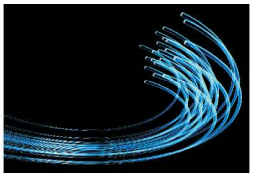







LU_LWL_xxxx
Fiber Patchcord

Lumics offers high quality fiber optic multimode patch cables as best and most reliable choice for all LuOcean diode laser modules

Please request advise for your fiber cable choice from Lumics

Features:
- Cables designed for LuOcean diode laser modules
- Low-OH material for long wavelength up to 2µm

Benefits:
- Bending limit protection
- Passive and water cooling
- Outgoing inspection and dust cap

Applications:
- Material processing
- Medical

Fiber Properties

Parameter								Unit
Core diameter	50	100(105)	200	400	600	800	1000	µm
Cladding diameter	125	125	280	440	720	880	1100	µm
Large Cladding diameter option *	no	660/no	500	480	720	880	1200	µm
Buffer(Silicon) /Coating (Nylon or Tefzel or Vestamid)	250	780/1100(250)	640/1300	700/1300	880/1320	1050/1350	1200/1400	
Numerical aperture	0.22 ± 0.02	0.22 ± 0.02	0.22 ± 0.02	0.22 ± 0.02	0.22 ± 0.02	0.22 ± 0.02	0.22 ± 0.02	
Mechanical/optical (NA 0.21) minimum bend radius **	30/50	100/50	75/100	72/200	108/300	132/400	180/800	mm
Effective NA at mechanical min. bend radius ***	-	0.215	0.206	0.192	0.192	0.189	0.192	
Operating and storage temperature	0 to +60	0 to +60	0 to +60	0 to +60	0 to +60	0 to +60	0 to +60	°C

* A large cladding diameter must be used only if a free standing fiber <600µm core or mode stripper is required. Cladding layer thickness to prevent leaky waveguide loss must be >10 times wavelength, ** mechanical limit to prevent cracks long term is 150x cladding diameter, short term 60x largest cladding diameter. *** Optical limit for NA 0.2/0.210/0.218 is 250/500/2000 x core diameter and typical fiber loss from core to cladding for Lumics LuOcean diode laser between lowering NA from 0.22 to 0.20 is 2%. Minimum bending radius must be the larger value of the mechanical and optical minimum radius given above. Fiber cables with end cap, free standing connector or mode stripper are limited to a maximum of one 360° turn per cable. The refractive index of the buffer is lower than the one of the cladding thus power is guided in the cladding but the glue to fix the fiber to the connector has a larger refractive than core or cladding thus light is coupled out in this area.



Cable / Connector Options

Parameter & Option Connector type	F-SMA glue fixed	HP-F-SMA free standing with cooling	D80 free standing with cooling	Unit
Maximum operating power range (1)	<=70	<=270	<=1000	W
Core fiber diameter corresponding to power	>=600/400/200	>=1000/800/600/400/200/105	>=400/200/105	µm
Large fiber cladding required	no	mandatory	mandatory	
Ferrule diameter (2)	<3.166 - <3.172 (glue fixed)	<3.169 - <3.174 (free standing)	<3.995 - <4.000 (free standing)	mm
End face ferrule to flange distance (2)	9.70 - 9.90	9.70 - 9.90	9.900 - 10.000	mm
"Fiber center core centricity ->	<=10 core (100-400)µm	<=12 core (100-400)µm	<=12 core (100-400)µm	µm
with relation to the ferrule outer ->	<=12 core >=600µm	<=15 core >=600µm	<=15 core >=600µm	µm
surface (2)"	<=15 core >=1000µm	<=20 core >=1000µm	<=20 core >=1000µm	µm
Fiber tip arrangement (3)	Non-free standing both ends	Free standing both ends	Only free standing both ends	
Operating and storage temperarture	<=60°C	<=60°C	<=60	°C
Cooling options (water also for FSMA available) (4)	no	optional air (5W cladding loss forced air)	optional water(>270W) forced air cooling	
Cladding mode stripper (4)	no	optional (module side)	optional (module side)	
Fiber end cap OD/length, depends on power level (5)	no	optional 1.5/3.8 <=200µm	optional 1.5<=200µm(2.3 >=400µm)/3.8	mm
AR coating on end cap (increase of power ~ 2%)	no	yes	yes	
Angular ferrule position fixed by key lock (6)	no	no	yes	
Ferrule material (7)	Arcap (AP1D CuNi25Zn12)	Arcap	Arcap	
Best choice for LuOcean diode laser		Mini (4/8), P2, M4	Mini (4/8), P2, M4	M4

Notes: (1) The power levels require a fiber centricity error is below the given values above and the cladding thickness >=10 times wavelength. (2) **A critical parameter is the maximum distance of the fiber core center after one 360° ferrule turn to the geometric cirular center of the ferrule referred here as fiber core centricity and the ferrule diameter tolerance which must tightly match the diode laser module receptacle of ID_FSMA(D80) = 3.176(4.004)mm - <3.179(4.007)mm and .** Use a fiber microscope to check fiber centricity and dust free fiber end facet. For cleaning and polishing refer to products and instructions from vendors of standard fiber kits for this purpose and the Lumics fiber cable manual. We recommend link-free cleaning cloth integrated in dispensers for non-free standing fibers and IPA rinse with blow dry by compressed nitrogen or clean dry air for free-standing fibers. (3) Advantage of free standing fibers are first much higher tolerance to centricity error, smaller diameter tolerance and higher power in the cladding on the exit side because of missing adhesive which may burn close to the fiber end facet or due to power extracted by the adhesive. Disadvantage are higher risk of fiber damage to the fiber tip due to mechanical stress by handling, cleaning and polish. The refractive index of the glue to fix non-free standing fibers is higher than the cladding refractive index thus light in the cladding is coupled to the connector. The refractive index of the fiber cable buffer is lower than that of the cladding refractive index thus light in the cladding is guided unless there is a mode stripper. (4) As an example at 180(70)/(45)W out of 200/100µm a well centered free (non-free) standing fiber only with specification with no cooling and no mode stripper according the table above the temperature of the F-SMA connector with ARCAP ferrule attached to a LuOcean module rises by no more than 20°C at a base module temperature of 25°C. Above 55°C fiber connector temperature or 4W loss into the fiber cladding, passive forced air cooling or water cooling together with mode stripping and large cladding fibers is necessary depending on the performance of the fiber and the duty cycle of operation. When a mode stripper is used to strip out power from of the fiber cladding which may damage the fiber in bended region in or distortes the focused beam characteristic out of the fiber a cooling option must be used. In this case convection (forced) air cooling works 3W (8W) loss in the fiber cladding. Above 8W fiber cladding loss and up to 85W fiber cladding loss water cooling option with quick connector for 6mm outer diameter water hose is required. (5) The fiber end cap must have a length of 3.8mm+-0.05mm and a outer diameter (OD) of >=1.5mm (2.3mm above a fiber core of 200µm) and is free standing. The end cap must be on the laser module side and the fiber cable is labeled on this side with "Input". The end cap length affects the focus plane thus a different length and tolerance as above reduces the coupling efficiency. For high power density with fiber diameter <=200µm the end cap is mandatory too guarantee diode life time. (6) The advantage of the D80 key lock is that the laser focus spot and the fiber core match always at the same angular position thus the power ex fiber is very stable upon plug in and out. The connector show typically 5% power variation during a 360° turn. (7) Arcap 12% of the thermal conductivity of copper but much better high abrasion resistance than copper and is magnetic which is necessary for the inductive Mini 3 and P2 (external) fiber sensor. Copper does not work for Mini 3 and P2 external sensor.

We manufacture diode lasers.

Fiber Option Selection Guide

			At fiber input (diode laser module side)							At fiber output			
Power at fiber output (W)	Wave-length (nm)	Fiber core dia-meter (µm)	Fiber type (1)	Fiber Cla-dding	Passive air cooling	Forced air cooling	Water cooling	Max. power loss (W)	Mode stripper (2)	Fiber type (1)	Passive air cooling	Forced air cooling	Water cooling
<=50	>670 and <1550	>=100	fs	small	yes	no	no	3.5	no	gf or fs	yes	no	no
<=70	>670 and <1550	>=100	gf	large	yes	no	no	3.5	no	fs	yes	no	no
<=70	>670 and <1550	>=200	gf	large	yes	no	no	3.5	no	fs	yes	no	no
>70 and <=170	>670 and <1550	>=200	fs	large	yes	no	no	3.5	yes	fs	yes	no	no
>170 and <=270	>670 and <1550	>=400	fs	large	yes	no	no	3.5	no	fs	yes	no	no
>170 and <=270	>670 and <1550	>=200	fs	large	no	yes	no	5	yes	fs	yes	no	no
<=400 and >270	>670 and <1550	>=200	fs	large	no	no	yes	90	yes	fs	yes	no	no
<=800 and >400	>670 and <1550	>=200	fs	large	no	no	yes	90	yes	fs	no	yes	no
<=20	>1900	>=200	gf	large	yes	no	no	3.5	no	gf or fs	yes	no	no
>20	>1900	>=200	fs	large	yes	no	no	3.5	yes	fs	yes	no	no
Notes													
(1) Explanation to fiber type: "gf" means glue fixed and "fs" means a free standing fiber within the connector													
(2) A connector with mode stripper requires always a cooling option (air or water) and a free standing fiber													
(3) Max. power loss : This means the maximum power extracted by the mode stripper or injected into the fiber cladding													

Product examples with maximum power loss into the fiber cladding

Lumics diode laser series	Wavelength (nm)	Fiber core diameter (µm)	Maximum loss into the cladding with fiber cable centricity of <=10µm (%)
Mini 8	445	200	20
Mini 8	445	400	2
Mini 4	600 - 1100	105	16
Mini 4	600 - 1100	200	3
Mini 4	14xx/15xx	200	3
Mini 4	19xx	200	7
Mini 4	600 - 1100	400	0.5
MINI 8	600 - 1100	105	20
MINI 8	600 - 1100	200	6
MINI 8	14xx/15xx	200	6
MINI 8	19xx	200	12
MINI 8	600 - 1100	400	1
MINI 8	19xx	400	7
M4	600 - 1100	200	13
M4	14xx/15xx	200	14
M4	19xx	200	20
M4	600 - 1100	400	2
M4	19xx	400	10

Protection Tube Options

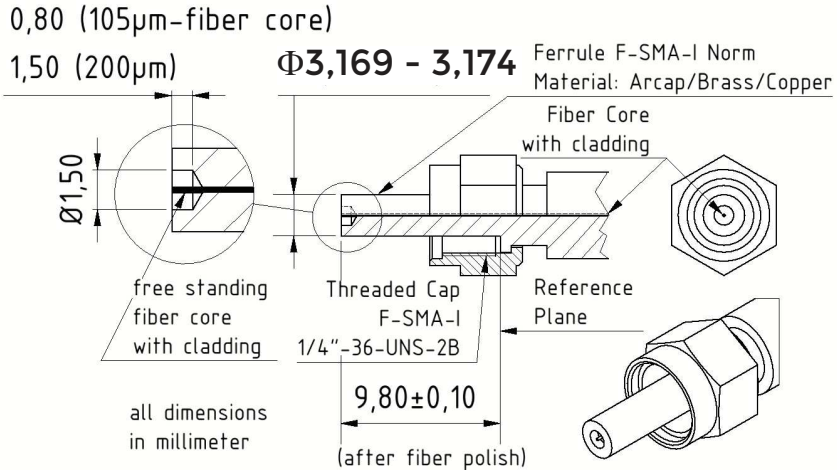
Parameter	Outer diam. (mm)	Features
Metal tube, strain relieve, bending limit, PVC coating (yellow color)	6.4	Robust tube, with bend-limiting

General Parameters

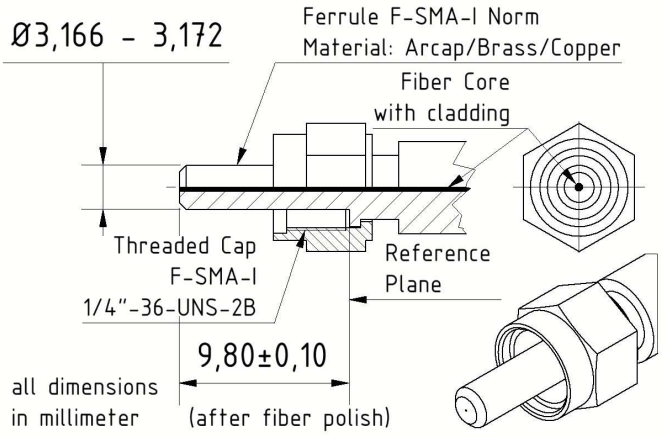
Type / Parameter		Unit
Storage temperature	(-)10 - (+)55	°C
Humidity / non condensing atmosphere	90	RH%
Compliance	ROHS	

We manufacture diode lasers.

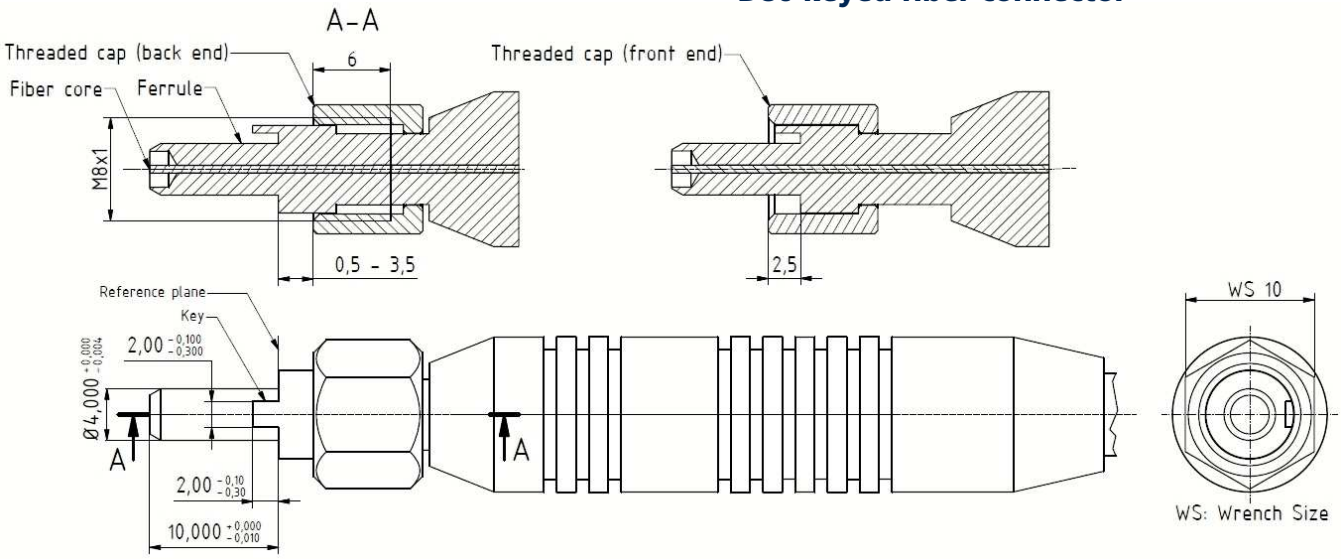
F-SMA free standing



F-SMA non free standing fiber connector

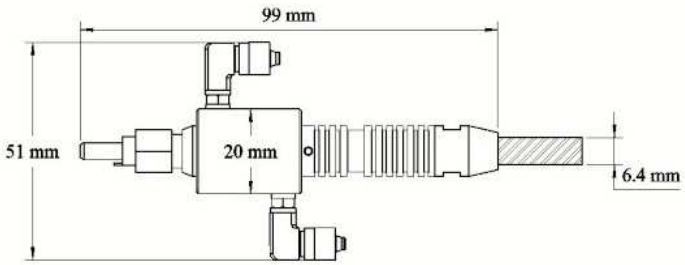


D80 keyed fiber connector



Connector with water cooling

Note : All fibers are glue fixed to the cooling connector body



Connector with air cooling

Note : All fibers are glue fixed to the cooling connector body