STRONG TERBULENCE

1.1 MGF FOR SISO SYSTEM:

$$M_{I_{ij}}(s)=\sum_{l=0}^{\infty}b_l(m_1\gamma_1,m_2\gamma_2)s^{-\frac{l\gamma_1+m_1\gamma_1}{2}}+\sum_{l=0}^{\infty}b_l(m_2\gamma_2,m_1\gamma_1)s^{-\frac{l\gamma_2+m_2\gamma_2}{2}} \tag{1.1}$$

Where,

$$b_l(m_1\gamma_1,m_2\gamma_2)=\frac{a_l(m_1\gamma_1,m_2\gamma_2)}{2}\Gamma\left(\frac{l\gamma_1+m_1\gamma_1}{2}\right) \tag{1.2}$$

$$b_l(m_2\gamma_2,m_1\gamma_1)=\frac{a_l(m_1\gamma_1,m_2\gamma_2)}{2}\Gamma\left(\frac{l\gamma_1+m_1\gamma_1}{2}\right) \tag{1.3}$$

1.2 PROBABILITY OF ERROR FOR M-PSK:

$$P_{MPSK}(E)=\frac{1}{\pi}\int_0^{\frac{(M-1)\pi}{M}}M_Z\left(\frac{\phi\gamma}{sin^2\theta}\right)d\theta \tag{1.4}$$

Where,

$$\phi=sin^2\left(\frac{\pi}{M}\right) \tag{1.5}$$

From equations (1.1) and (1.5),

$$\begin{aligned}P_{MPSK}(E)=&\sum_{l=0}^{\infty}b_l(m_1\gamma_1,m_2\gamma_2)\Lambda(m_1\gamma_1)(\phi\gamma)^{-\frac{l\gamma_1+m_1\gamma_1}{2}}\\&+\sum_{l=0}^{\infty}b_l(m_2\gamma_2,m_1\gamma_1)\Lambda(m_2\gamma_2)(\phi\gamma)^{-\frac{l\gamma_2+m_2\gamma_2}{2}}\end{aligned} \tag{1.6}$$

Where,

$$\Lambda(m_1\gamma_1)=\frac{1}{\pi}\int_0^{\frac{(M-1)\pi}{M}}(sin\,\theta)^{l\gamma_1+m_1\gamma_1}\,d\theta \tag{1.7}$$

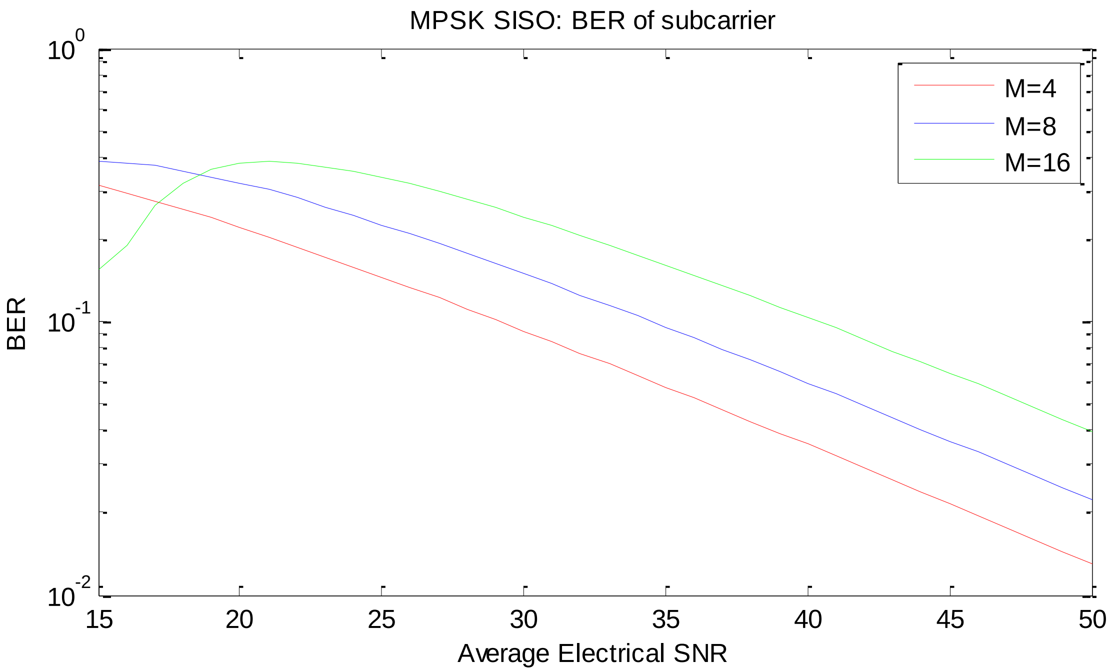
$$\begin{aligned}\Lambda(m_1\gamma_1)=&\frac{\Gamma\left[\frac{1}{2}(1+(l+m_1)\gamma_1)\right]}{2\sqrt{\pi}\Gamma\left[1+\frac{1}{2}(l+\mathrm{m}_1)\gamma_1\right]}+\\&\frac{\cos\left[\frac{\pi}{M}\right]2F1\left[\frac{1}{2},\frac{1}{2}-\frac{1}{2}(l+m_1)\gamma_1,\frac{3}{2},\cos\left[\frac{\pi}{M}\right]^2\right]}{\pi}\end{aligned} \tag{1.8}$$

and

$$\Lambda(m_2\gamma_2) = \frac{1}{\pi}\int_0^{\frac{(M-1)\pi}{M}} (sin\,\theta)^{l\gamma_2+m_2\gamma_2}\,d\theta \tag{1.9}$$

$$\Lambda(m_2\gamma_2) = \frac{\Gamma\left[\frac{1}{2}(1+(l+m_2)\gamma_2)\right]}{2\sqrt{\pi}\Gamma\left[1+\frac{1}{2}(l+\mathrm{m}_2)\gamma_2\right]} + \frac{\cos\left[\frac{\pi}{M}\right]2\mathrm{F}1\left[\frac{1}{2},\frac{1}{2}-\frac{1}{2}(l+m_2)\gamma_2,\frac{3}{2},\cos\left[\frac{\pi}{M}\right]^2\right]}{\pi} \tag{1.10}$$

1.3 PLOT OF BER Vs SNR FOR MPSK:



1.6 PROBABILITY OF ERROR FOR M-PAM:

$$P_{M-PAM}(E) = \frac{2}{\pi}\left(1-\frac{1}{M}\right)\int_0^{\frac{\pi}{2}} M_Z\left(\frac{\phi\gamma}{sin^2\,\theta}\right)d\theta \tag{1.18}$$

Where,

$$\phi = \frac{3}{(M^2-1)} \tag{1.19}$$

From equations (1.1) and (1.11),

$$P_{M-PAM}(E) = 2\left(1-\frac{1}{M}\right)\sum_{l=0}^{\infty} b_l(m_1\gamma_1, m_2\gamma_2)\Lambda(m_1\gamma_1)(\phi\gamma)^{-\frac{l\gamma_1+m_1\gamma_1}{2}} + \sum_{l=0}^{\infty} b_l(m_2\gamma_2, m_1\gamma_1)\Lambda(m_2\gamma_2)(\phi\gamma)^{-\frac{l\gamma_2+m_2\gamma_2}{2}} \tag{1.20}$$

Where,

$$\Lambda(m_1\gamma_1) = \frac{1}{\pi}\int_0^{\frac{\pi}{2}} (\sin\theta)^{l\gamma_1+m_1\gamma_1}\, d\theta \tag{1.21}$$

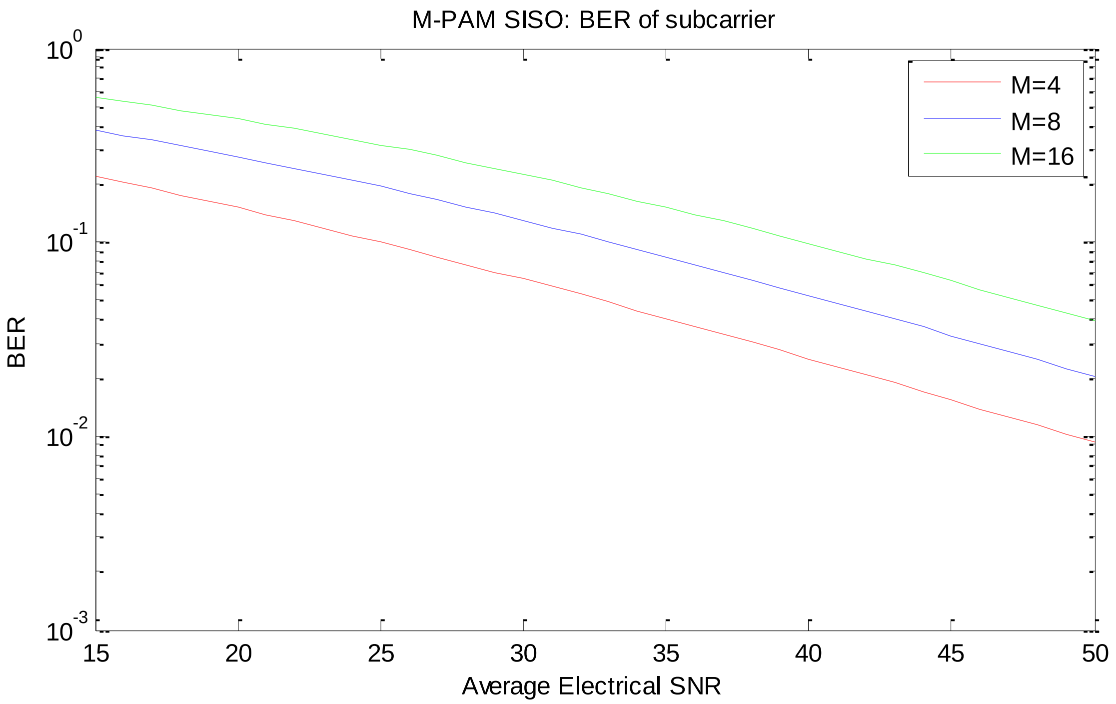
$$\Lambda(m_1\gamma_1) = \frac{\Gamma\left[\frac{1}{2}(1+(l+\mathrm{m}_1)\gamma_1)\right]}{2\sqrt{\pi}\Gamma\left[1+\frac{1}{2}(l+\mathrm{m}_1)\gamma_1\right]} \tag{1.22}$$

and

$$\Lambda(m_2\gamma_2) = \frac{1}{\pi}\int_0^{\frac{\pi}{2}} (\sin\theta)^{l\gamma_2+m_2\gamma_2}\, d\theta \tag{1.23}$$

$$\Lambda(m_2\gamma_2) = \frac{\Gamma\left[\frac{1}{2}(1+(l+\mathrm{m}_2)\gamma_2)\right]}{2\sqrt{\pi}\Gamma\left[1+\frac{1}{2}(l+\mathrm{m}_2)\gamma_2\right]} \tag{1.24}$$

1.7 PLOT OF BER Vs SNR FOR M-PAM:



1.8 PROBABILITY OF ERROR FOR M-QAM:

$$P_{MQAM}(E) = \xi_1 \int_0^{\pi/2} M_Z\left(\frac{\phi\gamma}{sin^2\theta}\right) d\theta - \xi_2 \int_0^{\pi/4} M_Z\left(\frac{\phi\gamma}{sin^2\theta}\right) d\theta \qquad (1.25)$$

Where,

$$\phi = \frac{3}{2(M-1)}, \xi_1 = \frac{4}{\pi}\left(1 - \frac{1}{\sqrt{M}}\right), and\ \xi_2 = \frac{4}{\pi}\left(1 - \frac{1}{\sqrt{M}}\right)^2 \qquad (1.26)$$

From equations (1.1) and (1.18),

$$\begin{aligned} P_{M-PAM}(E) = {} & 4\left(1 - \frac{1}{\sqrt{M}}\right) \sum_{l=0}^{\infty} b_l(m_1\gamma_1, m_2\gamma_2)\Lambda(m_1\gamma_1)(\phi\gamma)^{-\frac{l\gamma_1 + m_1\gamma_1}{2}} \\ & + \sum_{l=0}^{\infty} b_l(m_2\gamma_2, m_1\gamma_1)\Lambda(m_2\gamma_2)(\phi\gamma)^{-\frac{l\gamma_2 + m_2\gamma_2}{2}} - \\ & 4\left(1 - \frac{1}{\sqrt{M}}\right)^2 \sum_{l=0}^{\infty} b_l(m_1\gamma_1, m_2\gamma_2)\Psi(m_1\gamma_1)(\phi\gamma)^{-\frac{l\gamma_1 + m_1\gamma_1}{2}} \\ & + \sum_{l=0}^{\infty} b_l(m_2\gamma_2, m_1\gamma_1)\Psi(m_2\gamma_2)(\phi\gamma)^{-\frac{l\gamma_2 + m_2\gamma_2}{2}} \end{aligned} \qquad (1.27)$$

Where,

$$\Lambda(m_1\gamma_1) = \frac{1}{\pi}\int_0^{\frac{\pi}{2}} (sin\,\theta)^{l\gamma_1 + m_1\gamma_1}\, d\theta \qquad (1.28)$$

$$\Lambda(m_1\gamma_1) = \frac{\Gamma\left[\frac{1}{2}(1 + (l + \mathrm{m}_1)\gamma_1)\right]}{2\sqrt{\pi}\Gamma\left[1 + \frac{1}{2}(l + \mathrm{m}_1)\gamma_1\right]} \qquad (1.29)$$

and

$$\Lambda(m_2\gamma_2) = \frac{1}{\pi}\int_0^{\frac{\pi}{2}} (sin\,\theta)^{l\gamma_2 + m_2\gamma_2}\, d\theta \qquad (1.30)$$

$$\Lambda(m_2\gamma_2) = \frac{\Gamma\left[\frac{1}{2}(1 + (l + \mathrm{m}_2)\gamma_2)\right]}{2\sqrt{\pi}\Gamma\left[1 + \frac{1}{2}(l + \mathrm{m}_2)\gamma_2\right]} \qquad (1.31)$$

and,

$$\Psi(m_1\gamma_1) = \frac{1}{\pi}\int_0^{\frac{\pi}{4}} (sin\,\theta)^{l\gamma_1 + m_1\gamma_1}\, d\theta \qquad (1.32)$$

$$\Psi(m_1\gamma_1) = \frac{i2^{\frac{1}{2}(-1 - l\gamma_1 - \mathrm{m}_1\gamma_1)} e^{-\frac{1}{2}i\pi(1 + l\gamma_1 + \mathrm{m}_1\gamma_1)} (\mathrm{Cos}[\frac{1}{2}(l + \mathrm{m}_1)\pi\gamma_1]}{\pi(1 + l\gamma_1 + \mathrm{m}_1\gamma_1)} \qquad (1.33)$$

$$+\left(\frac{i\mathrm{Cos}\left[\frac{1}{2}\pi(-1+l\gamma_1+\mathrm{m}_1\gamma_1)\right])}{\pi(1+l\gamma_1+\mathrm{m}_1\gamma_1)}\right)\times$$

$$\mathrm{Hypergeometric2F1}\left[\frac{1}{2},\frac{1}{2}(1+(l+\mathrm{m}_1)\gamma_1),\frac{1}{2}(3+(l+\mathrm{m}_1)\gamma_1),\frac{1}{2}\right]$$

and

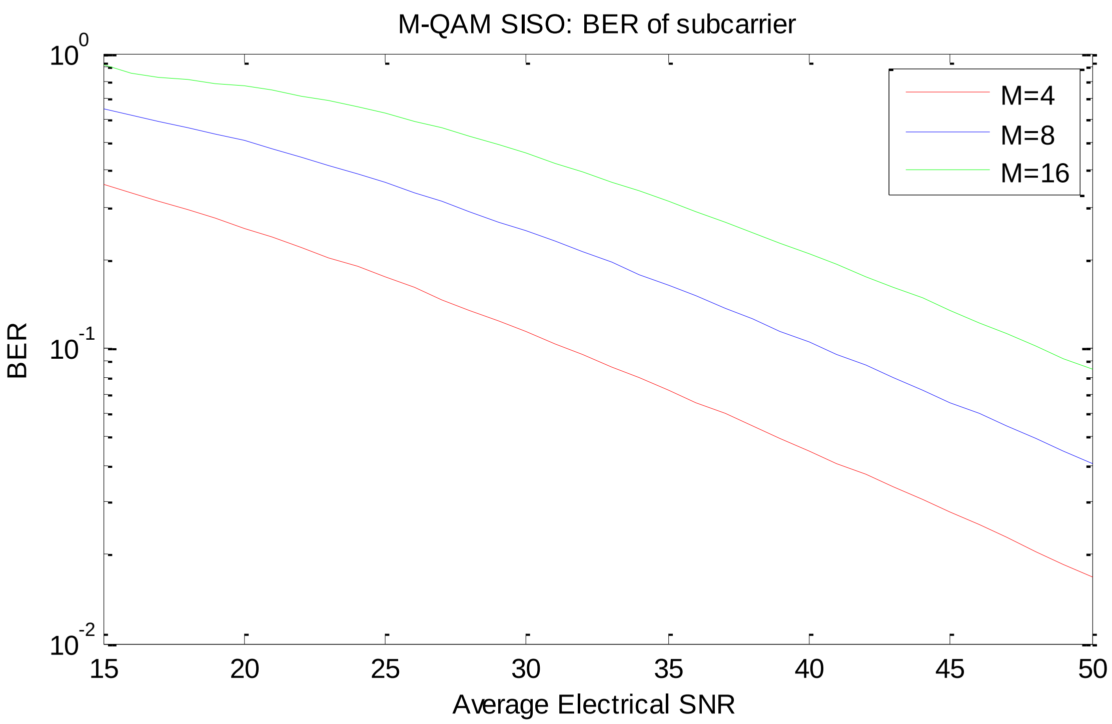
$$\Psi(m_2\gamma_2)=\frac{1}{\pi}\int_0^{\frac{\pi}{4}}(sin\,\theta)^{l\gamma_2+m_2\gamma_2}\,d\theta \tag{1.34}$$

$$\Psi(m_2\gamma_2)=\frac{i2^{\frac{1}{2}(-1-l\gamma_2-\mathrm{m}_2\gamma_2)}e^{-\frac{1}{2}i\pi(1+l\gamma_2+\mathrm{m}_2\gamma_2)}(\mathrm{Cos}[\frac{1}{2}(l+\mathrm{m}_2)\pi\gamma_2]}{\pi(1+l\gamma_2+\mathrm{m}_2\gamma_2)}$$

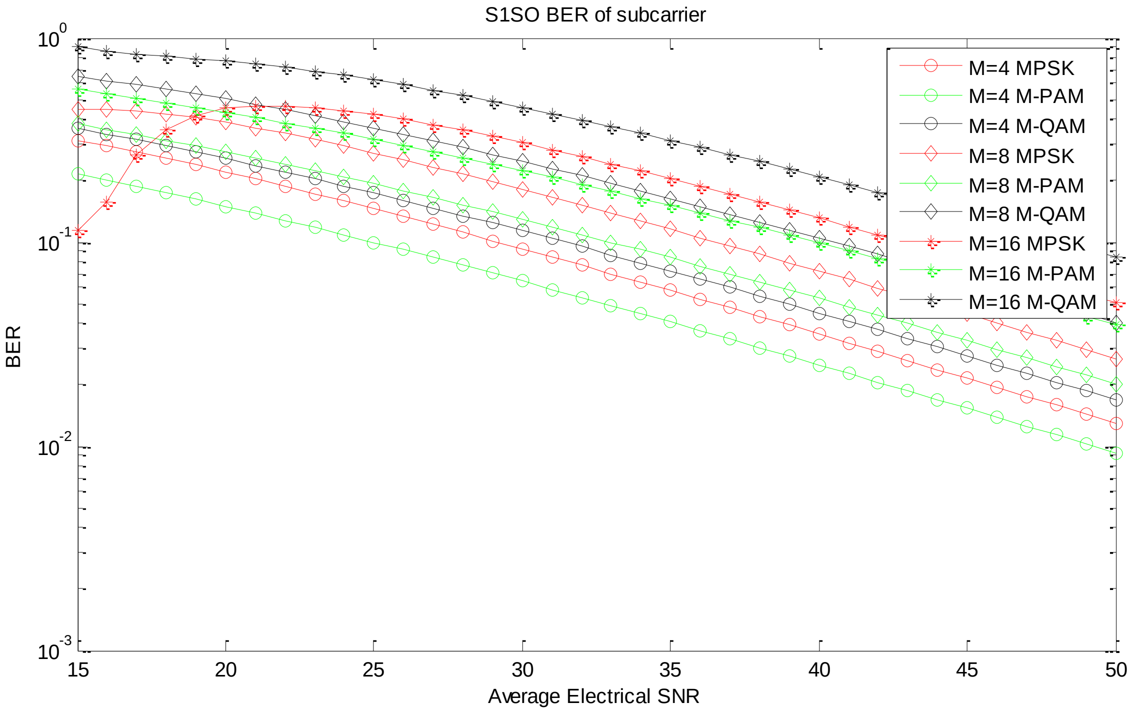
$$+\left(\frac{i\mathrm{Cos}\left[\frac{1}{2}\pi(-1+l\gamma_2+\mathrm{m}_2\gamma_2)\right])}{\pi(1+l\gamma_2+\mathrm{m}_2\gamma_2)}\right)\times \tag{1.35}$$

$$\mathrm{Hypergeometric2F1}\left[\frac{1}{2},\frac{1}{2}(1+(l+\mathrm{m}_2)\gamma_2),\frac{1}{2}(3+(l+\mathrm{m}_2)\gamma_2),\frac{1}{2}\right]$$

1.9 PLOT OF BER Vs SNR FOR M-QAM:



1.10 PLOT OF MPSK, M-PAM, M-QAM:



1.11 MGF FOR MIMO SYSTEM:

$$M_Y(s) = \sum_{k=0}^{n_T n_R} \binom{n_T n_R}{k} \sum_{i=0}^{\infty} \sum_{j=0}^{i} \frac{\tilde{c}_j\big(m_1\gamma_1, m_2\gamma_2\big)\tilde{c}_{i-j}\big(m_2\gamma_2, m_1\gamma_1\big)}{2\Gamma\Big((n_T n_R - k)m_1\gamma_1 + km_2\gamma_2 + j\gamma_1 + (i-j)\gamma_2\Big)} \Gamma\left(\frac{(n_T n_R - k)m_1\gamma_1 + km_2\gamma_2 + j\gamma_1 + (i-j)\gamma_2}{2}\right) s^{-\frac{(n_T n_R - k)m_1\gamma_1 + km_2\gamma_2 + j\gamma_1 + (i-j)\gamma_2}{2}} \quad (1.36)$$

Where,

$$\tilde{c}_0(m_1\gamma_1, m_2\gamma_2) = \left[\tilde{b}_0(m_1\gamma_1, m_2\gamma_2)\right]^{n_T n_R - k} \quad (1.37)$$

$$\tilde{c}_0(m_2\gamma_2, m_1\gamma_1) = \left[\tilde{b}_0(m_2\gamma_2, m_1\gamma_1)\right]^{n_T n_R - k} \quad (1.38)$$

$$\tilde{c}_m(m_1\gamma_1, m_2\gamma_2) = \frac{1}{m\tilde{b}_0(m_1\gamma_1, m_2\gamma_2)} \sum_{l=0}^{m} (l(n_T n_R - k) - m + l)\, \tilde{b}_0(m_1\gamma_1, m_2\gamma_2)\tilde{c}_{m-l}(m_1\gamma_1, m_2\gamma_2) \quad (1.39)$$

$$\tilde{c}_m(m_2\gamma_2, m_1\gamma_1) = \frac{1}{m\tilde{b}_0(m_2\gamma_2, m_1\gamma_1)} \sum_{l=0}^{m} (l(n_T n_R - k) - m + l) \times \tilde{b}_0(m_2\gamma_2, m_1\gamma_1)\tilde{c}_{m-l}(m_2\gamma_2, m_1\gamma_1) \quad (1.40)$$

1.12 PROBABILITY OF ERROR FOR MIMO M-PSK:

$$P_{MPSK}(E) = \frac{1}{\pi} \int_0^{\frac{(M-1)\pi}{M}} M_{Y^2}\left(\frac{\phi\gamma}{n_T^2 n_R sin^2\,\theta}\right) d\theta \quad (1.41)$$

Where,

$$\phi = sin^2\left(\frac{\pi}{M}\right) \quad (1.42)$$

From equations (1.36) and (1.41),

$$P_{MPSK} = \frac{1}{\pi} \int_0^{\frac{(M-1)\pi}{M}} \sum_{k=0}^{n_T n_R} \binom{n_T n_R}{k} \sum_{i=0}^{\infty} \sum_{j=0}^{i} \frac{\tilde{c}_j(m_1\gamma_1, m_2\gamma_2)\tilde{c}_{i-j}(m_2\gamma_2, m_1\gamma_1)}{2\Gamma\big((n_T n_R - k)m_1\gamma_1 + km_2\gamma_2 + j\gamma_1 + (i-j)\gamma_2\big)} \Lambda_{ij}(n_T n_R, M) \Gamma\left(\frac{(n_T n_R - k)m_1\gamma_1 + km_2\gamma_2 + j\gamma_1 + (i-j)\gamma_2}{2}\right)\left(\frac{\phi\gamma}{n_T^2 n_R}\right)^{-\frac{(n_T n_R - k)m_1\gamma_1 + km_2\gamma_2 + j\gamma_1 + (i-j)\gamma_2}{2}} \quad (1.43)$$

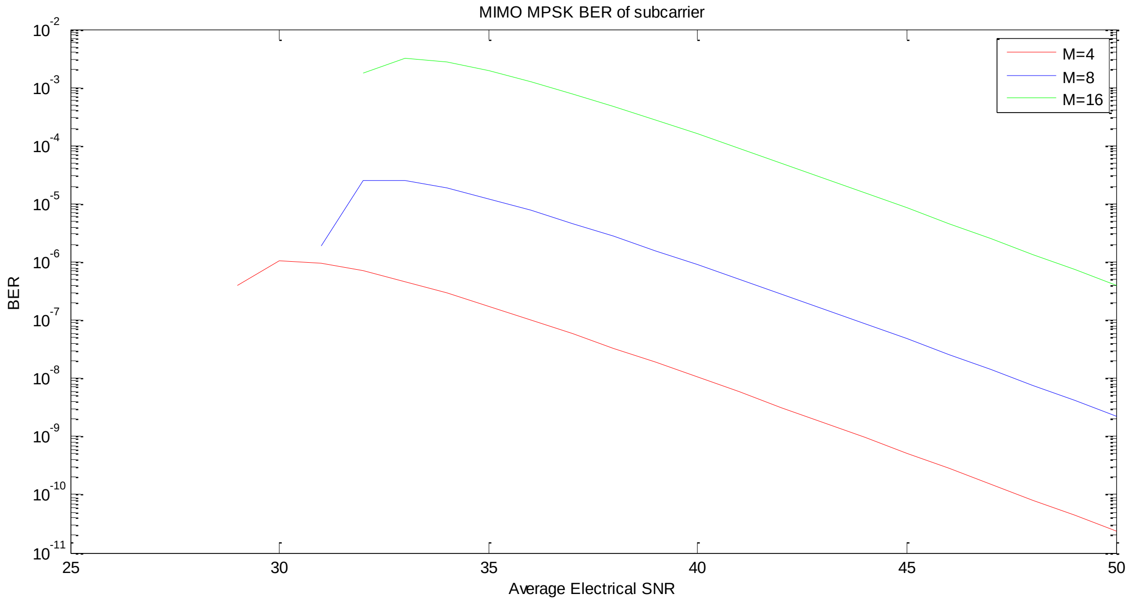
Where,

$$\Lambda_{ij}(n_T n_R, M) = \frac{1}{\pi} \int_0^{\frac{(M-1)\pi}{M}} \sin\theta^{(n_T n_R - k)m_1\gamma_1 + km_2\gamma_2 + j\gamma_1 + (i-j)\gamma_2}\, d\theta \quad (1.44)$$

$$\Lambda_{ij}(n_T n_R, M) = \frac{\sqrt{\pi}\Gamma\left(\frac{1+(n_T n_R - k)m_1\gamma_1 + j\gamma_1 + km_2\gamma_2 + (i-j)\gamma_2}{2}\right)}{2\Gamma\left(1+\frac{(n_T n_R - k)m_1\gamma_1 + j\gamma_1 + km_2\gamma_2 + (i-j)\gamma_2}{2}\right)} - \cos\left(\frac{M-1}{M}\pi\right)$$

$$2F1\left[\frac{1}{2}, \frac{1-(n_T n_R - k)m_1\gamma_1 - j\gamma_1 - km_2\gamma_2 - (i-j)\gamma_2}{2}; \frac{3}{2}; cos^2\left(\frac{M-1}{M}\pi\right)\right] \quad (1.45)$$

1.13 PLOT OF MIMO MPSK:



1.16 PROBABILITY OF ERROR FOR M-PAM:

$$P_{M-PAM}(E) = \frac{2}{\pi}\left(1-\frac{1}{M}\right)\int_0^{\frac{\pi}{2}} M_{Y^2}\left(\frac{\phi\gamma}{n_T^2 n_R sin^2\theta}\right)d\theta \quad (1.49)$$

Where,

$$\phi = \frac{3}{(M^2-1)} \quad (1.50)$$

From equations (1.36) and (1.48),

$$P_{M-PAM}(E) = 2\left(1-\frac{1}{M}\right)\sum_{k=0}^{n_T n_R}\binom{n_T n_R}{k}$$

$$\sum_{i=0}^{\infty}\sum_{j=0}^{i}\frac{\tilde{c}_j(m_1\gamma_1, m_2\gamma_2)\tilde{c}_{i-j}(m_2\gamma_2, m_1\gamma_1)}{2\Gamma((n_T n_R - k)m_1\gamma_1 + km_2\gamma_2 + j\gamma_1 + (i-j)\gamma_2)}\Lambda_{ij}(n_T n_R, M) \quad (1.51)$$

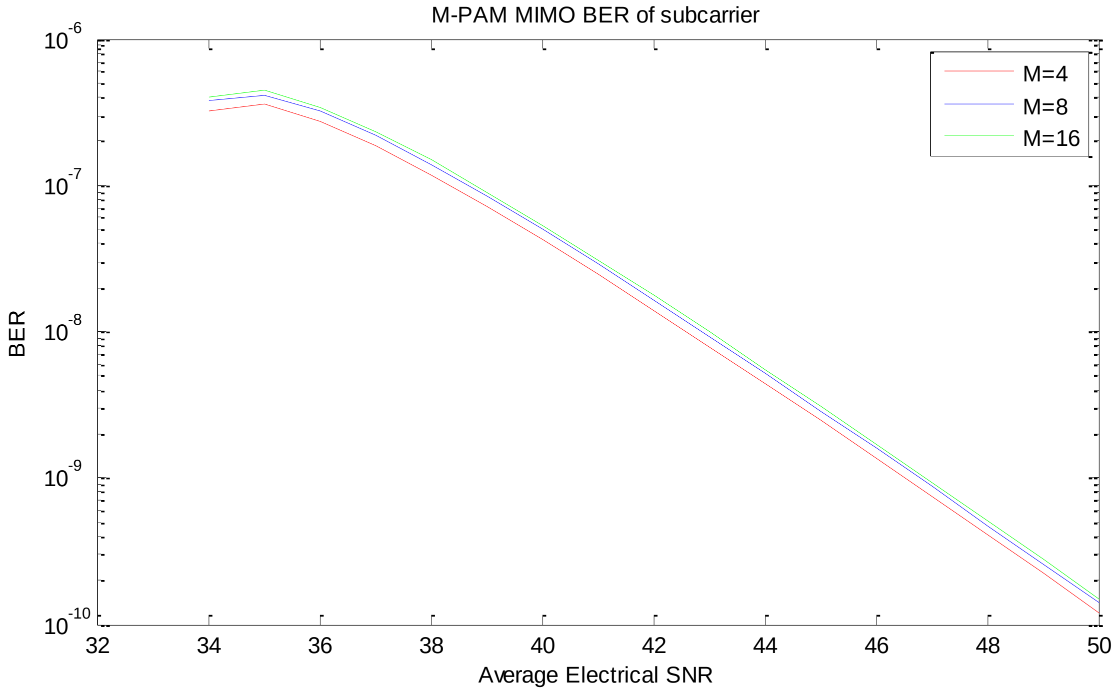
$$\Gamma\left(\frac{(n_T n_R - k)m_1\gamma_1 + km_2\gamma_2 + j\gamma_1 + (i-j)\gamma_2}{2}\right)\left(\frac{\phi\gamma}{n_T^2 n_R}\right)^{-\frac{(n_T n_R - k)m_1\gamma_1 + km_2\gamma_2 + j\gamma_1 + (i-j)\gamma_2}{2}}$$

Where,

$$\Lambda_{ij}(n_T n_R, M) = \frac{1}{\pi}\int_0^{\frac{\pi}{2}} (\sin\theta)^{(n_T n_R - k)m_1\gamma_1 + km_2\gamma_2 + j\gamma_1 + (i-j)\gamma_2}\ d\theta \qquad (1.52)$$

$$\Lambda_{ij}(n_T n_R, M) = \frac{\Gamma\left[\frac{1}{2}(1 - k\mathrm{m}_1\gamma_1 + \mathrm{m}_1 n_T n_R \gamma_1 + j(\gamma_1 - \gamma_2) + i\gamma_2 + km_2\gamma_2)\right]}{2\sqrt{\pi}\,\Gamma\left[\frac{1}{2}(2 - k\mathrm{m}_1\gamma_1 + \mathrm{m}_1 n_T n_R \gamma_1 + j(\gamma_1 - \gamma_2) + i\gamma_2 + km_2\gamma_2)\right]} \qquad (1.53)$$

1.17 PLOT OF MIMO M-PAM:



1.18 PROBABILITY OF ERROR FOR M-QAM:

$$P_{MQAM} = \xi_1 \int_0^{\pi/2} M_{Y^2}\left(\frac{\phi\gamma}{n_T^2 n_R \sin^2\theta}\right) d\theta - \xi_2 \int_0^{\pi/4} M_{Y^2}\left(\frac{\phi\gamma}{n_T^2 n_R \sin^2\theta}\right) d\theta \qquad (154)$$

Where,

$$\phi = \frac{3}{2(M-1)}, \xi_1 = \frac{4}{\pi}\left(1 - \frac{1}{\sqrt{M}}\right), and\ \xi_2 = \frac{4}{\pi}\left(1 - \frac{1}{\sqrt{M}}\right)^2 \qquad (1.55)$$

From equations (1.36) and (1.54),

$$P_{M-PAM} = 4\left(1 - \frac{1}{\sqrt{M}}\right)\sum_{k=0}^{n_T n_R}\binom{n_T n_R}{k} \qquad (1.56)$$

$$\sum_{i=0}^{\infty}\sum_{j=0}^{i}\frac{\tilde{c}_j(m_1\gamma_1,m_2\gamma_2)\tilde{c}_{i-j}(m_2\gamma_2,m_1\gamma_1)}{2\Gamma\left((n_Tn_R-k)m_1\gamma_1+km_2\gamma_2+j\gamma_1+(i-j)\gamma_2\right)}\Lambda_{ij}(n_Tn_R,M)$$

$$\left(\frac{\phi\gamma}{n_T^2n_R}\right)^{-\frac{(n_Tn_R-k)m_1\gamma_1+km_2\gamma_2+j\gamma_1+(i-j)\gamma_2}{2}} -$$

$$4\left(1-\frac{1}{\sqrt{M}}\right)^2\sum_{k=0}^{n_Tn_R}\binom{n_Tn_R}{k}\sum_{i=0}^{\infty}\sum_{j=0}^{i}\frac{\tilde{c}_j(m_1\gamma_1,m_2\gamma_2)\tilde{c}_{i-j}(m_2\gamma_2,m_1\gamma_1)}{2\Gamma\left((n_Tn_R-k)m_1\gamma_1+km_2\gamma_2+j\gamma_1+(i-j)\gamma_2\right)}$$

$$\psi_{ij}(n_Tn_R,M)\left(\frac{\phi\gamma}{n_T^2n_R}\right)^{-\frac{(n_Tn_R-k)m_1\gamma_1+km_2\gamma_2+j\gamma_1+(i-j)\gamma_2}{2}}$$

Where,

$$\Lambda_{ij}(n_Tn_R,M)=\frac{1}{\pi}\int_0^{\frac{\pi}{2}}(\sin\theta)^{(n_Tn_R-k)m_1\gamma_1+km_2\gamma_2+j\gamma_1+(i-j)\gamma_2}\,d\theta \tag{1.57}$$

$$\Lambda_{ij}(n_Tn_R,M)=\frac{\Gamma\left[\frac{1}{2}(1-k\mathrm{m}_1\gamma_1+\mathrm{m}_1n_Tn_R\gamma_1+j(\gamma_1-\gamma_2)+i\gamma_2+km_2\gamma_2)\right]}{2\sqrt{\pi}\,\Gamma\left[\frac{1}{2}(2-k\mathrm{m}_1\gamma_1+\mathrm{m}_1n_Tn_R\gamma_1+j(\gamma_1-\gamma_2)+i\gamma_2+km_2\gamma_2)\right]} \tag{1.58}$$

$$\psi_{ij}(n_Tn_R,M)=\frac{1}{\pi}\int_0^{\frac{\pi}{4}}(\sin\theta)^{(n_Tn_R-k)m_1\gamma_1+km_2\gamma_2+j\gamma_1+(i-j)\gamma_2}\,d\theta \tag{1.57}$$

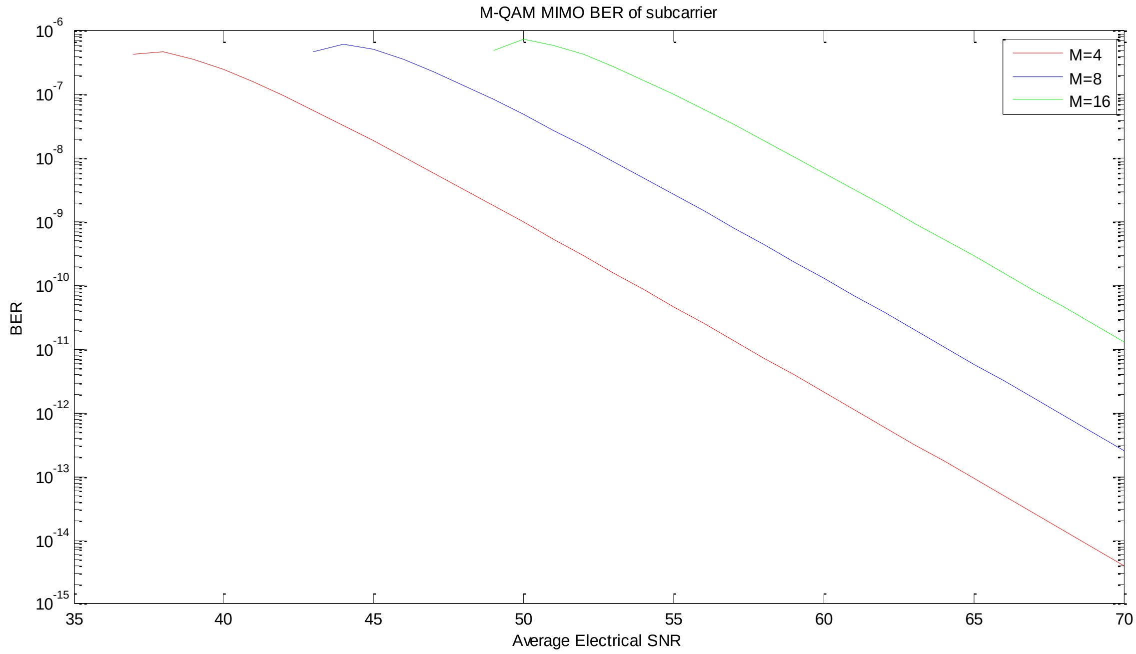
$$\psi_{ij}(n_Tn_R,M)=\frac{2^{\frac{1}{2}(-1+k\mathrm{m}_1\gamma_1-\mathrm{m}_1n_Tn_R\gamma_1-i\gamma_2-km_2\gamma_2+j(-\gamma_1+\gamma_2))}}{\left(\pi(-1-j\gamma_1+k\mathrm{m}_1\gamma_1-\mathrm{m}_1n_Tn_R\gamma_1-i\gamma_2+j\gamma_2-k\mathrm{m2y2})\right)}\times$$

$$e^{-\frac{1}{2}i\pi(1-k\mathrm{m}_1\gamma_1+\mathrm{m}_1n_Tn_R\gamma_1 1+j(\gamma_1-\gamma_2)+i\gamma_2+km_2\gamma_2)}$$

$$\begin{aligned}\mathrm{2F1}\Big[\frac{1}{2},\frac{1}{2}(1-k\mathrm{m}_1\gamma_1+\mathrm{m}_1n_Tn_R\gamma_1+j(\gamma_1-\gamma_2)+i\gamma_2+km_2\gamma_2),\frac{1}{2}(3-k\mathrm{m}_1\gamma_1\\+\mathrm{m}_1n_Tn_R\gamma_1+j(\gamma_1-\gamma_2)+i\gamma_2+km_2\gamma_2),\frac{1}{2}\Big]\times\end{aligned} \tag{1.58}$$

$$\left(\cos\left[\frac{1}{2}\pi(-1-k\mathrm{m}_1\gamma_1+\mathrm{m}_1n_Tn_R\gamma_1+j(\gamma_1-\gamma_2)+i\gamma_2+km_2\gamma_2)\right]\right.$$
$$\left.+i\,\sin\left[\frac{1}{2}\pi(-1-k\mathrm{m}_1\gamma_1+\mathrm{m}_1n_Tn_R\gamma_1+j(\gamma_1-\gamma_2)+i\gamma_2+km_2\gamma_2)\right]\right)$$

1.19 PLOT OF MIMO M-QAM:



1.20 PLOT OF MIMO MPSK, M-PAM, M-QAM: