

HY-330

fall semester 2024

Introduction to telecommunication systems theory

University of Crete
Computer Science Department

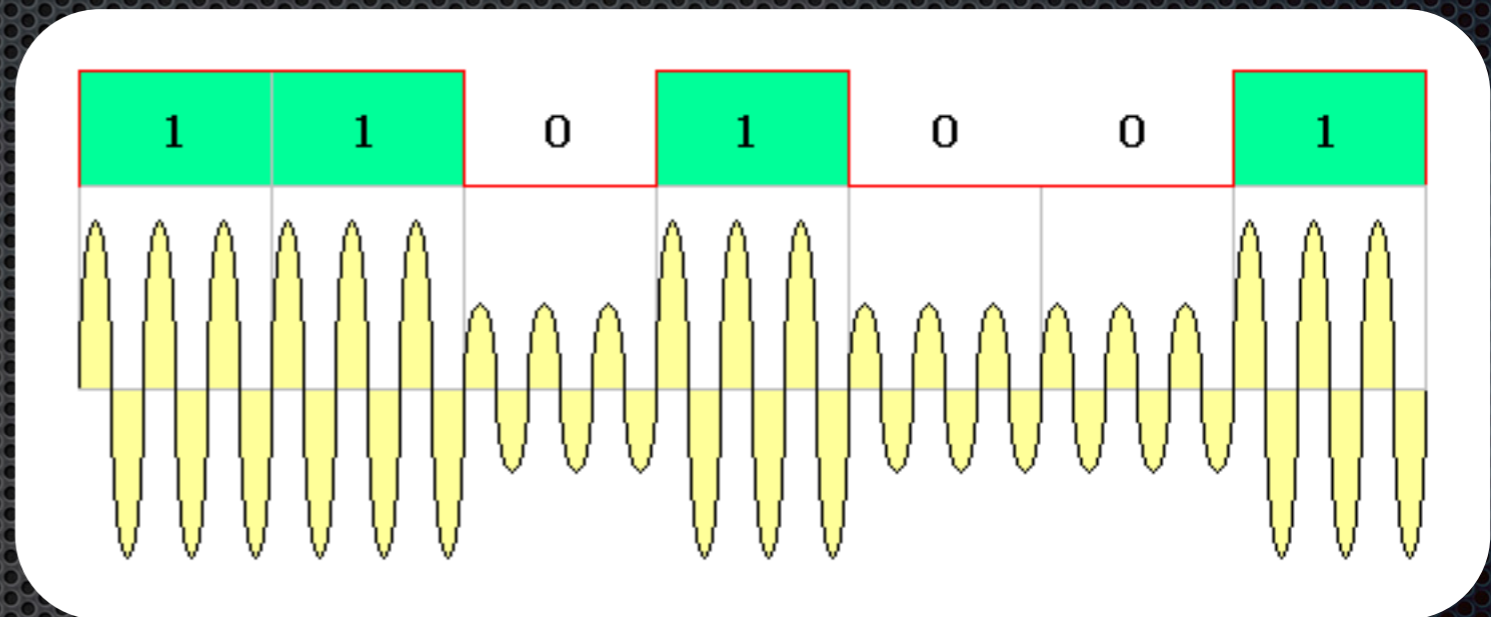
Stefanos Papadakis

Digital Modulations

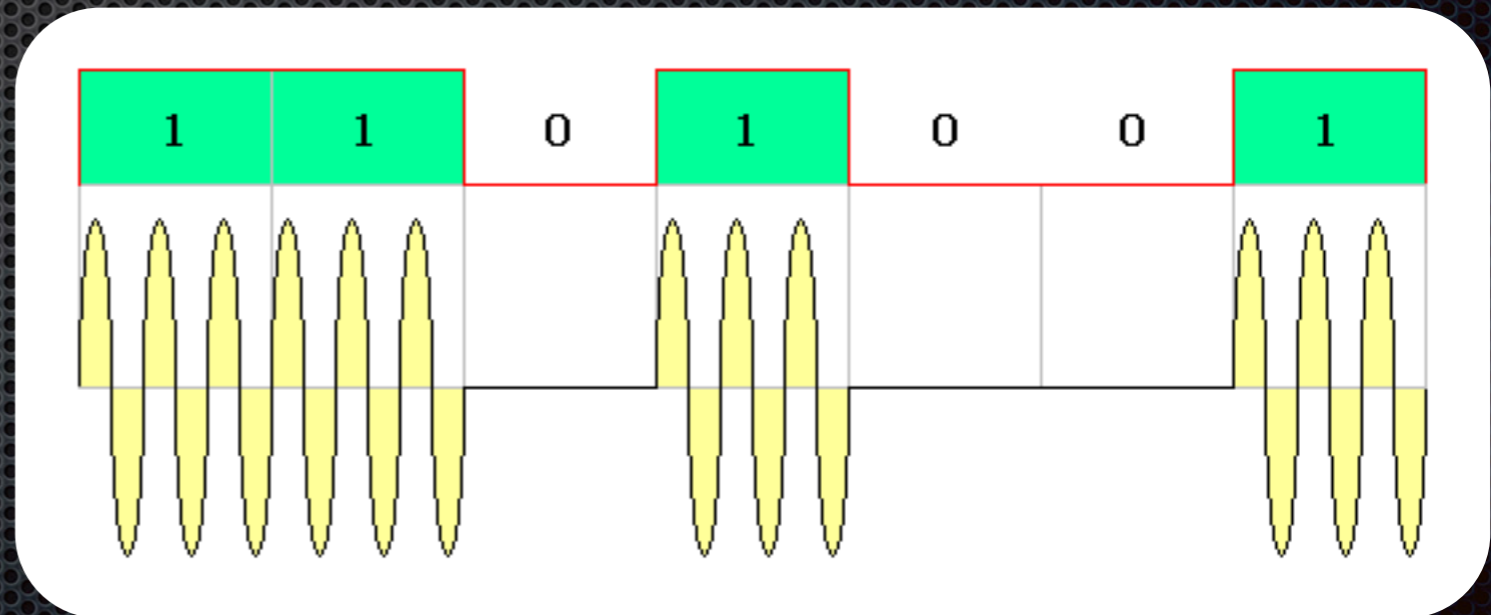
- ✦ QAM
- ✦ PSK
- ✦ Examples

Amplitude Modulation

- Amplitude Shift Keying (ASK)

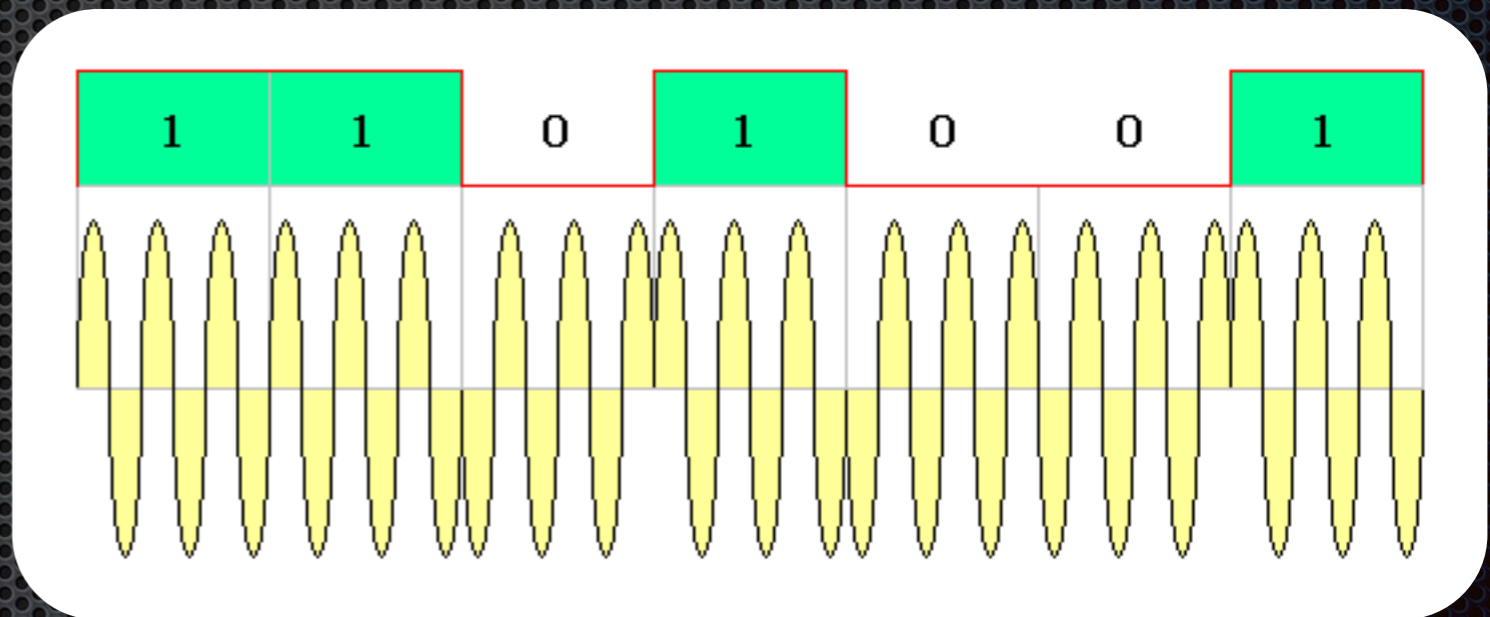


- On Off Keying (OOK)



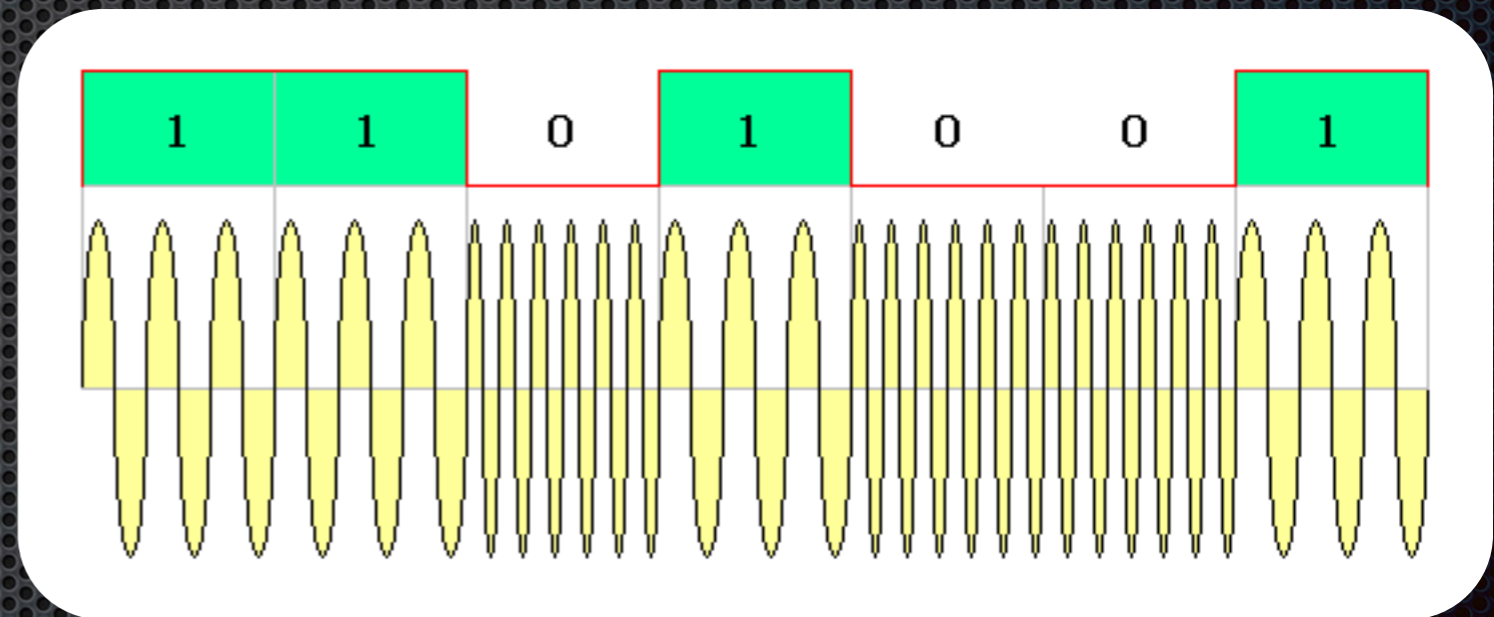
Phase Modulation

- Phase Shift Keying (PSK)



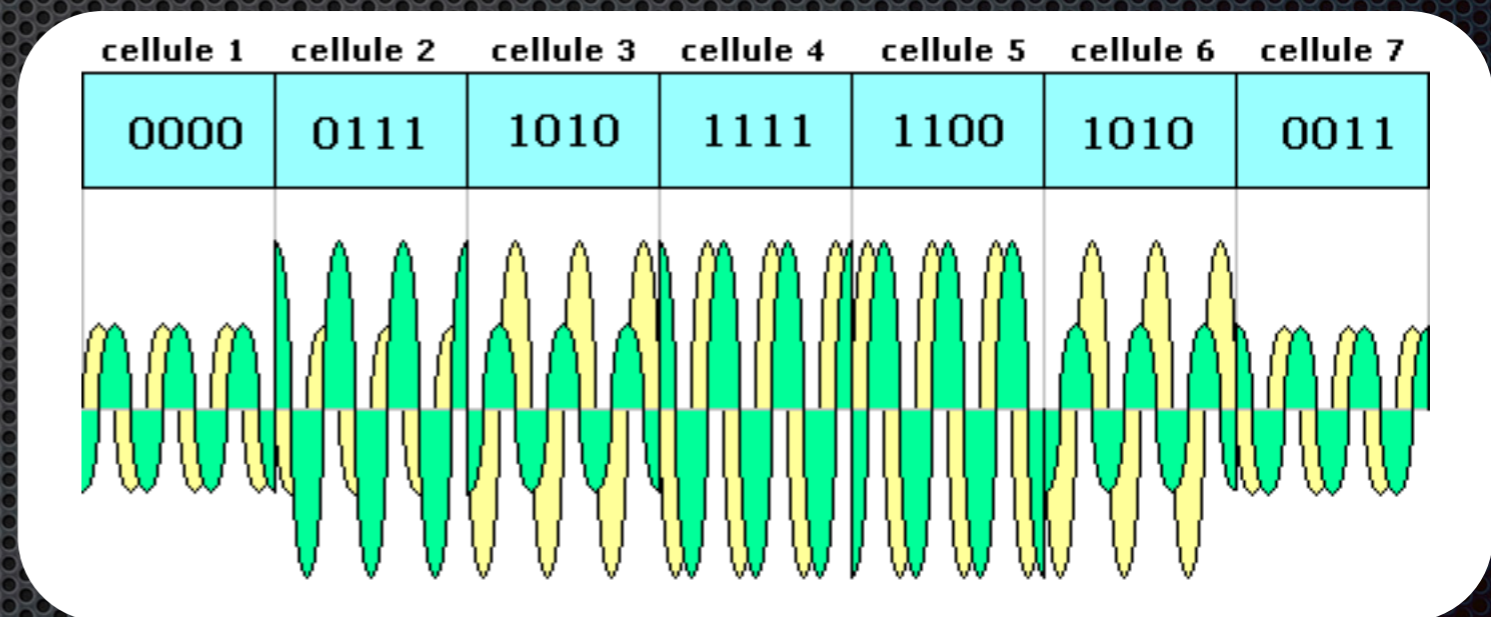
Frequency Modulation

- Frequency Shift Keying (FSK)



Amplitude & Phase Modulation?

- ✦ Quadrature Amplitude Modulation (QAM)



Quadrature Modulation

- Complex Number

$$z = x + i \cdot y$$

- Real \leftrightarrow In-phase

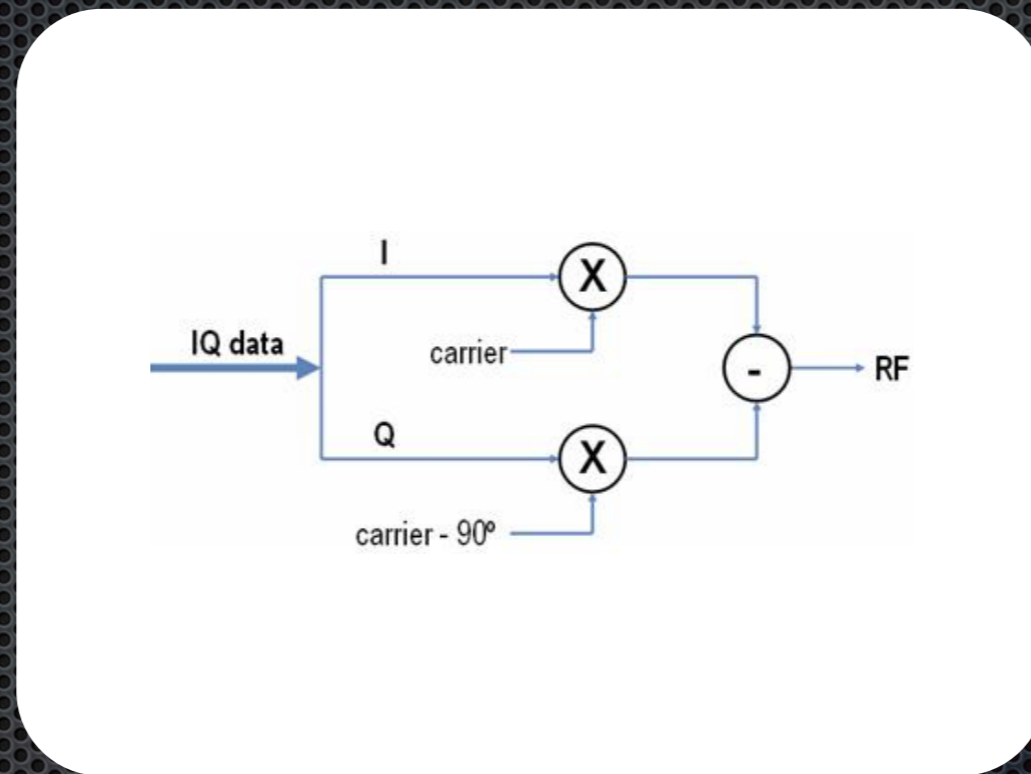
$$I(t)$$

- Imaginary \leftrightarrow Quadrature

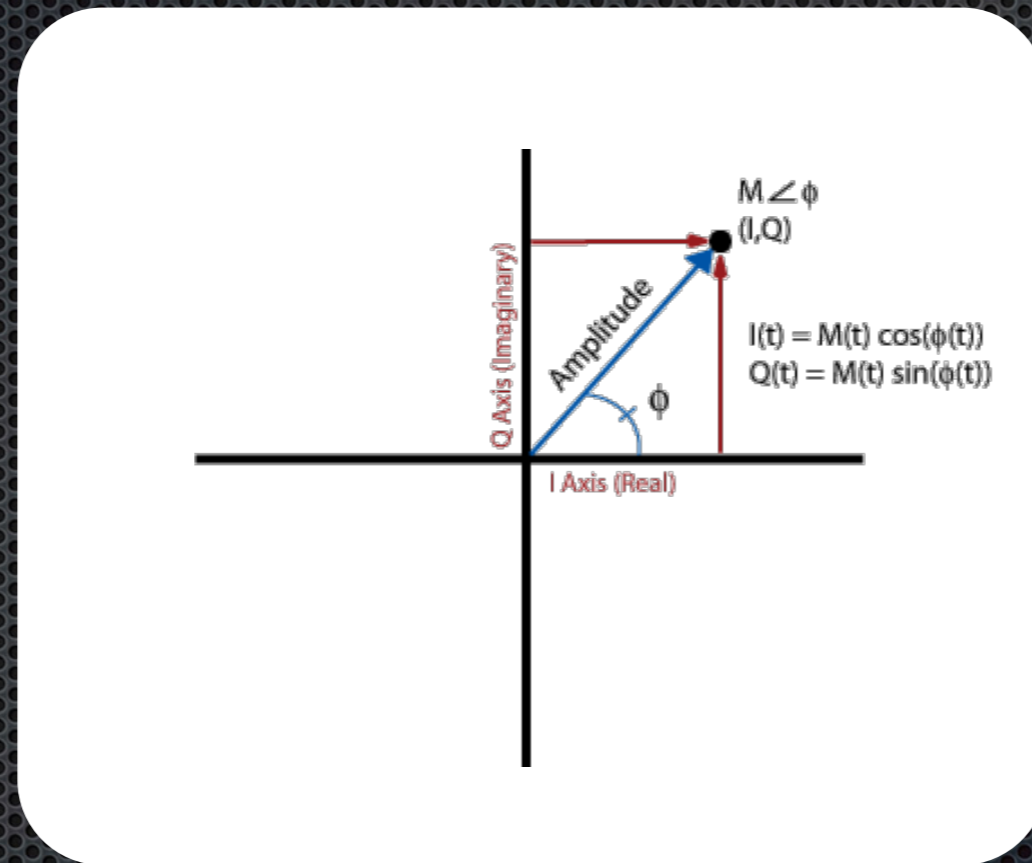
$$Q(t)$$

$$z(t) = I(t) \cdot \cos(\omega_c t) - Q(t) \cdot \sin(\omega_c t)$$

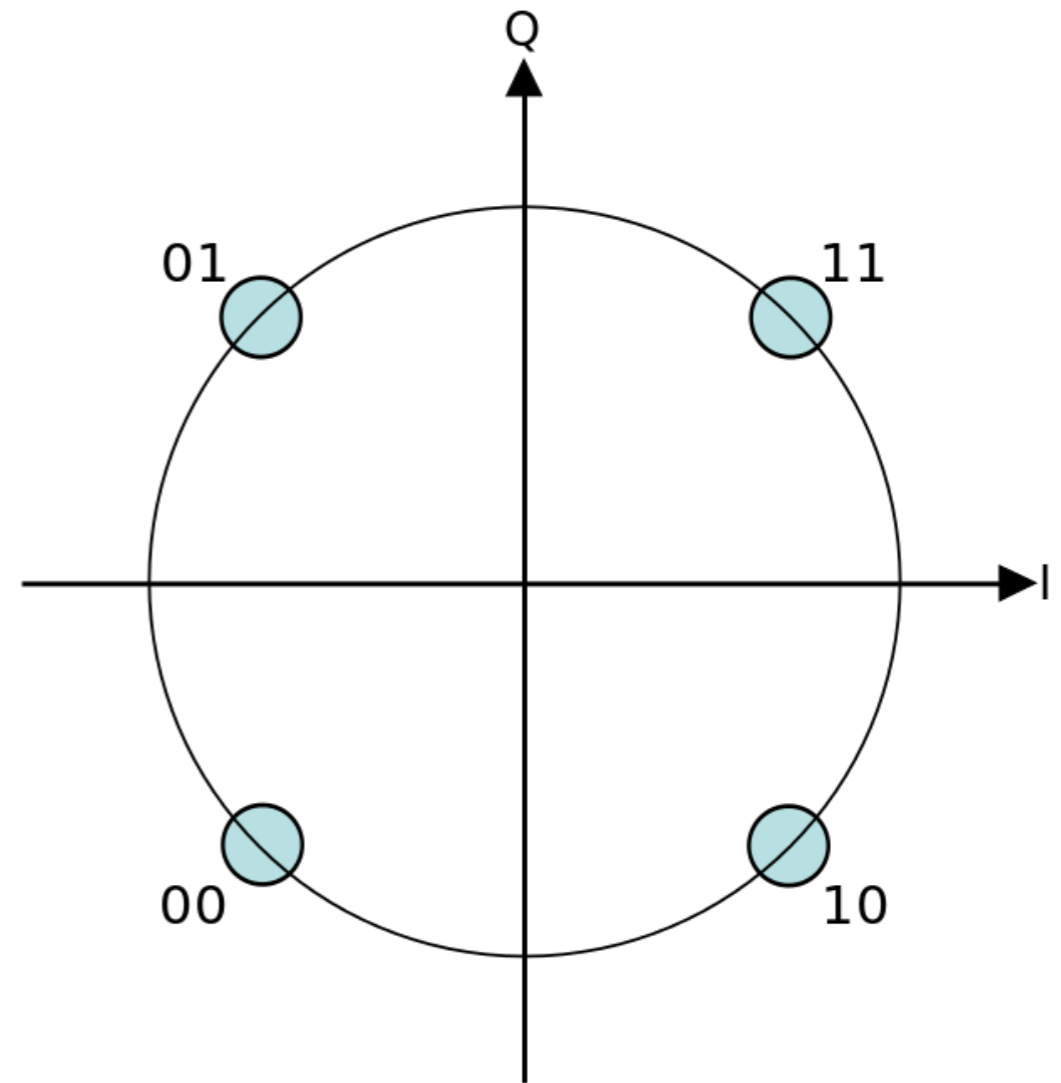
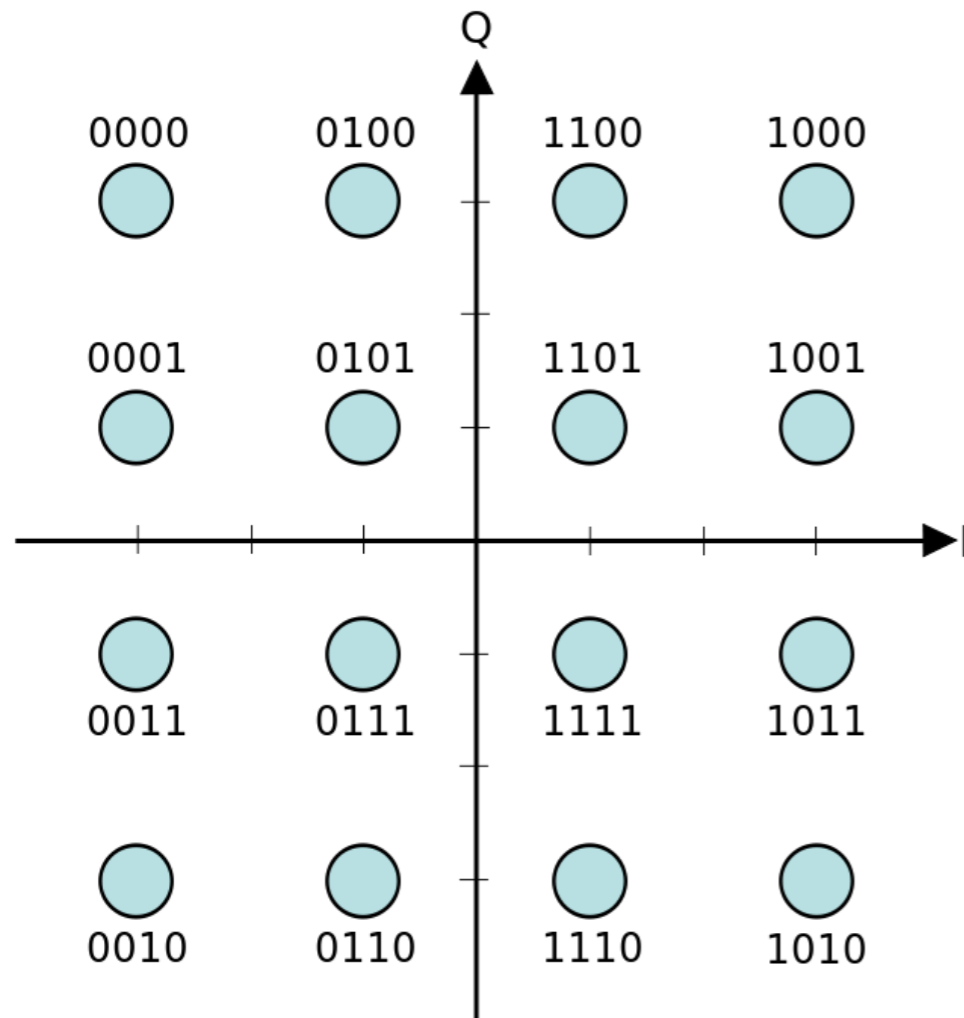
Quadrature Amplitude Modulation



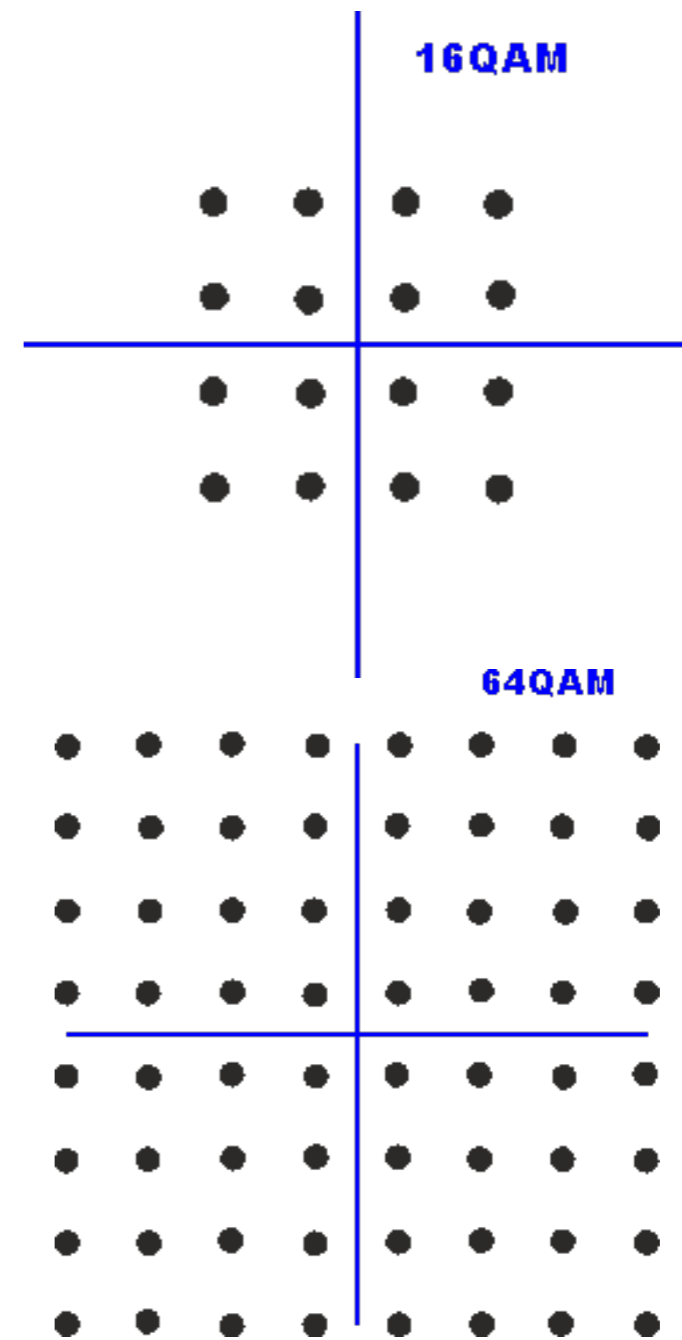
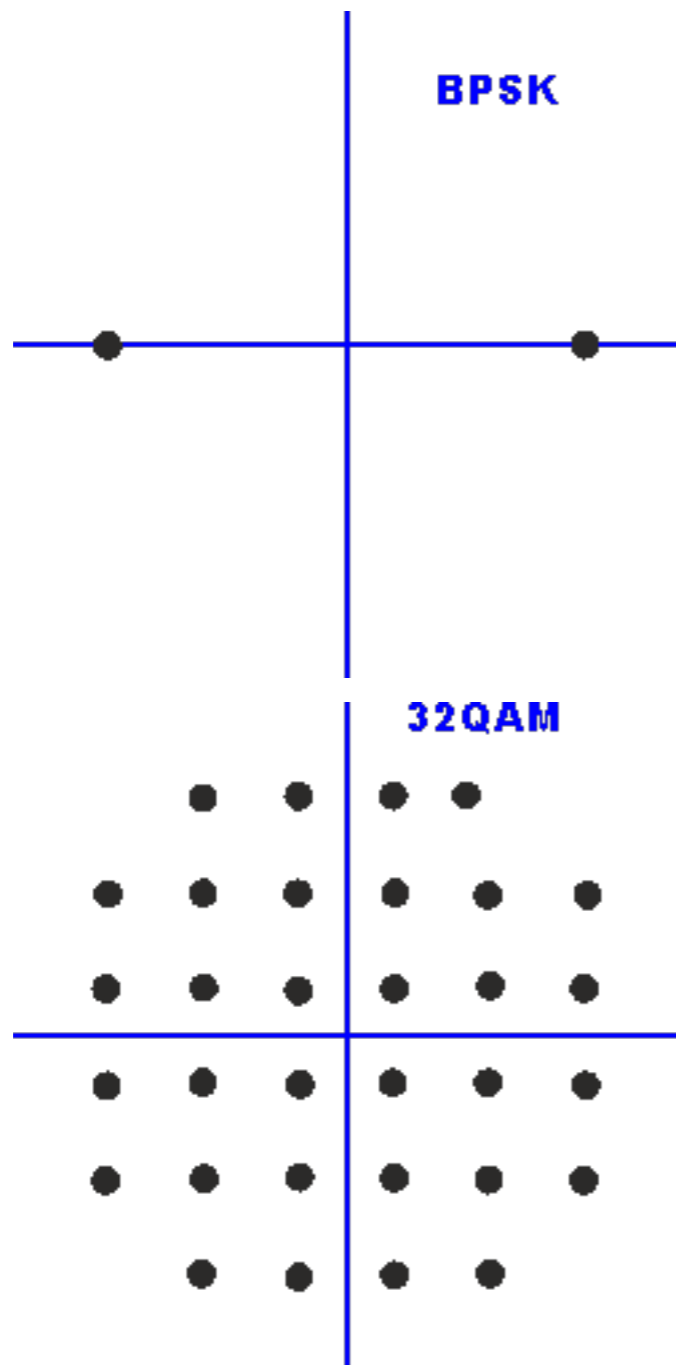
Quadrature Amplitude Modulation



Constellation Diagram

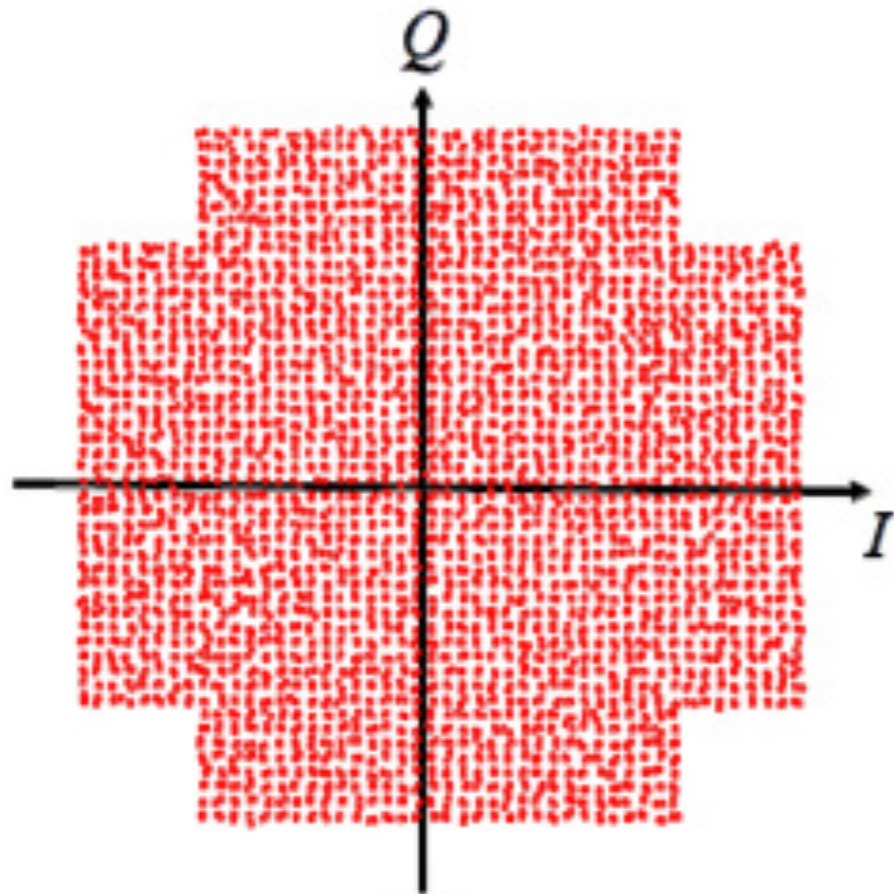


Constellation Diagram

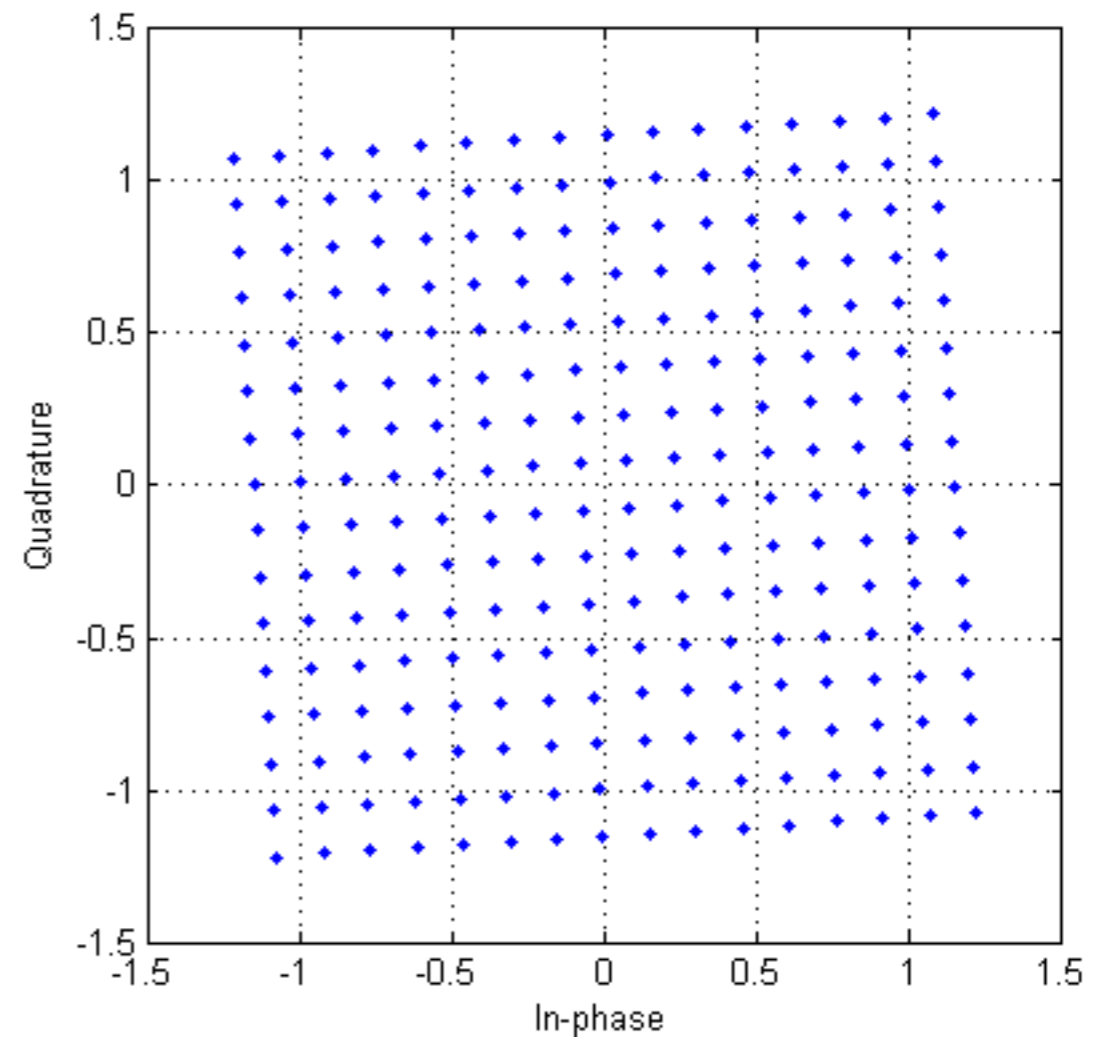


Constellation Diagram

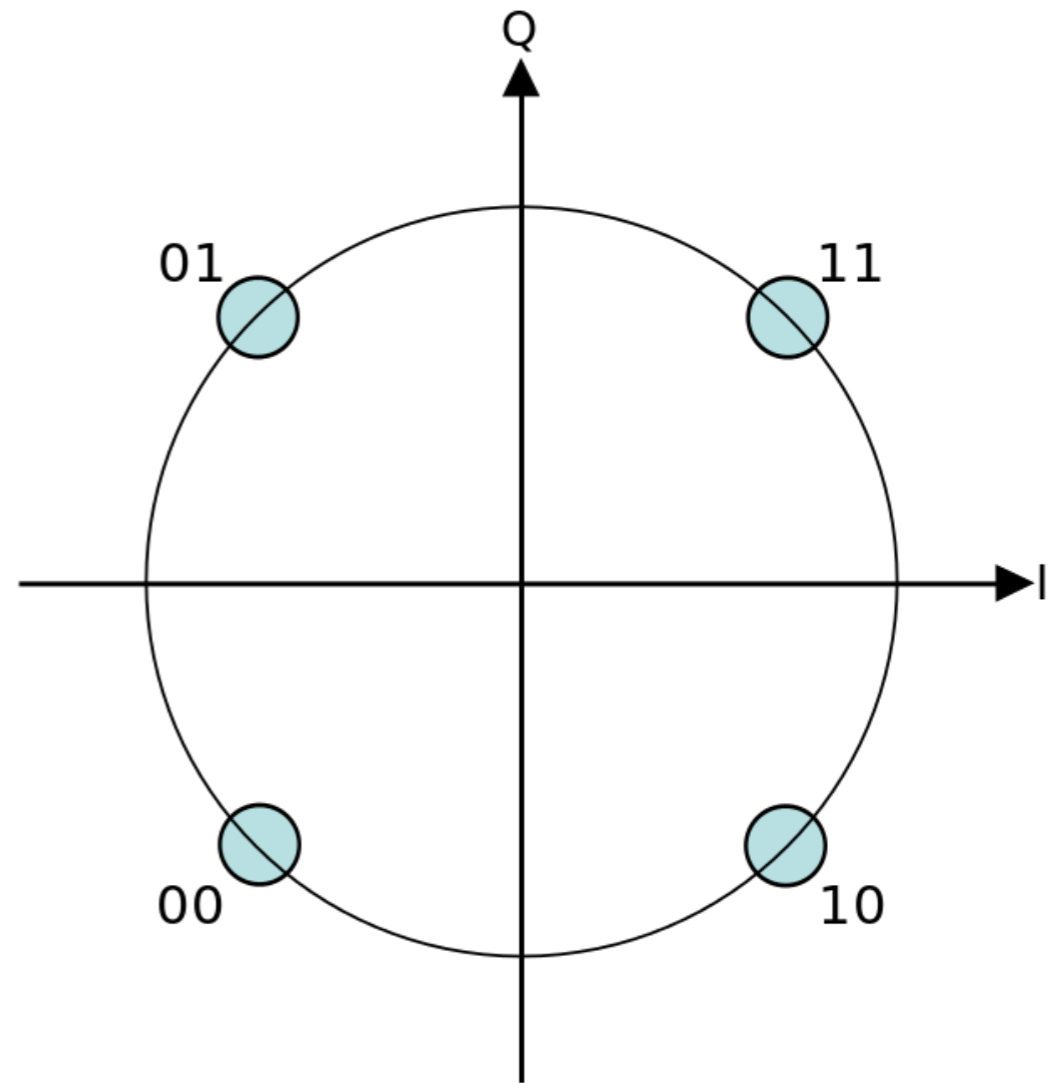
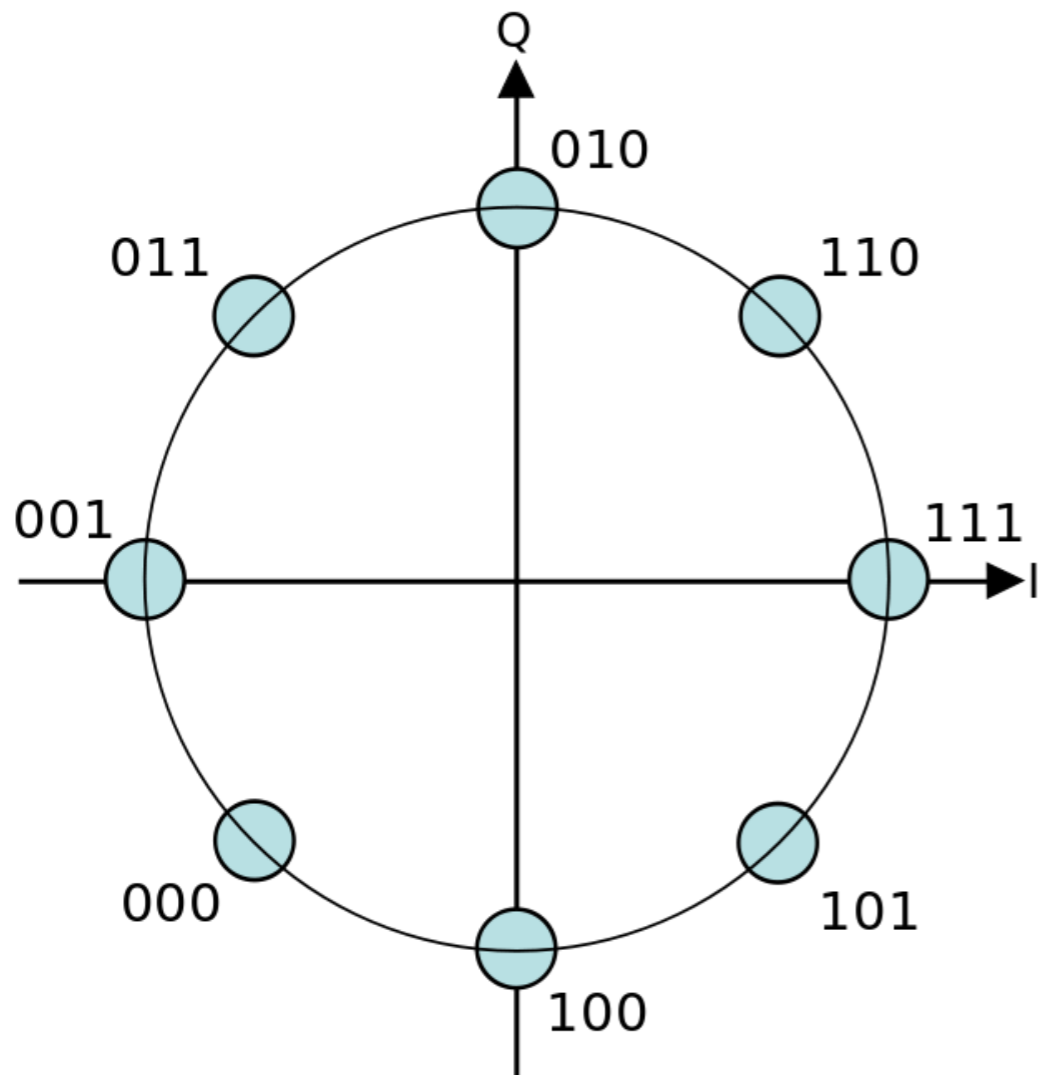
512-QAM



tilted 256-QAM



Phase-shift keying



Constellation

- BPSK: 1 bit/symbol
- QPSK: 2 bit/symbol
- 8-PSK: 3 bit/symbol
- 16-QAM: 4 bit/symbol
- 64-QAM: 6 bit/symbol
- 256-QAM: 8 bit/symbol
- 1024-QAM: 10 bit/symbol

Decision Regions

