Quick Installation Guide

Patara End-Pumped Laser
EPL-016-QTG

NORTHROP GRUMMAN

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Worldwide Technical Support and Product Information

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Important Information

Copyright

Export

This laser product is regulated by the Export Administration Regulations (EAR) of the USA. It may not be exported/re-exported without the prior written approval of the Bureau of Industry and Security, U.S. Department of Commerce.

Safety Information

Product End-of-Life Handling

Northrop Grumman is committed to protecting the environment. In accordance with the Waste Electrical and Electronic Equipment directive (WEEE) and Restriction of Hazardous Substances in the European Union (RoHS EU) directives, Northrop Grumman accepts the return of our products for disposal. When reclaiming the instrument, it must properly transferred according to local regulations concerning WEEE equipment. Contact Northrop Grumman or a local distributor for shipping instructions. Please package the products as directed for a return for repair.

ROC ROHS Declaration

In accordance with the Clause 6.2 of Marking for Control of Pollution Caused by Electronic Information Products (SJ/T11364:2006) for Measures for the Administration on Pollution Control of Electronic Information Products No. 39, Order of the Ministry of Information Industry of the Peoples' Republic of China, Northrop Grumman includes the following translation about our laser modules.

中华人民共和国，电子讯息产品管理办法：自我声明

生产商	Northrop Grumman Cutting Edge Optronics
生产商地址	20 Point West Blvd, St. Charles MO 63301 USA
产品名称 / 编号	Patara End-Pump Laser EPL-016-QTG

有毒有害物质或元素标认表

部件编号	部件名称	有毒有害物质或元素					
		铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (CrVI)	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
第一组	外壳	O	O	O	O	O	O
第二组	电线/ 连接排头	X	O	X	X	X	X
第三组	安装组件	O	O	O	X	O	O
第四组	开关组件	O	O	O	X	X	X
第五组	电路板/ 开关组件	X	O	O	O	X	X
第六组	阵列前端次模组	O	O	O	O	O	O
第七组	接触板	X	O	O	O	X	X
第八组	热交换组件	O	O	O	O	O	O
第九组	16 进制硬件	O	O	X	O	O	O
第十组	焊锡	X	O	X	O	O	O
第十一组	电线/ 连接排头	X	O	O	O	X	X
第十二组	基部/ 端帽	X	O	O	X	O	O
第十三组	硬件/ 装配	O	O	O	X	O	O
第十四组	时计组件	X	O	O	X	X	X
第十五组	包装物料	O	O	O	O	O	O

O：表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T 11363-2006 规定的限量要求以下

X：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出 SJ/T 11363-2006 规定的限量要求

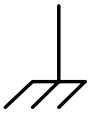
Conventions

The following conventions appear in this manual:

This icon denotes a caution or a warning, which advise of precautions to take to avoid injury, data loss, or a system crash.

Initial Capped	The first letter in uppercase refers to menu options, e.g., **Phase Delay**, **Pulse Width**.
CAPS	Front-panel buttons, knobs, and connectors appear in all uppercase letters, e.g., **MENU, CURRENT**.
▸	The ▸ symbol separates a sequence of button pushes, e.g., **MENU** ▸ **CHANNEL SETUP** ▸ **PULSE WIDTH** means pushing the **MENU** button, then push the **CHANNEL SETUP** soft key, and then push the **PULSE WIDTH** soft key.
italic	Italic text denotes references to other resources that may be helpful or to bring attention to important information.
	This icon denotes a note, which indicates important information.
I **O**	Power Switch Position Symbols I = On O = Off

The following conventions may appear on the product:

DANGER	An injury hazard immediately accessible as the marking is read.
WARNING	A hazard not immediately accessible as the marking is read.
CAUTION	A hazard to property including the product.
	ESD: Handle Appropriately
	Laser Emission: Use caution.
	Shock Hazard: Use caution.
	Caution: Risk of danger. Refer to manual.
	Chassis Ground

General Safety Summary

The Patara Laser System emits laser radiation that can permanently damage eyes and skin, ignite fires, and vaporize materials. This preface contains information and guidance about these hazards. To minimize the risk of injury or expensive repairs, carefully follow these instructions.

Do not attempt to operate the laser system before carefully reading this complete operation manual. For any questions on the product that have not been discussed sufficiently in this manual, contact the manufacturer for complete instructions. Failure to heed this warning may result in the destruction or serious damage to the device, and will void the product warranty.

The trouble shooting section is intended to help guide the user to the source of problems. Do not attempt repairs while the unit is under warranty; instead, report all problems to Northrop Grumman for warranty repair. We also suggest recording information about the laser such as power, settings, time and date.

Safety Overview

Safe operation of any laser should be reviewed prior to any new installation of the Patara laser.

CAUTION. The Patara laser is a Class IV, high power laser whose beam is, by definition, a safety hazard. Avoid eye or skin exposure to direct or scattered laser radiation. Avoid direct viewing of the beam or its specular reflection.

Follow the instructions contained in this manual for proper installation and safe operation of the laser. We recommend the use of protective eyewear at all times (the type of eyewear depends on the energy and wavelength of the laser beam and operating conditions). Consult ANSI, ACGIH, or OSHA standards for guidance.

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

WARNING. At all times during installation, operation, maintenance, or service of the laser, avoid exposure to laser or collateral radiation exceeding the accessible emission limits listed in “Performance Standards for Laser Products,” U.S. Code of Federal Regulations, 21 CFR 1040 10(d).

Precautions for Safe Operation

- Avoid looking directly into the laser beam or at specular reflection, even with protective eyewear on.
- Wear laser safety eyewear that is optically dense at the wavelengths of operation (798-816 nm pump light, 1064 nm fundamental, 532 nm second harmonic).
- Provide a controlled access area for laser operation and limit access to those trained in laser safety principles.
- Post warning signs in prominent locations near the laser operation area.
- Use safety interlocks on all entryways. All Northrop Grumman system control electronics are supplied with interlock inputs that can be used to preclude operation with an open safety door.
- Enclose beam paths wherever possible.
- Set up experiments so the laser beam is below eye level.
- Work in an area that is well lighted to avoid dilation of pupils.
- Set up a target for the beam.
- Set up shields to prevent reflected beams from escaping the laser operation area.
- View an infrared laser beam with a protected image converter at an oblique angle reflecting from a diffuse surface.
- Ensure that all electrical connections are made in a safe manner.
- Position equipment so that electrical connections are shielded from accidental touch.
- Do not smoke, eat, or drink in laser areas.
- Avoid leaving an operating laser unattended.

Center for Devices and Radiological Health Compliance

This laser product complies with Title 21 of the U.S. Code of Federal Regulations, Chapter 1, Subchapter J, Part 1040.10 and 1040.11, as applicable. To maintain compliance with these regulations, once a year or whenever the product has been subject to adverse environmental conditions (e.g. fire, flood, mechanical shock, spilled solvent), verify that the radiation controls are functioning properly. All warning labels should remain fully attached.

About This Manual

This manual describes the installation, operation, and service of the Patara End-Pumped Laser (EPL) System with the eDrive Nitro Laser Controller. The manual consists of the following chapters:

- *Chapter 1: Laser System Components* provides a description of the system components and unpacking procedures
- *Chapter 2: Laser System Setup* provides information on quick set-up of the laser head
- *Chapter 3: Laser Operation and Tuning* provides information on initial operation and optimizing the laser performance

Table of Contents

List of Figures and Tables

1

Chapter 1: Introduction

This introduction provides the following information:

- Laser System Components
- Unpacking the Laser System

Laser System Components

Before installing the laser, be familiar with the components of the laser system (see **Figure 1-1**).

Laser head

eDrive

Chiller

Laser Signal Cable

Diode Power Cable

Q-Switch RF Cable

AC Power Cables

Hose for Chiller

Filter housing and Filter

Filter Wrench

Figure 1-1. Laser System Components

Unpacking the Laser System

The Northrop Grumman Patara laser has been carefully packed for shipment. If the carton appears to have been damaged in transit, have the shipper's agent present when the unit is unpacked.

Inspect the unit as it is unpacked, looking for dents, scratches, or other evidence of damage. If damage is discovered, immediately file a claim against the carrier and notify the Northrop Grumman representative. Northrop Grumman will arrange for repair without waiting for settlement of the claim.

Keep the shipping container. If filing a damage claim, it may be needed to demonstrate that the damage occurred as a result of shipping. If returning the unit for service, the specially designed carton assures adequate protection.

A Patara laser system consists of:

- Laser head
- eDrive
- Laser signal cable
- Diode power cable
- Hoses and filter for chiller
- Filter wrench
- Power cord for chiller*
- Power cords for eDrive*
- Chiller

* United States or European standard as specified in contract

Please check the contents against the packing list and the sales order.

2

Chapter 2: Laser System Setup

Sections included in this chapter provide the following information:

- Laser Head Setup
- eDrive Setup
- Chiller Setup
- Connecting the Chiller

Laser Head Setup

The laser head should be mounted on an optical table or equivalent strong flat surface. There are three mounting holes provided to secure the laser. The laser should be installed in a clean environment.

In the direction of the laser output beam, a power meter with the power scale up to 30 W should be installed approximately 1.5 feet away from the laser. In order to protect the power meter, a negative lens (f=-100mm) with AR coating at 532 nm should be installed in front of the power meter as shown in **Figure 2-1**. If a negative lens is not available, the power meter should be at least 2 meters away from the laser so that the beam size is larger and the power density is below the damage threshold of the power meter.

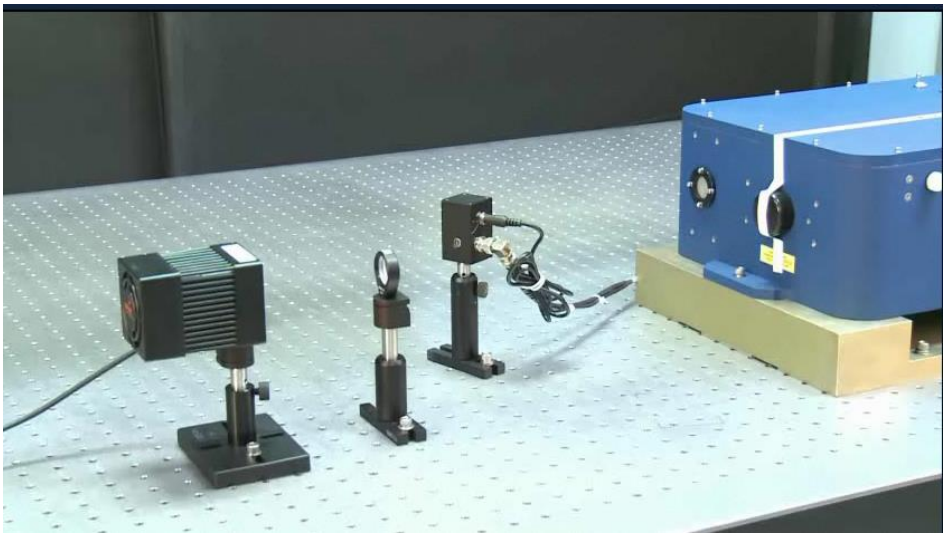


Figure 2-1. Basic Setup for the Laser Power Test

eDrive Setup

Input Power

Use only power cords suitable for the driver. Use a power source that delivers voltage in the range of 100 VAC (RMS) to 240 VAC (RMS) and 47 Hz to 63 Hz. Power switching is performed automatically (i.e., there are no configuration switches to set for high or low voltage ranging). **Table 2-1** provides recommended fuse selection for each voltage range.

Table 2-1. Recommended Fuse Ratings

AC Input	Frequency	Fuse Ratings
		(F1, F2)
120 V / 15 A	47-63 Hz	15 A
240 V / 7 A	47-63 Hz	8 A

Mounting

The front panel of the eDrive is designed with four holes to mount into an EIA-310D-compliant rack. If this option is used, the eDrive's weight requires extra side supports. If the eDrive is to be used on a desktop or table top, it is recommended that the eDrive be equipped with feet to prevent the driver from marring the surface when it is moved. The eDrive must be secured.

Clearance

Adequate clearance should be allowed on the front, sides, and rear of the eDrive for access to connections and components. The front and rear vents of the eDrive must be a minimum of 24 inches (61 cm) away from walls or vertical surfaces so air flow is not restricted.

Chiller Setup

Ambient Temperature and Relative Humidity

The chiller is designed for indoor installation in ambient temperatures between 5 °C and 30 °C (41 °F and 86 °F). Relative humidity should not exceed 80% (non-condensing).

Location

The chiller should be installed on a strong, level surface and be located as close to possible to the laser. It should not be installed closer than 4 feet (1.4 meters) to a heat generating source, such as heating pipes or boilers. If possible, the chiller should be located near a suitable drain to prevent flooding in the event of leaks. Do not place it where corrosive fumes, excessive moisture or dust, or high room temperatures are present.

For ease of positioning and maneuverability, the chiller is supplied with casters. The front wheels can be locked to keep the chiller in place while in use. To help prevent voltage drops, position the chiller as close as possible to the power distribution panel. Avoid voltage drops by using a properly grounded power outlet wired with 14 gauge or larger diameter wire. The use of an extension cord is not recommended

NOTE: The chiller may be located at a level below that of the equipment being cooled. As long as the process remains closed, overflow will not occur when adding cooling fluid to the chiller reservoir.

Oxygen Depletion Risk

In the event of a refrigerant leak, refrigerant gas may displace oxygen that could result in suffocation and death. Never place the chiller in a room that is smaller than the minimum room volume requirement as defined below. If the room is ventilated, the air distribution system must be analyzed to determine the worst case distribution of leaked refrigerant. A leak detector alarm device is always required in a ventilated room that does not meet the minimum room volume given below. Assure adequate and sufficient room volume and ventilation before placing a chiller that contains refrigerant in a room. Contact Polyscience at 800-229-7569 with any concerns or questions.

Pounds of refrigerant charge can be read directly from the nameplate on the chiller. Remember to include in the calculation any refrigerant that may be stored in any other containers.

Minimum Room Volume = Pounds of refrigerant x 110 cubic feet

Example: Two chillers are placed in a room, each containing 6 pounds of refrigerant. The minimum room volume shall be 12 x 110 cubic feet, or 1320 cubic feet.

Clearance

Adequate clearance should be allowed on the front, sides, and rear of the chiller for access to connections and components. The cabinet of the chiller is designed to vent air. Maintain free space, equal to the height of the chiller, for flow of air on the condenser side of the chiller (opposite to where the coolant lines connect). The two sides or the top must have an equal amount of free space. When air flow becomes impeded, cooling capacity decreases and electrical efficiency drops as motor load increases.

Electrical Power

An IEC power cord is provided with the chiller. It should be attached to the receptacle on the rear of the enclosure. Make sure that the power outlet used for the Chiller is properly grounded and matches the voltage and frequency indicated on the identification label on the back of the chiller.

For 208-230 V/60 Hz Polyscience chillers with less than 1.5 horsepower, the supplied power cord will be for connection to a NEMA 6-20 (North America) receptacle, in accordance with local electrical codes. A European cord will be supplied with 50 Hz models.

The use of an extension cord is not recommended. However, if one is necessary, it must be properly grounded and capable of handling the total wattage of the unit. The extension cord must not cause more than a 10% drop in voltage to the Chiller.

CAUTION. The chiller has been set 208-230 Volts at the factory for 60 Hz single phase or 200 volts for 50 Hz single phase. High voltages out of the specified range could damage the chiller.

WARNING. DO NOT plug the Chiller into the electrical outlet until the unit is ready for startup.

Chiller Cleaning Procedures

Please follow the proper procedures to clean the chiller before it is connected to the laser head. These procedures are listed on the CD (compact disc) shipped with the unit. They are also available through Northrop Grumman customer service.

WARNING. Make sure that the chiller will not contaminate the laser head.

Connecting the Chiller

Coolant Hoses and Filter Connections

The required coolant hoses, filters, and fittings are included in the plumbing kit that was shipped with the laser. They should be connected as illustrated in **Figure 2-2**. The correct coolant flow path starts with the supply port of the **chiller ▸ filter ▸ coolant in port of laser head ▸ laser head ▸ coolant out port of laser head ▸ return port of the chiller**. Please be aware of the flow direction of the filter.

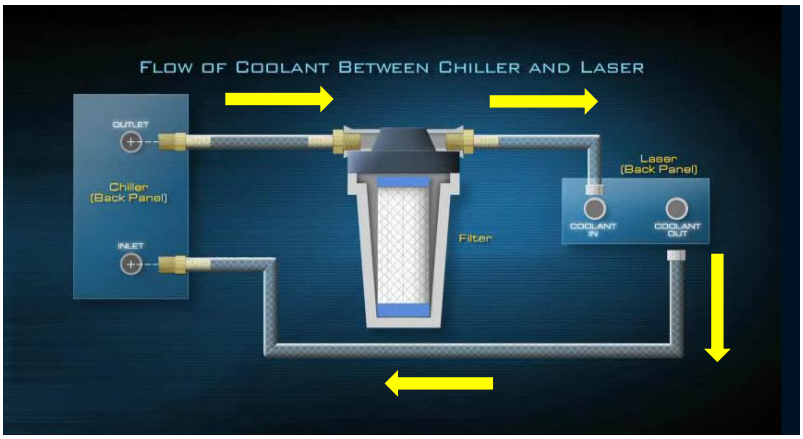


Figure 2-2. Filter Hoses and Coolant Connections

The filter may be attached to the back of the chiller, customer's equipment or a wall using the provided L-bracket.

NOTE: Threaded hose barbs and adapters should have threads wrapped 3-4 times with Teflon tape.

Figure 2-3 depicts the chiller with connected coolant hoses.

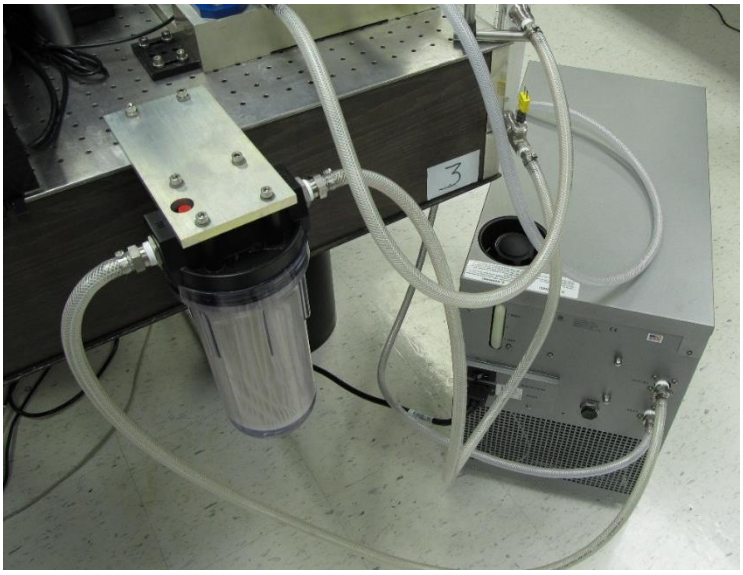


Figure 2-3. Chiller Assembled with Coolant Hoses and Filter

Connections on Laser Head

Figure 2-4 depicts the connectors on the rear panel of the Patara EPL. All of the connectors are clearly labeled.

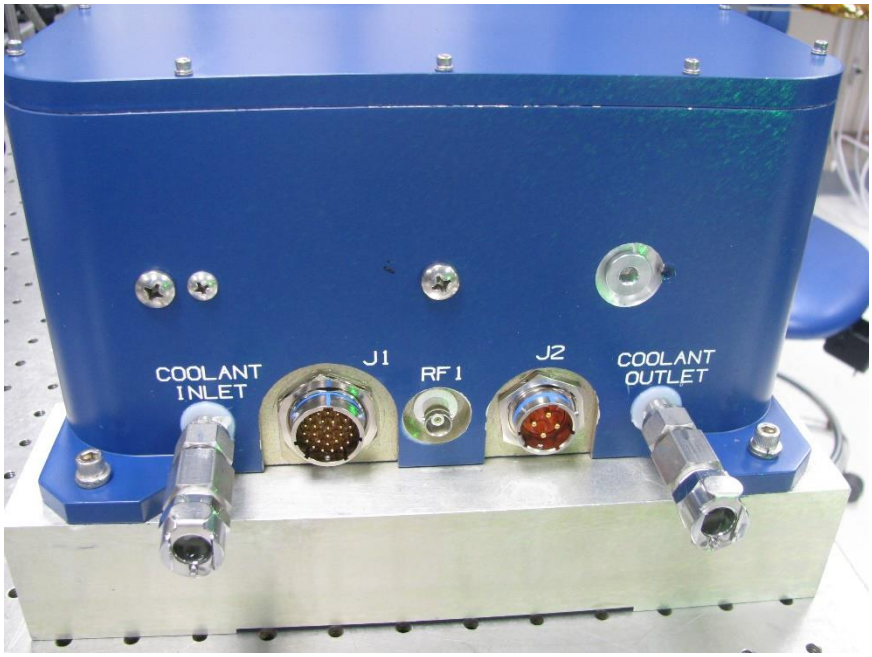


Figure 2-4. Connectors on the rear panel of the Patara EPL

1. **Plumbing Connection**: Push the barb fittings of coolant hose connectors gently into the **COOLANT IN** and **COOLANT OUT** ports by following the flow path direction. Wetting the o-rings of the quick disconnect fittings and receptacles can prevent the o-ring from being cut by the mating piece during insertion. Make sure that the quick disconnect fittings are locked. A click is heard once it is locked.

Figure 2-5. Plumbing Connection

2. Connect RF Cable: Connect the Q-switch RF cable to the BNC connector on the laser head (see **Figure 2-6**). Once it is aligned, the connector can be pushed in. Turn the locking ring of the connector in the clockwise direction until it is locked.

Figure 2-6. Signal Connection

3. Connect diode power. Remove the end cap and connect the female connector of the diode power cable to the **J2** connector on the laser head (see **Figure 2-7**). Once it is aligned, the connector can be pushed in. Turn the locking ring of the connector in the clockwise direction until it is locked.

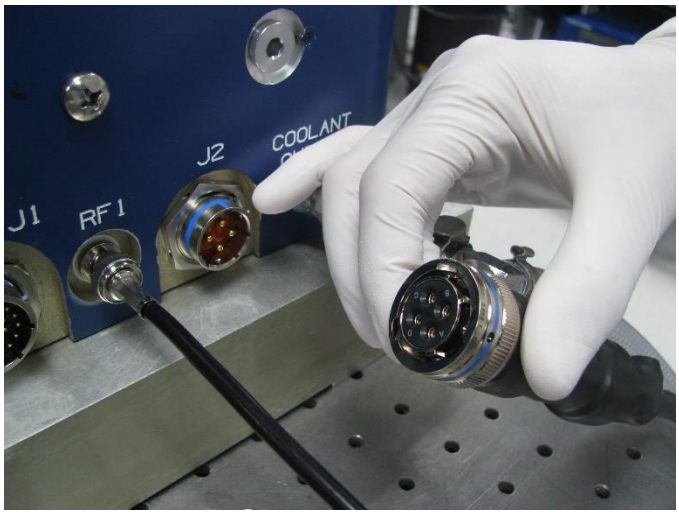


Figure 2-7. Diode Power Connection

4. Connect laser signal. Align the female connector of the laser signal cable to the **J1** connector on the laser head. Once it is aligned, the connector can be pushed in. Turn the locking ring of the connector in the clockwise direction until it is locked as shown in **Figure 2-8**.

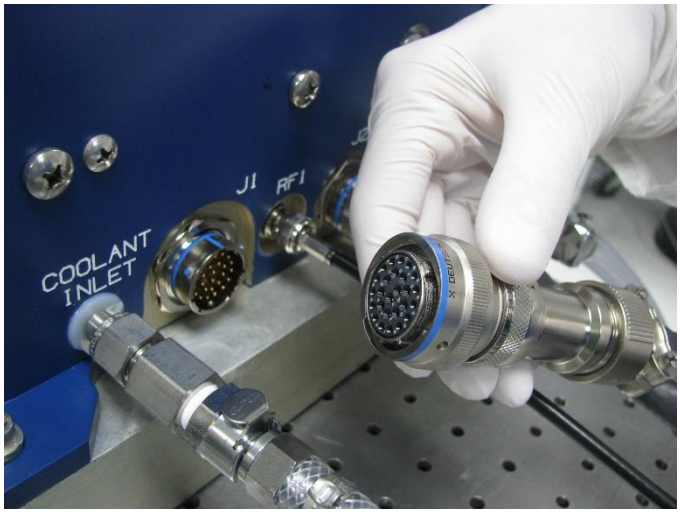


Figure 2-8. Laser Signal Connection

Connections on the eDrive

Figure 2-9 depicts the rear panel of the eDrive.

Figure 2-9. eDrive Rear Panel

1. **Chiller Interlock Connection**: Connect the 9 pin chiller interlock shorting connector as shown below.

Figure 2-10. Chiller Interlock Connector

2. **White Interlock Connection**: Connect the 2-pin white interlock shorting connector as shown below.

Figure 2-11. White Interlock Connectors

3. **Connect RF cable.** Connect the QS RF cable to the **RF OUT 1** connector as shown in **Figure 2-12**.

Figure 2-12. RF Cable

4. **Diode Power Connection:** Connect the male connector of the diodes power cable to the receptacle labeled **ARRAY POWER** on the back of the eDrive

Figure 2-13. Diode Power Cable

5. **Laser Signal Connection:** Connect the connector of laser signal cable to the receptacle labeled laser interface on the back of eDrive (see **Figure 2-14**). Once it is aligned, the connector can be pushed in. Turn the locking ring of the connector in the clockwise direction until it is locked.

Figure 2-14. RF Signal Cable

6. **Interlock Shorting BNC Connection**: Connect the three BNC shorting connectors to **TRIGGER/GATE IN**, **QSW THERM INTLK**, and **INTERLOCK** as shown below.

Figure 2-15. BNC Interlock Connection

3

Chapter 3: Laser Operation and Tuning

This chapter describes the initial operation and tuning of the Laser system. This chapter discusses:

- First Time Chiller Turn on Procedure
- First Time Laser Turn on Procedure
- Laser Performance Optimization
- Daily Operation

First-time chiller turn-on procedure

The first-time turn-on procedure should be similar for use with other chillers.

Filling the Reservoir

1. Remove the filler cap from the reservoir
2. Using a funnel, add Optishield Plus mixture (90% distilled water, 10% Optishield Plus) until it reaches the MAX line on the reservoir's fluid level gauge. If Optishield Plus is not allowed due to local regulations, use Optishield original formula.
3. When full, remove the funnel, but do not replace the cap at this time.

Electrical Power

1. Plug the Chiller's power cord into an appropriate electrical outlet. Place the **Circuit Breaker/Power Switch** on the rear of the instrument enclosure to the **On** position.
2. Three decimal points will appear on the Temperature display

Starting Process Fluid Flow

1. Press the **Power** Button on the front panel. The system startup sequence will begin and proceed as follows:
2. The pump will turn on and fluid will begin circulating through the system. The set point temperature will appear briefly on the Temperature display; after a few seconds, it will be replaced by the actual fluid temperature.

Check for leaks

1. Once the pump is turned on, check all of the connectors to see if there is any leakage. If a leak is observed, turn off the pump immediately and fix the leak.
2. The reservoir's fluid level will drop as the process and/or process cooling lines fill with fluid. Slowly add fluid to the reservoir until the liquid level remains stable.
3. Replace the reservoir cap

First time laser turn-on procedure

Turn on the Chiller

1. Ensure the cap that protects laser output window is removed and make sure the output window is clean.

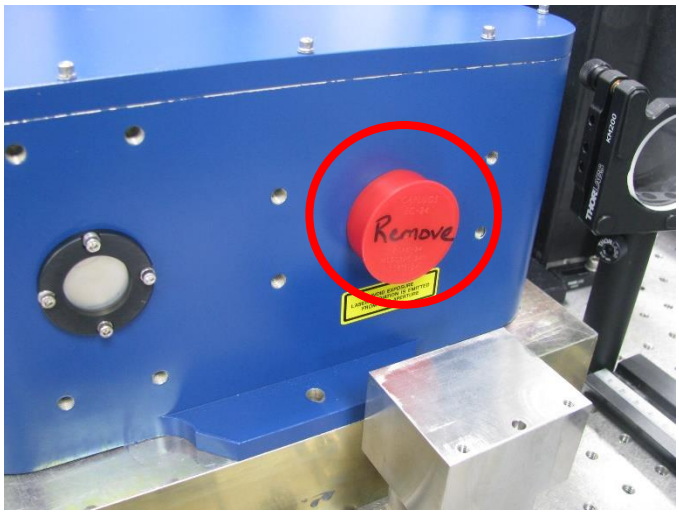


Figure 3-1. Output Window Cover

2. Turn on the chiller.
3. Check the temperature setting of the chiller. Refer to the ATP test report data summary included in the Patara EPL shipment for the coolant operational temperature. The chiller's temperature setting should be the same as in the report. If it is set to a different temperature, change it to match the setting on the report.
4. The flow rate for Patara EPL is 1.4 – 1.7 gpm. Ensure the flow rate meets the requirement. If it does not, open the valve inside the chiller until it matches the flow rate recorded in the ATP test report data summary. When adjusting and setting the flow rate, do not allow the coolant pressure to exceed 70 psi.

NOTE. Chiller flow rate calibration may be required. Please refer to the chiller user manual for instructions on calibration.

5. Run the chiller for approximately half an hour to allow the coolant temperature to stabilize at the set point.

Turn on the eDrive and Check Settings

1. Flip the power switch on the back panel of the eDrive to the **ON** or **I** position.
2. Make sure that the red **EMERGENCY** button is released. Turn on the eDrive by turning the key to **ON** position and pressing the **POWER** button to power up the eDrive.

3. Check all the laser parameters in the eDrive. The menu designations will help locate the settings. Use the following values for the Patara EPL:

Table 3-1. eDrive Settings

Main Menu	Menu 2	Menu 3	Parameter	Setting or Value
Channel Setup			Internal Trigger	Enabled
Channel Setup	**Q-Switch**		Q-Switch	Enabled
			Set Frequency	See ATP
			Set Window Width	See ATP
			Set Q-Switch Power	100%
	Q-Switch	**Set FPS Settings**	FPS	Enabled
			Set FPS Mode	Standard
			Set FPS Delay	See ATP
		-More-	Set Start Power	See ATP
			Set Window Length	See ATP
			FPS Modulation Type	See ATP
		-More-	PPK Open Offset	0 µs
			PPK Closed Offset	+00 ns
Channel Setup	**Channel 1**		Channel	Enabled
			Set Current	See ATP
		-More-	Set Slew Rate	10.0 A/S
			Slew Control	Enabled
			Set Standby Current	See ATP
		-More-	Set Current Limit	Factory set; see eDrive Menu map setting document
			Fault Setup	
			Set Voltage Dropout	9 V
			Current Tolerance	Disabled
			Set Current Tolerance	1.0 A
Channel Setup	**Comm 0 (Set COM 0 to OVEN TEC)**		TEC (Note, must be Disabled to change settings, and Enabled last)	Enabled
			Set Temp.	See ATP
			Set Tolerance Range	+1.5 °C
		-More-	Set Output Voltage	5.0 V
			Set Min. Temp.	+22.0 °C
			Set Max. Temp.	+45.0 °C
		-More-	Set P Const.	+4.0 °C
			Set I Const.	2.00 rep/min
			Set D Const.	0.00 cycles/min

Main Menu	Menu 2	Menu 3	Parameter	Setting or Value
		-More-	Set Control Function	H-BRIDGE
			Set Heat Mult.	1.000
			Set Cool Mult.	1.000
		-More-	Set Sensor Type	TS67
			Set Sensor Offset	0.00 °C
			TEC (Note, Enabled must be done last)	Enabled or Disabled
Comm Setup	**RS-232 Ch 0 Setup**		Set Baud Rate	9600 or 1200, 2400, 4800,19200, 38400
			Set Bit Frame	8N1, or 801, 8E1, 8N2
			Set Function (for internal TEC set to OVEN TEC)	None or OVEN TEC, SCPI PS, Loopback, Modbus
			Set Address	1 to 247
Comm Setup	**RS-232 Ch 1 Setup**		Set Baud Rate	9600
			Set Bit Frame	8N1, or 801, 8E1, 8N2
			Set Function	None or OVEN TEC, SCPI PS, Loopback, Modbus
			Set Address	1 to 247
Comm Setup	**Ethernet Setup**		DHCP	Enabled or Disabled
			Set Static IP	
			Set IP Address	192.168.0.10
			Set Mask	255.255.255.0
			Set Gateway	192.168.0.254
			Set Function	None or TCP/IP Modbus
			Set Address	1 to 247
Interface Setup	**Trig/Gate Setup**		Set Trig Out Mode	QSW Active High
Interface Setup	**Shutter Setup**		Shutter FPS	Enabled
			Set Shutter Speed	5 ms
			Closed to Standby	Disable

4. Verify that there are no objects in the laser beam path except for the negative lens and power meter.

WARNING. Wear proper laser safety eyewear to protect the eyes.

5. Once all the parameters are set correctly, and temperature of the chiller is stabilized, set the current to 5 A and press the **EMISSION** button.
6. Press the **SHUTTER** button to open the laser shutter. Gradually increase the current up to slightly above the threshold. Move the negative lens and power meter so that the beam is going through the center of the lens and hitting the center of the power meter.
7. Allow the TEC to reach optimum temperature. Gradually increase the current set point to the operating current specified in the ATP test report. Don't touch any part of the laser and wait for the laser to stabilize for thirty minutes (usually the laser takes around 20 minutes to reach 95% of the maximum power). Then check if the power is close to the result on the test report.

Occasionally the laser needs optimization for the first installation due to the slight differences of environments, chiller settings, and transportation vibration.

Laser Performance Optimization

Optimization of the laser may be required when the laser is initially installed or the laser performance has degraded due to aging laser diodes.

NOTE: Record optimization data on SVC-FORM-0019 (EPL Optimization Worksheet), which can be found on the Knowledge Center.

For this procedure, a green light should be visible from the laser. In the absence of any visible output, contact Northrop Grumman for assistance. To obtain the best performance, small adjustments may optimize the laser. To optimize the laser, follow these steps:

1. Wait for the laser to reach thermal stabilization.

Both the laser bench temperature and environmental temperature significantly impact the laser power. Wait for the laser to be thermally stabilized before attempting any adjustment.

2. Check the settings of the eDrive and chiller.

Check the performance with all items set to the values on the laser ATP test report data summary. Verify that all of the eDrive settings are correct.

The coolant flow rate and temperature have a significant impact on the laser performance. Make sure that the flow rate and temperature correlate to the values listed on the ATP test report.

3. Peak up the laser power by tuning the temperature of the TE Controller. Beginning with the TE Temperature from the ATP, adjust the temperature up and down in 0.2° C increments to optimize.

WARNING. To prevent damaging the HM mirror and LBO crystals, the laser output power should not decrease more than 10% when adjusting the TEC Temperature.

The phase matching of the second harmonic generation (SHG) crystals is crucial for the laser. This is achieved by setting the proper temperature on the SHG crystals using the eDrive.

4. Peak up the laser with adjustment of the cavity mirrors.

WARNING. Making mirror adjustments can be non-reversible. Do this step only when all the steps above have been completed and the laser does not meet the specifications with the correct settings.

   a. Locate the access holes for high-reflection mirror (HR) and harmonic mirror (HM). Notice the positions of HR and HM mirrors with respect to the direction of the laser output in **Figure 3-2.**
   b. Remove screws from access holes only in a dust free environment.
   c. Use a 1/8 inch ball driver to make adjustments. A fine adjustment is a 1 degree or less rotation. A small adjustment is about a 2° rotation. A coarse adjustment is 15°-20° rotation. If coarse adjustments are needed to obtain performance, reduce operating current by 1 A. Return to normal operating current when making small and fine adjustments. Do not exceed 45° on any one adjustment screw.
   d. The screws for the adjustments of the vertical tilt angle and the horizontal tilt angle are illustrated in **Figure 3-3**.

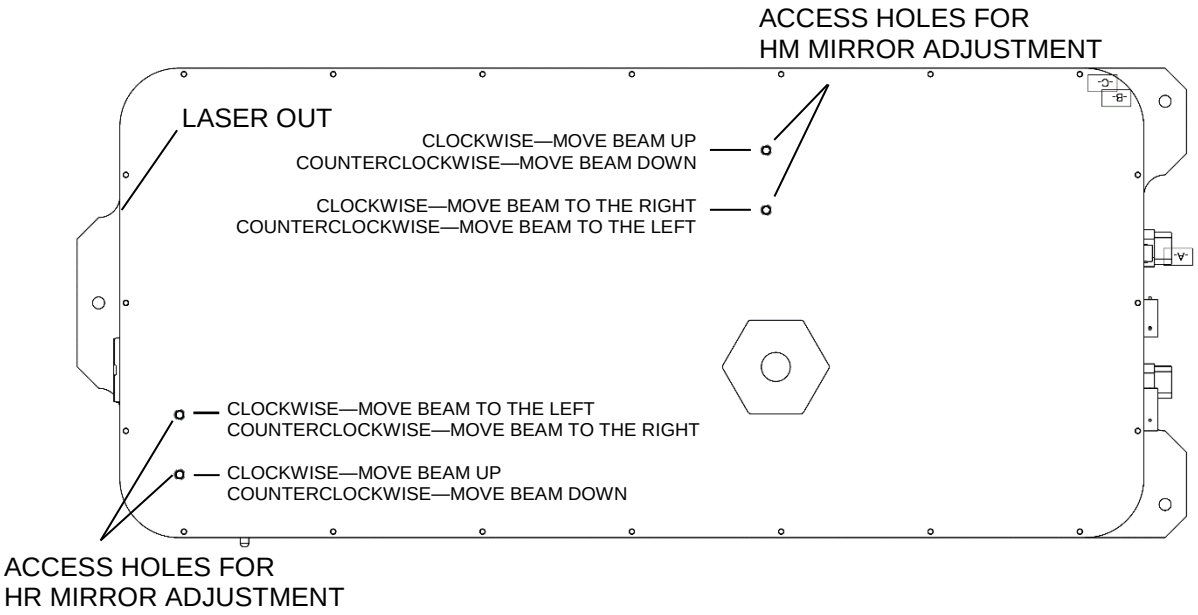


Figure 3-2. Accessible Holes for HR and OC Mirror Adjustment

e. Optimize power:

- Make small adjustments to the horizontal angle of HM mirror and observe the output power.
- Once a maximum is found, adjust the vertical control of HM mirror to maximize power.
- Make small adjustments to the horizontal angle of HR mirror and observe the output power.
- Once a maximum is found, adjust the vertical control of HR mirror to maximize power.
- Repeat the optimization steps with both the HR and HM until there is no significant performance improvement.
- If the laser is still not within 5% of the original power or not stable, repeat the eDrive current optimization, and HR / HM adjustment until there is no significant performance improvement.
- If the laser power can’t be restored to the specification, or the laser is not stable, then the “walking the cavity” procedure can be tried. Walking the cavity is sometimes required to optimize the laser and involves combining mirror mount adjustments.
  - Reduce current by 1A while making coarse adjustments. Return current to normal when making fine adjustments.
  - Make a horizontal adjustment to the HR mount. Recover the laser power by making a similar adjustment to the horizontal control of the HM mount.
  - Continue if improvement is noted. If there is no improvement, try the opposite direction.

- Perform the same procedure with the vertical adjustments of the HR and HM mount.
- Periodically check for hold off when making these adjustments (see *Check Hold Off* section below).
- If laser power is within +/-5% of nominal (typical power meter accuracy), and it has good beam shape and stability, stop and replace the access screws in the cover.
- If the power is low, check the hold off (see next section).

Check Hold Off

Checking hold off is a technique needed to verify proper operation of the laser. To check hold off, perform the following steps:

1. Turn on the laser and run for at least 20 minutes.
2. Lower the pump current to 5 A.
3. Press **EMISSION** to stop lasing.
4. Set the Q-Switch internal trigger (or external gate) mode to External Trigger mode in the **Channel Menu** on the eDrive. Ensure there is no input to the external gate BNC on the rear panel of the eDrive.
5. Press **EMISSION** and open the shutter to start lasing.
6. Gradually increase the current to the full operation current level.
7. Observe the beam output on the power meter. Hold off condition is met when no green light is visible or only a few mW.
8. If significant green power is observed, the laser does not hold off and may need internal repair.
9. Reduce the current to 5 A.
10. Press **EMISSION** to stop lasing.
11. Return the eDrive to internal trigger (or external gate) mode.
12. Press **EMISSION** and open the shutter to start lasing.
13. Gradually increase the current to the operation current.

Daily Operation

Output energy and repetition rate of the Patara EPL system are adjustable over a wide range. However, operating protocols must be observed to assure operation without risking internal damage to optical components.

CAUTION. The output beam of this system is a safety hazard. Avoid viewing the beam directly.

Turn On Procedure

1. Switch the chiller to the **ON** position. Verify correct flow rate and temperature setting to value specified on laser ATP test report data summary. Wait until the chiller has achieved proper temperature, which may take 5 to 10 minutes.
2. Turn the eDrive power enable key switch to the **ON** position.
3. Press the eDrive **POWER** switch. The LCD panel will illuminate.
4. Press **CURRENT** to verify the current, frequency, and TEC settings.

NOTE: Make sure the eDrive trigger signals are properly set if the laser uses external triggering.

5. Press **EMISSION** to fire the laser diode. The **EMISSION** and **LASER ON** indicators will begin to blink.
6. Press the **SHUTTER** button. The **EMISSION** and **LASER ON** indicators will become steady. The laser will automatically ramp the current to the set point with the preset slew rate. Wait for about 20 minutes to reach 95% of nominal output power.

Manual Interrupt Procedure

1. Press **SHUTTER** button on the eDrive front panel. The button will blink indicating the shutter is closed and the current is reduced to the standby current level.
2. Resume operation by pressing **SHUTTER** again. The laser will resume operation with no audible warning and the button will be illuminated.

NOTE: The laser diodes are operated at set standby current while the shutter is closed.

Interlock Interrupt

There is an interlock connector (white) at back panel of eDrive. If the continuity of the interlock is broken, the laser will stop lasing by closing the shutter and decreasing the current to standby. Once the continuity of the interlock is satisfied, the laser will ramp up the power automatically. For other interlock configurations, please contact Northrop Grumman.

CAUTION. Never look at the laser beam even it is off because the laser beam will ramp up the power automatically.

Shut Down Procedure

1. Press **SHUTTER** button to stop lasing.
2. Gradually decrease operating current to zero.
3. Press **EMISSION** on the eDrive to cease diode emission.
4. Press and hold **POWER** on the eDrive for 5 seconds until the display turns dark.
5. Turn the eDrive power enable key switch to **OFF**.
6. Let chiller run for 1 to 2 minutes.
7. Turn off the chiller.

For detailed operating instructions, please refer the *eDrive User Manual* (CEO-UMAN-0001).