FIBRAIN®
Fiber Optic Solutions

Technical whitepaper

ULTRA-LOW LOSS FIBERS

Products of the future, availabe today.

A lot of time has passed since the first low loss fiber was constructed by the specialists in Corning company. Such low less fiber with attenuation of 20 dB/km were limited to the laboratory purposes only. The following years brought progress in this area as in 1974 we could make use of optic fiber with lower attenuation at the level of 4 dB/km, whereas in 1979 single mode of 0,2 dB/km attenuation. From that point, time has been passing even quicker! In the optic fiber technology a lot of new things appear as state-of-the-art equipment is systematically implemented and used e.g. optic amplifiers, TDM CWDM, DWDM multiplexers and consequently the transmission speeds exceed 40 GBit/s. As a result only specialized optic fiber cables are able to meet demanding technical requirements.

A new kinds of fiber optic cables with the dispersion adapted to new applications such as DS. (G.653), NZDS (G.655/656/656+) appear on the market. While the process of creating such dispersion which follow the rapid development of the equipment and transmission system is at the appropriate level, the standard of improving the attenuation level is significantly lower.

The improvement of geometric parameters and limitation of tolerance of the fiber optic cables is substantial- coat diameter 125 µm ± 0,7 µm. A new optic fibers with reduced diameter of the original cover 200 µm provides the possibility of limiting the spaces between the fibers in a cable, which can be easily welded with G.652D fibers of 250 µm.

Therefore, the process of creating better mechanical characteristics of the optic fiber together with resistance to their bending, is improving considerably. Thanks to creating the profile of refractive index a new quality has been achieved in fibers of G.657A1, A2 standard, which are fully compatible with G.652D, G.657B2, B3 and consequently reflect their higher resistance or insensitiveness on coiling on a small diameters- from 20 mm for A1 to 10 mm for B3.

However limiting the attenuation of the fiber optic cables is much more time-consuming. Almost 30 years of intensive and hard work was required to reach such technological level which truly provides the possibility of manufacturing LOW LOSS optic fibers with attenuation being similar to this of material characteristics of quartz.

The first step toward this challenge was the reduction or removal of water point from the spectral characteristics and construction the fibers with reduced LWP, and so called ZWP with zero water point. But the increase of the purity and cleanliness on each manufacturing step of the optic fibers in „pure silica" technology from the pre-form to ready to use fiber, brought the successful results- limitation of the attenuation.
At present, low loss and pure quartz optic fibers with max 0,17 dB/km attenuation for 1550 nm wavelength and max 0,31 dB/km for the 1310 nm wavelength are available on the market. Low loss and pure quartz optic fibers possess at least 0,02 dB/km lower spectral attenuation in comparison to the standard ones G.652D. In such fibers, the retention of the flat spectral characteristics within the transmission windows provides the possibility of achieving substantially smaller deviations of the attenuation:
- 1310 nm (+20 nm / -35 nm) wavelength- max. deviation is 0,03 dB/km
- 1550 nm (+25 nm / -25 nm) wavelength- max. deviation is 0,02 dB/km with the retention of 1625 nm attenuation 0,20 dB/km.

The chromatic dispersion complies with ITU -T G.652 and the polarizing at the level of ≤ 0.04 ps / √ km of these fibers provides the possibility of using such fibers in high-speed systems, e.g. transmission of 10 Gbit/s and higher . Low loss fibers which are obtained in the pure quartz technology can work properly in large telecommunication networks at distances of even one thousand kilometers far, which limits the number of amplifiers and repeater in a optic fiber link. Bearing in mind further development of the networks, low-loss fibers can be used to design networks with extra supply, higher functionality, which at present offer 50 % extension of the useful range of its bandwidth providing 16 channel CWDM and support DWDM transmission. Optic fiber cables with ultra- low-loss fibers are available in the product portfolio of ELMAT company.

Physical characteristics

Coat diameter	125.0 ± 0.7 µm
Coat ovalness	≤ 0.7 %
Centricity error margin core/coat	≤ 0.5 µm, ≤ 0.2 µm
Original cover diameter	235 µm - 247 µm
Original cover diameter mistake margin	≤ 12 µm
Level of sifting quality test	100 kPsi (0.69 GPa)
Strenghts range of removing original cover	≥ 1.3 N < 8.9 N

Optic characteristics

Max. attenuation	dla 1310 nm ≤ 0.32 dB/km dla 1385 nm ≤ 0.31 dB/km dla 1490 nm ≤ 0.21 dB/km dla 1550 nm ≤ 0.18 dB/km dla 1625 nm ≤ 0.20 dB/km

Attenuation dependency from wavelength

Wavelength range (nm)	Wave reference (nm)	Attenuation change in regard to wave (dB/km)
1285 – 1330	1310	0.03
1360 – 1480	1385	0.04
1525 – 1575	1550	0.02
1460 – 1625	1550	0.04

Attenuation impurity / Non-continuity points	for 1310 nm and 1550 nm ≤ 0.05 dB
Attenuation in the macro-bend function	1 loop, 32 mm diameter (1.2") for 1550 nm < 0.03 dB 100 loop, 50 mm diameter (2") for 1310 nm < 0.03 dB 100 loop, 60 mm diameter (2.4") for 1550 nm < 0.03 dB, for 1625 nm < 0.03 dB
Zero-dispersion wavelength (λ0)	1302 – 1322 nm
Curve gradient for zero dispersion (S0)	≤ 0.090 ps/nm2-km
Typical gradient of the dispersion	0.087 ps/nm2-km
Diameter of the mode field	for 1310 nm 9.2 ± 0.4 µm for 1550 nm 10.4 ± 0.5 µm
Cut-off wavelength (λCC)	≤ 1260 nm
PMD fibers – LDV	2 < 0.04 ps/√km
Max. value for the single fiber	< 0.1 ps/√km
Typical value for LMC PMD fiber	< 0.02 ps/√km
Thermic cycle (-60°C do +85°C)	≤ 0.05 dB/km
Aging in high temperatures (85 ± 2° C)	≤ 0.05 dB/km
Temperature cycle / humidity (for -10° C to +85° C; 95% RH)	≤ 0.05 dB/km
Immersion in water (23 ± 2° C)	≤ 0.05 dB/km
Dynamic coefficient of fatigue for tension corrosion (nd)	≥ 20

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