

Infocommunication

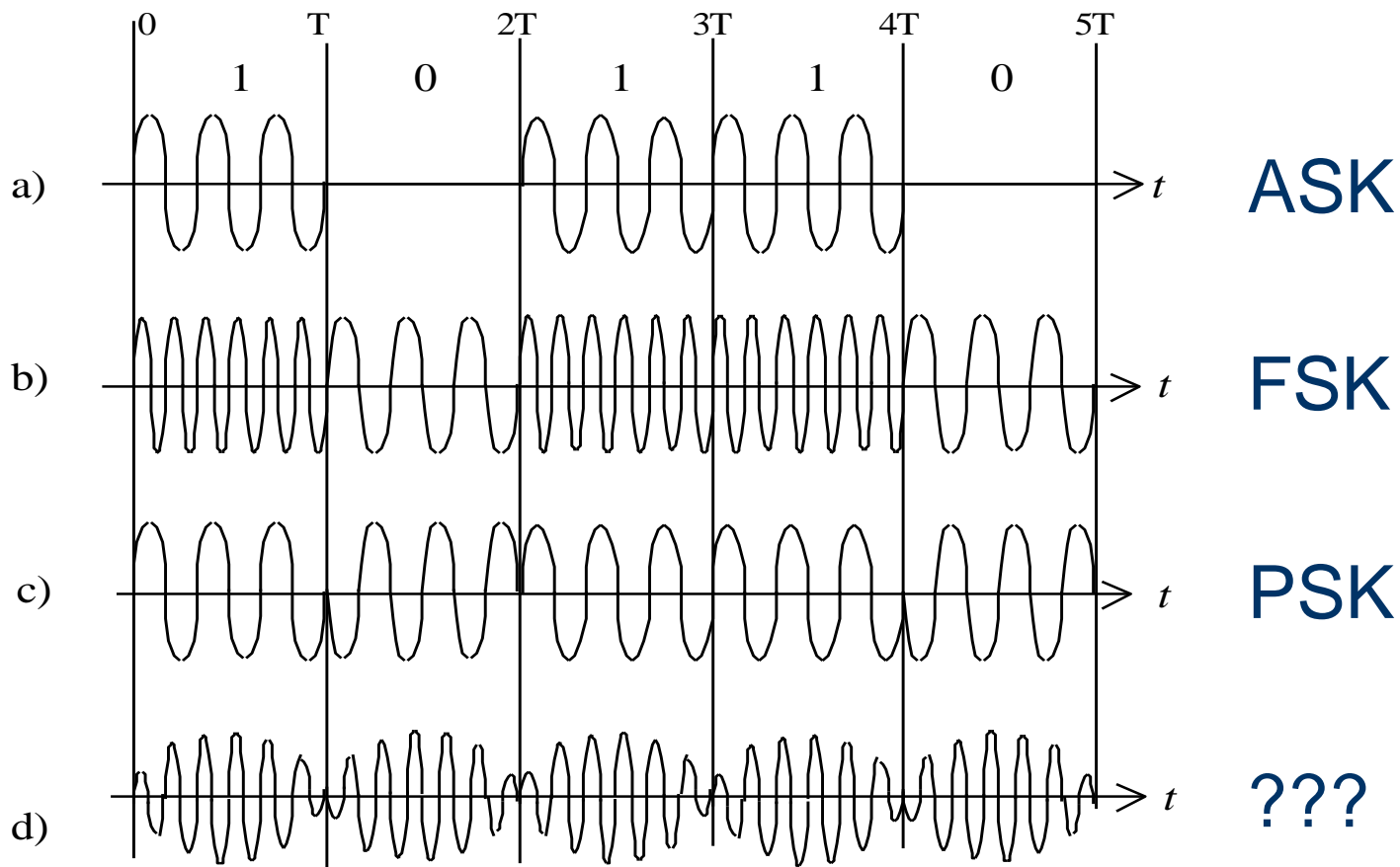
Digital carrier modulation

- Bálint TÓTH, BME TMIT -

Overview

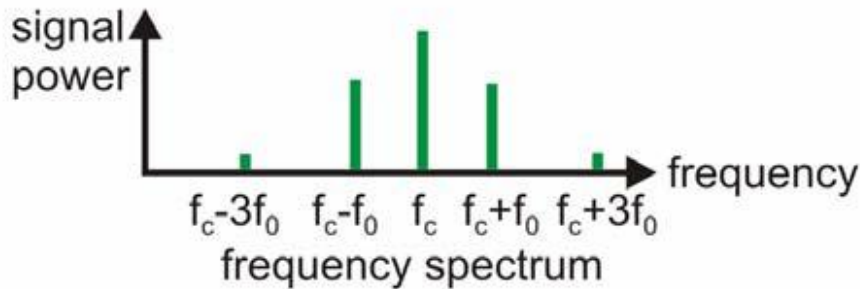
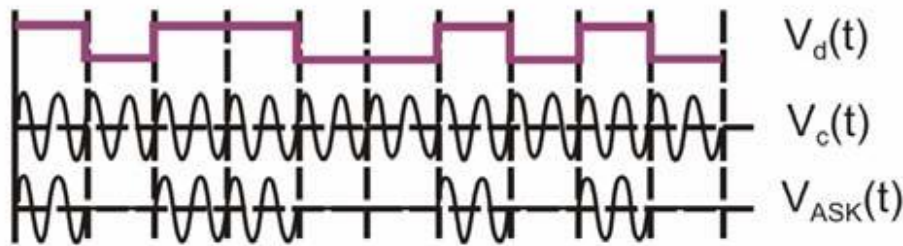
- PPT is for demonstration, not for learning!
- Review
 - Analog modulations (AM, PM, FM)
 - Digital baseband modulations (**PAM**, PPM, PDM)
- Digital carrier modulations:
 - Basic types:
 - ASK, OOK
 - PSK, BPSK, MSK, QPSK, 8PSK, 16PSK, ...
 - FSK, AFSK, MFSK, DTMF, ...
 - Quadrature Amplitude Modulation:
 - 2-QAM, 4-QAM, 8-QAM, 16-QAM, 32-QAM, 64-QAM ... 4096-QAM

Basic types of digital carrier modulation



ASK: Amplitude Shift Keying

ASK (Amplitude Shift Keying)



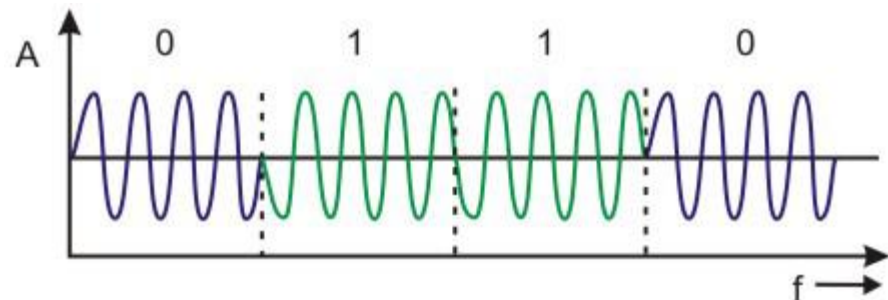
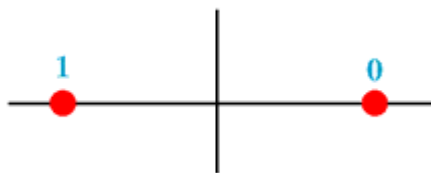
Example:

- Morse
- Optical cables

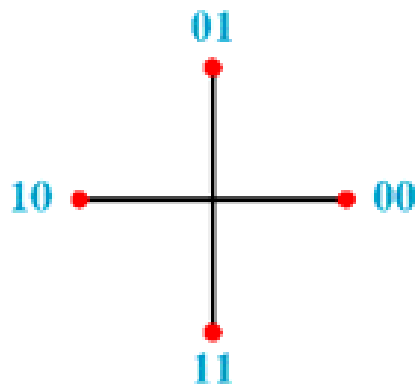


PSK:Phase Shift Keying

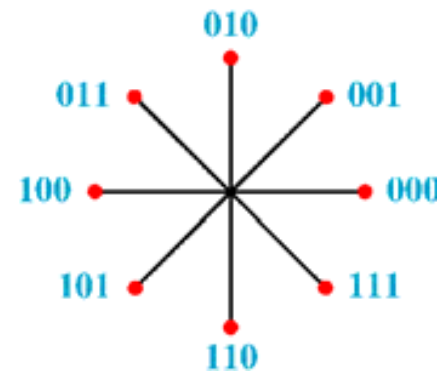
BPSK



QPSK (or 4PSK)

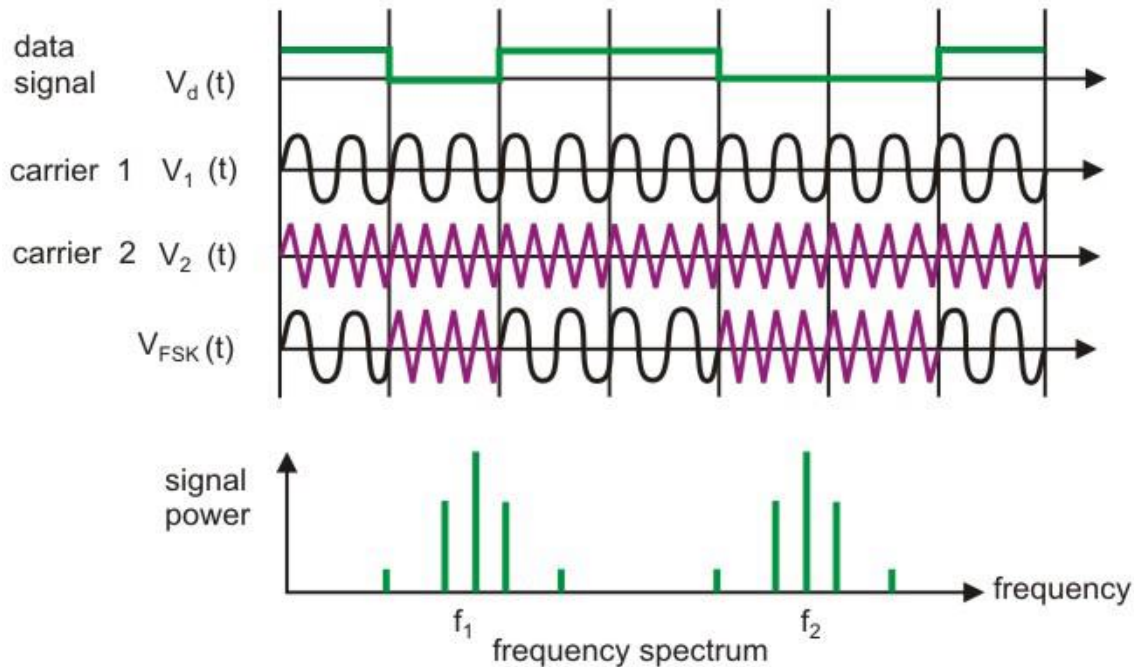


8PSK



FSK: Frequency Shift Keying

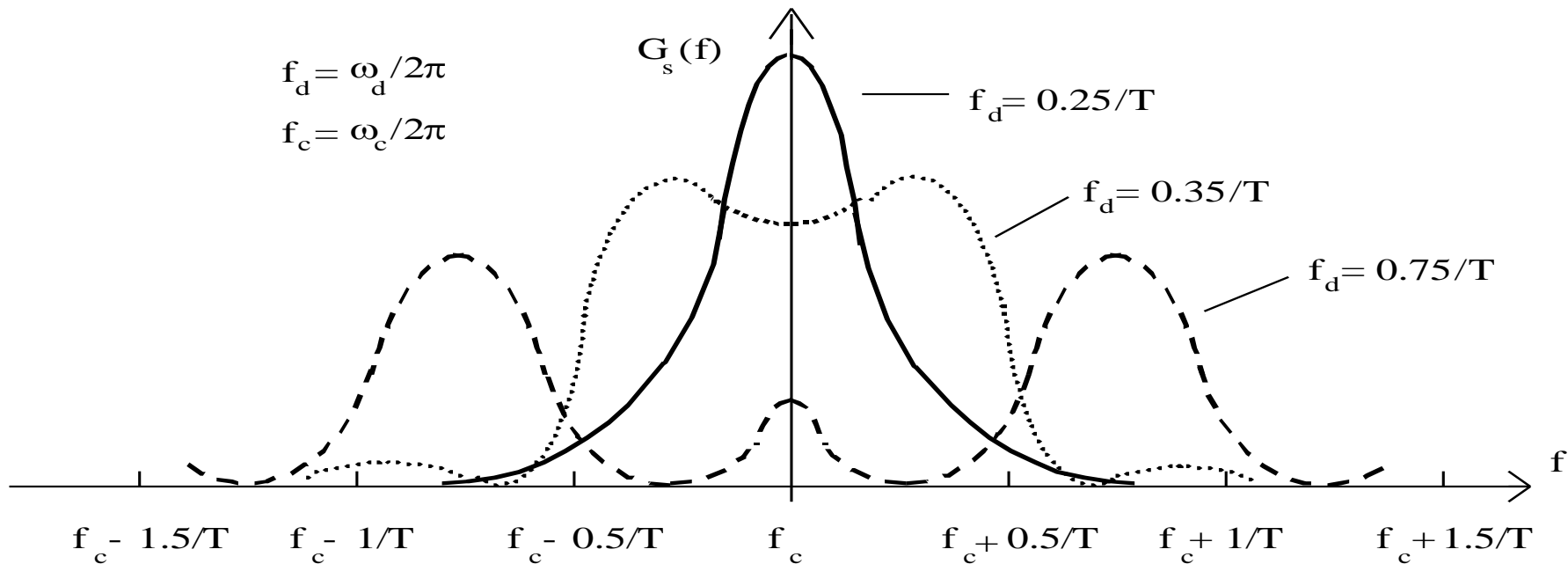
FSK (Frequency Shift Keying)



More noise-robust than ASK.

Example:
High-frequency radio.

Spectral Power Density Function of the Binary FSK Signal

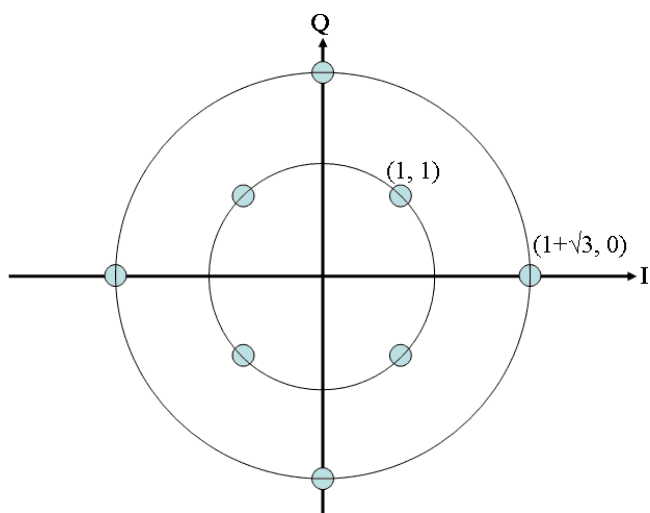


QAM: Quadrature Amplitude Modulation

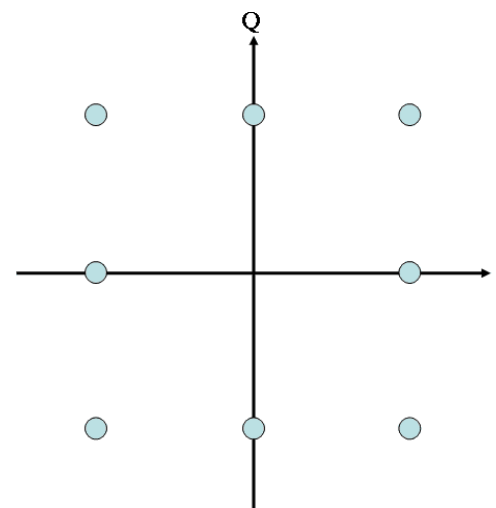
- Modulating the amplitude of two signals with different phases.
- Block diagramm.
- Constellation diagram.
- Variants:
 - 4-QAM
 - 8-QAM
 - 16-QAM
 - ...
 - 4096-QAM

8-QAM

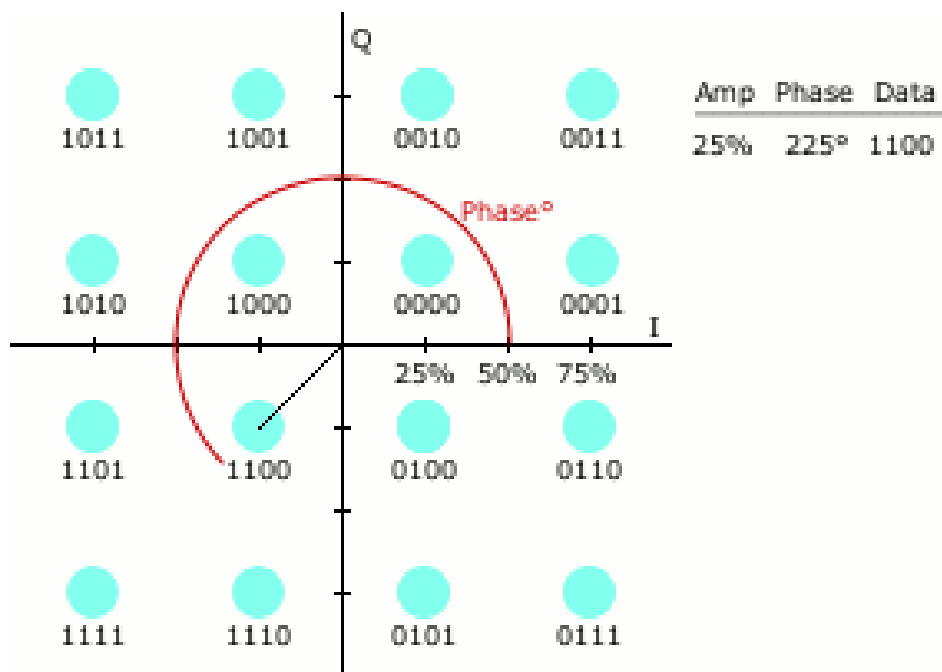
Circular



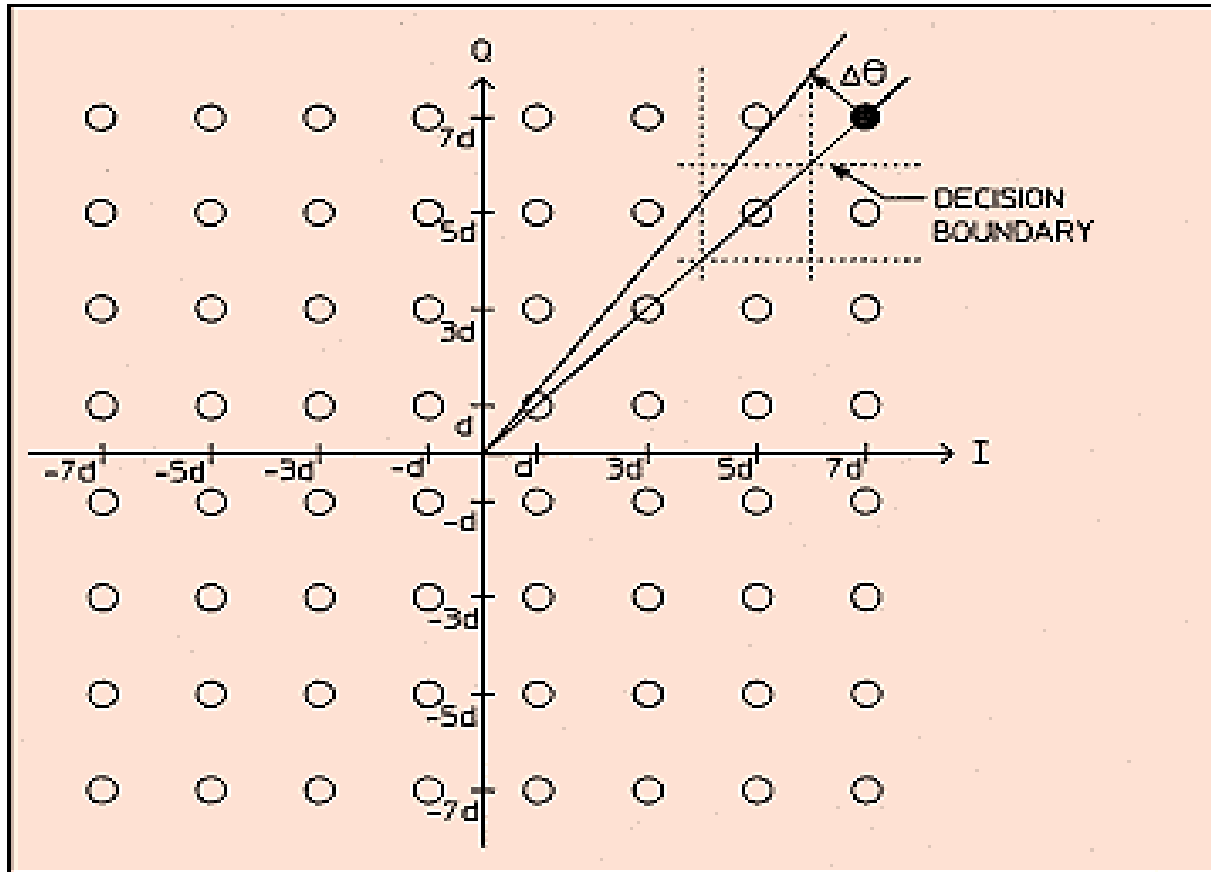
Rectangular



16-QAM



64-QAM



Example: digital TV (64-QAM, 256-QAM)

Real world 4096-QAM



Available symbol and bitrates

Modulation Technique	Baud rate	Bit rate
ASK, FSK, 2-PSK	N	N
4 PSK	N	$2N$
8 PSK	N	$3N$
16 QAM	N	$4N$
32 QAM	N	$5N$
64 QAM	N	$6N$
128 QAM	N	$7N$
256 QAM	N	$8N$