Receiver Sensitivity

Solution

Calculations:

First calculate the thermal noise using the formula

$$\sigma_T^2 = (4k_B T / R_L) F_n B$$

Boltzmann's constant $k_B = 1.38 \times 10^{-23}$ J/ºK. The temperature T, receiver load resistance R_L and the receiver bandwidth B are all given in the proper units. The receiver noise factor must be converted from 3 dB to a unitless quantity, i.e.,

$$3 = 10\log_{10}(F_n)$$
$$F_n = 10^{3/10} = 2$$

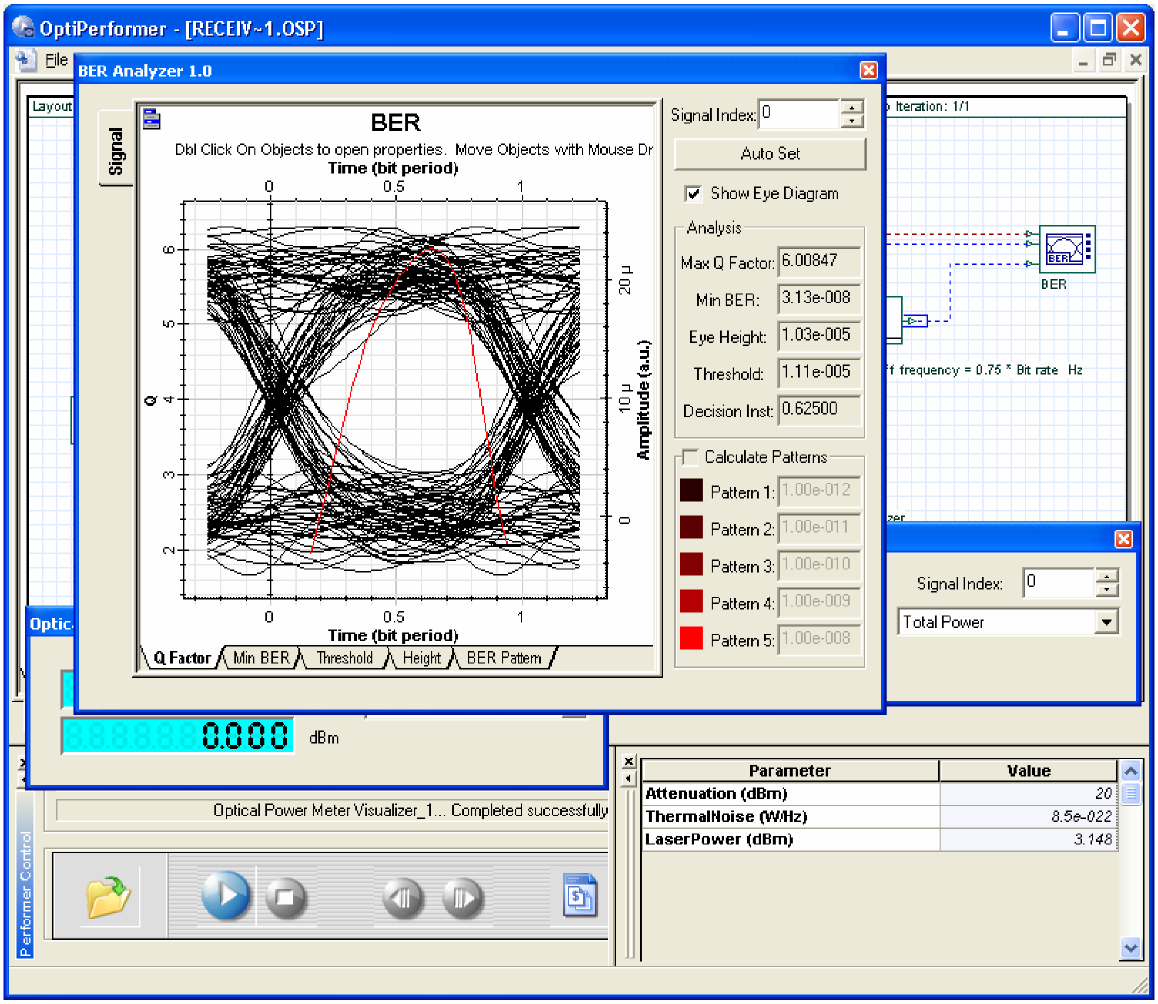
Now the thermal noise can be calculated and the result is $\sigma_T^2 = 6.075 \times 10^{-13}\ A^2$ or $\sigma_T = 7.79 \times 10^{-7}\ A$.

Given that the charge of an electron $q = 1.6 \times 10^{-19}$ C, we can use the formula

$$S = \frac{Q}{R}(qQB + \sigma_T)$$

to calculate the receiver sensitivity. The result is $S = 4.69 \times 10^{-6}$ W or 4.69 µW or -23.3 dBm.

The thermal noise value is entered as the parameter "ThermalNoise" in A^2/Hz. This parameter is used by PIN photodiode component. Thus we must factor out the bandwidth in the formula for σ_T^2 to obtain a value of 3.24×10^{-22} A^2/Hz.



Conclusions:

In this case, for a thermal noise parameter 8.5 x 10^{-22} A^2/Hz, the receiver sensitivity is discovered to be -20 dBm. The measured Q factor is 6.008, is very close to the target value.