JK300HP/JK300P/JK125P
Nd: YAG Industrial Laser

Pre-installation and User Manual

GSI Group - Laser Division
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Acceptance Sheet

The acceptance of this shipment by the Transport Company at GSI Group - Laser Divisions plant is an acknowledgement that it was properly packed and handed over in good condition.

The Transport Company that delivers this shipment to your premises is responsible for its safe delivery.

If the shipment has been made Free Carrier (FCA) GSI Group - Laser Divisions and is damaged externally, undertake the following actions:

- The delivery person must note the nature and extent of the damages on the freight bill.
- Notify the office of the Transport Company that delivered the shipment and request that the shipment be inspected.
- File a claim for damages with the Transport Company immediately.
- Retain all packing material until the shipment is inspected and the claim is settled.

If the shipment has been made FCA - Rugby – Packed and is damaged internally, undertake the following actions:

1. File a claim for damages with the Transport Company immediately.
2. Retain all packing material until the shipment is inspected and the claim is settled.
3. If the shipment has been made FCA - Rugby - Packed and shortages have occurred, undertake the following actions:
4. If 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 loading. File a claim immediately with the Transport Company responsible for shipment delivery.
5. Please contact GSI Group - Laser Division if you have any questions on arrival of a shipment made FCA - Rugby - Packed.
6. GSI Group - Laser Division accepts no responsibility for shipments made FCA - Rugby - Packed which are damaged or lost in transit. Claims for loss or damage must not be deducted from the invoice value, or payment withheld, awaiting adjustment or settlement of such claims.
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7. Notify us immediately by telephone or fax upon arrival of the shipment and carry out all procedures outlined above, except for those relating to the filing of claims. All documents resulting from these procedures must be mailed to GSI Group - Laser Division, Cosford Lane, Rugby, Warwickshire, CV21 1QN, England.

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Document Approval

Issue	Author	Approved for Issue	Date
1.0	Terry Cutmore		
2.0	Terry Cutmore		

SOFTWARE DISCLAIMER

Any software forming part of this equipment should be used only for the purpose for which it was supplied by GSI Group - Laser Division. No changes, modifications or copies (except for producing a necessary back-up copy) shall be undertaken by the User.

GSI Group - Laser Division accepts no responsibility for equipment malfunction resulting from any of the above actions.

SAFETY WARNING

It is of the utmost importance that the Safety Section of this manual is read and fully understood before any attempt is made to operate the equipment or undertake any actions which might necessitate removal of any parts from the equipment.

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Introduction to GSI Group - Laser Division

GSI Group - Laser Division is a worldwide technology company specialising in the development, production and support of lasers and laser-based systems. The Company organisation includes manufacturing operations located in North America and Europe along with a network of support centres.

GSI Group - Laser Division offers a complete range of lasers that cover applications in sectors including electronics, aerospace, automotive, advanced manufacturing, packaging and advanced research.

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

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1. General Information

1.1 Class of Laser

The JK300HP/JK300P/JK125P Series Laser is a Class 4 (IV) Laser system. Refer to Section 2 – Safety 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 JK300HP/JK300P/JK125P Series Laser is supplied with a Pre-installation and User Manual.

The Manual provides information on Pre-installation requirements, Installation Procedures, De-Commissioning Procedures and user information.

The Pre-installation section specifies site preparation and the interfaces that need to be in place prior to Laser delivery.

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

The User Manual section provides information on the Operating Procedures, Routine Maintenance to Level 1 and Fault Diagnosis.

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

1.4 Table of Definitions

Name	Definition
Aperture	An opening in the protective housing of a Laser enclosure or Laser unit through which Laser radiation is emitted.
Assist Gas	Gas that is fed to the beam focus at the workpiece to assist the cutting process. See Shielding Gas.
BCD	Binary Coded Decimal.
Beam Divergence	Laser beam diameter increases with increasing distance from the Laser owing to beam divergence (i.e. spread). It is expressed as the angle (mrad) the beam diameter increases per unit distance (mm). Beam divergence can be used to predict the minimum beam diameter achieved by focusing the beam with a lens.
Beam Dump	A device used to absorb beam energy when not required.
BET	Beam Expanding Telescope.
Beam Focus	The location beyond a focusing lens at which the beam diameter reaches a minimum value or focal point.
Beam Tube	A length of metal or PTFE (Teflon) tube located between component assemblies in the beam path. Prevents human access to the Laser beam and the ingress of dust. The Beam Tube is also known as the Gaiter.
Beam Path	Laser light directed to the workstation via a Shutter, Fibre and Focus Head. Multiple fibres can be accommodated in Timeshare and Energy Share configurations. See Timesharing and Energy Sharing.
Beam Stop	A device that stops a Laser beam path.
Beam Quality	Beam quality is defined using beam radius and half angle divergence and relates to 86.5% of enclosed power (ISO 11146).
Continuous Wave	Laser operating and continuously emitting radiation over periods of time greater than or equal to 0.25 seconds.
Depth of Focus	When a lens focuses a Laser beam to a small diameter, the Depth of Focus is that distance along the lens axis over which the beam may still be considered focused. Depth of Focus is defined as the axial distance over which the beam diameter is no more than 10% larger than the minimum diameter at the beam focal point.
Energy Sharing	The ability to share the laser beam down more than one fibre at the same time. See Beam Path.
Eyewear	Personal Protective eyewear that prevents Laser radiation reaching the eye directly. Laser safety eyewear reduces the incident light to a safe level, provided it is used correctly.
Fume	Airborne grit, particles, smoke, dust, vapours and gases generated by Laser processing of materials.
Graphical User Interface (GUI)	Graphical User Interface. The software for this interface between the Operator and the Laser System is called Laserview™ SE. The Laserview™ SE software can be run on either a Personal Computer (PC) or on an Industrial Touch Screen Computer. See also the Universal Front Panel (UFP).
Intensity	Beam intensity is strictly the power per unit area (Wcm^2) of beam cross-section. Intensity is also energy density - the energy per unit area of beam cross-section.
Invisible	Light outside the visible wavelength range 400 to 700nm.

Name	Definition
Laser Controlled Area	A work area controlled and supervised to protect personnel from Laser hazards.
Laser Safety Officer	Person knowledgeable in the evaluation and control of Laser hazards and has responsibility for overseeing control of Laser hazards.
LASER	Acronym: Light Amplification by the Stimulated Emission of Radiation.
Laser Resonator	An optical assembly that provides feedback for light emerging from the Laser rod (thus enabling oscillation) and allows extraction of light to provide the output beam. The resonator may include additional components to tailor the characteristics of the Laser beam - for example, beam divergence, polarisation or monochromaticity.
Light Spectrum	Invisible light of longer wavelength than red light (700nm). Invisible light of shorter wavelength than violet light (400nm). Visible light in the wavelength range of 400 to 700nm.
Local Control	Laser is operated and monitored via the control console (PC or GUI).
LSD	Least Significant Digit.
Machine Interface	Facility that allows an external controlling device such as a PLC to control and monitor the Laser.
MSD	Most Significant Digit.
Nd: YAG	Nd Neodymium: Doping to provide 1064nm wavelength of the beam. YAG Yttrium Aluminium Garnet. The host crystal contained in the Laser Head.
Parameter Update Strobe	The signal that is used to send information into the Laser.
Parameter Change Acknowledge	The signal that is used to acknowledge receipt of information by the Laser.
Remote Control	Laser is operated and monitored via the Machine Interface.
Simmer	Simmer current (or simmer arc) is a current, which is arranged to flow in the Arc-lamp after the lamp has been triggered (i.e. the impedance of the gas inside the lamp has been broken down). Simmering a lamp allows a quicker, more efficient response to current pulses and avoids the need to trigger the lamp before every Laser pulse.
Sinking	A term used to describe interface signals where current flows into the Signal Driver in the True state. No current flows in the False state.
Sourcing	A term used to describe interface signals where current flows out of the Signal Driver in the True state. No current flows in the False state.

Name	Definition
Spot Size	There are two possible interpretations of this phrase and care must be exercised. Spot size can represent: The actual diameter of the beam focus at the surface of the workpiece, based on knowledge of the Laser beam characteristics and the parameters of the optical focusing system. The diameter of a spot weld or drilled hole or the width of a seam weld or cut. Generally, spot size is interpreted according to the first definition. The Formula for calculating spot size is as follows: Focussed Spot Diameter = $\text{Fibre diameter} \times \frac{\text{Focal length of Focus Lens}}{\text{Focal length of Recollimating Lens}}$ This assumes aberration free lenses.
Shielding Gas	Gas that is fed to the beam focus at the workpiece during welding to exclude atmospheric oxygen. This prevents oxidisation of the weld.
Ready	Status of equipment during periods of inactivity.
Timesharing	The ability to switch Laser power between different workstations by selecting a different beam path. See Beam Path.
Universal Front Panel (UFP)	The touch screen fitted to the laser cabinet. See GUI.

The following convention is used throughout this manual

- 0 = signal False.
- 1 = signal True.

1.5 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 these offices can be found on our website at: www.gsig.com/lasers.

Or contact Customer Support at the manufacturing site in Rugby, UK:

Tel: +44 (0) 1788 532612

Fax: +44 (0) 1788 553564

Email: support.laserdivision@gsig.com

When contacting an office for support, please have the following information at hand:

- The Laser type
- The Laser serial number.
- Any relevant information (e.g. fault codes and descriptions) that would assist in fault diagnosis.

Product news and information resources can also be accessed via the GSI Group website at www.gsig.com/lasers.

1.6 CE Mark Information

The JK300HP/JK300P/JK125P Series Laser complies with all CE requirements and relevant European Union directives.

1.7 The JK300HP/JK300P/JK125P Series Laser

The JK300HP/JK300P/JK125P Series Lasers are Pulsed Output, Nd: YAG Lasers used for general welding, cutting and heat treatment applications.

The JK300HP/JK300P/JK125P Series of Lasers can be supplied as a Single Fibre System, a Time Share System, an Energy Share System or as Time Share/Energy Share System.

1.7.1 Main Assemblies

The main assemblies of the JK300HP/JK300P/JK125P Series Laser are:

1.7.1.1 Laser Head.

The Laser Head, mounted on top of the Laser cabinet, comprises a pumping chamber, with front and rear mirrors. The pumping chamber houses a cylindrical crystalline Laser Rod (Nd: YAG) and one or two gas filled tubes (Arc-lamps). This complete assembly is called the Optical Resonator.

The Optical Resonator converts electrical power into a beam of infrared Laser light, which is focused into a fibre optic cable that exits through the side of the Laser Cabinet Cover.

1.7.1.2 Power Supply Unit

The Power Supply Unit (PSU) provides electrical power to the Arc-lamps fitted inside the pumping chambers on the Laser head.

1.7.1.3 Heat Management System

The Heat Management System is located in the lower section of the laser cabinet and is accessed from the front of the cabinet. The Heat Management System combines two forms of cooling:

Water-cooling: This comprises two circuits:

1. An internal cooling circuit removes excess heat from critical optical components such as the Laser Head, Beam Dump and power supply modules.
2. An external (factory) chilled water supply passes through a Heat Exchanger whereby heat contained in the internal cooling circuit is dissipated and exchanged by the User's factory water system. This reduces internal water contamination, as the two systems are isolated from each other.

Air-cooling: Fans fitted to the Main Power Modules circulate air that passes though an air cooler behind the modules. This airflow controls the ambient temperature throughout the cabinet.

1.7.1.4 User Interface

There are two options for the User Interface:

- A Universal Front Panel (UFP) touch screen.
- A remote PC Interface Box with Laserview™ SE software allowing the customer to set-up his own PC. A Customer supplied Personal Computer with software, connector and Interface Box supplied by GSI Group - Laser Division.

Note *Laserview™ SE software is supplied on CD-ROM as part of the Consumables Installation.*

1.7.1.5 Fibre Optic Cable Assembly

Fibre-optic beam delivery is achieved by focusing Laser light into a fibre-optic cable. The fibre optic cable on the JK300HP and JK300P is 300µm diameter and on the JK125P it is

150µm diameter. The light is homogenised as it passes through the cable to the Focus Head.

As light exits from the fibre-optic cable, it expands into the Focus Head. This incorporates a Re-Collimating and Focusing lens assembly.

The Re-Collimating lens re-collimates the expanding beam from the fibre and a Focusing lens focuses the beam to a small spot on the workpiece surface. Different spot sizes are achieved by changing the combination of Recollimating and Focus lens focal lengths.

The JK300HP/JK300P/JK125P Series Laser can be supplied with up to four output fibres to provide a Timeshare facility. The output beam can be switched between these fibres by demand from a controlling Workstation.

The JK300HP/JK300P/JK125P can be supplied with up to 3 fibres in an energy share configuration. A Fibre-Optic Continuity Monitoring System (FCMS) monitors the integrity of the fibre cable. If any fracture or disconnection occurs in the cable, the FCMS will place the system into shutdown and generate an alarm on the Local or Remote Controller.

1.7.2 Control System and Local Controller

The JK300HP/JK300P/JK125P Series Laser has a unique control system by which 'intelligence' is exchanged between functional modules. Each functional module carries intelligence allowing highly accurate identification of maintenance requirements. This is termed ‘Distributed Intelligence’.

The JK300HP/JK300P/JK125P Series Laser Local Controller can be either a Personal Computer or a Universal Front Panel (UFP). The Laserview™ SE software is used to monitor and control the Laser, program parameters, alert the User to any maintenance requirements and for fault diagnosis.

1.7.3 Machine Interface

The Machine Interface, SK603, allows total operational integration of the Laser into a production line or cell. Options include Timeshare, Shutter Control, Power Control and Alarm Reporting.

1.7.4 Ancillaries

A range of ancillary fittings is available for the JK300HP/JK300P/JK125P Series Laser including a Cross-jet Nozzle, Cutting Nozzle, CCTV viewing and Auto-Focus Cutting Head.

1.8 Technical Specification

This table provides general technical data on the JK300HP/JK300P/JK125P Series Laser including the output specification and the services necessary for Laser operation.

Environment			
	JK300HP/JK300P/JK125P		
Storage Environment	Temperature not to fall below 2°C (35°F) unless the cooler has been drained.		
Operating Environment	Max temperature: 40°C (104°F) Min temperature: 5°C (40°F)		
Humidity Specification	Max humidity: 95% RH at 20°C (68°C) Max humidity: 50% RH at 40°C (104°F) These figures indicate the maximum humidity at the upper and typical temperature limits. Refer to Figure 1 for humidity figures within the temperature range.		
Electrical Supply Requirements			
	JK300P	**JK125P**	**JK300HP**
Supply	Three-phase, three-wire plus earth (ground).		
Line Voltages	380 - 415 V ± 10% at 50/60Hz		
Voltage Tolerances	±6%		
Supply Rating	11 kVA	8 kVA	15 kVA
Maximum Power Consumption	9.5 kW	6 kVA	13.7 kVA
Note: This equipment is built to operate at 50Hz or 60Hz within the relevant supply voltage range. This frequency is not interchangeable because a different Cooler Pump motor is used in each case. Consult GSI Group - Laser Division if it is necessary to operate this equipment on a different supply frequency.			

Cooling Water Supply			
A clean water supply is required to the following specification:			
Water pH	6.5 to 8.5		
Inlet Temperature	15ºC (59ºF)		
Minimum Differential Pressure	2 bar (29 psi)		
Maximum Absolute Pressure	6 bar (88 psi)		
Cooling water flow rate is automatically regulated internally according to water inlet temperature and duty of the equipment. This maintains the internal cooling water at the correct temperature.**Figure 2**			
Equipment Weight And Dimensions			
	JK300P	**JK125P**	**JK300HP**
JK300HP/JK300P/JK125P Cabinet Weight	224 kg (492.8 lbs.)	222 kg (488.4 lbs.)	266 kg (585.2 lbs.)
Dimensions	574 mm (22.6in) deep		
	1186 mm wide (46.7in)		
	1960 mm (77.2in) high		

Output Specification	JK300P	JK125P	JK300HP
Average Laser Power*	300 W	125 W	300 W
Maximum Peak Power	5 kW	2.3 kW	9 kW
Maximum pulse energy	40 J	17 J	56 J
Maximum frequency	1000	1000	1000
Pulse width range	0.2 – 20 ms	0.2 – 20 ms	0.2 – 20 ms
Shutter opening time	<50 ms	<50 ms	<50 ms
Standard pulse to pulse stability	3 ± %	3 ± %	3 ± %
Focus Head			
Options	Straight or Right Angled		
Focal Length of Re-collimating Lens when used with 60mm diameter output housing	200 mm	200 mm	200 mm
Focal Length of Re-collimating Lens when used with 40mm diameter output housing	100 mm	100 mm	100 mm
Fibre Optic Cable			
Fibre Diameter	300 μm	150 μm	300 μm
Standard Fibre Lengths	5 m, 10 m, 15 m, 30 m	5 m, 10 m, 15 m	5 m, 10 m, 15 m, 30 m

Customer Supplied PC	
Operating System:	Windows 2K/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

Note *The Laser control card can be configured for either RS232 or RS422 serial interface. Refer to Section 3.8.*

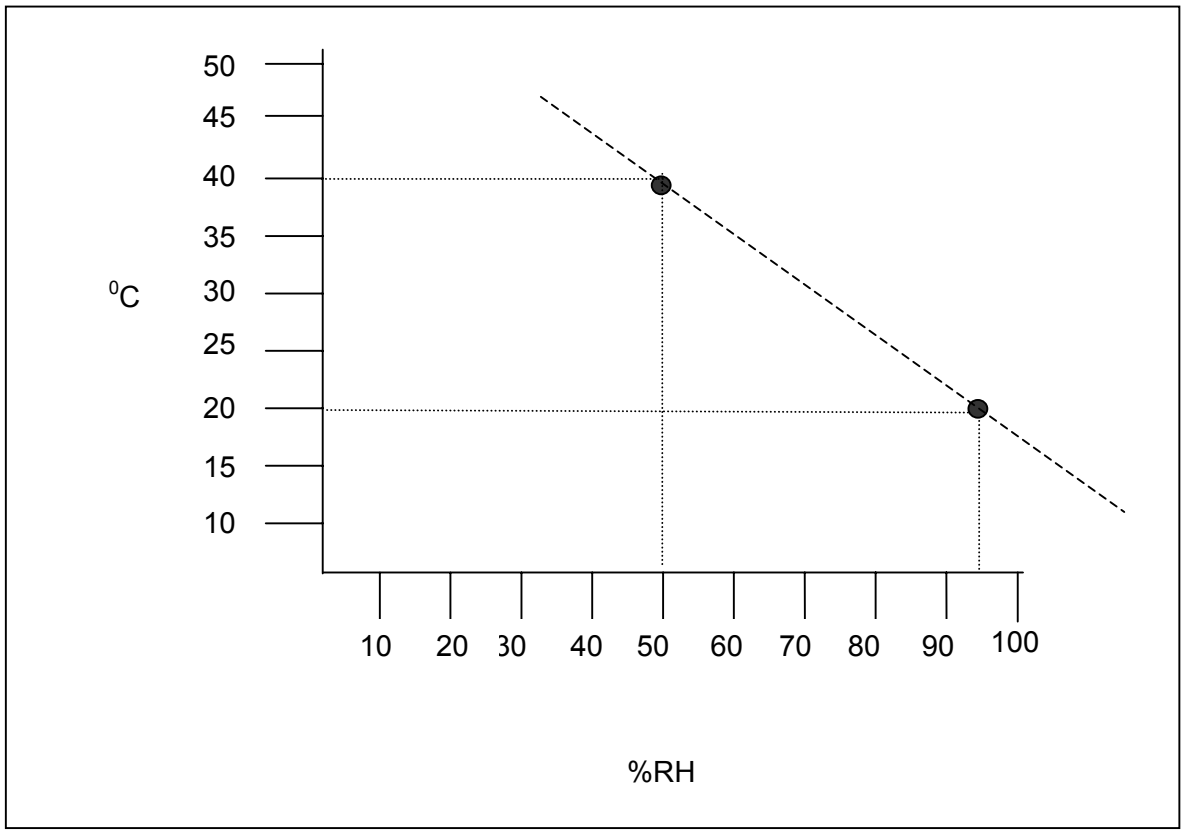


Figure 1 - Temperature /Relative Humidity Graph

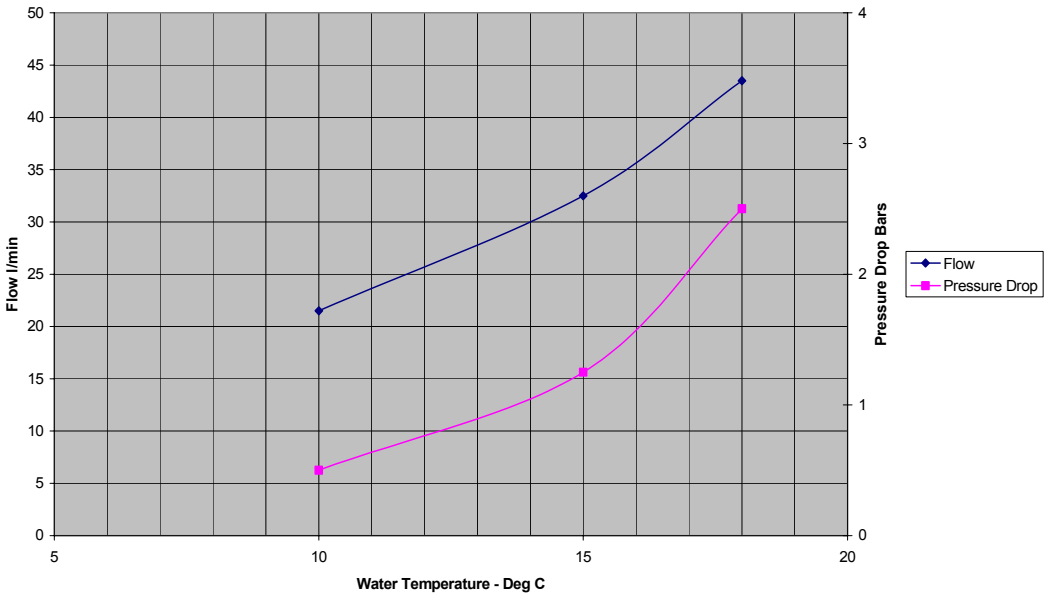


Figure 2 - External Water Parameters

1.9 Safety Interlocks

1.9.1 Customer Remote Interlocks

A Remote Interlock Connector (RIC) provides connection for customer remote interlocks to the JK300HP/JK300P/JK125P Series Laser.

The interlocks, connected in series, are normally closed. Opening the interlocks cuts the power supply to the Arc-lamp circuits. Manual intervention is then required to re-establish the power supply (See Section 2.7.5 for more information).

Remote interlock connection is via a 15-way D-type plug (male) (PL601), Refer to Section 3.7.

1.9.2 Shutter Interlocks (Beampath Interlocks)

The JK300HP/JK300P/JK125P Series Laser has two independent circuits that control the Shutter:

1.9.2.1 Safety control

Safety is provided by the Beam Delivery Interface card, using hard-wired circuits.

The Shutter is physically located in the optical path.

Shutter interlock connection is via PL602, Workstation Interlocks, Refer to Section 3.7.

1.10 Laser Power Delivery

Laser output power is delivered, via a fibre optic cable, to the Focus Head at the Workstation for processing. Up to four fibre optic cables can be fitted, permitting power to be directed to one of four workstations at any one time. This is called Timesharing.

The direction of the beam is controlled using an electro-mechanical Shutter. Each fibre has a dedicated Shutter that allows the beam to be switched into that fibre.

It is possible to share the laser beam down more than one fibre at the same time, this is called energy sharing.

The beam delivery options are:

- Up to a maximum 4-way timeshare.
- 3-way energy share.
- Combinations of 2-way timeshare and 2-way energy share.

Individual Shutters can be controlled via the Machine Interface by selecting the beam path (Shutter, Fibre and Focus Head) into which the Laser beam is to be directed. When the Laser is producing an output but no beam path is selected, the Laser output is 'dumped' into a water-cooled Beam Dump.

Shutters can only be activated when the associated safety circuits are healthy. The majority of Nd: YAG applications set the Laser to run at a predetermined output power and use the Shutter to control when and where the Laser processing takes place.

Refer to Figure 3 for details on Shutter timing.

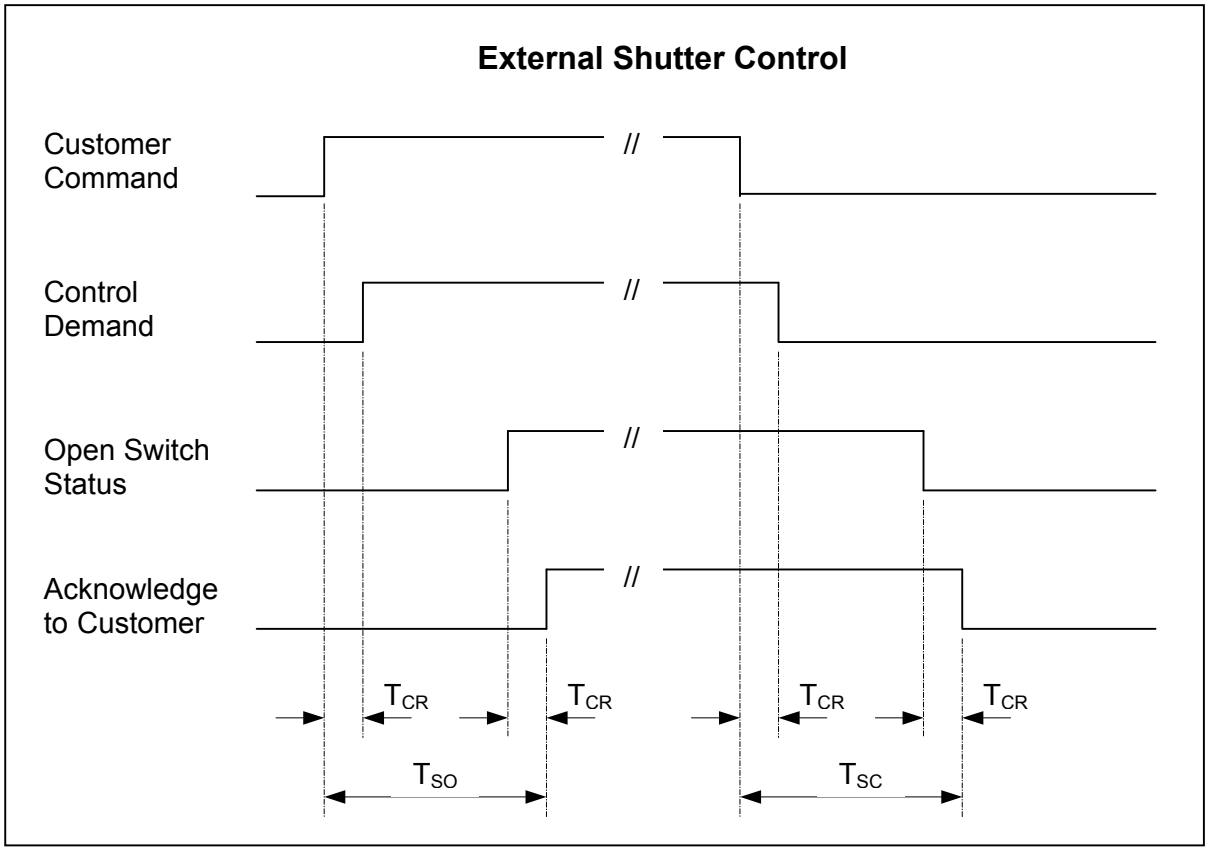


Figure 3 - Shutter Timing

Name	Description	Typical	Max
T_{CR}	Control Response Time	300µs	500µs
T_{SO}	Time from Customer Command to Shutter Open Acknowledge	-	50ms **See note below**
T_{SC}	Time from Customer Command to Shutter Closed Acknowledge	-	50ms **See note below**

Note *Shutter movements do not occur during a pulse. When laser pulse widths approaching 20ms are used, shutter operation could be delayed.*

1.11 Operating Parameters

Laser processing is controlled by a Parameter Set. A set number identifies each Parameter Set. The following six operating parameters can be changed locally or remotely.

- Pulse height.
- Pulse width
- Rate (Frequency).

The JK300HP/JK300P/JK125P Series Laser is capable of storing up to 10 active programmable Parameter Sets. The active Parameter Set can be selected via either the Local or Remote Controller. This allows the correct parameter values for specific processes to be established and programmed into the Laser.

It is possible to specify a set of operating limits for each set of parameters. Operating limits are set by enabling the power and energy trips. The limits are used to help ensure consistent quality of the parts processed by the Laser by preventing production of components at Laser power outside the predetermined limits.

1.11.1 Changing Parameters

Parameters are changed via either the local or the remote controller by the following procedure:

1. Select parameter to be changed.
2. Select the value of the parameter.
3. Send information to the Laser.
4. Wait for Laser to acknowledge it has received the information.

Parameters and parameter values are set as binary coded decimal values on either locally or remotely. The signal used to send the information into the Laser is known as Parameter Strobe. The signal used to acknowledge receipt of information by the Laser is known as ACK1 and ACK2.

The following is an example of setting a parameter value.

To set a rate frequency of 260Hz, the following BCD 'word' would be required:

A1	B8	B4	B2	B1	C8	C4	C2	C1
0	0	1	0	1	0	0	1	0

This gives a decimal word of 52, the step resolution for frequency adjustment is 5, thus the set frequency is 52 x 5 = 260Hz.

BCD data present at the Controller is accepted by the Laser only when the PARAMETER STROBE input is active. Reading of data is acknowledged by the PARAMETER ACKNOWLEDGE output from the Laser which remains active until the PARAMETER STROBE input is removed.

Figure 4 illustrates the times taken to change the parameters.

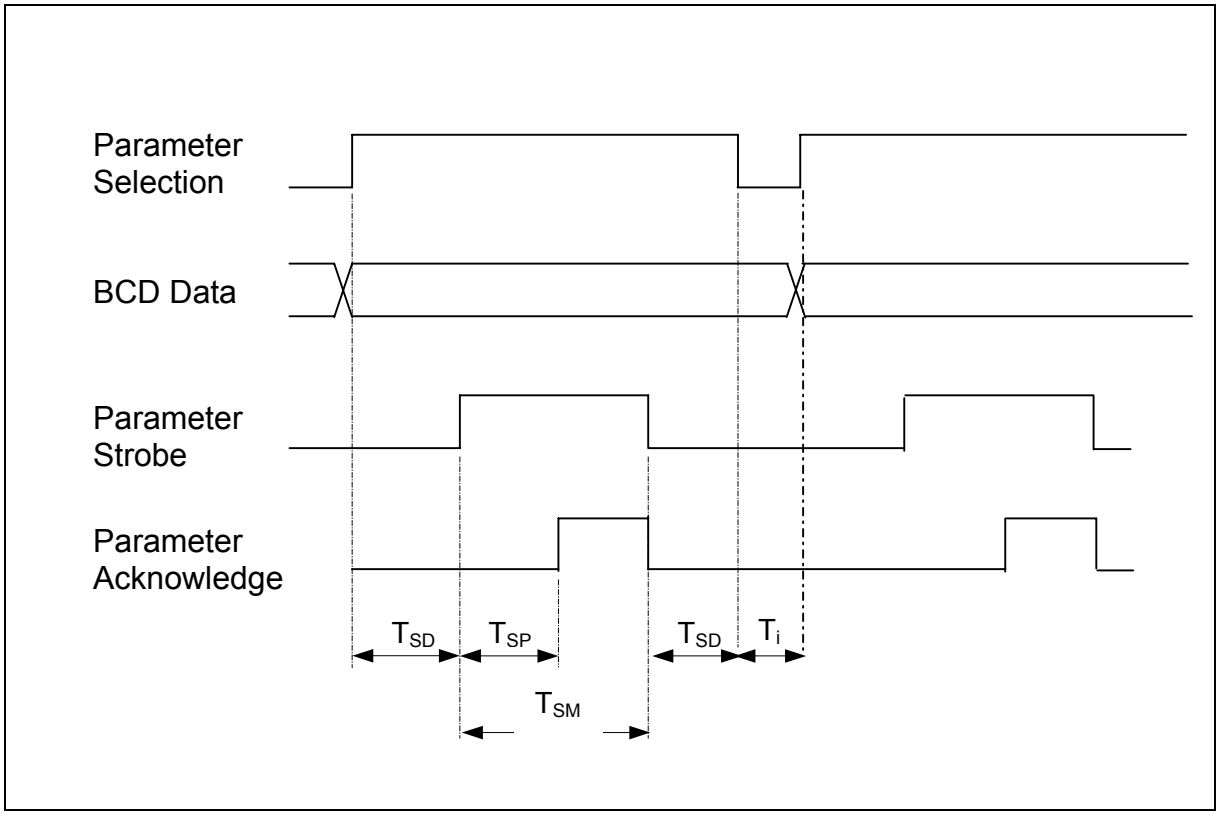


Figure 4 - Parameter Timing Diagram

Name	Description	Min	Max
T_{SD}	Strobe Delay Time	300µs	-
T_{SP}	Time from Strobe to Acknowledgement	-	2ms
T_{SM}	Minimum Strobe Width	1ms	-
T_i	Interval between parameter set	-	1ms

1.11.2 Parameter Set Selection

The required parameter set can be selected locally.

1.12 Laser Outputs

The JK300HP/JK300P/JK125P Series Laser has the facility to output the following information via either the Local or Remote Controller:

Laser Status:

- OFF / Ready/ON.
- Local / Remote control.

Shutter Status:

Open and Closed status of up to 4 Shutters.

Alarm Code:

- Alarm or warning code.

1.13 Operating Guidelines

To conserve energy consumption and extend Arc-lamp life, it is good practice to switch the Laser to Ready during periods of inactivity (no processing).

The frequency at which the Laser will be switched to Ready depends on the processing being carried out and may vary from high (between components) to low (production line maintenance periods).

High power continuous wave Nd: YAG Lasers require a short time for the Laser output to become usable after a large change in input power to the Arc-lamps (e.g. the transition from READY to ON). The JK300HP/JK300P/JK125P Series Laser requires approximately 2ms.

It is not advisable to switch the Laser to Ready if process time is less than several seconds. If the Laser is operating under this condition, the Laser must remain ON and the process must be controlled using the Shutter.

The time taken for the Laser output to increase from the Ready level to the target output and visa versa can be programmed as a Ramp Up and Ramp Down time. This time can be set from 0 seconds (+ Rise Time) to 9.99 seconds (+ Rise Time)

1.14 Processing Considerations

This section provides a brief overview of parameter control requirements for processing.

The programmable Ramp Up time is used to initiate a gradual increase in weld penetration. This reduces weld initiation defects.

The programmable Ramp Down time is used to obtain a controlled termination, or ‘Fade Out’, of a weld process. This reduces weld termination defects. This feature is used particularly on perimeter welds for circular components where the weld overlap is controlled to produce a defect free weld termination.

For applications that require the Laser output to vary from the READY to ON power levels at high frequency (5 – 1000Hz) a ‘Laser ON’ input is used with Ramp Up/Ramp Down times set to 0.

During this process, the Shutter is opened at the start of the process and remains open. The Laser output is then switched ON and OFF at high speed during the movement of the focused beam along the workpiece. The resultant ‘stitch’ weld can prove useful on distortion

sensitive components, as the input power to the component is significantly less than a continuous weld.

1.15 Fibre Optic Handling

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

CAUTION

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

1.15.1 Description

All JK Series Lasers are equipped with fibre optic beam delivery. The standard fibre cable lengths are 5m, 10m, 15m, and 30m.

Optimum fibre routing from the Laser to the point where processing is to be carried out is essential if long fibre lifetime is to be achieved. This is particularly important when the fibre is used in conjunction with a Robot.

The fibre optic is a complex component that incorporates optical, electrical and mechanical parts. Although fibres are designed for use in factory environments, care must be taken during installation and use to ensure optimum performance and acceptable lifetime.

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

1.15.2 Unpacking Fibre Optic Cable

Particular care should be taken with regard to possible termination damage when unpacking and uncoiling the fibre 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 with a feeding action and compensate 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 fibre.

1.15.3 Fibre Installation

- Ensure that the bend radius limitations (refer to Section 1.15.4) are observed.
- Avoid sharp or abrasive surfaces.
- When fitting the fibre cable, ensure that the orientation key in the fibre termination and the keyway in the fibre receiver are aligned.
- When fibre cable is run horizontally it is to be supported, or secured, at intervals no greater than 4m.
- Lengths of fibre cable subject to movement, particularly in robot applications, must be carefully routed and supported to maintain curvature above minimum bend radius throughout all motion. Adjustable spring tensioners or the incorporation of a helix in the cable route must accommodate motion without imparting excessive twist or to the conduit.
- 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.
- Fibre termination must not be subjected to forces caused by dropping, impacting or collision by heavy objects.
- Where the fibre input receiver is inside the Laser enclosure, ensure that there is enough conduit slack between the fibre receiver and the strain relief gland on the Laser lid. Make sure that there is no induced stress on the fibre termination or the input receiver.

1.15.4 Minimum Bend Radii

Condition	Min Bend Radius
Handling/Momentary Manually coiling/uncoiling. Threading cable through supports or laying in cable supports. Attaching to permanent stationary fixings.	120mm
Static/long Term Processes where Focus Head remains stationary. Final installed location of cable between Laser and work enclosure**.**	180mm
Repetitive Flexing/Dynamic Pre- or post-process positioning. In-process movement of cable. Multi-axis robot motion of Focus Head. Single-axis gantry type motion of Focus Head. Inertial acceleration/decelerations of suspended cable. Winding/unwinding of residual, suspended coils.	180mm

1.15.5 Fibre Optic Termination

Fibre termination is the section of fibre from the beginning of the termination boot to the exposed end of the fibre. This includes all mechanical, electrical and optical parts. No single part of the fibre termination is replaceable/repairable outside the manufacturing base.

- Ensure the fibre termination is always kept in a clean environment. If this is not possible, use the clean termination cover provided.
- During installation of the fibre, ensure that the protective covers are removed only when necessary.
- Keep the fibre termination placed downwards when uncovered and not installed.
- Do not attempt to dismantle the fibre termination.
- Always handle the termination by the boot not the optical termination.
- Care must be taken to prevent damage or contamination of any exposed electrical contacts.
- The fibre termination must not be subjected to forces caused by dropping, impacting or collision by heavy objects.

1.15.6 Fibre Routing

In static applications (i.e. fibre and Focus Head do not move), the fibre must not be bent greater than the minimum bend radius at any point along the route (refer to Section 1.15.4).

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

- The fibre cable should be held off the floor and routed along a path so that the fibre cable does not bend more than the minimum bend radius at any point along the fibre cable length throughout the production sequence.
- The fibre 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 fibre cable support points, the fibre 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 fibre cable.
- The fibre cable should never be pulled tight at any point along its length during the production sequence.
- The external surface of the fibre cable should be prevented from rubbing/abrasion 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 fibre cable and Focus Head should be kept to a minimum consistent with achieving process cycle time.
- At fibre cable installation and periodically during operation (e.g. once per shift), a dry run of the production sequence should be made. The fibre cable motion should be checked to ensure that the fibre routing still complies with the points of good practice above.

1.15.7 Fibre Removal

When removing the fibre termination from the fibre receiver (input or output), hold the termination and ease the fibre free. Never jerk the fibre free.

2. Safety

2.1 Laser Classification

Laser classification indicates the potential hazard presented to the User. There are two standards used to define Laser Products: Throughout the World, with the exception of North America, regulation IEC 60825-1 (EN 60825-1 in Europe) is used. This regulation defines Laser Products as Class 1 to Class 4. The classifications and risks for IEC60825-1 are defined in the following table.

Class	Risk	Description
Class 1	No risk to eyes. No risk to skin	Class 1 Laser Products are defined as safe in normal operations under reasonably foreseeable conditions, including direct viewing of the laser beam with optics that could concentrate the laser output into the eye. In addition to some intrinsically low power lasers products, Class 1 Laser Products also includes embedded products that totally enclose a higher Class of laser e.g. CD players, laser printers and most industrial laser processing machines.
Class 1M	Low risk to eyes. No risk to skin.	Class 1M Laser Products are defined as safe in normal operations under reasonably foreseeable conditions, including direct viewing of the laser beam, providing the user does **not** employ optics that could concentrate the laser output into the eye. Unsafe conditions include use of a telescope or binoculars with a 1M laser emitting a well-collimated laser beam or use of an eye loupe or magnifier with a high divergence 1M source.
Class 2	Low risk to eyes. No risk to skin	Class 2 Laser Products are those emitting visible light for which the natural aversion response to bright light (including the blink reflex) prevents retinal injury. This includes direct viewing of the laser beam with optics that could concentrate the laser output into the eye. These lasers do present a dazzle hazard and appear uncomfortably bright when viewed directly but should not cause harm if viewed for less than 0.25 seconds.
Class 2M	Low risk to eyes. No risk to skin	Class 2M Laser Products are those emitting visible light for which the natural aversion response to bright light (including the blink reflex) prevents retinal injury. However, as with Class 1M Laser Products, only provided the user does not employ optics that could concentrate the laser output into the eye.
Class 3R	Low risk to eyes. Low risk to skin	Class 3R Laser Products are those in which the output is up to a factor of five over the maximum allowed for Class 1 or Class 2. Because of inherent safety factors in the limits for these classes, the risk of injury for direct viewing of a Class 3R laser beam remains low, but greater precautions should be taken when using these lasers to prevent direct eye exposure, especially for invisible Class 3R lasers.
Class 3B	Medium risk to eyes. Low risk to skin	Class 3B Laser Products are those to which direct exposure of the eye is hazardous, even considering aversion responses. Scattered laser light is usually safe, for example diffuse reflections from a matt surface. However, viewing of specular reflections can be hazardous, e.g. from a mirror surface. The higher power Class 3B lasers are also a skin hazard, but the natural aversion response to localised heating generally prevents a skin burn.
Class 4	High risk to eyes. High risk to skin	Class 4 Laser Products are those to which direct exposure of the eye and skin is hazardous and scattered laser light may be hazardous to the eyes. Such lasers are also a fire hazard and their use requires extreme caution.

The JK300HP/JK300P/JK125P Series Laser is a Class 4 Laser System. All operators using this Laser equipment must be officially trained and authorised.

In North America, the Center for Devices and Radiological Health, a division of the FDA, regulates the classification of Laser Products and uses Federal Regulation 21 CFR Chapter J 1040.10.

This regulation defines Laser Products as Class I to Class IV.

The classifications and risks for 21 CFR Chapter J 1040.10 are defined in the following table.

Class	Risk	Description
Class I	No risk to eyes. No risk to skin	Class I Laser Products are considered to be incapable of producing damaging radiation levels and are determined to be eye safe. These Lasers are exempt from most control measures. Class I Laser Products also include embedded products that totally enclose a higher Class of Laser e.g. CD players, laser printers and most industrial laser processing machines.
Class IIa	Low risk to eyes. No risk to skin	Class IIa Laser Products are those emitting visible light for which the natural aversion response to bright light (including the blink reflex) prevents retinal injury. These lasers are not intended for viewing but are not hazardous if viewed for less than 1000 seconds. An example is a Supermarket Bar Code Scanner.
Class II	Low risk to eyes. No risk to skin	Output Power less than 1mW. Class II Laser Products are those emitting visible light for which the natural aversion response to bright light (including the blink reflex) prevents retinal injury. This includes direct viewing of the laser beam with optics that could concentrate the laser output into the eye. These lasers do present a dazzle hazard and appear uncomfortably bright when viewed directly but should not cause harm if viewed for less than 0.25 seconds.
Class IIIa	Low risk to eyes. Low risk to skin	Output Power up to 5mW. The risk of injury for direct viewing of a Class IIIa laser beam remains low unless viewed with optics that could concentrate the laser output into the eye.
Class IIIb	Medium risk to eyes. Low risk to skin	Output Power 5mW to 500mW. Direct exposure of the eye to the laser beam is hazardous. Scattered laser light is usually safe, for example diffuse reflections from a matt surface. However, viewing of specular reflections can be hazardous, e.g. from a mirror surface. The higher power Class IIIb lasers are also a skin hazard. The Class IIIb laser is not normally a fire hazard.
Class IV	High risk to eyes. High risk to skin	Output Power exceeds 500mW. Class IV Laser Products are those to which direct exposure of the eye and skin is hazardous and scattered laser light may be hazardous to the eyes. Such lasers are also a fire hazard and their use requires extreme caution.

The JK300HP/JK300P/JK125P Series Laser is a Class IV Laser System. All operators using this Laser equipment must be officially trained and authorised.

2.2 Laser Radiation Hazards

The JK300HP/JK300P/JK125P Series Laser is a Nd: YAG Laser. This Laser produces radiation with a 1064nm wavelength, powerful enough to melt and vaporise most materials. Even diffuse reflections can inflict serious injury if allowed to strike the body.

Effects on Body Tissue

Laser radiation is concentrated energy. If it strikes the body, most of the energy will be transferred to body tissue. Tissues will show burn damage that will spread depending on the irradiated area and duration of exposure.

High power exposure may cause the absorbing body tissue to explode and vaporise. Displacement of absorbing tissue may result in shear damage to adjacent tissue.

Effects on the Eye

Nd: YAG light presents a hazard to the eye because the light can damage retinal tissue. Exposure to moderate levels of Laser light can cause burns, which may be permanent. Nd: YAG light is invisible and personnel will be unaware of the risk of exposure.

Indirect Exposure

Control measures reduce the risk of direct beam exposure. However, there is also a risk of indirect exposure to radiation re-directed by components located in the beam path.

Reflective components present the greatest risk, since virtually 100% of the beam power can be redirected. The level of risk depends on the direction of the reflected beam relative to the personnel. A Class 4(IV) Laser beam can be reflected from non-reflective surfaces.

Exposure can be minimised by tilting of components in the beam path and/or appropriate positioning of personnel with respect to the reflected radiation.

The risk of indirect exposure can be minimised by the following precautions:

- Ensure no unintended/unnecessary components are in the Laser beam path.
- Ensure all optical components in the beam path are maintained in good condition (clean and undamaged).
- Ensure all necessary components in the beam path re-direct the lowest possible amount of light.
- Ensure all components in the beam path are securely mounted to avoid unexpected changes in component position/tilt.
- Ensure that components and personnel are positioned to reduce exposure of personnel to re-directed radiation.

2.3 Control Measures

The risk of personal injury can be minimised by the following measures:

- Never direct the Laser beam at other people.
- Never direct the Laser beam upwards. If possible, direct the Laser beam down towards the floor.
- Avoid mounting the Laser or any part of the beam path at eye level. If possible always arrange horizontal beam paths well above or below eye level.
- Always use a Beam Stop behind the target/work piece.

Precautions must be taken to prevent unauthorised personnel from entering the equipment work area when the Laser is operating.

Warning notices must be displayed to inform personnel of hazards.

- Access must be restricted to only those personnel who need to be present.

Control measures reduce the risk of injury to personnel but are not adequate on their own.

The safest mode of operation is to use a Class 1(I) enclosure in conjunction with the Laser. This establishes a physical barrier to prevent access and indirect exposure to the Laser beam/radiation. This method of operation is preferred by Safety Authorities and is recommended by GSI Group - Laser Division for use with the JK300HP/JK300P/JK125P Series Laser.

If a Class 1(I) enclosure is not employed and the Laser operates under Class 4(IV) conditions then additional precautions are required. Approved Laser safety goggles must be used at all times by all personnel in sight of the Laser. Laser safety goggles must be suitable for use with high power Lasers of 1064nm wavelength. It must be remembered that radiation from the JK300HP/JK300P/JK125P Series Laser is invisible.

Note *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.*

2.4 Electrical Safety

The JK300HP/JK300P/JK125P Series Laser power supply output can reach potentially lethal high voltage levels. Servicing of the power supply must be carried out by certified personnel only. Observe all precautions complying with accepted working codes of practice in the servicing of electrical equipment at all times.

Additionally, the following precautions must be observed:

- Where it is necessary to raise the Laser head lid with the power supply switched on (for setting-up or servicing procedures, e.g. fibre-optic alignment, rear mirror adjustment, etc.), extreme care must be taken when working on the equipment.
- Do not open cabinet doors while the supply isolator is closed.
- A two-minute period must be allowed after isolation of the power supply before opening the cabinet doors, removing covers or raising the Laser head lid. This delay permits the high voltage capacitors in the equipment to fully discharge.

Additional information and advice on the safe electrical practices associated with the JK300HP/JK300P/JK125P Series Laser is given below:

- All personnel working with the JK300HP/JK300P/JK125P Series Laser must be fully aware of the dangers of misuse of high voltage equipment and be familiar with its safe working practices.
- Before using this equipment, operators must be familiar with the operating instructions provided in the User Manual. If any uncertainty arises, seek advice from the Appointed Engineer or directly from GSI Group - Laser Division.

Service Engineers must comply with all Local Safety Precautions and follow the advice given below:

- Do not permit inexperienced personnel access to the Laser electrical circuits.
- Always ensure that cables and terminal connections are positioned to prevent arcing between components.
- Do not assume polarities of cabling or components, refer to available circuit diagrams or contact GSI Group - Laser Division.
- Do not attempt to carry out work on electrical circuits when alone. Always have a colleague nearby.
- Use only GSI Group - Laser Division approved spare parts, failure to do so will invalidate the warranty.
- Always adhere to Local Plant Regulations relating to work on electrical equipment.

2.5 Environmental Hazards

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

- Fire.
- Fume.
- Compressed Gases.
- Solvents.

2.5.1 Fire

Particular care is necessary when processing combustible materials.

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

Do not attempt to process reactive metals such as titanium and magnesium using oxygen as an assist gas. Such materials must be processed using inert gases only (e.g. nitrogen, argon, etc). Always consult the material manufacturer safety information before commencing processing.

To test for the potential reaction of a metal in the presence of oxygen, use the following procedure:

- Use a sample piece of the metal on which to test.
- Ensure that the gas line is fitted with a flashback arrestor.
- Ensure a colleague is present to turn off the Laser in event fire.
- Ensure a second colleague is present with a suitable fire extinguisher.
- Operate the Laser to safe test the metal.

2.5.2 Fume

Fume and fine particulate can be generated during processing. Fume 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.

  An exhaust appliance must be provided because, when assist gases are used in Laser processing, the local oxygen concentration may significantly increase from the normal value by 20% by volume. The exhaust appliance must be positioned as near as possible to the point of origin to prevent processing fumes contaminating the air of the workroom.

  Care is needed in the choice of evacuation equipment to avoid re-circulation of fine particulate around the building. Simple filtering systems are unlikely to remove harmful vapours and gases.

  Ensure that the venting of fume outside the building complies with Local Statutory Requirements. Particular care is needed in the siting of the exit vent, to ensure adequate atmospheric dilution has occurred prior to personnel exposure. The vent must be located away from personnel access, preferably at roof level.

- Use of Personal Protection Clothing (PPC).
- Personal Protective clothing must be supplied and worn. However, this is a last resort precaution and PPC should not be used as the primary safety precaution.

Guidance on welding fume and its removal can be obtained by contacting:

The Welding Institute,
Abington Hall, Abington,
Cambridge CB1 6AL, England.

General guidance can also be obtained from GSI Group - Laser Division.

2.5.3 Compressed Gases

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

Do not use grease on components that are exposed to oxygen. This increases risk of explosion.

All high-pressure gas lines must be constructed to a high standard using high integrity components. Flashback arrestors must be used in oxygen lines.

Adhere strictly to Manufacturers' Safety Recommendations and Procedures.

2.5.4 Solvents

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

GSI Group - Laser Division recommend that only PROPAN-2-OL (IPA) is used for cleaning optics. IPA is also identified as ISOPROPANOL or ISOPROPYL ALCOHOL.

WARNING

PROPAN-2-OL (IPA) IS FLAMMABLE AND TOXIC TO EYES, SKIN AND RESPIRATORY TRACT.

SKIN/EYE PROTECTION MUST BE USED.

AVOID REPEATED PROLONGED CONTACT.

USE ONLY IN WELL VENTILATED AREAS.

KEEP AWAY FROM OPEN FLAME OR OTHER SOURCES OF IGNITION.

2.6 Conditions of Use

The JK300HP/JK300P/JK125P Series Laser must only be used under the following circumstances:

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

WARNING

USE OF CONTROLS, ADJUSTMENTS OF PERFORMANCE OR PROCEDURES OTHER THAN THOSE SPECIFIED MAY RESULT IN EXPOSURE TO HAZARDOUS RADIATION.

2.6.1 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.

2.6.2 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.

2.6.3 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.

2.6.4 Due Authorisation

Due authorisation is the proposed arrangements, 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 or an authorised GSI Group - Laser Division engineer.

WARNING

EXPOSURE OF THE HUMAN BODY TO LASER RADIATION IS EXTREMELY DANGEROUS.

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 - Laser Division Instruction Manuals, Local Safety Regulations and using established good working practices for Laser processing.

2.7 Safety Control System

2.7.1 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.

Note *If a Class 1 enclosure is breached for servicing or maintenance work, and the Laser is in a Class 4 environment, appropriate controls must be specified.*

2.7.2 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.

2.7.3 Safety Labelling

Safety labels are fitted to the equipment in compliance with IEC regulations.

Before operating on any part of the Laser system, the hazard level must be checked by examining the following labels:

- Safety and Compliance labels - refer to Drawing EE13801DD.
- Label Locations - refer to Drawing M202439.

The following Class 4 (IV) information appears on label A, on drawing EE13801DD.

MAXIMUM OUTPUT:	1kW/5mW
PULSE DURATION:	CW
WAVELENGTH:	1064/635nm

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.

Labels must not be defaced or removed. Damaged or missing labels must be replaced immediately by contacting GSI Group - Laser Division quoting the label identification reference given on each label.

Customers must ensure any component fitted has the correct labelling (refer to GSI Group - Laser Division).

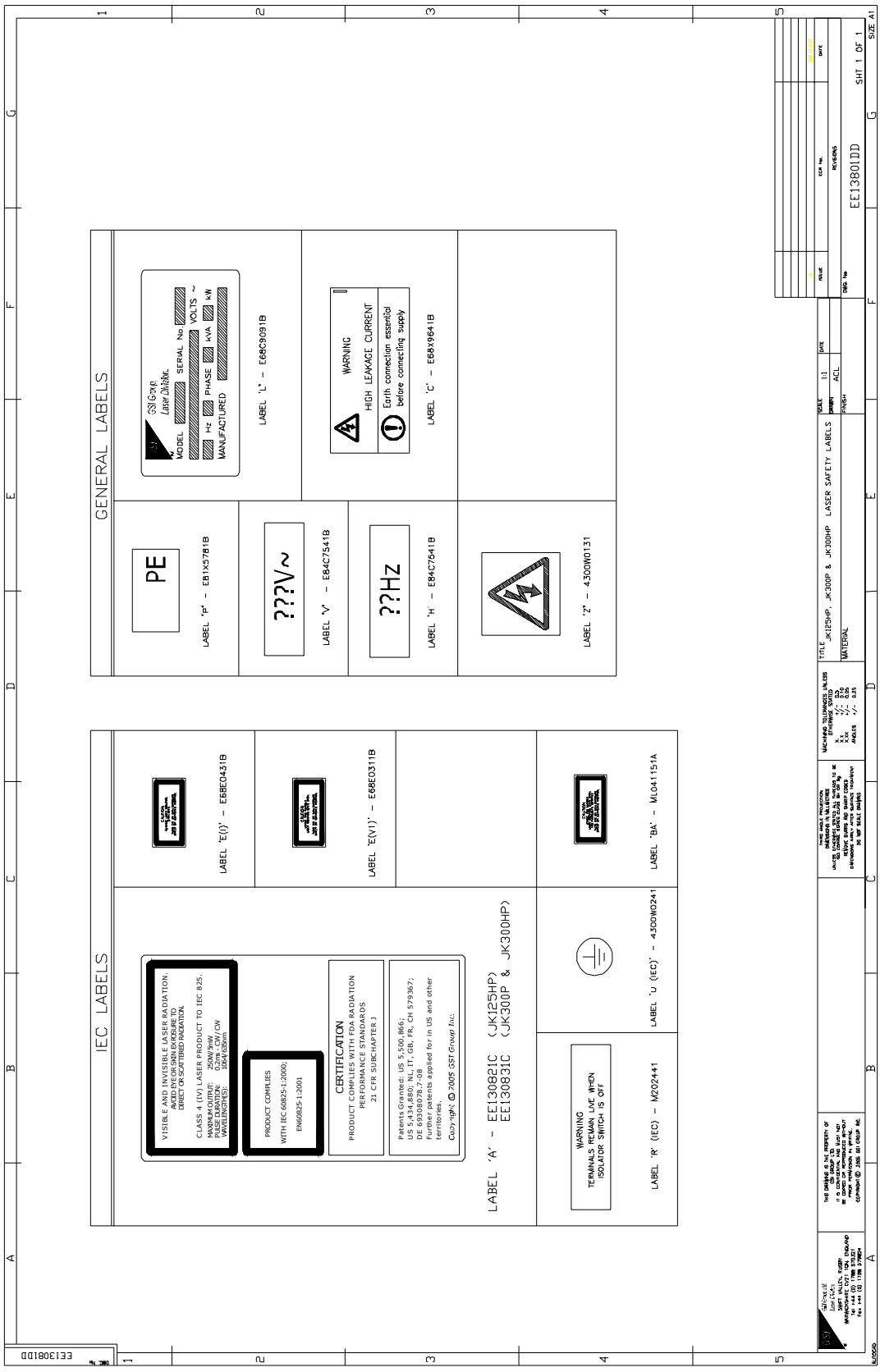


Figure 5 - Safety and Compliance labels

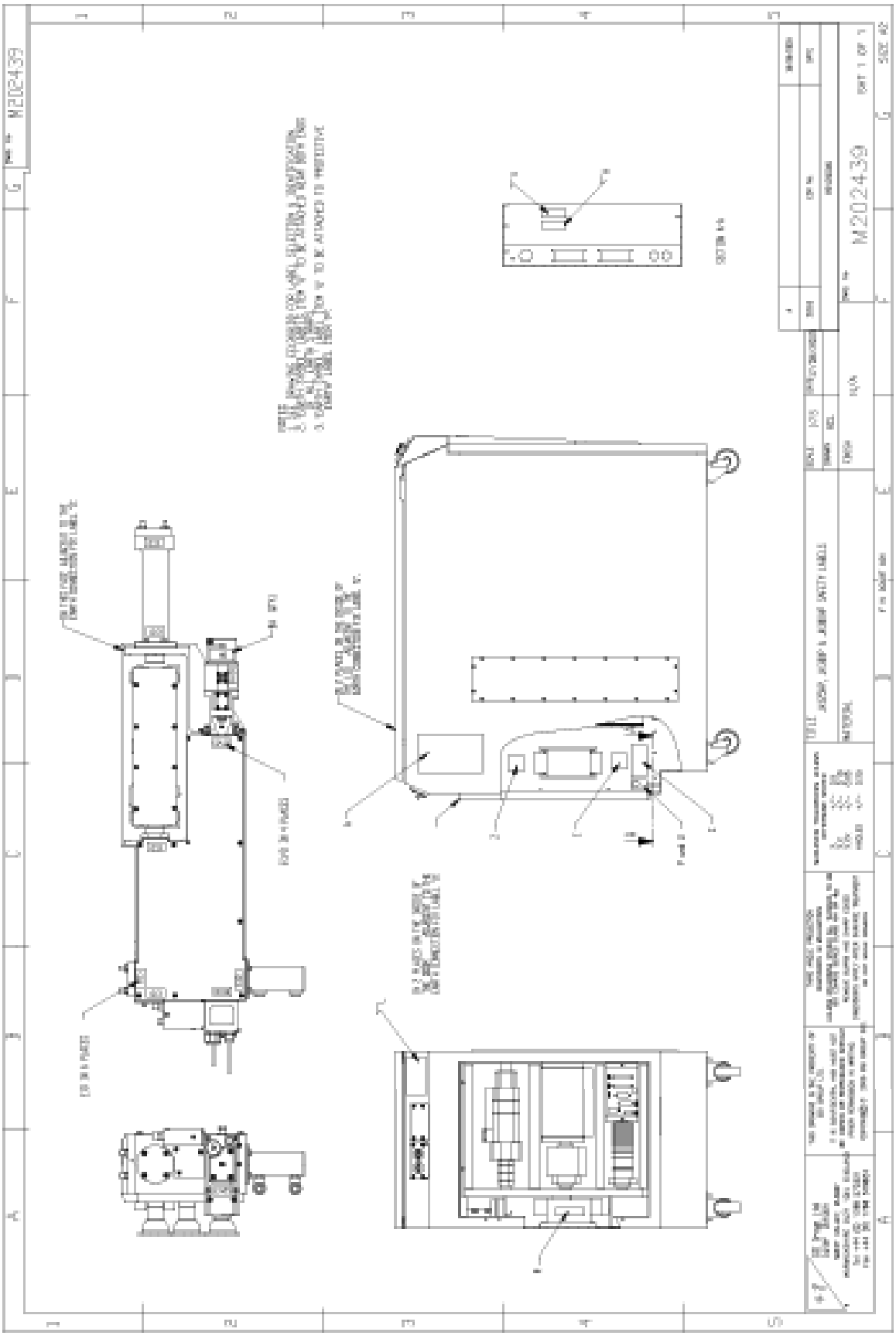


Figure 6 - Safety Label Locations

2.7.4 Safety Features

Two safety features of the JK300HP/JK300P/JK125P Series Laser which protect personnel from exposure to Laser radiation are:

- Remote Interlock Connector.
- Workstation Interlock.

2.7.5 Remote Interlock Connector

The Remote Interlock Connector enables an external Remote Safety Interlock to be fitted to the interlock circuit of the Laser. The Remote Interlock Connector is a requirement of the two principal Laser radiation standards:

Worldwide	IEC 60825-1 (Europe EN 60825-1).
North America	FDA Regulation 21 CFR Chapter J 1040.10.

When the terminals of the RIC are open circuit, exposure to Laser radiation is prevented. This is caused by either the RIC plug being removed or the terminals of a Safety Interlock Switch connected to the plug being open circuit.

In these circumstances, the interlock chain is broken, causing the Arc-lamp power circuits to be de-energised and the Shutter closed.

Restoring electrical continuity at the RIC will not restart the Laser. To restart, a normal Laser start-up Sequence has to be followed.

This facility is equivalent to a remote emergency stop control. It must not be used for planned shutdown of the Laser.

2.7.6 Workstation Interlock

Where safety interlock switches are operated frequently, a RIC is not suitable. In these circumstances, workstation interlocks are used.

If the terminals of the workstation interlock are open-circuit (not electrically joined) then the Laser Shutter closes, preventing the Laser beam from emitting from the Laser.

To enable Laser output, the terminals of the workstation interlock must be electrically joined, either by fitting a short-circuit link within the Shutter interlock plug or by connecting a safety interlock switch to the Shutter interlock plug.

WARNINGS

NO-ONE MUST ENTER AN AREA WHERE EXPOSURE TO HARMFUL LEVELS OF RADIATION IS POSSIBLE.

DO NOT CLOSE THE SHUTTER BY MEANS OF THE SHUTTER CLOSE COMMAND OR FROM A REMOTE CONTROLLER AS A MEANS OF PREVENTING EXPOSURE TO LASER RADIATION.

IF A SHUTTER INTERLOCK PLUG IS FITTED WITH A SHORT-CIRCUITING LINK, THE PLUG MUST BE WITHDRAWN FROM THE SOCKET BEFORE ENTERING AN AREA WHERE LASER RADIATION IS LIKELY TO EXCEED THE CLASS 1 (I) LIMIT.

IF THE LASER BEAM TERMINATES IN A CLASS 1 (I) WORK ENCLOSURE, THE ACCESS DOORS MUST BE PROTECTED BY SAFETY INTERLOCK SHUTTER SWITCHES CONNECTED TO THE SHUTTER INTERLOCK SOCKET.

2.8 Training

Operation of a Class 4 (IV) Laser system can represent a hazard not only to the User but also to personnel considerable distances from the system.

Persons in control of a Class 4 (IV) Laser system are required to have successfully completed training in the following areas:

- System operating procedures.
- The proper use of hazard control procedures, warning signs etc.
- The need for personal protection.
- Accident reporting procedures.
- The effects of the Laser upon the eye and skin.

2.9 Personal Protective Equipment

2.9.1 Eye Protection

Eye protection designed to provide adequate protection against specific Laser radiation, must be used in all hazard areas where Class 3B or Class 4 Lasers are in use.

The eye protection (goggles) is designed to protect the wearer against low level scattered light. Eye protection **cannot** withstand direct beam exposure. Eye protection must be in good condition, fit properly and be inspected regularly. Always dispose of damaged eye protection.

Protective eyewear must conform to the following standards:

Europe: EN 207 and EN208

2.10 Manual Handling

2.10.1 Manual Handling Requirements

Manual handling procedures must be observed and carried out in compliance with local factory regulations.

An assessment must be carried in order to carry out the following:

- Moving/positioning the cabinet without the use of lifting aids.
- Removal of component parts.

3. Pre-installation

3.1 Location of Laser System

GSI Group - Laser Division recommends that the JK300HP/JK300P/JK125P Series Laser is located within a room that contains no non-related equipment or personnel. This will enable the access controls and hazard precautions to be rigidly enforced.

It will also allow the clean environment requirement of the optical equipment to be maintained and will provide an ideal servicing location.

3.2 General Arrangement

3.2.1 Dimensions and Weight

Overall dimensions and footprint of the JK300HP/JK300P/JK125P Series Laser are shown in Figure 7. Refer to Section 1.8 for weight specifications.

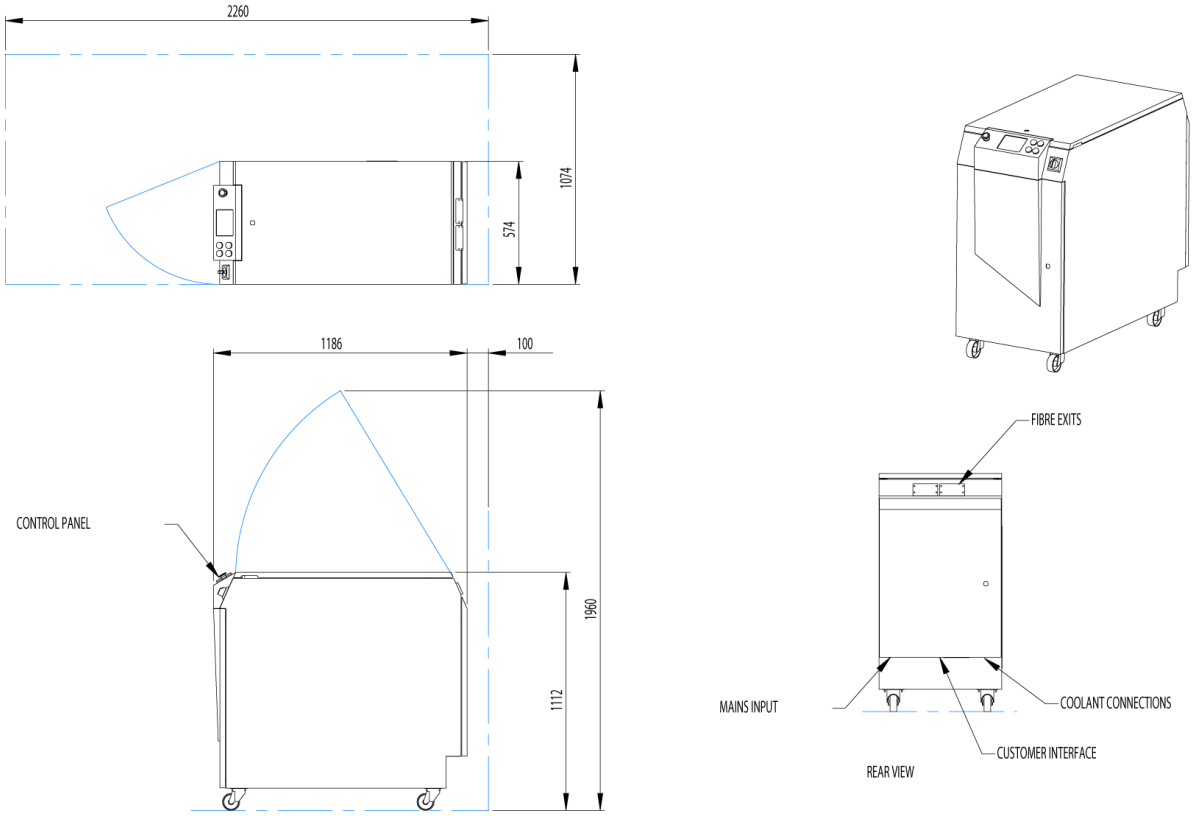


Figure 7 - Dimensions and Footprint

3.3 Site Preparation

3.3.1 Electrical Supply Requirements

The JK300HP/JK300P/JK125P Series Laser requires an electrical supply with the following specification:

Table 1 - Electrical Supply Requirements

Description	Specification		
	JK300HP	**JK300P**	**JK125P**
Supply*	3-phase, 3-wire plus earth (ground)		
Line voltages	380-415 V ± 10% at 50/60Hz		
Supply rating	15.9 kVA	11.1 kVA	8 kVA
Maximum power consumption	10 kW	8.6 kW	6 kW
*Use 16mm^2 cable with an 80A rating.			

Note *This equipment is designed to operate at 50Hz or 60Hz within the relevant supply range; the frequency is not interchangeable because a different Cooler Pump motor is used in each instance. Consult GSI Group - Laser Division if operation on a different supply frequency is required.*

3.3.2 Cooling Water Supply

The Heat Management System requires the existing factory water supply to provide water at 15ºC.

The maximum quantity of heat that has to be removed from the laser is 10kW. Refer to Table 1

3.3.2.1 External Cooling Water

The water shall be clean and free from solid and dissolved contaminants. The water must conform to the requirements of the European Union Drinking Water Directives 76/160 or 80/778, (bathing/drinking water) or to the requirements of water for drinking or industrial use as defined in the Clean Water Act (CFR 40) USA.

Quality Requirements

The following Quality requirements must be met:

- If the water has hardness greater than 0.1 mol/m^3 (Ca^{++} Mg^{++}), add hardness stabilisers to prevent boiler scale deposits, ensuring the overall hardness does not exceed 2 mol/m^3 (Ca^{++} Mg^{++}).
- Have a conductivity with additives of less than 100mS/m.
- Have a chloride content of less than 50 mg/L.
- Have a pH value of 6.5 to 8.5.
- Have particulate contamination with particulate less than 100µm.
- Have total dissolved solids less than 3000mg/L.

Inhibitors

The water shall contain a multi-metal corrosion inhibitor to counter the effects of salts and other contaminants in the water, ensuring effective protection against corrosion in stainless

steel, copper, copper alloys and aluminium. One suitable corrosion inhibitor is Sodium Nitrite ($NaNO_2$) as supplied by a reputable water treatment supplier.

The quantity of corrosion inhibitor requires to be determined by chemical analysis of the water to give a dosage as recommended by the corrosion inhibitor supplier (a typical dosage is approximately 1000 parts per million). Actual dosage is dependent on the volume of water in the cooling system.

Protection of the system cannot be ensured unless the level of corrosion inhibitor is regularly monitored. Hardness stabilisers may also be required to ensure hardness levels and pH levels are maintained within the prescribed limits (see requirements stated above).

Biocides

The external cooling water shall also include an active biocide to prevent fouling, leakage and corrosion. Temperatures that are generally encountered in the external cooling water are ideal for sustaining bacterial growth. A broad-spectrum biocide (e.g. Isothiazolone) must be introduced at levels recommended by the biocide manufacturer. Monitoring and adjustment of the biocide dosage must be made every three months. Refer to a reputable water treatment supplier.

Freeze Prevention

Mechanical means must be provided to prevent freezing, e.g. electrical heaters. The use of Ethylene Glycol and other similar agents is not recommended. Anti-freeze additives have inherent corrosive properties and are nutrients for a wide range of bacterial contamination.

If anti-freeze additives are used, then the User must understand that the adding of anti-freeze will reduce the thermal capacity of the coolant. Typically it will be necessary to reduce the coolant temperature by a few degrees to compensate for the lower thermal capacity – in extreme cases this may require the capacity of the chiller to be increased.

Dehumidification/Chiller bypass

The JK300HP/JK300P/JK125P Series Laser is fitted with an internal condenser that maintains the air within the cabinet at a low dew point to prevent condensation on the pumping chambers or other cooled surfaces. This condenser is fed from the external water supply at a constant rate independently of the cooler control valve. This provides a permanent bypass at all times so that chiller flow will be maintained even when the laser is switched off.

3.3.2.2 Internal Cooling Water Requirements

Pumping chamber circulating water shall be low in inorganic, organic or colloidal contaminants, conforming to ISO 3696 (EN ISO 3696) Grade 3 but with an improved conductivity. 10 litres (2.64 US gallons) are required for the installation of the JK300HP/JK300P/JK125P laser. This type of water is often referred to as de-mineralised water being produced by distillation, de-ionisation or by reverse osmosis. This water has the following basic requirements:

pH value at 25 °C	5.0 to 7.5 inclusive
Electrical conductivity at 25 °C	0.1mS/m max
Oxidizable matter Oxygen (O) content	0.4mg/L max
Residue on evaporation at 110 °C	2mg/kg max

Note *Electrical conductivity value applies to freshly prepared water. During storage, it is possible for contaminants such as atmospheric carbon dioxide and alkalis from containers to lead to changes in conductivity.*
A de-ioniser in the laser cooler system will reduce the conductivity to acceptable levels (this may affect de-ioniser life expectancy). Under normal operating conditions, the laser equipment initiates a warning message if the conductivity becomes greater than 0.07mS/m. A shutdown sequence will be initiated if the conductivity is greater than 0.1mS/m.

3.3.2.3 Water Supply Connection

CAUTION

Incorrect connection may result in serious damage to this equipment.

The water system connection must be made so that flow to the laser is in the correct direction, refer to the instructions printed on the Laser Cabinet.

Connection pipes must be tolerant of retaining water pressure transients that may be generated when the flow regulator valve closes. The magnitude of these pressure transients is dependent on the design of the facility water system and the total volume and flow rate of the water contained within the facility water system distribution pipes.

Refer to the following table:

Customer Connections	
Recommended maximum pressure rating	6 bar
Flow (Factory Supply)	½ inch 13mm internal diameter
Return	½ inch 13mm internal diameter

3.3.3 Gas Supply

Processing with the JK300HP/JK300P/JK125P Series Laser may require one or more of the following gas supplies:

Shielding gas for welding applications

The type and amount of gas required depends on the laser process. Shielding gas requirements are detailed in the User Manual.

Cutting Assist gas

The type and amount of gas required depends on the laser process. Cutting assist gas requirements are detailed in the User Manual.

3.3.4 Fume Control

Suitable air extraction must be provided in order to remove hazardous fumes that can be released during laser processing.

For more information, refer to Section 2 - Safety of this manual and to applicable environmental control legislation.

It must be noted that responsibility for providing adequate fume control lies with the User.

3.4 Environmental Conditions

3.4.1 Temperature and Humidity

Environment	Temperature
Storage environment	Temperature not to fall below 2°C (35°F)
Operating environment	Max temperature 40°C (104°F)
	Min temperature 5°C (40°F)
	Max humidity 95% RH at 20°C (refer to Figure 1)
	Max humidity 50%RH at 40°C (refer to Figure 1)

3.4.2 Degree of Protection given by Enclosure

The JK300HP/JK300P/JK125P Series Laser is a Class 4(IV) laser product. It is strongly recommended that a Class 1(I) enclosure be built around the laser workstation. Refer to Section 2 - Safety for laser hazards and safe operating information.

Laser Cabinet Recommendation

GSI Group - Laser Division also recommends that the laser cabinet is housed in the conditions of a Class 1 environment.

3.5 Electromagnetic Compatibility

The JK300HP/JK300P/JK125P Series Laser is certified to be in conformance with EMC Directive 89/336/EEC and amendments.

3.6 Transportation

WARNING

OBSERVE FACTORY SAFE LIFTING AND MANUAL HANDLING PROCEDURES BEFORE ATTEMPTING TO MOVE THIS EQUIPMENT.

The laser cabinet can be moved by the following methods:

- Forklift truck.
- Pallet truck.
- By hand (If cabinet is on castors).

3.7 Electrical Connections

3.7.1 Connection Panel

Connections between the JK300HP/JK300P/JK125P Series Laser and customer devices are made from connectors located at the rear of the laser cabinet.

Connector ID	Description
PL601	Customer Interlocks
PL602	Workstation Interlocks
SK603	Basic machine (M/C) Interface
SK604	Full M/C Interface - I/O card 1
SK605	Full M/C Interface - I/O card 2

3.7.2 PL601 - Customer Interlocks

The Customer Interlock connector enables remote interlocks to be connected to the laser interlock circuit. The Customer Interlock connection is made via a 15 way D-Type Plug (male). Refer to pin out Table 2.

Customer Remote Interlock – Customer Remote Interlocks 1 and 2 are inputs to the laser from an external Emergency Stop circuit, which, when the connection is removed will shut the laser down safely. Pins 8 + 15 and 7 + 14 need to be linked out before the laser can be powered up.

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.

Table 2 - PL-601 Customer Interlocks

PIN #	I/O	DESCRIPTION	PIN #	I/O	DESCRIPTION
1	O	Emergency Stop Output 1	9	O	Emergency Stop Output 1
2	O	Emergency Stop Output 2	10	O	Emergency Stop Output 2
3		Not Used	11		Not Used
4		Not Used	12		Not Used
5		Not Used	13		Not Used
6		Not Used	14	I	Customer Remote Interlock 2
7	I	Customer Remote Interlock 2	15	I	Customer Remote Interlock 1
8	I	Customer Remote Interlock 1			

3.7.3 PL602 – Workstation Interlocks

The Workstation Interlocks are used if Remote Interlocks are unsuitable. The Workstation Interlocks are made via a 25 way D-Type Plug (male). Refer to pin out Table 3

Each Workstation Interlock has dual channel external switches, which have to be connected to enable the shutter operation. The switches should be fed by a common external +24Vdc supply and 0V connected to the returns. Each interlock will draw approximately 60mA. The customer interlock switches should be arranged to interrupt the +24Vdc to disable the shutter.

Table 3 - PL-602 Workstation Interlocks

PIN #	I/O	DESCRIPTION	VOLTS	USED Y/N
1	I	CH 1 EXT SWITCH 1-	0 Vdc	YES
2	I	CH 1 EXT SWITCH +	24 Vdc	YES
3	I	CH 2 EXT SWITCH 1-	0 Vdc	YES
4	I	CH 3 EXT SWITCH 1-	0 Vdc	YES
5	I	CH 3 EXT SWITCH +	24 Vdc	YES
6	I	CH 4 EXT SWITCH 1-	0 Vdc	YES
7	I	CH 5 EXT SWITCH 1-	0 Vdc	NO
8	I	CH 5 EXT SWITCH +	24 Vdc	NO
9	I	CH 6 EXT SWITCH 1-	0 Vdc	NO
10	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A
14	I	CH 1 EXT SWITCH 2-	0 Vdc	YES
15	I	CH 2 EXT SWITCH +	24 Vdc	YES
16	I	CH 2 EXT SWITCH 2-	0 Vdc	YES
17	I	CH 3 EXT SWITCH 2-	0 Vdc	YES
18	I	CH 4 EXT SWITCH +	24 Vdc	YES
19	I	CH 4 EXT SWITCH 2-	0 Vdc	YES
20	I	CH 5 EXT SWITCH 2-	0 Vdc	NO
21	I	CH 6 EXT SWITCH +	24 Vdc	NO
22	I	CH 6 EXT SWITCH 2-	0 Vdc	NO
23	N/A	N/A	N/A	N/A
24	N/A	N/A	N/A	N/A
25	N/A	N/A	N/A	N/A

3.7.4 SK603 – Basic Machine (M/C) Interface

The Basic Machine (M/C) Interface connection is made via a 25 way D-Type Socket (female). Refer to pin out Table 4

To prevent operational problems caused by earth loops, the Machine Interface is opto-isolated.

The Machine Interface must be powered by a +24Vdc power supply capable of delivering 200mA. Power is provided by connecting to the PLC laser inputs.

Nominal load for each input is 5mA. The maximum current capability of each output is 50mA. Refer to Figure 8 - Location of M/C Interface Panel.

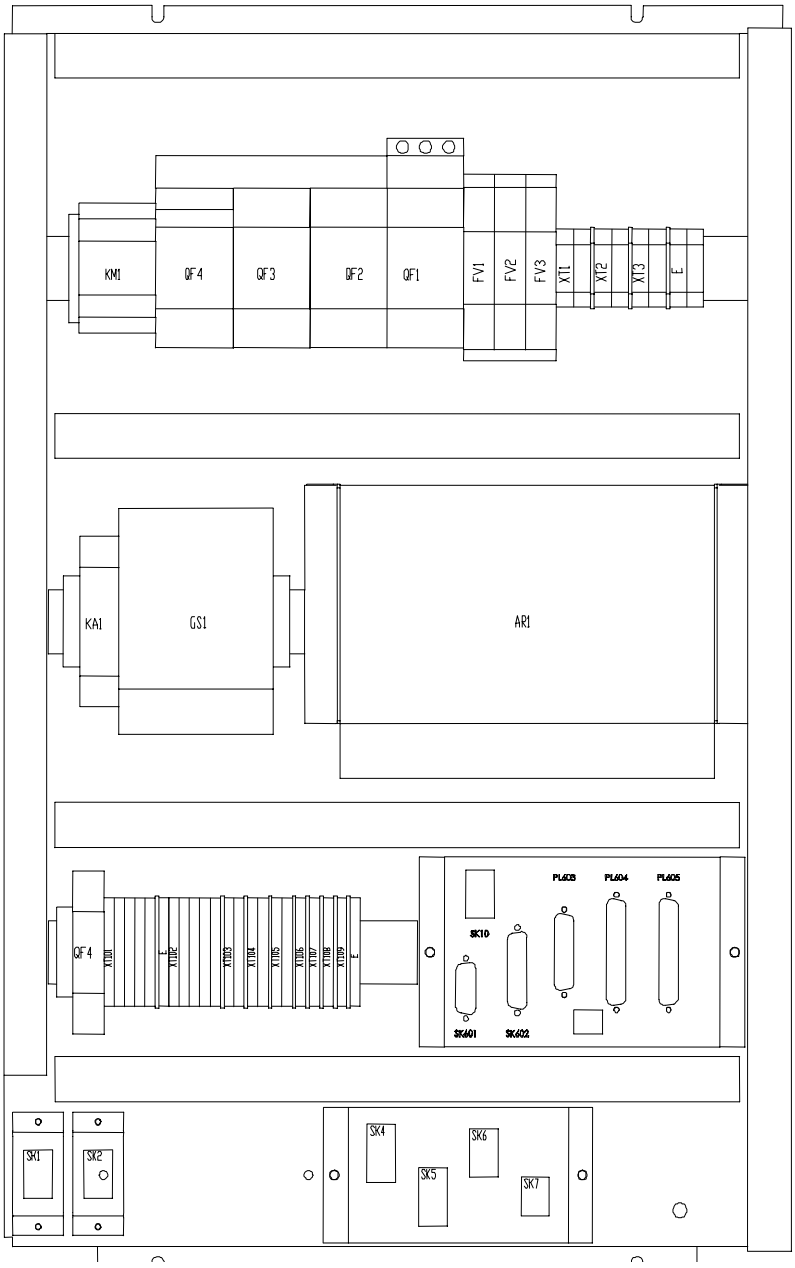


Figure 8 – Location of M/C Interface Panel

Table 4 - SK-603 Basic Machine (M/C) Interface

PIN #	I/O	FUNCTION	PIN #	I/O	FUNCTION
1	PEXT	External 24 Vdc	14	PEXT	External 24 Vdc
2	GNDEXT	External 0 Vdc	15	GNDEXT	External 0 Vdc
3	I	Select Trigger	16	I	Trigger Input
4	I	Select Laser ON	17	I	Select Multishot
5	I	Request Shutter 2	18	I	Request Shutter 1
6	O	Process Cycle Wait	19	O	Remote Ready Status
7	O	Laser ON Status	20	O	Warning Status
8	O	Alarm Status	21	O	SYNC Output
9	O	Shutter Status 2	22	O	Shutter Status 1
10	O	Ext. Power Feedback	23	GND	GNDEXT_INT
11	10 Vdc	EPC Ext. Power Control +	24	0 Vdc	EPC Ext. Power Control -
12			25		
13					

3.7.4.1 Configuration

The Machine Interface laser inputs and laser outputs may be configured as sinking or sourcing. There are two switches on the M/C interface panel that individually set the inputs and outputs as sinking or sourcing.

3.7.4.2 Switches in SINK Position

When the I/P switch is set to SINK, the external Controller output must “pull” current through the laser input. Likewise, when the O/P switch is set to SINK, the external Controller input must “pull” current through the laser output.

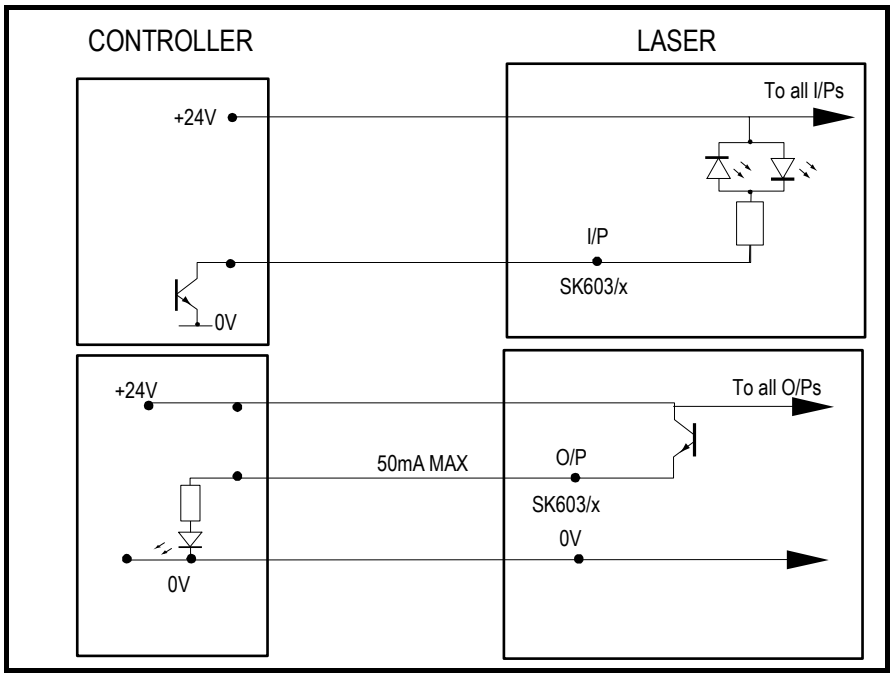


Figure 9 - Sinking Diagram

3.7.4.3 Switches in SOURCE Position

When the I/P switch is set to SOURCE, the external Controller output must “push” current through the laser input. Likewise, when the O/P switch is set to SOURCE, the external Controller input must “push” current through the laser output.

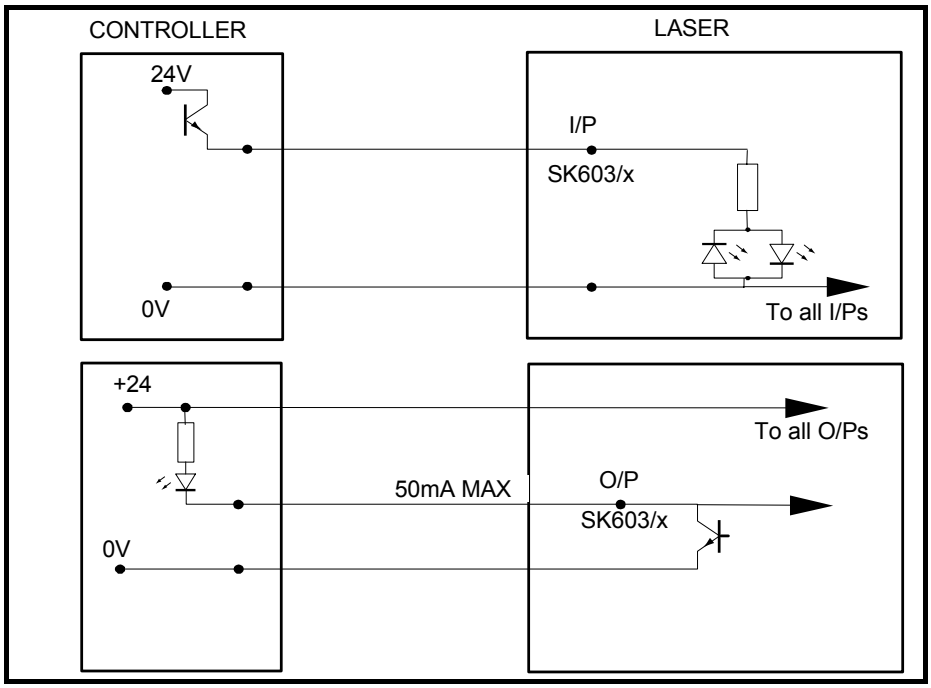


Figure 10 - Sourcing Diagram

3.7.4.4 Machine Interface Supply

The Machine Interface requires an external +24Vdc power supply capable of delivering 200mA. This power supply is provided to the remote control device by connecting the supply to the +V/0V laser inputs on the pin allocations shown in Table 4

3.7.4.5 Laser Inputs

The laser can be controlled in remote by using inputs on the Machine Interface. Ensure Remote Ready Status is true before using the following inputs:

Table 5 - Laser Inputs

SK603 Pin	Function	Remarks
4	SELECT LASER ON	False Off/Ready True ON
17	SELECT MULTISHOT	False Shutter is closed True Refer to Multishot section 3.7.4.6
3	SELECT TRIGGER	False Off/Ready True Refer to Trigger Input section 3.7.4.7
16	TRIGGER INPUT	False Off True Refer to Trigger Input section 3.7.4.7
11	EXT. POWER DEMAND +10Vdc	EPC – Refer to section 8.5.
24	EXT. POWER DEMAND 0V	EPC – Refer to section 8.5.
22	REQUEST SHUTTER 1	False Shutter closed True Request Shutter open
9	REQUEST SHUTTER 2	False Shutter closed True Request Shutter open

3.7.4.6 Multishot Function

The laser can operate in multishot mode, which will open the shutter for a desired number of laser shots. The number of shots required must be entered in Multishot on the Universal Front Panel (UFP). When the Multishot function has been used this value will default to 1 for single shot. Refer to Section 6.8.

When using the Multishot function the laser needs to know which shutter is required. The requested shutter needs to be true.

Note *The laser needs to be in Laser ON mode to operate the Multishot function (SK603/4).*

3.7.4.7 Trigger Input Function

The laser can operate using an external trigger signal to pulse the laser. To use this function the Select Trigger Input needs to be true (SK603/3). The external trigger signal can now be applied to Trigger Input (SK603/16).

3.7.4.8 Laser Status Outputs

The laser provides the following Status outputs to the Machine Interface:

Table 6 - Laser Status

SK603 Pin	Function	Remarks
7	LASER ON STATUS	False Off/Ready True ON
21	SYNC OUTPUT	False True
8	ALARM STATUS	False Alarm not present True Alarm present
20	WARNING STATUS	False Warning not present True Warning present
19	REMOTE READY STATUS	False Remote not enabled True Remote enabled
6	PROCESS CYCLE WAIT	False Process Cycle disabled True Process Cycle active
10	EXT. POWER FEEDBACK	False EPC disabled True EPC active
22	SHUTTER STATUS 1	False Shutter closed True Shutter open
9	SHUTTER STATUS 2	False Shutter closed True Shutter open

LASER ON Status output (SK603/7) indicates the current laser status. The output is decoded as follows:

- OFF is defined as when the Laser is completely OFF.
- READY is defined as when the lamp drivers are active up to simmer level.
- ON is defined as when the lamp drivers are active above simmer level.

REMOTE READY STATUS (SK603/19) is when the Laser is ready and has accepted control from the PLC.

3.7.4.9 Shutter Control

Up to four beam paths can be fitted to the laser. The Basic M/C Interface can control up to two shutters. Shutter commands to shutters that are not fitted to the laser are ignored by the interface.

The shutters are controlled using ‘Request Shutter’ inputs (SK603 pins 18 & 5).

Note *Any open shutter will be closed on the transition from local to remote control.*

After the remote control is granted, a transition of a ‘Request Shutter’ input from false to true is required to open a shutter. Therefore, if a ‘Request Shutter’ input is true when the laser is set to remote control, the shutter will not open.

3.7.4.10 Shutter Status

A ‘Shutter Status’ output (SK603 pins 22 & 9) is true to indicate a shutter is open and a beam path has been selected.

3.7.4.11 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.

3.7.5 SK604 – Full M/C Interface - I/O card 1 (Optional)

The Full (M/C) Interface connection is made via a 37 way D-Type Socket (female). Refer to pin out Table 7.

To prevent operational problems caused by earth loops, the Machine Interface is opto-isolated.

The Machine Interface must be powered by a +24Vdc power supply capable of delivering 200mA. Power is provided by connecting to the PLC laser inputs.

Nominal load for each input is 5mA. The maximum current capability of each output is 50mA.

Table 7 - SK-604 Full Machine Interface I/O Card 1

PIN #	I/O	FUNCTION	PIN #	I/O	FUNCTION
1	O	ACK 1	20	O	ACK 2
2	O	Remote Enabled	21	O	Energy Trip Status
3	O	Power Limit Status	22	O	SPARE Output 6
4	O	SPARE Output 7	23	O	SPARE Output 8
5		Not Used	24		Not Used
6		Not Used	25		Not Used
7		Not Used	26	O	SPARE Output 10
8	O	SPARE Output 9	27	O	Pointing Diode Status
9	O	SPARE Output 11	28	O	Shutter Status 4
10	O	Shutter Status 3	29	O	Shutter Status 6
11	O	Shutter Status 5	30	I	BCD E1
12	I	Parameter Strobe	31	I	BCD E3
13	I	BCD E2	32	I	BCD F1
14	I	BCD E4	33	I	BCD F3
15	I	BCD F2	34	I	Preset Range
16	I	BCD F4	35	I	Pointing Diode ON
17	I	SPARE Input 0	36	I	Request Shutter 4
18	I	Request Shutter 3	37	I	Request Shutter 6
19	I	Request Shutter 5			

3.7.6 SK605 – Full M/C Interface - I/O card 2 (Optional)

The Full (M/C) Interface connection is made via a 37 way D-Type Socket (female). Refer to pin out Table 8

To prevent operational problems caused by earth loops, the Machine Interface is opto-isolated.

The Machine Interface must be powered by a +24Vdc power supply capable of delivering 200mA. Power is provided by connecting to the PLC laser inputs.

Nominal load for each input is 5mA. The maximum current capability of each output is 50mA.

Table 8 - SK-605 Full Machine Interface I/O Card 2

PIN #	I/O	FUNCTION	PIN #	I/O	FUNCTION
1	O	Selected Pulse 1	20	O	Selected Pulse 2
2	O	Selected Pulse 3	21	O	Selected Pulse 4
3	O	Selected Pulse 5	22	O	Selected Sector 1
4	O	Selected Sector 2	23	O	Selected Sector 3
5		Not Used	24		Not Used
6		Not Used	25		Not Used
7		Not Used	26	O	Selected Sector 5
8	O	Selected Sector 4	27	O	SPARE Output 1
9	O	SPARE Output 0	28	O	SPARE Output 3
10	O	SPARE Output 2	29	O	SPARE Output 5
11	O	SPARE Output 4	30	I	BCD A2
12	I	BCD A1	31	I	BCD A4
13	I	BCD A3	32	I	BCD B2
14	I	BCD B1	33	I	BCD B4
15	I	BCD B3	34	I	BCD C2
16	I	BCD C1	35	I	BCD C4
17	I	BCD C3	36	I	BCD D2
18	I	BCD D1	37	I	BCD D4
19	I	BCDD3			

3.7.6.1 Minimum Interface Connections

Table 9 - Minimum Interface Connection Diagram For Single Fibre

PL/SK	PIN #	I/O	FUNCTION
PL601	8	I	Customer Remote Interlock 1
PL601	15	I	Customer Remote Interlock 1
PL601	7	I	Customer Remote Interlock 2
PL601	14	I	Customer Remote Interlock 2
PL602	1	I	0 vdc CH 1 EXT SWITCH 1-
PL602	2	I	24 vdc CH 1 EXT SWITCH +
PL602	14	I	0 vdc CH 1 EXT SWITCH 2-
SK603	1	PEXT	EXTERNAL 24 Vdc
SK603	2	GNDEXT	EXTERNAL 0 Vdc
SK603	4	I	Select Laser On
SK603	17	I	Select Multishot
SK603	18	I	Request Shutter 1
SK603	19	O	Remote Ready Status
SK603	22	O	Shutter Status 1
Need to link out for Remote P.C. Box PL10 if not supplied with laser.			
Plug	**From PIN**	**To PIN**	**FUNCTION**
PL 10	2	3	Remote Computer Interface Bax E-Stop 1.
PL 10	4	5	Remote Computer Interface Bax E-Stop 2.
PL 10	9	10	Remote Computer Interface Bax E-Stop 3.
PL 10	11	12	Remote Computer Interface Bax E-Stop 4.

3.8 Fibre Route Planning

The Fibre route must be planned in accordance with the safety precautions annotated in Section 1.15.

3.9 Installation Consumables

The consumables required for installation of the JK300HP/JK300P/JK125P Series Laser will be supplied by GSI Group - Laser Division.

3.10 Pre-installation Checks

To facilitate the installation of the JK300HP/JK300P/JK125P Series Laser, efforts must be made to ensure that all required services, working environment and relevant personnel are available prior to installation.

Refer to the following recommended checklist that can be used to determine that all site preparation requirements have been satisfied.

Check List			
Site Preparation Requirements			**Y/N**
1	Area prepared for laser footprint available.		
2	Foundation is capable of supporting the laser unit(s).		
3	Electrical supply meets specified requirements.		
4	Electrical supply fittings available, to allow laser connection.		
5	External water supply meets specified requirements.		
6	Specified pipework available to allow connection to external water supply.		
7	Suitable gas supply with specified pipework available to allow connection.		
8	Suitable extraction system to control fumes installed in work area.		
Environmental Conditions Requirements			**Y/N**
1	Laser operating conditions within specified temperature and humidity.		
2	Class 1(I) safety enclosure available for processing.		
Laser Interface Requirements			**Y/N**
1	Fibre routing planned, from the laser to the safety enclosure.		
2	Laser integration with the remote control device, complete.		
3	Laser operation interlock options complete where required.		
4	Fibre / focus head interlock configuration, complete where required.		
6	Workstation jigs suitable for focus lens mounting.		
Personnel Requirements			**Y/N**
1	Electrician:	To connect electrical supply.	
		To connect interface and interlocks.	
2	Plumber:	To connect cooling water supply.	

	Laser Cabinet Inspection	**Y/N**
1	Visually inspect; verify laser cabinet is intact and free from signs of damage.	
2	Inspect and verify laser rail is intact and secure.	
	Customer Connections	
1	Ensure all relevant connections are made:	
	a) PL601 Customer Interlocks	
	b) PL602 Workstation Interlocks	
	c) SK603 Basic machine (M/C) Interface	
	d) SK604 Full M/C Interface - I/O card 1	
	e) SK605 Full M/C Interface - I/O card 2	
	Site Requirements	
All site requirements have been undertaken and meet Pre-installation conditions as specified by GSI Group - Laser Division. Customer is to complete check list by signing and dating below:		
Customer:……..	**Date:……..**	

4. Installation

4.1 Equipment Warranty

Installation of the JK300HP/JK300P/JK125P Series Laser must be carried out by an Authorised GSI Group - Laser Division Engineer (or a GSI Group - Laser Division certified engineer). Installation carried out by personnel other than the aforementioned, will render the equipment warranty void.

4.2 Installation Procedure

Installation of the laser system is estimated to take approximately two days but no more than three days and includes the following:

- Equipment checks. Check system laser is intact, in good working condition and inspection of site service connection.
- Site location of laser system.
- Pre-installation check of laser system.
- Mains power connection (or inspection if carried out by customer).
- External water supply connection (or inspection if carried out by customer).
- Laser power up and system check.
- Fibre installation, including routing and alignment.

Provision of customer operator training:

- Basic safety instruction.
- Laser start-up and shut-down sequence.
- GUI Interface.
- Arc-lamp replacement.
- Rear mirror tuning.
- Cover slide replacement.
- Finding focus.

On completion of installation, the installation engineer and customer are to sign a certificate of completion to verify that:

- The Customer is satisfied with the laser installation.
- The Customer is competent to operate the laser.

4.3 Installation Toolkit

If installation is to be carried out by GSI Group - Laser Division personnel, all installation tools and equipment will be provided by GSI Group - Laser Division.

If installation is to be carried out by non-GSI Group - Laser Division personnel, all installation tools and equipment can be ordered from GSI Group - Laser Division on request.

4.4 Fibre Optic Handling

Refer to Section 1.15 - Fibre Optic Handling prior to installing the Fibre Optic cables. Ensure that the planned route of the Fibre Optic complies with all stated precautions.

Ensure that all safety precautions are observed whilst handling the Fibre Optic cables.

4.5 Installation Procedures

The GSI Group - Laser Division Installation Engineer will undertake the following procedures during the course of installation:

- External Water Supply Connection (or inspection if carried out by the Customer).
- Power Supply Connection (or inspection if carried out by the Customer).
- PC Communication Test.
- Filling of Internal Cooling System.
- Laser Tuning.
- Testing of Interlock circuits.
- Fibre Fitting, Alignment and Transmission.
- Fibre Routing.
- Focus Head Set-up.
- Machine Interface testing

4.6 Certification

The GSI Group - Laser Division Engineer will provide certificates for satisfactory System Installation. These will require Customer signatures. Certificates will also be provided for delegates who successfully complete Customer Training.

5. De-Commissioning

This section provides the procedures necessary to de-commission the JK300HP/JK300P/JK125P Series Laser.

5.1 Disconnect Power Supply

Disconnect Power Supply	
	**WARNING** **FOLLOW APPROVED SAFETY PROCEDURES WHEN WORKING WITH HIGH VOLTAGE POWER SUPPLIES AND EQUIPMENT.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.** **ENSURE THAT POWER TO SUPPLY CABLES IS ISOLATED BEFORE DISCONNECTING THIS EQUIPMENT.**
1	Check that the Laser Mains Isolator is OFF
2	Ensure power to supply cables is isolated at fuse board and locked out.
3	Using cabinet door key, open door to power distribution module.
4	Remove the 3-phase cable from distribution module.
5	Pull cable free from cabinet.

5.2 Connector Removal

Connectors Removal	
1	Unclip and remove the following (if connected):
	a) PL601 Customer Interlocks
	b) PL602 Workstation Doors.
	c) SK603 Basic machine interface
	d) SK604 Full machine interface – Full machine interface I/O card 1
	e) SK605 Full machine interface – Full machine interface I/O card 2.
2	Ensure connector ends are covered or placed in a safe location.

5.3 Disconnect External Water Supply

Disconnect External Water Supply	
	**WARNING** **ENSURE WATER SUPPLY IS ISOLATED BEFORE DRAINING COOLING WATER SYSTEM.**
1	Turn OFF external water supply.
2	Place drainage bowl underneath hose connectors.
3	Loosen the hose clips and remove the hoses.
4	Allow water to drain from system into drainage bowl.
5	Check system is drained of water; wipe up spillage using paper towels.

5.4 Drain Internal Cooling System

Drain Internal Water:	
	**CAUTION** **Ensure water is fully drained from internal cooling system. Ensure no residual water is left in pipework or pumping chambers. Failure to do so may result in severe damage to equipment during shipping.**
1	Refer to Section 9.4.2 and drain the coolant system.
2	Place drainage bowl below cooling system bay.
3	Remove filter bowl and empty into drainage bowl.
4	Remove de-ioniser bowl and empty into drainage bowl.
5	Bleed coolant from the system.
6	Replace filter and de-ioniser bowls.
7	Remove spillage with paper towels.

5.5 Fibre Removal

Fibre Removal	
	**CAUTION** **Fibre ends are easily damaged.** **Fibre handling guidelines must be observed throughout this procedure.**
1	Refer to Fibre Handling Guidelines in Section 1.15.
2	Remove fibre output end from focus head.
3	At laser rail, loosen hex screw in receiver collar.
4	Remove fibre input end from the receiver.
5	Feed fibre cable out of the laser cabinet.
6	Remove fibre, place in a safe location.

5.6 Re-packaging

Repackaging	
1	Refer to packing list (supplied on delivery).
2	Identify all parts on packing list that require separate packing.
3	Ensure laser and components are packaged correctly before shipping.

Intentionally Blank

6. Laser Operation

6.1 Overview

Laser operation consists of the following:

- Start up.
- Shutdown.
- Emergency Shutdown.
- Monitoring and Control.

The Laser is mechanically switched on and off by the mains disconnect switch located at the top right-hand corner of the Cabinet.

6.2 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.
- Ensure external power supplies are available and switched on.
- At the laser, set the MAINS DISCONNECT switch to ON.
- Verify that the white POWER ON lamp is lit [**~**].
- The fault lamp will flash ON/OFF.
- Touch Welcome screen.
- Select the Standby Button  , the amber EMISSION lamp will flash several times. The system will commence the start-up sequence and the Standby Button will grey out to indicate that the system is in Ready Mode.

  Select the On button  to operate the laser.

6.3 Laser Shut-down

The Power OFF Sequence is defined as:

- On the UFP, verify that Laser Status icon indicates STANDBY  . If not, select the Laser STANDBY button. Ensure Laser Status icon indicates STANDBY.

  Push OFF button  .

  Laser is now OFF. The Coolant Pump will continue to run for ten seconds to allow cooling after Laser operation.

When Coolant Pump stops running, set the MAINS DISCONNECT switch to OFF.

6.4 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.

1. Press the closest red EMERGENCY STOP button.
2. At the Control Panel, set the MAINS DISCONNECT switch to OFF.

3. Switch OFF the external Power Supply Isolator.
4. Switch OFF the external water supply.
5. Follow all Local Emergency Procedures.

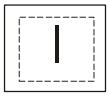
6.5 Keys

6.5.1 General

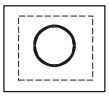
Keys are active areas of the UFP touch-screen, the same key is usually displayed in the same place.

6.5.2 Control Keys

On (Current state)



Standby



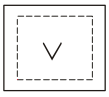
Off

The Control Keys are always displayed and are always active. The current state of the Laser is indicated by the key colour shown as white on a black background.

6.5.3 Navigation Keys

These keys are only shown if they are active.

Return Returns to the previous screen up the menu tree.



Rotate Moves between screens at the same level in the menu tree
If two are available then screens alternate 1-2-1-2 etc
If three are available then screens rotate 1-2-3-1-2-3 etc.

6.5.4 Function Keys

Function keys are placed under a line of text on the centre of the main screen area, and activates a function relevant to it. They either access a lower level screen, or turn something on or off.

6.5.5 Value Keys

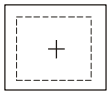
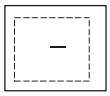
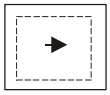
Value keys are placed under a value on the right-hand side of the screen and start or stop the editing of that value.

Example:

Function Key :		**Value key**
Shutter	:	2

6.5.6 Editing Keys

These keys are only shown when they are active.

	Increment	Increments the value.
	Decrement	Decrements the value.
	Cursor	Moves the cursor from left to right or from LSD to MSD (ie rotate right).

Editing is entered and exited by pressing the value displayed.

Editing keys appear when a numeric or state value is selected for editing and the cursor appears under the LSD.

In numeric editing:

> **Increment** and **Decrement** modify the value by the place-value of the digit at the cursor. If held for more than 1 sec the value auto-increments(-decrements) until the key is released. Values cannot exceed internal limits.

In state editing:

> **Increment** and **Decrement** rotate the value through the list of available states.
>
> *Incr*. rotates forwards; *Decr*. rotates backwards.
>
> In all cases, when the editing key is released, the resultant value is transmitted via network message. The value actually displayed is the result of polling the destination of the transmitted value**. It is therefore possible that the value displayed after editing is not what the operator expects.**

The **Special Function key** only appears if active; its function is defined for that screen only.

6.5.7 Status Bar

```
1  10  12.34 ALARM WARN
```

This is normally displayed on the bottom line of selected screens although occasionally it appears above the bottom row of keys. It shows:

Selected Shutter No and its state – = shutter is open.

Selected Shape No

Current Energy level

Indication of an active Alarm – ALARM = active alarm.

Indication of an active Warning – WARN = active warning.

6.5.8 Local warnings

Local messages such as “Out of range” or “Access disallowed*”* use the Warnings pop-up.

6.6 WELCOME screen

6.6.1 Function

Stays off until UFP is touched.

6.6.2 Entry

From Welcome screen to Main screen when UFP is touched.

6.6.3 Exit

Exits to Main screen when the screen is touched.

6.6.4 {Laser Descr) {Laser Type} {s/w}

Configuration data.

6.7 MAIN screen

6.7.1 Function

Top-level screen – gives access to principal functions.

6.7.2 Entry/Exit

Entry from Welcome Screen or return from sub-screens.

No exit (top-level).

6.7.3 'Operate'

Active Key – accesses the Operate screen.

6.7.4 'Setup'

Active Key – accesses the Setup screen.

6.7.5 'Alarm/Warnings'

Active Key – accesses the Alarm/Warnings screen.

6.7.6 'System'

Active Key – accesses the System Setup screen – access restricted by code.

When key is pressed. The operator must then press the right-hand hidden keys in the correct sequence.

If sequence is correct the System Setup screen is accessed and SYSTEM is pressed.

If incorrect. The System key must then be pressed again to re-start the process.

6.7.7 Status Bar

The Status bar is displayed and continuously updated.

6.8 OPERATE screen

6.8.1 Function

For manual operation of the laser.

6.8.2 Entry/Exit

From/to Main screen.

	Text	Key	Range
'Pulse Height' Value	Shows current value	Enables numeric editing of value. A new value has immediate effect.	0.0 – 100.0 %
'Multishot' Value	Shows current value. Updates (counts down) during Multishot process	Enables numeric editing of value. When editing, '*' key recalls the last value used (this recall value is stored locally)	0 - 999
'Align Diode' State	Shows current state	Enables selection of state via edit keys.	ON, OFF
'Shutter is Open [Closed]'	Text toggles between 'Open' and 'Closed'	Opens and closes the Shutter	

When pressed to 'Open' a confirmation prompt appears which remains until Yes  or No  is pressed.

Press to 'Close' has immediate effect (no prompt).

'Multishot'	Fixed text	Starts a Multishot sequence

When pressed a confirmation prompt appears. Pressing Yes  starts the Multishot sequence which runs until the sequence is terminated.

Multishot Value is always set to 1 on completion of a sequence.

Disallowed when Laser is in Remote.

6.8.3 Status Bar

The Status bar is displayed and continuously updated.

When editing the Pulse Ht Value, the Status Bar is displayed above the editing keys.

6.9 SETUP screen

6.9.1 Function

For setting up for manual operation of the laser.

6.9.2 Entry/Exit

From/to Main screen.

	Text	Key	Range
'Control' State	Shows current state	Enables selection of state via edit keys	Local, Remote

Edit is disallowed when Control is in Remote.

'Shutter No' Value	Shows currently active shutter	Enables numeric editing of value Active Shutter No is stored locally (network has no "active" shutter)	1 - 4
'Shape No'	Shows currently active	Enables numeric editing of value.	1 - 10

	Text	Key	Range
Value	shape		
'Pulse Trig' Value	Shows current state	Enables selection of state via edit keys	Internal, External
'Trip' Enable Value	Shows current state	Enables selection of state via edit keys	Enabled, Disabled
'Modify Shape' Value	Shows shape # to be modified	Enables numeric editing of value.	1 - 10
'Modify Shape'	Fixed text	Accesses the Modify Shape screens	
'Display Energy'	Fixed text	Accesses the Energy Monitor screen	

6.9.3 Status Bar

The Status bar is displayed and continuously updated.

6.10 MODIFY SHAPE screens

6.10.1 Function

For defining 2-sector shapes.

All new values have immediate effect.

6.10.2 Entry/Exit

Entry to first screen from Setup screen.

Down-arrow moves between first and second screens.

6.10.3 Title

'SHAPE {No}' shows Shape No being edited.

	Text	Key	Range
'Height 1' Value	Shows current value for Sector 1	Enables numeric editing of value.	0 – 100.0 %
'Width 1' Value	Shows current value for Sector 1	Enables numeric editing of value.	0 – 20.0 ms
'Height 2' Value	Shows current value for Sector 2	Enables numeric editing of value.	0 – 100.0 %
'Width 2' Value	Shows current value for Sector 2	Enables numeric editing of value.	0 – 20.0 ms

Values for both Height 1, Height 2, Width 1 and Width 2 are limited by operation parameters for maximum power output.

	Text	Key	Range
'Rep Rate' Value	Shows current value	Enables numeric editing of value.	0 – 1000.0 Hz
'Ramp Up'	Shows current value	Enables numeric editing of value.	0 - 9.9 sec
'Ramp Down'	Shows current value	Enables numeric editing of value.	0 - 9.9 sec
'En.Trip Hi' Value	Shows current value	Enables numeric editing of value.	0 – 12.34 J *see note below*
'En.Trip Lo' Value	Shows current value	Enables numeric editing of value.	0 – 12.34 J *see note below*

Note *This value is dependent upon the model of Laser.*

6.11 Energy MONITOR screen

6.11.1 Function

Shows the current Energy value in large-format. Continuously updated.

6.11.2 Entry/Exit

Entry from Setup screen.

Exit to Setup screen.

6.11.3 Status Bar

The Status bar is displayed and continuously updated.

6.12 SYSTEM screen

6.12.1 Function

For setting System parameters.

6.12.2 Entry/Exit

Entry to first screen from Main screen, by Access Code.

Down-arrow moves between first and second screen.

Exit from either screen to Main screen.

	Text	Key	Range
'Laser Type' value	Shows value from S/W		8 chars
'Shot Count' value	Shows current value	Enables Count to be set to 0	0 – 999999999
When pressed a confirmation prompt appears which remains until Yes  or No  is pressed			
'Shot Alarm' value	Shows current value	Enables numeric editing of value.	0 - 999999999
'Coolant Flow' value	Shows current value from S/W	Not editable	
'Flow Alarm' value	Shows current value	Enables numeric editing of value.	0 - 999 l/m
'Coolant Temp' value	Shows current value from S/W	Not editable	
'Coolant Setpoint' value	Shows current value	Enables numeric editing of value.	0 – 30.00 C

Not used on all Laser Types

6.13 ALARM / WARNINGS screen

6.13.1 Function

For displaying Alarm and Warnings.

6.13.2 Entry/Exit

Entry to first screen from Main screen.

Down-arrow moves between first and second screen.

Exit from either screen to Main screen.

6.13.3 Display

The screen displays any active Alarm or Warnings.

Only one Alarm can be active at a time.

There may be more than one active Warning; if there are more than three then the second screen is used; the Down-arrow key is not displayed unless a second screen is available.

Pressing any displayed Alarm or Warning will bring up the relevant Alarm/Warning (see below).

6.13.4 Alarm/Warning

6.13.4.1 Function

For displaying details of Alarm and Warnings.

Warnings may be Local (ie generated by the UFP) or from the Network.

6.13.4.2 Entry/Exit

Entry either automatically when an Alarm or Warning first becomes active, or from the Alarm/Warnings screen.

6.13.4.3 Display

Shows the Alarm or Warning number only.

On the Alarm display, the ‘Rst’ key will attempt to reset the Alarm.

The ‘Clr’ key exits the Alarm display, restoring the previous screen.

The ‘Double Up-arrow’ key is not available during a display.

6.13.4.4 Display Control

The Alarm display is displayed when an Alarm becomes active.

If ‘Reset’ is pressed, the system attempts to reset the Alarm and the Alarm display is cleared. If the Alarm remains active the Alarm display is re-displayed.

If ‘Clear’ is pressed, the Alarm display is cleared and does not show again unless it has become inactive in the interim (unless called from the Alarm/Warnings screen).

A Warning display is only displayed when the Warning first becomes active. Once cleared it does not show again unless it has become inactive in the interim (unless called from the Alarm/Warnings screen).

Intentionally blank

7. Alarm and Warning Handling

7.1 Alarm and Warning Display

System faults will cause either an Alarm or a Warning to be displayed on the screen.

Alarms will normally stop the Laser operating (some Shutter and Machine Interface alarms do not stop the Laser). Alarms cause the periphery of the relevant icon to flash in red and an Alarm Message to be displayed in the Alarm Banner. Alarm indications will remain present until the fault has been cleared and the RESET button selected. If more than one alarm exists, the next highest priority alarm will be displayed.

Warnings indicate a problem but allow continued operation. Warnings cause the periphery of the relevant icon to flash in yellow and a warning message to be displayed in the Message Banner. Warning indications will remain present until the problem has been cleared. This may or may not require manual intervention.

7.2 Alarms For Generic Control System

Lasers that allow alarm values to be read return values standardised across all lasers. The return values are four digit numbers formatted as follows:

Z S N N

Where:

Z is the alarm zone as detailed in the table below

Z	Device
1	System Level
2	Interlocks
3	Cooler
4	Power Supply
5	Shutter
6	Machine Interface

S is the sub zone number, i.e. for a system having more than one shutter, shutter 3 would be referenced by **Z** = 4, **S** = 3. For systems having only one of a particular zone type, **S** = 1.

N N is the actual alarm number.

7.3 System Level Alarms (Zone 1)

7.3.1 Alarm 1n01 : Communications Error

Meaning:

Communications between the user interface and the laser have failed. The user interface will attempt to automatically re-establish communications after 10 seconds. Pressing ‘RESET’ will immediately attempt to re-establish communications.

Possible Cause:

1. Serial communications cable disconnected.
2. Laser turned off.
3. Incorrect or poor connections in serial communications cable.

7.3.2 Alarm 1n02 : Serial Communications Fault

Meaning:

The laser did not receive a message over the serial link for 5 seconds, while the laser was on.

Possible causes:

1. Serial communications cable disconnected or loose.
2. Control program controlling the serial link is not transmitting data (program closed).
3. Faulty laser Control Card.

7.3.3 Alarm 1n03 : No Laser Type Configured

Meaning:

The laser has not been configured with a suitable laser type.

Possible causes

1. New laser control card.
2. Re-Programmed laser control card.

7.3.4 Alarm 1n04 : Laser Control Card Communication Fault

Meaning:

The Laser Control Card stopped communicating on the laser control network.

Possible causes:

1. Laser control card not fitted.
2. Loose laser control network connections.
3. Re-programming Laser Control Card.
4. Faulty Laser Control Card.

7.3.5 Alarm 1n05 : Pulse Generator Card Communication Fault

Meaning:

The Pulse Generator Card stopped communicating with the Laser Control Card.

Possible causes:

1. Incorrect address set on Pulse Generator address switch.
2. Pulse Generator Card not fitted.
3. Pulse Generator Card loose in the control rack.
4. Faulty Pulse Generator Card.
5. Faulty Laser Control Card.

7.3.6 Alarm 1n06 : Interlock Module Communication Fault

Meaning:

The Interlock Module stopped communicating on the laser control network.

Possible causes:

1. Interlock Module not fitted.
2. Loose laser control network connections.
3. Re-programming Interlock Module.

4. Faulty Interlock Module.

7.3.7 Alarm 1n07 : Software Error

Meaning:

The Interlock Module failed to initialise.

Possible causes:

1. Faulty Interlock Module.

7.3.8 Alarm 1n08 : Safety Relay Out Fault

Meaning:

The safety relay dropped out while the laser was on.

Possible causes:

1. Emergency shutdown occurred.
2. Loose connection on safety relay.
3. Faulty safety relay.
4. Faulty interlock module.

7.3.9 Alarm 1n09 : Safety Relay In Fault

Meaning:

The safety relay engaged while the laser was off.

Possible causes:

1. Faulty connections on safety relay.
2. Faulty safety relay.
3. Faulty interlock module.

7.3.10 Alarm 1n10 : Safety Relay Not Detected.

Meaning:

The Interlock Module timed out waiting for the Safety Relay to engage during the laser start up sequence.

Possible causes:

1. Loose connections to the safety relay.
2. Loose connections to the Interlock Module.
3. Faulty Safety Relay.
4. Faulty Interlock Module.

7.3.11 Alarm 1n11 : Emission Indicator Timeout

Meaning:

The Interlock Module timed out waiting for the emission indication sequence to complete during the laser start up sequence.

Possible causes:

1. 1. Faulty Interlock Module.

7.3.12 Alarm 1n12 : Laser Type Not Recognised By The Laser Control Network

Meaning:

The Interlock Module did not receive a correct laser type over the laser control network following a request.

Possible causes:

1. New laser control card.
2. Re-Programmed laser control card.
3. Loose Laser Control Network connections.
4. Faulty Interlock Card.
5. Faulty Laser Control Card.

7.3.13 Alarm 1n13 : LCC DSP Communications Fault

Meaning:

The Laser Control Card DSP has stopped communicating with the Laser Control Card Neuron device.

Possible causes:

1. Laser Control Card DSP not programmed.
2. Loose Laser Control Network connections.
3. Faulty Laser Control Card.

7.3.14 Alarm 1n14 : Unexpected power down

Meaning:

The Laser power failed while the laser was on.

Possible causes:

1. Power failed while laser was on
2. Faulty Laser Control Card.

7.4 Interlock Alarms (Zone 2)

7.4.1 Alarm 2n01 : Interlock Chain Input 1 Fault

Meaning:

For JK laser products this input is allocated to the Interlock chain voltage feed.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.2 Alarm 2n02 : Interlock Chain Input 2 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.3 Alarm 2n03 : Interlock Chain Input 3 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.4 Alarm 2n04 : Interlock Chain Input 4 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.5 Alarm 2n05 : Interlock Chain Input 5 Fault

Meaning:

For JK laser products this input is allocated to the Three Phase Overload suppressors. One or more of the three surge suppressors has been activated, due to a surge in the incoming voltage supply.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty suppressor due to surge.

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.6 Alarm 2n06 : Interlock Chain Input 6 Fault

Meaning:

For JK laser products this input is allocated to the Pump Overload. Circuit breaker supplying the cooler pump has tripped.

Possible causes:

1. Faulty pump.
2. Pump overheated.
3. Loose connection.
4. Faulty pump connections.

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.7 Alarm 2n07 : Interlock Chain Input 7 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.8 Alarm 2n08 : Interlock Chain Input 8 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.9 Alarm 2n09 : Interlock Chain Input 9 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.10 Alarm 2n10 : Interlock Chain Input 10 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.11 Alarm 2n11 : Interlock Chain Input 11 Fault

Meaning:

For JK laser products this input is allocated to the Cabinet Emergency Stop.

Possible causes:

1. Cabinet Emergency Stop is latched in position.
2. Loose connection.
3. Faulty interlock module.

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.12 Alarm 2n12 : Interlock Chain Input 12 Fault

Meaning:

For JK laser products this input is allocated to the Customer Interlock Input.

Possible causes:

1. Customer Interlock connection is open circuit.
2. Loose connection.
3. Faulty interlock module.

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.13 Alarm 2n13 : Interlock Chain Input 13 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.14 Alarm 2n14 : Interlock Chain Input 14 Fault

Meaning:

For JK laser products this input is allocated to the control rack dual shutter card slot 1 Emergency Stop circuit. Channel 1 of the dual shutter card.

Possible causes:

1. Interlock override not fitted to the control rack dual shutter card slot 1 (required if there is no dual shutter card fitted in slot 1).
2. Dual shutter card not fitted in slot 1 of the control rack.
3. Shutter card override connections not present (required if there is no shutter fitted to the dual shutter card channel 1).
4. Shutter fault on the shutter fitted to channel 1 of the dual shutter card in slot 1 of the control rack.
5. Dual shutter card fitted in slot 1 of the control rack is not programmed.
6. Laser Control Card not fitted.
7. Laser Control Card not programmed.
8. Faulty shutter connected to channel 1 of the dual shutter card fitted in slot 1 of the control rack.
9. Faulty shutter card fitted in slot 1 of the control rack.

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.15 Alarm 2n15 : Interlock Chain Input 15 Fault

Meaning:

For JK laser products this input is allocated to the control rack dual shutter card slot 2 Emergency Stop circuit. Channel 1 of the dual shutter card.

Possible causes:

1. Interlock override not fitted to the control rack dual shutter card slot 2 (required if there is no dual shutter card fitted in slot 2).
2. Dual shutter card not fitted in slot 2 of the control rack.
3. Shutter card override connections not present (required if there is no shutter fitted to the dual shutter card channel 1).
4. Shutter fault on the shutter fitted to channel 1 of the dual shutter card in slot 2 of the control rack.
5. Dual shutter card fitted in slot 2 of the control rack is not programmed.
6. Laser Control Card not fitted.
7. Laser Control Card not programmed.
8. Faulty shutter connected to channel 1 of the dual shutter card fitted in slot 2 of the control rack.
9. Faulty shutter card fitted in slot 2 of the control rack.

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.16 Alarm 2n16 : Interlock Chain Input 16 Fault

Meaning:

For JK laser products this input is allocated to the control rack dual shutter card slot 3 Emergency Stop circuit. Channel 1 of the dual shutter card.

Possible causes:

1. Interlock override not fitted to the control rack dual shutter card slot 3 (required if there is no dual shutter card fitted in slot 3).
2. Dual shutter card not fitted in slot 3 of the control rack.
3. Shutter card override connections not present (required if there is no shutter fitted to the dual shutter card channel 1).
4. Shutter fault on the shutter fitted to channel 1 of the dual shutter card in slot 3 of the control rack.
5. Dual shutter card fitted in slot 3 of the control rack is not programmed.
6. Laser Control Card not fitted.
7. Laser Control Card not programmed.
8. Faulty shutter connected to channel 1 of the dual shutter card fitted in slot 3 of the control rack.
9. Faulty shutter card fitted in slot 3 of the control rack.

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.17 Alarm 2n17 : Interlock Chain Input 17 Fault

Meaning:

For JK laser products this input is allocated to the control rack dual shutter card slot 1 Emergency Stop circuit. Channel 2 of the dual shutter card.

Possible causes:

1. Interlock override not fitted to the control rack dual shutter card slot 1 (required if there is no dual shutter card fitted in slot 1).
2. Dual shutter card not fitted in slot 1 of the control rack.
3. Shutter card override connections not present (required if there is no shutter fitted to the dual shutter card channel 2).
4. Shutter fault on the shutter fitted to channel 2 of the dual shutter card in slot 1 of the control rack.
5. Dual shutter card fitted in slot 1 of the control rack is not programmed.
6. Laser Control Card not fitted.
7. Laser Control Card not programmed.

8. Faulty shutter connected to channel 2 of the dual shutter card fitted in slot 1 of the control rack.
9. Faulty shutter card fitted in slot 1 of the control rack.

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.18 Alarm 2n18 : Interlock Chain Input 18 Fault

Meaning:

For JK laser products this input is allocated to the control rack dual shutter card slot 2 Emergency Stop circuit. Channel 2 of the dual shutter card.

Possible causes:

1. Interlock override not fitted to the control rack dual shutter card slot 2 (required if there is no dual shutter card fitted in slot 2).
2. Dual shutter card not fitted in slot 2 of the control rack.
3. Shutter card override connections not present (required if there is no shutter fitted to the dual shutter card channel 2).
4. Shutter fault on the shutter fitted to channel 2 of the dual shutter card in slot 2 of the control rack.
5. Dual shutter card fitted in slot 2 of the control rack is not programmed.
6. Laser Control Card not fitted.
7. Laser Control Card not programmed.
8. Faulty shutter connected to channel 2 of the dual shutter card fitted in slot 2 of the control rack.
9. Faulty shutter card fitted in slot 2 of the control rack.

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.19 Alarm 2n19 : Interlock Chain Input 19 Fault

Meaning:

For JK laser products this input is allocated to the control rack dual shutter card slot 3 Emergency Stop circuit. Channel 2 of the dual shutter card.

Possible causes:

1. Interlock override not fitted to the control rack dual shutter card slot 3 (required if there is no dual shutter card fitted in slot 3).
2. Dual shutter card not fitted in slot 3 of the control rack.
3. Shutter card override connections not present (required if there is no shutter fitted to the dual shutter card channel 2).

4. Shutter fault on the shutter fitted to channel 2 of the dual shutter card in slot 3 of the control rack.
5. Dual shutter card fitted in slot 3 of the control rack is not programmed.
6. Laser Control Card not fitted.
7. Laser Control Card not programmed.
8. Faulty shutter connected to channel 2 of the dual shutter card fitted in slot 3 of the control rack.
9. Faulty shutter card fitted in slot 3 of the control rack.

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.20 Alarm 2n20 : Interlock Chain Input 20 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.21 Alarm 2n21 : Interlock Chain Input 21 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.22 Alarm 2n22 : Interlock Chain Input 22 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.23 Alarm 2n23 : Interlock Chain Input 23 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.24 Alarm 2n24 : Interlock Chain Input 24 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.25 Alarm 2n25 : Interlock Chain Input 25 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.26 Alarm 2n26 : Interlock Chain Input 26 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.27 Alarm 2n27 : Interlock Chain Input 27 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.28 Alarm 2n28 : Interlock Chain Input 28 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.

2. Loose connection.
3. Faulty interlock module.

7.4.29 Alarm 2n29 : Interlock Chain Input 29 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.30 Alarm 2n30 : Interlock Chain Input 30 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.31 Alarm 2n31 : Interlock Chain Input 31 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.4.32 Alarm 2n32 : Interlock Chain Input 32 Fault

Meaning:

There is no voltage supply to this interlock input.

Possible causes:

1. Interlock supply not turned on.
2. Loose connection.
3. Faulty interlock module.

7.5 Cooler Alarms (Zone 3)

7.5.1 Alarm 3n01 : Cooler Module communication fault

Meaning:

Cooler Module n stopped communicating on the laser control network.

Possible causes:

1. Cooler Module
2. Loose laser control network connections.

3. Re-programming Cooler Module.
4. Faulty Cooler Module

7.5.2 Alarm 3n02 : No Pump On Response

Meaning:

The cooler module failed to report the pump contactor engaged during the laser sequence start up routine. The interlock module timed out before the response was received.

Possible causes:

1. Pump contactor failure.
2. Loose pump contactor connections.
3. Loose laser control network connections.

7.5.3 Alarm 3n03: Low Coolant Level

Meaning:

The coolant level in laser has fallen below the level of the detector.

Possible causes:

1. Coolant level is low.
2. Loose connections between detector and Cooler Module.
3. Faulty level detector.
4. Faulty Cooler Module.

7.5.4 Alarm 3n04: Over Temperature Switch

Meaning:

The temperature switch on the heat exchanger registered an over temperature fault.

Coolant is over temperature.

Possible causes:

1. Factory supply cooling water turned off.
2. Insufficient flow from factory cooling water supply.
3. Incorrect cooler valve setting.
4. Faulty temperature switch.
5. Loose connections.
6. Faulty Cooler Module.

7.5.5 Alarm 3n05: Cooler Module Relay Fault

Meaning:

The Cooler Module did not detect the pump relay engage when the pump was instructed to turn on, or the Cooler Module detected the pump relay disengaged while the cooler was running.

Possible causes:

1. Loose connections.
2. Faulty pump Relay.
3. Faulty cooler module.

7.5.6 Alarm 3n06: Cooler Module Relay Overload Fault

Meaning:

Circuit breaker supplying the pump has tripped.

Possible causes:

1. Faulty pump.
2. Pump overheated.
3. Loose connection.
4. Faulty pump connections.

7.5.7 Alarm 3n07: Low temperature fault

Meaning:

The coolant temperature has fallen below a configurable threshold.

Possible causes:

1. Incorrect cooler valve setting.
2. Cooler valve stuck in the open position.
3. Configurable threshold set too high.
4. Loose connections.
5. Faulty temperature sensor
6. Faulty Cooler Module.

7.5.8 Alarm 3n08: High temperature fault

Meaning:

The coolant temperature has raised above a configurable threshold.

Possible causes:

1. Incorrect cooler valve setting.
2. Cooler valve stuck in the closed position.
3. Factory supply cooling water turned off.
4. Insufficient flow from factory cooling water supply.
5. Configurable threshold set too low.
6. Loose connections.
7. Faulty temperature sensor.
8. Faulty Cooler Module.

7.5.9 Alarm 3n09: Very High temperature fault

Meaning:

The coolant temperature has raised above a fixed software temperature threshold.

Possible causes:

1. Configurable high temperature alarm level set too high.
2. Incorrect cooler valve setting.
3. Cooler valve stuck in the closed position.
4. Factory supply cooling water turned off.
5. Insufficient flow from factory cooling water supply.

6. Configurable threshold set too low.
7. Loose connections.
8. Faulty temperature sensor.
9. Faulty Cooler Module.

7.5.10 Alarm 3n10: High Conductivity fault

Meaning:

The coolant conductivity has raised above a configurable threshold.

Possible causes:

1. Water contamination.
2. Cooler filters require changing.
3. Configurable threshold set too low.
4. Loose connections.
5. Faulty conductivity sensor.
6. Faulty Cooler Module.

7.5.11 Alarm 3n11: Low Coolant Flow

Meaning:

The coolant flow level has fallen below a configurable threshold.

Possible causes:

1. Loss of coolant in the system.
2. Water leak.
3. Flow threshold set too high.
4. Incorrect flow meter factor setting.
5. Loose connections.
6. Faulty sensor.
7. Faulty Cooler Module.

7.5.12 Alarm 3n12: High Coolant Flow

Meaning:

The coolant flow level has raised above a configurable threshold.

Possible causes:

1. Air in the cooling system.
2. Water leak.
3. Flow threshold set too low.
4. Incorrect flow meter factor setting.
5. Loose connections.
6. Faulty sensor.
7. Faulty Cooler Module.

7.5.13 Alarm 3n13: Temperature Sensor Fault

Meaning:

The coolant temperature sensor is faulty.

Possible causes:

1. Faulty temperature sensor.
2. Loose connections.
3. Faulty Cooler Module.

7.5.14 Alarm 3n14: Conductivity Sensor Fault

Meaning:

The coolant conductivity sensor is faulty.

Possible causes:

1. Faulty conductivity sensor.
2. Loose connections.
3. Faulty Cooler Module.

7.6 Power Supply Alarms (Zone 4)

7.6.1 Alarm 4n01 : Power Supply Module communication fault

Meaning:

Power Supply n stopped communicating on the laser control network.

Possible causes:

1. Incorrect laser type specified.
2. Power Supply not fitted.
3. Loose laser control network connections.
4. Re-programming Power Supply.
5. Faulty Power Supply.

7.6.2 Alarm 4n02 : Power Supply Software Error

Meaning:

The power supply control software failed to initialise.

Possible causes:

1. Faulty power supply.

7.6.3 Alarm 4n03 : Power Supply Negative 15 Volt Fault

Meaning:

The negative 15 Volt supply for the internal power supply control has failed.

Possible causes:

1. Faulty power supply.

7.6.4 Alarm 4n04 : Power Supply Fan Fault

Meaning:

The power-supply cooling-fan is either running too slowly, or has stopped.

Possible causes:

1. Faulty power supply (faulty fan).

7.6.5 Alarm 4n05 : Power Supply Over Temperature

Meaning:

The power supply temperature switch has been activated.

Possible causes:

1. Configurable high temperature alarm level set too high.
2. Incorrect cooler valve setting.
3. Cooler valve stuck in the closed position.
4. Factory supply cooling water turned off.
5. Insufficient flow from factory cooling water supply.
6. Faulty power supply.

7.6.6 Alarm 4n06 : Power Supply Contactor In Fault

Meaning:

The power supply contactor is in when it should be out. The power supply should be off.

Possible causes:

1. Faulty power supply.

7.6.7 Alarm 4n07 : Power Supply Failed to initialise

Meaning:

The Interlock Module timed out waiting for power supply n to response to an initialisation command, and report that it had entered the initialised state during the laser start up sequence.

Possible causes:

1. Incorrect laser type setting.
2. Loose laser control network connections.
3. Faulty power supply.
4. Faulty Interlock module.
5. Faulty Laser Control Card.

7.6.8 Alarm 4n08 : Power Supply Contactor In Timeout

Meaning:

The power supply contactor did not engage within the timeout period during the laser start up sequence.

Possible causes:

1. Faulty power supply.

7.6.9 Alarm 4n09 : Power Supply Failed To Simmer

Meaning:

The Interlock Module timed out waiting for power supply n to enter, and report that it had entered the simmer state during the laser start up sequence.

Possible causes:

1. Incorrect laser type setting.

2. Loose laser control network connections.
3. Faulty power supply.
4. Faulty Interlock module.
5. Faulty Laser Control Card.

7.6.10 Alarm 4n10 : Power Supply Failed To Simmer Timeout

Meaning:

The power supply failed to simmer within the timeout period during the laser start up sequence.

Possible causes:

1. High coolant water conductivity.
2. Broken lamp.
3. Faulty power supply.

7.6.11 Alarm 4n11 : Power Supply Simmer Under Power Fault.

Meaning:

The simmer current was above operating limits when the power supply was on.

Possible causes:

1. Broken lamp.
2. Incorrect lamp type.
3. Faulty power supply.

7.6.12 Alarm 4n12 : Power Supply Simmer Over Power Fault

Meaning:

The power supply simmer circuit is on when it should have turned off.

Possible causes:

1. Faulty Power Supply.

7.6.13 Alarm 4n13 : Power Supply Failed To Enable

Meaning:

The Interlock Module timed out waiting for power supply n to enter, and report that it had entered the enabled state during the laser start up sequence.

Possible causes:

1. Incorrect laser type setting.
2. Loose laser control network connections.
3. Faulty power supply.
4. Faulty Interlock module.
5. Faulty Laser Control Card.

7.6.14 Alarm 4n14 : Power Supply Limit Fault

Meaning:

The output of the power supply is being driven to its limit.

Possible causes:

1. Wiring fault in the power supply demand.
2. Faulty pulse generator card.
3. Faulty power supply.

7.6.15 Alarm 4n15 : Power Supply IGBT Fault

Meaning:

The power supply IGBT is faulty.

Possible causes:

1. Faulty power supply.

7.6.16 Alarm 4n16 : Power Supply Earth Fault

Meaning:

The power supply has detected earth leakage current.

Possible causes:

1. Broken lamp.
2. Lamp lead damage.
3. Lamp lead connection problem.
4. Faulty Power Supply.

7.6.17 Alarm 4n17 : Power Supply Input Voltage Loss

Meaning:

The power supply input voltage has fallen below operating limits while the laser was running.

Possible causes:

1. Mains input power interrupt.
2. Faulty mains input connections.
3. Faulty power supply.

7.6.18 Alarm 4n18 : Power Supply Contactor Out Fault

Meaning:

The power supply contactor is out when it should be in. The power supply should be on.

Possible causes:

1. Unexpected shutdown.
2. Faulty power supply.

7.6.19 Alarm 4n19 : Power Supply Shutdown During Operation

Meaning:

The Interlock Module detected power supply n had shut down while the laser was on.

Possible causes:

1. Unexpected shutdown.
2. Faulty Power Supply.
3. Faulty Interlock Module.

7.6.20 Alarm 4n20 : Power Supply Contactor Out Timeout

Meaning:

The power supply contactor did not disengage within the timeout period during the laser shut down sequence.

Possible causes:

1. Faulty power supply.

7.6.21 Alarm 4n21 : Power Supply Residual Voltage Fault

Meaning:

Faulty or slow Power supply capacitor discharge.

WARNING

THE CAPACITOR BANK IN THE POWER SUPPLY MAY NOT BE FULLY DISCHARGED, HANDLE WITH CARE.

Possible causes:

1. Faulty power supply

7.7 Shutter Alarms (Zone 5)

7.7.1 Alarm 5n01 : Shutter communication fault

Meaning:

Shutter n stopped communicating with the laser control card.

Possible causes:

1. Incorrect address selected on shutter card address switch.
2. Shutter card not fitted.
3. Loose Shutter card.
4. Loose Laser Control Card.
5. Faulty Shutter Card.
6. Faulty Laser Control Card.

7.7.2 Alarm 5n02 : Shutter Initialisation Failure

Meaning:

The Laser Control Card failed to initialise the shutter card.

Possible causes:

1. Incorrect address selected on shutter card address switch.
2. Shutter card not fitted.
3. Loose Shutter card.
4. Loose Laser Control Card.
5. Faulty Shutter Card.
6. Faulty Laser Control Card.

7.7.3 Alarm 5n03 : Shutter Configuration Failure

Meaning:

The Laser Control Card failed to set the shutter configuration.

Possible causes:

1. Loose Shutter card.
2. Loose Laser Control Card.
3. Faulty Shutter Card.
4. Faulty Laser Control Card.

7.7.4 Alarm 5n05 : Shutter Emergency Stop Fault

Meaning:

The shutter failed to enter a safe state during normal operation.

Possible causes:

1. Loose shutter connections.
2. Loose Shutter card.
3. Loose Laser Control Card.
4. Faulty shutter.
5. Faulty Shutter Card.
6. Faulty Laser Control Card.

7.7.5 Alarm 5n06 : Shutter Close Fault

Meaning:

The shutter failed to close in a specified period.

Possible causes:

1. Loose shutter connections.
2. Loose Shutter card.
3. Loose Laser Control Card.
4. Faulty shutter.
5. Faulty Shutter Card.
6. Faulty Laser Control Card.

7.8 Machine Interface Alarms (Zone 6)

TBA

7.9 Warning Number Allocation

Lasers that allow warning values to be read using the Read_Warning_Value message, described in section 6, return values standardised across all lasers.

The return values are four digit numbers formatted as follows:

Z S N N

Where:

Z is the alarm zone as detailed in the table below:

Z	Device
1	System Level
2	Interlocks
3	Cooler
4	Power Supply
5	Shutter
6	Machine Interface

S is the sub zone number, i.e. for a system having more than one shutter, shutter 3 would be referenced by **Z** = 4, **S** = 3. For systems having only one of a particular zone type, **S** = 1.

N N is the actual warning number.

7.10 System Level Warnings (Zone 1)

7.10.1 Warning 1n01 : Serial Link Buffer Overflow

Meaning:

The serial communications handler received too much data.

Reset on read.

7.10.2 Warning 1n02 : Laser Control Card Communications Overflow

Meaning:

An onboard serial link on the Laser Control Card received too much data.

Reset on read.

7.10.3 Warning 1n03 : Incorrect packet data

Meaning:

The data to set a pulse shape was received in the wrong order.

Reset on read.

7.10.4 Warning 1n04 : Data Over Range

Meaning:

The parameter data received was over range.

Reset on read.

7.10.5 Warning 1n05 : Shutter Communications Timeout

Meaning:

A shutter open command was not received within 5 seconds of the previous command.

The shutter has closed due to the timeout.

Reset on read.

7.10.6 Warning 1n06 : Sector Over Range

Meaning:

The sector number received was over range. It was either over 20, or over the number of active sectors configured in the pulse shape. Use the set entire pulse shape to add further sectors to a pulse shape up to a maximum of 20 sectors.

Reset on read.

7.10.7 Warning 1n07 : Operating Envelope Over Range

Meaning:

The combination of pulse shape data exceeded the power supply working envelope.

Reset on read.

7.10.8 Warning 1n08 : High Output Trip

Meaning:

The laser output exceeded the configured output threshold limit.

Laser performed the specified action. Either continued, or entered standby.

Reset when laser restarts or enters on from standby.

7.10.9 Warning 1n09 : Low Output Trip

Meaning:

The laser output fell below the configured output threshold limit.

Laser performed the specified action. Either continued, or entered standby.

Reset when laser restarts or enters on from standby.

7.10.10 Warning 1n10 : Shot Limit Exceeded

Meaning:

The pulse laser shot threshold limit has been reached.

The lamps require changing to ensure specified laser output.

Reset when shot count is reset.

7.10.11 Warning 1n11 : Shutter Multi Pulse External Trigger Timeout

Meaning:

The shutter was open, in multi pulse mode, with external trigger enabled, but an external trigger signal was not received for 30 seconds.

Reset on read.

7.10.12 Warning 1n12 : Shutter Multi shot or Single shot not allowed while laser is off

Meaning:

A shutter multi pulse (Pulsed lasers) or single shot (CW lasers) was attempted when the laser was not on. Turn the laser on, and retry the operation.

Reset on read.

7.11 Cooler Warnings (Zone 3)

7.11.1 Warning 3n01 : Low Temperature

Meaning:

The coolant temperature is below a configurable threshold.

Reset when coolant temperature raises above the configurable threshold.

7.11.2 Warning 3n02 : High Temperature

Meaning:

The coolant temperature is above a configurable threshold.

Reset when coolant temperature falls below the configurable threshold.

7.11.3 Warning 3n03 : Low Flow

Meaning:

The coolant flow is below a configurable threshold.

Reset when coolant flow raises above the configurable threshold.

7.11.4 Warning 3n04 : High Flow

Meaning:

The coolant flow is above a configurable threshold.

Reset when coolant flow falls below the configurable threshold.

7.11.5 Warning 3n05 : High Conductivity

Meaning:

The coolant conductivity is above a configurable threshold.

Reset when coolant conductivity falls below the configurable threshold (usually after a filter change).

7.12 Power Supply Warnings (Zone 4)

7.12.1 Warning 4n01 : Disabled

Meaning:

The power supply has been disabled.

Reset when power supply enabled.

7.12.2 Warning 4n02 : Dumping Current

Meaning:

The Power Supply is dumping current following a shutdown.

Reset when current level falls below the threshold.

7.12.3 Warning 4n03 : Dump Resistors Cooling

Meaning:

The Power Supply has been restarted and stopped multiple times, building up heat in the dump resistors, which requires dissipating before allowing a further restart.

Reset when accumulated cooling time has elapsed.

7.13 Shutter Warnings (Zone 5)

7.13.1 Warning 5n01 : Fibre Temperature

Meaning:

The fibre temperature switch has overheated.

Requires laser (alarm) reset to clear.

7.13.2 Warning 5n02 : Shutter Temperature

Meaning:

The shutter housing temperature switch has overheated.

Requires laser (alarm) reset to clear.

7.13.3 Warning 5n03 : FCMS

Meaning:

The fibre continuity circuit has broken.

Requires laser (alarm) reset to clear.

7.13.4 Warning 5n04 : External Work Chamber Doors

Meaning:

The work chamber doors failed to close simultaneously.

Requires laser (alarm) reset to clear.

7.13.5 Warning 5n05 : Close

Meaning:

The shutter failed to close within specified time.

Requires laser (alarm) reset to clear.

7.13.6 Warning 5n06 : Open

Meaning:

The shutter failed to open within the specified time.

Requires laser (alarm) reset to clear.

7.13.7 Warning 5n07 : Shutter Switch Feedback Error

Meaning:

The shutter switch feedback is not in a recognised state.

Requires laser (alarm) reset to clear.

7.13.8 Warning 5n08 : Energy Share Configuration Fail

Meaning:

The Energy share position(s) failed configuration.

Requires laser (alarm) reset to clear, and retry.

7.13.9 Warning 5n09 : Datum Failure

Meaning:

The encoder shutter failed during shutter initialisation.

Requires laser (alarm) reset to clear, and retry.

7.13.10 Warning 5n10 : External Work Chamber Doors Open

Meaning:

The work chamber doors are open.

Reset when the work chamber doors are closed.

Intentionally blank

8. Optimisation

8.1 Introduction

The Optimisation procedure consists of tuning the Rear Mirror. When this has been done, the Laser will operate at maximum efficiency. The setting-up of External Power Control is described in Section 8.5.

8.2 Initial Set-up

Power-up the Laser (Refer to Section 6.2).

Select the LASER ON  button to switch the Laser ON.

Ensure all Shutters are closed.

8.3 Rear Mirror Tuning

Table 10 - Tuning Parameter Setup

Tuning Parameter Setup		
INITIAL TUNING PARAMETERS - For all Models - Tuning The REAR MIRROR		
HEIGHT - 10%	WIDTH - 5 ms	RATE - 20 Hz
OPTIMUM TUNING PARAMETERS - For All Models - Tuning The REAR MIRROR		
HEIGHT - 86%	WIDTH - 0.2 ms	RATE - 10 Hz

Note *All Steps are to be performed on the UFP (Universal Front Panel) and Rear Mirror ONLY.*

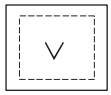
Step	Action	Button
1	On UFP Press SETUP.	
2	On UFP press the DOWN button.	
3	On UFP press MODIFY SHAPE.	
4	Click on **HEIGHT**, **WIDTH**, and **REP RATE** to set the correct Values for each Parameter. Use the parameters from Table 10.	

Table 11 - Example - Tuning Parameters Set-Up

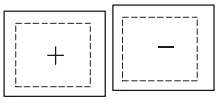
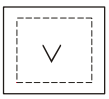
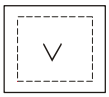
Step	Action	Button
1	To set-up for Height, starting at 10% select **HEIGHT 1**, which will highlight the numbers to the right.	
2	Use the Arrow Button to move the cursor to the correct location to change the number.	
3	Change the number by using the plus and minus buttons.	
4	Press **HEIGHT 1** again to remove the cursor from the number and accept the new number.	
5	Check that **HEIGHT 2** is at zero, if it is not, repeat Steps 1 to 4 for **HEIGHT 2**.	
6	Repeat Steps 1 to 4 to set-up **WIDTH 1** and to make sure that **WIDTH 2** is at zero.	
7	Move to the next page to set-up Rep Rate.	
8	Repeat Steps 1 to 4 to set-up the **REP RATE**	
9	Tune the **REAR MIRROR**.	
10	Repeat **Step 9** for each change that is made for **HEIGHT 1**, starting at 10% to Maximum Joules.	

Table 12 - Tuning the Rear Mirror

Step	Action	Button
1	On the UFP Press SETUP.	
2	In the Setup screen press the down button.	
3	Press **DISPLAY ENERGY**, this will display the Joules on the UFP.	
4	On the Rear Mirror, (Figure 11) loosen the set screws (item 3) located at the rear of the Rear Mirror housing located on the X-Adjuster (item 1) and Y-Adjuster (item 2).	
5	Adjust the X- Adjuster (item 1) to optimise for maximum Joules.	
6	Repeat Step 5 for Y- Adjuster (item 2).	
7	Repeat Steps 5 and 6 for INITIAL and OPTIMUM parameters as specified in Section 8.3 Rear Mirror Tuning.	

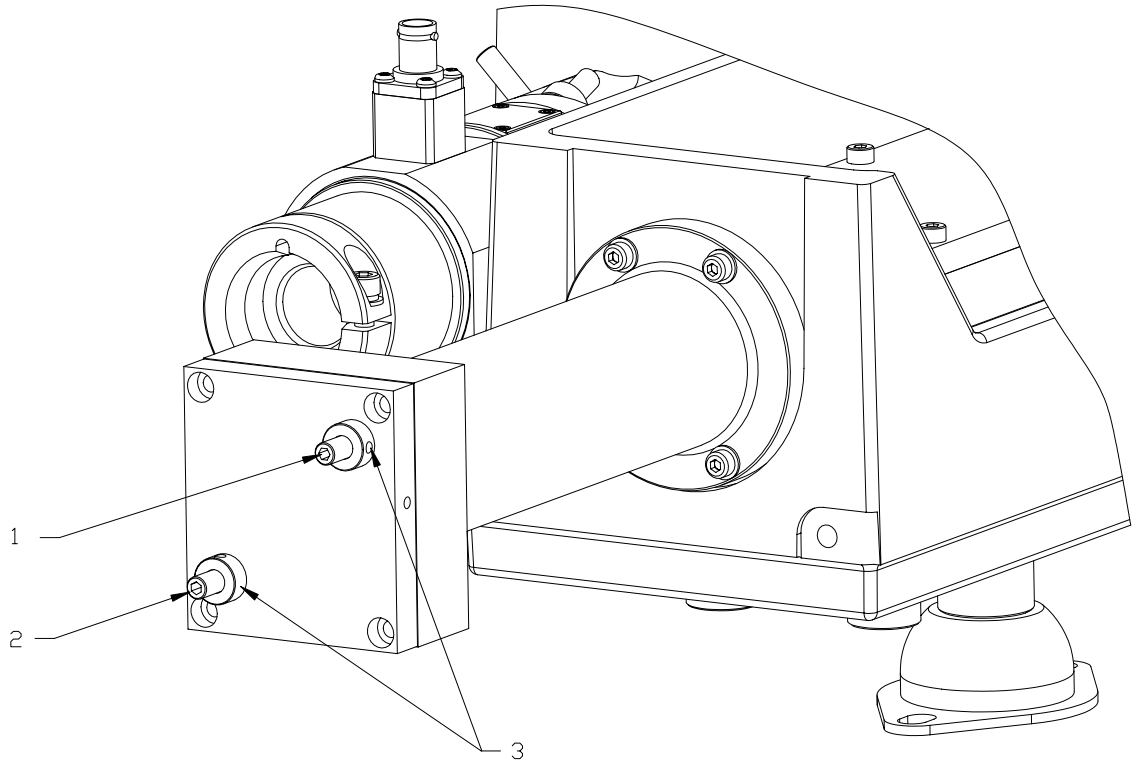
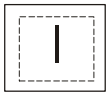


Figure 11 - Rear Mirror X and Y Adjusters

1. X Axis Adjuster
2. Y Axis Adjuster
3. Locking Screws

8.4 Focus Head Setup

Step	Action	Button
	**CAUTION** **If a Pointing Diode is fitted to the Laser System, it must be noted that the position of the focal plane of the Pointing Diode beam is different to that of the YAG beam. Therefore, the Pointing Diode beam must NOT be used to define the focal point for the Process.**	
	**CAUTION** **Fibre ends are easily damaged.** **Fibre handling precautions must be observed throughout this procedure, refer to Section 1.15.**	
1	Secure the Focus Head in a Z-axis position that allows small increments in vertical movement.	
2	Clamp a stainless steel test piece in position below the Focus Head.	
3	Position and secure the Focus Head approximately 5mm above the specified Focal Point of the Focus Head.	
4	Make sure that the Laser Status is READY. Refer to Section 6.2.	
5	Set to desired operating parameters. Refer to Section 8.3 for the Laser Parameters.	
6	Set the Laser to ON. Refer to Section 6.2	
7	Press OPERATE on the UFP.	
8	Press MULTIPULSE on the UFP to setup for a single spot weld on the test piece. **Note** *Check that Multipulse Count is set to a count of 1 before running Multipulse.*	
9	Produce a single spot weld on the test piece. Press ..	
10	Position the test piece so that a clean section is exposed to the Focus Head.	
11	Position the Focus Head 1mm closer to the test piece.	
12	Repeat Steps 7 to 11 until the Focus Head is 5mm below the specified Focal Point of the Focus Head.	
13	Measure the spot size recorded on the test piece. Refer to Figure 12.	
14	The Focal Point that gives the smallest spot size is the optimum and should be set on the Focus Head.	

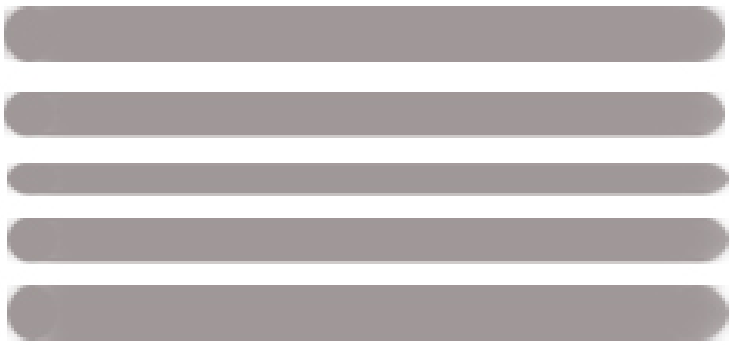


Figure 12 – Focus Burns

8.5 External Power Control (EPC) Set-up

Refer to the Section 3 for the Machine Interface (M/C) connections.

8.5.1 Set Up Procedure:

The analogue signal should be connected to SK603 – M/C Interface, as shown below:

SK603 – Pin 11 – Input (+)

SK603 – Pin 24 – Input (-)

WARNING
DO NOT USE AN INPUT SIGNAL GREATER THAN +10VDC. DAMAGE TO THE ANALOGUE INPUT DEVICE WILL OCCUR.

Connect an external +24 Vdc supply to the M/C Interface supply, as shown below:

SK603 – Pin 1 - External +24 Vdc

SK603 – Pin 14 - External +24 Vdc

SK603 – Pin 2 - External 0 Vdc

SK603 – Pin 15 - External 0 Vdc

The maximum input signal should be +10 Vdc, which is equivalent to the Height (%) entered in the active shape.

If pulse shaping, using more than one Height (%) value, then +10 Vdc is equivalent to both Height (%) parameters entered in the active shape.

For example:

If Height 1 is set to 100% and Height 2 is set to 50%, a +10 Vdc will operate at these parameters.

If the analogue input is +5 Vdc, Height 1 will operate at 50% and Height 2 operate at 25%.

Width and Rate parameters remain the same and are not changed when using the EPC function.

1. Switch ON and power-up the laser – Refer to Section 6.2.

Note *The EPC function can only be activated using the Laserview™ SE software.*

2. In the settings tab, External Power Control, tick the enable box.
3. Power Offset (W) will default to 0, or set to desired value.
4. Using the Universal Front Panel (UFP) set the laser status to ON (II). Refer to Section 6.2.
5. The laser is now ready to operate under EPC control.

9. User Maintenance

9.1 Introduction

Routine Maintenance is restricted to the following items:

- General inspection.
- Coolant replenishment
- Coolant Filter replacement.
- De-ioniser cartridge replacement.
- Pump replacement
- Arc-lamp replacement.
- Fibre optic cable replacement and alignment
- Pointing diode replacement and alignment
- Coverslide cleaning and replacement
- Focus lens cell replacement.
- Bulb replacement
- Surge suppressor replacement
- Bendlock assembly

The Coolant Replenishment Procedure has been included in this Section but it is not a Routine Maintenance task. It has been included to ensure that, if required, the correct procedures for draining and filling are available to the User

All other Maintenance and Servicing tasks are contained in the Servicing and Maintenance Manual issued to Authorised personnel only.

9.2 User Maintenance Tasks

Task	Periodicity	Reference	Maint. Level
General Inspection	Weekly	Section 9.3	1
Coolant replenishment		Section 9.4	1
Coolant Filter Replacement	12 months or 2000 hours*	Section 9.5	1
De-ioniser cartridge replacement	12 months or 2000 hours*	Section 9.6	1
Pump replacement		Section 9.7	1
Arc-lamp Replacement	As necessary or when elapsed hours of Lamp reaches the configured limit	Section 9.8	1
Fibre optic cable replacement and alignment		Section 9.9	1
Coverslide cleaning and replacement	As necessary	Section 9.10	1
Focus lens cell replacement.		Section 9.11	1
Surge Suppressor Replacement	On failure	Section 9.12	1
Bulb replacement	On failure	Section 9.14	1
Bendlock assembly		Section 9.15	1
Pointing diode replacement and alignment		Section 9.16	1

* Whichever is sooner.

9.3 General Inspection

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Carry out Power OFF Sequence. Wait for 2 minutes. This ensures that the capacitors have discharged to a safe level.
2	Unlock and open Laser Head lid.
3	Carry out an inspection of the Fibre Optic Assembly. Check for signs of damage, overheating, loose joints or any indication that could be interpreted as an early warning of a problem. A damaged Fibre Optic Assembly or component must be replaced immediately.
4	Examine Laser beam path and ensure all housings and beam sealing tubes are in good condition, fit correctly and are secure. Check for any gaps or openings between Laser path and Beam Delivery components.
	**WARNING** **IF ANY FAILURE OR DAMAGE IS NOTED, THE LASER MUST NOT BE OPERATED AGAIN UNTIL THE DEFECT HAS BEEN CORRECTED.** **IF ANY FAILURE OR DAMAGE APPEARS TO BE A RESULT OF EXPOSURE TO THE LASER BEAM, THE CAUSE MUST BE ASCERTAINED AND CORRECTED IMMEDIATELY.**
5	Check all Safety Labels are in position, secure and legible If any labels are missing or illegible, replacements can be obtained from GSI Group - Laser Division quoting the part numbers..

9.4 Coolant Replenishment

Personnel authorised to Maintenance Level 1 can carry out this procedure.

9.4.1 Materials

Parts Required	**Part Number**
10 litres of Analar Grade 3 Water	1D0M00801
Tools/Equipment	**Spares/Consumables**
Standard Tool Kit	O-Ring Kit
Door Key	Paper Towels
Container - 10 litres or greater capacity	Plastic Bag
Funnel	

9.4.2 Draining Procedure

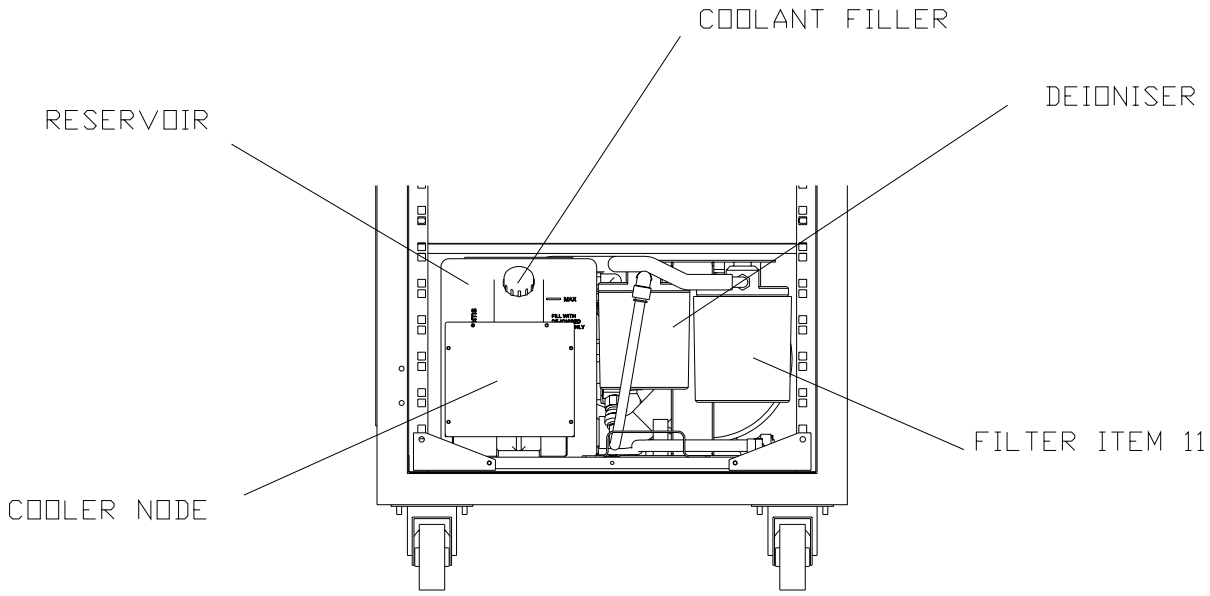


Figure 13 – Coolant Draining

Refer to Figure 13 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Carry out Power OFF Sequence. Wait for 2 minutes. This ensures that the capacitors have discharged to a safe level.
2	**ISOLATE AND LOCK OUT THE MAINS SUPPLY TO THE LASER.**
3	Unlock and open the Laser Head lid.
4	Remove the hose from the Beam Dump housing.
5	Unlock and open the front door.
6	Disconnect Cooler Node cable assembly.
7	Using the handle located on the Cooler assembly tray, pull the tray out all the way.
8	Identify the reservoir hose. Position a container on the floor adjacent to the reservoir Hose.
9	Connect the reservoir hose to the water fitting. Lower the reservoir hose into the container.
10	Remove the reservoir hose from the water fitting.
11	Using the handle located on the Cooler assembly tray, carefully lift and place the Cooler assembly on the rail and slide it back into position. **Note** *Check to make sure that no hose lines are twisted or pinched.*
12	Connect Cooler Node Cable assembly.
13	Close and lock the front door
14	Replace the hose on the Beam Dump housing.
15	Close and lock the Laser Head lid.

9.4.3 Filling Procedure

The Coolant level should be between the minimum line and the maximum line indicated on the reservoir. If it is close to the minimum line, Coolant should be added.

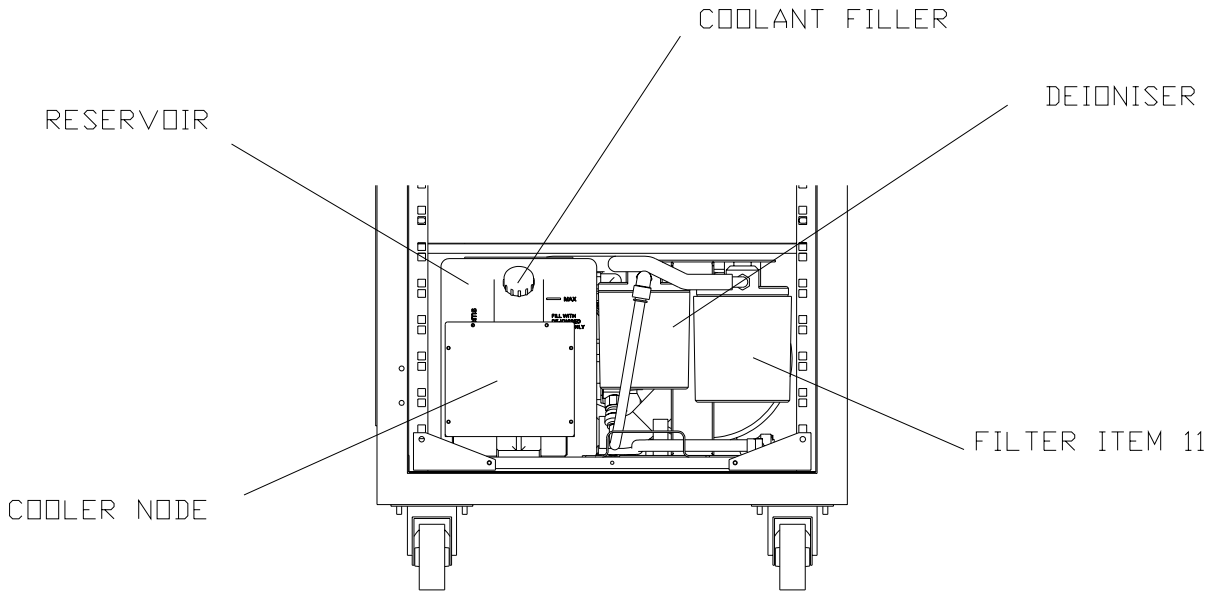


Figure 14 – Coolant Filling

Refer to Figure 14 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Carry out Power OFF Sequence. Wait for 2 minutes. This ensures that the capacitors have discharged to a safe level.
2	**ISOLATE AND LOCK OUT THE MAINS SUPPLY TO THE LASER.**
3	Unlock and open the Laser Head lid.
4	Make sure that the hose is connected to the Beam Dump housing.
5	Unlock and open the front door.
6	Using the handle located on the Cooler assembly Tray, pull the tray out half way.
7	Remove the yellow cap from the top of the Reservoir Tank.
	**CAUTION** **Always use new Coolant. Do not fill Laser with used Coolant as it could be contaminated.**
8	Fill the Reservoir Tank with Analar Grade 3 water until level reaches max line on reservoir. Refer to the water specification in Section 3.3.2.2
9	Replace the yellow cap to the top of the reservoir tank.
10	If necessary, connect Cooler Node cable assembly.
11	Carry out the Power ON Sequence.
12	Allow the cooling system to run for 1 minute.
13	Carry out the Power OFF Sequence.
14	Inspect the pipework and fittings for any signs of leaks.
15	Rectify the cause of any leaks.
16	Check the Coolant level. Add more Coolant if necessary.
17	Using the handle located on the Cooler Assembly tray, carefully lift and install the Cooler Assembly on the rail and slide it back into position. **Note** *Check to make sure that no hose lines are twisted or pinched.*
18	Close and lock the front door.
19	Carry out the Power ON Sequence.
20	Reset the water run-time hours to zero.
21	For reservoir operation, refer to the LaserView™ software help file.
22	For touch screen operation, refer to Section 6.

9.5 Filter Replacement Procedure

Personnel authorised to Maintenance Level 1 can carry out this procedure.

Parts Required	**Part Number**
Paper Filter	MP010995MS
Tools/Equipment	**Spares/Consumables**
Standard Tool Kit	O-Ring Kit
Filter Wrench	Paper Towels
Door Key	Plastic Bag

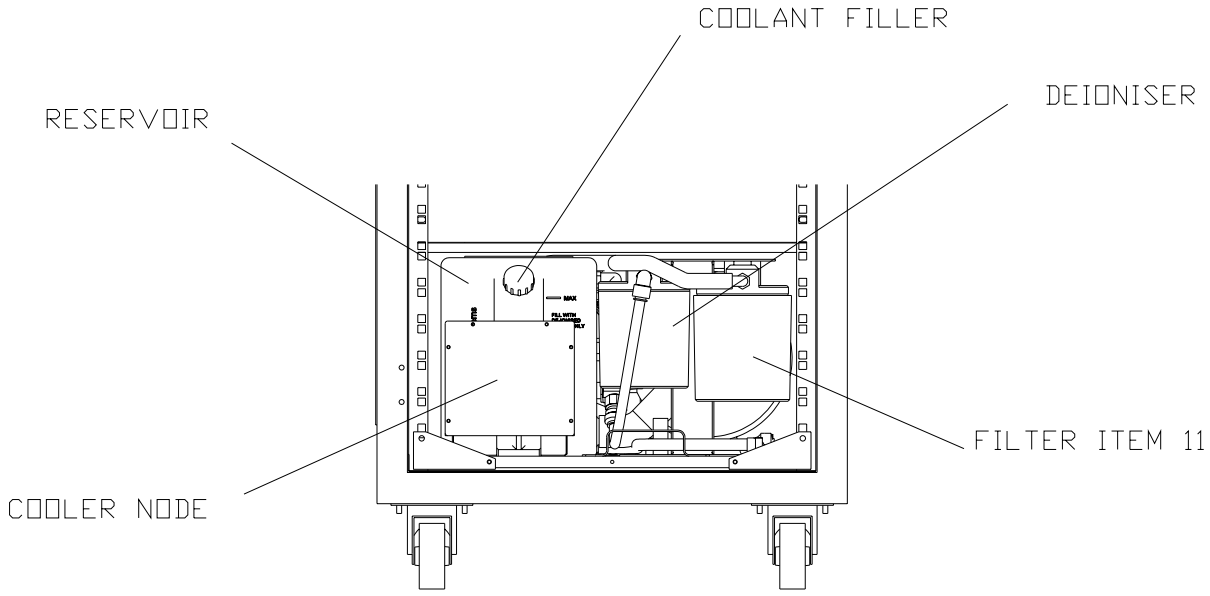


Figure 15 – Filter Replacement Procedure

Refer to Figure 15 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Carry out Power OFF Sequence. Wait for 2 minutes. This ensures that the capacitors have discharged to a safe level.
2	**ISOLATE AND LOCK OUT THE MAINS SUPPLY TO THE LASER.**
3	Unlock and open Laser Head lid.
4	Remove the hose from the Beam Dump housing.
5	Unlock and open the front door.
6	Refer to Section 9.4.2 and drain the coolant if required.
7	Using a filter wrench, unscrew and remove Filter Body (item 11).
8	Remove and dispose of the Paper Filter. *The Paper Filter is non-hazardous and can be disposed of through normal Industrial Waste routes*
9	Empty the coolant from the Filter Body (item 11).
10	Inspect the O-Ring for signs of damage. Replace if necessary.
11	Remove the packaging from the new Filter.
12	Partly fill the Filter Body with coolant.
13	Fit a new filter in the Filter Body (Item 11). Ensure that the filter is located correctly over the spigot on the base of the Filter Body.
14	Ensure the O-Ring is fitted and serviceable.
15	Install the Filter Body and tighten using a filter wrench.
16	Replace the hose on the Beam Dump housing.
17	Refer to Section 9.4.3 and refill with Coolant.
	**WARNING** **RUN THE LASER FOR AT LEAST ONE MINUTE AND CHECK FOR LEAKS BEFORE RUNNING THE LASER IN 'LASER ON' STATUS.**

9.6 De-ioniser Replacement Procedure

Personnel authorised to Maintenance Level 1 can carry out this procedure.

Parts Required	**Part Number**
De-ioniser Resin Refill	MP010483MS
Tools/Equipment	**Spares/Consumables**
Standard Tool Kit	O-Ring Kit
Door Key	Paper Towels
Filter Wrench	Plastic Bag

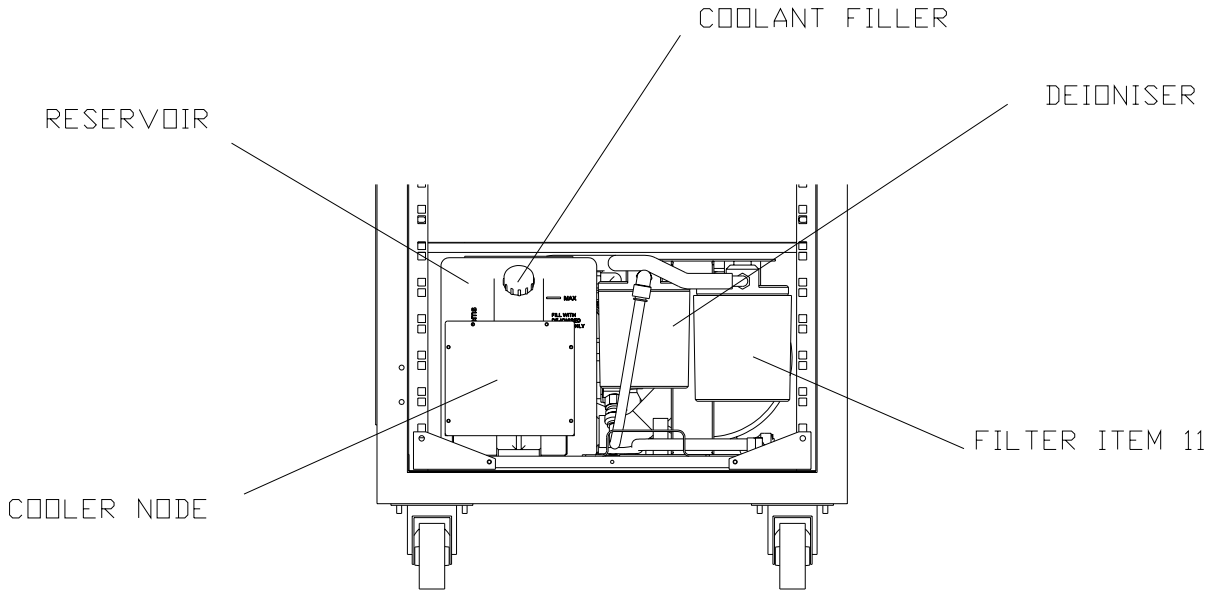


Figure 16 - De-ioniser Replacement Procedure

Refer to Figure 16 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Carry out a Power OFF Sequence. Wait for 2 minutes. This ensures that the capacitors have discharged to a safe level.
2	**ISOLATE AND LOCK OUT THE MAINS SUPPLY TO THE LASER.**
3	Unlock and open Laser Head lid.
4	Unlock and open Laser Head lid.
5	Remove the hose from the Beam Dump housing.
6	Refer to Section 9.4.2 and drain the Coolant if required.
7	Using the filter wrench, unscrew and remove the De-ioniser body.
8	Remove the De-ioniser cartridge from the De-ioniser body.
9	Remove and retain the rubber gasket. Inspect for signs of damage and replace if necessary.
10	Inspect the O-Ring for signs of damage and replace if necessary.
11	Remove De-ioniser cartridge.
12	Refit cartridge in De-ioniser body.
13	Install the washer.
14	Ensure O-Ring is fitted and serviceable.
15	Refit the De-ioniser Body and tighten using a filter wrench.
16	Replace the hose on the Beam Dump housing.
17	Refill the coolant if required (Section 9.4.3).
	**WARNING** **RUN THE LASER FOR AT LEAST ONE MINUTE AND CHECK FOR LEAKS BEFORE RUNNING THE LASER IN 'LASER ON' STATUS.**

9.7 Coolant Pump Replacement

Personnel authorised to Maintenance Level 1 can carry out this procedure.

9.7.1 Materials

Part Required	**Part Number**
Coolant Pump Assembly 50Hz	480002601
Coolant Pump Assembly 60Hz	480002701
10 litres of Analar Grade 3 Water	1D0M00801
Tools/Equipment	**Consumables**
13mm Ratchet Socket.	Paper Towels
Container Capacity - 10 Litres or larger	PTFE Tape or Loctite 5331 Thread Sealant
Door key	

9.7.2 Removal Procedure

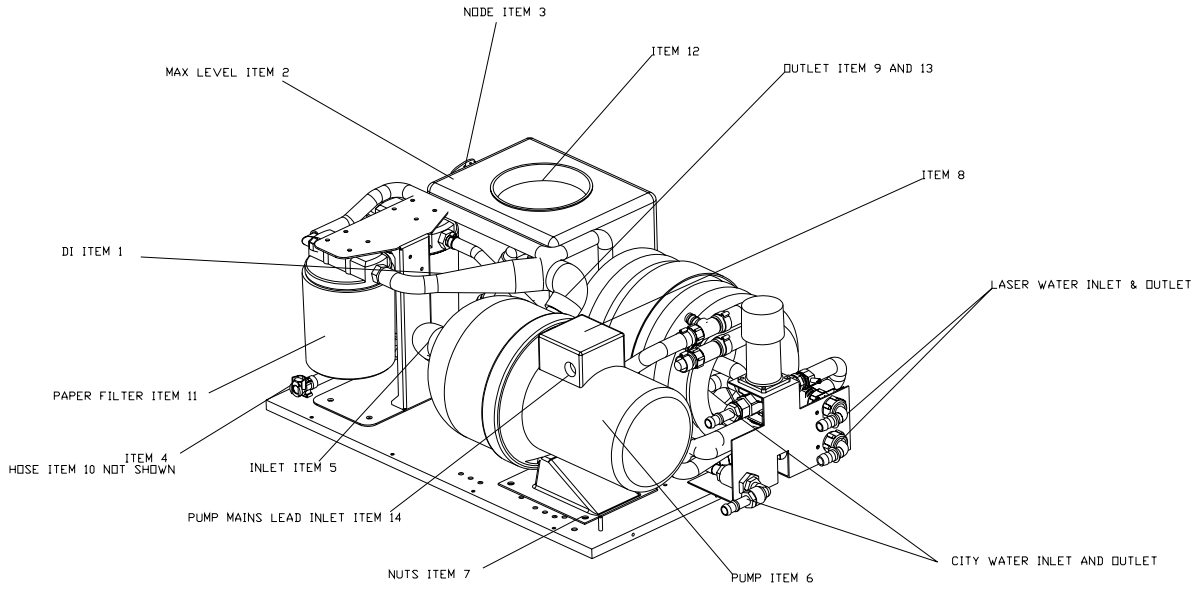


Figure 17 – Coolant Pump Removal

Refer to Figure 17 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Carry out Power OFF Sequence. Wait for 2 minutes. This ensures that the capacitors have discharged to a safe level.
2	**ISOLATE AND LOCK OUT THE MAINS SUPPLY TO THE LASER.**
3	Unlock and open the front door.
4	Refer to Section 9.4.2 and drain the Coolant.
5	Loosen the hoseclips on the Coolant Pump inlet and outlet pipes (items 5 and 9).
6	Pull the inlet and outlet pipes (items 5 and 9) away from the Coolant Pump (item 6) connectors.
7	Using a spanner, remove the pump outlet adaptor.
8	Remove all 4 Bolts from the top of the electrical panel cover (item 8) located at the top of the Pump
9	Remove the three screws located in the base of the Electrical Panel (item 8).
10	Remove and retain the Electrical Panel (item 8) from the top of the Coolant Pump (item 6). **Note** *Do Not Remove Three Phase Terminals, or any Plugs inside of the Electrical Panel (Item 8)*
11	Remove and retain the four nuts and bolts (item 7) securing the Coolant Pump to the cabinet base. The bolts are accessible from underneath the cabinet.
	**CAUTION** **The Coolant Pump is heavy. Care must be taken when lifting the Coolant Pump Assembly.**
12	Remove the Coolant Pump (item 6).

9.7.3 Installation Procedure

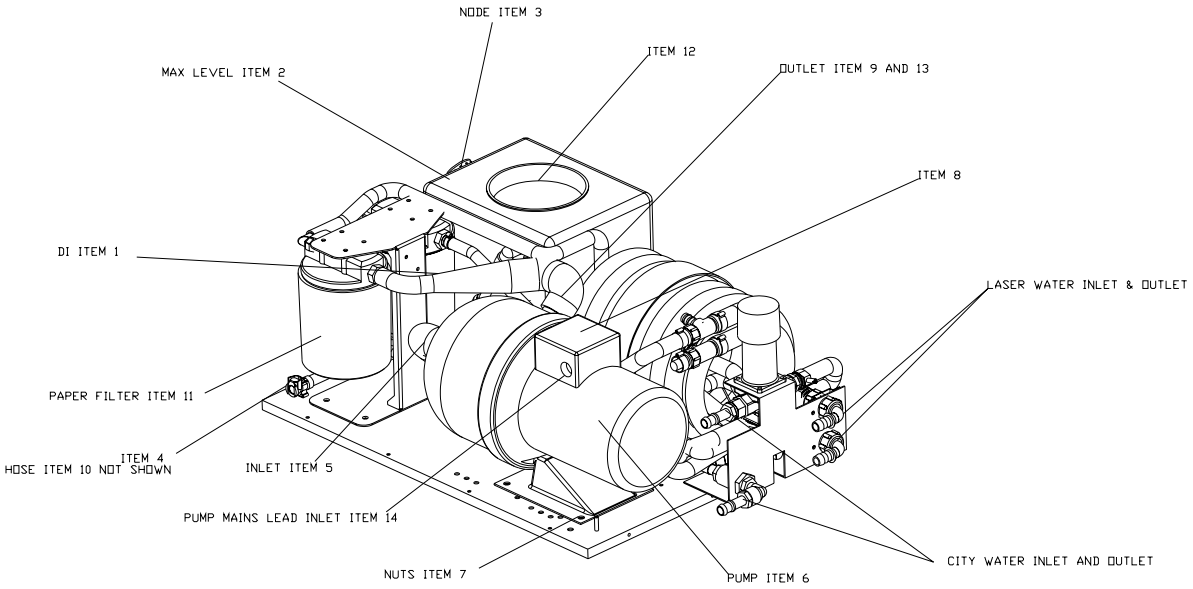


Figure 18 – Coolant Pump Installation

Refer to Figure 18 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
	**CAUTION** **The Coolant Pump is heavy. Care must be taken when lifting the Coolant Pump Assembly.**
1	Position Coolant Pump (item 6) on plinth in cabinet.
2	Loosely secure Coolant Pump (item 6) to plinth using four nuts and bolts (item 7).
3	Remove the 4 bolts and three screws from the new Electrical Panel cover (item 8) located at the top of the new Pump (item 6) as in steps 8 and 9 of 9.7.2.
4	Fit the original Electrical Panel box (item 8) to the top of the new Coolant Pump (item 6).
5	Secure with the three screws into the base of the Electrical Panel box (item 6) and the 4 bolts for the cover of the Electrical Panel box (item 6) on top of the Coolant Pump (item 6).
6	Fit the Pump Outlet adaptor to the Coolant Pump outlet (item 9). Use PTFE Tape or Loctite 5331 Thread Seal.
7	Connect the supply and return coolant pipes (items 5 and 9) to the Coolant Pump (item 6).
8	Tighten the hoseclips on the Supply and Return Coolant pipes.
9	Tighten the four nuts and bolts (item 7) securing the Coolant Pump (item 6) to the plinth.
10	Refer to Section 9.4.3 and refill the Coolant.
11	Make sure that the phase rotation is correct by checking the direction of the Coolant Pump impellers, (Counter Clockwise/Anti Clockwise - Direction). **Note** *Refer to the label located at the rear of the Coolant Pump.*
	**CAUTION** **The Coolant Pump is heavy. Care must be taken when lifting the Coolant Pump Assembly.**
12	Carefully lift the Coolant Pump assembly and slide it back into position, making sure that no pipes are twisted or pinched.

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9.8 Arc-lamp Replacement

Personnel authorised to Maintenance Level 1 can carry out this procedure.

9.8.1 Materials

Parts Required	Part Number
Arc-lamps x 2 or complete set for JK300HP and JK300P	P55B6770B
Arc-lamp x 1 for JK125P	12280360A
GSI Group - Laser Division recommends that Arc-lamps are changed as a complete set or in pairs. This will increase system running time.	
Tools/Equipment	Spares/Consumables
Standard Tool Kit	Paper towels
Arc-lamp handle	Plastic gloves.
Eye protection	Lint free cloth

9.8.2 Replacement Procedure

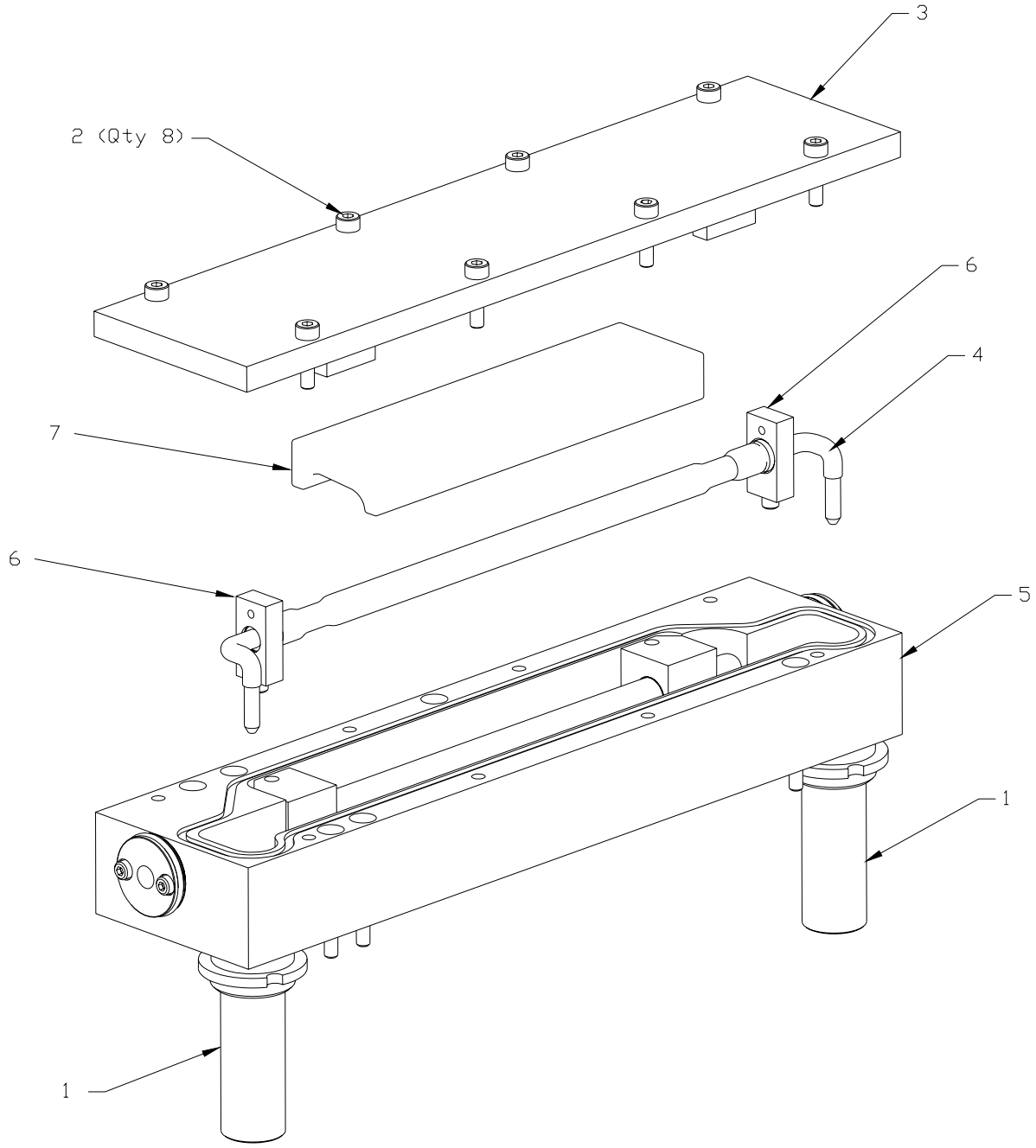

Figure 19 – Arc-lamp

Refer to Figure 19 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Carry out Power OFF Sequence. Wait for 2 minutes. This ensures that the capacitors have discharged to a safe level.
2	**ISOLATE AND LOCK OUT THE MAINS SUPPLY TO THE LASER.**
3	Unlock and open the Laser Head Lid.
4	Remove and retain the 8 bolts (item 2) securing the Pumping Chamber lid (item 3).
	**CAUTION** **WEAR PLASTIC GLOVES** **Optical components are fragile and are easily damaged. Extreme care must be taken when handling optical components. Always handle optical components in a clean environment.**
5	Lift the Pumping Chamber Lid (item 3) clear of the Pumping Chamber (item 5), and place in a clean area.
	**CAUTION** **The Arc-lamps are made of glass and may splinter or shatter. Eye protection must be worn whilst removing the Arc-lamps. Carefully remove broken glass with tweezers or long nose pliers.**
6	Remove Ceramic Reflector (item 7) from Pumping Chamber (item 5) and place in clean safe location.
7	Gently lift the Arc-lamps (item 4) until it is clear of the Pumping Chamber (item 5), and place in clean safe location.
8	Remove All PTFE Lamp Supports (item 6) from Arc-Lamps (item 4), and place in clean safe location.
9	If Arc-lamp (item 4) has broken, carefully remove glass with tweezers or long nose pliers. Dispose of glass in suitable container.
10	Using lint free cloth, carefully dry excess water from inside the Pumping Chamber (item 5).
11	If applicable, repeat steps 6 to 9 to remove second Arc-lamp (item 4).

9.8.3 Installation Procedure

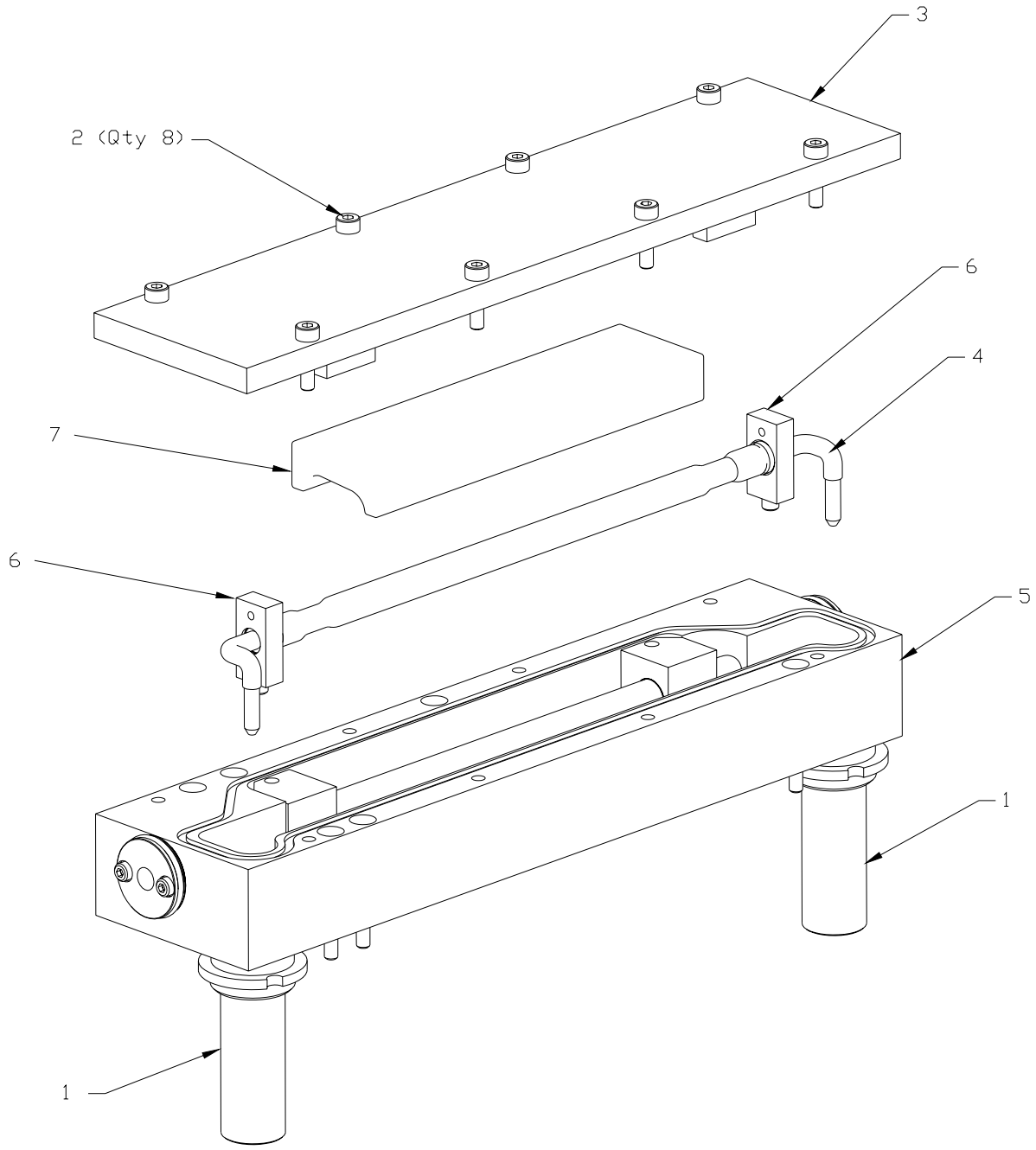

Figure 20 - Arc-lamp

Refer to Figure 20 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
	**CAUTION** **WEAR PLASTIC GLOVES.** **Optical components are fragile and are easily damaged. Extreme care must be taken when handling optical components. Always handle optical components in a clean environment.**
1	Ensure the Pumping Chamber (item 5) is dry.
2	Carefully remove the new Arc-lamps (item 4) from packaging.
3	Fit all PTFE lamp Supports (item 6) over the new Arc-lamp (item 4) ends.
4	Check Arc-lamp (item 4) polarised ends making sure correct ends are being installed into correct Lamp Terminal Socket (item 1).
5	**Note** *If Arc-lamp (item 4) is not connected into correct Lamp Terminal Socket (item 1), Example : + Arc-lamp end to + Lamp Terminal Socket, Arc-lamp (item 4) will cause damage.*
	**CAUTION** **Make sure that the lamp leads are formed such that they DO NOT TOUCH the sides of the pumping chamber.**
6	Push the Arc-lamp (item 4) gently into Lamp Terminal Socket (item 1) making sure PTFE Lamp Support (item 6) are positioned over location pin. Push Arc-lamp (item 4) all the way into lamp Terminal Socket (item 1). Make sure that the lamp leads are formed such that they **DO NOT TOUCH** the sides of the pumping chamber.
7	**Note** *PTFE Lamp Support (item 6) should be flush with top of Pumping Chamber (item 5).*
8	If applicable, repeat steps 3 to 5 for second Arc-lamp (item 4).
9	Carefully place Ceramic Reflector (item 7) on top of Pumping Chamber (item 5).
	**CAUTION** **Care must be taken when replacing the Pumping Chamber lid to avoid damage to the Arc-lamps, Laser Rod or ceramic Reflectors.**
10	Position Pumping Chamber Lid (item 3) over the Pumping Chamber (item 5).
11	Lower the Pumping Chamber Lid (item 3) onto the Pumping Chamber (item 5).
12	Secure the Pumping Chamber Lid (item 3) to Pumping Chamber (item 5) with 8 bolts (item 2).
13	Carry out the Power ON Sequence. Refer to Section 6.2.

Step	Action
	**WARNING** **ENSURE COOLER OPERATES FOR AT LEAST ONE MINUTE AND CHECK FOR LEAKS BEFORE RUNNING THE LASER IN LASER ON STATUS.**
14	Check the Pumping Chamber (item 5) for signs of leaks. If leaks are detected shut down the Laser immediately.
15	If necessary, rectify cause of the leak. Wipe up any spillage using paper towels.
16	If the Laser was shut down in step 14, repeat step 13 to restart the Laser.
17	Reset shot count to zero on UFP (Universal Front Panel).
18	Refer to Section 8.2 and carry out the Optimisation Procedure if required.
19	Close and lock the Laser head Lid.

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9.9 PIPA Fibre Optic Cable Replacement

Personnel authorised to Maintenance Level 2 can carry out this procedure.

9.9.1 Materials

Parts Required	**Part Number**
PIPA Fibre Cable	Refer to Section 1.15
Tools/Equipment	**Spares/Consumables**
Standard Tool Kit	Fibre Termination Protective Cover
Digital Volt Meter	Tape

9.9.2 Removal Procedure

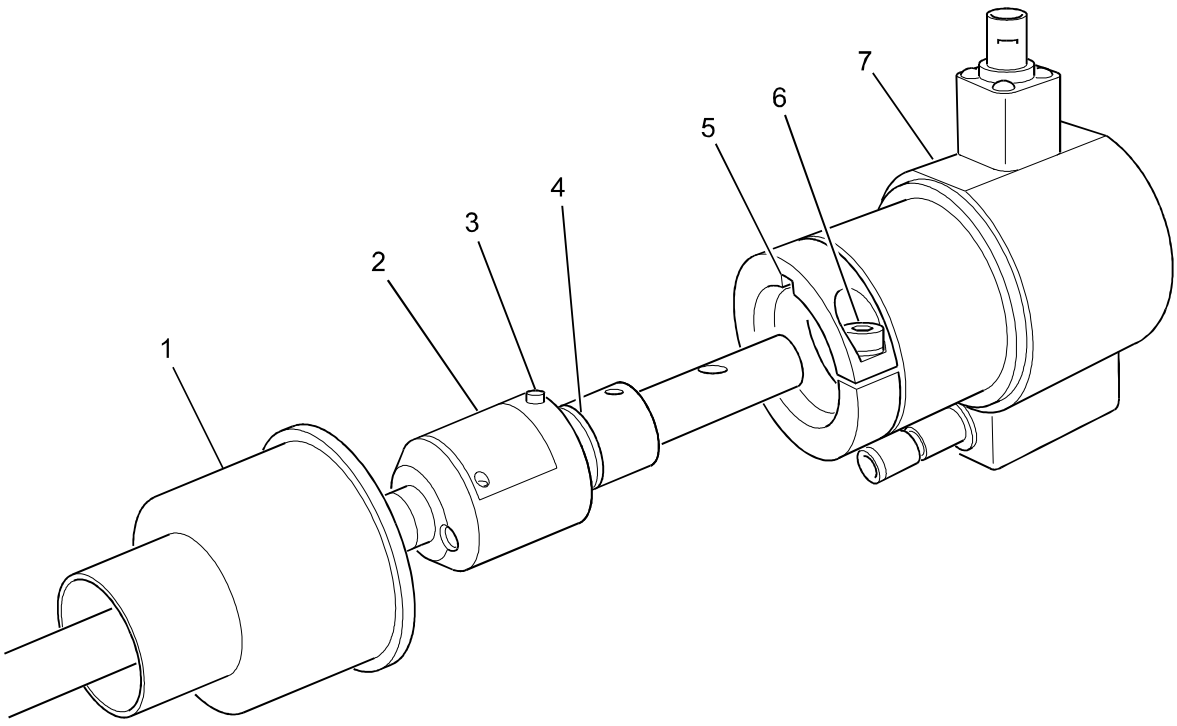


Figure 21 – PIPA Fibre Cable Removal

Refer to Figure 21 for item identification.

Item	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Ensure Power is switched OFF. Wait for 2 minutes. This ensures that the capacitors have discharged to a safe level.
	**CAUTION** **Refer to Section 1.15 – Fibre Optic Handling.**
2	Unlock and open the laser head lid.
3	Pull back the Blue Protective Cover (item 1) to expose the PIPA Fibre Termination (item 2).
4	Unscrew, but do not remove, the clamping screw (item 6) to loosen the Retaining Clamp.
5	Carefully and in a straight line, withdraw the PIPA Fibre Termination (item 2) from the PIPA Fibre Receiver (item 7).
6	Fit a protective cover (not illustrated) over the PIPA Fibre Termination (item 2).
7	Carefully remove the PIPA Fibre cable from the Laser Head.
8	Place a piece of tape over the exposed end of the PIPA Fibre Receiver (item 7) to prevent ingress of dirt or moisture.

9.9.3 Installation Procedure

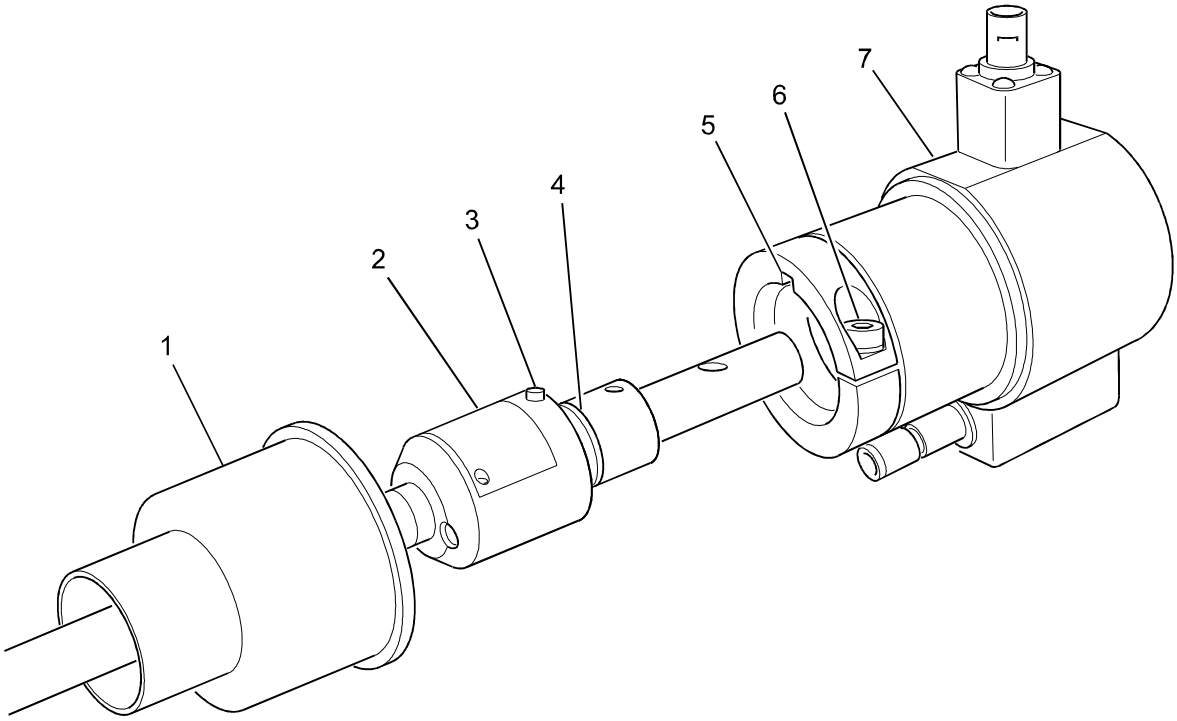


Figure 22 - PIPA Fibre Cable Installation

Refer to Figure 22 for item identification.

Item	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Ensure Power is switched OFF.
	**CAUTION** **Refer to Section 1.15 – Fibre Optic Handling.**
2	Unlock and open the laser head lid.
3	Remove the protective cover (not illustrated) from the PIPA Fibre Termination (item 2).
4	Inspect the PIPA Fibre cable for damage. Replace if necessary.
5	Ensure the O-Ring (item 4) is fitted and serviceable. Replace if necessary.
	**CAUTION** **The Fibre Input Termination and the Fibre Output Termination are different. Ensure that the Fibre Termination with the chamfer is installed to the Laser Head Fibre Receiver.**
6	Pull back the blue protective Cover (item 1) from the PIPA Fibre Termination (item 2).
7	Ensure that the rear edge of the PIPA Fibre Termination (item 2) **IS** chamfered.
8	Ensure the Locating Pin (item 3) on the PIPA Fibre Termination (item 2) is aligned with the Locating Hole (item 5) on the PIPA Fibre Receiver (item 7).
9	Insert the PIPA Fibre Termination (item 2) into the PIPA Fibre Receiver (item 7). *The Fibre Termination will enter the Fibre Receiver easily and then stop. Slight pressure is then required to ensure that the FCMS connectors have fully connected. The Fibre Termination is fully inserted when no aluminium on the Fibre Termination is visible at the entrance to the Fibre Receiver.*
10	Tighten the Retaining Clamp screw (item 6) to secure the PIPA Fibre Termination (item 2) in the PIPA Fibre Receiver (item 7).
11	Position the blue protective Boot (item1) over the PIPA Fibre Termination (item 2).
12	Verify the laser power after the Focus Head. In cases where this is not as expected, carry out the PIPA Alignment Procedure. Refer to Section 9.9.5.

9.9.4 Fibre Output Termination Replacement Procedure

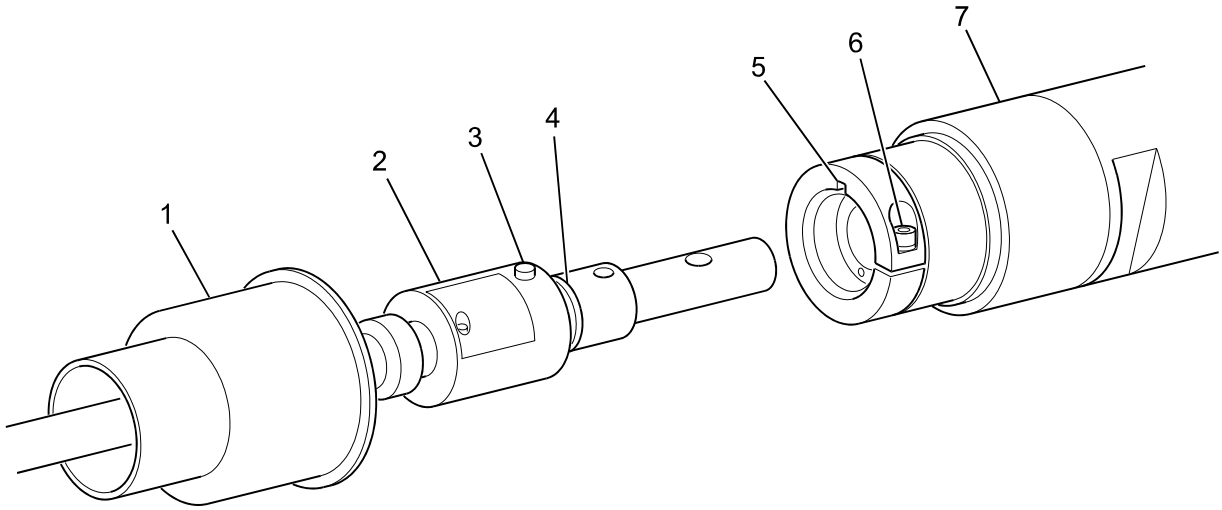


Figure 23 – Fibre Output Termination

Refer to Figure 23 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
Removal Procedure	
1	Ensure Power is switched OFF.
2	Pull back the protective Cover (item 1) to expose the Focus Head (item 7).
3	Unscrew, but do not remove, the Clamping screw (item 6) to loosen the Retaining Clamp.
4	Carefully and in a straight line, withdraw the Fibre Output Termination (item 2) from the Focus Head (item 7) and remove the Focus Head.
5	Place the Focus Head (item 7) in protective packaging to prevent ingress of dirt or moisture.
6	Install a protective Cover (not illustrated) over the Fibre Output Termination (item 2).
Installation Procedure	
1	Remove protective Covers from the Focus Head (item 7) and the Fibre Output Termination (item 2).
2	Inspect the Focus Head (item 7) for damage. Replace if necessary.
3	Pull back the protective Cover (item 1) from the Fibre Output Termination (item 2).
4	Ensure that the rear edge of the Fibre Output Termination is **NOT** chamfered.
5	Ensure the Locating Pin (item 3) on the Fibre Output Termination (item 2) is aligned with the Locating Hole (item 5) on the Focus Head (item 7).
6	Insert the Fibre Output Termination (item 2) into the Focus Head (item 7). *The Fibre Output Termination will enter the Focus Head easily and then stop. A slight pressure is then required to ensure that the FCMS connectors have fully connected. The Fibre Output Termination is fully inserted when no aluminium on the Fibre Output Termination is visible at the entrance to the Focus Head.*
7	Tighten the Retaining Clamp screw (item 6) to secure the Fibre Output Termination (item 2) in the Focus Head (item 7).
8	Position the protective Cover (item1) over the Fibre Output Termination (item 2).
9	If necessary, place a protective cover over the exposed end of the Focus Head (item 7).

9.9.5 Alignment Procedure

Personnel authorised to Maintenance Level 2 can carry out this procedure.

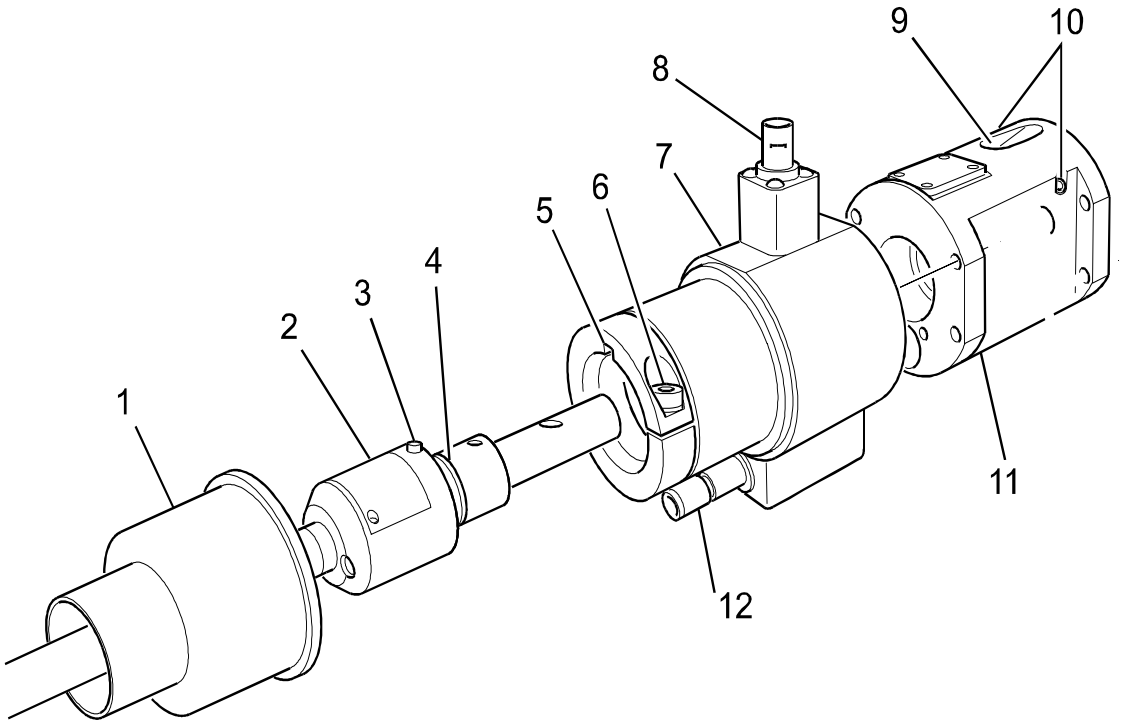


Figure 24 – Fibre Optic Cable Alignment

Refer to Figure 24 for item identification.

Item	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Ensure Power is switched OFF.
	**CAUTION** **Refer to Section 1.15– Fibre Optic Handling.**
2	Ensure Fibre Optic cable is fitted correctly and is serviceable.
3	Ensure that the Output end of the Fibre Optic Cable is positioned so that the laser beam is directed into a Beam Dump. GSI Group - Laser Division recommend using a water-cooled beam dump (Part Number – PG037430X).
4	Unlock and lift the Laser Head lid.
5	Connect a DVM to the BNC connector on the Fibre Receiver. Set the DVM to the dc Volts range.
	**WARNING** **THE LASER IS SWITCHED ON IN THE NEXT STEP.** **WEAR GOGGLES.** **ENSURE ALL SAFETY PROCEDURES ARE OBEYED.**
6	Set the Height to 10% and switch the Laser ON.
7	The DVM should indicate approximately 350mV. **Note** *This value is a guideline only, the actual value can vary depending upon the Laser model.*
8	Loosen, but do not remove, the Locking screw on the Z Adjuster (item 9).
9	Adjust the X, Y and Z setting screws (items 9 & 10) until the DVM indicates the lowest voltage reading. *Note* *There is no requirement to adjust the Z axis at low power settings as the beam size is too small.*
10	Increase the Height by 10% increments up to approximately 50%. This will give full power at source, ie 300W for JK300HP. Repeat step 9 at each Height setting. **Note** *Refer to the test documentation supplied with your laser.*
11	When Alignment is successfully completed, set the Shutter to CLOSED, switch the Laser to OFF and carry out the Power Down sequence.
12	Tighten the Locking screw on the Z Adjuster (item 9).
13	Remove the DVM.
14	Close and lock the Laser Head lid.

9.10 Cover Slide Replacement Procedure

9.10.1 Materials

Part Required	Part Number
Cover Slide	1234123YA
Tools/Equipment	**Spares/Consumables**
Standard Tool Kit	O-Ring Kit
Rubber Bulb Puffer	PROPAN-2-OL
Small Vacuum Cleaner	Lint Free Tissues
Plastic Gloves	

9.10.2 Removal Procedure

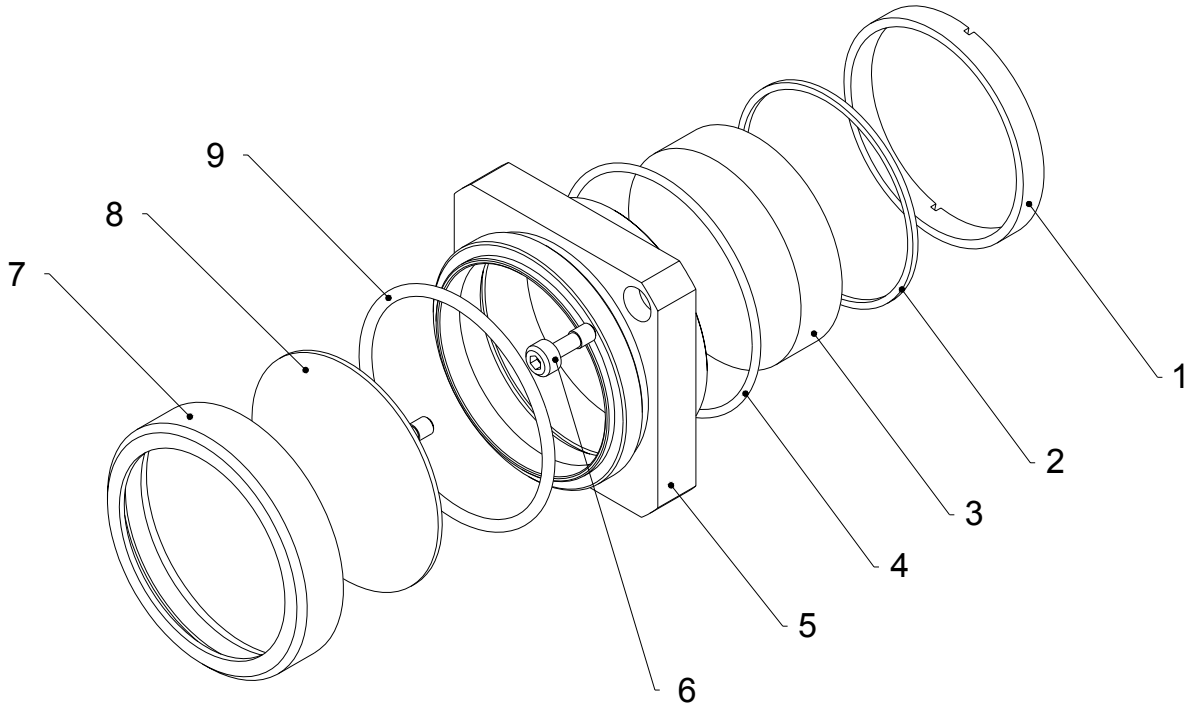


Figure 25 – Cover Slide Removal Procedure

Refer to Figure 25 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Carry out Power OFF Sequence.
2	Remove excess dust from the area around Cover Slide (item 8) using a small vacuum cleaner.
3	Unscrew and remove the Cover Slide holder (item 7), cover slide (8) and O-ring (item 9). Take care not to strike or damage Focusing Head.
4	Remove O-Ring (item 9) from the cover slide holder.
5	Remove Cover Slide (item 8) from the cover slide holder (item 7).

9.10.3 Cleaning and Installation Procedure

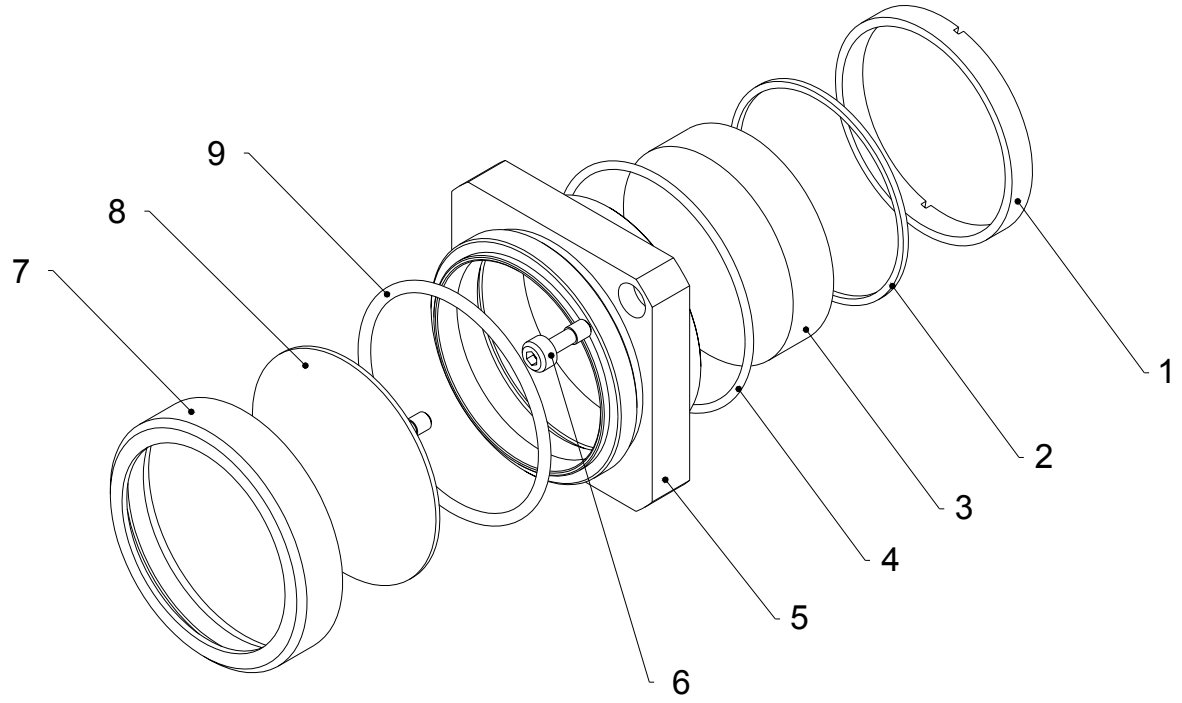


Figure 26 – Cover Slide Installation Procedure

Refer to Figure 26 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Clean the cover slide holder (item 4) and place in a clean environment.
2	Using Rubber Bulb Puffer, remove dust particles from faces of Cover Slide (item 8). If Cover Slide (item 8) is damaged or cannot be cleaned sufficiently, replace Cover Slide.
	**CAUTION** **WEAR PLASTIC GLOVES.** **Optical components are fragile and are easily damaged. Extreme care must be taken when handling optical components. Always handle optical components in a clean environment.**
3	Place Cover Slide (item 8) in a clean environment.
4	Carefully fold a lens tissue into a pad that is just slightly narrower than Cover Slide (item 8).
5	Dampen tissue using PROPAN-2-OL (or approved cleaner). Wipe tissue across the full area of Cover Slide (item 8) in a single stroke. **Note** *(Do not use multiple passes as it leaves streaks on the slide).*
6	Hold Cover Slide (item 8) by the edge and wipe once more in a single straight movement. Dispose of the pad. If necessary, make up a new pad and repeat the process until Cover Slide (item 8) looks clean when viewed as a mirror.
7	Check the cleanliness of Cover Slide (item 8) again.
8	Ensure the cover slide (item 8) is clean.
9	Ensure O-Ring (item 9) is serviceable, replace if damaged.
10	Fit Cover Slide (item 8) in the cover slide holder (item 7). Ensure O-Ring (item 9) is in position on Focusing Head. Offer both Cover Slide (item 8) and the cover slide holder (item 7) together to Focusing Head. Screw the cover slide holder (Item 7) on to the focussing head secure the cover slide (Item 8) and O-ring (Item 9) in position

9.11 Focus lens cell Replacement Procedure

9.11.1 Materials

Part Required	**Part Number**
Focus lens cell	Various
Lens Ring Tool [60mm SQ Head]	ML123431B
Tools/Equipment	**Spares/Consumables**
Standard Tool Kit	O-Ring Kit
Rubber Bulb Puffer	PROPAN-2-OL
Finger Cots	Lens Free Tissues
Plastic Gloves	

9.11.2 Replacement Procedure

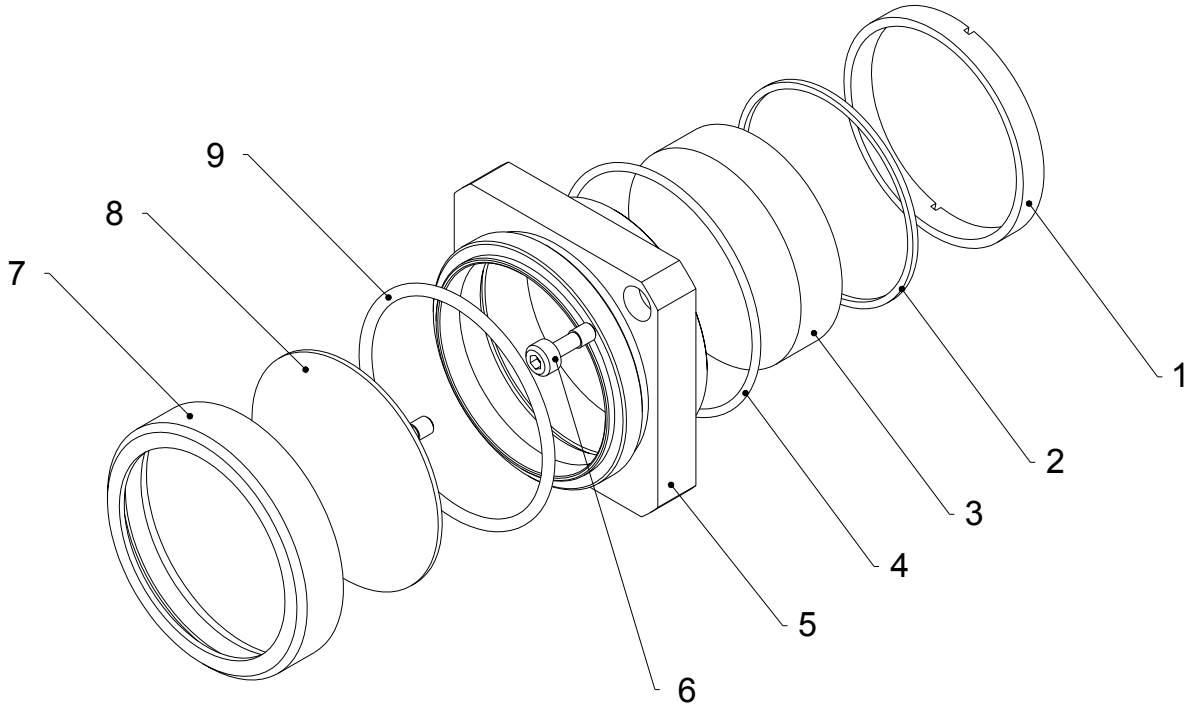


Figure 27 – Focus lens cell Removal Procedure

Refer to Figure 27 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
Removal Procedure	
1	Carry out Power OFF Sequence.
2	Using a 3mm allen key unscrew the captive screws (item 6) on the focus lens cell body (item 5).
3	Holding the lens cell body, slowly slide down and remove the lens cell (item 5).
Installation Procedure	
1	Locate captive screws (item 6) on the replacement lens cell body (item 5) on to the focus head assembly.
2	Slide the lens cell upwards into position.
3	Using a 3mm allen key tighten the captive screws (item 6).

9.11.3 Cleaning Procedure

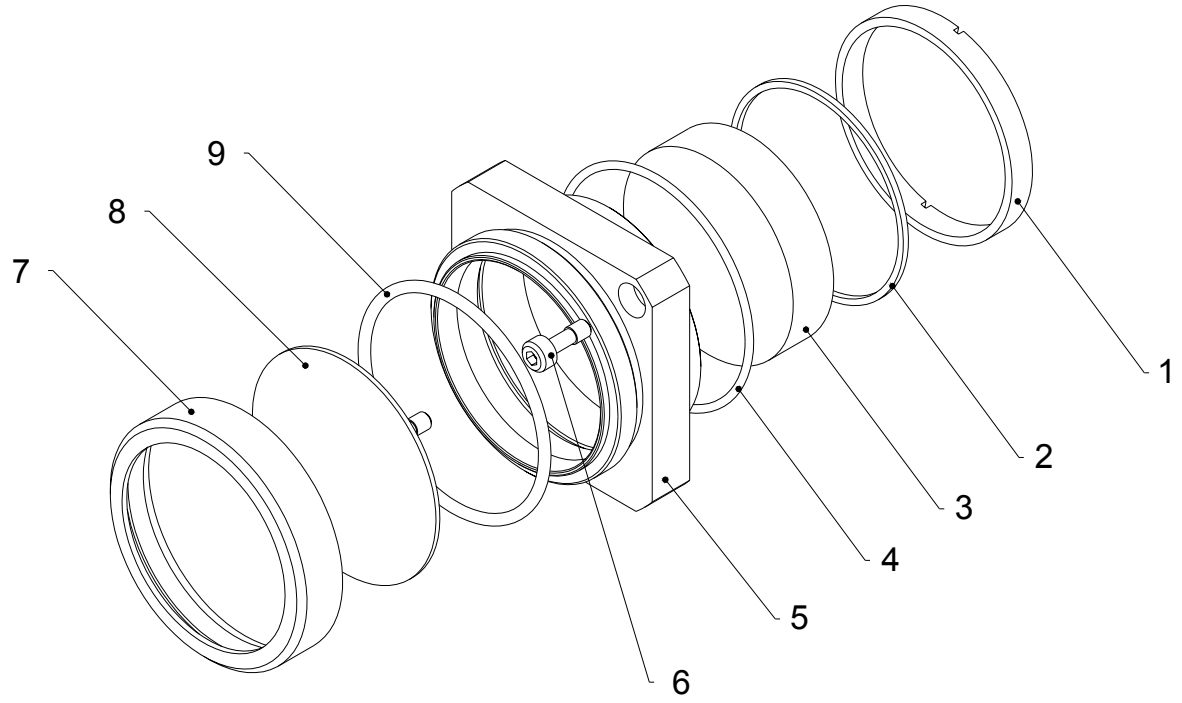


Figure 28 – Focus lens cell

Refer to Figure 28 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Clean the Focus lens cell holder (item 5) and place in a clean environment.
2	Using Rubber Bulb Puffer, remove dust particles from faces of Focus lens cell (Item 3). If Focus lens cell (Item 3) is damaged or cannot be cleaned sufficiently, replace the Focus lens cell.
	**CAUTION** **WEAR PLASTIC GLOVES.** **Optical components are fragile and are easily damaged. Extreme care must be taken when handling optical components. Always handle optical components in a clean environment.**
3	Place Focus lens cell (Item 3) in a clean environment.
4	Carefully fold a lens tissue into a pad that is just slightly narrower than Focus lens cell (Item 3).
5	Dampen the tissue with PROPAN-2-OL (or approved cleaner). Wipe tissue across the full area of the Focus lens cell (Item 3) in a single stroke. **Note** *(Do not use multiple passes as it leaves streaks on the slide).*
6	Hold the Focus lens cell (Item 3) by the edge and wipe once more in a single straight movement. Dispose of the pad. If necessary, make up a new pad and repeat the process until Focus lens cell (Item 3) looks clean when viewed as a mirror.
7	Check the cleanliness of Focus lens cell (Item 3) again.

9.12 Focus Lens Replacement Procedure

9.12.1 Materials

Part Required	Part Number
Focus lens cell	Various
Lens Ring Tool [60mm SQ Head]	ML123431B
Tools/Equipment	**Spares/Consumables**
Standard Tool Kit	O-Ring Kit
Rubber Bulb Puffer	PROPAN-2-OL
Finger Cots	Lens Free Tissues
Plastic Gloves	

9.12.2 Removal Procedure

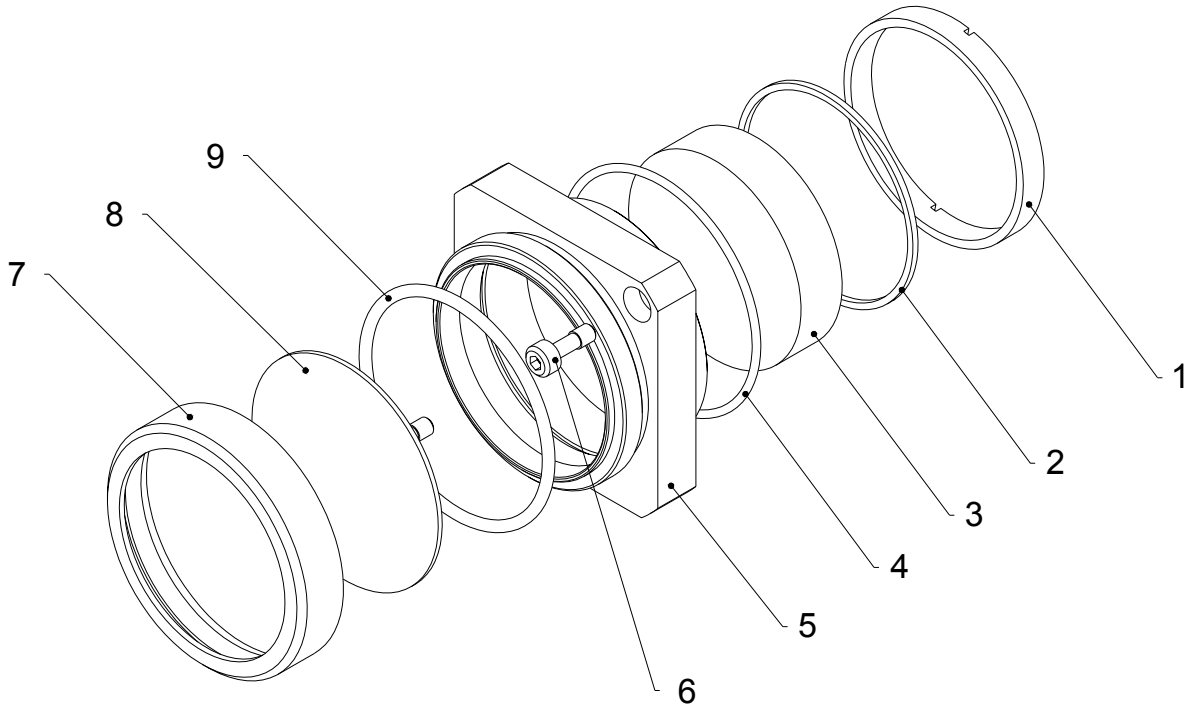


Figure 29 – Focus Lens

Refer to Figure 29 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Carry out Power OFF Sequence.
2	**Note** *To remove the lens the correct tool must be used to prevent optical damage.* Refer to Section 9.10 to remove the coverslide assembly.
3	Using the correct tool, remove the locking ring (item 1) in a counter clockwise direction.
4	Remove the spacer if fitted.
5	Using lens-cleaning tissues, push the focus lens up from the underneath (coverslide end). This will free the PTFE seal (item 2).
6	Carefully remove the PTFE seal (item 2).
7	The lens (item 3) will be free to move. Carefully remove the lens taking care not to touch the optic with your hands.
8	Clean or replace the focus lens. Refer to section 9.11.3 to clean the optics.

9.12.3 Installation Procedure

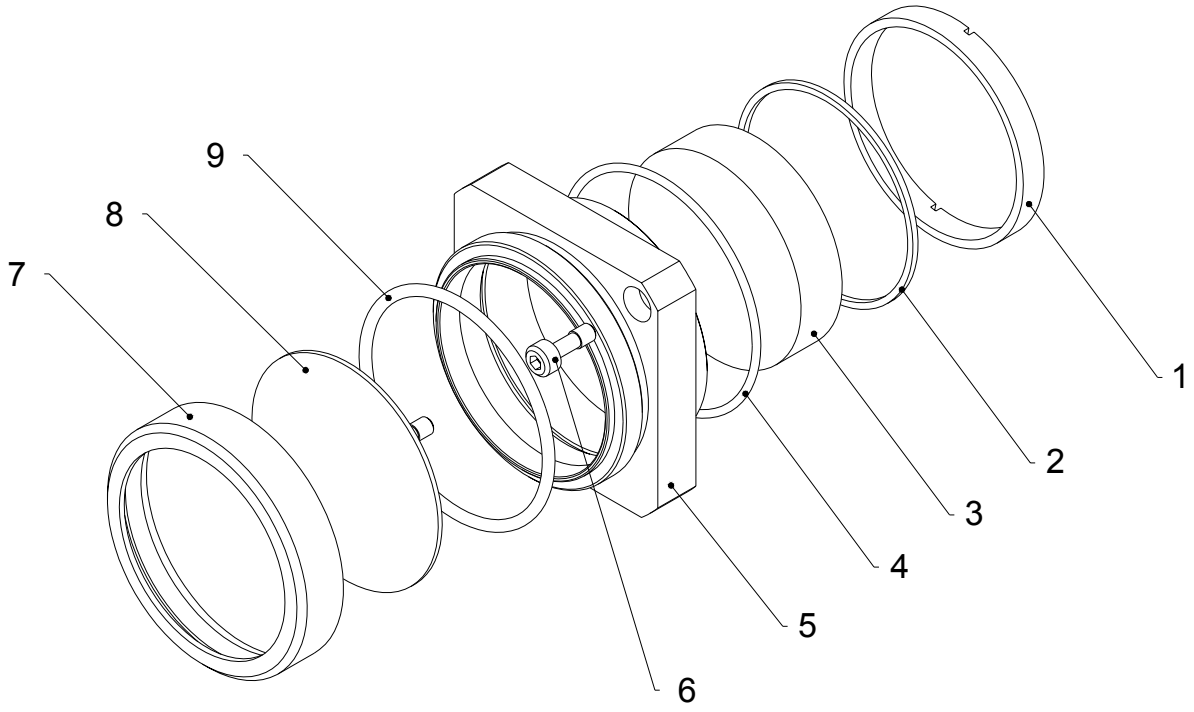


Figure 30 – Focus Lens

Refer to Figure 30 for item identification.

	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Inspect the optic for damage or debris. If necessary refer to section 9.11.3 to clean the optics.
2	Check that the O-ring seal (item 4) is serviceable and free from dust or contamination.
3	Replace or clean the O-ring seal (item 4) if required.
4	Using a lens tissue, from the underside of the lens cell (item 5) (coverslide end) lower the lens (item 3) into position. **The lens should be fitted flat side down.**
5	Check that the lens (item 3) is sitting flat in the lens cell (item 5).
6	Check that the PTFE seal (item 2) is serviceable and free from dust or contamination. Replace or clean PTFE seal (item 2) if required.
7	Fit the PTFE seal (item 2) into position on top of the lens (item 3). Do not touch the lens.
8	Screw the locking ring (item 1) clockwise, back into position. Tighten using the correct tool.
9	Inspect the lens cell for dust or contamination. Use a puffer to remove any dust particles.
10	Refer to Section 9.10 and fit the coverslide assembly.
11	Refer to Section 9.11 and install the focus lens cell assembly.

9.13 Surge Suppressor Replacement Procedure

Personnel authorised to Maintenance Level 1 can carry out this procedure.

9.13.1 Materials

Part Required	**Part Number**
Surge Suppressor	85D884501
Tools/Equipment	**Consumables**
Door key	

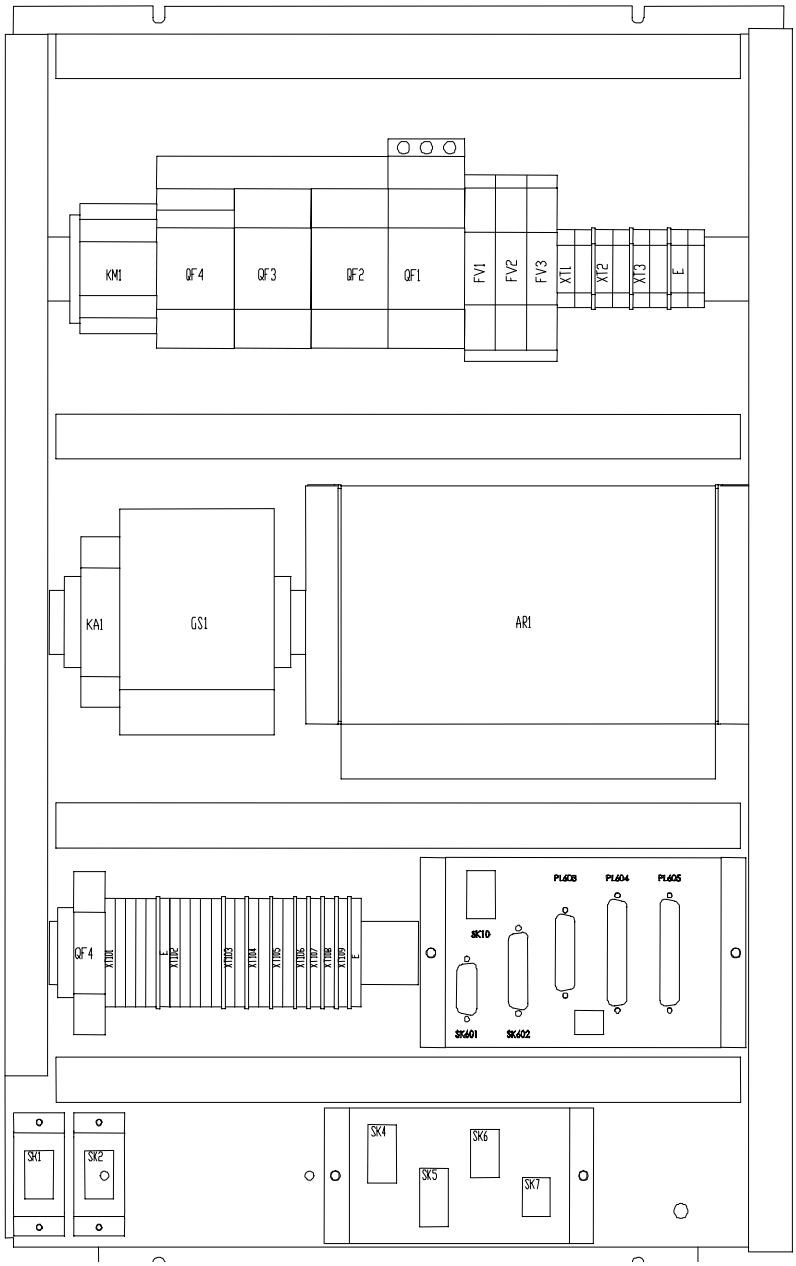


Figure 31 – Surge Suppressor Replacement Procedure

Refer to Figure 31 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Carry out Power OFF Sequence. Wait for 2 minutes. This ensures that the capacitors have discharged to a safe level.
2	Unlock and open End Bay door.
3	Locate and remove unserviceable Suppressor FV1, FV2 or FV3 (item 1).
4	Fit a serviceable Suppressor
5	Close and lock End Bay door.

9.14 Bulb Replacement Procedure

Personnel authorised to Maintenance Level 1 can carry out this procedure.

9.14.1 Materials

Part Required	Part Number
Bulb 24V 2.6W	640000821
Tools/Equipment	**Consumables**
Bulb Extraction Tool	

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Carry out Power OFF Sequence.
2	Unscrew, remove and retain coloured outer Cover of the Lamp.
3	Remove and retain inner Cover.
4	Using Lamp Extraction Tool, rotate unserviceable Bulb 90^0 anti-clockwise and remove.
5	Using Lamp Extraction Tool, insert serviceable Bulb and rotate 90^0 clockwise. Ensure bulb is secured.
6	Withdraw Lamp Extraction Tool.
7	Refit Inner Cover.
8	Refit Outer coloured Cover.

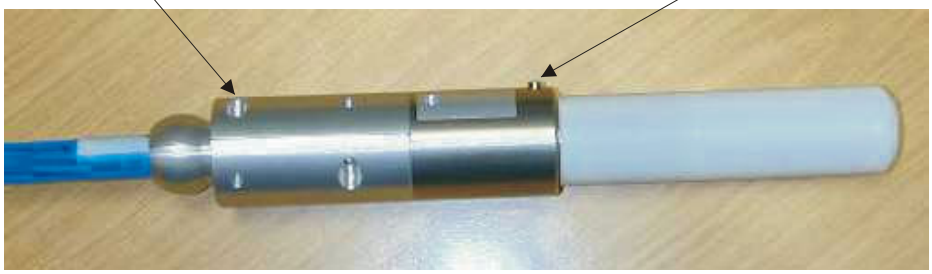
9.15 Bendlock Assembly

The Bendlock Assembly is available for Output Fibre Termination on PIPA Fibres used in robot applications.

9.15.1 Assembly Instructions

1. Fit the two Bendlock adaptors using the 4 M3 screws

2. Remove Locator Screw



3. Fit the 18 rings over the Fibre Termination onto the cable

4. Replace the Locator screw

5. Build up the Bendlock assembly using the split-rings, sleeve and snap ring

6. Completed bendlock assembly

9.16 Pointing Diode Replacement

Personnel authorised to Maintenance Level 2 can carry out this procedure.

9.16.1 Materials

Part Required	**Part Number**
Pointing Diode Assembly	PC120150X
Tools/Equipment	**Consumables**
Standard Tool Kit	
Door key	

9.16.2 Replacement Procedure

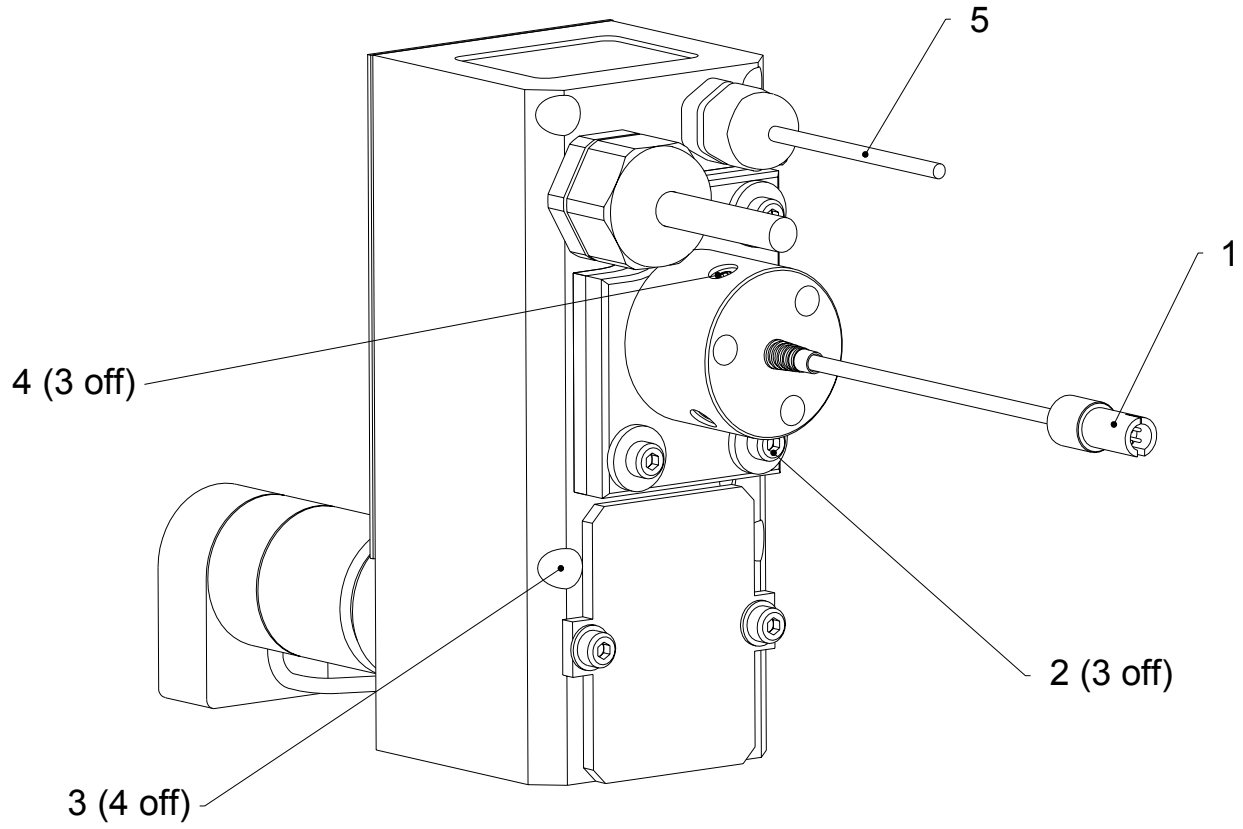


Figure 32 – Pointing Diode

Refer to Figure 32 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
Removal Procedure	
1	Ensure the Power is switched OFF. Wait for 2 minutes. This ensures that the capacitors have discharged to a safe level.
2	Unlock and open the Laser Head lid.
3	Unplug the pointing diode power lead (item 1).
4	Using a 3mm allen key unscrew and remove the screws (item 2) holding the pointing diode assembly in position.
5	Remove the pointing diode assembly from the shutter.
6	Place some tape over the hole at the rear of the shutter to prevent optics from any airborne contamination.
Installation Procedure	
	**CAUTION** **If a blanking plate is fitted on the shutter assembly, using screws (item 2), please remove before installing the pointing diode assembly. Unplug pointing diode flying lead (item 5) from the blanking plate.** **OR** **Remove any tape covering the hole at the rear of the shutter assembly.**
1	Fit screws (item 2) into pointing diode assembly.
2	Offer both pointing diode and screws (item 2) together to shutter assembly.
3	Locate and tighten the screws (item 2) to hold the pointing diode into position using a 3mm allen key.
4	Refer to section 9.16.3 and carry out the pointing diode alignment procedure.

9.16.3 Alignment Procedure

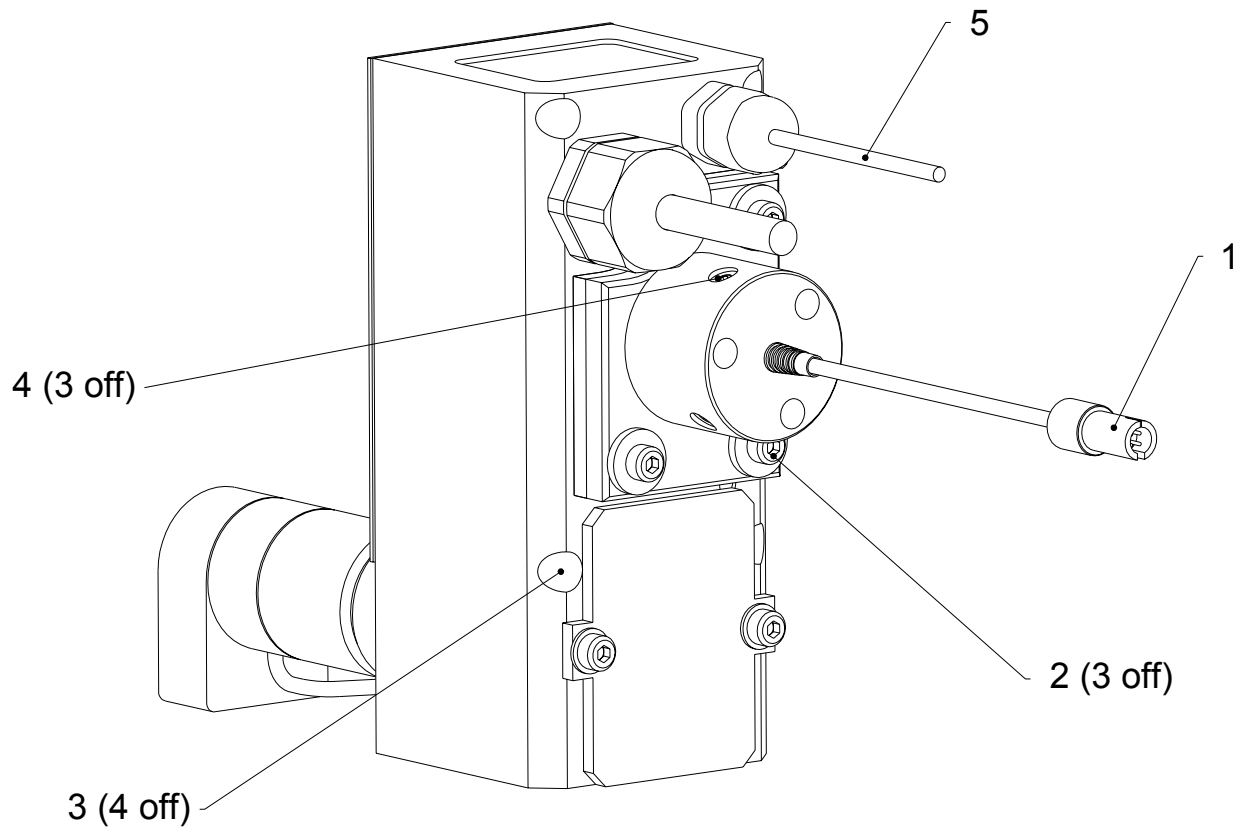


Figure 33 – Pointing Diode

Refer to Figure 33 for item identification.

Step	Action
	**WARNING** **ELECTRIC SHOCK HAZARDS EXIST.** **ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.**
1	Turn the laser mains isolator ON.
2	Turn the pointing diode ON. **Note** *If you have more than one shutter and pointing diode fitted, please ensure the correct pointing diode is ON*
3	Using a suitable piece of white card, check if a red beam is present at the workpiece ie. at the end of the PIPA fibre and focus head assembly.
4	If no beam is present, loosen the screws (item 2) holding the pointing diode assembly.
5	Reposition the diode assembly, on the oversized holes, looking for a beam at the workpiece.
6	When you have a beam present at the workpiece tighten the screws (item 2).
7	Using a 1.5mm allen key, locate the three adjusters (item 4) on the diode body.
8	Adjust each one in turn to optimise for the brightest beam at the workpiece. **Note** *If there is no change in brightness, loosen all three adjusters to allow the diode to move freely.*
9	When optimised for the maximum brightness, tighten all three adjusters on to the diode.
10	Close and lock laser head cover.
11	Turn the pointing diode OFF.

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10. Laser Processing

10.1 Overview

This is a generic overview of laser processing and is not specific to the JK300HP/JK300P/125P lasers.

Note *Setting up a Laser process is an involved process. This section is for guidance only and is not intended for use without reference to Technical Instruction.*

Fibre-optic beam delivery is achieved by focusing Laser light into a fibre-optic cable. The light is homogenised as it passes through the cable to the Focus Head.

As light exits from the fibre-optic cable it expands into a Focus Head. This incorporates a re-collimating and focusing lens assembly.

A primary lens re-collimates the expanding beam from the fibre and a focusing lens focuses the beam down to a small spot on the workpiece surface. Different spot sizes are achieved by changing the combination of recollimating and focus lens focal lengths.

A laser can be fitted with a Focus Head that uses a variety of Recollimating and Focusing Lens combinations. This provides a range of focused Laser beam spot sizes.

Different Focus Lenses used in conjunction with a Recollimating Lens will achieve different nominal spot sizes.

Focused spot size on the workpiece greatly influences processing performance. In general, whilst operating in Continuous Wave mode, spot size governs both depth and maximum travel speed achievable when welding and cutting.

At a given demand (Mean Power), smaller spot size achieves greater intensity and higher processing speeds. However, small spot sizes require the use of a lens with a short focal length. This means that the lens has to be positioned close to the workpiece thus increasing risk of damage to the optics caused by fume and spatter generated during processing. The degree of risk is dependent on the materials and type of process being undertaken.

The use of an Air Knife positioned in front of the output housing can protect the optics during welding operations. This consists of a jet of high velocity compressed air directed perpendicular to the beam path. A special welding nozzle can be fitted which incorporates an Air Knife and Gas Shielding.

10.2 Welding with Pulsed Lasers

Pulsed ND: YAG lasers employ a power supply designed for delivering high peak powers during the laser pulse and do not have CW capability. Pulsing implies that the laser's active medium is excited by a very quick response stimulus. This allows a laser to transmit a burst of energy for a brief length of time (generally in terms of milliseconds). Peak pulse powers for pulsing ND: YAG lasers can reach values of over 30 times greater than the maximum average power levels. This allows low to medium power lasers to achieve enough energy to reach vaporisation temperatures for most materials.

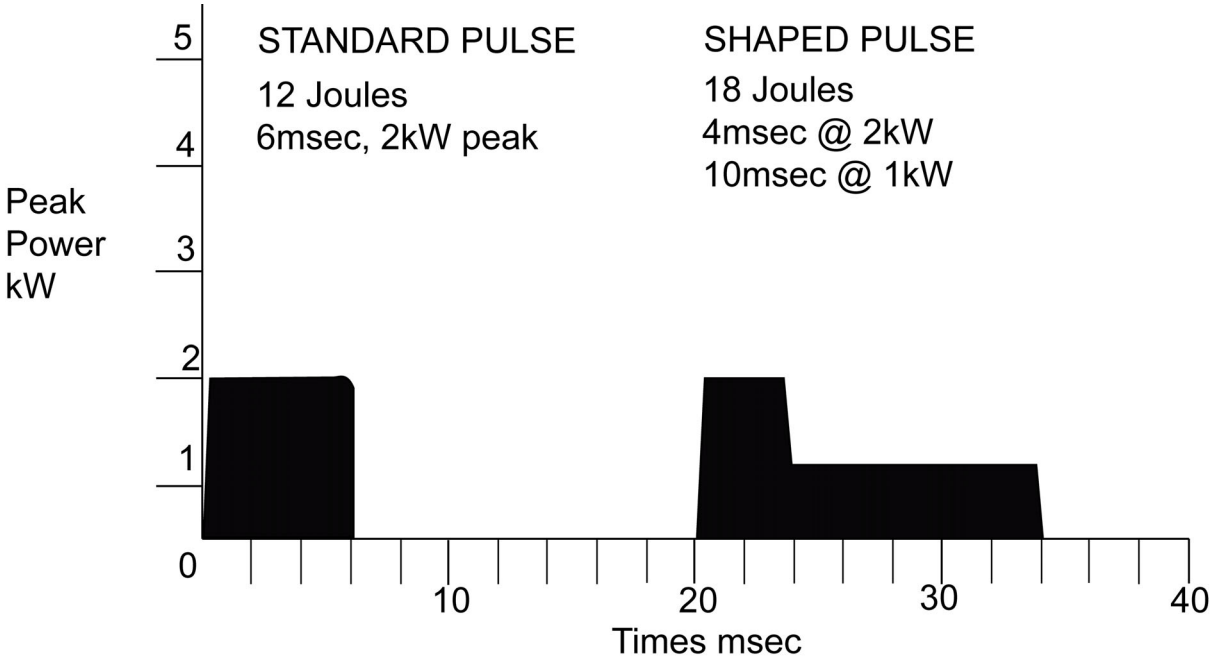

Figure 34 - Basic laser pulse and shaped pulse

The basic laser pulse from the pulsed laser is a rectangular pulse. Often the single sector standard pulse is quite adequate when welding standard ferrous alloys without any coating or carrying out standard pulsed YAG cutting applications. However, when welding reflective or dissimilar materials, pulse shaping has a measurable effect on the quality and consistency. Lasers are generally rated by their CW output, but pulsed lasers are discussed in terms pulsed energy, peak power, pulse width and frequency.

10.2.1 Pulse energy

The volume of the melt puddle for each pulse is determined by pulse energy. There is a minimum pulse energy required for weld penetration to a certain weld depth for a given material. The energy per pulse, in Joules (E) is related to the average power (P) and the pulse frequency (f) as follows:

E(Joules) = P (Watts) /f (Hz)

10.2.2 Peak Power

Refer to Figure 34, the height of the pulse is the peak power; peak power is required for precious metal welding and a range of aluminium alloys. The peak power (P_p) can be calculated by the following:

P_p (kW) = E (Joules) / t (seconds)

10.2.3 Pulse frequency and overlap

During pulsed ND: YAG welding, seam welds are produced by a series of spot welds. The pulsing rate of the laser results in faster or slower seam welding as the rate is increased or decreased. To produce hermetic welds, the pulse rate (f), spot diameter (d) and the weld speed (v) have to be matched to produce the required percent overlap (%OL). In general, typical values for hermetic welds are between 70 to 80 %OL and for non-hermetic welds are between 50 to 60 %OL. The percent overlap can be calculated as follows:

%OL = 100[(d-v/f)/d]

Figure 35 shows the relationship between the welding speed and the frequency for three different percent overlaps.

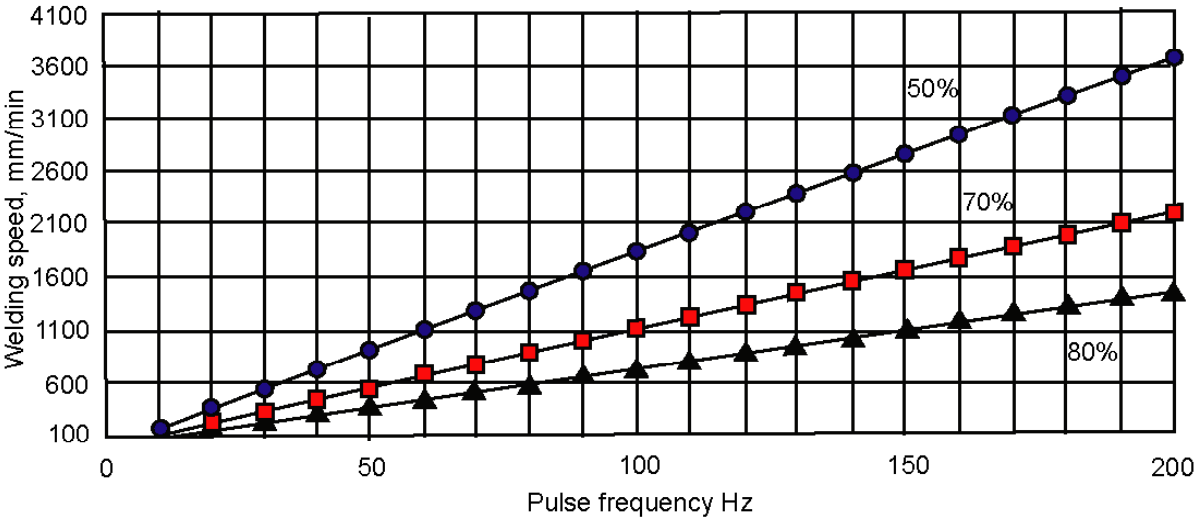

Figure 35 – Welding speed vs repetition rate for different percent overlaps (spot size 0.60mm)

In general the higher the peak power the greater the penetration up to limit where the intensity on the surface causes material to be ejected. At these levels, the process is starting to drill.

10.3 Welding in Continuous Wave Mode

Welding is achieved by focusing the Laser beam onto the material surface at an intensity sufficient to effect material heating, melting and vaporisation.

By moving the workpiece relative to the Laser beam, a continuous weld can be produced along a pre-determined path.

In a given material, the geometric characteristics of the weld (depth, width, cross-sectional area etc) are controlled by the following parameters:

- Laser average power.
- Welding speed.
- Focused spot size.

Increased power (with other parameters constant) increases weld width, depth and cross-sectional area.

Increased welding speed decreases depth and cross-sectional area.

Increased focus spot size will increase weld width and decrease depth. In this case, weld cross-sectional area may not change or may reduce depending on the focused spot diameter.

10.4 Welding in Modulation Mode

High Peak Power improves processing of reflective and high heat conductivity materials. When welding aluminium alloys this capability is crucial to developing a stable Melt Puddle at the focus point, especially when lap welding. The energy is quickly drawn away from the Melt by the alloy. The variation in surface reflectivity can be quite large due to surface oxidisation in aluminium alloys. High peak power overcomes these effects thus ensuring a good process.

Variations in focus position are tolerated more efficiently using a Modulated Beam. When the weld surface varies in distance from the Focus Lens, the use of high Peak Power overcomes the loss of weld penetration due to the lower intensity in the focus spot.

10.5 Jigs and Fixtures

Control of the material position relative to the Laser beam is achieved using Jigs and Fixtures. Good position control is essential if good quality, consistent results are to be achieved.

If flat sheet materials are to be processed, the simplest form of control is by clamping the material in a fixed plane relative to the Laser beam. Figure 36 shows two simple arrangements, A - clamping from below and B - clamping from above.

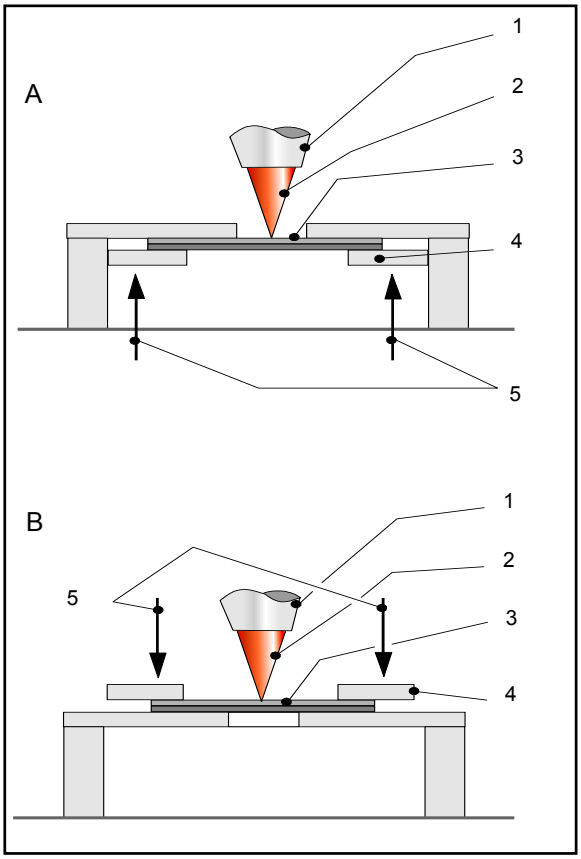

Figure 36 – Position Control Methods

Clamping from above allows high pressures to be exerted on the workpiece and enables rapid changing of components.

Clamping from below offers the advantage of always presenting the surface of the workpiece consistently in position with respect to the Laser beam. This method is recommended when processing sheet materials, which vary in thickness.

Experience has shown that the clamping method used should ensure that the parts to be welded are held with the joint ±0.2mm relative to the Laser beam focus position.

10.6 Shielding Gas

During welding operations, it is normally necessary to provide an inert gas shield around the weld to prevent oxidation.

Under normal conditions, adequate gas shielding can be provided via a pipe to the weld area around the beam/material interaction point. Gas flow should typically be 10 - 20 litres/minute Argon.

Where materials such as Titanium and its alloys require processing with zero contamination, it is necessary to employ a more sophisticated gas delivery system.

Using a Gas Shoe will achieve the conditions required to process materials without contamination. This device provides an inert atmosphere not only in the region of the molten weld puddle but also to the solidified weld as it cools. Slightly more gas flow is required when using the gas shoe, typically 30 - 50 litres/minute Argon.

Processing materials such as Stainless Steel, Aluminium and Titanium may require inert gas shielding to the Weld Underbead during full penetration welding. A very effective method is to introduce a channel flooded with inert gas underneath the weld. A gas inlet at one end of the channel and an outlet at the other is one method of maintaining a constant stream of gas along the underbead. The gas outlet should be slightly constricted to help retain the gas at the underbead but not to cause excessive pressure. Excessive pressure causes concavity of the Underbead or blows holes in the weld. Flow rates should typically be 2 - 5 litres / minute.

The absence of gas shielding when welding thin sheet mild steel (< 0.3 mm) may not adversely affect the properties of the weld and will, in general, allow welds to be produced at higher speeds and with greater penetration.

For most welding applications, Argon is efficient and cheap. The use of Helium as a shielding gas is not normally necessary. However, the use of Helium when welding Aluminium alloys is a significant benefit as it offers improved process stability. This results in a smoother top bead and allows greater penetration to be achieved.

The table below gives details of Gas Shielding requirements and the recommended Shielding Gas.

Material	Gas Shielding Requirements	Recommended Gas
Mild steel 0 -3.0 mm	Gas shielding not always necessary	Argon
Steel > 3.0 mm	Gas shielding recommended	Argon
Stainless steel and nickel alloys	Gas shielding recommended	Argon
Aluminium alloys	Gas shielding essential	Argon/Helium
Titanium alloys	Gas shielding essential	Argon
Copper alloys	Gas shielding may prevent effective coupling of the beam into workpiece	

10.7 Fume and Spatter Control

During welding operations it is normally necessary to prevent spatter and fume from impacting and accumulating on the Cover Slide that protects the Focusing Lens.

Fume and spatter control is easily achieved by use of a Cross-jet. This is a high velocity compressed air jet, directed perpendicular to the beam path, in front of the Focus Head between the Cover Slide and the workpiece.

If a Cross-jet is used, care must be taken to locate it in a position where the airflow does not disrupt the gas shielding.

10.8 Material Welding

Laser welding is a highly controllable fusion welding process. This process can be used to weld all metallic materials that are weldable using conventional welding processes.

Materials welded using high power Lasers are as follows:

Material	Information
Zinc-coated automotive steel	Generally weldable with coating thickness up to 15μm/side if a joint gap is introduced to allow vaporising zinc to escape.
Carbon and Carbon-Manganese steels	Readily weldable up to 3mm without gas shield and in greater thickness with gas shield. May encounter cracking in steels with high Carbon content.
Stainless steel and Nickel-based alloys	Readily weldable with good gas shield. Cleaning and degreasing prior to welding often necessary.
Titanium and Titanium alloys	Readily weldable but requires excellent gas shielding
Aluminium and Aluminium alloys	Pure and lean alloys are readily weldable with good gas shielding. 5000 and 6000 series alloys may require filler wire in addition to overcome cracking.
Copper and Copper alloys	Generally weldable although combination of high reflectivity and thermal conductivity can cause problems. Bismuth- and alloys containing Lead can crack.

Some of the benefits of Laser welding such as high welding speed and minimum workpiece distortion, are maximised when the Laser is used to make autogenous welds (i.e. with no material addition in the form of filler wire, powder, shim etc.). However, some materials require material addition to give high quality welds with acceptable properties.

At the high power level of the JK300HP/JK300P/125P Series Laser, welding with material addition is readily achievable although welding speeds are generally lower than with autogenous welding.

Some highly reflective materials can be difficult to weld because the majority of the Laser beam is reflected from the material surface preventing heating and melting. This is the case with Gold, Silver, their alloys and with some Copper alloys.

With all materials, it is important that surfaces to be welded are free of oxidation, oil, grease, cutting fluid etc. Contamination of this kind is likely to result in porosity and other defects in the weld. Appropriate cleaning procedures must be applied to remove contamination from surfaces to be welded.

10.9 Cutting in CW Mode

Focusing the Laser beam onto the surface of the material to be cut at an intensity sufficient to ensure material heating, melting and vaporisation achieves cutting. A co-axial assist gas is applied through the cutting nozzle that directs the gas at the beam/material interaction point. , A continuous cut can be produced along a predetermined path by moving the workpiece relative to the Laser beam.

The assist gas facilitates removal of molten material from the cut. In a given material, the Laser Average Power, the cutting speed and the type of gas used control the thickness of material that can be cut. The width of cut is controlled by the focused spot size.

Increased power (with other parameters constant) increases the thickness of material that can be cut.

Increased Laser power decreases cutting speed.

Increased focused spot size increases the width of cut.

Cutting performance is normally presented in the form of material thickness versus cutting speed graphs.

10.10 Cutting in Modulation Mode

When cutting, the square wave pulsed output of the Laser is used to improve the piercing speed. When starting a cut, square wave also improves the cut quality for thick materials. It also improves cut quality when cutting at an angle to the surface of the part.

Pulsing improves the cutting of high heat conductivity metals such as Aluminium, by using the peak intensities to overcome energy lost to conductivity and reflectivity.

Modulation also improves the edge quality of the cuts where intricate features are to be trepanned and Laser power reduced while maintaining a high intensity focus.

10.11 Cutting Fixtures

Control of the material position relative to the Laser beam is achieved using Jigs and Fixtures. Good position control is essential if good quality, consistent results are to be achieved.

If flat sheet materials are to be processed, the simplest form of control is by clamping the material in a fixed plane relative to the Laser beam. Refer to Figure 36 that shows two simple arrangements, clamping from above or below.

Experience has shown that the clamping method used should ensure that the parts to be welded are held with the joint ±0.5mm relative to the Laser beam focus position.

10.12 Cutting Assist Gas

The co-axial assist gas used in Laser cutting facilitates removal of molten material from the cut.

Both Air and Oxygen are used in Laser cutting and contribute additional heat during the cutting of steels. This is due to an exothermic reaction that occurs between the Oxygen in the assist gas and the Iron in the steel. This additional heat increases both cutting depth and cutting speed.

Oxygen bearing assist gas pressure is required to be optimised to achieve best results.

Excessive pressure can produce uncontrolled burning of the cut edge. This may result in a cut of varying width.

Insufficient pressure may lead to failure to cut through the material and possible nozzle blockage or optic damage.

A good starting pressure for cutting with Air or Oxygen assist gas is 3-5 bar (measured close to the nozzle).

Gases with high Oxygen purity can offer an increase in performance of between 10 and 20%; however the benefits of increased performance must be balanced against the corresponding increase in the cost of the gas.

10.13 Inert Assist Gases

Inert gases such as Argon or Nitrogen can be used as assist gases during cutting. Unlike Oxygen-bearing gases, they do not contribute additional heat to the process. Their use is primarily to assist in the removal of molten material and prevent oxidation of the cut faces. This is important for applications where the cut faces are to be welded subsequently without the need for further edge preparation and cleaning.

At very high pressures, e.g. ~15bar, cuts free from dross can be produced which require no further cleaning. Careful optimisation of gas pressure and cutting speed is required to achieve this condition. It is essential to ensure that the cutting nozzle and gas system are adequate to handle such high pressures safely.

10.14 Cutting Different Materials

A wide range of metallic materials can be cut successfully using the JK300HP/JK300P/125P Series Laser.

For processing guidelines, please refer to GSI Group - Laser Division.

10.15 Process Preparation

10.15.1 Choice of Focused Spot Size

High welding and cutting speed is normally desirable from a productivity viewpoint but, in some applications, the use of short focal length lenses to achieve high speeds can present problems.

The following factors need to be considered when choosing focused spot size:

10.15.2 Part/Focus Position

The process tolerance to variations in Laser focus point is a function of the depth of focus, i.e. the distance above and below the actual focus position over which the focused spot diameter is approximately constant. The depth of focus is proportional to lens focal length. If the position of the part is within the depth of focus, the process will be consistent and reproducible.

If parts cannot be positioned accurately relative to the focus position of the beam because, for example, part-to-part dimensional variations are significant or low accuracy work handling is used, then it may be necessary to use a longer focal length focusing lens. This will increase process tolerance but will limit maximum processing speed.

10.15.3 Weld Shape, Cut Width and Joint Strength

Processing using small focused spot size at high-speed results in production of narrow welds or cuts of small cross-sectional area.

When welding, this increases the need to ensure accurate alignment of the joint to be welded and the focused Laser beam. If this is difficult, for example because of part-to-part variations or low accuracy work handling, a larger spot size may be necessary resulting in production of a wider weld. This allows a greater tolerance to alignment of the focused beam with the joint.

When cutting this produces a narrow cut (or kerf) which increases the need to ensure accurate focused Laser beam alignment with the desired cut path. A wider cut, produced using a larger focused spot size, may be more tolerant to part alignment.

Additionally, producing a narrow cut can present problems as scrap material, for example circular slug resulting from cutting a circular aperture, may not drop cleanly away because of limited clearance. A wider cut produced using a larger focused spot size, would increase clearance and improve the chances of scrap parts dropping away cleanly.

With overlap and overlap T-welds, the production of a narrow weld results in limited weld width at the joint interface. For structural overlap welds, it is normally necessary for weld width at the interface to be greater than the material thickness. To produce a weld of suitable width, a larger focused spot size may be required at the expense of welding speed.

10.15.4 Cover Slide Damage

The use of a short focal length lens is not advisable when welding or cutting materials that generate high levels of fume and spatter. Fume and spatter can impinge on the Cover Slide below the Focusing Lens and cause a reduction in Laser beam transmission through it. Eventually this will result in overheating and fracture of the Cover Slide and possible irreparable damage to the Focusing Lens.

Materials that may generate high levels of fume and spatter are Zinc coated steels and some high Magnesium content Aluminium alloys.

10.15.5 Processing Access

Processing access is affected by the choice of focusing lens focal length. The Laser beam diameter after it has passed through the Recollimating Lens in the Focus Head is constant; however a short focal length Focusing Lens results in greater focused beam cone angle than a long focal length Focusing Lens

The greater cone angle can limit beam access that could be a problem when, for example, welding in the bottom of a groove or between closely packed tubes. In such cases, it may be necessary to use a longer focal length focusing lens that results in a smaller cone angle.

10.15.6 Finding Focus

Nearly all welding and cutting is carried out with the Laser beam focused on the material surface. Before setting up a new process, it is important to know the accuracy of the focus beam position.

The focus beam position is a fixed distance from the end of the Focus Head, i.e. the cover slide position.

Refer to Section 7.2 for details.

10.15.7 Welding

10.15.7.1 Gas Shielding

When preparing a welding process, it is important to establish a gas shield/gas flow rate that achieves effective shielding and is reliable for production use. Care in setting up gas shielding at this point can prevent time consuming and costly problems before production welding starts.

Because of the wide range of materials/components and different End User requirements, there are few rules that apply to setting up effective gas shielding.

However, the following points should be considered when setting up gas shielding:

- Turn on shielding gas on prior to initiating a weld in order to purge the gas delivery system and displace air from the weld region.
- A pipe fitted to deliver shielding gas to the weld must be positioned ahead of the welding point and arranged to direct shielding gas at the point of beam / material interaction. Pipe to be angled at ~45º to the surface of the part being welded
- The distance from the end of the pipe to the beam material interaction point must be far enough to prevent the pipe being damaged by heat from the process but close enough to ensure good coverage of the weld. Normally, a distance of 10-20mm is suitable.
- Gas flow rate should be adjusted to the minimum value necessary to achieve the required shielding effect. Normally the requirement is to prevent visible oxidation of the surface, i.e. to produce a bright, shiny weld topbead. This is achievable with flow rates

of 10-20 litres/minute when using a pipe or 30-50 litres/minute when using a Gas Shoe.

- Ineffective shielding does not necessarily indicate insufficient gas flow rate. Excessive gas flow rate can cause turbulence in the weld area and result in entrapment of air that leads to oxidation.
- When a weld is terminated, it may be necessary to stop the workpiece or Focus Head motion and continue the supply of shielding gas for a few seconds to prevent oxidation of the hot solidified metal at the weld termination point.
- Care must be taken to prevent interaction between the Air Knife, used to protect the Cover Slide from fume and spatter, and the flow of shielding gas.
- Many variables influence the effectiveness of gas shielding. Take note of all aspects of successful set-ups so that they can be reproduced if necessary.

10.15.7.2 Cross-jets

It is important to set up a Cross-jet that prevents fume and spatter impinging on the Cover Slide.

It is normally sufficient to use a Cross-jet positioned to blow a high velocity jet of air across the gap between the Cover Slide and the workpiece.

When setting up a cross-jet, the following points should be considered:

- Some materials produce more fume and spatter than others. Materials that produce a lot of fume and spatter for example, Zinc-coated steels and some Aluminium alloys, warrant additional attention on setting up a Cross-jet.
- The optimum Cross-jet position between the workpiece and The Cover Slide requires investigation for each welding task. If the Cross-jet is placed too close to the workpiece, the jet of air can interact with the flow of shielding gas and reduce shielding effectiveness. If it is placed too close to the Cover Slide, the cross-jet may be ineffective in preventing fume and spatter hitting the Cover Slide.
- The optimum rate of airflow for Cross-jet use requires investigation for each welding task. If the rate is too low, the Cross-jet will be ineffective. If the rate is too high, an excessive volume of air will be used and the process will become very noisy.
- The Cross-jet should be positioned so deflected fume and spatter is not blown onto other equipment in the workstation.
- The Cross-jet air supply must be switched on prior to initiation of welding to allow steady state flow conditions to be achieved. Cross-jet air supply must be left running for a period after weld termination. This prevents fume in the atmosphere from being deposited on to the Cover Slide.
- The air supplied to the Air Knife is to be clean and free from moisture and oil.

10.15.7.3 Part Fit-up

Laser welding is a high precision fusion welding process that is often carried out without material addition in the form of wire, powder and shim.

This means that the parts to be Laser welded have to fit closely together to achieve successful welds.

Generally, parts should fit together so that any gap remaining between them is less than10% of the thickness of the thinnest material being welded. If greater gaps exist than it is likely that the weld produced in an overlap configuration will exhibit undercut (a concave underbead and/or topbead, see Figure 37). It is possible that with inadequate fit-up the Laser beam will melt the top and bottom plates in a lap joint but fail to join them together. It is

possible that, in a butt weld, no weld will be produced, as the focused Laser beam will pass through the joint gap without melting the material.

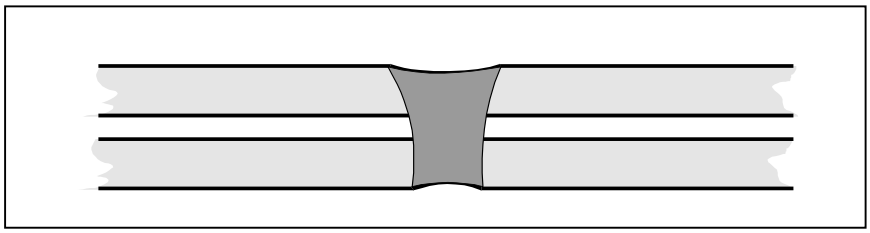

Figure 37 – Undercut Overlap Weld

It is important when setting up a new process to ensure that the parts to be welded have a dimensional accuracy suitable to ensure good fit-up and that the fixing of parts into the jigs is accurate.

10.15.8 Cutting

10.15.8.1 Nozzle Set-up

The quality of cut, ultimate cutting speed and consistency of cutting performance in different cutting directions are all dependent on the positioning of the cutting nozzle relative to the Laser beam focus and the workpiece surface.

When setting up for Laser cutting, the following points should be considered:

- Optimum results will be achieved with the beam accurately positioned to pass centrally down the nozzle and to exit the nozzle aperture concentrically. Nozzle position should be adjusted to achieve this.
- The optimum position of the Laser beam focus below the nozzle is dependent on material type and thickness, assist gas type and pressure and cut quality requirements. For most cutting tasks, the Laser beam focus position should be ~1mm below the end of the nozzle. The workpiece should be positioned coincident with the Laser beam focus position. (The distance between the end of the nozzle and the workpiece is termed Standoff).
- Cutting performance is highly dependent on cutting nozzle condition. Nozzles damaged by workpiece contact, contamination or overheating due to beam clipping should be replaced.

10.15.8.2 Assist Gas

Cut quality and cutting speed are dependent on gas type and pressure

When setting up a cutting process, the following points should be considered:

- If using Oxygen gas assist, great care must be taken to optimise gas pressure to achieve high cut speed and quality. Optimum pressure is dependent on material type and thickness, nozzle outlet diameter, and Standoff. For most cutting tasks in steel and stainless steel, gas pressure is ~4 bar.
- If using inert gas assist, it may be necessary to cut with the Laser beam focus position below the material surface to produce a cut with minimum taper. In this case, the nozzle position will require adjustment to maintain a ~1mm Standoff.
- If using inert gas assist, great care must be taken to optimise gas pressure to achieve good cut quality free from oxidation. Optimum pressure is dependent on material type and thickness, nozzle outlet diameter and Standoff. For most cutting tasks, the gas

pressure is ~8 bar, although the use of significantly higher pressures may be needed if cuts free from dross are required.

- Switch on assist gas prior to commencement of cutting to allow purging of the gas delivery system and establish steady state flow conditions.

10.16 Optimisation

10.16.1 Use of Ramp Up and Ramp Down

Optimisation of Ramp Up and Ramp Down is important in welding applications where weld initiation and termination points form an integral part of the welded component and must be free of defects and/or of good surface appearance

Ramp Up time is defined in the Parameter Set Table and sets the time for the Laser to reach the set Laser power output when switched ON from READY. When welding, the Ramp Up feature can be used to increase weld penetration in a controlled manner at the start of the welding to fade in the weld smoothly.

Ramp Down time sets the time for the Laser to reach zero when switched from ON to READY. When welding, the Ramp Down feature can be used to decrease weld penetration gradually in a controlled manner at the end of welding to fade out the weld smoothly. The Ramp Down facility is used when welds are made in circular components to ensure smooth fade out in the area of weld overlap.

Optimum settings depend on material type and thickness, welding power and speed and other processing parameters as well as the precise quality and appearance requirements of the finished component.

Optimum settings are best defined by conducting structured processing trials at different Ramp Up and Ramp Down times on representative components.

10.17 Record Keeping

Establishing a Laser process for use in a production welding or cutting application requires many parameters to be set and adjusted. The goal is to develop an optimised and tolerant process that will prove reliable in use and allow the speed and quality benefits offered by Laser processing to be realised.

In order for such a process to be established and to ensure it can be repeated, it is important that accurate process records are kept and maintained.

11. Spares

Refer to the Spares Navigator CD for all consumable spares information.

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