

VID6: Dynamic Digital Modulation

By Prof. Gregory D. Durgin

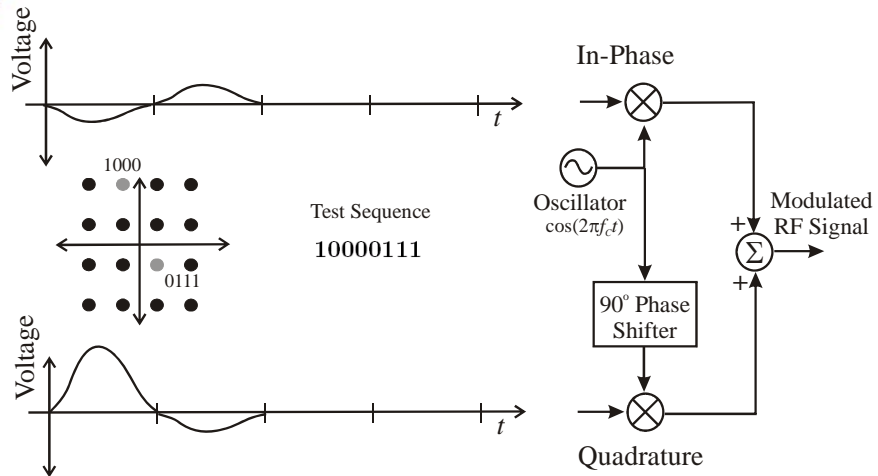
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- Symbol Rate
 - Symbol Rate is equal to $1/[\text{Symbol Period}]$
 - Measured in Symbols/sec (baud)
 - Determines overall RF bandwidth
- Bit Rate
 - Bit Rate = Symbols/sec x Bits/Symbols
 - Depends on signal constellation



M-ary QAM

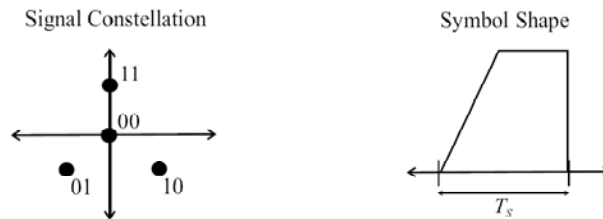


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Example: Design QAM Constellation

Digital Transmissions: A digital alien signal is received from outer space which uses the following (bizarre) signal constellation and symbol shape.



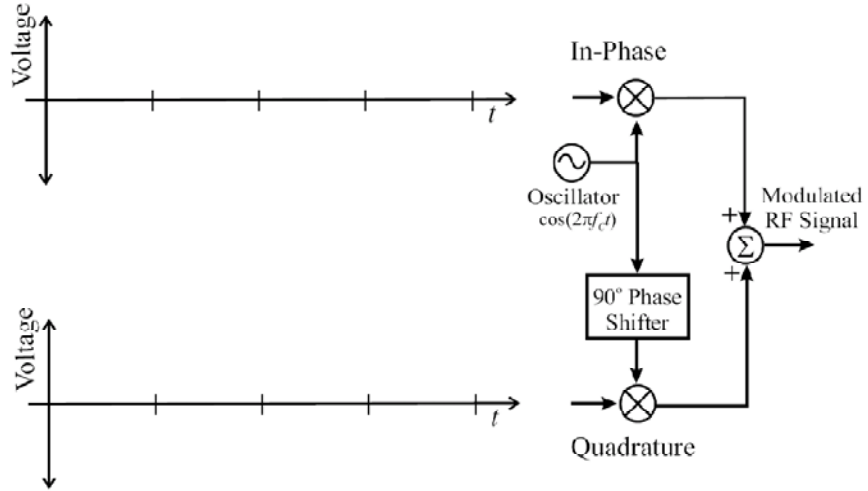
(a) In the two graphs below, make a rough sketch of the in-phase and quadrature signals that would be sent into the alien's IQ-modulator for the following data sequence: **10000111**

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Solution Format

10000111

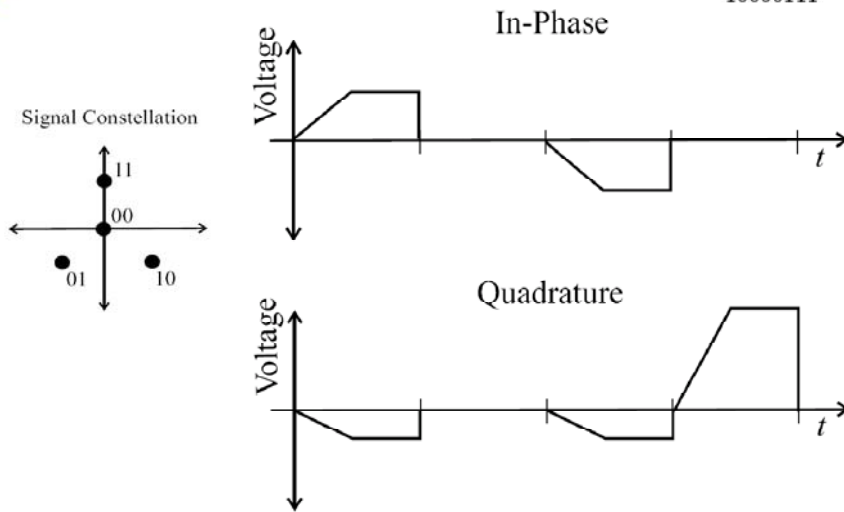


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Solution

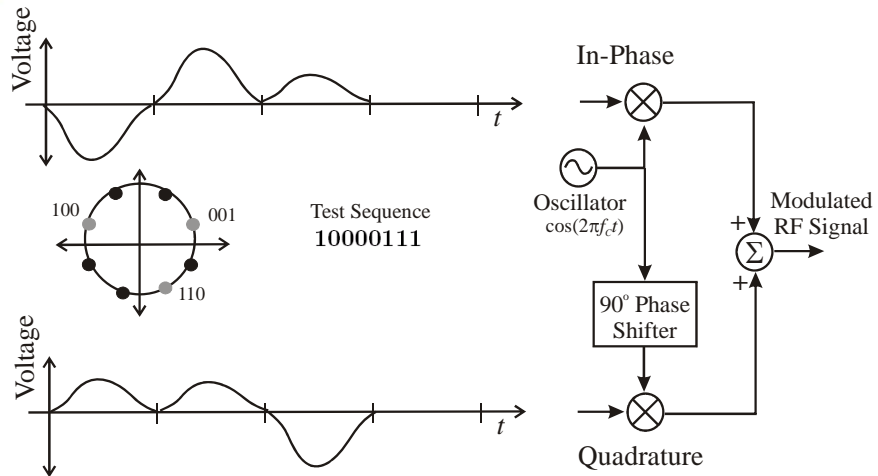
10000111



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M-ary PSK

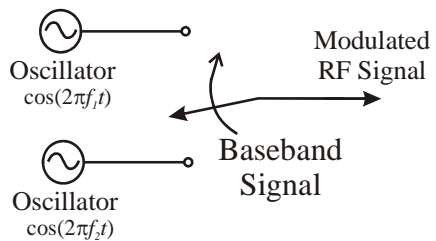
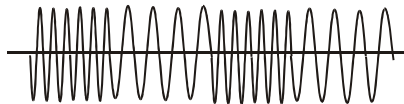


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Frequency Shift Keying (FSK)

- Flip between two or more frequencies
- Similar to FM modulation
- Not as straight-forward to represent on an IQ signal constellation



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Minimum Shift Keying (MSK)

- Most common form of FSK
- Switch between two frequencies separated by
- Minimum amount of bandwidth for an FSK signal
 - Oscillators separated by frequency = $\frac{1}{2}$ bit rate
 - Closer spacing causes self-interference and data loss
- Gaussian Minimum Shift Keying
 - MSK modulation followed by Gaussian filter
 - Common form of MSK used in GSM cellular

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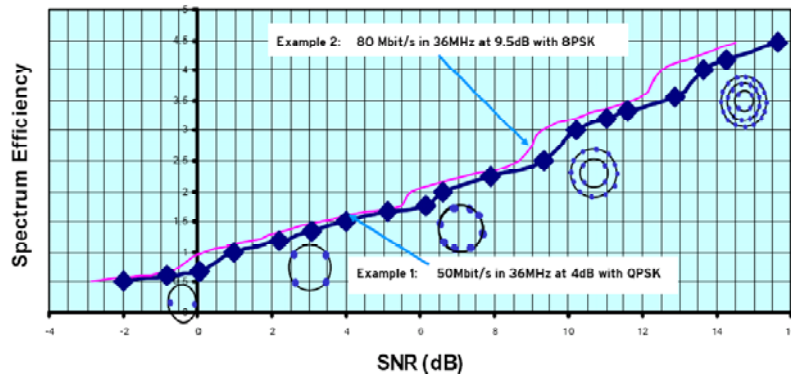
Satellite Video Broadcast

- Typically MPEG2 or MPEG4 encoded video
- Low-order modulation used
 - QPSK, 8PSK, or low-order QAM in 36 MHz channels
 - Adjustable depending on SNR
- Error Correction
 - BCH Forward Error Correction Codes
 - Low-Density Parity Check Codes

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Adjustable Satellite Video Constellation



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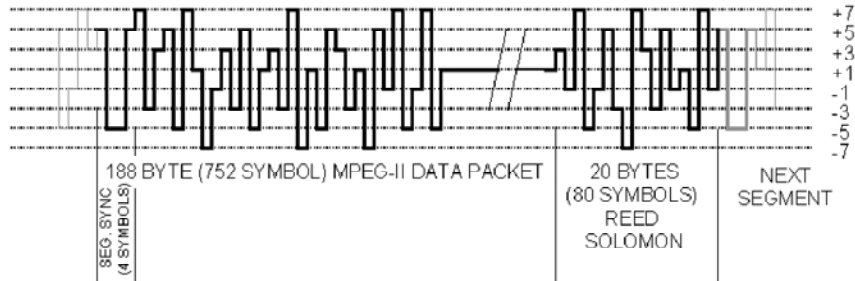
North American Terrestrial Video

- ATSC Digital/HDTV Standard
- Uses MPEG2 and 8VSB Modulation
 - Cable also uses 16-VSB & 256-QAM with higher SNR
 - Europe uses OFDM transmission for HDTV
- All Analog Stations must be off the air in 16 February 2009
- Numerous resolutions and rates supported

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8VSB Signal Structure



NOTE: 4 SYMBOLS PER BYTE

FIGURE 2: ATSC BASEBAND DATA SEGMENT

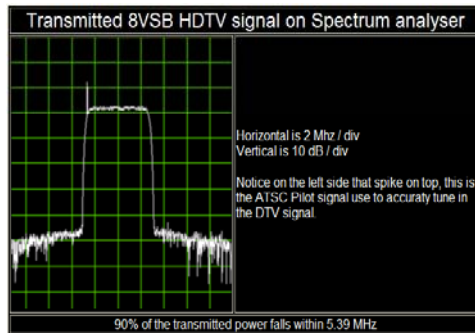
D. Sparano, "What Exactly is 8-VSB Anyway?", www.8VSB.com

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8VSB Modulation

- Note carrier synch tone
- Fits in standard 6 MHz analog TV slot
- 3 bits/symbol
- 10.76 Mbaud
- 32 Mbits/sec

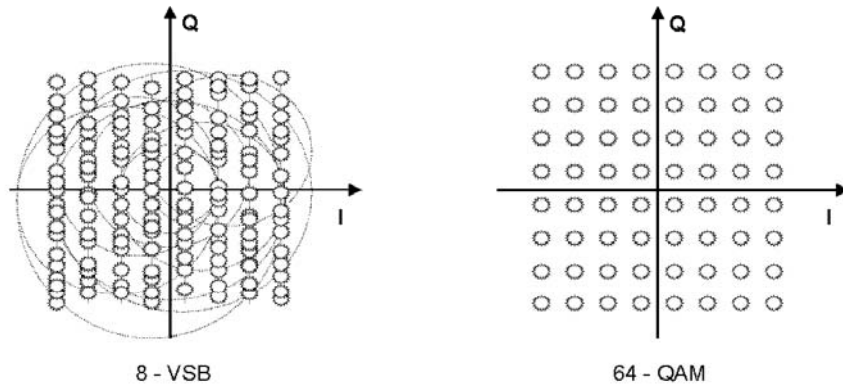


Taken from <http://www.8vsb.com/>

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Signal Constellation of 8VSB

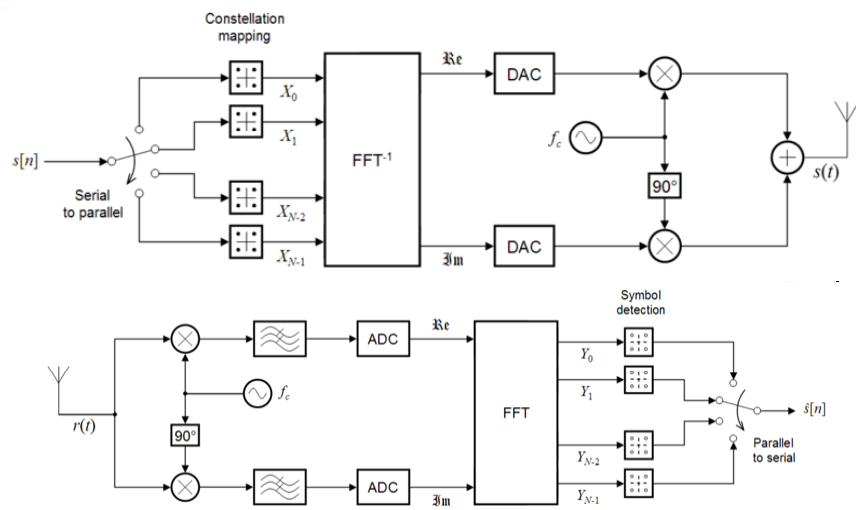


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Orthogonal Frequency Division Mult.

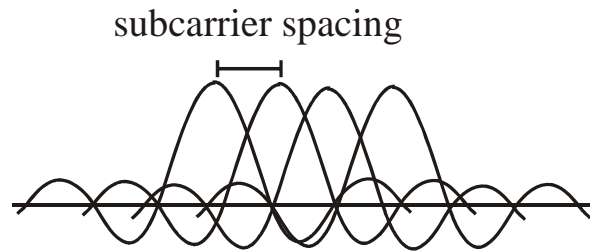


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OFDM Spectrum



Symbols in Frequency Domain