Declaration of Conformity

Laser Quantum declares that the product:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>opus</td>
<td>532 nm, 660 nm or 1064 nm DPSS laser</td>
</tr>
</tbody>
</table>

has been manufactured in conformity with the following standards:

- **BS EN 61010-1:2010** Safety requirements for electrical equipment for measurement and laboratory use. General requirements
- **BS EN 61326-1:2013** Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements
- **RoHS: 2011/65/EU** Restriction on the use of certain hazardous substances in electrical and electronic equipment

Caution
Failure to read this manual carefully before operating the laser may result in catastrophic damage to the system which may void the warranty.
Section 1: Introduction

The opus is a Diode-Pumped Solid-State (DPSS) laser system emitting light in the Infra-Red (1064 nm) or visible regions of the spectrum (532 nm or 660 nm), depending on the variant ordered. It is a Class 4 laser product. This manual describes the set-up requirements and operational procedures to ensure safe operation of the system.

Warning: Use of controls or procedures or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Section 1.1: Operational Requirement – Electrical Specification

The mpc6000 Power Supply Unit (PSU) requires

- Input Voltage 12 V DC
- Acceptable range 11 V to 14 V (Ripple 1% Peak to Peak)
- Input Current 16 A
- Minimum of 16 A must be available from the external source

Note the centre pin of the input connector is positive and the external DC source output shall not be referenced to mains ground.

Section 1.2: Operational Requirement – Environment

- Optimal Operating Temperature Range – Laser Head: 22ºC to 37ºC
- Maximum Operating Temperature – Laser Head: 40ºC
- Maximum Operating Temperature – PSU: 40ºC

For optimal performance, the laser head should be mounted onto an appropriate heatsink in a stable environmental temperature. The heatsink requirements will depend on the ambient temperature of the operating environment and the operating power of the laser (Section 6).

In the event of the laser head or PSU over-heating, a controlled shut down of the system will occur (Section 6.1). The system can only be restarted once it has been cooled to a safe temperature.

Section 1.3: Storage Requirement – Environment

- Temperature Range: 5ºC to 45ºC
- Humidity: Non-Condensing

Section 2: Laser Safety

The opus is a Class 4 laser product, this is denoted by the laser warning label affixed to the laser head; examples for both Infra-Red (1064 nm) and visible (532 nm) wavelengths are reproduced below. A further label also appears adjacent to the laser aperture.

When operating the laser, those in the environment must adhere to the following instructions to avoid eye damage and prevent the risk of fire:

- Laser safety goggles must be worn at all times when the laser is in operation
- Always ensure the beam is safely collected in a suitable beam stop or that the laser is disabled when not in use

For a full description of laser safety procedures, the user is referred to Declaration of Conformity standards plus:

- FDA Code of Federal Regulations (CFR) Title 21 Subchapter J section 1040.10 Laser products
- American National Standards for Safe Use of Lasers – ANSI Z136
Section 3: System Specifications

A full list of parts supplied with the laser systems appears in Section 3.1.

The dimensions (mm) and weights (kg) are shown in Section 3.2. These measurements should be referred to whilst integrating the system.

Section 3.1: Parts List

The opus laser system comes complete with:

- opus laser head
- mpc6000 Microprocessor Controlled Power Supply Unit (PSU)
- Umbilical Cable – to connect the laser head and PSU

Depending on the purchase specification, some or all of the following items may also be included:

- RS232 Serial Cable – for communication with the mpc6000 via computer
- External Power Supply Source (Mains AC to 12 V DC Desktop Module)
- IEC Mains Lead
- PSU Key Set – to operate the interlock key on the PSU control panel
- Interlock dongle – to enable the laser system (Green spot on casing and Green LED)**
- RemoteApp™ software suite & Operating Manual – delivered on a USB flash drive

** Note: If a red spot interlock dongle has been supplied, Section 5.1 is amended to include an additional safety warning which must be taken into consideration before operating the laser.

Section 3.2: Weights and Dimensions

opus laser head
Weight: 1.6 kg

mpc6000 PSU
Weight: 1.7 kg
Section 4: PSU Configuration Drawings

Fig 4.1

Key Switch  LCD Screen  Encoder

Menu Up Button "Unselect"
Menu Down Button "Select" & "Set"

Fig 4.2

1 2 3 4 5 6

1 Green  Serial Valid (OK)
2 Red  Laser Enabled
3 Red  Power Fail
4 Red  Over Temp Head
5 Red  Over Temp PSU
6 Green  Power LED

LED Functions

Attention: The laser contains components which can be damaged if exposed to an electro-static discharge. Ensure the connector pins on the back of the laser head are never exposed to an electro-static discharge.

Section 5: Laser Operation

Section 5.1: Switching the Laser ‘on’

1. Ensure the mpc6000 is not powered (i.e. 12 V DC source is switched off).
2. Connect the Umbilical Cable to the port marked ‘Laser Umbilical’ on the mpc6000 before connecting the other end to the laser head. Tighten the locking posts on the screws at both ends so they are finger tight.
3. Switch on the 12 V DC source, this should illuminate the mpc6000 green power LED. At this stage the thermal control circuitry is activated but no laser emission should occur.
4. The analogue Control port (see Fig 4.2) is multi-functional as it has connections for Interlock, Enable Switch and Laser Power Control. The Interlock must be closed to allow the laser to operate and this can be achieved using the supplied green spot interlock dongle.
5. With the Key Switch turned to the ‘on’ position, a momentary press of the Enable button will start the laser.

Attention: The laser contains components which can be damaged if exposed to an electro-static discharge. Ensure the connector pins on the back of the laser head are never exposed to an electro-static discharge.

Caution

Care must be taken to prevent direct exposure to the laser beam before the system is enabled.

Warning: If a red spot Interlock Dongle has been supplied with the laser system this will over-ride the need to press the Enable button. Turning the Key Switch to the ‘on’ position will start the laser.

6. Using the Encoder and Menu Up/Down buttons (see Fig 4.1) the operation current or power can be adjusted (see Section 5.3: Front Panel Controls).
7. The laser can be operated in either Power mode or Current mode, the selection of either mode is described in Section 5.3:

Power Mode
The laser power is constant and a feedback control loop maintains the power at the level requested by the operator via the Front Panel LCD.

Current Mode (opus 660 and opus 1064)
The pump diode current as selected by the operator is a percentage of the total pump diode current available. The requested current remains constant, however the power may drift due to environmental changes.
Section 5.2: Switching the Laser 'off'

The laser is switched off by turning the Key Switch to the 'off' position or disabling the interlock connection.

Section 5.3: Front Panel Controls

On the front panel of the PSU: ‘up’ button is marked 'down' button is marked.

In order to adjust the laser output, the user must first select the parameter mode displayed on the LCD screen by pressing the menu down button. This action changes the text to the navigation colour Blue. Depressing the menu down button again will change the text to the selected colour Red. The rotary encoder allows the selection of the required parameter (power or current). Once selected, depressing the menu up button once will return the parameter back to the navigation colour Blue. The laser is now operating in the selected mode.

Using the rotary encoder select the parameter power or current, depending on selected mode. Depressing the menu down again will change the selected colour Red. The value can then be changed using the rotary encoder. The value will change faster if the rotary encoder is depressed whilst rotated.

Once the desired value is reached, depressing the menu up button twice will store the parameter in long-term memory.

The selected parameter power or current - depending upon the operating mode – is represented on the top horizontal bar. The actual output power is displayed on the screen and on the bottom horizontal bar.

Both the laser head and power supply temperatures are displayed on the screen, as well as the Status display. The Status messages are tabulated below:

<table>
<thead>
<tr>
<th>Status message</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>KEYSWITCH : OFF</td>
<td>Keyswitch/Interlock disabled</td>
</tr>
<tr>
<td>ENABLE TO START</td>
<td>Laser ready, awaiting Enable button</td>
</tr>
<tr>
<td>LASER DISABLED</td>
<td>Laser disabled via RS232 command</td>
</tr>
<tr>
<td>LASER EMISSION</td>
<td>Danger! Laser emission</td>
</tr>
</tbody>
</table>

Section 5.4: Control Port - Functionality

The mpc6000 can be operated directly via the Control port (see fig. 4.2) by applying 0 to 5 V, interlocks and push button in accordance with the diagrams in this section.

![Diagram of Control Port](image)

The remote Interlock, Enable and Enable LED can be wired in accordance with the diagrams below [Fig 5.1 & Fig 5.2], to be used as part of a laboratory interlock safety circuit. If the Interlock is broken the system will shut down, the Enable button must be pressed to restart the system.

Connections to the control port shall be “potential free” i.e. isolated from mains voltage by a barrier rated at 3KV (e.g. Double Insulation, Etc).

The combined electrical resistance of the “Enable Switch”, “Interlock” and associated wiring shall be less than 5 ohms.

If a solid-state device such as an opto-isolator is used as the switching element(s), the total combined voltage drop must not exceed 500mV.

The current through the “Interlock” and “Enable Switch” circuitry is less than 100mA. The LED current source is 10V via a 540R resistor.

The PSU has its own 5 V source (pin 1) which must be shorted to pin 4 to allow full Power Mode operation. By wiring a variable potentiometer in accordance with the diagram [Fig 5.3] the laser current can be varied smoothly (Current Mode only).
Section 5.5: RS232 Port - Functionality

Control of the laser can be achieved via the RS232 port using a terminal emulator such as HyperTerminal or PuTTY. This allows the operator to:

- Turn the laser on/off
- Control the laser power
- Query for information such as laser head/PSU temperature
- Check the laser status

It is necessary to have the Interlock and Enable switches closed via the Control port in order to enable the laser, prior to controlling the laser through the RS232 port. Pins 1 and 4 of the Control port must be shorted together to allow maximum current to be set by the RS232 commands.

The RS232 port uses the standard 9-way connector pin configuration

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>TXD: RS232 - Transmit</td>
</tr>
<tr>
<td>3</td>
<td>RXD: RS232 - Receive</td>
</tr>
<tr>
<td>5</td>
<td>GND - Ground</td>
</tr>
</tbody>
</table>

Port settings are:

- Baud Rate: 19,200
- Parity: None
- Stop Bit: 1
- Hand Shaking: None

The operator must wait for a response from the PSU before sending the next command. A response is any text string (including null) followed by a Carriage Return, Line Feed.

Section 5.6: RS232 Port – Serial Commands

<table>
<thead>
<tr>
<th>Serial Command</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>Disables the laser, regardless of the interlock status</td>
</tr>
<tr>
<td>ON</td>
<td>Enables the laser subject to Interlock and Enable Switch status</td>
</tr>
<tr>
<td>CONTROL=CURRENT</td>
<td>Sets the Current mode on **</td>
</tr>
<tr>
<td>CONTROL=POWER</td>
<td>Sets the Power mode on</td>
</tr>
<tr>
<td>CURRENT=###</td>
<td>This sets the current to the diodes as a % of the maximum e.g. to set a current of 85% of maximum send CURRENT=85, followed by striking the RETURN key *</td>
</tr>
<tr>
<td>POWER=###</td>
<td>This sets the output power of the laser. For example, to set a power of 2800 mW, send the string POWER=2800, followed by striking the RETURN key</td>
</tr>
<tr>
<td>POWER?</td>
<td>Returns the power of the laser (read from the internal photodiode)</td>
</tr>
<tr>
<td>STEN=YES/NO</td>
<td>Enable (YES) or disables (NO) laser as default at start-up. This serial command must be followed by WRITE</td>
</tr>
<tr>
<td>STPPOW=###</td>
<td>### is the optical power in mW. Sets the default start-up power. This serial command must be followed by WRITE</td>
</tr>
<tr>
<td>ACTP=###</td>
<td>### is in mW. Recalibrates the APC mode (See section 5.8)</td>
</tr>
<tr>
<td>WRITE</td>
<td>Stores APC calibration, STEN and STPPOW in memory</td>
</tr>
<tr>
<td>LASTEMP?</td>
<td>Returns the temperature of the laser head in degrees centigrade</td>
</tr>
<tr>
<td>PSUTEMP?</td>
<td>Returns the temperature of the PSU in degrees centigrade</td>
</tr>
<tr>
<td>STATUS?</td>
<td>Returns the status of the Interlock</td>
</tr>
<tr>
<td>TIMERS?</td>
<td>Returns the timers of the laser and PSU:</td>
</tr>
<tr>
<td></td>
<td>PSU Time=########.#                                                        Total time the system has been powered</td>
</tr>
<tr>
<td></td>
<td>Laser Enabled Time=########.#                                             Total time the diodes have been powered</td>
</tr>
<tr>
<td></td>
<td>Laser Operation Time=########.#                                           Total time the diodes have been powered &gt;1A</td>
</tr>
<tr>
<td>VERSION?</td>
<td>Returns the software version</td>
</tr>
</tbody>
</table>

* A minimum % current threshold level is required to achieve laser emission. This threshold varies from laser to laser and is also dependent on the laser power.

** opus 660 and opus 1064
Section 5.7: RemoteApp™

Using Laser Quantum's unique RemoteApp™ software suite the laser can be controlled via the RS232 port. The application is supplied on a USB Flash Drive and should install automatically. Alternatively it can be downloaded from www.laserquantum.com. Follow the on-screen prompts to install the software onto the computer. RemoteApp™ includes a comprehensive instruction manual which can be accessed via the ‘Help’ and ‘Contents’ tabs.

The RemoteApp™ can also be used if a remote connection is required by our Service & Support Centre and is a powerful tool if performance optimisation is required.

Section 5.8: Re-calibrating the Laser Power

The laser can be recalibrated at any time during its use to ensure the APC mode is in good agreement with any external power meter device. Recalibration is a simple process that takes place via the RS232 port. The procedure for recalibration requires the RS232 port to be configured for use with a terminal emulator (section 5.5). The following procedure must be followed:

1. Select an intermediate power that the laser is capable of reaching. Set the laser to this power by typing the command `POWER=###`. “###” represents this intermediate or characteristic operating power level.

2. After a period of 5 minutes, measure the actual power using a calibrated, external power.

3. Type the command `ACTP= [external power meter reading in mW]`

4. Confirm that the laser has adjusted its power such that the external power meter now reads ###mW within a few mW

5. If necessary, repeat steps 3 and 4 until the calibration agrees

6. Once accepted, type the command WRITE to store the new calibration

**Please Note:** Take extra care to remove back-reflections to the laser. Any magnitude of back reflection may disturb the resonant cavity and will affect the APC feedback control loop.

Section 6: Cooling Requirements and Power Consumption

Section 6.1: Cooling Requirements

The laser has a characteristic warm-up period before it reaches specification; this time depends partly on the heatsink to which it is attached. However, the typical warm-up time is 10 minutes from switch on.

In order for the laser to perform to specification it must be adequately heatsinked. Operating the laser on an inadequate heatsink will adversely affect its stability and may result in thermal shutdown of the laser or reduction in optical power. Operating the laser on an Aluminium optical bench should produce optimum performance, although in higher powered systems this alone might not be enough to effectively remove the heat away from the laser. The user should consult section 6.2 of the user manual where the power consumption figures presented can be used as a first approximation of heat-dissipation. An additional cooling aid might be required (e.g. TEC, forced air cooling, water cooling). For further information on heatsinking, please consult your sales representative who will be able to provide a heatsink solution.

opus laser head

Once the maximum operational temperature for the laser head (see Section 1.2) has been reached, one of two things will occur:

1) The current to the diode will immediately be switched off and the laser system will need to be restarted once the temperature has been restored to normal

2) If de-rating is enabled the current will gradually be reduced to zero in order to try to allow the laser head temperature to stabilise. If the current does reach zero the system will need to be restarted. The effects of de-rating are shown in the table below:

<table>
<thead>
<tr>
<th>Current to Laser</th>
<th>Head/Laser OVERTEMP LED</th>
<th>Colour of Laser and PSU text on LCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>As set by user</td>
<td>Off</td>
<td>Orange</td>
</tr>
<tr>
<td>Begins to de-rate</td>
<td>Flashes</td>
<td>Flash Red and White</td>
</tr>
<tr>
<td>Reduced to zero</td>
<td>On</td>
<td>Flash Red and White</td>
</tr>
</tbody>
</table>

mpc6000 PSU

A similar arrangement occurs for the PSU once the maximum operating temperature (see Section 1.2) has been reached. Note: The indicator LED in this instance is marked ‘PSU OVERTEMP LED’.
**Section 6.2: Power Consumption**

The power consumption shown is that which is drawn at the plug from the mains supply in both the maximum and typical states. The maximum power will usually be drawn at start up and the typical power is when all temperatures are stabilised and the system is operating at the specified power. Peak values are shown in all cases.

Maximum at 240 V supply – using the supplied External Power Supply Source:

240 W

At the 12 V input the MPC6000 can draw maximum of 16 A

**532 nm Laser System: Maximum (laser system power shown in blue)**

- 2000 mW  65 W
- 3000 mW  70 W
- 6000 mW  110 W

**532 nm Laser System: Typical (laser system power shown in blue)**

- 2000 mW  60 W
- 3000 mW  65 W
- 6000 mW  105 W

**660 nm Laser System: Maximum (laser system power shown in blue)**

- 1500 mW  95 W

**660 nm Laser System: Typical (laser system power shown in blue)**

- 1500 mW  85 W

**1064 nm Laser System: Maximum (laser system power shown in blue)**

- 1,000 mW  55 W
- 4,000 mW  100 W
- 10,000 mW  180 W

**1064 nm Laser System: Typical (laser system power shown in blue)**

- 1,000 mW  45 W
- 4,000 mW  80 W
- 10,000 mW  150 W

The power dissipation of the laser head is no more than 40% of the total power consumption. The values shown are system power consumption.

**Section 7: Laser Maintenance**

If the opus is operated in a smoky or dirty environment, occasional cleaning of the laser window may be necessary. To perform this procedure, the laser must be turned off and, using optical cloth dampened with research grade methanol, the laser window must be wiped gently.

- Always follow the instructions given in this operating manual
- Never touch the connector on the laser head with anything other than the umbilical cable provided and always follow the connection instructions in this operating manual
- Do not open the laser head or PSU; this will immediately invalidate the warranty
- Do not subject the laser head to mechanical shock; if severe this can cause mis-alignment of the laser cavity
- Do not allow the output window of the laser to be touched as this may damage the precision optical coatings used. Avoid very dirty atmospheres where dirt may settle on the window
- Do not operate or store this laser system in very humid or damp environments

**Section 8: Liability**

Laser Quantum accepts no liability for damage to persons or property caused by incorrect or unsafe use of any of its products; this is the sole responsibility of the user. Proper safety regulations for the use of these products must be observed at all times.
Section 9: Warranty

Laser Quantum provides a return to base warranty across all our product ranges (see Support Section 10). The warranty period for your laser can be found on the invoice provided with the system. Any time period referred to by the sale is based on psu/controller time, NOT lasing time.

Warranty cover for the laser is subject to proper use, care and protection from mistreatment. Examples of mistreatment include, but are not limited to any of the following:

- Any deviation from the instructions laid out in the operating manual
- Opening the product or breaking the warranty seals
- Operation in any hostile environment as outlined in the operating manual
- Any damage due to operation in unclean environments
- Any substantial mechanical shock
- Any damage through static discharge (this will not occur under normal operation)

The definition of mistreatment and its applicability to the warranty is at the reasonable discretion of Laser Quantum.

Laser Quantum's obligation under this warranty is limited to the replacement or repair of the product which having been returned to the factory is found to be defective, and where the defect was not caused by factors external to the product. Any replacement part/product is under warranty for the remainder of the initial product warranty period.

Section 10: Support

Should the laser fall below acceptable specification performance, please contact our service and support team on +44 161 975 5306 or email: support@laserquantum.com. They will provide initial assistance to rectify the problem remotely. If this is not possible, they will provide you with a Return Material Authorisation (RMA) Form and instruction on how to package and return the laser safely to us for assessment.

For our commitment to the 'Waste Electrical' compliance requirements we recommend you to return your systems back to the manufacturing site at end of life. This take-back service will enable us to put the systems beyond use and disseminate the parts into recycling waste streams.

PLEASE DO NOT RETURN THE LASER WITHOUT PRIOR CONTACT WITH AND AGREEMENT FROM OUR SUPPORT TEAM

E: info@laserquantum.com
W: www.laserquantum.com