Digital Mapping Schemes for Broadcasting

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Contents

Abstract—A brief description about the design and implementataion of digital mapping schemes for broadcasting application using DVB-S2 [1] standard.
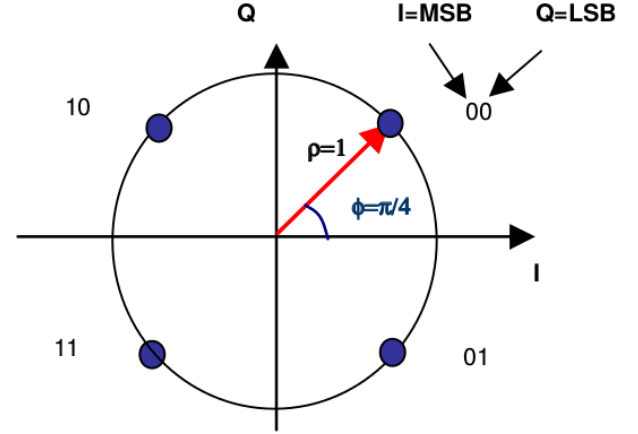

Fig. 1: Constellation diagram of QPSK

1. Phase Shift Keying (PSK)

$$Y_k = X_k + V_k, \quad k = 1, \ldots, N \qquad (1.1)$$

where X_k is the transmitted symbol from the constellation symbols of specified mapping $\{X\}$ in the kth time slot and $V_k \sim \mathcal{N}\left(0, \sigma^2\right)$.

A. QPSK

Constellation Mapping symbol set $\{X\}$ is generated by

$$\{X\} = \left\{e^{j\frac{2\pi n}{4}}\right\} \quad n = 0, 1, \ldots, 3 \qquad (1.2)$$

Demapping can be done by using,

$$\frac{2\pi}{4}i < \angle Y_k < \frac{2\pi}{4}(i+1) \implies \hat{X}_k = X_i \quad i = 0, \ldots, 3 \qquad (1.3)$$

Fig. 1 Shows the Constellation mapping for QPSK scheme and similarly Fig. 2 Shows the Simulation diagram.
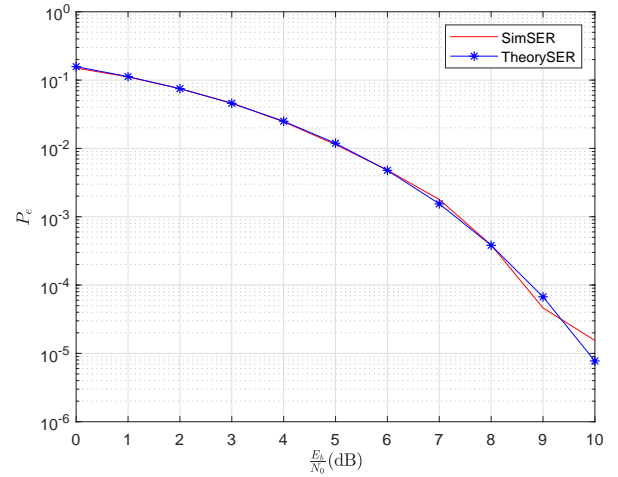
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Fig. 2: SNR vs BER for QPSK

B. 8PSK

Constellation Mapping symbol set $\{X\}$ is generated by

$$\{X\} = \left\{e^{j\frac{2\pi n}{4}}\right\} \quad n = 0, 1, \ldots, 7 \qquad (1.4)$$

Demapping can be done by using,

$$\frac{2\pi}{8}i < \angle Y_k < \frac{2\pi}{8}(i+1) \implies \hat{X}_k = X_i \quad i = 0, \ldots, 7 \qquad (1.5)$$
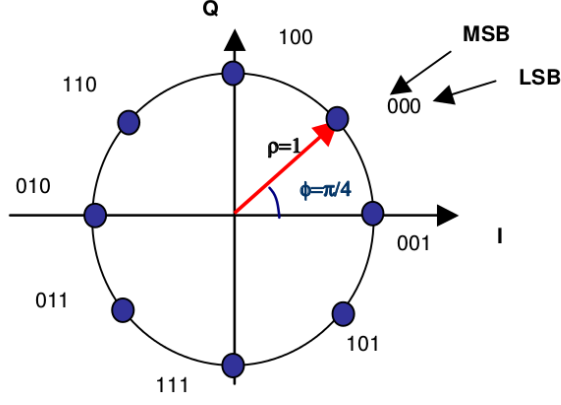
Fig. 3: Constellation diagram of 8-PSK

Fig. 3 Shows the Constellation mapping for 8-PSK symbols.and similarly Fig. 4 Shows the Simulation diagram.
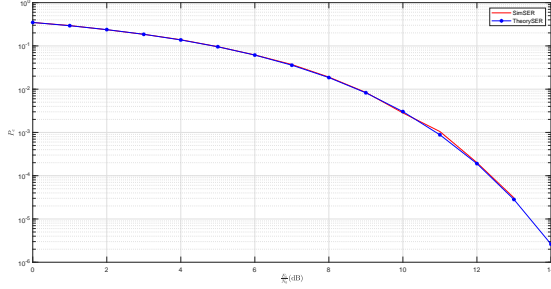

Fig. 4: SNR vs BER for 8-PSK

2. Amplitude Phase Shift Keying (APSK)

A. 16-APSK

Constellation Mapping symbol set $\{X\}$ is generated by

$$\{X\} = \begin{cases} r_1 e^{j\left(\phi_1 + \frac{2\pi}{4}n\right)} & n = 0, \ldots, 3 \\ r_2 e^{j\left(\phi_2 + \frac{2\pi}{12}n\right)} & n = 0, 1, \ldots, 11 \end{cases} \quad (2.1)$$

Demapping can be done by using,

$$|Y_k| < \frac{r_1 + r_2}{2} \&\& \frac{2\pi}{4}i < \angle Y_k < \frac{2\pi}{4}(i+1) \quad (2.2)$$

$$\implies \hat{X}_k = X_i \quad i = 0, \ldots, 3 \quad (2.3)$$

$$|Y_k| > \frac{r_1 + r_2}{2} \&\& \frac{2\pi}{12}i < \angle Y_k < \frac{2\pi}{12}(i+1) \quad (2.4)$$

$$\implies \hat{X}_k = X_i \quad i = 4, \ldots, 15 \quad (2.5)$$

Where $\frac{r_2}{r_1} = 2.6, \phi_1 = 45, \phi_2 = 15$ Fig. 5 Shows the Constellation mapping for 16-APSK symbols and similarly Fig. 6 Shows the Simulation diagram.
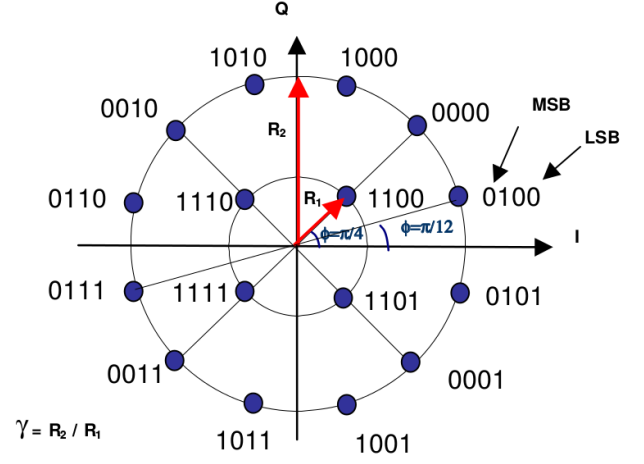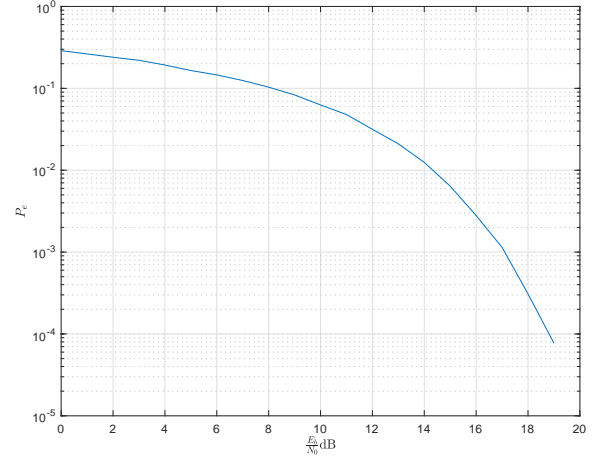

Fig. 5: Constellation diagram of 16APSK

Fig. 6: SNR vs BER for 16-APSK

B. 32-APSK

Constellation Mapping symbol set $\{X\}$ is generated by

$$\{X_n\} = \begin{cases} r_1 e^{j\left(\phi_1 + \frac{2\pi}{4}n\right)} & n = 0, \ldots, 3 \\ r_2 e^{j\left(\phi_2 + \frac{2\pi}{12}n\right)} & n = 0, 1, \ldots, 11 \\ r_3 e^{j\left(\phi_3 + \frac{2\pi}{16}n\right)} & n = 0, 1, \ldots, 16 \end{cases} \quad (2.6)$$

Where $\frac{r_2}{r_1} = 2.54, \frac{r_3}{r_2} = 4.33,, \phi_1 = 45, \phi_2 = 15, \phi_3 = 0.$

Demapping can be done by using,

$$|Y_k| < \frac{r_1 + r_2}{2} \&\& \frac{2\pi}{4}i < \angle Y_k < \frac{2\pi}{4}(i+1)$$
(2.7)

$$\implies \hat{X}_k = X_i \quad i = 0, \dots, 3$$
(2.8)

$$\frac{r_1 + r_2}{2} < |Y_k| < \frac{r_2 + r_3}{2} \&\& \frac{2\pi}{12}i < \angle Y_k < \frac{2\pi}{12}(i+1)$$
(2.9)

$$\implies \hat{X}_k = X_i \quad i = 4, \dots, 15$$
(2.10)

$$|Y_k| > \frac{r_2 + r_3}{2} \&\& \frac{2\pi}{12}i < \angle Y_k < \frac{2\pi}{12}(i+1)$$
(2.11)

$$\implies \hat{X}_k = X_i \quad i = 16, \dots, 31$$
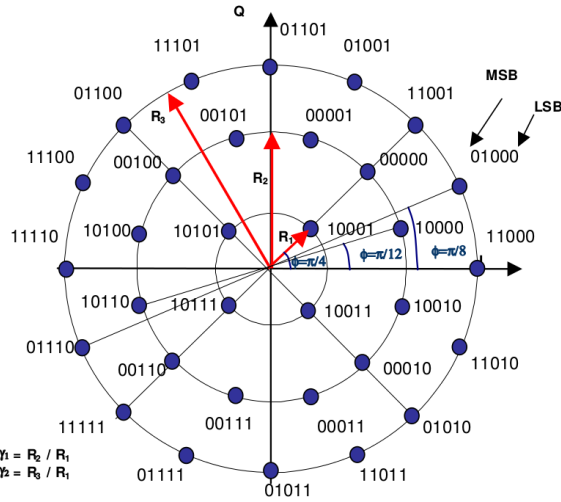(2.12)

Fig. 7: Constellation diagram of 32APSK

Fig. 8: SNR vs BER for 32-APSK

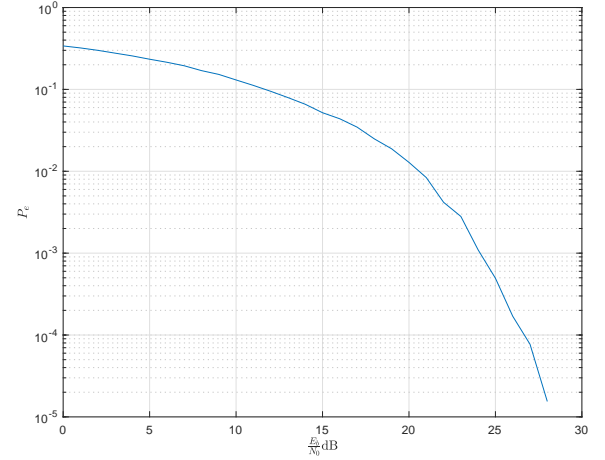Fig. 7 Shows the Constellation mapping for 32-APSK symbols and similarly Fig. 8 Shows the Simulation diagram.

REFERENCES

[1] A. Morello and V. Mignone, "DVB-S2X: The New Extensions to the Second Generation DVB Satellite Standard DVB-S2," *Int. J. Satell. Commun. Netw.*, vol. 34, no. 3, pp. 323–325, May 2016. [Online]. Available: https://doi.org/10.1002/sat.1167