

# G4 Pulsed Fiber Laser

## *OEM Safety and System Integration Manual*

Module types C1 and C2



Module type C1 - fitted with IBeam1 delivery optic



Module type C2 - fitted with IBeam2 delivery optic

# 1 Preface

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## Definition of Symbols and Terms



**This symbol is to alert the user to the danger of exposure to hazardous invisible laser radiation**



**This symbol is to emphasise important information regarding installation points or operating procedures**

**DANGER:** Describes hazards that could directly or indirectly lead to serious personal injury or death.

**WARNING:** Describes hazards or practices that could directly or indirectly lead to serious personal injury or death.

**CAUTION:** Describes hazards or practices that could lead to minor personal injury or G4 Laser damage.

**LASER INTEGRATOR:** Any person that integrates the laser into their equipment, or any person who uses the laser in the form as supplied by SPI Lasers UK Ltd.

**G4 LASER:** The definition of “G4 Laser” as used herein means the item that was procured from SPI Lasers UK Ltd. The G4 Laser is sold ready for use for its intended purpose as a laser component for incorporation.

## Document References

Please refer to the G4 Laser Specification and the Laser Interface Manual appropriate to your G4 Laser type for functional specifications and operating instruction. For more information visit [www.spilasers.com/customer-login](http://www.spilasers.com/customer-login).

Document number	Description
SM-S00360	G4 V8 control interface manual
SM-S00220	G4 Accessories Datasheet

## Warnings



**WARNING:** If the fiber laser described in this manual is used in a manner not specified by SPI Lasers UK Ltd, the protection provided by the equipment may be impaired.



**WARNING:** Attempts to modify or alter the device, or the use of controls, adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.



**CAUTION:** Modifications to the device or the use of controls or adjustments or performance of procedures other than those specified herein:

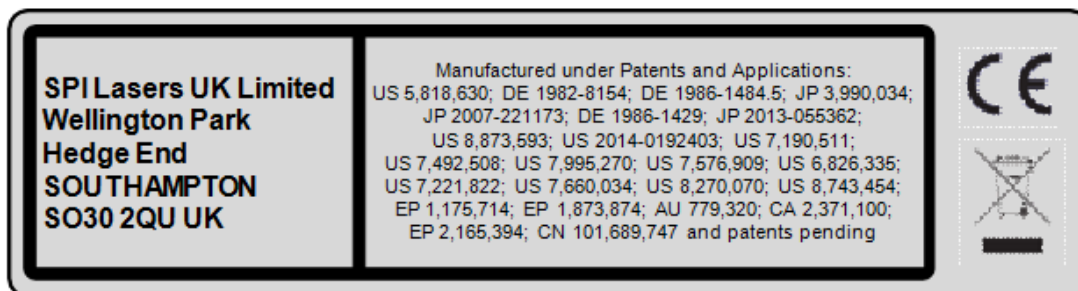
- will invalidate the warranty
- may result in patent infringement

**Laser Integrators are not authorised to modify the specification of the G4 Laser.**

## Licensing

This G4 Laser carries no license by IMRA America, Inc. for pulsed operation less than 100 ps.

Prior to importing into the United States of America, Germany, or Japan, please verify that United States patent no. US 5,818,630 is identified on a label attached to the G4 Laser. Please contact your sales representative if United States patent no. US 5,818,630 is NOT identified on a label attached to the G4 Laser. An example of the label is as shown below:



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## 2 Laser Safety

### 2.1 Laser Hazard Information



**DANGER:** The Fiber Laser Module described in this G4 Laser Manual carry a Class 4 Laser rating and emit invisible laser radiation in the region of 1000 - 1200 nm with a rated average output power of up to 200 W.

The G4 Laser contains embedded laser devices that emit invisible radiation in the region of 900 - 1000 nm with a total output power of up to 270 W for the rated output power of the laser modules: this radiation is not accessible to the user unless the protective housing is opened.

The laser may emit significantly higher powers under a single fault condition <400 W 1000 - 1200 nm.

**AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION.**

*Contact with direct or scattered laser radiation can cause permanent damage to the eyes, burn human tissue and start fires.*



**DANGER:** The internal visible pilot laser (model dependent) carries a Class 3R laser rating and emits visible laser radiation in the region of 630 - 670 nm with an average output power of up to 0.3 mW.

In the case of Class 3R Pilot Laser the laser may emit powers of up to 5 mW under single fault conditions.

**AVOID DIRECT EYE EXPOSURE.**

### 2.2 Protective Eyewear

The following optical density rating is advised for protective eyewear:

Optical Density	Wavelength Range	Standard
<b>DR L6</b>	900 – 1050 nm	EN 207
<b>DR LB7</b>	1050 – 1200 nm	EN 207
<b>R1</b>	400 – 700 nm	EN 208



**WARNING:** Any reduction in beam diameter conducted by the end user, e.g. resulting from the use of focus optics, will increase the optical density required for protective eyewear. It is the responsibility of the end user to ensure correct protection is in place. The user must complete a documented risk assessment and provide any required personal protection equipment (PPE) before operation of the laser.

It is recommended that glass based protective eye wear be used due to the relatively high peak powers associated with IR output of the G4 Lasers, especially when used in a laser lab prior to fully validated and eye-safe installation.

## 2.3 Laser Safety on Installation

The G4 Laser is a Class 4 OEM laser device specifically designed for incorporation or integration into other equipment. As such, it DOES NOT MEET the full requirements for a stand-alone laser system as defined by 21 CFR 1040.10 and IEC/EN 60825-1:2014.

During installation it is vital that the laser hazard is fully managed. In particular, the laser integrator is required to provision the engineering requirements detailed in IEC/EN 60825-1. These include, but are not limited to:

- Provision of a protective housing which prevents human access to laser radiation in excess of the Accessible Emission Limit (AEL) for Class 1 (see Section 4.2 detailed in IEC/EN 60825-1).
- The beam delivery cable is not Class 1 under a worst-case single fault, no cable break or fiber break detection is offered on this device. The integrator must either include the beam delivery cable inside the Class 1 enclosure with the Pulsed Laser Aperture or undertake suitable measures to ensure that under reasonable and foreseeable use, the cable is suitably positioned to prevent it from becoming damaged or mishandled.
- The beam delivery cable has not been designed for robotic applications. The laser must not be designed into systems where the Beam Delivery Cable will be subject to high levels of acceleration, torsion and twist, or combination thereof. If this is a requirement for the integration please contact SPI Lasers UK Ltd to discuss the application in more detail.
- Provision of a remote interlock connector which, when open-circuited, prevents access to laser radiation in excess of Class 1M (Section 4.4 detailed in IEC/EN 60825-1).
- Provision of a manual reset function to enable resumption of accessible Class 4 laser radiation emission after interruption of emission caused by use of the remote interlock connector or an interruption of longer than 5 s of electrical mains power (Section 4.5 detailed in IEC/EN 60825-1).
- Provision of a key-operated master control. The key should be removable and the laser radiation shall not be accessible when the key is removed (Section 4.6 detailed in IEC/EN 60825-1).
- Provision of a fail-safe or redundant audible or visible emission indicator. This should be repeated at the laser aperture if it is located more than 2 m from the original emission indicator (Section 4.7 detailed in IEC/EN 60825-1).
- Provision of a beam stop or attenuator is permanently attached to prevent access to laser radiation in excess of Class 1M (Section 4.8 detailed in IEC/EN 60825-1).

If the G4 Laser module has the optional internal, visible Pilot Laser, it is vital that the laser integrator ensures that the laser hazard is fully managed. In particular, the laser integrator is required to provision the engineering requirements detailed in IEC/EN 60825-1. Be aware that the visible Pilot Laser may carry Class 3R eye safety rating and as such SPI Lasers recommends use of suitable safety goggles as detailed in Section 2.2. See G4 Laser label for Pilot Laser details.

**If the enclosure in which the laser is mounted is opened, the interlock must interrupt the IR but not necessarily the Pilot Laser, under this condition the enclosure is classed**

with the G4 Laser integrated Pilot Laser Class (see device labels for details). The lasers enclosure should be labeled so to reflect this class.

i.e. for the laser to be considered Class 3R the selection of the Pilot Laser must physically interrupt the 36 V Laser Diode Supply, to prevent any IR emission under a single fault condition. The pilot laser operates from the 36 V logic supply so will still function.

It is the responsibility of the laser integrator to provide the engineering requirements to meet Section 4.0 of IEC/EN 60825-1. Review this section for guidance on compliance.



**WARNING:** Take care when in close proximity to the beam delivery optic - HIGH MAGNETIC FIELDS MAY BE PRESENT. PACEMAKERS OR OTHER SIMILAR IMPLANTED DEVICES MAY BE AFFECTED



## 2.4 Laser Safety under Ethernet Control



**WARNING:** It is possible for multiple users to connect to and control a G4 Laser simultaneously via the Ethernet port. The laser will respond to each command in the order in which it is received and does not differentiate between commands sent from different Ethernet controllers.

Care should be taken especially when controlling the laser remotely across a network as another user could be working with the laser.

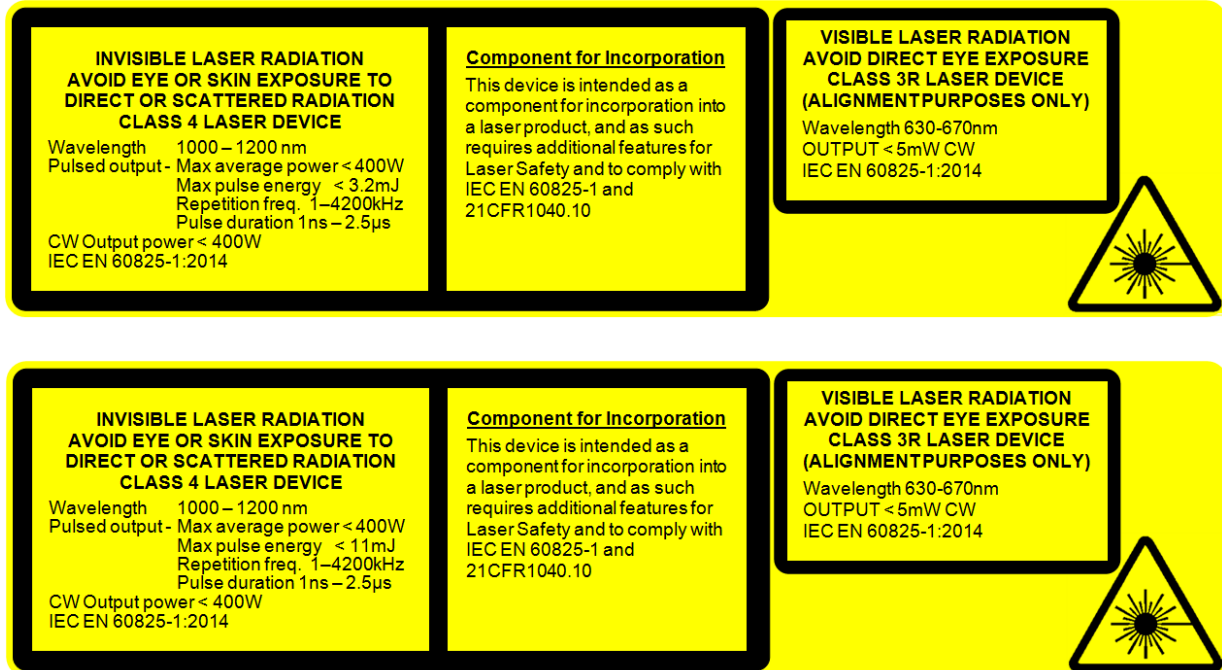
It is the Integrators responsibility to ensure that any remote connectivity to the laser cannot inadvertently allow the IR to be enabled during the Integration process when, IR, Pilot Laser and interlock systems are being installed.

We recommend that any user intending to control the laser via Ethernet, remotely across a network should first check that the laser is installed in an interlocked, Class 1 enclosure.



## 2.5 Laser Safety Labeling

Some example safety labels for type C1 and C2 lasers are illustrated below.



Laser safety warning label incorporating the elements required by IEC/EN 60825-1:2014, specifically:

- Laser Warning Triangle.
- Component for Incorporation Labelling.
- G4 Laser Device Classification Label.
- Maximum optical output parameters of the laser.

Note: these examples are used on devices where the internal red alignment Pilot Laser is fitted. Refer to your G4 Laser product specification or safety label for device specific details.



The G4 Laser aperture label is attached to the Beam Delivery Optic.



## 3 Regulatory Compliance

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### 3.1 CE Marking



**CAUTION:** - If the laser is used in a manner not specified by the manufacturer, the protections incorporated may be impaired and the warranty will be void.

The G4 Laser is specifically designed as an OEM, low-voltage, DC-powered laser device for incorporation or integration into other equipment and has a requirement for a current-controlled power supply for incorporation within a finished laser system.

As such, it DOES NOT MEET the full requirements for a stand-alone laser system as defined by IEC/EN 60825-1 and 21 CFR 1040.10 under the Radiation Control for Health and Safety Act of 1968.

It is the responsibility of the equipment manufacturer to meet all of the regulatory requirements for the final system. Nonetheless, the module has been labeled to facilitate final system compliance with regulatory requirements.

**Note:** Lasers produced and labeled as Alpha build standard may have been manufactured prior to the completion of formal qualification and are therefore not CE marked.

SPI Lasers UK Ltd recommends the use of a power supply incorporating reinforced (double) insulation rated to a withstand voltage level of 3 kV AC. Alternative electrical power supply configurations are possible. For the G4 Laser integration in an industrial environment, the selected power supply should be compatible with the intended environment and additional screening may be required to meet the applicable EMC standards. Suitable signal cables of 3 m length or less should be used.

### 3.2 RoHS Directive Compliance

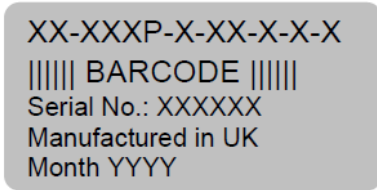
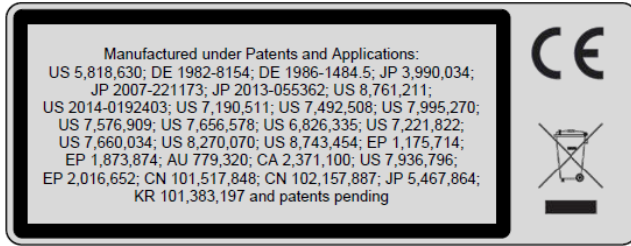
This G4 Laser is RoHS compliant in accordance with Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

### 3.3 WEEE Directive Compliance

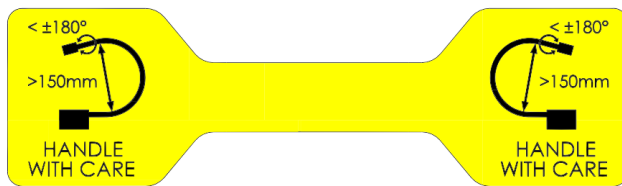


This logo is incorporated in G4 Lasers labeling. It indicates that, at end of life, this G4 Laser should be separately collected from unsorted waste with a view to meeting the recovery and recycling targets specified in the appropriate national regulations implementing “Directive 2002/96/EC on waste electrical and electronic equipment (WEEE)” for a G4 Laser of its class.

### 3.4 Compliance Labeling



Please refer to the part number and serial number shown on this label when contacting SPI Lasers Product Service & Support Team.



This label is attached to the optical cable.



This label shows the location of the earth stud.

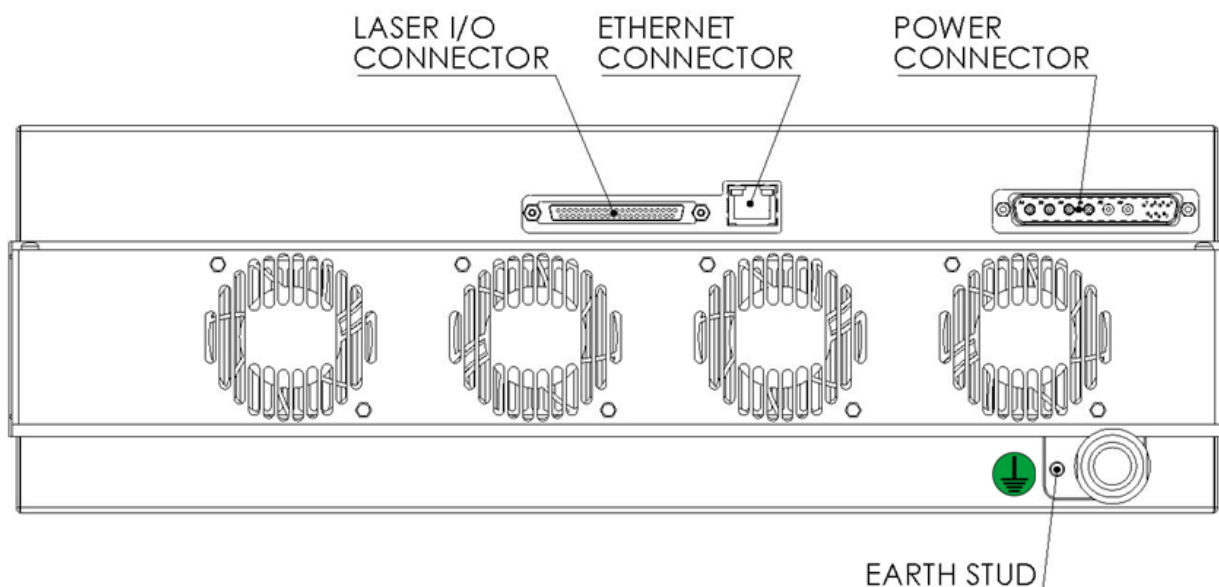
## 4 Electrical Integration Details

### 4.1 Safety Warning



**WARNING:** Connecting the G4 Laser to non-isolated (active) power supplies and with unspecified control-line states could lead to uncontrolled IR emission with the associated risk of personal exposure to hazardous radiation and device damage.

### 4.2 Location of Connectors

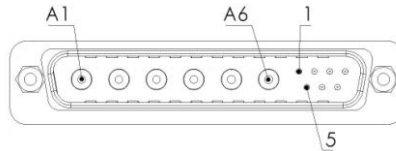


### 4.3 Earth Bonding

The integrator must comply with 61010-1:2010, Section 6.5.2 in the connection of the Protective Bonding fixing point. The G4 bonding fixing point is an M5 threaded hole and requires a fixing torque of 2Nm. The bonding point on the G4 Laser is for 'earth' connection to the chassis in which the laser is mounted. It should not be connected to the 0 V of the Diode 36 V PSU or the Logic 36 V PSU.

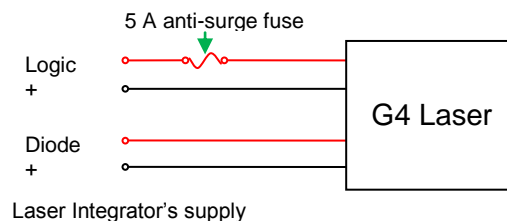
## 4.4 Power Connector

### 4.4.1 Power Connector Pin-Out



Pin	Signal Name	Level	Action
A1, A3	Diode Power Supply +	+33V	Power supply for pump Laser diodes
A2, A4	Diode Power Supply -	0 V	
A5, A6	Reserved		
1, 3, 4, 6, 7	Reserved		
2	Logic Power Supply +	+33V	Power supply for logic board (+ Pilot Laser if fitted)
5	Logic Power Supply -	0 V	

G4 Laser modules are supplied with a power supply cable (PT-E02469) with 2 pairs of conductors to allow easy connection to the required power supplies. Alternatively a shielded cable is available as a G4 accessory (PT-E02474). SPI Lasers recommends that the laser integrator implement the fuse shown below in their equipment to protect the logic supply to the G4 Laser.

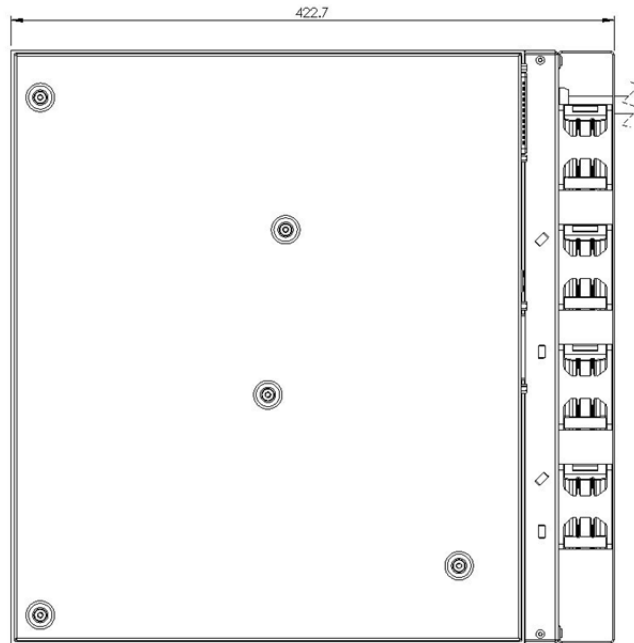


### 4.4.2 Power Supply Requirement

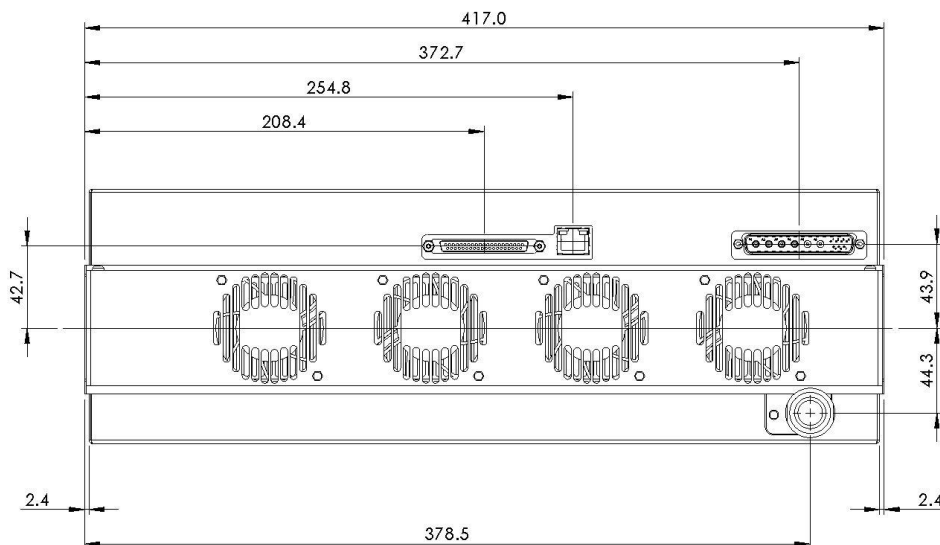
Parameter	Condition	Value
Output Voltage	Continuously rated	36 V DC (33 – 39 V)
Logic Power	Continuously rated	<50 W
Diode Power	Continuously rated	<900W
Minimum Load		No minimum load
Ripple and Noise	EIAJ test method, 20 MHz	<1% pk-pk
Hold Up	100% rated output power	>16 ms
Turn on Overshoot	Cold start no load	<5%
Load Regulation	0-100% load change	<1%
Line Regulation	Assuming $\pm 10\%$ input change	<0.5%
Voltage Isolation	Input-output (reinforced)	$\geq 3$ kV AC RMS
Voltage Isolation	Output-ground (operational)	$\geq 500$ V AC RMS

## 5 Mechanical Integration Details

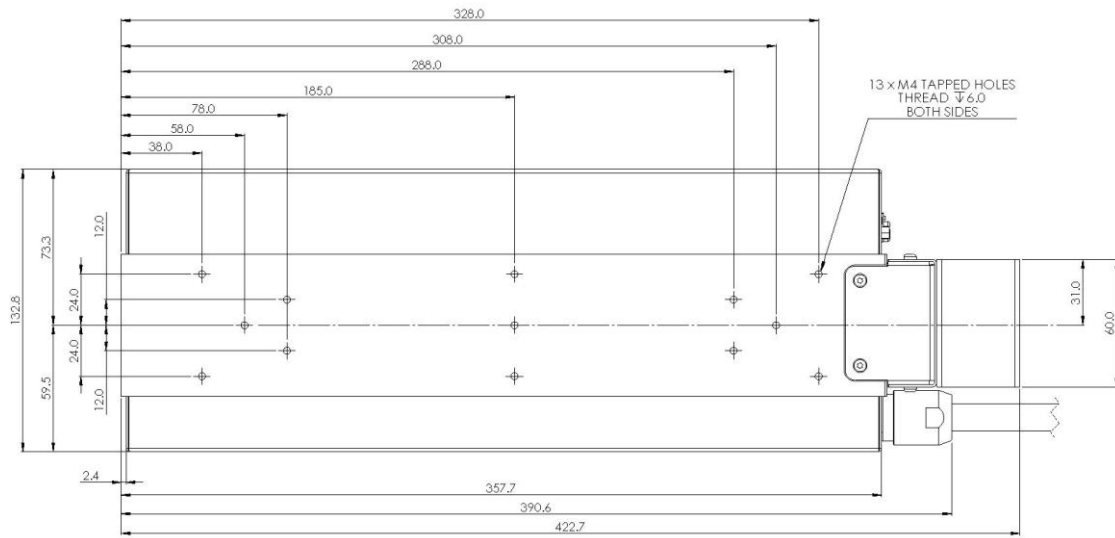
### 5.1 Top View



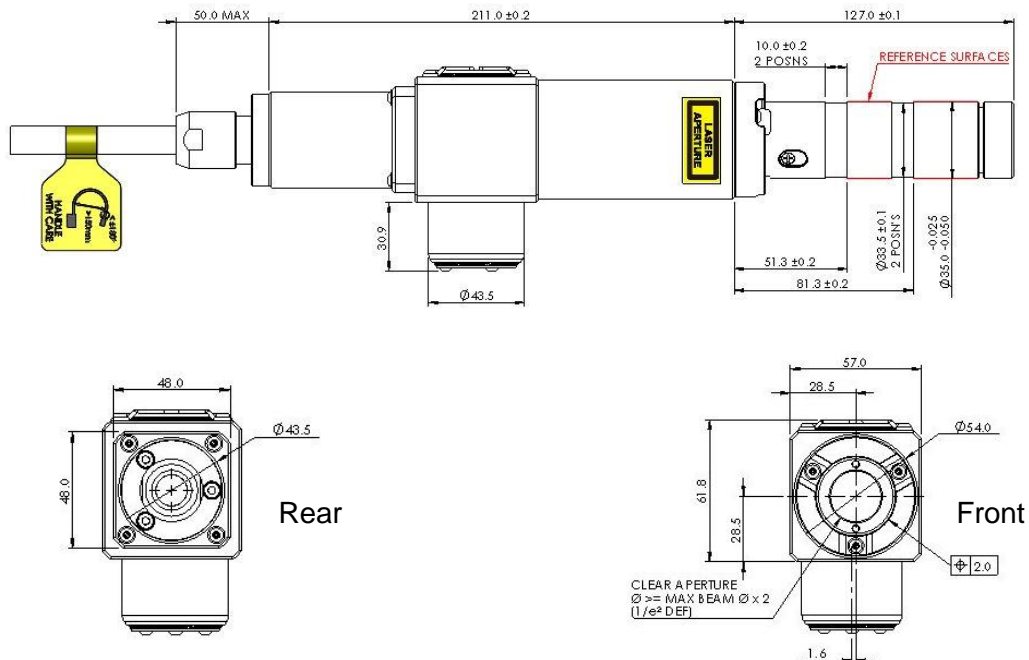
### 5.2 Front View, Cable Locations and Earth Stud Label



### 5.3 Side View and Mounting Hole Location

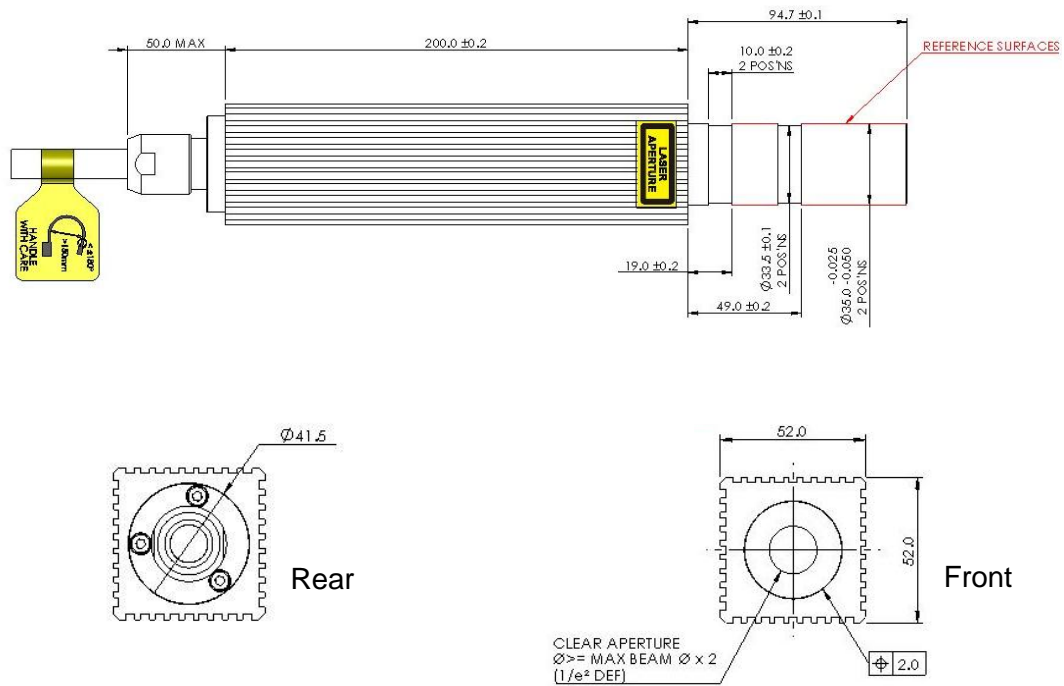


### 5.4 IBeam1 Delivery Optic (Type C1) - Dimensions and Labeling



**CAUTION:** The beam delivery optic cable should not be flexed to produce bend diameters <150 mm or twisted more than 180 degrees.

## 5.5 IBeam2 Delivery Optic (Type C2) - Dimensions and Labeling



**CAUTION:** The beam delivery optic cable should not be flexed to produce bend diameters <150 mm or twisted more than 180 degrees.

## 5.6 Mass of Laser Module and Beam Delivery Optics

Item	Approximate Mass
Air-Cooled Laser Module (including IBeam1 delivery optic and 3m cable)	26.5 kg
Air-Cooled Laser Module (excluding beam delivery optic and cable)	23.5 kg
IBeam1 (excluding cable)	1.8 kg
IBeam2 (excluding cable)	1.6 kg



## 6 Environmental and Cooling Details

### 6.1 Air-Cooled Lasers

G4 Lasers which are air-cooled have integrated temperature-controlled fans. The air intake is at the back of the laser, and the air exhaust is at the front (i.e. the fans are pulling air through the laser). The G4 Laser module should be located in an environment providing a free flow of **clean air** and protected from any processing that generates air-borne particulates. Cooling performance will be degraded from:

- Non-clean air leading to deposits on the heat-sink fins.
- Recirculation of air due to insufficient air-flow management.

#### 6.1.1 Operating and Storage Conditions

Parameter	Units	Min	Max
Operating temperature	°C	10	40
Storage temperature range	°C	-10	60
Relative humidity (non condensing) (operating & storage)	%	5	95



**WARNING:** High powered G4 Fiber Lasers may emit hazardous levels of audible noise. There may be sound pressure levels of 83dB 1m from the fans when running at full speed.

Laser Integrators should review the impact of the noise levels given above and apply appropriate noise reduction measures to reduce the noise level at relevant locations below that required by regional requirements or legislation.

Failure to do so may result in

- permanent hearing loss
- tinnitus
- tiredness, stress, headaches
- other effects such as loss of balance, loss of awareness
- interference with speech communication
- inability to hear acoustic warning signals

The fans should not be run at full speed when it is not necessary.