

**GSI**

TM

# JK Fiber Laser

## Installation and Operation Manual





# JK™ Fiber Laser

## Industrial Fiber Laser

### Installation and Operation Manual

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## INTRODUCTION

GSI Group is a worldwide technology company specialising in the development, production and support of Lasers, Laser-based Systems and Precision Motion products. The Company organisation includes manufacturing operations located in North America, Europe and Asia along with a network of support centres.

GSI Group, Laser Division offers a complete range of lasers that cover applications to cut, drill, weld, engrave and mark a large variety of materials and items in market sectors including electronics, aerospace, automotive, advanced manufacturing and advanced research

GSI Group collaborates with customers to develop laser systems that increase productivity, solve manufacturing problems and meet the requirements of leading-edge production techniques.

Thank-you for purchasing this product. You can now benefit from the superior and reliable performance of an advanced laser system.

Please find the necessary time to read this manual thoroughly. It begins with safety measures that must be observed by all personnel authorised to use this system, and includes relevant installation details.

It is vital that we draw your attention to the following:

**WARNING: Certain precautions essential for the safe operation and maintenance of this high power laser are included within the manual and must be fully understood prior to the application of any electrical power to the system!**

**WARNING: No modifications or adjustments to components and controls should be undertaken other than those specified herein. Failure to observe this condition may result in hazardous laser radiation exposure!**

### After Sales Support

GSI Group, Laser Division supports its installed base worldwide, through a network of Regional Offices, Distributors and Machine Integrators.

For after sales support, please contact the local GSI Group office, Distributor or Machine Integrator that you purchased the laser from. Full contact details of the GSI Group offices can be found on our website at [www.gsiglasers.com](http://www.gsiglasers.com) – Contact Us. Should you have any queries about this system, or experience any difficulties in its use, do not hesitate to contact us. Our engineers and technical staff are on hand to provide professional advice

### **GSI Group, Laser Division - Service and Technical Support Hotline**

Telephone : +44 (0)1788 532612  
Fax: +44 (0)1788 553564  
Email : support.laserdivision@gsig.com

When contacting a Customer Centre, please have the following information at hand:

- The Laser model.
- The Laser serial number.
- Number of accumulated laser hours.
- Typical operating parameters.
- Any relevant information (e.g. fault codes and descriptions) that would assist in fault diagnosis.

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# 1. GENERAL INFORMATION

## 1.1 Class of Laser

The JK Fiber Laser is a Class 4 (IV) Laser system. Refer to Section 5 – Safety and Standards for information on Laser radiation hazards and safety precautions in a Class 4 (IV) environment.

## 1.2 Intended Users

All operators using this Laser equipment must be officially trained and authorised. They must also be fully conversant with the following:

- Laser hazards, safety procedures and correct use of related safety equipment.
- Hazards related to the use of Lasers for materials processing, prescribed safety procedures and related equipment.
- The contents of this manual, and therefore the related safety provisions prescribed for the safe installation of the equipment.

Authorised Personnel are classified as Engineers who have attended official GSI Group - Laser Division Training Courses and have been certified as competent.

## 1.3 Documentation

The JK Fiber Laser is supplied with a Installation and Operation Manual.

The Manual provides information on Pre-installation requirements, Installation and De-Commissioning Procedures and gives a basic overview of operating the laser.

The Installation section provides information and the procedures necessary for installation and commissioning.

The User Manual section provides information on the Operating Procedures, Routine Maintenance and Fault Diagnosis.

### Safety Paragraphs

Throughout the documentation ‘**WARNING**’, ‘**CAUTION**’ and ‘**Note**’ paragraphs appear. It is the responsibility and duty of all personnel who operate and maintain this equipment to fully understand the **WARNING**, **CAUTION** and **Note** procedures in order to reduce or eliminate hazards.



#### **WARNING**

**WARNING TEXT MUST BE OBSERVED TO PREVENT PERSONAL INJURY TO YOURSELF AND OTHERS.**



#### **CAUTION**

**Caution text must be observed to prevent possible damage or destruction to equipment or loss of operational effectiveness.**

**Note** text must be observed for essential and effective operating procedures and conditions.

## 2. THE JK FIBER LASER

The JK Fiber Laser is a continuous wave Ytterbium doped Fiber Laser used for micro welding and fine cutting applications.

### 2.1 Main Assemblies

The JK Fiber Laser is packaged in a 19" rack enclosure. The main assemblies of the JK Fiber Laser are:

#### 2.1.1 Laser Assembly – Laser Tray & Diode Tray

The laser assembly, which comprises the Laser Tray and Diode Tray is a monolithic block mounted in the centre of the 19" rack enclosure. The laser beam is delivered to the work station / work piece through an optical Fiber enclosed within a conduit which exits at the rear of the enclosure

#### 2.1.2 Low Voltage DC PSU

The LV DC Power Supply Unit (PSU) converts the Mains electrical input to DC and thus provides electrical power to the diode sources in the diode tray and control boards. Fans at the rear of the unit provide cooling to the PSU.

#### 2.1.3 Heat Management

**Water-cooling:** Water cooling for the Laser assembly is via fittings on the rear of the enclosure

**Air-cooling:** Fans positioned at the rear of the unit provide the necessary cooling on air-cooled units

#### 2.1.4 Machine Interface

The Machine Interface (PL5), allows total operational integration of the Laser into a production line or cell. Options include Power Control, Parameter Selection and Alarm Reporting. There are 7 user configurable signal lines for each of input and output. See Section 9 on the Control Interface for more details.

#### 2.1.5 Fiber Optic Cable Assembly

The laser beam from the JK Fiber Laser is delivered to the work station through a Fiber-optic cable enclosed within a conduit, the conduit exits at the rear of the unit and is non-detachable. The distal end of the fiber is designed to fit into one of the range of Process Tools (see Section 2.3).

## 2.2 Control System and Local Controller

The JK Fiber Laser Local Controller can be either a Personal Computer or an Industrial Touch Screen Computer, which is embedded into the laser front panel. It is referred to as the Graphical User Interface (GUI). The GUI is used to monitor and control the Laser, program parameters, alert the User to any maintenance requirements and to aid in fault diagnosis. FiberView™ is the GUI program from GSI specifically written for this family of Fiber Lasers. It is supplied on a CD-ROM.

## 2.3 Process Tools

A range of optimised Process Tools are available for the JK Fiber Lasers, including Cutting Heads, Welding Heads and Galvanometer based Scanning Heads. These have carefully designed optical elements providing diffraction limited performance. The Cutting head has inbuilt fine focus adjustment of the focus lens position, and a coaxial gas flow that provides a highly laminar flow due to the optimised design. The Weld Head can be fitted with a crossjet nozzle for workpiece shielding. CCTV viewing with a 'through the lens' built in illumination system is available for the Process Tools.

As light exits from the Fiber-optic cable, it expands into the Process Tool. This incorporates a Re-Collimating and Focusing lens assembly. Different laser spot sizes on the workpiece are achieved by changing the combination of Recollimating and Focus lens focal lengths.

For the Cutting Head spot sizes in the range 11µm to 35µm are available.

For the Welding Head spot sizes in the range 11µm to 52µm are available.

Please contact your GSI appointed Sales representative for more details on these parts.



### 3. INSTALLATION REQUIREMENTS

This table provides general data on the services necessary for Laser operation.

<b>Environment</b>	
Storage Environment	Temperature not to fall below 2°C (35°F) unless the coolant has been drained.
Operating Environment (Water Cooled)	Max temperature: 45°C (113°F) Min temperature: 5°C (40°F)
Humidity Specification	Max humidity: 85% RH at 20°C (68°F) Max humidity: 50% RH at 40°C (104°F)
<b>Electrical Supply Requirements</b>	
Supply	Single Phase
Line Voltages	100 – 240V AC nominal ±10% 90 – 264V AC actual
Frequency	47 – 63Hz
Maximum Supply Rating	1270 VA
Maximum Power Consumption	1145 W
<b>Note</b> Consult GSI Group - Laser Division if it is necessary to operate this equipment on a different supply frequency.	

<b>Cooling Water Supply</b>	
A clean water supply is required to the following specification:	
Water pH	6.5 to 8.5
Inlet Temperature	20°C - 25°C
Minimum Flow Rate	6 l/min
Minimum Differential Pressure	1 bar (15 psi)
Maximum Absolute Pressure	6 bar (90 psi)
Cooling capacity	Up to 800W
Coolant Connections	Push fit, 8mm outside diameter hose.
<b>Equipment Weight And Dimensions</b>	
Weight	50W / 100W WC – 30kg 50W / 100W AC – 35kg 200W WC – 35kg
Dimensions	50W / 100W WC – 4U x 450 Deep 50W / 100W AC – 6U x 450 Deep 200W WC – 5U x 450 Deep

<b>Customer Supplied PC – For operating FiberView™ Software</b>	
Operating System:	Windows XP
Minimum Hardware Specification:	Processor 1GHz
	Hard drive with 250MB free space
	256Mb RAM
	CD Drive
	1 x RS232 Interface Port
	Minimum screen resolution 1024 x 768
	Optional - 1 x RS422 Interface Port
	Optional - Floppy Drive

## 4. TECHNICAL SPECIFICATION

This table provides general technical data on the JK Fiber.

<b>Output Specification</b>	
Average Laser Power	50, 100, 200W
Beam Quality	M2 <1.1, TEM <sub>00</sub>
Operating Modes	CW, modulated, peak power enhancement
Wavelength	1075-1095nm
Laser Linewidth	2nm
<b>Laser Power Stability</b>	
Short Term Stability (1Hz-1MHz)	1.0% RMS (0.5% typically)
Long Term Stability (1 sec – 10 Hours)	±3.0% maximum (±1.5% typically)
<b>Warm Up Time</b>	
CW, Air Cooled, Open Loop	15 minutes
CW, Water Cooled, Open Loop	5 minutes
Wall Plug Efficiency	>17.5%
Output Power Dynamic Range	10-105%
Min Rise/Fall Time	5μs
Max Modulation frequency	50kHz
<b>Focus Head</b>	
Options	Cutting & Welding, Right Angled
Focal Length of Re-collimating Lens	25, 35, 50, 76mm
Focal Length of Focus Lens	76, 114mm
<b>Fiber Optic Cable</b>	
Standard Fiber Lengths	2m, 5m, 10m

## 5. SAFETY AND STANDARDS

### 5.1 General

Only authorised personnel who have been instructed in, and fully understand, the necessary safety procedures must use this laser.

Access to the laser should be restricted to authorised personnel. Suitable warnings signs should be placed around the area where it is operating.

Any local safety requirements for the operation of this equipment must be complied with.

### 5.2 Optical Safety

This is a high power Class 4 (IEC 825-1:2001) / IV (CDRH) laser system.

**WARNING: Laser radiation can cause serious eye damage - including blindness. Never look directly into the laser beam.**

**Injury to the eyes and skin can result from direct exposure to high power laser radiation.**

When the system is operational, all personnel must at all times wear approved laser goggles or glasses. It is vital that these are effective at the wavelength(s) emitted by this laser! The wavelength of the main beam is given on the Laser Radiation Warning and Classification Labels (see Section 6).

**Administrative procedures must be introduced to enforce the above requirement on use of protection. In Europe, Laser safety goggles must comply with EN 207 and EN 208.**

Information to assist with the selection of suitable eye protection is provided on the Laser Radiation Warning and Classification Label.

Never look directly into the main beam or any reflected laser beams - even when wearing eye protection - or blindness may occur.

Ensure that the beam is never reflected - even partially - back along its path into the laser head, as this will result in optical damage to its components.

Ensure that the beam is not directed towards reflective objects. (Note that personal jewellery is a potential hazard.)

It is strongly recommended that the laser is positioned so that beams are not at eye level, and the beam is not pointed at a room entrance. Take care that laser light cannot escape through windows.

Interaction of the beam with certain materials can cause potentially harmful levels of visible radiation to be emitted. Appropriate protective measures must be taken in this case.

### 5.3 Electrical Safety

Only qualified technical personnel who are familiar with the equipment should ever remove the covers from the laser. No electrical hazard exists if the system is operated normally.

**WARNING: This equipment contains lethal AC voltages. These may still be present even when the power is disconnected.**

### 5.4 Safety Interlocks

#### 5.4.1 Customer Remote Interlocks

A Remote Interlock Connector (RIC) provides connection for customer remote interlocks to the JK Fiber Laser.

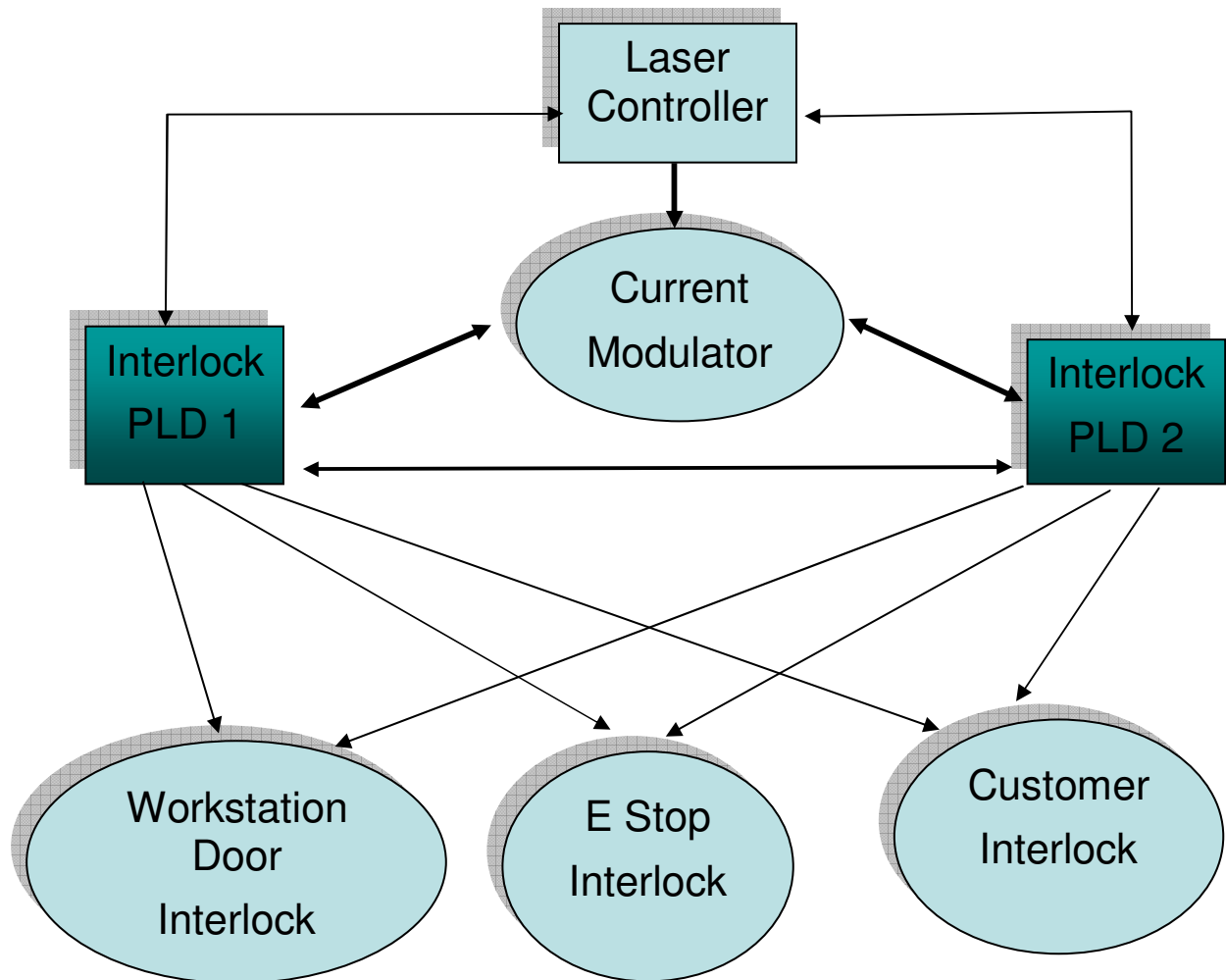
The interlocks are closed in normal operation. Opening the interlocks cuts the power supply to the diode circuits. Manual intervention is then required to re-establish the power. Remote interlock connection is via connector SK11. See Section 9.6 for more details on use of the interlock functions.

#### 5.4.2 Safety Interlocks

The Fiber Laser has two independent and cross-checked circuits that monitor the safety status of the laser. The diagram below illustrates this functionality.

### 5.4.3 Safety control

Safety is provided by the Laser control card.



## 5.5 Environmental Hazards

Materials used in Laser processing applications can become hazardous if safe working practices are not followed. Hazards can result from the following:

### 5.5.1 Fire

Particular care is necessary when processing combustible materials. Combustible materials include plastics, waxes, and some metals. The use of oxygen as an assist gas on combustible materials can exacerbate a fire hazard. Compressed gases and solvents used for equipment maintenance also increase the risk of Laser-initiated fires.

### 5.5.2 Fume

Fume and fine particulate can be generated during processing. Fumes can include metallic particles, dust, chemical and gaseous vapours. Such materials must always be regarded as a potential health and safety hazard. Ensure measures are taken to prevent inhalation.

Always consult the following regulations/recommended practices:

- Health and Safety Regulations.
- Local and Plant Regulations.
- Material Manufacturers' Safety Recommendations.

The following guidelines will reduce or eliminate fume hazards:

- Containment of processing by-products in a safety enclosure.
- Evacuation of the processing by-products and assist gases.

## 5.6 Compressed Gases

Statutory requirements relating to the storage, use and transport of compressed gases must be followed, in particular the handling of gas cylinders.

All high-pressure gas lines must be constructed to a high standard using high integrity components. Do not use grease on components that are exposed to oxygen. This increases risk of explosion. Flashback arrestors must be used in oxygen lines.

Strictly adhere to Manufacturers' Safety Recommendations and Procedures.

## 5.7 Solvents

Solvents are used for the maintenance of equipment. Solvents are hazardous to health if adequate precautions for use and storage are not taken.

## 5.8 Conditions of Use

The JK Fiber Laser must only be used under the following circumstances:

- On approved materials.
- Using an approved process.
- Under approved conditions.
- With due and proper authorisation.

### 5.8.1 Approved Materials

Approved materials can be processed without hazard to personnel or damage to the Laser product. These materials have been assessed for their toxicity and fire potential. Approved materials have an approved process method and recommended arrangements for fume containment and removal.

### 5.8.2 Approved Process

An approved process does not present a hazard to the health of personnel or possible damage to the Laser equipment. The approved process has recommended arrangements for processing by-products and fume containment and removal.

### 5.8.3 Approved Conditions

Approved conditions satisfy the requirements of applicable safety standards and statutory requirements relating to electrical, Laser radiation and health hazards. Approved conditions meet the requirements of the Plant Safety Officer and the Local Safety Inspectorate.

### 5.8.4 Due Authorisation

Due authorisation is the proposed arrangement, reviewed and approved by the following members of the User's organisation:

- A competent authorised person having a professional qualification in an appropriate technical discipline ('Technical Referee').
- The Supervisor of the Technical Referee.
- The Plant Safety Officer.

Practices that may result in accidental bodily exposure (e.g. holding work pieces by hand), must be avoided.

Do not attempt to process parts with personnel inside the safety enclosure.

Safety equipment must be complete, intact and free from damage.

Parts must only be processed in strict conformity with GSI Group Instruction Manuals, Local Safety Regulations and using established good working practices for Laser processing.

## 5.9 Equipment Standards

### 5.9.1 International Standards and Directives

This laser component is designed to comply with the following:

Electromagnetic compatibility	89/336/EEC and amendments
Low voltage	73/23/EEC and amendments
Machinery directive	98/37/IEC and amendments
EMC Immunity	EN61000-62:2001 Class A
EMC emissions	EN61000-4:2001 Class A
Safety of Machinery	EN292, EN60204-1
Safety of laser products	EN60825-1
CDRH	Compliance with 21 CFR 1040.10 and 1040.11; except for deviations pursuant to Laser Notice No. 50, dated 26 July 2001.
CE	Yes

### 5.9.2 Declaration of Incorporation

Use of the GSI Group Ltd, Laser Division product(s) referred to in this Manual, as part of a whole Machine may not ensure conformity of the whole Machine with the Machinery Directive. Machinery may not be put in to service until it has been declared in conformity with the relevant provisions of the Directive.

## 5.10 References

For further guidance on the safe use of laser equipment, the following is a list of suggested reading:

### 1) Laser Safety Guide

Laser Institute of America, 12424 Research Parkway, Orlando Florida 32826-3249, USA

### 2) American National Standard for the Safe Use of Lasers (ANSI Z136.1-1986)

Laser Institute of America, 12424 Research Parkway, Orlando Florida 32826-3249, USA

### 3) Radiation Safety of Laser Products - Equipment Classification, Requirements and User's Guide (BS EN 60825)

BSI, Linford Wood, Milton Keynes MK14 6LE, UK

## 6. SAFETY CONTROL SYSTEM

### 6.1 Safety Category

A Laser Safety Officer must be appointed to specify the level of safety precautions and control to be implemented during normal operating and maintenance work.

At all times a Laser must be operating in a controlled area, appropriate to the level of hazard it represents.

### 6.2 Safety Compliance

The following standards apply to Laser safety:

- **Worldwide:** IEC 60825-1: 2001
- **Europe:** EN 60825-1: 2001
- **North America:** FDA Regulation 21 CFR Chapter J 1040.10.

### 6.3 Safety Labelling

Safety labels are fitted to the equipment in compliance with IEC regulations, and also with 21 CFR 1040.10 pursuant to Laser Notice No. 50, dated 26 July 2001. Before operating on any part of the Laser system, the hazard level must be checked by examining the Safety and Compliance labels - refer to Figures below.

The labels illustrated in this section are essential for the safe operation of the laser. They must not be removed under any circumstances, and any missing or defaced labels must be immediately replaced. Spares can be obtained from GSI Group. Customers must ensure any component fitted has the correct labelling (refer to GSI Group).

#### 6.3.1 Laser Classification Labels

An example of the Laser Classification label is shown here, along with its location on the rear panel of the laser.



This information is supplied for safety purposes only and serves principally to assist in the selection of suitable protective eyewear and guarding, including integral viewing panels. These values reflect an appropriate safety margin; it is not an output specification.



## **7. DAMAGE DURING SHIPMENT**

By accepting a shipment at our plant, the transportation company acknowledges that it was handed over to them in good conditions and properly packed. The transportation company that delivers this shipment to your door is responsible for its safe delivery.

### **7.1 Shipments F.O.B. our plant**

#### **7.1.1 External damage**

If shipment has been made F.O.B. our plant, and is damaged externally:

1. Write on the delivery note or the freight bill the nature and extent of damages.
2. Notify the office of the transportation company that delivered the shipment to you and request them to inspect the shipment.
3. File a claim for damages with the transportation company at once.
4. Retain all packing material until shipment is inspected and your claim is settled.

#### **7.1.2 Internal damage**

If shipment has been made F.O.B. our plant, and is damaged internally, carry out steps 2 to 4 above immediately upon discovery of the damages.

#### **7.1.3 Shortages**

If shipment has been made F.O.B. our plant, and the shipment delivered to you is not in agreement with the quantity of containers shown on your receipt, accept it only after such shortages have been noted on the freight bill or bill of lading. File a claim with the transportation company that delivered the shipment to your door at once.

GSI Group accepts no responsibility for shipments made F.O.B. our plant that are damaged or lost in transit. Claims for loss or damage must not be deducted from our invoice, or payment withheld, awaiting adjustment or settlement of such claims.

If, upon arrival of a shipment made F.O.B. our plant, you have any questions, please do not hesitate to call us.

### **7.2 Shipments F.O.B. destination**

If shipment has been made F.O.B. destination and damages or shortages have occurred notify GSI Group immediately by telephone or fax upon arrival of the shipment. Please carry out all of the procedures outlined above for those relating to the filing of claims. All documents resulting from these procedures should be mailed to:

GSI Group - Laser Division  
Cosford Lane, Swift Valley  
Rugby, Warwickshire,  
CV21 1QN, UK  
Telephone: 44 (0) 1788 537075  
Fax: 44 (0) 1788 579824

## 8. FIBER OPTIC HANDLING

These guidelines must be read before unpacking and handling the Fiber Optics.



### CAUTION

**Serious damage can be caused if the Fiber Optic cable is handled incorrectly.**

### 8.1 Description

JK Fiber Lasers are equipped with Fiber optic beam delivery. The standard Fiber cable lengths are 2m, 5m, and 10m.

Optimum Fiber routing from the Laser to the point where processing is to be carried out is essential if long Fiber lifetime is to be achieved. The Fiber optic is a complex component that incorporates optical and mechanical parts. Although Fibers are designed for use in factory environments, care must be taken during installation and use to ensure optimum performance and acceptable lifetime.

Fiber optic cables are more fragile than electrical cables, although superficially they look similar. If Fibers are treated and handled as electrical cables, they will fail prematurely. Fiber replacement can be both time-consuming and expensive.

### 8.2 Unpacking Fiber Optic Cable

Particular care should be taken with regard to possible termination damage when uncoiling the Fiber as there is a tendency for the coil to spring apart, possibly resulting in the terminations colliding with other objects.

- The cable is very flexible and easily bent when uncoiling. At no time shall the minimum bend radius be exceeded.
- Take care not to twist the cable when uncoiling. Always unravel the cable compensating for any twist that might occur.
- Do not drop the cable or allow it to impact with surfaces or other objects.
- Never pull on a termination to unravel a Fiber.

### 8.3 Fiber Installation

- Ensure that the bend radius limitation of 75mm is observed at all times.
- Avoid sharp or abrasive surfaces.
- When the Fiber cable is run horizontally it is to be supported, or secured, at intervals no greater than 4m.
- Grouping the cable with stiffer service cables/pipes is permissible but the cable must not be used as a supporting member for a group of more flexible cables/pipes.
- Fiber termination must not be subjected to forces caused by dropping, impacting or collision by heavy objects.

### 8.4 Fiber Optic Termination

Fiber termination is the section of Fiber from the end of the conduit to the exposed end of the Fiber. This includes all mechanical and optical parts. No single part of the Fiber termination is replaceable / repairable outside the manufacturing base.

- Ensure the Fiber termination is always kept in a clean environment. If this is not possible, use the clean termination cover provided.
- During installation of the Fiber, ensure that the protective covers are removed only when necessary.
- Take especial care not to let any contamination enter the side opening on the Fiber termination.
- Keep the Fiber termination placed downwards when uncovered and not installed.
- Do not attempt to dismantle the Fiber termination.
- Always handle the termination by the conduit not the optical termination.

- The Fiber termination must not be subjected to forces caused by dropping, impacting or collision by heavy objects.

## 8.5 Fiber Routing

In static applications (i.e. Fiber and Focus Head do not move), the Fiber must not be bent greater than the minimum bend radius at any point along the route.

In dynamic applications (i.e. Fiber and Focus Head move), the following points of good practice should be adhered to:

- The Fiber cable should be held off the floor and routed along a path so that the Fiber cable does not bend more than the minimum bend radius at any point along the Fiber cable length throughout the production sequence.
- The Fiber cable should be supported at points along its length to prevent gross movements under the action of its own weight during the production sequence.
- At the Fiber cable support points, the Fiber cable should be held using mechanical parts which prevent the minimum bend radius being exceeded and which do not result in a radial compressive force on the Fiber cable.
- The Fiber cable should never be pulled tight at any point along its length during the production sequence.
- The external surface of the Fiber cable should be prevented from rubbing / abrading at support points or on any other parts in the workstation (e.g. jigs, fixtures, production parts, workstation walls, floors, robot parts).
- Acceleration and deceleration of the Fiber cable and Focus Head should be kept to a minimum consistent with achieving process cycle time.
- At Fiber cable installation and periodically during operation (e.g. once per shift), a dry run of the production sequence should be made. The Fiber cable motion should be checked to ensure that the Fiber routing still complies with the points of good practice above.

## 8.6 Fiber Removal

When removing the Fiber termination from the Fiber output receiver, hold the termination and ease the Fiber free. Never jerk the Fiber free.

## 9. CONTROL INTERFACE ELECTRICAL CONNECTIONS

### 9.1 Connection Panel

Connections between the Fiber Laser and customer devices are made from connectors located at the rear of the laser unit.

**Table 1 – Interface Connectors**

Connector ID	Description
PL5	Machine Interface
PL9	General Purpose IO
SK101	TTL Trigger / Gate
SK10	Remote Control Box
SK11	Customer Interlocks

### 9.2 PL5 – Machine (M/C) Interface

The Machine (M/C) Interface connection is made via a 25 way D-Type Plug (male). The functions of the digital inputs and outputs can be defined via the laser software. Tables 2 and 3 show the full list of functions for the system. To prevent operational problems caused by earth loops, the Machine Interface is opto-isolated.

**Table 2 - Laser Inputs**

ID	Input Function Description	Comments
0	Unused	Inputs assigned this value are ignored
1	Laser Start	False: Takes the laser to OFF in remote control True: Takes the laser from OFF to STANDBY under remote control
2	Laser On / Process Cycle Start	False: Sets laser to STANDBY or stops a defined process cycle True: Sets laser to ON or starts a defined process cycle (if laser already in STANDBY)
3	Trigger / Gate Input	False: No laser Output. True: Gated Mode: Laser output. Triggered Mode: Laser pulse on rising edge. Recommended Configuration: Use Input 6.
4	Trigger Source Select (Internal / External)	False: Laser runs at pulse rate defined by internal parameters. True: Laser is triggered or gated by Trigger Input
5	Process Cycle Step	Advances to next process step on rising edge.
6	Alarm Reset	Resets Alarm condition on rising edge.
7	Strobe	Read parameter set / process cycle data on rising edge.
8	Parameter Set / Process Cycle Select (Bit 0)	Parameter set or Process cycle can be selected using these inputs.
9	Parameter Set / Process Cycle Select (Bit 1)	
10	Parameter Set / Process Cycle Select (Bit 2)	
11	Parameter Set / Process Cycle Select (Bit 3)	

ID	Input Function Description	Comments
12	Parameter Set / Process Cycle Select (Bit 4)	
13	Parameter Set / Process Cycle Select (Bit 5)	
14	Parameter Set / Process Cycle Select (Bit 6)	

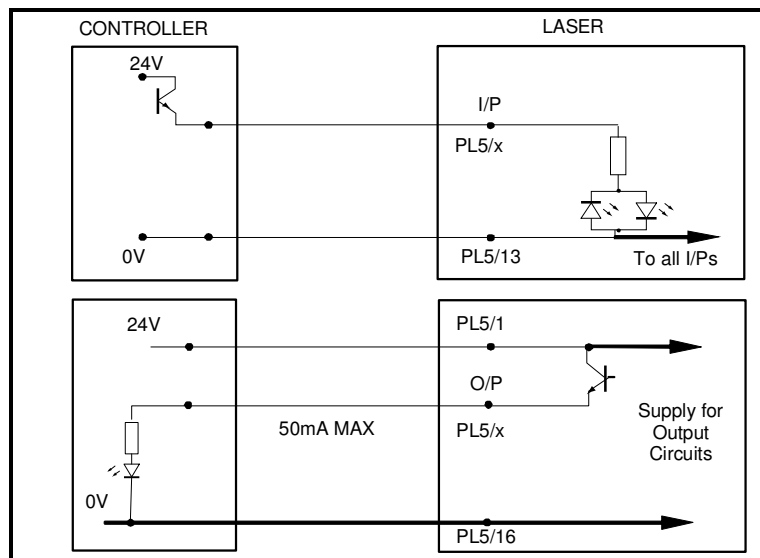
Table 3 - Laser Status Outputs

ID	Output Function Description	Comments
0	Unused	Outputs assigned this value are not updated
1	Laser Standby	False:Laser OFF or ON True: Laser in Standby
2	Laser On / Process Cycle Active	False:Laser OFF/Standby or Process Cycle Stopped True: Laser ON or Process Cycle Running
3	Remote Control	False: LOCAL control Mode True: REMOTE control Mode
4	Sync	Synchronised True with duration of laser pulsing.
5	Process Cycle Wait	False: Process cycle running or in Autostep mode. True: Waiting for Process Cycle Step input
6	Processing Mode	False: Normal Mode True: Process Cycles Mode
7	Alarm	False:Alarm not present True: Alarm present
8	Warning	False:Warning not present True: Warning present
9	Energy Warning	False: Laser Energy inside set limits. True: Laser Energy outside set limits.
10	Acknowledge	False:Data not accepted or strobe off True: Data accepted
11	Parameter Set / Process Cycle Selected (Bit 0)	Provides monitor output to confirm parameter set or process cycle selected
12	Parameter Set / Process Cycle Selected (Bit 1)	
13	Parameter Set / Process Cycle Selected (Bit 2)	
14	Parameter Set / Process Cycle Selected (Bit 3)	
15	Parameter Set / Process Cycle Selected (Bit 4)	
16	Parameter Set / Process Cycle Selected (Bit 5)	
17	Parameter Set / Process Cycle Selected (Bit 6)	
18	Process Cycle Active Step (Bit 0)	Provides monitor output for Process Cycle progress
19	Process Cycle Active Step (Bit 1)	
20	Process Cycle Active Step (Bit 2)	
21	Process Cycle Active Step (Bit 3)	
22	Process Cycle Active Step (Bit 4)	
23	Process Cycle Active Step (Bit 5)	
24	Process Cycle Active Step (Bit 6)	
25	Process Cycle Active Step (Bit 7)	
26	Back reflection warning	True: Back reflection signal above warning level. False: Back reflection signal below warning level.

ID	Output Function Description	Comments
27	Burn Back / Safe Mode detected	True: Condition detected False: Condition not detected.
28	Laser Over Temperature	True: One of monitored temperatures above Alarm level.
29	Back Reflection Alarm	True: Back reflection signal above alarm level. False: Back reflection signal below alarm level.
30	Emergency Stop Alarm	True: E-stop or an Interlock activated. False: E-stop and Interlocks not activated.
31	Cooler Interlock Status	True: Cooler OK (See section 9.6.4) False: Cooling supply fault.

**9.2.1 Configuration**

The Machine Interface laser inputs and laser outputs are provided as sourcing only. Figure 1 shows the configuration and connection method.



**Figure 1 - Sourcing Diagram**

**9.2.2 Machine Interface Supply**

The Machine Interface must be powered by a power supply in range of +15 to +30V (typically +24V) capable of delivering 200mA. Power is provided by connecting the external supply between PEXT and GNDEXT on the pin allocations shown in Table 4. Nominal load for each input is 5mA. The maximum current capability of each output is 50mA.

**Table 4 - PL5 Basic Machine (M/C) Interface**

PIN #	I/O	PIN NAME	DEFAULT FUNCTION
1	PEXT	PEXT	External 24 Vdc
2	PEXT	PEXT	External 24 Vdc
3	I	IN0	Laser Start
4	I	IN1	Laser ON / Process Cycle Start
5	I	IN3	Unused
6	I	IN5	Trigger Source Select
7	O	OUT1	Laser ON / Process Cycle Active
8	O	OUT3	Alarm Status

9	O	OUT5	Energy Warning
10	O	AOUT	Ext. Power Feedback
11	AI	AIN+	Analogue Input +
12			
13	I	COMMON	Dig Input Common
14	GNDEXT	GNDEXT	External 0 Vdc
15	GNDEXT	GNDEXT	External 0 Vdc
16	I	TRIGGER IN	Trigger Input
17	I	IN2	Process Cycle Step
18	I	IN4	Alarm Reset
19	O	OUT0	Laser Standby
20	O	OUT2	Remote Status
21	O	OUT4	Warning
22	O	OUT6	Process Cycle Wait
23	GNDEXT	GNDEXT	External 0 Vdc
24	AI	AIN-	Analogue Input -
25			

### 9.2.3 Laser Inputs

The laser can be controlled in Remote Mode by using inputs on the Machine Interface. Ensure Remote Ready Status is true before using any of the inputs.

### 9.2.4 Laser Status Outputs

The laser provides status outputs to the Machine Interface. Connection details are shown in Table 3.

### 9.2.5 Laser Diagnostic Outputs

Laser diagnostic outputs are grouped into the following:

- Alarms that stop the laser.
- Warnings that indicate a problem but allow continued laser operation.

The presence of an alarm or warning is indicated by the transition of the 'Alarm Status' or 'Warning Status' output from false to true.

Alarm codes will remain present until the alarm has been manually reset.

Warning codes will remain present until the condition causing the warning has cleared. This may not require manual intervention.

## 9.3 PL9 – General IO

The general IO connection is not implemented.

## 9.4 SK101 – TTL Trigger / Gate

The TTL Trigger connection is made via a 50R BNC Socket. The function of this input is defined by the trigger mode, selected via the laser control panel. The same function is also available via the Machine Interface (PL5) on Pin 16.

## 9.5 SK10 – Remote Control Box

The Remote Control Box connection is reserved for the connection of the GSI Remote Control Box option.

## 9.6 SK11 - Customer Interlocks

The Customer Interlock connector enables remote interlocks to be connected to the laser interlock circuits. The Customer Interlock connections are made via a 15 way D-Type Socket (female). Connection details are shown in Table 5

**Table 5 - SK11 Customer Interlocks**

<b>PIN #</b>	<b>I/O</b>	<b>DESCRIPTION</b>	<b>ELECTRICAL</b>
1	I	Customer Interlock 1 +	Links to Pin 9 with volt free connection
2	+24V	Internal +24V	Links to Pin 10 with volt free connection
3	O	Emergency Stop Output 1	Volt free output from Laser ESTOP (Channel 1)
4	O	Emergency Stop Output 2	Volt free output from Laser ESTOP (Channel 2)
5	I	Workstation Interlock 1 +	Links to Pin 13 with volt free connection
6	+24V	Internal +24V	Links to Pin 14 with volt free connection
7		Cooler Interlock +	Links to Pin 15 with volt free connection
8		Not Connected	
9	GND	Internal GND	Links to Pin 1 with volt free connection
10	I	Customer Interlock 2 -	Links to Pin 2 with volt free connection
11	O	Emergency Stop Output 1	Volt free output from Laser ESTOP (Channel 1)
12	O	Emergency Stop Output 2	Volt free output from Laser ESTOP (Channel 2)
13	GND	Internal GND	Links to Pin 5 with volt free connection
14	I	Workstation Interlock 2 -	Links to Pin 6 with volt free connection
15	GND	Internal GND	Links to Pin 7 with volt free connection

### 9.6.1 Customer Remote Interlock

Customer Interlocks 1 and 2 are inputs to the laser from an external Emergency Stop circuit. The 2 inputs are required to operate in synchrony. Customer Interlock 1 input, on pin 1, is in the 'healthy' (closed) state, when the GND on pin 9 is connected to it. Customer Interlock 2 input, on pin 10, is in the 'healthy' (closed) state, when the 24V on pin 2 is connected to it. So, pins 1 and 9 need to be linked together, and pins 2 and 10 need to be linked together, before the laser can be powered up. When one of the circuits is open the laser will shutdown and an alarm will be generated. The alarm cannot be reset until both circuits are opened and then closed, in synchrony.

### 9.6.2 Emergency Stop Outputs

These are volt free outputs from the laser. These outputs are from auxiliary contacts on the emergency stop pushbuttons in the laser.

### 9.6.3 Work Station Interlock

Workstation Interlocks 1 and 2 are inputs to the laser from external work handling equipment. The 2 inputs are required to operate in synchrony. Workstation Interlock 1 input, on pin 5, is in the 'healthy' (closed) state, when the GND on pin 13 is connected to it. Workstation Interlock 2 input, on pin 14, is in the 'healthy' (closed) state, when the 24V on pin 6 is connected to it. So, pins 5 and 13 need to be linked together, and pins 6 and 14 need to be linked together, before the laser will give output power. When one of the circuits is open the laser will switch off to a safe state and a warning will be generated. To remove the Warning, both circuits must be opened and then closed in synchrony.

### 9.6.4 Cooler Interlock

The Cooler Interlock is an input to the laser from external water cooling equipment. The Cooler Interlock input, on pin 7, is in the 'healthy' (closed) state, when the GND on pin 15 is connected to it. So, pins 7 and 15, before the can be powered up. When the laser is off, and the circuit is open, the laser will generate a warning. When the laser is on, and the circuit is open, the laser will shutdown and an alarm will be generated. To remove the Warning / reset the Alarm, the circuit must be closed.

## 9.7 Minimum Interface Connections

The minimum interconnections needed to operate the laser are shown in Table 6.



PL/SK	PIN #	I/O	FUNCTION
<b>Required for Local or Remote Operation</b>			
SK11	1	I	Customer Interlock 1
SK11	9	GND	Internal GND for Customer Interlock 1
SK11	2	+24V	Internal +24V for Customer Interlock 2
SK11	10	I	Customer Interlock 2
SK11	5	I	Workstation Interlock 1
SK11	13	GND	Internal GND for Workstation Interlock 1
SK11	6	+24V	Internal +24V for Workstation Interlock 2
SK11	14	I	Workstation Interlock 2
SK11	7	I	Cooler Interlock
SK11	15	GND	Internal GND for Cooler Interlock
<b>Required for Remote Operation (Default Pin Config)</b>			
PL5	1/2	PEXT	External 24Vdc
PL5	14/15	GNDEXT	External 0Vdc
PL5	4	I	Laser On
PL5	3	I	Laser Start

**Table 6 - Minimum Interface Connection Table**

## 10. LASER OPERATION

### 10.1 Overview

Laser operation consists of the following:

- Start up.
- Shutdown.
- Emergency shutdown.
- Monitoring and control.

**Note that neither the OEM nor Rack Mounted versions of the laser have a Mains power isolation switch on them.**

For the Rack Mounted version, as soon as the Mains Power lead is plugged into the rear of the laser is made live, then the unit will have power applied to it. Cooling fans will be activated and the Front Panel LED will light up. The laser will then be in a state to receive operator commands.



### 10.2 Full Laser Start-up

Throughout the user maintenance procedures, the terms Power ON Sequence and Power OFF Sequence are used.

The Power ON Sequence is defined as:



- Ensure external water supply is ON (Water Cooled Units only)
- Ensure external power supplies are available and switched on
- Verify that the white POWER ON LED is lit
- Verify the fault lamp is not flashing.

If the Laser is being controlled via the FiberView™ programme, then:

- Select the Standby button , the amber EMISSION lamps will flash several times. The system will commence the start-up sequence and the Standby Button will grey to indicate that the system is in Ready Mode.
- Select the On button  to operate the laser.

### 10.3 Full Laser Shut-down

The Power OFF sequence is defined as:

- At the FiberView™ control screen, verify that laser status icon is grey indicating STANDBY . If not, select the laser STANDBY button. Ensure laser status icon indicates STANDBY.
- Push OFF Button .
- Laser is now OFF.
- Set the external laser isolator switch to OFF.

### 10.4 Emergency Shutdown

The emergency stop procedure must only be used if external conditions deem it necessary. It must not be used as a shutdown method in normal conditions.

- Press the closest red EMERGENCY STOP button.
- Switch OFF the external Power Supply Isolator.
- Switch OFF the external water supply (Water Cooled versions only).
- Follow all Local Emergency Procedures.

# 11. FIBERVIEW™

## 11.1 Overview

FiberView™ is part of the FiberStudio™ suite of software programs for controlling and monitoring the JK FiberLaser range.

The initial configuration of the laser can be set from FiberView, and then the operating parameters selected. During operation the conditions within the laser can be monitored. Various levels (Maintenance, Supervisor, Operator) of access are allowed to the features of the programme for control of the laser in a production environment.

If the FiberView programme is run with no laser connected to the PC, then an option is available to in a simulation mode. This mode is useful for safely familiarising the user with the operation of the programme.

## 11.2 Basic Operation

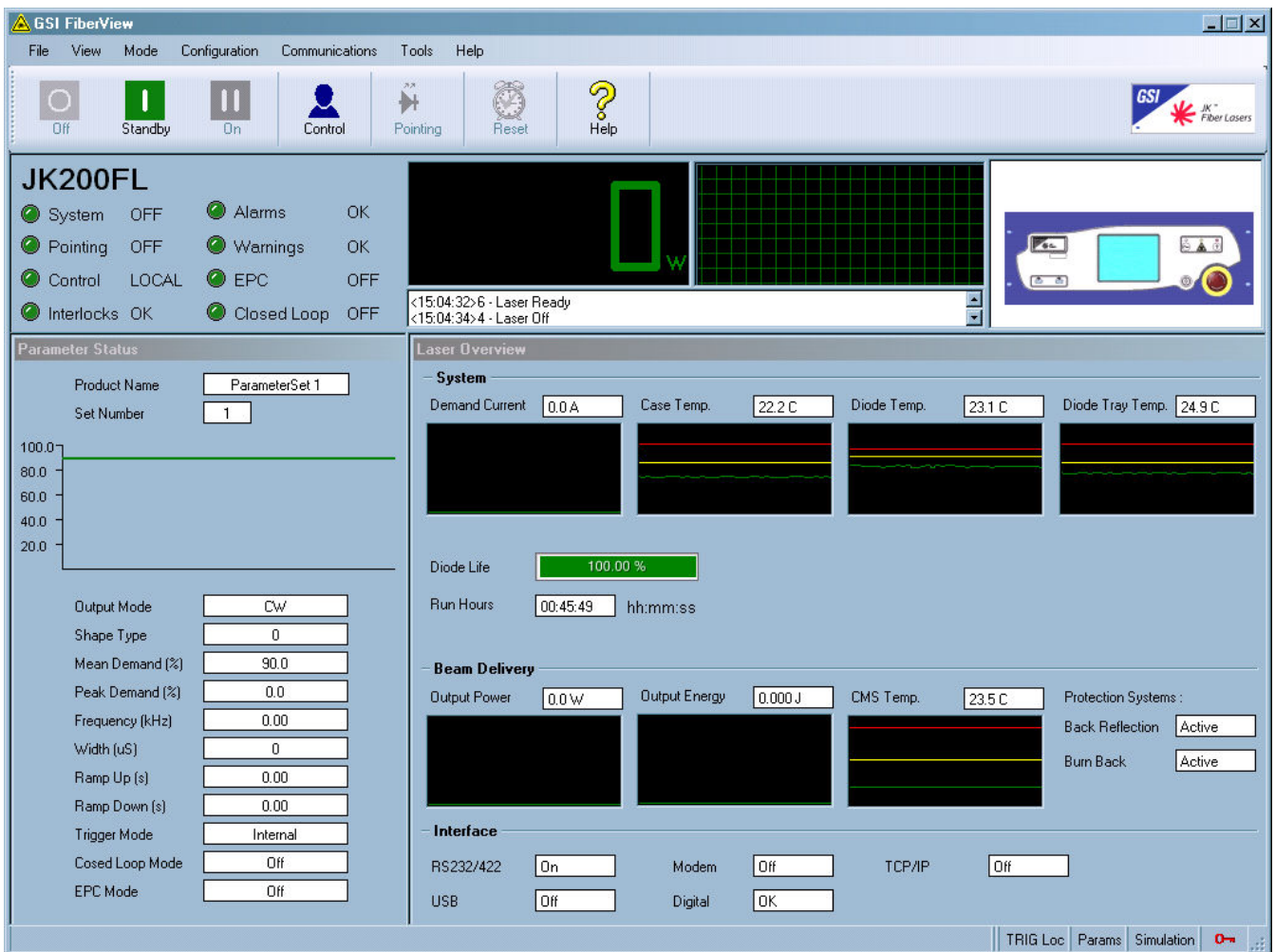




Figure 11.1 FiberView Overview Screen

On starting the FibreView programme in its default mode, a screen similar to Figure 11.1 appears.

To select the laser operating parameters, on the Menu bar select: View – Windows – Parameter Set Programming. Here the laser can be set to CW or pulsed (modulated) operation, and the demand level is determined. Note that 100% demand will deliver just over the specified maximum power of the laser.

In Pulsed Mode a frequency and pulse width can be set. In this mode the laser drive is turned rapidly switched on and off to modulate the output beam. The effect is to 'chop' the CW output into a series of pulses.

Returning to the Laser Overview Screen (on the Menu bar select: View – Windows – Laser Overview), will allow the laser conditions to be monitored whilst it is running.

To operate the laser, click on the green Standby Button  to enable the laser, and then click the black On Button  to start the laser output beam.

To turn the laser off, press the red Off Button , or the green Standby Button .

**Note** *Restarting the laser output from Standby Mode is faster than from the Off condition.*

## 11.3 Other Settings

### 11.3.1 Machine Interface

The Machine Interface functions are described in Section 9.2. The configuration of the 7 outputs and inputs can be designated and confirmed by selecting from the Menu bar: View – Windows – Maintenance – Machine Interface.

To alter the configuration use the Menu bar in the Maintenance - Machine Interface window and select Action – Change Configuration. To write the new configuration to the laser select Action – Save Configuration.

### 11.3.2 Interlocks

If there is an error condition on one of the Interlocks, the Interlock indicator in the top left area of the FiberView window will turn red.

To find more information on which Interlock has been activated, select View – Windows – Maintenance – Interlock Status. Any activated interlocks will be highlighted with red indicators. Alternatively hover the mouse over the red indicator and a pop up box will show which Interlock has been activated

After clearing the interlock condition, use the Reset button on the main FiberView Toolbar to reset the indicator status and allow the laser to be restarted.

### 11.3.3 Alarms and Warnings

If there is an error condition that triggers a Warning or Alarm, the corresponding indicator in the top left area of the FiberView window will turn red.

To find more information on which Warning or Alarm has been activated, hover the mouse over the red indicator and a pop up box will show which Warning or Alarm has been activated. This information is also displayed in the two line status window under the Power output display.

A record of Warnings or Alarms can also be viewed by selecting View – Windows – Logs, and then clicking on 'Alm' or 'Warn' on the Logs window toolbar.

After clearing the Alarm condition, use the Reset button on the main FiberView Toolbar to reset the indicator status and allow the laser to be restarted.