Cutoff Wavelength
Measurement Method

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Optical Fiber

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Scope

This information describes the reference method for measuring the fiber cutoff wavelength (λ_{CF}) and the cable cutoff wavelength on uncabled fiber (λ_{CCF}) by the transmitted power method for Corning® single-mode optical fibers.

General

The minimum wavelength at which an optical fiber will support only one propagating mode is referred to as the cutoff wavelength. If the system operating wavelength is below the cutoff wavelength, multimode operation may take place and the introduction of an additional source of dispersion may limit a fiber's information carrying capacity.

It's important to note that the physical deployment of the fiber plays an important role in defining the region of single-mode operation. Typical deployment conditions for cabled fibers in the field, with varying lengths and bend configurations, will typically shift the actual cutoff to shorter wavelengths than the measured fiber cutoff wavelength (λ_{CF}). Therefore, the cabled fiber cutoff wavelength (λ_{CC}) is of more interest to the cabler because it's a more accurate representation of the cutoff wavelength that can be expected in actual use. Because cabling the fiber tends to shift the cutoff to shorter wavelengths, a conservative estimate of cabled cutoff can be made by measuring uncabled fiber in the cable cutoff configuration (λ_{CCF}).

Measurement Description

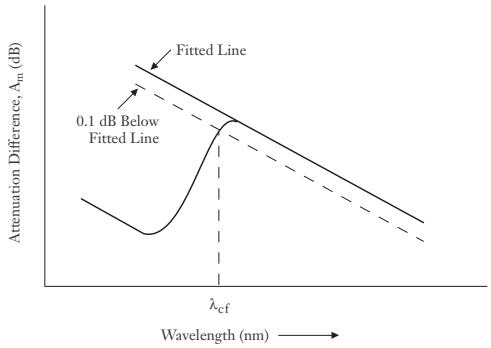
To determine the cutoff wavelength of a single-mode fiber by the transmitted power method, the transmitted spectral power versus wavelength for the sample fiber is compared to the transmitted spectral power versus wavelength for two meters of a multimode fiber by applying the equation:

$$A_m(\lambda) = 10 \log_{10} \frac{P_s(\lambda)}{P_m(\lambda)} \text{ in dB.}$$

where: A_m = attenuation difference
P_s = power from the single-mode fiber
P_m = power from the multimode fiber

A multimode fiber is used as the reference fiber to permit mapping out the spectral response of the measurement system. To determine the cutoff wavelength, $A_m(\lambda)$ is plotted against wavelength. A straight line is fitted to the long-wavelength backslope of the plot and dropped 0.1 dB. As depicted in Figure 1, its subsequent intersection with the curve denotes the cutoff wavelength. An optimal fit can be used to control errors in the transition zone.

Cutoff Wavelength Plot
Figure 1



Measurement Conditions

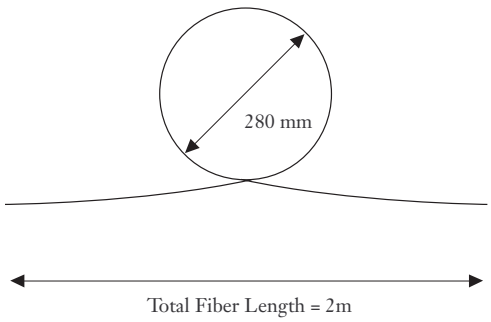
The fiber ends are stripped of coating and prepared with end angles less than 2° with a near-perfect mirror surface. Cladding mode stripping is also provided.

- Launch Spot Size: 200 µm
- Launch Numerical Aperture: 0.20
- Source Spectral Width: ≤ 10 nm Full Width at Half Maximum (FWHM)
- Measurement Wavelength: 1000 nm to 1600 nm in 10 nm steps

The sample fiber is deployed in accordance with TIA standard (see references) as shown here.

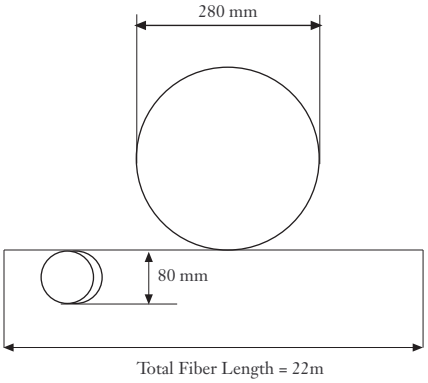
Fiber Deployment: Fiber Cutoff Wavelength (λ_{CF})
Figure 2

The test sample shall be 2 meters of fiber deployed in a single turn of constant radius of 140 mm. There shall be no additional bends less than 140 mm radius. A typical deployment is shown in Figure 2.



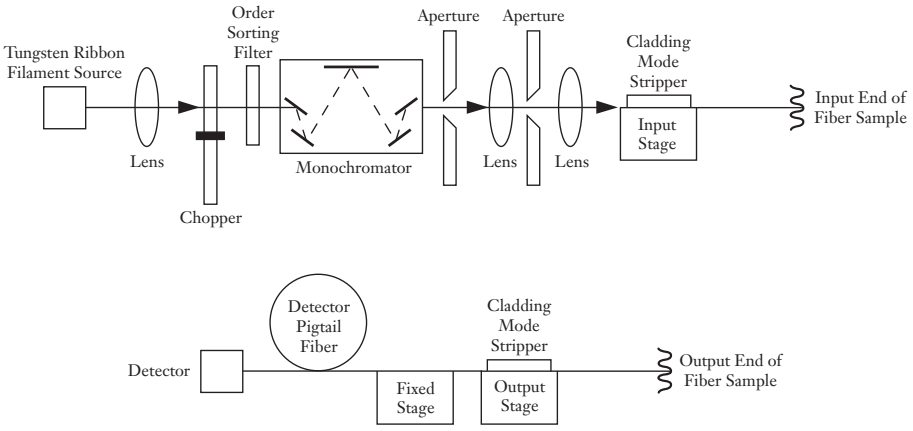
Fiber Deployment: Cable Cutoff Wavelength of Uncabled Fiber (λ_{CCF})
Figure 3

The test sample shall be 22 m of uncabled fiber coiled into a loop with a minimum radius of 140 mm to conservatively simulate cabling effects. To simulate the effects of a splice organizer, apply two loop of 80 mm diameter near one end, as shown in Figure 3. For fiber designs where the 22 m cable cutoff measurement agrees with a surrogate 2-meter measurement (2 loops @ 80 mm diameter), the 2-meter surrogate measurement is used.



Apparatus

Figure 4 shows the apparatus used to measure the cutoff wavelength in Corning® single-mode optical fibers.



References

TIA-455-80B, Measurement Cut-off Wavelength of Uncabled Single-Mode Fiber By Transmitted Power.

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