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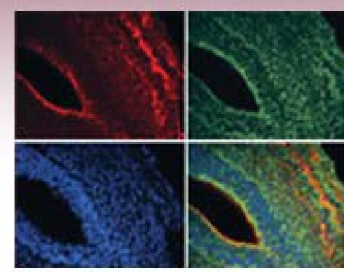
THORLABS

RGB50HB - November 01, 2017

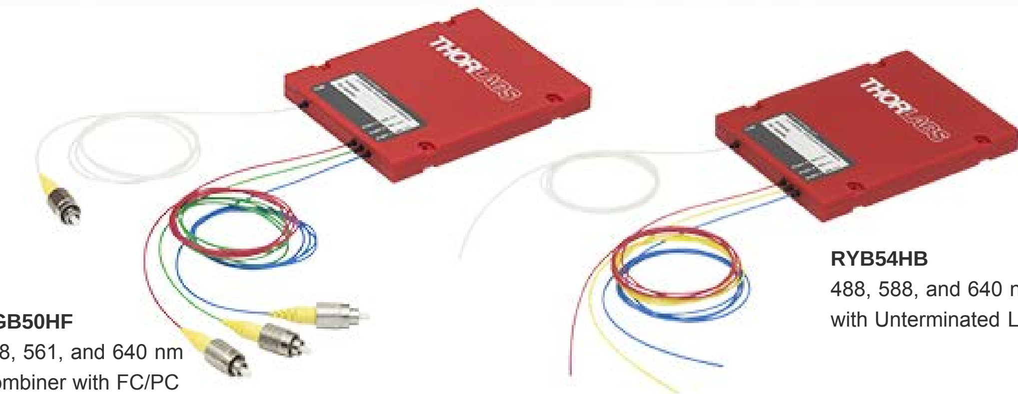
Item # RGB50HB was discontinued on November 01, 2017. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

RGB COMBINERS

- ► **Combine Three Input Colors into a Single Output**
- ► **Excellent for Confocal Microscopy, Fluoresence and Other Applications with Multiple Illumination Sources**
- ► **Unterminated, FC/PC, or FC/APC Outputs**



Use with Microscopy Setups to Create Three-Color Images



RYB54HB
488, 588, and 640 nm Combiner with Unterminated Leads

RGB50HF
488, 561, and 640 nm Combiner with FC/PC Connectors

OVERVIEW

Features

- Combine Three Colors into a Single Fiber Output
- Excellent for Confocal Microscopy, Fluorescence Microscopy, and Other Applications Requiring Multiple Laser Sources
- Seven Color Combinations (See the Table Below to the Right for Options)
- Color-Coded Inputs for Easy Identification
- Reversible: Can Also be Used to Split 3 Input Colors
- 0.8 m Long Single Mode Fiber Leads on All Ports
- Available with 2.0 mm Narrow Key FC/PC or FC/APC Connectors or Unterminated Leads
- Each Combiner is Shipped with an Individualized Product Data Sheet (See Below for Sample Data Sheets)
- Mount to an Optical Table with the FCQB Mounting Base (Available Below)

Click for Details
The ports on the RGB combiner are labeled with the wavelength and feature color-coded jackets on the fiber leads. The common port (COM) has a white jacket.

General Specifications	
Port Configuration	1x3
Termination	2.0 mm Narrow Key FC/PC or FC/APC or No Connectors (Scissor Cut)
Fiber Lead Length and Tolerance	0.8 m +0.075 m/-0.0 m
Jacket	Ø900 µm Loose Hytrel® Tube
Pigtail Tensile Load	5 N
Package Dimensions	3.94" x 3.15" x 0.39" (100.0 mm x 80.0 mm x 10.0 mm)
Mounting	Four Through Holes for #2 (M2) Screws[a]
Operating Temperature	-40 to 85 °C
Storage Temperature	-40 to 85 °C

- Through holes provide compatibility with the FCQB mounting base, available below.

Thorlabs' RGB combiners, also known as 3-wavelength combiners, allow three colors to be combined into a single output fiber. Seven wavelength combinations are available; options are listed in the table to the right. These combiners are ideal for use with fiber-coupled light sources, such our MCLS1, to create three color images in confocal microscopy setups. They can also be used to split three wavelengths entering the common port into three separate output ports.

Quick Links	
Blue/Green/Red	473, 532, and 640 nm
	473, 561, and 640 nm
	488, 532, and 640 nm
	488, 561, and 640 nm
Blue/Yellow/Red	488, 588, and 640 nm
Blue/Orange/Red	488, 594, and 640 nm
Red/NIR/NIR	642, 785, and 852 nm

Click to Enlarge
RGB46HA Combiner (FC/APC Connectors) Mounted on Thorlabs' FCQB Mounting Base (Available Below)

As seen in the image to the above right, a label on the top of the housing indicates the wavelength for each port, or channel. Additionally, the jacket on each fiber leg is color coded (visible wavelengths only); white indicates the common port. Each of the ports with an assigned wavelength has a ±5 nm bandwidth around that center wavelength. The graphs provided below give an example of the insertion loss in each channel for each of the color combinations offered. An insertion loss close to zero indicates high transmission at that wavelength, while a high value of insertion loss indicates low transmission of the signal. These RGB combiners provide low crosstalk (good isolation) between the wavelengths in each port; for each channel, signals at the center wavelengths of the other two channels are suppressed by at least 10 dB relative to the channel's specified wavelength.

The RGB combiners are tested during the manufacturing process to ensure that they meet specifications. Each RGB combiner is shipped with a detailed test report that includes transmission and isolation measurements as well an insertion loss plot showing the performance of Ports 1, 2, and 3. Sample data sheets for RGB combiners can be viewed below for each wavelength combination.

Each combiner is contained in a compact 3.94" x 3.15" x 0.39" (100.0 mm x 80.0 mm x 10.0 mm) housing that includes four through holes for mounting the device to our FCQB mounting base (available separately below). All fiber leads are jacketed in Ø900 µm loose Hytrel® tubes and are 0.8 m long. These combiners are offered from stock with 2.0 mm narrow key FC/PC or FC/APC connectors or with unterminated leads. For applications sensitive to connector losses, we recommend splicing unterminated leads together since FC/PC and FC/APC connectors may not ideally mate the fiber cores of the 460HP and 630HP fiber.

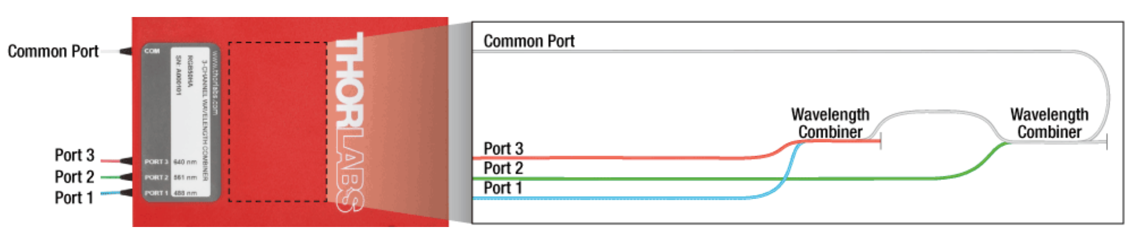
Thorlabs also offers 2-color combiners which mix two specified wavelengths into a single fiber. Other fiber types and select wavelength combinations are available upon request. If a custom connector configuration is needed, one-day turnaround is possible for small orders if the order is placed before 12 PM EST. Please contact Technical Support with inquiries.

RGB VERIFICATION

RGB Combiner Design

Thorlabs' RGB Combiners are designed to combine light at three wavelengths into a single common fiber. As shown in the diagram below, the combiner internally consists of two fused fiber wavelength combiners that merge light from the three wavelength ports (ports 1 - 3) into a single output (common port). In the combiner shown in the diagram below, light from port 1 and port 3 are combined first, and then light from port 2 is added using a second wavelength combiner. Depending on the wavelength configuration of each port, the order in which the ports are combined may vary.

Because RGB combiners are bidirectional, the they can also split light inserted into the common port. For optimal splitting performance, the input light should only contain wavelengths specified for the three output ports. Out-of-band performance can be estimated using the data sheets provided with each RGB combiner; click here for a sample data sheet or see below for sample data sheets for each wavelength combination.

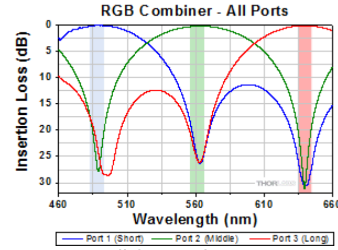


Schematic of the internal components of an example RGB Combiner. The zoom panel shows an example configuration of how (ports 1 - 3) are combined into the common port.

RGB Combiner Manufacturing and Verification Process

To manufacture the RGB combiner, three optical fibers are fused together to form the two wavelength couplers that comprise the RGB combiner. This section details the step-by-step process for manufacturing and verifying the performance of an example RGB combiner. The exact configuration of the fibers within the combiner may vary depending on the specified wavelengths.

During each manufacturing step, the output power and insertion loss (IL) at each port is monitored. As seen in the graph to the right and definition below, insertion loss (measured in dB) is the ratio of the input power to the output power from each leg of the coupler as a function of wavelength. Each port of the coupler is designed to have high transmission of a single wavelength while supressing other wavelengths, which minimizes cross talk between the ports.



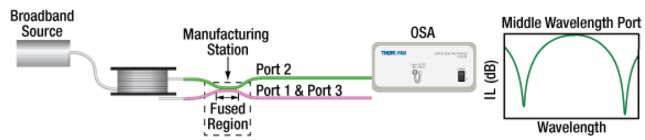
Click to Enlarge
The shaded regions in the plot indicate the bandwidth where each port meets the specified performance.

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

where P_{in} and P_{out} are the input and output powers (in mW).

Step 1

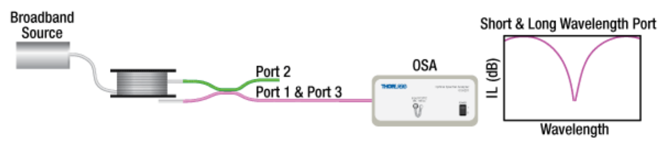
At the first stage, two fibers are fused on a manufacturing station to separate out the center wavelength channel of the RGB combiner. The output in this channel is monitored during the fusing process using a source on one side and an optical spectrum analyzer (OSA) on the other. The insertion loss as a function of wavelength is calculated from the spectrum obtained from the OSA.



Click to Enlarge
In the diagram, the fibers are color-coded; green for port 2 (middle wavelength) and violet for a mix of short and long wavelengths.

Step 2

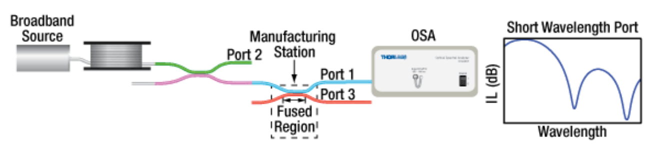
The other fiber end from the first wavelength split contains both the short and long wavelengths of the original source. The insertion loss from the short/long wavelength channel can be similarly determined using a source and OSA at this port.



Click to Enlarge
In the diagram, the fibers are color-coded; green for port 2 (middle wavelength) and violet for a mix of short and long wavelengths.

Step 3

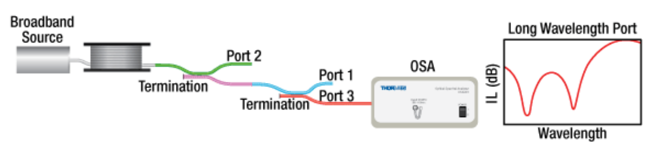
To separate the short and long wavelength channels after the first split, a second fused fiber stage is added (shown in the diagram to the right). The output from the short wavelength channel is measured during the fusing process and the insertion loss is calculated from these measurements.



Click to Enlarge
In the diagram, the fibers are color-coded; green for port 2 (middle wavelength), violet for a mix of short and long wavelengths, blue for port 1 (short wavelength), and red for port 3 (long wavelength).

Step 4

In the final step, the output from the long wavelength port is measured using the OSA for quality control. At this point, unused fiber leads at each wavelength split are terminated. The insertion loss from each output port can be combined to generate the insertion loss plot shown above.



Click to Enlarge
In the diagram, the fibers are color-coded; green for port 2 (middle wavelength), violet for a mix of short and long wavelengths, blue for port 1 (short wavelength), and red for port 3 (long wavelength).

DAMAGE THRESHOLD

Laser-Induced Damage in Silica Optical Fibers

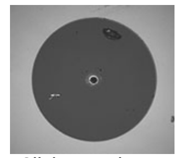
Quick Links

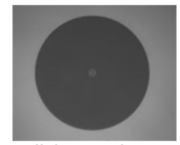
The following tutorial details damage mechanisms relevant to unterminated (bare) fiber, terminated optical fiber, and other fiber components from laser light sources. These mechanisms include damage that occurs at the air / glass interface (when free-space coupling or when using connectors) and in the 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)

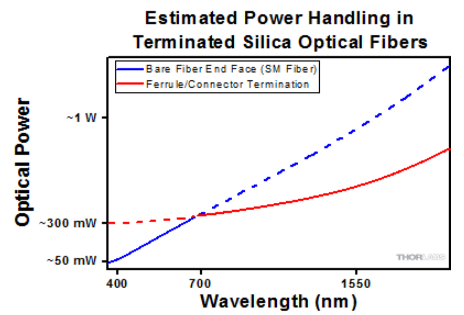
The effective area of a multimode (MM) fiber is defined by the core diameter, which is typically far larger than the MFD of an SM fiber. For optimal coupling, Thorlabs recommends focusing a beam to a spot roughly 70 - 80% of the core diameter. The larger effective area of MM fibers lowers the power density 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.

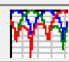
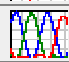
2. After connecting the fiber or component, the system should be tested and aligned using a light source at low power. The system power can be ramped up slowly to the desired output power while periodically verifying all components are properly aligned and that coupling efficiency is not changing with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

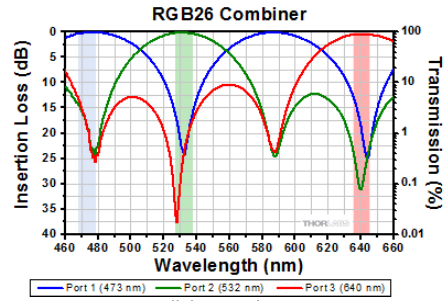
4. Users should always choose the appropriate optical fiber for a given application. For example, large-mode-area fibers are a good alternative to standard single mode fibers in high-power applications as they provide good beam quality with a larger MFD, decreasing the power density on the air/fiber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

RGB Combiner: 473, 532, and 640 nm

RGB26 Specifications				
Port		**1**	**2**	**3**
Color		Blue	Green	Red
Wavelength		473 nm	532 nm	640 nm
Bandwidth[a]		±5 nm	±5 nm	±5 nm
Insertion Loss[a,b]		≤0.7 dB	≤0.7 dB	≤0.7 dB
Transmission[a,b]		≥85%	≥85%	≥85%
Isolation[a,c]	@ 473 nm	N/A	≥10 dB	≥10 dB
	@ 532 nm	≥10 dB	N/A	≥10 dB
	@ 640 nm	≥10 dB	≥10 dB	N/A
Polarization-Dependent Loss[a]		≤0.2 dB		
Optical Return Loss[a]		≥60 dB		
Fiber Type[d]		460HP		
Max Power Level[e]		50 mW (Connectors or Bare Fiber) 100 mW (Spliced)		

- All values are specified over the bandwidth without connectors.
- Transmission is calculated from the measured insertion loss; both values are provided here for convenience.
- Isolation represents the maximum crosstalk between the channels.
- Other fiber types are available upon request. Please contact Technical Support with inquiries.
- Specifies the total maximum power allowed through the component. Coupler performance and reliability under high power conditions must be determined within the user's setup

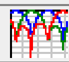
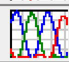


Click to Enlarge
Click Here for Raw Data
This plot shows an example of the spectral performance of a RGB26 RGB wavelength combiner. The lines represent the spectral response of each channel, while the colored regions denote the bandwidth around the center wavelengths. This data is typical; performance of each combiner may vary within the combiner specifications. Data was obtained without connectors.

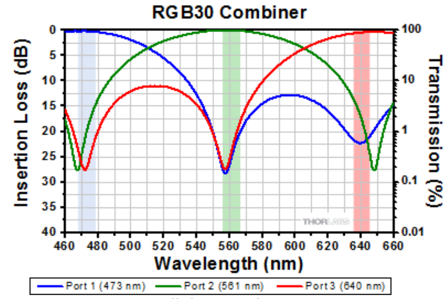
Each RGB combiner is shipped with a detailed test report that includes transmission and isolation measurements as well an insertion loss plot showing the performance of Ports 1, 2, and 3.

Part Number	Description	Price	Availability
RGB26HB	RGB Combiner: 473, 532, and 640 nm, No Connectors	$867.00	Today
RGB26HF	RGB Combiner: 473, 532, and 640 nm, FC/PC Connectors	$908.00	Today
RGB26HA	RGB Combiner: 473, 532, and 640 nm, FC/APC Connectors	$908.00	Today

RGB Combiner: 473, 561, and 640 nm

RGB30 Specifications				
Port		**1**	**2**	**3**
Color		Blue	Green	Red
Wavelength		473 nm	561 nm	640 nm
Bandwidth[a]		±5 nm	±5 nm	±5 nm
Insertion Loss[a,b]		≤0.7 dB	≤0.7 dB	≤0.7 dB
Transmission[b]		≥85%	≥85%	≥85%
Isolation[a,c]	@ 473 nm	N/A	≥10 dB	≥10 dB
	@ 561 nm	≥10 dB	N/A	≥10 dB
	@ 640 nm	≥10 dB	≥10 dB	N/A
Polarization-Dependent Loss[a]		≤0.2 dB		
Optical Return Loss[a]		≥60 dB		
Fiber Type[d]		460HP		
Max Power Level[e]		50 mW (Connectors or Bare Fiber) 100 mW (Spliced)		

- All values are specified over the bandwidth without connectors.
- Transmission is calculated from the measured insertion loss; both values are provided here for convenience.
- Isolation represents the maximum crosstalk between the channels.
- Other fiber types are available upon request. Please contact Technical Support with inquiries.
- Specifies the total maximum power allowed through the component. Coupler performance and reliability under high power conditions must be determined within the user's setup.

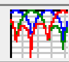
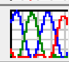


Click to Enlarge
Click Here for Raw Data
This plot shows an example of the spectral performance of a RGB30 RGB wavelength combiner. The lines represent the spectral response of each channel, while the colored regions denote the bandwidth around the center wavelengths. This data is typical; performance of each combiner may vary within the combiner specifications. Data was obtained without connectors.

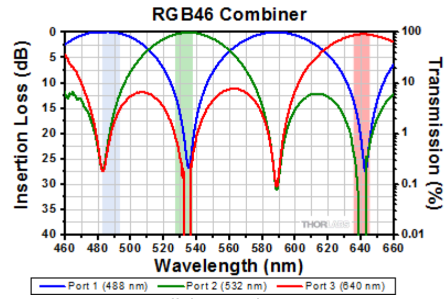
Each RGB combiner is shipped with a detailed test report that includes transmission and isolation measurements as well an insertion loss plot showing the performance of Ports 1, 2, and 3.

Part Number	Description	Price	Availability
RGB30HB	RGB Combiner: 473, 561, and 640 nm, No Connectors	$867.00	Today
RGB30HF	RGB Combiner: 473, 561, and 640 nm, FC/PC Connectors	$908.00	Today
RGB30HA	RGB Combiner: 473, 561, and 640 nm, FC/APC Connectors	$908.00	Today

RGB Combiner: 488, 532, and 640 nm

RGB46 Specifications				
Port		**1**	**2**	**3**
Color		Blue	Green	Red
Wavelength		488 nm	532 nm	640 nm
Bandwidth[a]		±5 nm	±5 nm	±5 nm
Insertion Loss[a,b]		≤0.7 dB	≤0.7 dB	≤0.7 dB
Transmission[b]		≥85%	≥85%	≥85%
Isolation[a,c]	@ 488 nm	N/A	≥12 dB	≥12 dB
	@ 532 nm	≥12 dB	N/A	≥12 dB
	@ 640 nm	≥12 dB	≥12 dB	N/A
Polarization-Dependent Loss[a]		≤0.2 dB		
Optical Return Loss[a]		≥60 dB		
Fiber Type[d]		460HP		
Max Power Level[e]		50 mW (Connectors or Bare Fiber) 100 mW (Spliced)		

- All values are specified over the bandwidth without connectors.
- Transmission is calculated from the measured insertion loss; both values are provided here for convenience.
- Isolation represents the maximum crosstalk between the channels.
- Other fiber types are available upon request. Please contact Technical Support with inquiries.
- Specifies the total maximum power allowed through the component. Coupler performance and reliability under high power conditions must be determined within the user's setup.



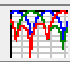
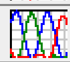
Click to Enlarge
Click Here for Raw Data
This plot shows an example of the spectral performance of a RGB46 RGB wavelength combiner. The lines represent the spectral response of each channel, while the colored regions denote the bandwidth around the center wavelengths. This data is typical; performance of each combiner may vary within the combiner specifications. Data was obtained without connectors.

Each RGB combiner is shipped with a detailed test report that includes transmission and isolation measurements as well an insertion loss plot showing the performance of Ports 1, 2, and 3.

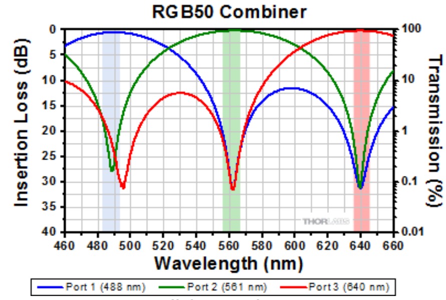
Part Number	Description	Price	Availability
RGB46HB	**RGB Combiner: 488, 532, and 640 nm, No Connectors**	**$867.00**	**Today**
RGB46HF	**RGB Combiner: 488, 532, and 640 nm, FC/PC Connectors**	**$908.00**	**Today**
RGB46HA	**RGB Combiner: 488, 532, and 640 nm, FC/APC Connectors**	**$908.00**	**Today**

RGB Combiner: 488, 561, and 640 nm

RGB50 Specifications			
Port	**1**	**2**	**3**

Color		Blue	Green	Red
Wavelength		488 nm	561 nm	640 nm
Bandwidth[a]		±5 nm	±5 nm	±5 nm
Insertion Loss[a,b]		≤0.7 dB	≤0.7 dB	≤0.7 dB
Transmission[b]		≥85%	≥85%	≥85%
Isolation[a,c]	@ 488 nm	N/A	≥15 dB	≥15 dB
	@ 561 nm	≥15 dB	N/A	≥15 dB
	@ 640 nm	≥15 dB	≥15 dB	N/A
Polarization-Dependent Loss[a]		≤0.2 dB		
Optical Return Loss[a]		≥60 dB		
Fiber Type[d]		460HP		
Max Power Level[e]		50 mW (Connectors or Bare Fiber) 100 mW (Spliced)		

- All values are specified over the bandwidth without connectors.
- Transmission is calculated from the measured insertion loss; both values are provided here for convenience.
- Isolation represents the maximum crosstalk between the channels.
- Other fiber types are available upon request. Please contact Technical Support with inquiries.
- Specifies the total maximum power allowed through the component. Coupler performance and reliability under high power conditions must be determined within the user's setup.



Click to Enlarge

Click Here for Raw Data

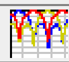
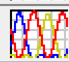
This plot shows an example of the spectral performance of a RGB50 RGB wavelength combiner. The lines represent the spectral response of each channel, while the colored regions denote the bandwidth around the center wavelengths. This data is typical; performance of each combiner may vary within the combiner specifications. Data was obtained without connectors.

Each RGB combiner is shipped with a detailed test report that includes transmission and isolation measurements as well an insertion loss plot showing the performance of Ports 1, 2, and 3.

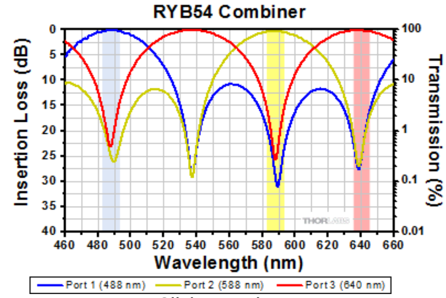
Part Number	Description	Price	Availability
RGB50HB	RGB Combiner: 488, 561, and 640 nm, No Connectors	$867.00	Today
RGB50HF	RGB Combiner: 488, 561, and 640 nm, FC/PC Connectors	$908.00	Today
RGB50HA	RGB Combiner: 488, 561, and 640 nm, FC/APC Connectors	$908.00	Today

RYB Combiner: 488, 588, and 640 nm

RYB54 Specifications			
Port	**1**	**2**	**3**
Color	Blue	Yellow	Red

Wavelength		488 nm	588 nm	640 nm
Bandwidth[a]		±5 nm	±5 nm	±5 nm
Insertion Loss[a,b]		≤0.7 dB	≤0.7 dB	≤0.7 dB
Transmission[b]		≥85%	≥85%	≥85%
Isolation[a,c]	@ 488 nm	N/A	≥12 dB	≥12 dB
	@ 588 nm	≥12 dB	N/A	≥12 dB
	@ 640 nm	≥12 dB	≥12 dB	N/A
Polarization-Dependent Loss[a]		≤0.2 dB		
Optical Return Loss[a]		≥60 dB		
Fiber Type[d]		460HP		
Max Power Level[e]		50 mW (Connectors or Bare Fiber) 100 mW (Spliced)		

- All values are specified over the bandwidth without connectors.
- Transmission is calculated from the measured insertion loss; both values are provided here for convenience.
- Isolation represents the maximum crosstalk between the channels.
- Other fiber types are available upon request. Please contact Technical Support with inquiries.
- Specifies the total maximum power allowed through the component. Coupler performance and reliability under high power conditions must be determined within the user's setup.



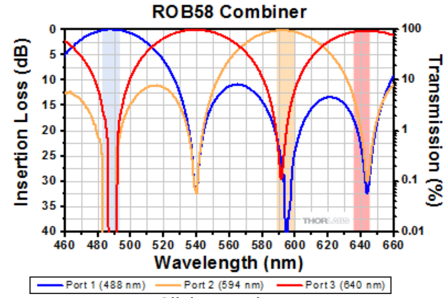
Click to Enlarge
Click Here for Raw Data
This plot shows an example of the spectral performance of a RYB54 RYB wavelength combiner. The lines represent the spectral response of each channel, while the colored regions denote the bandwidth around the center wavelengths. This data is typical; performance of each combiner may vary within the combiner specifications. Data was obtained without connectors.

Each RYB combiner is shipped with a detailed test report that includes transmission and isolation measurements as well an insertion loss plot showing the performance of Ports 1, 2, and 3.

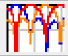
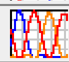
Part Number	Description	Price	Availability
RYB54HB	RYB Combiner: 488, 588, and 640 nm, No Connectors	$867.00	Today
RYB54HF	RYB Combiner: 488, 588, and 640 nm, FC/PC Connectors	$908.00	Today
RYB54HA	RYB Combiner: 488, 588, and 640 nm, FC/APC Connectors	$908.00	3-5 Days

ROB Combiner: 488, 594, and 640 nm

ROB58 Specifications			
Port	**1**	**2**	**3**
Color	Blue	Orange	Red



Click to Enlarge
Click Here for Raw Data
This plot shows an example of the spectral performance of a ROB58 ROB wavelength combiner. The lines represent the spectral response of each channel, while the colored regions denote the bandwidth around the center wavelengths. This data is typical; performance of each combiner may vary within the combiner specifications. Data was obtained without connectors.

Wavelength		488 nm	594 nm	640 nm
Bandwidth[a]		±5 nm	±5 nm	±5 nm
Insertion Loss[a,b]		≤0.7 dB	≤0.7 dB	≤0.7 dB
Transmission[b]		≥85%	≥85%	≥85%
Isolation[a,c]	@ 488 nm	N/A	≥10 dB	≥10 dB
	@ 594 nm	≥10 dB	N/A	≥10 dB
	@ 640 nm	≥10 dB	≥10 dB	N/A
Polarization-Dependent Loss[a]		≤0.2 dB		
Optical Return Loss[a]		≥60 dB		
Fiber Type[d]		460HP		
Max Power Level[e]		50 mW (Connectors or Bare Fiber) 100 mW (Spliced)		

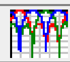
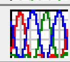
- All values are specified over the bandwidth without connectors.
- Transmission is calculated from the measured insertion loss; both values are provided here for convenience.
- Isolation represents the maximum crosstalk between the channels.
- Other fiber types are available upon request. Please contact Technical Support with inquiries.
- Specifies the total maximum power allowed through the component. Coupler performance and reliability under high power conditions must be determined within the user's setup.

Each ROB combiner is shipped with a detailed test report that includes transmission and isolation measurements as well an insertion loss plot showing the performance of Ports 1, 2, and 3.

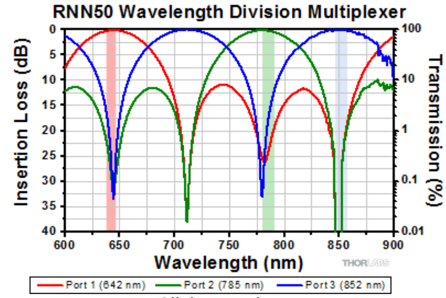
Part Number	Description	Price	Availability
ROB58HB	**ROB Combiner: 488, 594, and 640 nm, No Connectors**	**$867.00**	**Today**
ROB58HF	**ROB Combiner: 488, 594, and 640 nm, FC/PC Connectors**	**$908.00**	**Today**
ROB58HA	**ROB Combiner: 488, 594, and 640 nm, FC/APC Connectors**	**$908.00**	**Today**

Red-NIR-NIR Combiner: 642, 785, and 852 nm

RNN50 Specifications			
Port	**1**	**2**	**3**
Color (Fiber Jacket)	Red	Green	Blue

Wavelength		642 nm	785 nm	852 nm
Bandwidth[a]		±5 nm	±5 nm	±5 nm
Insertion Loss[a]		≤0.7 dB	≤0.7 dB	≤0.7 dB
Transmission[b]		≥85%	≥85%	≥85%
Isolation[a,c]	@ 642 nm	N/A	≥12 dB	≥12 dB
	@ 785 nm	≥12 dB	N/A	≥12 dB
	@ 852 nm	≥12 dB	≥12 dB	N/A
Polarization-Dependent Loss[a]		≤0.2 dB		
Optical Return Loss[a]		≥60 dB		
Fiber Type[d]		630HP		
Max Power Level[e]		300 mW (Connectors or Bare Fiber) 500 mW (Spliced)		

- All values are specified over the bandwidth without connectors.
- Transmission is calculated from the measured insertion loss; both values are provided here for convenience.
- Isolation represents the maximum crosstalk between the channels.
- Other fiber types are available upon request. Please contact Technical Support with inquiries.
- Specifies the total maximum power allowed through the component. Coupler performance and reliability under high power conditions must be determined within the user's setup.



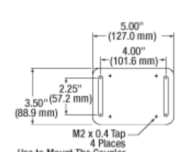
Click to Enlarge
Click Here for Raw Data
This plot shows an example of the spectral performance of a RNN50 3-wavelength combiner. The lines represent the spectral response of each channel, while the colored regions denote the bandwidth around the center wavelengths. This data is typical; performance of each WDM may vary from unit to tunit. Data was obtained without connectors.

Each combiner is shipped with a detailed test report that includes transmission and isolation measurements as well an insertion loss plot showing the performance of Ports 1, 2, and 3.

Part Number	Description	Price	Availability
RNN50HB	**3-Wavelength WDM: 642, 785, and 852 nm, No Connectors**	**$867.00**	**Today**
RNN50HF	**3-Wavelength WDM: 642, 785, and 852 nm, FC/PC Connectors**	**$908.00**	**Today**
RNN50HA	**3-Wavelength WDM: 642, 785, and 852 nm, FC/APC Connectors**	**$908.00**	**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 Accept 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**	**Today**