

Few-mode Fibre (FMF)

The MDM transmission system uses the limited orthogonal modes in few mode fibre (FMF) as the independent channels to carry out information transmission in order to multiply the transmission capacity of the system. The few mode optical fibre uses different modes in the fibre as a new degree of freedom, the spectrum efficiency of the system can be improved successfully by FMF. As FMF has large mode field areas, its nonlinear tolerance is always better than that of SMF. It not only improves the capacity of optical transmission system, but also avoid the nonlinear effects. The MDM system based on FMF can solve the future single mode fibre bandwidth crisis.

YOFC FMFs taking advantages of PCVD process which is able to manufacture complex index-profile accurately, can get various types of core layer structure, such as Step-Index, Graded-Index etc. According to different design, 2-mode, 4-mode, 6-mode, 9-mode FMFs and even Ultra-low-loss(ULL) FMFs can be realized.

Characteristics

- Strictly controlled optical and geometrical parameters
- Customized waveguide is available
- Low macro-bending loss
- Low DMD for graded index fibre
- High DMD for step index fibre

Applications

- Mode division multiplexing(MDM)
- Communication
- Sensing

Specifications

Two Mode Fibre (Graded-Index)

Fibre Type		FM GI-2	
Part No.		FM2010-A	
Optical Characteristics@1550nm		Range	Typical Value
Core Diameter (μm)		20.0 ± 0.3	-
Cladding Diameter (μm)		125.0 ± 0.5	-
Cladding Non-circularity (%)		< 0.7	-
Wavelength (nm)		1450 - 1700	-
Coating Diameter (μm)		245.0 ± 10.0	-
Dispersion ($\text{ps}/(\text{nm} \cdot \text{km})$)	LP01	≤ 23	21.2
	LP11	≤ 23	20.5
Dispersion Slope ($\text{ps}/(\text{nm}^2 \cdot \text{km})$)	LP01	≤ 0.11	0.098
	LP11	≤ 0.11	0.096
Effective Area (μm^2)	LP01	≥ 100	112
	LP11	≥ 140	152
Attenuation (dB/km)	LP01	≤ 0.21	0.19
	LP11	≤ 0.21	0.20
Differential Group Delay (ps/m)	LP11-LP01	-0.3 to 0.3	-0.14

Two Mode Fibre (Step-Index)

Fibre Type		FM SI-2	
Part No.		FM2010-B	
Optical Characteristics@1550nm		Range	Typical Value
Core Diameter (μm)		14.0 ± 0.5	-
Core Refractive Index @1550nm		1.4485	-
Cladding Diameter (μm)		125.0 ± 0.7	-
Cladding Non-circularity (%)		< 0.7	-
Coating Diameter (μm)		245.0 ± 10.0	-
Dispersion (ps/(nm · km))	LP01	< 22	21
	LP11	< 21	19.5
Dispersion Slope (ps/(nm ² · km))	LP01	< 0.1	0.08
	LP11	< 0.1	0.07
Effective Area (μm^2)	LP01	> 100	130
	LP11	> 200	220
Attenuation (dB/km)	LP01	< 0.21	0.19
	LP11	< 0.21	0.19
Differential Group Delay (ps/m)		LP11-LP01	< 2.1

ULL-Two Mode Fibre (Step-Index)

Fibre Type		FM SI-2-ULL	
Part No.		FM2010-C	
Optical Characteristics@1550nm		Range	Typical Value
Core Diameter (μm)		16.0 ± 0.2	-
Cladding Diameter (μm)		125.0 ± 1.0	-
Cladding Non-circularity (%)		< 0.7	-
Wavelength (nm)		1450 - 1700	-
Coating Diameter (μm)		245.0 ± 10.0	-
Dispersion (ps/(nm · km))	LP01	21.0 - 23.0	22.53
	LP11	21.0 - 23.0	22.82
Dispersion Slope (ps/(nm ² · km))	LP01	0.08 - 0.11	0.1012
	LP11	0.08 - 0.11	0.1011
Effective Area (μm^2)	LP01	150 - 200	169
	LP11	150 - 200	167
Attenuation (dB/km)	LP01	≤ 0.17	0.161
	LP11	≤ 0.17	0.161
Differential Group Delay (ps/m)		LP11-LP01	≤ 5

Four Mode Fibre (Graded-Index)

Fibre Type		FM GI-4	
Part No.		FM2011-A	
Optical Characteristics@1550nm		Range	Typical Value
Core Diameter (μm)		23.0 ± 0.3	-
Cladding Diameter (μm)		125.0 ± 0.5	-
Cladding Non-circularity (%)		< 0.7	-
Wavelength (nm)		1450 - 1700	-
Coating Diameter (μm)		245.0 ± 10.0	-
Dispersion (ps/(nm · km))	LP01	≤ 23.0	21.4
	LP11	≤ 23.0	21.5
	LP21	≤ 23.0	21.6
	LP02	≤ 23.0	22.0

Four Mode Fibre (Graded-Index)

Fibre Type		FM GI-4	
Part No.		FM2011-A	
Optical Characteristics@1550nm		Range	Typical Value
Dispersion Slope (ps/(nm ² · km))	LP01	≤ 0.11	0.099
	LP11	≤ 0.11	0.100
	LP21	≤ 0.11	0.099
	LP02	≤ 0.11	0.100
Effective Area (μm ²)	LP01	≥ 100	118
	LP11	≥ 140	155
	LP21	≥ 200	204
	LP02	≥ 200	217
Attenuation (dB/km)	LP01	≤ 0.21	0.194
	LP11	≤ 0.21	0.191
	LP21	≤ 0.21	0.194
	LP02	≤ 0.21	0.194
Differential Group Delay (ps/m)	LP11-LP01	≤ 0.5	0.17
	LP21-LP01	≤ 0.5	0.30
	LP02-LP01	≤ 0.5	0.31

Four Mode Fibre (Step-Index)

Fibre Type		FM SI-4	
Part No.		FM2011-B	
Optical Characteristics@1550nm		Range	Typical Value
Core Diameter (μm)		18.5 ± 0.3	-
Cladding Diameter (μm)		125 ± 0.5	-
Cladding Non-circularity (%)		< 0.7	-
Wavelength (nm)		1450 - 1700	-
Coating Diameter (μm)		245.0 ± 10.0	-
Dispersion (ps/(nm · km))	LP01	≤ 23	21.9
	LP11	≤ 23	22.5
	LP21	≤ 23	22.0
	LP02	≤ 23	21.8
Dispersion Slope (ps/(nm ² · km))	LP01	≤ 0.11	0.102
	LP11	≤ 0.11	0.104
	LP21	≤ 0.11	0.100
	LP02	≤ 0.11	0.095
Effective Area (μm ²)	LP01	≥ 160	190
	LP11	≥ 160	181
	LP21	≥ 160	200
	LP02	≥ 160	182
Attenuation (dB/km)	LP01	≤ 0.21	0.191
	LP11	≤ 0.21	0.189
	LP21	≤ 0.21	0.189
	LP02	≤ 0.21	0.189
Differential Group Delay (ps/m)	LP11-LP01	≤ 5	1.70
	LP21-LP01	≤ 5	3.61
	LP02-LP01	≤ 5	3.65

ULL-Four Mode Fibre (Step-Index)

Fibre Type		FM SI-4-ULL	
Part No.		FM2011-C	
Optical Characteristics@1550nm		Range	Typical Value
Core Diameter (μm)		22.0 \pm 0.2	-
Cladding Diameter (μm)		125.0 \pm 1.0	-
Cladding Non-circularity (%)		< 0.7	-
Wavelength (nm)		1450 - 1700	-
Coating Diameter (μm)		245.0 \pm 10.0	-
Dispersion (ps/(nm·km))	LP01	21.0 - 25.0	22.51
	LP11	21.0 - 25.0	23.90
	LP21	21.0 - 25.0	24.74
	LP02	21.0 - 25.0	23.14
Dispersion Slope (ps/(nm ² ·km))	LP01	0.08 - 0.11	0.1015
	LP11	0.08 - 0.11	0.1046
	LP21	0.08 - 0.11	0.1033
	LP02	0.08 - 0.11	0.1014
Effective Area (μm^2)	LP01	200 - 300	269
	LP11	200 - 300	254
	LP21	200 - 300	277
	LP02	200 - 300	244
Attenuation (dB/km)	LP01	\leq 0.17	0.161
	LP11	\leq 0.17	0.161
	LP21	\leq 0.17	0.163
	LP02	\leq 0.17	0.168
Differential Group Delay (ps/m)	LP11-LP01	\leq 5	2.08
	LP21-LP01	\leq 5	4.43
	LP02-LP01	\leq 5	4.63

Six Mode Fibre (Graded-Index)

Fibre Type		FM GI-6	
Part No.		FM2012-A	
Optical Characteristics@1550nm		Range	Typical Value
Core Diameter (μm)		25.6 \pm 0.3	-
Cladding Diameter (μm)		125.0 \pm 1.0	-
Cladding Non-circularity (%)		< 0.7	-
Wavelength (nm)		1450 - 1700	-
Coating Diameter (μm)		245.0 \pm 10.0	-
Dispersion (ps/(nm·km))	LP01	20.0 - 22.0	21.31
	LP11	20.0 - 22.0	21.40
	LP21	20.0 - 22.0	21.28
	LP02	20.0 - 22.0	21.18
	LP31	20.0 - 22.0	21.32
	LP12	20.0 - 22.0	21.68
Dispersion Slope (ps/(nm ² ·km))	LP01	0.09 - 0.11	0.0988
	LP11	0.09 - 0.11	0.0987
	LP21	0.09 - 0.11	0.0990
	LP02	0.09 - 0.11	0.0981
	LP31	0.09 - 0.11	0.1011
	LP12	0.09 - 0.11	0.0960
Effective Area (μm^2)	LP01	100 - 240	123
	LP11	100 - 240	162
	LP21	100 - 240	217
	LP02	100 - 240	203
	LP31	100 - 240	225
	LP12	100 - 240	235

Six Mode Fibre (Graded-Index)

Fibre Type		FM GI-6	
Part No.		FM2012-A	
Optical Characteristics@1550nm		Range	Typical Value
Attenuation (dB/km)	LP01	≤ 0.22	0.207
	LP11	≤ 0.22	0.206
	LP21	≤ 0.22	0.208
	LP02	≤ 0.22	0.208
	LP31	≤ 0.22	0.21
	LP12	≤ 0.22	0.21
Differential Group Delay (ps/m)	LPmn-LP01	-0.2 to 0.2	0.13

Six Mode Fibre (Step-Index)

Fibre Type		FM SI-6	
Part No.		FM2012-B	
Optical Characteristics@1550nm		Range	Typical Value
Core Diameter (μm)		16.0 ± 0.2	-
Cladding Diameter (μm)		125.0 ± 1.0	-
Cladding Non-circularity (%)		< 0.7	-
Wavelength (nm)		1450 - 1700	-
Coating Diameter (μm)		245.0 ± 10.0	-
Dispersion (ps/(nm · km))	LP01	21 - 24	21.85
	LP11	21 - 24	22.63
	LP21	21 - 24	22.83
	LP02	21 - 24	23.71
	LP31	21 - 24	22.71
	LP12	21 - 24	22.89
Dispersion Slope (ps/(nm ² · km))	LP01	0.08 - 0.11	0.1046
	LP11	0.08 - 0.11	0.1038
	LP21	0.08 - 0.11	0.0983
	LP02	0.08 - 0.11	0.09
	LP31	0.08 - 0.11	0.0821
	LP12	0.08 - 0.11	0.0911
Effective Area (μm ²)	LP01	130 - 140	134
	LP11	120 - 130	125
	LP21	130 - 140	135
	LP02	110 - 120	119
	LP31	140 - 150	145
	LP12	150 - 160	153
Attenuation (dB/km)	LP01	≤ 0.22	0.201
	LP11	≤ 0.22	0.205
	LP21	≤ 0.22	0.21
	LP02	≤ 0.22	0.21
	LP31	≤ 0.22	0.215
	LP12	≤ 0.22	0.215
Differential Group Delay (ps/m)	LP11-LP01	≤ 5	4.4
	LP21-LP01	≤ 10	9.5
	LP02-LP01	≤ 10	9.52
	LP31-LP01	≤ 15	14
	LP12-LP01	≤ 12	10.04

Nine Mode Fibre (Graded-Index)

Fibre Type		FM GI-9	
Part No.		FM2013-A	
Optical Characteristics@1550nm		Range	Typical Value
Core Diameter (μm)		33.0 ± 0.3	-
Cladding Diameter (μm)		125.0 ± 1.0	-
Cladding Non-circularity (%)		< 0.7	-
Wavelength (nm)		1450 - 1700	-
Coating Diameter (μm)		245.0 ± 10.0	-
Dispersion ($\text{ps}/(\text{nm} \cdot \text{km})$)	LP01	21.0 - 24.0	21.33
	LP11	21.0 - 24.0	21.39
	LP21	21.0 - 24.0	21.55
	LP02	21.0 - 24.0	21.31
	LP31	21.0 - 24.0	20.79
	LP12	21.0 - 24.0	21.05
	LP41	21.0 - 24.0	20.35
	LP22	21.0 - 24.0	22.40
Dispersion Slope ($\text{ps}/(\text{nm}^2 \cdot \text{km})$)	LP03	21.0 - 24.0	19.05
	LP01	0.08 - 0.11	0.0989
	LP11	0.08 - 0.11	0.0989
	LP21	0.08 - 0.11	0.1011
	LP02	0.08 - 0.11	0.0988
	LP31	0.08 - 0.11	0.0966
	LP12	0.08 - 0.11	0.0984
	LP41	0.08 - 0.11	0.0925
Effective Area (μm^2)	LP22	0.08 - 0.11	0.1010
	LP03	0.08 - 0.11	0.0883
	LP01	110 - 400	149
	LP11	110 - 400	196
	LP21	110 - 400	240
	LP02	110 - 400	254
	LP31	110 - 400	290
	LP12	110 - 400	302
Attenuation (dB/km)	LP41	110 - 400	331
	LP22	110 - 400	392
	LP03	110 - 400	276
	LP01	≤ 0.22	0.201
	LP11	≤ 0.22	0.201
	LP21	≤ 0.22	0.203
	LP02	≤ 0.22	0.202
	LP31	≤ 0.22	0.203
Differential Group Delay (ps/m)	LP12	≤ 0.22	0.204
	LP41	≤ 0.22	0.204
	LP22	≤ 0.22	0.204
	LP03	≤ 0.22	0.204
	LPmn-LP01	-0.5 to 0.5	0.05