PES UNIVERSITY ONLINE

DIGITAL COMMUNICATION

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POWER SPECTRA OF PAM

Polar NRZ

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POWER SPECTRUM

Polar NRZ

- Let b_k be the k^{th} bit. We assume that bits 0 and 1 occur with equal probability
- Further, assume that the sequence of bits are independent
- We need to calculate the autocorrelation function $R_A(n)$

- Observe that $R_A(n) = \mathbb{E}(A_k A_{k-n})$
- It is easy to see that $\mathbb{E}(A_k) = -a \times {}^1/_2 + a \times {}^1/_2 = 0$
- Now, it can be seen that $R_A(0) = \mathbb{E}\left(A_k^2\right) = a^2 \times {}^1/_2 + a^2 \times {}^1/_2 = a^2$
- Also, for any general n, $R_A(n) = \mathbb{E}(A_k A_{k-n}) = \mathbb{E}(A_k)\mathbb{E}(A_{k-n}) = 0$
- Combining the above results, we get

$$R_A(n) = a^2 \delta(n)$$

POWER SPECTRUM

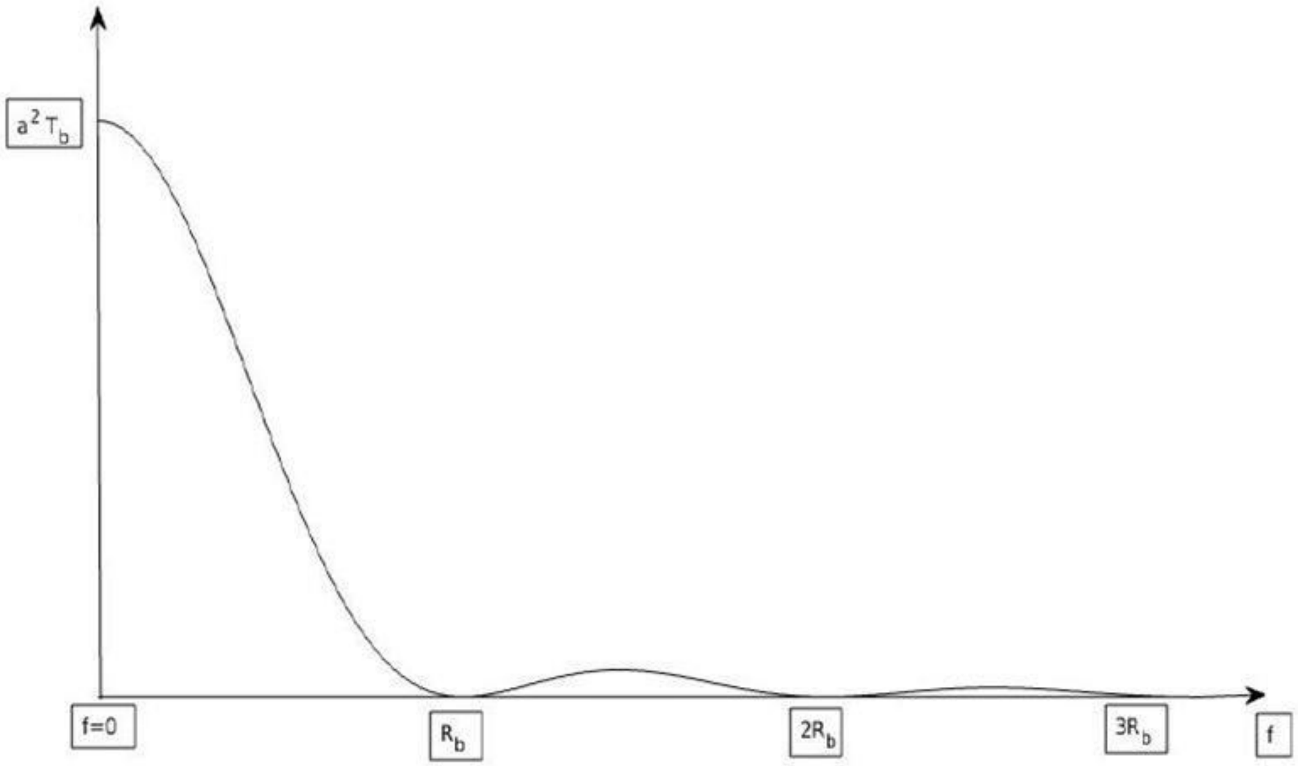
Polar NRZ

- Substituting in the formula for $S_X(f)$

$$S_X(f) = \frac{T_b{}^2 sinc^2(fT_b)}{T_b} \sum_{n=-\infty}^{\infty} a^2 \delta(n) e^{-j2\pi fnT_b}$$

$$= T_b sinc^2(fT_b) \sum_{n=-\infty}^{\infty} a^2 \delta(n) e^{-j2\pi fnT_b}$$

$$\boxed{\therefore S_X(f) = a^2 T_b sinc^2(fT_b)}$$

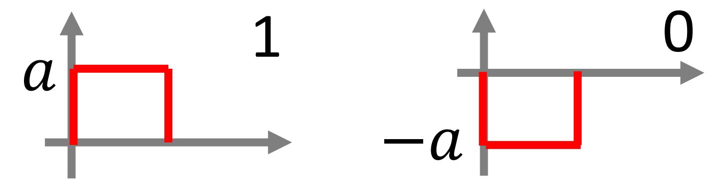


- Observe that there is no DC content
- The BW of polar NRZ is also $R_b = {}^1/_{T_b}$

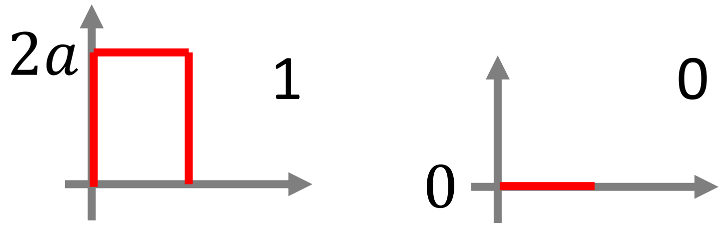
POWER SPECTRUM

Polar NRZ Vs. Unipolar NRZ

- Note that in polar NRZ, the energy per bit (whether 0 or 1) is $E_b = a^2 T_b$



- Average power in polar NRZ, $P = {}^{E_b}/_{T_b} = a^2$
- To achieve the same error performance (that is, same gap between represented values for bits 0 and 1), we need the following signals for unipolar NRZ



- Average power in unipolar NRZ

$$P = {}^{1}/_{2} \times {}^{4a^2T_b}/_{T_b} + {}^{1}/_{2} \times {}^{0}/_{T_b} = 2a^2$$

- Unipolar NRZ needs twice the power. The reason is the presence of DC component

THANK YOU

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