Photonic Systems Laboratory

Photonic Systems and Technologies – Lab 2
Introduction to Optical Transmitter

1. Topics covered

- Optical spectrum and time evolution of a continuous wave Fabry-Perot (FP) laser
- Distributed feedback (DFB) laser: optical spectrum and direct modulation

2. Laboratory simulations

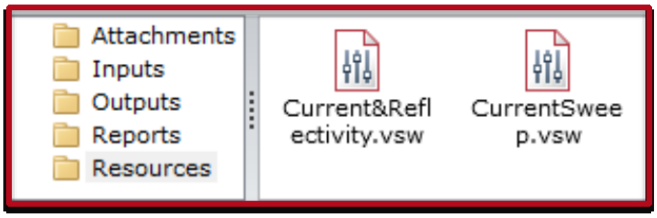
2.1. Part 1 – Fabry-Perot laser

a. Open setup Tx1_02. For this study, the laser module has been configured to model a bulk FP laser. The reflectivity of the facet (***InterfaceReflectionCoefficient***) is set to 0.32 and the laser is driven by DC current provided by DCSource. Run the program.

Question 1: Describe the optical spectrum of the FP laser output

Question 2: Measure the longitudinal mode separation ($\delta\nu$) and calculate the laser cavity length (L) based on this value, knowing that the group refractive index of the laser material is 3.7. Check if your result approximates to the value set at the parameter ***DeviceSectionLength*** given for the laser module.

b. Open setup Tx1_03. In this example we look at the relationship between optical output power and drive current. The output power is measured by the *FreqPowerMeter* module. The drive current is swept and the *NumericalAnalyzer2D* plots optical power versus laser diode drive current. Run the simulation by double clicking the ***CurrentSweep.vsw*** in the resources folder (performs the sweep for you)



Question 3: Describe the behavior of the laser.

Question 4: Estimate the external differential quantum efficiency η_{edqe} from the graph.

c. Change the parameter ***InterfaceReflectionCoefficient*** of the laser to 0.5 and then to 0.2. Run each time the simulations and note the threshold current.

Question 5: What is the relationship between the threshold current and facet reflectivity ? Why?

Question 6: What is the relationship between the external differential quantum efficiency and facet reflectivity? Why?

d. Open setup Tx1_05 in order to investigate the relationship between the resonant frequency and drive current of the laser. Change the time window to 64 bits in order to have a longer simulation time. Run the ***CurrentSweep.vsw***: the waveform output at the different current and the power versus current are displayed.

Question 7: Estimate the resonant frequency f_0 at the different drive currents I_b above threshold (I_{th}). Yyou can use vertical markers in the time trace to help you. Plot f_0^2 versus (I_b/I_{th} -1). Is this the behavior you would expect?

2.2. Part 2 – distributed feedback laser

Open setup Tx1_08. The FP laser has been modified by adding a distributed feedback section (a grating in the cavity). The program also includes direct modulation: the electrical NRZ signal provided by the *PRBS* and *Coder_NRZ* is injected into the DFB through the module *LaserDriver*. This electrical NRZ signal is turned into an optical NRZ at the laser output by direct modulation.

e. First turn off the data modulation by changing the ***PRBS_Type*** to **One** and run the program. Change the resolution of the optical spectrum analyzer to 0.01 nm: ***Control Panel/Frequency Resolution/Resolution Bandwidth***.

Question 8: How many longitudinal modes do you see?

f. Turn the PRBS back on and run the program

Question 9: What can you say about the modulated power spectrum?

g. Change the extinction ratio of the data signal by changing LaserDriver-DriveAmplitude (take several values) and look at the chirp for these cases. Note the presence of transient and adiabatic – i.e. long term difference between 1 and 0 level– chirp?

Question 10: Describe how the chirp change with extinction ratio. Can you think of an explanation? (going back to the reason why directly modulated lasers exhibit chirp …)