

Preinstallation Manual
The Coherent Innova[®]
Sabre MotoFRED[™] Ion Laser

 **COHERENT[®]**
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Technical Support

In the US:

Should you experience any difficulties with your laser or need any technical information, please visit our web site www.coherentinc.com. Additional support can be obtained by contacting our Technical Support Hotline at 800-367-7890 (408-764-4557 outside the U.S.) or E-mail (clg.tech.services@coherentinc.com). Telephone coverage is available Monday through Friday (except U.S. holidays and company shutdowns).

If you call outside our office hours, your call will be taken by our answering system and will be returned when the office reopens.

If there are technical difficulties with your laser that cannot be resolved by support mechanisms outlined above, please E-mail or telephone Coherent Technical Support with a description of the problem and the corrective steps attempted. When communicating with our Technical Support Department, via the web or telephone, the model and Laser Head serial number of your laser system will be required by the Support Engineer responding to your request.

Outside the U.S.:

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

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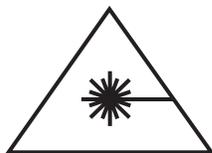
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Preface

This manual provides preinstallation instructions for the Innova Sabre MotoFreD ion laser. Please refer Chapter Three, Laser Safety, in the operator's manual which describes laser safety features and precautions. If you are unfamiliar with ion lasers in general, refer to Chapter Ten, Theory of Operation, in the operator's manual.



Read this manual carefully before operating the laser for the first time. Give special attention to the material in Chapter Three, Laser Safety, in the operator's manual, which describes the safety features built into the Innova Sabre MotoFreD ion laser.



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

U.S. Export Control Laws Compliance

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

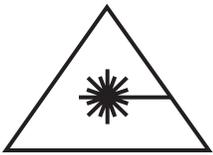
Export and re-export of lasers manufactured by Coherent are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components are regulated by the State Department under the International Traffic in Arms Regulations.

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.

Symbols Used in This Manual and on the Laser System



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



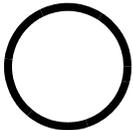
This symbol is intended to alert the operator to the danger of exposure to hazardous visible and invisible laser radiation.



ALTERNATING CURRENT.



DIRECT CURRENT



OFF OR STOP.



ON OR START.



PROTECTIVE CONDUCTOR TERMINAL



STANDBY



EARTH (GROUND) TERMINAL

Introduction

Although some initial tasks can be performed by the customer, first system turn-on must only be performed by a Coherent trained service engineer.

Utility Requirements

The Sabre MotoFreD ion laser requires electrical power and cooling water for the system. The electrical power must meet the specifications in Table 1. The pressure and temperature requirements for the cooling water is shown in Figure 2.

Electrical Service

The electrical service needs to be three phase 480 VAC in WYE configuration, with no neutral and the yellow/green wire to building ground. There is no neutral connection. The Innova Sabre MotoFreD ion laser system will operate with either 60 Hz or 50 Hz line frequency.

Electrical power must meet the specifications in Table 1. The power supply is delivered with a 3 m (10 feet) power cable without a connector attached to the free end unless otherwise specified at the time of order. The cable is type W-4/4, #4 AWG, four wires. You must provide the hardware necessary to connect this cable to your electrical service. The facility outlet must have a fuse or circuit breaker on each phase. Consult applicable local electrical codes to select this hardware.

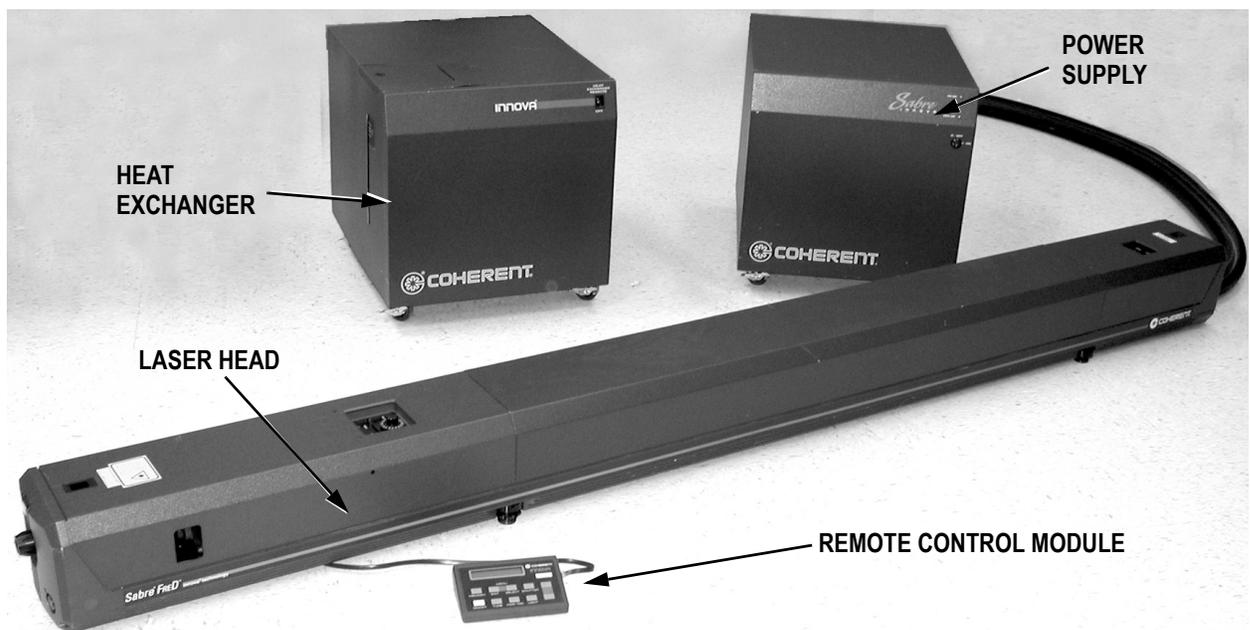
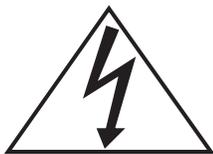


Figure 1. Innova Sabre MotoFRED Ion Laser System

Table 1. Utility Requirements

<p>ELECTRICAL: Line voltage:</p>	<p>480 VAC $\pm 10\%$¹, 3-phase with ground, no neutral, WYE configuration. Phase balance <3% between phases. Maximum current consumption (typical): 70 Amps per phase at 480 VAC ²</p>
<p>Line frequency:</p>	<p>50/60 Hz</p>
<p>Maximum power consumption:</p>	<p>55 kW</p>
<p>ENVIRONMENTAL:</p>	<p>For optimum performance, the laser should be located in a room maintained at a temperature of 10 to 40°C (50 to 104°F).</p>
<ol style="list-style-type: none"> 1. The laser system will operate properly between 432 VAC and 528 VAC provided that the voltage between each pair of phases is within 3% of each other. Power companies almost always provide balanced 3-phase power, but if a heavy load is connected asymmetrically, the line balance can be disturbed. This results in excessive ripple current through the capacitors of the DC filter. This ripple current degrades the noise performance of the laser and shortens the lifetime of the filter capacitors. 2. Consult applicable electrical codes for your area to select appropriate electrical service hardware. Power supply is fused at 80 amps. 	



In order to achieve the laser's specified input voltage, European installations normally use a Transformer. The Innova Sabre MotoFreD ion laser power cord is suitable for connection to a transformer, but should not be directly connected to a AC mains circuit as distributed in Europe.

The Innova Sabre MotoFreD ion laser power supply uses an input power cord which is typically not approved for direct connection in Europe but is however suitable for operation in other geographical areas. The power cord is safe and does meet all requirements.

Do not directly connect a Innova Sabre MotoFreD ion laser power supply to the AC power in an European installation, without first verifying that the voltages are correct and that the wiring used meets all of the local regulatory requirements.

In addition, Coherent recommends that a main power disconnect be located in the same room as the laser system. This disconnect must be capable of interrupting the full load current and disconnecting all phases simultaneously. Consult applicable electrical codes for your area to select this hardware.

Cooling Water

The Innova Sabre MotoFreD ion laser requires a flow of water to cool the laser head and electrical components inside the power supply. Because the properties of the cooling water are critically important to the performance of the laser, the Innova Sabre MotoFreD ion laser is delivered with a separate heat exchanger that connects to the power supply to form a closed water loop. This allows the quality of the water through the laser system to be carefully controlled which translates to longer life span of the plasma tube. It also eliminates condensation as a source of system failure. The use of a heat exchanger also improves beam pointing and power stability since the heat exchanger regulates the cooling water temperature within $\pm 1^\circ\text{C}$ ($\pm 1.8^\circ\text{F}$). The plant water required for the water to water heat exchanger can be either tap water or any closed loop water cooling system. The requirements for the plant water are illustrated in Figure 2.

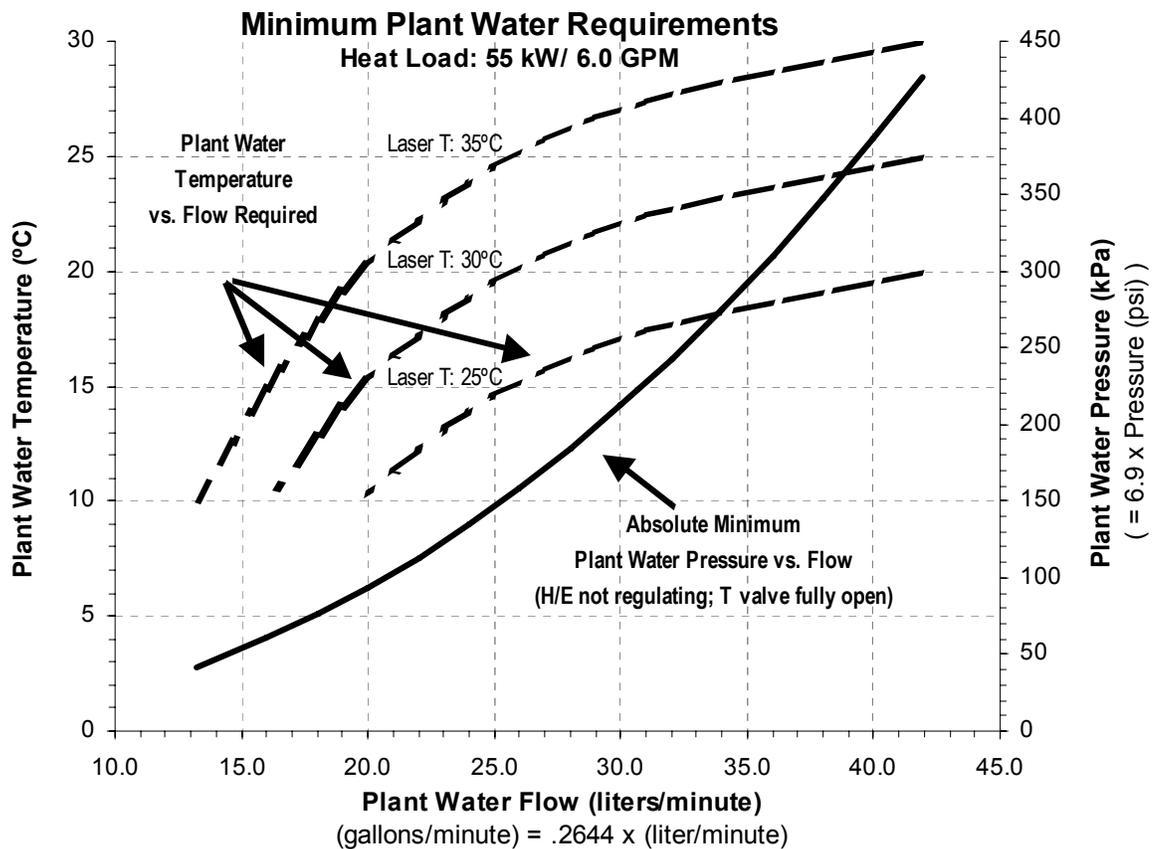


Figure 2. Minimum Plant Water Requirements

It is important to note that the minimum temperature delta between the plant side of the Innova Sabre MotoFreD ion laser's heat exchanger and the laser side is 5°C (9°F).

To determine the minimum pressure requirements of the facility water, the temperature of the water must first be determined. The following illustrates, through example, how to use the graph in Figure 2 to determine the facility water requirements. Note that the graph is for maximum heat load of the laser system, 55 kW.

Typical: The Innova Sabre MotoFreD ion laser system is factory set (referring to the Customer data sheet delivered with the system) for operation at 30°C (86°F). The temperature of the plant (facility) water is measured to be 20°C (68°F).

Determination of required facility water flow:

From the "Plant Water Temperature" axis draw a level horizontal line connecting the 20°C mark to the 30°C "Laser T" curve. From the point where the horizontal line intersects the 30°C curve, drop a vertical line down to the "Water Flow" axis. The point of intersection on the flow axis gives the flow requirement for the facility water, which in this case is read to be 25.6 liters/minute (6.8 GPM).

Determination of absolute minimum facility water pressure:

Draw a vertical line from the required facility water flow (determined in the previous step) up to the "Plant Water Pressure" curve. From the point where the vertical line intersects the pressure curve, draw a level horizontal line over to the "Plant Water Pressure" axis. The point where the horizontal line intersects the pressure axis gives the required facility water pressure, which in this case is read to be 155 kPa (23 psi).

This is the absolute minimum pressure required to cool the laser to 30°C with the heat exchanger temperature valve fully open and not regulating. To properly operate the heat exchanger with the valve regulating, it is recommended that the facility pressure exceed this minimum by at least 10 to 20 psi.

The laser cooling water properties are maintained by the heat exchanger and the deionizing cartridge. A summary of these properties are given in Table 4 and Table 5.

It is advisable to check local and state regulations which may control the use of city water for cooling. Some regulatory codes will not allow the discharge of cooling water into the sewer system.

Selecting The Correct Cooling Water Temperature

The cooling water of any Ion laser can condense moisture from the air when the temperature of the cooling water is lower than the dew point of the air. The system must not operate under these conditions since it will lead to catastrophic failure in the power supply. Under most conditions, it is recommended to select the inlet cooling water temperature to 30°C (86°F). The following information provides recommendations for operating conditions outside of the normal temperature and humidity range.

The conditions that lead to a situation where there can be condensation are warm and humid weather combined with water that is cooler than the surroundings. High risk conditions which will lead to condensation are:

- Operating the laser in a room that is not air conditioned in high humidity conditions
- Using cooling water that is not temperature controlled
- Leaving the cooling water on when the laser is not operating for extended time periods

The parameters required to determine if the cooling water temperature will lead to condensation is:

- Room temperature
- Relative humidity

Since the weather conditions change, these factors need to be periodically check especially in the spring and summer seasons. In environments that are air conditioned, we recommend setting the cooling water temperature to 30°C (86°F). As explained below for conditions that are not air conditioned, we recommend that the cooling water temperature be increased to the air temperature to avoid condensation in humid climates.

The recommended minimum inlet cooling water temperature is provided in Table 2 and Table 3 for the complete operating temperature range of the Innova Sabre MotoFreD ion laser. Note that the first table is for temperature on the Celsius scale and the second is for temperatures on the Fahrenheit scale. To use this chart, find the row with the closest room temperature. Next read across until you find the column with the nearest relative humidity for the room with the laser. The number in the box is the recommended temperature for the inlet cooling water. If a closed loop cooling system is being used then select this temperature as the temperature set point. As an example, if the current room temperature is 28°C and the relative humidity is 68%, then the recommended inlet cooling water temperature is 35°C and the nearest relative humidity is 70%.

Table 2. Recommended Minimum Inlet Cooling Water Temperature (°C)

ROOM TEMPERATURE (°C)	MAXIMUM RELATIVE HUMIDITY							
	30%	40%	50%	60%	70%	80%	90%	95%
10	20	20	20	20	20	20	20	20
15	20	20	20	20	20	20	20	20
20	20	20	20	20	25	25	25	25
25	25	25	25	25	30	30	30	30
30	30	30	30	30	35	35	35	35

The minimum inlet cooling water temperature should account for variations in cooling water temperature with the thermal load, temperature stability of the cooling water system, and seasonal variations in cooling water temperature.

Table 3. Recommended Minimum Inlet Cooling Water Temperature (°F)

ROOM TEMPERATURE (°F)	MAXIMUM RELATIVE HUMIDITY							
	30%	40%	50%	60%	70%	80%	90%	95%
50	68	68	68	68	68	68	68	68
60	68	68	68	68	68	68	68	68
70	70	70	70	70	77	77	77	77
80	77	77	77	77	86	86	86	86
90	86	86	86	86	95	95	95	95

The minimum inlet cooling water temperature should account for variations in cooling water temperature with the thermal load, temperature stability of the cooling water system, and seasonal variations in cooling water temperature.

Selecting the cooling water temperature must also take into account changes in the cooling water temperature. For a closed loop cooling water system, there can be variations in the water temperature due to changes in the thermal load and the response time of temperature controller. The number given by the table will be the minimum water temperature that should be observed for the current room temperature and humidity conditions.

In many climates, the cooling water temperature should be changed due to seasonal variations in the ambient conditions. For example in times of high relative humidity and high room temperatures, the cooling water temperature will have to be increased to avoid problems with condensation. Under extreme conditions of temperature and humidity, the laser should not be operated as noted in Table 2 and Table 3. This can be solved by air conditioning the room with the laser to reduce both the room temperature and the humidity.

When using tap water as cooling source, seasonal variations in the water temperature often can lead to conditions that will produce condensation. In this case, mixing some hot water with the inlet cooling water will be required to eliminate condensation or alternatively reducing the room temperature and humidity with an air conditioning system.

Table 4. Laser Cooling Water Properties

Laser Cooling Water Parameter	Requiements
Hardness	<100 mg/liter (5.9 grains/gallon) or 100 parts per million of calcium
Resistivity	50 kΩ-cm to 2.0 MΩ-cm; (>100 kΩ-cm recommended) Resistivity <100 kΩ-cm: Warning to replace cartridge
pH	6 to 8
Particulate size	<200 microns in diameter
Heat load	55 kW
Pressure differential ⁽¹⁾	240 kPa (35 psi) at 22.7 liters/minute (6.0 gallons/minute) ⁽²⁾
Maximum static pressure ⁽³⁾	620 kPa (90 psi)
Inlet temperature	10°C to 35°C (41°F to 95°F) ⁽⁴⁾
<p>(1) The pressure differential is the inlet pressure minus the drain pressure.</p> <p>(2) Standard system with 7.6 m distance (25 feet) between facility water and heat exchanger; (3/4 inch diameter hoses).</p> <p>(3) The static pressure is the inlet pressure measured under conditions of zero flow.</p> <p>(4) The temperature control valve should be set to a temperature between 20°C (68°F) and 35°C (95°F) [30°C (86°F) recommended] to avoid condensation inside the laser system in case of high humidity.</p>	

Table 5. Plant Water Requirements

Plant Water Parameter	Requirements
Hardness	<100 mg/liter (5.9grains/gallon) or 100 parts per million of calcium
Heat load	55 kW
Pressure differential ⁽¹⁾	170 kPa typ. (25 psi); 415 kPa max. (60 psi) ⁽²⁾
Maximum static pressure ⁽³⁾	620 kPa (90 psi)
Inlet temperature	10°C to 30°C (41 to 86°F) ⁽⁴⁾

- (1) The pressure differential is the inlet pressure minus the drain pressure.
 (2) Standard system with 7.6 m distance (25 feet) between facility water and heat exchanger; (3/4 inch diameter hoses).
 (3) The static pressure is the inlet pressure measured under conditions of zero flow.
 (4) The temperature control valve for the laser cooling water should be set to a temperature between 20°C (68°F) and 35°C (95°F) [30°C (86°F) recommended] to avoid condensation inside the laser system in case of high humidity.



Do not use de-ionized water in the internal cooling loop.

Water that is high in resistivity (>2 MΩ-cm) will slowly dissolve metal components in the cooling path. Dissolved metals, as with dissolved salts and minerals, can result in these materials depositing on the envelope of the plasma tube, and thereby lead to possible tube failure.

Nitrogen Purge

Innova Sabre MotoFreD ion laser operation in SHG wavelengths requires a source of high purity nitrogen gas. The end user must supply a grade 5 (99.999%) quality or better. Nitrogen boil-off is recommended. A regulator that is oil and contaminate free must also be provided. Teflon tubing must be used and is provided in the maintenance kit.



Note: The maintenance kit does not include a flowmeter and customers are required to obtain this device in order to monitor nitrogen flow. Coherent offers a flowmeter (PN 2902-0065) with a resolution of 0 - 2 SCFH and is well suited for this application.



When the crystal is not in use, store it in a desiccant box or leave it in the system. If the crystal is left in the system, both of the following conditions must be satisfied:

- **The keyswitch must be in the ON position to insure proper heating of the crystal.**
- **The Nitrogen purge must be turned on.**

Failure to follow these requirements will likely result in irreversible damage from condensation of water vapor on the crystal Brewster surfaces. When the system is in operation, the Nitrogen purge must be on.

Environmental Requirements

Ambient Temperature

The room in which your laser is located should be maintained at a temperature of 10 to 30°C (50 to 86°F).

Relative Humidity

The humidity of the room must fall within the range of 10 to 90% and be **non-condensing**. Refer to Table 2 and Table 3 to determine the acceptable temperature / humidity relation.

Altitude

The maximum operational altitude for the Innova Sabre MotoFreD ion laser is 2,000 meter maximum.

Site Preparation

To assist in planning the work space, the dimensions of the components constituting the Innova Sabre MotoFreD ion laser system are listed in Table 3. Enough space should be left around the laser head so that the components inside can be accessed. The laser head and power supply are connected through a 3 m (10 feet) umbilical. When planning the work space, allow sufficient space to avoid bending or crimping the umbilical sharply. Allow for a bend radius of at least 30 cm (12 inches). In order to maximize the system's

immunity to externally generated electromagnetic interference, take care not to route system cables in close proximity to other equipment cables.

The Innova Sabre MotoFreD ion laser is a precision instrument whose performance depends on its environment. Vibrations can be transmitted to the laser head from the surface on which it rests, causing beam pointing instability and power fluctuations. To minimize vibrations, the laser head should be placed on a stabilized optical table and isolated from mechanical contact with other equipment.

All Innova Sabre MotoFreD ion laser systems include purge kits for dry nitrogen because of the hygroscopic nature of the BBO frequency doubling crystal. The purge kit consists of a variable flowmeter, necessary connectors and hoses, a particulate filter, and special intracavity parts. A user-supplied source of dry nitrogen is required. The recommended grade of bottled nitrogen has a minimum purity of 99.999% and is sometimes known as scientific grade. A high purity “boil-off” nitrogen source may be used as an alternative. Dry air may not be used as it contains oxygen which can be converted to ozone by the deep UV produced by the plasma discharge.

Table 6. System Dimensions

	LENGTH	WIDTH	HEIGHT
LASER HEAD	257.5 cm (101.4 inch)	20.3 cm (8 inch)	19.1 cm to 20.4 cm (7.53 inch to 8.03 inch)
POWER SUPPLY	57.8 cm (22.75 inch)	47.8 cm (18.8 inch)	50.8 cm (20.0 inch)
HEAT EXCHANGER	57.8 cm (22.75 inch)	47.8 cm (18.8 inch)	50.8 cm (20.0 inch)

Receiving the System

The Innova Sabre MotoFreD ion laser is shipped in three crates: one contains the power supply, one the heat exchanger and the third the laser head. Accessories, including the remote control module, are packed in separate boxes and shipped in the laser head crate. A packing list, which details all the ordered items, is included in the shipment. Please check items received against this packing list.



Please advise your receiving department to perform the damage inspection procedure prior to signing the bill of lading.

Damage Inspection

Carefully inspect each crate and note any damage. All Innova Sabre MotoFreD ion laser crates are shipped with rough handling indicators affixed to their front and back. Examine these indicators upon receipt. If the indicator bar is red, the crate has received handling which may have damaged the contents. Indicate any such signs on the bill of lading.

Report any damage immediately to the shipping carrier and to the Coherent Order Administration Department, 800-438-6323.

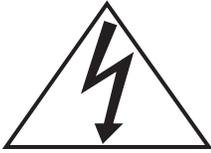
Pre-Installation

Placement of Power Supply and Heat Exchanger

Both power supply and heat exchanger are designed to fit next to each other under tables that have at least 53 cm (21 inches) of clearance. The connecting cable and water hoses are 4.6 m long (15 feet), if a different placement is desired.

Installing the Electrical Connector

The AC electrical connector must only be installed by a qualified individual in accordance with all applicable codes. The unterminated 4-wire main power cable from the power supply rear panel, contains red, white, black and yellow/green wires. Install your power connector onto this power cable. The yellow-green wire is earth ground. The red, white and black wires are incoming power lines that need to be connected to the three phases in the correct phase order. There is no neutral connection. The heat exchanger uses a three-phase motor, which will run in opposite direction if the incorrect phase order is used. The correct phase order is red - white - black. Incorrect phase orders are connections where the number of interchanged pair of wires is odd. The laser system will not turn on if the phase order is incorrect and the remote will display the fault: "Line Phase Order". In that case the power connector wiring needs to be corrected by swapping one pair of phase connections. The work should be performed by a qualified individual in accordance with all applicable codes.



Do not change any wiring inside the power supply or heat exchanger.

External Interlock

The Innova Sabre MotoFreD ion laser is equipped with an external interlock connection located on the rear of the power supply. When the system is shipped, this connection is jumpered. An external interlock circuit can be connected to the laser system and wired to, for example, a door switch to provide additional laser operating safety. When the door is opened, the laser will shut down.

For more information, refer to the operator's manual.

External Switch

The Innova Sabre MotoFreD ion laser power supply is equipped with an externally accessible switch that closes when the laser tube becomes energized. This provides a convenient way of having e.g., a safety light automatically switched on as the laser starts. The switch is located on the rear of the power supply.

For more information, refer to the operator's manual.

External Shutter Interlock

This interlock is connected to the external shutter in the laser head. As long as the circuit is closed, the external shutter can be opened and closed from the Remote Control Module through the system software. If the circuit is opened, the external shutter will close overriding the software setting. This feature provides the user with a convenient way of having the laser light conditionally switched off without turning off the laser system in case a door into the laboratory is opened.

For more information, refer to the operator's manual.

System Parameters

Table 7. Operating Tube Voltage/Current Range

LASER MODELS	NOMINAL TUBE VOLTAGE AT MAXIMUM TUBE CURRENT	MAXIMUM TUBE CURRENT
Innova Sabre MotoFreD	534	65
The above specifications subject to change without notice.		

System Weight and Dimensions

Table 8. System Weights

	LASER HEAD	POWER SUPPLY	HEAT EXCHANGER
CRATED	215 kg (475 lbs)	134 kg (295 lbs)	102 kg (225 lbs)
UNCRATED	129 kg (285 lbs)	107 kg (235 lbs)	75 kg (165 lbs)
The above specifications subject to change without notice.			

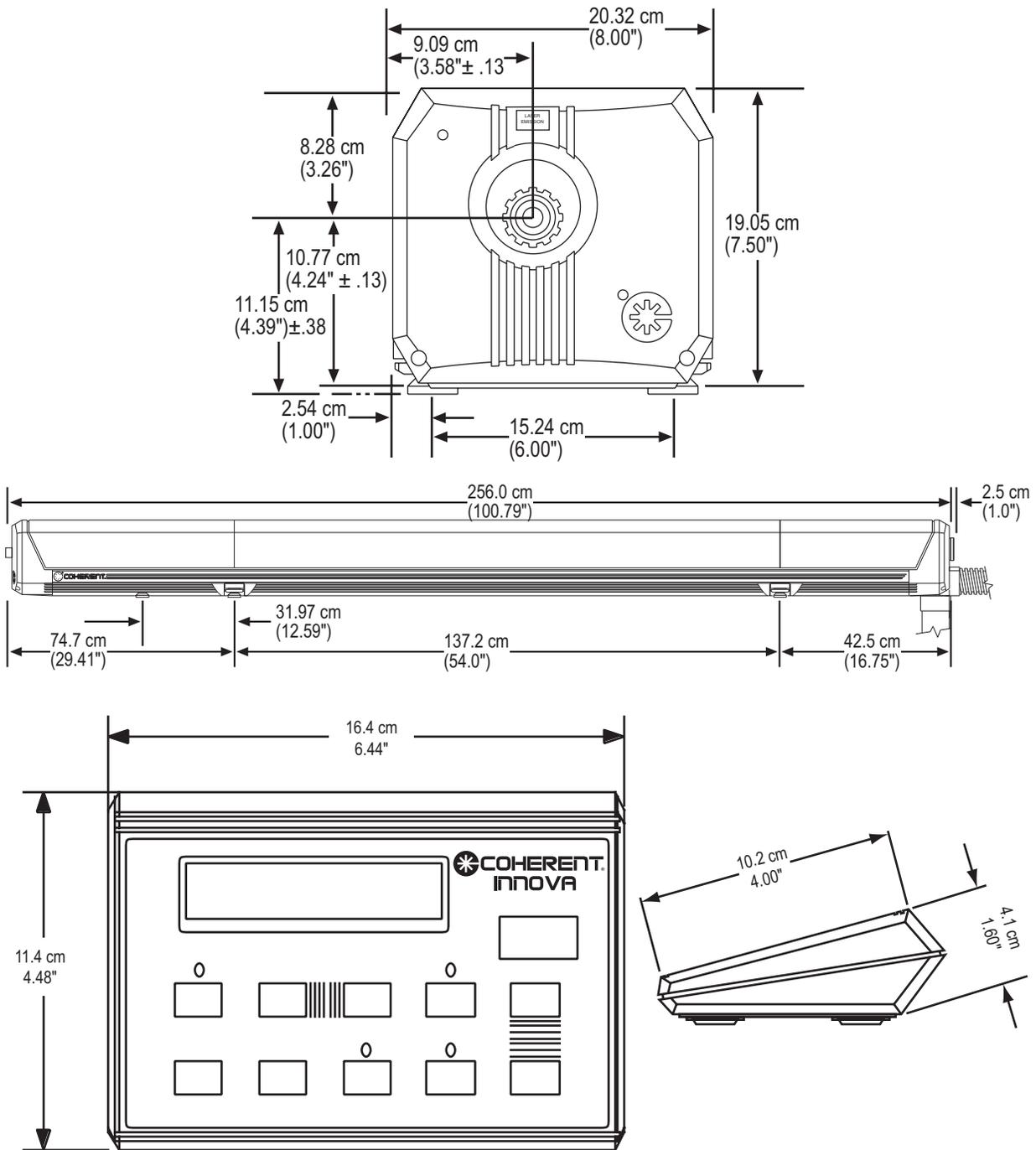


Figure 3. Laser Head and Remote Dimensions

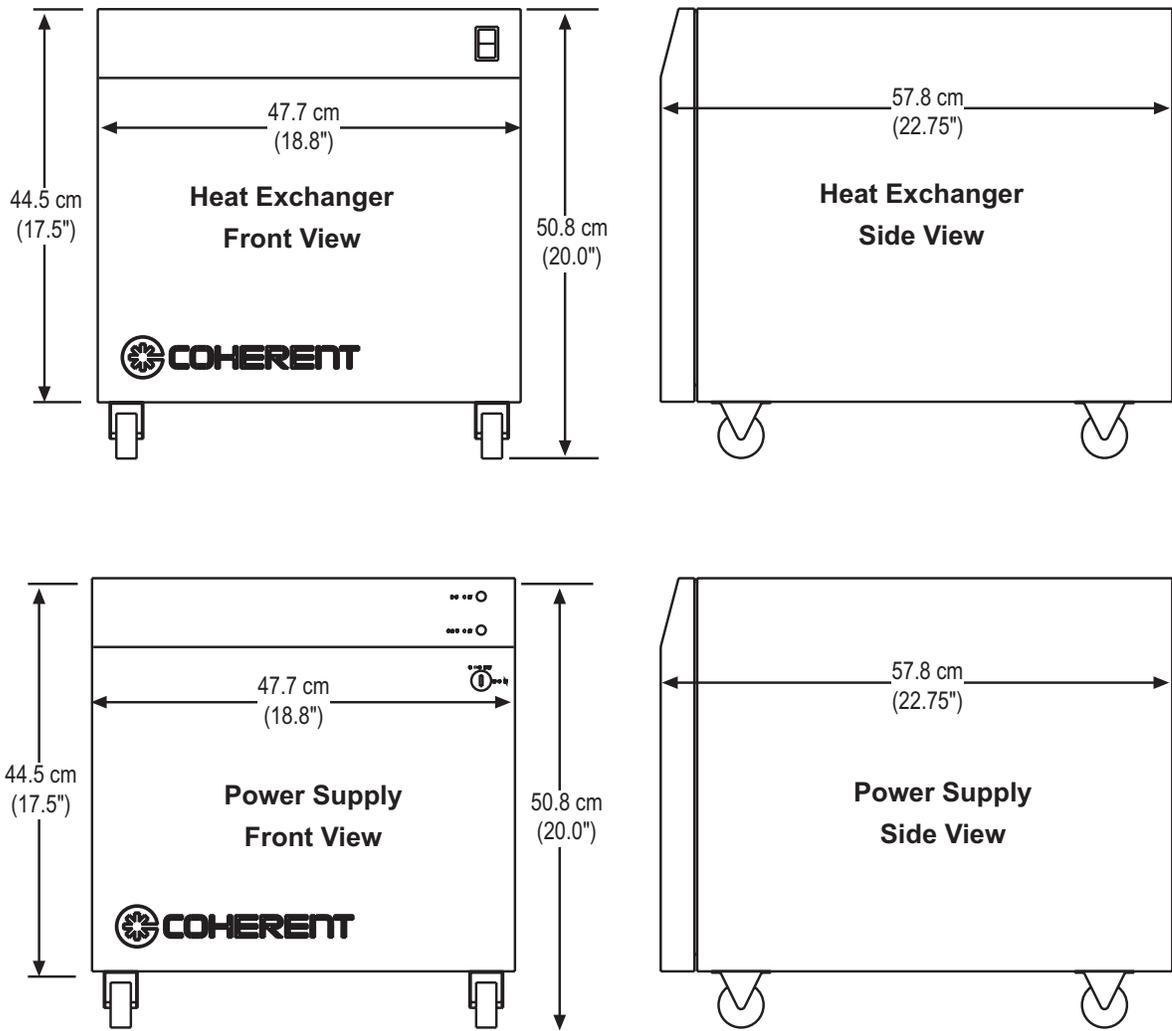


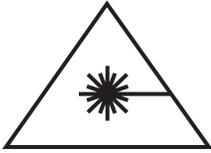
Figure 4. Heat Exchanger and Power Supply Dimensions

Test and Maintenance Equipment

In addition to the maintenance kit supplied by Coherent with your Innova Sabre MotoFreD Ion Laser, it is recommended that you acquire the items listed below for the general upkeep of your laser.

Output Mode Measurements

When your system is installed, you may verify that the output mode meets specifications. If an application demands routine examination of the laser mode, several options are available which differ widely in cost and accuracy of measurement. The simplest and most inexpensive device is a mode cup, a short focal length lens or mirror which can be used to project the beam onto a wall or screen for visual inspection.



Use extreme caution when projecting an expanded laser beam with a mode cup. The expanded beam is sufficiently intense to cause severe eye damage.

For more precise measurements, a beam scanner, spectrum analyzer or M² meter such as the Coherent ModeMaster™ Beam Propagation Analyzer can be used. Contact Coherent Technical Support at 800-367-7890 for more information on how this equipment can be used with your Innova Sabre MotoFreD Ion Laser.

Output Power Measurements

The Innova Sabre ion laser has a built-in power monitor which reports the laser output power through the LCD on the remote control module. The power monitor is factory calibrated and requires no further adjustment. The correct wavelength must be selected on the remote control module for proper calibration.

If you wish to have an accessory power meter available, it should be rated for the full power output of the laser. Coherent offers a variety of instruments for laser test and measurement. For additional detailed information, including product selection guides, please visit our web site at www.Coherent.com.

For the most common diagnostics needs – measuring the output power of the Innova Sabre MotoFreD Ion Laser – Table 9 lists the recommend power meter and detectors that is ideally suited for the Ion product family.

Table 9. Recommended Power Meter

	COHERENT POWER METER 0.3 - 10.6 μM FOR ALL INNOVA MODELS	PART NUMBER	MAXIMUM POWER (IN WATTS)
	Fieldmax II™ TOP Power Meter	1098580	
PS10 Detector	1098350	1	
PM10 Detector	1097901	10 ⁽¹⁾	
PM30 Detector	1098314	30 ⁽²⁾	
(1) Can be used up to 30 watts intermittently (< 5 min. intervals) (2) Can be used up to 100 watts intermittently (< 5 min. intervals)			

FieldMaxII™ TOP

FieldMaxII TOP offers the flexibility necessary for field service applications. The user interface is intuitive and improved LCD display technology offers a digital tuning mode especially useful for tweaking lasers. FieldMaxII TOP is both battery and AC operated, and captures every pulse to 300 pps. (PC software available.).

Innova[®] Sabre MotoFRED[™] Ion Laser Preinstallation Manual
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