

Digital Modulation : ASK FSK

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- Digital Communication
 - Noise Immunity
 - Economic \rightarrow Profitable
 - Viability of distortion less regenerative repeaters
- But ... digital signals cannot be directly transmitted
- Solution?

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- **Digital Modulation**

- Encoding Digital information
- Modifying carrier wave \rightarrow Amplitude, Frequency, Phase

- Two methods of Digital Modulation

- Amplitude Shift Keying (ASK)
- Frequency Shift Keying (FSK)

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- Simplest
- Carrier wave
 - Analog
 - High frequency
- A digital signal \rightarrow changes amplitude of carrier

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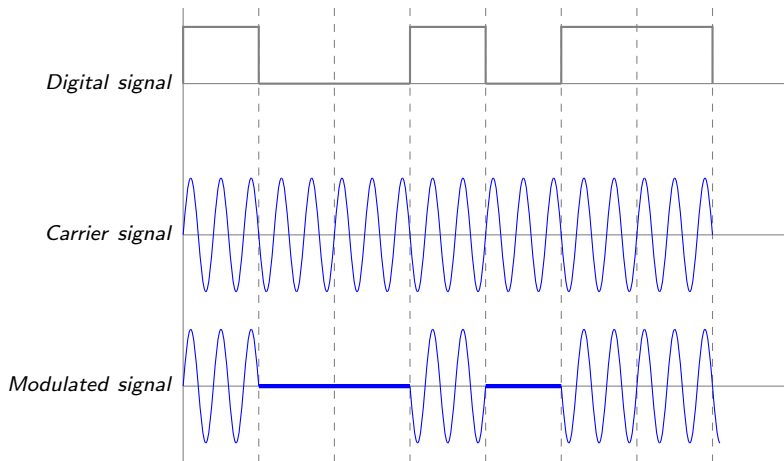


Figure: Binary signal modulation with ASK

Amplitude Shift Keying (ASK)

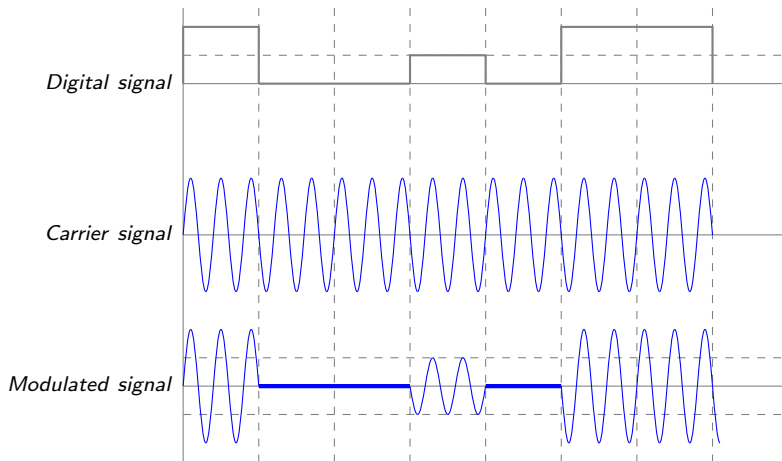


Figure: Multilevel signal modulation with ASK

Amplitude Shift Keying (ASK)

Demodulation of ASK

- Synchronous
- Asynchronous

Amplitude Shift Keying (ASK)

Demodulation of ASK

- Synchronous
 - efficient
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Amplitude Shift Keying (ASK)

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 - costly
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 - less costly

Amplitude Shift Keying (ASK)

Demodulation of ASK

- Synchronous
 - efficient
 - costly
- Asynchronous
 - less costly
 - less SNR
 - poor performance

Amplitude Shift Keying (ASK)

- **Applications**

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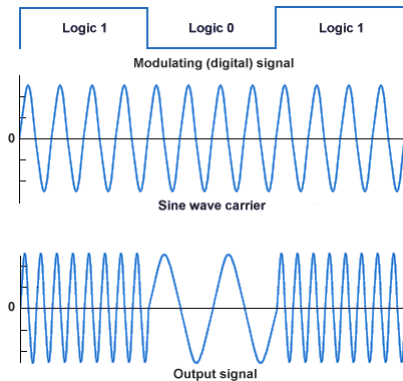
- Broadcasting digital signal

Amplitude Shift Keying (ASK)

- **Applications**

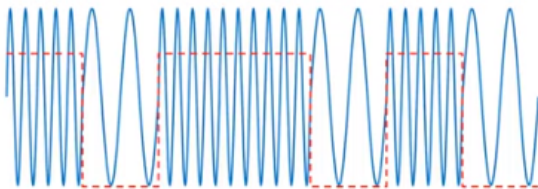
- Broadcasting digital signal
- In optical fiber communication for lesser intensity modulation

Frequency Shift Keying



Frequency Shift Keying

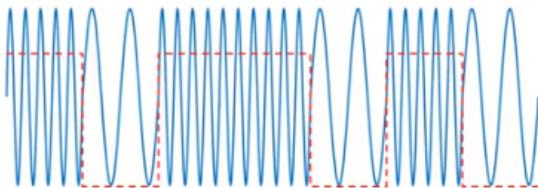
- 1 Discrete variation of carrier signal frequency.



- 2 Different from the continuous variation of carrier signal frequency in analog FM modulation.
- 3 Number of discrete frequencies can be
 - two : Binary FSK or BFSK
 - More than two : M-ary FSK

Frequency Shift Keying

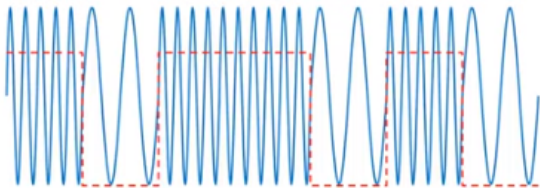
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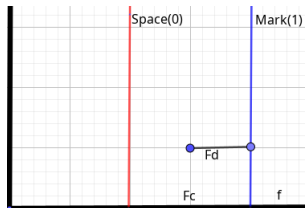
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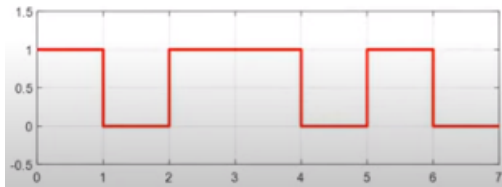
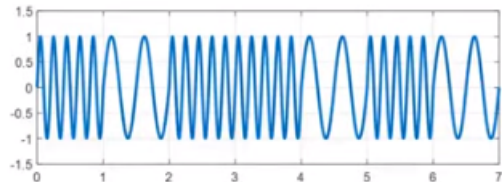
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BFSK

- 1 Two frequencies : Mark and Space
- 2 Same amount of deviation from the carrier frequency f_c

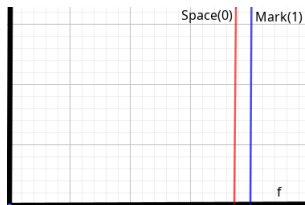


- 1 Carrier amplitude doesn't change(only frequency).So simplifies the amplifier design and selection

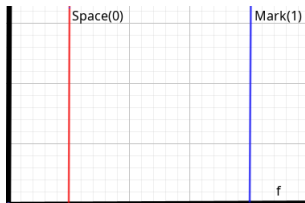


Tone Spacing

- How far apart should the mark and space be?
 - Too close - InterSymbol interference(ISI)



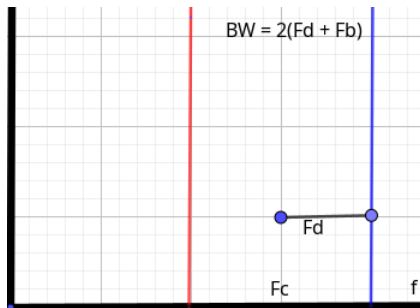
- Too far - Excessive Bandwidth



Minimum FSK Bandwidth

① Function of

- Frequency Deviation(F_d)
- Bit Rate(F_b)

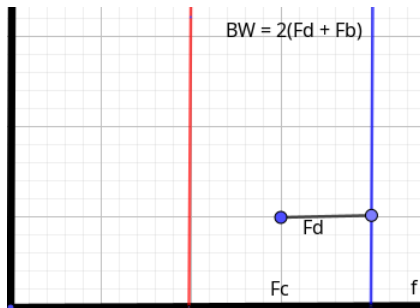


② But how far apart the tone should be?

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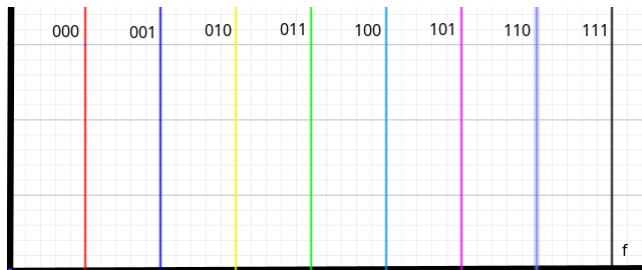
Modulation Index

- ① Tones should be as close as possible without creating ISI.
- ② Modulation Index

$$h = \frac{2 * F_d}{F_b}$$

- ③ Optimal detection occurs when $h \geq 1$
- ④ Why MFSK needs less bandwidth than BFSK for a given bit rate?

- 1 More than two frequencies



- 2 Each MFSK tone corresponds to $\log_2 M$ bits
- 3 BFSK Formulas are applicable for MFSK too.

Application of FSK

① *Paging*($F_d \uparrow, F_b \downarrow$)



② Digital Radio Technology

③ Data Collection and Remote Controls

Thank You
Any Question?