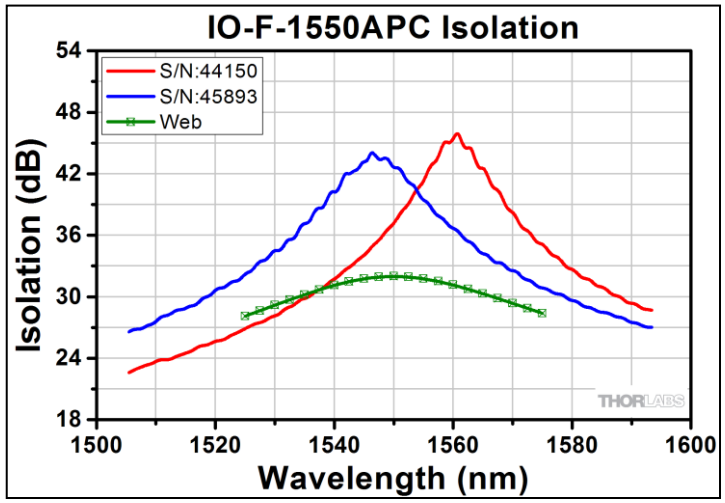
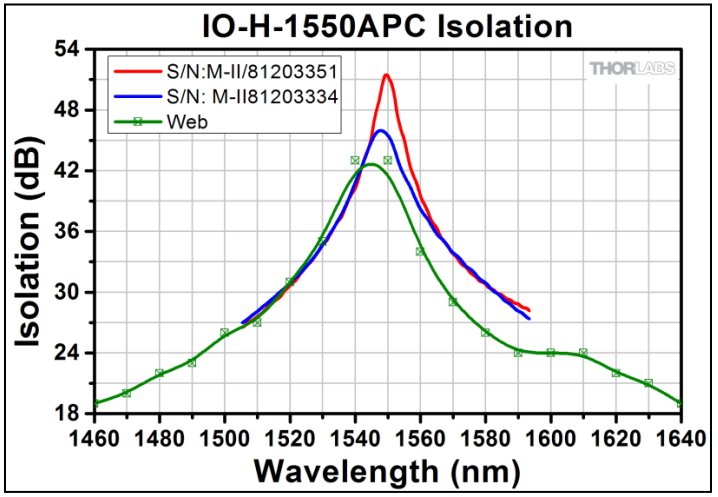
Isolation and Transmission Properties of IO-F & IO-H Fiber Isolators

- The IO-F series isolators provide a versatile platform to build isolators at a variety of bandwidths.
  - Due to the manual construction, some uncertainty exists as to the wavelength of peak isolation resulting in a broad spectral plot of the minimum device performance.
- The IO-H series isolators have been optimized for performance at 1550 nm thereby providing a spectral plot that is more indicative of device performance.



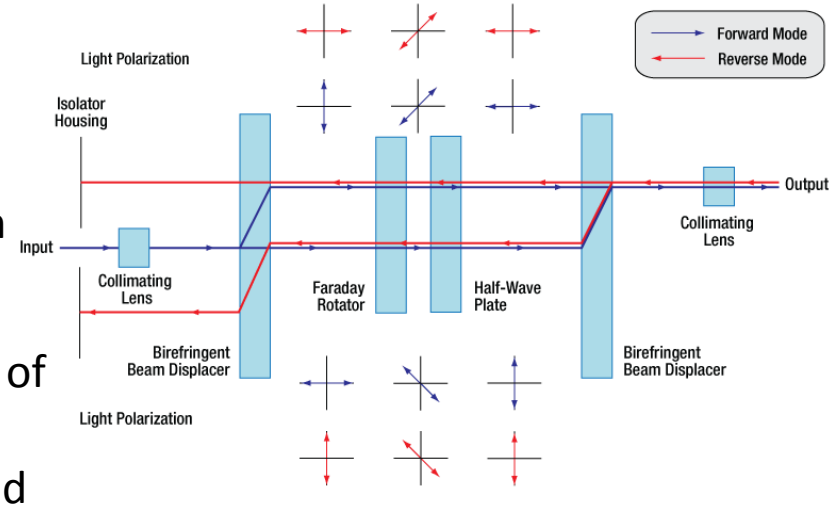


Background

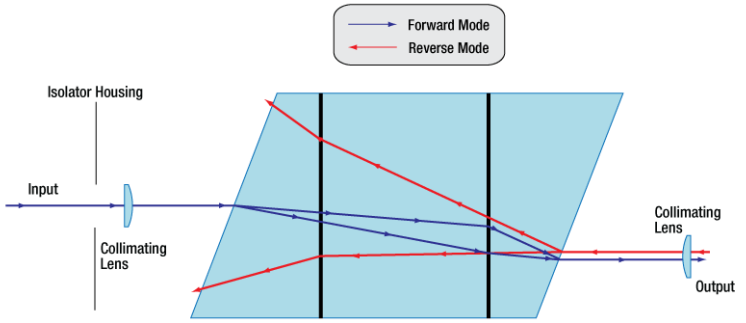
- Optical isolators prevent back reflections from re-entering the light source, protecting the source from optical feedback and damage.
- A Faraday rotator in conjunction with a half-wave plate, between two beam-displacement polarizers, blocks the return beam independent of input polarization.
- Here we examine the typical performance of two fiber-coupled optical isolators (IO-F-1550APC and IO-H-1550APC) to understand the specifications and plots provided on the Thorlabs website.
- It is important to note that the IO-F-1550APC was designed to provide a versatile platform to customize performance over various wavelength bands defined by the choice of half-wave plate and collimating lenses, while the IO-H-1550APC was designed to provide optimum isolation at 1550 nm alone.

Optical Isolator Principle

IO-H-1550APC

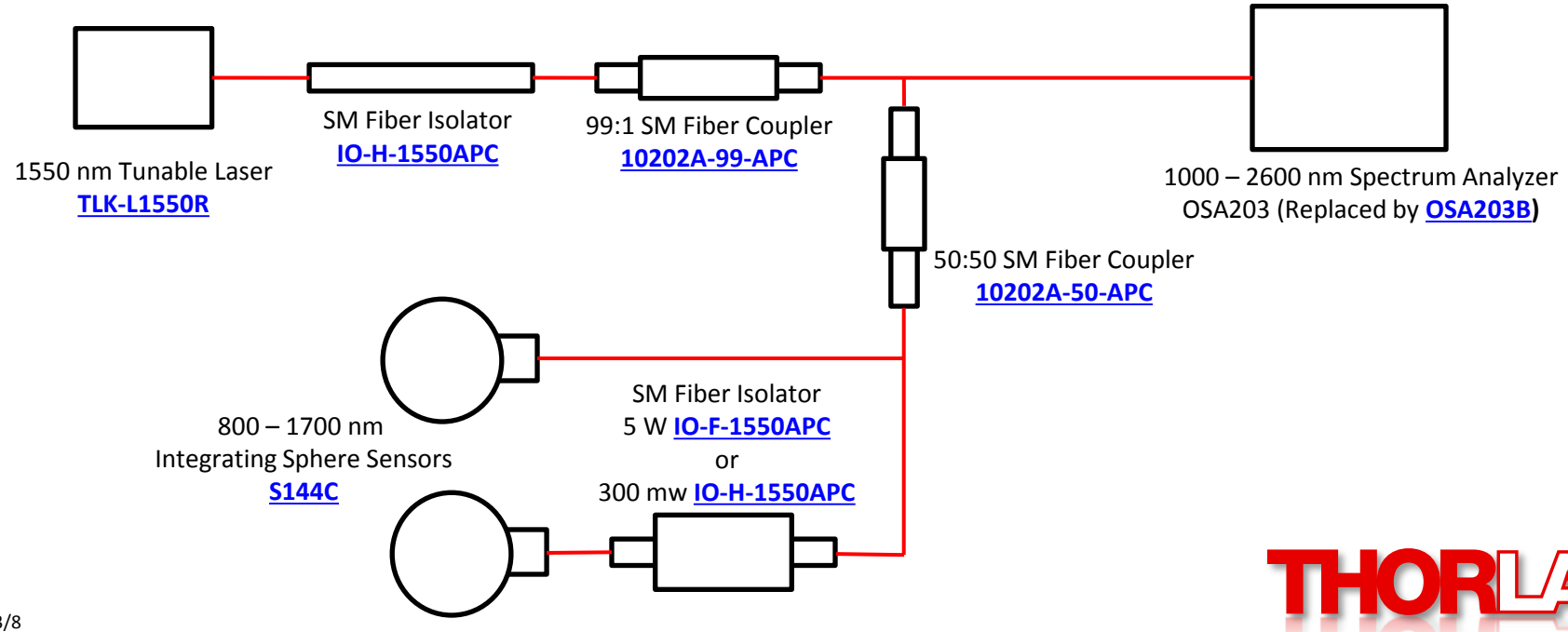


IO-F-1550APC



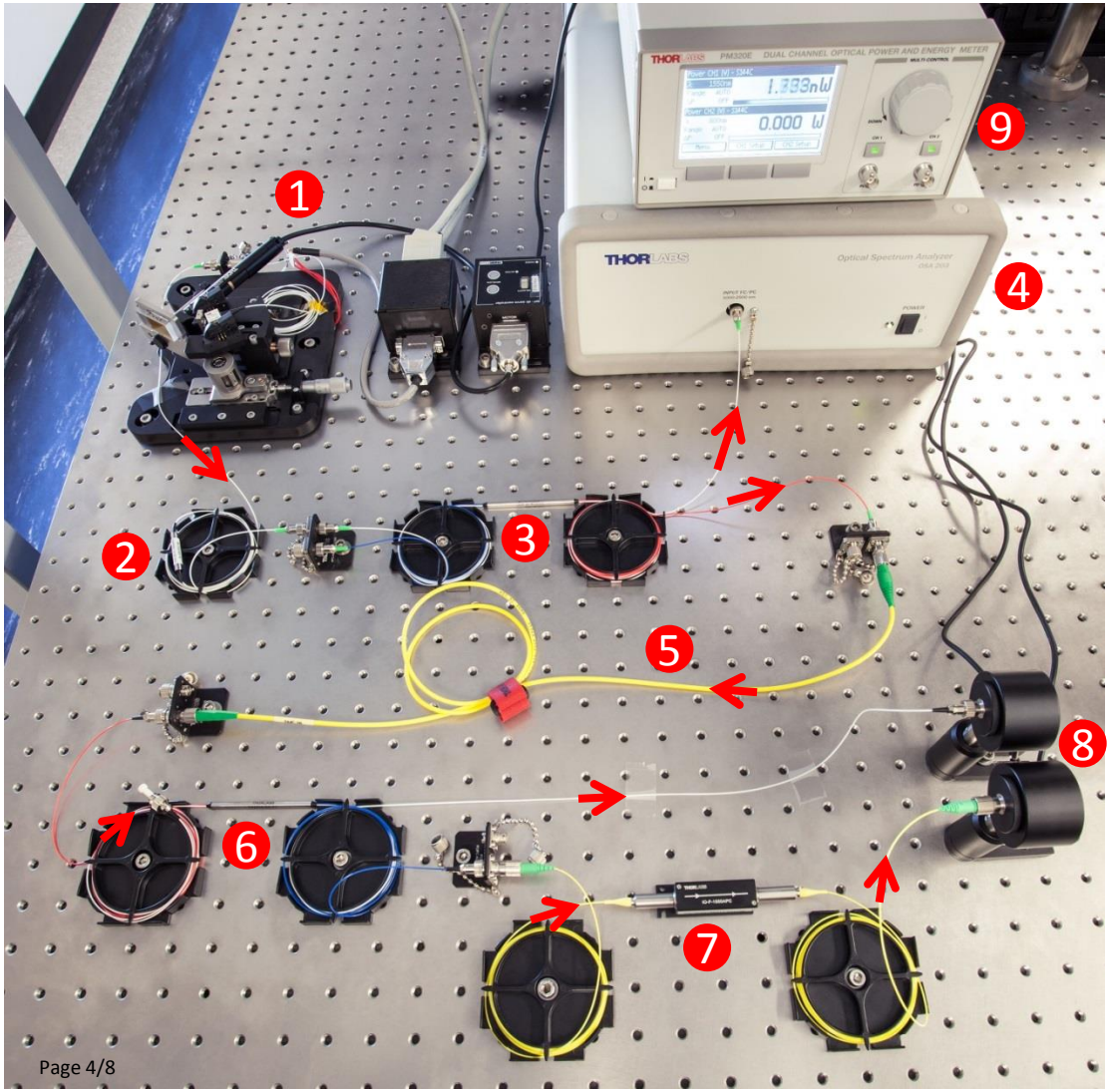
Experimental Design

- The TLK-L1550R Tunable Laser allows the source to be controlled and swept through 1505 - 1593 nm (at 0.6 – 0.8 nm step sizes) with the Z812 motorized actuator and TDC001 controller.
- A 99:1 fiber coupler sent 1% of the light to the OSA203B Spectrum Analyzer to record the center wavelength of the source at each data point.
- During testing, a 50:50 fiber coupler split the light in half, directing half the light through the isolator under test and then into a power sensor while the other half coupled directly to a reference power sensor.
- Prior to testing, the isolator was removed from the system in order to calibrate both of the power sensors. The calibration was used to calculate the performance of the isolator at each measured wavelength accurately.



Experimental Setup

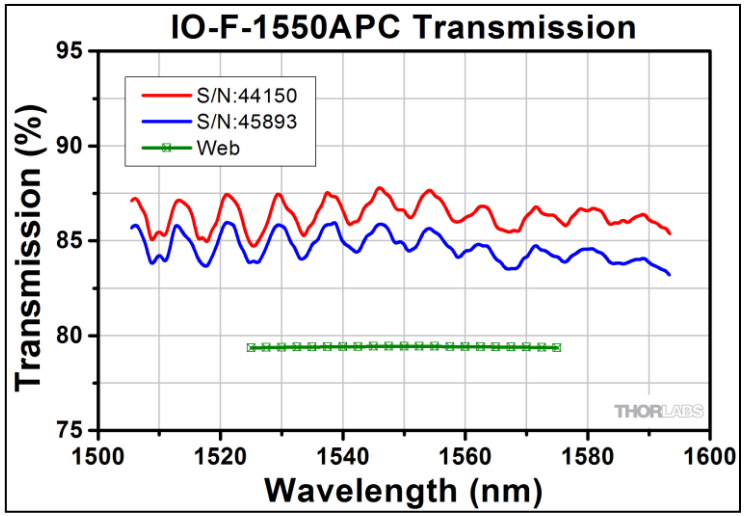
The experimental setup for measuring the transmission and isolation of the optical isolator under test. Measuring in the forward direction of the isolator provides the transmission data while measuring in the backward direction provides the isolation data.

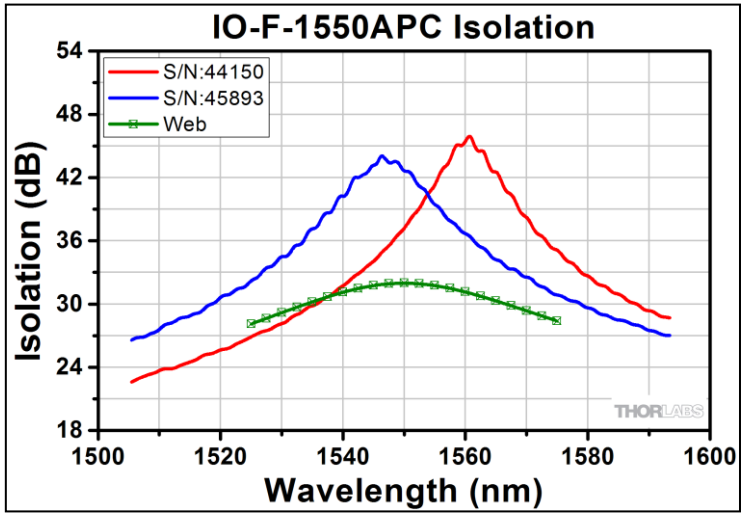


1) 1550 nm Tunable Laser: **TLK-L1550R**
2) SM Fiber Isolator: **IO-H-1550APC**
3) 99:1 SM Fiber Coupler: **10202A-99-APC**
4) 1000 – 2600 nm Spectrum Analyzer: OSA203 (Replaced by **OSA203B**)
5) SM Fiber Patch Cable: **P3-SMF28E-FC-1**
6) 50:50 SM Fiber Coupler: **10202A-50-APC**
7) SM Fiber Isolator: **IO-F-1550APC** or **IO-H-1550APC**
8) 800 – 1700 nm Integrating Sphere Sensors: **S144C**
9) Dual-Channel Power & Energy Meter: **PM320E**

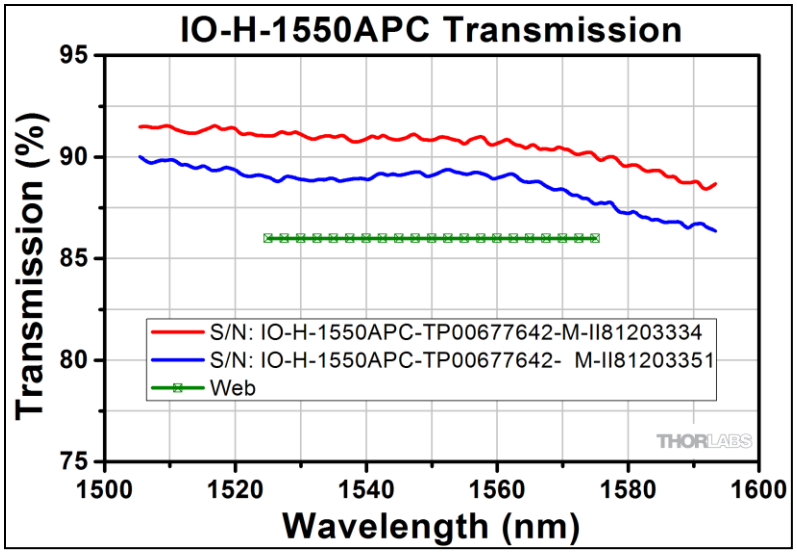
Results: IO-F-1550APC

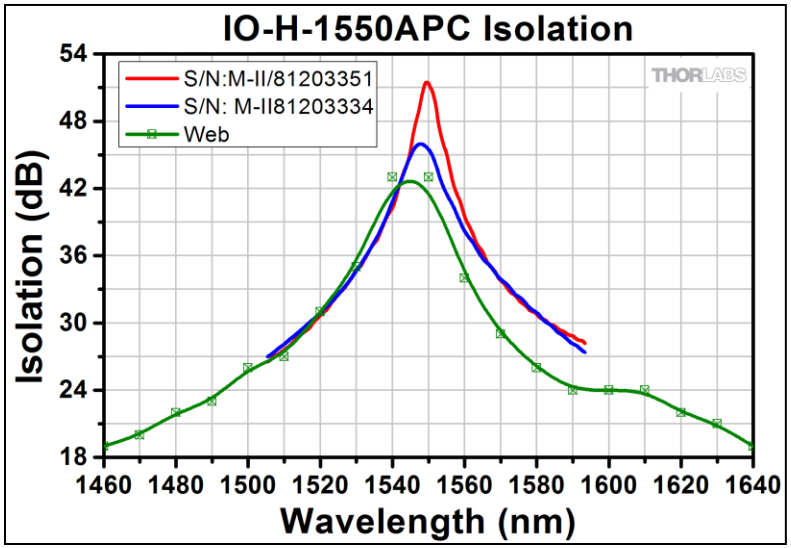
- The transmission plot shows two units provided transmission >5% above spec. However, it is interesting to note an etalon effect across the measured bandwidth. The etalon corresponds to an optical thickness of approximately 150 µm, which was caused by the air gap within the zero-order half-wave plate.
- The isolation plot shows the difference in the shape and peak wavelength between the tested units. This difference is the result of the manual alignment of the half-wave plate within the versatile platform. As the rotation changes, the resultant retardance shifts the center frequency of the isolation peak. The broad, low-amplitude specification on this isolator (green plot) accounts for the change in the isolation tails as the peak isolation wavelength shifts away from the designed wavelength of the half-wave plate.





Results: IO-H-1550APC





- The transmission plot shows two units provided a few percent transmission above the web specification. An etalon can be observed in this plot but with a reduced amplitude compared to the IO-F isolator. This etalon corresponds to an optical thickness on the order of 300 µm, which can be attributed to the window in front of the OSA detector.
- The isolation plot shows the curve with a smaller bandwidth and reduced peak wavelength variance compared to the IO-F isolators, thus providing a specification that is nearly identical to the measured performance. The consistency in performance is the result of a device optimized and stamped for a single wavelength in the telecom band.

Experimental Limitations

- Measurements were limited to two randomly selected units of each device to provide general characteristics.
- Measurements were carried out with APC fiber connectors on the device under test, which introduces uncertainties in the exact amount of light coupled into the device.
  - Web specification determined by cut back measurement and does not include connector coupling loss.
- Power and wavelength variations from the tunable laser source create uncertainty in the exact wavelength and calibration for each data point.
- During isolation measurements, the power levels before/after the device under test were orders of magnitude apart. The significant figures on the power measurement and the difference in the noise floor of the detectors then creates uncertainty in the exact isolation measure.

These results describe a brief investigation to provide insights into the general behavior of our components and should be interpreted with the experimental limitations in mind.

Summary

- Measurements were carried out to assess the transmission and isolation of the IO-F and IO-H series optical isolators.
- The experimental results show:
  - The IO-F platform provides versatility to create isolators at a variety of bandwidths, but the manual construction creates some uncertainty in the peak and width of the isolation.
  - The IO-H platform was optimized for use specifically at 1550 nm thereby providing a spec that is nearly identical to the device performance.
- These results indicate that the specification plots provided on the Thorlabs website should be interpreted as the minimum performance of the isolators at a specific wavelength.