Multimode Chromatic Dispersion
Measurement Method

CORNING
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Optical Fiber

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Scope

This information describes the current reference method for measuring the dispersion of Corning® multimode optical fibers.

General

The dispersion is a measure of the time-based broadening which occurs in pulses of light as they propagate along a length of fiber. Chromatic dispersion is caused when different wavelengths of light within a pulse propagate at different velocities. This pulse broadening limits the data transmission rate for systems using wide spectral width light emitting diodes (LED) and therefore is an important parameter to system designers.

Measurement Method

Chromatic dispersion values are obtained by measuring the relative time of flight differences between laser pulses at five or more different wavelengths on a full length of fiber (≥ 1 km). A spectrally and temporally narrow pulse of light is launched at each wavelength through a mode scrambler into the full length of fiber using the apparatus shown in Figure 2. A mode scrambler is used to generate a spatially, angularly and uniformly overfilled launch condition to ensure consistent measurement results. A centroid calculation is performed on the pulse data at each wavelength. After the data has been acquired on the long length, the fiber is cut back to short reference length (2 meters). The relative time delays are measured on the reference fiber in a similar manner. The relative time delays of the reference fiber are then subtracted from the relative time delays of the long length of fiber at each wavelength and the data is then least-squares curve fit to equation 1 to obtain a time-delay curve.

[1] Time delay = $\tau(\lambda) = A + B\lambda^2 + C\lambda^{-2}$

where: λ = the operating wavelength of interest
$A,B \& C$ = fit parameters

The first derivative of the time-delay curve is the dispersion curve. Differentiating equation 1 gives dispersion as shown in equation 2.

[2] Dispersion = $D(\lambda) = 2(B\lambda - C\lambda^{-3}) = \frac{S_o}{4}\left(\lambda - \frac{\lambda_o^4}{\lambda^3}\right)$

λ_o and S_o can then be defined as follows:

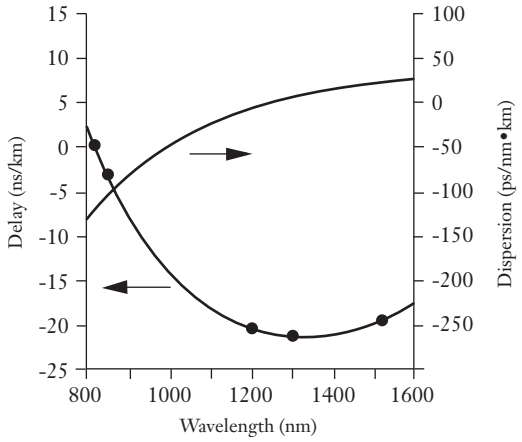
$\lambda_o \equiv \left(\frac{C}{B}\right)^{1/4}$

$S_o \equiv S(\lambda_o) = 8B$

where: λ = the operating wavelength of interest
λ_o = the zero dispersion wavelength
S_o = the dispersion slope at λ_o

A typical time-delay curve and dispersion curve for a multimode fiber, where λ_o and the minimum dispersion are near 1300 nm, are shown in Figure 1.

Typical Time-Delay Curve
Figure 1



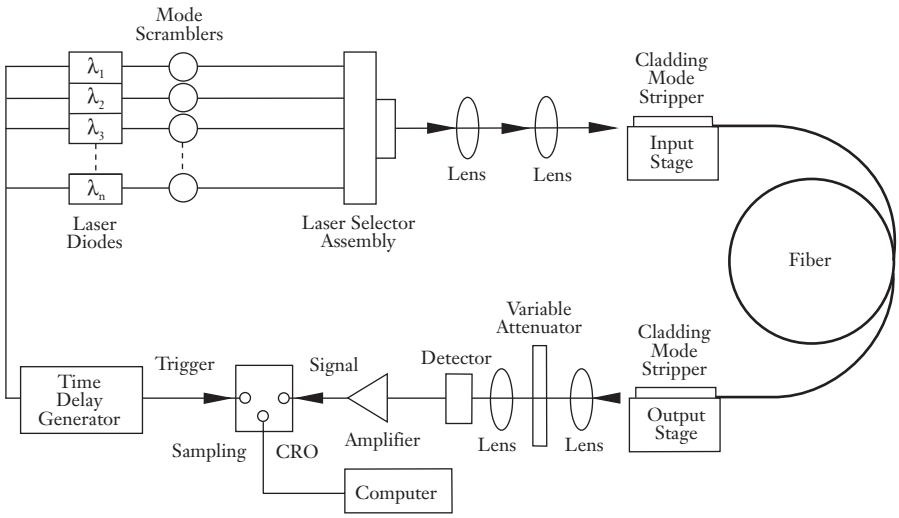
Measurement Conditions

The fiber is wound with near zero tension onto a large diameter (≥ 36 cm) measurement spool to provide a measurement condition which will influence the accuracy of the measurement result. The fiber ends are stripped of coating and prepared with end angles less than 2° with near-perfect mirror surfaces. Mode stripping is provided to assure the removal of cladding modes.

• Fiber Length	Full length and 2.0 ± 0.2 meters
• Launch Spot Size	≥ 62.5 μm
• Launch Numerical Aperture	0.275
• Source Spectral Width	≤ 10 nm Full Width at Half Maximum (FWHM)
• Pulse Duration	≤ 400 ps FWHM
• Measurement Wavelengths	Spaced between 800 nm and 1600 nm
• Other	The semiconductor lasers are coupled to mode scramblers to produce a nearly Lambertian output approximately 62.5 μm in diameter.

Apparatus to Measure Chromatic Dispersion

Figure 2 shows the apparatus used to measure the pulse delay in Corning® optical fibers.



References

EIA/TIA-455-168A (FOTP-168), Chromatic Dispersion Measurement of Multimode Graded-Index and Single-Mode Optical Fibers by Spectral Group Delay Measurement in the Time Domain.

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