3.1 Solu:

$$X_{16QAM}(t) = \gamma_1 A_c \cos(w_c t + \Delta\theta) - \gamma_2 A_c (1+\varepsilon) \sin w_c t$$

(a) $\Delta\theta \neq 0$, $\varepsilon = 0$

$$X_{16QAM}(t) = \gamma_1 A_c \cos(w_c t + \Delta\theta) - \gamma_2 A_c \sin w_c t$$

$$= \gamma_1 A_c [\cos w_c t \cos\Delta\theta - \sin w_c t \sin\Delta\theta] - \gamma_2 A_c \sin w_c t$$

$$= \gamma_1 A_c \cos\Delta\theta \cos w_c t - (\gamma_1 A_c \sin\Delta\theta + \gamma_2 A_c) \cdot \sin w_c t$$

nomalized coefficient: $\gamma_1 \cos\Delta\theta$, $-(\gamma_1 \sin\Delta\theta + \gamma_2)$

$\beta_1 = \cos\Delta\theta$, $\beta_2 = -\sin\Delta\theta + 1$; $\beta_1 = \cos\Delta\theta$, $\beta_2 = -\sin\Delta\theta + 2$;

$\beta_1 = \cos\Delta\theta$, $\beta_2 = -\sin\Delta\theta - 1$; $\beta_1 = \cos\Delta\theta$, $\beta_2 = -\sin\Delta\theta - 2$;

$\beta_1 = -\cos\Delta\theta$, $\beta_2 = \sin\Delta\theta + 1$; $\beta_1 = -\cos\Delta\theta$, $\beta_2 = \sin\Delta\theta + 2$;

$\beta_1 = -\cos\Delta\theta$, $\beta_2 = \sin\Delta\theta - 1$; $\beta_1 = -\cos\Delta\theta$, $\beta_2 = \sin\Delta\theta - 2$;

$\beta_1 = 2\cos\Delta\theta$, $\beta_2 = -2\sin\Delta\theta + 1$; $\beta_1 = 2\cos\Delta\theta$, $\beta_2 = -2\sin\Delta\theta + 2$;

$\beta_1 = 2\cos\Delta\theta$, $\beta_2 = -2\sin\Delta\theta - 1$; $\beta_1 = 2\cos\Delta\theta$, $\beta_2 = -2\sin\Delta\theta - 2$;

$\beta_1 = -2\cos\Delta\theta$, $\beta_2 = 2\sin\Delta\theta + 1$; $\beta_1 = -2\cos\theta$, $\beta_2 = 2\sin\Delta\theta + 2$;

$\beta_1 = -2\cos\Delta\theta$, $\beta_2 = 2\sin\Delta\theta - 1$; $\beta_1 = -2\cos\theta$, $\beta_2 = 2\sin\Delta\theta - 2$;

(b) $\Delta\theta = 0$, $\varepsilon \neq 0$.

$$X_{16QAM}(t) = \gamma_1 A_c \cos w_c t - \gamma_2 (A_c (1+\varepsilon) \sin w_c t$$

nomalized coefficient: $(\gamma_1, \; -\gamma_2(1+\varepsilon))$.

Similar to (a), there are 16 different combinations

3.2 Solu:

If $NF < 10dB$.

$$NF = \frac{Noise, out}{A_0^2 \cdot P_{RS}}$$

$$\frac{Noise, out}{A_0^2} = Noise, in = NF \cdot P_{RS}$$

$$\therefore \quad Noise, in \cdot B = NF/_{dB} - 174dB/Hz + 10\lg B$$
$$= (10 - 174 + 53)\ dBm$$
$$= -111\ dBm.$$

IF $NF < 10dB \Rightarrow Noise, in \cdot B < -111 dBm$.

$$IIP_3 = P_{in} + \frac{P_{in} - P_{IM,in}}{2}$$

Since the maximum tolerable noise is $-108dBm$, the IM can contribute more than 3 dB.

So $P_{IM,in} > -111dBm$

$\Rightarrow IIP_3 < -18 dBm$.

It demonstrates that if the RX contributes less noise, the receiver's linearity requirement can be loose.

3.3 solu:

For WCDMA.

Receiver sensitivity : $-104\,dBm$.

B : 5MHZ.

Assum: $NF = 3\,dB$

$$Noise_{in\,B} = -174\,dBm + 3 + 10\lg(384KHZ)$$
$$= -115\,dBm.$$

For an acceptable BER, SNR of 9 dB is required.
i.e. the total noise in the desired channel must remain below $-113\,dBm$.

$\Rightarrow$ The intermodulation can contribute at most 2dB

i.e. $P_{IM,in} = -117\,dBm$.

$$IIP_3 = \frac{-46\,dBm - (-117\,dBm)}{2} + (-46\,dBm)$$

$$= -10.5\,dBm.$$

3.4 Solu:

IMX2000. maximum tolerable relative noise floor.

In DCS1800 RX Band 1805 ~ 1880 MHZ.

TX Power remain below -71 dBm in 100-KHZ bandwidth.

of DCS 1800.

$-71\text{dBm} - 10\lg 10\text{kHz} = -121\ \text{dBm}/\text{Hz}$.

TX outpower : 24 dBm.

$\Rightarrow$ The Max Tolerable relative noise floor:

$-145\ \text{dBc}/\text{Hz}$.

3.5

Soln:

This problem is the same as Problem 3.3.

3.6 Solu:

SNR = 17 dB

That means the total noise should reamain below -81 dBm.

Let me assume $NF = 10\,dB$

$B = 1\,MHz$.

$$\text{Noise by Rx} = -174\,dBm/Hz + 10\lg B + NF.$$
$$= -104\,dBm.$$

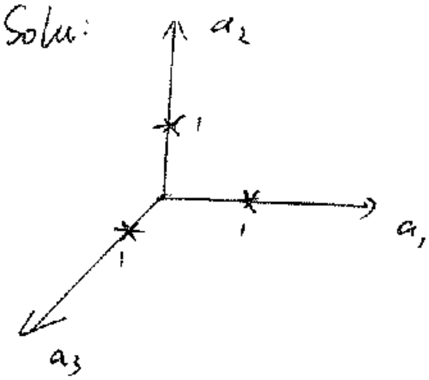
So IM can contribute maximum 23 dB.

$\Rightarrow$ -81.02 dBm.

$$IIP_3 = \frac{(-39) - (-81.02)}{2}\,dB + (-39\,dBm)$$

$$= -18\,dBm.$$

3.7 Solu:

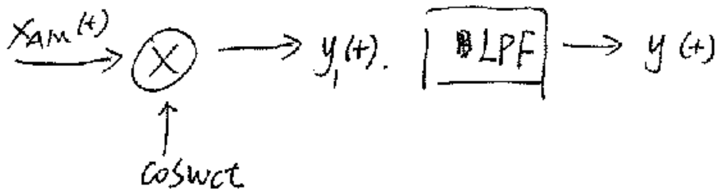


the constellation of $X_{FSK}(t) = a_1 \cos w_1 t + a_2 \cos w_2 t + a_3 \cos w_3 t$.

3.8 Sol:

Demodulation of AM

$$x_{AM}(t) = A_c\,[1+ m\,x_{BB}(t)]\cdot \cos w_c t$$



$$y_1(t) = A_c\,[1+ m\,x_{BB}(t)]\,\cos^2 w_c t$$

$$= A_c\,[1+ m\,x_{BB}(t)]\,\frac{1+\cos 2\theta}{2}$$

$$y(t) = LBF\,[y_1(t)]$$

$$= \frac{1}{2} A_c\,[1+ m\,x_{BB}(t)]$$

From the equation of $y(t)$, we can easily find the original information $x_{BB}(t)$.

3.9 Solu:

Demodulation of PSK

$$X_{PSK}(t) = a_n \cos w_c t$$

$$\begin{array}{c} X_{PSK}(t) \longrightarrow \otimes \xrightarrow[y_1(t)]{} \boxed{LPF} \longrightarrow y(t) \\ \uparrow \\ \cos w_c t \end{array}$$

$$y_1(t) = a_n \cos w_c t \cdot \cos w_c t$$

$$= \frac{1}{2} a_n (1 + \cos 2w_c t)$$

$$\Downarrow$$

$$y(t) = LPF\,[y_1(t)]$$

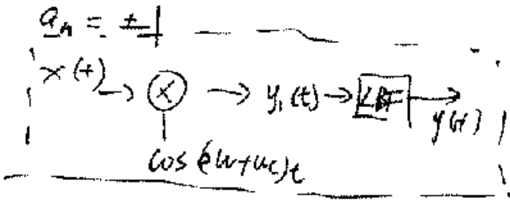
$$= \frac{1}{2} a_n .$$

From the result of $y(t)$, we can easily find the original binary sequence a_n.

3.6 Solu:

$$x_{BPSK}(t) = a_n \cos w_c t$$

Proof:



$$y_1(t) = x_{BPSK} \cdot \cos(w_c + \Delta w)t.$$

$$= a_n \cos w_c t \cdot \cos(w_c + \Delta w)t.$$

$$= \frac{1}{2} a_n [\cos(2w_c + \Delta w)t + \cos \Delta w t]$$

$$y(t) = [y_1(t)]^{LPF}$$

$$= \frac{1}{2} a_n \cdot \cos \Delta w t.$$