ONS Problem Set 2

Wednesday, November 15, 2017

Problem 1: Optical transceiver

a) What is an optical transceiver? What are the main components?

b) There are three fundamental processes found in semiconductor devices which are utilized in optical transceivers. Describe these processes and their applications.

c) What is RIN? Mention two ways to overcome the impact of RIN in data transmission.

Problem 2: Optical receiver

a) What is shot noise?

b) Assume an ideal receiver. Given an average number of photons $\langle N_e \rangle$ for a received logical one, what is the required $\langle N_e \rangle$ for misinterpreting, with a probability of only 10^{-9}, a nominally logical one as a logical zero? (Hint: Use the Poisson distribution for the probability to find zero photons, if an average of $\langle N_e \rangle$ photons is received). What would be the required power at the receiver for 10 Gbit/s at a carrier wavelength of 1.55 µm?

c) Most often, photodetector outputs are further amplified by electrical amplification stages. Depict a high-impedance amplifier (HIA) setup. What is the main benefit of this amplifier setup? Given a load resistance R_L = 10 kΩ and total capacitance of 1.6 pF (photodiode capacitance plus input capacitance of the amplifier), what is the 3 dB bandwidth of the HIA setup?

d) Depict a transimpedance amplifier (TIA) setup. What is the main benefit of this amplifier setup? Given an open loop gain G = 100, load resistance R_F = 10 kΩ and total capacitance of 1.6 pF (photodiode capacitance plus input capacitance of the amplifier), what is the 3 dB bandwidth of the TIA setup?

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