

Performance of M -ary orthogonal modulation (M -FSK, M -PPM)

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- In M -ary orthogonal modulation, each symbol is sent using a unique pulse:

$$s_m(t) = \sqrt{E_s} \varphi_m(t), \quad m = 1, \dots, M$$

m	$\bar{s}_m = (s_{m1}, s_{m2}, \dots, s_{mM})$
1	$(\sqrt{E_s}, 0, \dots, 0)$
2	$(0, \sqrt{E_s}, \dots, 0)$
...	...
M	$(0, 0, \dots, \sqrt{E_s})$

- The pairwise distance is $d_{12} = \sqrt{2E_s}$
- Every signal point is at the same distance! Gray mapping is NOT possible
- For $M > 2$, the NN approximation is

$$P_b = \frac{M - 1}{2} Q\left(\sqrt{\frac{E_s}{N_0}}\right)$$