1 Theory, assumed state of knowledge

Lecture (CE II/Script): Chaper 2; especially sections 2.3: Binary transmission

2 What is shown?

An antipodal transmission is used as a basis for this demo. Two basic waveforms can be used alternatively:

$$\text{a)}\ e(t) = rect(\frac{t}{Ts})$$

$$\text{b)}\ e(t) = \sum_{i=1}^{7} c(i) rect(\frac{t - iT}{T}); \qquad T = \frac{T_S}{7}, \qquad c(i) \in \{-1, 1\}$$

The sequence of 7 weighting factors $c(i)$ for the second waveform is called *Barker code* (of length 7). The ACF of this waveform has – if not looking at the *sidelobes* with values -1 – a width of two times the duration of the short rect impulse (i.e. $2T$). The binary symbols to be transmitted are generated by a random generator, but only blocks of 5 bits are transmitted with zeros between the blocks. Therefore the transmit signal $s(t)$ consists of blocks with $e(t)$, each weighted randomly with $+1/-1$ values. Between the blocks a zero-signal is sent.

The eye pattern (or eye diagram) is a plot of all possible shapes of the matched filter (MF) output signal $y(t)$ in the receiver, usually plotted in a $2T_S$ interval with the sampling instant in the center. Here, the synchronization is such that – after pushing the gui button "Eye on" – 5 eyes occur, with only the three in the middle being real eyes which resulted for a continuous transmission (without zero signals between the bocks).

Additionally it is possible to show a block diagram model of the transmission with the transmit signal $s(t)$ and the MF output signal $y(t)$. A further trial shows $y(t)$ or the eyes for a basic waveform which does not fulfill the first Nyquist criterium. This example was discussed in the lecture.

Noise will be added to the signal at the input of the receiver if the demoplayer button "Noise" is pushed. The SNR can be set with the button "SNR | Eb/N0" (left/right mouse button – increase/decrease). In this case bit errors will be counted if they occur, and the resulting bit error rate will be displayed.

3 What is demonstrated?

The intention of his demo is to get familar with the eye pattern, which is used in simulations and real measurements in practice to see how far the first Nyquist criterium is fulfilled or not. Interymbol interference can be seen clearly. Additionally it can be demonstrated how the eye closes if noise is added. The cumulative setting ("Eye on") shows that – after waiting long enough – the eye will close in any case for the gaussian amplitude distribution of the noise. This means that for gaussian noise the error probabilities can be arbitrary small, but never be exactly zero.