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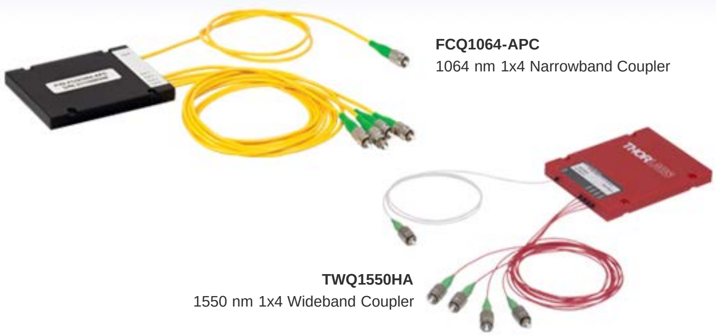
FCQ1315-APC - December 19, 2017

Item # FCQ1315-APC was discontinued on December 19, 2017. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

1 X 4 SINGLE MODE FIBER OPTIC COUPLERS

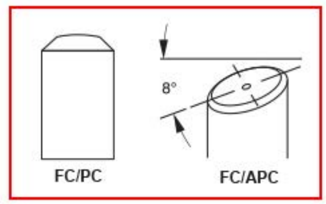
- ▶ **Wavelengths from 560 nm to 1550 nm Available**
- ▶ **25:25:25:25 Split Ratio**
- ▶ **Terminated with 2.0 mm Narrow Key FC/PC or FC/APC Connectors**



FCQ1064-APC
1064 nm 1x4 Narrowband Coupler

TWQ1550HA
1550 nm 1x4 Wideband Coupler

Use for Splitting Signals



OVERVIEW

Features

- Split Input Signal Evenly Into Four Output Ports
- Multiple Wavelength/Bandwidth Combinations Available (See Table to the Right for Options)
- 25:25:25:25 Split Ratio
- 2.0 mm Narrow Key FC/PC or FC/APC Connectors
- Individual Test Report Included with Each Wideband Coupler
- Mount to an Optical Table with the FCQB Mounting Base (Available Below)
- Contact Us for Custom Wavelength, Coupling Ratio, and Connector Options

Click to Enlarge
1x4 Wideband Coupler Mounted on FCQB Base (Available Below)

1x4 SM Fiber Optic Coupler Quick Links[a]	
Center Wavelength	**Bandwidth**
560 nm	±50 nm
630 nm	±15 nm
850 nm	±100 nm
1064 nm	±15 nm
1064 nm	±100 nm
1300 nm	±100 nm
1310/1550 nm	±40 nm
1550 nm	±100 nm
Mounting Base	

- . Green shading denotes wideband couplers.

Thorlabs' Single Mode 1x4 Fiber Optic Couplers allow a user to split a single input signal evenly into four output signals. Several center wavelength options are available (see the table to the right for details). Narrowband couplers have a ±15 nm bandwidth, dual window couplers have a ±40 nm bandwidth around each center wavelength, and wideband couplers have a ±50 nm or ±100 nm bandwidth. 1x4 couplers are manufactured using three 50:50 fiber couplers to split the signal from the input port (see the *1x4 Coupler Tutorial* for details); they cannot be used in reverse to combine light from four sources. The unused ports on these internal 50:50 fiber couplers are terminated in a manner that minimizes back reflections.

For our wideband 1x4 couplers, Thorlabs provides an individual test data sheet with each coupler that includes coupling data and performance graphs. These graphs, which show data within the design bandwidth and also show measured data outside of the specified bandwidth including the entire wavelength range where the coupling ratio meets the specified tolerance. Sample data sheets for our 1x4 wideband couplers can be viewed below. Please note that the data sheets for the 630 nm 1x4 couplers do not include performance graphs, but a typical performance plot is included in the spec sheets below.

Each coupler is contained in a compact 100 mm x 80 mm x 10 mm housing that includes four through holes for mounting the device to our FCQB mounting base (available separately below). Narrowband and dual window couplers feature a labeled black housing and 0.8 m fiber leads jacketed using Ø3 mm yellow furcation tubing. Wideband couplers use a labeled red housing and 0.8 m fiber leads jacketed using Ø900 µm Hytrel® tubing. Couplers are offered from stock with 2.0 mm narrow key FC/PC or FC/APC connectors. Custom coupler configurations with other wavelengths, fiber types, coupling ratios, or port configurations are also available. If a custom connector configurations is needed, one-day turnaround is possible for small orders if the order is placed before 12 PM EST. Please contact Tech Support with inquiries.

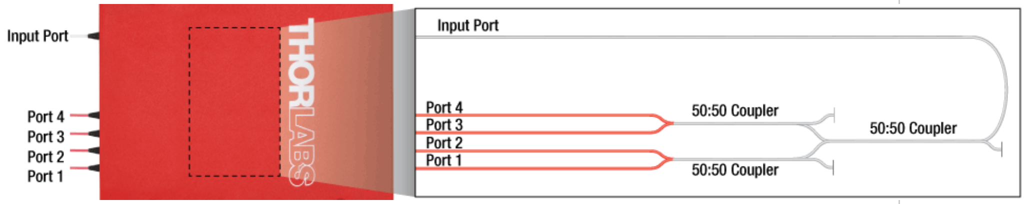
Alternative Fiber Coupler Options								
Double-Clad Couplers	**Single Mode Couplers**			**Multimode Couplers**		**Polarization-Maintaining Couplers**		**Wavelength Division Multiplexers (WDM)**
2x2	1x2	2x2	1x4	1x2	2x2	1x2	2x2	

1X4 COUPLER TUTORIAL

Definition of 1x4 Fused Fiber Optic Coupler Specifications

This tab provides a brief explanation of how we determine several key specifications for our 1x4 couplers. 1x4 couplers are manufactured using three 50:50

couplers internally to split the input signal evenly among four outputs (as shown in the schematic below). Any unused ports are terminated using a propietary method that reduces back reflections. 1x4 couplers are not recommended for light combining applications and should only be used to split light. For combining light of different wavelengths, Thorlabs offers a line of wavelength division multiplexers (WDMs). The ports on our 1x4 couplers are configured as shown in the schematic below.



Excess Loss

Excess loss in dB is determined by the ratio of the total input power to the total output power:

$$\text{Excess Loss}(dB) = 10\log\frac{P_{input}(mW)}{P_{port1}(mW) + P_{port2}(mW) + P_{port3}(mW) + P_{port4}(mW)}$$

P_{input} is the input power and $P_{port1}+P_{port2}+P_{port3}+P_{port4}$ is the total output power. All powers are expressed in mW.

Optical Return Loss (ORL) / Directivity

The directivity refers to the fraction of input light that is lost in the internally terminated fiber ends within the coupler housing. It can be calculated in units of dB using the following equation:

$$\text{Directivity}(dB) = 10\log\frac{P_{t1}(mW) + P_{t2}(mW) + P_{t3}(mW)}{P_{input}(mW)}$$

where P_{t1}, P_{t2}, and P_{t3} are the optical powers (in mW) in the internally terminated fiber ends shown in the image above. This is the result of back reflections at each coupler junction and represents a loss in the total light output at the output ports. For a 1x4 coupler with an even split, the directivity is equal to the optical return loss (ORL).

Insertion Loss

The insertion loss is defined as the ratio of the input power to the output power at one of the output legs of the coupler. Insertion loss is always specified in decibels (dB). It is generally defined using the equation below:

$$\text{Insertion Loss}(dB) = 10\log\frac{P_{in}(mW)}{P_{out}(mW)}$$

where P_{in} and P_{out} are the input and output powers (in mW). For our 1x4 couplers, the insertion loss specification is provided for each output port. To define the insertion loss for a specific output (e.g., port 1 or port 2), the equation is rewritten as:

$$\text{Insertion Loss}_{input\rightarrow port1}(dB) = 10\log\frac{P_{input}(mW)}{P_{port1}(mW)}$$

$$\text{Insertion Loss}_{input\rightarrow port2}(dB) = 10\log\frac{P_{input}(mW)}{P_{port2}(mW)}$$

Insertion loss inherently includes both coupling (e.g., light transferred to the other output legs) and excess loss (e.g., light lost from the coupler) effects. The maximum allowed insertion loss for each output is specified. Because the insertion loss in each output is correlated to light coupled to the other outputs, no coupler will ever have the maximum insertion loss in all outputs simultaneously.

Calculating Insertion Loss using Power Expressed in dBm

Insertion loss can also be easily calculated with the power expressed in units of dBm. The equation below shows the relationship between power expressed in mW and dBm:

$$P(dBm) = 10\log P(mW)$$

Then, the insertion loss in dB can be calculated as follows:

$$\text{Insertion Loss}(dB) = P_{in}(dBm) - P_{out}(dBm)$$

Coupling Ratio

Insertion loss (in dB) is the ratio of the input power to the output power from each leg of the coupler as a function of wavelength. It captures both the coupling ratio and the excess loss. The coupling ratio is calculated from the measured insertion loss. Coupling ratio (in %) is the ratio of the optical power from each output port to the sum of the total power of all output ports as a function of wavelength. It is not impacted by spectral features such as the water absorption region because all output legs are affected equally.

Uniformity

The uniformity is also calculated from the measured insertion loss. Uniformity is the variation (in dB) of the insertion loss over the bandwidth as a function of wavelength. It is a measure of how evenly the insertion loss is distributed over the spectral range. The uniformity is defined as the difference between the insertion loss in one output leg at a given wavelength and the highest or lowest value of insertion loss over the specified wavelength range in that same output leg.

DAMAGE THRESHOLD

Laser-Induced Damage in Silica Optical Fibers

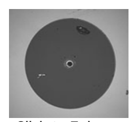
Quick Links
Damage at the Air / Glass Interface
Intrinsic Damage Threshold
Preparation and Handling of Optical Fibers

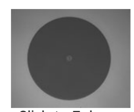
The following tutorial details damage mechanisms relevant to unterminated (bare) fiber, terminated optical fiber, and other fiber components from laser light sources. These mechanisms include damage that occurs at the air / glass interface (when free-space coupling or when using connectors) and in the optical fiber itself. A fiber component, such as a bare fiber, patch cable, or fused coupler, may have multiple potential avenues for damage (e.g., connectors, fiber end faces, and the device itself). The maximum power that a fiber can handle will always be limited by the lowest limit of any of these damage mechanisms.

While the damage threshold can be estimated using scaling relations and general rules, absolute damage thresholds in optical fibers are very application dependent and user specific. Users can use this guide to estimate a safe power level that minimizes the risk of damage. Following all appropriate preparation and handling guidelines, users should be able to operate a fiber component up to the specified maximum power level; if no maximum is specified for a component, users should abide by the "practical safe level" described below for safe operation of the component. Factors that can reduce power handling and cause damage to a fiber component include, but are not limited to, misalignment during fiber coupling, contamination of the fiber end face, or imperfections in the fiber itself. For further discussion about an optical fiber's power handling abilities for a specific application, please contact Thorlabs' Tech Support.

Damage at the Air / Glass Interface

There are several potential damage mechanisms that can occur at the air / glass interface. Light is incident on this interface when free-space coupling or when two fibers are mated using optical connectors. High-intensity light can damage the end face leading to reduced power handling and permanent damage to the fiber. For fibers terminated with optical connectors where the connectors are fixed to the fiber ends using epoxy, the heat generated by high-intensity light can burn the epoxy and leave residues on the fiber facet directly in the beam path.


Click to Enlarge
Damaged Fiber End


Click to Enlarge
Undamaged Fiber End

Damage Mechanisms on the Bare Fiber End Face

Damage mechanisms on a fiber end face can be modeled similarly to bulk optics, and industry-standard damage thresholds for UV Fused Silica substrates can be applied to silica-based fiber. However, unlike bulk optics, the relevant surface areas and beam diameters involved at the air / glass interface of an optical fiber are very small, particularly for coupling into single mode (SM) fiber. therefore, for a given power density, the power incident on the fiber needs to be lower for a smaller beam diameter.

The table to the right lists two thresholds for optical power densities: a theoretical damage threshold and a "practical safe level". In general, the theoretical damage threshold represents the estimated maximum power density that can be incident on the fiber end face without risking damage with very good fiber end face and coupling conditions. The "practical safe level" power density represents minimal risk of fiber damage. Operating a fiber or component beyond the practical safe level is possible, but users must follow the appropriate handling instructions and verify performance at low powers prior to use.

Estimated Optical Power Densities on Air / Glass Interface[a]		
Type	Theoretical Damage Threshold[b]	Practical Safe Level[c]
CW (Average Power)	~1 MW/cm^2	~250 kW/cm^2
10 ns Pulsed (Peak Power)	~5 GW/cm^2	~1 GW/cm^2

- . All values are specified for unterminated (bare) silica fiber and apply for free space coupling into a clean fiber end face.
- . This is an estimated maximum power density that can be incident on a fiber end face without risking damage. Verification of the performance and reliability of fiber components in the system before operating at high power must be done by the user, as it is highly system dependent.
- . This is the estimated safe optical power density that can be incident on a fiber end face without damaging the fiber under most operating conditions.

Calculating the Effective Area for Single Mode and Multimode Fibers

The effective area for single mode (SM) fiber is defined by the mode field diameter (MFD), which is the cross-sectional area through which light propagates in the fiber; this area includes the fiber core and also a portion of the cladding. To achieve good efficiency when coupling into a single mode fiber, the diameter of the input beam must match the MFD of the fiber.

As an example, SM400 single mode fiber has a mode field diameter (MFD) of ~Ø3 µm operating at 400 nm, while the MFD for SMF-28 Ultra single mode fiber operating at 1550 nm is Ø10.5 µm. The effective area for these fibers can be calculated as follows:

SM400 Fiber: Area = Pi x (MFD/2)^2 = Pi x (1.5 µm)^2 = 7.07 µm^2 = 7.07 x 10^{-8} cm^2

SMF-28 Ultra Fiber: Area = Pi x (MFD/2)^2 = Pi x (5.25 µm)^2 = 86.6 µm^2 = 8.66 x 10^{-7} cm^2

To estimate the power level that a fiber facet can handle, the power density is multiplied by the effective area. Please note that this calculation assumes a uniform intensity profile, but most laser beams exhibit a Gaussian-like shape within single mode fiber, resulting in a higher power density at the center of the beam compared to the edges. Therefore, these calculations will slightly overestimate the power corresponding to the damage threshold or the practical safe level. Using the estimated power densities assuming a CW light source, we can determine the corresponding power levels as:

SM400 Fiber: 7.07×10^{-8} cm^2 x 1 MW/cm^2 = 7.1×10^{-8} MW = 71 mW (Theoretical Damage Threshold)
7.07×10^{-8} cm^2 x 250 kW/cm^2 = 1.8×10^{-5} kW = 18 mW (Practical Safe Level)

SMF-28 Ultra Fiber: 8.66×10^{-7} cm^2 x 1 MW/cm^2 = 8.7×10^{-7} MW = 870 mW (Theoretical Damage Threshold)
8.66×10^{-7} cm^2 x 250 kW/cm^2 = 2.1×10^{-4} kW = 210 mW (Practical Safe Level)

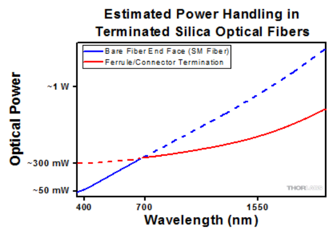
The effective area of a multimode (MM) fiber is defined by the core diameter, which is typically far larger than the MFD of an SM fiber. For optimal coupling, Thorlabs recommends focusing a beam to a spot roughly 70 - 80% of the core diameter. The larger effective area of MM fibers lowers the power density on the fiber end face, allowing higher optical powers (typically on the order of kilowatts) to be coupled into multimode fiber without damage.

Damage Mechanisms Related to Ferrule / Connector Termination

Fibers terminated with optical connectors have additional power handling considerations. Fiber is typically terminated using epoxy to bond the fiber to a ceramic or steel ferrule. When light is coupled into the fiber through a connector, light that does not enter the core and propagate down the fiber is scattered into the outer layers of the fiber, into the ferrule, and the epoxy used to hold the fiber in the ferrule. If the light is intense enough, it can burn the epoxy, causing it to vaporize and deposit a residue on the face of the connector. This results in localized absorption sites on the fiber end face that reduce coupling efficiency and increase scattering, causing further damage.

For several reasons, epoxy-related damage is dependent on the wavelength. In general, light scatters more strongly at short wavelengths than at longer wavelengths. Misalignment when coupling is also more likely due to the small MFD of short-wavelength SM fiber that also produces more scattered light.

To minimize the risk of burning the epoxy, fiber connectors can be constructed to have an epoxy-free air gap between the optical fiber and ferrule near the fiber end face. Our high-power multimode fiber patch cables use connectors with this design feature.



Click to Enlarge
Plot showing approximate power handling levels for single mode silica optical fiber with a termination. Each line shows the estimated power level due to a specific damage mechanism. The maximum power handling is limited by the lowest power level from all relevant damage mechanisms (indicated by a solid line).

Determining Power Handling with Multiple Damage Mechanisms

When fiber cables or components have multiple avenues for damage (e.g., fiber patch cables), the maximum power handling is always limited by the lowest damage threshold that is relevant to the fiber component.

As an illustrative example, the graph to the right shows an estimate of the power handling limitations of a single mode fiber patch cable due to damage to the fiber end face and damage via an optical connector. The total power handling of a terminated fiber at a given wavelength is limited by the lower of the two limitations at any given wavelength (indicated by the solid lines). A single mode fiber operating at around 488 nm is primarily limited by damage to the fiber end face (blue solid line), but fibers operating at 1550 nm are limited by damage to the optical connector (red solid line).

In the case of a multimode fiber, the effective mode area is defined by the core diameter, which is larger than the effective mode area for SM fiber. This results in a lower power density on the fiber end face and allows higher optical powers (on the order of kilowatts) to be coupled into the fiber without damage (not shown in graph). However, the damage limit of the ferrule / connector termination remains unchanged and as a result, the maximum power handling for a multimode fiber is limited by the ferrule and connector termination.

Please note that these are rough estimates of power levels where damage is very unlikely with proper handling and alignment procedures. It is worth noting that optical fibers are frequently used at power levels above those described here. However, these applications typically require expert users and testing at lower powers first to minimize risk of damage. Even still, optical fiber components should be considered a consumable lab supply if used at high power levels.

Intrinsic Damage Threshold

In addition to damage mechanisms at the air / glass interface, optical fibers also display power handling limitations due to damage mechanisms within the optical fiber itself. These limitations will affect all fiber components as they are intrinsic to the fiber itself. Two categories of damage within the fiber are damage from bend losses and damage from photodarkening.

Bend Losses

Bend losses occur when a fiber is bent to a point where light traveling in the core is incident on the core/cladding interface at an angle higher than the critical angle, making total internal reflection impossible. Under these circumstances, light escapes the fiber, often in a localized area. The light escaping the fiber typically has a high power density, which burns the fiber coating as well as any surrounding furcation tubing.

A special category of optical fiber, called double-clad fiber, can reduce the risk of bend-loss damage by allowing the fiber's cladding (2nd layer) to also function as a waveguide in addition to the core. By making the critical angle of the cladding/coating interface higher than the critical angle of the core/clad interface, light that escapes the core is loosely confined within the cladding. It will then leak out over a distance of centimeters or meters instead of at one localized spot within the fiber, minimizing the risk of damage. Thorlabs manufactures and sells 0.22 NA double-clad multimode fiber, which boasts very high, megawatt range power handling.

Photodarkening

A second damage mechanism, called photodarkening or solarization, can occur in fibers used with ultraviolet or short-wavelength visible light, particularly those with germanium-doped cores. Fibers used at these wavelengths will experience increased attenuation over time. The mechanism that causes photodarkening is largely unknown, but several fiber designs have been developed to mitigate it. For example, fibers with a very low hydroxyl ion (OH) content have been found to resist photodarkening and using other dopants, such as fluorine, can also reduce photodarkening.

Even with the above strategies in place, all fibers eventually experience photodarkening when used with UV or short-wavelength light, and thus, fibers used at these wavelengths should be considered consumables.

Preparation and Handling of Optical Fibers

General Cleaning and Operation Guidelines

These general cleaning and operation guidelines are recommended for all fiber optic products. Users should still follow specific guidelines for an individual product as outlined in the support documentation or manual. Damage threshold calculations only apply when all appropriate cleaning and handling procedures are followed.

1. All light sources should be turned off prior to installing or integrating optical fibers (terminated or bare). This ensures that focused beams of light are not incident on fragile parts of the connector or fiber, which can possibly cause damage.

2. The power-handling capability of an optical fiber is directly linked to the quality of the fiber/connector end face. Always inspect the fiber end prior to connecting the fiber to an optical system. The fiber end face should be clean and clear of dirt and other contaminants that can cause scattering of coupled light. Bare fiber should be cleaved prior to use and users should inspect the fiber end to ensure a good quality cleave is achieved.

3. If an optical fiber is to be spliced into the optical system, users should first verify that the splice is of good quality at a low optical power prior to high-power use. Poor splice quality may increase light scattering at the splice interface, which can be a source of fiber damage.

4. Users should use low power when aligning the system and optimizing coupling; this minimizes exposure of other parts of the fiber (other than the core) to light. Damage from scattered light can occur if a high power beam is focused on the cladding, coating, or connector.

Tips for Using Fiber at Higher Optical Power

Optical fibers and fiber components should generally be operated within safe power level limits, but under ideal conditions (very good optical alignment and very clean optical end faces), the power handling of a fiber component may be increased. Users must verify the performance and stability of a fiber component within their system prior to increasing input or output power and follow all necessary safety and operation instructions. The tips below are useful suggestions when considering increasing optical power in an optical fiber or component.

1. Splicing a fiber component into a system using a fiber splicer can increase power handling as it minimizes possibility of air/fiber interface damage. Users should follow all appropriate guidelines to prepare and make a high-quality fiber splice. Poor splices can lead to scattering or regions of highly localized heat at the splice interface that can damage the fiber.

2. After connecting the fiber or component, the system should be tested and aligned using a light source at low power. The system power can be ramped up slowly to the desired output power while periodically verifying all components are properly aligned and that coupling efficiency is not changing with respect to optical launch power.

3. Bend losses that result from sharply bending a fiber can cause light to leak from the fiber in the stressed area. When operating at high power, the localized heating that can occur when a large amount of light escapes a small localized area (the stressed region) can damage the fiber. Avoid disturbing or accidently bending fibers during operation to minimize bend losses.

4. Users should always choose the appropriate optical fiber for a given application. For example, large-mode-area fibers are a good alternative to standard single mode fibers in high-power applications as they provide good beam quality with a larger MFD, decreasing the power density on the air/fiber interface.

5. Step-index silica single mode fibers are normally not used for ultraviolet light or high-peak-power pulsed applications due to the high spatial power densities associated with these applications.

560 nm 1x4 Fiber Optic Couplers

- Split 560 nm Signals at 25:25:25:25 Coupling Ratio
- ±50 nm Bandwidth
- Individual Test Report Included with Each Coupler; Click Here for a Sample Data Sheet
- Available with 2.0 mm Narrow Key FC/PC or FC/APC Connectors

These 1x4 Wideband Fiber Optic Couplers are designed for splitting a single input signal at 560 nm equally into four output signals. The couplers have an operating bandwidth of ±50 nm and are available with 2.0 mm narrow key FC/PC or FC/APC connectors. They have a max power level of 100 mW with connectors or bare fiber and 250 mW when spliced (see the *Damage Threshold* tab for more details).

Item #	Info[a]	Center Wavelength	Bandwidth	Coupling Ratio (%)[b]	Coupling Ratio Tolerance	Insertion Loss[b]	Excess Loss[b]	Uniformity[b]	Fiber Type[d]	Termination
TWQ560HF[c]		560 nm	±50 nm	25:25:25:25	±5.0%	≤7.6 dB (Each Output Port)	≤0.6 dB	≤1.5 dB	460HP	FC/PC
TWQ560HA[c]										FC/APC

- . Please click on the blue icon for complete specifications.
- . Please see the *1x4 Coupler Tutorial* tab for more information on these terms.
- . All values are specified at room temperature over the bandwidth without connectors and measured using the white port as the input.
- d. Other fiber types may be available upon request.

Part Number	Description	Price	Availability
TWQ560HF	**1x4 Wideband Fiber Optic Coupler, 560 ± 50 nm, 25:25:25:25 Split, FC/PC**	**$945.00**	**Today**
TWQ560HA	**1x4 Wideband Fiber Optic Coupler, 560 ± 50 nm, 25:25:25:25 Split, FC/APC**	**$995.00**	**Today**

630 nm 1x4 Fiber Optic Couplers

- Split 630 nm Signals at 25:25:25:25 Coupling Ratio
- ±15 nm Bandwidth
- Individual Test Report Included with Each Coupler; Click Here for a Sample Data Sheet
- Available with 2.0 mm Narrow Key FC/PC or FC/APC Connectors

These 1x4 Narrowband Fiber Optic Couplers are designed to split a single input signal at 630 nm equally into four output signals. The couplers have an operating bandwidth of ±15 nm and are available with 2.0 mm narrow key FC/PC or FC/APC connectors. They can handle a max power of 300 mW with connectors or unterminated (bare) fiber and 0.5 W when spliced (see the *Damage Threshold* tab for more details).

Item #	Info[a]	Center Wavelength	Bandwidth	Coupling Ratio (%)[b]	Coupling Ratio Tolerance	Insertion Loss[b,c]	Excess Loss[b,c]	Uniformity	Fiber Type	Termination
TNQ630HF		630 nm	±15 nm	25:25:25:25	±5.0%	≤7.6 dB (Each Output Port)	≤0.6 dB	-	630HP	FC/PC
TNQ630HA										FC/APC

- . Please click on the blue icon for complete specifications.
- . Please see the *1x4 Coupler Tutorial* tab for more information on these terms.
- . All values are specified at room temperature over the bandwidth without connectors and measured using the white port as the input.
- d. Other fiber types may be available upon request.

Part Number	Description	Price	Availability
TNQ630HF	**1x4 Wideband Fiber Optic Coupler, 630 ± 15 nm, 25:25:25:25 Split, FC/PC**	**$510.00**	**Today**
TNQ630HA	**1x4 Wideband Fiber Optic Coupler, 630 ± 15 nm, 25:25:25:25 Split, FC/APC**	**$562.00**	**Today**

850 nm 1x4 Fiber Optic Couplers

- Split 850 nm Signals at 25:25:25:25 Coupling Ratio
- ±100 nm Bandwidth
- Individual Test Report Included with Each Coupler; Click Here for a Sample Data Sheet
- Available with 2.0 mm Narrow Key FC/PC or FC/APC Connectors

These 1x4 Wideband Fiber Optic Couplers are designed for splitting a single input signal at 850 nm equally into four output signals. The couplers have an operating bandwidth of ±100 nm and are available with 2.0 mm narrow key FC/PC or FC/APC connectors. They can handle a max power of 500 mW with connectors or unterminated (bare) fiber and 2 W when spliced (see the *Damage Threshold* tab for more details).

Item #	Info[a]	Center Wavelength	Bandwidth	Coupling Ratio (%)[b]	Coupling Ratio Tolerance	Insertion Loss[b]	Excess Loss[b]	Uniformity[b]	Fiber Type[d]	Termination
TWQ850HF[c]		850 nm	±100 nm	25:25:25:25	±6.0%	≤7.8 dB (Each Output Port)	≤0.6 dB	≤2.0 dB	780HP	FC/PC
TWQ850HA[c]										FC/APC

- . Please click on the blue icon for complete specifications.
- . Please see the *1x4 Coupler Tutorial* tab for more information on these terms.
- . All values are specified at room temperature over the bandwidth without connectors and measured using the white port as the input.
- d. Other fiber types may be available upon request.

Part Number	Description	Price	Availability
TWQ850HF	**1x4 Wideband Fiber Optic Coupler, 850 ± 100 nm, 25:25:25:25 Split, FC/PC**	**$862.00**	**Today**
TWQ850HA	**1x4 Wideband Fiber Optic Coupler, 850 ± 100 nm, 25:25:25:25 Split, FC/APC**	**$913.00**	**Today**

1064 nm 1x4 Fiber Optic Couplers

- Split 1064 nm Signals at 25:25:25:25 Coupling Ratio
- ±15 nm or ±100 nm Bandwidth
- Individual Test Report Included with Each Wideband Coupler; Click Here for a Sample Data Sheet
- Available with 2.0 mm Narrow Key FC/PC or FC/APC Connectors

These 1x4 Fiber Optic Couplers are designed for splitting a single input signal at 1064 nm equally into four output signals. These couplers feature an operating bandwidth of ±15 nm or ±100 nm and are available with 2.0 mm narrow key FC/PC or FC/APC connectors. Wideband couplers can handle a max power of 1 W with connectors or bare fiber and 5 W when spliced (see the *Damage Threshold* tab for more details).

Item #	Info[a]	Center Wavelength	Bandwidth	Coupling Ratio (%)[b]	Coupling Ratio Tolerance	Insertion Loss[b]	Excess Loss[b]	Uniformity[b]	Fiber Type[c]	Termination
FCQ1064-APC[d]		1064 nm	±15 nm	25:25:25:25	±3%	≤7.2 dB	0.35 dB (Typical)	-	HI1060 FLEX	FC/APC
TWQ1064BHF[e]		1064 nm	±100 nm	25:25:25:25	±3.5%	≤7.1 dB (Each Output Port)	≤0.4 dB	≤1.0 dB	HI1060 FLEX	FC/PC
TWQ1064BHA[e]										FC/APC

- . Please click on the blue icon for complete specifications.
- . Please see the *1x4 Coupler Tutorial* tab for more information on these terms.
- . Other fiber types may be available upon request.
- d. All values are specified without connectors.
- . All values are specified at room temperature over the bandwidth without connectors and measured using the white port as the input.

Part Number	Description	Price	Availability
FCQ1064-APC	**Customer Inspired!1x4 Narrowband Fiber Optic Coupler, 1064 ± 15 nm, 25:25:25:25 Split, FC/APC**	**$479.00**	**Today**
TWQ1064BHF	**1x4 Wideband Fiber Optic Coupler, 1064 ± 100 nm, 25:25:25:25 Split, FC/PC**	**$862.00**	**Today**
TWQ1064BHA	**1x4 Wideband Fiber Optic Coupler, 1064 ± 100 nm, 25:25:25:25 Split, FC/APC**	**$913.00**	**Today**

1300 nm 1x4 Fiber Optic Couplers

- Split 1300 nm Signals at 25:25:25:25 Coupling Ratio
- ±100 nm Bandwidth
- Individual Test Report Included with Each Coupler; Click Here for a Sample Data Sheet
- Available with 2.0 mm Narrow Key FC/PC or FC/APC Connectors

These 1x4 Wideband Fiber Optic Couplers are designed for splitting a single input signal at 1300 nm equally into four output signals. The couplers have an operating bandwidth of ±100 nm and are available with 2.0 mm narrow key FC/PC or FC/APC connectors. They can handle a max power of 1 W with connectors or bare fiber and 5 W when spliced (see the *Damage Threshold* tab for more details).

Item #	Info[a]	Center Wavelength	Bandwidth	Coupling Ratio (%)[b]	Coupling Ratio Tolerance	Insertion Loss[b]	Excess Loss[b]	Uniformity[b]	Fiber Type[d]	Termination
TWQ1300HF[c]		1300 nm	±100 nm	25:25:25:25	±3.0%	≤6.9 dB (Each Output Port)	≤0.3 dB	≤0.5 dB	SMF-28e+	FC/PC
TWQ1300HA[c]										FC/APC

- . Please click on the blue icon for complete specifications.
- . Please see the *1x4 Coupler Tutorial* tab for more information on these terms.
- . All values are specified at room temperature over the bandwidth without connectors and measured using the white port as the input.
- d. Other fiber types may be available upon request.

Part Number	Description	Price	Availability
TWQ1300HF	**1x4 Wideband Fiber Optic Coupler, 1300 ± 100 nm, 25:25:25:25 Split, FC/PC**	**$862.00**	**Today**
TWQ1300HA	**1x4 Wideband Fiber Optic Coupler, 1300 ± 100 nm, 25:25:25:25 Split, FC/APC**	**$913.00**	**Today**

1310/1550 nm 1x4 Fiber Optic Couplers

- Split 1310 nm or 1550 nm Signals at 25:25:25:25 Coupling Ratio
- ±40 nm Bandwidth
- Available with 2.0 mm Narrow Key FC/PC or FC/APC Connectors

These 1x4 Dual-Window Fiber Optic Couplers are designed for splitting a single input signal at 1310 nm or 1550 nm equally into four output signals. The couplers have an operating bandwidth of ±40 nm and are available with 2.0 mm narrow key FC/PC or FC/APC connectors.

Item #	Info[a]	Center Wavelength	Bandwidth	Coupling Ratio (%)[b]	Coupling Ratio Tolerance	Insertion Loss[b,c]	Excess Loss[b,c]	Uniformity[b]	Fiber Type	Termination
FCQ1315-FC		1310/1550 nm	±40 nm	25:25:25:25	±2.5%	6.2 dB	0.15 dB (Typical)	-	SMF-28 Ultra	FC/PC
FCQ1315-APC						≤7.6 dB	0.3 dB (Typical)			FC/APC

- . Please click on the blue icon for complete specifications.
- . Please see the *1x4 Coupler Tutorial* tab for more information on these terms.
- . These specifications were measured without connectors.

Part Number	Description	Price	Availability
FCQ1315-FC	**Customer Inspired!1x4 Dual Window Fiber Optic Coupler, 1310/1550 nm, 25:25:25:25 Split, FC/PC**	**$208.00**	**Today**
FCQ1315-APC	**Customer Inspired!1x4 Dual Window Fiber Optic Coupler, 1310/1550 nm, 25:25:25:25 Split, FC/APC**	**$260.00**	**Lead Time**

1550 nm 1x4 Fiber Optic Couplers

- Split 1550 nm Signals at 25:25:25:25 Coupling Ratio
- ±100 nm Bandwidth
- Individual Test Report Included with Each Coupler; Click Here for a Sample Data Sheet
- Available with 2.0 mm Narrow Key FC/PC or FC/APC Connectors

These 1x4 Wideband Fiber Optic Couplers are designed for splitting a single input signal at 1550 nm equally into four output signals. The couplers have an operating bandwidth of ±100 nm and are available with 2.0 mm narrow key FC/PC or FC/APC connectors. They can handle a max power of 1 W with connectors or bare fiber and 5 W when spliced (see the *Damage Threshold* tab for more details).

Item #	Info[a]	Center Wavelength	Bandwidth	Coupling Ratio (%)[b]	Coupling Ratio Tolerance	Insertion Loss[b]	Excess Loss[b]	Uniformity[b]	Fiber Type[d]	Termination
TWQ1550HF[c]		1550 nm	±100 nm	25:25:25:25	±3.0%	≤6.9 dB (Each Output Port)	≤0.3 dB	≤0.5 dB	SMF-28e+	FC/PC
TWQ1550HA[c]										FC/APC

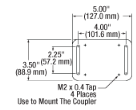
- . Please click on the blue icon for complete specifications.
- . Please see the *1x4 Coupler Tutorial* tab for more information on these terms.
- . All values are specified at room temperature over the bandwidth without connectors and measured using the white port as the input.
- d. Other fiber types may be available upon request.

Part Number	Description	Price	Availability

TWQ1550HF	1x4 Wideband Fiber Optic Coupler, 1550 ± 100 nm, 25:25:25:25 Split, FC/PC	$760.00	Today
TWQ1550HA	1x4 Wideband Fiber Optic Coupler, 1550 ± 100 nm, 25:25:25:25 Split, FC/APC	$811.00	Today

Mounting Base

- Mounting Base for Thorlabs' RGB Wavelength Combiners and 1x4 Single Mode (SM) Couplers
- Four M2 Taps for Mounting Fiber Optic Component Housing
- 2.25" (57.2 mm) Long Clearance Slots Accepts 1/4"-20 (M6) Screws
- Four M2 Mounting Screws Included



Click to Enlarge

Our FCQB mounting base provides two 2.25" (57.2 mm) long clearance slots for 1/4" (M6) cap screws for mounting Thorlabs' RGB wavelength combiners or 1x4 couplers to an optical table or other tapped surface. The two clearance slots are located 4" (101.6 mm) apart at opposite edges of the mounting base. Four M2 taps between the clearance slots are positioned to align with the through holes in Thorlabs' RGB wavelength combiners and 1x4 SM couplers. Four M2 screws are included.

Part Number	Description	Price	Availability
FCQB	Mounting Base for Thorlabs' RGB Combiners and 1x4 SM Couplers	$35.75	3-5 Days

FCQ1315-APC - 1x4 Dual Window Fiber Optic Coupler, 1310/1550 nm, 25:25:25:25 Split, FC/APC

Specifications

Specifications[a]	
Coupling Ratio	25:25:25:25
Center Wavelength	1310/1550 nm
Bandwidth	±40 nm
Insertion Loss	≤7.6 dB
Excess Loss	0.3 dB (Typical)
Polarization-Dependent Loss (PDL)	<0.3 dB
Fiber Type	SMF-28 Ultra
Port Configuration	1x4
Fiber Lead Length and Tolerance	0.8 m +0.075 m/-0 m
Termination	2.0 mm Narrow Key FC/APC
Package Size	3.94" x 3.15" x 0.39" (100 mm x 80 mm x 10 mm)
Jacket	Ø3 mm Furcation Tubing
Operating Temperature	-40 to 85 °C

a. All specifications are measured without connectors during the manufacturing process.