

Physical Layer Design for a Narrow Band Communication System

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Abstract—This a simple document explaining a question about the concept of similar triangles.

Download all python codes from

svn co <https://github.com/SiddharthPh/Summer2020/trunk/geometry/codes>

and latex-tikz codes from

svn co <https://github.com/gadepall/school/trunk/ncert/geometry/figs>

1 SPECIFICATIONS

1.0.1. 8-PSK Consider

$$\mathbf{y} = \mathbf{s} + \mathbf{n} \quad (1.0.1.1)$$

where $\mathbf{s} \in \{s_0, s_1, s_2, s_3, s_4, s_5, s_6, s_7\}$

$$s_0 = \begin{pmatrix} \sqrt{E_s} \\ 0 \end{pmatrix} \quad (1.0.1.2)$$

$$s_1 = \begin{pmatrix} \sqrt{\frac{E_s}{2}} \\ \sqrt{\frac{E_s}{2}} \end{pmatrix} \quad (1.0.1.3)$$

$$s_2 = \begin{pmatrix} 0 \\ \sqrt{E_s} \end{pmatrix} \quad (1.0.1.4)$$

$$s_3 = \begin{pmatrix} -\sqrt{\frac{E_s}{2}} \\ \sqrt{\frac{E_s}{2}} \end{pmatrix} \quad (1.0.1.5)$$

$$s_4 = \begin{pmatrix} -\sqrt{E_s} \\ 0 \end{pmatrix} \quad (1.0.1.6)$$

$$s_5 = \begin{pmatrix} -\sqrt{\frac{E_s}{2}} \\ -\sqrt{\frac{E_s}{2}} \end{pmatrix} \quad (1.0.1.7)$$

$$s_6 = \begin{pmatrix} 0 \\ -\sqrt{E_s} \end{pmatrix} \quad (1.0.1.8)$$

$$s_7 = \begin{pmatrix} \sqrt{\frac{E_s}{2}} \\ -\sqrt{\frac{E_s}{2}} \end{pmatrix} \quad (1.0.1.9)$$

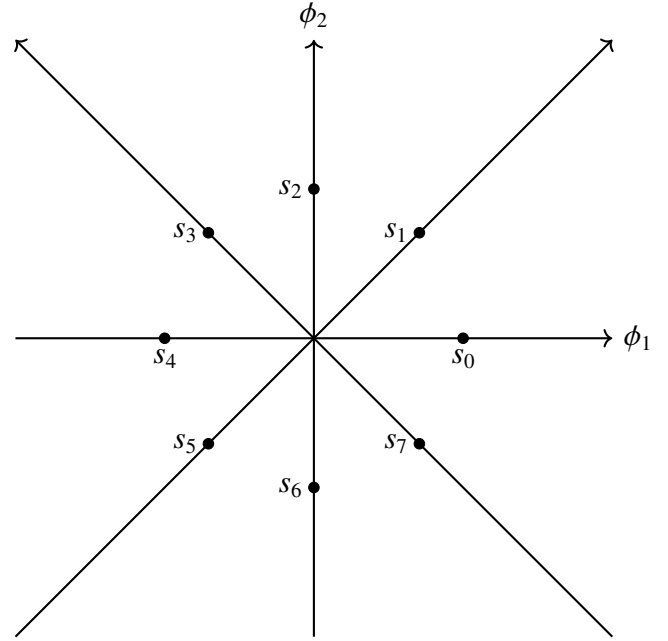


Fig. 1.0.1.1: Constellation diagram

1.0.2. Encoding

s_0 denote bits 000, s_1 denote bits 001, s_2 denote bits 011, s_3 denote bits 010, s_4 denote bits 110, s_5 denote bits 111, s_6 denote bits 101, s_7 denote bits 100.

1.0.3. Decoding

Let \mathbf{r} be the received bits, $\mathbf{r} = [r_1, r_2, r_3]$.

$$r_1 = \begin{cases} 0, & \mathbf{y} \in D1 \cup D2 \cup D3 \cup D4 \Leftrightarrow y_1(\sqrt{2} - 1) + y_2 > \\ 1, & \mathbf{y} \in D5 \cup D6 \cup D7 \cup D8 \Leftrightarrow y_1(\sqrt{2} - 1) + y_2 < \end{cases} \quad (1.0.3.1)$$

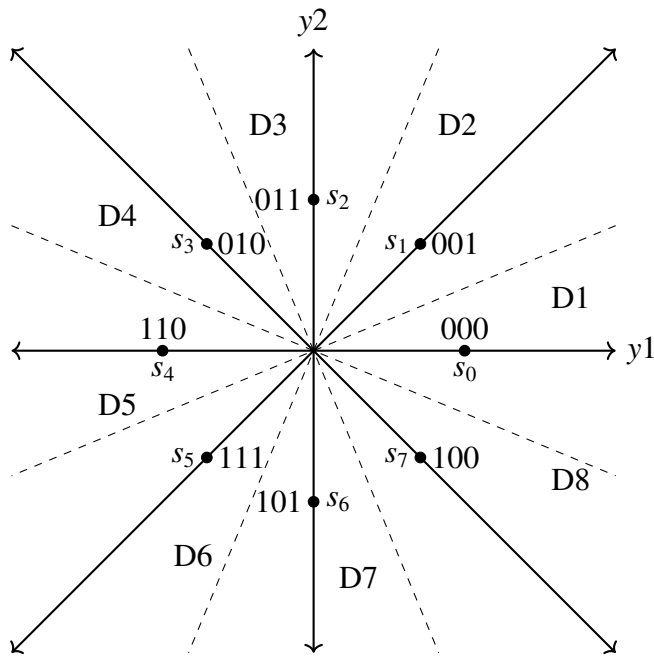


Fig. 1.0.3.1: decision regions

$$r_2 = \begin{cases} 0, & \mathbf{y} \in D2 \cup D1 \cup D8 \cup D7 \iff y_2 - (\sqrt{2} + 1)y_1 < 0 \\ 1, & \mathbf{y} \in D3 \cup D4 \cup D5 \cup D6 \iff y_2 - (\sqrt{2} + 1)y_1 > 0 \end{cases} \quad (1.0.3.2)$$

$$r_3 = \begin{cases} 0, & \mathbf{y} \in D4 \cup D5 \cup D1 \cup D8 \iff y_2 + (\sqrt{2} + 1)y_1 < 0, y_2 - (\sqrt{2} - 1)y_1 > 0 \\ 1, & \mathbf{y} \in D2 \cup D3 \cup D6 \cup D7 \iff y_2 + (\sqrt{2} + 1)y_1 > 0, y_2 - (\sqrt{2} - 1)y_1 < 0 \end{cases} \quad (1.0.3.3)$$

From eq.??,eq.?? and eq.??

For detecting s_0 , $y_2 + (\sqrt{2} - 1)y_1 > 0$ and $y_2 - (\sqrt{2} - 1)y_1 < 0$.

For detecting s_1 , $y_2 - (\sqrt{2} + 1)y_1 < 0$ and $y_2 - (\sqrt{2} - 1)y_1 > 0$.

For detecting s_2 , $y_2 - (\sqrt{2} + 1)y_1 > 0$ and $y_2 + (\sqrt{2} + 1)y_1 > 0$.

For detecting s_3 , $y_2 + (\sqrt{2} - 1)y_1 > 0$ and $y_2 + (\sqrt{2} + 1)y_1 < 0$.

For detecting s_4 , $y_2 + (\sqrt{2} - 1)y_1 < 0$ and $y_2 - (\sqrt{2} - 1)y_1 > 0$.

For detecting s_5 , $y_2 - (\sqrt{2} + 1)y_1 > 0$ and $y_2 - (\sqrt{2} - 1)y_1 < 0$.

For detecting s_6 , $y_2 - (\sqrt{2} + 1)y_1 < 0$ and $y_2 + (\sqrt{2} + 1)y_1 < 0$.

For detecting s_7 , $y_2 + (\sqrt{2} - 1)y_1 < 0$ and $y_2 + (\sqrt{2} + 1)y_1 > 0$.

1.0.4. The following code has simulation of 8PSK.

codes/8psk.py