PAM, QAM, gap

1. Expressions for PAM and QAM

	PAM	QAM
d_{min}	$\sqrt{\frac{12\mathcal{E}_x}{M^2-1}} = \sqrt{\frac{12\mathcal{E}_x}{4^{\bar{b}}-1}}$	$\text{SQ} : \sqrt{\frac{6\mathcal{E}_x}{M-1}} = \sqrt{\frac{12\overline{\mathcal{E}}_x}{M-1}} = \sqrt{\frac{12\overline{\mathcal{E}}_x}{4^{\bar{b}}-1}}$ $CR : \sqrt{\frac{6\mathcal{E}_x}{\frac{31}{32}M-1}} = \sqrt{\frac{12\overline{\mathcal{E}}_x}{\frac{31}{32}M-1}} = \sqrt{\frac{12\overline{\mathcal{E}}_x}{\frac{31}{32}4^{\bar{b}}-1}}$
$\mathcal{E}_x$	$\frac{d^2}{12}[M^2-1]$	$SQ : 2\overline{\mathcal{E}_x} = \frac{d^2}{6}(M-1)$ $\text{CR} : 2\overline{\mathcal{E}_x} = \frac{d^2}{6}(\frac{31}{32}M-1)$
$\overline{\mathcal{E}_x}$	$\frac{d^2}{12}[M^2-1]$	$SQ : \frac{d^2}{12}(M-1)$ $CR : \frac{d^2}{12}(\frac{31}{32}M-1)$
$\bar{b}$	$log_2 M = \frac{1}{2}log(12\frac{\overline{\mathcal{E}_x}}{d^2}+1)$	$SQ : \frac{1}{2}log_2(\frac{6\mathcal{E}_x}{d^2}+1) = \frac{1}{2}log_2(12\frac{\overline{\mathcal{E}_x}}{d^2}+1)$ $\text{CR} : \frac{1}{2}log_2(\frac{32}{31}(\frac{6\mathcal{E}_x}{d^2}+1)) = \frac{1}{2}log_2(\frac{32}{31}(12\frac{\overline{\mathcal{E}_x}}{d^2}+1))$
P_e	$2(1-\frac{1}{M})Q(\sqrt{\frac{3}{M^2-1}SNR})$	$\text{SQ} : < 4(1-\frac{1}{\sqrt{M}})Q[\frac{d}{2\sigma}] < 4Q[\sqrt{\frac{3}{M-1}SNR}]$ $\text{CR} : < 4(1-\frac{1}{\sqrt{2M}})Q[\frac{d}{2\sigma}] < 4Q[\sqrt{\frac{3}{\frac{31}{32}M-1}SNR}]$
$\overline{P_e}$	$2(1-\frac{1}{M})Q(\sqrt{\frac{3}{M^2-1}SNR})$	$\text{SQ} : \leq 2(1-\frac{1}{2^{\bar{b}}})Q[\frac{d}{2\sigma}] = 2(1-\frac{1}{2^{\bar{b}}})Q[\sqrt{\frac{3}{M-1}SNR}]$ $\text{CR} : \leq 2(1-\frac{1}{2^{\bar{b}+0.5}})Q[\frac{d}{2\sigma}] = 2(1-\frac{1}{2^{\bar{b}+0.5}})Q[\sqrt{\frac{3}{\frac{31}{32}M-1}SNR}]$
P_b	$\approx N_b Q[\frac{d}{2\sigma}] = N_b Q[\sqrt{\frac{3}{M^2-1}SNR}]$	$\text{SQ} : \approx N_b Q[\frac{d}{2\sigma}] = N_b Q[\sqrt{\frac{3}{M-1}SNR}]$ $\text{CR} : \approx N_b Q[\frac{d}{2\sigma}] = N_b Q[\sqrt{\frac{3}{\frac{31}{32}M-1}SNR}]$

2. Gap (for uncoded PAM, QAM)

$\bar{b} = \frac{1}{2}log_2(1+\frac{SNR}{\Gamma})$

$\bar{P}_e$	Γ
10^{-5}	7.8 dB
10^{-6}	8.8 dB
10^{-7}	9.5 dB
10^{-8}	10.2 dB
10^{-9}	10.8 dB