YLP-HP series

Ytterbium Pulsed Fiber Laser

6U rack mountable version

User's Guide

Issued 02 September 2008

Please take time to read and understand this User's Guide and familiarize yourself with the information that we have compiled for you before you use 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.

Notices

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⚠ CAUTION:

The IPG Laser YLP-HP series laser is a Class IV laser product.

The laser may emit up to 1kW of average power and up to 1MW of peak power of invisible laser radiation in the optical band near 1064 nm. Refer to the device specification for particular maximum values of the average and peak powers.

Avoid eye or skin exposure to direct or scattered radiation emitted from the optical output.

Do not open the device. There are no user serviceable parts, equipment or assemblies associated with this product. All service and maintenance will be performed only at the factory.

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1. Safety Information

Safety Conversions

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

This device is classified as a high power Class IV laser instrument under IEC 60825 and 21 CFR 1040.10. This product emits wavelength light at or around 1064 nm at total power of light radiated out of the optical output up to 1000 W. 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.

WARNING:

Use appropriate laser safety eyewear when operating this device. The selection of appropriate 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 emits light over a range of wavelengths and the end user should confirm the laser safety eyewear used protects against light emitted by the device over its entire range of wavelengths.

WARNING:

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

CAUTION:

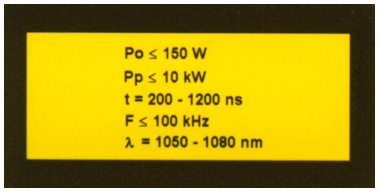
Do not install or terminate fibers and output head when the laser is active.

Safety Labels and Labeling Locations:

The figures below show labels and their placement on the product.

Aperture Label

Location: Collimator assembly or output cable exit port.

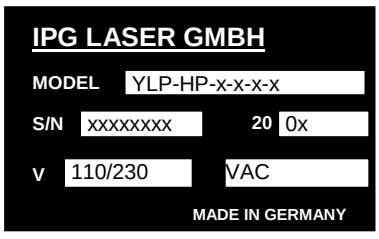


Explanatory Label

Location: Front Panel of the Unit

Certification Logotype

Location: Front Panel of the Unit



Identification Label

Location: Rear or side panel of the Unit

General Safety Instructions

In order to ensure the safe operation and optimal performance of the product, please follow these warnings and cautions in addition to the other information contained elsewhere in this document.

CAUTION:

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

WARNING:

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

WARNING:

This device and all parts or components thereof are not meant to be operator serviced, except for the replaceable fuse(s). Refer all servicing to qualified IPG personnel. To prevent electrical shock, do not remove covers or system components. Any tampering with or disassembly of the device or parts or components will void the warranty and possibly expose the operator to an electrical shock hazard.

WARNING:

For continued protection against fire hazard, replace the line fuses with only the same types and ratings. The use of other fuses or material is prohibited.

CAUTION:

This instrument uses water for cooling. Without proper water cooling the laser will be damaged. Please set cooling water temperature and provide water flow as required in the device specification.

WARNING:

Laser radiation is emitted from all optical outputs simultaneously. Avoid exposure from all unused optical ports.

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. This product must be used only in normal conditions.

CAUTION: 

The laser is sensitive to the power reflected back to the laser. Please do not exposure laser output to the reflected surfaces.

Back Reflection Prevention

CAUTION: 

Back reflection into the laser cavity can degrade the laser performance or cause laser failure. The laser is designed to accommodate normal back reflections exhibited from use of your laser output.

For collimated outputs, maintaining a clean output lens is essential. Always close (re-cap) the collimator after use. Do not touch the output lens and do not clean with any solvents.

Optical damage may result from failure to comply with the above instructions. Such damage is not covered by the warranty.

CAUTION: 

Do not mark copper plates or similar materials. You can damage the laser. Such damage is not covered by the warranty.

2. Description

The **YLP-HP Series** is maintenance-free Q-switched pulsed Ytterbium fiber lasers designed for OEM applications. These lasers deliver a high power 1.064µm laser beam directly to the work piece via a flexible metal-sheathed fiber cable. Collimated and then typically focused to a spot size of a few tens microns or less low divergence beam can mark, engrave, cut, drill or machine a variety of materials.

YLP-HP Series provides a wide choice of pulse durations, repetition rates and peak powers. The fiber based design and rugged metal case allow these compact fiber lasers to operate in industrial environment. The lasers up to 500W of average power are assembled in 6U height 19" rack mountable housings and up to 1kW in standalone cabinets.

Optical output of the laser is a few meters long delivery fiber terminated with an optical isolator. The isolator ensures output power stability and protects the laser against reflected light.

Control Interface: the 19" base lasers are equipped with RS-232C interface allowing full control and laser status diagnostics.

Factory sealed YLP-HP lasers can be built directly into micro-machining, material processing and production marking. No special installation and laser readjustment is required on the customer place. These water cooled lasers require no replacement parts and no after-installation service.

3. Accessories

The laser is shipped together with the following accessories:

Part	Quantity	Description
Laser device	1	Ytterbium fiber laser
Power key	2	For switching power supply
Interlock connector	1	Interlock mating connector with short circuit inside
Power supply cable	1	Plug according to IEC/EN 60320-1/C19
User's Guide	1	This Document

4. Environment and Precautions

CAUTION:

Before turning the power to the device on, make sure the laser optical output is properly aligned and terminated.

CAUTION:

If the output of the device is delivered through a lens with an anti-reflection coating make sure that the lens is of good quality and clean. Any dust on the output burn 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.

CAUTION:

Always switch the laser off when working with the isolator such as mounting the isolator into a fixture, viewing the end face with optical instruments, etc. If necessary, align the isolator at low output power and then increase the output power gradually.

CAUTION:

Do not expose the device to a high moisture environment.

CAUTION:

This instrument uses water for cooling. Without proper water cooling the laser will be damaged. Please set cooling water temperature and provide water flow as required in the device specification.

CAUTION:

The optical isolator should be installed on conductive heatsink for efficient heat dissipation. Please note that isolation efficiency depends on temperature of isolator case and internal parts. For best operation it is strongly recommended to keep isolator case temperature near 25°C

WATER COOLING.

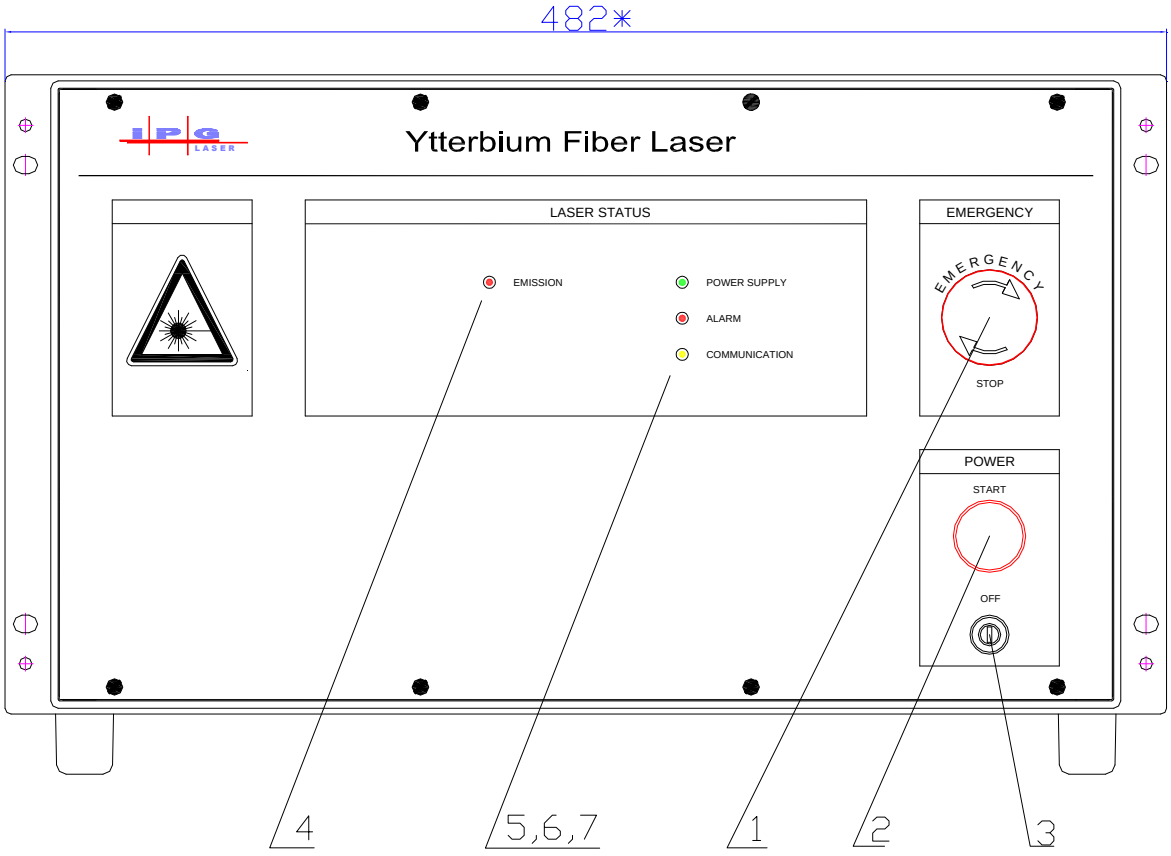
There is a risk of condensation damage when laser is placed in a high temperature and humidity environment, while cooling water temperature is colder than the dew point of the surrounding air. The cooling water temperature must always be above the dew point temperature.

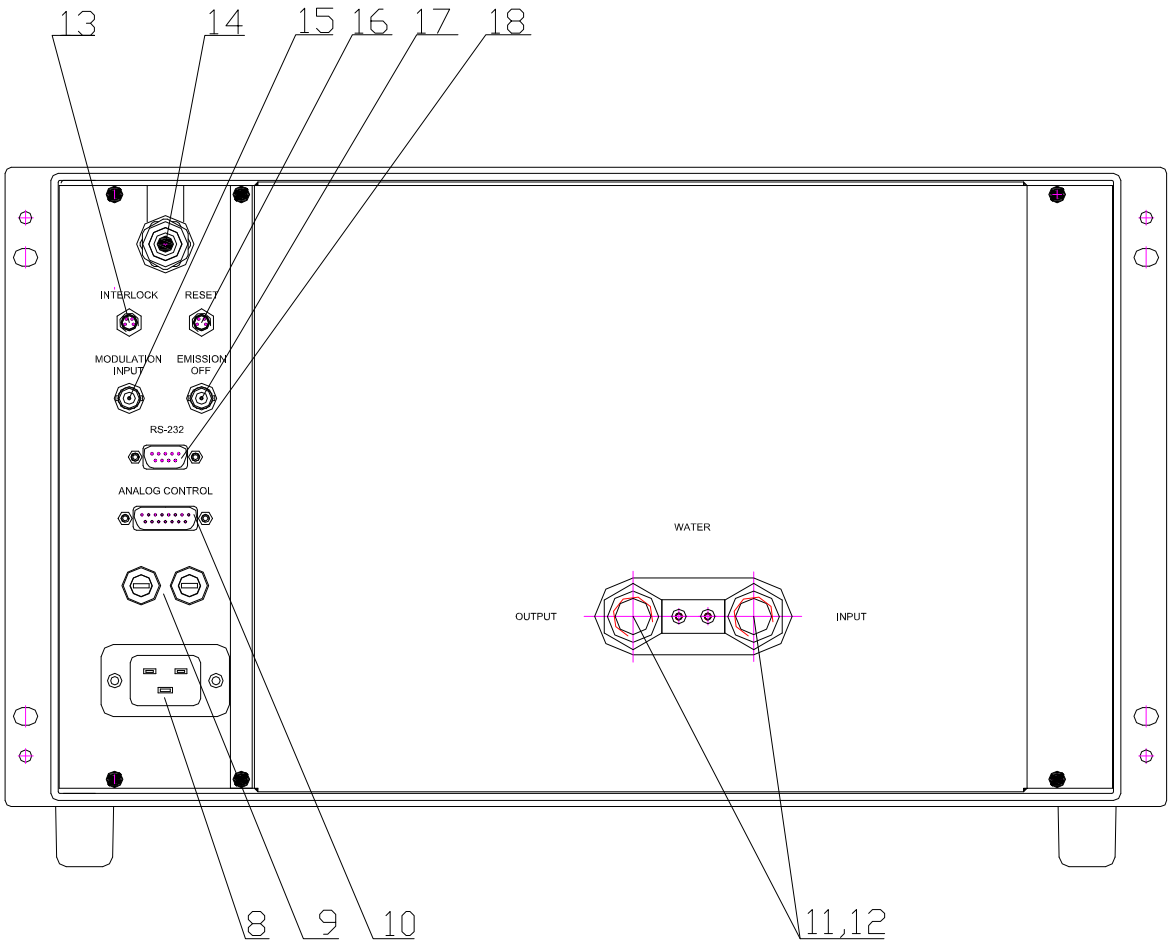
Dew point temperatures table (minimum temperature of the cooling water)

	Relative Humidity, %															
Air, Temp ℃	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**
16				0	2	4	5	7	8	9	10	11	12	13	14	15
18			1	3	4	6	8	9	11	12	13	14	15	16	17	18
21		1	3	5	7	9	11	12	13	14	16	17	18	18	19	21
24		3	6	8	9	11	13	14	16	17	18	19	20	21	22	23
27	2	5	8	10	12	14	16	17	18	19	21	22	23	24	25	26
29	4	7	10	12	14	16	18	19	21	22	23	24	26	27	28	28
32	7	10	12	15	17	19	21	22	23	25	26	27	28	29	31	31
35	9	12	15	17	19	21	23	24	26	27	29	30	31	32	33	34
38	11	14	17	20	22	24	26	27	29	30	31	33	34	35	36	37

Failure to comply with the cautions and instructions in this document may lead to damaging the fiber laser and will void the warranty.

5. Front and Rear Panels Controls





The operating controls and indicators of the Laser Front and Rear panels are listed in table below.

1	**EMERGENCY** button	Button switches OFF the laser in the case of emergency
2	**MAIN SWITCH** button	Press to turn ON power supply voltage of the laser.
3	**POWER** key	Key to turn ON and OFF the power
4	**EMISSION** led	Indicates that laser emission is ON
5	**POWER SUPPLY** led	Indicates that power is supplied to the laser
6	**ALARM** led	Indicates that laser internal alarm occurs
7	**COMMUNICATION** led	Indicates communication through RS-232
8	**AC OUTLET**	230 VAC or 100/230VAC 50/60 Hz (refer to the specification) Outlet according to IEC/EN 60320-1/C19
9	**Fuses holders**	Replaceable fuses 10A x250V
10	**Analog control**	Not used
11, 12	**WATER IN/OUT**	Outlets for water connection
13	**EMERGENCY INTERLOCK**	External E-stop. When shorted, laser operation is enabled. short pins 1 to 4 and 2 to 3 simultaneously. When opened, laser power supply voltage is switched OFF open pins 1 to 4 and 2 to 3 simultaneously. Connector type "Phoenix contact p/n 1500303"
14	**OPTICAL OUTPUT**	Optical fiber cable with output head
15	**MODULATION INPUT**	BNC connector, External modulation input LOW – LD current is switched OFF HIGH– pump LD current is switched ON disconnected - LD current is switched OFF Refer to the specification for the voltage levels
16	**Reset**	External main power switching ON circuit. Connect pins 1 and 3 for short time to switch ON main power supply (equivalent to pressing start button of the front panel). Pins 2 and 4 are short connected if the main supply is switched ON and are disconnected if it is switched OFF. Connector type "Phoenix contact p/n 1500347"
17	**Emission OFF**	Not used
18	**RS-232C connector**	DB-9 plug connector, RS-232C computer interface

6. Laser Operation

NOTE: 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 Laser immediately.

Switching Laser ON and OFF.

1. Connect water for cooling, refer to laser specification and the dew temperature table for minimum acceptable water temperature.
2. Make sure, that the water flow is not less than specified.
3. Remove the protection cap from the laser output optical head and terminate optical radiation.
4. Connect the laser "Modulation Input" to the control system.
5. Connect the laser RS-232C port to a PC or other control RS-232C device.
6. Connect the power cord to the AC Line, make sure that power AC line voltage corresponds to the laser specification.
7. Put on protection glasses.
8. Insert the key rotate clockwise to activate control electronics of the laser.
9. Press the start button on the front panel to activate the main power supply. **POWER SUPPLY** led should emit.
10. The device is ready for operation.
11. The laser emission will be switched ON after receiving "Laser ON" command via RS-232C interface. After accepting "Laser ON" command the **EMISSION** led starts to emit.
12. Now the laser optical output is controlled via **MODULATION INPUT**.

LOW level or floating	The laser emit only remnant power
HIGH level	The laser emit programmed power

13. The red diode can be switched ON during laser operation (if the option is installed). The guide laser should be turned ON when the laser is OFF ("Laser OFF" command executed). If the laser is ON, the emission is automatically stopped. To recover laser operation it is necessary to send "Laser OFF" and "Laser ON" again. Switching laser ON is enabled only after sending "Guide Laser OFF" command.
14. To deactivate the laser, send RS-232C command "Laser OFF".
15. Rotate key counterclockwise to switch OFF the Laser main supply.
16. Each RS-232 commands causes **COMUNICATION** led to blink.

IMPORTANT:

The laser is equipped with internal housekeeping supply for independent electronic board and guide laser operation only. Operation at housekeeping provides no supply to the pump laser diodes and bring the device down to **Class I** laser product. To activate housekeeping supply rotate clockwise the key on front panel without pressing start button. The customer may operate with the laser control electronics (like communication via RS-232C and configuration) and activate the guide laser (red diode) if installed

Emergency Status.

The **ALARM** led starts to emit if an internal failure occurs in the laser. The reason of the failure may be decoded from "Device Status" bytes of the laser, use command "Read Device Status" to read it.

Possible reasons of the **ALARM** status are:

- internal failure observed during the laser self-checking
- high level of "BACK REFLECTION", the power reflected back to the laser is higher than acceptable. Investigate the reason of back reflection and remove it.
- temperature alarm of the module. The module automatically stops emission if the laser temperature is out of specified temperature range. Please check if environmental conditions are within specification and is there sufficient water flow to cool the laser.

To reset alarms send "Reset alarms" RS-232C command.

NOTE: The laser is sensitive to the back reflected signal. The strong back reflection may destroy laser and/or output fiber termination assembly.

Operation Features.

1. The power setting can be changed during the laser operation by sending appropriate command through RS232. Laser response time to the power setting change is within specified delays for rise/fall times (refer to the laser specification)

2. The laser emission is not allowed simultaneously with the guide laser operation. If the "Laser ON" command was sent to the laser during guide laser operation, the laser will not emit power, and will not start to emit it even after switching OFF the guide laser. It is necessary to send "Laser OFF" command to restart the laser emission. Until the restart is done status bit "Laser is not ready for emission" will be active.

3. The laser automatically switches OFF emission, if the module temperature rises above or drops below specified maximum/minimum operating temperatures (for operating temperature range see laser specification). The internal Alarm flag will be set and lights the alarm led on front panel. The laser does not recover the emission until the reset of alarm is done.

4. The laser has an internal back reflection sensor. It switches emission OFF if the reflected level is potentially dangerous for the laser. The internal Alarm flag will be set and lights the alarm led on front panel. The laser does not recover the emission and holds the alarm until reset of alarm is done.

Operating modes and options.

1. The laser may be equipped with options and control modes, which extend and/or change laser operation. List of installed options may be read by RS-232C interface using appropriate command. Below is the options matrix, which shows compatible combinations of modes and options which can be installed to the laser.

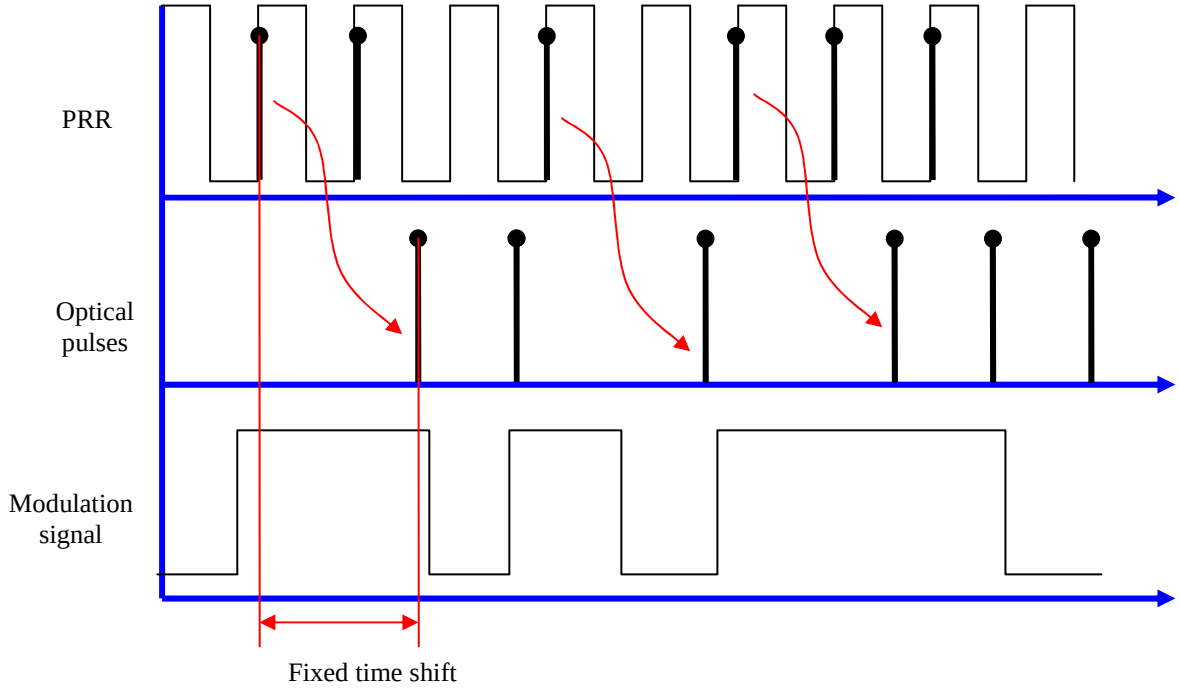
Option	Description	Customer configurable	Other necessary options
HC	High Contrast	no	no
ExtPRR	Extended Pulse Repetition Rate	yes	no
AdjPulse	Adjustable Pulse Duration option	no	no
BS	Bitstream mode	yes	HC
BS1	Bitstream 1 mode	yes	HC

2. **"HC"** High contrast option ensures no power leakage if the Modulation signal is LOW. Switching OFF time is instant for this option and typically less than 3 us. It is perfectly suited for "point to point" applications, like fine drilling, when there should be no power leakage between jumps. Please note that using **BS1** option can result in some value of CW remnant power while Modulation is LOW. Refer to the device specification for more details.

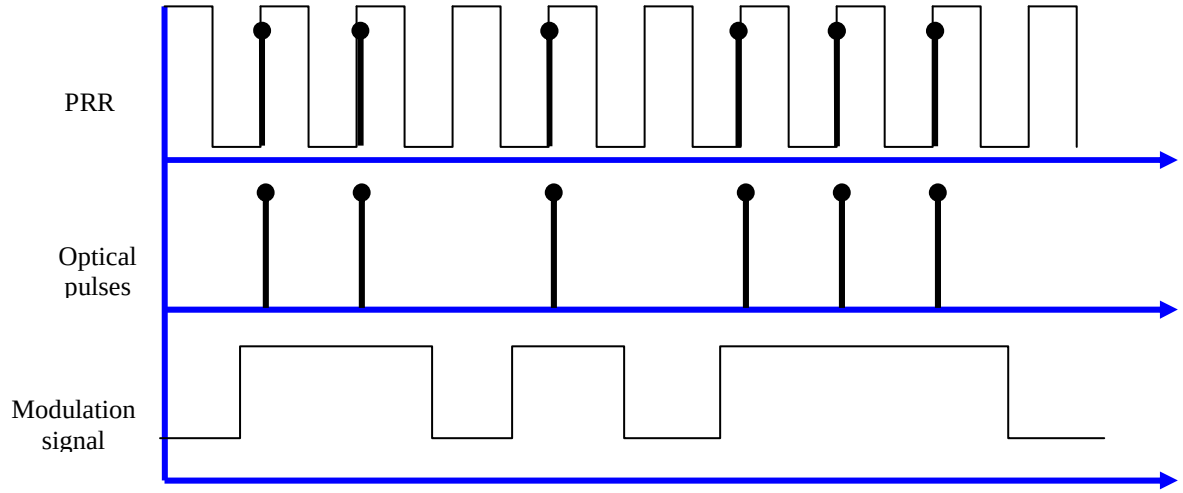
3. **"ExtPRR"** Extended PRR mode allows to operate with PRR less than nominal. Average power is proportionally reduced while operating PRR less than nominal, but pulse energy is kept constant.

4. **"AdjPulse"** option. Adjustable pulse duration option allows user to change shape and duration of optical pulse to one from the preinstalled discrete set. The set of preset optical pulse shapes is defined in the device specification and is calibrated at the factory. Please note that operating parameters of the laser like maximum energy and average power may change with pulse duration (refer to the device specification for detail).

5. **"BS"** Bitstream mode allows modulation of each pulse individually. Assuming that the laser operates at constant PRR the Modulation signal can be used as a mask. In the case of Modulation is HIGH the pulse will be emitted at pulse synchronization signal, in the case of Modulation is LOW the pulse is not emitted. There is a constant time shift (typically 256us, may vary depending on the model) between first rising edge of PRR signal after the Modulation signal becomes HIGH and the emitted optical pulses train. This option is perfectly fit to raster marking technique. The option HC is always included, if BS option is installed. Sample of a control diagram is shown below.



6. **"BS1" option.** There is no time shift (time shift typically less 2 us) between first PRR pulse (after the Modulation signal becomes HIGH) and the emitted optical pulses train. Sample of a control diagram is shown below. BS1 option (unlike BS) requires from the laser to be ready of emission instantly. This result in leakage of a small amount of CW power in "Laser Emission ON" and "Modulation OFF" state.



7. RS-232 communication Interface

RS-232C electrical connector.

RS-232C connector is the DB9 type plug (male). The RS-232C interface is galvanically isolated.

Pin assignment is shown in the table below and standard for communicating with a PC COM port. Use crossed RS-232C cable to link the laser and a PC.

PIN No.	Description
1, 4, 6-9	Not connected
2	RxD, receive
3	TxD, transmit
5	Interface ground, galvanically isolated from the laser internal ground

RS-232C Command Structure Description

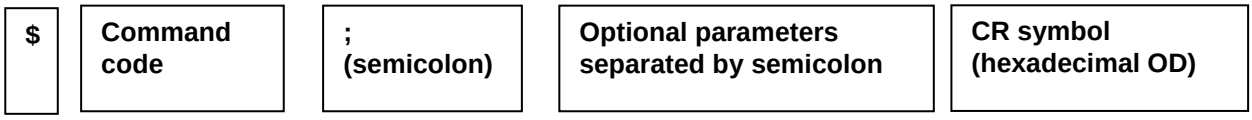
1. Initialization of RS-232:

   speed: 57600 bits per second

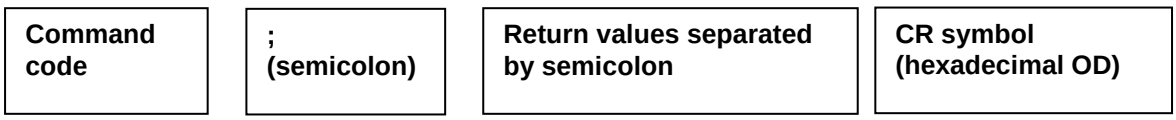
   parity / flow control: none

   start / stop bits: 8 data bits, 1 start bit and 1 stop bit

2. Firmware command structure:



3. Laser reply structure:



4. The command code is individual for each command, it is shown in the table below.

5. Command parameter is a text string. If the parameter is a numerical value, it should be converted into ASCII string.

6. The returned value is also a text string. If the requested value is numerical, the opposite conversion from text string to the numerical value is required.

7. All commands should be terminated by "Carriage Return" symbol, hexadecimal value "0D". The RS-232C buffer of the laser receives bytes until the CR symbol occurs. All bytes before this symbol are interpreted as a command. Bytes after CR until next CR will be interpreted as a next command.

8. For all "set" commands device returns as the parameter "Y" if the command was successfully executed and "N" if the command was not executed.

9. For all strings sent to the laser, which were not recognized as valid commands the laser sends "E" as parameter.

10. After switching on electrical power device state is the following:

    Pulse repetition rate: nominal PRR

    Laser is in OFF state

    Set power is zero

RS-232C Command Codes. Table for monitoring and configuration.

Type	Command	Command code	Parameters or return values	Description/Parameters
Read	Device ID	1	string, up to 24 char	Read device identifier written to the laser in the factory
Read	Device SN	2	string, up to 24 char	Read device serial number
Read	FW revision	3	string, up to 255 char	Read device firmware revision
Read	Vendor	99	string, up to 255 char	Read device vendor written to the laser in the factory
Read	Device Status	4	up to 32 bit integer	Read device status, binary decoding is required
Read	Device temperature	5	float, 1 digit after point	Read module temperature in degree Celsius
Read	Extended Status	11	up to 32 bit integer	Read device extended status binary decoding is required
Read	BR Counter	12	up to 32 bit integer	Read back reflection counter
Read	Session BR Counter	13	up to 32 bit integer	Read back reflection counter for current session. Session starts with supplying voltage to the laser module.
Read	Nominal average Power	14	float, 1 digit after point	Read nominal average power of the laser in [W] Return value is float in [W].
Read	Nominal Pulse Duration	15	up to 32 bit integer	Read nominal pulse duration of the laser [ns]
Read	Nominal Pulse Energy	16	float, 2 digit after point	Read nominal pulse energy of the laser [mJ]
Read	Nominal Peak Power	17	float, 1 digit after point	Read nominal peak power of the laser in [kW]. Value is calculated via nominal energy and nominal pulse duration.
Read	PRR Range	18	see description	Read pulse repetition rates range. Return value is two floats separated by semicolon, correspondingly for minimum and maximum PRRs in [kHz].

Type	Command	Command code	Parameters or return values	Description/Parameters
Read	Operating Mode	23	16 bit integer	Read control interface operating mode, binary decoding is required.
Set	Operating Mode	24	16 bit integer	Set control interface operating mode, binary encoding is required.
Read	Installed Options	25	16 bit integer	Read list of installed options and operating modes, binary decoding is required
Set	Start Operating Mode	26	16 bit integer	Set initial control interface operating mode, binary encoding is required. This mode becomes active after supplying the laser with electrical power. Value is stored permanently in the laser EEPROM.
Read	Start Operating Mode	27	16 bit integer	Read control interface operating mode, which activates after connecting the laser to the supply voltage. The value is stored permanently in the laser EEPROM, binary decoding is required
Read	Operating Power [W]	33	float, 1 digit after point	Read back operating power in [W] set by command 32
Read	Operating Power [%]	34	float, 1 digit after point	Read back operating power in [%] set by command 32
Read	Operating Pulse Energy	36	float, 2 digit after point	Read operating pulse energy in [mJ]. Value is calculated using nominal laser parameters and power settings.

RS-232C Command Codes. Table of control commands.

Type	Command	Command code	Parameters or return values	Description/Parameters
Set	PRR	28	float, 1 digit after point	Set operating pulse repetition rate in [kHz] **Note:** changing of PRR is recommended when the laser is in "Laser Emission OFF" state.
Read	PRR	29	float, 1 digit after point	Read back operating pulse repetition rate in [kHz] set by command 28
Set	Laser Emission ON	30		Command to switch ON laser emission
Set	Laser Emission OFF	31		Switch OFF laser emission.
Set	Operating Power	32	float, 1 digit after point	Set operating power in [%]. Range 0…100, resolution 255 levels for full scale
Set	Guide Laser ON	40		Switch ON guide laser
Set	Guide Laser OFF	41		Switch OFF guide laser.
Set	Reset Alarms	50		Reset alarms, see alarms description for details
Set	Save Parameters	54		Permanently save parameters to EEPROM: 1) preset pulse duration

Command $30 "Laser Emission ON" can not swich ON optical emission if the status bit "Laser is ready for emission" is not HIGH. In this case the reason of the not ready state (like active state of guide laser, etc.) should be removed and "Laser emission OFF" command shoul be sent to reset "not ready" state.

RS-232C Command Codes. Table for Extended PRR mode.

Type	Command	Command code	Parameters or return values	Description/Parameters
Read	min/max PRR	46	see description	Read back minimum and maximum operating PRRs. Return value is two float in [kHz] values separated by semicolon.

RS-232C Command Codes. Table for Adjustable Pulse Duration mode.

Type	Command	Command code	Parameters or return values	Description/Parameters
Read	Pulse Duration	48	16 bit integer	Read back pulse duration in [ns] set by command 49
Set	Pulse Duration	49	16 bit integer	Set optical pulse duration in [ns]. The set value should correspond to one from the list returned by the command 51
Read	List of Pulse Durations	51	<int1>;<int2>;…;<intN>	Read list of preset pulse durations in [ns]. List of 16 bit integers separated by semicolon

Command "$4" "Read device status"- return value interpretation.

Bit	State	Description
0	1 0	Back reflection Alarm active No BR alarm
1	1 0	Temperature Alarm active. Laser module temperature is out of specified range. No temperature alarm
2		Reserved
3	1 0	System Alarm active No system alarm
4		Reserved
5		Reserved
6	1 0	Laser is ready for emission Laser is not ready for emission
7	1 0	At least one of the warnings is activated No warning is activated

Command "$11" "Read device extended status"- return value interpretation.

Bit	State	Description	Message Type
0	1 0	Reserved	Warning
1	1 0	Reserved	Warning
2	1 0	Reserved	Warning
3	1 0	Laser ON time (Modulation HIGH state) is lower than specified Not lower than specified	Warning
4	1 0	Laser OFF time (Modulation LOW state) is lower than specified Not lower than specified	Warning
5	1 0	Guide laser was activated Guide laser was not activated	Warning
6		Reserved	Information
7		Reserved	Information
8	1 0	Laser emission is ON (laser is pumped) Laser emission is OFF (laser is not pumped)	Information
9		Reserved	
10		Reserved	
11	1 0	Laser emission ON command was received by RS232C Laser emission OFF command was received by RS232C This bit is valid in RS-232C control mode only	Information
12	1 0	Guide laser ON command was received by RS232C Guide laser OFF command was received by RS232C	Information
13		Reserved	Warning
14		Reserved	Warning
15		Reserved	Warning

Operating modes commands

Command "$23" "Read operation mode"- return value interpretation

Command "$27" "Read start operation mode"- return value interpretation

Command "$24" "Set operation mode"- value for setting

Command "$26" "Set start operation mode"- value for setting

Bit	State	Description	Access
0		Reserved	
1		Reserved	
2		Reserved	
3		Reserved	
4	1 0	Adjustable pulse duration mode is active (to activate) Not active (to deactivate)	if installed
5		Reserved	
6	1 0	Extended PRR mode is active (to activate) Is not active (to deactivate)	if installed
7	1 0	Modulation signal (BNC connector) is in use (to use) Not is use (to not use)	RS-232C control mode only
8		Reserved	
9		Reserved	
10	1 0	Bitstream 1 (BS1) mode is active (to activate) Not active (to deactivate)	if installed
11	1 0	Bitstream (BS) mode is active (to activate) Not active (to deactivate)	if installed

NOTE: The bits marked as "Reserved" in the structure above are used for another purpose and are not allowed to be changed by customer. To preserve these bits first read status from device and then change required bits only (keeping others without changing).

Read options command

Command "$25" "Read installed options and operating modes"- return value interpretation.

Bit	State	Description
0		Reserved
1		Reserved
2	1 0	Extended PRR mode option is installed Not installed
3	1 0	Adjustable Pulse Duration option is installed Not installed
4		Reserved
5		Reserved
6		Reserved
7	1 0	Guide laser is installed Not installed
8	1 0	High Contrast (HC) option is installed Not installed
9		Reserved
10	1 0	Bitstream 1 (BS1) mode is installed Not installed
11	1 0	Bitstream (BS) mode is installed Not installed

8. Warranty

General Warranty

All products are warranted by IPG against defects in materials and workmanship for the period of time as set forth on the applicable purchase order or in the specifications starting with the date of shipment. IPG also warrants that this product will meet applicable specifications under normal use.

IPG shall, at its option, repair or replace any product that proves, in the reasonable opinion of IPG, to be defective in materials or workmanship during the warranty period. All products repaired or replaced under warranty are only warranted for the remaining un-expired period of time in the original warranty for the particular defective product. IPG reserves the right to issue a credit note for any defective products that have proved defective through normal usage.

Warranty Limitations

This warranty excludes products, parts (including fiber connectors) or equipment which have been tampered with, opened, disassembled, opened, or modified by persons other than IPG personnel, misused, neglected, or damaged by accident, used in applications which exceeds their specifications or ratings, used outside of environmental specifications for the product, used with buyer software or interfacing, improperly installed, maintained or otherwise abused or used other than in accordance with the information and precautions contained in this User's Manual. It is the customer's responsibility to understand and follow operating instructions in this User's Guide and specifications prior to operation—failure to do so may result in voiding this warranty. Accessories and fiber connectors are not covered by this warranty.

Buyer must claim under the warranty in writing no later than 31 days after the claimed defect is discovered. This warranty does not extend to any third party, including without limitation Buyer's end-users or customers, and does not apply to any parts, equipment or other products not manufactured by IPG.

Device Software

Any device software provided now or in the future is provided solely under non-exclusive license from IPG Laser. By using the software, you agree to the terms herein. The device software is protected by trade secret laws, United States copyright laws and international treaty provisions. IPG Laser reserves all ownership rights. The owner of the device may only use the device software only with the product(s) identified by IPG Laser, and may make duplicate copies of the software solely for archival backup purposes. Any alterations of the device software will void the warranty on the equipment provided by IPG Laser.

The device software is provided "as is" with no warranties whatsoever, whether express or implied, including the warranties of fitness for a particular purpose. IPG Laser does not warrant that the functions contained in the software will meet the user's requirements or that the operation of the equipment or device software will be uninterrupted or error free. Not all device software has gone through IPG Laser's normal quality control or product purposes, but is provided to users as an accommodation to respond to their requests. End-user support is not implied or provided, and you are assumed to have working knowledge of a particular development language. IPG Laser may make changes to the device software and has no obligation to distribute newer versions.

EXCEPT FOR THE LIMITED WARRANTIES EXPRESSLY SET FORTH ABOVE, IPG SPECIFICALLY DISCLAIMS ANY AND ALL OTHER WARRANTIES TO BUYER, INCLUDING WITHOUT LIMITATION, ANY AND ALL IMPLIED WARRANTIES, SUCH AS FREEDOM FROM INFRINGEMENT, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Exclusive Remedies

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. IN NO EVENT SHALL IPG BE LIABLE FOR DIRECT, INDIRECT, SPECIAL, INCIDENTAL, CONSEQUENTIAL, EXEMPLARY OR PUNITIVE DAMAGES (EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES) ARISING FROM OR RELATING TO THE PRODUCT (INCLUDING, LOSS OF PROFITS) WHETHER BASED ON CONTRACT, TORT OR ANY OTHER LEGAL THEORY. IPG'S MAXIMUM LIABILITY WILL NOT EXCEED, IN THE AGGREGATE, THE TOTAL AMOUNT PAID FOR THE PRODUCT BY BUYER.

9. Changes

We reserve the right to make changes in design or constructions of any of our products at any time without incurring any obligation to make changes or install the same on units previously purchased.

10. Service and Repairs

CAUTION: 

No operator serviceable parts inside. Refer all servicing to qualified IPG personnel. All requests for repair or replacement under this warranty must be made as soon as possible after the defect has been noticed and must be directed to IPG Laser or its representative in your area. Items authorized for return by us must be returned in a suitable container.

Any damage noted upon receipt of the unit must be documented for appropriate claim against the carrier.

IMPORTANT:

Never send any product back to IPG without a Return Merchandise Authorization (RMA). The customer will be charged for the cost of repairing the product if the product is not under warranty or if the repair is not covered under the warranty.

Instruction for product return.

1. **IPG Laser will only accept returns for which IPG Laser has issued an approved Return Merchandise Authorization (RMA). You should send filled RMA request form to pulsed-lasers-service@ipgphotonics.com account to discuss the return and get a RMA number. Please contact your local IPG office, in case the laser was bought not directly from IPG Laser GmbH.** You must return defective products freight prepaid and insured to IPG Laser at the address shown herein. All products which have returned to IPG Laser but which are found to meet all previously applicable specifications for such products or which indicate damage to the fiber connectors not resulting from defect manufacturing, shall be subject to IPG Laser' standard examination charge in effect at the time and these costs shall be charged to the Buyer. All products returned to IPG Laser which are not accompanied by an itemized statement of defects, shall be returned to the Buyer at the Buyer's expense and IPG Laser shall not carry out any evaluation of such products. IPG Laser warrants to Buyer that its services, labor and replacement parts, assemblies and modules will be free of defects in material and workmanship for ninety (90) days from the date of shipment or performance of services.
2. Warranty Returns - Domestic & *International Buyers should pay for one-way freight costs to IPG Laser. IPG Laser will reimburse Buyers for applicable reasonable third-party freight costs and IPG Laser will pay for freight return cost back to the Buyer.
3. Non-Warranty Returns - Domestic & *International Buyers are responsible for two-way freight costs. If shipment consists of returns that are both warranty and non-warranty, the shipment will be considered as non-warranty. Any UNAUTHORIZED shipments billed to IPG Laser without authorization will be re-invoiced to the Buyer. Confirming purchase orders are required for non-warranty returns.
4. *International Returns must include applicable DUTIES AND TAXES, and you must mark air bills with "RETURNED FOR REPAIR". In any event, where IPG Laser accepts a shipment, IPG Laser will invoice to the Buyer for any charges as stated above.
5. Returns for credit will not be accepted unless authorized in advance, in writing by IPG Laser, in accordance with IPG Laser' Terms and Condition, including the warranty provisions. In most cases, restocking fees will apply.
6. All returns must be packaged adequately to avoid damage during shipment.
7. Complete packing list with product model and serial number will insure prompt repair, if the other terms of this form are followed.
8. See the IPG Terms and Conditions for the applicable warranty for the products before you request the return of the products.