



Specialty Photonics Division  
**Your Optical Fiber Solutions Partner**

# High-Power Products



Power Combiners

Cladding Pumped Fibers



A Furukawa Company

# We **expanded** our **capabilities** so you have more **options**

OFS Specialty Photonics Division has all the experience and capability to generate the high powers you need from today's and tomorrow's specialty optical fibers.

We design and manufacture the components you are looking for:

- Ytterbium (Yb) and erbium/ ytterbium (Er/Yb)-doped cladding pumped fibers
- Power Combiners
- Multimode launch fibers matched to the input fibers
- Metalized multimode launch fiber pigtails
- Complete metallization and ferrule capabilities for diode subassemblies
- Fiber Bragg gratings, grating-based reflectors, and filters
- A variety of fiber end preparations
- Connectorization
- Hermetic and strain relief ferrules

Ask us about other options available:

- ⚙ Cladding Pumped Fiber Lasers
- ⚙ Gain Modules
- ⚙ Custom Designs

To order items in this brochure, please contact our facility in:

- ⚙ Somerset, New Jersey  
1-732-748-7402
- ⚙ or by email inquiry to:  
Info@SpecialtyPhotonics.com

Using these building blocks, customers can specify splicing and other parameters for the creation of various assemblies, such as:

- Gain Modules
- Cladding Pumped Fiber Lasers (CPFLs)
- Cladding Pumped Fiber Amplifiers (CPFAs)

The options are extensive:

- Yb or Er/Yb and other dopants
- Double cladding
- Air cladding
- Large Mode Area fibers
- Single-mode and polarization-maintaining constructions
- 7:1 or 19:1 ratios for power combining
- High reflectivity
- Supported output powers 10 to >40 watts with high damage threshold
- Stability for either pulsed or CW lasers
- Strong technical support for testing under high power generation

## Applications for High-Power Products

Power requirements have increased in a number of industries, requiring larger throughput than traditional solid-state lasers. Fiber lasers and amplifiers provide better beam profile characteristics, higher wallplug efficiencies, compact footprints, turnkey operation, longer reliability and maintenance-free operation. They also provide much higher energies during pulsed operation and at higher repetition rates.

- CATV
- Industrial
- Telecommunications
- Medical lasers
- Military defense
- Spectroscopy



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OFS Specialty Photonics Division

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25 Schoolhouse Road, Somerset, NJ 08873  
Priorparken 680 DK-2605 Broendby, Denmark

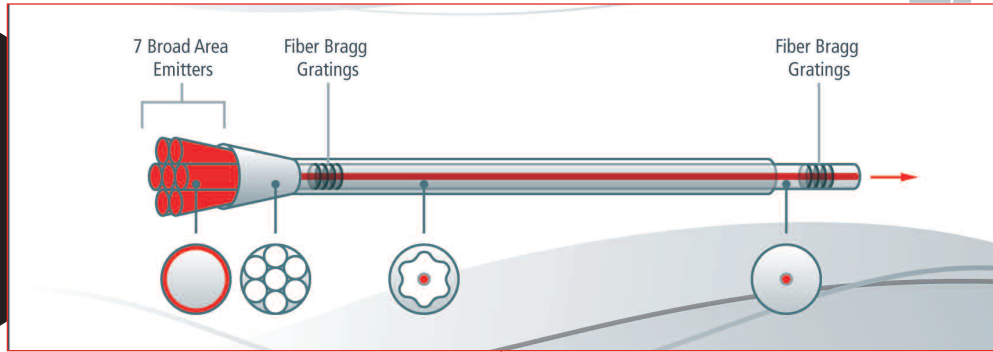
[www.SpecialtyPhotonics.com](http://www.SpecialtyPhotonics.com)

[www.SpecialtyPhotonics.com](http://www.SpecialtyPhotonics.com)

# LASER

## Cladding Pumped Fiber **LASER (CPFL)**

High-Power Assemblies with OFS Components



Output Wavelength:  
 1064 nm  
 1083 nm  
 1100 nm  
 1117 nm

**CLADDING PUMPED FIBERS**  
 Also Available Separately  
 Yb 130  $\mu\text{m}$

**POWER COMBINERS for CPFLasers**

Multimode Input (105/125 $\mu\text{m}$ )	CPF Output (0.45 NA)
7 fibers 0.15 NA	1 - undoped 125 $\mu\text{m}$
7 fibers 0.22 NA	1 - undoped 200 $\mu\text{m}$
19 fibers 0.15 NA	1 - undoped 200 $\mu\text{m}$

# AMPLIFIER

**CLADDING PUMPED FIBERS**  
 Also Available Separately

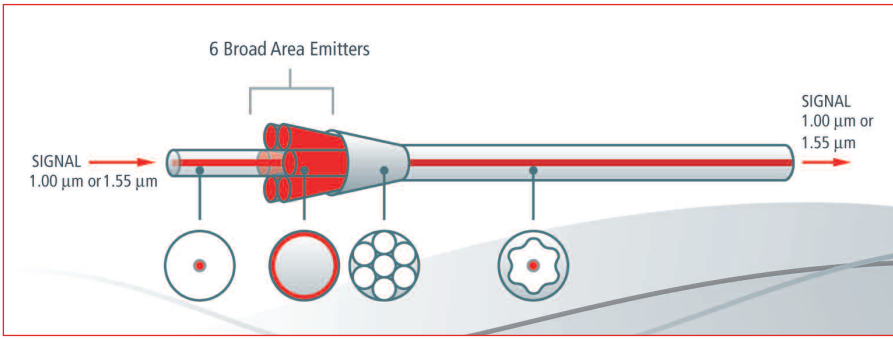
ErYb 130  $\mu\text{m}$       PM ErYb 125  $\mu\text{m}$   
 Yb 130  $\mu\text{m}$       PM Yb 125  $\mu\text{m}$   
 PM Yb 200  
 Custom available: Yb and ErYb Large Mode Area

**POWER COMBINERS for CPFAmplifiers**

Input	CPF Output (0.45 NA)
6 MM 105/125 $\mu\text{m}$ + 1 SM signal fiber	1 - undoped 125 $\mu\text{m}$
18 MM 105/125 $\mu\text{m}$ + 1 SM signal fiber	1 - undoped 200 $\mu\text{m}$
6 MM 105/125 $\mu\text{m}$ + 1 PM signal fiber	1 - undoped PM 125 $\mu\text{m}$

Large Mode Area fibers available separately by special arrangement.

## Cladding Pumped Fiber **AMPLIFIER (CPFA)**



**CLADDING PUMPED FIBER GAIN MODULE CONFIGURATIONS**

Includes Power Combiner and Cladding Pumped Fiber

Yb Gain Module      PM Yb Gain Module  
 ErYb Gain Module      PM ErYb Gain Module

## Full Specification Information for Products Available Separately

Multimode Power Combiners

Polarization-Maintaining Power Combiners

Single-Mode Power Combiners

Erbium-Ytterbium Cladding Pumped Fiber

Ytterbium Cladding Pumped Fiber

Polarization-Maintaining Erbium-Ytterbium  
Cladding Pumped Fiber

Polarization-Maintaining Ytterbium  
Cladding Pumped Fiber

Multimode Step-Index Launch Fibers matched  
to input fibers — Contact us for specifications.

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### Other Product Capabilities —

Contact us for purchases by special arrangement:

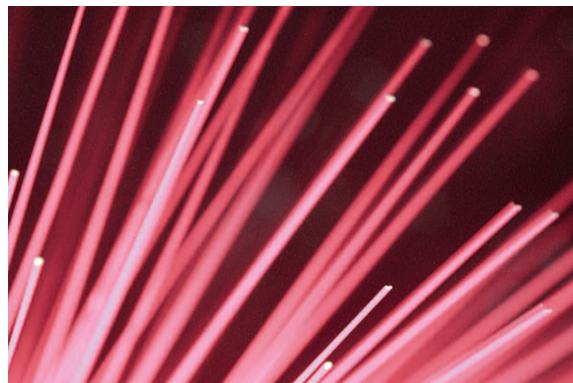
Erbium-Ytterbium Large Mode Area Fibers

Ytterbium Large Mode Area Fibers

Cladding Pumped Fiber Gain Modules

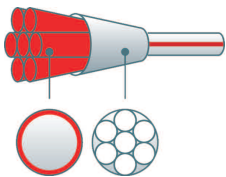
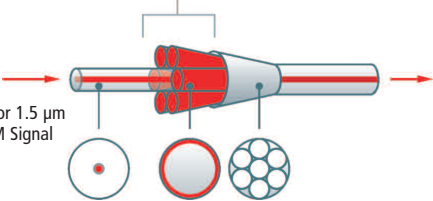
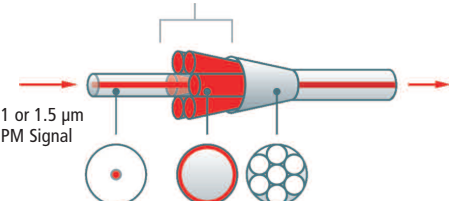
Cladding Pumped Fiber Amplifiers

Cladding Pumped Fiber Lasers



# Power Combiners

Power Combiners are available in all-fiber Multimode, Polarization-Maintaining, or Single-Mode constructions. They are designed for efficient coupling into cladding pumped fibers. Custom designs and value-added Gain Module or Laser Assemblies are also available. See individual variations below:

Product Description	Typical Applications	Features and Benefits
<p><b>Multimode</b></p> <p>Multimode Power combiners couple 7 or 19 multimode high-power sources into cladding pumped fiber.</p> <p>MM Input Fiber (7 shown)</p>  <p>for connection to Broad Area Emitters</p>	<ul style="list-style-type: none"> <li>• High-power fiber lasers for use in the following industries: <ul style="list-style-type: none"> <li>Industrial</li> <li>Military</li> <li>Medical</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Easy splicing</li> <li>• High coupling efficiency</li> <li>• Compatible with pump diodes with multimode input fiber of 0.15 NA or 0.22 NA</li> <li>• Provides scalability</li> </ul>
<p><b>Single-Mode</b></p> <p>Single-Mode Power Combiners couple 6 or 18 multimode high-power sources and 1 single-mode signal source for combined power output or for use with a cladding pumped fiber.</p> <p>MM Input Fiber (6 shown)</p>  <p>1 or 1.5 <math>\mu\text{m}</math> SM Signal</p> <p>for connection to Broad Area Emitters</p>	<ul style="list-style-type: none"> <li>• This "Signal fiber design" is used for applications in the following industries: <ul style="list-style-type: none"> <li>Industrial</li> <li>Military</li> <li>Medical</li> </ul> </li> <li>• A single-mode Power Combiner can be used to construct an amplifier for use in telecommunications</li> <li>• Optimized for 1 <math>\mu\text{m}</math> and 1.5 <math>\mu\text{m}</math> applications</li> </ul>	<ul style="list-style-type: none"> <li>• Compatible with 915 nm and 976 nm pump diodes with multimode pigtail fiber with NA of .15 or .22</li> <li>• Easy splicing</li> <li>• High coupling efficiency</li> <li>• Provides scalability</li> </ul>
<p><b>Polarization-Maintaining</b></p> <p>Polarization-Maintaining Power Combiners couple 6 multimode high-power sources and 1 polarization-maintaining (PM) source for combined power output or for use with a PM cladding pumped fiber.</p> <p>MM Input Fiber (6 shown)</p>  <p>1 or 1.5 <math>\mu\text{m}</math> PM Signal</p> <p>for connection to Broad Area Emitters</p>	<ul style="list-style-type: none"> <li>• This "Signal fiber design" is used to construct high-power amplifiers requiring signal polarization outputs for use in the following industries: <ul style="list-style-type: none"> <li>Industrial</li> <li>Military</li> <li>Medical</li> <li>Telecommunications</li> </ul> </li> <li>• Optimized for 1 <math>\mu\text{m}</math> and 1.5 <math>\mu\text{m}</math> applications</li> </ul>	<ul style="list-style-type: none"> <li>• All PM design—PM signal input and output</li> <li>• Compatible with 915 nm and 976 nm pump diodes with multimode pigtail fiber with NA of .15 or .22</li> <li>• Easy splicing</li> <li>• High coupling efficiency</li> <li>• Provides scalability</li> </ul>

# Multimode Combiner Specifications

Multimode Input Fibers	7 : 1		19 : 1
Number of input fibers	7	7	19
Numerical aperture	.165	.22	.165
Core diameter	105 ± 3 μm	105 ± 3 μm	105 ± 3 μm
Cladding diameter	125 ± 2.5 μm	125 ± 2.5 μm	125 ± 2.5 μm
Coating outer diameter	250 ± 15 μm	250 ± 15 μm	250 ± 15 μm
Pigtail fiber length	1 meter	1 meter	1 meter

Output Fiber			
Numerical aperture	.45 ± .03	.45 ± .03	.45 ± .03
Cladding diameter	125 ± 2.5 μm	200 ± 2.5 μm	200 ± 2.5 μm
Coating outer diameter	250 ± 15 μm	300 ± 15 μm	300 ± 15 μm
Pigtail fiber length	1 meter	1 meter	1 meter

Performance			
Multimode transmission (*2)	>90%	>90%	>90%
Optical return loss	40 dB	40 dB	40 dB
Maximum total input power	35 Watts (*3)	(*3)	100 Watts (*3)
Operating temperature	0 to +70°C	0 to +70°C	0 to +70°C

Compatibility			
Recommended for use with these OFS cladding pumped fibers	Yb 130	Contact us for availability	Contact us for availability

Order by Part Number	TFB11A0	TFB2220	TFB4120
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(\*2) Tested by multimode input light with 70% and 99% of power confined with NA of 0.09 and 0.15 , respectively.

(\*3) These values are based on testing to date with 5W/leg conditions. Device capability is higher but has not yet been formally tested.

# Single-Mode Combiner Specifications

MM Input Fibers	for 1 $\mu\text{m}$ Applications			for 1.5 $\mu\text{m}$ Applications	
Number of input fibers	6	6	18	6	6
Numerical aperture	.165	.22	.165	.165	.22
Core diameter	105 $\pm$ 3 $\mu\text{m}$	105 $\pm$ 3 $\mu\text{m}$	105 $\pm$ 3 $\mu\text{m}$	105 $\pm$ 3 $\mu\text{m}$	105 $\pm$ 3 $\mu\text{m}$
Cladding diameter	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$
Coating outer diameter	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$
Pigtail fiber length	1 meter	1 meter	1 meter	1 meter	1 meter
SM Signal Input Fiber					
Numerical Aperture	0.15 $\pm$ .015	0.15 $\pm$ .015	0.15 $\pm$ .015	0.15 $\pm$ .015	0.15 $\pm$ .015
MFD @ operating wavelength (1060 or 1550 nm)	8.0 $\mu\text{m}$	8.0 $\mu\text{m}$	8.0 $\mu\text{m}$	10.3 $\mu\text{m}$	10.3 $\mu\text{m}$
Cladding diameter	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$
Coating Outer diameter	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$
Splice to SMF28	< 0.3 dB	< 0.3 dB	< 0.3 dB	< 0.3 dB	< 0.3 dB
Pigtail fiber length	1 meter	1 meter	1 meter	1 meter	1 meter
Undoped Output Fiber					
Cladding numerical aperture	.45 $\pm$ .03	.45 $\pm$ .03	.45 $\pm$ .03	.45 $\pm$ .03	.45 $\pm$ .03
MFD @ operating wavelength (1060 or 1550 nm)	7.0 $\mu\text{m}$	7.0 $\mu\text{m}$	7.0 $\mu\text{m}$	10.2 $\mu\text{m}$	10.2 $\mu\text{m}$
Cladding diameter	125 $\pm$ 2.5 $\mu\text{m}$	200 $\pm$ 2.5 $\mu\text{m}$	200 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	200 $\pm$ 2.5 $\mu\text{m}$
Coating outer diameter	250 $\pm$ 15 $\mu\text{m}$	300 $\pm$ 15 $\mu\text{m}$	300 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	300 $\pm$ 15 $\mu\text{m}$
Pigtail fiber length	1 meter	1 meter	1 meter	1 meter	1 meter
Performance					
Multimode transmission (*2)	>90%	>90%	>90%	>90%	>90%
SM transmission	>85%	>85%	>85%	>85%	>85%
Optical return loss (multimode)	40 dB	40 dB	40 dB	40 dB	40 dB
Maximum total input power	35 Watts (*3)	(*3)	100 Watts (*3)	35 Watts (*3)	(*3)
Operating temperature	0 to +70°C	0 to +70°C	0 to +70°C	0 to +70°C	0 to +70°C
Compatibility					
Recommended for use with these OFS cladding pumped fibers	Yb 130	Contact us for availability	Contact us for availability	ErYb 130	Contact for availability
Order by Part Number	TFB13A5	TFB2325	TFB4320	TFB1310	TFB23C0

(\*2) Tested by multimode input light with 70% and 99% of power confined with NA of 0.09 and 0.15, respectively.

(\*3) These values are based on testing to date with 5W/leg conditions. Device capability is higher but has not yet been formally tested.

# Polarization-Maintaining Combiner Specifications

MM Input Fibers	for 1 $\mu\text{m}$ Applications		for 1.5 $\mu\text{m}$ Applications	
Number of input fibers	6	6	6	6
Numerical aperture	.165	.22	.165	.22
Core diameter	105 $\pm$ 3 $\mu\text{m}$	105 $\pm$ 3 $\mu\text{m}$	105 $\pm$ 3 $\mu\text{m}$	105 $\pm$ 3 $\mu\text{m}$
Cladding diameter	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$
Coating outer diameter	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$
Pigtail fiber length	1 meter	1 meter	1 meter	1 meter
Signal Input Fiber				
One signal fiber type	PM 980	PM 980	PM 1550	PM 1550
Numerical aperture	0.13 $\pm$ .015	0.13 $\pm$ .015	0.13 $\pm$ .015	0.13 $\pm$ .015
Cladding diameter	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$
Coating outer diameter	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$
Pigtail fiber length	1 meter	1 meter	1 meter	1 meter
Undoped PM Output Fiber				
Cladding numerical aperture	.45 $\pm$ .03	.45 $\pm$ .03	.45 $\pm$ .03	.45 $\pm$ .03
MFD @ operating wavelength (1060 or 1550 nm)	7.0 $\mu\text{m}$	7.0 $\mu\text{m}$	10.2 $\mu\text{m}$	10.2 $\mu\text{m}$
Cladding diameter	125 $\pm$ 2.5 $\mu\text{m}$	200 $\pm$ 2.5 $\mu\text{m}$	125 $\pm$ 2.5 $\mu\text{m}$	200 $\pm$ 2.5 $\mu\text{m}$
Coating outer diameter	250 $\pm$ 15 $\mu\text{m}$	300 $\pm$ 15 $\mu\text{m}$	250 $\pm$ 15 $\mu\text{m}$	300 $\pm$ 15 $\mu\text{m}$
Pigtail fiber length	1 meter	1 meter	1 meter	1 meter
Performance				
Multimode transmission (*1)	>90%	>90%	>90%	>90%
PM transmission	>80%	>80%	>80%	>80%
Extinction ratio @ operating wavelength (*2)	>20 dB	>20 dB	>20 dB	>20 dB
Optical return loss (multimode)	40 dB	40 dB	40 dB	40 dB
Maximum total input power	35 Watts (*3)	(*3)	35 Watts (*3)	(*3)
Operating temperature	0 to +70°C	0 to +70°C	0 to +70°C	0 to +70°C
Compatibility				
Recommended for use with these OFS cladding pumped fibers	Yb PM 125	Yb PM 200	ErYb PM 125	Contact us for availability
Order by Part Number	TFB1353FFAxis	TFB23B3FFAxis	TFB1346FFAxis	TFB2366FFAxis

(\*1) Tested by multimode input light with 70% and 99% of power confined with NA of 0.09 and 0.15, respectively.

(\*2) Axis orientation is aligned for standard designs. Other alignment options are available by request.

(\*3) These values are based on testing to date with 5W/leg conditions. Device capability is higher but has not yet been formally tested.

# Cladding Pumped Fibers

## 130 $\mu\text{m}$ Erbium-Ytterbium and 130 $\mu\text{m}$ Ytterbium

### Product Description

These fibers enable fiber lasers and amplifiers with good beam profile characteristics, high wallplug efficiencies, compact foot-prints, superior reliability, and maintenance-free operation. They also accommodate high energies during pulsed operation and at high repetition rates.

### Erbium-Ytterbium

The 125  $\mu\text{m}$  single-mode core of this fiber is co-doped with both erbium and ytterbium. It is then surrounded by a silica cladding and covered with a low-index protective coating. The resulting double-clad fiber is used for single-mode fiber lasers and amplifiers operating in the 1540 to 1565 nm range.

### Ytterbium

The single-mode core of this fiber is doped with ytterbium. It is then surrounded by a silica cladding and covered with a low-index protective coating. The resulting double-clad fiber is used for single-mode fiber lasers and amplifiers operating in the 1040 to 1200 nm range.

### Typical Applications

- Construction of multi-watt amplifiers around 1550 nm

### Typical Applications

- Construction of single-mode fiber lasers emitting at 1040 to 1200 nm

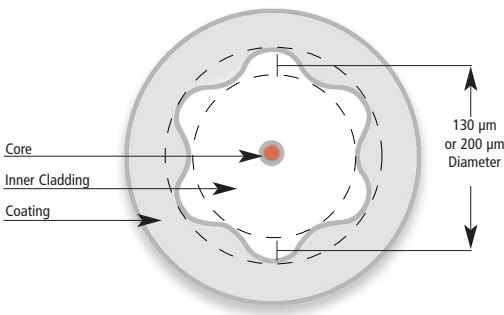
### Features and Benefits

- Active ion concentrations optimized for efficiency
- High erbium concentration for short devices
- Wide pump wavelength window from 910 to 1060 nm
- Low-splice-loss achieved to conventional single-mode or dispersion-shifted fiber

### Features and Benefits

- Star-shaped cladding gives efficient mode mixing and improves splice-ability
- Tough, low-index polymer coating maintains strength and gives high cladding NA
- Small core NA leads to a small beam size at the laser wavelength

### Cladding Pumped Fiber Design



## Fiber Specifications (typical)

Properties	ErYb 130	Yb 130
Core numerical aperture	0.17	0.12
Cladding numerical aperture	0.45	0.45
Cutoff wavelength	<1500 nm	<1040 nm
Mode field diameter @ 1060 nm	not specified	6 $\mu\text{m}$
Mode field diameter @ 1550 nm	7 $\mu\text{m}$	not specified
Ytterbium clad absorption @ 915 nm	>0.5 dB/m	>0.5 dB/m
Erbium peak absorption near 1535 nm	40 dB/m	not specified
Star cladding diameter	130 $\mu\text{m}$	130 $\mu\text{m}$
Coating outer diameter	250 $\mu\text{m}$	250 $\mu\text{m}$
Mechanical and Testing Data		
Proof test level	100 kpsi	100 kpsi
Order by Part Number	108 728 635	107 986 820

(also specify fiber length in meters)

# Cladding Pumped Fibers

## 125 $\mu\text{m}$ Polarization-Maintaining Erbium-Ytterbium and 125 $\mu\text{m}$ or 200 $\mu\text{m}$ Polarization-Maintaining Ytterbium

### Product Description

The single-mode core of this polarization-maintaining fiber is doped with ytterbium. It is then surrounded by a silica cladding and covered with a low-index protective coating. These fibers enable fiber lasers and amplifiers with good beam profile characteristics, high wallplug efficiencies, compact footprints, superior reliability, and maintenance-free operation. They also accommodate high energies during pulsed operation and at high repetition rates.

### Typical Applications

- Fiber lasers
- Fiber amplifiers
- High-energy, pulsed operation

### Erbium-Ytterbium

Erbium-Ytterbium double clad fiber is used for single-mode fiber lasers and amplifiers operating in the 1540 to 1565 nm range.

### Features and Benefits

- High conversion efficiency
- Patented cladding results in efficient mode mixing while maintaining good splice-ability
- Proprietary low-index polymer coating for high cladding NA with good fiber strength
- Core NA allows splicing to standard single-mode fiber

### Ytterbium

Ytterbium double-clad fibers are used for single-mode fiber lasers and amplifiers operating in the 1040 to 1200 nm range.

### Features and Benefits

- Active ion concentrations optimized for efficiency
- High erbium concentration for short devices
- Wide pump wavelength window from 910 to 1060 nm
- Low-splice-loss achieved to conventional single-mode or dispersion-shifted fiber

## Fiber Specifications (typical)

Properties	ErYb PM 125	Yb PM 125	Yb PM 200
Core numerical aperture	0.17	0.12	0.12
Cladding numerical aperture	0.45	0.45	0.45
Cutoff wavelength	<1500 nm	<1040 nm	<1040 nm
Mode field diameter @ 1550 nm	7 $\mu\text{m}$	not specified	not specified
Mode field diameter @ 1060 nm	not specified	6 $\mu\text{m}$	6 $\mu\text{m}$
Ytterbium clad absorption @ 915 nm	>0.5 dB/m	>0.5 dB/m	>0.15 dB/m
Erbium peak absorption near 1535 nm	40 dB/m	not specified	not specified
Beat Length @ 1060 nm	<4.0 mm	<4.0 mm	<4.0 mm
Beat Length @ 1550 nm	<6.0 mm	<6.0 mm	<6.0 mm
Circular cladding diameter	125 $\mu\text{m}$	125 $\mu\text{m}$	200 $\mu\text{m}$
Coating outer diameter	250 $\mu\text{m}$	250 $\mu\text{m}$	300 $\mu\text{m}$

### Mechanical and Testing Data

Proof test level	100 kpsi	100 kpsi	100 kpsi
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### Order by Part Number

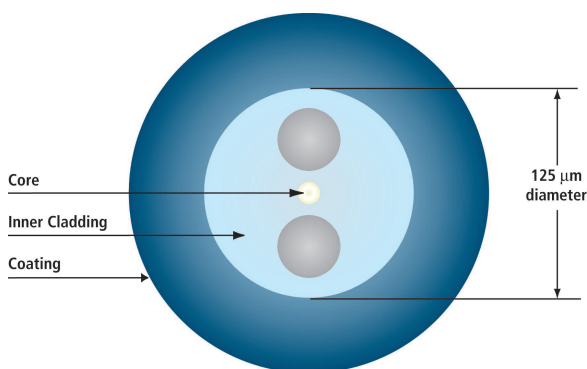
(also specify fiber length in meters)

300 380 334

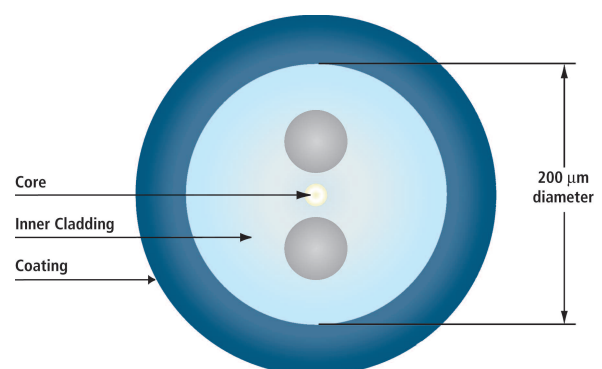
552 HPWR 004

552 HPWR 003

### 125 $\mu\text{m}$ Design



### 200 $\mu\text{m}$ Design



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