Signal Representation

$$s(t) = \begin{cases} \sqrt{E_b}\, g(t), & bit = +1 \\ -\sqrt{E_b}\, g(t), & bit = -1 \end{cases}$$

$$\int_0^T g^2(t)\,dt = 1$$

$$\left\{ \begin{array}{ll} s_1(t), & bit\ +1 \\ s_2(t), & bit\ -1 \end{array} \right\}$$

$$s_1(t) = \alpha\, g(t)$$

$$s_2(t) = -\alpha\, g(t)$$

$g(t)$ → unit energy.

→ basis function

orthogonal $\rightarrow \int_0^T \phi_i(t)\,\phi_j(t)\,dt = 0 \; ; \quad \underbrace{}_{i \neq j}$

orthonormal $\rightarrow \int_0^T \phi_i^2(t)\,dt = 1 \; ;$

signal set

$s_1(t)$
$s_2(t)$
$s_3(t)$
$\vdots$
$s_N(t)$

$$\boxed{s_i(t) = \sum_{j=1}^{M} \alpha_{ij}\, \phi_j(t) \qquad i = 1 \ldots N}$$

basis set

$\phi_1(t)$
$\phi_2(t)$
$\vdots$
$\phi_M(t)$

cont. time signal

$$s_1(t) \longrightarrow \begin{bmatrix} \alpha_{11} \\ \alpha_{12} \\ \vdots \\ \alpha_{1M} \end{bmatrix} ; \quad \bar{\alpha}_1 \quad M \times 1$$

vector

T

$N = 2^K$

$$\boxed{\alpha_{ij} \triangleq \int_0^T s_i(t)\, \phi_j(t)\, dt}$$

ϕ_j

$N \gg M$

$N \geq M$

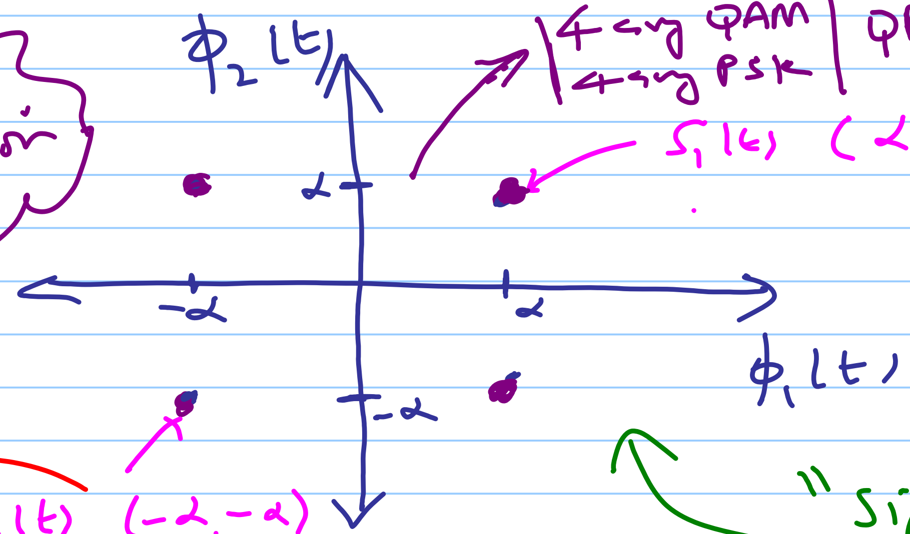
$\{ s_1(t), s_2(t), \ldots s_N(t) \} \longleftrightarrow \{ \bar{\alpha}_1, \bar{\alpha}_2 \, \ldots \, \bar{\alpha}_N \}$

$N \gg M$ $\quad M = 2$ $\quad$ compact $\quad$ $M \times 1$

Gram-Schmidt orthogonalization

4-ary QAM | QPSK

4-ary PSK



$\alpha + j\alpha$

$\bar{\alpha}_1 = \begin{bmatrix} \alpha \\ \alpha \end{bmatrix};$

$\bar{\alpha}_3 = \begin{bmatrix} -\alpha \\ -\alpha \end{bmatrix};$

"signal constellation"

$\rightarrow$ PAM / QAM

3-dim vector space $\Rightarrow \{ \bar{q}_1, \bar{q}_2, \bar{q}_3 \}$ orthonormal

l. i.