DIGITAL COMMUNICATION

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POWER SPECTRA OF PAM

Bipolar NRZ

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POWER SPECTRUM
Bipolar NRZ

- Let b_k be the k^{th} bit. We assume that bits 0 and 1 occur with equal probability
- Given the alternating pattern of bipolar NRZ, the sequence is not independent
- We need to calculate the autocorrelation function $R_A(n)$ in a different way

To find $R_A(0)$:

b_k	A_k	P_r
0	0	1/2
1	a	1/4
	-a	1/4

$$\therefore R_A(0) = E[A_k{}^2] = 0^2\tfrac{1}{2} + a^2\tfrac{1}{4} + (-a)^2.\tfrac{1}{4} = \tfrac{a^2}{2}$$

To find $R_A(1)$:

b_k	b_{k-1}	A_k	A_{k-1}	P_r	$A_k A_{k-1}$
0	0	0	0	1/4	0
0	1	0	a -a	1/4	0
1	0	a -a	0	1/4	0
1	1	a	-a	1/8	$-a^2$
		-a	a	1/8	a^2

$$\therefore R_A(1) = E[A_k.A_{k-1}] = \tfrac{1}{4}(0+0+0)\tfrac{1}{8}(-a^2 - a^2) = \tfrac{-a^2}{4}$$

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To find $R_A(2)$:

b_k	b_{k-2}	A_k	A_{k-2}	P_r	$A_k A_{k-2}$
0	0	0	0	1/4	0
0	1	0	a	1/4	0
			-a		
1	0	a	0	1/4	0
		-a			
1	1	a	a	1/16	a^2
		a	-a	1/16	$-a^2$
		-a	a	1/16	$-a^2$
		-a	-a	1/16	a^2

$$\therefore R_A(2) = E[A_k . A_{k-2}] = \tfrac{1}{4}(0+0+0) + \tfrac{1}{16}(a^2 - a^2 - a^2 + a^2) = 0$$

$$\therefore R_A(n) = \begin{cases} \frac{a^2}{2} & n = 0 \\ \frac{-a^2}{4} & n = \pm 1 \\ 0 & Elsewhere \end{cases}$$

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

$$S_X(f) = T_b sinc^2(fT_b)\left[\frac{a^2}{2} + \left(\frac{-a^2}{4}\right)\left\{e^{j2\pi fnT_b} + e^{-j2\pi fnT_b}\right\}\right]$$

$$= \frac{a^2 T_b}{2} sinc^2(fT_b)[1 - cos2\pi fT_b] = \frac{a^2 T_b}{2} sinc^2(fT_b).2sin^2\pi fT_b$$

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

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

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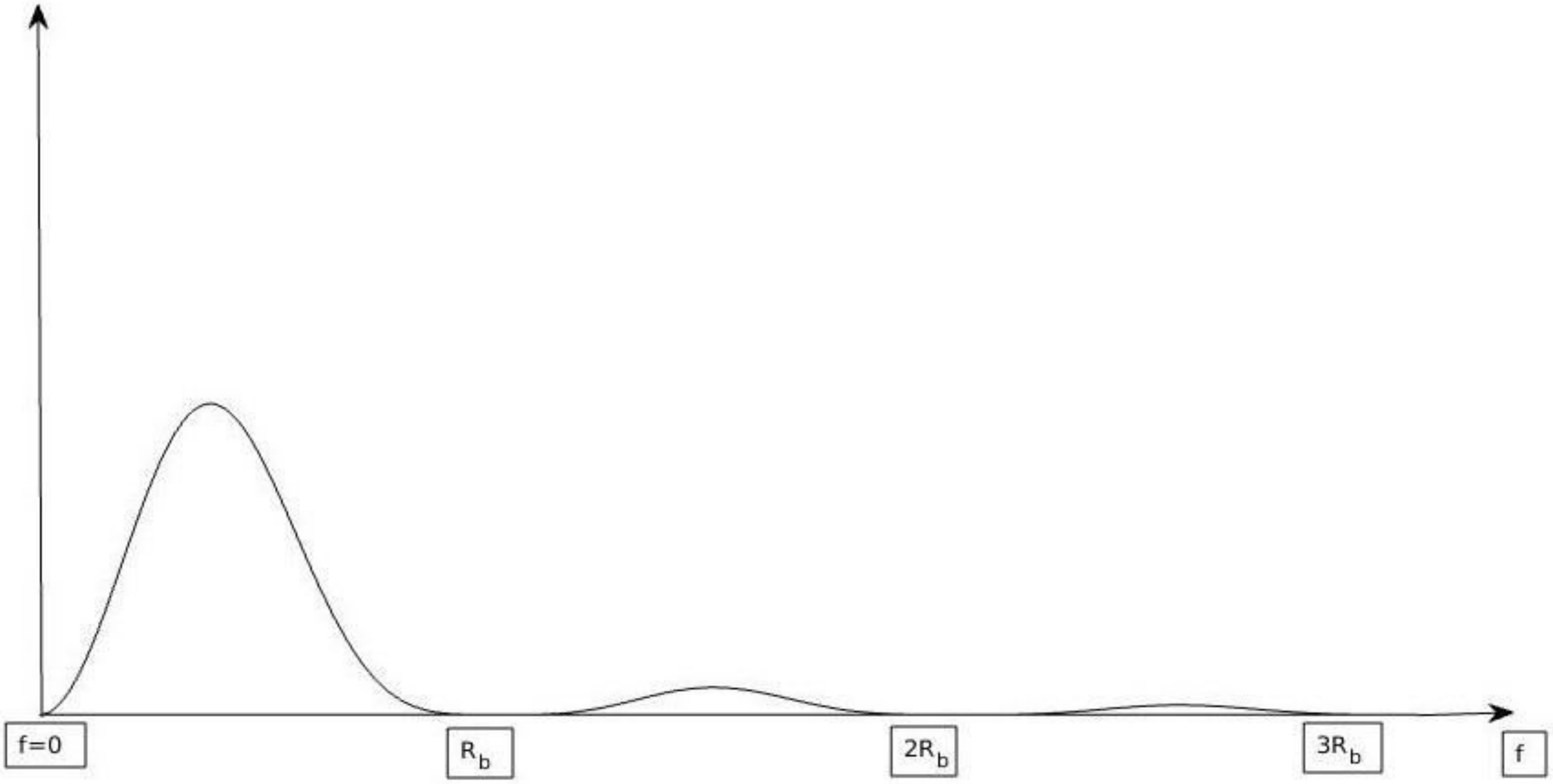

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THANK YOU

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