Operator's Manual for

56RCS Series Laser Systems

This manual applies to the following laser systems:

56RCS/001 Series
56RCS/002 Series
56RCS/004 Series
56RCS/005 Series

Manufactured by

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1 Introduction

The 56RCS series of laser modules represents a full solution for diode laser beam delivery. The modules provide a wide variety of power, wavelength, and output beam options along with high-performance current and temperature control in the same rugged package. This manual describes system operation and summarizes handling procedures recommended to ensure reliable operation and highest performance.

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

Wenn andere als die hier angebenen Kontrollfunktionen oder Einstellungen oder die Ausführung von Abläufen erfolgen, kann zu einer Aussetzung von gefährlicher Strahlung führen.

1.1 About this manual

This manual contains all the information required to operate CVI Melles Griot's 56RCS series laser.

If you have any questions or comments about this manual or the laser system itself, please call your local sales or service office, or contact our Customer Service staff at (760) 438-2131.

1.1.1 Conventions used in this manual

Throughout this manual you will find information that is separated from the regular text by lines and labeled by an icon in the margin. Lasers are potentially dangerous devices, and some of this information is vital for your safety. The significance of the notations is explained below.

Lasers are electrical devices and improper use can expose the operator or others to potentially lethal voltages. The "Hazard" icon, represented by a triangle with a lightning bolt, identifies precautions needed to avoid *electrical* injury or damage to the equipment.

Skin and eyes may be damaged if exposed to laser beams. The "Caution" icon, represented by a triangle with laser burst, identifies precautions needed to avoid *eye and/or skin* injury to anyone in the area. Most RCS Series lasers are Class IIIb/3B, and as such the skin and eyes may be damaged if exposed to the laser beam

The "Note" icon, represented by a triangle with an exclamation point, indicates information that is particularly important to the optimum performance of the laser system or information about the procedure or topic under discussion.

To designate the controls, indicators, and connectors in this manual, the following conventions are used:

Hardware labels: These are written as they appear on the hardware (e.g., if a control is labeled POWER on the hardware, it will be called the POWER control in this manual; if it is labeled Power on the hardware, it will be referred to as the Power control).

Item names: Controls, connectors, and other items that do not have labels will be referred to by initial capitals (e.g., Laser Emission Indicator)

The abbreviations, acronyms and symbols used in this manual are listed below.

Table 1: Abbreviations, Acronyms and Symbols

	Description
CDRH	Center for Devices and Radiological Health
cw	Continuous wave
dc	Direct current
FCC	Federal Communications Commission
IEC	International Electrotechnical Commission
LED	Light-emitting diode
OEM	Original equipment manufacturer
p-p	peak-to-peak
Vac	volts ac
Vdc	volts dc

1.1.2 Federal Communications Commission (FCC) Statement

The Federal Communications Commission, in 47 CFR Part 15 subpart B, has specified that the following notice be brought to the attention of the users of this product:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

1.1.3 European Standard Statement:

This product has been tested and found to comply with the limits for Class A Information Technology Equipment according to European Standard EN 55022. The limits for Class A equipment were derived for commercial and industrial environments to provide reasonable protection against interference with licensed communication equipment.

Properly shielded and grounded cables and connectors must be used in order to reduce the potential for causing interference to radio and TV communications and to other electrical or electronic equipment. CVI Melles Griot cannot accept responsibility for any interference caused by using other than recommended cables.

1.1.4 Industry Canada Compliance Statement

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conform à la norme NMB-003 du Canada.

NO USER SERVICABLE PARTS ARE INSIDE. ANY SERVICE OR OPERATION WITH THE PROTECTIVE COVERS REMOVED SHALL BE DONE ONLY BY QUALIFIED PERSONNEL

2 For Your Safety

2.1 Introduction

Because your safety is paramount, the RCS Series laser system has many built-in safety features to help ensure that the laser emits light only when you want it to and only when you have determined that conditions are safe for it to do so. A key switch prevents unauthorized access. Laser Emission Indicators on the rear of the laser illuminate whenever laser emission is possible. To prevent accidental exposure to the laser beam, there is, at minimum, a 3 second delay between the time the Laser On switch is activated and laser emission occurs. A remote interlock connection is provided that can be configured to shut the laser off if a laboratory door or an instrument access panel is inadvertently opened. Finally, a manual shutter is available that can block all laser radiation in an emergency.

Please keep in mind, however, that these built-in features will not protect you or your equipment if you do not adhere to the specific precautions and instructions delineated in this manual.

This chapter includes information about:

- Safety instructions to follow to avoid accidental beam exposure
- References on laser safety

2.2 Safety

Please be advised that CVI Melles Griot laser products have intentional safety and protective features incorporated in them to meet safety, CDRH, IEC, CE and other regulatory standards. Any third party accessories used with these products must maintain the proper use of and access to these features. Use of any third party accessories that have not been approved in writing by CVI Melles Griot for use with our lasers will void all warranties and may not meet the requirements of CE, CDRH and other standards. The products meet requirements “as shipped” and CVI Melles Griot will not be held responsible for any damage, injury or loss incurred in any manner whatsoever as a result of unapproved accessories used with our products.

All maintenance or service requiring access to the interior of the laser or power supply must be performed by an authorized CVI Melles Griot representative. In addition, removal of any warranty labels will void your warranty.

Be advised that there are potential hazards to personnel or equipment if the specific precautions and instructions described in this manual are not adhered to.

With any laser system there are two major safety issues—electrical safety and laser safety. These issues are discussed in the following sections.

2.3 Laser Safety

Laser light can be hazardous to the skin or the eye, causing burns, eye damage, and even blindness. The CVI Melles Griot CDRH compliant laser systems meet all of the requirements of 21 CFR 1040.10 subchapter J as set forth by the U.S. Food and Drug Administration, Center for Devices and Radiological Health (CDRH). The systems also comply with all applicable European laser safety standards.

Never look into the laser beam or into the laser aperture (even when the laser is off), with or without appropriate safety goggles. Permanent eye damage or blindness may result!

In addition, keep all parts of the body and reflective materials out of the beam path.

The laser system should not be operated unless all appropriate safety precautions are taken. These include, but are not limited to:

- Providing enclosed paths for laser beams whenever possible.
- Wearing appropriate certified laser safety glasses when working around a functioning laser device.
- Designating a controlled area specifically for laser operation. Access to this area should be limited to those individuals who have been instructed in the safe operation of lasers.
- Posting warning signs in conspicuous locations near the laser area.
- Setting up laser equipment so that the beam is not at eye level.
- Setting up a target covered with flat black paint or other anti-reflective coating and using shields as necessary to prevent strong reflections from going beyond the area where the laser is being used.

Adjustments, use of controls, or performance of procedures other than those specified in this manual may result in exposure to hazardous laser radiation.

For more information on laser safety, the following sources are available:

"American National Standard for the Safe Use of Lasers"
ANSI Z136.1-2007
The American National Standards Institute (ANSI)
http://www.ansi.org/

"A Guide for Control of Laser Hazards"
The American Conference of Governmental and Industrial Hygienists (ACGIH)
http://www.acgih.org/

"Laser Safety Guide"
Laser Institute of America
http://www.laserinstitute.org/

3 Initial Installation

3.1 Introduction

This chapter includes information about:

- Unpacking the system
- Inspecting the system for damage and completeness
- Connecting the components of the system and mounting.

3.2 Unpacking your system

Retain the shipping container, which is designed to protect the laser system during shipment and storage. The container should always be used to ship and store the system.

Immediately upon receipt of your CVI Melles Griot laser system, inspect the packaging for obvious signs of damage. The laser's packaging is quite substantial and will protect the equipment from normal shipping stresses. If the packing cartons are significantly damaged and you suspect damage has occurred to one of the components, file a claim with the shipper and have a representative from the shipper present when the unit is unpacked.

When unpacking the laser system, look for dents, scratches and other signs of damage to the components. If damage is evident, immediately file a claim with the shipper and contact your nearest CVI Melles Griot representative.

Save the original shipping container and packaging materials for use in storage or if product return is required. CVI Melles Griot cannot honor the warranty for improperly packaged equipment.

4 System Description

4.1 Introduction

This chapter describes 56RCS series laser and gives a functional description of all user-accessible controls, indicators and connectors.

4.2 Laser System Construction

The 56RCS module encompasses a precision-collimated opto-mechanical assembly, a low-noise current controller, and a temperature controller. The module may be powered by a single DC power supply; no other inputs are necessary for operation. Other electrical inputs that may be used are the high speed and analog modulation input and remote on/off input. All electrical connections are made through the 15-pin D-sub connector at the rear of the module.

To provide maximum protection against electrical damage during storage and transportation, keep the laser inside a static dissipative bag or other similar type container.

To provide maximum immunity to electrical noise, the 56RCS enclosure forms an electrical shield, or Faraday cage, around the laser and control circuitry. This shield is connected to voltage return.

A number of accessories are available for use with the 56RCS series. Power supplies to provide dc power to the laser and operate from 90 to 240 Vac 50/60 Hz:

- 56IMA020 for 5 Vdc
- 56IMA021 for 9 Vdc

If your requirements call for optical or mechanical configurations other than the standard product, please contact our Laser Group for a customized design.

All maintenance or service requiring access to the interior of the laser must be performed by an authorized CVI Melles Griot representative.

Caution: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure

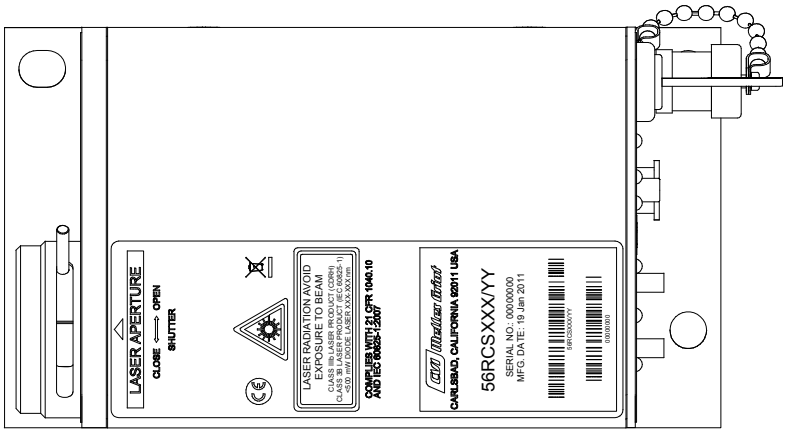


Figure 1: Top

Figure 2: Side

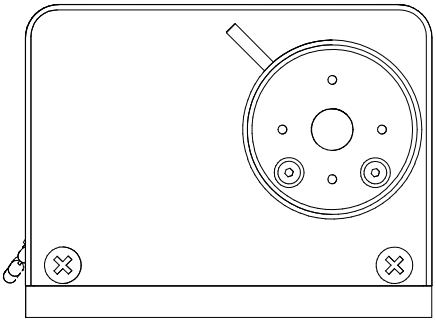


Figure 3: Front

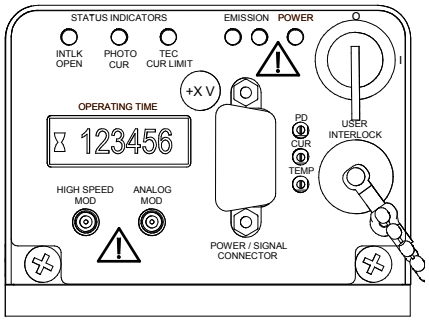


Figure 4: Rear

5 Initial Operation

5.1 Introduction

1. Unpack the module and examine it for any damage that may have occurred during shipment. Save the packaging in case the unit must be returned to CVI Melles Griot.
2. Mount the module securely to a heat sink. For best performance, the temperature of the module should be at room temperature.
3. Make certain that laser safety and ESD precautions are in place.
4. Apply appropriate DC power to the 15-pin rear panel connector. See page 4-1 for appropriate connections.

NOTICE: Make sure that the input voltage is correct for the laser. Red and infrared lasers require 5 Vdc. Ultraviolet, violet, and blue lasers require 9 Vdc.

5. Turn the key switch to the ON or "I" position. The rear LED should be illuminated, indicating the module is powered and laser emissions are possible. The emissions LED will illuminate before the onset of laser radiation.
6. Open the manual beam shutter by sliding the shutter to the open position as indicated on product label.

6 Handling Precautions

6.1 Diode Laser

While commercial diode lasers are capable of operating continuously for many thousands of hours, they are more sensitive to electrical transients than almost any other electronic component. Reverse bias voltages as small as a few volts and over-currents of only a few milliamps lasting less than a microsecond can be enough to damage a diode laser. While the 56RCS series is designed with safe laser diode operation in mind, it is impossible to guard against all electrical transients. The following guidelines should help prevent damage.

6.1.1 ESD prevention

Standard ESD-prevention measures, including conductive garments, wrist straps, conductive mats, grounded soldering irons, humidifiers, and air ionizers, should be instituted in any environment where diode laser assemblies are used.

6.1.2 Electrical Connections

Use only high-quality contacts to ensure reliable electrical connections to the module.

6.1.3 Input Power

Make certain that the dc power supply is well regulated, transient-free and is not susceptible to transients from nearby electronic equipment such as lights, computers, electric motors, welders, etc. A surge suppressor is recommended. Use of a stable dc power supply also enhances the performance of the current/temperature controller built into the module. Make sure the connecting cables are a large enough wire gauge to minimize voltage loss due to wire resistance. For red and infrared lasers the 56IMA020 (5 Vdc) is recommended, and the or 56IMA021 (9 Vdc) is recommended for violet lasers.

6.1.4 Mounting the Module

Mounting the module should be a carefully considered operation to disallow the entry of electrical transients. Ideally, the cable delivering power to the module should be shielded and should have connectors with metal backshells connected to the cable shield for highest immunity.

6.1.5 Electrical Environment

Eliminate, to the furthest extent possible, nearby sources of electrical noise and transients (e.g., electric motors, spark-generating devices, RF equipment, and equipment generating strong magnetic fields). These things can disrupt the operation of the laser module.

6.1.6 Optical Feedback

In some applications, a substantial amount of the output power of the laser module may be reflected back at the diode laser. This should be avoided if possible, since increased power density at the diode laser facets can cause catastrophic optical damage.

6.2 Mounting

Both thermal and mechanical issues should be considered when mounting the module. All 56RCS models are compatible with both ¼-20 and M6 SHC mounting screws.

6.2.1 Heat Sinking

A mount with 13 watts of heat sinking capability is recommended for maximum diode laser lifetime. Care must be taken to ensure that the temperature of the unit's baseplate remains between 5 °C and 40 °C for the module to perform to specifications.

6.2.2 Mounting Stresses

The precise optical alignment of the laser module can be disturbed by excessive stress applied in mounting. Be sure to employ low-stress clamping and mounting techniques.

6.2.3 Optimum Performance

Achieving the highest level of performance from the 56RCS module requires care in setup. In addition to the measures suggested above, the following steps could lead to improved stability and noise performance.

1. **Stabilize environment temperature:** Although the unit is capable of operation in a fairly wide temperature range, the current and temperature controllers built into the 56RCS will drift with temperature. A more stable environment temperature will lead directly to greater current and temperature stability, and, consequently, to superior frequency and amplitude stability.
2. **Minimize mechanical vibrations:** Mechanical vibrations can lead to noise in sensitive electronics, and disrupt the operation of systems requiring careful optical alignment.
3. **Minimize back reflections:** At levels far below those required to cause damage, reflections back to the diode laser can result in highly unstable behavior from the module. Observed responses to low levels of optical feedback include: power fluctuations at time scales from nanoseconds to hours; increased mode hopping; multimode oscillation; hysteresis during current and temperature scans; wavelength shifts; enhanced relaxation oscillations; and frequency noise. Any application involving retro-reflections must be handled with great care.
4. **Avoid etalon effects:** Interferences between stray reflections can cause vastly increased system noise as optical surfaces shift and vibrate on the scale of a wavelength. Employ wedged, AR-coated, or tilted surfaces wherever feasible.

The 56RCS has been designed to give the most stable, reliable and versatile performance attainable in a self-contained, compact, and cost-effective package. If you have questions concerning the best use of the module in your system, or comments about the 56RCS laser module in general, please contact CVI Melles Griot.

6.2.4 Reference Surfaces

The opto-mechanical reference surfaces are the bottom and the right edge of the baseplate.

7 Electrical Controls

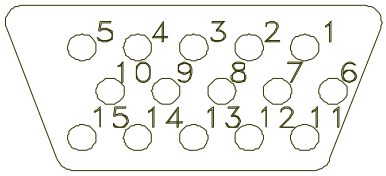


Figure 5: RCS electrical feature connector.

Table 2: Pinout

Pin	Function	Description	Signal type	Comments
1	**Temperature Monitor**	Optical block thermistor resistance monitor signal	Voltage output	● +1.000 Vdc = 10,000 ohms = 25 °C ● Range 0.6 V to 2.6 Vdc ● Keystone type MS97 thermistor
2	**Interlock**	One of two laser operation interlocks – shorting pin to power return enables laser output – open circuit to turn off laser.	Sense input	● Short/open to operate/disable laser ● Temperature control operates normally regardless of interlock state ● Interlock current ~10 mA
3	**Laser Current Monitor**	Laser diode current monitor signal.	Voltage output	● +1.000 Vdc = 100 mA ● Range 0.00 Vdc to 3.00 Vdc
4	**Small Signal Ground**	Small signal ground reference eliminates power return voltage drop errors when measuring monitor signal voltages	Power ground	● Use as ground reference when measuring voltage at monitor signal outputs. ● Prevents errors caused by voltage drops in power leads.
5	**Modulation Input**	Signal input that scales the laser operating current proportional to the voltage applied	Voltage input	● 5 Vdc ≥ zero optical output ● 0 Vdc ≥ full optical output ● Linear decrease in optical output with increasing voltage until knee current reached at ~3 Vdc ● Bandwidth DC to > 5 MHz ● Same as rear panel analog modulation connector.
6	**Photodiode Monitor** (Internal to the Laser Diode)	Photocurrent monitor signal for the photodiode	Voltage output	● +5 Vdc = 1 mA photodiode current ● Range 0 to +5 Vdc ● Laser datasheet shows the photocurrent measured at the time of shipment.

Pin	Function	Description	Signal type	Comments
7	**Tec Supply Voltage**	Terminal that accepts a separate power source for the temperature control circuit	Power input	● Separate power line for TEC prevents large current changes from drooping MAIN supply voltage ● Must be equal to or less than MAIN supply voltage. ● Infinite duration reverse polarity protection ● Internal fuse, over voltage protection
8	**Main Supply Voltage**	Terminal that accepts a separate power source for the laser control circuits	Power input	● Voltage either +5 or +9 Vdc ● Infinite duration reverse polarity protection ● Voltage tolerance ±0.3 Vdc ● Automatic over/under voltage shutdown when voltage tolerance > ±0.5 Vdc ● Automatic restart when voltage error corrected ● Internal fuse, over voltage protection
9	**Tec Supply Return**	Return for temperature control circuit power source	Power ground	● Power source return
10	**Main Supply Return**	Return for laser control circuit power source	Power ground	● Power source return
11	**Chassis Ground**	Connection to laser housing	Safety Earth	● Access to chassis ground for compliance with: IEC 61010-1 IEC 60950
12	**Laser Emissions**	Voltage signal for indicating when laser emissions are imminent (not just when the laser is ON) that can drive an external indicator lamp with appropriate current limiting resistor.	Voltage output	● Zero volts output when either interlock is open. ● Output voltage equal to main supply voltage when both interlocks closed. ● Output can drive up to 50 mA into an external LED (anode to pin, cathode to circuit ground), internal 470 ohm series resistor for current limiting ● Output is engaged 3 seconds prior to laser emissions

Pin	Function	Description	Signal type	Comments
13	**Fault Signal**	Voltage signal for indicting when an internal fault is detected. If the signal voltage is high; the thermistor resistance or photodiode current monitors could be checked to isolate the problem further. This signal is for information only and is not required for laser operation.	Voltage output	● Zero volt output when laser is operating within specification ● Output may pulse high for a short time (<1 minute) after turn-on, this is normal. ● Faults lasting longer than a few minutes are abnormal. ● Appling a half scale or higher modulation signal (~+2 to +5 Vdc) may be indicated as a fault because the photocurrent is too low. A fault indication during modulation can be ignored. ● High output indicates that internal photodiode photocurrent has dropped below the set point or the TEC current is at its limit for more than 10 seconds. ● Laser is turned off if the TEC is at the current limit for more than 10 seconds. Laser automatically restarts when TEC returns to operation at a current lower that the limit.
14 & 15	**Reserved**	For future I/O	TBD	● Reserved for future use

7.1 Rear Panel

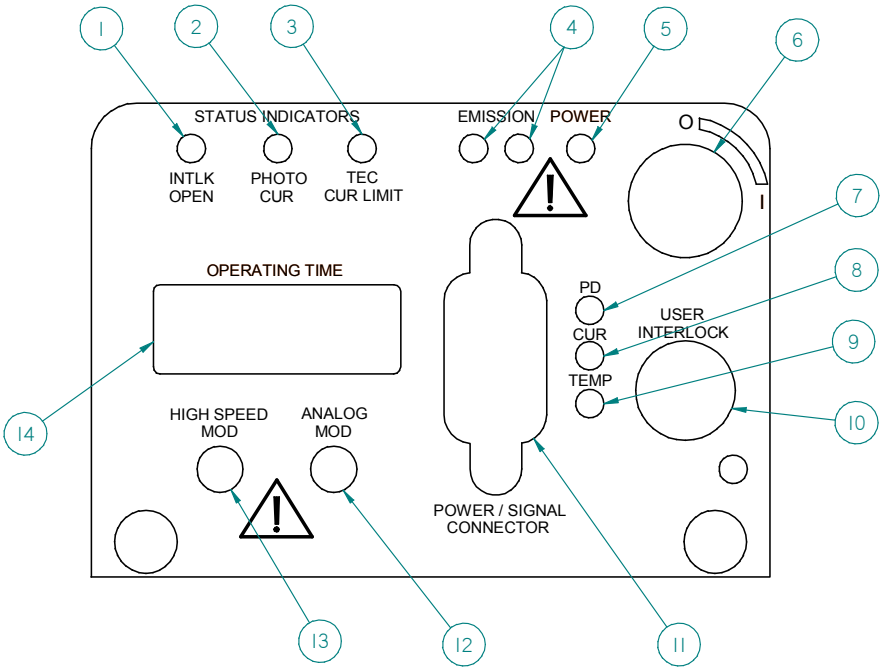


Figure 6: RCS control panel.

1. LED: INTLK OPEN: fault indicator helps users isolate operation problems when installed in the end system. The product has two independent interlock circuits – rear panel BNC and HD DB15, pin 2 that prevent laser operations unless both are shorted to chassis ground. If either connection to chassis ground is open, the “INTERLOCK OPEN” lamp illuminates and laser operation is inhibited.
2. LED: PHOTO CUR: fault indicator illuminates when the optical power monitor internal to the laser diode reads an optical power that is less than an adjustable trip point level. The trip point is adjusted by the user using the PD control (item 7) described later in this section. When properly set-up, illumination of this LED indicates degraded laser performance. Under normal conditions the LED should be off. Modulation causes the laser optical power to decrease and the LED will illuminate when modulating, this is normal and does not indicate degraded laser performance.
3. LED: TEC CUR LIMIT: fault indicator illuminates when the temperature controller is operating at its maximum current. Each time the product is powered up the “TEC CURRENT LIMIT” may illuminate for several seconds and then extinguish indicating that the temperature controller has used all current available to bring the laser to its operating temperature quickly. If the product is operated at too high or low of an ambient temperature, the lamp could illuminate continuously indicating that the temperature control loop can not maintain the laser operating temperature. Laser temperature can not be maintained when the TEC controller is operating at its current limit and may result in laser mode hopping, or in extreme situations, reduction of laser lifetime. For this reason, if the TEC operates at its limit current for more than 10 seconds the laser is automatically turned off. While in this state, the TEC CUR LIM LED is illuminated and one of the EMISSIONS LED’s is flashing, the other is continuously illuminated. If temperature control is regained the TEC CUR LIM LED extinguishes and the laser automatically restarts after the CDRH delay period. This automatic shutdown/restart feature is optional and can be disabled at the factory upon request.
4. LED: EMISSIONS: The two indicators are controlled by separate circuitry for redundancy; use caution whenever EITHER lamp is illuminated or flashing. The first lamp illuminates when both safety interlocks are closed and the CDRH delay period is started. The second lamp flashes during the mandatory CDRH delay period changing to steady illumination and emission of laser light.
   If a fault occurs (open interlock, TEC at current limit for more than 10 sec, or main voltage out of range) the second EMISSIONS lamp will flash. The “POWER ON” lamp will also flash if improper voltage range caused the fault. After the fault has been corrected the user must wait through another CDRH delay with the emissions lamp flashing before laser emission resumes.
5. LED: POWER: The POWER lamp illuminates when voltage is supplied to the product. If the supplied voltage is above or below the recommended range, laser operation is inhibited and the “POWER ON” lamp flashes. The EMISSIONS LED also flashes if the key switch is set to the ON

position indicating that the laser will automatically restart when the supply voltage problem is corrected.

6. KEY LOCK SWITCH: The key lock switch provides a lock-out method to prevent laser operation by unauthorized users. Turning the key to the ON “1” position initiates the laser turn-on sequence. Turning the key to the OFF “0” position immediately terminates the laser output and turns off the temperature controller. The key can be removed only when it is in the OFF “0” position.
7. PHOTOCURRENT SETPOINT: Most laser diodes contain an internal monitor photodiode in addition to the laser chip to provide a relative indicator for the output laser beam power. The PHOTOCURRENT SETPOINT control sets a trip point for this relative power signal that causes the PHOTO CUR LED to illuminate when the relative power drops below the trip point value. This LED provides a quick indication that the laser output power is proper.
   The trip point can be accurately set to illuminate the LED for any specific output power reduction (i.e. 3% or 10%, etc.). To set the control, direct the laser output into an optical power meter and turn on the laser. Apply a DC voltage to the analog modulation input until an optical power equal to your desired trip point is observed on the power meter. Adjust the PHOTOCURRENT SETPOINT control until the PHOTO CUR LED just illuminates. The control is now set to illuminate the LED when the laser output power drops to the level shown on the meter when the DC modulation signal was applied.
8. OPERATING CURRENT ADJUST: This control adjusts the DC current into the laser diode. The control operates over its full range with maximum power occurring when rotated fully clockwise and minimum power occurring when rotated counter-clockwise. Note the laser may not meet all specification over the full range of the control.
9. TEMPERATURE ADJUST: This control allows the laser temperature to be adjusted over a wide temperature range. This is useful for temperature tuning the laser wavelength or optimizing the laser for operation in specific ambient temperature ranges.
10. INTERLOCK BNC: The center conductor of the BNC must be shorted to the main supply negative terminal or chassis ground for laser output to occur. When the interlock is open the temperature controller continues to function normally. When the interlock if closed, the CDRH delay is initiated, EMISSONS LED flashes followed by laser turn on.
11. FEATURE CONNECTOR: DB15 connector for supplying power and accessing other functions. See section 4-1 for pin descriptions.
12. ANALOG MODULATION INPUT: SMB connector input for dc to > 5 MHz analog modulation signal. See section 4.2 for detailed operation instructions.
13. DIGITAL MODULATION INPUT: SMB connector input for dc to >300MHz high speed modulation signal. See section 4.2 for detailed operation instructions.

14. OPERATING HOURS: The hour meter displays total laser run time. The hour meter does not run when either of the user interlocks are un-shorted or power is interrupted to the product.

7.2 Modulation Inputs

The 56RCS product family incorporates flexible features to electrically control the laser output power. Two separate modulation circuits are built-in, High Speed Modulation and Analog Modulation. These circuits can be used individually or simultaneously providing unique overall system capabilities allowing easy integration of the 56RCS into the most demanding applications. The tables below summarize key features of the 56RCS analog and high speed modulation capability. A block diagram of the modulation circuits is shown in Figure 7.

Analog Modulation Input	
Key Features	● DC coupled ● Good speed (~70 ns rise and fall) ● Good bandwidth (>5 MHz) ● Highly linear power control ● 0 to 4 Vdc calibrated scaling (other calibrations by special order) ● Excellent pass band flatness
Applications	● Computer-to-plate (CTP) power correction across page ● Variable brightness laser source ● Microscopy ● AOM elimination ● Fluorescence

High Speed Modulation Input	
Key Features	● DC coupled (allows bias point selection) ● Very high speed (<1 ns rise and fall) ● Wide Bandwidth >300 MHz
Applications	● AOTF or AOM elimination ● CTP character generation ● Spectroscopy ● Fluorescence

7.3 Modulation Block Diagram

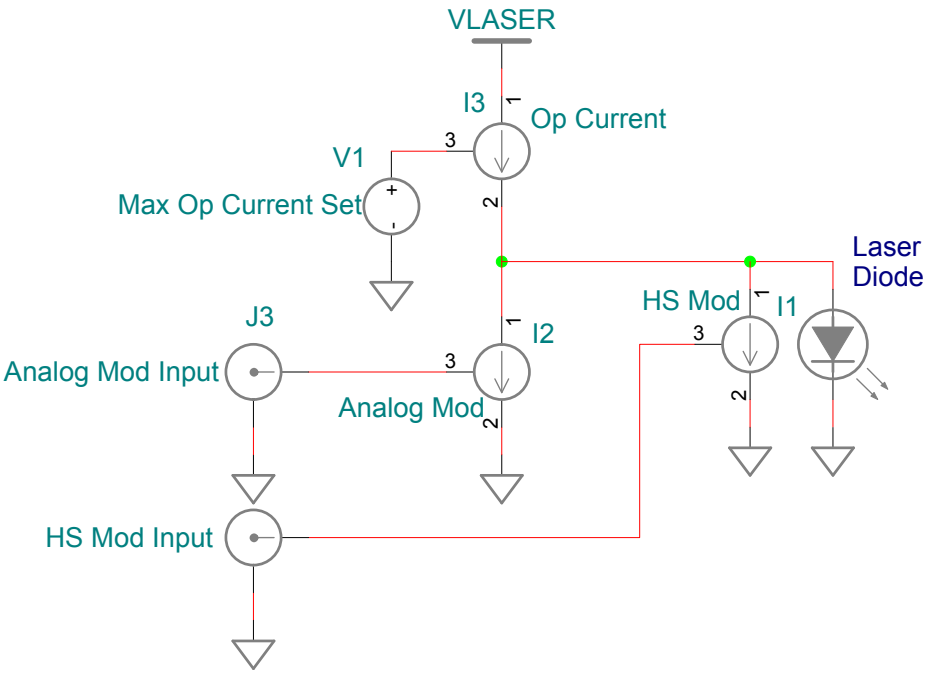


Figure 7: Block diagram of 56RCS modulation circuits.

Source I3 is a fixed current source programmed to supply the maximum or limit laser operating current. Source I2 is a current sink controlled by the analog modulation input signal that steals current from source I3. Source I1 is a high speed current sink that steals from the remaining current. The total current flowing through the laser is expressed by the simple equation $I_{op} = I3 - I2 - I1$.

7.3.1 Analog Modulation Input Overview

The analog modulation input allows highly linear modulation of the RCS laser from dc to >5 MHz. This input accepts a 0 to 4 Vdc signal where 0.0 Vdc corresponds to full optical power and 4.0 Vdc corresponds to the laser threshold. Thus an applied voltage of 2.0 Vdc will reduce the laser output power to ½ of its full power. Figure 8 shows the analog modulation input transfer function.

When no signal applied to the modulation input the laser output is at full power. As the analog modulation input voltage becomes more positive the output power is reduced linearly until the laser threshold current is reached at approximately 4 Vdc. A small amount of light is still emitted by the product at threshold due to spontaneous emission in the laser. Increasing the analog modulation input voltage above 4 volts reduces the laser drive current further and this then reduces the spontaneous emission light.
At some input voltage about 5.5 Vdc, but less than 10 Vdc, (varies with individual lasers) all light output is inhibited for most lasers. Further increases in the analog modulation input voltage will not have any effect

on the laser. Note that the 56RCS product will not be damaged by modulation input signals up to 12 Vdc. Zero optical output is not possible with all lasers when using the analog modulation input. If zero optical output is required the high speed modulation input must be used.

The analog modulation circuit operates by changing the laser operating current proportional to the voltage applied. Because current is controlled instead of light the modulation voltage range for linear output and the voltage range for LED emission are similar even when the variation in light output over each range is dramatically different as shown in Figure 8.

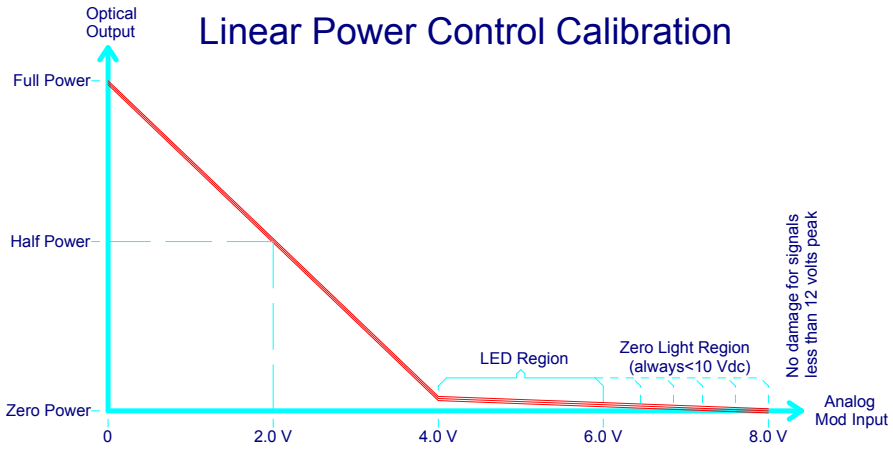


Figure 8: Electrical transfer function of the analog modulation input.

7.3.2 Digital Modulation using the Analog Input

While designed for analog modulation, the input is also compatible with CD4000 CMOS or other logic families when appropriate level shifting is used as shown in Figure 9. This circuit, added by the user external to the laser uses a CMOS level shifter to invert the logic and level shift the signal from 5 Vdc logic to 12 Vdc ensuring that zero optical output is reached for a logic zero input. Note that the capacitance of 50 ohm coax cable is around 3 pF/cm and cables longer than 60 cm will degrade the 56RCS rise and fall time performance. If zero optical output is not required the CMOS gate can be substituted with a 74HCT04 gate eliminating the need for a separate 12 Vdc power supply.

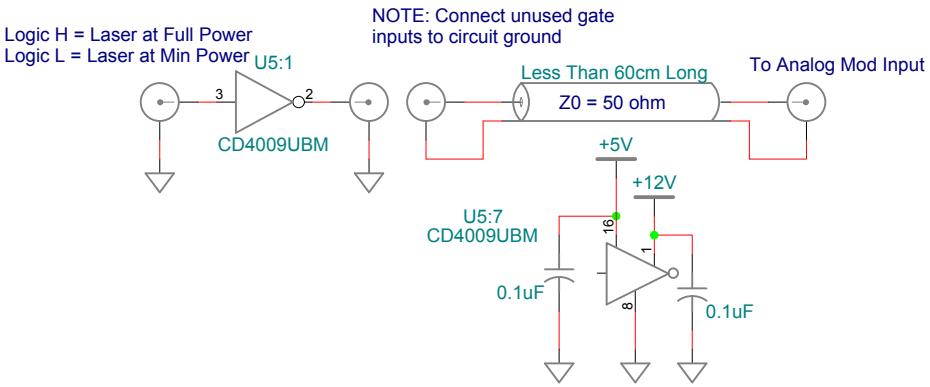


Figure 9: Example of digital modulation through the analog modulation input. The circuit shown specifically ensures zero light output from the laser when off.

7.3.3 Electrical Model of Analog Modulation Input Pin

Figure 10 shows an equivalent electrical circuit for the analog modulation input pins. The analog modulation feature can be accessed from either the rear panel SMB connector or at pin 5 of the DB15 feature connector. As noted in the drawing, the two inputs are connected together with a small resistance.

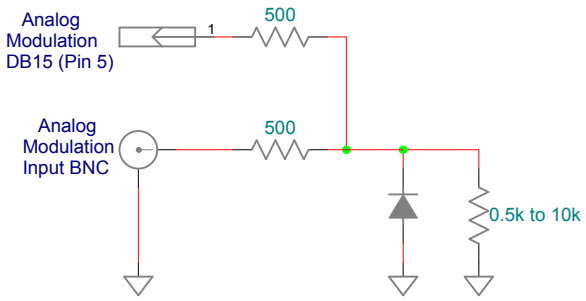


Figure 10: Equivalent circuit for the analog modulation input pins

7.3.4 Scaling of the Analog Modulation Input

The analog modulation input transfer function can be scaled to suit particular applications. A simple method for making the input compatible with a high voltage source is shown in Figure 11.

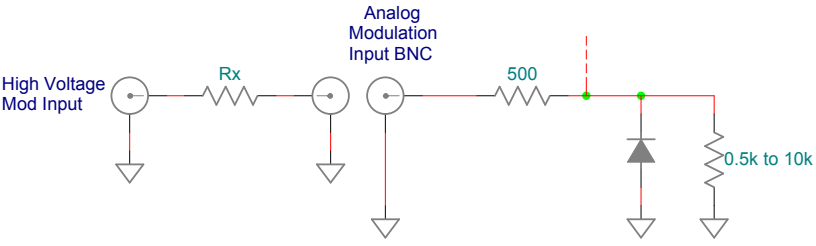


Figure 11: Schematic drawing showing how the analog modulation input voltage range can be expanded.

7.3.5 Reversing analog modulation polarity

The standard polarity for 56RCS product is designed such that +4 Vdc input turns the laser off and 0 Vdc yield full power. The simple external circuit shown in Figure 12 allows the user to change the modulation polarity such that +5 Vdc must be applied to the circuit input for full laser power output.

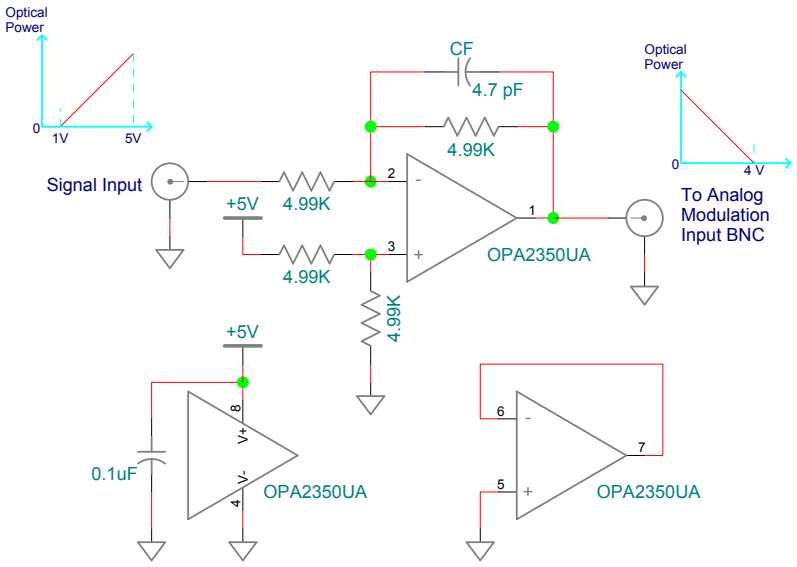


Figure 12: Circuit for inverting the analog modulation input response (i.e., 5 V corresponds to full optical power instead of zero volts). The value of capacitor CF may need to be increased to reduce overshoot if the amplifier drives more than a few feet of coax cable.

7.3.6 High Speed Modulation Input

The high speed modulation capability is completely independent of the analog modulation function as shown in Figure 7 and can be used simultaneously. The key feature is very high speed digital switching that produces transition times less than 1 nsec for most lasers models with 0% to 100% modulation depth. The transfer function for the high speed modulation (HS Mod) input is shown in Figure 13. The HS Mod transfer function has a 0.6 Vdc offset at low voltages below which no change in output will occur and the slope may vary between lasers models.

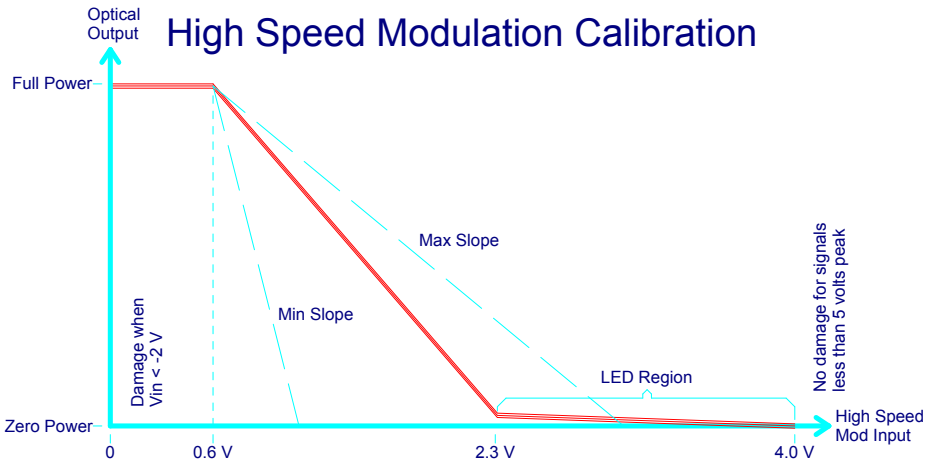


Figure 13: Transfer function for high speed modulation input.

The equation below provides an estimate for high speed input modulation depth (expressed as laser operating current change) for a given voltage in the high speed input.

$$I_{HS} \cong 60 \times [V_{HS} - 0.6volts] \text{ in mA}$$

For example, a 2 Vdc signal applied to HS input reduces laser current by 84 mA. The user can refer to the laser operating current on the customer data sheet in order to calculate input voltage according to modulation depth requirements.

The HS modulation input is robust when connected to a signal source but care should be exercised so that the HS modulation input is never allowed to become more negative than -2 Vdc. The input can also be damaged by input voltages greater than +5 Vdc.

7.3.7 High speed modulation equivalent circuit

Figure 14 shows an equivalent circuit for the high speed modulation input. The input impedance is approximately 50 ohms and signals should be delivered by 50 ohm coax cable. The input does not match the transmission line perfectly and some reflected power should be expected. To prevent anomalous behavior the signal source output should properly terminate the transmission line.

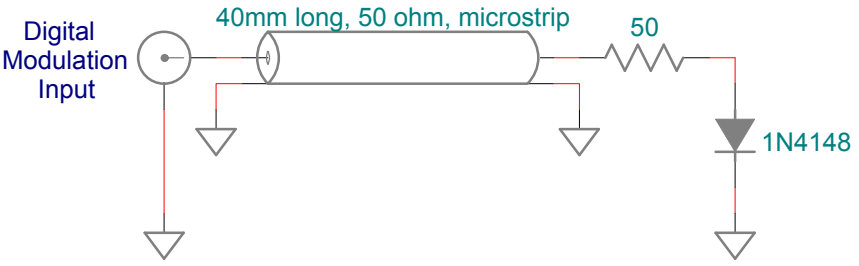


Figure 14: Equivalent circuit for the High Speed Modulation Input

7.3.8 Characterizing modulation response

The experimental setup shown in Figure 13 is useful for setting up and characterizing the modulation from an RCS series laser. In addition to the laser, the setup comprises a signal generator, variable beam attenuator, focusing lens, high-speed photodetector, signal pre-amplifier, and 2-channel oscilloscope. Note that the detector, pre-amplifier, and oscilloscope *all* must have sufficient bandwidth to accurately measure the highest frequency signal being modulated. Additionally, the variable attenuator must be adjusted so that the optical power on the photodetector is within the linear band of the detector and detection electronics. Too high of a power will saturate the detector and grossly distort the measured modulation results. Too low of a power will result in noisy signals.

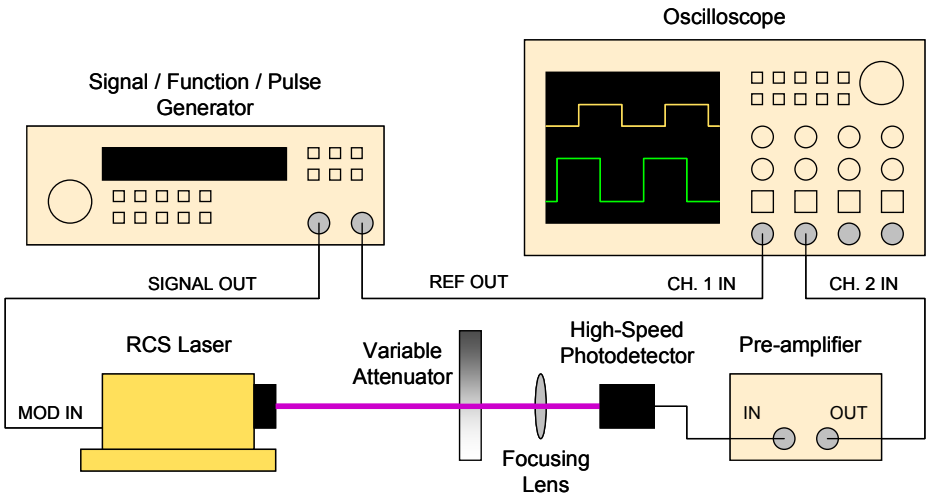


Figure 13. Recommended test setup for characterizing laser modulation performance.

7.3.9 High speed modulation with ac signal sources

Although primarily designed for use with digital/pulse modulation the high speed input can also accept an ac signal input. When using ac signal sources, such as from a function generator, a dc offset voltage should be added to the signal to center the ac modulation in the center of the laser power band. An ac signal is one whose average dc voltage is zero so that the signal carrier both positive and negative voltage swings. Without a dc offset, only the positive-going portion of the signal will affect modulation. In addition, if the signal contains large negative voltage swings, damage to the modulation circuitry may result.

Sources with Built-in dc Offset

Most bench-top function generators have a variable dc offset adjustment. If using the analog modulation input, adjusting the dc offset to 2.5 Vdc will center the ac signal about the 50% power point of the laser. Increasing ac signal amplitude will then increase modulation

symmetrically about this point (for example, 20% to 80% or 10% to 90%).

To set the dc offset level when using the high-speed modulation input, use the test setup describe in Section 4.3.8. Ensure that the detector is operating in its linear range, and adjust the oscilloscope so that full optical power is near the top (or bottom) of the scope screen and zero optical power is near the bottom (or top) of the scope screen symmetrical about the center of the screen. With no ac signal applied (or its amplitude minimized), adjust the dc offset of the function generator until the scope trace is centered on the screen. At this point, the average output power of the laser is at 50% of its full power. As before, adding AC signal amplitude increases modulation symmetrically about this point.

Sources without Built-in dc Offset

Some signal generators, particularly those designed for high frequency RF use, do not have built-in dc offset. To use these sources to modulate RCS lasers, a bias-tee circuit may be used. The bias-tee mixes ac and dc signals and may be purchased off-the-shelf from RF suppliers, such as Picosecond Pulse Labs in Boulder, CO.

8 Specifications

56RCS Integrated Laser Modules

8.1 General Package Specifications

Mounting:	to optical table by 1/4-20 or M6 screws
Package dimensions:	see outline and mounting drawings
Input connector:	15-pin D-sub
Power on monitor	LED indicator on rear panel
Included documentation	laser assembly data sheet, user guide

8.2 General Specifications

Input power: 5.0 or 9.0 ± 0.3 Vdc at 4.0 amps maximum (model dependent)
Maximum heat dissipation: 13 W

8.3 Environment

Temperature (operating)	5 to 40°C (heat sink temperature; may require lower ambient temperature if heat sinking is limited)
Temperature (storage)	-10 to 50°C
Operating relative humidity	<95% non-condensing

8.4 Modulation Specifications

High Speed Modulation

Modulation bandwidth (-3db)	dc to >300 MHz
Rise/Fall Time	<1 nsec
Input Impedance	50 ohm
Input connector type	SMB
Pulse Over/Undershoot	<10%

Analog Modulation

Modulation bandwidth (-3db)	dc to >5 MHz, 20% to 80% modulation
Rise/fall time	<70 nsec
Input	0 to 5 Vdc (TTL compatible)
Input connector type	SMB
Pulse over/undershoot	<10%

8.5 Compliance

Once the laser is incorporated into another piece of equipment, it becomes the responsibility of the equipment manufacturer or integrator to make sure that the overall device conforms to the applicable regulations and norms.

In order for this laser to comply with the following requirements, it needs to be operated with a dc voltage supply that provides 9 ± .5 Vdc at 3.8 amps for violet lasers and 5.00 ± 0.25 Vdc at 3.8 amps for all other lasers.

EMC: Meets IEC 61326-1 EMC standards when used with a 56IMA020 or 56IMA021 power supply.

CDRH: Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50 Dated July 26, 2001

IEC: This device complies with IEC 60825-1:2007

The labels shown below are required by the U.S. Food and Drug Administration, Center for Devices and Radiological Health (CDRH) as well as by the standard, IEC 60825-1:2007. The next pages show the location of these labels on the 56RCS series laser system.

Table 3: Product Emission Data

Model Series	Wavelength (nm)	Maximum Power (mW)	Beam Size (mm)	Beam Divergence (mrad)	Safety classification
56RCS001	405 to 410	60	0.7	<0.9	3B
56RCS002	405 to 410	60	2.9	<0.3	3B
56RCS004	635 to 645	30	1.1	<0.8	3B
56RCS005	440 to 445	50	1.0	<1.1	3B

Table 4: Modulation Specifications

Model Series	Maximum Modulation Bandwidth (MHz)
56RCS001	5
56RCS002	5
56RCS004	5
56RCS005	5

Table 5: RCS-series Lasing Medium

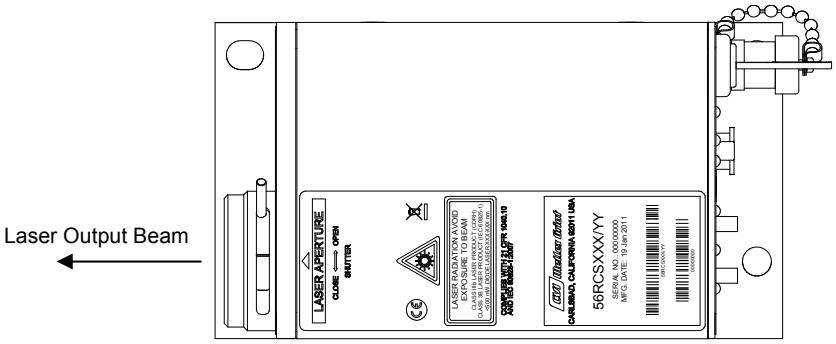
Wavelength	Lasing Medium
375 nm	InGaN
400 to 410 nm	InGaN
442 nm	InGaN
488 nm	InGaN
660 nm	AlGaInP
635 to 645 nm	AlGaInP
785 nm	AlGaAs
830 nm	GaAlAs

The following fuses, located on the internal electronics, are to be replaced only by CVI Melles Griot service personnel.

- F1, F2: Littelfuse part no. R45201.5

8.6 Product Label

8.7 Warning Labels and Aperture Location



9 In Case of Difficulty

9.1.1 Introduction

There are no user serviceable parts in 56RCS series laser or the dc power supply.

If a problem occurs with the system itself, it must be corrected or repaired by an authorized CVI Melles Griot service representative or returned to a CVI Melles Griot service center.

9.2 Reporting information

When contacting CVI Melles Griot, please have the following information ready for the Customer Service representative:

- Laser head and controller model numbers and serial numbers
- Approximate purchase date and hours in service
- Accessories, options or modifications installed
- All information from the laser head data label
- Symptoms of the malfunction, including any error message

10 Service, Support, and Warranty

CVI Melles Griot lasers contain no user-serviceable parts and, depending upon usage rate, should give years of trouble-free service. Nonetheless, if you should experience problems, CVI Melles Griot is committed to providing the best possible support and service.

10.1 Warranty

All CVI Melles Griot lasers and controllers, unless otherwise specified, are covered by the comprehensive warranty described below.

10.1.1 Basic Warranty

For a period of 12 months, unless otherwise stated, CVI Melles Griot warrants the 56RCS series laser to be free from defects in materials and workmanship, hereinafter called the “Nonconformity”. These warranties do not apply to systems that CVI Melles Griot determines, upon inspection, to have failed, or have become defective or unworkable due to abuse, mishandling, misuse (including but not limited to: optical feedback into laser cavity, improper mounting, exceeding recommended temperature range, contamination by particulates or chemicals), alteration of laser or power supply or opening of cover (unless approved in writing by CVI Melles Griot), negligence, improper installation, use which is not in accordance with the information and precautions described in this operator’s manual, or other causes beyond the control of CVI Melles Griot.

This warranty does not apply to any products or components not manufactured by CVI Melles Griot.

EXCEPT FOR THE FOREGOING WARRANTY, CVI MELLES GRIOT SPECIFICALLY DISCLAIMS AND EXCLUDES ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING IMPLIED WARRANTIES OF NONINFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.

Buyer shall notify CVI Melles Griot of any nonconformity during the warranty period, obtain a return authorization for the nonconforming products, and return the nonconforming products, freight prepaid, to a facility designated by CVI Melles Griot, along with a written statement describing the nonconformity. The sole and exclusive obligation assumed by CVI Melles Griot under this warranty is to use reasonable commercial efforts to repair, replace, or refund the purchase price for any products that are returned to CVI Melles Griot as set forth above

and which are determined, at the reasonable discretion of CVI Melles Griot, to be nonconforming product.

Products that are repaired or replaced within the warranty period are warranted only for the remaining unexpired portion of the original warranty period. However, the warranty period does not include the time period between when CVI Melles Griot receives the nonconforming products and when CVI Melles Griot returns the repaired or replacement products to Buyer. Buyer agrees that the foregoing provisions constitute the sole and exclusive remedies available to Buyer for breach of warranty by CVI Melles Griot with respect to the products.

IN NO EVENT WILL CVI MELLES GRIOT BE LIABLE FOR ANY INDIRECT, INCIDENTAL, SPECIAL, OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO, LOSS OF ANTICIPATED PROFITS OR BENEFITS, EVEN IF CVI MELLES GRIOT HAS BEEN INFORMED OF THE POSSIBILITY THEREOF IN ADVANCE. IN NO CASE WILL THE AGGREGATE LIABILITY OF CVI MELLES GRIOT BE GREATER THAN THE PURCHASE PRICE PAID BY BUYER TO CVI MELLES GRIOT FOR THE PRODUCTS THAT ARE THE SUBJECT OF BUYER'S CLAIM.

10.2 Sales and Service Offices

To find an authorized CVI Melles Griot service facility near you, contact the nearest CVI Melles Griot office, listed before, or contact the factory at (760) 438-2131.

United States 2051 Palomar Airport Road, 200 Carlsbad, CA 92011 (760) 438-2131 Fax: (760) 438-5208 **France** 12 Avenue Jean Bart 78960 Voisins Le Bretonneux France 78960 01 30 12 06 80 Fax: 01 30 60 08 51 **Germany** Lilienthalstraße 30-32 D-64625 Bensheim (0 62 51) 84 06-0 Fax: (0 62 51) 84 06-22	**Japan** 7F Totate International Building 2-12-19 Shibuya Shibuya-Ku, Tokyo, Japan 3-3407-3614 Fax: 3-3486-0923 **Singapore** 994 Bendemeer Road #06-05 Kallang Basin Industrial Estate Singapore 339943 392-5368 Fax: 392-550