
FIBER LASER

MODEL: YLR-200-SM-CS

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Preface

Please take time to read and understand this User's Guide and familiarize yourself with the operating and maintenance instructions that we have compiled for you before you use the product. We recommend that the operator read Chapter 1, Safety Instructions, prior to operating the product.

This User's Guide should stay with the product to provide you and all future users and owners of the product with important operating, safety and other information.

US Export Control Compliance

IPG's policy and business code is to comply strictly with the U.S. export control laws.

Export and re-export of lasers manufactured by IPG are subject to the US Export Administration Regulations administered by the Department of Commerce, Bureau of Industry and Security.

The applicable restrictions vary depending on the specific product involved, intended application, the product destination and the intended user. In some cases, an individual validated export license is required from the U.S. Department of Commerce prior to resale or re-export of certain products. Please contact IPG, if you are uncertain about the obligations imposed by US law.

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1. Introduction

IPG YLR product line has been developed to meet industrial market demands on efficient reliable maintenance-free high power lasers. YLR products are diode – pumped ytterbium fiber lasers with output power scaled from 200 W up to 60 kW at wavelength region of 1060 – 1100 nm. These lasers are air- or water- cooled. Typical wall plug efficiency of a YLR laser exceeds 25%.

The IPG fiber laser has been designed and tested with safety in mind. By following this User's Guide and applying sound laser safety practices, it can be a safe and reliable device.

Because of its special characteristics, laser light poses safety hazards different than light from other sources. All laser users and persons near the laser must be aware of the hazards involved in operating a laser.

In order to ensure the safe operation and optimal performance of the product, please follow these warnings in addition to the other information contained elsewhere in this document. These safety precautions must be observed during all phases of operation, maintenance, and repair of this instrument.


Operators are urged to adhere to these recommendations and to apply sound laser safety practices at all times.

2. Safety Information

Safety Conventions

IPG Photonics uses various words and symbols in this User's Guide that are designed to call your attention to hazards or important information. These include:

WARNING:  

Refers to a potential *personal* hazard. ( *Electrical*) ( *Laser radiation*) It requires a procedure that, if not correctly followed, may result in bodily harm to you and/or others. Do not proceed beyond the WARNING sign until you completely understand and meet the required conditions.

CAUTION: 

Refers to a potential *product* hazard. It requires a procedure that, if not correctly followed, may result in damage or destruction to the product or components. Do not proceed beyond the CAUTION sign until you completely understand and meet the required conditions.

IMPORTANT

Refers to any information regarding the operation of the product. Please do not overlook this information.

Laser Classification **IV > 200 W at 1070 nm**

This device is classified as a high power **Class IV** laser instrument under 21 CFR 1040.10. This product emits invisible laser radiation at or around a wavelength of **1070 nm**, and the total light energy radiated from the optical output is greater than **200W** per optical output port. This level of light may cause damage to the eye and skin. Despite the radiation being invisible, the beam may cause irreversible damage to the cornea. Laser safety eyewear is not provided with this instrument, but must be worn at all times while the laser is operational²

WARNING:



Use appropriate laser safety eyewear when operating this device. The selection of laser safety eyewear requires the end user to accurately identify the range of wavelengths emitted from this product. If the device is a tunable laser or Raman product, it emits light over a range of wavelengths and the end user should confirm that the laser safety eyewear being used protects against light emitted by the device over its entire range of wavelengths.

WARNING:



Use of controls, adjustments, or performance of procedures other than those set forth in this User's Guide, may result in hazardous radiation exposure.

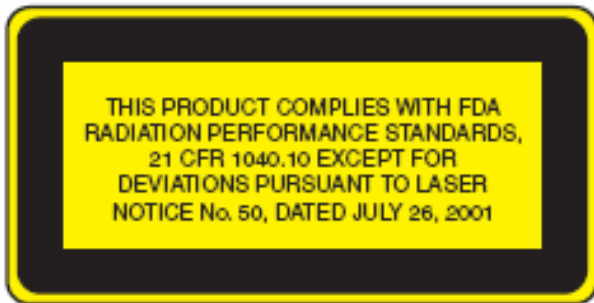
CAUTION:



Do not install or terminate fibers when laser is active.

Device Safety Label Locations

The figures below show the required laser safety labels and the locations of these labels on the product.



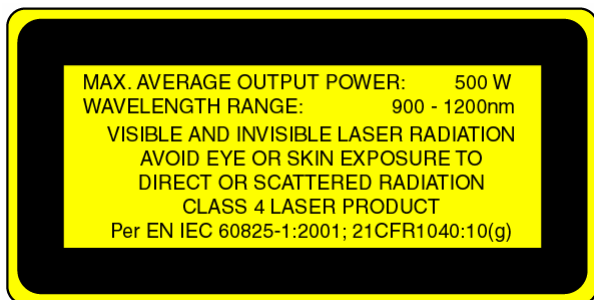
Certification Label
Location

Front, rear, side
or top panel of the device
enclosure.



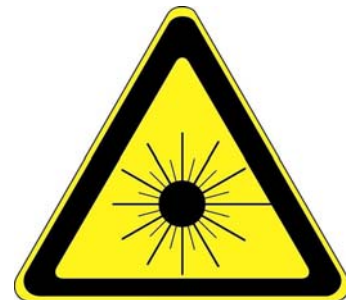
Aperture Label
Location

Front, rear, side or top panel
of the device enclosure and
on the collimator assembly.



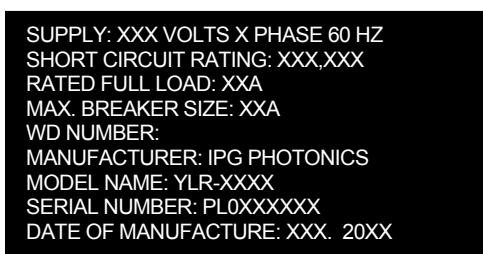
Warning Label
Location

Front, rear, side or top panel
of the device enclosure.



Hazard Symbol
Location

Front, rear, side or top panel
of the device enclosure and
on the collimator assembly.



Identification Label
Location

Front, rear, side or top panel
of the device enclosure.



Warning Label
Location

Front, rear, side or top panel
of the device enclosure.

General Safety Instructions

WARNING:



Exercise caution to avoid/minimize specular reflections because reflections at the laser's wavelength are invisible.

There are often numerous secondary beams present at various angles near the laser. These beams are specular reflections of the main beam from various surfaces. Although these secondary beams may be less powerful than the total power emitted from the laser, the intensity may be large enough to cause damage to the eye and skin as well as materials surrounding the laser.

The laser light is strong enough to burn skin, clothing and paint. Further, laser light can ignite volatile substances such as alcohol, gasoline, ether and other solvents. Exposure to solvents or other flammable materials and gases must be avoided and considered when installing and using this device.

Light-sensitive elements in equipment, such as video cameras, photomultipliers and photodiodes may also be damaged from exposure to the laser light.

We also recommend that you follow these procedures to operate the IPG laser safely:

- Never look directly into the laser output port when the power is on.
- Set up the laser and all optical components used with the laser away from eye level.
- Provide enclosures for laser beam.
- A room properly designated for laser use must have limited access. Signs should be posted and door interlocks implemented where necessary. Limit access to the area to individuals who are trained in laser safety while operating the laser.
- Avoid using the laser in a darkened environment.
- Do not enable the laser without a coupling fiber or equivalent attached to the optical output connector.
- Do not open the device. There are no user serviceable parts, components or assemblies associated with this instrument.
- Always switch the laser off when working with the output such as mounting the fiber into a fixture, etc. If necessary, align the output at low output power and then increase it gradually.

- Do not install or terminate fibers when laser is active.

WARNING:



If this instrument is used in a manner not specified in this document, the protection provided by the instrument may be impaired and the warranty will be voided.

CAUTION:



If the output of the device is delivered through a lens with an anti-reflection coating make sure that the lens quality is adequate and that it is clean.

Any dust on the end of the delivery optics assembly can burn the lens and damage the laser. Check the quality of the spot emitted from the laser output at low power levels using an infrared viewer and then gradually increase the output power.

Do not allow the laser to run for more than 1 minute below 10% of nominal output power as stated in the specification.

CAUTION:



Hot or molten pieces of metal may be present when using this laser. Exercise caution if debris is being generated in your application.

Electrical Safety

WARNING:



The input voltage to the laser is potentially lethal. All electrical cables and connections should be treated as if it were a harmful level. All parts of the electrical cable, connector or device housing should be considered dangerous.

Make sure this instrument is properly grounded through the protective conductor of the AC power cable. Any interruption of the protective grounding conductor from the protective earth terminal can result in personal injury.

Always use your device in conjunction with a properly grounded power source.

For continued protection against fire hazards, replace line fuses (if applicable) only with those that have the same specifications. The use of other fuses or materials is prohibited.

Before supplying the power to the instrument, make sure that the correct voltage of the AC power source is used. Failure to use the correct voltage could cause damage to the instrument.

Before switching the power on, make sure that line voltage corresponds to the specified level.

There are no operator serviceable parts inside. Refer all servicing to qualified IPG personnel. To prevent electrical shock, do not remove covers. Any tampering with the product will void the warranty.

Environmental Safety

WARNING:



NEVER look directly into a live fiber and make sure that you wear appropriate laser safety eyewear at all times while operating the product.

Proper enclosures should be used to secure a laser safe work area. This includes but is not limited to laser safety signs, interlocks, appropriate warning devices and training/safety procedures. Also, it is important to install the output assembly away from eye level.

The interaction between the laser and the material being processed can also generate high intensity UV and visible radiation. Ensure that laser enclosures are in place to prevent eye damage from visible radiation.

CAUTION:



Injury to the laser is possible, unless caution is employed in operating the device.

IPG provides the following recommendations to promote the long life of the IPG laser:

- Do not expose the device to a high moisture environment.
- The device may have fans for active cooling. Make sure there is sufficient airflow to cool the device. Any objects or debris that cover the ventilation holes must be removed at all times.
- Wait at least 2 minutes after switching on the device before enabling maximum emission.
- Operation at higher temperatures will accelerate aging, increase threshold current and lower slope efficiency. If the device is overheated, discontinue use and call IPG immediately for assistance.
- Ensure that the work surface is properly ventilated. Gases, sparks and debris that can be generated from interaction between the laser and the work surface can pose additional safety hazards.

For additional information regarding Laser Safety please refer to the list below, which contains some available information:

Laser Institute of America (LIA)

13501 Ingenuity Drive, Suite 128
Orlando, Florida 32826
Phone: 407.380.1553, Fax: 407.380.5588
Toll Free: 1.800.34.LASER
Email: lia@laserinstitute.org

American National Standards Institute

ANSI Z136.1 – 2000, American National Standard for the Safe Use of Lasers
(Available through LIA)

International Electro-technical Commission

IEC 60825-1, Edition 1.2, 2001-08
Safety of laser products –
Part 1:
Equipment classification, requirements and user's guide.
(Available through LIA)

Center for Devices and Radiological Health

21 CFR 1040.10 – Performance Standards for Light-Emitting Products
<http://www.fda.gov/cdrh/rad-health.html>

US Department of Labor – OSHA

Publication 8-1.7 – Guidelines for Laser Safety and Hazard Assessment.
<http://www.osha.gov/>

Laser Safety Equipment

Laurin Publishing
Laser safety equipment and Buyer's Guides
<http://www.photonics.com/Directory/>

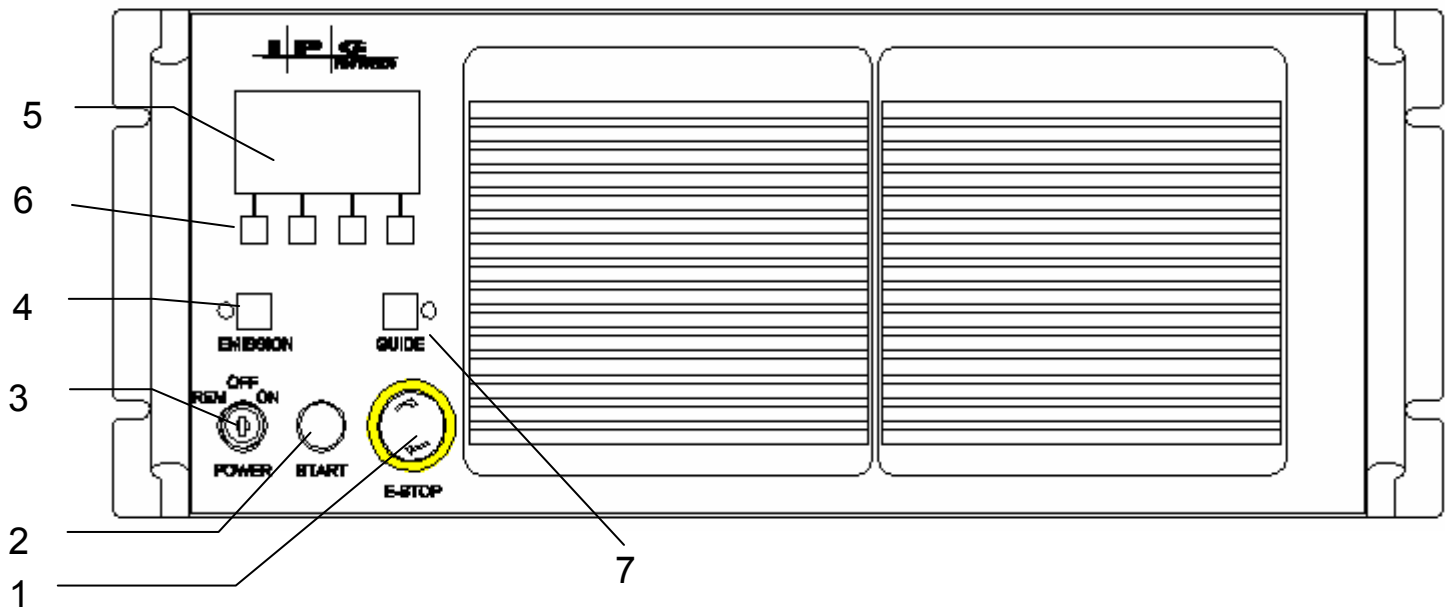
IPG Photonics recommends that the user of this product investigate any local, state or federal requirements as well as facility or building requirements that may apply to installing or using a laser or laser system.

3. Description of your device

Certification

IPG certifies that this instrument has been thoroughly tested and inspected, and found to meet published specifications prior to shipping. Upon receiving your device, check the packaging and parts for any possible damage that may have occurred in transit. If damage is apparent please contact IPG immediately.

Front panel view of your device



1. Emergency Stop Button

Temporarily suspends power to the laser. When active, power supply is disabled. (Reset by turning clockwise).

2. Start Button

Enables laser's DC power supply.

3. Keyswitch

3-position key switch controls the main AC power to the device(keys provided).

Left position – remote mode, Central position – laser Off, Right position – local mode.

4. Emission Button w/Indicator

Enables laser emission. LED indicator is lit when emission is enabled. Note: when the unit is being controlled through a remote interface, the emission button will only allow emission to be disabled, not enabled.

5. Display

Shows model number and status of the laser.

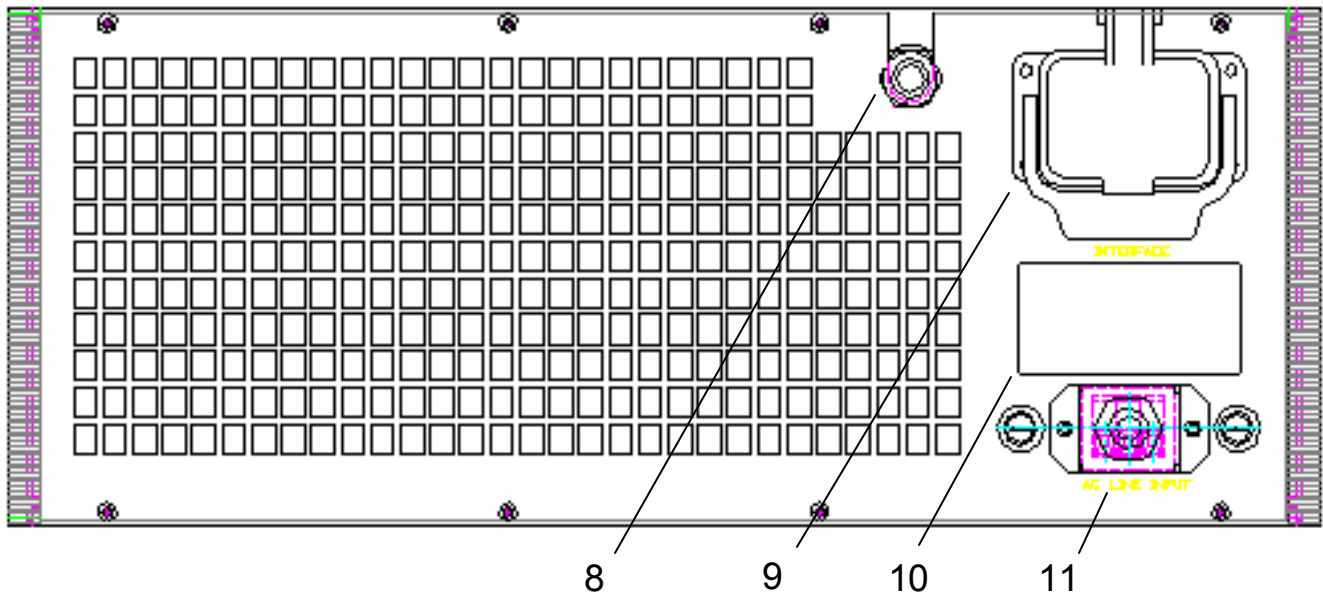
6. Software Keys

The softkeys are located directly below the display. Their function will vary depending on the mode that the front panel interface is in. When a softkey function is available, a small label will appear on the display directly above the softkey.

7. Guide Laser Button

This button controls the emission of the red guide laser if equipped.

Rear panel view of your device



8. Laser Output

The output of the laser is delivered through this location.

9. Hardwiring Interface

Harting 24 pin connector provides digital interface with robots or hardwiring control of the laser.

10. Laser Data Tag

Tag provides laser information such as serial number and operating voltage.

11. AC line input

AC line input as well as fuse access.

Output Power Monitor Filtering

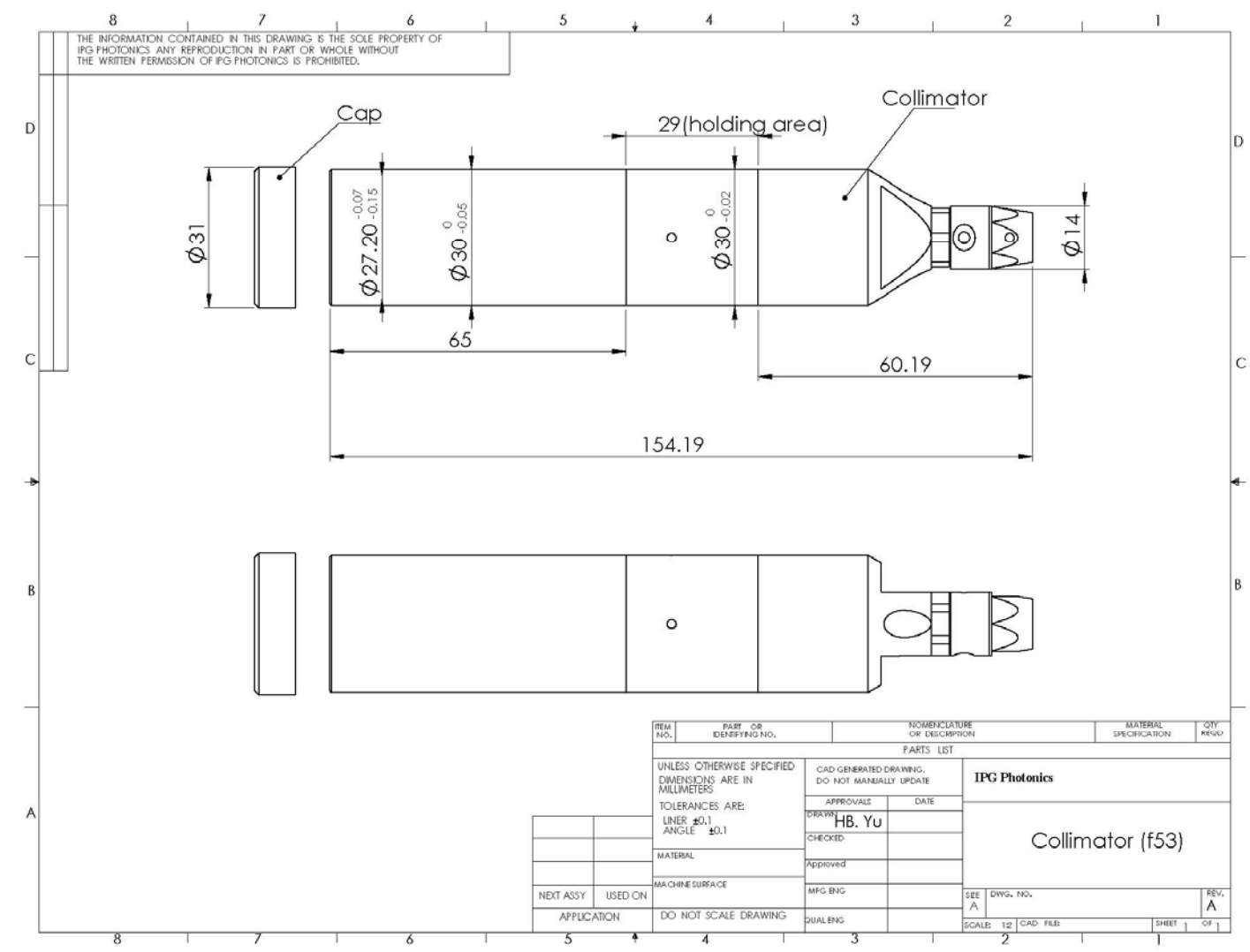
The output power measurements reported by the RS-232 and front panel, are averaged by a window filter. This will give more accurate measurements when the laser output is modulated by the digital modulation or analog control signal.

The size of the averaging window can be set by the laser operator. The window size can vary from 0.2 seconds to 5.0 seconds in 0.2 second steps. A value of 0.2 seconds effectively disables the averaging feature. Please note that larger averaging window values will cause a significant delay in the response of the power monitor.

The size of the averaging window can be set through the RS-232 or front panel interfaces.

The RS-232 commands to control the filtering are listed in the RS-232 section of the manual.

Output Collimator



4. Using your device

Precautions

Refer to the specification for proper electrical power requirements.

Before switching the power on, make sure that the incoming AC voltage is equal to the level noted in the specification.

Operate only in an environment with sufficient airflow capacity that allows for the specified heat load developed during operation.

Electrical Power Connection

A power cord is not provided with the laser. Wire the terminal block on the rear panel of the laser to single-phase 110-220 VAC wall outlets. L2 = Neutral connection, PE = Ground, L1 = Line Voltage. Refer to the specification on power requirements.

Interlocks

There are interlock circuits on the interface connector pin out, see interface connector pin out for description.

To reset the unit after either interlock channel connection shuts down the system, the user must correct the condition and press the remote START button to resume operation.

Interface Connector Pin Out

Harting Han 24 pin connector

| Pin | Description | Notes |
|-----|-------------------------------|---|
| 1 | Interlock Channel 1 | Contact Closure 24VDC |
| 2 | Interlock Channel 2 | Contact Closure 24VDC |
| 3 | Interlock Channel 2 | Contact Closure 24VDC |
| 4 | Interlock Channel 1 | Contact Closure 24VDC |
| 5 | RS232 Tx | |
| 6 | RS232 Rx | |
| 7 | RS232 Com | |
| 8 | Remote Laser Power Key Switch | Contact Closure 24VDC |
| 9 | Remote Laser Power Key Switch | Contact Closure 24VDC |
| 10 | Remote Start PB | Contact Closure 24VDC |
| 11 | Remote Start PB | Contact Closure 24VDC |
| 12 | Analog Control Input | Analog Input 0 -10VDC |
| 13 | Analog Output Power Monitor | Analog Output 0 -5VDC (where 4VDC = Pout Nominal) |
| 14 | Common | Analog Common |
| 15 | Modulation + | 24VDC Input |
| 16 | Modulation - | 24VDC Input Return |
| 17 | Guide Control | 24VDC Input |
| 18 | Emission Enable | 24VDC Input |
| 19 | Reserved | |
| 20 | Common | |
| 21 | Reserved | |
| 22 | Power On | 24VDC Output |
| 23 | Power Supply Active | 24VDC Output |
| 24 | Emission On | 24VDC 100mA Output |

Initial Power-up Sequence

WARNING:



All electrical connections must be connected prior to applying power to the unit. In addition and where applicable, all connections must be secured with screws to ensure proper functionality.

1. Properly align the output fiber into the delivery optics.
 - Inspect the optical output end face to check for dust and debris.
 - Properly secure optical output collimator.

WARNING:



NEVER look directly into a live fiber and make sure that you wear appropriate laser safety eyewear at all times while operating the product. Make sure all power is removed from the laser when handling the delivery cable.

2. Make sure the interlock (pins 1-4, 2-3) is closed.
3. Make sure the front panel e-stop is released.
4. Make sure there is sufficient clearance for the air-cooling vents to allow proper cooling of the device.
5. Turn the front panel Key Switch clockwise to the “ON” position.
6. Press the START button to turn the laser unit on.

The laser is now ready for operation.

Front Panel Interface

Operating Modes

The front panel interface can operate in one of several modes. The modes are:

Normal Operating Mode

In this mode the display will look similar to this:

| YLR-200-SM-CS | |
|---------------|----------|
| OUTPUT POWER | OFF |
| CURRENT | 0.00 A |
| TEMPERATURE | 24.3 C |
| SETPOINT | 50.0 % |
| MENU | SET LRGE |

The display shows the selected output channel, the power and current levels for the selected output channel, as well as the setpoint.

The softkeys will have the following functions:

MENU

Pressing this softkey will switch the front panel interface to menu mode.

SET

Pressing this key will enable adjustment of the setpoint. When this is happening the setpoint will be highlighted and the softkeys will switch to the following:

OK

Pressing this key will accept the modified value of the setpoint. Note: until this button is pressed, there will be no change to the output power level. If the new setpoint is unacceptable, a message will be shown on the display and the previous setpoint will be restored.

(-)

Pressing this key will decrease the setpoint.

(+)

Pressing this key will increase the setpoint.

END

Pressing this key will abandon any changes and restore the previous value for the setpoint.

LRGE

Pressing this key will switch the front panel interface to show the output power level in large characters.

Menu Mode

In this mode the display will look similar to this:

| CONTR | COMM | INFO |
|--------------|------|------------|
| MODULATION | | DISABLED |
| EXT CONTROL | | DISABLED |
| EXT GUIDE | | DISABLED |
| PWR AVG SIZE | | 0.2 |
| < | > | SEL RET |

This mode will allow the user to view and modify several operating parameters.

The softkeys will have the following functions in this mode:

< (Left Arrow)

The left arrow will navigate to the menu to the left of the current one, as shown in the tabs on the top of the display. If the current menu is already the leftmost one, the arrow symbol will disappear and this key will have no effect.

> (Right Arrow)

The right arrow will navigate to the menu to the right of the current one, as shown in the tabs along the top of the display. If the current menu is the rightmost one, the arrow symbol will disappear and this key will have no effect.

SEL

This key will select the current menu for editing. If there are no editable items in the menu, this label will disappear and the key will have no effect. Once this key is pressed, the softkeys will change to up and down arrows as well as one labeled “Exit”. The up and down arrows can be used to select the item within the menu that needs to be edited. When the item is selected, turning the encoder knob will start editing the selected item.

RET

Pressing this key will return the front panel interface to the normal operating mode.

The following parameters are available while in menu mode:

Modulation (Editable)

This will enable or disable the modulation feature.

Ext Control (Editable)

This will enable or disable external control of the laser's output level with an external control voltage.

Ext Guide (Editable)

This will enable or disable control of the red guide beam from an external hardware input.

Baud Rate (Editable)

This will set the baud rate of the laser's RS-232 interface. Values of 9600, 19200, 38400, and 57600 are available.

Elapsed Time (Read Only)

This indicates the elapsed operating time for the unit, in hours and minutes. This elapsed time will only accrue when emission is enabled.

Firmware Rev. (Read Only)

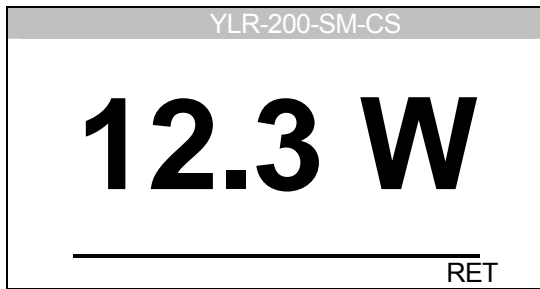
This shows the revision level of the firmware running in the device's controller.

Bootloader Rev. (Read Only)

This shows the revision level of the bootloader running on the device's controller.

Large Power Display Mode

In this mode the display will look similar to this:

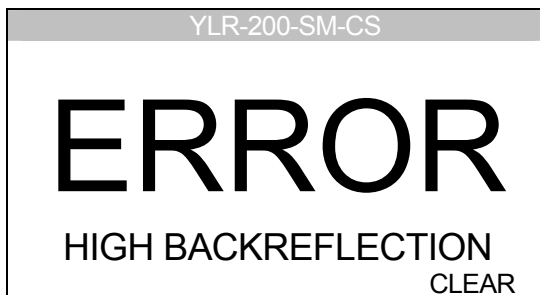


In this mode, the total output power level of the unit will be shown in large characters. If the optical emission is off, the text “Off” will be shown. If emission is on, but the power level is below the reliable measurement threshold of the laser, the text “Low” will be shown. Otherwise, the actual total power level will be displayed.

The only available softkey is labeled “RET”. Pressing it will return the front panel interface to normal operating mode.

Error Mode

In this mode the display will look similar to this:



This mode will be activated automatically when an error is detected in the unit. The only softkey that may be available is labeled “Clear”. Pressing the key will clear any errors that require operator intervention to clear. The softkey will only be available when at least one of the errors that are present require operator action to clear.

The following error messages may be displayed:

"POWER SUPPLY OFF"

This message indicates that the laser module power supply is off. If no other errors are present, the power supply can be started by turning the keyswitch to the “Start” position momentarily. If there are other errors present, they must be cleared before the power supply can be started.

"OVERHEATED"

This message indicates that the laser module's temperature has exceeded the maximum threshold. The error will clear automatically when the temperature of the module drops 2 °C below the maximum.

"HIGH BACKREFLECTION"

This message indicates that a high backreflection condition has been detected.

"COLLIMATOR TEMP LOW"

This message indicates that the output collimator is below operating temperature or has been disconnected.

"MODULE ERROR"

This message indicates that the laser's optical module is reporting a problem.

"UNEXPECTED EMISSION"

This message indicates that the laser has detected optical power being emitted when emission was disabled.

"MODULE DISCONNECTED"

This message indicates that the internal communication link with the optical module has been lost.

"COLLIMATOR TEMP HIGH"

This message indicates that the output collimator has overheated.

Remote control

WARNING:



All electrical connections, including interlocks and the RS-232 interface, must be connected prior to applying power to the unit. In addition and where applicable, all connections must be secured with screws to ensure proper functionality.

Please see the Interface Connector Pin Out table for additional information.

1. -Properly align the output fiber into the delivery optics.
 - Inspect the optical output end face to check for dust and debris.
 - Properly secure optical output collimator.

WARNING:



NEVER look directly into a live fiber and make sure that you wear appropriate laser safety eyewear at all times while operating the product. Make sure all power is removed from the laser when handling the delivery cable.

2. Make sure the external interlock/e-stop (pins 1-4, 2-3) is closed/released.
3. Make sure the front panel e-stop is released.
4. Make sure there is sufficient clearance for the air-cooling vents to allow proper cooling of the device.
5. Turn the front panel Key Switch counter clockwise to the “REM” position.
6. Actuate the External Key Switch (pins 8 and 9).
7. Actuate the External START (pins 10 and 11) PB to turn the laser unit on.

The laser is now ready for operation.

The output optical power can be turned on/off or analog-controlled through the HAN 24 Pin connector, provided on the rear panel of the laser. See specifications for pin-out and signal timing for these lines.

When the unit is being operated remotely (key switch in the “REM” position) the keypad does not function as the laser is under complete remote control.

IMPORTANT

The unit has been programmed to turn the emission indicator and warning lights on, as soon as emission is enabled. This provides a visible warning that emission has been enabled and the laser can emit. The output power is displayed on the LCD Display, when the laser emission is present. When analog control mode is desired the user must select analog control mode.

The guide laser can be controlled externally via the front panel interface or through the RS-232 interface commands.

Analog Control Functions

When external analog control is enabled via RS-232 interface or handheld, the connector on the back panel provides laser control. Applying 0-10 VDC between pins 12 and 14 controls output power from 0 to 100%.

Modulation

WARNING:



When using the modulation input, make sure the modulation signal is connected prior to setting and or enabling laser emission. The laser will not emit radiation in modulation mode (must be enabled via RS-232) if no modulation input signal is present. If the modulation signal is introduced after the current level is set and the emission is enabled, the laser may emit high levels of optical radiation.

To modulate the lasers emission on or off a 24VDC signal is to be supplied to the modulation pins 15 and 16 on the Harting connector on the rear panel. A high signal turns the emission on and a low signal turns the emission off. It can be used in combination of RS-232 or analog controls.

Over Temperature Protection

The device is protected from overheating. If the temperature of the laser module exceeds 55°C, the drive current will be shut off automatically and the warning message “**Overheat**” will be displayed.

If the display shows a value for temperature higher than the maximum (55°C), the device is overheated. Make sure the air-cooling system is operating by ensuring that there is adequate airflow.

CAUTION: 

If the device becomes overheated, do not use it and call IPG immediately for assistance.

CAUTION: 

Operation at higher temperatures will accelerate aging, increase threshold current and lower slope efficiency.

5. Computer Interface / Commands

RS-232 Configuration

The RS-232 interface has been set to the following parameters:

57600 Baud, 8 data bits, 1 stop bit, no parity and no flow control.

RS-232 Connection

A three wire (RxD, TxD, GND) interface is used. Most computers are DTE (Data Terminal Equipment) devices. The laser is also a DTE device and therefore you must use a DTE-to-DTE interface cable. These cables are also called null-modem, modem-eliminator, or crossover cables. In addition, the interface cable must have the proper connector on each end. Cables typically have 9 pins (DB-9) or 25 pins (DB-25) with 'male' pins or 'female' receptacles inside the connector shell. The RS-232 communication connection on the rear panel of the Laser Rack is contained within the 24-pin Harting connector. Please see the Interface Connector Pin-Out on pages 19 or 33 for reference. The other end of this cable needs to match the computers interface connector. Remember that this cable must be wired in a null-modem or crossover configuration.

RS-232 Operation

The commands sent from the computer consist of a command code and an optional parameter (ASCII string), terminated by a 'carriage return' byte (CR, 0D – hex, \r). There must be a space character between a command and the parameter. The commands are shown here as all uppercase for clarity; the actual commands are not case sensitive. If a CR terminated string is received, but no valid command is found, a response of "BCMD" will be sent. All responses will be terminated with a "carriage return" character.

RS-232 Interface Commands

| Code | Description | Examples |
|------|--|--|
| SDC | Set Diode Current – Sets the diode current. The units are in percent of maximum current. The setpoint must be below 100% and above the minimum current setpoint. The current may also be set to 0. The response from the laser will be the command echoed back, a delimiter of “: “, and then the current setpoint for the laser. A value that is outside the acceptable range will receive a response of "ERR: Out of Range". | <p>Sent: “SDC 34.2” Response: “SDC: 34.2” (Current Setpoint is set to 34.2%)</p> <p>Sent: “SDC 104.2” Response: “ERR: Out of Range” (The setpoint is unchanged)</p> |
| RCS | Read Current Setpoint – Reads the setpoint for the pump current. The response is the command echoed back, followed by a delimiter of “: “, and then the current setpoint in %. | <p>Sent: “RCS” Response: “RCS: 56.7” (Indicates that the pump current setpoint is 56.7%)</p> |
| RNC | Read Minimum Current Setpoint – Reads the minimum current setpoint that can be set in the laser. The response will be the command echoed back, followed by a delimiter of “: “, then the minimum current as a percentage of the maximum. | <p>Sent: “RNC” Response: “RNC: 12.0” (Indicates that the minimum setpoint is 12.0 %)</p> |
| RDC | Read Diode Current – Reads the actual pump diode current in amps. The response is the command echoed back, a delimiter of “: ”, and then the current in amps. | <p>Sent : “RDC” Response: “RDC: 4.5” (Indicates that the diode current is 4.5 amps)</p> |
| ROP | Read Output Power – Reads the output power in watts. The response will be the command echoed back, a delimiter, and then either the power in watts, “Off” if the laser is off”, or “Low” if the power is below the reliable measurement threshold of the laser. | <p>Sent: “ROP” Response: “ROP: 96.1” (Indicates that the output power is 96.1 watts)</p> <p>Sent: “ROP” Response: “ROP: Off” (Indicates that emission is off)</p> <p>Sent: “ROP” Response: “ROP: Low” (Indicates that the output power is below the accurate measurement range of the laser)</p> |
| RFV | Read Firmware Version | <p>Sent: “RFV” Response: “RFV: 1.0.103”</p> |
| RCT | Read Laser Temperature – Reads the internal temperature of the laser. The response will be an echo of the command, | <p>Sent: “RCT” Response: “RCT: 34.5”</p> |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------|--|--------|-----------|--------|---|--------|---|--------|---|--------|---|--------|-----------|--------|---|--------|--|--------|---|--------|-----------|---------|--|---------|---|---------|---|---------|-----------|---------|--|--|
| | a delimiter of “: “, and the temperature in degrees centigrade. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| STA | <div>Read Device Status – Reads the internal status of the laser. The response is the command echoed back, a delimiter of “: “, and then the status as a bit-encoded 32-bit unsigned word. Undefined bits or bits defined as “Reserved” can be in any state and should be ignored. Each of the bits has the following meaning:</div> <table><tr><td>Bit 0:</td><td>Reserved.</td></tr><tr><td>Bit 1:</td><td>0 = Temperature OK. 1 = Overtemperature Condition.</td></tr><tr><td>Bit 2:</td><td>0 = Emission is Off. 1 = Emission is on or starting.</td></tr><tr><td>Bit 3:</td><td>0 = Backreflection Level is OK. 1 = High Backreflection Level.</td></tr><tr><td>Bit 4:</td><td>0 = Analog Control Mode is disabled. 1 = Analog control mode is enabled.</td></tr><tr><td>Bit 5:</td><td>Reserved.</td></tr><tr><td>Bit 6:</td><td>0 = All modules communicating. 1 = Module(s) disconnected.</td></tr><tr><td>Bit 7:</td><td>0 = All modules OK. 1 = Module(s) failed.</td></tr><tr><td>Bit 8:</td><td>0 = Aiming Beam Off. 1 = Aiming Beam On.</td></tr><tr><td>Bit 9:</td><td>Reserved.</td></tr><tr><td>Bit 10:</td><td>0 = Optical Interlock OK. 1 = Optical Interlock Failed.</td></tr><tr><td>Bit 11:</td><td>0 = Power Supply OK. 1 = Power Supply Off.</td></tr><tr><td>Bit 12:</td><td>0 = Modulation Disabled. 1 = Modulation Enabled.</td></tr><tr><td>Bit 13:</td><td>Reserved.</td></tr><tr><td>Bit 14:</td><td>0 = Laser Enable is not asserted. 1 = Laser Enable is asserted.</td></tr></table> | Bit 0: | Reserved. | Bit 1: | 0 = Temperature OK. 1 = Overtemperature Condition. | Bit 2: | 0 = Emission is Off. 1 = Emission is on or starting. | Bit 3: | 0 = Backreflection Level is OK. 1 = High Backreflection Level. | Bit 4: | 0 = Analog Control Mode is disabled. 1 = Analog control mode is enabled. | Bit 5: | Reserved. | Bit 6: | 0 = All modules communicating. 1 = Module(s) disconnected. | Bit 7: | 0 = All modules OK. 1 = Module(s) failed. | Bit 8: | 0 = Aiming Beam Off. 1 = Aiming Beam On. | Bit 9: | Reserved. | Bit 10: | 0 = Optical Interlock OK. 1 = Optical Interlock Failed. | Bit 11: | 0 = Power Supply OK. 1 = Power Supply Off. | Bit 12: | 0 = Modulation Disabled. 1 = Modulation Enabled. | Bit 13: | Reserved. | Bit 14: | 0 = Laser Enable is not asserted. 1 = Laser Enable is asserted. | <div>Sent: “STA” Response: “STA: 4100”</div> <div>This translates to the following: 4100 = 0x1004, so bits 2 and 12 are set. This means that emission is on and modulation is enabled.</div> |
| Bit 0: | Reserved. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 1: | 0 = Temperature OK. 1 = Overtemperature Condition. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 2: | 0 = Emission is Off. 1 = Emission is on or starting. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 3: | 0 = Backreflection Level is OK. 1 = High Backreflection Level. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 4: | 0 = Analog Control Mode is disabled. 1 = Analog control mode is enabled. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 5: | Reserved. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 6: | 0 = All modules communicating. 1 = Module(s) disconnected. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 7: | 0 = All modules OK. 1 = Module(s) failed. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 8: | 0 = Aiming Beam Off. 1 = Aiming Beam On. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 9: | Reserved. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 10: | 0 = Optical Interlock OK. 1 = Optical Interlock Failed. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 11: | 0 = Power Supply OK. 1 = Power Supply Off. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 12: | 0 = Modulation Disabled. 1 = Modulation Enabled. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 13: | Reserved. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit 14: | 0 = Laser Enable is not asserted. 1 = Laser Enable is asserted. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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| | Bit 15: | 0 = Emission is not in the 3 second safety start-up state. 1 = Emission is in the 3 second safety start-up state. | |
| | Bit 16: | Reserved. | |
| | Bit 17: | 0 = Control OK 1 = Unexpected emission detected. | |
| | Bit 18: | Reserved. | |
| | Bit 19: | Reserved. | |
| | Bit 20: | Reserved | |
| | Bit 21: | 0 = Keyswitch is in ON position. 1 = Keyswitch is in REM position. | |
| | Bit 22: | 0 = Aiming beam is controlled by RS-232 and Handheld interfaces. 1 = Aiming beam is controlled by hardware input signal. | |
| | Bit 23 – Bit 28: | Reserved. | |
| | Bit 29: | 0 = All modules enabled. 1 = Module(s) disabled. | |
| | Bit 30: | 0 = Collimator connected. 1 = Collimator disconnected. | |
| | Bit 31: | Reserved. | |
| | | | |
| EMON | Start Emission – Starts emission when the laser keyswitch is in the ON position. When the keyswitch is in the REM position, this command will have no effect and an error message will be returned. | <p>Sent: "EMON" Response: "EMON" (Emission is started, assuming the keyswitch is in the ON position).</p> <p>Sent: "EMON" Response: "ERR: Keyswitch in remote" (Emission is unchanged because the keyswitch is in the REM position).</p> | |
| EMOFF | Stop Emission – Stops emission when the laser keyswitch is in the ON position. When the keyswitch is in the REM position, this command will have no effect and an error message will be returned. | <p>Sent: "EMOFF" Response: "EMOFF" (Emission is stopped, assuming the keyswitch is in the ON position).</p> <p>Sent: "EMOFF"</p> | |

| | | |
|-------|--|---|
| | | Response: "ERR: Keyswitch in remote" (Emission is unchanged because the keyswitch is in the REM position). |
| EMOD | Enable Modulation – Enables the modulation control input. When emission is already on, this command will have no effect and an error message will be returned. | Sent: "EMOD" Response: "EMOD" (The modulation input is enabled) Sent: "EMOD" Response: "ERR: Emission is on" (The modulation state is not changed because emission is on) |
| DMOD | Disable Modulation – Disables the modulation control input. When emission is already on, this command will have no effect and an error message will be returned. | Sent: "DMOD" Response: "DMOD" (The modulation input is enabled) Sent: "DMOD" Response: "ERR: Emission is on" (The modulation state is not changed because emission is on) |
| EEC | Enable External Control – Enables the external control input. When emission is already on, this command will have no effect and an error message will be returned. | Sent: "EEC" Response: "EEC" (External analog control is enabled) Sent: "EEC" Response: "ERR: Emission is on". (External analog control is not changed because emission is on). |
| DEC | Disable External Control – Disables the external control input. When emission is already on, this command will have no effect and an error message will be returned. | Sent: "DEC" Response: "DEC" (External analog control is disabled). Sent: "DEC" Response: "ERR: Emission is on". (External analog control is not changed because emission is on). |
| RERR | Reset Errors – Resets any resettable errors. | Sent: "RERR" Response: "RERR" |
| ABN | Aiming Beam On | Sent: "ABN" Response: "ABN" (Not applicable when external aiming beam control is enabled). |
| ABF | Aiming Beam Off | Sent: "ABF" Response: "ABF" (Not applicable when external aiming beam control is enabled). |
| EEABC | Enabled External Aiming Beam Control. | Sent: "EEABC" Response: "EEABC" (The aiming beam will be controlled by the hardware input signal). |

| | | |
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| DEABC | Disable External Aiming Beam Control. | <p>Sent: "DEABC"</p> <p>Response "DEABC"</p> <p>(The aiming beam will be controlled from the RS-232 and handheld interfaces)</p> |
| SFWS | <p>Set Filter Window Size – Sets the size of the power monitor averaging filter window. Units are seconds. The allowable range is 0.2 to 5.0., in 0.2 second increments. Any value that is sent will be truncated to the lowest multiple of 0.2 seconds. The command will echo back the command and the actual windows size set. If a value outside the allowable range is sent, and error message will be returned and the windows size will not be changed.</p> | <p>Sent: "SFWS 1.2"</p> <p>Response "SFWS: 1.2"</p> <p>(The output power averaging window will be set to 1.2 seconds).</p> <p>Sent: "SFWS 2.55"</p> <p>Response "SFWS: 2.4"</p> <p>(The output power averaging window will be set to 2.4 seconds, because 2.35 is not a multiple of 0.2).</p> <p>Sent: "SFWS 7.2"</p> <p>Response "ERR: Out of Range"</p> <p>(The window size is unchanged because 7.2 is over the maximum value of 5.0).</p> |
| RFWS | Read Filter Window Size – Reads the size of the output power averaging filter window. Units are seconds. | <p>Sent: "RFWS"</p> <p>Response "RFWS: 3.4"</p> <p>(Indicates that the averaging window is 3.4 seconds).</p> |

6. Specifications

This section lists specifications of the product. Specifications describe warranted performance under the temperature range 25°C +/- 5°C and relative humidity <80% (unless otherwise noted). All specifications apply after the instrument's temperature has been stabilized after 1 hour of continuous operation.

Optical Characteristics

| Characteristic | Test Condition | Symbol | Min. | Typ. | Max. | Unit |
|---|---|-----------------------|---------------|-------|-------|------|
| Mode of Operation | -- | -- | CW | | | -- |
| Polarization State | -- | -- | Random | | | -- |
| Maximum Output Power | | P _{OUT, MAX} | 200 | | | W |
| Stable Power Range | 100%=200W | | 10 | | 100 | % |
| Central Emission Wavelength | P _{OUT} = 200 W | -- | 1065 | 1070 | 1080 | nm |
| Emission Bandwidth | FWHM P _{OUT} = 200 W | $\Delta\lambda$ | -- | 2.5 | 4 | nm |
| Power Control Modes | | | Remote, Local | | | |
| Output Power Stability Peak-to-Peak, Long Term (24 hours) | T _{CASE} = Const P _{OUT} = 200 W | -- | -- | +/- 1 | +/- 2 | % |
| Switching ON/OFF Time | P _{OUT} = 200 W | -- | -- | -- | 50 | μs |
| Max Modulation Frequency | P _{OUT} = 200 W | -- | -- | -- | 50 | kHz |
| Aiming Laser Wavelength | -- | -- | 640 | 670 | 680 | nm |
| Aiming Laser Output Power | -- | -- | -- | -- | 1 | mW |

Optical Cables and Connectors

| Characteristic | Test Condition | Symbol | Min. | Typ. | Max. | Unit |
|------------------------------|----------------|--------|--------------------------------|-------|-------|------|
| Output Beam Mode | | | TEM ₀₀ | | | |
| Beam Quality Factor | | M2 | | 1.05 | 1.1 | |
| Fiber Mode Field Diameter | | | 10.6 | | | μm |
| Fiber Numerical Aperture | | | 0.063 | 0.065 | 0.067 | rad |
| Beam Diameter | | | 6.65 | 7 | 7.35 | mm |
| Beam Divergence | | | | | 0.3 | mrad |
| Delivery Cable Length | | | 10 | | | m |
| Minimum Cable Bending Radius | Without stress | | | 50 | 80 | mm |
| Delivery Cable Diameter | | | 8 | | | mm |
| Output Connector | | | Collimator OD=30mm, L=129mm | | | |
| Output Location | | | Rear Panel | | | |

General Characteristics

| Characteristic | Test Condition | Symbol | Min. | Typ. | Max | Unit |
|---|----------------|-----------------|-----------------|------|-----|------|
| Operating Environment Temperature Range | -- | T _{OP} | 0 | -- | +35 | °C |
| Storage Temperature | -- | T _{ST} | -20 | -- | +70 | °C |
| Relative Humidity | -- | -- | 10 | -- | 90 | %RH |
| Cooling Method | -- | -- | Forced Air | | | -- |
| Dimensions | W x H x D | -- | 483 x 177 x 500 | | | mm |
| Weight | | | | 33 | 35 | kg |

Electrical Characteristics

| Characteristic | Test Condition | Symbol | Min. | Typ. | Max. | Unit |
|------------------------|--------------------------|----------------|------|------|------|------|
| Input AC Voltage Range | -- | U _S | 85 | -- | 250 | VAC |
| Input AC Frequency | -- | -- | 47 | -- | 63 | Hz |
| Power Consumption | P _{OUT} = 100 W | -- | -- | 1000 | 1200 | W |

Controls and Interface

| Interface (Label on drawings) | Description |
|-------------------------------|--|
| Remote Control | Harting HAN 24 DD Connector Location at Rear |
| Local Control | Front Panel Software Keys |
| Indicator Lights | Display – Power On Green LED – Power Supply Active Red LED – Emission On Yellow LED – Guide Laser On All Indicators Located on Front Panel |
| LCD Display | Items to be shown on LCD: Model number, Output Power (W), Diode Current, Temperature, Current Setpoint, Laser Status |

Final Test Data

The following data will accompany each laser shipment.

- Maximum Output Power
- Output Power (W) vs. Current Setpoint (%) graph
- Output 2D Beam Profile
- Output Emission Spectrum
- Output Power Stability (over 8 hours)

7. Serviceable Items

Serviceable Items



The unit should never be operated with any of the covers removed.

The input voltage to the laser is potentially lethal. All electrical cables and connections should be treated as if it were a harmful level. All parts of the electrical cable, connector or device housing should be considered dangerous.

This device is classified as a high power **Class IV** laser instrument under 21 CFR 1040.10. This product emits invisible laser radiation at or around a wavelength of **1070 nm**, and the total light energy radiated from the optical output is greater than **200W** per optical output port. This level of light may cause damage to the eye and skin. Despite the radiation being invisible, the beam may cause irreversible damage to the cornea. Laser safety eyewear is not provided with this instrument, but must be worn at all times while the laser is operational. The following items are field replaceable. Service personnel should always follow the correct Lockout/Tagout procedures to remove all potential energy from the system before servicing.

Fuses: To replace the main power fuses, use the following procedure.

1. Unplug the line cord and remove keys from laser.
2. Turn the laser so the rear panel is easily accessible.
3. Locate the fuses and unscrew the covers.
4. The fuses should be easily removable after the covers have been removed.
Important- Replace blown or damaged fuses with only the same Amperage fuses.
5. Replace covers and tighten securely.

Filter Media: To access the filters, use the following procedure.

1. Remove the black covers on the front panel of the laser. Upon removal, the filter element will be exposed.
2. Remove the used filter and replace with a new filter.
3. Snap the cover back on and dispose of the dirty filter element.

8. Warranty

General Warranty

IPG warrants to the original purchaser that the IPG product conforms to applicable specifications and is free from defects in materials and workmanship. These warranties start on the shipment date from IPG and continue until the end of the warranty period listed in IPG's sales order, or in IPG's specifications or one year, which ever occurs later.

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Service and Repairs

There are no operator serviceable parts inside. Please refer all servicing to qualified IPG personnel.

Many issues and questions regarding the safety, set-up, operation and maintenance of the IPG products can be resolved by reading this User's Guide carefully. If you have questions regarding the safety, set-up, operation or maintenance of your IPG product, please call our Quality Manager located in Oxford, Massachusetts, USA, at 508-373-1100.

If you cannot resolve the issues through the use of this User's Guide or over the telephone with our technical support group, you may need to return the product to IPG.

All product returns require a Return Merchandise Authorization (RMA) from IPG.

To obtain an RMA, call the Quality Manager of IPG Photonics Corporation at 508-373-1100.

If you return a product with a RMA, please follow these procedures:

- ❑ Products must be carefully packed in a suitable shipping container(s). Buyer assumes all responsibility for products damaged in shipment to IPG.
- ❑ Buyer must issue a purchase order for the value of the replaced parts/service items and IPG will issue credit or invoice when the parts/service are received. Speak to IPG Quality Manager for the amount authorized under the required purchase order.
- ❑ All requests for repair or replacement under this warranty must be made to IPG within 30 days after discovery of the defect (but not later than 7 days after warranty expiration).
- ❑ All products returned to IPG but which meet applicable specifications, not defectively manufactured or used not in accordance with this User's Guide, will result in the Buyer being charged IPG's standard examination charge.
- ❑ Complete packing list with product model and serial number will ensure prompt repair.
- ❑ Be sure to include with the returned product your 'ship to' address for the return of the serviced product.

Shipping Instructions:

Warranty Returns - Domestic & *International Buyers pay for one-way freight costs and insurance to IPG. IPG will pay for freight return cost and insurance back to the Buyer.

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Shipping address for returns to US:

IPG Photonics Corporation
50 Old Webster Road
Oxford, MA 01540
Attn: Product Returns
Tel: 508-373-1100

***International Returns must include applicable DUTIES AND TAXES, and you must mark air bills with "U.S. GOODS, RETURNED FOR REPAIR."**