
Photonics
Fiber Optic Solutions for demanding applications
Product Presentation 2012
DIAMOND
the fiber meeting

Diamond SA

Diamond Headquarters Losone, Switzerland

Ceramic and MVT Headquarters Port, Switzerland

➔ **Mechanical:**

- Integrated Ceramic production (pressing, sintering, machining)
- Complete metal fine machining (drilling, milling, EDM) with specialty for hard metals (Ti, WC, Kovar, stainless)
- High quality 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)
- Expanded beam technology:non-contact (X-beam, PSf), contact (PS)
- Splice technology (MM, SM, PM, dissimilar fiber, PCF fibers)

➔ **Assembly:**

- Epoxy Polymerization
- Modules termination (Active or Passive, PM, PS)
- Sealing (epoxy)
- Active component alignment and laser welding
- Clean room packaging

➔ **Measurement:**

- High quality and reliable measurements and tests of fiber optic components, using specific instruments and simulating several environments.

Fiber connectors IEC standards

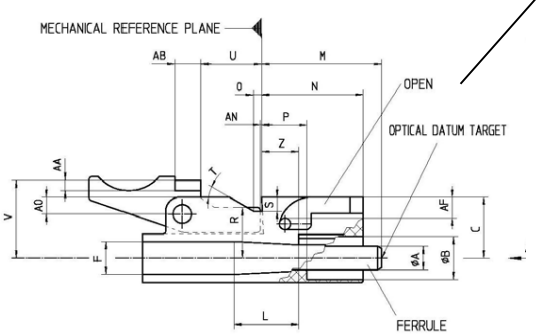
Testing
IEC 61753 Performance
IEC 62005 Reliability

Fiber
IEC 60793

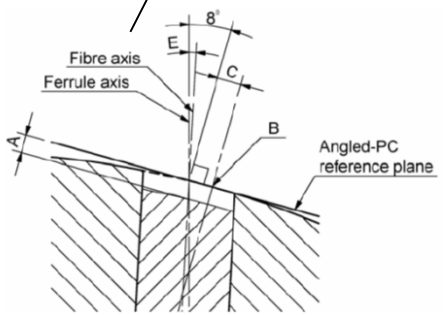
Cable
IEC 60794

Connector
IEC 61754 Mechanical
IEC 61755 Optical

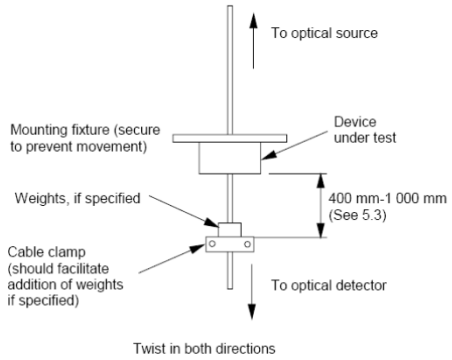
Environment
IEC 61300 Test&Meas



61754-3 LSA / AVIM
61754-15 LSH / E-2000™
61754-20 LC / F-3000™



61755-3-5 PC NS
61755-3-6 APC NS
61755-3-7 PC Ti
61755-3-8 APC Ti



Diamond Technologies

Insertion Loss Theory according to IEC
Active Core Alignment (ACA)
Expanded Beam technologies (EB)
Polarization Orientations (PO)
Epoxy Sealing (ES)

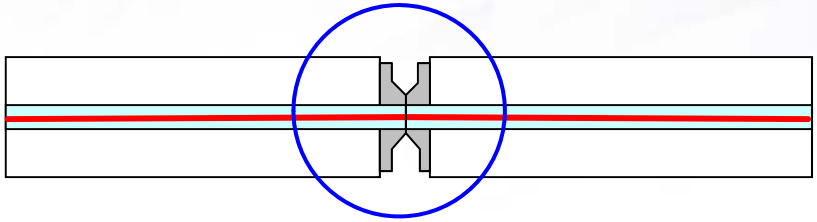
Insertion Loss for SM, LW, PM

Good contact bring = Low Insertion loss and high Return Loss

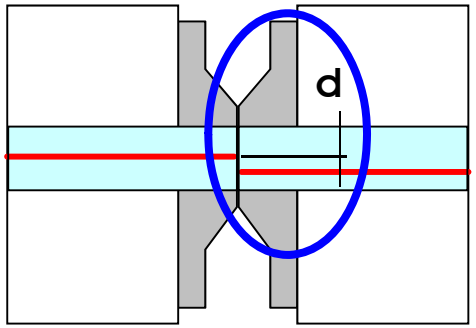
$$IL = -10 \cdot \log\left(\frac{(2\omega_2\omega_1)^2}{(\omega_2^2+\omega_1^2)^2} \cdot \exp\left(\frac{-2 \cdot d^2}{\omega_2^2+\omega_1^2} - 2\pi^2 \cdot \frac{n_0^2}{\lambda^2} \frac{\omega_2^2\omega_1^2}{\omega_2^2+\omega_1^2} \sin^2(\theta) \right) \right)$$

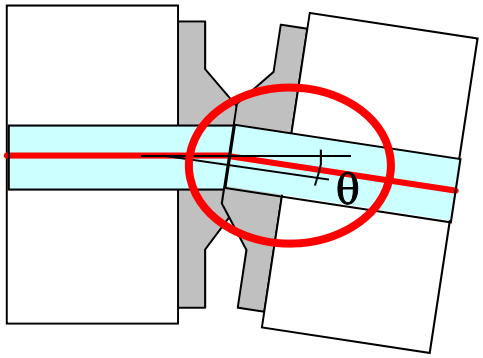
D. Markuse IL calculation

- λ Wavelength
- n_0 Core index of refraction
- ω_1 MFR of emitting fiber
- ω_2 MFR of receiving fiber
- d lateral offset
- θ Angle misalignment



$$IL = K_1 \cdot d^2 + K_2 \cdot \theta^2$$

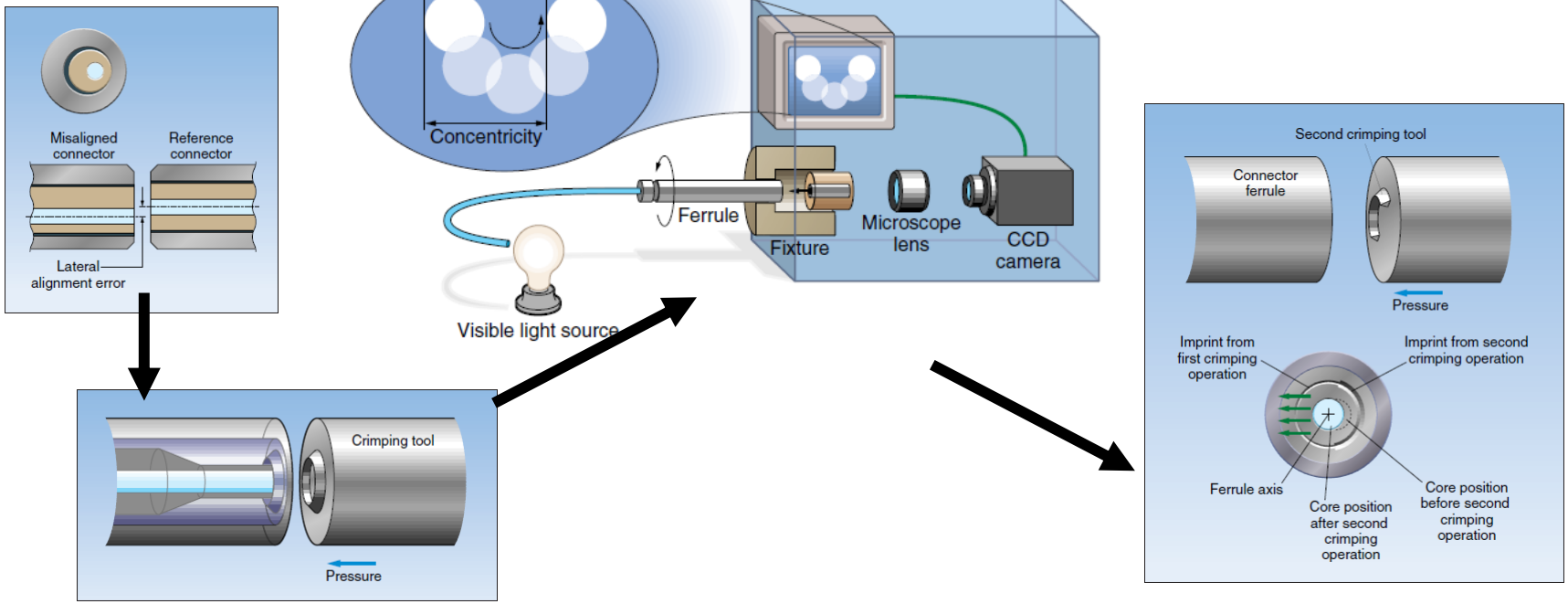




Bi-component ferrule and Active Core Alignment (ACA)

Plastic deformation of the metal insert in order to center the fiber core for eccentricity < 0.125µm

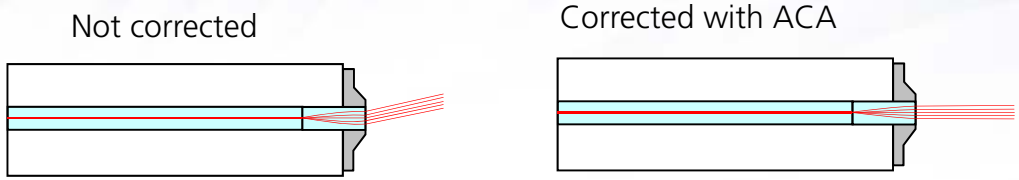
See white paper

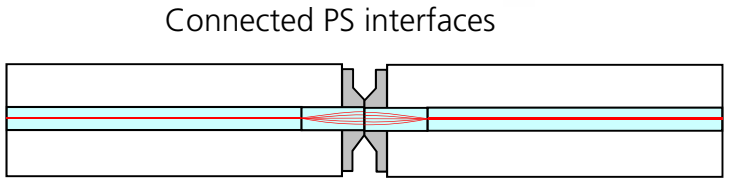


Expanded Beams technologies

Contact:

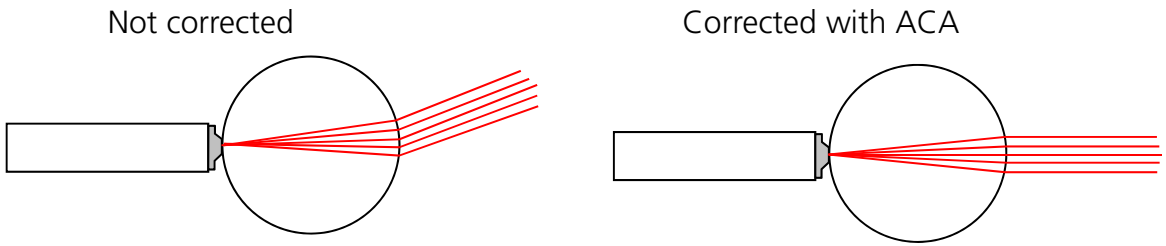
GRIN lens



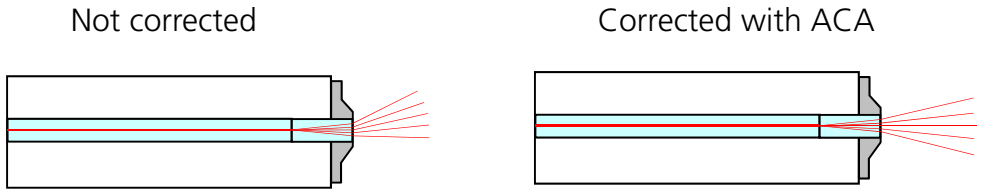


Non-Contact:

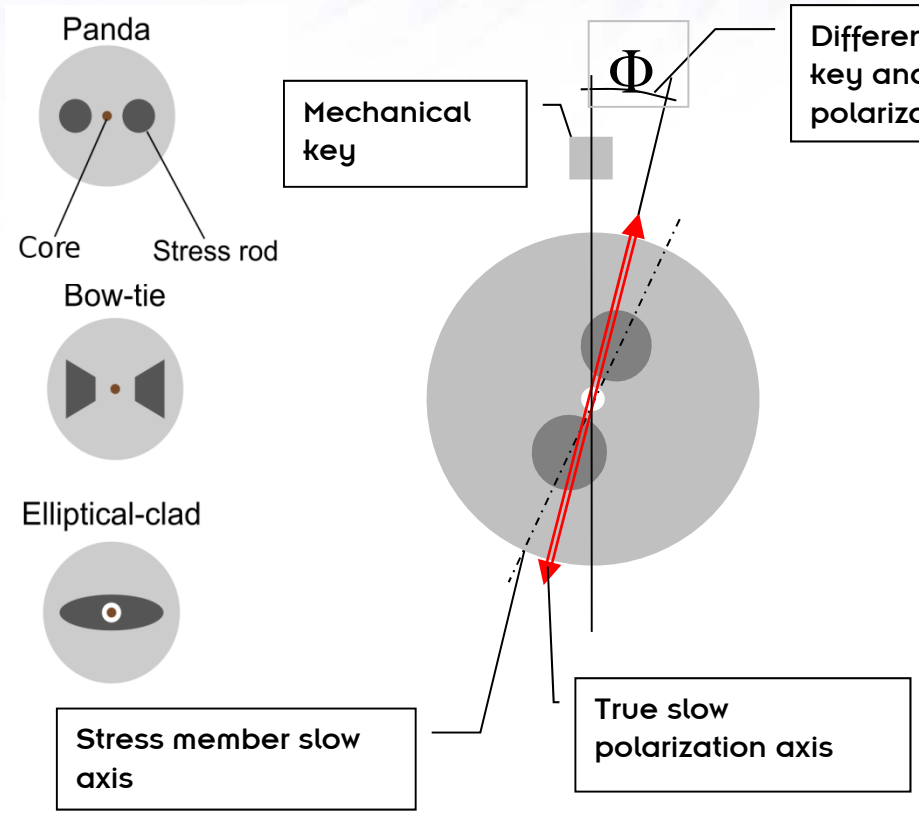
Ball Lens



End cap



Active Polarization Orientation (APO)



- ➔ PPO = Passive Polarization Orientation
- ➔ APO = Active Polarization orientation
  - Injection of Polarized light
  - Difference passive-active goes from few degree up to 15° for small core.
- ➔ Diamond = **ACA + A(P)PO independent** of each other!

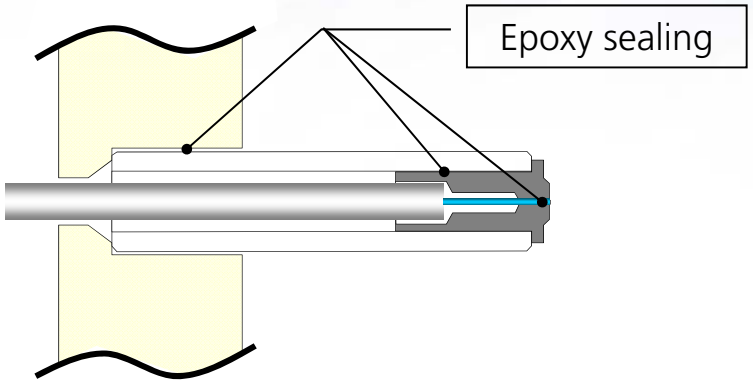
Epoxy Sealing (ES)

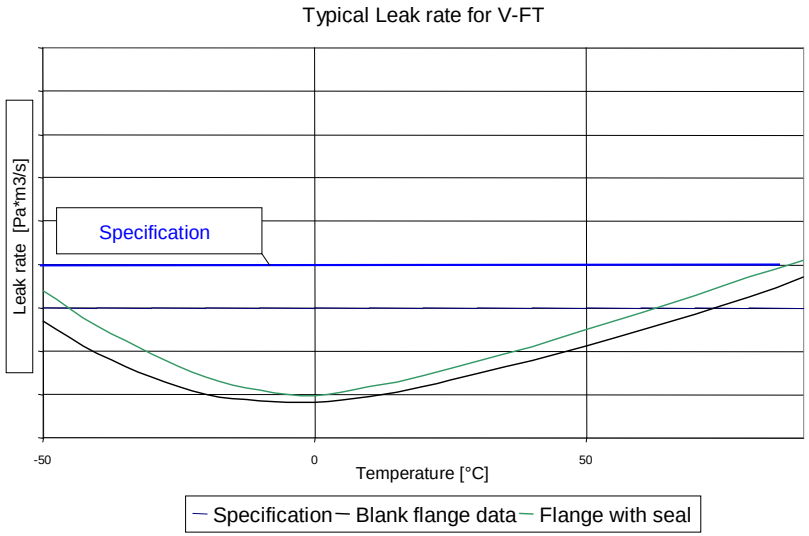
➔ Principle

- Fiber sealed in insert (glass on metal)
- Insert sealed in ferrule (metal on ceramic)
- Ferrule sealed in flange (ceramic on metal

➔ Advantages

- Compatible with all fibers types
- Low leak rate
- Low degassing
- Wide operation temperature





Diamond Products

Mechanical and Optical interfaces from Diamond

Optical Interfaces

0.1dB

Low Wavelength (VIS/NIR)

Power Solution (PS)

Polarization Maintaining (PM)

Special Interfaces:

Special adapters (MAS, IMOD)

Vacuum Feedthrough (V-FT)

What exists and what is standardized

Mechanical and Optical Interface Combination								
		Optical Interfaces						
		Standard		0.1dB Grade	LW	PS	PM	
		SM	MM					
Mechanical Interfaces	E-2000	X	X	X	X	X	X	IEC 61754-15
	F-3000	X	X	X	X	X	X	IEC 61754-28
	DMI	X	X	X	X	X	X	Diamond
	FC	X	X	X	X	*	X	IEC 61754-13
	LSA (DIN)	X	X	X	X	*	X	IEC 61754-3
	AVIM	X	X	X	X	*	X	Diamond
	Mini-AVIM	X	X	X	X	X	X	Diamond
	SC	X	X	X	X	*	X	IEC 61754-4
	ST	X	X			*		IEC 61754-2
	MU	X	X					IEC 61754-6
	FSMA	X						IEC 61754-22
	Diamond	X	X	X	X			Diamond
		IEC 61755-1	***IEC 61755-1-1* in preparation**	**Diamond**	**Diamond**	**Diamond**	**Diamond**	**Standards**

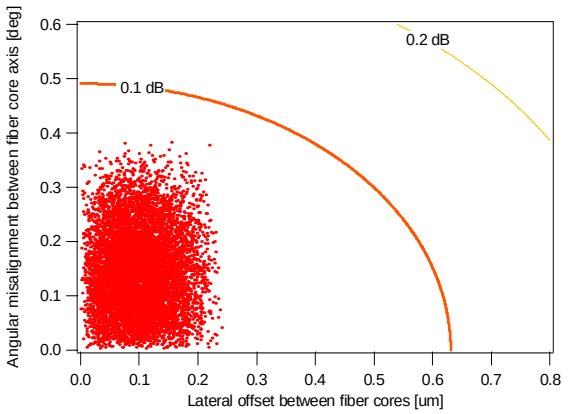
LW=low wavelength (VIS/NIR); PS=Power Solution; PM=Polarization Maintaining

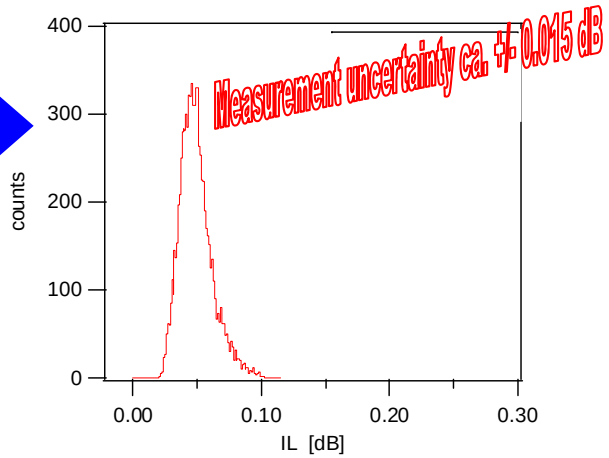
0.1dB Grade Optical Interface

➔ 0.1dB Grade Optical Interface definition

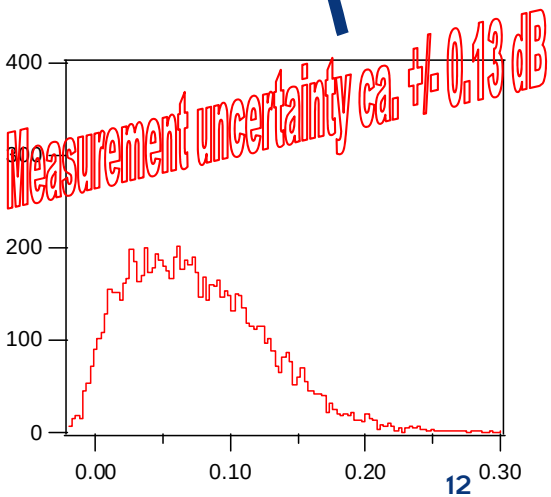
- ACA, eccentricity < 0.125*µ*m
- Exit angle < 0.4° and keyed
- 0.1dB Grade ferrules (low diameters tolerance (<0.2*µ*m))
- Ultra polish with 100% Endface inspection
- IL measurement < 0.15dB

Eccentricity and exit angle measurement errors





IL measurement errors



Low Wavelength (VIS/NIR) Optical Interface

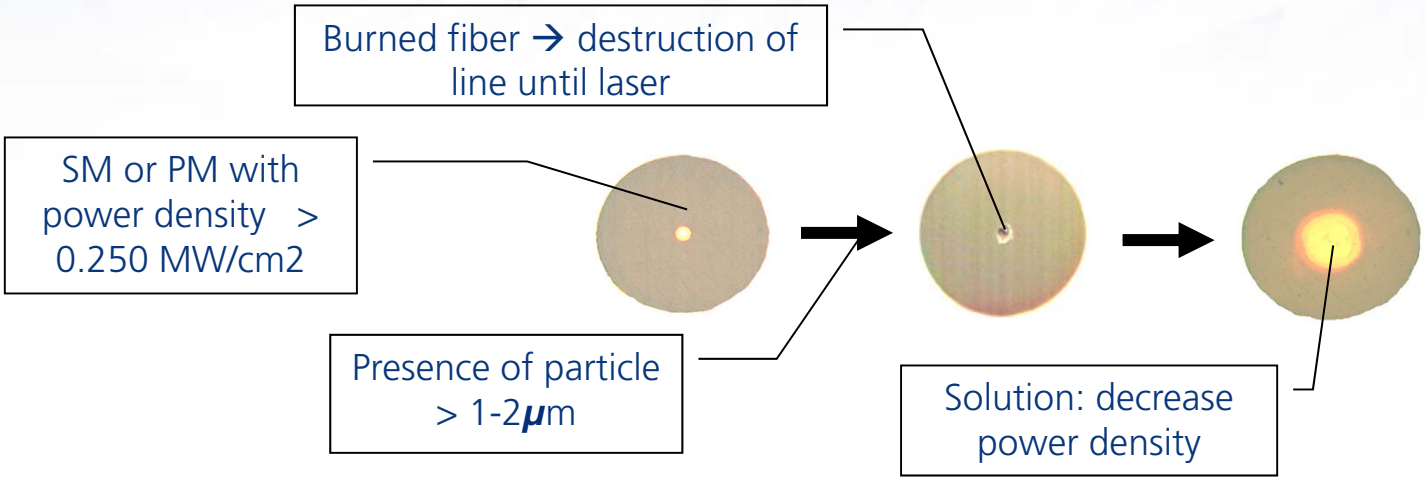
Definition: Low wavelength: 600nm < lambda < 1200nm
Ultra low wavelength: 400nm < lambda < 600nm

➔ VIS/NIR Optical Interface specifications:

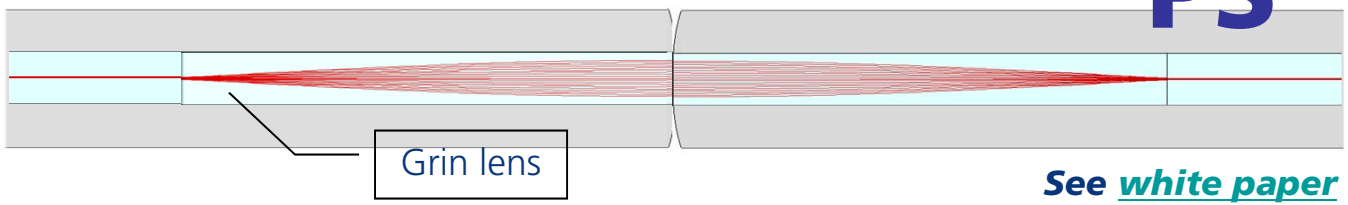
- ACA, eccentricity < 0.125μm
- Exit angle < 0.6°
- 0.1dB Grade ferrules (low diameters tolerance (<0.2μm)
- Ultra polish with 100% Endface inspection

SM Low Wavelength Specification				
WAVELENGTH (nm)	MFD (µm) NA 0.12	IL [dB] 97% (typ)	RL [dB] PC 0°	RL [dB] APC 8°
1625 - 1550 - 1310	9	0.25 (0.1)	50*	75*
1060 - 980	6.6	0.3 (0.15)	45	70
830 - 780	5.2	0.4 (0.2)	40	70
635	4.4	0.6 (0.3)	40	70
532 - 460	3.5	0.8 (0.4)	35	60
405	2.9	1.0 (0.5)	35	60
TEST CONDITIONS		IEC 61300-3-34 Random mating	IEC 61300-3-6 OCWR method *OLCR method	

Power Solutions (PS, PSf)

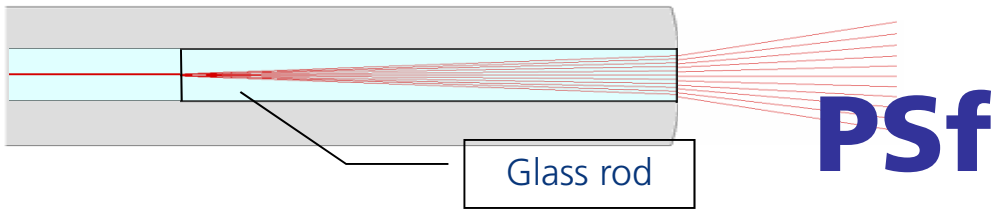


For contact → Power density < 16x



See white paper

For non contact → Power density < 64x



Power Solution (PS) Optical Interface

- Features and applications
  - Lower the power density by a factor of ca. 20x
  - Especially used for EDFA and RAMAN amplifiers
  - Power limit at ca. 0.3MW/cm2 for 1-2μm particle burn
    - ITU 652.D or 657.B3 → >3W (MFD=9μm)
    - HI-1060 at 980nm → > 1.5W (MFD=6μm)
- PS Optical Interface definition
  - Eccentricity < 7 μm (not controlled, but measured and keyed)
  - Exit angle < 0.1° (controlled with ACA)
  - Collimated
  - 0.1dB Grade ferrules (low diameters tolerance (<0.2μm))
  - Ultra polish with 100% Endface inspection

PS - SM Power Solution Specification

WAVELENGTH (nm)	IL 97% (typ)	IL max (typ)	RL PC 0° (APC 4°) connected	RL PC 0° (APC 4°) non-conn.
1625 - 1550 - 1310	0.6 (0.3)	0.4 (0.2)	45(75)	16(70)
1060 - 980 (Corning HI-1060)	0.9(0.45)	0.8 (0.4)	35 (60)*	
TEST CONDITIONS	IEC 61300-3-34 Random mating	IEC 61300-3-4 Against Reference	IEC 61300-3-6 OLCR method *OCWR method	

Polarization Maintaining (PM) Optical Interface

- Features
  - Specification based on Panda Diamond provided fibers
  - PER measurement quality depends on length of fibers and becomes un-reliable with short length.
  - Orientation can always be performed reliably.
- PM Optical Interface definition
  - ACA, eccentricity < 0.15μm
  - Exit angle < 0.6°
  - 0.1dB Grade ferrules (low diameters tolerance (<0.2μm)
  - Ultra polish with 100% Endface inspection
  - Active Polarization Orientation < ±2°

PM - SM Polarisation Maintaining Specification

WAVELENGTH (NA 0.12±0.02)	IL [dB]	ER [dB]	RL [dB]	
	97% (typ)	min (typ)	PC 0°	APC 8°
1625 - 1550 - 1310nm	0.3 (0.15)	23 (28)	50*	70*
1060 - 980nm	0.5 (0.25)	21 (26)	50	70
830 - 780nm	0.6 (0.3)	20 (25)	40	70
635nm	0.8 (0.4)	20 (25)	40	70
532 - 460nm	1.2 (0.6)	20 (23)	35	60
405nm	1.5 (0.75)	18 (21)	35	60
TEST CONDITIONS	IEC 61300-3-34 Random mating	IEC 61300-3-40 Low coherence	IEC 61300-3-6 *OLCR method OCWR method	

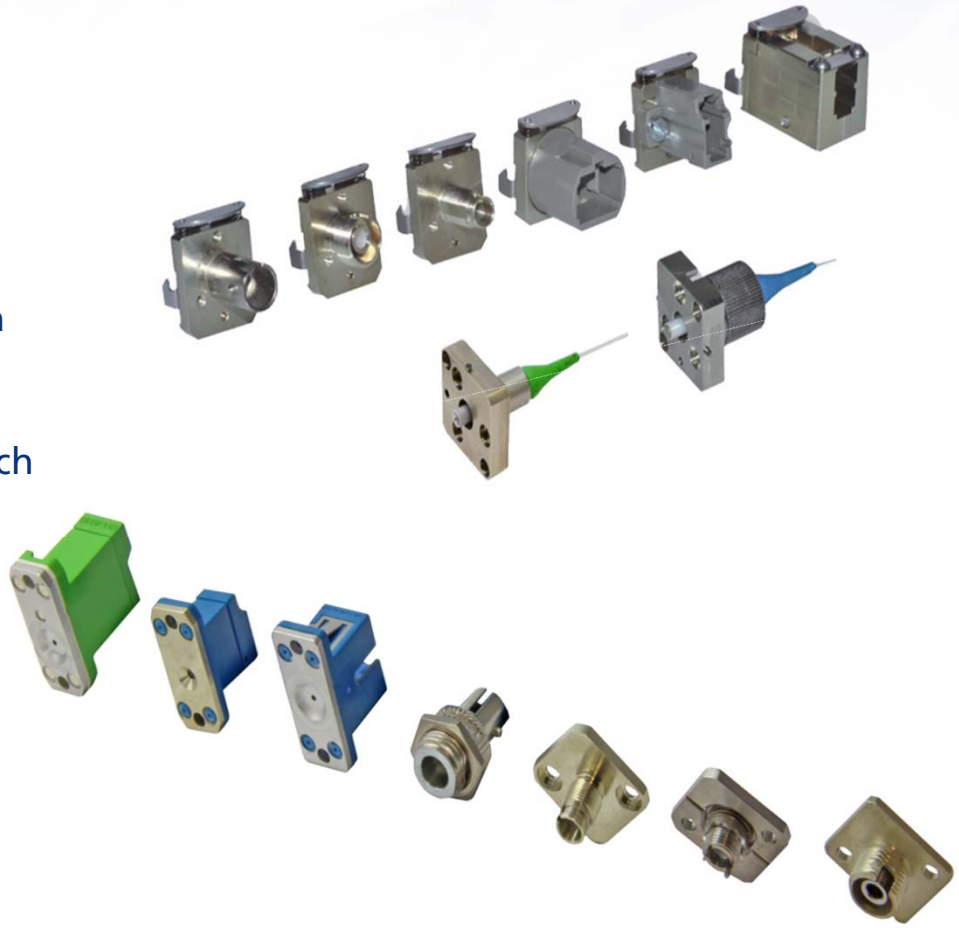
Special Adapter (MAS, IMOD)

➔ Multipurpose Adapter System - MAS

- Universal Flange (FC or Mini-AVIM)
- Connector adapter (E-2000™, F-3000™/LC, SC, DIN LSA, FC)
- For F-3000™/LC with reduction sleeve 2.5mm to 1.25mm
- Applications: Measurement Instruments, Light source, Bench hybrid adapter

➔ Interface Module – IMOD

- Half adapter
- Various design to match repeatability requirements
- Applications: Light source injection, Optical interface to free space



Vacuum Feedthrough (V-FT)

V-FT - Technical Characteristics			
ENVIRONMENT			Notes/standards
He Leak rate	$< 10^{-9}$	Atm*m^3/s	over temperature range
Operation Temperature	-25 to +70	°C	
Non-Operation Temperature	-40 to +85	°C	
OPTICAL			
Insertion Loss, IL	0.3 typical, 0.6 max	dB	IEC 61300-3-4 method C
Return Loss, RL	PC >40; APC >75	dB	IEC 61300-3-6 method OLCR
Extinction Ratio, ER	ER>23; ER typical 28*	dB	Similar to IEC 61300-3-40
MECHANICAL CHARACTERISTICS			
Mating durability	250 mate/de-mate		IEC 61300-2-2
Vibration	1oct/min, 10g@60Hz-2kHz		IEC 61300-2-1 (sinusoidal)
CABLE	Homologated cables		
Torsion	2N, 25 cycles 180°		IEC 61300-2-5
Static side load	0.2N, 90°, 5min		IEC 61300-2-42
Fiber Retention	5N, 1min		IEC 61300-2-4

* with Fujikura PM1550nm fiber

Services

Laboratory measurements

Custom developments

Laboratory Measurement Services

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Economic Affairs DEA
Swiss Accreditation Service SAS

Based on the Accreditation and Designation Ordinance dated 17 June 1996 (as of 4 April 2006) and on the advice of the Federal Accreditation Commission, the Swiss Accreditation Service (SAS) grants to

Diamond SA
Test & Calibration
Via dei Patrizi 5
CH- 6616 Losone

the accreditation as

Calibration laboratory for fiber optic measurement instruments

in accordance with the Standard ISO/IEC 17025. The ranges and measurement uncertainties are listed in the Official SCS-Directory of the Accredited Calibration Laboratories.

Accreditation mark and number: SCS 101
Date of accreditation: 11 March 2002
Date of the last renewal of accreditation: 11 March 2007
The accreditation is valid until: 10 March 2012

CH-3003 Berne-Wabern, 11 March 2007
Swiss Accreditation Service

The Head
Hanspeter Ischi

SAS is a signatory of the multilateral agreements of the European co-operation for Accreditation (EA) for calibration, testing, inspection and certification of products, personnel, quality and environmental management systems, of the International Accreditation Forum (IAF) for certification of products, quality and environmental management systems and of the International Laboratory Accreditation Cooperation (ILAC) for calibration and testing.

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Economic
Swiss Accreditation Service SAS

Based on the Accreditation and Designation Ordinance date and on the advice of the Federal Accreditation Commission, grants to

Diamond SA
Test & Calibration
Via dei Patrizi 5
CH-6616 Losone

the accreditation as

Testing laboratory for fiber optic components

in accordance with the Standard ISO/IEC 17025. The scope
Directory of the Accredited Testing Laboratories.

Accreditation mark and number: STS 333
Date of accreditation: 11 March 2002
Date of the last renewal of accreditation: 11 March 2007
The accreditation is valid until: 10 March 2012

CH-3003 Berne-Wabern, 11 March 2007
Swiss Accreditation Service

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Accreditation Forum (IAF) for certification of products, quality and environm
Laboratory Accreditation Cooperation (ILAC) for calibration and testing.

- ➔ DIAMOND Test and calibration laboratory
  - **STS 333** as fiber optic components testing laboratory
  - **SCS 101** for fiber optic instruments calibration laboratory
- ➔ Swiss Accreditation Service SAS in accordance with ISO / IEC 17025:2005
- ➔ Our laboratory services are open to subsidiaries, distributors and end customers

Custom Developments

- Complete connectors designed to customer cable – environment – optical performance requirements
- Optical terminae for Inserts for the various Optical Interfaces provided by Diamond
  - SM, MM, 0.1dB, VIS/NIR, PS, PSf, PM
  - Fusion spliceable termini for SM, MM (VIS/NIR, PS, PSf and PM on demand)
- Design services for helping the integration
- Qualification in our International Accredited Laboratory