

Luminos Photonics Positioner

User Manual

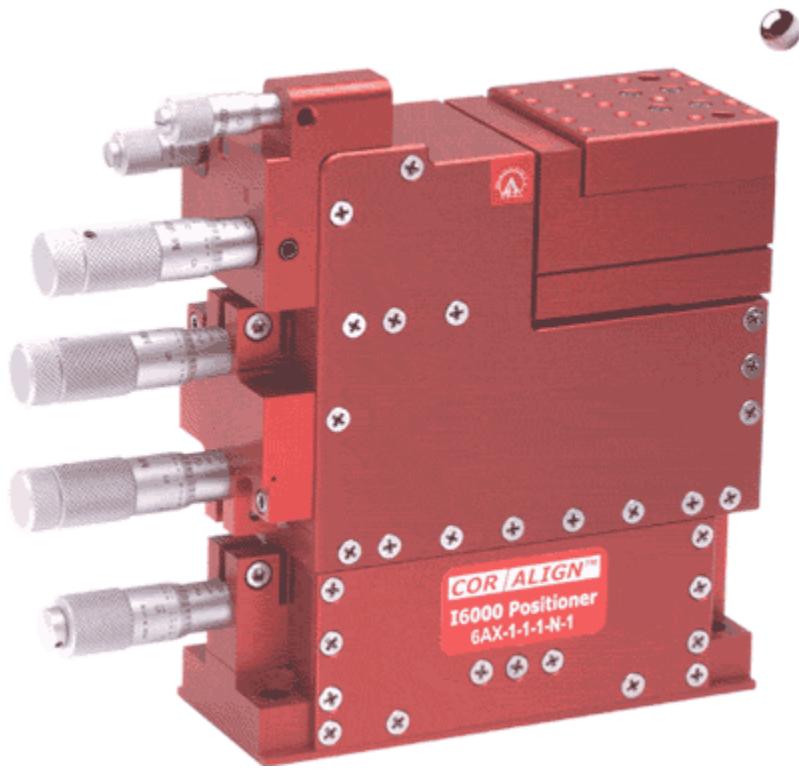


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Introduction to the I6000/I6005 Photonics Positioner

Welcome to the Luminos Photonics Positioner - a positioning system so stable and easy to adjust that aligning single mode optical fibers is as easy as tuning a radio. There is no need to let go of the micrometers during operation; the Luminos Photonics Positioner is extremely touch insensitive. With the patented ergonomic inline design, all micrometers are easily accessible on one side. Just rest your hand comfortably on the table and enjoy the ease and efficiency of quickly aligning any type of fiber.

No fiber alignment challenge is too difficult - even 1-2 micron core lensed fibers can easily be aligned. The Luminos Photonics Positioner uses a patented Ratio Drive™ for the X & Y axes resulting in less hysteresis and increased resolution.

Conventional stacked stages have separate frames with each frame simply mounted on the output of the previous stage. This results in the stiffness at the micrometer being degraded by the lack of stiffness between the mounting reference and output of each stage below it. Hand forces on the micrometer are then easily transmitted directly to the output causing the alignment to wander; thus typically resulting in an adjust-release-wait cycle by the operator.

In contrast, the Luminos Photonics Positioner consists of only two frames. The Z stage is one frame while all the other micrometers are anchored to a shared fixed frame that is attached directly to the output of the Z stage. The Z stage is exceptionally stiff and therefore is not a factor. By sharing a common rigid frame, forces exerted on the micrometers by the operator during adjustment are shunted directly to the base instead of to the output. The operator can then quickly align without letting go.

The Luminos Photonics Positioner is also vibration and temperature insensitive. Internal viscous damping eliminates many of the resonance effects typically associated with flexure stages.

Luminos stages generate extremely smooth linear motion utilizing patented flexure technology. The error motion associated with frictional ball bearings has been eliminated. Consequently, these stages move with smooth monotonic motion. The force required from an actuator in order to move a stage is also linear without the typical stiction that is found with ball or frictional type stages.

In general, single stage flexure designs are subject to arcuate motional error as each single stage moves in a physical arc. In the Luminos design, the large travel Z stage is a frictionless dual compensated flexure design wherein two precision flexure stages are made to move identically together such that the arcuate errors are eliminated. This technique offers a straightness of motion that is comparable to a precision bearing stage while affording a large travel not commonly found in flexure designs. The flexure stages used for transverse ("X") and vertical ("Y") motion are single stage flexures; however, they are oriented such that their resultant arcuate motions are in the large travel "Z" direction (typically the optical axis). The overall result is that the Luminos stages can be operated in even a manual mode without the operator experiencing objectionable off-axis motion.

The rotational stages are also flexure based with frictionless drive systems. All the rotational axis are coincident and pass through a focal point that is located 1" in front of the stage and ½ inch above the work plate. This allows for up to 4 – 6 Axis stages to be arranged in a cluster around a small sample if desired. The Pitch and Yaw flexure stages have been carefully designed as “dual compensated flexure stages” identical in concept to the Z Axis stage. This allows a operator to pivot in virtual space without any significant off-axis arc error motion. Believe it or not, two aligned tapered optical single mode fibers with a mode field diameter of even 2 microns can be rotated throughout pitch and yaw while maintaining the optical signal. The roll stage is a frictionless drive single stage design. In a typical alignment of a fiber array, the bulk of any Roll adjustment is carried out in a far-field alignment state in order to align the fibers at either end of a fiber array. Subsequent fine rotational adjustments are then very minor and off-axis error motion is negligible. Tests have shown that SM fiber arrays up to 100 fibers wide (0.25mm spacing) can be aligned readily using a manual Luminos Photonics Positioner. The precision and ease of use of this stage truly cannot be appreciated without having used it. In most cases, the Luminos Photonics Positioner enables difficult array elements to be easily aligned where the only previous option was to use an automated system. Luminos also offers full automation solutions based on the Luminos Photonics Positioner positioning platform that are truly unique. A complete automated solution including controllers can be held in your hand.

Feature Summary

- Patented Inline actuators provide ease of access and multiple unit workstations.
- Patented Ratio Drive™ system affords superior resolution for far less cost.
- Small footprint allows multiple unit workstations (Fig 2).
- Onboard controller for actuators avoids high cost of separate motion controllers.
- Damped exterior shell design provides superior vibration and touch insensitivity.
- Lightweight aluminum construction allows system to be moved easily by other motion equipment.
- High mechanical stiffness affords rugged and stable base system.
- Patented linear dual flexure Z offers frictionless repeatable straight travel.
- Dual flexure Yaw and Pitch stages provide extreme resolution without arc error.

With positioning this easy... the possibilities are endless.

Getting Started

Before unpacking the positioner, please read Unpacking and Transportation on page 10.

Reading the Micrometers

The following table gives the conversion necessary to interpret the numbers read from the micrometer.

| Axis | Smallest Division (A) | | 1 Rotation (B) | |
|--------------|-----------------------|-------------|----------------|-------------|
| Pitch | 30 | arc seconds | 15 | arc minutes |
| Yaw | 30 | arc seconds | 15 | arc minutes |
| Roll | 10 | arc seconds | 10 | arc minutes |
| Y | 1 | μm | 25 | μm |
| X | 1 | μm | 25 | μm |
| Z | 0.001 | inches | 0.025 | inches |

Each line on the shaft of the micrometer corresponds to one rotation. The “smallest division” refers to the divisions on the knob of the micrometer. Clockwise rotation of each micrometer causes movement in a positive direction as shown in Figure 1 (pg. 4).

To calculate the position, count the number of divisions on the shaft between the current position and zero. Multiply that number by the movement per rotation (B) given in the table above. Then, count the number divisions on the knob from zero, multiply that number by the movement per smallest division (A in the table above). Add the two products calculated to give the position. The formula is summarized as:

$$\text{Position} = (\text{Shaft Divisions} \times B) + (\text{Knob Divisions} \times A)$$

Note: If the coarse adjustment of the X or Y axis is moved, the position read from the micrometer of that axis will not be the same physical position as before moving the coarse adjustment.

Mounting the Positioner

The Luminos Photonics Positioner mounts using 1/4-20 screws on 1 inch and 4 inch centers

Mounting Devices and Accessories

The device mounting plate (the square plate at the top of the positioner) is where devices and accessories are mounted.

As shown in Figure 1 (pg. 4), the center of rotation for all axes is 1 inch out and 1/2 inch up from the end of the device mounting plate. To avoid having to adjust the X,Y and Z axes when rotating the device, the device alignment point should be as close as possible to the rotation center.

Accessories

There are many accessories available including a contact sensing system for sensing very small forces in the Z (focal) direction. Contact us if there is an accessory you require.

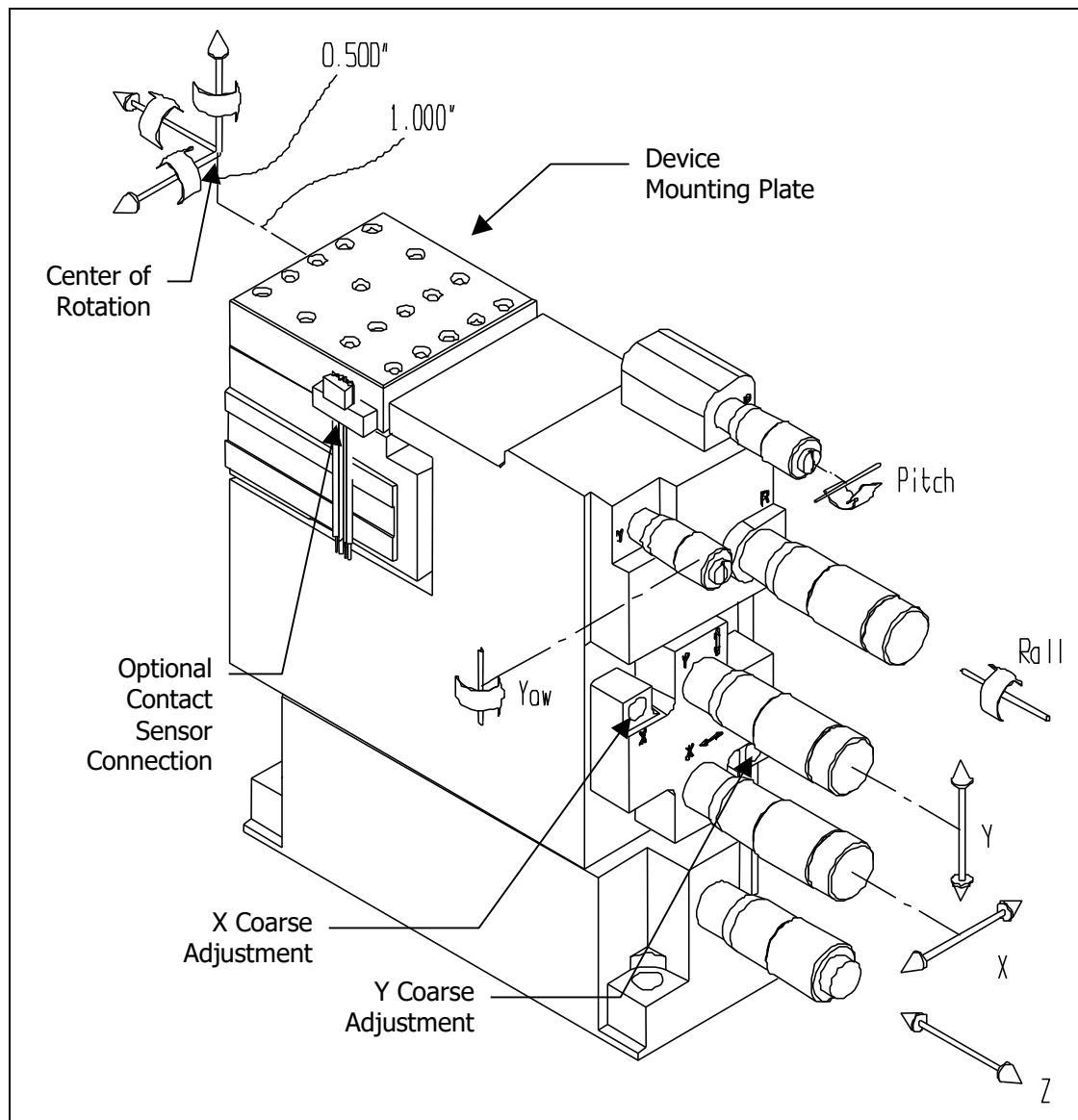


Figure 1 - Luminos Photonics Positioner 6-Axis Positioner

Luminos Photonics Positioner Specifications

Travel

| Axis | | Actuator¹ | Coarse | Total |
|-------------|--------------|-----------------------------|---------------|-----------------|
| Z – focus | | 12.7mm (0.5") | N/A | 12.7mm (0.500") |
| I6000 | Y – vertical | 0.5mm (0.02") | 2mm (0.080") | 2.5mm (0.1") |
| | X – lateral | 0.5mm (0.02") | 2mm (0.080") | 2.5mm (0.1") |
| I6005 | Y – vertical | 2.5mm (0.1") | N/A | 2.5mm (0.1") |
| | X – lateral | 2.5mm (0.1") | N/A | 2.5mm (0.1") |
| Roll | | 3 degrees | N/A | 3 degrees |
| Yaw | | 3 degrees | N/A | 3 degrees |
| Pitch | | 3 degrees | N/A | 3 degrees |

Setability² (Micrometer)

| Axis | | Resolution | Movement /Division |
|-------------|---|------------------------------|---|
| Z | | 0.25 micron (10 μ -inch) | 0.001" |
| I6000 | Y | 10nm (0.4 μ -inch) | 1 μ m - 25x Ratio Drive TM |
| | X | 10nm (0.4 μ -inch) | 1 μ m - 25x Ratio Drive TM |
| I6005 | Y | 50nm (2 μ -inch) | 5 μ m - 5x Ratio Drive TM |
| | X | 50nm (2 μ -inch) | 5 μ m - 5x Ratio Drive TM |
| Roll | | 0.1 arc sec | 10 arc sec |
| Yaw | | 0.2 arc sec | 30 arc sec |
| Pitch | | 0.2 arc sec | 30 arc sec |

Resolution (Stepper Motor – Type A)

| Axis | | Resolution | Total Steps |
|-------------|---|------------------------|---|
| Z | | 100nm (4 μ -inch) | 128 000 |
| I6000 | Y | 4nm (0.16 μ -inch) | 128 000 - 25x Ratio Drive TM |
| | X | 4nm (0.16 μ -inch) | 128 000 - 25x Ratio Drive TM |
| I6005 | Y | 20nm (0.8 μ -inch) | 128 000 - 5x Ratio Drive TM |
| | X | 20nm (0.8 μ -inch) | 128 000 - 5x Ratio Drive TM |
| Roll | | 0.1 arc sec | 101 206 |
| Yaw | | 0.2 arc sec | 60 416 |
| Pitch | | 0.2 arc sec | 60 416 |

Stage Configuration & Arc Error Motion

| Axis | | Flexure Type | Arc Error |
|-------------|--|---------------------|--------------------------------------|
| Z | | Dual | None - True Linear Motion |
| Y | | Single | Max 30 μ m - Arc Error in Z only |
| X | | Single | Max 30 μ m - Arc Error in Z only |
| Roll | | Single | Max 35 μ m |
| Yaw | | Dual | None |
| Pitch | | Dual | None |

Linear Stiffness

| Along Axis | | Stiffness | Comments |
|-------------------|--|------------------|---------------------------------|
| Z | | 130 kN/m | measured at the rotation center |
| Y | | 95 kN/m | measured at the rotation center |
| X | | 40 kN/m | measured at the rotation center |

| Torsional Stiffness | | |
|----------------------------|-----------------------|---|
| About Axis | Stiffness | Comments |
| Z – roll | 75Nm/rad | measured at the rotation center |
| Y – yaw | 100Nm/rad | measured at the rotation center |
| X – pitch | 130Nm/rad | measured at the rotation center |
| Maximum Load | | |
| Static Load | Transient Load | Comments |
| 2.2 lbs (1kg) | 10 lbs (4.5kg) | stage must be protected from shock loading during transport and usage |
| Physical Properties | | |
| Characteristic | Specifications | Comments |
| Construction | Aluminum | 6061 & 7075 - T6 anodized |
| Weight | 1.5kg | Approximate |
| Body Dimensions | 5.79" x 1.75" x 5.19" | LxWxH excluding micrometers |
| Mounting Height | 5.19" | Base to top of mounting plate |
| Mounting Config. Imperial | 0.26" dia. holes | 1.00" x 4.00" ³ centers |
| Mounting Config. Metric | 6.6mm dia. holes | 25mm x 100mm centers |
| Concurrent Rotation Center | 1/2" | Above top of mounting plate |
| | 1" | Out from end of mounting plate |

¹ 'Actuator' refers to a micrometer or stepper motor.

² Operator dependent

³ Compatible with 1.00" grid optical tables, units mount on 2" intervals with 0.25" allowance for routing of cables etc.

What is Ratio Drive™?

Ratio Drive™ is a means of "dividing down" the motion of the actuator to give higher resolution at the output of a positioner stage. This causes the output of the positioner stage to be only a fraction of the movement of the actuator - increasing resolution and decreasing backlash (since no gears are used in the Ratio Drive™). This technique allows the use of a standard micrometer or inexpensive stepper motor for enhanced, high precision alignment. Note: Ratio Drives™ are only on the X and Y axes.

25x Ratio Drive™

With the 25x Ratio Drive™, 12.7mm of micrometer travel is divided down 25.4 times to give 0.5mm of travel at the output plate. Coarse adjustments using an Allen key add an additional 2mm for a total of 2.5mm of travel. With the stepper motor actuator, the X & Y stages achieve a resolution of 4 nanometers on X and Y axes.

Products that incorporate the 25x Ratio Drive™ include the I3000, I5000 and I6000.

5x Ratio Drive™

A 5x Ratio Drive™ divides the motion down by 5 times so that one 12.7mm of actuator travel becomes 2.5mm at the output. With this option, there are no coarse adjustments and the full 2.5mm of travel is available from the micrometer or stepper motor. With the stepper motor actuator, the X & Y stages achieve 20 nanometers of resolution.

Products that incorporate the 5x Ratio Drive™ include the I3005, I5005 and I6005.

Note that the accuracy, backlash, repeatability and resolution are improved considerably on the X and Y axes by the 5x Ratio Drive and more so by the 25x Ratio Drive.

Available Options

Z Actuator

Manual Imperial Micrometer (default)

*A micrometer where the smallest division is 0.001 inches
(0.025" per revolution)*

Differential Micrometer (Imperial)

A double threaded micrometer for increased resolution where the smallest division is 0.00002 inches.

Stepper, Fine Travel, 0.1µm microstep, RS-232 Onboard Controller

Stepper, Long Life, 0.2µm microstep, RS-232 Onboard Controller

X Actuator

Manual Imperial Micrometer (default)

A micrometer where the smallest division is 1 µm (25 µm per revolution)

Stepper, Fine Travel, 0.1µm microstep, RS-232 Onboard Controller

Stepper, Long Life, 0.2µm microstep, RS-232 Onboard Controller

Y Actuator

Manual Imperial Micrometer (default)

A micrometer where the smallest division is 1 µm (25 µm per revolution)

Stepper, Fine Travel, 0.1µm microstep, RS-232 Onboard Controller

Stepper, Long Life, 0.2µm microstep, RS-232 Onboard Controller

Roll Actuator

Manual Micrometer (default)

*A micrometer where the smallest division is 10 arc sec
(10 arc min per revolution)*

Stepper, Fine Travel, 0.1µm microstep, RS-232 Onboard Controller

Stepper, Long Life, 0.2µm microstep, RS-232 Onboard Controller

Yaw Actuator

Manual Micrometer (default)

*A micrometer where the smallest division is 30 arc sec
(15 arc min per revolution)*

Stepper, Fine Travel, 0.1µm microstep, RS-232 Onboard Controller

Stepper, Long Life, 0.2µm microstep, RS-232 Onboard Controller

Pitch Actuator

Manual Micrometer (default)

*A micrometer where the smallest division is 30 arc sec
(15 arc min per revolution)*

Stepper, Fine Travel, 0.1µm microstep, RS-232 Onboard Controller

Stepper, Long Life, 0.2µm microstep, RS-232 Onboard Controller

XY Coarse Adjust

40 pitch set screw (default)

A flush set screw that gives 1/40 inches per revolution. Requires 3/32" ball point hex driver, McMaster-Carr Catalogue # 7268A54

40 pitch thumbscrew

A small knob that gives 1/40 inches per revolution at the output; allows easy adjustment of the coarse control.

80 pitch thumbscrew

A small knob that gives 1/80 inches per rotation at the output; allows easy adjustment of the coarse control.

Mounting Axis

Horizontal (default)

The positioner is set up to be balanced in the horizontal and upright position.

Vertical

The positioner is set up to be balanced with the micrometers pointing up. This configuration requires more preload on the z-axis.

Units

Imperial (Default)

1" table: 1/4-20, 4-40 device mounting plate

SI

25mm table: M6, M2.5x0.7mm device mounting plate

Note: Imperial and SI units are dimensionally the same.

Unpacking and Transportation

Do not discard packaging! The warranty is void if a Positioner is not shipped in the original packaging.

Locking Strip Removal

To prevent damage to the Z axis linkage during transportation a plastic locking strip is inserted between the upper and lower part of the unit (see Figure 2, below). To remove the locking strip, apply hand force to the upper portion of the unit (Z axis direction), remove locking strip and carefully allow the unit to return to its pre-loaded position. This procedure is applicable to all positioner types.

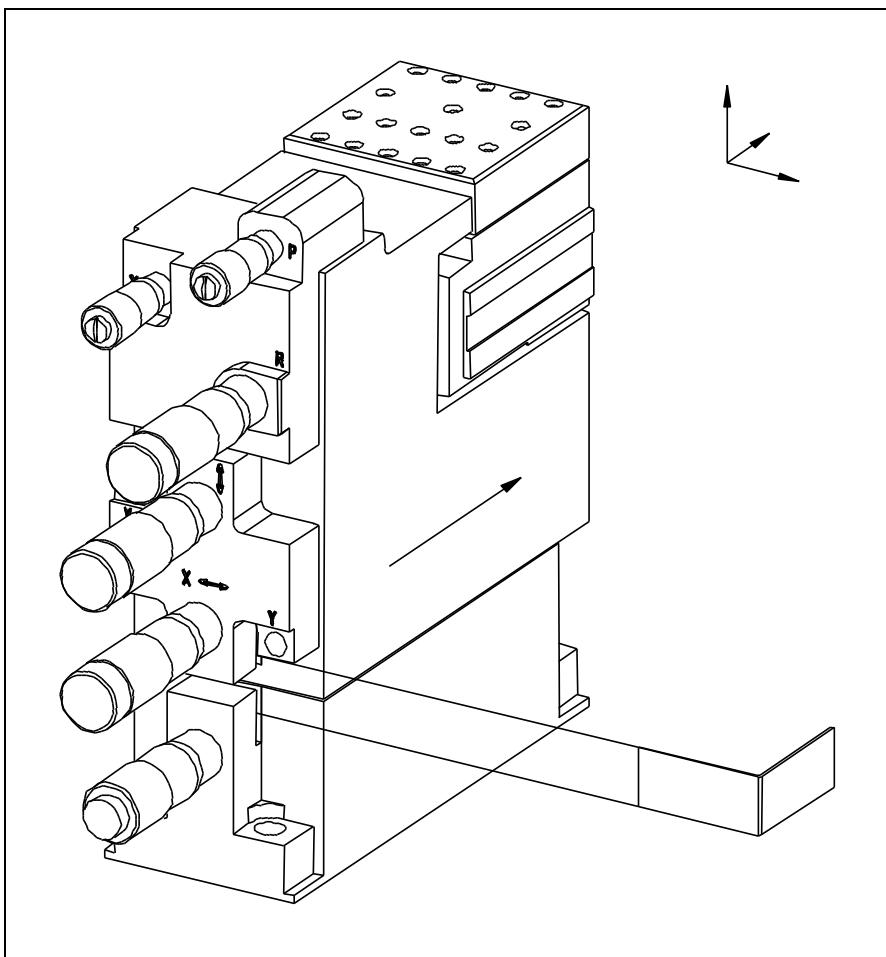


Figure 2 – Unpacking

Contact Us

Thank you for purchasing a Luminos product. We want to ensure your experience is a positive one. If you have any questions, concerns, or comments do not hesitate to contact us.

Mailing Address

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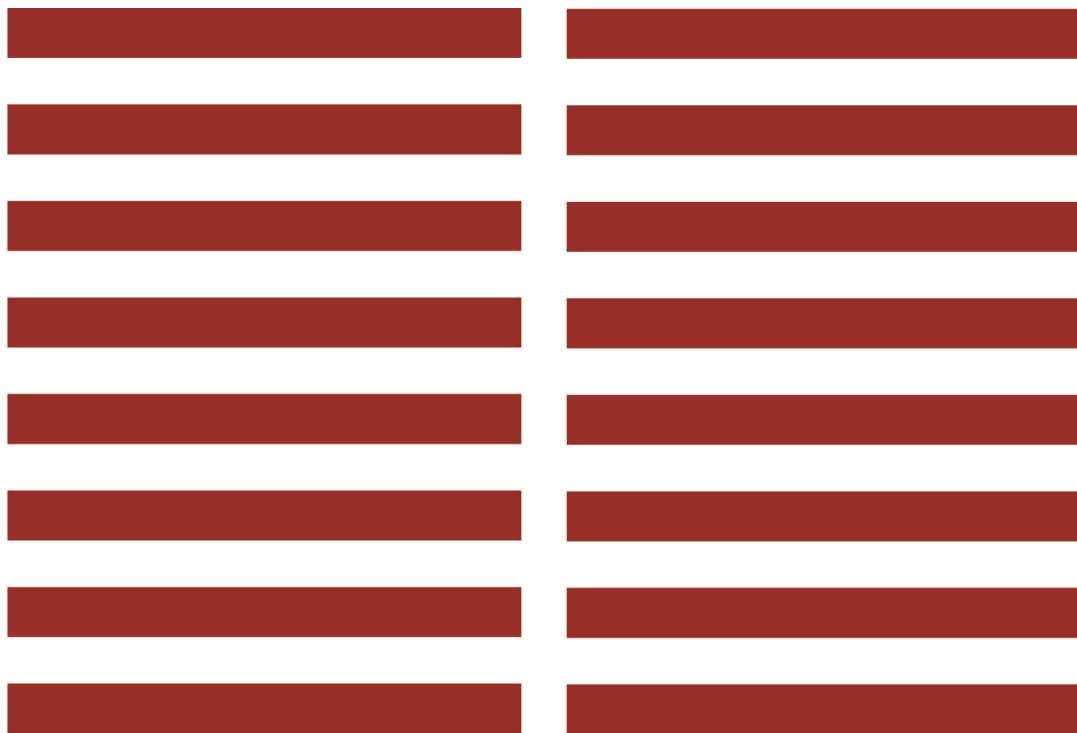
Warranty

All items manufactured by Luminos Photonics are warranted to meet Luminos Photonics published specifications and to be free of defects in materials and workmanship as defined in the specifications for 90 days after delivery. Luminos Photonics will, at its own option, repair or replace without charge any listed item discovered to be defective.

Luminos Photonics will not be held liable for any loss beyond the purchase price paid by the buyer for the goods to which claim is made. Luminos Photonics does not give implied warranties of merchantability, fitness for a particular purpose, or of any other nature in connection with the sale of any Luminos Photonics products.

Products not returned in original packaging will void this warranty.

This warranty does not extend to cover damage resulting from alteration, misuse, negligence, abuse, normal wear and tear, or accident.



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PHOTONICS

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