Mid-IR Faraday Isolator

Mid-IR ISO-FRDY Series User's Manual

Newport®

Experience | Solutions

Warranty

Newport Corporation warrants that this product will be free from defects in material and workmanship and will comply with Newport's published specifications at the time of sale for a period of one year from date of shipment. If found to be defective during the warranty period, the product will either be repaired or replaced at Newport's option.

To exercise this warranty, write or call your local Newport office or representative, or contact Newport headquarters in Irvine, California. You will be given prompt assistance and return instructions. Send the product, freight prepaid, to the indicated service facility. Repairs will be made and the instrument returned freight prepaid. Repaired products are warranted for the remainder of the original warranty period or 90 days, whichever is longer.

Limitation of Warranty

The above warranties do not apply to products which have been repaired or modified without Newport's written approval, or products subjected to unusual physical, thermal or electrical stress, improper installation, misuse, abuse, accident or negligence in use, storage, transportation or handling. This warranty also does not apply to fuses, batteries, or damage from battery leakage.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE. NEWPORT CORPORATION SHALL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, OR CONSEQUENTIAL DAMAGES RESULTING FROM THE PURCHASE OR USE OF ITS PRODUCTS.

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This manual has been provided for information only and product specifications are subject to change without notice. Any change will be reflected in future printings.

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Newport Corporation Calling Procedure

If there are any defects in material or workmanship or a failure to meet specifications, promptly notify Newport's Returns Department by calling 1-800-222-6440or by visiting our website at www.newport.com/returns within the warranty period to obtain a **Return Material Authorization Number (RMA#).** Return the product to Newport Corporation, freight prepaid, clearly marked with the RMA# and we will either repair or replace it at our discretion. Newport is not responsible for damage occurring in transit and is not obligated to accept products returned without an RMA#.

E-mail: rma.service@newport.com

When calling Newport Corporation, please provide the customer care representative with the following information:

- Your Contact Information
- Serial number or original order number
- Description of problem (i.e., hardware or software)

To help our Technical Support Representatives diagnose your problem, please note the following conditions:

- Is the system used for manufacturing or research and development?
- What was the state of the system right before the problem?
- Have you seen this problem before? If so, how often?
- Can the system continue to operate with this problem? Or is the system nonoperational?
- Can you identify anything that was different before this problem occurred?

Table of Contents

1 General Information

1.1 Introduction

Your Newport Faraday Isolator is essentially a uni-directional light valve. It is used to protect a laser source from destabilizing feedback or actual damage from back-reflected light. Figure 1 below identifies the main elements of your Faraday Isolator.

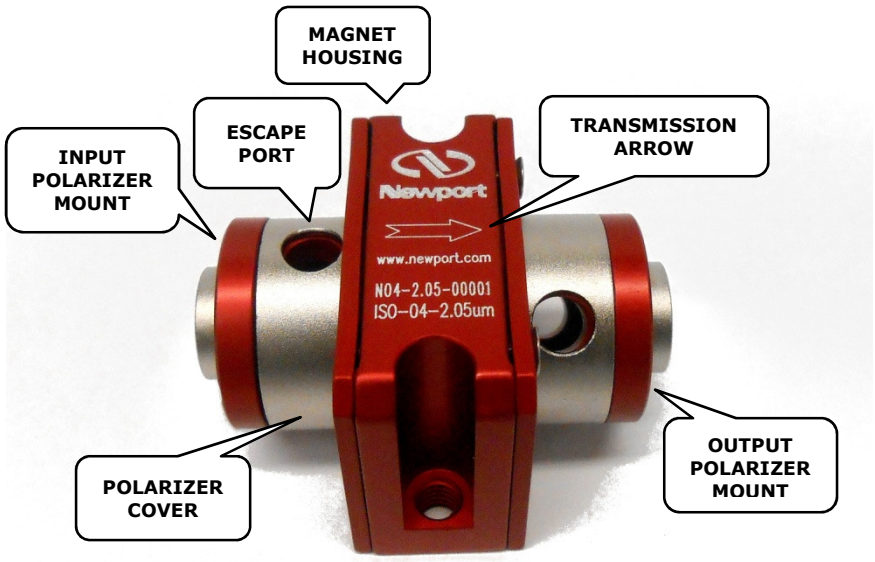


Figure 1: Newport's Mid-IR Faraday Isolator

The Faraday Isolator is a cylindrically-shaped magneto-optic device in which strong permanent magnets are used to generate axially-oriented fields within the magnet housing. The strong longitudinal field causes 45 degrees of non-reciprocal polarization rotation for propagating light via the Faraday Effect in the crystal located within the magnet housing. In operation, the magnet housing is sandwiched between input and output polarizers that have their transmission axis oriented 45 degrees relative to each other to account for the 45 degrees of Faraday rotation in the forward (transmission) direction. In the reverse (isolation) direction the non-reciprocal Faraday rotation and the 45 degree polarizer transmission axis angle add so that the polarization transmitted by the output polarizer is rejected at the input polarizer.

Your Newport Faraday Isolator is labeled with a serial number on the baseplate of the device.

1.2 Safety

The operational hazards presented to operating personnel by the use of your Newport Faraday Isolator are listed below. An explanation of how the Faraday Isolator is designed, together with procedures users can employ to eliminate or minimize these hazards are also listed.

1. Danger of sharp ferromagnetic objects being attracted to the residual permanent magnet fields outside of the isolator. This hazard is of most concern if such fields cause flying objects when being handled.

Your Newport Faraday Isolator requires strong internal magnetic fields to operate properly. Efforts have been made to minimize external fields from the device while still maintaining a relatively small and cost effective package. The external fields are designed to be well within federal safety guidelines which limit external fields from magnetic devices to be less than 2K Gauss at a radial distance of 5cm from the outside of the device. However, such fields can be sufficient to attract nearby objects such as knives and razor blades. Should attraction of such objects begin to occur there would be a strong attractive force directing these objects towards the interior of the magnet housing. This could be particularly likely to result in injury (e.g. a cut or puncture wound) if such attraction occurred while the device was being handled – particularly if a body part of the operating personnel is near a beam Aperture (i.e. end) of the device.

To minimize the above risks remove all loose ferromagnetic objects from the path over which your Newport Faraday Isolator is to be moved prior to attempting to move it. **Do not** pick up the isolator by its ends (i.e. apertures) where the attractive magnetic fields are strongest. Always pick the isolator up along its sides.

2. Never attempt to disassemble the magnetic housing of your Faraday Rotator/Isolator. Serious injury could result.

3. Reflection of rejected beams from the input and output polarizer.

The polarizer covers have been positioned at the factory to block all beams rejected from the polarizers. In the event that your Faraday Isolator will be used with transmitted average powers in excess of 25W, or will block backward propagating light in excess of 0.5W average power, these polarizer covers must be rotated to allow rejected beams to exit (see Figure 1) onto user supplied beam dumps. **These rejected beams can represent a hazard to users and/or their colleagues. Care must be exercised to ensure that all rejected beams (both transmission and isolation**

directions) are accounted for and terminated into functional beam dumps. Wherever possible keep the strongest rejected beams in the horizontal plane of the table or otherwise safest direction (typically down into the table). **Always wear laser safety glasses/goggles consistent with all laser frequencies and power levels present.** See the following sections for further details.

4. Failure of operating personnel to observe standard laser safety by sighting down through the isolator when laser radiation is present.

It is never appropriate to view through the device in the transmission, isolation, or rejected beam direction when laser radiation is present – even with laser safety goggles.

Never sight through your Newport Faraday Isolator in either direction when there is any possibility of laser radiation being present.

5. Harm caused by external magnetic fields.

Your Newport Faraday Isolator has been designed to meet existing federal safety guidelines for external fields as noted previously. Such guidelines could change in the future as more information becomes known or reviewed regarding the interaction between magnetic fields and human health. Since there exist various claims regarding the potential harmful (and beneficial!) effects of magnetic fields on humans it is prudent to limit interaction with these fields as much as possible.

Personnel with any magnetically-sensitive implants such as pacemakers should consult their medical doctor regarding any potential complications which could arise from the isolator external magnetic fields.

6. Other non-health related hazards.

The Faraday Isolator external magnetic fields can draw ferromagnetic objects into the magnet housing that can damage the optical elements within the device. Keep a suitable area in all directions around the Faraday Isolator clear of any loose ferromagnetic objects. Ideally, use non-magnetic tools (such as stainless steel or titanium) and hardware to secure the Faraday Isolator. If only ferromagnetic tools are available use extreme care when using them around the Faraday Isolator. It is always helpful to bring such tools towards an aperture (or end) radially rather than along the optical beam path. Doing this ensures that the fields will tend to pull such objects into the magnet housing endplate rather than into the optical aperture. Where possible use two hands, one to hold the tool and the other to guide it to the desired destination.

Another concern regarding external magnetic fields is their effect on magnetically-sensitive devices. The external fields are strong enough to induce a pulse of current in electronic devices (such as digital watches) that can destroy them. The fields can also disrupt the operation of other mechanical devices with

ferromagnetic parts in them. Finally, the external fields can erase information from magnetic strips such as are found on credit and ID cards. Remove all magnetically-sensitive materials and devices such as watches, computer hard drives and magnetic strips from operators prior to working in the proximity of an isolator.

1.3 Operation

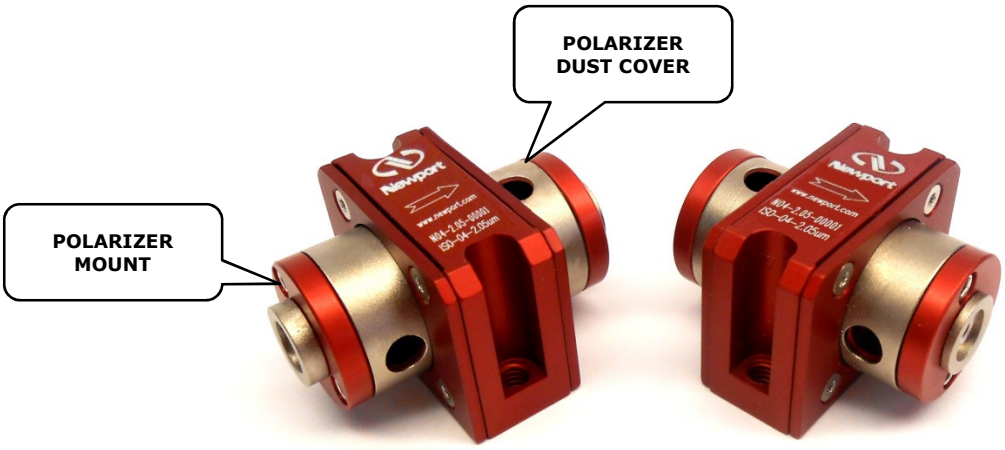


Figure 2: Overall view of a Newport 1µm ISO-FRDY Series Faraday Isolator

With the polarizer covers open, a polarizing beamsplitter cube (PBSC) can be seen at each end of the device. The output PBSC is oriented with its transmission axis rotated 45 degrees relative to the input PBSC. The input polarization shown is horizontal on the left and vertical on the right for a 2.0µm device. However, not that in a 4.55µm device, the orientations are reversed; vertical polarization on the left and horizontal on the right. This is better illustrated later in this section. In either case, the polarization always follows the orientation of the escape ports.

The central magnet housing together with the crystal residing in its center forms a Faraday rotator. The Faraday rotator rotates the input horizontal transmission axis by 45 degrees so that transmitted light has a polarization aligned with the output transmission axis. The input and output PBSCs work in conjunction with the central Faraday rotator to form a Faraday isolator as described previously in Section 1.

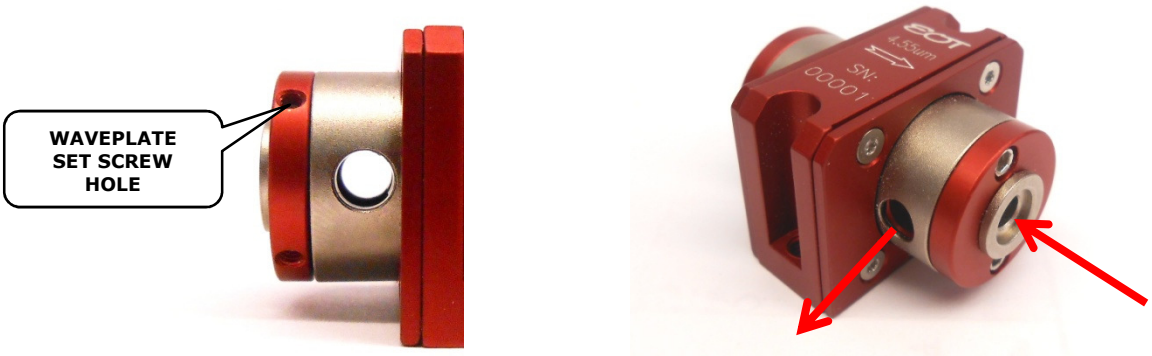


Figure 3: Rejected beam direction

Figure 3 shows the waveplate set screw holes. The rejected beam port that is between these set screw holes is the direction that a backward propagating beam (i.e. a beam going the opposite direction of the arrow on the isolator body) will be rejected.

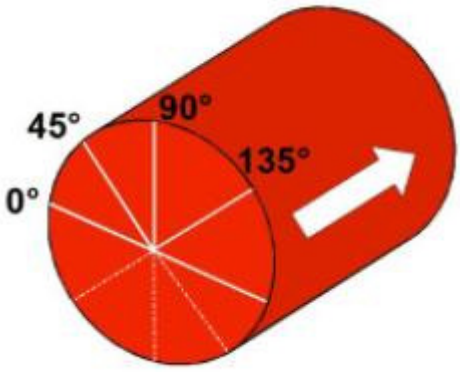


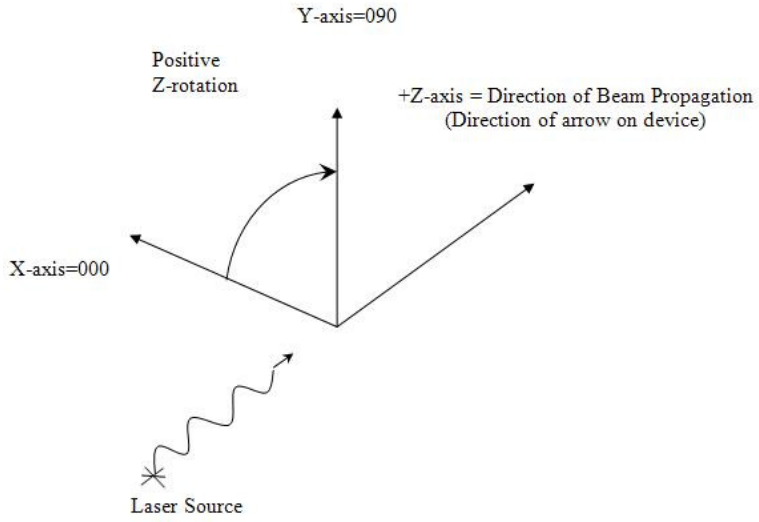
Figure 4: Polarization Orientation Diagram

Figure 4 shows the coordinate system for the Faraday Isolators. A horizontal orientation is referred to as 0° while a vertical orientation is 90°. While looking in the direction of the transmitted beam, rotating clockwise from the 0° gives an increasing orientation value, going toward 45°, then 90°, and finally 135° before coming around again to 0°.

45° of rotation can be achieved in either direction (e.g. 0° to 45° or 45° to 0°) without the use of a waveplate. If the output polarization needs to be the same as or 90° off from the input polarization, a waveplate will be needed. Waveplates are installed on the input side of the device unless otherwise specified.

Figure 5 below shows a 2.05µm device and a 4.55µm device where both have a horizontal input polarization. The 4.55µm device has escape ports shifted 90° with respect to the 2.05µm device.

Figure 5: 2.05µm, 4.55µm Horizontal Polarization



1.3.1 Using your Faraday Isolator

Observe the guidelines for safe use of your Faraday Isolator found in Section 1.2 above when removing your isolator from its shipping container. Do not remove the protective dust cover end caps from the polarizers until the device is in a clean, relatively dust-free environment. Save the protective end caps, packaging material and containers in the event that the device should ever need to be returned to Newport.

Figure 6: Remove the protective dust cover endcaps in a clean environment

Verify that the Input and Output polarization states are consistent with the intended mode of operation. If not, either send the device back to Newport (see Page iii) or, if desired, readjust the isolator as required (see Section 1.3.2).

With the source laser off, or running at very low power (less than 250mW), position the Faraday Isolator such that the source laser beam can be directed through the Input Aperture.

Critical alignment of the Faraday Isolator should be done at low power (less than 250mW) in order to prevent optical damage to your isolator or laser source.

Use IR cards or viewers to ensure that the source laser beam is centered on the input and output apertures. It is also preferable to use an IR viewer to ensure that weak reflections from AR coated optical surfaces in the Faraday Isolator are not being directed back into the source laser. The optical surfaces in the Faraday Isolator are angled slightly to reduce these reflections. However, if any such reflections exist the device may typically be tilted by a small amount to ensure that such back reflections are not coaxially aligned with the source laser beam. Increasing the distance between the Faraday Isolator and the source laser can also help ensure that no reflections couple back into the source laser if necessary.

At this point the Faraday Isolator should be secured to the work surface with two (2) #4 or M3 screws. Alternatively, the holes are also tapped for two (2) 8-32 screws. Steel (ferromagnetic) ball drivers or other such wrenches will be attracted to the external magnetic field surrounding the device. If possible use anti-magnetic stainless steel or titanium tools. If ferromagnetic tools are used it is desirable to introduce them slowly toward the device from the sides along the direction of the mounting holes.

If the Faraday Isolator will be used with average powers in excess of 25W transmitted or 0.5W rejected backward propagating radiation the Polarizer Covers will need to be rotated so that the Escape Ports allow rejected polarization light to be safely dumped onto a beam dump. Failure to allow these rejected polarizations to escape can cause the device to heat up. Such heat can degrade the performance of the Faraday Isolator, or in severe cases, cause damage to optical components in the isolator. While working with low alignment level power and wearing safety glasses physically grasp the Polarizer Cover and rotate it by 90 degrees. Any rejected polarized beams (in either the forward or backward propagating directions) can now exit the polarizer assembly. Use an IR viewer or IR card to locate these beams. Ensure that they are terminated on beam dumps consistent with the maximum amount of power that may be in such beams. In addition to high rejection (>30dB) of any undesired linear polarization component in transmission, the Input and Output PBSC may reflect as much as 3% of the desired transmitted polarization. If the Faraday Isolator is used in applications where strong reflections and/or optical gain elements (amplifiers) exist there may be very high power rejected beams for backward propagating light at the input polarizer. If the average power levels used do not exceed 25W transmitted or 0.5W of backward propagating power then the Polarizer Covers may be kept in their factory positioned orientation – that is with all rejected beams blocked by the Polarizer Cover. However, if the Faraday Isolator is to be used with very high peak intensities it is prudent to allow rejected beams to escape on to external beam dumps to prevent any ablation damage to the nickel-plated Polarizer Covers. Follow the same procedure above as for high average powers in order to safely terminate all rejected beams.

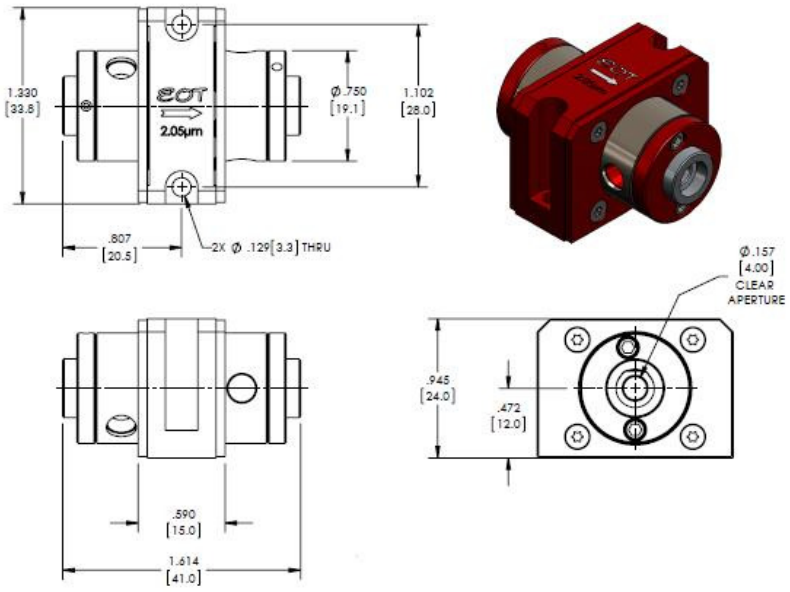


Figure 7: Diagram View of 2.05µm Aperture Faraday Isolator

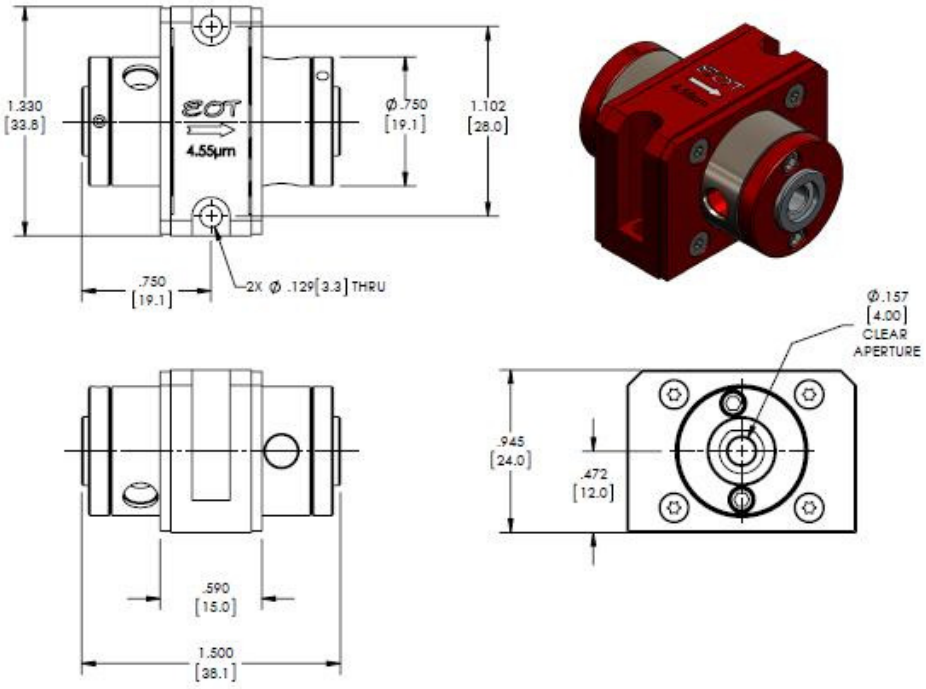


Figure 8: Diagram View of 4.55µm Aperture Faraday Isolator

1.3.2 Tuning your Faraday Isolator

A. *Maximizing Isolation*

If it becomes necessary to operate the isolator at a different wavelength or temperature than it was aligned at in the factory the isolator can be tuned to maximize isolation at your operating conditions. Isolation of the device will change with wavelength used and the temperature of the device. Loosen the four (4) T6 torx screws on the input side of the isolator enough to allow the input polarizer mount to rotate as shown in Figure 7. ***Only*** loosen the screws enough to let the mount rotate. Loosening too much or completely removing the screws may damage the isolator. To tune the isolator to your specific conditions, place it in the beam path in the reverse direction – the arrow on the isolator body will point back toward the laser source. Ensure that the polarization going into the isolator matches the output polarization of the isolator, which is now the end facing the laser. Make sure all rejected beams are going in a safe direction. Turn the loosened polarizer until the laser power going through the device is minimized. Carefully retighten the four (4) T6 torx screws to a torque of 3 in*lbs. Retighten the screws slowly in a star pattern to help ensure the alignment of the mount stays true.

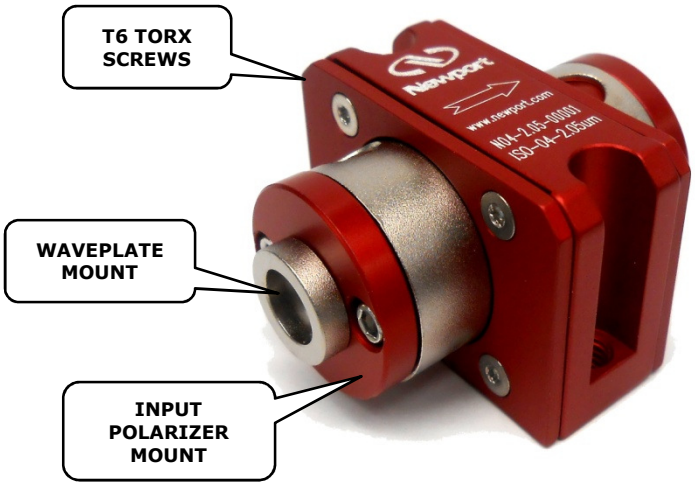


Figure 9: Rotating input polarizer

B. *Aligning Input Polarization*

If the device was purchased with a waveplate, the input polarization can be adjusted. This allows transmission to be maximized. This should be adjusted any time the isolation of the device is tuned. To do so, remove the two backing screws shown in Figure 8 with a 0.035” hex driver. Loosen the revealed set screws to allow the waveplate mount to rotate freely. If these set screws are loosened too much, the entire waveplate mount may fall out. To align the input polarization, insert the device in the forward direction – the arrow on the isolator body will point in the direction of the beam propagation. Ensure that the polarization going into the isolator matches the desired input polarization of the isolator.

Make sure all rejected beams are going in a safe direction. Rotate the waveplate mount until the transmitted power is maximized, or the power rejected off the first polarizer is minimized. Retighten the set screws using 0.7 in*lbs. and replace the backing screws, also tightening to 0.7 in*lbs.

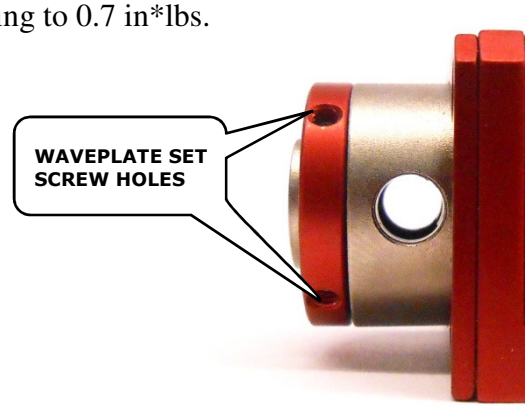


Figure 10: Waveplate Set Screw Location

1.4 Specifications

Model	ISO-FRDY-04-2050-Y	ISO-FRDY-04-4550-Y
Input Polarization	Horizontal	Horizontal
Clear Aperture (mm)	4	4
Isolation (dB) @ 22℃	>30	>30
Transmission (%) @ 22℃	>92	>65
Pulse Damage Threshold (J/cm^2) for a 10ns pulse	5	5
Polarizer Type	PBS Cube	PBS Cube

Notes:

1. Operating Temperature: Performance of Newport's Faraday Rotators/Isolators is related to operating temperature. For information on the effect of operating temperature on Newport's Faraday Rotators/Isolators, please review our technical bulleting, *Effects of Temperature on Newport's Faraday Rotators/Isolators.*

2. For incident powers ≥50W, please consult Newport. You may either contact Newport's technical support department at support@newport.com or view our website, www.newport.com.

3. Pulsed Damage Threshold: The pulsed damage threshold of your free space Faraday rotator or isolator can be determined at pulsewidths other than 10ns by using the "Root T" scaling method.

2 Factory Service Information

2.1 Service Form

Newport Corporation
U.S.A. Office: 800-222-6440
FAX: 949/253-1479

Name _____ Return Material Authorization # _____
(Please obtain RMA# prior to return of item)

Company _____

Address _____ Date _____

Country _____ Phone Number _____

P.O. Number _____ FAX Number _____

Item(s) Being Returned:

Model # _____ Serial # _____

Description

_____
_____
_____
_____
_____

Reason for return of goods (please list any specific problems)

_____
_____
_____
_____
_____
_____

Notes:

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