

1 Theory, assumed state of knowledge

Lecture (CE II/Script): Chapters 2, 3; especially section 3.5: error probabilities, error rates

2 What is shown?

This demonstration is concerned with error probabilities and their measurement with the help of simulations. Whereas *error probabilities* can be defined theoretically, the *error rate* is measured by simulations or measurements. The more errors are counted, the more the error rate approaches the bit error probability. Errors in this context can be either bit errors or symbol errors.

To study this topic, there are simulations of transmissions with different modulation methods. Currently the following are available:

- 2 PSK (BPSK), 4 PSK (QPSK), 8 PSK
- 4 ASK, 16 QAM
- 4 FSK, incoherent reception

The number of transmitted bits can be varied, and the quality of the measurement can be judged by the scattering of measured error rate values around the corresponding error probability value. The transmission channel is an AWGN channel. The diagrams in the plotbox show bit error probabilities P_b as curves over E_b/N_0 (i.e. theoretical curves). N_0 is here the TWO-SIDED power density spectrum of the WNG. Measured bit error rates are red points within these diagrams.

The two theoretical curves for BPSK and QPSK are – because they are plotted over E_b/N_0 – identical. The same is true for 4 ASK and 16 QAM. While these curves and the curve from incoherent 4 FSK are exact, the curve for 8 PSK can only be found through numerical integration over the amplitude probability density function before the decision. For 8 PSK a quite good approximation is used here, which is valid for Gray-Coding. See also gui button “theoretical”. The theoretical curves are plotted each time a new demonstration is started.

3 What is demonstrated?

The intent of this demonstration is to contrast the measured error rates and the theoretical error probabilities, and to make clear the “rule of thumb”, which says, that an error rate measurement in practice is just adequate, when more than 100 absolute errors have been counted. Therefore, with 100 bit errors and a bit error probability of 0.01 one would expect good results if the number of transmitted bits is more than 10000. An additional intention of this demo is to deepen the understanding and handling of error probability curves.