

LASER

FIBER OPTIC SOLUTIONS FOR LASER INDUSTRY





LASER

The industrial manufacturing segment, and the various diagnostics/surgery developments in the medical segment, are among the main drivers of laser industry development. The advantages of optical fiber over bulk optics include lower maintenance requirements and ease of deployment. Due to its large power density limit (ca. 10GW/cm²), glass optical fiber is well adapted to transporting energy from one point to another with limited loss. For this application, an understanding of the various failure modes of the interconnects is indispensable.



Diamond with its 35 years experience in fiber optic interconnect development, industrialization, production and qualification tests, dispose of all the competencies to provide the market with solution best suited to application in this market segment.

Diamond vertical integration can be summarized as follows:

Mechanical

- Integrated Ceramic production (pressing, sintering, machining)
- Precision metal machining (drilling, milling, EDM, ...) with expertise in non-standard metals (Ti, WC, Kovar, stainless, ...)
- High precision plastic injection
- Ultra-high precision lapping
- Ultra-high precision drilling
- Fiber-ferrule polishing

Optical

- Fiber active core alignment (A.C.A)
- Active Polarization Orientation (A.P.O)
- Optical interfaces: PSf, PSI, PSi, PSm, PSb, PSc, PS/PM
- Splice expertise (MM, SM, PM, dissimilar fiber, PCF fibers)

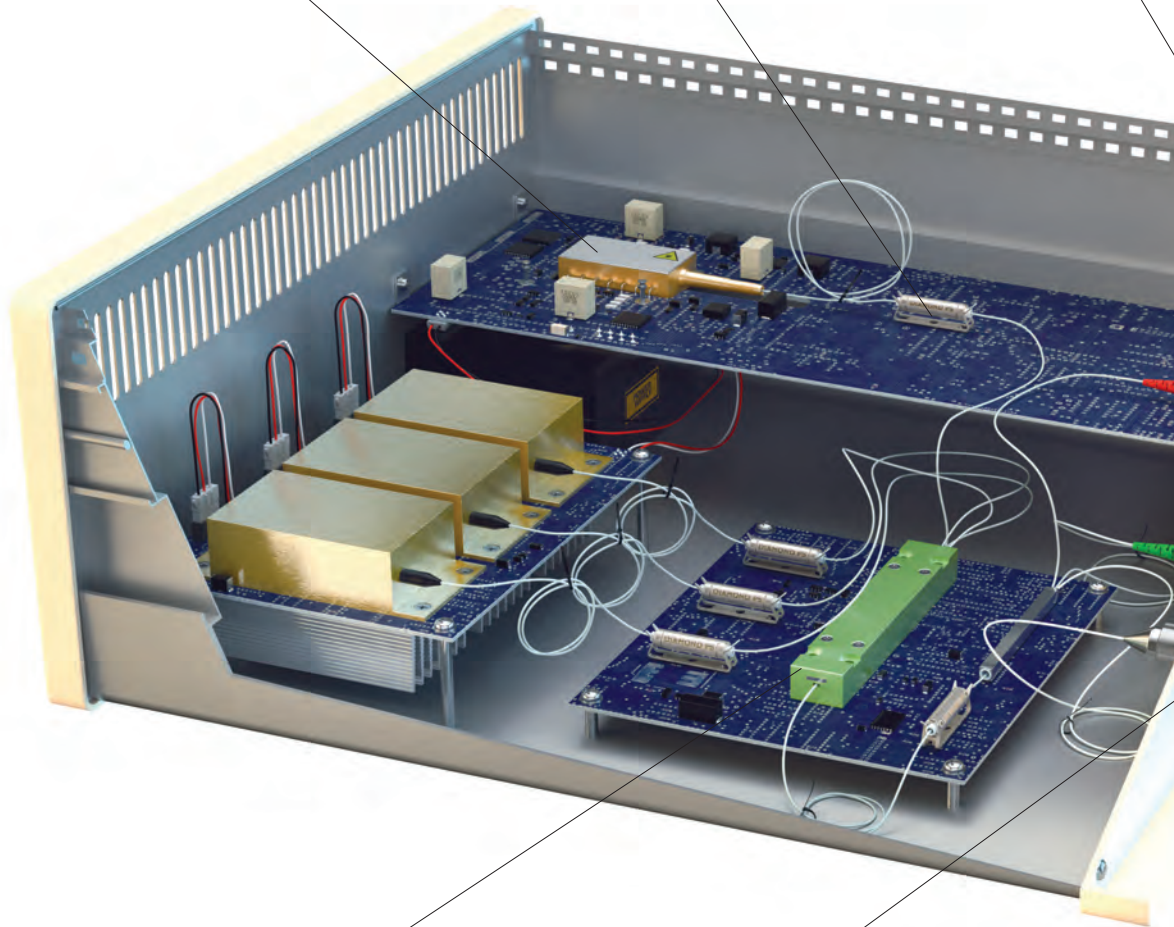
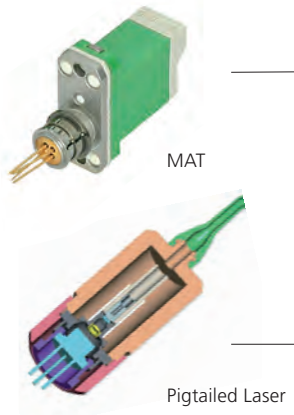
Assembly

- Epoxy polymerization
- Modules termination (active or passive, PM, PS)
- Sealing (vacuum grade epoxy)
- Active component alignment and laser welding
- Clean room assembly and packaging

Services

- Optical and mechanical accredited measurements (STS 0333 per ISO / IEC 17025:2005)
- Optical instrument calibration (SCS 0101 per ISO / IEC 17025:2005)

APPLICATIONS

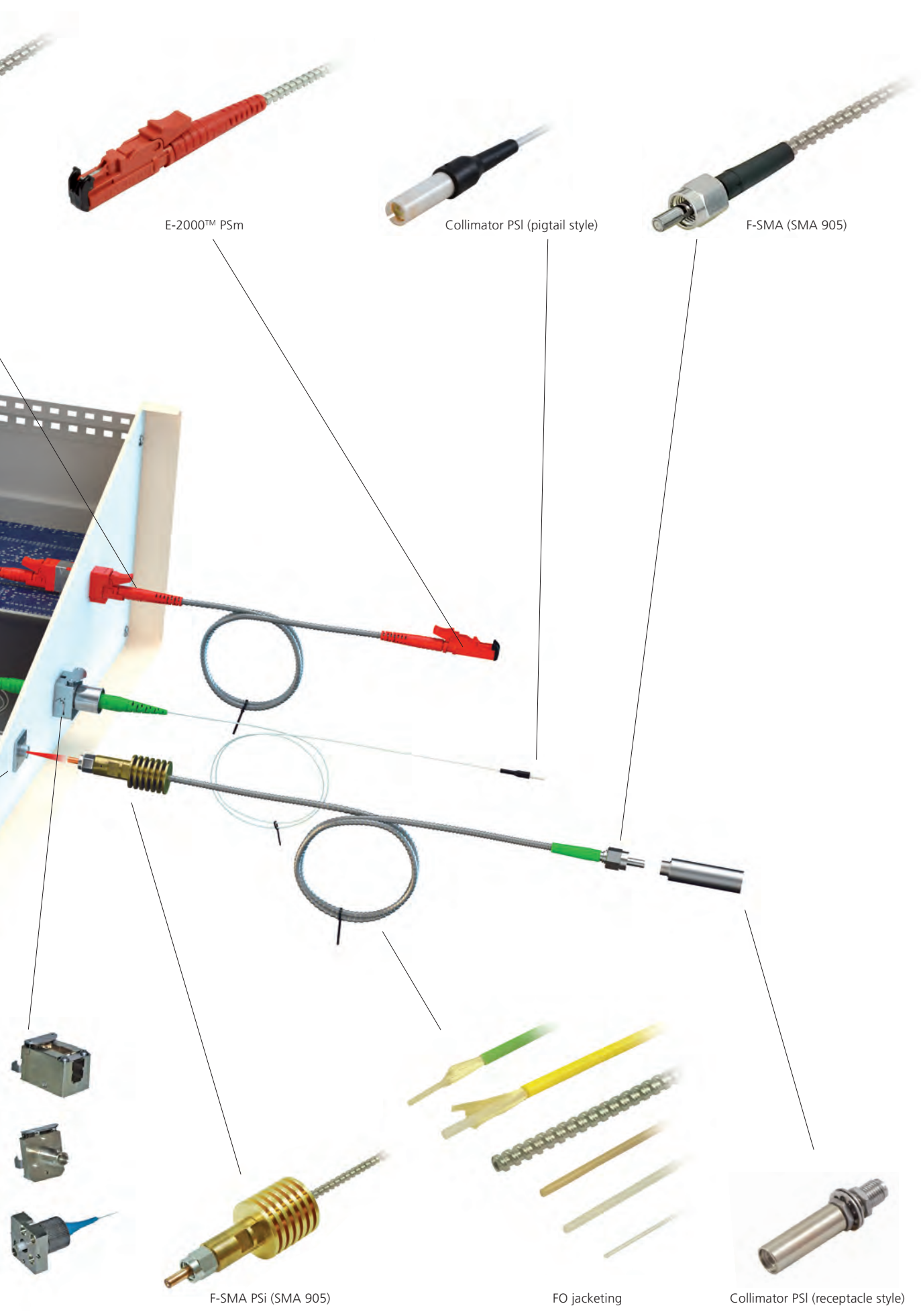


Couplers & combiners



Receptacle IMOD

MAS



E-2000™ PSm

Collimator PSI (pigtail style)

F-SMA (SMA 905)

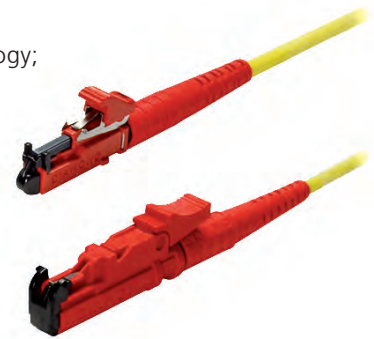
F-SMA PSI (SMA 905)

FO jacketing

Collimator PSI (receptacle style)

E-2000 PS, F-3000 PS and DMI PS

Diamond PS connectors are based on contacted expanded beam technology; where a section of graded index fiber is spliced as a collimating lens. This enlarges the beam diameter and reduces power density at the connector interface. Using Diamond Active Core Alignment (ACA) technology, we can achieve unrivaled low IL performance for the PS technology by aligning the fiber exit angle instead of the core eccentricity. This technology is applicable to most connectors interfaces, but due to safety issues Diamond suggests to use it on E-2000™ and F-3000™ connectors with integrated metal protection caps and shutters.



PS Connectors Features:

- 16x reduced power density
- Low Insertion loss
- Ultra high polish for High return loss
- E-2000™ and F-3000™ with integrated metal protection caps and Shutters
- E-2000™ with interchangeable colour- and mechanical-coded frames and thumb-latches.

DMI PS Features

- Minimum space requirement (footprint of 4.5x21mm)
- Consistent high performance solution
- Available in PC, APC and PM termination
- Tested for SM up to 10W for 1h and 3W continuous
- Validated for MM 100 up to 50W
- Standard Diamond 2.5 mm ferrule with Active Core Alignment (ACA)
- Easy installation by use of standard clip-on system
- DMI assembly tool is available.



E-2000 PS/PM and DMI PS/PM

Diamond offers a wide range of PS/PM connectors to meet the most challenging optical performance requirements. Utilizing our Active Core Alignment process, we are able to independently optimize both insertion loss (IL) and extinction ratio (ER), eliminating the need to compromise one performance feature over another.

Features

- All features of PS connectors
- Low insertion Loss and high return loss
- High extinction ratio
- Wide wavelength range 400 nm – 1550 nm



E-2000 PSm and DMI PSm

If Multimode 100 μ m fibers are used for quite long time, a high power application requires a defined high quality optical interface. The actual standards for optical interface exists for SM fibers and are not completely compatible with high power application and large core fibers.

Diamond has developed a specific optical interface for this reason to improve from the standards.



Features

- Improved power resistance (up to 50W for 100 μ m fiber)
- Excellent contact over all fiber surface
- Color and mechanical coding for the E-2000™ (see E-2000™ for more information)
- Ultra high precision ferrule and sleeves diameter (split for adapter, full for Interface Modules)

F-SMA PSi (SMA 905)

Diamond has further developed its existing F-SMA (SMA 905) MM connectors specifically for medium-high power laser delivery and thermal management in various applications.

This class of connectors is employed typically for beam injection of medium-high power Diode Lasers (DL) in order to provide a fiber-optic link between the DL source and the target.

High power transmission is achieved by the copper alloy ferrule and the excellent fiber alignment.

Laser safety can be ensured by using steel-armored protection tubes.

Diamond's enhanced F-SMA PSi (SMA 905) connector is based on the Cu-ferrule free-standing fiber technology with outstanding mechanical tolerances and eccentricity. Mode strip technology to remove the undesired cladding modes, as necessary if intermediate connection are made, can be added to the connector.



X-BEAM PS for Medium-High Power

The X-BEAM PS connector is based on expanded beam technology by coupling the multimode fiber with a collimating spherical lens.

Beam expansion can ensure medium-high power handling, which is especially challenging in harsh environment conditions.

The X-BEAM – X-BEAM connection opto-mechanical design is also highly critical in terms of lens-to-lens and lens-receiving fiber interfaces, particularly at medium-high power. The receiving lens-to-fiber optics must ensure an efficient and accurate refocusing of the almost collimated beam into the core of the fiber for safe further beam propagation in the next assembly slots.

The typical X-BEAM PS – X-BEAM PS connection losses are < 0.5 dB thanks to the use of an antireflective (AR) coating on the lenses in the desired wavelength range.



Collimators PSI

Diamond offers a wide range of collimators with low back reflection, designed to collimate light exiting a fiber to a desired beam size.

Features

- Medium-High power handling
- Robust and compact design
- Available for MM, SM and PM fibers
- Wide wavelength range
- Wide range of beam sizes
- Available for ferrules 1.25 mm, 2.5 mm, 3.175 mm
- Available for receptacles and connectors
- Coated lenses to improve back reflection
- Custom materials, geometries and specifications upon request



Pigtail style



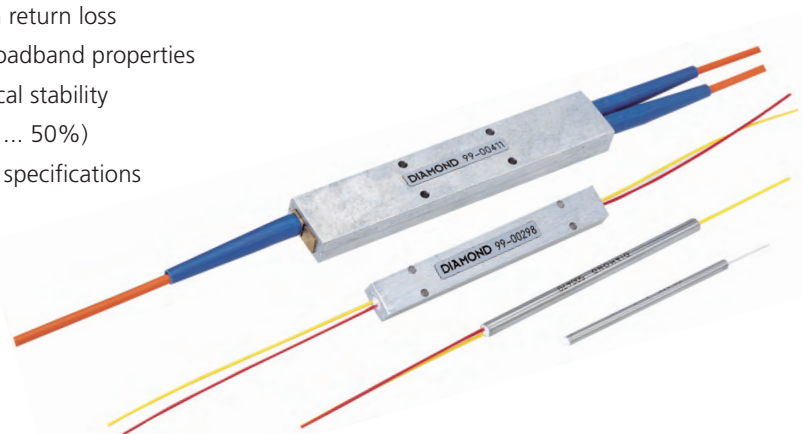
Receptacle style

Couplers & combiners

Diamond couplers are used as passive distribution and collection points for light and optical data transmission.

Diamond fusion couplers offer the following features:

- Low insertion loss and high return loss
- Wavelength-selective or broadband properties
- High thermal and mechanical stability
- For any coupling ratio (1% ... 50%)
- Manufactured to customer specifications



IMOD – INTERFACE MODULE

The Interface Module (IMOD) is used to terminate a connector for free space applications. Various options are available to fix the ferrule in a location optimal for your application.

These options can be adapted to most mechanical interface for PC, and APC versions, such as: E-2000™, SC, F-3000™, ST™, LSA (DIN), FC, Mini-AVIM.



IMOD are available in three different configurations

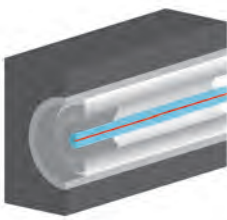


Fig.1 Without any stopper; for applications which doesn't require specific tolerances or exact ferrule axial positioning.

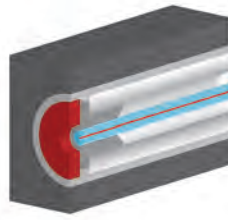


Fig.2 With ferrule ZrO2 cylinder stopper, for a good axial repeatability.

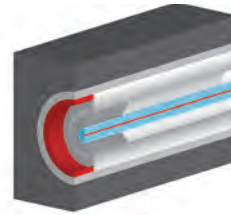


Fig.3 With ferrule front face stopper, for superior axial repeatability.

Features

- High precise and repeatable ferrule positioning
- Custom materials and geometries upon request

MAS – Multipurpose Adapter System

The Multipurpose Adapter System (MAS) is a hybrid flexibleadapter. The Universal adapter is mounted on a chassis or used on a bench and is available in FC or Mini-AVIM.

The other side of the adapter is changeable on the fly and is available in the following mechanical interfaces: E-2000™, SC, LSA DIN, ST™, F-3000™ (100% compatible with the LC), FC (wide and narrow key).

Features

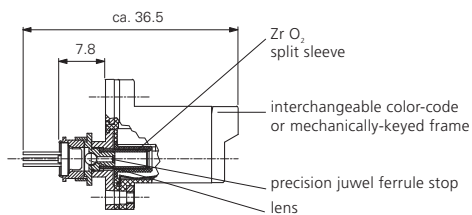
- Easy use
- Low insertion loss
- Large choice of Mechanical Interface
- Easy cleaning of internal connectors



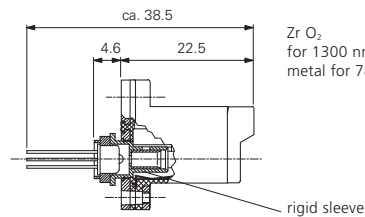
Interchangeable adapters (upper), Universal Adapter (lower)

MAT – MAR

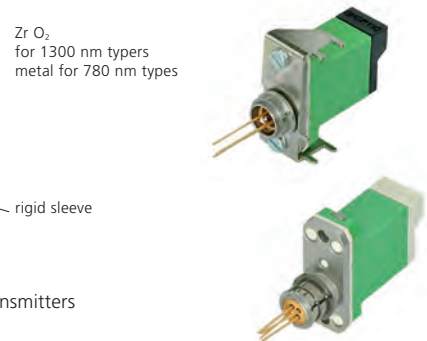
Transmitter (MAT) and Receiver (MAR) modules are designed as an IMOD with the appropriate fitting to adapt to an active component. The MAT requires an optical component to focus the light source (Laser, LED) to the ferrule position in the housing. Depending on the type of fiber (SM, PM or MM) the active alignment device secured by laser welds on the fixing flange is designed to guarantee optimal performance. (E-2000™ is our termination of choice for these products).



Construction for LED source transmitters and receivers (2 axis alignment)



Construction for LD source transmitters (3 axis alignment)

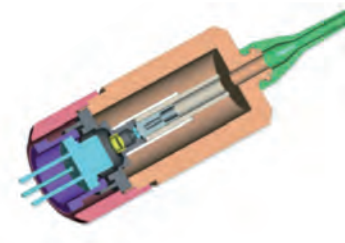


Features

- Compact solution
- Precise Fiber core alignment
- SM, PM and MM
- Customizable

Pigtailed Laser with Active Laser Welding

Thanks to a special lens and the diode active alignment on X/Y/Z axis, the light injection is more than 55%. Solutions are available for SM and PM fibers and can be assembled with all Diamond connector types.



Features

- High precise and repeatable ferrule positioning
- Custom materials and geometries upon request

Fiber Optic Jacketing

Diamond assemblies can be offered with the following different plastic and metal flexible jacketing for several applications:

- Elastomer (Hytrel)
- PEEK (Victrex 450)
- PA (Nylon)
- PTFE (Teflon)
- Stainless steel

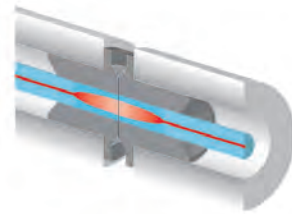


POWER SOLUTION OPTICAL INTERFACES

Diamond uses different methods for expanded beam alignment, depending on the final use of the assembly. The main expanded beam types can be defined as following: spliced GRIN lenses and spliced glass rod-, or endcap which allows a Diverging, Collimated or Focused exit beam. These optical interfaces are also suitable for high power applications.

PS Collimated (Contact)

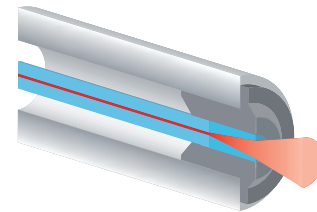
Diamond offers the Power Solution optical Interface which expands the MFD of a SM fiber by splicing a GRIN lens at the extremity. The MFD at the end of the connector is thus expanded by a factor of 4 to 5, increasing the contact surface by a factor of about 15. As a result the heat issues decrease but cleanliness of the connectors and mating adapters is still important.



PSf Free Space (Diverging, non contact)

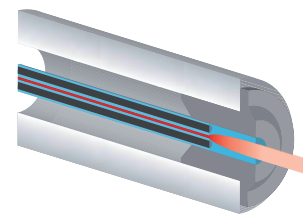
A glass rod is spliced at the end of a SM fiber. This allows the beam to be expanded before it exits the glass, diminishing the power density at the glass-air interface.

This technique is used for high-power applications, at the injection or at the output to minimize the chances of burns at the interface. Diamond provides the SM Power Solution Freespace Optical Interface using this technology.



PS/PM Collimated Polarization Maintaining (Contact)

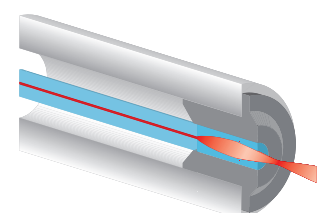
Polarization plays an important role in the industrial photonics market and when coupled with medium-high power application, creates a market of high criticality. Sensors and communication systems have been designed using Polarization Maintaining or Polarizing fibers. Special connectors are required for such application, because their connection must be made with a certain orientation. Only connectors with an orientation key are capable of properly terminating these fibers.



PSI Lensed (Focused)

Diamond offers focused beam on a customer requirement base. Using Diamond mature PS technology (based on GRIN lens), a focused beam optimized for free space light transmission, can be designed and produced easily.

This technology is especially used for measurements (interferometric) and for sensing.

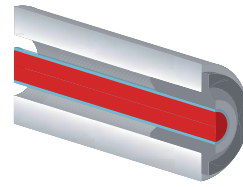


PSm (Power Solution Multimode)

Multimode fiber interconnects have not been as well defined as SM fibers. The contact surface for SM is not guaranteeing a complete contact for MM fibers which when combined with high power is critical. Visual inspection for such application is very critical and no standard dedicated for this interface help the users.

Diamond has established a new Optical Interface, the PSm, to fill this void and help end-users to dispose of reliable connectors.

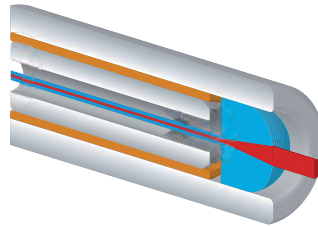
The optical interface used 100% concentricity measurement control and optical geometry measurements. A special visual completes the Optical Interface definition.



PSc Collimator Systems

Collimators are for use in a wide variety of optical systems.

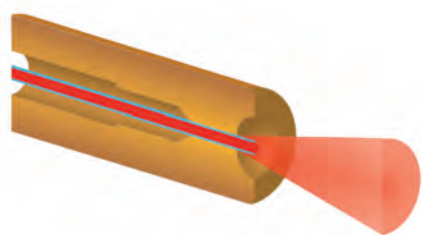
These modules are designed to collimate or focus light exiting an optical fiber to a desired beam diameter or spot size a specific distance away. Collimators are used with laser diodes, photodiodes, acoustic-optic modulators and other fiber optic devices where a specific output is needed.



PSi Free Standing

The fiber-end free from epoxy glue allows a proper thermal dissipation in the region of maximum power density.

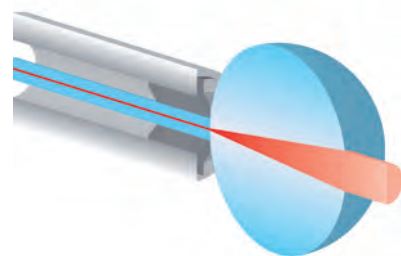
A proprietary design mode-stripper can be integrated to obtain laser power confinement in the fiber core. The amount of power stripped out from the cladding is a function of the laser Beam Product Parameter (BPP) and of the receiving fiber core diameter and numerical aperture (NA).



PSb Ball Lens (X-BEAM)

A ferrule is placed behind a ball lens which is glued into a housing. This technology expands and collimates the transmission signal and reduces the impact of both misalignment as well as endface contamination.

Depending on the concentricity, the expanded beam exits the lens at a certain angle. To minimize this exit angle, Diamond uses the ACA process.



Laboratory

The test and calibration laboratory at DIAMOND SA has been accredited by the Swiss Accreditation Service SAS since March 2002. We are accredited as testing laboratory STS 333 for fiber optic components and as calibration laboratory SCS 101 for fiber optic measurement instruments in accordance with the standard ISO / IEC 17025:2005. The accredited test and calibration laboratory STS 333 / SCS 101 performs measurements, tests and calibrations not only for DIAMOND SA, subsidiaries and DIAMOND representatives all over the world but also directly for external customers.



ISO 7 Cleanroom

The worldwide market for fibre optic solutions used within fields that are very sensitive to environmental contamination, such as medicine, laboratories, space, research, life sciences and industry, is experiencing steady growth. DIAMOND has responded to this growing demand by creating a new ISO 7 cleanroom (class 10'000 according to FED STD 209E), in order to supply products such as connector sets, pigtailed, patchcords, adapters and mechanical parts that are cleaned and packaged in a controlled environment.

Processes inside the Diamond cleanroom include cleaning, drying, controlling and packaging, and these are preceded by a preparation and preconditioning process outside the cleanroom.

For details of the processes, or to enquire about a customized process, please contact us.

Cleanroom main characteristics:

- **Class:** ISO 7 (according to norm DIN EN ISO 14644-1)
- **Type:** Turbulent air flow
- **Flow rate:** Min. 40 air exchanges/h
- **Filters:** 3 ULPA U15 filters
- **Air flow:** 3,600 m³/h total
- **Overpressure:** 24 Pa
- **ESD-compliant:** Yes
- **Surface:** 40 m²
- **Power supply:** Lights and filters are under UPS

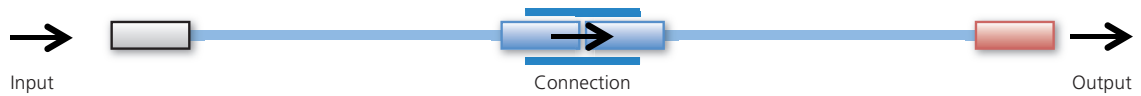


High Power Facility

To develop high power products, a facility allowing high power measurements is indispensable. Our laboratory already possesses a 10W SM fiber laser; we have now created a new separate facility for high power application, reaching 200W CW for measurements and tests. Such a facility is indispensable to understanding and testing new products.

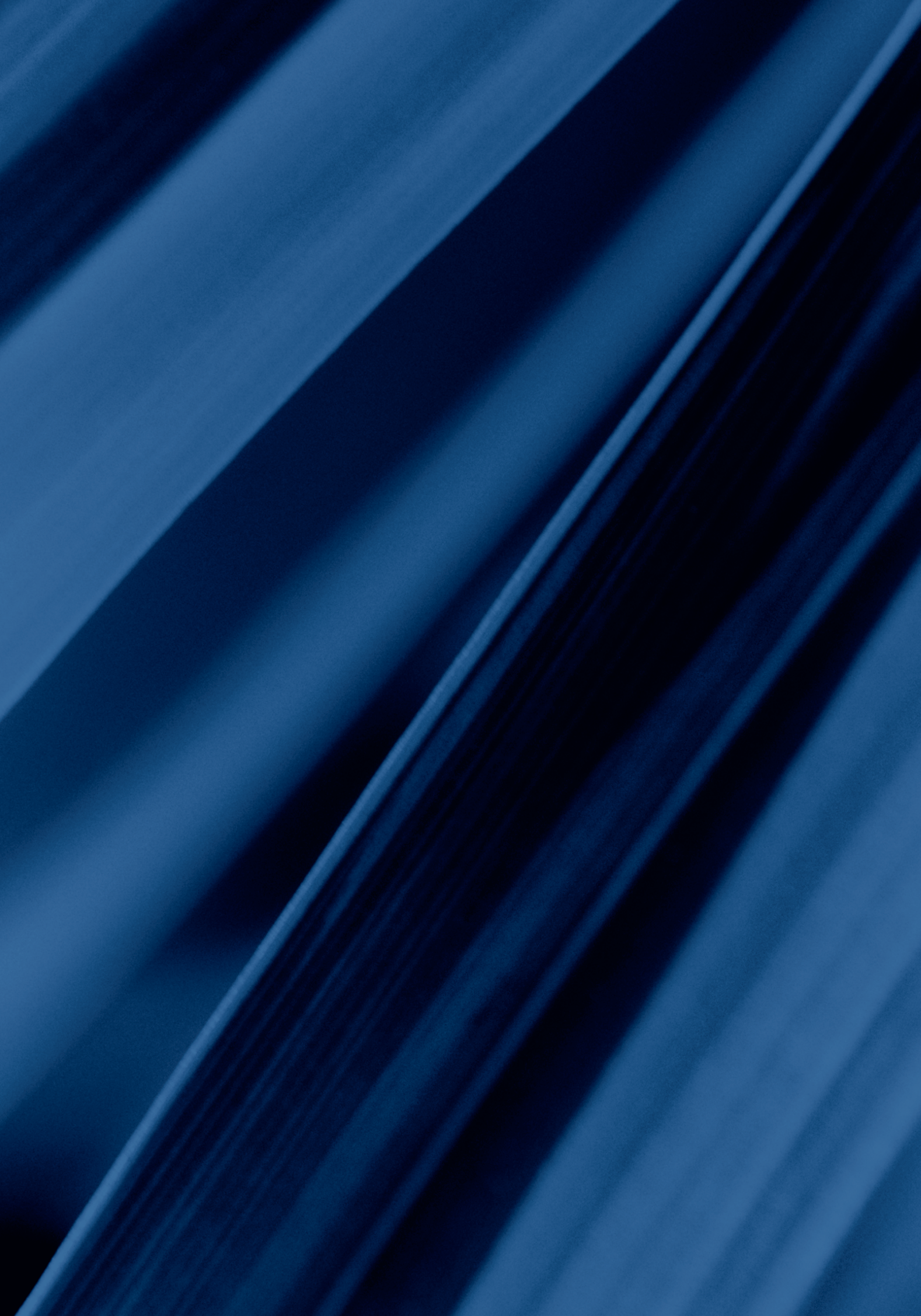


AVAILABLE CONFIGURATIONS



Fiber type	Mechanical Interface	Use	Optical Interface	1550nm	1060nm	800nm	VIS	Power Limit
SM	E-2000™	Connection	PS	✓	✓	*	*	6W
	F-3000™	Connection	PS	✓	✓	*	*	6W
	DMI	Connection	PS	✓	✓	*	*	6W
	E-2000™	Input+output	PSf	✓	✓	✓	✓	10W
	F-3000™	Input+output	PSf	✓	✓	✓	✓	10W
	FC	Input+output	PSf	✓	✓	✓	✓	10W
	DMI	Input+output	PSf	✓	✓	✓	✓	10W
PM	E-2000™	Connection	PS/PM	✓	✓	*	*	3W
	F-3000™	Connection	PS/PM	✓	✓	*	*	3W
	DMI	Connection	PS/PM	✓	✓	*	*	3W
	E-2000™	Input+output	PSf/PM	✓	✓	✓	✓	10W
	F-3000™	Input+output	PSf/PM	✓	✓	✓	✓	10W
	DMI	Input+output	PSf/PM	✓	✓	✓	✓	10W
MM 100	E-2000™	Connection	PSm	✓	✓	✓	✓	50W
	X-Beam	Connection	PSb	*	*	✓	*	50W
	SMA 905	Input	PSi	*	*	✓	*	50W
	E-2000™	Output	PSf	✓	✓	✓	✓	100W
	SMA 905	Output	PSf	✓	✓	✓	✓	100W
MM 200	X-Beam	Connection	PSb	*	*	✓	*	200W
	SMA 905	Input	PSi	*	*	✓	*	200W
	SMA 905	Output	PSf	✓	✓	✓	✓	200W

✓ Product * Please inquire - Not planned



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