

## Spot Series Lasers (Short Pulse Optical Technology)



Elforlight Ltd  
Nene House  
Drayton Way  
Daventry  
Northants  
NN11 8EA  
UK

Tel +44 1327 300069

[www.elforlight.com](http://www.elforlight.com)

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## 1.1. System Description

The SPOT laser systems consist of a laser head with a separate laser controller unit. The laser controller unit contains the drive circuits for the pump laser diode and the temperature control of the laser system, as well as the DC supplies for these modules and to supply the HV for the Pockels Cell. There is an interconnecting cable from the laser head which is hard wired into the laser head while having a 37 way 'D' connector for connection to the laser controller unit.

The laser controller is shipped with a plug top AC/DC converter, but customers can use their own supply if preferred. The supply requirements are 12VDC@ 5A

SPOT lasers are designed to generate short pulses of laser output at 1064nm (and harmonics if specified). The output power level will depend on the model but it should be remembered that all SPOT lasers emit laser radiation which is potentially hazardous and it is therefore strongly recommended that before operating the laser for the first time users should thoroughly familiarise with the contents of this manual. Of particular importance are the sections dealing with safe operation of the laser and general safety issues.

Please refer to Section 2 for full details of laser controller operation.

### Q-switch voltage adjustment with repetition rate

With variation of repetition rate up to 50 kHz, it is necessary to adjust the high voltage applied to the Q-switch to optimise output in terms of pulse width and stability. This can be done by monitoring the output pulse on a photodiode and oscilloscope whilst adjusting the voltage using the carat keys '<' and '>' on a connected PC. Once set, these values will be stored in the controller. One hundred values can be stored. Value 0 is for external TTL input and values 1-99 represent 1-99kHz internal TTL. When a frequency is set by using the 'FREQ' command, the associated stored Qswitch voltage value will be automatically used. This can still be varied using the keyboard and any subsequent change will become the new value.

#### **PLEASE NOTE:**

*Although the controller is capable of generating up to 99kHz internal pulses, the laser head is currently only specified to operate up to 50kHz.*

## 1.2. Laser Safety

This handbook contains a description of controls, adjustments, and procedures for normal operation of the laser. *CAUTION - Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.*

### Classification

Elforlight SPOT series lasers are classified as class 4 Lasers as defined by BS EN 60825-1:1994 and by the United States Centre for Device and Radiological Health (CDRH) 21 CFR Ch. 1 subsection 1040. This designates potential danger of eye or skin damage by exposure to direct or scattered radiation. It is recommended that all users should thoroughly familiarise themselves with these safety standards before operating the laser for the first time. It should be noted that all SPOT lasers are designed as OEM sub-systems. As such they do not comply with all the requirements of BSEN 60825-1:1994 and CDRH 21 CFR Ch. 1 subsection 1040. It is the user's responsibility to ensure full compliance with these standards.

### Emission

The laser emits CW or pulsed radiation at 1064nm, 532nm and 355nm (or as otherwise specified). Powers up to 2Watts may be generated. The laser head also contains a laser diode emitting radiation at 808 nm within the head package. **THE LASER HEAD COVER MUST NOT BE REMOVED.** No customer serviceable parts are contained therein. Such access may invalidate any warranty offered by the manufacturer.

### Indicators

An emission indicator on the front panel of the laser controller indicates that laser emission is possible.

### External interlock

The SPOT series laser systems are provided with an external interlock facility which is available on the Hirose 4-way socket on the front panel. This connector requires contact closure to enable laser operation. The laser is supplied with a combined interlock/keyswitch Hirose connector and 1m of lead, it is recommended that this be wired into an external interlock chain - e.g. a room door switch or enclosure cover switch. If the interlock is broken, it is necessary to remove the DC supply from the laser, then remake the interlock connection and commence the start sequence again to resume laser output.

### **1.3. Recommended Safety Precaution during Laser Operation**

The laser should be used in an enclosed area with access restricted to trained personnel. The area should be clearly labelled, and the entrance marked with the class of laser (Class 3B).

Only trained personnel should be allowed to use the laser.

The keyswitch contacts must be shorted together to enable the laser to operate. The user can add a keyswitch of their own choice or use a set of contacts within their own equipment, etc. If a keyswitch is used the key should be removed from the laser when not in use, and / or unattended, and stored in a safe place.

Eye and skin exposure to direct or scattered laser radiation is hazardous and should be considered potentially extremely harmful.

Suitable eye protection should always be worn whilst laser output is possible. Contact Elforlight for advice on suitable eye protection products.

The laser beam path should be terminated with a non-reflecting beam stop. Beam paths should be enclosed where possible and should not be at eye level if practical.

Care should be taken that all mirrors and optics used are securely positioned and fixed to prevent movement. Care should always be taken to prevent stray reflections from surfaces in the beam path.

## 1.4. System Handling, Mounting and Heatsinking

It must be appreciated that any solid-state laser system, especially the laser head, is a sensitive piece of scientific equipment. Whilst every effort has been made to provide a product that is rugged and reliable it is essential that the laser head is handled with care – especially when mounting. Do not drop or subject the head to impact shock such as placing it down hard on a surface.

**ANY DAMAGE OR MALFUNCTION OF THE EQUIPMENT DUE TO EXCESSIVE FORCE MAY INVALIDATE ANY WARRANTY.**

## 1.5. Basic Operation

The SPOT series Diode Pumped Laser Systems are designed for simple, user-friendly control with the minimum of user defined parameters. SPOT lasers are designed as fixed power level devices under automatic operation, or power can be varied by adjusting the pump diode current via RS232 interface. The laser head incorporates laser diode protection circuitry and therefore the laser diode is protected even when disconnected from the laser controller. However, Elforlight recommend the observance of full anti-static precautions during connection and disconnection of the system sub-units. Please contact Elforlight for recommended anti-static procedures.

Connect the laser head to the controller using the 37 way 'D' connector socket on the front of the controller. Be sure that the cable is kept away from the laser beam path. Ensure the external interlock contacts are made via the supplied 4-way Hirose connector on the front panel. Ensure that the external interlock circuit is closed, either by shorting the wires (temporarily for test only), or via a user-supplied door or enclosure protection circuit. This interlock should be incorporated into an area or enclosure interlock system. Please contact Elforlight for advice regarding suitable interlock arrangements.

Either connect a user supplied TTL trigger signal to the external trigger SMA connector on the controller or select an appropriate frequency via the PC interface using the 'FREQ' command. If using an external signal, select it using the 'FRQSRC 0' command.

Connect a suitable DC supply to the front panel socket. Apply power and close the keyswitch contacts.

## Operation:

The SPOT laser executes a start-up procedure during which the output power will vary. During this sequence, the front panel LED emission indicator flashes at 0.5 Hz. Only when the LED is on continuously is the laser stabilised and ready for use. Before this, lower or higher powers may be observed from the laser. The SPOT laser exhibits two different start-up sequences depending on the length of time the unit has been connected to the mains supply. These may be described as:

1. 'Cold start' sequence.

2. 'Warm start' sequence.

1. The cold start sequence is activated when the system has been powered down and is subsequently reconnected to the DC supply, that is, on initial start-up.

- 1.1 Connect DC laser controller and switch ON. Close keyswitch contacts.

The cold start sequence now begins with a thermal stabilisation period. From power up this phase takes a total of 1 minute. During this period, no laser output will be generated.

After the above 1 minute 'warm up' period, the controller switches automatically to a current ramp mode which varies with parameter settings but should last no more than 30 seconds. During this period, some laser light may or may not be emitted depending on the individual set up parameters of the laser.

At the end of this period the Emission indicator will remain permanently on and the laser is ready for use.

The warm start sequence is activated any time the key-switch contacts change state provided the system has been powered up for at least 1 minute.

The warm start sequence activates the ramp period as in 1.1 above.

**NOTE (1)** if the system is powered down even momentarily at any time, when the system is powered up subsequently the system will automatically revert to the cold start sequence.

**NOTE (2)** during the ramp operation phase the laser output power will vary significantly from the specified output power. This behaviour is quite normal as during this period optical stabilisation is occurring.

**NOTE (3)** breaking the interlock chain causes the laser to shut down. Once the chain is remade, it is necessary to either issue a 'INTLK 0' command via RS232 or restart the laser. If power has not been removed, this will then cause the laser to start in the "warm start" sequence describes above.



## 1.6. Operation with power variation

Power variation is possible by USB interface, with commands sent from suitable RS232 terminal software.

To operate the laser using power variation by RS 232 interface, first boot the computer and run the terminal software. Then connect the USB lead, and power up the laser as described above. Check which port the laser is using with Windows Device Manager under the Ports setting. An introductory message appears:

```
Power On reset occurred  
EEprom data CRC correct  
State: STANDBY
```

Close the keyswitch contacts. The followings messages display sequentially:

```
KEYSWITCH ON  
State: TEMPERATURE STABILISATION  
State: RAMPING CURRENT  
State: EMISSION
```

The time intervals between stages of this sequence will vary depending on the laser but should be no more than 1-2 minutes for temperature stabilisation and no more than 30 seconds for ramping current. "EMISSION" confirms the laser is operating.

During this start-up phase, the emission LED flashes. Once ready, the emission LED becomes solid.

The "+" and "-" keys can then be used to increase and decrease the pump diode current and hence laser power. This varies the ISET command in 1% increments as a percentage of the ILIM value. The value will be shown on screen as it is changed. The diode current can also be directly input using the ISET n(%) See test data for calibration of values with current and corresponding power output.

## **2. SPOT Laser controller**

The SPOT laser controller is a fully integrated stand-alone controller that only requires a 12VDC power supply. A plug top unit is supplied with the controller, but the customer is free to provide their own 12V supply providing it is 5A capable.

The SPOT laser software is limited in functionality. It enables the user to exercise the following:

Check laser status & parameters.

Vary laser power by varying pump diode current.

Reset the interlock.

Change TTL trigger frequency and source, internal or external.

Check the last stored fault.

Set and read the real time clock.

## 2.1. Front panel

1. DC OK Indicator. On when DC input supply is OK.
2. Emission indicator. Off when laser is in standby. Flashes during warmup and solid when laser emission is active.
3. Fault indicator. Laser is in a fault condition. Interrogate terminal with FAULT command for details.
4. Interlock indicator. Off when interlock made. On when interlock broken.
5. Keyswitch/interlock connector. Details in section 2.3.
6. USB connector. For PC connection use a USB A to USB B cable. One is supplied with the controller.
7. Laser head connector. 37 way 'D' type. DO NOT DISCONNECT THIS CABLE WHILE THE CONTROLLER IS POWERED UP!
8. SMA connector. External trigger for user TTL input, 0-50 kHz.
9. DC input connector, 12V @ 5A



## 2.2. Rear panel



## 2.3. SPOT Laser RS232 Commands

Allows User to change laser diode current (ISET), and thus laser power

+	Increment ISET parameter by 1% of ILIM
-	Decrement ISET parameter by 1% of ILIM
ISET <enter>	Display working current value
ISET n <enter>	Set working current value in % of ILIM. $0 \leq n \leq 100$

Increasing/decreasing Q-switch voltage using keyboard. Will also show increase/decrease, current value, and frequency pointer position:

“Shift” plus “>”	Increment QSW voltage by 0.1V
“Shift” plus “<”	Decrement QSW voltage by 0.1V

```
<0-10V OUT VALUE 4.5V, PTR 10  
>0-10V OUT VALUE 4.6V, PTR 10
```

Resulting value is stored in the currently selected internal frequency table. Above example shows 10kHz table position changing from 4.5V up to 4.6V. Table position 0 is reserved for external input – this value will need to be adjusted every time the external trigger frequency is changed.

ALL <enter>	Display laser system status.
FAULT <enter>	Display last stored fault condition with timestamp.
HELP <enter>	Display list of RS232 commands available.
TIME <enter>	Display present time from RTC clock
TIME hh:mm:ss <enter>	Set time to desired value
DATE <enter>	Display date
DATE dd/mm/yy	Set date to desired value
INTLK <enter>	Display latched interlock status
INTLK 0 <enter>	Clear interlock fault
INTLK 1 <enter>	Test interlock, simulate interlock broken

If the red INTERLOCK led on the front panel is lit, the software interlock latch can be cleared by the INTLK 0 command providing the interlock circuit is made.

FREQ <enter>	Display Q-Switch trigger frequency.
FREQ n <enter>	Set trigger frequency, where frequency in range 0-50kHz
FREQSRC <enter>	Display Q-Switch TTL source
FREQSRC n <enter>	Set trigger signal source (0-external, 1-internal)
STATE <enter>	Display current operating condition

**RS232 protocol:**

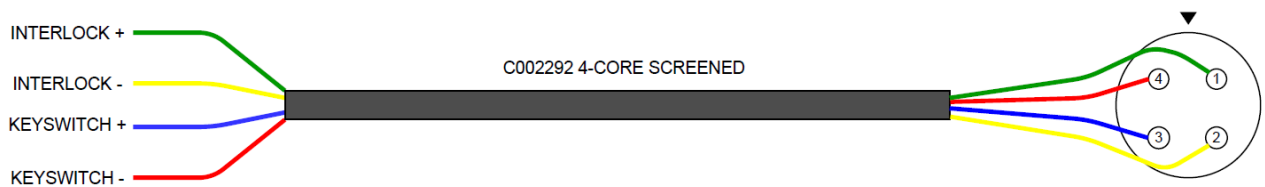
115400 baud

1 start bit, 8 data bits, no parity, 1 stop bit

No hardware handshaking

No software handshaking

## 2.4. Keyswitch and interlock connector



HIROSE INTERLOCK/KEYSWITCH  
SOCKET FRONT PANEL VIEW

