interface**

<table>
<thead>
<tr>
<th><strong>INSTRUCTION SENT TO LASER</strong></th>
<th><strong>RESPONSE FROM LASER</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ECHO OFF PROMPT OFF</strong></td>
<td><strong>ECHO OFF PROMPT ON</strong></td>
</tr>
<tr>
<td>Command + &lt;CR&gt;&lt;LF&gt;</td>
<td>&lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Query + &lt;CR&gt;&lt;LF&gt;</td>
<td>Data + &lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Command = (bad data)</td>
<td>Error, bad param. (s)</td>
</tr>
<tr>
<td>(Illegal operand)</td>
<td>+ &lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Command &lt;CR&gt;&lt;LF&gt;</td>
<td>Error, bad command</td>
</tr>
<tr>
<td>(Illegal instruction)</td>
<td>+ &lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Bad Query&lt;CR&gt;&lt;LF&gt;</td>
<td>Error, bad command</td>
</tr>
<tr>
<td>(Illegal instruction)</td>
<td>+ &lt;CR&gt;&lt;LF&gt;</td>
</tr>
</tbody>
</table>

Multiple items will be separated by the “&” character. For example, a list of faults will be returned as “3&5&6.”

<table>
<thead>
<tr>
<th><strong>INSTRUCTION SENT TO LASER</strong></th>
<th><strong>RESPONSE FROM LASER</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ECHO ON PROMPT OFF</strong></td>
<td><strong>ECHO ON PROMPT ON</strong></td>
</tr>
<tr>
<td>Command + &lt;CR&gt;&lt;LF&gt;</td>
<td>Command + &lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Query + &lt;CR&gt;&lt;LF&gt;</td>
<td>Query + Data + &lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Command = (bad Data)</td>
<td>Command = (Bad Data)</td>
</tr>
<tr>
<td>(Illegal operand)</td>
<td>+ Error, bad param.</td>
</tr>
<tr>
<td></td>
<td>+ &lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Bad Command + &lt;CR&gt;&lt;LF&gt;</td>
<td>Bad Command</td>
</tr>
<tr>
<td>(Illegal instruction)</td>
<td>+ Error, bad command</td>
</tr>
<tr>
<td></td>
<td>+ &lt;CR&gt;&lt;LF&gt;</td>
</tr>
<tr>
<td>Bad Query&lt;CR&gt;&lt;LF&gt;</td>
<td>Bad Query</td>
</tr>
<tr>
<td>(Illegal instruction)</td>
<td>+ Error bad command</td>
</tr>
<tr>
<td></td>
<td>+ &lt;CR&gt;&lt;LF&gt;</td>
</tr>
</tbody>
</table>

1. Multiple items will be separated by the “&” character. For example, a list of faults will be returned as “3&5&6.”

**Query**

The single character “?” before an instruction to the laser indicates a query. The laser returns information after each query.
Delimiters

The single characters “=” and “:” are equivalent delimiters between text and data in all commands. For example:

\[ C = 10 \] is equivalent to \[ C: 10 \]

Enhanced Serial Protocol

The laser is often used near other equipment that can create electrical noise on RS232. This noise can lead to errors in the laser's status or the laser can fault because it received the wrong message. Although a shielded cable should always be used, noise can still interfere with RS232 signals. To solve noise issues, we recommend using the enhanced serial protocol. A comparison between messages with and without this protocol is shown below.

Enhanced Serial Protocol example

<table>
<thead>
<tr>
<th></th>
<th>Without EP</th>
<th>With EP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmit</td>
<td>?SSPH</td>
<td>?SSPH :Index num CRC</td>
</tr>
<tr>
<td>Receive</td>
<td>25</td>
<td>25 :OK :Index num CRC</td>
</tr>
</tbody>
</table>

Features Of Enhanced Serial Protocol

- Acknowledgements ensure the messages were received correctly
- Index numbers ensure messages are not skipped
- Cyclic Redundancy Check (CRC) codes ensure accuracy

Figure 6-1. Enhanced Serial Protocol
Enhanced Protocol Commands

To start the Enhanced Serial Protocol, use the “EP=1” command. After this, future commands and replies must have the proper suffix added in order to be accepted as error free. The suffix contains:

- **Index.** This is used as a sequence number so messages don't get out of order when errors occur. The index is decided by the customer equipment. It contains the “:” (colon) character followed by one digit “0” to “9”. The digit should change in sequence for each successful message. If the message is not successful, the digit remains the same.

- **Cyclic Redundancy Check (CRC).** This is used to detect bit errors in the message. It contains two hex characters. For example “A9” would represent the hex value “0xA9”. The CRC is calculated from the start of the message body up to and including the Index. The CRC is calculated with the polynomial 0x4D. This corresponds to $x^8 + x^6 + x^3 + x^2 + 1$. Sample code to calculate the CRC or verify contents against a CRC can be found here [http://www.codeproject.com/Articles/19059/C-CCITT-8-CRC-Algorithm](http://www.codeproject.com/Articles/19059/C-CCITT-8-CRC-Algorithm). Please note however that the polynomial should be changed to 0x4D in this algorithm.

- **Acknowledgment Token.** These are characters that are used to tell if a message was received by the laser correctly. The token precedes the Index and CRC and will have one of the following values:
  - !K The message was successfully received by the laser.
  - !R A reply was expected by the customer equipment but not received. The customer equipment uses this to tell the laser to send the reply again.
  - !I The message was not correctly received by the laser. The customer equipment must be sent again.
  - !O The message was partly received by the laser but the UART had overrun errors. The customer equipment must be sent again.
  - !N This is a notification message sent by the laser on its own. It is not a reply to a command from the customer equipment. This may be used in future product models.
Enhanced Protocol Replies

The laser always replies to every command with an acknowledgment. If the customer equipment does not see the reply, it can assume failure after a time-out and try again using the same index number. In order to minimize chances of errors, messages from customer equipment to laser are not echoed back when the enhanced serial protocol is active.

Commands from the customer equipment always finish with the carriage return character (ASCII 0x0D). This character is not included in the CRC. The laser will use the '!I' acknowledgment token if the carriage return is not received. The Line Feed character (ASCII 0x0A) is option from customer equipment but will always be sent from the laser in replies.

Enhanced Protocol Example

For example, the following would be a typical exchange when querying SESAM spot hours, assuming no errors. The customer equipment waits for the ‘!K’ acknowledgment token to assume success. If the index is ‘2’, the command and reply look like:

<table>
<thead>
<tr>
<th>Laser</th>
<th>Customer Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>?SSPH:24E</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>2844:!K:2C8</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
</tbody>
</table>

In this example, the reply was successfully received by the laser. The CRC to send the command is ‘4E’ and the CRC on reply is ‘93’. A ':' (colon) character is used to separate the reply message from the acknowledgment token.

If the laser did not properly receive the command, it will reply with the '!I' acknowledgment token to ask for the command to be resent. Assuming the index is ‘7’, the command and replies look like:

<table>
<thead>
<tr>
<th>Laser</th>
<th>Customer Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>!I:78C</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>?SSPH:7B9</td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>2844:!K:7C2</td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
</tbody>
</table>

In this example, the command had an error while initially being transmitted to the laser. The laser asked for it to be resent by using the '!I' acknowledgment token and the customer equipment was able to send it successfully on the second try. Note that the index and CRC are always used, even with the acknowledgment. If the acknowledgment was not successfully received, the customer equipment can ask for the laser's acknowledgment to be resent by sending the '!R' acknowledgment token. The customer equipment should retry at least 6 times.
RS-232 Interface Connection

The Monaco’s RS-232 port configuration is in Table 6-2, and typical cable requirements are shown in Figure 6-2. The 9-pin RS-232 port is configured as a data communications equipment (DCE) device using only pins 2 (serial data out), 3 (serial data in) and 5 (signal ground). Handshake lines RTS, CTS, DTR and DSR (pins 4, 6, 7 and 8) are not used and have no connections inside the power supply.

![RS-232 Pin Configuration](image)

Figure 6-2. RS-232 Pin Configuration

RS-232 Port Configuration

The factory set baud rate is 19200.

Table 6-2. RS-232 Port Description

<table>
<thead>
<tr>
<th>CONFIGURATION</th>
<th>DCE, NO HANDSHAKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data bits</td>
<td>8</td>
</tr>
<tr>
<td>Stop bits</td>
<td>1</td>
</tr>
<tr>
<td>Parity</td>
<td>none</td>
</tr>
<tr>
<td>Baud rate</td>
<td>19200 (factory setting)</td>
</tr>
</tbody>
</table>

Instruction Set

Table 6-3 describes the instructions for use in RS-232 serial command communication with the Monaco system.
### Table 6-3. RS-232 Commands and Queries (Sheet 1 of 8)

<table>
<thead>
<tr>
<th>COMMANDS &amp; QUERIES</th>
<th>RETURNED INFORMATION</th>
</tr>
</thead>
</table>
| PROMPT=n >=n       | n = 0 turns off “Monaco >” prompt  
|                    | n = 1 turns on “Monaco >” prompt |
| ?                  | A query.              |
| ?ALL               | Returns the value of every parameter. |
| ?ARR               | Returns the laser amplifier repetition rate (in kilohertz). |
| AUTOIP             | Set available IP address. |
| ?AUTOIP            | Returns an available IP address.  
|                    | n = 0  
|                    | n = 1 |
| ?BAT               | Returns battery voltage, nominal 3V. |
| BP=nnnnnn          | Sets the number of pulses in a burst.  
|                    | Allowed range is 1 to 1,000,000 pulses. |
| ?BP                | Returns the number of pulses in a burst.  
|                    | Number of pulses is 1 to 1,000,000. |
| ?BT                | Returns laser head baseplate measured temperature in °C. |
| CHEN = n           | Set chiller enable:  
|                    | n = 0 turns off the chiller  
|                    | n = 1 turns on the chiller |
| ?CHEN              | Returns status of chiller enable. |
| CHENAUTO           | Set chiller Enable Automatic setting |
| ?CHENAUTO          | Returns chiller Enable Automatic setting |
| ?CHF               | Returns chiller model. |
| ?CHFAULT           | Returns chiller faults. |
| ?CHFH              | Returns chiller high flow rate warning |
| ?CHFL              | Returns chiller low flow rate warning |
| ?CHP               | Returns chiller pressure |
| ?CHSN              | Returns chiller serial number. |
| ?CHST              | Returns chiller set point. |
| ?CHSTAT            | Returns chiller status. |
| ?CHT               | Returns chiller temperature. |
| ?CHTH              | Returns chiller high temperature limit. |
### Table 6-3. RS-232 Commands and Queries (Sheet 2 of 8)

<table>
<thead>
<tr>
<th>Commands &amp; Queries</th>
<th>Returned Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>?CHTL</td>
<td>Returns chiller low temperature limit.</td>
</tr>
<tr>
<td>CHTYPE</td>
<td>Sets the chiller model type.</td>
</tr>
<tr>
<td>?CHTYPE</td>
<td>Returns chiller type.</td>
</tr>
<tr>
<td>?CPUT</td>
<td>Returns CPU temperature.</td>
</tr>
<tr>
<td>?CWE</td>
<td>Returns the number of hours until the next warning.</td>
</tr>
<tr>
<td>?D1H</td>
<td>Returns the number of operating hours on laser diode 1.</td>
</tr>
<tr>
<td>?D1RC</td>
<td>Returns the set maximum current of diode 1 in Amps as nn.nn.</td>
</tr>
<tr>
<td>?D1SN</td>
<td>Returns serial number of the diode 1.</td>
</tr>
<tr>
<td>?D2H</td>
<td>Returns the number of operating hours on laser diode 2.</td>
</tr>
<tr>
<td>?D2RC</td>
<td>Returns the set maximum current of diode 2 in Amps as nn.nn.</td>
</tr>
<tr>
<td>?D2SN</td>
<td>Returns serial number of the diode 2.</td>
</tr>
<tr>
<td>?D3H</td>
<td>Returns the number of operating hours on laser diode 3.</td>
</tr>
<tr>
<td>?D3LLEN</td>
<td>Returns the D3 light loop enable.</td>
</tr>
<tr>
<td>?D3RC</td>
<td>Returns the D3 rated current.</td>
</tr>
<tr>
<td>?D3RCLL</td>
<td>Returns the D3 rated current before light loop.</td>
</tr>
<tr>
<td>?D3SN</td>
<td>Returns the serial number of laser diode 3.</td>
</tr>
<tr>
<td>?DATA</td>
<td>Return data from the datalogger.</td>
</tr>
<tr>
<td>DHCP</td>
<td>Enables or disables DHCP. n = 0 n = 1</td>
</tr>
<tr>
<td>?DHCP</td>
<td>Returns the status of DHCP.</td>
</tr>
<tr>
<td>DNS = nnn.nnn.n.n</td>
<td>Sets the DNS address when DHCP is disabled.</td>
</tr>
<tr>
<td>?DNS</td>
<td>Returns the DNS server address.</td>
</tr>
<tr>
<td>?DSH</td>
<td>Returns the hours of DS.</td>
</tr>
<tr>
<td>?DSLLEN</td>
<td>Returns DS light loop enable.</td>
</tr>
<tr>
<td>?DSRC</td>
<td>Returns the DS rated current.</td>
</tr>
<tr>
<td>?DSSN</td>
<td>Returns the serial number for DS.</td>
</tr>
</tbody>
</table>
Table 6-3. RS-232 Commands and Queries (Sheet 3 of 8)

<table>
<thead>
<tr>
<th>COMMANDS &amp; QUERIES</th>
<th>RETURNED INFORMATION</th>
</tr>
</thead>
</table>
| ECHO=n                   | Turns the Characters transmitted to the laser (echoed) on or off.  
| E=n                      | n = 0 turns off echo  
|                           | n = 1 turns on echo  
<p>|                           | A change in echo mode will take effect with the first command sent after the echo command.                                                           |
| EM                       | Sets external modulation.                                                                                                                                  |
| ?EM                      | Returns external modulation status.                                                                                                                         |
| EXIT                     | Closes an Ethernet connection.                                                                                                                                |
| ?F                       | Displays a list of faults, if present. Use ?FNAME command to show a description of a particular fault. If a fault is present, it will turn off the laser. |
| FACK = 1                 | Send “FACK=1” to acknowledge faults and return the laser to a ready state if the fault condition is lifted.                                               |
| ?FAULTS                  | Returns a list of numbered codes of all active faults. separated by an &amp;, or returns “System OK” if no active faults.                                      |
| ?FH                      | Returns the fault history with index numbers delimited by “&amp;” sign with no spaces. Faults are recorded in chronological order since last AC power up or last FHC command. Fault history is limited to the last 20 faults. |
| FHC                      | Clears the fault history.                                                                                                                                   |
| ?FNAME:nn                | Returns the description of fault code or warning code nn.                                                                                                   |
| ?FV                      | Returns the FPGA version.                                                                                                                                  |
| GATEWAY =nnn.nnn.n.n     | Set the gateway when DHCP is disabled.                                                                                                                       |
| ?GATEWAY                 | Returns the Ethernet gateway.                                                                                                                                |
| ?GUI                     | Returns the minimum required GUI version.                                                                                                                     |
| HB                       | Sets the heartbeat timeout in secs, 0-300. (0=disabled).                                                                                                     |
| ?HB                      | Returns the heartbeat timeout in seconds (0=disabled).                                                                                                      |
| HELP                     | Query commands, with optional filter.                                                                                                                         |
| ?HELP                    | Shows a list of all commands or a subset if a keyword is used. For example, “?HELP PULSE” shows all PULSE related commands.                                 |</p>
<table>
<thead>
<tr>
<th>COMMANDS &amp; QUERIES</th>
<th>RETURNED INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>?HH</td>
<td>Returns the number of operating hours on the system head.</td>
</tr>
<tr>
<td>?HHL</td>
<td>Returns the set head humidity limit.</td>
</tr>
<tr>
<td>HOSTNAME</td>
<td>Sets host name for Ethernet connection.</td>
</tr>
<tr>
<td>?HOSTNAME</td>
<td>Returns host name of Ethernet connection.</td>
</tr>
<tr>
<td>?HSN</td>
<td>Returns serial number of the laser head.</td>
</tr>
<tr>
<td>?HSV</td>
<td>Returns firmware version of the laser head as HEAD rev x.xx, date.</td>
</tr>
<tr>
<td>?HV</td>
<td>Displays the internal revision level of major hardware components.</td>
</tr>
<tr>
<td>IP = nnn.nnn.n.n</td>
<td>Sets the static IP address.</td>
</tr>
<tr>
<td>?IP</td>
<td>Returns the IP address for Ethernet.</td>
</tr>
<tr>
<td>IPMAX</td>
<td>Sets Start of range for AutoIP.</td>
</tr>
<tr>
<td>?IPMAX</td>
<td>Returns an available IP address.</td>
</tr>
<tr>
<td>IP MIN</td>
<td>Sets start of range for AutoIP.</td>
</tr>
<tr>
<td>?IPMIN</td>
<td>Returns start of range for AutoIP.</td>
</tr>
<tr>
<td>?IRE</td>
<td>Returns laser pulse energy in μJ.</td>
</tr>
<tr>
<td>?IREC</td>
<td>Returns IR count.</td>
</tr>
<tr>
<td>IRECAL</td>
<td>IR calibration, 0-1.</td>
</tr>
<tr>
<td>?IRECAL</td>
<td>Returns IR calibration status.</td>
</tr>
<tr>
<td>IREP1</td>
<td>Sets IR point 1 calibration, 0-100.</td>
</tr>
<tr>
<td>IREP2</td>
<td>Sets IR point 2 calibration, 0-100.</td>
</tr>
<tr>
<td>IRES</td>
<td>Sets IR photocell slope, 0-9999.</td>
</tr>
<tr>
<td>?IRES</td>
<td>Returns IR photocell slope.</td>
</tr>
<tr>
<td>?IRPOUT</td>
<td>Returns laser power in W.</td>
</tr>
<tr>
<td>?K</td>
<td>Returns laser enable keyswitch state: 0 = laser in Standby (laser diodes cannot be turned on) 1 = laser enabled</td>
</tr>
<tr>
<td>L</td>
<td>L=0 turns off laser  L=1 turns on laser</td>
</tr>
</tbody>
</table>
Table 6-3. RS-232 Commands and Queries (Sheet 5 of 8)

<table>
<thead>
<tr>
<th>COMMANDS &amp; QUERIES</th>
<th>RETURNED INFORMATION</th>
</tr>
</thead>
</table>
| ?L=n                | Returns laser state. For example:  
                     0 if the laser is in (STANDBY)  
                     1 if the laser is in ON  
                     2 if the laser is in STANDBY because FAULT occurred |
| ?LASTIP             | Returns last used static IP address. |
| ?LM                 | Returns the laser model |
| ?LNAME              | Returns name of the specified laser state. For example, send “?LNAME 1” to get the description of state 1. |
| LOCKOUT             | Prevents other users from controlling this laser, 0-1. |
| ?LOCKOUT            | Returns lockout state. |
| ?MAC                | Returns the MAC address of the Ethernet interface. |
| ?NEW                | Returns every parameter that has changed. |
| ?ORR                | Returns the laser pulse or microburst output repetition rate in Hz. |
| PC=n                | Sets pulse control:  
                     n = 0 is pulse control off  
                     n = 1 is pulse control on |
| ?PC                 | Returns the status of pulse control:  
                     0 = pulse control off  
                     1 = pulse control on |
| ?PD3T               | Returns the PD3 temperature. |
| ?PENERGYV           | Returns the external pulse energy control voltage. |
| PM=n                | Sets the pulse mode:  
                     n = 0 for Continuous pulsing  
                     n = 1 for Gated mode  
                     n = 2 for Divided mode  
                     n = 3 for Divided and Gated mode |
| ?PM                 | Returns the pulse mode:  
                     1 = Gated mode  
                     2 = Divided mode  
                     3 = Divided and Gated mode  
                     4 = Burst mode  
                     5 = Burst and Divided mode |
<p>| PROMPT              | Displays a prompt before each command. |</p>
<table>
<thead>
<tr>
<th>COMMANDS &amp; QUERIES</th>
<th>RETURNED INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>?PSSN</td>
<td>Returns the power supply serial number.</td>
</tr>
<tr>
<td>PW=n</td>
<td>Sets the pulse width in femtoseconds. Values for n must be within the range of pulse widths tested for the laser as listed on the data-sheet provided with the system.</td>
</tr>
<tr>
<td>?PW</td>
<td>Returns the pulse width in femtoseconds.</td>
</tr>
<tr>
<td>QUIT</td>
<td>Closes an Ethernet connection.</td>
</tr>
<tr>
<td>?READY</td>
<td>Returns laser ready status.</td>
</tr>
<tr>
<td>?RELH</td>
<td>Returns the measured relative humidity % in laser head.</td>
</tr>
<tr>
<td>REN</td>
<td>Sets recirculator control, 0-1.</td>
</tr>
<tr>
<td>?REN</td>
<td>Returns recirculator control status.</td>
</tr>
<tr>
<td>RL</td>
<td>Sets the pulse energy percent, from 0 to 100.</td>
</tr>
<tr>
<td>?RL</td>
<td>Returns the current pulse energy level percent setting.</td>
</tr>
<tr>
<td>?RR</td>
<td>Returns the laser pulse or microburst output repetition rate in Hz.</td>
</tr>
<tr>
<td>RRD</td>
<td>Allows the amplifier laser pulse repetition rate (configured using the SET command below) to be divided by an integer. For example, to divide the amplifier repetition rate by 4, enter RRD=4. Limit 65,535.</td>
</tr>
<tr>
<td>?RRD</td>
<td>Returns the laser pulse repetition rate divisor.</td>
</tr>
</tbody>
</table>
| S=n                | Sets the external shutter state:  
|                   | n = 0  closes external shutter  
|                   | n = 1  opens external shutter  |
| ?S                 | Returns the status of the external shutter:  
|                   | 0 = shutter closed  
|                   | 1 = shutter open  |
| ?SC                | Returns the shutter cycle counter value. |
| SCI                | Sets inversion of shutter control input, 0-1. |
| ?SCI               | Returns inversion of shutter control input value. |
| SCOI               | Sets shutter control output inversion, 0-1. |
| ?SCOI              | Returns shutter control output inversion value. |
| ?SE                | Returns the external shutter control state. |
| ?SEEDOPTEN         | Returns the seed optimization enable status. |
### Table 6-3. RS-232 Commands and Queries (Sheet 7 of 8)

<table>
<thead>
<tr>
<th>COMMANDS &amp; QUERIES</th>
<th>RETURNED INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>?SESSIONS</td>
<td>Lists the active connections.</td>
</tr>
<tr>
<td>SET=(w,x,y,z)</td>
<td>Sets up to 4 laser parameters simultaneously: amplifier repetition rate (ARR), pulse width (PW), repetition rate divisor (RRD), and number of pulses per microburst. The command is of the form SET=(w,x,y,z) where (w) is the requested amplifier rep rate in kHz, (x) is the pulse width in femtoseconds, (y) is the repetition rate divisor (RRD), and (z) is the number of pulses per microburst. Values for the amplifier repetition rate must be chosen from those in the GUI Amplifier Rep Rate drop down menu. Missing parameters are left unchanged e.g. “SET=ARR,,RRD,” will leave PW and microburst pulses unchanged. For a full description of the SET command, see “SET Command” on page 6-17.</td>
</tr>
<tr>
<td>?SET</td>
<td>Returns the provide the current values for the laser parameters: amplifier repetition rate (ARR) in kHz, pulse width (PW) in femtoseconds, repetition rate divisor (RRD), and number of pulses per microburst (e.g. “1000,400,2,1”).</td>
</tr>
</tbody>
</table>
| ?SIS | Returns the status of the shutter interlock sense:  
\[\begin{align*} 
0 &= \text{shutter interlock closed} \\
1 &= \text{shutter interlock open} 
\end{align*}\] |
| ?SPC | Returns the spot transition count. |
| ?SRR | Returns the seed laser pulse repetition rate. |
| ?SSI | Returns the status of the shutter installation:  
\[\begin{align*} 
0 &= \text{Shutter not installed} \\
1 &= \text{Shutter installed} 
\end{align*}\] |
| SSP | Sets the SESAM spot position. For example, use “SSP=+” to shift to the next available spot. |
| ?SSP | Returns current SESAM spot position. |
| ?SSPH | Returns current SESAM spot hours. |
| ?SSPS | Returns SESAM spot status. |
| ?ST | Returns the name of the current laser state such as “Standby”, “Ready”, “Fault”, or “On” when the laser reaches those steady state conditions. It can also return transient laser states, such as diode current ramping up or down. The ?L command is a short form of this command. |
| ?SV | Displays the revision level of major software components. |
| SUBNET | Sets the subnet when DHCP is disabled. |
| ?SUBNET | Returns the Ethernet subnet. |
The table below shows the RS-232 commands and queries for the Monaco Lasers Operator's Manual:

<table>
<thead>
<tr>
<th>COMMANDS &amp; QUERIES</th>
<th>RETURNED INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME = 'yyyy-mm-dd hh:mm'</td>
<td>Sets local time on the laser clock.</td>
</tr>
<tr>
<td>?TIME</td>
<td>Returns local time on the laser clock.</td>
</tr>
<tr>
<td>TIMEZONE</td>
<td>Sets local time zone on the laser clock.</td>
</tr>
<tr>
<td>?TIMEZONE</td>
<td>Returns local time zone on the laser clock.</td>
</tr>
<tr>
<td>?TSTL</td>
<td>Checks if all temperature servos are tight locked.</td>
</tr>
<tr>
<td>?TSTLS</td>
<td>Returns the temperature servos tight locked status: 0 = Not within 0.1ºC 1 = within 0.1ºC</td>
</tr>
<tr>
<td>?W</td>
<td>Displays a list of warnings, if present. Then use the ?WNAME command to show a description of a particular warning. Warnings will not turn off the laser.</td>
</tr>
<tr>
<td>?WH</td>
<td>Displays the warning history.</td>
</tr>
<tr>
<td>WHC</td>
<td>Clears the warning history.</td>
</tr>
<tr>
<td>?WNAME</td>
<td>Returns the description of a warning code. For example send &quot;?WNAME 500&quot; to get the description for warning 500.</td>
</tr>
</tbody>
</table>

Table 6-3. RS-232 Commands and Queries (Sheet 8 of 8)
WARNING!
To avoid injury or damage, the laser output must be blocked or directed at an intended target. All personnel in the area must be wearing laser safety glasses.

Initial Start-up Procedure
To start the Monaco laser system, perform each of the following steps in the order listed. The Initial Start-up procedure must be used after the power switch on the rear panel has been shut off. Refer to Table 4-1 for more information.

After a complete shut down, the warm up time may take up to 40 minutes while the crystal and chiller temperatures stabilize to the set values.

Preliminary
1. Check that the chiller reservoir is full, the coolant lines are connected, and the chiller power switch is in the <ON> position.
2. Set the keyswitch to the <STANDBY> position.
3. Set the power switch on the power supply rear panel to the <ON> position. The AC power indicator will light.¹
4. Allow at least 40 minutes for the temperature servos and the chiller to achieve operating temperature.
5. Select which method of communication to set up the laser connection. Connect a Microsoft computer to the system using the RS-232 Connection, Ethernet Connection, or the USB Connection.

After preliminary steps of the Initial Start-up procedure have been completed, perform the Standby Start-up in the following procedure to complete the Initial Start-up.

¹ If the indicator does not light, refer to Section Seven: Service and Maintenance for more information.
Standby Start-up Procedure

For routine operation of the Monaco, Coherent recommends using the Standby Start-up procedure to turn on the laser. After a Standby Shut-down the Standby Start-up can be performed whenever the rear panel power switch has been left in the ON position and all crystal and chiller temperatures are locked and stable.

For Standby Start-up of Monaco laser system, enter the following commands in the order listed.

1. **Keyswitch:**
   - Set the keyswitch to the <ENABLE> position

2. **Set up the Triggering parameters:**
   - PM=n to set the pulse mode

3. **Set up the repetition rate and pulse width:**
   - SET=nnnnnn to set the Rep. Rate (Hz) value

4. **Open the Shutter:**
   - S = 1 to open the shutter or press the shutter button on the power supply front panel
   - The shutter indicator will light on the power supply front panel

5. **Turn on pulsing:**
   - PC = 1 to turn on pulses

6. **Turn on diodes:**
   - L=1 to turn on diodes. They will typically ramp to their set current within 30 seconds.

---

1. Laser in the standby state with main AC power on as described in Table 4-1.
When the Monaco laser system is used on a regular routine basis, the system can be powered down to the Standby mode. This method avoids the time necessary to stabilize the system during the Initial Power-up procedure.

1. **Close Shutter:** (this will stop lasing)
   - \( S = 0 \) or press the shutter button on the power supply front panel

2. **Turn diodes off:**
   - \( L = 0 \) to stop lasing

3. **Keyswitch:**
   - Turn the keyswitch to the <STANDBY> position
   - The key can be removed for safety

4. **Chiller:**
   - The chiller should remain on

To remove all power from the Monaco, complete the Standby Shut-down procedure before performing these additional steps for a complete shutdown. This procedure is recommended when performing system maintenance or repair. Use the Initial Power-up procedure to turn on the Monaco after a complete system shut-down.

1. **AC mains Power:**
   - Turn off the power switch on the rear panel

2. **Chiller Power:**
   - Turn off the power to the chiller

The serial command SET configures up to four laser parameters simultaneously: amplifier repetition rate (ARR), pulse width (PW), repetition rate divisor (RRD), and number of pulses per microburst. The command is of the form \( \text{SET}=w,\text{x, y, z} \) where \( w \) is the requested amplifier rep rate in kHz, \( x \) is the pulse width in femtoseconds, \( y \) is the repetition rate divisor, and \( z \) is the number of pulses per microburst. If a value for a variable is left blank then the laser parameter remains at its previous setting. For example, entering “\( \text{SET}=500,\text{,}2 \)” would configure the laser for an amplifier repetition rate of 500kHz and set the number of pulses per microburst to 2, but would leave the previous values for the repetition rate divisor and pulsewidth unchanged. If the microburst value is not used in the SET command,
it is assumed to be set to 1. For example SET=1000 sets the amplifier rep rate to 1MHz, leaves pulse width and repetition rate divisor unchanged, and sets the microburst to 1 pulse. Entering the query “?SET” will provide the current values for the laser parameters w,x,y, and z (e.g. “1000,400,2,1”).

Amplifier Repetition Rate (w): The SET command allows the user to configure the laser’s amplifier repetition rate value. For a repetition rate divisor of one (RRD=1) this will also be the laser’s output pulse/microburst repetition rate (ORR). Values for w (in kHz) must be chosen from those in the GUI Amplifier Rep Rate drop down menu (see Figure 6-3). For example, for the laser shown a value of 400 could be entered for w in the SET command to configure the laser for 400kHz operation, “SET=400”. However “SET=300” could not be entered because it is not a repetition rate value available from the drop down menu.

![Figure 6-3. Amplifier Rep Rate Drop Down Menu](image)
**Pulse Width (x):** The SET command also allows the user to configure the laser’s output pulse width. Values for \( x \) (in femtoseconds) must be within the range of pulse widths tested for the laser as listed on the datasheet provided with the system. For example, if the laser was not tested at 900 fsec pulse width as shown on the datasheet, then “SET=1000,900,” could not be entered as a valid command. Note that a value for the amplifier repetition rate (parameter \( w \)) must also be entered into the SET command to configure the pulse width.

**Repetition Rate Divisor (y):** The SET command also allows the user to configure the repetition rate divisor (RRD) of the laser. This enables Monaco laser output at lower pulse repetition rates by using the AOM to reduce the amplifier repetition rate (see “Divided Mode” on page 4-15). The laser’s output pulse (or microburst) repetition rate would be the amplifier repetition rate divided by RRD. Values for \( y \) can be from 1 to 65535. For example, by using the command “SET=1000,,4,” the output repetition rate would be 250kHz.

**Number of Pulses per Microburst (z):** The SET command also allows the user to configure the number of pulses in each microburst from the laser (see “Microburst Mode” on page 4-13). Note that \( z=1 \) (one pulse in each microburst) is simply a continuous stream of single pulses. If the microburst value is not used in the SET command, it is assumed to be set to 1. Values for the amplifier repetition rate (\( w \)) and for \( z \) must be chosen from those in the GUI Amplifier Rep Rate drop down menu (see Figure 6-3). For example, in the laser shown, “SET=500,,2” could be entered to configure the laser for 500kHz repetition rate with 2 pulses per microburst, but “SET=400,,2” is not an available option.

### Table 6-4. SET Command Examples

<table>
<thead>
<tr>
<th>SET COMMAND</th>
<th>LASER OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SET=1000,400,1,1</td>
<td>1 MHz output rep rate [400 fsec pulse width]</td>
</tr>
<tr>
<td>SET=500,450,2,2</td>
<td>250 kHz microburst rep rate [450 fsec pulse width [2 pulses per microburst]</td>
</tr>
<tr>
<td>SET=400</td>
<td>Set output rep rate to 400 kHz, pulse width and repetition rate divisor are unchanged, microburst set to 1 pulse</td>
</tr>
<tr>
<td>SET=200,,4,1</td>
<td>50 kHz output rep rate, pulse width unchanged</td>
</tr>
</tbody>
</table>
SECTION SEVEN: SERVICE AND MAINTENANCE

Introduction

The power supply and the laser head are not operator serviceable. Contact customer service or an authorized representative for instructions on separating the power supply and laser head.

Troubleshooting

Table 7-1 lists some possible problems/error messages with a reference to the associated troubleshooting chart located in this section.

Fault Conditions/
Fault Handling

When a fault condition occurs, the fault indicator in the System Faults Panel on the Main menu tab of the GUI will change from green to red. Most faults will shut down laser operation, and the ramp down typically takes a few seconds to maintain system life. The temperature servos stay on. The laser will not start when a fault is active. See Table 7-1 for a list of common system faults and troubleshooting procedures. For any system faults not listed please contact Coherent service or an authorized Coherent representative.

To return the system to operation, the condition that caused the fault must be corrected. In addition, the fault must be acknowledged by pressing the <Clear> button on the Main menu tab in the System Fault Panel of the Coherent GUI.

Warning messages are displayed in the System Faults Panel on the Main menu tab of the GUI. Warnings do not shut the laser down. Warnings do not need to be acknowledged to start up or continue laser operation, and are provided for customer information only.

When an Monaco fault condition occurs, the emission indicators will turn off and the shutter, if equipped, will close.
Table 7-1. Troubleshooting/Fault Messages

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>TROUBLESHOOTING REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC ON indicator on Coherent power supply front panel does not light when power switch on rear panel is ON.</td>
<td>Chart 1</td>
</tr>
<tr>
<td>Laser does not start (no light output).</td>
<td>Chart 2</td>
</tr>
<tr>
<td>Laser Emission indicator on Coherent power supply front panel or on the laser head does not light when keyswitch is in the Laser Enable position.</td>
<td>See Note 1</td>
</tr>
<tr>
<td>Low output power.</td>
<td>Chart 3</td>
</tr>
<tr>
<td>Laser output is unstable.</td>
<td>Chart 4</td>
</tr>
<tr>
<td>Laser shuts down (no light output).</td>
<td>Chart 5</td>
</tr>
</tbody>
</table>

**FAULT MESSAGES:**

| # 1 Emission Lamp Interlock Fault                                      | Contact Coherent          |
| # 2 External Interlock Fault                                           | Chart 8                   |
| # 4 High Humidity Fault                                                | Change Desiccant          |
| # 16 Baseplate Temperature Fault                                       | Chart 7                   |
| # 17 Baseplate 2 Temperature Fault                                     | Chart 7                   |
| # 31 Shutter State Mismatch Fault                                      | Chart 11                  |
| # 50 Chiller Water Level Fault                                         | Chart 14                  |
| # 51 Chiller Temperature Fault                                         | Chart 14                  |
| # 52 Chiller Comm Fault                                                | Chart 9                   |
| # 53 Chiller Flow Fault                                                | Chart 10                  |
| # 80 Thread Exception Fault                                            | Chart 6                   |
| # 301 Dropped Connection Fault                                         | Chart 12                  |
| # 304 Power On Self Test Fault                                         | Record fault number and contact Coherent |
| # 500 Relative Humidity Warning                                        | Consider change to desiccant |
| # 505 Chiller Water Level Warning                                      | Chart 10                  |
| # 506 Chiller Flow Warning                                             | Chart 10                  |

Note 1. Contact Coherent or an authorized representative. The laser emission lamp will not light if an interlock is open. Check interlocks before contacting Coherent or representative.
Table 7-1. Troubleshooting/Fault Messages (Continued)

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>TROUBLESHOOTING REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td># 515 Chiller-Baseplate Delta Warning</td>
<td>Chart 10</td>
</tr>
<tr>
<td># 804 CPU Temperature Warning</td>
<td>Check ambient temperature is within operating specifications</td>
</tr>
</tbody>
</table>

Note 1. Contact Coherent or an authorized representative. The laser emission lamp will not light if an interlock is open. Check interlocks before contacting Coherent or representative.
Chart 1.  AC ON Indicator Does Not Light

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 2. Laser Does Not Start (No Light Output)$^1$

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.

---

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 2. Laser Does Not Start (No Light Output) [Continued]

The numbered paragraphs below are keyed to and supplement the flowchart for this chart.

[1] Assumptions:

• The operating parameters are correctly set for the corresponding operating mode as described in “Section Four: Operation”.
• The Coherent GUI is connected to the laser in question.
• The Extended Interface and External Interlock connectors are active. It is helpful to verify that the external device supplying this signal is operational.

[2] If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 3. Low Output Power

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.

---

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 3.  Low Output Power [Continued]

The numbered paragraphs below are keyed to and supplement the flowchart for this chart.

[1] Assumptions:
   • The operating mode parameters have the correct settings as described in “Section Four: Operation” on page 1.
   • The power output level is set properly using the RL command.
   • All temperature servos are locked.

[2] If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 4. Laser Output Unstable

Refer to the assumptions on the facing page.

Check output power with an external power meter. Power fluctuating?

YES

Set pulse mode continuous (PM=0) and system to internal modulation (EM=0). Is power stable?

YES

Check external gate or modulation configuration and signal quality. Power unstable?

NO

Contact chiller supplier.

NO

Check chiller. Is the chiller temperature stable?

YES

Check ?SRR. Is seed frequency stable?

NO

Contact Coherent service or an authorized service representative

Resume Operation

Power fluctuating?

NO

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 4.  Laser Output Unstable [Continued]

The numbered paragraphs below are keyed to and supplement the flowchart for this chart.

[1] Assumptions:
- The laser system has been installed in accordance with the installation procedures in “Section Three: Installation”
- The laser system has been turned on and set up as described in “Section Four: Operation”
- The laser is in continuous mode (PM=0), or the external gate or modulation configuration is set properly, and signal quality meets the requirement (see Figure XX and Table XX).

[2] The laser may not function correctly if the external gate or trigger configuration is not set properly.

[3] If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 5. Laser Shuts Down (No Light Output)

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
The numbered paragraphs below are keyed to and supplement the flowchart for this chart.

[1] Assumptions:
   • The laser system had been operating immediately prior to shut-down.
   • The laser is set to Continuous mode.
   • The interlocks are closed as described in “Section Three: Installation”. The laser will not operate with the interlock circuits open.
     If a user interlock is installed, the user interlock can be verified by temporarily replacing it with the interlock defeat supplied with the system.
   • The operating parameters are correctly set for the operating mode as described in “Section Four: Operation”
   • The external enable function is active.

[2] External equipment consists of any equipment connected to the Gate/External Modulation or External Interlock/Chiller Control connector.

[3] The laser will not output pulses unless External Interlock or Extended Interface connector is connected and active. It is helpful to verify that the external device supplying this signal is operational.

[4] If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 6.  Cycle the Power (Thread Exception, FPGA Read/Write, Power On Self Test Faults)\(^1\)

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized service representative.
Chart 6.  Cycle the Power (Thread Exception, FPGA Read/Write, Power On Self Test Faults)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>To Clear the fault press the CLEAR button in the System Faults panel of the GUI Main menu tab or send a FACK=1 command. If the fault clears resume operation.</td>
</tr>
<tr>
<td>[2]</td>
<td>Turn the power switch on the power supply rear panel to OFF for at least 3 seconds. Then turn the switch back to ON.</td>
</tr>
<tr>
<td>[3]</td>
<td>If the fault persists, contact Coherent or an authorized representative.</td>
</tr>
<tr>
<td>[4]</td>
<td>If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.</td>
</tr>
</tbody>
</table>
Chart 7. Temperature Faults or Warnings

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 7. Temperature Faults

The temperature faults indicate that the allowable ranges of temperature control have been exceeded. The Servo Temperature Fault indicates that a servo drive has been maximized without reaching the control temperature.

[1] To Clear the fault, press the CLEAR button in the System Faults panel of the GUI Main menu tab or send a FACK=1 command.
   If the fault does not clear, a message will appear in the System Faults panel on the Main menu tab.
   If the fault clears resume operation.

[2] Verify the chiller water temperature is correct and that the chiller is operational.

[3] If the fault persists, contact Coherent or an authorized representative.

[4] If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent or an authorized representative.
Chart 8. **External Interlock Fault**

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.

---

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
The laser system will not operate with an open interlock circuit. The external interlock supplied with the system or a user-furnished interlock must be installed. Refer to the paragraph titled “Interlocks” on page 5.

[1] To Clear the fault, press the CLEAR button in the System Faults panel of the GUI Main menu tab or send a FACK=1 command.
   If the fault does not clear, a message will appear in the System Faults panel on the Main menu tab.
   If the fault clears resume operation.

[2] Check that the connector that is connected to the External Interlock connector on the laser head rear panel is firmly seated.

[3] If a user interlock is installed, turn the keyswitch to <Standby> and replace the user interlock circuit with the External Interlock supplied with the system. If the fault clears, the user interlock circuit is defective.
   If the fault does not clear, verify continuity of the interlock connector.
   If the fault clears, resume normal operation.

[4] If the fault persists, contact Coherent or an authorized representative.

[5] If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent or an authorized representative.
Chart 9. Chiller Comm Fault

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.

---

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 9.  Chiller Comm Fault

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
|[1]| To Clear the fault, press the CLEAR button in the System Faults panel of the GUI Main menu tab or send a FACK=1 command.  
If the fault does not clear, a message will appear in the System Faults panel on the Main menu tab.  
If the fault clears resume operation.  |
|[2]| Check that the chiller cable is connected to the laser head rear panel and is firmly seated.  |
|[3]| If the fault persists, contact Coherent or an authorized representative.  |
|[4]| If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent or an authorized representative.  |
Chart 10. Chiller Flow Fault

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 10. Chiller Flow Fault

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
| [1] | To clear the fault, press the CLEAR button in the System Faults panel of the GUI Main menu tab or send a FACK=1 command.  
If the fault does not clear, a message will appear in the System Faults panel on the Main menu tab.  
If the fault clears resume operation. |
| [2] | Check that the chiller hoses are connected to the laser head rear panel and the connector is firmly seated. |
| [3] | Check that the hoses are not excessively long and have a diameter (ID) equal to or greater than 3/8”. |
| [4] | Check that there are no kinks or crimps in the hose to reduce the flow. |
| [5] | If the fault persists, contact Coherent or an authorized representative. |
| [6] | If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent or an authorized representative. |
Chart 11. Shutter State Mismatch Fault

1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
### Chart 11. Shutter State Mismatch Fault

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
</table>
| [1]  | To Clear the fault, press the CLEAR button in the System Faults panel of the GUI Main menu tab or send a FACK=1 command.  
If the fault does not clear, a message will appear in the System Faults panel on the Main menu tab.  
If the fault clears resume operation. |
| [2]  | Check that the connector that is connected to the External Interlock connector on the laser head rear panel is firmly seated. |
| [3]  | If a user interlock is installed, turn the keyswitch to <Standby> and replace the user interlock circuit with the External Interlock supplied with the system. If the fault clears, the user interlock circuit is defective.  
If the fault does not clear, verify continuity of the interlock connector.  
If the fault clears, resume normal operation. |
| [4]  | If the fault persists, contact Coherent or an authorized representative. |
| [1]  | If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent or an authorized representative. |
1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 12. Dropped Connection Fault

[1] To clear the fault, press the CLEAR button in the System Faults panel of the GUI Main menu tab or send a FACK=1 command.
If the fault does not clear, a message will appear in the System Faults panel on the Main menu tab.
If the fault clears resume operation.

[2] Check that the connections to the computer (USB, RS-232, or Ethernet) and/or Extended Interface on the laser head rear panel are firmly seated.

[3] Check that the computer’s power saving, sleep, and hibernation settings do not allow the computer to turn off during laser operation.

[4] If the fault persists, contact Coherent or an authorized representative.

[5] If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent or an authorized representative.
1. If the laser system must be returned directly to Coherent, a Return Material Authorization (RMA) number is required. Contact Coherent or an authorized representative.
Chart 13. Chiller Water Level/Chiller Temperature Fault

[1] To clear the fault, press the CLEAR button in the System Faults panel of the GUI Main menu tab or send a FACK=1 command. If the fault does not clear, a message will appear in the System Faults panel on the Main menu tab. If the fault clears resume operation.

[2] Check that the chiller hoses are connected to the laser head rear panel and the connector is firmly seated.

[3] Check that the chiller is filled with Coherent recommended Coolflow (available from Hydratech) at 20-25% volume mixed with distilled water.

[4] If the fault persists, contact Coherent or an authorized representative.

[1] If the laser system must be returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent or an authorized representative.

a. [http://www.hydratech.co.uk/coolflowige.html](http://www.hydratech.co.uk/coolflowige.html)
Changing the Laser Head Desiccant

The humidity sensor is located within the access cover and can be read in the **Humidity** panel of the **Temperature Menu Tab**. When the relative humidity inside the laser head reads > 8% as measured by the sensor, a warning message will be displayed in System Faults panel on the Main menu tab of the GUI.

The desiccant housing is located inside the access cover. The desiccant cover location is shown in Figure 7-1.

If the desiccant needs to be replaced more than once in 12 months, contact a Coherent representative for further evaluation.

![Desiccant Access](figure7-1.jpg)

---

**Criteria for Replacement**

Check the relative humidity reading on the Temperature Menu Tab screen (or using the ?RELH serial command) and replace the desiccant if >8%.

---

**Do not remove the access cover while the laser is on. Turn the keyswitch to the STANDBY position, and turn OFF the main AC power (the switch is located on the rear panel of the power supply).**

---

**Desiccant Replacement Procedure**

If the desiccant needs to be replaced.

1. Put laser in Standby Mode. Turn off the power switch from the back panel of the laser power supply.
2. Remove the access cover to expose the desiccant housing.
3. Remove screws holding the desiccant canister.
4. Remove the old desiccant pouch and replace it with a new pouch.
5. Secure the housing canister.
6. Re-install the access cover.
7. Turn main AC power switch on the rear panel of the power supply to the <ON> position and perform the procedure titled “Initial Start-up Procedure” on page 2.
APPENDIX A: THERMAL MANAGEMENT

Introduction

When installing the Monaco laser head, a heat load must be properly dissipated. Insufficient cooling can trigger an over-temperature condition, especially with the higher power models.

See Table A-1 for the recommended water flow rate. It is recommended to maintain the water temperature constant to a value within 20-25°C.

Table A-1. Heat Load and Flow Rate

<table>
<thead>
<tr>
<th>MODEL</th>
<th>HEAT LOAD</th>
<th>FLOW RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MONACO</td>
<td>500 W</td>
<td>4.9 L/min (1.3 gal/min)</td>
</tr>
</tbody>
</table>

The temperature of the laser head baseplate is monitored and displayed on the Temperature Menu Tab of the GUI. The baseplate temperature is used to monitor the effectiveness of heat dissipation.

In all cases Monaco lasers will operate properly over a wide range of operating temperatures, but for maximum power and pointing stability and minimum pointing angle drift, the temperature of the base plate should vary no more than ±1°C. The Monaco laser will shut down if the baseplate temperature exceeds 33°C.

The conditions which generate the most heat in the Monaco laser head are:

- Diodes ON
- Pulsing OFF

When heat is efficiently dissipated, it serves several purposes:

- **Avoid over-temperature faults.** The laser will automatically shut down if the baseplate temperature exceeds 33°C.

- **Consistent pointing angle.** The pointing angle of the laser changes up to 25 microradians per °C change in the baseplate temperature. Maximizing the baseplate temperature stability will minimize temperature-induced pointing angle drift.
**Enhanced power stability.** Excessive changes in the laser baseplate temperature will affect the temperature and efficiency of the SHG and HG crystals. This, in turn, will reduce the power stability of the laser.

The Monaco laser operates optimally when the baseplate temperature is less than 25°C. If the baseplate temperature rises above 25°C, the laser rod temperature may not be well controlled when operating the laser at maximum power.

**Water Cooling**

The Monaco laser has a closed-loop chiller as a standard part of the system.

1. Fill the chiller with Coherent recommended Coolflow (available from Hydratech¹) at 28% volume mixed with distilled water for corrosion and algae control. Otherwise, the PH level becomes too aggressive for the cooling circuit materials.

2. Do NOT operate the laser with diode current below 80%. Operating the laser at low diode current may result in a temperature fault.

---

**NOTICE!**

To avoid damage to the Monaco system, use ONLY distilled water in the chiller’s closed loop system. DO NOT use facility tap or deionized water.

---

**NOTICE!**

To avoid damage to the Monaco system, do not use the chiller for any equipment other than the Monaco laser. Galvanic corrosion will occur if materials are incompatible.

---

**Chiller**

Coherent provides a chiller to be used with the Monaco as described in Table A-2.

---

¹. [http://www.hydratech.co.uk/coolflowige.html](http://www.hydratech.co.uk/coolflowige.html)
### Table A-2. Recommended Chillers

<table>
<thead>
<tr>
<th>MODEL</th>
<th>PRODUCT</th>
<th>PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monaco</td>
<td>P307 Termotek, 570W 100-240V AC 50/60Hz RoHS Compliant</td>
<td>1254673</td>
</tr>
</tbody>
</table>
APPENDIX B: PACKING PROCEDURE

Introduction

The following packing procedure for the Monaco laser system is the factory recommended procedure. This procedure must be followed if the laser system is shipped to another location after initial installation or returned to the factory for service. For a complete list of all items shipped with the laser system, see Table B-1.

The Monaco shipping crate consists of three compartments. Before crating, the laser head is packaged into protective bags as shown in Figure B-1 and then placed into the longest (full length) crate compartment, onto a cushioned support platform, as shown in Figure B-2. It is then secured to the shipping crate using shipping straps as shown in Figure B-3.

The power supply is packed in its original box and loaded into the crate using lift assist straps as shown in Figure B-3. The straps are later used to remove the power supply from the crate during unpacking.

The accessories kit is loaded into the remaining crate compartment and into cushioning as shown in Figure B-3. All components listed in Table B-1, as applicable, are included in the crate. For a more detailed description of how to pack and ship the laser system, see “Packing the System” on page B-3.
### Table B-1. Monaco Crate Contents

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Laser Head</td>
</tr>
<tr>
<td>2.</td>
<td>Power Supply</td>
</tr>
<tr>
<td>3.</td>
<td>Accessory Kit</td>
</tr>
<tr>
<td></td>
<td>Standard:</td>
</tr>
<tr>
<td></td>
<td>Power Supply Cable</td>
</tr>
<tr>
<td></td>
<td>Interlock/IO Adapter Cable</td>
</tr>
<tr>
<td></td>
<td>USB Cable</td>
</tr>
<tr>
<td></td>
<td>DB9 Cable, Chiller to Laser Head</td>
</tr>
<tr>
<td></td>
<td>Mini BNC Cable, Qty 3</td>
</tr>
<tr>
<td></td>
<td>Rubber Hose, Blue, 10 Feet</td>
</tr>
<tr>
<td></td>
<td>Rubber Hose, Red, 10 Feet</td>
</tr>
<tr>
<td></td>
<td>Quick Disconnect Fitting, Insert</td>
</tr>
<tr>
<td></td>
<td>Quick Disconnect Fitting, Body</td>
</tr>
<tr>
<td></td>
<td>Hose Clamp, Qty 4</td>
</tr>
<tr>
<td></td>
<td>Power Supply Keys (2)</td>
</tr>
<tr>
<td></td>
<td>USB Flash Drive (Coherent GUI software)</td>
</tr>
<tr>
<td></td>
<td>Operator’s Manual</td>
</tr>
<tr>
<td></td>
<td>Final Test Data Sheets</td>
</tr>
<tr>
<td></td>
<td>Optional:</td>
</tr>
<tr>
<td></td>
<td>CoolFlow DTX Coolant</td>
</tr>
</tbody>
</table>
Packing the System

Use the following procedure to pack the laser system:

---

Drain all residual water from the laser head prior to packing for shipment.

---

1. Check that the coolant hose input and output connector valves are open.
2. Drain all coolant from the laser head.
3. Package the laser head and water lines with the low outgassing bag, and tape the bag closed as shown in Figure B-1.
4. Package the laser head and water lines with the humidity barrier bag, and tape the bag closed as also shown in Figure B-1.

Note: The outgassing and humidity barrier bags may be different from the bags in the below figures.
Figure B-1. Laser Head Protective Bags
5. Place the laser head into the shipping crate and onto the support platform as shown in Figure B-2. Check that the laser head is completely seated on the platform.

![Figure B-2. Laser Head Crate Platform](image)
6. Place cardboard edge protectors between the shipping straps and the laser head to protect the laser head from damage as shown in Figure B-3. Secure the laser head into the crate using the shipping straps. Verify that the head is firmly seated. Check that the strap latches are resting on the edge protectors.

7. Lower the power supply box into the crate using the lift assist straps as shown in Figure B-3. (The lift assist straps are also used to remove the power supply from the crate during unpacking.)

8. Place the accessory kit into the foam cutout as shown in Figure B-3.

---

*Figure B-3. Crate Contents*
9. Install the crate cover and secure it to the crate using two wire clips on each side of the crate as shown in Figure B-4.

**Figure B-4. Crate Clips Securing Cover**

---

**Notice:**
To prevent damage, the shipping container must post the warnings shown in Figure B-5 and Figure B-6, below.

---

**Figure B-5. Shipping Container Warning**
10. Notify the shipper that the crate contents are fragile, sensitive to shock and moisture, and must be shipped in the upright position. See Figure B-5 and Figure B-6 for a closeup of the shipping container warnings and crate orientation.

11. Coherent recommends installing a shock watch and a tip-tilt sensor on the inside and outside of the crate before shipping.
WARRANTY

Coherent, Inc. warrants Diode-Pumped Solid State laser systems to the original purchaser (the Buyer) only, that the laser system, that is the subject of this sale, (a) conforms to Coherent's published specifications and (b) is free from defects in materials and workmanship.

Laser systems are warranted to conform to Coherent's published specifications and to be free from defects in materials and workmanship for a period of 12 months.

Responsibilities of the Buyer

The Buyer is responsible for providing the appropriate utilities and an operating environment as outlined in the product literature. Damage to the laser system caused by failure of Buyer's utilities or failure to maintain an appropriate operating environment, is solely the responsibility of the Buyer and is specifically excluded from any warranty, warranty extension, or service agreement.

The Buyer is responsible for prompt notification to Coherent of any claims made under warranty. In no event will Coherent be responsible for warranty claims made later than seven (7) days after the expiration of warranty.

Limitations of Warranty

The foregoing warranty shall not apply to defects resulting from any of the following:

- Components and accessories manufactured by companies, other than Coherent, which have separate warranties
- Improper or inadequate maintenance by the Buyer
- Buyer-supplied interfacing
- Operation outside the environmental specifications of the product
- Unauthorized modification or misuse
- Improper site preparation and maintenance, or
- Opening the housing

Coherent assumes no responsibility for customer-supplied material. The obligations of Coherent are limited to repairing or replacing, without charge, equipment which proves to be defective during the warranty period. Replacement sub-assemblies may contain recondi-
tioned parts. Repaired or replaced parts are warranted for the duration of the original warranty period only. The warranty on parts purchased after expiration of the system warranty is ninety (90) days. Coherent’s warranty does not cover damage due to misuse, negligence or accidents, or damage due to installations, repairs or adjustments not specifically authorized by Coherent.

This warranty applies only to the original purchaser at the initial installation point in the country of purchase, unless otherwise specified in the sales contract. Warranty is transferable to another location or to another customer only by special agreement which will include additional inspection or installation at the new site. Coherent disclaims any responsibility to provide product warranty, technical or service support to a customer that acquires products from someone other than Coherent or an authorized representative.

THIS WARRANTY IS EXCLUSIVE IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL OR IMPLIED, AND DOES NOT COVER INCIDENTAL OR CONSEQUENTIAL LOSS. COHERENT SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.
## Glossary

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>Degrees centigrade or Celsius</td>
</tr>
<tr>
<td>°F</td>
<td>Degrees Fahrenheit</td>
</tr>
<tr>
<td>Ω</td>
<td>Ohms</td>
</tr>
<tr>
<td>µm</td>
<td>Micron(s) = (10^{-6})</td>
</tr>
<tr>
<td>µJ</td>
<td>MicroJoule(s) = (10^{-6}) Joules</td>
</tr>
<tr>
<td>µrad</td>
<td>Microradian(s) = (10^{-6}) radians</td>
</tr>
<tr>
<td>µs</td>
<td>Microsecond(s) = (10^{-6}) seconds</td>
</tr>
<tr>
<td>µsec</td>
<td>Microsecond(s) = (10^{-6}) seconds</td>
</tr>
<tr>
<td>1/e^2</td>
<td>Beam diameter parameter</td>
</tr>
<tr>
<td>A</td>
<td>Amperes</td>
</tr>
<tr>
<td>AC</td>
<td>Alternating current</td>
</tr>
<tr>
<td>Amp</td>
<td>Amperes</td>
</tr>
<tr>
<td>CDRH</td>
<td>Center for Devices and Radiological Health</td>
</tr>
<tr>
<td>cm</td>
<td>Centimeter(s)</td>
</tr>
<tr>
<td>CPU</td>
<td>Central processing unit</td>
</tr>
<tr>
<td>CW</td>
<td>Continuous wave (operating mode)</td>
</tr>
<tr>
<td>DAC</td>
<td>Digital-to-analog converter</td>
</tr>
<tr>
<td>DC</td>
<td>Direct current</td>
</tr>
<tr>
<td>DCE</td>
<td>Data communications equipment</td>
</tr>
<tr>
<td>ESD</td>
<td>Electro-static discharge</td>
</tr>
<tr>
<td>fs</td>
<td>Femtoseconds = (10^{-15}) seconds</td>
</tr>
<tr>
<td>fsec</td>
<td>Femtoseconds = (10^{-15}) seconds</td>
</tr>
<tr>
<td>gpm</td>
<td>Gallons per minute</td>
</tr>
<tr>
<td>Hz</td>
<td>Hertz or cycles per second (frequency) ((= 1/\text{pulse period}))</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/output</td>
</tr>
<tr>
<td>IR</td>
<td>Infrared (wavelength)</td>
</tr>
<tr>
<td>kg</td>
<td>Kilogram(s) = (10^3) grams</td>
</tr>
<tr>
<td>kHz</td>
<td>Kilohertz = (10^3) hertz ((1000\text{ Hertz}))</td>
</tr>
<tr>
<td>kV</td>
<td>Kilovolt(s) = (10^3) volts</td>
</tr>
<tr>
<td>kohm</td>
<td>Kilohm(s)</td>
</tr>
<tr>
<td>LCD</td>
<td>Liquid crystal display</td>
</tr>
<tr>
<td>LD</td>
<td>Laser diode</td>
</tr>
<tr>
<td>LED</td>
<td>Light emitting diode</td>
</tr>
<tr>
<td>m</td>
<td>Meter(s)</td>
</tr>
<tr>
<td>mA</td>
<td>Milliamperes = (10^{-3}) Amperes</td>
</tr>
<tr>
<td>mAmp</td>
<td>Milliampere(s)</td>
</tr>
<tr>
<td>mm</td>
<td>Millimeter(s)</td>
</tr>
<tr>
<td>mrad</td>
<td>Milliradian(s)</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
<td>------------</td>
</tr>
<tr>
<td>msec</td>
<td>Millisecond(s)</td>
</tr>
<tr>
<td>mV</td>
<td>Millivolt(s)</td>
</tr>
<tr>
<td>mW</td>
<td>Milliwatt(s)</td>
</tr>
<tr>
<td>nm</td>
<td>Nanometers $= (10^{-9} \text{ m})$ (wavelength)</td>
</tr>
<tr>
<td>OEM</td>
<td>Original equipment manufacturer</td>
</tr>
<tr>
<td>PRF</td>
<td>Pulse repetition frequency</td>
</tr>
<tr>
<td>ps</td>
<td>Picoseconds $= (10^{-12} \text{ seconds})$</td>
</tr>
<tr>
<td>psec</td>
<td>Picoseconds $= (10^{-12} \text{ seconds})$</td>
</tr>
<tr>
<td>psi</td>
<td>Pounds per square inch</td>
</tr>
<tr>
<td>QS</td>
<td>Q-switch</td>
</tr>
<tr>
<td>RF</td>
<td>Radio frequency</td>
</tr>
<tr>
<td>RH</td>
<td>Relative humidity</td>
</tr>
<tr>
<td>RMA</td>
<td>Return material authorization</td>
</tr>
<tr>
<td>rms</td>
<td>Root mean square</td>
</tr>
<tr>
<td>RXD</td>
<td>Receive Data</td>
</tr>
<tr>
<td>SHG</td>
<td>Second harmonic generation</td>
</tr>
<tr>
<td>TEM</td>
<td>Transverse electromagnetic mode</td>
</tr>
<tr>
<td>TTL</td>
<td>Transistor-to-Transistor Logic</td>
</tr>
<tr>
<td>TXD</td>
<td>Transmit Data</td>
</tr>
<tr>
<td>UV</td>
<td>Ultraviolet (wavelength at 355 nm)</td>
</tr>
<tr>
<td>V</td>
<td>Volt(s)</td>
</tr>
<tr>
<td>VAC</td>
<td>Volts, alternating current</td>
</tr>
<tr>
<td>VDC</td>
<td>Volts, direct current</td>
</tr>
<tr>
<td>W</td>
<td>Watt(s)</td>
</tr>
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</table>
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