



High-Energy Ultrafast Laser

HE1060-series



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1. Explanation of symbols



Important information. Non-compliance with the information within these sections may result in improper operation of the laser or adversely affect the performance of the system.



Critical information. Non-compliance with the information within these sections may result in serious system damage and potentially void your warranty.



Laser safety information. These sections advise on proper conduct when operating high power laser systems. Observe the instructions to avoid personal injuries.

2. Laser Safety



Use of controls or adjustments or performance of procedures other than those specified in this manual unless performed under the direction of Fianium Engineer, may result in hazardous radiation exposure for which Fianium Ltd will not be liable. In addition, any of these operations will also void the product warranty.



The laser beam is emitted from the remote head unit at the end of the flexible cable attached to the rear of the laser enclosure where the laser aperture label is fixed.

There is a facility for an external laser safety interlock to be connected into your existing interlocks if required. The supplied D-plug has a wire loop that closes the interlock. If the interlock is opened, the laser will have to be reset. To do this, turn the key switch to the off position and return it to the on position.



This is a sealed laser unit. There is no reason to open the laser. The removal of any panels will invalidate the warranty.

3. Labels Fixed to this Unit



Classification Label
(A)



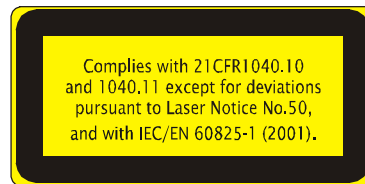
Manufactured Label
(B)



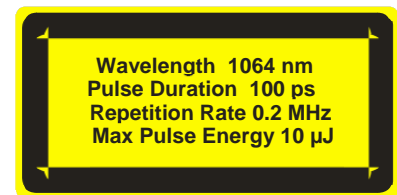
Warning
Triangle
(C)



Laser Aperture
(D)



Certification Label
(E)



Typical Product
Information Label
(F)



Serial number label
(G)



ANSI Laser Safety Label
(H)

Label A and B are fixed to the side of the Remote Head

Label C is fixed to the front panel above the Laser emission indicator

Label D is fixed on the top of the manual shutter at the front of the Remote Head

Label E and F are fixed to the side of the Remote Head

Label G is fixed on the rear panel of the System Unit.

Label H is fixed to the side of the Remote Head

4. Key Procedures to follow



Read the [Laser Safety Section](#) on Page 5 of this manual, before operating the Laser.

Connect the coaxial RF cable and remote head control cable between the chassis and the remote-head, before applying electrical power to the laser (Refer to Assembly instructions in section 9.3).

Always switch-off the laser before removing electrical power.

The HE1060 series is fitted with an external isolator. It is good practice to minimize the risk of back reflection into the laser. In particular:

1. In bulk-optic systems, please make sure that all reflective optics are not creating spurious back reflected light into the laser. Also the optics should be bolted down properly to avoid accidental spurious back reflected light into the laser.
2. When setting up a new experiment for the first time, be careful not to cause back reflection into the amplifier.

Note: There is an automatic back reflection protection in the laser. If the laser shuts down whilst aligning bulk optics, please check for optical pulse train before applying power to the laser.

5. Getting Started

Section 7 of this manual describes the HE1060 system in detail.

In order to get started using the HE1060 system, please refer to sections 9 and 11 of this manual.

Section 9 - Installation

Section 11 - PC operation of the HE1060-

When the HE1060 laser is powered, the air-cooling fans on the instrument will be enabled continuously. The speed of the fans is reduced when the key switch is in the OFF state.

When power is applied to the laser, an internal diagnostic and temperature stabilization process prevents the laser oscillator from switching on for 10 minutes (30 minutes for frequency converted systems).

If power is maintained on the system, the oscillator is self-starting and operates without a warm-up period. However, as soon as power is removed and then applied to the laser, the user will have to allow for warm-up time.

6. Introduction

The HE1060 is a high power fiber laser source with an additional output pulse modulator to enable selection of repetition rates from 1MHz down to a single pulse.

Positioned in between the master oscillator and the high-power fiber amplifier, an integrated pulse-picker system sets the fundamental pulse repetition frequency to 1MHz.

Within the remote head, an output pulse modulator allows the selection of lower frequencies down to a single pulse output and different amplitudes.

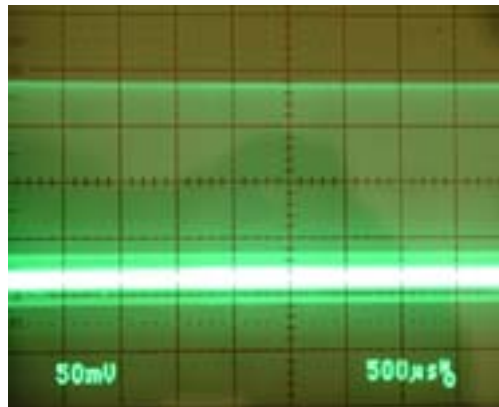
This is a Class 4 OEM laser and you must read the laser safety section of this manual before operating the laser. This product also contains pump laser diodes which are Class 4 lasers at 915nm.

7. System Description

7.1 Master Source

The master source is a passively mode-locked fiber laser which operates at a repetition rate in the MHz range, providing transform limited pulse in the picoseconds range (Please refer to the technical sheet for specifics of your units). The pulse-to-pulse stability of the master source is excellent as shown in the scope trace below.

The master source is self-starting and operates maintenance-free with high reliability since there are no bulk optic elements within the laser cavity



7.2 Power Amplifier

The high power fiber amplifier is pumped by a high power, multi-emitter laser diode pump module which is air-cooled with inlet and outlet fans forcing the air over the pump heat sink.

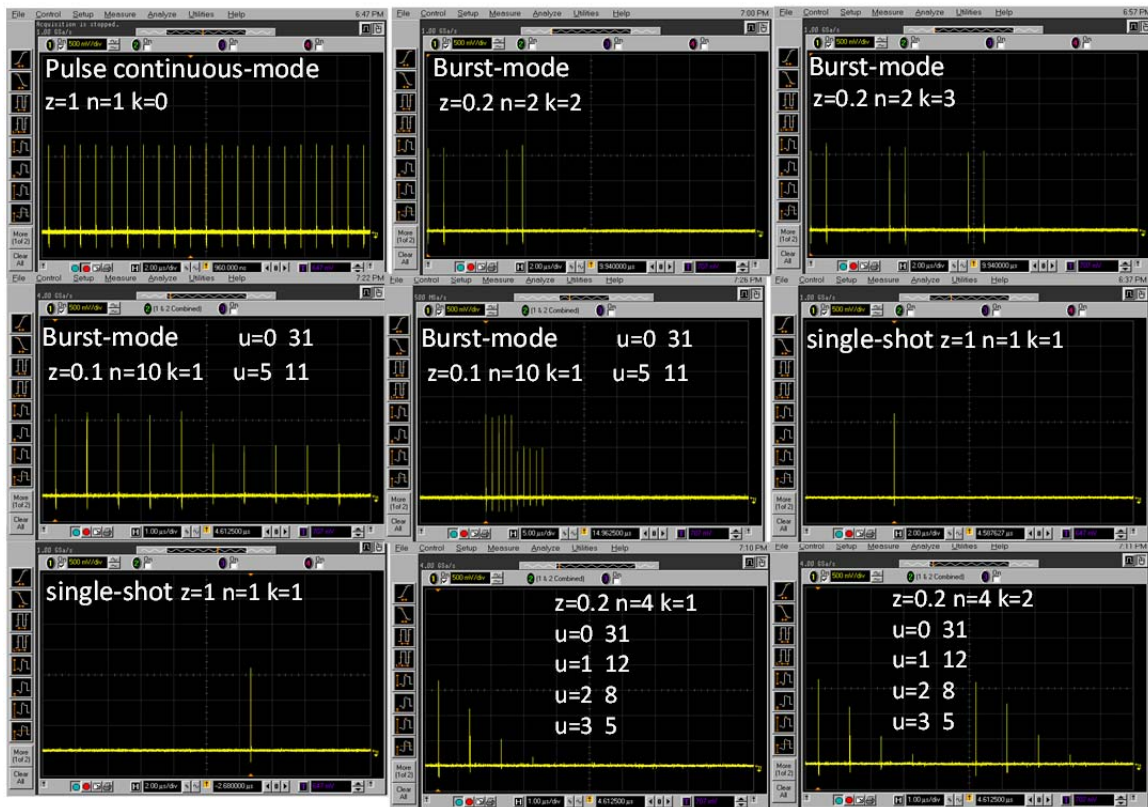
7.3 Pulse Picker (Variable Repetition-Rate Models Only)

This system allows varying the repetition-rate of the system.

This can be done via software with the `r` command (please refer to page 20 for more details on the [USB communication](#)). If the pulse picker module is enabled, the command "`r?`" will return the repetition-rate currently set, and, for example, `r=1` will select 1MHz repetition-rate. Please refer to the data sheet of your unit for information of the repetition rates available.

7.4 Output Pulse Modulator (Optional)

Located within the remote head is the second stage pulse picker. This allows the generation of lower repetition rates and more complex pulse outputs, for example single pulse output, amplitude modulated pulse outputs and burst pulse outputs. The output modulator can either be PC operated using the software commands Z, N, K, U, and TRIGGER, which are explained in section 12.3, or externally operated using a signal generator as explained below.



Examples of output pulse modulation for different command combination.

7.4.1 Externally Controlled Trigger Mode Operation (Default)

The output modulator can be externally controlled using a signal generator. In the default configuration, the modulator can only be operated via pin-13 in the interlock port, see section 8.1. The signal generator will provide a TTL signal in which the transition from low level (<1.5V) to high level (>3.5V) triggers the modulator to output a pre-defined pulse sequence using software commands Z, K, N and U.

7.4.2 Externally Controlled Gate Mode Operation (Optional)

It is also possible to externally control the output modulator in gate mode. In this option, the TTL signal provided by the external signal generator directly modulates the laser output. This is instead operated via pin-15 in the Interlock-port, and installation of a modified Firmware version is required. This should be requested as an optional feature. Because pin-15 is a digital input, this is only capable of modulation without amplitude control. Furthermore, when this option is installed, the laser output is only enabled when a high-level TTL signal is fed into pin-15 in the interlock-port.

DC Electrical Characteristics

Symbol	Parameter	T _A = +25°C		Unit	Description
		Min.	Max.		
V _{IH}	HIGH Level Input Voltage	3.5		V	Laser output enabled
V _{IL}	LOW Level Input Voltage		1.5	V	Laser output disabled

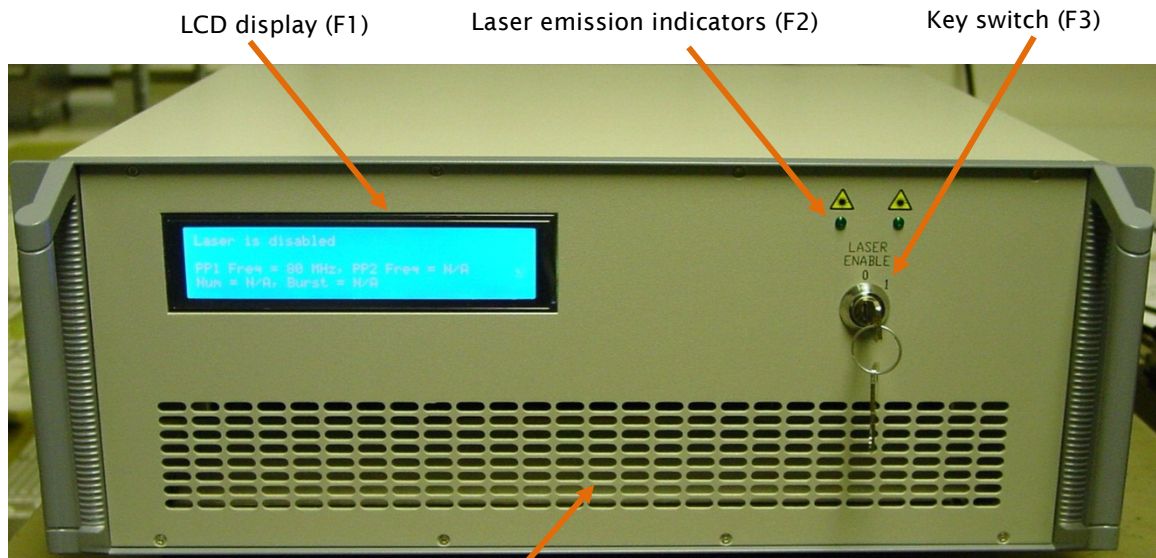
The recommended maximum input frequency of this control is 1MHz, limited by the performance of components within the laser.

7.5 Frequency conversion Module (Frequency Converted Models Only)

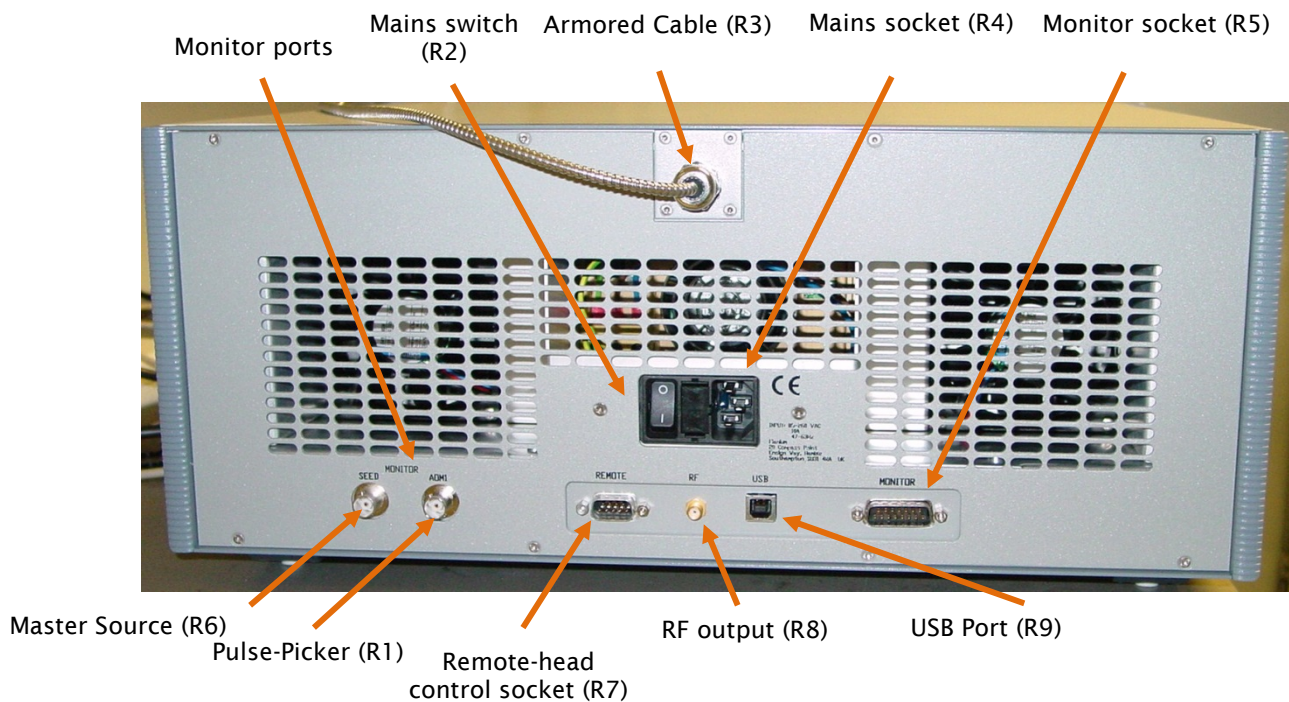
Located within the remote head is the frequency conversion module. This allows the generation of different wavelengths.

8. System Overview

The figure below shows an overview of the laser system. The front and rear panel controls and their position are shown in the images below.



Ventilation grille, do not block



8.1 Interlocks

To ensure safe operation, the laser system has a two safety interlocks that minimize the risk of user exposure to harmful laser radiation.

15-Way Plug interlock (R5).

The 15-way plug provided with the laser plugs into the Monitor socket (R5) in the main-unit rear panel.

Key switch interlock (F3)

The key switch enables the master source oscillator and the high power section of the laser. It can only be enabled if the other interlocks are enabled first.

15-Way Plug (R5)	Key switch (F3)	Laser enabled
Off	Off	Off
Off	On	Off
On	Off	Off
On	On	On

Interlock operating sequence

Provision for External Interlocks

The laser has a facility to be integrated into existing interlock systems. On the interlock 15-way plug connector, a looped wire links pins 1 and 2 enabling all laser driver modules in the system. An external interlock system can be connected to the 15-way plug connector by connecting the input and output wires to pins 1 and 2. When the interlock is activated, this opens the circuit between pins 1 and 2, and consequently, all laser modules are instantaneously disabled. The complete pin layout of the Monitor socket is shown overleaf.

Pin	Signal	Direction	Format	Description
1	Interlock	Output	+5V	Current limited output for remote interlock
2	Remote Interlock	Input	TTL	Return signal for remote interlock
3	Output level	Input	Analogue 0-5V	Analogue voltage for output power control. 0V corresponds to minimum power.
4	Modulate	Input	TTL	Switches on and off the high power amplifier stage. 0 V = disabled +5 V = enabled
5,6,7, 12,14, 15	Do not connect			With output modulator gate-mode control (optional), pin 15 is used as TTL input.
8	0 V	Ground		0V reference for control signals.
9	nAlarm	Output	TTL	Indicates when an alarm has occurred. 0 V = Alarm +5 V = No Alarm
10	nLaser Emit	Output	TTL	Indicates when the laser output has been enabled.
11	AOM2_Sync_Out	Output		This TTL output indicates when AOM2 is pulse picking.
13	Trigger	Input		This TTL input gates the AOM2 stage. It is used to start a pulse picking sequence. Active high. Pulled high internally.

8.2 Remote Socket (R7)

This socket can be used to carry photodiode and control signals between the main unit and the laser remote-head. The cable connection is only available in selected systems, and the socket should never be accessed by the customer without the correctly supplied hardware.

8.3 Master Source Pulse Train Monitor (R6)

This port can be used to monitor the pulse train produced by the master source. Use a fast oscilloscope (200 MHz or faster) with an input impedance of 50 Ohm.

8.4 Pulse-Picker Monitor Port (R1)

This port allows the operator to monitor the operation and the repetition rate of the pulse picker. It can be connected to a channel on an oscilloscope with an input impedance of 50 Ohms. This connector is only available in selected systems.

8.5 RF Output (R8) - For models with output modulator

In laser models with output modulator, this SMA connector provides an output power in excess of 2W, and it must be connected to the laser remote-head before turning on the laser power-supply.

8.6 USB Port (R9)

Use this port to connect your system to a PC. The port supports both USB 1.1 and USB 2.0 specifications. The USB socket is used for all communication between a PC and the laser system.

8.7 Status LEDs (F2)

The two green LEDs will illuminate when the key-switch (F3) is in the 1 position, indicating that the master source and the preamplifiers are operating properly. The LEDs are turned off if an alarm occurs. Refer to the "Alarms" section of the manual for information on how to identify the alarm type.

9. Installation

9.1 Storage and Transport

During storage and transportation, the ambient and environmental conditions listed below must be observed:-

Storage/Transportation conditions	Temperature: 0°C – 60°C (no freezing permitted)
	Humidity: 0 % - 90 % (no condensation)
	Pressure: 500 – 1060 hPa



After unpacking the laser, allow it to sit for 6 hours so that it can be acclimatized to its new environment.

Please use the original packaging whenever transporting the laser.

9.2 Packaging List

The following items are delivered in the package.

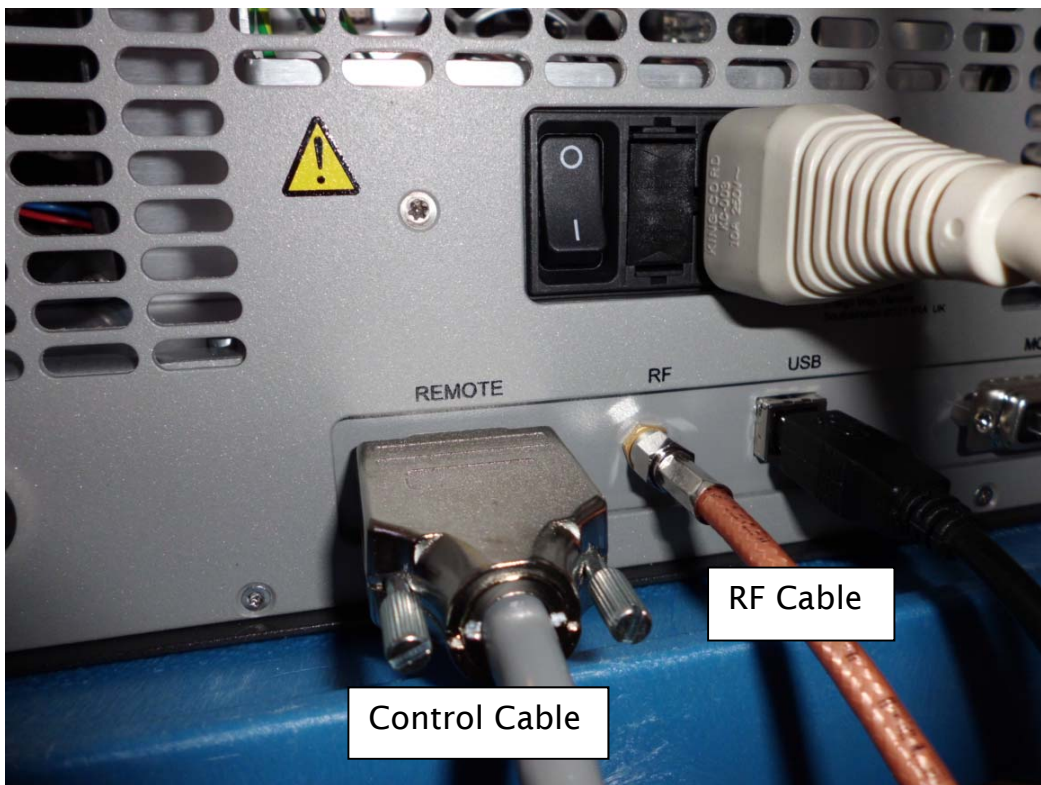
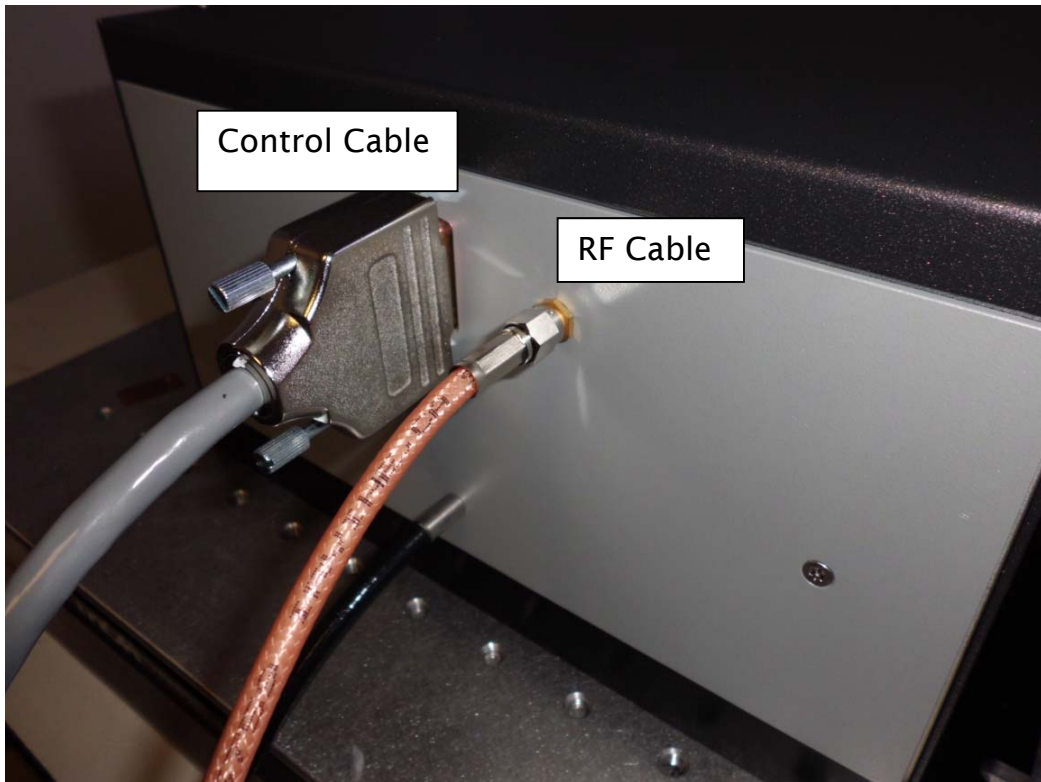
Item	Notes
System Unit	System Unit is joined to Remote-Head by an armoured tube that cannot be detached
Remote-Head	
Interlock Connector	
Interlock Key	
USB Memory Stick	Contains manual, USB driver and HyperTerminal laser Connection
Manual	
USB cable	
Coaxial RF-Cable	
Remote head signal cable.	

9.3 Assembly

When installing the laser, ensure that the air ventilation grill at the front and at the rear of the main unit are not blocked from the front out to the back.



1. Place the Remote Head on to a flat surface. Secure it in place using the four mounting brackets.
2. Place the System Unit on to a surface capable of holding its weight.
3. Fit the RF cable to the SMA socket on both the laser and the Remote Head (only for models with output modulator).
4. Plug the remote-head signal cable to the Remote Socket (R7), and then to the 15-way socket in the laser Remote Head.
5. Open the output shutter located on the front of the Remote Head. Ensure that the beam output is clear of any debris or objects capable of high back reflection.
6. Plug the 15-pin D plug on the Monitor Socket in the rear panel.
7. Insert the interlock key into the key switch.
8. Check that the mains switch is in the 'Off' position and insert the mains cable. Ensure the mains cable can be disconnected without moving the System Unit.
9. Attach the USB cable between the System Unit and a PC with Windows XP operating system or higher version.



10. Software Installation

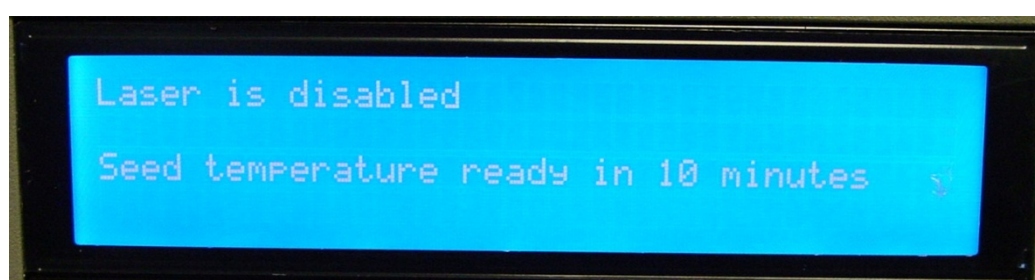
Please refer to the Software Installation Manual.

11. Operating Instructions

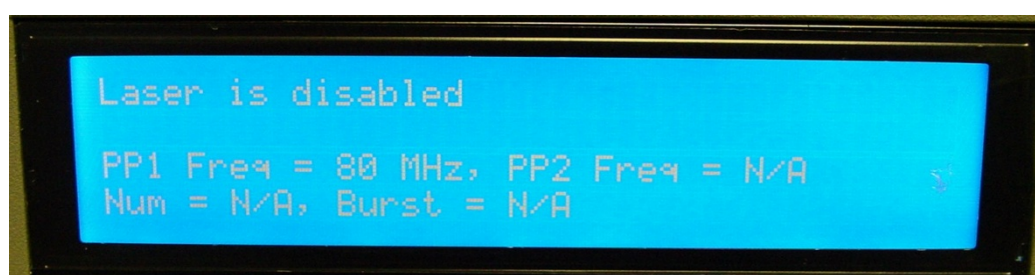
11.1 PC Operation

The laser is controlled using the USB interface on the rear panel. The front panel contains an interlock key switch, which enables and disables the laser, two laser emission warning LEDs and a status display.

For electronically switchable Wavelength models, select the type of output by typing out=0 for visible and out=1 for IR

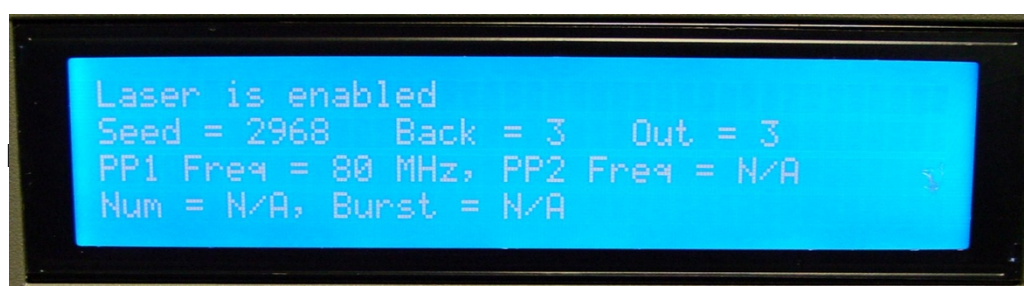


To ensure stable operation of the master source, a warm-up timer is implemented in the control software. The master source can only be enabled after the specified warm-up time has elapsed, when the master source cavity has reached a stable temperature. The time elapsed until the master source can be enabled is shown on the LCD display. Once the warm-up has completed the LCD display changes to:



The warm-up timer is implemented in software. If the mains power is disconnected, the system will go through the warm-up procedure again.

To enable the master source, turn the key switch (F3) to the 1 position. Both laser emission indicator LEDs (F2) will switch on, indicating normal operation of the laser. The LCD display will change as shown overleaf.



At this point, both the master source and the low-power optical preamplifiers are active. The master source does not require any adjustments and self-starts mode-locking operation once the laser has been enabled.

11.2 LCD Display Explained

During laser operation, the LCD display holds essential information about the status of the laser and the operation parameters of its subsystems:

The first line shows the status of the laser (enabled/disabled). Only when the laser is enabled will there be any IR light present at the output of the system.

The second line displays internal power levels collected at three points of the optical chain:

1. Seed displays the output level of the low power preamplifier that seeds the power amplifier. This value is controlled by the microprocessor and should remain constant throughout the laser operation.
2. Back displays the amount of back-reflected light recorded by the preamplifier. This value is monitored by the microprocessor and, should it get too high, the system is disabled to prevent optical damage to the high power fiber amplifiers.
3. Out is a value proportional to the output level of the laser. This parameter is enabled only in some systems.

The third and fourth lines of the display show advanced pulse information, only relevant for certain types of pulse-picked systems.

This information is available when the output modulator operates at a frequency of 1MHz or less. The number of pulses output per sequence (Num) and the number of repetitions (Burst) is displayed here.

11.3 Output Power Adjustment

Connect the laser to a PC-compatible computer using the provided USB cable (connected to the USB port (R9)). Refer to the Software Installation Manual for details on setting up the communication between the laser system and a PC. Once the laser is connected, adjust the output power using the Q command (refer to the [Software Commands](#) section on page 20 of this manual for a detailed list of software options).

11.4 Power Off Procedure

Switching off the laser is performed in the reverse order of powering up. Make sure that the amplifiers are switched off (Q=0) before the laser is disabled (key switch (F3) is moved back to 0 position).

12. USB Communication

12.1 Software Installation

Install the laser USB drivers provided on the product CD (Please refer to the SW installation manual). Install and connect the HyperTerminal application. Alternatively, you may use any COM-enabled communication handling application (PuTTY, HyperTerminal, Kermit, etc). Refer to the relevant Software Installation Manual for your operating system.

12.2 Command Reference

The USB communication between the laser and PC is carried out via a virtual COM port. The virtual COM port settings are shown below.

Parameters	Value
Data transfer rate (baud)	19200
Number of data bits	8
Parity	None
Stop bit	1
Flow control	No

The commands should be sent as ASCII strings terminated by a Carriage Return (CR) code. The laser replies are in the same format.

12.3 Software Commands

The following commands are available on the USB interface. This type of formatting allows the laser system's output to be viewed easily using terminal emulator software.

Command	Parameter	Description
A?		Get Alarms
A=	0	Clear all alarms
B?		Get back reflection monitor value
C?		Get amplifier alarm threshold (optional feature)
D?		Get master source alarm level
H?		Display list of commands
I?		Get status display interval
I=		Set status display interval
J?		Get laser serial number
L?		Get back reflection alarm level
M?		Get laser control mode
M=	1/2	Set laser control mode
N=	1-10	Number of pulses in a burst
OUT=	1/2	Set the output wavelength
O?		Get master source timer status
P?		Get preamplifier monitor value
Q?		Get amplifier control DAC value
Q=		Set amplifier current control DAC value in USB mode
S?		Get maximum permissible Q value (factory set)
R?		Get Repetition Rate
R=		Set Repetition Rate
T?		Get chassis temperature
V?		Get control software version and release date
W?		Get laser operating time counter
X?		Get status display mode
X=	0/1	Set status display mode
K	0-10	Set the number of repetitions at Output Modulator
K?	0-10	Get the number of repetitions at Output Modulator
U	0-9 0-255	Set amplitude of pulse using output modulator. Data format is: address, amplitude. Example: U=0 255 (100% transmission) U=0 0 (0% transmission)
U?		Get amplitude for this pulse. Data format is: address, amplitude
Z	0.01-R	Set Output Modulator repetition rate to this frequency in MHz. Maximum value is defined by the R= command
Z?		Get Output Modulator repetition rate to this frequency in MHz
ext	0-255	Set external sync output delay. Delay = 10ns + (ext * 500ps). This signal can be used to synchronise external electronics to the laser output
ext?	0-255	Get external sync output delay

Trigger	1	Software trigger to output programmed sequence
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13. Display Modes

The laser source has three distinct display modes, selectable by using the X command.

13.1 Scrolling Mode (X=0)

Typing X=0 at any point during laser operation enables the scrolling mode. The scrolling mode is activated only when the master oscillator is running (the master source start button is depressed and the green LED is on). If the master source is disabled, the scrolling mode also stops. In scrolling mode, the key parameters of the laser are measured and displayed. The scrolling information can be viewed on HyperTerminal or any terminal emulator software.

13.2 Default Mode (X=1)

The default mode is the mode the laser reverts to after power is removed from the laser. It is a non-scrolling mode (no information is displayed on the terminal screen). The user may enter into this mode by typing X=1.

13.3 System Integration Mode (X=2)

This mode will be enabled when the user want to integrate the laser in an automation system, controlled by a computer. The System Integration Mode is essentially identical to the Default Mode, but the information returned to the terminal is minimized, making it easier for user-written software to interpret the laser command output. Please refer to the Remote Control Manual for further information on using the System Integration Mode.

13. Alarms

When an alarm occurs, the laser is disabled and the LEDs on the front panel will switch off. The alarm can be identified using the “a?” command and can be cleared by using the command a=0 (see the [Software Commands](#) section for more details). Should the system fail to recover from an alarm please consult Fianium for assistance.

In User mode, the “A?” command returns a value indicating the type of alarm event which has been detected.

Value	Description
0	No alarm detected
1	Output power failure alarm
2	N/A
4	Mode lock alarm
8	Back reflection alarm
16	Driver alarm
32	N/A
64	N/A
128	N/A
256	Flash memory alarm
512	Power supply failure alarm

14. Laser Operation Modes

The laser can be controlled using either of the methods below. The control mode is defined using the M=command. The control mode selected is stored in long term flash memory. This means that when the laser is switched on next time, the operating mode is remembered.

The laser will be factory preset in one of the two USB control modes:

USB controlled open loop mode (M=1). In this mode, the Q= command is used on the USB interface to set the amplifier current and therefore the output power.

USB Closed loop control (M=4). In this mode, the G= command is used on the USB interface to set the output power and therefore the amplifier.

External voltage controlled open loop mode (M=2). In this mode, a voltage within the range 0V up to +5V DC is applied to pin 3 of the Monitor socket. This control voltage is used to set the amplifier current and therefore the output power.

15. Customer Service

In the unlikely event of a malfunction within your laser system, contact Fianium Ltd for remote diagnosis or return (support@fianium.com).

If the product is to be returned to Fianium, ensure that all relevant return documentation is included within the shipment. Details of the documentation required can be obtained from Fianium Ltd.

The laser source should be returned within the original packaging and include all accessories and documentation as originally delivered in order to prevent damage to the product during transport. If the original packaging is unavailable, please contact Fianium Ltd for a replacement.

End of document