Laser Software

Developer's Guide

May 2005
Part No. 90-1501A

New Wave Research contact information

New Wave Research ™ , Inc. can be reached at:
48660 Kato Road
Fremont CA 94538
Tel: 510-249-1550
Tel: 800-566-1743
FAX: 510-249-1551
E-mail: customer-service@new-wave.com
Web: http://www.new-wave.com

CONTENTS

OVERVIEW

This document describes interfacing a New Wave Research™ laser to a computer or other device using a RS232 serial connection. It covers how to use the supplied software, as well as how to write your own software for controlling the laser.

Lasers Supported

The information in this manual applies to lasers manufactured by New Wave Research™ that include an imbedded microcontroller and a RS232 (serial) computer interface, **with the exception of lasers produced prior to 2001, and those equipped with the "older" electronics package**, which use an older microcontroller and command set, and are not compatible with the software written for the newer systems.

Models supported include:

- Polaris
- Tempest
- QuikLaze 50ST
- QuikLaze 50ST2
- Orion
- EzMark
- EzLaze II
- EzLaze 3
- Jasper

Models which are NOT supported:

- MiniLase
- QuikLaze

Hardware Connection

The computer (or other controller) is connected to the laser by connecting a cable from a RS232 serial port on the computer to the RS232 port on the back of the laser. A straight-through cable should be used when connecting the computer to the laser, DO NOT USE A NULL-MODEM CABLE. Pinouts for the laser and computer are supplied below for reference.

Laser RS232 Port Pinout

The RS232 port on the back of the laser is a female DB9 connector. The pins are numbered as shown here (as viewed when looking at the back of the laser):

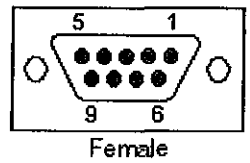

Figure 1: Female DB9 connector

Table 1: DB9 female pin number, name and description

Pin No.	Name	Description
1	+12VDC	Power for remote box. 1A maximum current
2	Tx	RS232 Transmit
3	Rx	RS232 Receive
4	NC	No connection
5	Gnd	Ground
6	NC	No connection
7	NC	No connection
8	NC	No connection
9	NC	No connection

PC Serial Port Pinout

Most PC's come with at least one serial port; usually it is a male DB9 (9-pin) connector on the back of the computer. Some older computers use a DB25 (25-pin) connector, which have a different pinout.

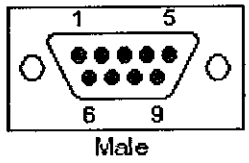

Figure 2: DB9 Male connector

Table 2: DB9 male pin number, name and description

Pin No.	Name	Description
1	DCD	Data Carrier Detect †
2	Rx	RS232 Receive
3	Tx	RS232 Transmit
4	DTR	Data Terminal Ready †
5	Gnd	Ground
6	DSR	Data Set Ready †
7	RTS	Request to Send †
8	CTS	Clear to Send †
9	RI	Ring Indicator †
† denotes signal not used by the laser interface		

Making an Interface Cable

To make your own cable to connect a PC to the laser, connect pins 2, 3 and 5 on the laser RS232 port to the same pins on the DB9 serial connector on the PC, as shown in Figure 3: Laser RS232 Interface Cable:

Laser RS232 Interface Cable

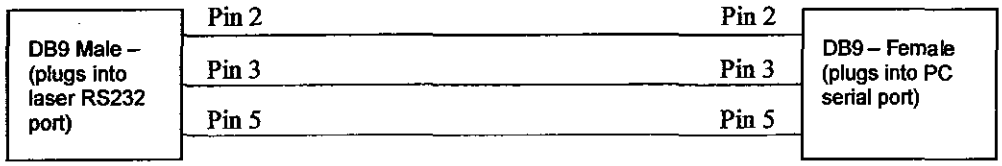

Figure 3: Laser RS232 Interface Cable

Special Note About Connecting a Palm™ Handheld Computer

It is possible to connect a Palm™ handheld computer to the laser and control it from the handheld. Many Palm computers use a serial port to connect to the PC. This same port can be used to connect to a laser however, special cabling is required. Contact New Wave Research for details on connecting a Palm to a laser.

SOFTWARE INTERFACE

It is possible to control the laser using a variety of methods: you can use the software supplied by New Wave Research ™ or you can write your own. Following are briefly described methods:

LaserExec Software

LaserExec is a Windows™ program that lets you interactively control the laser from the computer. It can:

- Store and recall settings
- Control most laser functions
- Includes on-line help that details its use and operation.

It is described in further detail later.

Writing Your Own Programs

If you need to incorporate control of the laser into your own software, New Wave Research ™ provides a variety of tools and methods to make that job easier.

32-bit Windows Operating Systems (Windows™ 95/98, Window™ NT, Windows™ 2000, Windows™ XP)

If you are working in a 32-bit Windows™ environment, you can make use of the supplied ActiveX Control component to quickly and easily integrate laser control into most development environments. New Wave Research™ also supplies Windows Dynamic Link Libraries (DLLs), Delphi VCL components and Dynamic Data Exchange (DDE) interfaces for controlling our lasers from Windows. Any of these methods frees you from having to use and understand each laser's particular command set and ensures future compatibility for your software. **If you are using Windows, the ActiveX control interface is the preferred method, for ease-of-use, future expandability and ease of maintenance.**

Other Operating Systems

For other operating systems, we provide complete documentation of the serial command set for each laser. Using this, you can write your own programs for any system that supports serial communications. **Using this method requires that you completely read and understand the command set documentation and requires that your program take responsibility for initializing the laser and setting all the required laser parameters. Additionally, your program will need to periodically check the laser status and respond to events (such as interlock conditions) accordingly.** The laser command sets are provided in separate documents.

LASEREXEC SOFTWARE

LaserExec is a Windows™ application supplied by New Wave Research™ for controlling a laser over the RS232 port. It is useful for doing simple, interactive control of the laser from the PC.

System Requirements

To install LaserExec you need the following:

- Intel-compatible PC running Windows™ 95, 98, NT 4, 2000 or XP.
- A serial port on the PC (a USB-to-RS232 adapter may be used).
- A cable for connecting the PC serial port to the laser's RS232 port.
- Approximately 1MB free disk space.

Getting the Latest Version

Go to New Wave Research ™ 's web site at www.new-wave.com to check for updates.

Installation

LaserExec is complete when you install the Laser Software Developer's Kit (SDK). It can also be installed on any computer by copying the LaserExec.EXE file.

Using LaserExec

Before starting the program, make sure the Lasers RS232 port is connected to the computers serial port and that the laser is turned on. When the program is started, LaserExec will check for a laser connected to any of the available serial ports on the computer and initialize the laser.

Press F1 at any time to view the on-line help and get detailed instructions on operating the software.

WRITING PROGRAMS TO CONTROL THE LASER

Before starting to write your own program, check with New Wave Research ™ for any updates to the documentation and/or laser interface by contacting New Wave Research ™ Technical Support.

Getting Technical Support

If you have any questions, contact New Wave Research ™ via any of the following methods:

Internet

Check New Wave Research ™ 's web site at www.new-wave.com for software and documentation updates.

Email

support@new-wave.com

Phone/Fax

Phone 510/249-1550

Fax 510/249-1551

Supported Platforms and Development Environments

Currently, New Wave Research ™ supplies software, examples and documentation for developing applications using the following operating systems and environments:

- **Operating Systems**: Windows™ 95/98, Windows™ NT 4.0, and Windows™ 2000 and XP.
- **Development Environments**: Microsoft Visual C++, Microsoft Visual Basic, Borland Delphi, Borland C++ Builder and any other Window development environment that supports ActiveX controls.

Choosing an Interface Method

You can choose a variety of different methods in your software. Each method has advantages and disadvantages. Try to avoid using the laser's RS232 command set directly; rather, use one of the provided object-oriented approaches whenever possible. Most Windows™ development environments support ActiveX controls or DDE interfaces – using one of these frees you up from having to understand the complexities of the low-level laser command set or having to change your software should changes be made to the command set in the future.

The following is a list of pros and cons of each method:

ActiveX Control

ActiveX controls are special program objects that can be integrated into Windows™ programs. Most Windows™ development environments allow you to import an ActiveX control into your program, set the properties at design-time and easily manipulate it at run-time.

Advantages:

- Supported by a wide variety of Windows™ development environments (Visual C++, Visual Basic, Delphi, LabVIEW, C++ Builder and more...). Can also be used within many applications such as Microsoft™ Word™ and Excel™.
- Built-in support for serial communications.
- Object-oriented design – simplifies many tasks and handles errors in a consistent way.
- Future compatibility – your software is isolated from future changes to the laser's low-level command set or interface hardware. Just download and install the latest ActiveX control to ensure compatibility.

Disadvantages:

- Installation – must be installed and registered on the user's system. (Most installation programs can do this automatically.)
- Only supported by 32-bit versions of Windows™.

Delphi Control

The Delphi control is similar to the ActiveX control but is supplied in a special format for use with Borland Delphi or C++ Builder only.

Advantages:

- Requires little or no code to be written.
- Requires no special installation on user's machine and can be compiled into your application.
- Object-oriented design – simplifies many tasks and handles errors in a consistent way.
- Built-in support for serial communications.
- Future compatibility – your software is isolated from future changes to the laser's low-level command set, or interface hardware. Just download and install the latest control to ensure compatibility.

Disadvantages:

- Works with Borland Delphi and Borland C++ Builder only.

Direct Control using the RS232 Command Set

The command set is the lowest level of control for the laser. Using the command set should be considered a last alternative because the disadvantages heavily outweigh the advantages.

Advantages:

- Platform and operating system independent. This is the only option currently available for DOS, Windows™ 3.1, PalmOS, Unix, Linux and other non-Windows™ platforms.

Disadvantages:

- Requires in-depth knowledge of the low-level command set and serial interface programming. The burden is on the programmer to conform to the command protocol and syntax.
- Future compatibility problems – it is possible New Wave Research ™ may make enhancements to the command set or change the interface hardware (to USB for example) such that you are required you to change your software.

ACTIVEX CONTROL

Installation/Requirements

When you install the software developer's kit (SDK), the ActiveX control is installed on your computer and registered with the system. If you plan to use the ActiveX control in your own software, you must make sure that you distribute the ActiveX control with your software and that your installation program handles registering the control with Windows™. The ActiveX control is in a file named **NWLaserXControl.OCX**. Contact New Wave Research ™ if you have any questions about file distribution.

Using the ActiveX Control

Once installed, the ActiveX control is registered with the Windows™ operating system under the object name **NWLaserXControl**, containing the CoClass **NWLaserX,** which implements the properties and methods needed to control the laser.

A help file is also included which details the specific properties and methods of the control.

To use the control in your own software, follow these steps:

1. Create an instance of the laser control object. (Some development environments do this for you automatically when you add the control to your application.)
2. Set the PortNumber property to the COM port that is connected to the laser.
3. Call the InitializeLaser function, it will return TRUE if successful.
4. Set any properties (RepRate, OutputLevel etc…) to their desired values.
5. Set the LaserEnabled property to True, this turns on the laser power supply and cooling system.
6. Check the LaserStatus to make sure that all the safety interlocks are satisfied -- the laser will not fire if any interlocks are tripped.
7. Call FireLaser to start the laser firing, call StopLaser to stop it.

Examples

Visual Basic

The following is a simple code fragment showing how to create an instance of the laser control object and an example of enabling the laser.

```
Dim Laser As Object
Sub EnableLaser
    ' Create a laser object if it hasn't been done yet
    If Laser Is Nothing Then
       Set Laser = CreateObject("NWLaserXControl.NWLaserX")
    End If
    If Laser.Initialize Then
       Laser.RepRate = 10 ' set the rep rate to 10Hz
       Laser.LaserEnabled = True' turn on the laser power supply, get it ready…
    End If
    End Sub
```

DELPHI COMPONENT

Installation/Requirements

The Delphi laser control component is supplied as a library package file (.BPL).

Refer to the Delphi documentation to install third-party components. Once installed, the laser control component should appear on your component palette under the tab named "New Wave".

A help file is also included, which can be integrated with Delphi's on-line help so that you can get help on using the component from within Delphi. Refer to your Delphi manual for information on importing third-party help files.

Using the Component

To use the component, simply place it on a form in your application, set the necessary properties and you are done! You will probably also want to add some error handling and the ability to change some of the properties at run-time. The supplied help file is the best source of up-to-date information on the details of using the component.

RS232 COMMAND SET REFERENCES

The RS232 command set represents the lowest-level way to control the laser. In most cases, it is preferable to use the ActiveX control or the Delphi component as these objects will do everything that the command set will do and are much easier to use. It is recommended that you only use the command set if you are programming in an environment that does not support ActiveX controls.

Because the command sets are slightly different for different models of lasers, the command sets for each laser are documented separately. These documents are included with the Laser SDK (Software Developers Kit), and available for downloading from the New Wave Research ™ website at www.new-wave.com.

QUIKLAZE AND POLARIS CONTROLLER COMMAND SET

This document describes the remote control interface for the following New Wave Research ™ lasers:

- QuikLaze 50ST/50ST2
- Polaris

All of these lasers are water-cooled and share a common command set. Some commands are dependent on certain options which may or may not be available on a specific laser. This document describes the hardware interface, the protocol and syntax used by all the commands, and describes each command in detail.

Laser Software Developer's Kit for Windows™

If you are writing software to control the laser with Windows 98, NT, 2000, or XP, it is recommended that you use the ActiveX or DLL interfaces supplied with the New Wave Research ™ Laser (SDK). This will streamline your software development efforts and insure future compatibility. Contact New Wave Research ™ to get a copy of the Laser SDK, or visit www.new-wave.com for more information.

Specifications Subject to Change

New Wave Research ™ reserves the right to make changes to the laser command sets and implementation described in this document. We always strive to maintain backward compatibility whenever possible, but cannot guarantee that changes we make will not impact customer-written code. Following the guidelines and examples in this document will minimize the chance that any future changes to the laser hardware or firmware will impact your software.

HARDWARE CONNECTION

The computer (or other controller) is connected to the laser by connecting a cable from a RS232 serial port on the computer to the RS232 port on the back of the laser. A straight-through cable should be used when connecting the computer to the laser, DO NOT USE A NULL-MODEM CABLE. Pinouts for the laser and computer are supplied herein for reference.

Laser RS232 Port

The RS232 port on the back of the laser is a female DB9 connector. The pins are numbered as shown here (as viewed when looking at the back of the laser):

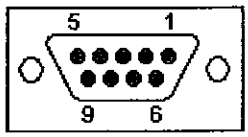

Figure 4: DB9 female pins

Table 3: DB9 connector pin assignment

Pin No.	Name	Description
1	+12VDC	Power for remote box. 1A maximum current.
2	Tx	RS232 Transmit
3	Rx	RS232 Receive
4	NC	No connection
5	Gnd	Ground
6	NC	No connection
7	NC	No connection
8	NC	No connection
9	NC	No connection

PC Serial Port

Most PC's come with at least one serial port; usually it is a male DB9 (9-pin) connector on the back of the computer. Some older computers use a DB25 (25-pin) connector, which have a different pinout.

PC Serial Port

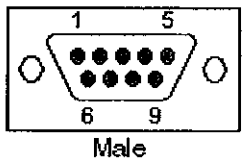

Figure 5: Male PC Serial Port connector

PC Serial Port

Table 4: Male Serial port Pin no., Name and Description

Pin No.	Name	Description
1	DCD	Data Carrier Detect †
2	RxD	RS232 Receive
3	TxD	RS232 Transmit
4	DTR	Data Terminal Ready †
5	Gnd	Ground
6	DSR	Data Set Ready †
7	RTS	Request to Send †
8	CTS	Clear to Send †
9	RI	Ring Indicator †
† denotes signal not used by the laser interface		

Interface Cable

If you wish to make your own cable to connect a PC to the laser, all you need to do is to connect pins 2,3 and 5 on the laser RS232 port to the same pins on the DB9 serial connector on the PC, as shown below:

Laser RS232 to PC Interface Cable

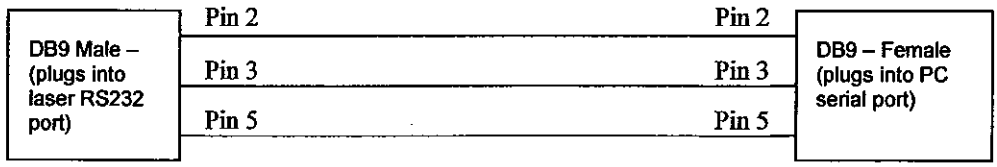

Figure 6: Laser RS232 to PC Interface Cable

SERIAL PORT PROTOCOL

The laser uses the following RS232 serial communication protocol:

- Baud Rate: 9600.
- Stop Bits: 1.
- Parity: None.
- Flow Control: None.
- Hardware Handshaking: None.

Make sure that the host computer or controller has its serial port setup using these parameter values.

COMMAND SYNTAX

All commands (except the global commands) use ASCII characters and are composed of the following fields:

<Prefix><Address><Command String>[Parameters]<Terminator>

Field	Description
Prefix	Single semicolon character ";", must precede all commands. All devices will reset their command input buffer when the prefix is received.
Address	2 ASCII characters. All lasers use "LA" for their address.
Command String	Commands are specific to each device -- see the following sections for the commands that each device supports.
Parameters	Some commands may have parameters which immediately follow the command string. Multiple parameters are separated by commas. You must supply the correct number of characters for all parameters under all circumstances. For example, if a command expects a three-digit value, then the parameter must in the form "000", "001"... "100" etc.
Terminator	ASCII carriage return character (decimal value 13). The receiving device does not process any commands until the terminator is received.

Command Types

There are two types of commands; Control Commands that set a value or initiate an action and Query Commands that request information. (The laser will respond in accordance with the command.)

Control Commands

A device must always parse a control command and return a response immediately.

- If the command is a recognized command and the parameter is valid, then the device returns an "OK<CR>". (<CR> = ASCII carriage return, decimal value 13).
- If the command is not recognized by the device, then it responds with "?0<CR>.
- If the command is recognized, but the parameter value is missing or invalid, then the device responds with a "?1<CR>".
- If the command is recognized, but the controller is not in serial (RS-232) mode, then the device responds with a "?2<CR>".
- If the command is recognized, but the controller cannot execute it at this time, then the device responds with a "?3<CR>".
- If the command is recognized, but the command refers to an option not installed on the laser, then the device responds with a "?4<CR>".

If a control command is received while the device is executing a previous command and the commands are mutually exclusive (cannot be executed in parallel), then the previous command is aborted and the new one executed. It is up to the host controller (the PC) to poll the device and make sure the previous command is finished when required.

Query Commands

Query commands return a value to the PC as soon as the command is parsed and executed. The value returned will depend on the command. The response is always terminated with a <CR>. If a query command is not recognized by the device, then a "?0" is returned.

Global Commands

Global commands are commands accepted by any device on the serial bus and do not need to include the prefix, address or terminator fields. Currently, the only global command is the ESC character (ASCII escape, decimal value 27). Sending an ESC character will stop firing the laser if it is running.

LASER CONTROLLER COMMAND SET

Following are the commands recognized by the laser. For clarity, the command prefix, address and terminator characters are not shown in the descriptions, but must be included when sending a command. For example, the complete form of the **AT?** command is **";LAAT?**<cr>" (where <cr> = ASCII 13).

Parameters

Command parameters are denoted by a "#" character, with the number of "#" characters corresponding to the number of digits or characters expected in the parameter. You must always supply the correct number of digits for a parameter. For example, if a command expects 3 digits and the parameter value is 0 (zero), a "000" must be sent.

AT?, AT### Laser Output Attenuator Control-- an "AT?" returns the current attenuator setting from 000 to 255. An "AT###" sets the attenuator position to the requested value. The ### parameter is 3 digit decimal number ranging from 000 to 255. To get the maximum energy out of the laser, set this value to 255; 0 (zero) will yield the minimum amount of energy. While the attenuator motor is moving, the *Motor Moving* bit will be set (see the SS command). Note: The attenuator must be installed on the laser – see the **SV?** command for details.

BU?, BU##### Set Burst Count -- sets the maximum number of shots that will be fired when laser is in Burst Mode. Values are from 0001 to 4000 in ASCII decimal. A "BU?" will return the current burst count setting. See also the MO command.

DQ?, DQ# Disable/Enable Q-Switch -- this disables/enables the Q-switch. A "DQ1" disables the Q-switch and a "DQ0" enables the Q-switch to fire. The laser will not produce output pulses when the Q-switch is disabled. A "DQ?" returns the current status as either a "0" (zero) or a "1". This is overridden if external triggering of the Q-switch is used via rear panel switch. The laser defaults to having the Q-switch enabled at power up. See also the QD command.

EC?, EC# Command Echo Enable/Disable -- an "EC1" will enable command echoing and "EC0" will disable it. The laser defaults to echo off at power up. A "EC?" will return the current status. A "1" indicates enabled, and a "0" (zero) indicates disabled.

GO Laser Fire Command -- will start firing the laser if the laser has been started and is ready. The laser must be enabled with the ON command and all safety interlocks must be satisfied in order to fire the laser.

HS#?, HS?, HS# Laser Wavelength Control -- an "HS#" sets the current position of the wavelength wheel to the specified value. Each position of the wavelength wheel corresponds to a different output wavelength. See the NH? command for how many positions is possible. The wavelength wheel must be installed to set the wavelength position. (See the **SV?** command for how to tell if the wheel is installed.

While the wavelength wheel motor is moving, the *Motor Moving* bit will be set (see the SS command), the laser cannot be fired, and no other motors can be moved.

An "HS#?" returns the filter *configuration byte* for the specified hole number on the wavelength selector wheel. The hole number is a single-digit decimal value from 0 (zero) to 6. The value of the filter configuration byte indicates which wavelength will selected by the specified hole on the wavelength selector wheel. "HS0?" will return the filter configuration byte for the default output wavelength on a single-wavelength system (without a selector wheel).

Values for the filter configuration byte are:

Bit 7	**Bit 6**	**Bits 5-2**	**Bits 1-0**
Reserved for internal use	Attenuator Polarity	Wavelength Selection	Filter Energy Transmission
	0 = normal 1 = reversed	0000 = none 0001 = IR 0010 = Green 0011 = UV 0100-111 = reserved	00 = none 01 = low 10 = high 11 = n/a

0 0 0 0 1 0 1 0

0 0 8 2 = 10_{10}

IS

Get Interlock and Laser Status -- returns a 2-digit ASCII hex value corresponding to the current interlock state. Bit numbers in the following table go from to 0 (zero) (the least significant bit) to 7 (the most significant bit). **NOTE: You must periodically (at least once every two seconds) send either the IS or SS command to poll the laser status while it is enabled, or it will shutdown automatically.**

Bit Number	Name	Description
0	Flow Switch	A 1 indicates that the coolant flow interlock is NOT satisfied. It is normal for this bit to be set whenever the coolant pump is not running. See the ON command for details.
1	Temperature	A 1 indicates that the laser has overheated.
2	External Interlock	A 1 indicates that the external interlock is NOT satisfied. The laser cannot be started or fired until this interlock is satisfied
3	Workpiece Interlock	A 1 indicates that the workpiece interlock is NOT satisfied. The laser will not fire unless this interlock is satisfied. This interlock will only inhibit firing, it will not shut down the laser.
4	Laser On	Indicates that the laser power supply is enabled. See the ON command.
5	Laser Firing	Indicates that the laser is firing. See the GO command.
6	Laser Starting	Indicates the laser is in its startup state. When a laser is first enabled with the ON command, it will be in the startup state for about 10 seconds, during which time it cannot be fired.
7	RS232 Mode	A 1 indicates that the laser is in remote mode. This bit MUST be set to control the laser over the serial port. See the SM command for details.

Figure 7: Bit, Number Name and Description

LT?

Get Laser Type -- returns a decimal digit corresponding to the current laser type:

1 = Polaris

2 = EzLaze II and EzLaze 3

3 = QuikLaze family

4 = Tempest

5 = Jasper

6 = Orion

7 = EzMark

8 = Pegasus

MD? Get Manufacture Date -- returns the manufacture date of the laser in the format MM/DD/YY. For example, a date of Sept 10, 2000 would be received as "09/10/00".

MO?, MO# Laser Fire Mode -- an "MO#" command selects the current firing mode, where # = 0 (zero) for Continuous, 1 for Single shot, 2 for Burst. See also the BU command.

MR? Maximum Repetition Rate -- returns the maximum rep rate of the laser in Hertz (Hz) as a 3-digit decimal value. For example, a 20Hz laser will return "020".

NH? Number of Holes -- returns the number of holes available on the marker or wavelength wheel. If a wavelength wheel is installed it will always return a 6, if a marker wheel is installed, it will return a value corresponding to the number of apertures loaded.

OF Laser Off -- will put the laser into the Stop state and shut off the coolant pump and high-voltage network. The laser cannot be fired from this state.

ON Laser On -- initiates the startup of the laser power supply, turns on the coolant pump, enables the high-voltage network and puts the laser into the Standby state. Will not fire laser. The laser will go through a 10-second startup period when going from the Stop state to the Standby state. The *Laser Starting* bit will be set during this period (see the IS and SS commands for details). All safety interlocks must be satisfied to put the laser into the Standby mode.

ENABLES LASER— STATUS MSG REQD. TO MAINTAIN (10 SECS)

PM?, PM# Pulse Mode -- enables or disables the long pulse mode. When enabled, the q-sw pulse is increased for welding applications. When disabled, the standard q-sw pulse length is used. A "1" enables long pulse mode and a "0" (zero) disables (default) it. A "?" will return the current mode ("1" = long pulse, "0" (zero) = short pulse).

RP#### Rotating Polarizer -- sets the rotating polarizer position. Parameters are decimal values from 0 (zero) to the maximum channel travel. The maximum travel is found by sending the RPT? query command. This will return a decimal value from 0000 to 1024. The RP? will return the current position of the channel. This command is only valid if the polarizer option is installed. (See the SV? command).

While the polarizer motor is moving, the *Motor Moving* bit will be set (see the SS command), and no other motors can be moved.

RPxxx Rotating Polarizer Position -- sets a new rotating polarizer position measured in motor steps.

RP? Rotating Polarizer Position Query -- will return the current rotating polarizer position in steps.

RPT? Rotating Polarizer Travel Query -- will return the current maximum rotating polarizer travel in steps.

RPTZxxx! Rotating Polarizer Travel Zero -- will set a new zero offset value. Parameters are in motor steps. After homing the motors, this is the amount the motor will be moved off the hardstop. Default value is 10 steps.

RPTZ? Rotating Polarizer Travel Zero Query -- will return the current zero offset amount in motor steps.

RR?, RR### Laser Repetition Rate-- the RR### command sets the current laser pulse repetition rate in Hz up to the maximum of the laser (see the MR? command). The parameter is a 3-digit ASCII decimal number. A "RR?" will return the current rep rate of the laser. If queried when not in RS-232 mode, the value returned will reflect the 0 (zero) to 5V direct port input for the rep rate.

RS Reset -- resets the controller to power up condition. Laser is shut down and stopped. All outputs are set to initial conditions.

SC Laser Shot Count -- returns an 8-digit ASCII hex value corresponding to current shot count. Values range from 00000000 to FFFFFFFF in hex.

SM#, SM? Serial Mode -- turns on or off RS-232 control. 0 (zero) = serial mode off, 1 = serial mode on. Laser is stopped when serial mode is turned on or off. The laser will not accept any control commands (only queries) unless it is in serial mode. A "SM?" returns the current setting.

SN? Serial Number -- returns the currently set serial number of the system as a 6-digit ASCII decimal number.

SP?, SP### Spot Marker Control.-LED (Available only for EzLaze II, EzLaze 3 and QuikLaze 50ST/50ST2).

A SP### command sets the current spot marker value from between 000 to 255 in decimal. A "SP?" returns the current setting.

SR+/-##, SR?, SRT? Shutter Rotation Control -- an SR+/-## command sets the number of degrees (in decimal) and the direction to rotate the X/Y shutters, where the rotation can range from -Max Travel to + Max Travel. For example, to set the shutter rotation to +45 degrees, send "SR+45". A "SR?" command will return the current rotation angle in degrees. The maximum travel is found by sending the SRT? query command. This will return a decimal value from 0000 to 1024. Default maximum travel values will be 90 degrees. Special systems may have extended travel amounts. The shutter rotation option must be installed to use this command – see the SV command for details.

While the shutter motor is moving, the *Motor Moving* bit will be set (see the SS command), and no other motors can be moved.

SS

Get System Status -- Returns a six-digit ASCII hex value related to the current state of the system. **NOTE: You must periodically (at least once every two seconds) send either the IS or SS command to poll the laser status while it is enabled, or it will shutdown automatically.** A one (1) in the bit position indicates that the status is enabled. Bit numbers in the following table go from to 0 (zero) (the least significant bit) to 23 (the most significant bit).

Table 5 Bit Number, Name and Description hex value

Bit Number	Name	Description
0	Flow Switch	A 1 indicates that the coolant flow interlock is NOT satisfied. It is normal for this bit to be set whenever the coolant pump is not running. See the ON command for details.
1	Temperature	A 1 indicates that the laser has overheated.
2	External Interlock	A 1 indicates that the external interlock is NOT satisfied. The laser cannot be started or fired until this interlock is satisfied
3	Workpiece Interlock	A 1 indicates that the workpiece interlock is NOT satisfied. The laser will not fire unless this interlock is satisfied. This interlock will only inhibit firing, it will not shut down the laser.
4	Laser On	Indicates that the laser power supply is enabled. See the ON command. †
5	Laser Firing	Indicates that the laser is firing. See the GO command. †
6	Laser Starting	Indicates the laser is in its startup state. When a laser is first enabled with the ON command, it will be in the startup state for about 10 seconds, during which time it cannot be fired.
7	RS232 Mode	A 1 indicates that the laser is in remote mode. See the SM command for details.
8	Ext. Q-Switch	A 1 indicates that the Q-switch is set to external trigger mode.
9	External Trigger	A 1 indicates that the flashlamp is set to external trigger mode
10	Single Shot Mode	A 1 indicates that the laser is in single-shot mode. See the MO command.
11	Variable Mode	A 1 indicates that the laser is in continuous fire mode. See the MO command.
12	Burst Mode	A 1 indicates that the laser is in burst fire mode. See the MO command.
13	Q-Switch Disabled	A 1 indicates that the Q-switch is disabled. See the DQ command.

Bit Number	Name	Description
14	Fixed Rep Rate Mode	A 1 indicates that the laser is in fixed repetition rate mode.
15	Warm-up Mode	A 1 indicates that the laser is firing in warm-up mode (with the Q-switch disabled). See the WU command for details.
16	Closed Loop Range Warning	A 1 indicates that the closed loop control system cannot meet the current energy target with any attenuator setting between 0 (zero) and 100%. (Bit 16 is used on QuikLaze 50ST and QuikLaze 50ST2 only).
17	Unused	50ST with closeloop CES or QuikLaze 50ST2 with IR, Green ORUV3.
18	Motors Homing	A 1 indicates that the laser is initializing the position of one of the motor-driven accessories such as the wavelength wheel, attenuator or marker wheel. While the motor(s) are homing, the laser cannot be fired and the position of any of the accessories cannot be controlled. The laser only goes through the homing sequence when first powered up or after a RS command.
19	Coolant Low	A 1 indicates that the coolant level in the reservoir is low.
20	Motor Moving	A 1 indicates that one of the accessory motors is moving into position. Only one motor can be moved at a time.
21	OK to Start	A 1 indicates that the laser can be started (ie. the ON command can be sent).
22	OK to Fire	A 1 indicates that the laser can be fired.
23	Reset Fault	A 1 indicates that a laser power supply reset fault has occurred. This is a fatal error and will require resetting the laser to recover.

ST Stop Laser Firing -- ceases laser pulsing. Does not turn off the high voltage or flashlamp simmer, only stops triggering.

SV? Get Accessory Configuration -- returns a two-digit ASCII hex value that indicates which accessory controls are currently installed on the laser. A one (1) in the bit position indicates that the option is installed.

Table 6 Accessory configuration

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Unused	Rotating Polarizer	XY Shutter Rotation	Marker Wheel	Wavelength Selector Wheel	Y Shutter	X Shutter	Attenuator

Description of Options

Attenuator – used for fine control of the output energy of the laser.

X Shutter, Y Shutter – The XY Shutter is a 2-axis adjustable output aperture that can be used to change the size of the beam.

Wavelength Selector – Used to select the laser output wavelength.

Marker Wheel – Selects different beam sizes and shapes.

XY Shutter Rotation – Allow the XY Shutter to rotate the aperture as well as adjust its size.

Polarizer – Provides control of the beam's polarization.

VO?, VO### PFN Voltage Setting -- the VO### command sets the voltage of the PFN (Pulse Forming Network) to control the output of the laser. The parameter is a 3-digit ASCII decimal value between 000 and 255. VO? returns the current setting.

VN Version Number -- returns the firmware version number as a number in the form "*Major.Minor*". For example: "1.2".

WU?, WU#### Enable laser "warm-up" mode -- the WU#### command will fire the laser for the specified number of pulses are the current rep rate *with the Q-switch disabled* (no pulses will be emitted from the laser). The parameter is a four-digit ASCII decimal number between 0000 and 4000. A value of 0000 disables the warm-up function. A WU? returns the current setting. See the SS command for details on how to tell when the laser is in warm-up mode.

XS?, XS###, XT? X Shutter Control -- sets the X shutter aperture position. Parameter is a decimal number ranging from 0 (zero) to the maximum shutter travel, with 0 (zero) = closed and maximum = full open. A "XS?" returns the current X shutter setting from 0000 to maximum. The maximum shutter travel can be queried by sending the XT? command. This will return a decimal value from 0000 to 1024 corresponding to the maximum shutter travel. This command is only valid if the X Shutter option is installed. (See the SV? command.)

While the shutter motor is moving, the *Motor Moving* bit will be set (see the SS command), and no other motors can be moved.

YS?, YS###, YT? Y Shutter Control -- sets the Y shutter aperture position. Parameter is a 3-digit decimal number ranging from 0 (zero) to the maximum shutter travel, with 0 (zero) = closed and maximum = full open. A "YS?" returns the current Y shutter setting from 0000 to maximum. The maximum shutter travel can be queried by sending the YT? command. This will return a decimal value from 0000 to 1024 corresponding to the maximum shutter travel. This command is only valid if the XY Shutter option is installed. (See the SV? command.)

While the shutter motor is moving, the *Motor Moving* bit will be set (see the SS command), and no other motors can be moved.

EXAMPLES

The following examples show the general procedure recommended for controlling the laser.

Initializing the Laser

Open the serial port.

Send ";LAVN" to check the firmware version number.

Send ";LASM1" to enable serial port control of the laser. The laser should send back an "ok".

Send ";LASS" to check the status of the safety interlocks and motors. Wait until the Motor Moving bit is cleared before proceeding.

If safety interlocks are satisfied, then send ";LAON" to put the laser in Standby mode.

Polling the Status

You must periodically (at least once every two seconds) send either the ";LAIS" or ";LASS" command to poll the laser status while it is enabled (after sending the ";LAON" command), or it will shutdown (return to the Stop state) automatically. This is a safety precaution, so that should the software crash the laser will not be left in an unsafe state for too long a period.

Firing the Laser

Set the desired laser energy, aperture settings, wavelength etc... .

Send ";LAGO" to start the laser firing.

Send ";LAST" to stop firing.

Send ":LAOF" to put the laser into the Stop state.

EZLAZE II, EZMARK, AND ORION CONTROLLER COMMAND SETS

This document describes the remote control interface for the following New Wave Research ™ lasers:

- EzLaze II
- EzLaze 3
- EzMark
- Orion

All of these lasers are air-cooled and share a common command set. Some commands are dependent on options which may or may not be available on a specific laser. This section describes the hardware interface, the protocol and syntax used by all the commands, and describes each command in detail.

Laser Software Developer's Kit for Windows™

If you are writing software to control the laser with a computer using Windows 98, NT, 2000, or XP, it is recommended using the ActiveX , DDE, or DLL interfaces supplied with the New Wave Research ™ Laser Software Developer's Kit (SDK). This will streamline your software development efforts and insure future compatibility. Contact New Wave Research ™ to get a copy of the Laser SDK, or visit www.new-wave.com for more information.

Specifications Subject to Change

New Wave Research ™ reserves the right to make changes to the laser command sets and implementation described in this document. We always strive to maintain backward compatibility whenever possible, but cannot guarantee that changes we make will not impact customer-written code. Following the guidelines and examples in this document will minimize the chance that any future changes to the laser hardware or firmware will impact your software.

HARDWARE CONNECTION

The computer (or other controller) is connected to the laser by connecting a cable from a RS232 serial port on the computer to the RS232 port on the back of the laser. A straight-through cable should be used when connecting the computer to the laser, DO NOT USE A NULL-MODEM CABLE. Pinouts for the laser and computer are supplied herein for reference.

Laser RS232 Port

The RS232 port on the back of the laser is a female DB9 connector. The pins are numbered as shown here (as viewed when looking at the back of the laser):

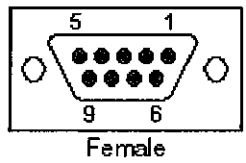

Figure 8: Female RS232 pinout

Table 7: Pin Number, Name, and Description of the female RS232 pinout

Pin No.	Name	Description
1	+12VDC	Power for remote box. 1A maximum current.
2	Tx	RS232 Transmit
3	Rx	RS232 Receive
4	NC	No connection
5	Gnd	Ground
6	NC	No connection
7	NC	No connection
8	NC	No connection
9	NC	No connection

PC Serial Port

Most PC's come with at least one serial port; usually it is a male DB9 (9-pin) connector on the back of the computer. Some older computers use a DB25 (25-pin) connector, which have a different pinout.

PC Serial Port

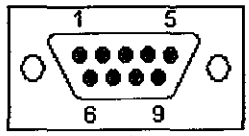

Figure 9: Male RS232 pinout

PC Serial Port

Table 8: Table 1 Pin Number, Name, and Description of the male RS232 pinout

Pin No.	Name	Description
1	DCD	Data Carrier Detect †
2	Rx	RS232 Receive
3	Tx	RS232 Transmit
4	DTR	Data Terminal Ready †
5	Gnd	Ground
6	DSR	Data Set Ready †
7	RTS	Request to Send †
8	CTS	Clear to Send †
9	RI	Ring Indicator †
† denotes signal not used by the laser interface		

Interface Cable

To make your own cable connecting a PC to the laser, connect pins 2,3 and 5 on the laser RS232 port to the same pins on the DB9 serial connector on the PC, as shown below:

Laser RS232 to PC Interface Cable

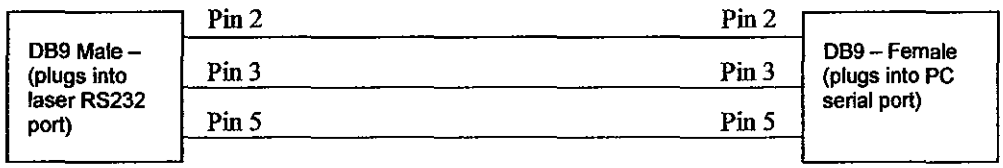

Figure 10: Interface Cable for Laser RS232 to PC

SERIAL PORT PROTOCOL

The laser uses the following RS232 serial communication protocol:

- Baud Rate: 9600.
- Stop Bits: 1.
- Parity: None.
- Flow Control: None.
- Hardware Handshaking: None.

Make sure that the host computer or controller has its serial port setup using these parameter values.

COMMAND SYNTAX

All commands (except the global commands) use ASCII characters and are composed of the following fields:

<Prefix><Address><Command String>[Parameters]<Terminator>

Table 9: Command Syntax

Field	Description
Prefix	Single semicolon character ";", must precede all commands. All devices will reset their command input buffer when the prefix is received.
Address	2 ASCII characters. All lasers use "LA" for their address.
Command String	Commands are specific to each device -- see the following sections for the commands that each device supports.
Parameters	Some commands may have parameters which immediately follow the command string. Multiple parameters are separated by commas. You must supply the correct number of characters for all parameters under all circumstances. For example, if a command expects a three-digit value, then the parameter must in the form "000", "001"... "100" etc.
Terminator	ASCII carriage return character (decimal value 13). The receiving device does not process any commands until the terminator is received.

Command Types

There are two types of commands: Control command that set a value or initiate actions and Query Commands that request information. The laser will respond in the proper manner to each type of command.

Control Commands

A device must always parse a control command and return a response immediately.

- If the command is a recognized command and the parameter is valid, then the device returns an "OK<CR>". (<CR> = ASCII carriage return, decimal value 13).
- If the command is not recognized by the device, then it responds with "?0<CR>
- If the command is recognized, but the parameter value is missing or invalid, then the device responds with a "?1<CR>".
- If the command is recognized, but the controller is not in serial (RS-232) mode, then the device responds with a "?2<CR>".
- If the command is recognized, but the controller cannot execute it at this time, then the device responds with a "?3<CR>".
- If the command is recognized, but the command refers to an option not installed on the laser, then the device responds with a "?4<CR>".

If a control command is received while the device is executing a previous command and the commands are mutually exclusive (cannot be executed in parallel), the previous command is aborted and the new one executed. It is up to the host controller (the PC) to poll the device and make sure the previous command is finished when required.

Query Commands

Query commands return a value to the PC as soon as the command is parsed and executed. The value returned will depend on the command. The response is always terminated with a <CR>. If a query command is not recognized by the device, then a "?0" is returned.

Global Commands

Global commands are commands accepted by any device on the serial bus and do not need to include the prefix, address, or terminator fields. Currently, the only global command is the ESC character (ASCII escape, decimal value 27). Sending an ESC character will stop firing the laser if it is running.

LASER CONTROLLER COMMAND SET

The commands recognized by the laser are described in this section. For clarity, the command prefix, address and terminator characters are not shown in the following descriptions, but must be included when sending a command. For example, the complete form of the **AT?** command is **";LAAT?**<cr>" (where <cr> = ASCII 13).

Parameters

Command parameters are denoted by a "#" character, with the number of "#" characters corresponding to the number of digits or characters expected in the parameter. You must always supply the correct number of digits for a parameter, for example, if a command expects 3 digits and the parameter value is 0 (zero), a "000" must be sent.

AT?, AT### Laser Output Attenuator Control -- an "AT?" returns the current attenuator setting from 000 to 255. An "AT###" sets the attenuator position to the requested value. The ### parameter is 3 digit decimal number ranging from 000 to 255. To get the maximum energy out of the laser, set this value to 255; 0 (zero) will yield the minimum amount of energy. While the attenuator motor is moving, the *Motor Moving* bit will be set (see the SS command). See also the EN command for setting the energy range.

Note: The attenuator must be installed on the laser. (See the **SV?** command for details.)

DQ?, DQ# Disable/Enable Q-Switch -- this disables/enables the Q-switch. A "DQ1" disables the Q-switch and a "DQ0" enables the Q-switch to fire. The laser will not produce output pulses when the Q-switch is disabled. A "DQ?" returns the current status as either a "0" (zero) or a "1". This is overridden if external triggering of the Q-switch is used via rear panel switch. The laser defaults to having the Q-switch enabled at power up. See also the QD command.

EC# Command Echo Enable/Disable -- an "EC1" will enable command echoing and "EC0" will disable it. The laser defaults to echo off at power up.

EN?, ENL, ENH Output Energy Range Control -- an "ENH" will set the energy level to the high energy range and a "ENL" will set it to the low energy range. This control is used for coarse energy control – use the AT command for fine energy control. An "EN?" returns the current energy high/low setting, as either an "H" or "L".

GO Laser Fire Command -- will start firing the laser if the laser has been started and is ready. The laser must be enabled with the ON command and all safety interlocks must be satisfied in order to fire the laser.

HS#?, HS?, HS# Laser Wavelength Control -- an "HS#" sets the current position of the wavelength wheel to the specified value. Each position of the wavelength wheel corresponds to a different output wavelength. See the NH? command for how to tell how many positions are possible. The wavelength wheel must be installed to set the wavelength position. (See the **SV?** command to tell if the wheel is installed.)

While the wavelength wheel motor is moving, the *Motor Moving* bit will be set (see the SS command), the laser cannot be fired, and no other motors can be moved.

The "HS?" command returns the current wheel position.

An "HS#?" returns the filter *configuration byte* for the specified hole number on the wavelength selector wheel. The hole number is a single-digit decimal value from 0 (zero) to 6. The value of the filter configuration byte indicates which wavelength will selected by the specified hole on the wavelength selector wheel. "HS0?" will return the filter configuration byte for the default output wavelength on a single-wavelength system (without a selector wheel).

Values for the filter configuration byte are:

Table 10: Filter configuration byte values

Bits 7-6	**Bits 5-2**	**Bits 1-0**
Attenuator Polarity	Wavelength Selection	Filter Energy Transmission
00 = normal 01 = reversed	0000 = none 0001 = IR 0010 = Green 0011 = UV 0100-111 = reserved	00 = none 01 = low 10 = high 11 = n/a

IS

Get Interlock and Laser Status -- returns a 2-digit ASCII hex value corresponding to the current interlock state. Bit numbers in the following table go from to 0 (the least significant bit) to 7 (the most significant bit). **NOTE: You must periodically (at least once every two seconds) send either the IS or SS command to poll the laser status while it is enabled, or it will shutdown automatically.**

Table 11: 2-digit ASCII hex value corresponding

Bit Number	Name	Description
0	Unused	Not used
1	Unused	Not used
2	External Interlock	A 1 indicates that the external interlock is NOT satisfied. The laser cannot be started or fired until this interlock is satisfied
3	Workpiece Interlock	A 1 indicates that the workpiece interlock is NOT satisfied. The laser will not fire unless this interlock is satisfied. This interlock will only inhibit firing, it will not shut down the laser.
4	Laser On	Indicates that the laser power supply is enabled. See the ON command.
5	Laser Firing	Indicates that the laser is firing. See the GO command.
6	Laser Starting	Indicates the laser is in its startup state. When a laser is first enabled with the ON command, it will be in the startup state for about 10 seconds, during which time it cannot be fired.
7	RS232 Mode	A 1 indicates that the laser is in remote mode. This bit MUST be set to control the laser over the serial port. See the SM command for details.

LT?

Get Laser Type. Returns a decimal digit corresponding to the current laser type:

1 = Polaris

2 = EzLaze II and EzLaze 3

3 = QuikLaze Series 50ST / 50ST2

4 = Tempest

5 = Jasper

6 = Orion

7 = EzMark

8 = Pegasus

MD?

Get Manufacture Date -- returns the manufacture date of the laser in the format MM/DD/YY. For example, a date of Sept 10, 2000 would be received as "09/10/00".

MO?, MO# Laser Fire Mode -- an "MO#" command selects the current firing mode, where # = 0 (zero) for Continuous, 1 for Single shot, 2 for Burst. **NOTE: Burst mode will fire at 5Hz for a maximum of 50 shots. This will be followed by a 20 second cool down interval (called the "burst lockout" period), during which time you cannot operate the laser. See the SS command for details on how to tell when the laser is in the burst lockout period.**

MR? Maximum Repetition Rate -- returns the maximum rep rate of the laser in Hertz (Hz) as a 3-digit decimal value. For example, a 20Hz laser will return "020".

MS?, MS# Marker Wheel Control -- the MS# command sets the current position of the marker aperture wheel (if installed). Values are from 1 to the maximum number of holes determined by the "NH?" command. A "MS?" returns the current position. The marker wheel must be installed to use this command. (See the SV?command.)

While the marker wheel motor is moving, the *Motor Moving* bit will be set (see the SS command), and no other motors can be moved.

NH? Number of Holes -- returns the number of holes available on the marker or wavelength wheel. If a wavelength wheel is installed it will always return a 6, if a marker wheel is installed, it will return a value corresponding to the number of apertures loaded.

OF Laser Off -- will put the laser into the Stop state. The laser cannot be fired from this state.

ON Laser On -- initiates the startup of the laser power supply and puts the laser into the Standby state. Will not fire laser. The laser will go through a 10-second startup period when going from the Stop state to the Standby state. The *Laser Starting* bit will be set during this period (see the IS and SS commands for details). All safety interlocks must be satisfied to put the laser into the Standby mode.

RR?, RR### Laser Repetition Rate -- the RR### command sets the current laser pulse repetition rate in Hz up to the maximum of the laser (see the **MR?** command). The parameter is a 3-digit ASCII decimal number. An "RR?" will return the current rep rate of the laser in RS-232 mode.

RS — Reset -- resets the controller to power up condition. Laser is shut down and stopped. All outputs are set to initial conditions.

SC — Laser Shot Count -- returns an 8-digit ASCII hex value corresponding to current shot count. Values range from 00000000 to FFFFFFFF in hex.

SM#, SM? — Serial Mode -- turns on or off RS-232 control. 0 (zero) = serial mode off, 1 = serial mode on. Laser is stopped when serial mode is turned on or off. The laser will not accept any control commands (only queries) unless it is in serial mode. An "SM?" returns the current setting.

SN? — Serial Number -- returns the currently set serial number of the system as a 6-digit ASCII decimal number.

SP?, SP### — Spot Marker Control -- an SP### command sets the current spot marker value from between 000 to 255 in decimal. A "SP?" returns the current setting.

SR+/-##, SR? — Shutter Rotation Control -- an SR+/-## command sets the number of degrees (in decimal) and the direction to rotate the X/Y shutters, where the rotation can range from -00 to + 90 degrees. For example, to set the shutter rotation to +45 degrees, send "SR+45". A "SR?" command will return the current rotation angle in degrees. The shutter rotation option must be installed to use this command. (See the SV? command for details.

While the marker wheel motor is moving, the *Motor Moving* bit will be set (see the SS command), and no other motors can be moved.

SS — Get System Status -- returns a six-digit ASCII hex value related to the current state of the system. **NOTE: You must periodically (at least once every two seconds) send either the IS or SS command to poll the laser status while it is enabled, or it will shutdown automatically.** A one (1) in the bit position indicates that the status is enabled. Bit numbers in the following table go from to 0 (zero) (the least significant bit) to 23 (the most significant bit).

Table 12: ASCII hex value related to the current state of the system

Bit Number	Name	Description
0	Unused	Not used
1	Unused	Not used
2	External Interlock	A 1 indicates that the external interlock is NOT satisfied. The laser cannot be started or fired until this interlock is satisfied
3	Workpiece Interlock	A 1 indicates that the workpiece interlock is NOT satisfied. The laser will not fire unless this interlock is satisfied. This interlock will only inhibit firing, it will not shut down the laser.
4	Laser On	Indicates that the laser power supply is enabled. See the ON command. †
5	Laser Firing	Indicates that the laser is firing. See the GO command. †
6	Laser Starting	Indicates the laser is in its startup state. When a laser is first enabled with the ON command, it will be in the startup state for about 10 seconds, during which time it cannot be fired.
7	RS232 Mode	A 1 indicates that the laser is in remote mode. See the SM command for details.
8	Ext. Q-Switch	A 1 indicates that the Q-switch is set to external trigger mode.
9	External Trigger	A 1 indicates that the flashlamp is set to external trigger mode
10	Single Shot Mode	A 1 indicates that the laser is in single-shot mode. See the MO command.
11	Variable Mode	A 1 indicates that the laser is in continuous fire mode. See the MO command.
12	Burst Mode	A 1 indicates that the laser is in burst fire mode. See the MO command.
13	Q-Switch Disabled	A 1 indicates that the Q-switch is disabled. See the DQ command.
14	Unused	
15	Unused	
16	Unused	
17	Low Energy Mode	A 1 indicates the laser is in low energy mode. See the ENH, ENL commands.

Bit Number	Name	Description
18	Motors Homing	A 1 indicates that the laser is initializing the position of one of the motor-driven accessories such as the wavelength wheel, attenuator or marker wheel. While the motor(s) are homing, the laser cannot be fired and the position of any of the accessories cannot be controlled. The laser only goes through the homing sequence when first powered up or after a RS command.
19	Unused	
20	Motor Moving	A 1 indicates that one of the accessory motors is moving into position. Only one motor can be moved at a time.
21	OK to Start	A 1 indicates that the laser can be started (ie. the ON command can be sent).
22	OK to Fire	A 1 indicates that the laser can be fired.†
23	Reset Fault	A 1 indicates that a laser power supply reset fault has occurred. This is a fatal error and will require resetting the laser to recover.

† If the *Laser On* bit is set, AND the *Laser Firing* bit is NOT set, AND the *OK to Fire* bit is NOT set, then the laser is in its "burst lock" cool down period. The burst lock period is over when the *Laser On* bit is set and the *OK to Fire* bit is set.

ST

Stop Laser Firing.

Ceases laser firing and places the system in standby mode.

SV?

Get Accessory Configuration -- returns a two-digit ASCII hex value that indicates which accessory controls are currently installed on the laser. A one (1) in the bit position indicates that the option is installed.

Table 13: ASCII hex value indicating accessory control

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Unused	Unused	XY Shutter Rotation	Marker Wheel	Wavelength Selector Wheel	Y Shutter	X Shutter	Attenuator

Description of Options

Attenuator – Used for fine control of the output energy of the laser.

X Shutter, Y Shutter – The XY Shutter is a 2-axis adjustable output aperture that can be used to change the size of the beam.

Wavelength Selector – Used to select the laser output wavelength.

Marker Wheel – Selects different beam sizes and shapes.

XY Shutter Rotation – Allows the XY Shutter to rotate the aperture as well as adjust its size.

VN

Version Number -- returns the firmware version number as a number in the form "*Major.Minor*". For example: "1.2".

XS?, XS###

X Shutter Control -- sets the X shutter aperture position. Parameter is a 3-digit decimal number ranging from 000 to 255, with 0 (zero) = closed and 255 = full open. A "XS?" returns the current X shutter setting from 000 to 255. This command is only valid if the XY Shutter option is installed. (See the SV?command).

While the shutter motor is moving, the *Motor Moving* bit will be set (see the SS command), and no other motors can be moved.

YS?, YS###

Y Shutter Control -- sets the Y shutter aperture position. Parameter is a 3-digit decimal number ranging from 000 to 255, with 0 (zero) = closed and 255 = full open. A "YS?" returns the current Y shutter setting from 000 to 255. This command is only valid if the XY Shutter option is installed. (See the SV?command).

While the shutter motor is moving, the *Motor Moving* bit will be set (see the SS command), and no other motors can be moved.

EXAMPLES

The following examples show the general procedure recommended for controlling the laser.

Initializing the Laser

Open the serial port.

Send ";LAVN" to check the firmware version number

Send ";LASM1" to enable serial port control of the laser. The laser should send back an "ok".

Send ";LASS" to check the status of the safety interlocks. Wait until the Motor Moving bit is cleared before proceeding.

If safety interlocks are satisfied, then send ";LAON" to put the laser in Standby mode.

Polling the Status

You must periodically (at least once every two seconds) send either the ";LAIS" or ";LASS" command to poll the laser status while it is enabled (after sending the ";LAON" command), or it will shutdown (return to the Stop state) automatically. This is a safety precaution, so that should the software crash the laser will not be left in an unsafe state for too long a period.

Firing the Laser

Set the desired laser energy, aperture settings, wavelength etc...

Send ";LAGO" to start the laser firing.

Send ";LAST" to stop firing.

Send ":LAOF" to put the laser into the Stop state.