Graphical User Interface
User Manual

Release 4.3 CW–M High Power Fibre Lasers

Table of Contents

1. Document History

Date	Author	Change
23/7/13	S Quin	Improved the maintenance section. Listed all the options in the Supervisor Settings section.
26/9/14	J Messenger	Updated for the new layout of the GUI.

2. Definition of Symbols and Terms

This symbol alerts the user to the hazard of exposure to hazardous invisible laser radiation

This general warning symbol emphasizes important information needed during installation and operation

DANGER	Describes hazards that could directly or indirectly lead to serious personal injury or death.
CAUTION:	Describes hazards that could lead to personal injury or product damage.
PRODUCT:	The definition of 'Product' as used herein means the item that was procured from SPI Lasers UK Limited (hereinafter referred to as SPI). The Product is sold ready for use for its intended purpose as a laser Product for Incorporation.
LASER INTEGRATOR:	Any person who integrates the OEM Fibre Laser into their equipment, or any person who uses the OEM Fibre Laser in the form as supplied by SPI.

3. Warnings

CAUTION: If the OEM Fibre Laser controlled through the graphical user interface described in this User Manual is used in a manner not specified by SPI the protection provided by the equipment may be impaired.

CAUTION: Attempts to modify or alter the OEM Fibre Laser, or the use of controls, adjustments or performance of procedures other than those specified herein or in the OEM Fibre Laser Product Manual may result in hazardous radiation exposure.

> **CAUTION**: Modifications to the Product or the use of controls or adjustments or performance of procedures other than those specified herein:
> - may be unsafe
> - will invalidate the warranty
> - may result in patent infringement

Laser Integrators are not authorized to modify the specification of the Product.

4. Laser Safety – Hazard Information

> **DANGER**: The Fibre Laser controlled through the graphical user interface described in this User Manual carries a Class 4 Laser rating and emits laser radiation in the region of 1050-1250nm that is invisible to the human eye.
> Contact with direct or scattered laser radiation can cause damage to the eyes, burn human tissue and start fires.

> **CAUTION**: The fibre laser controlled through the graphical user interface described in this User Manual also carries a Class 2 <1mW CW laser with visible radiation in the region of 650-680nm. Avoid eye or skin exposure to direct or scattered radiation.

Ensure that operators are fully aware of all safety implications identified in the Safety Section of the Product Manual SM-S00051 before attempting to install or operate the laser.

5. Warranties

The user is granted a royalty-free perpetual, non-exclusive license to use this software for the sole purpose of facilitating demonstration and operation of SPI's R4 series of Fibre Lasers. All rights and title to patents, trademarks or any other proprietary or intellectual property that have been issued or pending that relate to this software remain the title of SPI Lasers UK Limited (hereafter 'SPI') and/or its licensors.

This software is provided to facilitate demonstration and operation of the laser with no obligation on the part of SPI to provide end user support or customization.

The software is provided "as is" with no warranties of fitness for a particular purpose. SPI does not warrant that the functions contained will be uninterrupted or error free. There is no obligation on the part of SPI to provide end user support or customization.

SPI may make changes to the software without the obligation to distribute newer versions.

6. Introduction

This GUI User Manual describes the control and operation of SPI's R4 CW-M High Power Fibre Lasers using a PC based Graphical User Interface (GUI). This GUI User Manual does not provide exhaustive information on the functioning of the laser. The user should read the Product Manual in conjunction with this manual. The purpose of this User Manual is to familiarise the user with the operation of the GUI.

The laser can be operated in the following configurations:-

Ethernet

RS-232

PC   Laser   Signal Generator

Laser in **internal** (From GUI) control mode with setup and operation under RS-232 control from the GUI. An external signal generator with TTL output is required to provide the laser modulation waveform.

PLC controller

Ethernet

RS-232

PC   Laser   Signal Generator
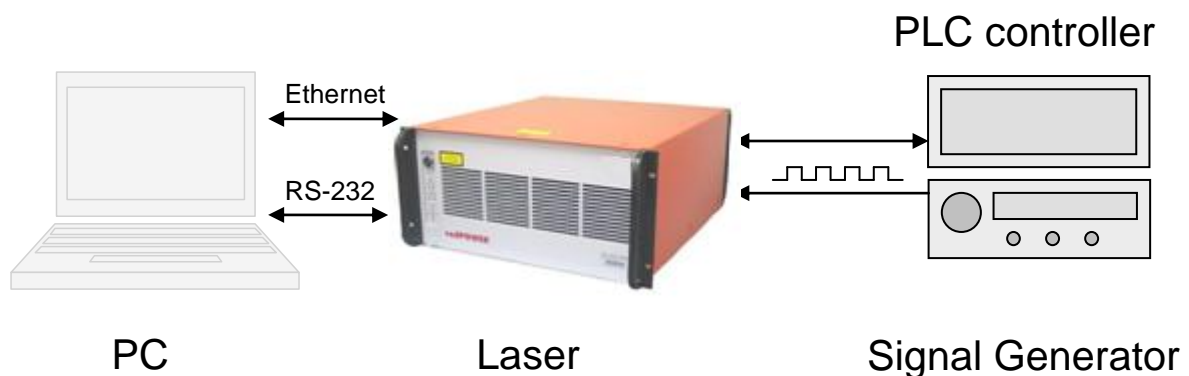
Laser in **external** (From PLC Port) control mode with external analogue signals for power setpoint and readback. Full control and monitoring of the laser status is possible over its I/O port while it can be monitored using the GUI. An external signal generator with TTL output is required to provide the laser modulation waveform.

7. Installation

As the GUI is a standalone .EXE with no supporting files required an installer package is not required. Copy the provided .EXE file into an appropriate folder on your PC to install the GUI.

8. Start up problems

8.1. No COM port available

The user may see the following message before the application starts:

"COM port selected is not currently available"

If the initialisation file is not found (as will be the case the first time the software is run), or an RS–232 port previously used has been removed from the system, the default port may not exist on the PC running the application.

If the user has been working with a PC using a USB–Serial converter, this may be displayed if the serial cable is removed and the application started.

9. Connecting to the R4 Fibre laser

Refer to the Product Manual SM–S00051for information on how to connect to the laser.

10. Main Window

When the application successfully runs the main window of the GUI will appear as shown below.
The GUI supports multiple languages. A flag representing each supported language is present in the top right of the main window. Clicking the appropriate flag will set the desired language.
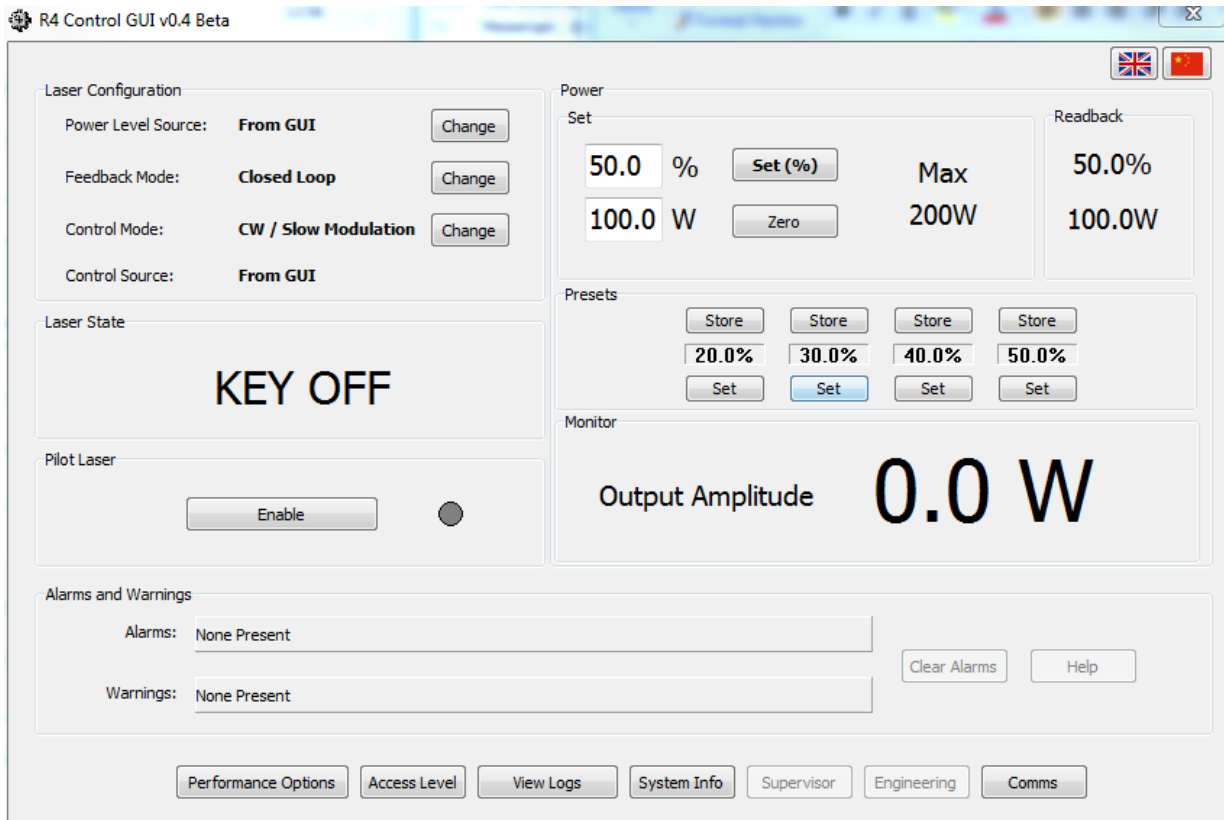
The main window contains the most common controls needed to operate the laser, as well as parameters read back from the laser such as the currently set power level. The sections of this window are described below.

10.1. Laser Configuration
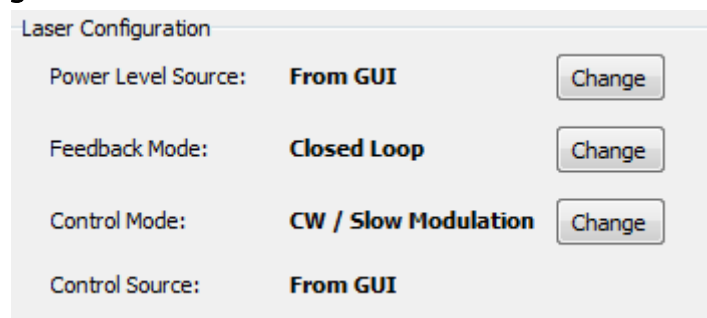
This section allows the user to adjust three parameters:

- Power Level Source – Clicking "Change" will toggle between "From GUI" or "From PLC Port". This sets whether the laser's power level is set by the "Power" section of the main window described below (From GUI) or by a voltage on the PLC port (From PLC Port).

- Feedback Mode – Allows the user to select Open Loop or Closed Loop power control. RS (Reduced Specification) lasers do not allow Closed Loop operation, and so this option is disabled.
- Control Mode – Allows the user to select between two control modes – one suitable for "CW / Slow Modulation" and the other for "Fast Modulation". For the differences between these modes, and guidance on when they should be used, refer to the laser manual.

There is also a fourth parameter "Control Source" displayed here. This cannot be set in the GUI, but is set by toggling the "Use Port" pin on the PLC port (see the laser product manual). When the Control Source is set to "PLC Port", many functions of the GUI will be disabled as signals on the PLC port will control these options.

The Laser Configuration cannot be altered while the key switch is on.

10.2. Laser State
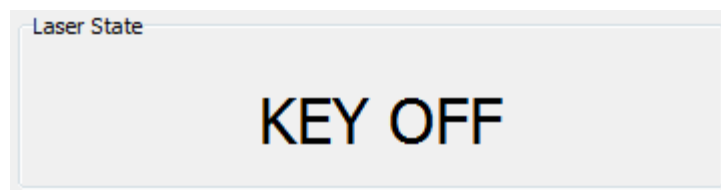
This section displays the current state of the laser system. Possible states are detailed below:

- KEY OFF. The laser is disarmed (safe) and emission is not possible.
- SAFETY DELAY. This mode is entered for a short period after the key is turned.
- IDLE. The laser is armed but not currently emitting.
- EMITTING. The laser is currently emitting light.
- CYCLE KEY. A key cycle is required before operation can continue. This message is displayed if the laser is powered up with the key in the "on" position, if the user attempts to arm the laser with the interlock open, or after certain alarms are cleared.
- ALARM. An error condition is present. See the "Alarms and Warnings" section in this document.

10.3. Power Setpoint and Readback
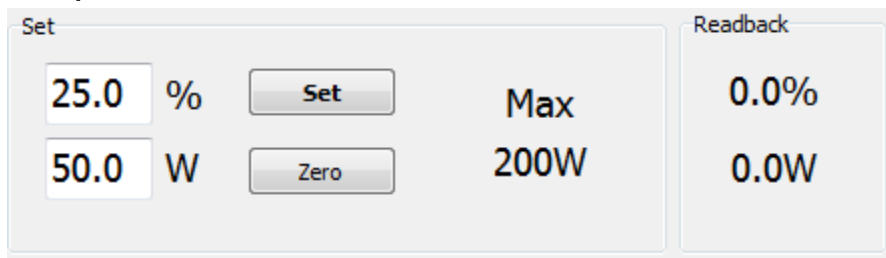
This section is used to set the required power. Note that if either "Power Level Source" or "Control Source" is set to "From PLC Port", this section will be disabled.

The desired power value can either be entered in watts, up to the maximum value shown, or in percent. Enter the desired value and press Enter or click "Set". Both displays will update when either one is altered. The "Readback" values on the right will display the power level that the laser is currently set to.

When the power level is being set from the PLC port, the "Readback" values will display the power level being set by the external voltage.

10.4. Power Presets
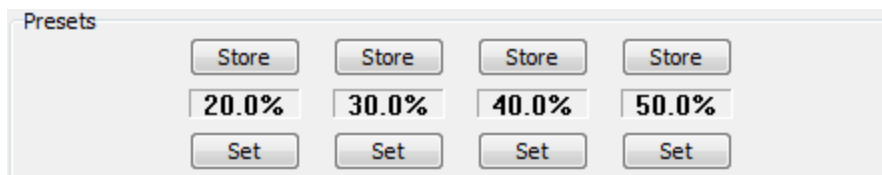
This section allows four power presets to be set and recalled. Power presets can only be set or recalled when the laser is in "From GUI" control mode.

10.5. Power Monitor

This section displays the actual laser output power taken from the internal photodiode.

The caption changes depending on whether the laser is set to "CW/Slow Modulation" or "Fast Modulation" mode:

- In "CW/Slow Modulation" mode, the caption is "Output Amplitude" because the laser is monitoring each pulse individually and only measuring the power when the laser is actually emitting.
- This means that, if the laser is set to 300 watts, the Output Amplitude will show as 300 watts regardless of what the duty cycle is.

- In "Fast Modulation" mode, the caption is "Average Output Power" because the laser is disregarding the modulation signal and reporting the average power over time.
- This means that, if the laser is set to 300 watts, the power displayed will be 300 watts if continuous modulation is being used. If the modulation signal is at 50% duty cycle, the power displayed will be 150 watts.

10.6. Pilot Laser Control
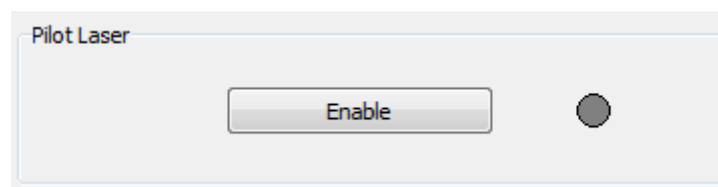
This allows the red pilot laser to be enabled and disabled. The circular indicator shows the current state of the laser. This control is disabled when the laser is being controlled from the PLC Port.

It is possible for the supervisor to set which modes the pilot laser can be used in. If the Enable button is clicked when the laser is in a mode which does not allow pilot laser emission, an error message "The Pilot Laser is not operable in this control state!" will appear.

10.7. Alarms and Warnings

This section displays information on any alarms and warnings which are currently present. Warnings are for information only, and will disappear when the error condition is removed. Alarms are latching, requiring clearance by a supervisor, and prevent operation of the laser while the alarm state is present.

Alarms and warnings appear as shown:
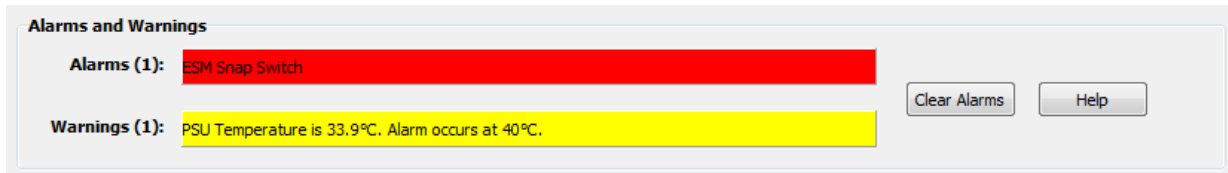
If there are multiple alarms or warnings the display will cycle through them.

The "Clear Alarms" button can be used to clear any alarms that are present. This requires both that the alarm condition is no longer present (for example, if a temperature alarm occurs, the laser must cool down before the alarm can be cleared) and that the user is logged in with an appropriate access level.

A Fibre Fail Alarm can only be cleared by running a special routine (see Supervisor section).

The "Help" button can be used to display more information about alarms and warnings that have occurred, along with information on how to clear them or prevent them happening again:
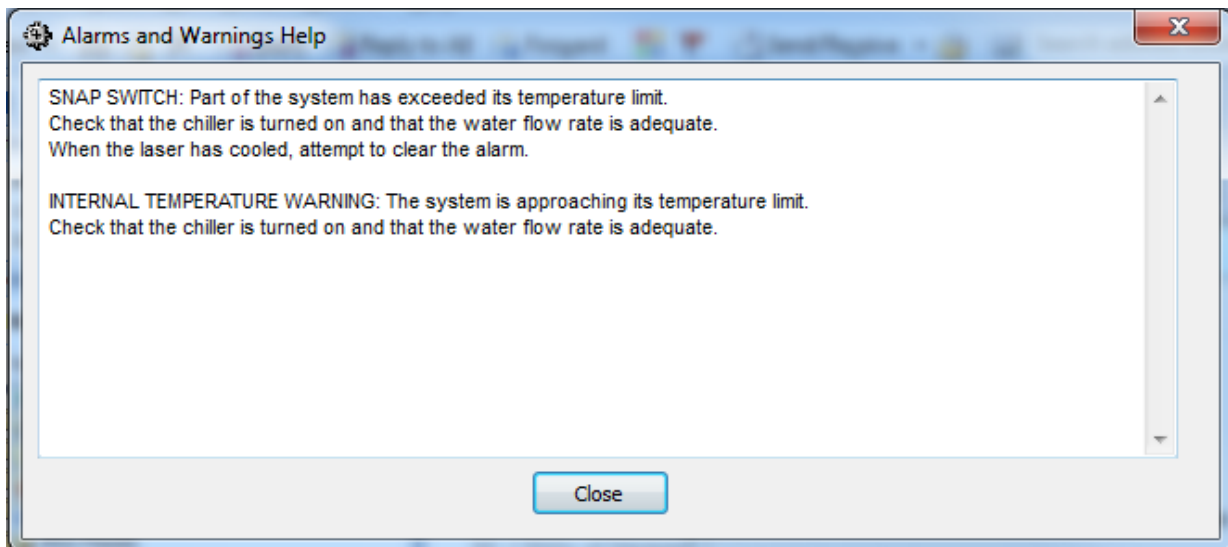
11.   Communications

The Communications dialog box is brought up by clicking the "Comms" button on the main window.
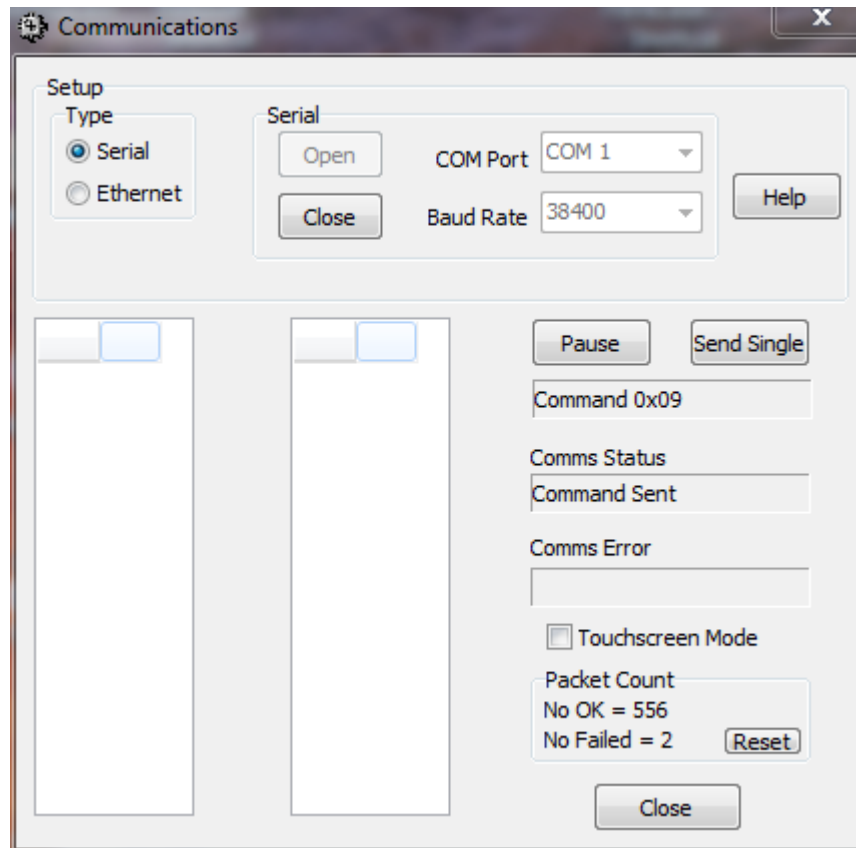
There are two possible ways to establish communications between the laser and the PC: RS–232 and Ethernet. The two radio buttons in the top left allow the user to select which type of interface they desire. The "Help" button will display troubleshooting information for the selected interface.

11.1. RS–232 Connection

To establish serial communications the COM port and baud rate must be set. Should the user wish to change the COM port, click the "Close" button and select a com port from the "Com Port" drop down menu. Only the COM ports available will be displayed. The baud rate may also be changed in the same way. Click the "Open" button and the COM port should open. The communication status for normal operation is shown by the "Command…" indicator cycling through the numbered commands. RS–232 settings are stored when the application is shut down.

11.2. Ethernet Setup

The user can change the Ethernet settings by entering the Supervisor window and selecting the "Set Setting" command. This allows the user to change:

1. Static IP Address
2. Static IP Mask
3. Static IP Gateway
4. Ethernet Mode (Static or DHCP)
5. Flash the Ethernet interface with new firmware.

Note that commands 1 through 4 cannot be executed when connected via Ethernet. Command 5 can only be executed when connected via Ethernet.

11.3. Ethernet Connection
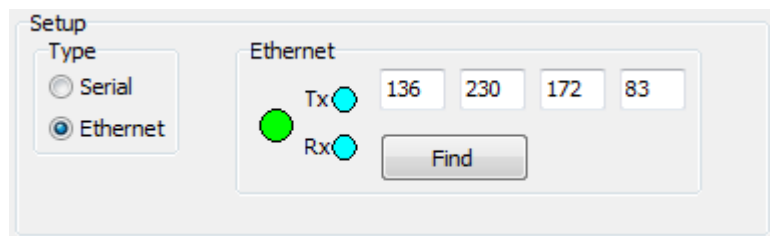
If the user knows the IP address of the laser then this may be typed directly into the four edit boxes provided.

11.4. Ethernet – Finding lasers on the network

If the IP address is not known then the GUI provides the capability of finding the laser on the network. Pressing the "Find" button displays a new dialog box as shown:
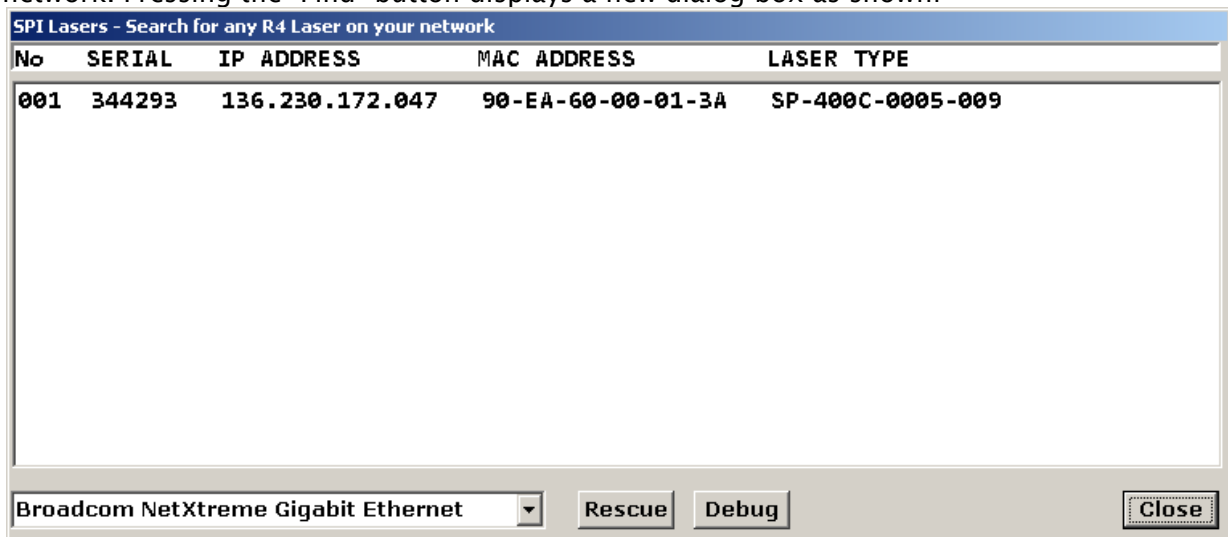
The central display panel shows a list of lasers found on the network. For the user the most important item is the serial number. If this laser displayed is double clicked then the dialog box is closed and the IP address is filled into the boxes in the Communications window.

The GUI is multiple network card compliant. If two network cards are fitted the user should select the card which is connected (via the network) to the laser. In the example above the "Broadcom" network card is selected.

11.5. Ethernet – Changing IP settings over the network

The user should normally set the laser IP status by using the RS-232 interface, however it is possible to set the laser parameters over the Ethernet connection. This can be done by pressing the "Rescue" button. A new dialogue box like this appears:

The user must know the serial number of the laser as well as the addresses and mode required. Pressing the Set button should change the settings of the laser selected. Note that the mechanism used is UDP - this is not as reliable as TCP so depending upon network reliability the user may need another attempt.

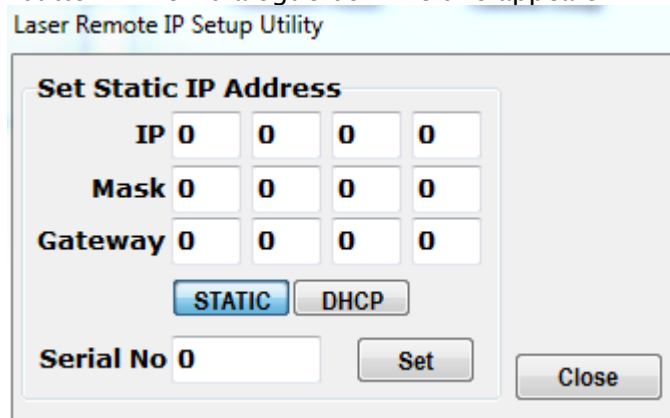This feature is also useful if the laser is mistakenly set to a static IP address which is not accessible with the current network configuration.

11.6. Ethernet – Debugging

Pressing the "Debug" button provides additional information about the network connection. This feature should only be used to provide additional information to SPI if requested.

11.7. Command Analysis

The communications dialog box may also be used to assist the user in debugging their own communications software. The automatic transmission cycle can be interrupted by pressing the pause button as shown here:
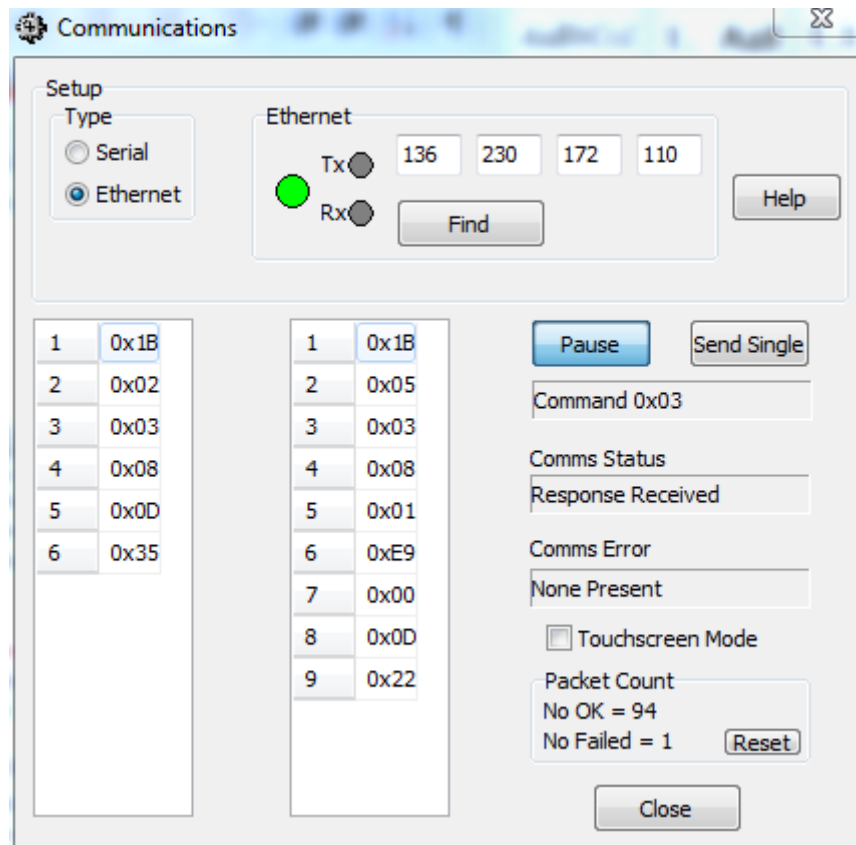
The values of the bytes transmitted and received are shown in grids. Pressing the next button will transmit the next command in the cycle. If a specific command is required which is not part of the automatic cycle the user should navigate to that command, click the button and then return to the Communications dialog box. Pressing the "Send Single" button will send the desired command.

11.8. Touchscreen Mode

The last item to note on Communications dialog box is the "Touchscreen Mode" check box which may be checked when using a touch screen (see Touch Screen section below).

12.   Access Level dialog box

This dialog box is opened by clicking the "Access Level" button on the main window:
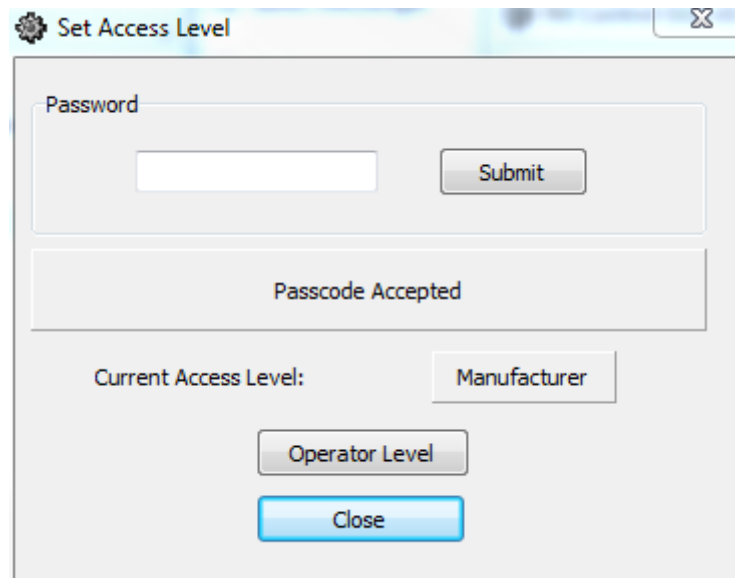
There are two levels of access allowed to Users. The default is the "Operator" level which permits all basic operational commands and setup windows to be accessed. The "Supervisor" level requires a passcode to allow access to extended setup and reset options. Higher level access options remain greyed out until the correct passcode is entered. The Supervisor passcode can be found on the test report for each laser.

The supervisor access period is limited to 10 minutes. To prevent unauthorized changes to the setup and to ensure that supervisor access is not left open to operators the "Operator Level" button should be pressed to revert the access back to operator level. The "Operator Level" button in the supervisor window has the same function.

To enter the Supervisor passcode click on the edit box to the right of the "Set" button. Enter the passcode. Note that the passcode is displayed as "XXXX" to ensure security.

13.   Retrieving the log

This is accessible using the "View Logs" button on the main window.
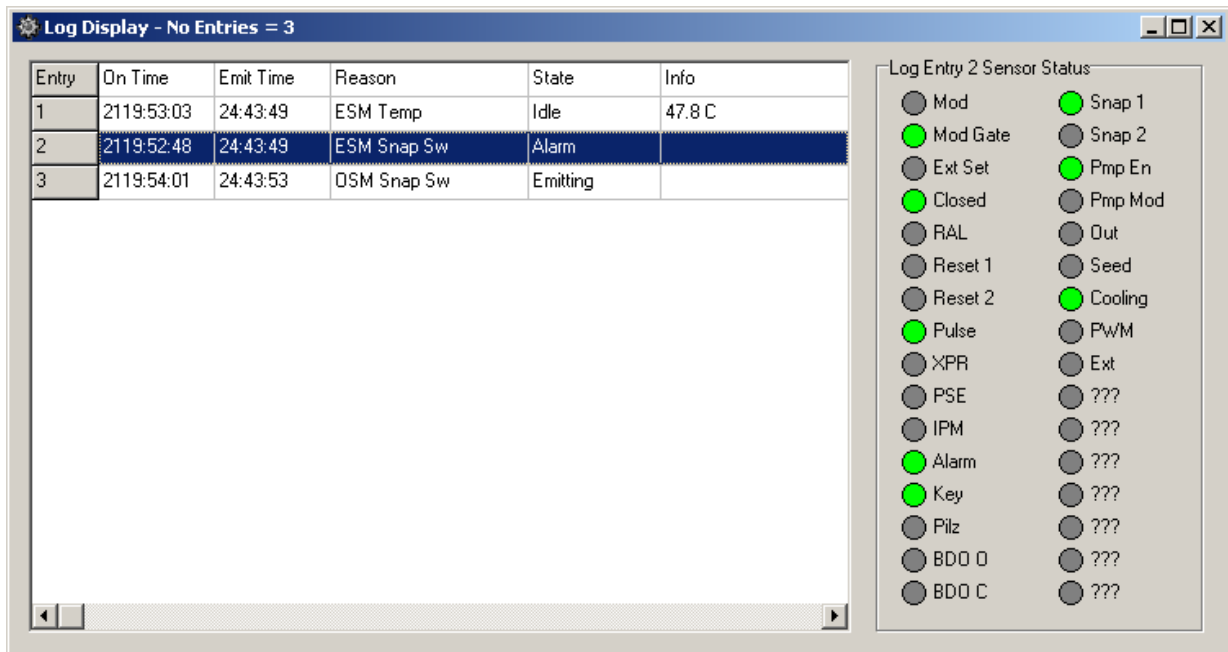
The number of entries is shown in the Log Display window's title bar, and the entries are shown in a grid. Each log entry may be selected individually to view more information. The details of the selected entry are displayed in the right hand panel. This panel shows the state of the laser sensors and settings at the point the alarm was triggered. From the example above we can see, among other things, that the cooling water was flowing and that the key switch was closed.

14.   System Info Window

This window is opened by clicking the "System Info" button on the main window.

It provides more detail on the functioning of the laser than is available on the main window.

14.1. Hardware Status

The top section gives the product code, serial number, cooling configuration (water or air), variant code, and rated power of the laser.

14.2. Temperature Sensors

This section gives the temperature readings from the sensors fitted within the laser. If a temperature sensor is causing a warning condition, it will appear as yellow text on a grey background. If it is causing an alarm condition, it will appear as bold red text.

Two of the temperature readings may not be present depending on the configuration of the attached laser. The BDO temperature only appears if the laser is fitted with a BDO that has a temperature sensor. The Inlet Water temperature only appears if the laser is configured for humidity sensing.

14.3. Digital I/O Status

This section indicates the state of the input and output pins of the 25-way I/O port on the R4 Fibre Laser. The pin numbering is given in the fibre laser Product Manual. The "Port Status" at the top of this section indicates whether the PLC port is currently being actively used to control the laser. This is set by Pin 3, "Use Interface" – if this pin is high, the laser will be set to "From PLC Port" control mode.

14.4. Software Version Information

This section gives the version numbers of the firmware on the fibre laser's NXP and AD processors. Holding the mouse pointer over the NXP firmware number will give additional detail about the version.

14.5. On Times

This section gives, to the nearest second, the total time the unit has been powered on and the total time it has been emitting.

14.6. Relative Humidity

This section only appears if humidity sensing functionality is fitted and enabled in the connected laser. Relative Humidity (RH) and Dew Point – temperature at which condensation will start to form – are given for the Electronics Module and the Optical Module. If the inlet water temperature gets too close to the dew point, a warning will appear. If the inlet water temperature decreases further, the solenoid will close and an alarm will trigger.

15. Performance Options

This window allows setting of the pump simmer settings and control of the XPR mode. These options must be enabled by the Supervisor before they are visible. The circles to the right of this window indicate whether each feature is currently off (red) or on (green).
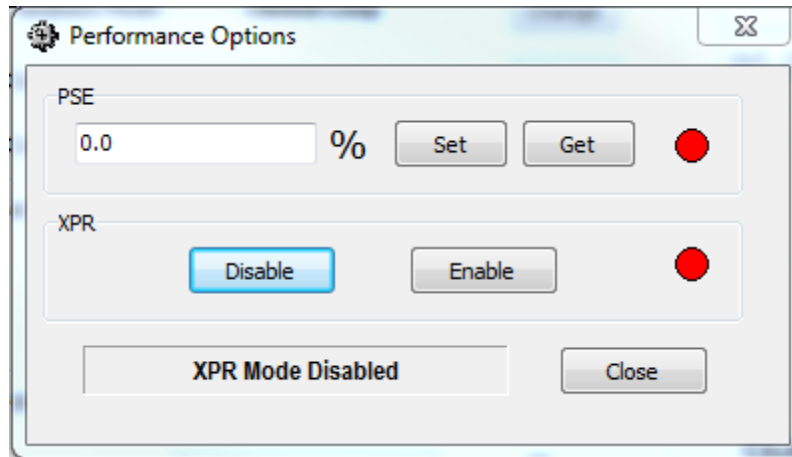
15.1. XPR

XPR stands for Extended Performance Range. This mode is designed specifically for operation at low average powers, but with a reduced optical response time. Refer to the Product Manual for further details. The Mode is controlled by the Enable and Disable buttons.

15.2. PSE

PSE is used to ensure the first pulse has similar characteristics to all subsequent pulses. Refer to the Product Manual for further details. Enter the required simmer level in the box, then click "Set". The Get button gets the current simmer level. To disable PSE, set the level to zero.

⚠️	**CAUTION:** When PSE mode is engaged it is possible for the Fibre Laser to emit at output powers of up to 4W when NO modulation signal is present. The output level will depend upon the PSE setting.

16.   Supervisor Window
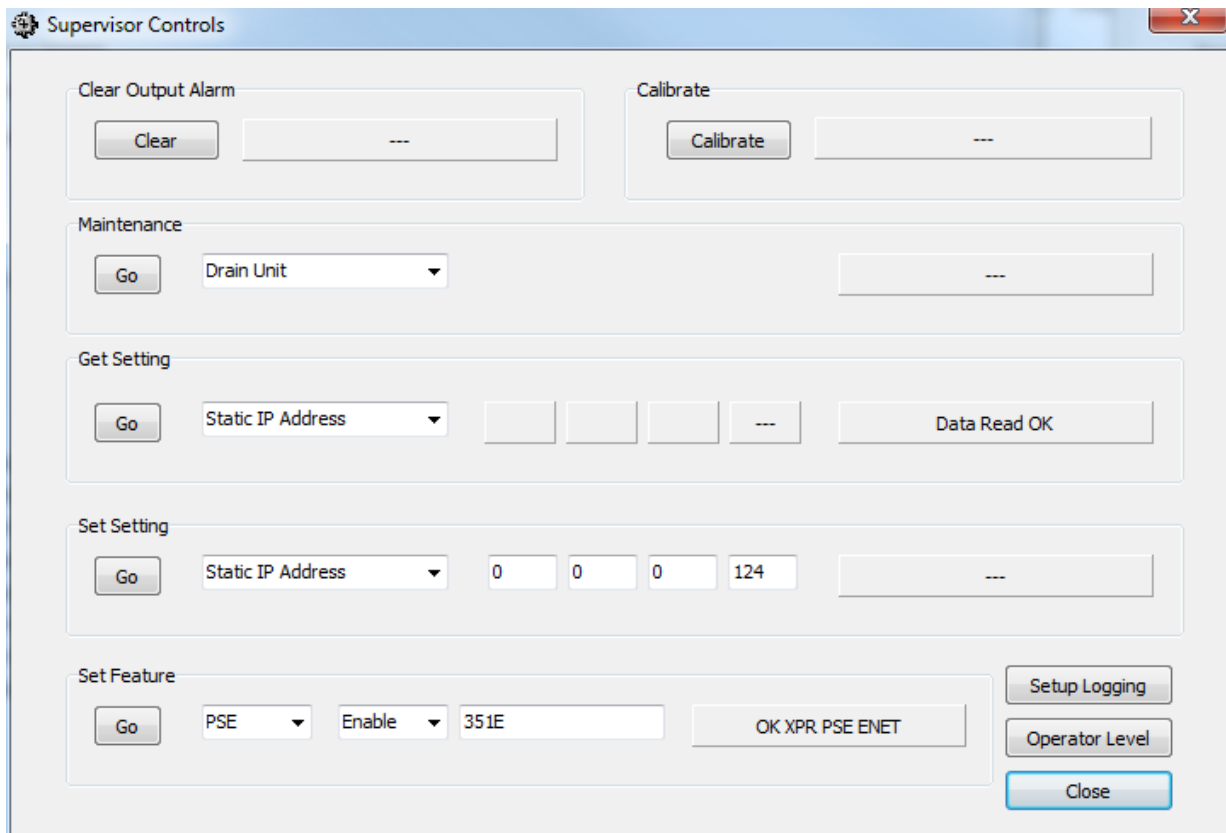
The Supervisor button on the main window is greyed out unless the Supervisor access level has been selected in the Access window.

Clicking the Supervisor button on the main window gives access to some setup and reset operations which are not available with the operator access level. Once the window has been opened the supervisor has one minute to complete the required tasks.

The following functions are available:

16.1. Clear Output Alarm

> ⚠️ **CAUTION**: If the reset routine is unsuccessful after the first attempt, contact the supplier immediately for advice.

> ⚠️ **CAUTION**: During the conditional reset procedure the fibre laser will be set to emit optical power. Ensure the beam delivery optic is securely mounted, pointing towards a suitable beam dump and the end cap has been removed before starting the reset sequence.

> **CAUTION:** Before starting the reset sequence, ensure all laser safety precautions are adhered to and laser safety eyewear is worn at all times as defined in Section 1.2. of the product manual.

If the laser internal output power monitoring system detects the absence of an optical output in response to an input set-point and modulation signal, an Output Power Alarm will be activated and the system safety shut-down will activate. If this alarm is activated a self checking routine can be executed to conditionally reset the system.

To reset the Output Power Alarm:

- Apply a constant CW TTL high signal to either the modulation input on the PLC port or the BNC connector and close the key switch.
- Click the "Clear" button to initiate the reset procedure and wait for confirmation of successful execution in the read back window. Once confirmed, recycle the front panel or remote key-switch to reset the laser system.

The laser is now reset and ready for continued operation.

16.2. Calibrate

> **CAUTION:** During the self-calibration procedure the fibre laser will be set to full rated output power. Ensure the beam delivery optic is securely mounted, pointing towards a suitable beam dump and the end cap has been removed before starting calibration.

The high reliability design of the fibre laser includes the provision of optical pump power overhead in order to compensate for the random failure of the pump diodes over the system design life as well as any temperature dependence in the optical system. In the event of a pump diode failure the drive current to output power calibration will change. With closed loop power control this may prevent the laser from reaching the power set-point. To prevent this, a simple periodic recalibration procedure ensures that the available diode current is incrementally increased to maintain the rated laser output power over life.

- Ensure the laser is in the emit mode.
- Click the "Go" button to initiate the calibration procedure and wait for confirmation of successful execution in the read back window.

Note : RS (Reduced Specification) lasers do not have an automated calibration routine. To replace this feature, a manual calibration feature is available. In the event of a pump diode

failure the drive current to output power calibration will change. The manual calibration routine is accessed from the Maintenance command on the Supervisor tab, and is described in the below section.

16.3. Maintenance

Several different maintenance commands can be selected from the drop-down list. The user should refer to the command manual FS-S00031 for comprehensive information. The options available are:

16.3.1. Drain Unit

This option will keep the water flow solenoid valve open to allow the laser to be drained of water prior to shipment. Note that the laser must be powered when draining takes place as the valve needs power to be kept in the open state.

16.3.2. Set RS-232 Baud Rate

The RS-232 baud rate may be changed using this option. Reliable RS-232 operation will depend upon the type of RS-232 cable, its length and how electrically noisy the operating environment. If the cable supplied by SPI is used, the recommended speed is 38400. If this option is left at "Auto" there is the possibility that a communication error will occur depending upon the sequence of turning on the laser and GUI.

16.3.3. Set & Get CANOpen ID

This option is reserved for future use.

16.3.4. Set Calibration

HS lasers can carry out an automatic calibration routine to determine the calibration value. However, RS lasers require the user to set the value manually. This option facilitates this manual setting.

The procedure for using this command is as follows:-

> ⚠ **CAUTION**: During the manual calibration procedure the fibre laser will be set to full rated output power. Ensure the beam delivery optic is securely mounted, pointing towards a suitable beam dump and the end cap has been removed before starting calibration.

1. Using appropriate safety arrangements, aim the laser at a power meter capable of absorbing the rated power of the laser.
2. Using the power setting window of the GUI set the laser to 100% power
3. Adjust the calibration value bring the laser output back to its rated power. Increasing the calibration value increases the laser power. Lasers start life set to 205. Only

increase the calibration value to allow rated power to be achieved – do not exceed rated power at 100% power setting.

4. If a setting of 255 is reached and the laser is not at rated power then the laser has reached End of Life.

5. When the calibration value is correct set the power to zero using the power setting window and disable the laser using the key switch. Cycle the mains power.

The new calibration value is now set and the calibration is complete.

16.3.5. Get Calibration

The current calibration value may be read using this command.

16.4. Settings

The settings which may be changed by the supervisor are:

16.4.1. Safety Delay

IMPORTANT: If the default value of this setting is changed the Customer accepts the responsibility for meeting the laser safety compliance requirements to the appropriate standards for the integrated laser system.

The "Safety delay" is the length of time between the laser being enabled by the closure of the safety relay, and laser emission being permitted. During this period the "Laser Enabled" LED indicators on the panel display flash. The default delay time is 4 seconds. This can be adjusted if required. Enter the new required value in milliseconds.

16.4.2. Static IP address

This is used to set up the Ethernet interface. The address is a number such as 192.168.1.53. This address must be within the range of the network to which it is connected. If in doubt contact your network administrator.

16.4.3. Static IP Mask

This is used to set up the Ethernet interface. The network mask is usually set to 255.255.255.0.

16.4.4. Ethernet Mode

There are two options, either "Static" or "DHCP". Your network administrator will be able to assist you in selecting the correct setting for your network.

16.4.5. RAL time out

The diode used in the Red Alignment Laser (RAL) has a finite life, so by default after 10 minutes it will turn off. The time may be changed to suit the user. The time is in minutes, and may be a minimum of 1 and a maximum of 250.

16.4.6. Static IP Gateway

This is used to set up the Ethernet interface. The Gateway value should be provided by your network administrator.

16.4.7. Ethernet MAC Address

The MAC address is a unique number which all network components must have to operate successfully within the network environment. This number can only be read and not set.

16.4.8. Current IP Address

The IP address is used by the Ethernet interface. It can only be read and not set. If the Ethernet mode is set to "Static" then this address will be the same as the "Static IP Address". If "DHCP" is selected then the network will allocate this address.

16.4.9. Flash Ethernet I/Face

This can only be set. The Ethernet interface has its own processor, and its firmware may be updated using this option. The SPI service department will supply the file to use and full instructions as to how to carry this out.

16.4.10. Ethernet Firmware Version

This value can only be read.

16.4.11. Pilot Laser set up

The Pilot Laser behaviour may be changed using this option. When selected, a configuration matrix will appear. The columns of the matrix are the states of the laser. The Pilot Laser may only be turned on if the user places a tick in the relevant state on the "Allow On" row. The default setting does not allow the pilot laser to be on in Idle, Emitting or Delay states. To replicate this behaviour the user need only tick one box:

In any other state such as Key Open, the user may send the "RAL On" command via the computer interface or assert the RAL On pin on the 25 way IO connector if this is being used. As soon as the key switch is closed to arm the laser the pilot laser will be extinguished.

To provide greater flexibility the user may also configure the pilot laser behaviour in other states:

- "Allow On" permits the pilot laser to be on in this state if the user requires it.
- "Auto On" will automatically turn the pilot laser on when this state is entered. "Allow On" must also be ticked in order for this functionality to work.
- "Auto Off" will automatically extinguish the pilot laser when this state is entered. (This will also happen if "Allow On" is not ticked – "Auto Off" will automatically turn the pilot laser off, but allow it to be re-enabled.)

16.4.12. Solenoid always on

Water-cooled lasers contain a solenoid valve to close and open the water flow through the coolant circuit. If enabled, this feature will open the solenoid all the time (except when a humidity alarm is present). If disabled, the solenoid will open and close in response to laser mode and temperature.

16.4.13. OPF Alarm

This feature is not currently in use.

16.5. Set Feature

This function will enable or disable a specific feature such as XPR. To see what features have been enabled select "None" from the drop down list. A list of enabled features will appear followed by "OK".
The passcode is required both to enable and disable features, which are:

16.5.1. XPR – eXtended Performance Range.

This reduces the total available power of the laser but the first pulse after a long delay is better formed.

16.5.2. PSE – Pulse Shape Equalisation

This improves the first pulse response of the laser without reducing the power output.

16.5.3. CAN

This feature is not currently supported.

16.5.4. IPM

This feature is not currently supported.

17.   Touch Screen Support

The GUI can provide touch screen support for PCs equipped with a touch screen. Touch screen support is enabled using the setting in the Communications window. It provides a pop up keyboard for number or passcode entry. Two examples are shown here:

18.   Controlling Multiple Lasers

One instance of the application cannot control multiple lasers. However, if multiple copies of the program are copied into separate folders, each one can be run individually and configured to operate a separate laser. Each instance of the program will create its own INI file with its own configuration settings.