Übung 2

Problem 1: Signal to Noise Ratio *4 points*

A binary signal is sent via a 3 kHz wide channel with a signal to noise ratio of 20 dB. Calculate the maximum data rate.

$$C_s = B \cdot ld\left(1 + SNR\right) \quad // \text{ Shannon}$$

C_s - max. data rate

B - bandwith

SNR - signal power / noise power

$SNR_{dB} \rightarrow SNR$:

$$SNR_{dB} = 10 \cdot \log_{10}(SNR)$$

$$20\,dB = 10 \cdot \log_{10}(SNR)$$

$$2\,dB = \log_{10}(SNR) \quad \rightarrow \quad SNR = 100$$

$$C_s = 3000\,Hz \cdot ld(101) \cdot bit$$

$$= 19974,63\ bit/s$$

$$= 20\ kbit/s$$

Problem 2: Maximum Data Rate

4 points

A quaternary signal is sent via a 20 MHz wide channel. The medium experiences interference. We measure a signal to noise ratio of 30 dB. Calculate the maximum data rate that can be achieved over this channel.

$SNR_{dB} = 30\ dB \rightarrow SNR = 1000$

for binary signal

$C_S = 20\ MHz \cdot ld(1001) \cdot bit$ // Shannon

$= 199,3\ Mbit/s$

Because we have a quarternary signal, instead of a binary signal, the max. data rate has to be multiplied by the factor 2.

$\Rightarrow C_S = 398,7\ Mbit/s$

Problem 3: Noiseless channel

4 points

Specify the maximum data rate that can be achieved over a noiseless 4 kHz wide channel.

$C_S = 2 \cdot B \cdot \log_2(n)$ // Nyquist

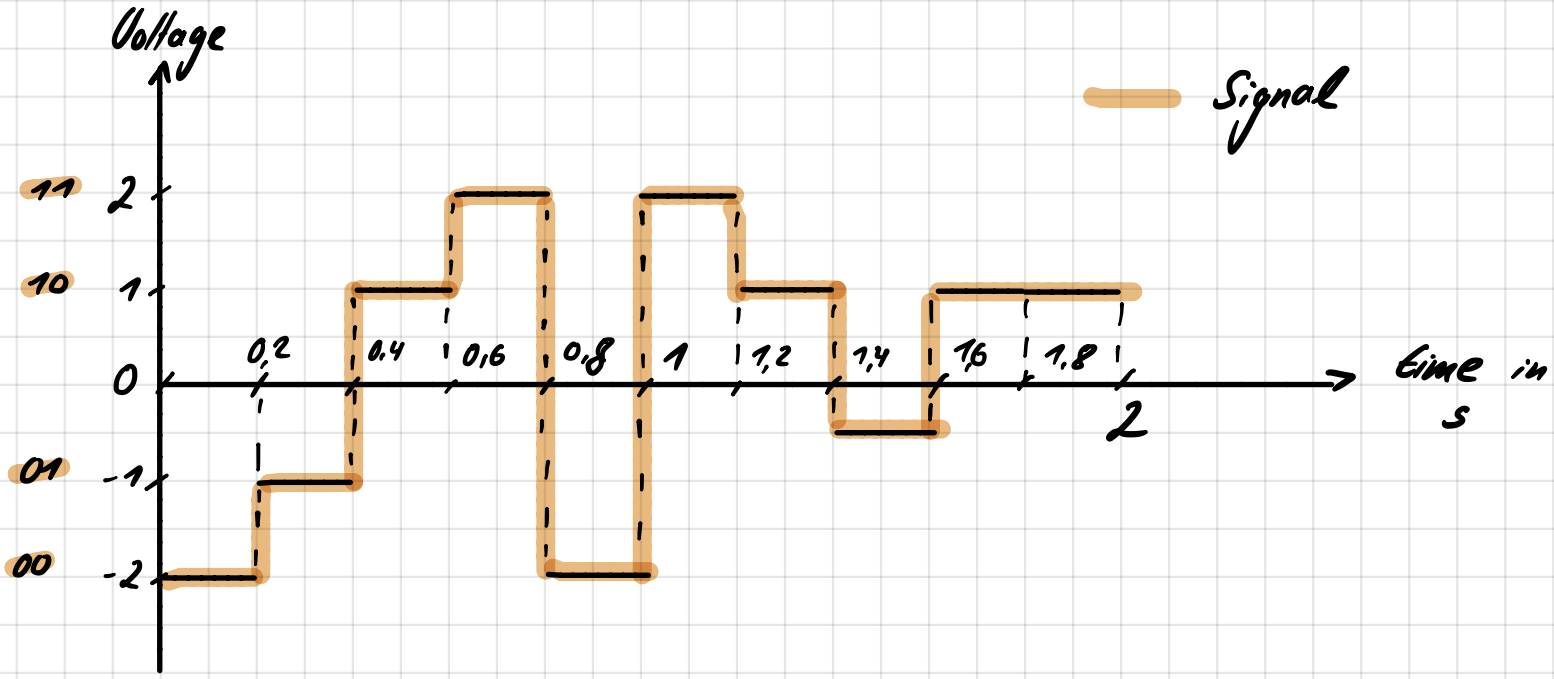
$C_S = 2 \cdot 4000\ Hz \cdot ld(2) \cdot bit$

$= 8000\ bps = 8\ kbit/s$

Problem 4: Multilevel Signals

3 points

Represent the following sequence of bits as a quaternary signal with a baud rate of 5/s in a time-voltage-diagram: 00011011001110011010. Determine the bitrate.



Problem 5: Units

2 points

What is the difference between 1 kb, 1 kB, and 1 KiB?

kb : kilobit , 1 kilobit is always equal to 1000 bit

kB : is ambiguous, could mean a) 1 kB = 1000 byte

b) 1 kB = 1024 byte

kiB : was introduced to erase the ambiguity of kB.

The kibibyte emphasize the use of the binary base

2 1 kiB = 1024 byte

Problem 6: Base- and Broadband *3 points*

Explain the term baseband and broadband. Why do we need broadband communication? Explain how broadband communication of baseband signals is achieved. Give example application scenarios.

Baseband

=> information is transmitted as a digital signal over the medium.

Therefor encoding procedures are necessary, to define the represenTation of high (1) and low (0)

Broadband

=> information is transmitted as a analogous signal over the medium.

The use of different frequencies allows to transfer multiple signals at the same time.

Baseband signals on Broadband communication & e.g.

The baseband signal is modulated onto a carrier signal, which has a specific frequency.

Because one baseband signal doesn't use the whole frequency range of the broadband, many baseband signals can be transfered by using different frequency carrier signals.

A good example are radio networks, which use a specific frequency, which you can tune your radio to, so that the signal can be processed by the radio.