Probability of Error in MPSK

As Γ increases with *M*, the probability of error would also be increased. So, the *symbol* probability of error is:

$$P_E \approx 2\,\text{Erfc}\left(\sqrt{\frac{2E_{\text{Avg}}}{\eta}}\sin\frac{\pi}{M}\right) \qquad \& \qquad P_E \approx 2\,\text{Erfc}\left(\sqrt{T_0 B\frac{2S}{N}}\sin\frac{\pi}{M}\right)$$

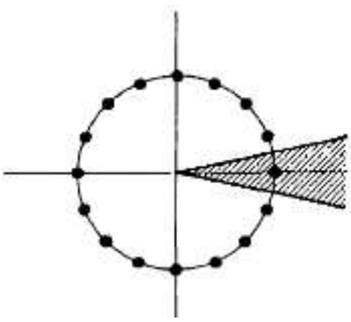
Note: these formulas are for $M \geq 4$ only, and if we use *M*=2, we'll get twice the correct result of BPSK.

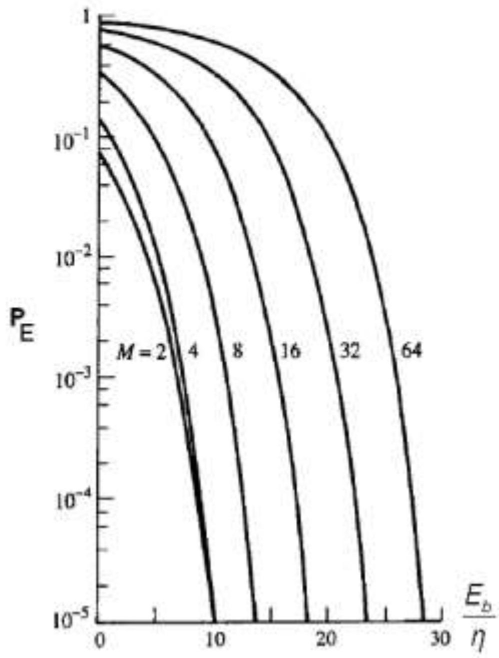
Now, if we use gray code to map binary symbols to phasor state, the probability of *bit* error is:

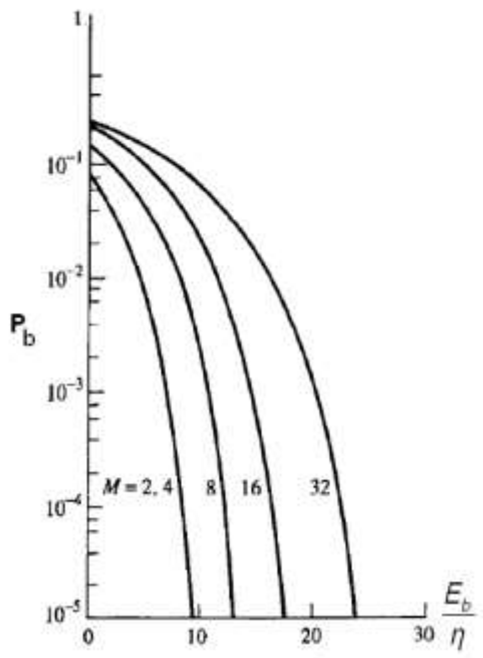
$$P_b = \frac{P_E}{\log_2 M}$$

To compare the performance of MPSK through *M*, we should express P_E in terms of E_b, where:

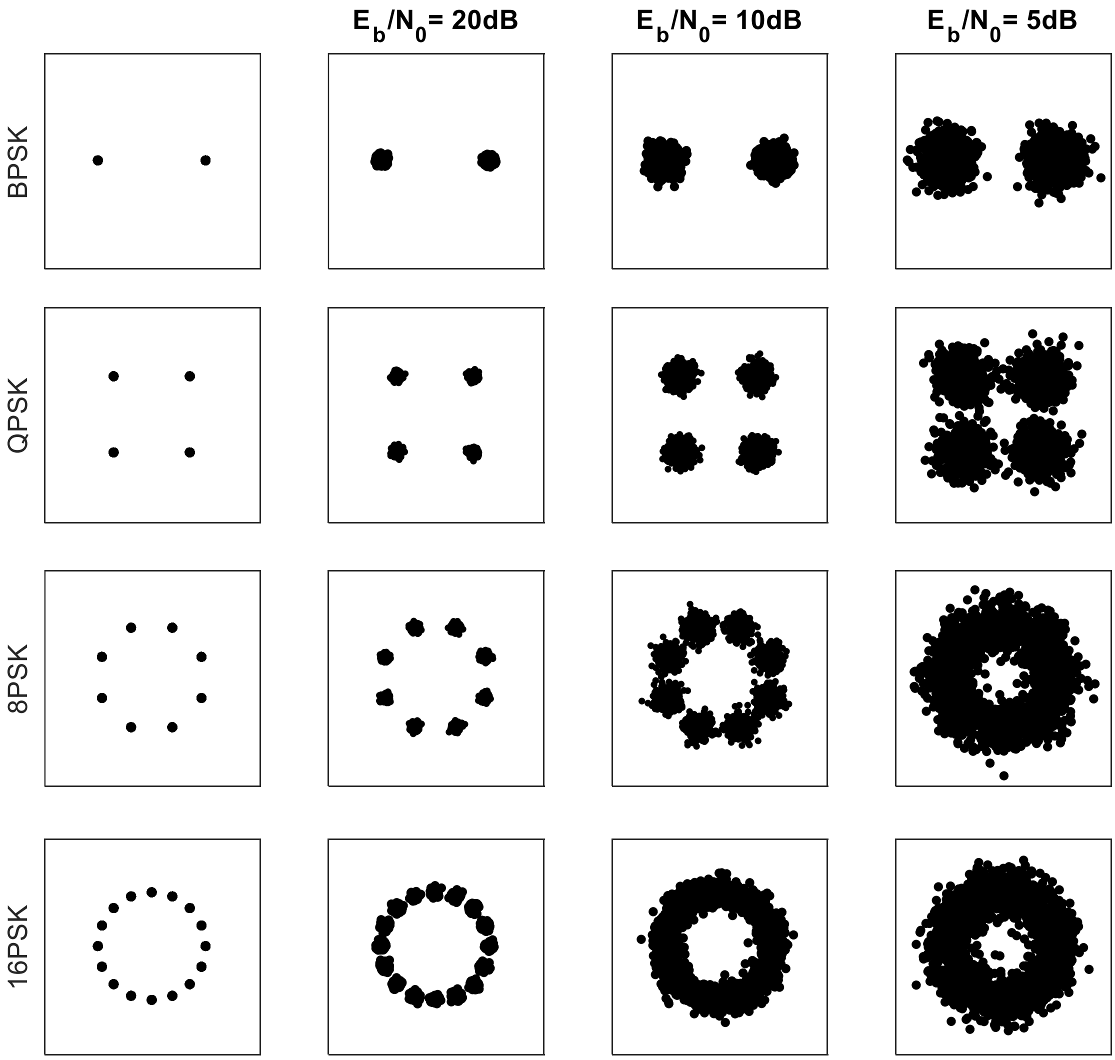
$$E_b = \frac{E_{\text{Avg}}}{\log_2 M}$$







For 32PSK, 64PSK and higher *M* values, it will become so difficult (or sometimes impossible) to distinguish between close phases.



Bandwidth of MPSK Signals

The power spectra of MPSK signals possess a main lobe bounded by well-defined spectral nulls (i.e., frequencies at which the power spectral density is zero). Accordingly, the spectral width of the main lobe provides a simple and popular measure for the bandwidth (null-to-null bandwidth).

So, the channel bandwidth required to pass MPSK signals (more precisely, the main spectral lobe of M-ary signals) is given by:

$$B = R_s = \frac{R_b}{\log_2 M}$$

Where R_s is the symbol rate (bauds per second), R_b is the binary data rate (bits per second).