Minimum shift keying

MSK

let $h = \frac{1}{2}$, $f_1 - f_2 = \frac{f_b}{2}$

for two carrier f_1 & f_2,

for coherent freq diff $= \frac{f_b}{2} = \frac{1}{2T_b}$

non coherent " " $= f_b = \frac{1}{T_b}$

So, when $h = \frac{1}{2}$, CPFSK is known as MSK or Fast FSK.

Generation

~~Signal space diagram~~ of MSK:

As we know $s(t) = \sqrt{\frac{2E_b}{T_b}} \cos\left[2\pi f_c t + \theta(t)\right]$

where, $\theta(t) = \theta(0) \pm \frac{\pi t}{2T_b}$

$$s(t) = \sqrt{\frac{2E_b}{T_b}} \left[\cos 2\pi f_c t \cos(\theta(t)) - \sin 2\pi f_c t \sin(\theta(t))\right]$$

$$= \sqrt{\frac{2E_b}{T_b}} \cos(\theta(t)) \cos 2\pi f_c t - \sqrt{\frac{2E_b}{T_b}} \sin\theta(t) \sin 2\pi f_c t$$

2017

My Family Thursday 02 Week 6 / Day 33

Both are $2T_b$ duration

$$S(t) = S_I(t)\cos 2\pi f_c t - S_Q(t)\sin 2\pi f_c t$$

In phase component — Quadrature phase component

My Friends

$$\therefore \text{Now, } \cos\{\theta(t)\} = \cos\left[\theta(0) \pm \frac{\pi t}{2T_b}\right] \quad 0 \le t \le T_b$$

$$S_I(t) = \sqrt{\frac{2E_b}{T_b}}\left\{\cos\theta(0)\cos\frac{\pi t}{2T_b} + \sin\theta(0)\sin\frac{\pi t}{2T_b}\right\}$$

My Health

as $\theta(0) = 0$, $\cos\theta(0) = 1$, $\sin\theta(0) = 0$

$\theta(0) = \pm\pi$, $\cos\theta(0) = -1$, $\sin\theta(0) = 0$

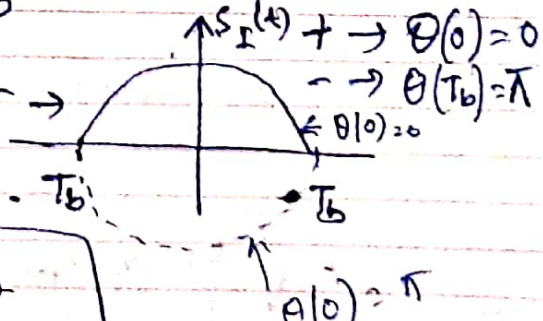
an even multiple of T_b.

$\theta(t) = 0$ or $\pm\pi$

My Skills

$$\therefore S_I(t) = \pm\sqrt{\frac{2E_b}{T_b}}\cos\frac{\pi t}{2T_b} \quad -T_b \le t \le T_b \quad \text{--- (1)}$$

Half cosine function →



As at $t = 0$ $\cos[\theta(0)] = 1$

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at $t = T_b$ $\cos[\theta(T_b)] = 0$

at $t = -T_b$ $\cos[\theta(T_b)] = 0$

∴ Half cosine function

Notes:

Scanned with CamScanner

$\sin\theta(0)\cos(\pi\cdot)$ $\pm$ $\cos\theta\sin\theta\cdot$
$\pm T_b$ 0 T_b
$\theta - T_b - 2T_b$

My Family Friday 03 Week 6 / Day 34

Now, $S_Q(t) = \sqrt{\frac{2E_b}{T_b}} \sin[\theta(t)] = \sqrt{\frac{2E_b}{T_b}} \sin\left[\theta(0) \pm \frac{\pi t}{2T_b}\right]$

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at $t=0$, $\sin\theta = 0$
$t = T_b$ $\sin[\theta(t)] = \pm 1$ or -1
$t = 2T_b$ $\sin\theta(t) = 0$
again we half sine wave for

$\therefore \theta(t) = \theta(0) \pm \frac{\pi t}{2T_b}$ $\quad 0 \le t \le 2T_b$

$\theta(T_b) = \theta(0) \pm \frac{\pi}{2}$ (1)

My Health

$\Rightarrow \theta(0) = \theta(T_b) \mp \frac{\pi}{2}$

$\Rightarrow$ ~~$\theta(t) = \theta(0)$~~

$\therefore S_Q(t) = \sqrt{\frac{2E_b}{T_b}} \sin\left[\left\{\theta(T_b) \mp \frac{\pi}{2}\right\} \pm \frac{\pi t}{2T_b}\right]$

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$= \sqrt{\frac{2E_b}{T_b}} \sin\left[\theta(T_b) \mp \frac{\pi}{2}\right] \cos\left(\frac{\pi t}{2T_b}\right) \pm \cos\left[\theta(T_b) \mp \frac{\pi}{2}\right] \sin\left(\frac{\pi t}{2T_b}\right)$

Now, $\theta(T_b) \mp \frac{\pi}{2} = 0$ or π.

$\therefore S_Q(t) = \pm\sqrt{\frac{2E_b}{T_b}} \sin\left(\frac{\pi t}{2T_b}\right)$ (2)

$+ \to \theta(T_b) = \pi/2$
$- \to \theta(T_b) = -\pi/2$

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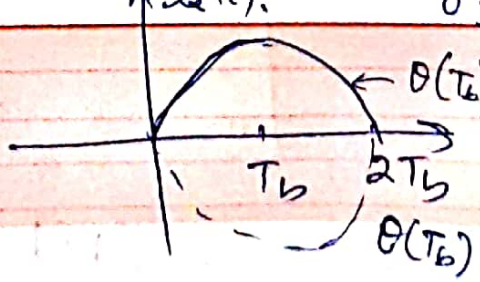
$S_Q(t)$. $\quad 0 \le t \le 2T_b$



Notes:

$$S(t) = \pm\sqrt{\frac{2E}{T_b}}\cos\left(\frac{\pi t}{2T_b}\right)\cos 2\pi f_c t - \sqrt{\frac{2E_b}{T_b}}\sin\left(\frac{\pi t}{2T_b}\right)\sin 2\pi f_c t$$

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$$= \pm\sqrt{E_b}\left\{\sqrt{\frac{2}{T_b}}\cos\left(\frac{\pi t}{2T_b}\right)\cos 2\pi f_c t\right\} - \left\{\pm\sqrt{E_b}\right\}\left\{\sqrt{\frac{2}{T_b}}\sin\left(\frac{\pi t}{2T_b}\right)\sin 2\pi f_c t\right\}$$

$\phi_1(t)$ $\qquad$ $\phi_2(t)$

$$= \pm\sqrt{E_b}\,\phi_1(t) - \left\{\pm\sqrt{E_b}\right\}\phi_2(t)$$

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$$= \pm\sqrt{E_b}$$

- $\phi_1(t)$ & $\phi_2(t)$ → orthogonal

$$= \sqrt{E_b}\,\phi(0)\,\phi_1(t) - \sqrt{E_b}\,\phi(T_b)\,\phi_2(t)$$

$$= \sqrt{E_b}\cos\{\theta(0)\}\phi_1(t) + \{-\sqrt{E_b}\sin\{\theta(T_b)\}\}\phi_2(t)$$

x_1 message $0, \pi$ $\qquad$ x_2 $\qquad$ $\pi/2, -\pi/2$

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$$= x_1\phi_1(t) + x_2\phi_2(t) \quad \text{— (3)}$$

$$\phi_1(t) = \sqrt{\frac{2}{T_b}}\cos\left(\frac{\pi t}{2T_b}\right)\cos 2\pi f_c t$$

$$\phi_2(t) = \sqrt{\frac{2}{T_b}}\sin\left(\frac{\pi t}{2T_b}\right)\sin 2\pi f_c t$$

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$x_1 = \sqrt{E_b}\cos[\theta(0)]$ $\quad \{\theta(0) = 0 \text{ & } \pi$

$x_2 = \{-\sqrt{E_b}\cos[\theta(T_b)]\}$ $\quad \theta(T_b) = \frac{\pi}{2}$ or $-\frac{\pi}{2}$

Notes:

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State Space diagram

My Family

Saturday

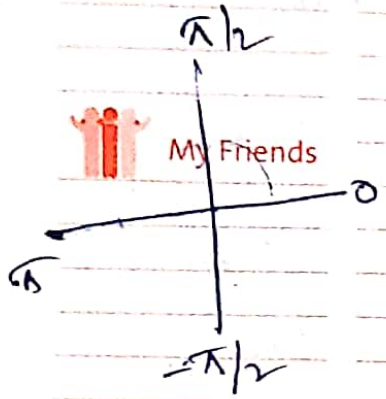
04

at T_T

Initial → phase increase or decrease

Week 6 / Day 35

$\theta(0)$	$\theta(T_b)$	Tx Symbol
π	$\pi/2$	1
π	$\pi/2$	0
π	$-\frac{\pi}{2}$	1
0	$-\frac{\pi}{2}$	0



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My Health

ARW Sunday

05

Week 6 / Day 36

x_1	x_2
$\sqrt{E_b}$	$-\sqrt{E_b}$
$-\sqrt{E_b}$	$-\sqrt{E_b}$
$-\sqrt{E_b}$	$\sqrt{E_b}$
$\sqrt{E_b}$	$\sqrt{E_b}$

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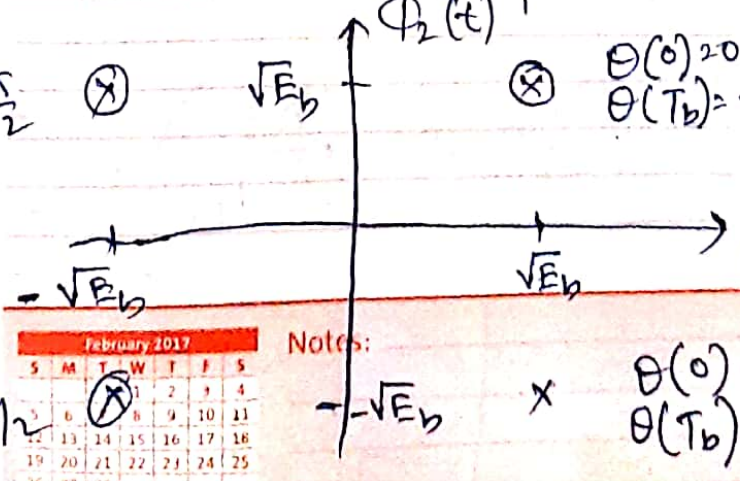
~~State space diagram~~

$\theta(0) = \pi$
$\theta(T_b) = -\frac{\pi}{2}$
bit = 1

$\theta(0) = 0$
$\theta(T_b) = -\frac{\pi}{2}$
bit 0



My Money

$\theta(0) = \pi$
$\theta(T_b) = \pi/2$
bit = 0

Notes:

$-\sqrt{E_b}$ × $\sqrt{E_b}$

$\theta(0) = 0$
$\theta(T_b) = \frac{\pi}{2}$ bit 1

Same as QPSK.

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Tuesday

07

Week 7 / Day 38

MSK Transmitter

To implement eq (3)

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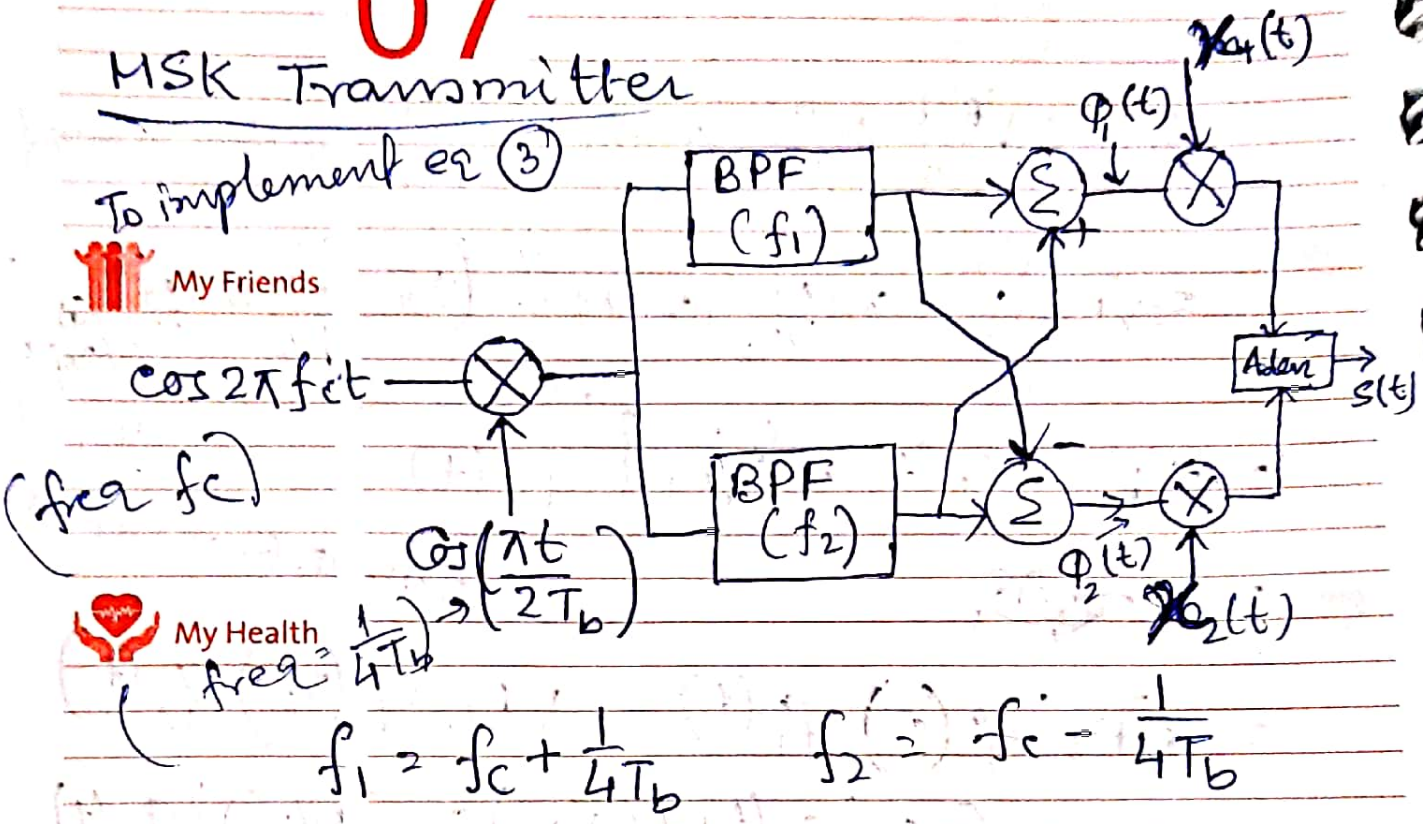


My Health

$f_1 = f_c + \frac{1}{4T_b}$ $f_2 = f_c - \frac{1}{4T_b}$

My Skills

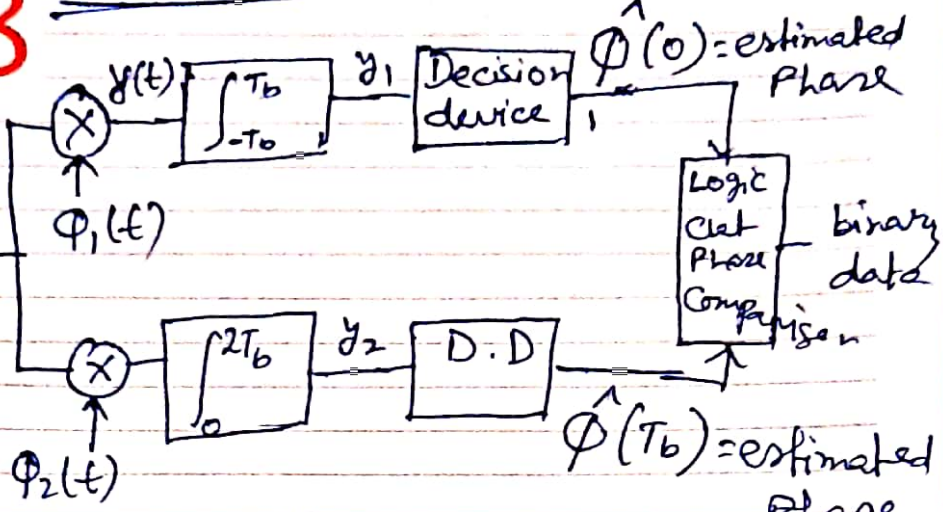
My Money

February 2017

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

Notes:

MSK Receiver



$$y_1 = \int_{-T_b}^{T_b} y(t)\,\phi_1(t)$$

$$= x_1$$

$$= \sqrt{E_b}\cos[\phi(0)] = \pm\sqrt{E_b}$$

If $y_1 > 0 \sim \hat{\phi}(0) = 0$

$y_1 < 0 \sim \hat{\phi}(0) = \pi$

Similarly $y_2 = \int_0^{2T_b} y(t)\,\phi_1(t)$

$= x_2 = \sqrt{E_b}\sin[\phi(T_b)] = \pm\sqrt{E_b}$

If $y_2 > 0 \sim \hat{\phi}(T_b) = -\pi/2$

$y_2 < 0 \sim \hat{\phi}(T_b) = \pi/2$

Notes: