CHALMERS – Space, Earth and Environment

RRY100 – Satellite Communications 2024

Homework 5

Deadline 2024-10-18, 07:59

An antenna of 15 m diameter is used to receive transmission from an 11 GHz satellite with an elevation angle of 5^{o}. When the antenna is pointed at zenith, the measured noise temperature at the feed output flange is 65 K. The aperture efficiency of the antenna is $\eta = 0.6$.

Questions:

1. Assume that the noise temperature contribution from the antenna sidelobes is constant at all angles. Estimate the antenna noise temperature at an elevation angle of 5^{o}. (Hint: Use Figure **??** to find the sky noise temperature at zenith and calculate its contribution to the antenna noise temperature. Hence find the sidelobe contribution.)

2. Heavy rain in the antenna beam increases the sky noise temperature to 190 K at 5^{o} elevation angle. Find the antenna noise temperature under these conditions.

3. A LNA (low noise amplifier) with a noise temperature of 175 K is connected to the antenna by a waveguide with a loss of 0.9 dB and a physical temperature of 290 K. Calculate the system noise temperature:
   (a) under clear-sky conditions
   (b) under heavy rain conditions as described above (see question 2.)

4. Find the earth station G/T in clear sky conditions.

5. Imagine now that you want to send uncoded binary data with a data rate of $R_b = 34$ Mbit/s over an available channel with bandwidth 26 MHz. A Nyqvist filtering with roll-off factor $\beta = 0.5$ shall be used.
   (a) Which M-PSK modulation is most suitable for this purpose, BPSK, QPSK or 8PSK?
   (b) What carrier-to-noise ratio C/N is required if we want to achieve a BER $= 10^{-6}$? (Hint: Use Figure 2 to derive the required E_b/N_0.)

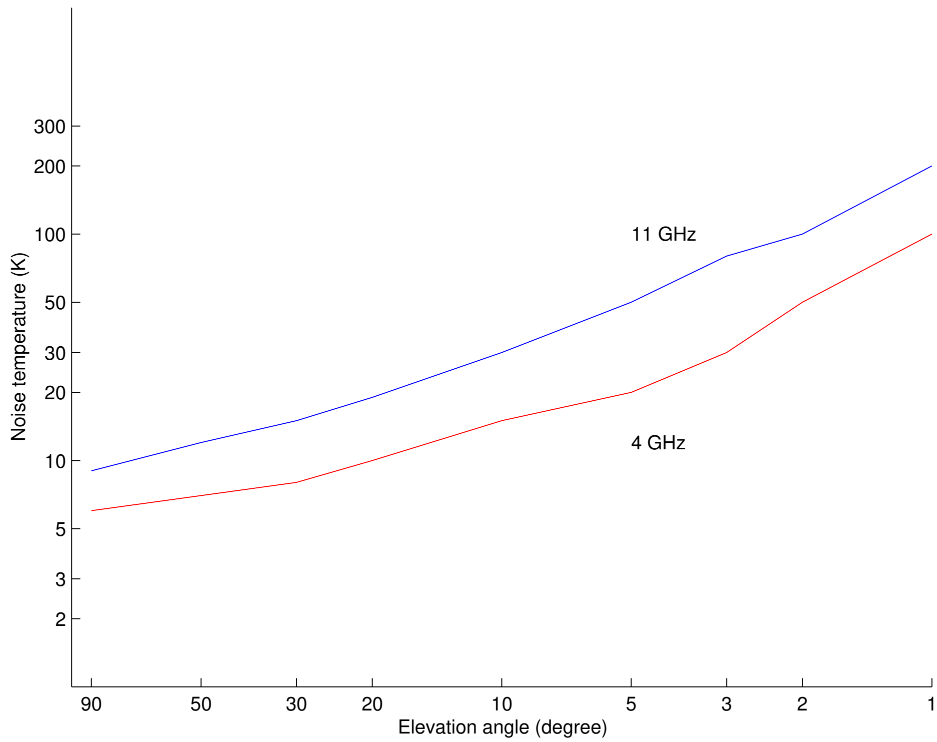

Figure 1: Sky noise temperature as a function of elevation angle at 4 GHz and 11 GHz. Clear-sky conditions.

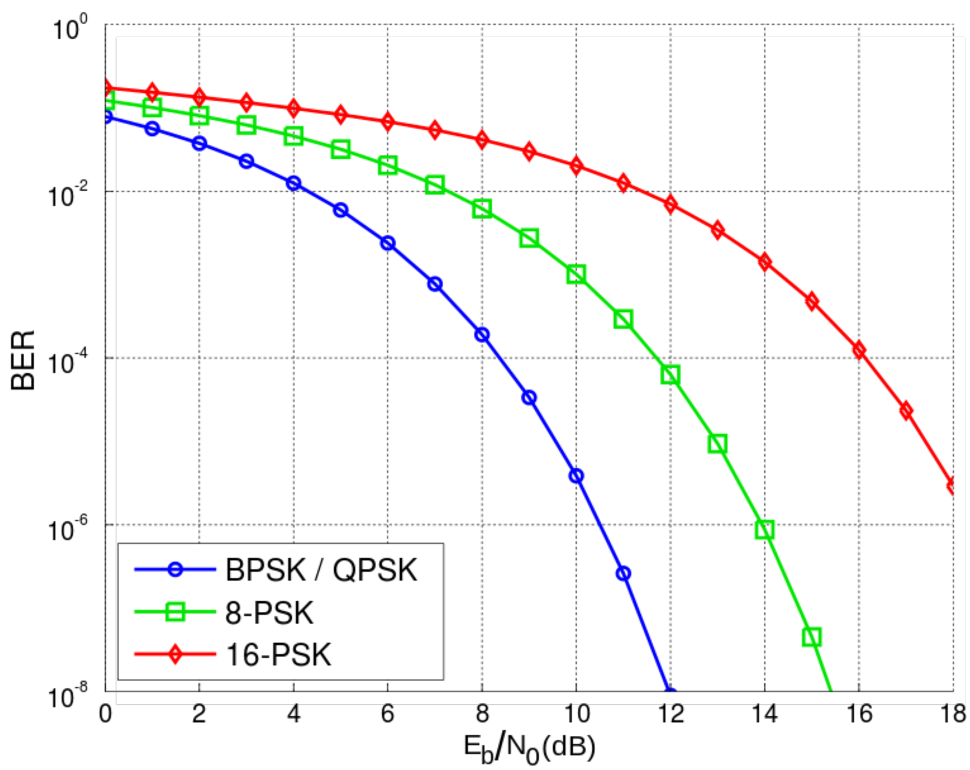

Figure 2: Relation between BER and E_b/N_0 for different M-PSK modulations.