Frequently Asked Questions for DynaDelay™ Differential Group Delay Lines

1. Q: What are the main differences between the 10G and 40G dynamic differential group delay modules?

A: Actually, either product can be used for testing either 10G or 40G systems. The parameters that would determine which one should be used are DGD range and resolution. See the table below.

Parameters	DynaDelay	DynaDelay 40
DGD range	-45 to +45 ps	0 to 22.5 ps
DGD resolution	1.36 ps	0.36 ps
2nd order PMD	< 90 ps^2	< 30 ps^2
Transient DGD	1.36 ps max	0.35 ps max

2. Q: What is the principle of operation of the DynaDelay modules?

A: A DynaDelay module consists of an optical module and an electronic drive circuit. The optical unit consists of a set of birefringent crystals and polarization switches. The DGD values are adjusted by aligning the optical axes of the birefringent crystals in 64 different combinations. Each combination acts as a uniaxial birefringent crystal with a different optical path length, which corresponds to different DGD values. The DGD adjustment is achieved by activating polarization switches in the optical module. Users need only provide electronic control signals from a computer or a TTL circuit to control the device. For additional information, refer to L. S. Yan et al, "Fast Digitally Variable Differential Group Delay Module Using Polarization Switching", Post deadline Paper FA5-1, OFC 2002 .

3. Q: What kind of control signal does the DynaDelay require?

A: The DynaDelay can be controlled by a 6-bit parallel TTL signal, which can be generated by a personal computer connected via a parallel port or plug-in digital I/O port, or by any other electronic circuit that has TTL outputs. It can also be controlled by a PC through a standard serial port (RS-232) connection. LabView (version 6.0 and above) based control programs are provided.

4. Q: How can I use a DynaDelay module for 1st order PMD emulation?

A: General Photonics makes a first-order PMD emulator that uses a polarization controller and a DynaDelay module to emulate 1st order PMD effects in network fiber, using a Maxwellian distribution with an average value set by the user.

5. Q. PMD emulation and testing for 10Gb/s systems sometimes requires a DGD range of 0 to 100 ps. Is a longer range DGD module available?

A: Longer range DGD modules may be available. Contact General Photonics for details.

6. Q: Can DynaDelay modules be used for 2nd order PMD emulation?

A: Yes. Although a single DynaDelay module is useful primarily for first order PMD emulation, multiple DynaDelay units can be cascaded with polarization controllers for higher order PMD emulation. Details can be found in the following reference: OFC 2003, Paper MF6. General Photonics also offers an all-order PMD emulator (the PMDE-301) based on this principle.

7. Q: PMD emulation requires that minimal 2nd order PMD be generated at small DGD settings. Do your devices meet this requirement?

A: Yes. General Photonics has measured the first and second order PMD values for DynaDelay series DGD devices. The maximum second order PMD is on the order of 90 ps^2 for the 10G version. At small DGD settings, the second order PMD is negligible, as shown in Figure DGD-1.

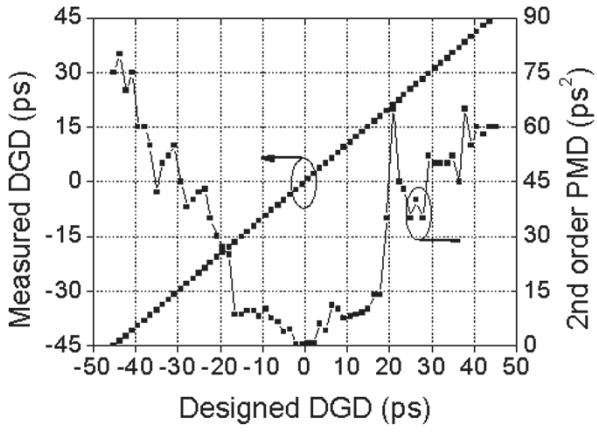

Figure DGD-1. Measured DGD and 2nd order PMD vs. set DGD..

8. Q: What advantages does DynaDelay have over other PMD emulators on the market?

A: First, it has very stable operation. The DGD value variation due to temperature changes from 0-80°C is on the order of

0.1 ps. Second, magneto-optic polarization switching is faster than switching methods using liquid crystals. DynaDelay also uses an all-electrical switching method that provides more reliable performance than emulators with mechanical beam splitting/ moving arm designs.

9. Q: What are the insertion loss and PDL of DynaDelay modules? What is the operating temperature range? How stable is the steady-state insertion loss?

A: DynaDelay modules have a typical insertion loss of about 1.3~1.5 dB without fiber connectors, as shown in Figure DGD-2.

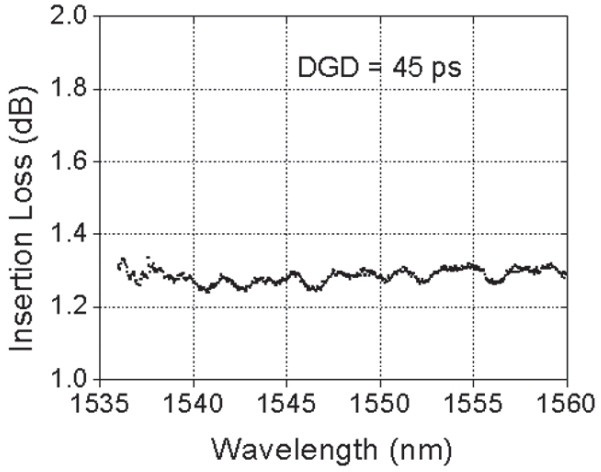

Figure DGD-2. Insertion loss vs. wavelength.

The worst-case PDL is < 0.35 dB, as shown in Figure DGD-3. The PDL averaged over all DGD states is less than 0.2 dB. The recommended operation temperature range is 0-50°C. At steady state, the insertion loss stays constant, although different steady states may have slightly different constant insertion losses due to PDL

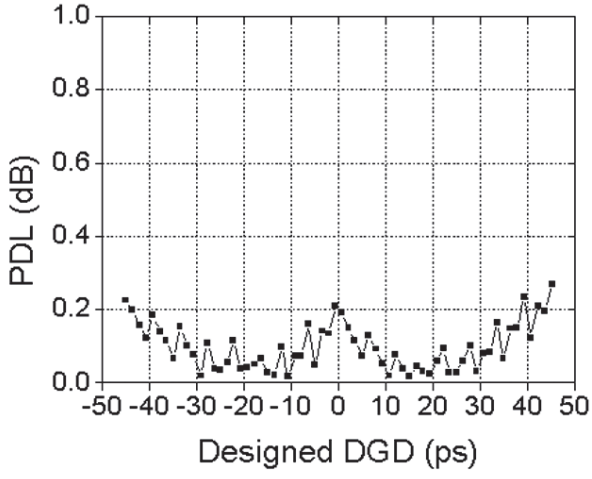

Figure DGD-3. PDL vs. DGD setting

10. Q: DynaDelay uses a dynamic switching mechanism. Can these devices operate properly near a magnetic field?

A: For stable operation, we recommend keeping these devices away from strong magnetic fields. If a magnetic field environment is unavoidable, please specify this when ordering. GP can modify the package design to provide better magnetic field shielding.

11. Q: How fast is the dynamic switching time?

A: The switching time is typically on the order of 500~1000 microseconds.

12. Q: Can DynaDelay modules be customized with different numbers of sections?

A: Our standard 10 Gb/s DynaDelay modules have 6 sections or less. For 40 Gb/s modules, 7 sections are standard. Customers can request DynaDelay devices with fewer sections than the standard models. Such devices can have either the standard DGD value range with fewer steps, or the standard resolution with a smaller total DGD value range.

13. Q: Are DynaDelay modules bi-directional?

A: No. These devices are designed for uni-directional operation in optical systems.

14. Q: What is the wavelength coverage of your device? What is the wavelength dependent loss?

A: DynaDelay modules are designed to cover long-haul communication wavelengths centered at 1550 nm. The wavelength tolerance is ±50 nm. Due to a small wavelength sensitivity in the polarization switches, the higher order PMD value will increase when the operation wavelength is close to the wavelength band edge

The insertion loss also has a small dependence on the optical wavelength, as shown in Figure DGD-2 in question 9 of this FAQ

15. Q: Does the PSP (principal state of polarization) of the DynaDelay module change during operation?

A: The PSP does not change. These modules can be modeled as uniaxial birefringent crystals (the index difference can be positive or negative) of fixed orientation and adjustable length.

16. Q: What is the optical power ratio between the fast and slow axes? Are they equal?

A: DynaDelay modules are designed for operation with arbitrary input polarization states. For system PMD compensation, input polarization states can be distributed all over the Poincaré sphere. Therefore, no precautions are taken to maintain certain power splitting ratios. The power split can be an arbitrary number. By user request, General Photonics can construct DynaDelay modules that force a 1:1 power splitting ratio. Please contact the General Photonics sales department for details.

17. Are there any sudden DGD value jumps between two adjacent DGD states?

A: Our tests showed no sudden jumps in DGD value between two adjacent DGD states, as shown in Figure DGD-4. Transient DGD values during switching are bounded by the initial and final states.

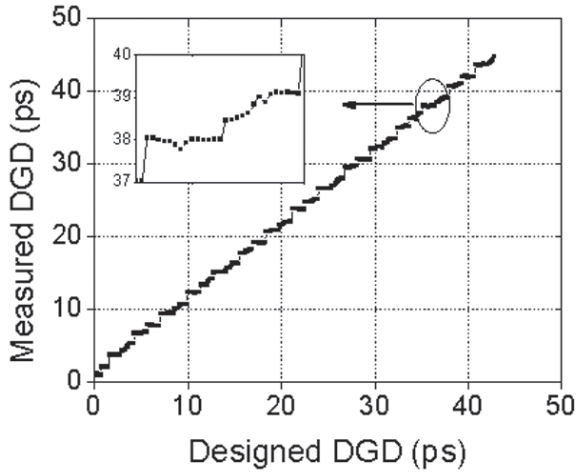

Figure DGD-4. Detailed DGD switching process and transient DGD value measurement results.