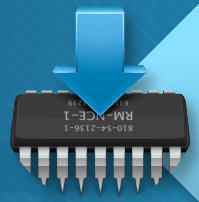
Communication Systems

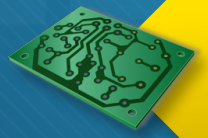
Muhammad Obaidullah

Process of Modulation

Modulation Types

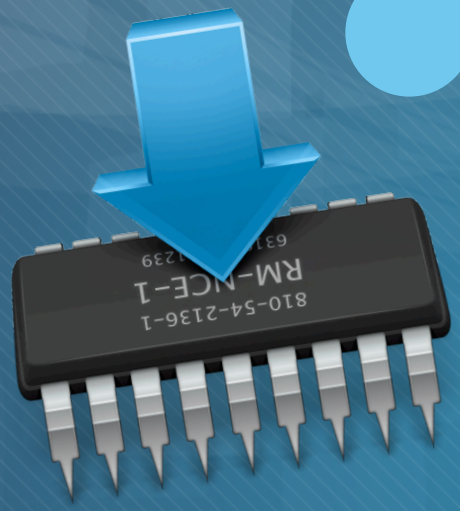


On Off Keying
OOK



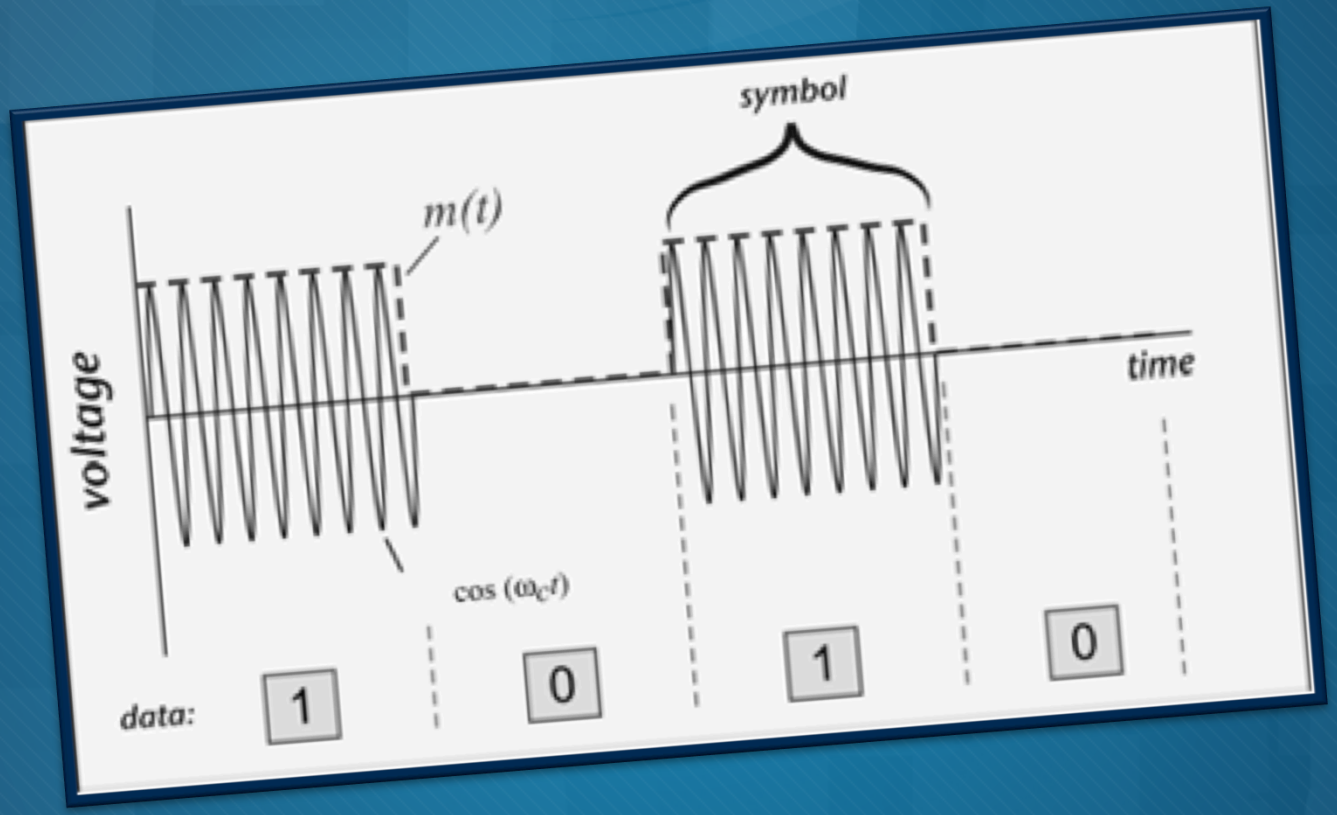
Binary Phase Shift Keying
BPSK

Frequency Shift Keying
FSK

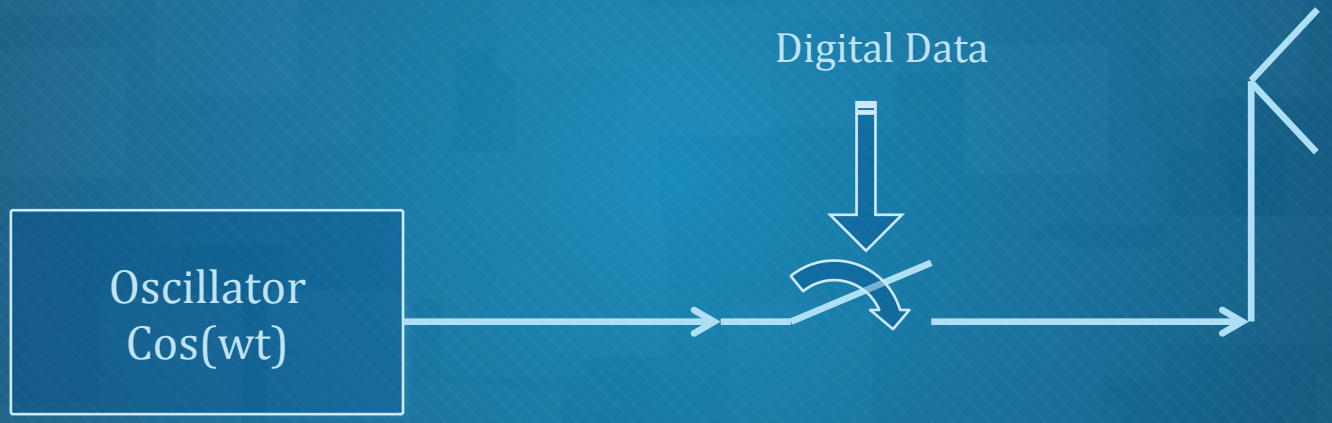


On Off Keying

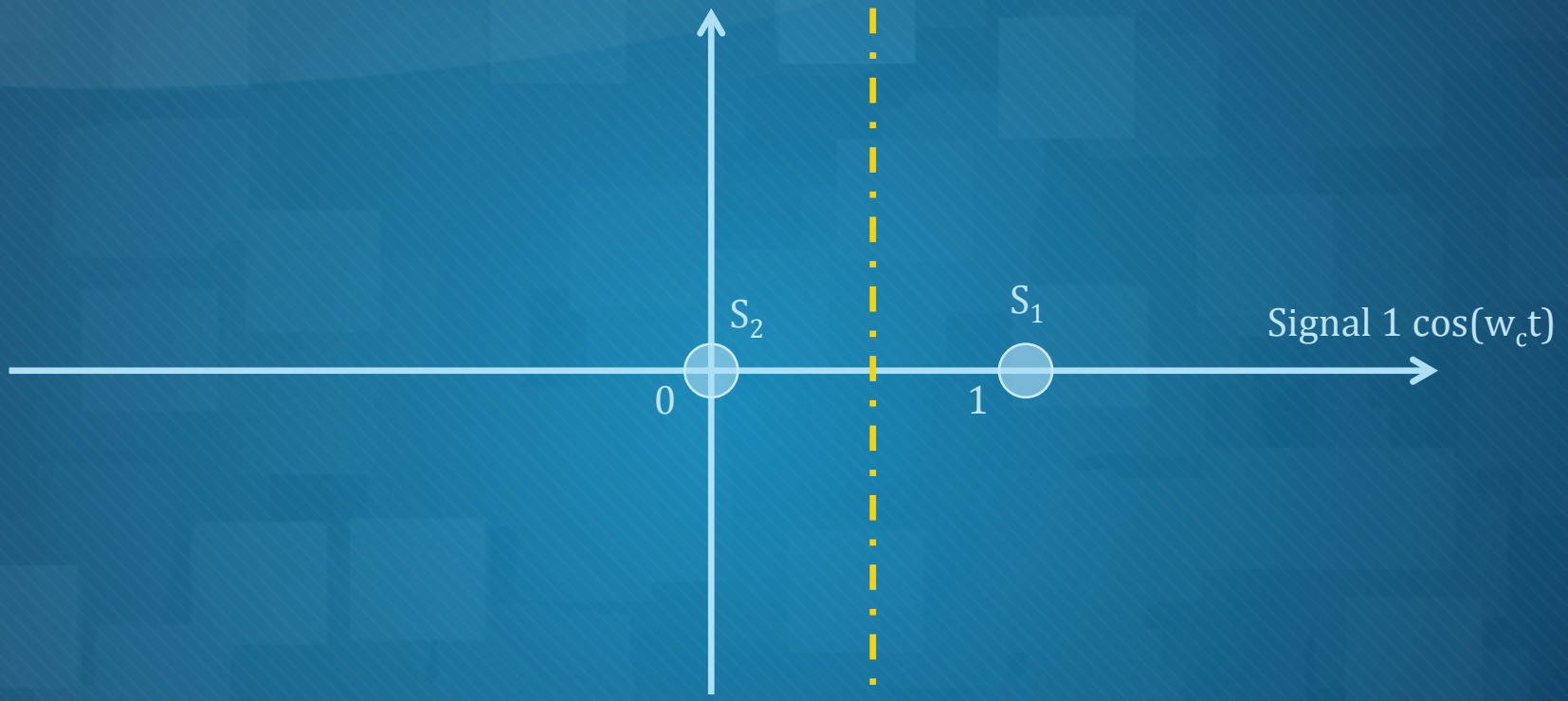
OOK



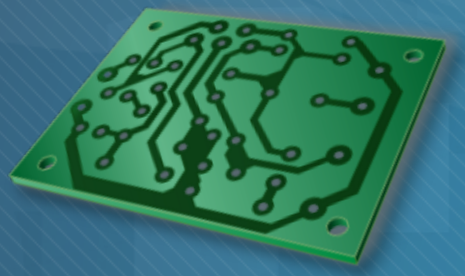
The Message signal is transmitted when the bit is 1 and it is not transmitted when the bit is 0.



The Message signal is transmitted when the bit is 1 and it is not transmitted when the bit is 0.

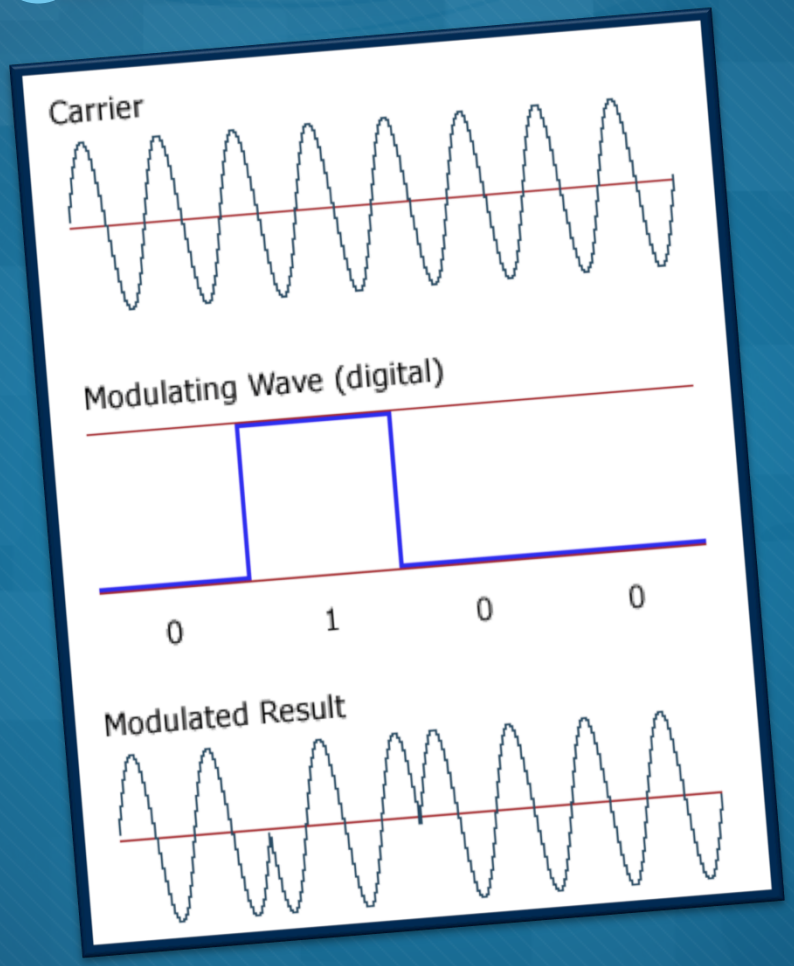


The Message signal is transmitted when the bit is 1 and it is not transmitted when the bit is 0.

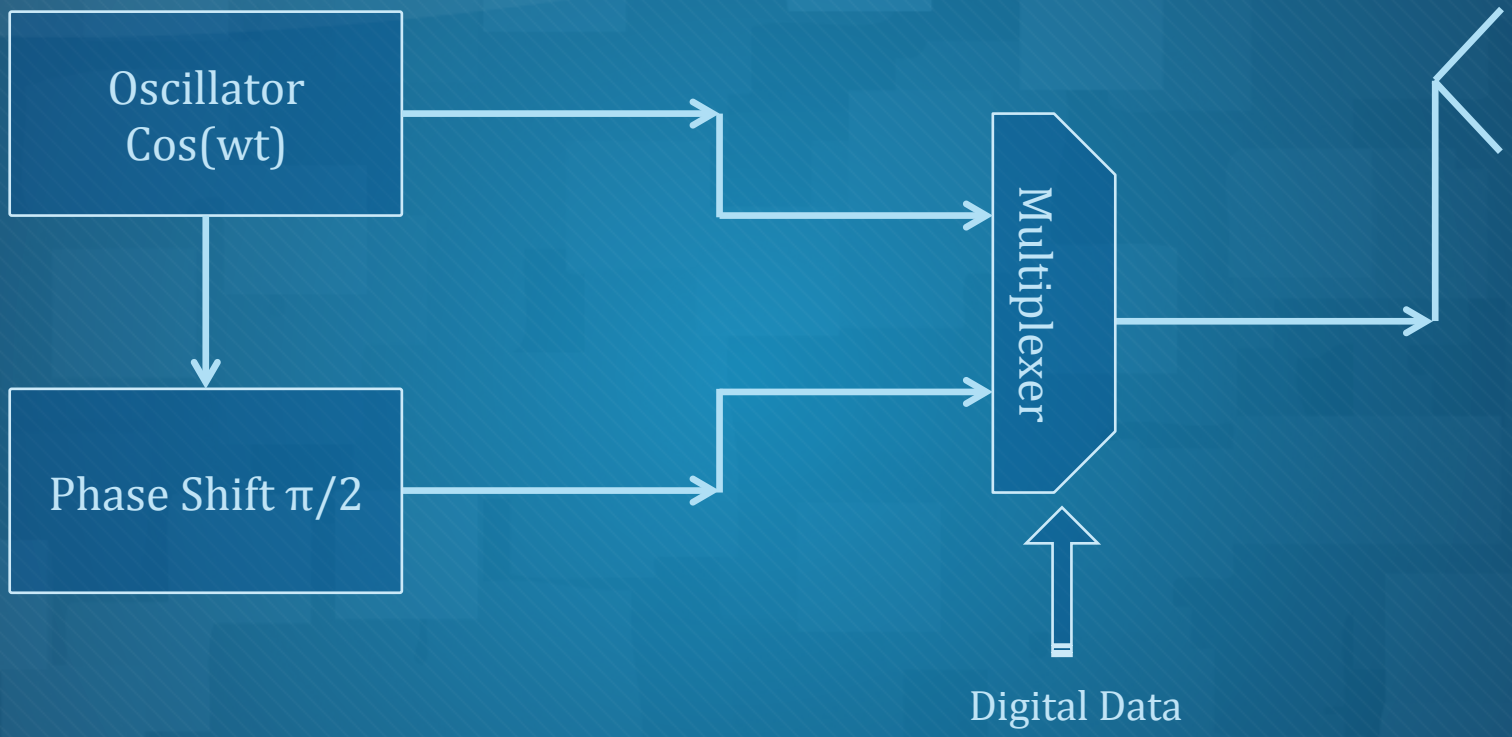


Phase Shift Keying

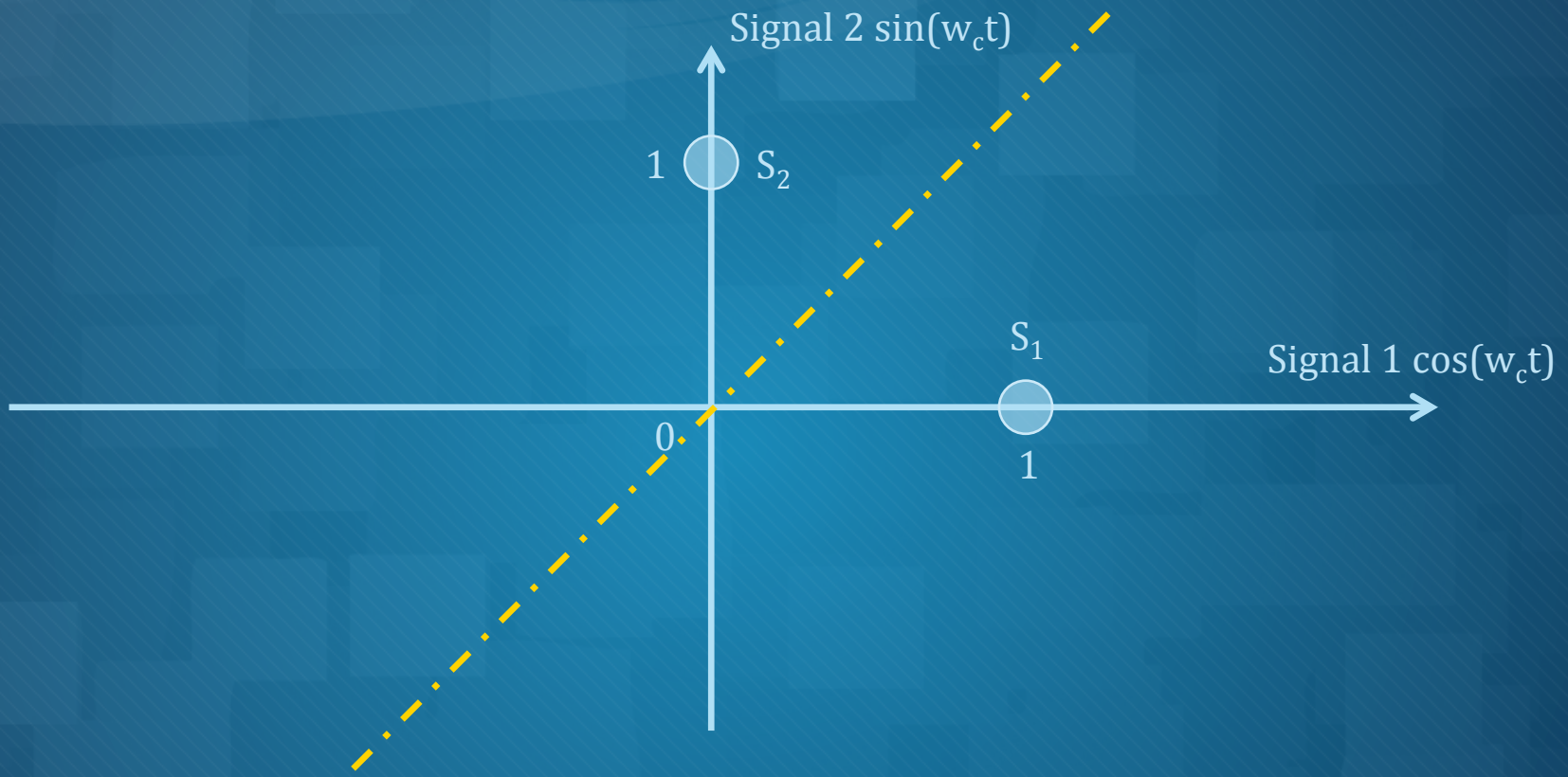
BPSK



A different phase of carrier is sent for each symbol (1 or 0).

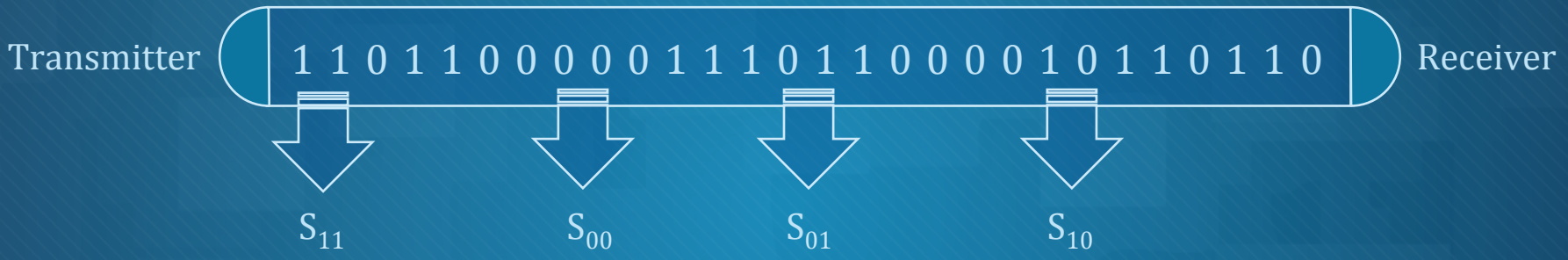


Multiplexer chooses the signal according to the digital data incoming and sends it to antenna.



The Message signal is transmitted when the bit is 1 and it is not transmitted when the bit is 0.

Consider the following System.



$$S_{00}(t) = \sqrt{Es}\ \cos(2\pi f_c t + 3\pi/4)$$

$$S_{01}(t) = \sqrt{Es}\ \cos(2\pi f_c t - 3\pi/4)$$

$$S_{10}(t) = \sqrt{Es}\ \cos(2\pi f_c t + \pi/4)$$

$$S_{11}(t) = \sqrt{Es}\ \cos(2\pi f_c t - \pi/4)$$

Name	Symbol	Phase Shift
S_{00}	00	$3\pi/4$
S_{01}	01	$-3\pi/4$
S_{10}	10	$\pi/4$
S_{11}	11	$-\pi/4$

Simplification of System.

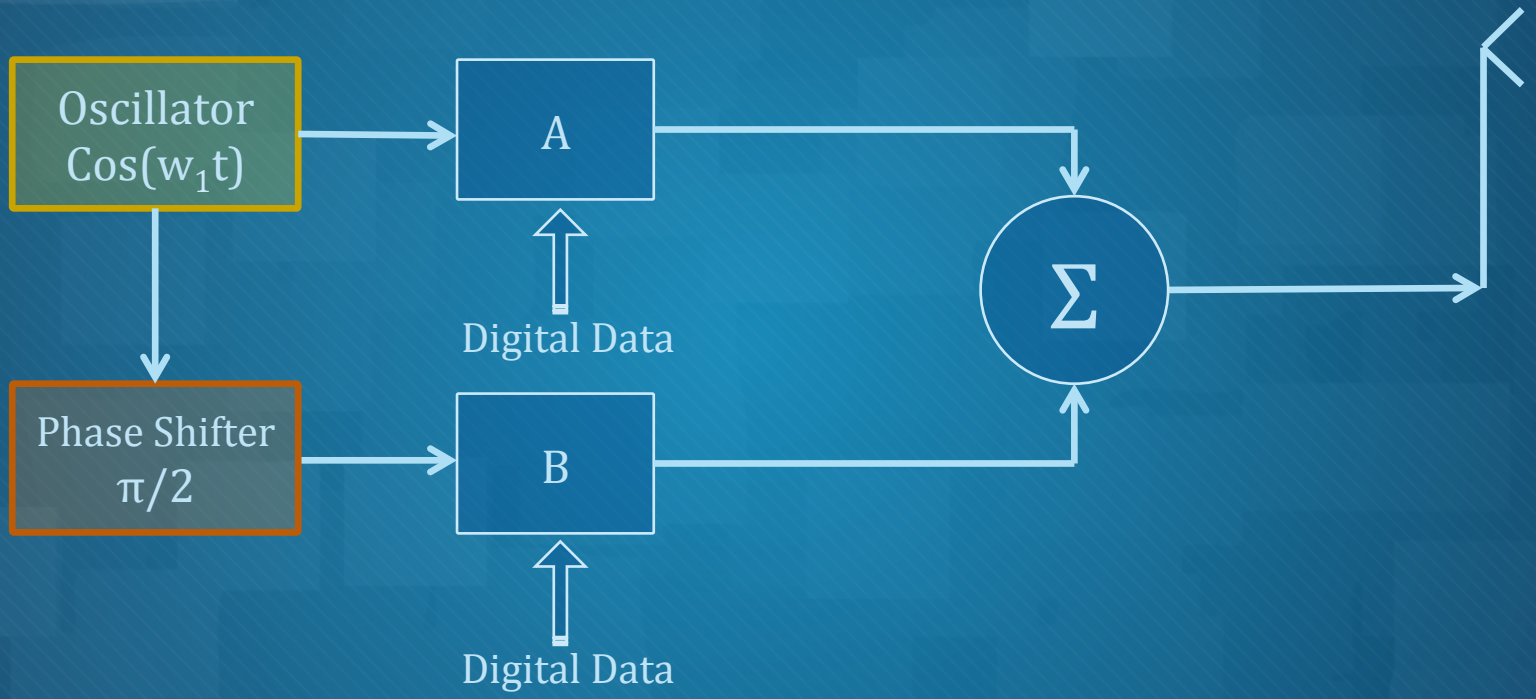
$\cos(A+B) = \cos(A)\cos(B) - \sin(A)\sin(B)$
$\cos^2(A) = \frac{1}{2} + \cos(2A)/2$
$\sin^2(A) = \frac{1}{2} - \cos(2A)/2$

$$S_{00}(t) = \sqrt{Es}\ \cos(2\pi f_c t + 3\pi/4) = -(\sqrt{2Es})/2\ \cos(2\pi f_c t) - (\sqrt{2Es})/2\ \sin(2\pi f_c t)$$

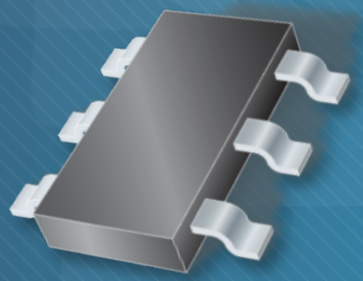
$$S_{01}(t) = \sqrt{Es}\ \cos(2\pi f_c t - 3\pi/4) = -(\sqrt{2Es})/2\ \cos(2\pi f_c t) + (\sqrt{2Es})/2\ \sin(2\pi f_c t)$$

$$S_{10}(t) = \sqrt{Es}\ \cos(2\pi f_c t + \pi/4) = +(\sqrt{2Es})/2\ \cos(2\pi f_c t) - (\sqrt{2Es})/2\ \sin(2\pi f_c t)$$

$$S_{11}(t) = \sqrt{Es}\ \cos(2\pi f_c t - \pi/4) = +(\sqrt{2Es})/2\ \cos(2\pi f_c t) + (\sqrt{2Es})/2\ \sin(2\pi f_c t)$$

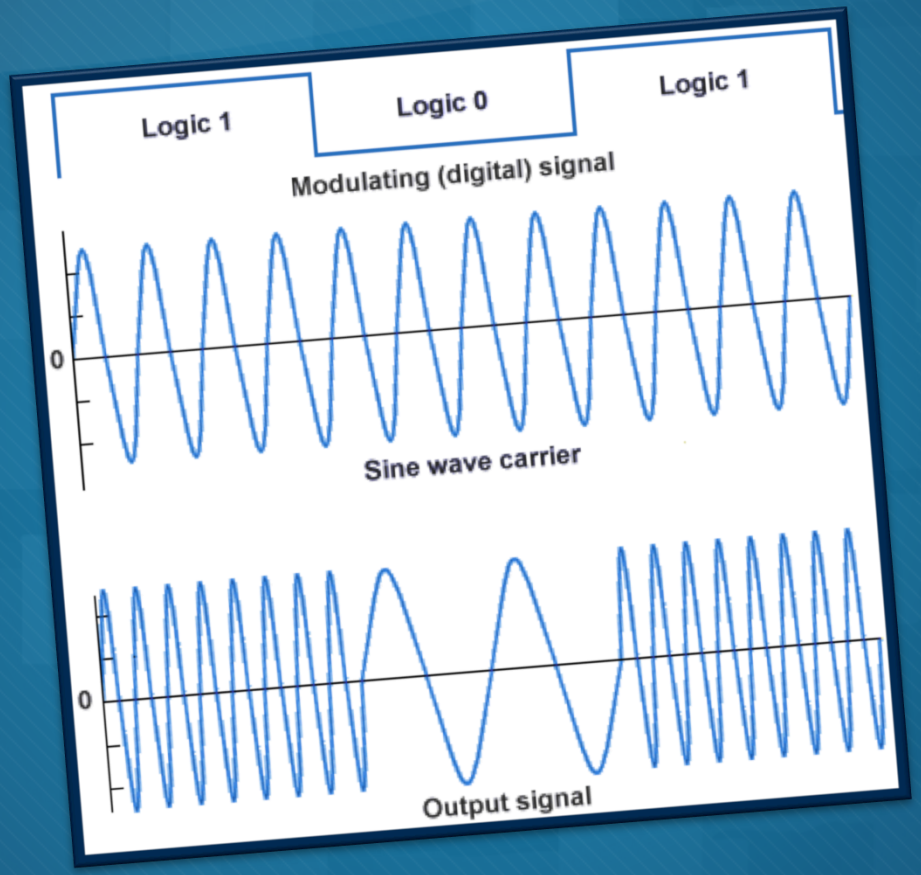


Any phase shifted sinusoidal can be considered as Amplitude modulation of the original sinusoidal signal.

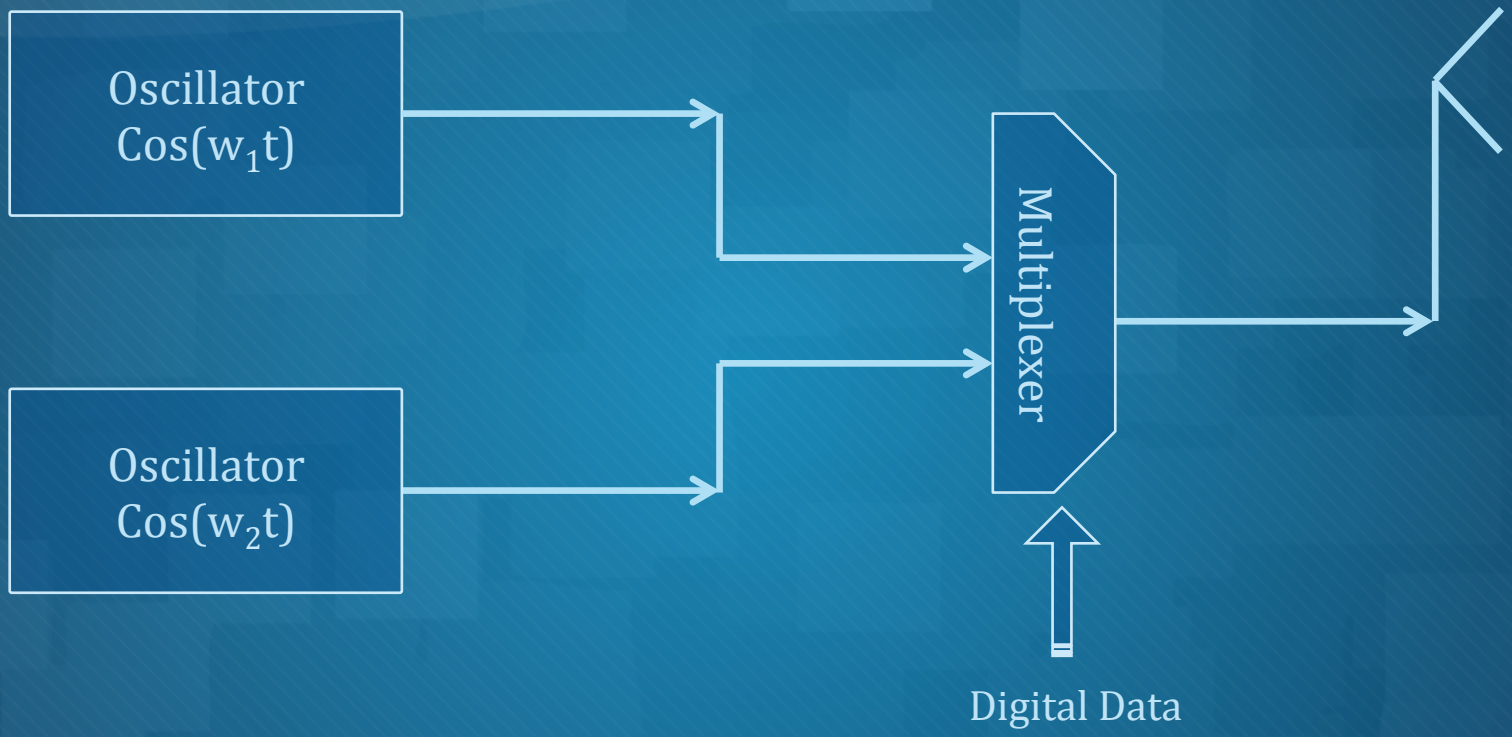


Frequency Shift Keying

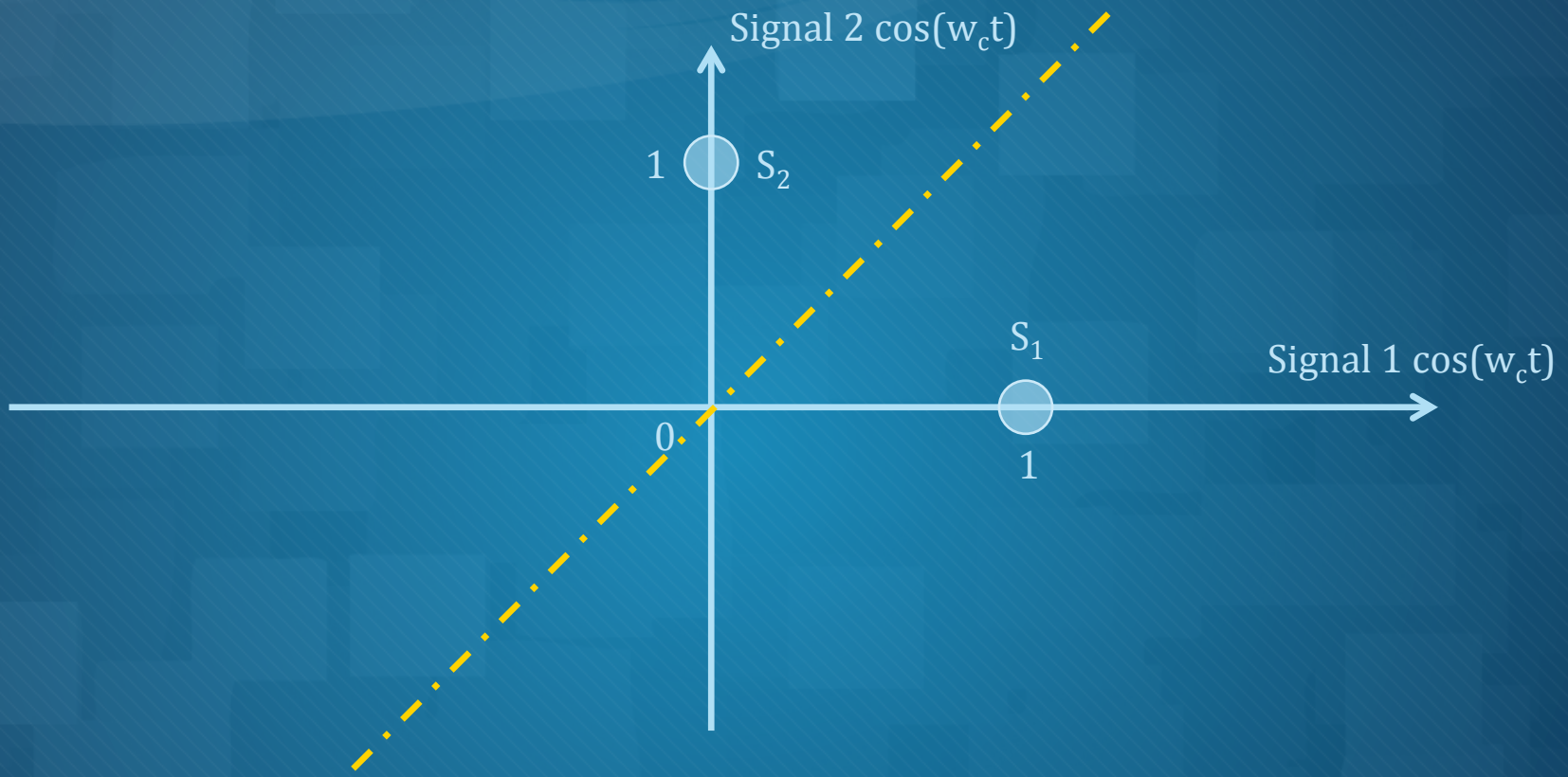
FSK



A different frequency of carrier is sent for each symbol (1 or 0).



Multiplexer chooses the signal according to the digital data incoming and sends it to antenna.



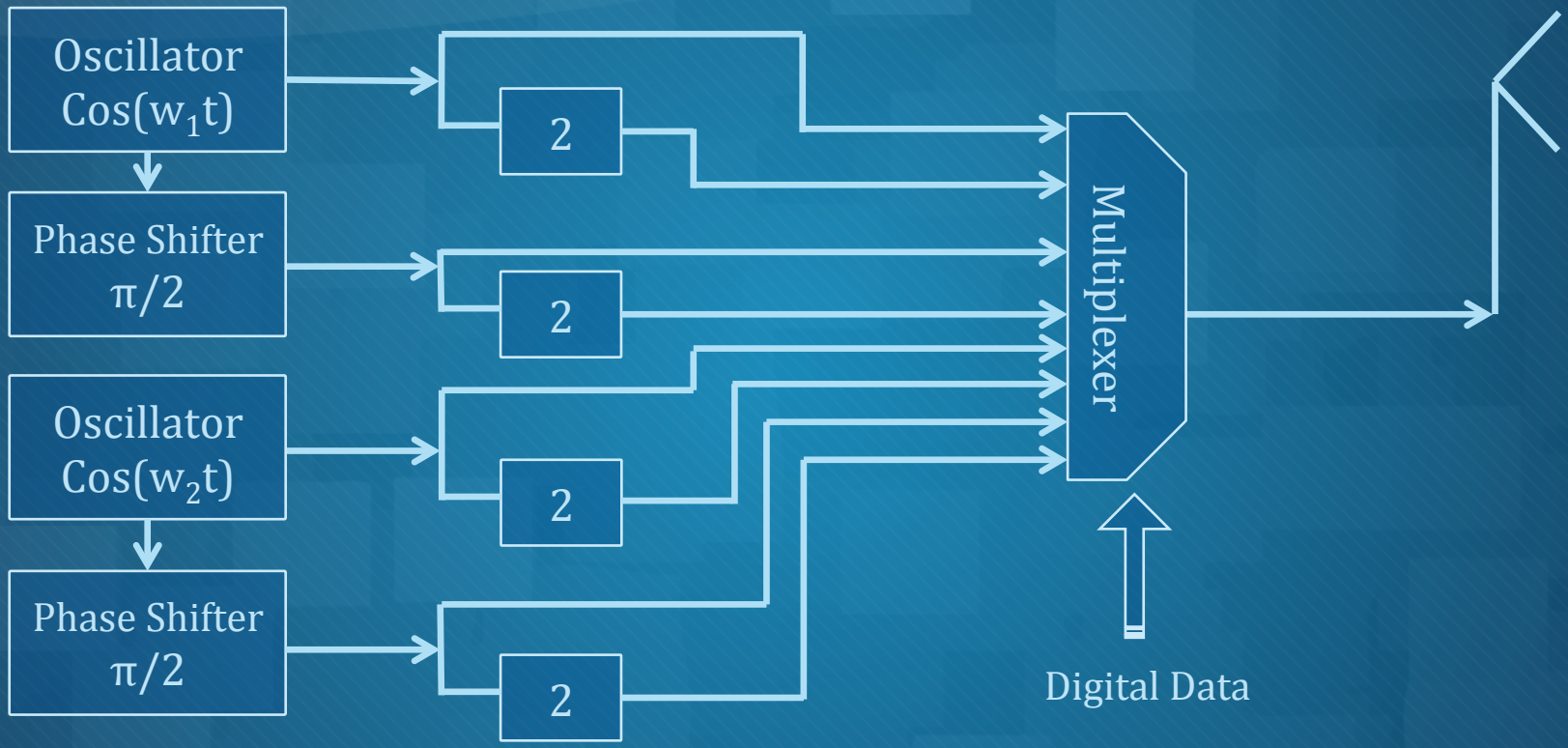
The Message signal is transmitted when the bit is 1 and it is not transmitted when the bit is 0.

Combination of ASK, PSK, FSK

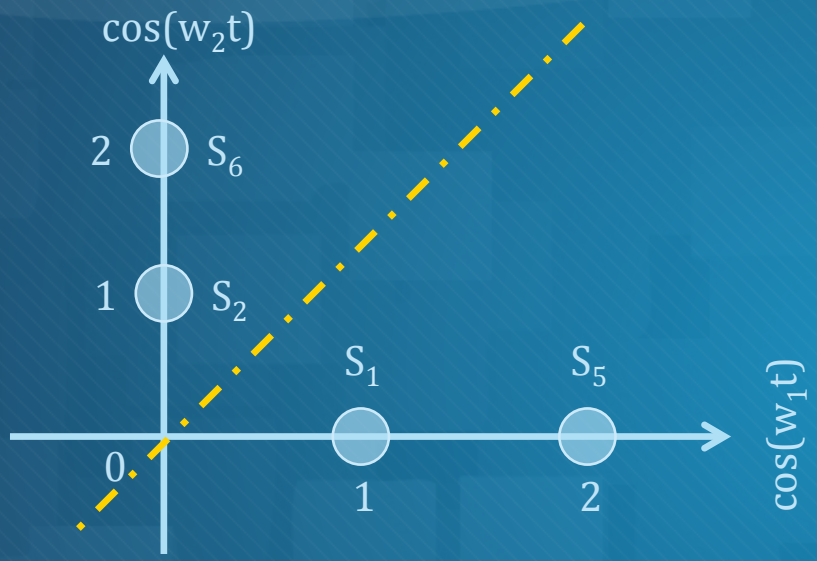
An Example

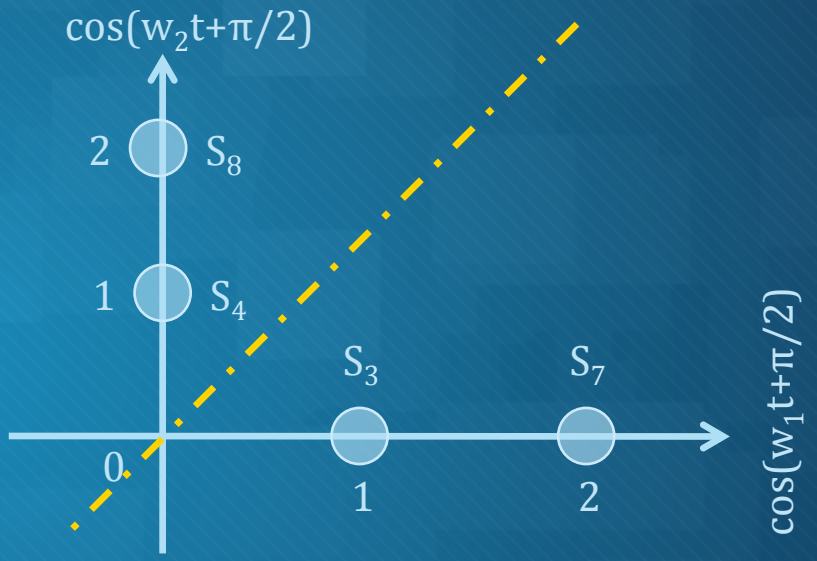
Name	Symbol	Signal
S_1	000	$\cos(w_1 t)$
S_2	001	$\cos(w_2 t)$
S_3	010	$\cos(w_1 t+\pi/2)$
S_4	011	$\cos(w_2 t+\pi/2)$
S_5	100	$2\cos(w_1 t)$
S_6	101	$2\cos(w_2 t)$
S_7	110	$2\cos(w_1 t+\pi/2)$
S_8	111	$2\cos(w_2 t+\pi/2)$

A System modulates the carrier according to the given chart.



Multiplexer chooses the signal according to the digital data incoming and sends it to antenna.

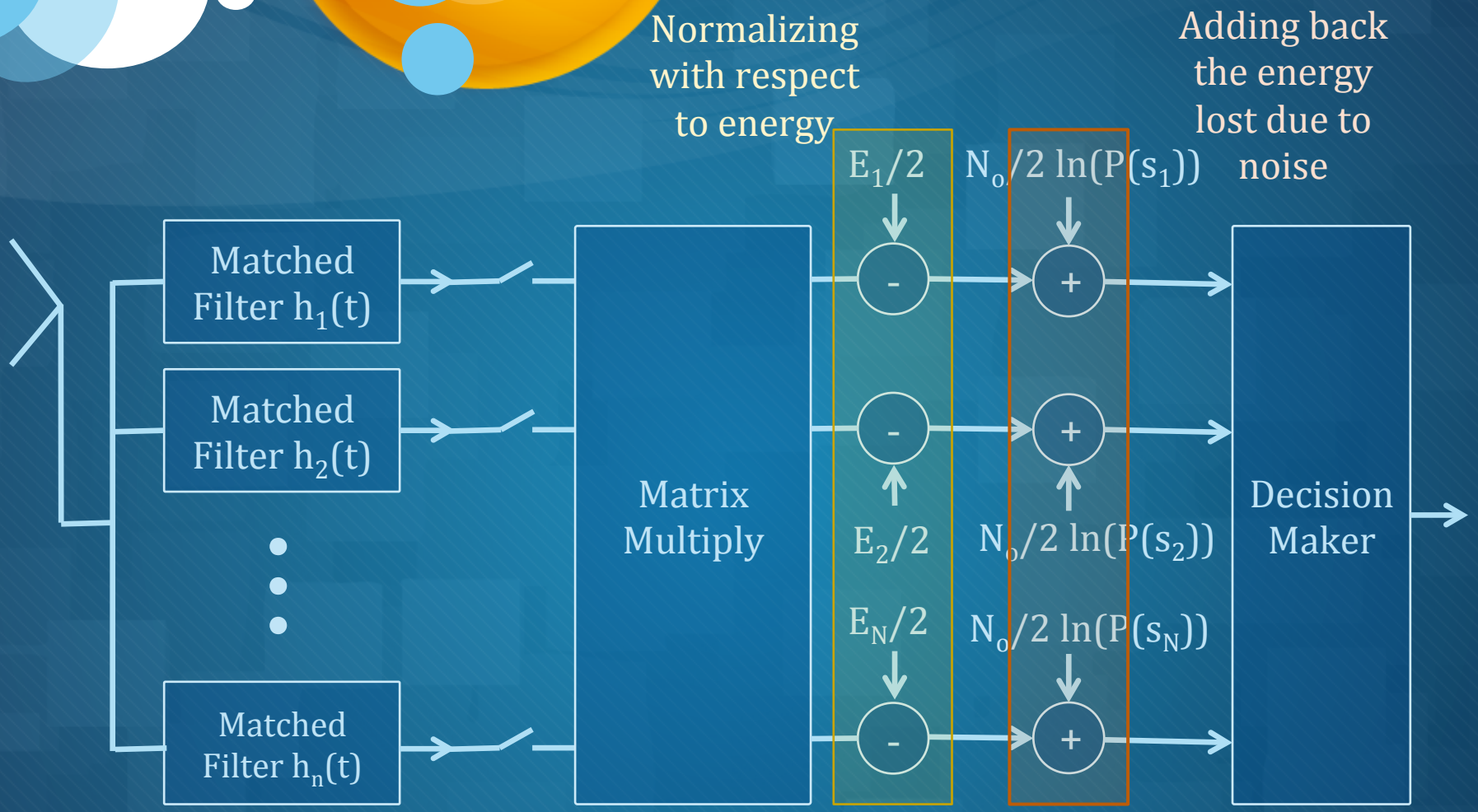




There are six different possible combinations of constellation diagram.

Optimal Receiver Design

The Approach



Multiplexer chooses the signal according to the digital data incoming and sends it to antenna.

Determining Error Probability

Making it Easy Peasy

Consider the following System.