



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 | 200 | 400 | 600 | 800 | 1000 | µm |
| Cladding diameter | 125 | 125 | 280 | 440 | 720 | 880 | 1100 | µm |
| Large Cladding diameter option * | no | 660 | 500 | 480 | 720 | 880 | 1200 | µm |
| Buffer(Silicon) /Coating (Nylon or Tefzel or Vestamid) | 250 | 780/1100 | 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 buffer.



Cable / Connector Options

| Parameter & Option | Connector type F-SMA | HP-F-SMA with cooling | D80 with cooling | Unit |
|--|-----------------------------|---|--|------|
| Maximum operating power range (1) | <=70 | <=270 | <=1000 | W |
| Core fiber diameter corresponding to power | >=600/400/200/105 | >=600/400/200/105 | >=400/200/105 | µm |
| Large fiber cladding required | no | mandatory | mandatory | |
| Ferrule diameter (2) | 3.166 - 3.172 | 3.166 - 3.172 | 3.996 - 4.000 | 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 temperature | <=60°C | <=60°C | <=60 | °C |
| Cooling options (water also for FSMA available) (4) | no | optional air (>4W 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/thickness, depends on power level (5) | optional 1.5/3.8 | optional 1.5/3.8 <=200µm | optional 1.5(or 2.4 >400µm)/3.8 | mm |
| AR coating on end cap (increase of power ~ 2%) | yes | yes | yes | |
| Angular ferrule position fixed by key lock (6) | no | no | yes | |
| Ferrule material (7) | Arcap (AP1D CuNi25Zn12) | Copper | Copper | |
| 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 circular 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 = 3.173mm - 3.178mm.** 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 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 to 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 distorts 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

| Power at fiber output (W) | Wave-length (nm) | Fiber core diameter (μm) | At fiber input (diode laser module side) | | | | | | | At fiber output | | | | |
|---|------------------|--------------------------|--|----------------|---------------------|--------------------|---------------|---------------------|-------------------|-----------------|---------------------|--------------------|---------------|----|
| | | | Fiber type (1) | Fiber Cladding | 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 | fs | 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 | | 35 | yes | fs | yes | no | no |
| <=800 and >400 | >670 and <1550 | >=200 | fs | large | no | no | yes | | 35 | 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 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

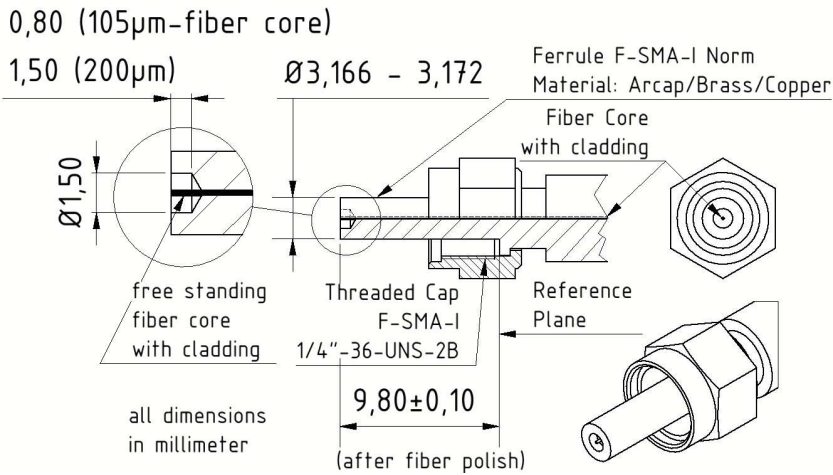
| Parameter | Outer diam. (mm) | Features |
|---|------------------|---------------------------------|
| Metal tube, strain relieve, bending limit, PVC coating (yellow color) | 6.4 | Robust tube, with bend-limiting |

General Parameters

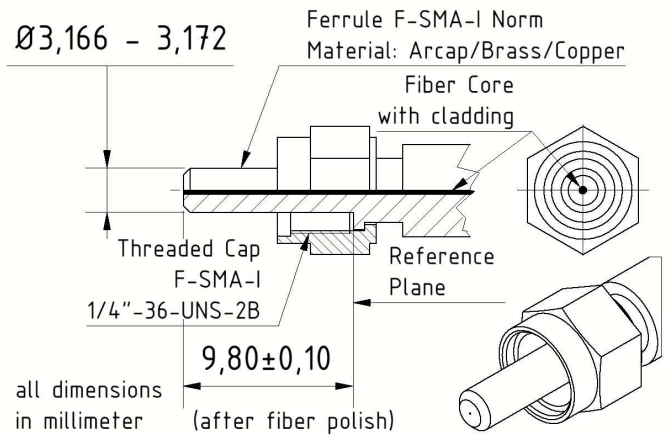
| Type / Parameter | | Unit |
|--------------------------------------|---------------|------|
| Storage temperature | (-)10 - (+)55 | °C |
| Humidity / non condensing atmosphere | 90 | RH% |
| Compliance | ROHS | |

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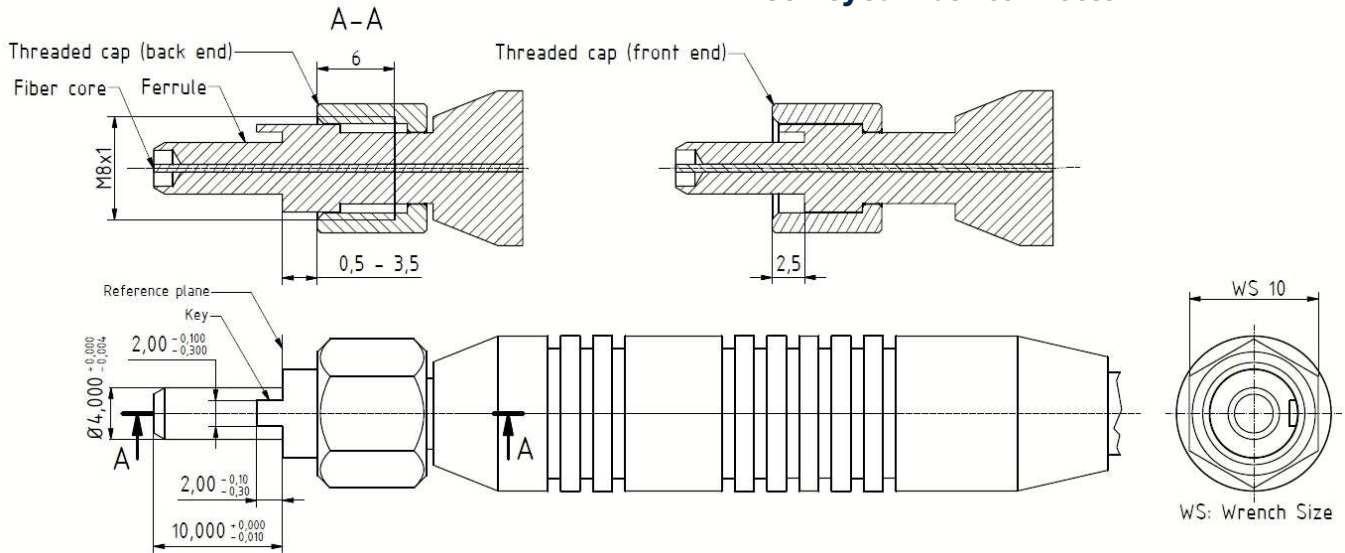
F-SMA free standing



F-SMA non free standing fiber connector

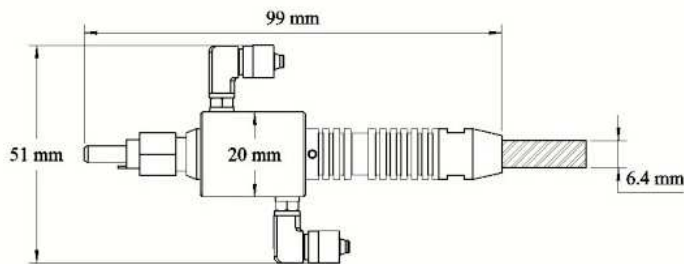


D80 keyed fiber connector



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

