

User Manual

REA PowerPULSE Diode-Pumped Laser Modules Nd:YAG, 4.0mm -12.0mm Diameter Rod

- REA-XX06
- REA-XX08
- REA-XX10
- REA-XX12



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| 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 Pointe West Blvd St. Charles, MO 63301 USA | | | | | | |
| 产品名称 / 编号 | Laser Modules | | | | | | |
| | RBxx-xxx-xxx-xxxx or RBxx-xxxxxx-xxx-xxxx | | | | | | |
| | RBAxx-xxx-xxx-xxxx or RBAxx-xxxxxx-xxx-xxxx | | | | | | |
| | RDxx-xxx-xxx-xxxx | | | | | | |
| | RExx-xxx-xxx-xxxx | | | | | | |
| 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 | 电线/ 连接插头 | X | ○ | ○ | ○ | X | X |
| 第二组 | 基部/ 端帽 | X | ○ | ○ | X | ○ | ○ |
| 第三组 | 硬件/ 装配 | ○ | ○ | ○ | X | ○ | ○ |
| 第四组 | 時計组件 | X | ○ | ○ | X | X | X |
| 第五组 | 阵列前端次模组 | ○ | ○ | ○ | ○ | ○ | ○ |
| 第六组 | 接触板 | X | ○ | ○ | ○ | X | X |
| 第七组 | 热交换组件 | ○ | ○ | ○ | ○ | ○ | ○ |
| 第八组 | 16 进制硬件 | ○ | ○ | X | ○ | ○ | ○ |
| 第九组 | 焊锡 | X | ○ | X | ○ | ○ | ○ |
| 第十组 | 包装物料 | ○ | ○ | ○ | ○ | ○ | ○ |
| 0: 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 you 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 that you push 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 to you or to bring attention to important information.



This icon denotes a note, which alerts you to important information.



Power Switch Position Symbols

I = On O = Off

The following conventions may appear on the product:

DANGER

An injury hazard immediately accessible as you read the marking.

WARNING

A hazard not immediately accessible as you read the marking.

CAUTION

A hazard to property including the product.



ESD: Handle Appropriately



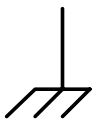
Laser Emission: Use caution.



Shock Hazard: Use caution.



Caution: Risk of danger. Refer to manual.



Chassis Ground

General Safety Summary

The REA PowerPULSE module emits laser radiation that can permanently damage eyes and skin, ignite fires, and vaporize substances. The laser safety section (Chapter 2) contains information and guidance about these hazards. To minimize the risk of injury or expensive repairs, carefully follow these instructions.

Do not open the factory packaging before carefully reading this complete operation and maintenance manual. If you have any questions on the product which have not been discussed sufficiently within the 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 *Service* section is intended to help guide you to the source of problems. Do not attempt repairs while the unit is under warranty; instead, report all problems to Northrop Grumman (NG) for warranty repair.

Use the form in *Appendix A: Customer Service* to describe issues with the module. We also suggest that you record information about the module such as power, settings, time and date.

About this Manual

This manual describes the installation, operation, and service of the REA PowerPULSE module. The manual consists of the following chapters:

- *Chapter 1: Introduction* provides a theory of operation description of the module and specifications
- *Chapter 2: Laser Safety* describes proper safety procedures you should understand before operating the module.
- *Chapter 3: Module Details* provides information about unpacking, storing and proper environmental conditions for operation.
- *Chapter 4: Installation and Operation* discusses how to setup your module and powering on your system for the first time.
- *Chapter 5: Maintenance* provides information on proper maintenance of your module.
- *Chapter 6: Service* provides resources to help fix problems with the REA PowerPULSE module
- *Appendix A: Customer Service* provides information to expedite any service request before contacting NG.
- *Appendix B: System International Units* identifies commonly used units of measurement found in this manual.
- *Appendix C: Acronyms* provides a list of commonly used abbreviations and their descriptions used throughout this manual.

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Chapter 1: Introduction

This introduction provides the following information:

- Theory of operation
- Temperature Tuning of Laser Diodes
- REA PowerPULSE Series description
- Specifications
- High Voltage DC Power Supply
- Closed Loop Re-circulating Chiller

Theory of Operation

The REA PowerPULSE module was designed for use as a building block “engine” in the development or production of medium power rod laser systems or as a drop-in replacement for arc lamp pump chambers in industrial lasers. It is well suited for medium power applications such as laser marking, and can provide high stability and beam quality for more precise micro-machining and scientific applications.

Northrop Grumman Cutting Edge Optronics (NG) diode pumped, solid-state lasers and pump modules use temperature-tuned GaAlAs laser diodes. These diodes replace arc lamps or incandescent light sources as the optical pump source. The principal advantages of this approach include:

- Longer lifetime
- More compact size
- More efficient operation

The REA PowerPULSE module uses arrays of solid-state laser diodes to optically pump a neodymium-doped yttrium aluminum garnet (Nd:YAG) lasing medium. The diode optical output power is radially coupled into the laser rod. The Nd:YAG laser rod has an anti-reflection coating chosen for the highest gain wavelength of this material, 1064 nm. The PowerPULSE REA module is constructed within a durable and rigid structure. Exterior components and connections are shown in Figure 1-1.

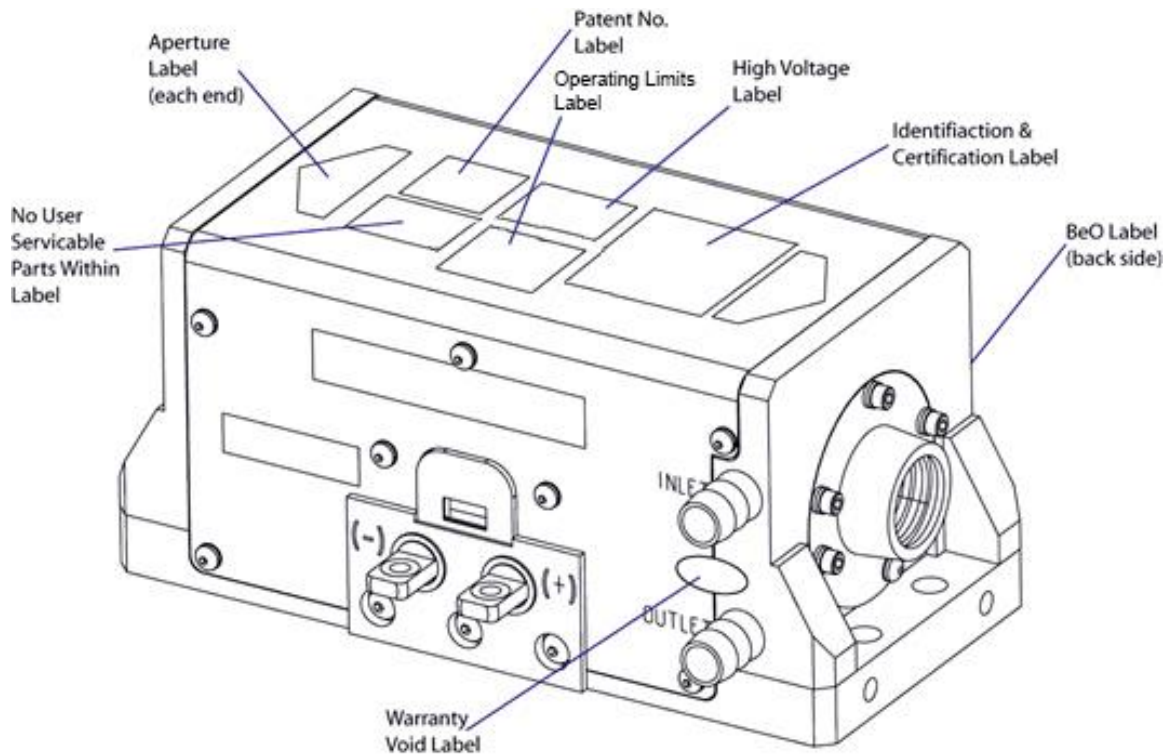


Figure 1-1 Exterior Components and Connections

Temperature Tuning of Laser Diodes

The laser diodes are located within the REA PowerPULSE Series module and tuned, wavelength matched, via the closed loop chiller. For maximum efficiency, the diode output wavelength must match the laser medium absorption characteristics (see Figure 1-2). The output spectrum of a conventional pump source for Nd:YAG operation, the xenon arc lamp, and 808 nm diode array is also shown.

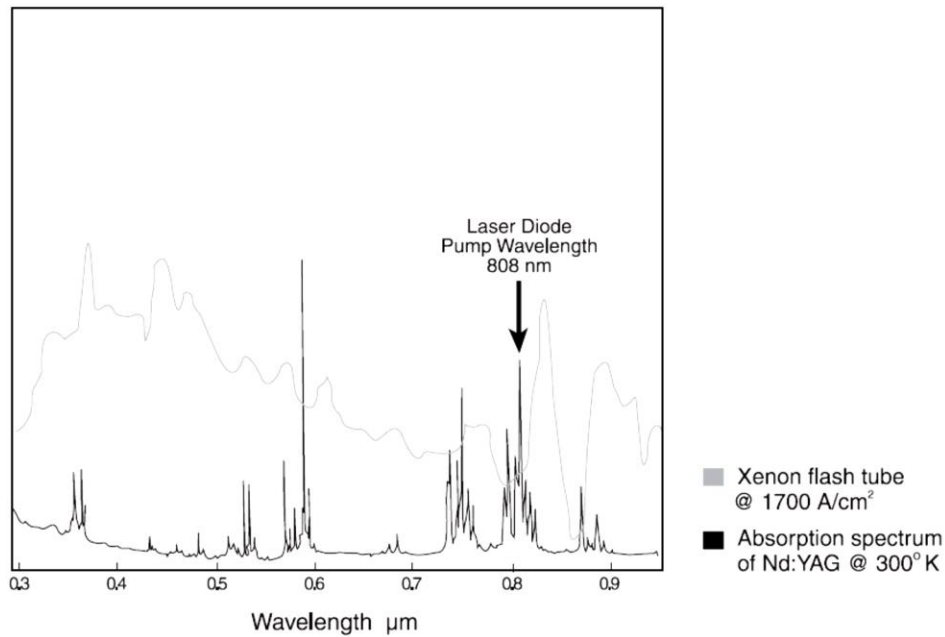


Figure 1-2 Nd:YAG Absorption Characteristics

A single GaAlAs laser diode bar has a 2 nm FWHM distribution of output wavelengths. However, the process used in the manufacture of GaAlAs laser diodes results in a peak output wavelength for each diode that fits within a 10 nm distribution of wavelengths from 800-810 nm. To match the diode output to an absorption peak of the laser medium, diodes are selected with similar peak output wavelengths within the manufacturing range. Temperature tuning is possible because GaAlAs diode characteristics are such that 0.25 nm of wavelength shift occurs for every 1°C change in temperature of the diode junction. Cooling shortens the wavelength, and heating lengthens it. Figure 1-3 shows the percentage of pump light of different wavelengths absorbed by two passes through a 6.35 mm thick rod of 0.6% doped Nd:YAG. In NG modules, the laser diode center wavelength, under normal operating conditions, is near the absorption peak of the laser medium. The operating temperature of closed loop chiller is carefully chosen to shift the diode temperature, so that the wavelength matches the absorption peak. The final test report, included with each module, indicates the optimum operation temperature for that module.

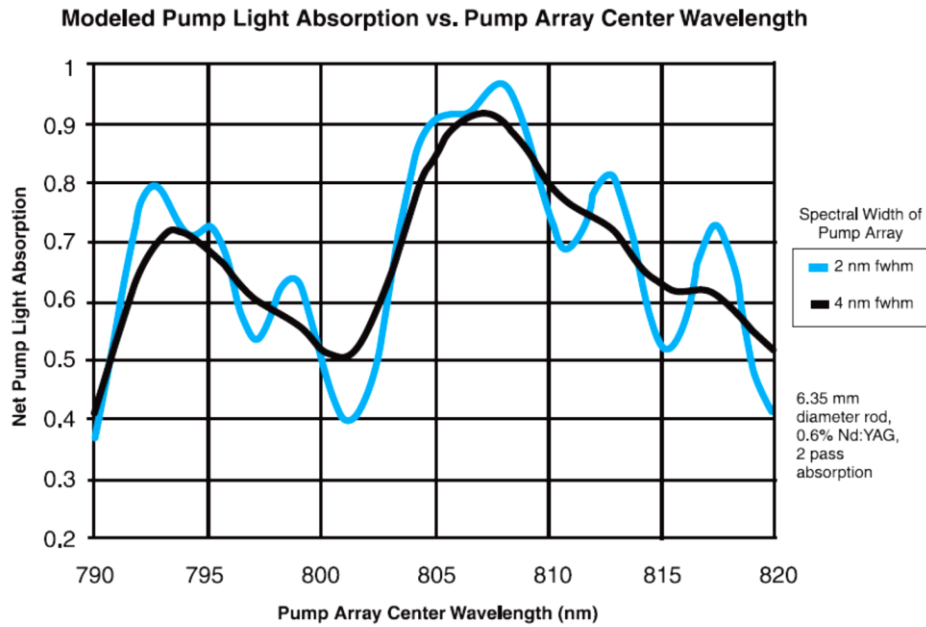


Figure 1-3 Pump Light Absorption vs. Pump Array Center Wavelength

REA PowerPULSE Series Description

The REA PowerPULSE Series module utilizes a radial longitudinal pump geometry to excite the solid-state laser medium (see Figure 1-4). This pump geometry results in excellent gain uniformity and lensing performance. The reflector directs the divergent diode light back to the laser medium, which is kept in a flow tube for coolant circulation. The laser medium is a rod of neodymium-doped yttrium aluminum garnet (Nd:YAG). Both ends of the rod are optically polished and include anti reflection coatings at the lasing wavelength. The ends of the rod may be curved to compensate for thermal lensing, depending on module configuration.

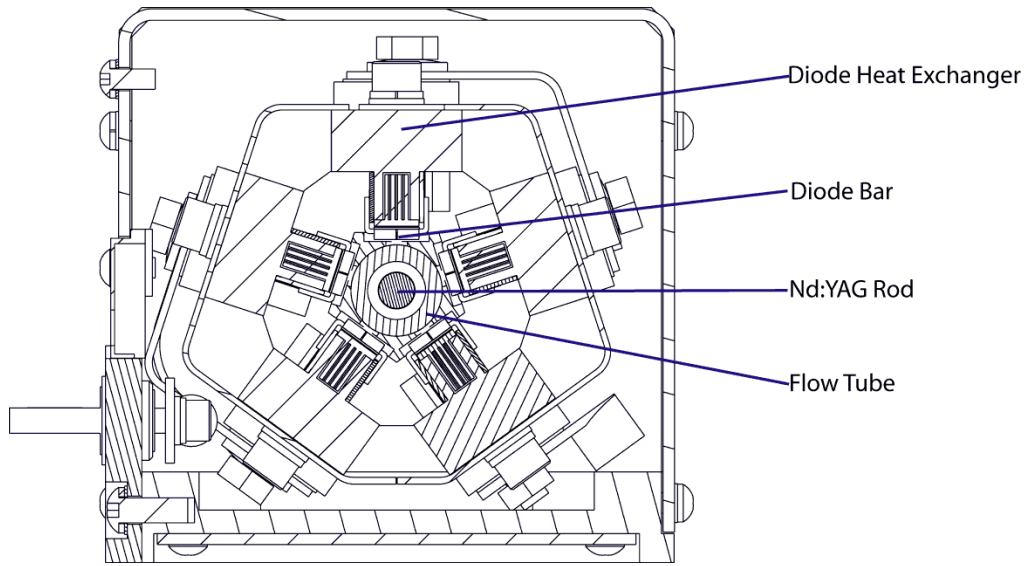


Figure 1-4 Radial Pump Geometry

The REA PowerPULSE comes in various physical configurations per Table 1-1 depending on the rod diameter and number of ASM's per array.

Table 1-1 REA PowerPULSE Physical Configuration

| Model Number | Rod Diameter (mm) | Length 06 Long (Inches) | Length 08 Long (Inches) | Length 10 Long (Inches) | Length 12 Long (Inches) | Width (Inches) | Height (Inches) | Beam Height (Inches) |
|--------------|-------------------|-------------------------|-------------------------|-------------------------|-------------------------|----------------|-----------------|----------------------|
| REA40XX | 4.0 | 5.74 | 6.57 | N/A | N/A | 3.27 | 3.06 | 1.5 |
| REA50XX | 5.0 | 5.74 | 6.57 | 7.40 | 8.23 | 3.27 | 3.06 | 1.5 |
| REA63XX | 6.35 | 5.74 | 6.57 | 7.40 | 8.23 | 3.27 | 3.06 | 1.5 |
| REA70XX | 7.0 | 5.74 | 6.57 | 7.40 | 8.23 | 3.27 | 3.06 | 1.5 |
| REA80XX | 8.0 | 5.74 | 6.57 | 7.40 | 8.23 | 3.57 | 3.41 | 1.75 |
| REA90XX | 9.0 | 5.74 | 6.57 | 7.40 | 8.23 | 3.57 | 3.41 | 1.75 |
| REA100XX | 10.0 | 5.74 | 6.57 | 7.40 | 8.23 | 3.57 | 3.41 | 1.75 |
| REA120XX | 12.0 | 5.74 | 6.57 | 7.40 | 8.23 | 3.57 | 3.41 | 1.75 |

Specifications

REA PowerPULSE Series modules are tested to exceed the following specifications. The standard production test configuration consists of a 280 ± 5 mm cavity utilizing a flat high reflector and a flat 70% reflective output coupler.

The power consumption can be calculated with the following formula:

Total Power Consumption =

(# Bars) x (Diode Voltage per Bar) x (Duty Cycle) x (Operating Current)

Common REA PowerPULSE power consumptions are listed in Table 1-2 below. For models not listed please contact NG to determine the power consumption.

Table 1-2 REA PowerPULSE Series Model Specifications¹

| Model Number ² | ASM per Module | Diode Bias Voltage ³ | Power Consumption ^{4,5} (50 Watt bar) | Power Consumption ^{4,5} (100 Watt bar) | Power Consumption ^{4,5} (200 Watt bar) |
|----------------------------------|-----------------------|--|--|---|---|
| REAXX06-YPW | 30 | 60 * Y | 840 * Y | 1200 * Y | 2100 * Y |
| REAXX08-YPW | 40 | 80 * Y | 1120 * Y | 1600 * Y | 2800 * Y |
| REAXX10-YPW | 50 | 100 * Y | 1400 * Y | 2000 * Y | 3500 * Y |
| REAXX12-YPW | 60 | 120 * Y | 1680 * Y | 2400 * Y | 4200 * Y |

¹Specifications subject to change without notice

²The X in the model number represents the rod size. The Y in the model number represents the number of bars per array sub-module. The W in the model number represents the wattage per bar: 5= 50W, 1= 100W, 200 = 200W

³ Assumes 2.2V per bar. Depending on the driver/controller used, the power supply voltage may be approximately 30 volts higher than shown in the table

⁴ At end of life, operating current is 70A for 50 W bars, 100A for 100W bars and 175A for 200W bars

⁵ Assumes 15% duty factor

Table 1-3 REA PowerPULSE Series General Specifications

All REA PowerPULSE Series Models

| | |
|-------------------------------|---|
| Type | Pulsed Diode Pumped Nd:YAG Rod ³ |
| Dopant Level | Application Dependent |
| Output Wavelength | 1064 nm |
| Pulse Repetition Rate | See Final Test Report |
| Duty Cycle (Max) | 15% |
| Operating Current | See Final Test Report |
| Cooling | Closed Loop Recycling Coolant ¹ |
| Coolant Flow | > 2.0 GPM |
| Coolant Pressure ² | 50 PSI |
| Operating Temperature | 20-30 °C non-condensing |

¹NG recommends Optishield Plus[®] /distilled water coolant (10% Optishield Plus[™], 90% distilled water).

²NG modules are leak tested to 80 psi with Nitrogen gas. NG recommends 50 psi, as displayed on the chiller, for actual operation.

³ YLF configurations are available by special request.

High Voltage DC Power Supply

A high voltage DC power supply is required to provide the DC voltage to run the diode arrays in an REA PowerPULSE Series module. NG will recommend a power supply based on the customer's application.

Closed Loop Re-circulating Chiller

Coolant flow direction is polarized on the REA PowerPULSE Series laser module. Inlet and Outlet hose barbs are marked on the laser module. Be sure to connect the coolant filter for the selected chiller on the Inlet connection, so only clean coolant from the filter flows through the laser module. Dirty coolant deposits dirt on the laser rod, which results in low output power.

The module coolant loop is designed for an operating pressure of 50 psi. The selected chiller must have a heat capacity of greater than the power consumption for the specific model of REA PowerPULSE Series module. Table 1-4 shows recommended chillers. The chillers have the following features:

- DI Compatible (Stainless or plastic wetted components)
- Internal 1kW Heater included
- Turbine Pump standard
- RS 232 or RS 485 is not standard, but available
- Dry Contact Remote Start is not standard, but available

Table 1-4 Recommended Chiller Models

| Polyscience Chiller Part No. | Electrical (VAC / Phase / Freq) | Flow Rate | Chiller Capacity ¹ |
|------------------------------|---------------------------------|-----------|-------------------------------|
| 6762T41CE30D | 230V / 1 / 60 Hz | 3.5 GPM | 2300 W |
| 6162T41CE30D | 230V / 1 / 60 Hz | 3.5 GPM | 2900 W |
| 6862T66CE70D | 230V / 1 / 60 Hz | 7.0 GPM | 5200 W |
| 6752T41CE30E | 240V / 1 / 50 Hz | 2.9 GPM | 2200 W |
| 6852T66CE70E | 240V / 1 / 50 Hz | 7.0 GPM | 4371 W |

¹ For heat capacities that are not included in the table contact NG for assistance.

Chapter 2: Laser Safety

Please read this section carefully before installing or operating your REA PowerPULSE Series module. We recommend that all service and repair operations be performed by an NG service engineer. If you do plan to service your laser module, please follow the procedures in the Service section of this manual.

Sections included in this chapter provide the following information:

- Caution & Warning Statements
- Precautions for Safe Operation of Class IV Lasers
- Center for Devices and Radiological Health (CDRH) OEM Product
- Safety Device Checklist

Caution & Warning Statements



WARNING The NG REA PowerPULSE Series component, when used as a laser oscillator, 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. When energized, a large amount of high power invisible laser radiation is emitted from the laser module.

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



WARNING 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 your laser, avoid exposure to laser or collateral radiation exceeding the accessible emission limits listed in "Performance Standards for Laser Products," United States Code of Federal Regulations, 21 CFR 1040.10(d).



ESD CAUTION The laser diodes in the REA PowerPULSE Series are sensitive to Electro-Static Discharge (ESD). Never handle the REA PowerPULSE Series module without being properly grounded through the use of properly installed and maintained grounding wrist straps or other ESD control devices. Subjecting the REA PowerPULSE Series to static shock can seriously damage or destroy the diode bars, and will void the product warranty.



ELECTRICAL WARNING The voltages in this system can be harmful or even lethal. Whenever handling or servicing the laser, always disconnect the power cord to the power supplies and drivers. Use a voltmeter to verify all electronics are discharged before touching or grounding of electrical connections.

Precautions for Safe Operation of Class IV Lasers

- Never look directly into the laser beam or at specular reflection, even with protective eye-wear on.
- Always wear laser safety eye-wear that is appropriate for the output power at the wavelengths of operation (808 nm pump light and 1064 nm fundamental).
- Set aside a controlled-access area for laser operation; limit access to those trained in the principles of laser safety.
- Post readily readable warning signs in prominent locations near the laser operation area.

- Use safety interlocks on all entryways. All NG system control electronics are provided with interlock inputs to preclude operation with an open safety door. NOTE: when multiple interlocks are used, they must be connected in SERIES for proper function.
- Restrict access to laser areas to those who have been instructed in the necessary safety precautions.
- Enclose beam paths wherever possible.
- Set up experiments so the laser beam is below eye level.
- Work in an area that is well lit 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.
- The Q-switched output power of the laser emits extremely high peak optical powers, powers that can severely damage a wide array of optical components and detectors. Know the limits of your components before exposing them to the Q-switched beam.
- View an infrared laser beam with a protected image converter at an oblique angle reflecting from a diffuse surface. Do not use phosphorus cards in the Q-switched beam.
- Ensure that all electrical connections are made in a safe manner.
- Where possible, position equipment so that electrical connections are shielded from accidental touch.
- No smoking, eating, or drinking should be allowed in laser areas.
- Never leave an operating laser unattended.

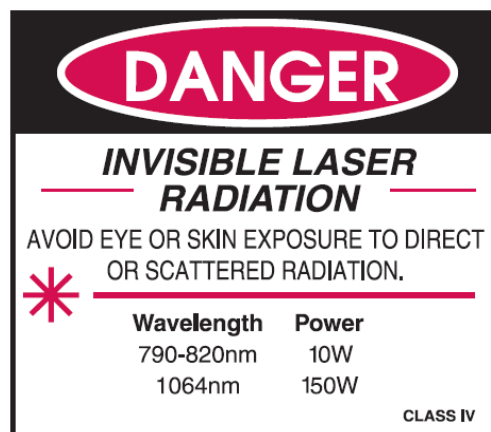


Figure 2-1 Standard Safety Warning Sign

Center for Devices and Radiological Health (CDRH) OEM Product

The REA PowerPULSE Series module is considered a component according to the Food and Drug Administration, Code of Federal Regulations Title 21, Section

1002.1(b) for use in an end system, and therefore does not fully comply with all the requirements of the Code of Federal Regulations for laser-based systems. The REA PowerPULSE Series module is capable of emitting Class IV radiation, and extreme care must be exercised in its installation and operation. Only persons familiar with the safety precautions and practices in this manual should operate the laser product.

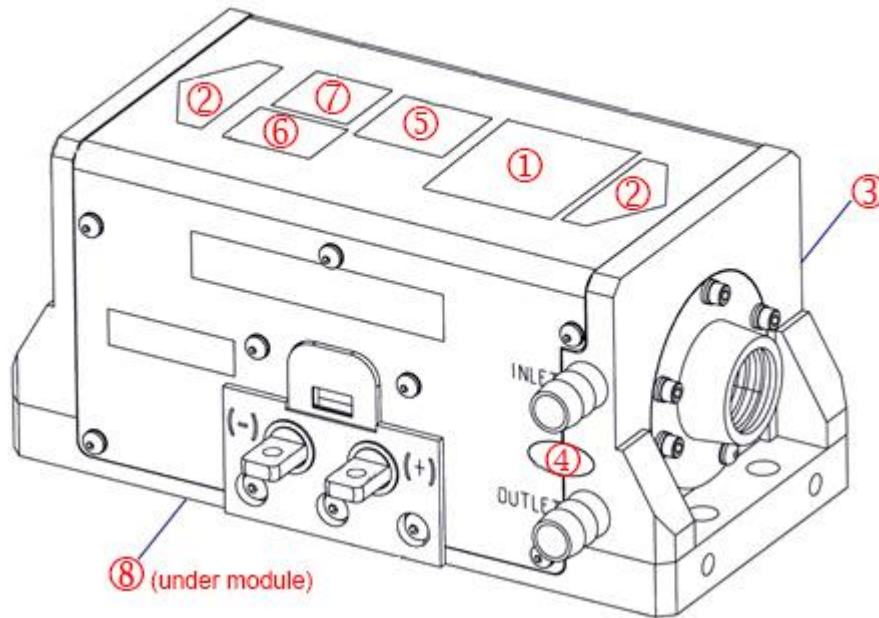


Figure 2-2 Radiation Control Drawing



Figure 2-3 Warning Labels

Safety Device Checklist

1. Verify that all labels are securely affixed.
2. Verify that the safety interlock system is working properly.
3. Locate the module so that operation of laser and/or adjustment of control electronics do not require exposure to laser radiation.

Chapter 3: Module Details

This chapter describes basic operation of your REA PowerPULSE Series module. This chapter discusses:

- Unpacking the Module
- REA PowerPULSE Series Module
- REA PowerPULSE Timer
- Closed Loop Chiller
- High Voltage DC Power Supply

Unpacking the Module

The REA PowerPULSE Series module was carefully packed for shipment. If the carton appears to have been damaged in transit, have the shipper's agent present when you unpack.



CAUTION The module is susceptible to damage due to electro-static discharge (ESD). Always use proper ESD control devices when handling the module.



CAUTION Do not open sealed package until package has normalized to room temperature. Condensation can seriously damage the diode arrays in the laser module and may void warranty.

Inspect the unit as you unpack it, looking for dents, scratches, or other evidence of damage. If you discover any damage, immediately file a claim against the carrier and notify your NG representative. NG will arrange for repair without waiting for settlement of your claim.

Keep the shipping container. If you file a damage claim, you may need it to demonstrate that the damage occurred as a result of shipping. If you need to return the unit for service, the specially designed carton assures adequate protection. A manual and a final test report should accompany each unit shipped.

REA PowerPULSE Series Module

The approximate diode bias voltage for the different models of REA PowerPULSE Series module can be found in the Specifications table at the end of chapter one. The electrical system should deliver additional voltage, depending on the FETs and the wiring used. NG will recommend a power supply for the specific application. The REA PowerPULSE Series module is designed for variable operating parameters. The pulsed diodes can operate with a maximum duty cycle of 15%. **DO NOT** operate in Continuous Wave (CW) mode. See the Final Test report for recommended operating parameters. The maximum operating limits are engraved on the cover as well as a dog tag attached to the module.

The REA PowerPULSE Series module connects to a diode driver in via power lugs on the base of the laser module.

The diode arrays within the REA PowerPULSE Series module are aligned and sealed at the factory. Other than the laser rod, there are no user serviceable parts within the module. Contact NG technical service for repairs. Before lasing, the

operator should verify that rod faces are clean. If necessary, the rod faces can be cleaned by following the procedure in the maintenance section of this manual.

Reverse Bias Protection

Diodes are polarized with respect to electrical flow. A forward biased diode readily conducts; while a reverse biased diode blocks conduction. If sufficient voltage is applied in the reverse direction, the diode is permanently damaged. Laser diodes are the single most expensive component of a REA PowerPULSE Series module, so the customer should be careful to connect diode drive current correctly.

In order to provide the REA PowerPULSE Series modules with some protection against reverse biasing, all REA PowerPULSE Series modules are equipped with a reverse protection diode. This is another diode, usually located in the module, which forms a circuit across the laser diode arrays in the opposite flow direction (Figure 3-1). In the event of the laser diode drive current being reversed, the reverse bias protection diode will act like a short circuit, allowing the electricity to flow for a brief time with no resistance. However, the reverse bias protection diode is not able to withstand the high currents that laser diodes require. The protection diode will burn out after a brief time, and the drive current will be sent through the laser diodes in reverse.

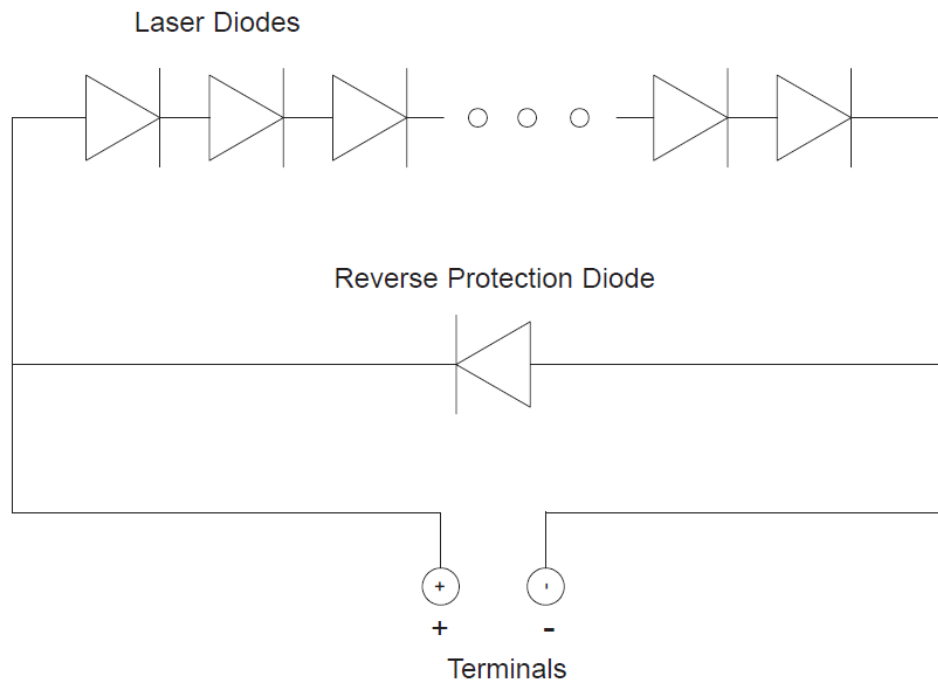


Figure 3-1 Reverse Bias Protection Diode Circuit

Customers are recommended to configure their drive electronics for use with NG's reverse bias protection diodes. The driver should be able to detect the shorted condition because with a short across the array, the full power supply voltage will suddenly be impressed across the driver control FETs. For drivers which have a fixed power supply voltage, a much larger voltage across the drive FETs will

increase the heat load and cause a dramatic rise in their temperature. For drivers which have the capability to supply the voltage to produce the necessary current, a sudden decrease in output voltage should cause a corresponding large decrease in the voltage required internally within the driver, which could be detected and reported. If any of the conditions are detected, the driver should suspend diode drive current and send the operator an error message.

Module Storage

Proper storage of the REA Series module involves four steps:

1. Remove all coolant from module by blowing dry air through it for 20 minutes.
2. Place a shorting connector across the module power lugs.
3. Install rod end covers over both beam tube supports.
4. Store module in a clean, dry atmosphere (relative humidity less than 30%). If necessary, place module in a sealed bag with some form of desiccant.

REA PowerPULSE Timer

The REA PowerPULSE Series module includes an electronic timer circuit which monitors the operation of the laser module and tracks the number of hours of operation, the number of pulsed shots, and the number of on/off cycles over the lifetime of the head. These data may be displayed to the user on a 4-digit LCD display on the front of the module. This timer is powered by the applied module operating voltage and will only be operational when the module is operating.

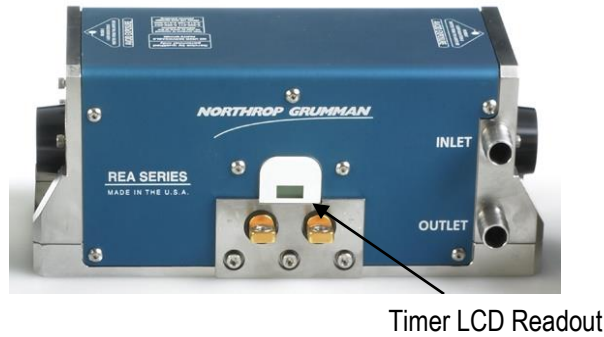


Figure 3-2 REA PowerPULSE Series Electronic Timer

Startup Display

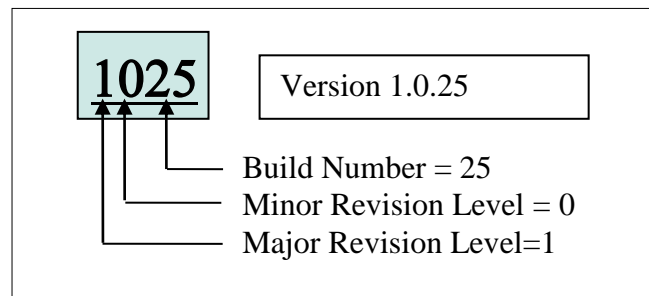
On startup, the timer will display a 4-digit software revision number. This number will be underlined and the digits are decoded as follows:

Digit 1: Major Revision Level

Digit 2: Minor Revision Level

Digits 3-4: Build Number

An example is shown below:




After 2-3 seconds, the display will then display the number of power on/off cycles which have occurred. This count is not the number of shots or pulses which have been generated by the module, but instead is the number of times the module has gone from an inactive state to an active state. This number is incremented each time the timer goes through its startup routines.

After a short delay, the timer will transition to a repeating display mode.

Repeating Display Mode

In this mode, the timer displays a sequence start indicator followed by up to three timer values depending on the operating mode and the configuration which was applied at the factory. These are described below.

Sequence Start Indicator

In order to indicate the beginning of the display sequence, the timer displays the Sequence Start Indicator. The display briefly shows the following: 

First Value

This value is the module hour counter. If the number of hours exceeds 9999, then the display will scroll to the left to show the additional digits.

Second Value

This value will show the number of shots or pulses which the module has generated. See the description below for an explanation of the meaning of the shot counter display.

Third Value (Optional)

This value is configured at the factory when the module is built. Contact NG for information regarding the values which may be configured. If no value is configured, the display cycle starts over. Typically, the module will be programmed to display the on/off cycle count in this third position.

After displaying all of these values, the cycle will repeat with the display of the sequence start indicator.

Shot Count Display:

The shot count display is capable of displaying a very large number of shots with 3 significant figures. The first 3 digits of the shot count represent the first 3 digits of the number of shots. The fourth digit represents the number of zeros to place behind this 3 digit number. For example, if the readout showed **8385** this would represent approximately 83,800,000 shots. If the value shown has a line beneath it, such as **1480** then the fourth digit should be increased by 10 to determine the number of zeros. In this case, the shot count would be approximately 1,480,000,000,000.

Closed Loop Chiller

The single most common cause of laser module return for repair involves customer damage. More than one third of all customer damaged laser modules involve cooling problems. Coolant problems almost always require the replacement of the diode arrays - the single most expensive component in NG laser modules. Read the following section carefully to avoid damaging arrays.



CAUTION Do not operate module without cooling. Inadequate heat dissipation will seriously damage the laser diodes and will void warranty.

Table 3-1 Cooling System Requirements

| Chiller and Cooling System Requirements |
|--|
| Optishield Plus [®] /distilled water coolant (10% Optishield Plus [®] , 90% distilled water) ^{1, 2} |
| Capable of recommended flow rate at 60 psi. |
| Filter connected between chiller and inlet on module ^{3, 4} |
| Module first in coolant loop ⁵ |
| Chiller Heat Capacity > Power Consumption (Table 1-2) |
| Flow sensor (connected to coolant interlock on drive electronics) ⁶ |
| <p>¹ Clean coolant is important to keeping coolant lines from clogging. Untreated tap water is not an acceptable coolant and may cause damage. Optishield Plus[®] is the recommended coolant. It is made from DI water with additives to control the pH. By using DI water in the solution, scale will not form in the cooling loop. It contains biocide to prevent algae growth and corrosion inhibitors to protect yellow metals and aluminum.</p> <p>² Optishield Plus is available from Opti Temp, Inc (http://www.optishield.net/).</p> <p>³ The filter should be capable of removing particles 5 μm or larger. The filter should be changed at a minimum of every month. The filter should be changed more frequently if the pH drops below 8 or the filter or coolant show any discoloration.</p> <p>⁴ Every month, or whenever the filter is changed, the coolant should be drained. The chiller should then be cleaned. Finally clean coolant should be circulated.</p> <p>⁵ This ensures the cleanest, coolest coolant passes through the diodes (the most expensive component of most lasers).</p> <p>⁶ When not using NG drive electronics, verify that flow sensor interrupts current to diodes less than 1 second after a low flow condition occurs.</p> |

Table 3-2 Avoid with Chillers

| Avoid with Chillers |
|--|
| Untreated Deionized water ¹ |
| Iron or aluminum parts in plumbing loop |
| Operation below air condensation temperature |

¹ NG recommends chiller coolant have a resistivity between 300 and 700 kΩ. Deionized water can be used if the resistivity is closely monitored and the coolant loop does not have iron or aluminum parts. The pH of the DI water should be controlled between 7.0 and 8.0.

Operating the Chiller



WARNING. Do not operate module without cooling. Inadequate heat dissipation will seriously damage the laser diodes and will void warranty. If you notice coolant in the immediate vicinity of the module, shut the laser system down immediately. Check to see if the coolant is coming from the module. If so, return the module for repair. If not, repair the source of the leak and allow the module to dry thoroughly before resuming operation.

The REA PowerPULSE Series module has a coolant loop to prevent thermal damage to the laser diodes. The diodes should be kept at approximately 20-30 °C. See the Final Test report for optimum temperature and flow rate settings.



NOTE: Running the chiller continuously inhibits biological growth and corrosion. If the chiller is to be shut down for more than 1 week, the coolant loop should be drained, flushed with 3% hydrogen peroxide solution and purged with oil-free, dry filtered air or (N₂). See *Chapter 5: Maintenance* for more detail.

Operating the laser diodes for even a short period of time (less than 1 second) without coolant will cause permanent damage. To help prevent this, all NG drive electronics are equipped with a coolant interlock. This interlock interrupts drive current to the diodes when coolant flow rate drops below set point. For this to function properly, a flow sensor must be used in the coolant loop. When setting up the laser module for the first time, NG recommends testing the flow interlock before firing. This can be accomplished by setting the drive current to a very low level (~ 1 A) then attempting to fire the laser with the chiller off. In case the interlock does not function correctly, be prepared to manually turn off the module. By testing the interlock with a minimal current, the risk of damaging the laser module diodes is minimized



WARNING. Do not operate the coolant system below air condensation temperature (dew point) at the laser head. Condensation on the diode arrays can seriously damage the laser head and will void the warranty. Consult NG technical service if you have any questions.

Air Condensation Temperature

The air condensation temperature (or dew point) is the highest surface temperature that allows water to form from the ambient water vapor. The dew point is dependent on the surrounding air temperature and relative humidity. If a surface (such as a laser diode) is cooled at or below the condensation temperature, water may collect on that surface. A formula for calculating dew point is given below, along with a calculated table. All temperatures are given in Celsius.

Condensation Temperature

$$T_d = \frac{237.7 \times \alpha(T, RH)}{17.27 - \alpha(T, RH)} \quad \alpha(T, RH) = \frac{17.27 \times T}{237.7 + T} + \ln\left(\frac{RH}{100}\right)$$

where

T is the ambient air temperature in degrees Celsius ($0 < T < 60$)

RH is the relative humidity in percent ($1\% < RH < 100\%$)

T_d is the air condensation temperature

For example, suppose your chiller is running at 22 °C and the ambient air temperature near the laser is 28 °C (82 °F). Referring to Figure 3-3 and Table 3-3, find the intersection of the 28 °C air temperature and the curve for the 22 °C diode temperature. At a relative humidity of 70 percent or greater, condensation will form on the laser diodes.

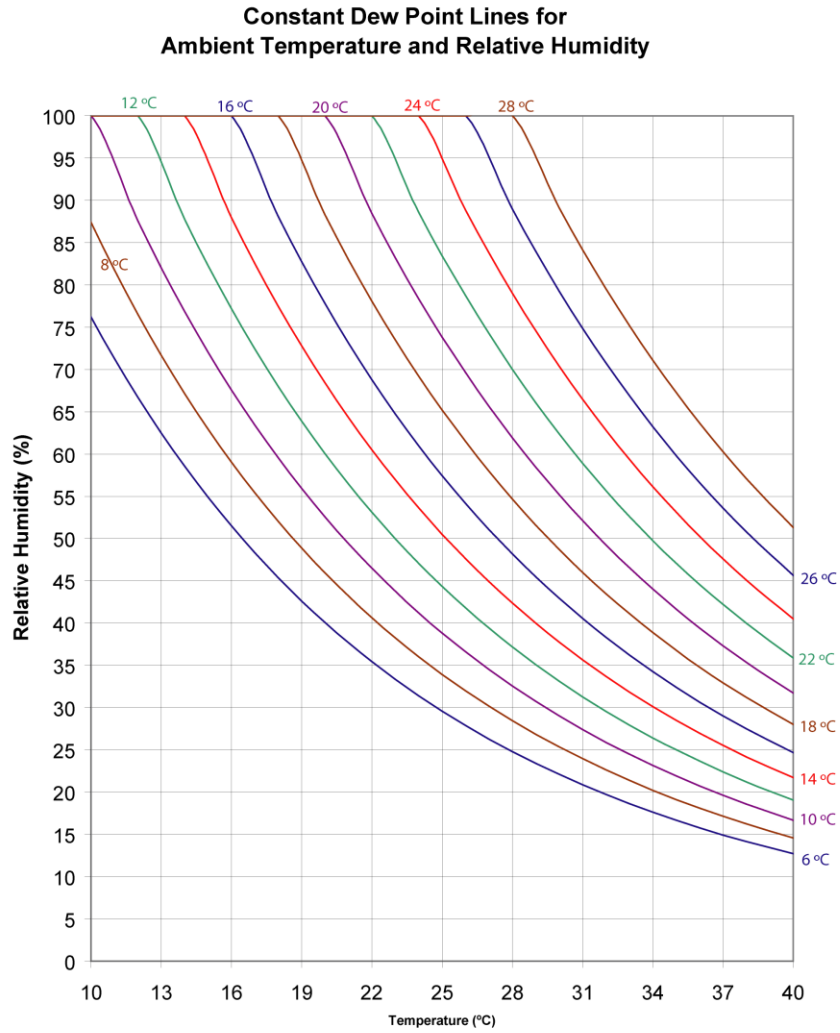


Figure 3-3 Constant Dew Point Lines for Ambient Temperature and Relative Humidity

Table 3-3 Table of Air Condensation at Ambient Air Temperature (°C) and Relative Humidity (%)

| | | Relative Humidity | | | | | | | | | | |
|--------------------|----|-------------------|-------|-------|------|------|------|------|------|------|------|------|
| | | 1% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% |
| Air Temperature °C | 10 | -43.9 | -20.2 | -11.9 | -6.8 | -3.0 | 0.1 | 2.6 | 4.8 | 6.7 | 8.4 | 10.0 |
| | 12 | -42.6 | -18.7 | -10.3 | -5.0 | -1.2 | 1.9 | 4.5 | 6.7 | 8.7 | 10.4 | 12.0 |
| | 14 | -41.4 | -17.1 | -8.6 | -3.3 | 0.6 | 3.7 | 6.4 | 8.6 | 10.6 | 12.4 | 14.0 |
| | 16 | -40.2 | -15.6 | -7.0 | -1.6 | 2.4 | 5.6 | 8.2 | 10.5 | 12.5 | 14.4 | 16.0 |
| | 18 | -39.0 | -14.1 | -5.3 | 0.2 | 4.2 | 7.4 | 10.1 | 12.4 | 14.5 | 16.3 | 18.0 |
| | 20 | -37.8 | -12.5 | -3.6 | 1.9 | 6.0 | 9.3 | 12.0 | 14.4 | 16.4 | 18.3 | 20.0 |
| | 22 | -36.6 | -11.0 | -2.0 | 3.6 | 7.8 | 11.1 | 13.9 | 16.3 | 18.4 | 20.3 | 22.0 |
| | 24 | -35.4 | -9.5 | -0.4 | 5.3 | 9.6 | 12.9 | 15.7 | 18.2 | 20.3 | 22.3 | 24.0 |
| | 26 | -34.2 | -8.0 | 1.3 | 7.1 | 11.3 | 14.8 | 17.6 | 20.1 | 22.3 | 24.2 | 26.0 |
| | 28 | -33.0 | -6.5 | 2.9 | 8.8 | 13.1 | 16.6 | 19.5 | 22.0 | 24.2 | 26.2 | 28.0 |
| | 30 | -31.8 | -4.9 | 4.6 | 10.5 | 14.9 | 18.4 | 21.4 | 23.9 | 26.2 | 28.2 | 30.0 |
| | 32 | -30.6 | -3.4 | 6.2 | 12.2 | 16.7 | 20.3 | 23.2 | 25.8 | 28.1 | 30.1 | 32.0 |
| | 34 | -29.5 | -1.9 | 7.8 | 13.9 | 18.5 | 22.1 | 25.1 | 27.7 | 30.0 | 32.1 | 34.0 |
| | 36 | -28.3 | -0.4 | 9.5 | 15.7 | 20.2 | 23.9 | 27.0 | 29.6 | 32.0 | 34.1 | 36.0 |
| | 38 | -27.1 | 1.1 | 11.1 | 17.4 | 22.0 | 25.7 | 28.9 | 31.6 | 33.9 | 36.1 | 38.0 |
| | 40 | -26.0 | 2.6 | 12.7 | 19.1 | 23.8 | 27.6 | 30.7 | 33.5 | 35.9 | 38.0 | 40.0 |

If required to operate a laser in conditions near to the condensation temperature, take precautions to keep the REA PowerPULSE Series module dry. The module should be operated inside an area that is purged with nitrogen (N₂) or encased in a sealed enclosure with a desiccant.

High Voltage DC Power Supply

The REA PowerPULSE module requires a high voltage DC power supply to provide electricity to the laser diodes. The chosen power supply should be regulated. Unregulated supplies tend to either drop below the minimum voltage required to maintain regulation, or to sit at an unnecessarily high voltage at lower currents, causing FET overheating.

The chosen power supply should be capable of providing the diode bias voltage and power specified in Table 1-2 *REA PowerPULSE Module Specifications*.



WARNING. Hazardous voltages are present during normal operation. Before removing the cover, the power source should be disconnected and a period of 20 minutes allowed for the discharge of stored capacitance. Use a voltmeter to verify all electronics are discharged before touching or grounding of electrical connections.

Chapter 4: Installation and Operation

NG recommends using the eDrive diode drive electronics, an external power supply, and a closed loop chiller to operate the REA PowerPULSE module (see Chapter 1 for chiller capacities). The following chapter contains step by step procedures detailing the installation and operation of the REA PowerPULSE module with these peripherals. This chapter covers:

- REA PowerPULSE Module Assembly and Connections
- Closed Loop Chiller
- Starting the Laser Module
- Standby Condition
- Turning Off the System

The purchaser is responsible for any loss and injury during installation and use of the REA PowerPULSE module. NG recommends that a qualified service technician install and maintain the laser. If you intend to service the laser yourself, please follow the following procedures.

REA PowerPULSE Module Connections



CAUTION. The module is susceptible to damage due to electro-static discharge (ESD). Always use proper ESD control devices when handling the module.

See Module Connection Diagram (figure 4-1).

1. Check to make sure the AC power switch located on the rear panel of the eDrive Laser Diode Controller is in the **OFF** position.
2. Connect the Array Drive lugs from the rear of the eDrive to the power lugs on the side of the REA PowerPULSE module. (Positive to positive and negative to negative.)



ELECTRICAL WARNING The voltages in this system can be harmful or even lethal. Whenever handling or servicing the laser, always disconnect the power cord to the power supplies and drivers. Use a voltmeter to verify all electronics are discharged before touching or grounding of electrical connections.

3. Connect the lab door interlock switch (or other interlock used) to the **Interlock** connector on the rear of the eDrive. If multiple interlocks are needed, be sure all interlocks are connected in *SERIES* to this port. If no remote interlocks are used, short the connection to allow for normal laser operation.
4. Prior to connecting an external power supply, check to make sure the AC power switch of the external power supply is in the **OFF (O)** position. Then, connect the output of the supply to the input power lugs of the eDrive located at the upper left of the rear panel.
5. Verify the eDrive has clear space in rear and on each side of unit to allow proper air flow.
6. Verify shroud over eDrive power lugs is in place to prevent human access to dangerous voltage.
7. Plug the eDrive and external power supply cords into the appropriate facility power.

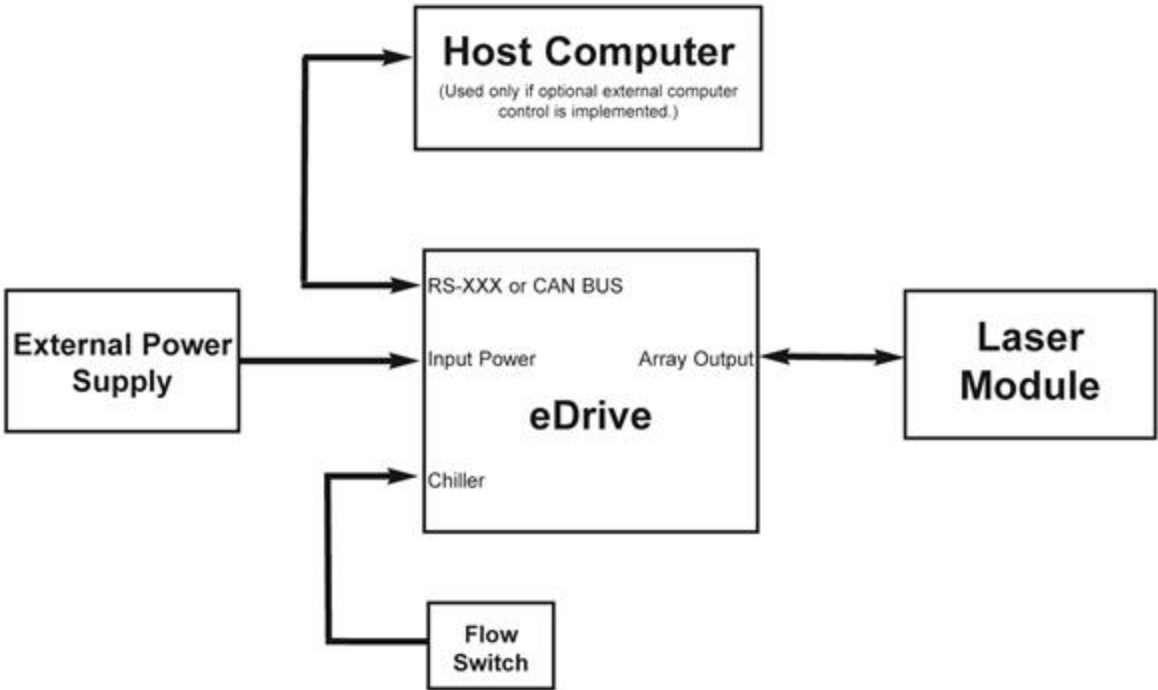


Figure 4-1 Connection Diagram

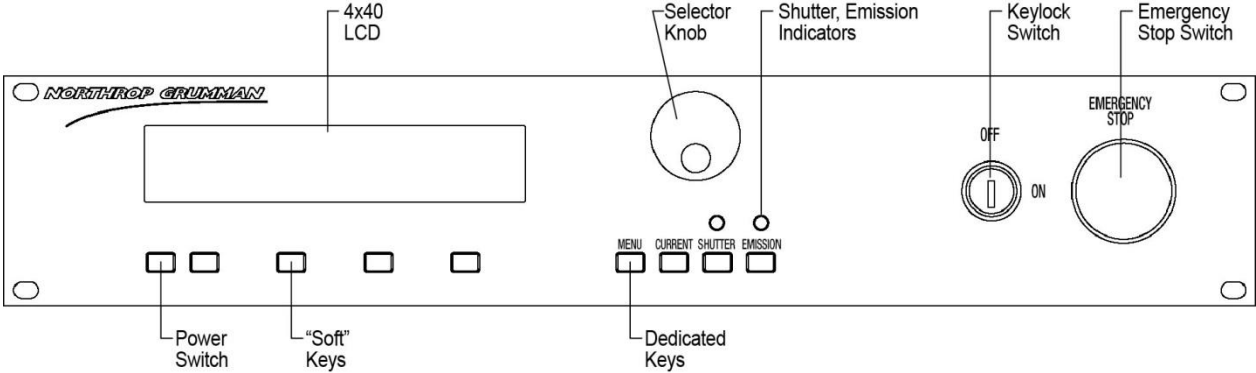


Figure 4-2 2U eDrive Front Panel

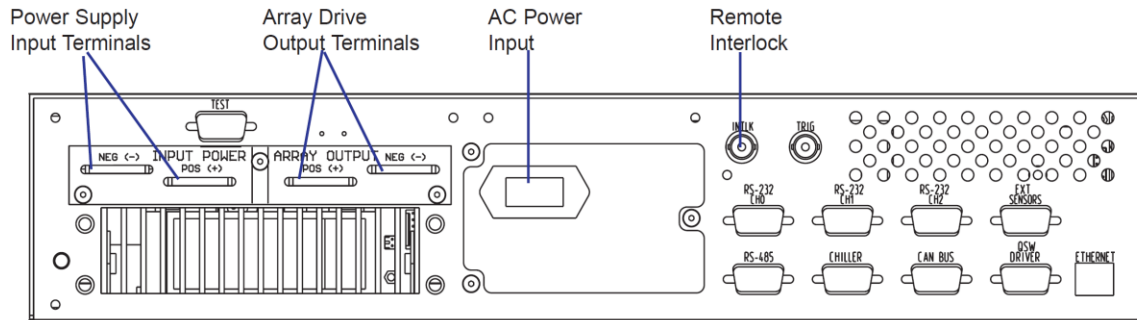


Figure 4-3 eDrive Rear Panel

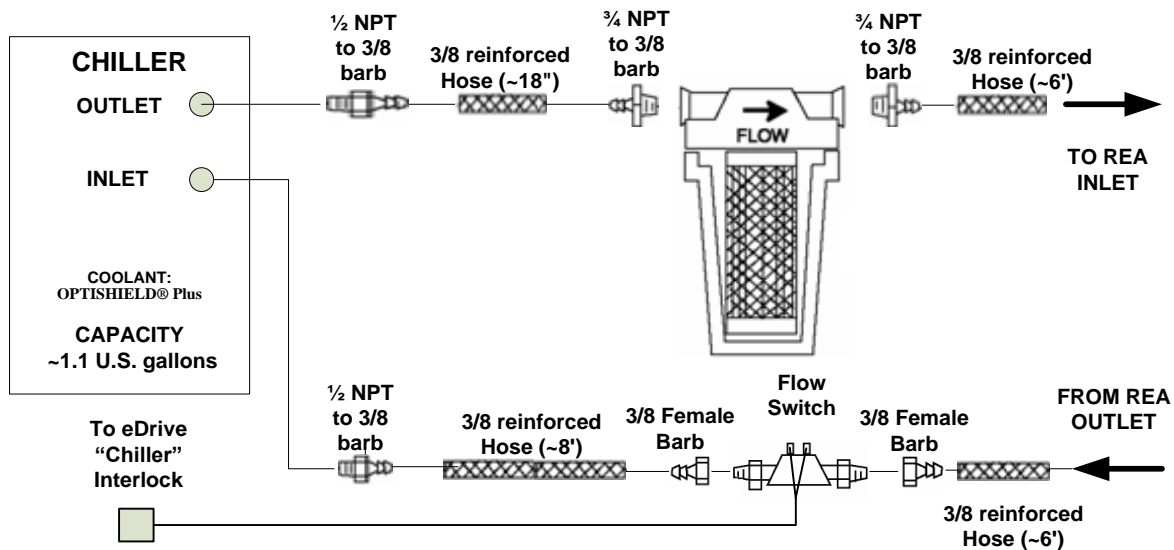


Figure 4-4 Chiller Assembly Drawing

Closed Loop Chiller Assembly

1. Place the chiller on the floor near the REA PowerPULSE laser module. Refer to the chiller instruction manual for power requirements, settings and instructions on how to set up the chiller.
2. Attach the cooling lines (included with the plumbing accessory kit) to the hose barb fittings on the chiller and on the REA PowerPULSE laser module. Remember to attach the filter between the chiller and the laser module. The filter may be attached to the back of the chiller or to some other stable mounting point (i.e. wall).
3. Connect coolant flow switch to the 9-pin **CHILLER** connector on the back of the eDrive. Older plumbing kits used the **INTLKBNC** connector on rear of eDrive diode driver. When connecting the coolant flow switch, make sure that it is connected to the return line of the chiller and the arrow located on the top of the switch is pointing in the direction of coolant flow.

The standard plumbing arrangement for a typical closed loop chiller (including hose diameters) is shown in Figure 4-4. The input/output coolant connections on the REA PowerPULSE are polarized. Coolant flow direction is important, see Figure 1-1 for coolant inlet and outlet orientation for the REA PowerPULSE module.



CAUTION. Do not use deionized (DI) water in the closed loop chiller based system. If you must use DI water, monitor the resistivity (between 300 and 700 k Ω) closely and avoid iron or aluminum parts in the coolant loop.

4. Fill the chiller reservoir and filter housing manually with coolant (10% Optishield Plus[®], 90% distilled water) The coolant is made from DI water with additives to control the pH. By using DI water in the solution, scale will not form in the cooling loop. The coolant contains corrosion inhibitors and biocide to inhibit algae growth.



CAUTION. Do not allow chiller to fill the filter housing, as air can become trapped within the system.

5. Power on the chiller
6. Make sure no air remains trapped in the lines resulting in a positive back pressure when chiller is turned off. Positive back pressure can hold the flow switch closed even though flow is not being supplied to the laser module. Air is trapped in the lines if coolant level drops when chiller is turned on and then rises when turned off. Failure to heed this warning may result in the destruction or serious damage to the device, and will void the product warranty.
7. Verify the pressure gauge located on the front panel of the chiller reads approximately 60 psi. If it does not, adjust the bypass valve on the rear of the chiller.
8. Minimum coolant flow is two gallons per minute. See the Final Test report for optimum flow rate.



NOTE. Chiller flow rate calibration may be required. Please refer to the chiller user manual for instructions on calibration. A video of flow calibration of a Polyscience 6000 series chiller can be found on the Knowledge Center at http://www.ngceoservice.com/Level_1_PA-016-QTGP, Patara Level 1 Maintenance Video, Chapter 19: *Flow Rate Calibration*

9. Set the temperature located on the front panel of the chiller to the optimum temperature listed on the final test report, typically between 20 °C and 35 °C.

Starting the Laser Module

Pre-Start Conditions

1. Wear laser safety goggles which protect user from 1064 nm (fundamental) and 808 nm radiation.
2. Position the REA PowerPULSE module in a laser cavity such the output will be directed toward a safe target.
3. Verify that the system is correctly assembled.
4. Verify that the rod faces are clean and not capped or covered.
5. Verify that the filter on the closed loop chiller is connected to the inlet hose barb.
6. Switch the Closed Loop Chiller to the **ON** position. Verify coolant flow from chiller.



WARNING. Do not operate coolant system below air condensation temperature (dew point) at laser head. Condensation on the diode arrays can seriously damage the laser head and may void warranty. Consult NG Technical Services if you have any questions.

Turning the System On

1. Verify coolant temperature and flow rate are correct.
2. Turn power switch on external power supply to **ON** position. Set the voltage to the voltage shown on the Pulsed REA PowerPULSE Module Final Test report, and set the current to supply the required amount for the application.
3. Turn the AC power switch on rear of the eDrive to the **ON** position (4U only).
4. Turn the Key switch to the **ON** position.
5. Ensure the Estop button is released
6. Press the main AC **POWER** switch of the eDrive, located on the front panel.
7. Before applying current to diodes, shut off chiller to verify that the Flow Interlock Fault occurs within 1 second.
8. Restart the chiller. Select **Clear** and verify the error display is no longer present.

Powering the REA PowerPULSE Module

1. From eDrive main menu, select **Channel Setup ▶ Channel 1 ▶ Set Current Limit**. Use the selection knob to set your maximum current amplitude to a value considered safe for the intended module. The eDrive will not allow the current amplitude to be set higher than the limit. PowerPULSE modules should *never* be run with more than the maximum operating conditions engraved on the module.
2. From the main menu, select **Channel Setup ▶ Channel 1 ▶ Set Current**. Use the selector knob to select a low current level of approximately 10A.
3. From the main menu, select **Channel Setup ▶ Channel 1 ▶ More ▶ Set Duty Cycle Limit**. Use the selector knob to set the duty cycle limit to 15%.
4. From the main menu, select **Channel Setup ▶ Channel 1 ▶ More ▶ Set Frequency**. Use the selector knob to select the frequency shown on the Final Test Report.
5. From the main menu, select **Channel Setup ▶ Channel 1 ▶ More ▶ Set Pulse Width**. Use the selector knob to select the pulse width shown on the Final Test Report.
6. Press **EMISSION**. After a few warning beeps (approximately 4 second delay), the eDrive applies current to the PowerPULSE module.
7. Open shutter (if installed).
8. Using an infrared viewer or phosphor card, increase the current checking for output at the laser threshold current indicated on the Final Test Report.
9. Slowly adjust the current setting to the desired current level. (For initial use, see Final Test Report). Do not run the current any higher than the maximum current engraved on the cover of the laser module.



WARNING. Do not exceed the QCW operating limits engraved on the cover of the laser module.

10. If you cannot achieve desired output within 10% of previous operating current, contact NG Technical Service for assistance.

Standby Condition

If you are finished using the module but want to use it again within the next hour, it is best to go to “standby”. To go to standby from a lasing condition, press the **EMISSION** button on the eDrive Laser Controller. In this condition, the drive current to the laser diode shuts off but the closed loop chiller maintains the optimum diode temperature.

To resume lasing, press the **EMISSION** button on the eDrive laser controller. Again an audible warning will sound for approximately 4 seconds prior to firing the module.

Turning Off the System

1. Close shutter (if installed).
2. Slowly decrease the current to 10A in 10A decrements.
3. Press the **EMISSION** button to turn off eDrive output. Press the main AC **POWER** switch of the eDrive, located on the front panel. Hold down for approximately 5 seconds until the eDrive shuts down.
4. Turn the key switch on the eDrive to the **OFF** position.
5. Switch the main AC power switch on the external power supply, located on the front panel, to the **OFF** position.
6. Turn the AC power switch on rear of the eDrive to the **OFF** position (4U only).
7. Using a voltmeter, verify voltage has discharged on module power lugs
8. Allow chiller to run for a couple of minutes (1-2 minutes).
9. Switch the closed loop chiller to the **OFF** position.
10. Remove the key. Do not leave the laser accessible to people who are untrained in laser safety or operation.



WARNING. Hazardous voltages are present in this system during normal operation. Use a voltmeter to verify all electronics are discharged before touching or grounding of electrical connections.

Chapter 5: Maintenance

The chapter contains information in these sections:

- Rod Removal and Replacement
- Rod Cleaning
- Leak Test Procedure
- Extend Lifetime of Laser Diodes
- Increasing the Operating Current, Pulse Width or Frequency
- Cleaning the Chiller
- High Voltage DC Power Supply Maintenance

Rod Removal and Replacement

The only user serviceable part in the REA PowerPULSE module is the Nd:YAG rod, which can be replaced by the user. Frequent replacement may be a sign of a problem in the application. Contact NG if you have any further questions.



CAUTION. The module is susceptible to damage due to electro-static discharge (ESD). Always use proper ESD control devices when handling the module.



CAUTION. Ensure gloves or finger cots are worn during this procedure and that it is carried out in a clean environment, preferably under a laminar flow hood.

NG has manufactured three different configurations for mounting the laser rod. Determine the configuration you have from the graphics below (Figures 5-1, 5-3, and 5-4) and follow the steps for rod replacement.

No Retainer Cap Configuration

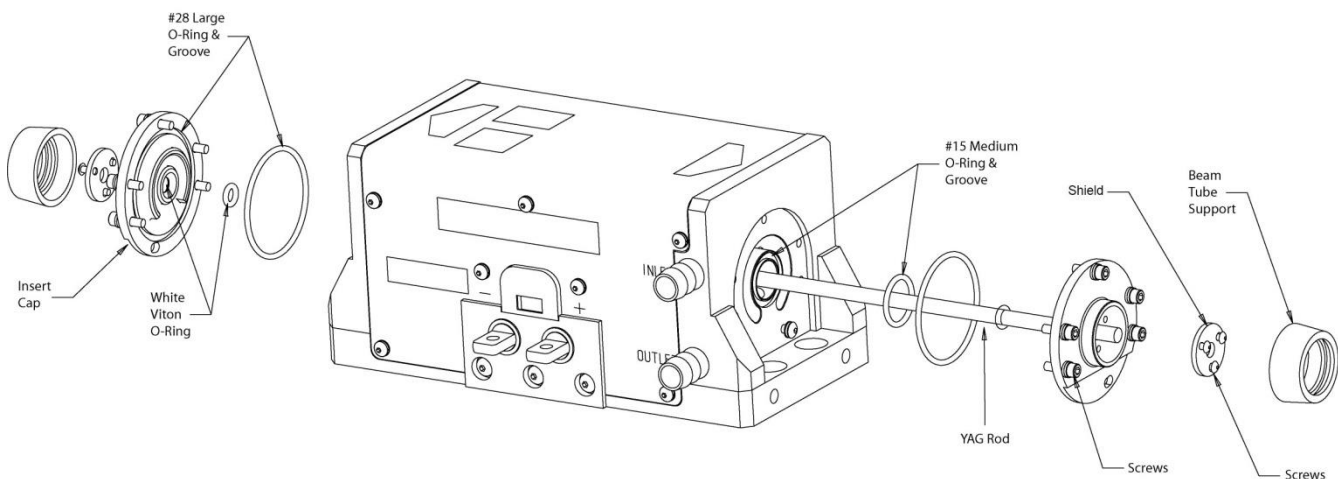


Figure 5-1 No Retainer Cap Rod Replacement Drawing

1. Remove beam tube supports and the shields from both ends of the rod.



CAUTION. Use extreme caution during the remaining steps of this procedure to insure that the rod faces and/or coatings are not damaged. Never use a tool that can scratch the rod on the O-rings.

2. Starting with the end of the module without the hose barbs apply methanol to the rod O-ring.

3. Remove the six screws that hold the insert to the endplate and then slowly rotate and pull the insert off of the rod.
4. Moving to the other end of the module with the hose barbs remove the six screws holding the insert to the endplate and pull the insert and rod out of the module.
5. Apply methanol to the rod O-ring and remove the second insert.
6. Remove rod from its packaging and inspect end faces under 50X magnification.
7. Inspect rod O-rings in the center of the inserts, if no damage is found reuse the original O-rings. If damage is found, replace with the appropriate O-ring from Table 5-1.

Table 5-1 Replacement Rod O-rings

| Rod Diameter (mm) | 4.0 | 5.0 | 6.35 | 7.0 | 8.0 | 9.0 | 10.0 | 12.0 |
|-------------------|------|------|------|-----------|------|---------|------|------|
| O-ring | #007 | #008 | #010 | #70-258SS | #011 | #70-334 | #012 | #013 |

8. Each insert has one large O-ring groove on the surface near the edge of the insert this is the inside surface of the insert, Figure 5-2 shows correct installation of the #28 black O-ring into this groove.
9. Lubricate both white O-rings in the center of the inserts and both #28 black O-rings with the syringe of methanol.
10. Place a #15 black medium O-ring in the matching groove on the right endplate of the module with the two hose barbs and lubricate with methanol, as shown in Figure 5-2.



Figure 5-2 No Retainer Cap Version O-rings

11. Push the rod through the white O-ring in the center bore of one insert from the inside surface side of the insert until it sticks past and out the other side about 1/8" making sure not to shave or cut the white O-ring.
12. Holding the rod with one insert on it carefully slide the end without the insert in to the center bore of the hose barbed end plate until the rod comes out the other end of the module, being careful not to hit the rod end on the endplate.

13. Holding the insert up against the hose barbed endplate so it is flat and level place a gloved fingertip over the rod to keep it from being pushed out in step 14.
14. With one hand held as stated in step 13, use the other hand to push the second insert onto the exposed rod end making sure the white O-ring is not damaged as the rod passes through the center bore of the insert and the #28 black O-ring faces the endplate.
15. Once the inserts are pushed safely onto the rod ends they should lay flush with each of their endplates of the module with the #28 black O-rings as the seal between the two pieces.
16. Fasten each of the two inserts to their endplates with five #4 sized 3/8" SHC Screws and one #4 sized 3/8" BHC Screw that goes in the slotted hole, shown in Figure 5-3, of each insert.
17. Clean the rod ends at 50x with canned air and methanol soaked cotton swabs.
18. Reattach the shields.
19. Double check the rod ends with a microscope after the shields are in place to ensure the rod ends are still clean. Then replace the beam tube supports.

Retainer Cap with Shield Configuration

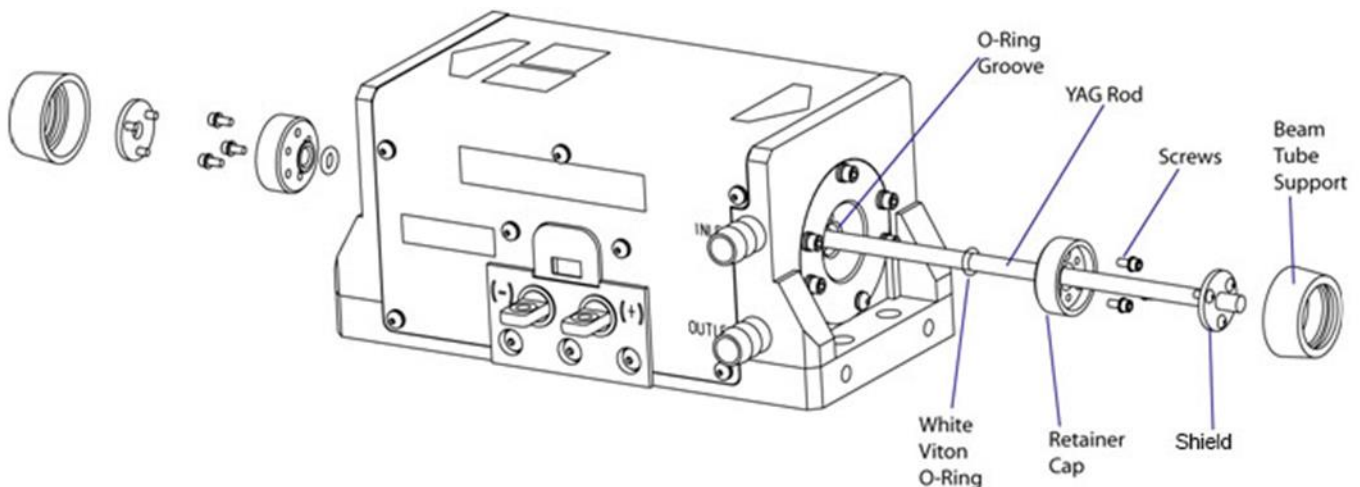


Figure 5-3 Retainer Cap with Shield Rod Replacement Drawing

Retainer Cap without Shield Configuration

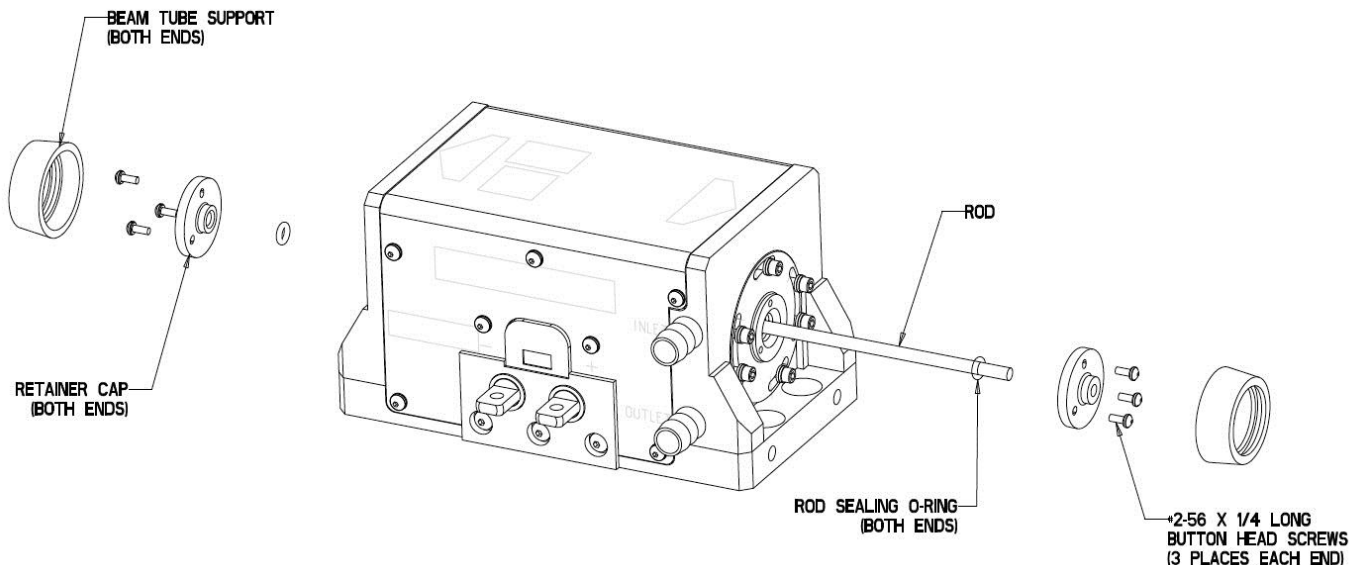


Figure 5-4 Retainer Cap without Shield Rod Replacement Drawing

1. Place a shorting connector across the power lugs.
2. Remove all coolant from module by blowing dry air (or nitrogen) through the rod and array inlet ports at 5 psi for 20 minutes.
3. Remove the two beam tube supports from the ends of the module.
4. Remove the two shields from the ends of the module, if applicable.
5. Remove the two retainer caps from the ends of the module.



CAUTION. Use extreme caution during the remaining steps of this procedure to insure that the rod faces and/or coatings are not damaged. Never use a tool that can scratch the rod or damage the o-rings.

6. Wear gloves. Apply methanol to the o-rings on the rod ends. Using your index finger and thumb, gently rotate the rod in a clockwise motion and apply slight pressure to break the o-ring seal.
7. Carefully press one end of the rod until one of the o-rings is unseated. If the rod does not easily unseat, you may have to push from the opposite end.
8. When the laser rod unseats, carefully pull it completely out of the module from the protruding end.
9. Wrap the used rod in lens tissue and set aside.
10. Unwrap the new rod and inspect the end faces.
11. See Table 5-1 to determine the correct replacement o-rings for the module.

12. Place one of the o-rings over the end of the rod.



CAUTION. The rod is very fragile. Be careful not to chip or scratch the rod while inserting it.

13. Insert the end of the rod (without the o-ring) into the rod hole of the first endplate. Looking through the rod hole in the second endplate, center the rod and continue to push until it protrudes through the rod hole in the second endplate. The rod must be perfectly centered to avoid damage.
14. Align and install one of the retainer caps over the end of the rod with the o-ring. Attach with the hardware removed during disassembly.
15. Place the second o-ring on to the opposite end of the rod.
16. Inspect the rod end for cleanliness. If needed, clean the end of the rod with methanol and lint-free swabs.
17. Align and install the second retainer cap onto the rod to properly position the o-ring into the o-ring groove in the endplate. Attach with the hardware removed during disassembly.
18. If specific orientation of the rod is required:
 - a. Remove the second retainer cap.
 - b. Loosen the 4 screws on the first retainer cap. Do not completely remove them.
 - c. Using your index finger and thumb on the rod end (without the retainer cap), gently rotate the rod until the appropriate rod orientation is achieved.
 - d. Make sure the rod is equidistant from each end of the laser module before tightening retainer cap.
 - e. Tighten the four screws and locking hardware on the first retainer cap.
 - f. Replace the second retainer cap and tighten the screws and locking hardware.
 - g. Inspect both rod ends for cleanliness. If necessary, clean the rod ends with a puff of dry nitrogen or moisture-free canned air.
19. Replace the two shields on the retainer caps, if applicable.
20. Replace the beam tube supports.
21. Leak test the rod coolant loop according to the Leak Test Procedure section in this chapter.
22. If the laser module leaks: first fix the leak, then test again for leaks. Firing wet diodes will permanently damage them.

Rod Cleaning



CAUTION. Ensure gloves or finger cots are worn during this procedure and that it is carried out in a clean environment, preferably under a laminar flow hood.

1. Blow optical surface with dry nitrogen
2. Remove the fasteners to expose the rod end.
 - a. For the configuration shown in Figure 5-1, remove the shield
 - b. For the configuration shown in Figure 5-3, remove the shield and then the retainer cap
 - c. For the configuration shown in Figure 5-4, remove the retainer cap
3. Using hemostats and lens tissue or a tightly wrapped cotton tipped applicator, wetted with acetone or methanol, wipe the rod face from the center of the rod to the edges.
4. Inspect the rod for cleanliness.
5. Reinstall retainer caps and shields per your configuration.

Leak Test Procedure

Laser diodes are very sensitive to coolant damage. If you have access to pressurized nitrogen and a pressure gage, you can test for leaks without exposing the diodes to coolant.

1. Attach a nitrogen source to one of the coolant ports on the module being tested (test article) and attach the termination valve to the other coolant port on the test article.
2. Close the termination valve.
3. Open the inlet valve and adjust the regulator to obtain 80 psi on the pressure gauge.
4. Close the inlet valve. Wait.
5. Return after 30 minutes and record pressure on the gauge. Subtract this pressure from starting pressure of 80 psi to get the pressure drop over 30 minutes.
6. Pass/Fail requirements: if the pressure drop is greater than 3 psi FAIL, if the pressure drop is less than 3 psi PASS.

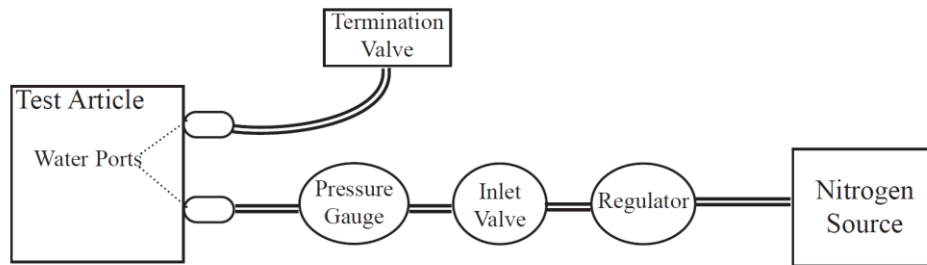


Figure 5-5 Nitrogen Leak Test Layout

Extend Lifetime of Laser Diodes

The specification for the REA PowerPULSE output is provided in the Final Test Report delivered with the module. As the diodes age, an increase in current, pulse width, or frequency may be required to maintain power and beam quality so the diodes can continue to be used. Once the maximum peak current or duty cycle is reached, consider replacing diodes or upgrade the laser. Please contact NG for detailed information.

Increasing the Operating Current, Pulse Width, or Frequency



CAUTION. Increasing the operating current, pulse width or frequency before it becomes necessary can severely shorten diode lifetime.

Before increasing the operating current, pulse width, or frequency, ensure:

- the coolant temperature is at the correct set point
- all optical surfaces are clean
- the chiller coolant and filter are clean.

If the temperature is correct and the optical surfaces and coolant are clean, yet the output power is still low, the operating current may need to be slightly raised. Contact NG Technical Service if you have any questions.

Adjusting the Temperature Set Point for the Re-circulating Chiller

The temperature set point for the chiller was determined at NG and indicated on the Final Test Report. Normally the temperature will not need adjustment. It is possible however, that this adjustment may be recommended during the latter part of the laser diodes' lifetime and after several current increases. Increasing the diode drive current increases the heat load on the diode, resulting in a shift in diode wavelength. In order to compensate for this shift, a slight decrease of the temperature set point on the chiller may be required. Changing the temperature set point will change the output wavelength of the laser diode; this adjustment should be done in one degree Celsius increments. Look for an increase in optical output power on an external power meter. Wait a few minutes between each adjustment allowing the chiller to stabilize. Continue until you obtain the maximum possible power.

Cleaning the Chiller

The cooling fluid should run for a maximum period of 1 month after which the system should be drained, cleaned and refilled with clean coolant. The filter on the closed loop system should be monitored weekly. The system should also be drained, cleaned and refilled with clean coolant if any discoloration of the filter occurs.

Chemicals and Supplies Needed

- 3% Hydrogen Peroxide solution sufficient to fill the system.
- Optishield Plus[®] and distilled water solution (10% Optishield Plus[®], 90% distilled water).
- Distilled water, sufficient to fill the system.

Two replacement particle filters (Hydronix pleated 5 μ m polyester filter, part number SPC-25-1005, is available at multiple online retailers).

Cleaning Procedure

1. Drain chiller and clean any residue or contamination in the reservoir with the use of a bottle brush or alcohol wipes.
2. Using a filter housing wrench, dismantle the particle filter housing. Empty the coolant trapped in the filter housing into a container for later disposal.
3. Dispose of the expired particle filter and clean any residue or contamination from the inside of the filter housing. Install a new filter in the housing.
4. Refill with distilled water and circulate for 5 minutes.
5. Drain system completely as detailed in steps 1 and 2.
6. Fill the chiller with a 3% solution of Hydrogen Peroxide. Care should be taken to ensure that the mixture completely fills to the top of the reservoir to ensure all

wetted surface areas of the chillers are cleaned. Cycle the chiller on and off. Top off the reservoir as necessary to ensure it is full of the cleaning solution. Ensure that the cap of the chiller reservoir is loose or remove it completely to allow gas to escape from the system.

7. Circulate the cleaning solution through the system including the laser module for 40 minutes.
8. Drain the cleaning solution mixture from the chiller as detailed in steps 1 and 2.
9. Refill and circulate distilled water for 5 minutes and drain. Ensure that the cap of the chiller reservoir is loose, or remove it completely to allow gas to escape from the system.
10. Drain the chiller and dispose of the filter.
11. Disconnect the chiller from the laser module and blow out water from the laser module coolant loop prior to refilling the chiller coolant reservoir.
12. Reconnect the laser module coolant loop.
13. Install new 5 micron filter into housing.
14. Record cleaning date on sticker with a one-month reminder to drain & clean the system. Affix sticker to chiller (or cabinet).
15. Refill the chiller reservoir with Optishield plus and distilled water coolant following the manufacturer's directions. Run for 30 minutes with the cap loose to allow gas to escape from the system.
16. Secure the reservoir cap.
17. The chiller is now ready to use.

High Voltage DC Power Supply Maintenance

Consult power supply manual for regularly scheduled maintenance and calibration details.



WARNING. Hazardous voltages are present during normal operation. Before removing the cover, the power source should be disconnected and a period of 20 minutes allowed for the discharge of stored capacitance. Use a voltmeter to verify all electronics are discharged before touching or grounding of electrical connections.

Chapter 6: Service

At Northrop Grumman Cutting Edge Optronics, we are proud of the durability of our products. Our manufacturing and quality control processes emphasize consistency, ruggedness, and high performance. Nevertheless, even the finest instruments break down occasionally. We believe that the reliability record of our instruments compares favorably with that of our competition, and we hope to demonstrate our superior service by providing dependable instruments and, if the need arises, service facilities that can restore your instrument to peak performance without delay.

When calling for service dial (636) 916-4900 and follow prompts for department directory. For email correspondence use ngceoservice@ngc.com

This chapter provides reference to types of customer service needs:

- Contact Customer Service
- Return the Instrument for Repair

Contact Customer Service

To expedite your service needs, please complete the questionnaire in *Appendix A: Customer Service* **before** you contact Cutting Edge Optronics Customer Service. Complete the questionnaire with as much detail as possible and retain a copy for your records.

E-mail or fax the form to Cutting Edge Optronics (refer to the second page of this manual for contact information) and notify your customer service representative that it has been sent.

Return the Instrument for Repair

Instructions on returning your module to NG are located on the Knowledge Center website at http://www.ngceoservice.com/Support_Documentation , see SVC-FORM-0004 *Laser module Return Instructions*.



CAUTION. Failure to follow proper shipping instructions may result in damage to the instrument.



WARNING. Damage from residual coolant due to condensation or expansion can be catastrophic to the diode arrays or laser rod if not dealt with properly. Such damage is excluded from warranty coverage.

Appendix A: Customer Service

This form has been provided to encourage you to tell us about any difficulties you may have experienced while using your Northrop Grumman Cutting Edge Optronics instruments or user manuals. Call or email our customer service department to bring attention to problems that you may not have personally experienced. We are always interested in improving our products and manuals, and we appreciate all suggestions.

Date:

Name:

Company or Institution:

Department:

Address:

Module Model Number:

Serial Number:

Chiller Model Number:

Serial Number:

External Power Supply Model Number:

Serial Number:

eDrive Model Number:

Serial Number:

Module Manufacture Date:

Questions

What is the coolant flow rate (GPM)?

What is the set temperature on the chiller (°C)?

What is the coolant pressure on chiller (PSI)?

What are the set current and actual current from eDrive (A)?

What is the pulse width (μ s)?

What is the repetition rate (kHz)?

What is the external power supply voltage (V)?

What is the laser cavity configuration?

What is the measured power (W)?

When did the problem happen?

Have you changed any settings recently (yes/no)?

What are the changes made recently to the system?

Please describe the problem or module behavior as detailed as possible:

Suggestions

Email or send to:
Northrop Grumman
Cutting Edge Optronics, Inc.
20 Point West Boulevard
Saint Charles, MO 63301 USA
Phone: (636) 916-4900
FAX: 636-916-4994
Email: ngceoservice@ngc.com

Appendix B: System International Units

The following System International (SI) units, abbreviations, and prefixes are used throughout Cutting Edge Optronics user manuals:

| Quantity | Unit | Symbol |
|-----------------------|---------|----------|
| mass | gram | g |
| length | meter | m |
| time | second | s |
| frequency | Hertz | Hz |
| force | Newton | N |
| energy | Joule | J |
| power | Watt | W |
| electric current | Ampere | A |
| electric charge | Coulomb | C |
| electric potential | Volt | V |
| resistance | ohm | Ω |
| inductance | Henry | H |
| magnetic flux | Weber | Wb |
| magnetic flux density | Tesla | T |
| luminous intensity | candela | cd |
| temperature | Kelvin | K |

| Abbrv. | | Prefixes |
|--------|----------------|----------|
| tera | (10^{12}) | T |
| giga | (10^9) | G |
| mega | (10^6) | M |
| kilo | (10^3) | k |
| deci | (10^{-1}) | d |
| centi | (10^{-2}) | c |
| milli | (10^{-3}) | m |
| micro | (10^{-6}) | μ |
| nano | (10^{-9}) | n |
| pico | (10^{-12}) | p |
| femto | (10^{-15}) | f |
| atto | (10^{-18}) | a |

Appendix C: Acronyms

| Acronym | Description |
|---------|--|
| ACGIH | American Council of Government Industrial Hygienists |
| ANSI | American National Standards Institute |
| AO | Acusto-Optical (type of Q-switch) |
| AR | Anti-Reflective |
| ASM | Array Sub-Module |
| CDRH | Center for Devices and Radiological Health - U.S. Food and Drug Administration |
| CFR | Code of Federal Regulations |
| CW | Continuous Wave |
| DC | Direct Current |
| EO | Electro-Optical (type of Q-switch) |
| ESD | Electro-Static Discharge |
| FET | Field Effect Transistor |
| FDA | U.S. Food and Drug Administration |
| FWHM | Full Width - Half Max |
| GaAlAs | Gallium Aluminum Arsenide |
| GPM | Gallons Per Minute |
| HR | High Reflector |
| HV | High Voltage |
| IR | Infrared |
| KTP | Potassium Titanyl Phosphate |
| LBO | Lithium Triborate |

| Acronym | Description |
|----------------|---|
| MCC | Meters Concave |
| Nd:YAG | Neodymium-doped Yttrium Aluminum Garnet |
| Nd:YLF | Neodymium-doped Yttrium Lithium Fluoride |
| NG | Northrop Grumman |
| NIR | Near Infrared |
| OSHA | Occupational Safety and Health Administration |
| PRF | Pulse Repetition Frequency |
| PSI | Pounds per Square Inch |
| QCW | Quasi-Continuous Wave |
| SHG | Second Harmonic Generator |
| TTL | Transistor - Transistor Logic |
| VAC | Volts, Alternating Current |