122 DISPERSION-COMPENSATING FIBER: PRECISION AND REPETITION

APPLICATION NOTE

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It is common knowledge in the industry that installing dispersion-compensating fiber (DCF) within a network is a good way to compensate for dispersion. What is not widely known, however, is that to achieve adequate results with DCF, highly precise dispersion tests must be carried out several times, at various levels.

DCF Characteristics

Typical DCF has negative dispersion and produces a negative slope, with nominal values that are typically ten times higher than those of the fiber to compensate for. Therefore, to adequately compensate for the dispersion in 90 km of G.652 fiber, approximately 9 km of DCF must be installed (this is a general rule of thumb, as the exact ratio is DCF-dependent). In addition, the typical attenuation found in a DCF is three times higher than in standard fiber, and the polarization mode dispersion (PMD) coefficient is about double. Also, the effective areas are extremely small.

Typical DCF Specifications

Characteristic	Unit	Value
Attenuation	dB/km	0.62
A_{eff}	μm^2	12.0
PMD coefficient	ps/√km	0.1

Effects

The impact that inherent DCF specifications have on dispersion testing is two-fold.

First, the PMD in 9 km of DCF is typically about 0.3 ps. Depending on the actual fiber, some may have more, others may have less but, either way, the PMD coefficient is significantly higher than that of the rest of the network. When DCF is positioned between the two stages of an amplifier (as in most networks), it is quite possible that this amplifier has never been included in the PMD tests performed, so the measured PMD levels may not have been truly representative of the actual PMD in the network. Traditional PMD test equipment cannot test through EDFAs, so fiber sections are tested between EDFAs, leaving out an important PMD contributor, which is located within the EDFA itself. The solution to this shortcoming is to use an instrument based on the Generalized Interferometric method (GINTY), as only this technology enables PMD measurements of entire links, including EDFAs.

Second, when a network presents low dispersion, high power and small effective areas (increasing power density) —or any combination of the three—non-linear effects such as four-wave mixing (4WM) occur,. As described earlier, to compensate for their high loss, DCF is usually positioned between the pre-amp and the booster amp of an EDFA; i.e., where power is high. And since the effective area is very small, two of the three elements are always there to cause destructive damage (for comparison purposes, DCF typically has 12 μm^2, whereas G.652 has around 80 μm^2 and G.653, which is extremely prone to 4WM, has 55 μm^2). In addition, DCF is installed to reduce chromatic dispersion (CD), thereby inviting the third element.

To avoid over-compensating with the DCF and thus avoid 4WM potential, it is extremely important to measure the link's chromatic dispersion very precisely—prior to DCF installation. Then, just before commissioning, the total CD (including the DCF) must be measured and, again, this can only be done with an instrument that can test through EDFAs.

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Appnote122.1AN

Printed in Canada 04/10