DISPERSION AND 10 GIGABIT ETHERNET TRANSMISSION

027

TECHNICAL NOTE

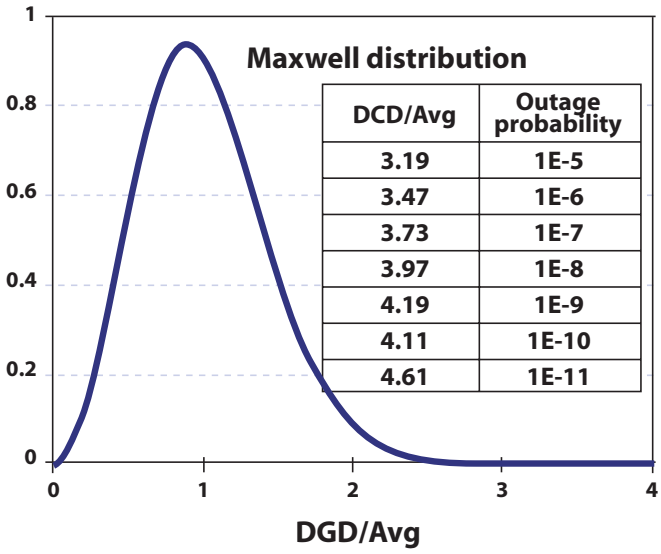
Francis Audet, Senior Product Manager, Optical NSP Business Unit

Dispersion does not affect all networks equally. In SONET/SDH DWDM systems using non-return-to-zero (NRZ) pulses, the threshold for chromatic dispersion (CD) at OC-192/STM-64 10 Gb/s is 1176 ps/nm. For G.652 fibers, with CD typically less than 19 ps/nm•km in the C band, this corresponds to around 60 to 80 km between regeneration or compensation sites.

For 10 Gigabit Ethernet (10GigE) transmission systems, however, as defined by the IEEE 802.3ae-2002 standard, tolerances for dispersion are much lower. There are two main reasons for this.

The first and most direct reason is that the forward error correction (FEC) applied to 10GigE is not as robust as the one generally applied to SONET/SDH transmission, which by default makes 10GigE less tolerant to dispersion.

The second reason has to do with the difference in acceptable outage probability for SONET/SDH and 10GigE, respectively. These constraints do not only affect CD tolerance, but PMD as well.



DCD/Avg	Outage probability
3.19	1E-5
3.47	1E-6
3.73	1E-7
3.97	1E-8
4.19	1E-9
4.11	1E-10
4.61	1E-11

For SONET/SDH transmission at 10 Gb/s, standard G.959-1 (Optical Transport Network Physical-Layer Interfaces) and system vendors have defined that the maximum differential group delay (DGD) for these networks is 30 ps, which leads to a generally accepted polarization mode dispersion (PMD) level of 10 ps. As DGD varies statistically according to Maxwellian distribution in most normal fibers, the average DGD (i.e., PMD) value must remain lower than 10 ps in order to obtain a DGD value of less than 30 ps, 99.999% of the time.

On the other hand, for 10GigE systems, the maximum DGD is 19 ps, and because 99.999% of the time is just not good enough for this type of transmission, this translates to an average **PMD** value of approximately **5 ps**. For 10GigE applications, it is crucial to attain "Seven 9s" reliability; in other words, the DGD level must be lower than 19 ps, 99.99999% of the time. So instead of a PMD value three times lower than the maximum DGD (like in SONET/SDH), the ratio is now 3.73.

Similarly, the maximum tolerance for **chromatic dispersion** is only **738 ps/nm**; i.e., significantly lower than for SONET/SDH.

Testing

It is also important to keep in mind that the central wavelength of these 10GigE signals may fall anywhere in the C band (1530 to 1565 nm), which means that the range over which chromatic dispersion can occur is wide. Consequently, it is dangerous to assume that the central wavelength of a component will remain the same. In fact, just because the central wavelength obtained with one particular transmitter on one particular day is 1550 nm, this may not be the case for a subsequent replacement transmitter.

In summary, for 10GigE applications, it is always more cautious to conduct dispersion testing – even on short-link networks.

EXFO Corporate Headquarters > 400 Godin Avenue, Quebec City (Quebec) G1M 2K2 CANADA | Tel.: 1 418 683-0211 | Fax: 1 418 683-2170 | info@EXFO.com

Toll-free: 1 800 663-3936 (USA and Canada) | www.EXFO.com

EXFO Montreal	2650 Marie-Curie	St-Laurent (Quebec) H4S 2C3 CANADA	Tel.: 1 514 856-2222	Fax: 1 514 856-2232
EXFO Toronto	160 Drumlin Circle	Concord (Ontario) L4K 3E5 CANADA	Tel.: 1 905 738-3741	Fax: 1 905 738-3712
EXFO America	3701 Plano Parkway, Suite 160	Plano, TX 75075 USA	Tel.: 1 800 663-3936	Fax: 1 972 836-0164
EXFO Europe	PARIS > Le Dynasteur, 10/12 rue Andras Beck	92366 Meudon la Forêt Cedex FRANCE	Tel.: +33.1.40.83.85.85	Fax: +33.1.40.83.04.42
	SOUTHAMPTON > Omega Enterprise Park, Electron Way	Chandlers Ford, Hampshire S053 4SE ENGLAND	Tel.: +44 2380 246810	Fax: +44 2380 246801
EXFO Asia	151 Chin Swee Road, #03-29 Manhattan House	SINGAPORE 169876	Tel.: +65 6333 8241	Fax: +65 6333 8242
EXFO China	No.88 Fuhua, First Road Central Tower, Room 801, Futian District	Shenzhen 518048, CHINA	Tel.: +86 (755) 8203 2300	Fax: +86 (755) 8203 2306
	Beijing New Century Hotel Office Tower, Room 1754-1755 No. 6 Southern Capital Gym Road	Beijing 100044 P. R. CHINA	Tel.: +86 (10) 6849 2738	Fax: +86 (10) 6849 2662

EXPERTISE REACHING OUT

Tnote027.1AN

ISO 9001 Printed in Canada 06/05