Photonic Systems Laboratory

Photonic Systems and Technologies – Lab 4
Optical fiber and propagation

Topics covered

- Influence of the fiber attenuation and dispersion on the data transmission

Laboratory simulations

1) Open the setup **Fiber1_01** The set up is used to measure fiber attenuation by the "cut back" method.

The power of the light from the CW source is measured by a power meter ***PowerMeter***. The output unit of the power meter is set to dBm.

The power at the output of the fiber is also measured. The difference (between the power at the fiber input and output) are calculated by the module ***Sub***. The measured quantities and their difference are displayed by a text visualizer module ***NumericalAnalyzer1D***.

Question 1: Run the simulation for the 1 km length of fiber. From the loss measurement calculate the attenuation of the fiber per km.

Question 2: In a real experiment, the power at the input of the fiber is generally not known as it is difficult to work out exactly how much light is coupled from the source to the fiber. As such you would need two measurements. What would they be ? Run the experiment and calculate again the attenuation of the fiber.

2) Open the setup **Fiber1_02**. In this model, we look at the effect of linear dispersion on the transmission of optical pulses.

A pulse generated by the module ***TxPulse*** is transmitted through a fiber. The pulse at the input and output of the fiber is displayed by a ***SignalAnalyzer*** *(Scope)* set to show the waveform. To see the chirp of the pulse, click in the menu on view, then on Control Panel and label Chirp.

Run the sweep ***Fiber Length.vsw*** in the Resources folder.

Question 3: Looking at the pulse waveform and the chirp, describe the pulse changes after propagation through the fiber. Conclude about the origin of pulse broadening.

Question 4: Alter the sign of the fiber dispersion parameter in the fiber module and rerun the simulation sweep. What is the difference now?

3) Open the setup **Fiber1_03**. In this lab, we use one channel transmission system to investigate the dependence of the bit error rate (BER) of the system on the characteristics of an optical fiber. We will see in a next lecture how to estimate BER, but here we use this value to quantify the quality of the transmission: a low BER means better transmission (less errors made)

The schematic consists of a transmitter ***TxExtModLase****r* (externally modulated laser), a fiber ***FiberNLS***, a receiver ***Rx_OOK***, clock recovery, BER estimator and ***SignalAnalyzers****.*

The estimated BER is displayed in the ***NumericalAnalyzer2D***. The eye diagrams can be displayed in the VPIphotonicsAnalyzer by clicking in the menu on the “Turn on Eye” button (previously, they should be activated by setting the parameter SignalAnalyzer Active = ON).

We will just investigate here the dependence of BER on fiber dispersion: we neglect the effects of attenuation and nonlinearities.

FiberNLS ***Attenuation*** = 0 dB/m
FiberNLS ***Dispersion*** = 16e-6 s/m2
FiberNLS ***DispersionSlope*** = 0.08e3 s/m3
FiberNLS ***NonLinearIndex*** = 0 m2/W

Modify the sweep to vary the fiber length between 50 and 1400 km in steps of 50 km. Plot the BER vs fiber length for transmission rates of 2.5 Gbit/s and 10 Gbit/s.

Question 5: What is the maximum length to guarantee a BER < 10e-9 transmission in these 2 cases ? Explain the difference.