ASSIGNMENT COVER SHEET

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Question	Max [%]	Mark [%]
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b	5	
c	5	
d	5	
Receiver	/40	
e	10	
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g	20	
Equaliser	/40	
h	20	
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1 Transmitter and pulse shaping

1.1 Real World Feasibility

1.1.1 Binary Polar Signalling

Binary polar signalling is a very robust signalling method as is has a much higher noise tolerance. However, it has a much lower throughput compared to other options such as 4-PAM and 8-PAM. The noise tolerance makes binary polar signalling suitable for wireless communications as this environment can have much more noise over a much further distance.

1.1.2 4-PAM

4-PAM is also a reasonably robust signalling method as there is still some noise tolerance as the different levels are reasonably well defined. This signaling method also allows double the data rate when compared to binary polar signalling. These properties make this method well suited to wired communication as noise is less noticeable in the signal as the medium can be controlled.

1.1.3 8-PAM

8-PAM however, has comparatively poor noise performance, which could require significant error correction with large overhead which could negate the improved throughput compared to other methods.

1.1.4 Recommedation

Overall, I would recommend using 4-PAM as it has a strong balance between data through put and noise tolerance. As 8-PAM has only 50% more throughput but half the separation between signals of 4-PAM. Overall the double throughput of 4-PAM to binary signalling is worth the decreased noise resilience.

1.2 Power Spectral Density of 4-PAM (Rectangular Pulse Shaping)

With a rectangular pulse shaping the PSD of a 4-PAM signal is shown in (8) and the values for S_x and R_n can be found in (5) and (3, 1) respectively.

$$R_n = \lim_{N\to\infty} \frac{1}{N} \sum_k a_k a_{k-n} \tag{1}$$

Assuming that the data is random:

$$P_{a_k} = \begin{cases} \frac{1}{4} & a_k = 3 \\ \frac{1}{4} & a_k = 1 \\ \frac{1}{4} & a_k = -1 \\ \frac{1}{4} & a_k = -3 \end{cases} \qquad \text{Therefore,} \quad R_n = 0 \tag{2}$$

As in the previous equation the probabilities are equal for all a_k,

$$R_0 = \lim_{N\to\infty} \frac{1}{N} \sum_k {a_k}^2 \quad \text{With,} \quad P_{{a_k}^2} = \begin{cases} \frac{1}{2} & a_k^2 = 9 \\ \frac{1}{2} & a_k^2 = 1 \end{cases} \tag{3}$$

Therefore,

$$R_0 = 5 \tag{4}$$

$$S_x(f) = \frac{1}{T_s}[R_0 + 2\sum_{n=1}^{\infty} R_n \cos 2\pi n f T_s] \tag{5}$$

As,

$$T_b = \frac{1}{R_b} \quad \text{Therefore with a bitrate of 1Mbps,} \quad T_b = \frac{1}{1 \times 10^6} \tag{6}$$

As 4-PAM has two bits per pulse $T_s = 2T_b$ so $T_s = 2\mu s$ Therefore,

$$S_x(f) = \frac{1}{T_s}[5 + 0] \quad \text{For } T_s = 2\mu\text{s} \quad S_x = 2500000 \tag{7}$$

The equation for PSD is,

$$S_y(f) = \left|\frac{T_s}{2}\text{sinc}(\frac{f\pi T_s}{2})\right|^2 S_x(f) \tag{8}$$

So,

$$S_y(f) = \left|\frac{T_s}{2}\text{sinc}(\frac{f\pi T_s}{2})\right|^2 (2500000) \tag{9}$$

This results in the following PSD,

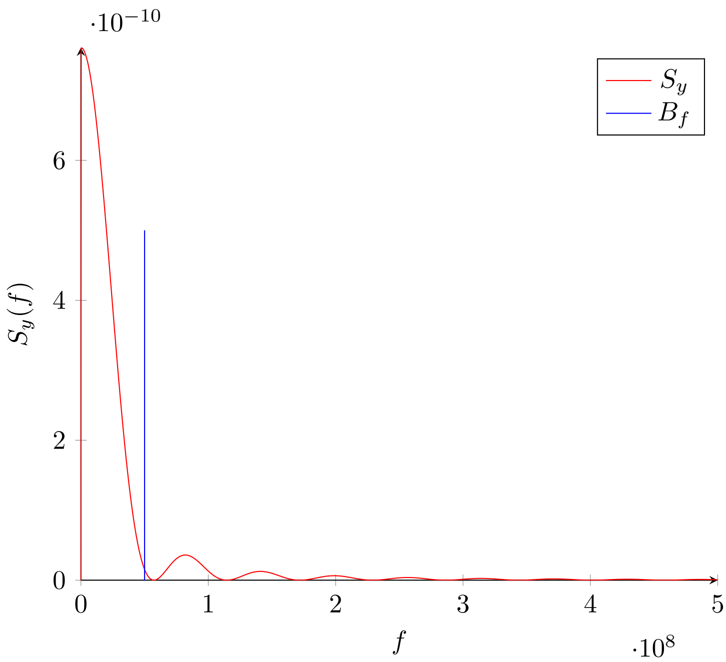

Figure 1: PSD of a 4-PAM Signal with rectangular pulse shaping

1.3 Power Spectral Density of 4-PAM (Nyquist Pulse Shaping)

2 Receiver

3 Equaliser