1 Theory, assumed state of knowledge

Lecture (CE II/Script): Chaper 3; especially section 3.3.5: Characteristics of some modulation methods

2 What is shown?

The demonstration is concerned with the *raised cosine* basic waveform, which is used very often for digital transmission. There is a parameter in the definition which is called the *rolloff factor* α. Therefore the raised cosine waveform is really a class of basic waveforms.

All basic waveforms $e(t)$ from this class fulfill the first *Nyquist criterion*. It says, that the ACF of $e(t)$ for arguments kT_S for $|k| = 1, 2, ...$ is zero. For $k = 0$ the result is always the energy. For that reason there will be no *intersymbol interference* (ISI) at the receiving side after the matched filter at sample points kT_S, provided that the channel is free of distortion.

The rolloff factor α can be variied between 0 and 1. For $\alpha = 0$ the *si function* (or *sinc function*) results and for $\alpha = 0$ a waveform with a spectrum which is a cos shape between -90 and +90 degree. The rolloff factor is used to match real conditions in practical applications: The si function, which goes from -infintity to +infinity in time, can be approximated only very roughly in pactice, and the first Nyquist criterion cannot be fulfilled. The rolloff factor $\alpha = 1$ has the disadvantage that the bandwidth which is needed on the transmission channel is doubled compared with $\alpha = 0$. The advantage for $\alpha = 1$ is that there is no problem to fulfill the first Nyquist-Criterion in practice. In practice a common compromise is to have α not less than 0.2.

The ACF is important for the first Nyquist criterion. In frequency domain the ACF corresponds to the magnitude squared of $E(f)$ which is the *energy density spectrum* of $e(t)$. The energy density spectrum for $\alpha = 1$ was used to give this waveform class it's name: Because $E(f)$ is identical with half of the period of a cosine, the square is a full cosine period, which is *raised* in a way, that it begins and ends with 0.

3 What is demonstrated?

The intention of this demo is to look a bit closer to the raised cosine waveform, which is commonly used as basic waveform in real digital transmission systems. It should become clear what the meaning of the rolloff factor is, and what influence it has on the bandwidth needed on the transmission channel. Additionally the knowledge of the relations between signals, autocorrelation functions, spectra and energy density spectra should be deepened.