

## Frequency Shift Keying (FSK) - Modulation

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### Revisit: FM - Frequency Modulation

- Information is differentiated by different **carrier wave frequencies**
  - c.f. AM (Amplitude Modulation)?
- In detail...

$$\begin{aligned} \boxed{y(t)} &= A_c \cos \left( 2\pi \int_0^t f(\tau) d\tau \right) \\ \text{FM modulated signal} &= A_c \cos \left( 2\pi \int_0^t [f_c + f_\Delta x_m(\tau)] d\tau \right) \\ &= A_c \cos \left( 2\pi \boxed{f_c} t + 2\pi \boxed{f_\Delta} \int_0^t \boxed{x_m(\tau)} d\tau \right) \end{aligned}$$

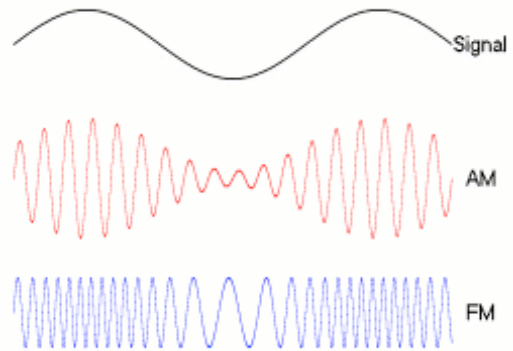
Base carrier frequency      Instantaneous carrier frequency      Message (baseband) signal

→ **Difference** between instantaneous and base frequency of carrier is directly **proportional** to instantaneous value of input signal

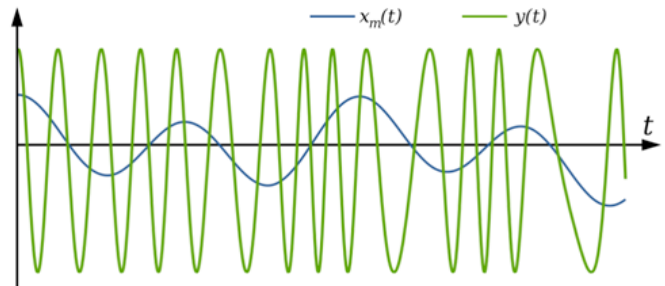


# Illustration

- Message signal and its FM, AM



- Message signal and its FM



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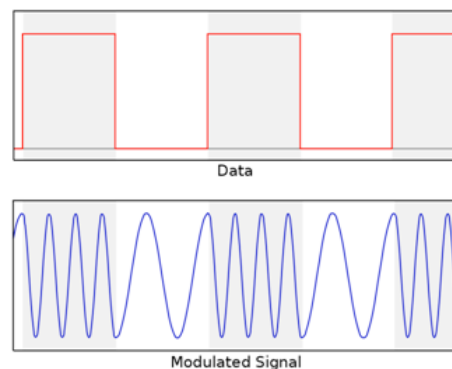
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## FSK - Frequency Shift Keying

- Unlike FM, FSK sends **digital data**
  - by shifting carrier's frequency among **a set of discrete values**

- Digital Data: “0” or “1”
- FM signal



Q: How many frequencies are used in this example?



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- Glossary -“Keying”
  - shaping of a signal to convey information = modulation
  - FSK
  - PSK (Phase Shift Keying)

Images for gear shift

Report images



More images for gear shift

- MATLAB illustration



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## Line Encoding

- NRZ (Non-Return-to-Zero)
  - Remain fixed for the duration of the bit time (not return to zero).
- RZ (Return-to-Zero)
  - First half of bit time: represented by binary levels
  - Second half-bit is always zero (returns to zero).
- MAN (Manchester)
  - First half of bit time: represented by binary levels
  - Second half-bit time: its complement levels



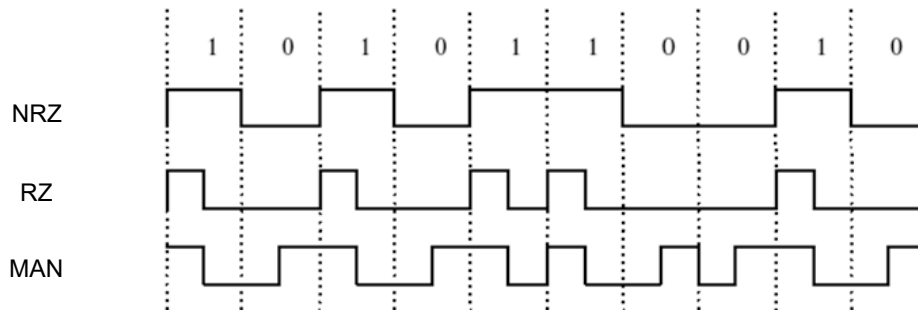
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# Line Encoding - Examples

- Example:



- See also MATLAB illustration (and spectral density as well)



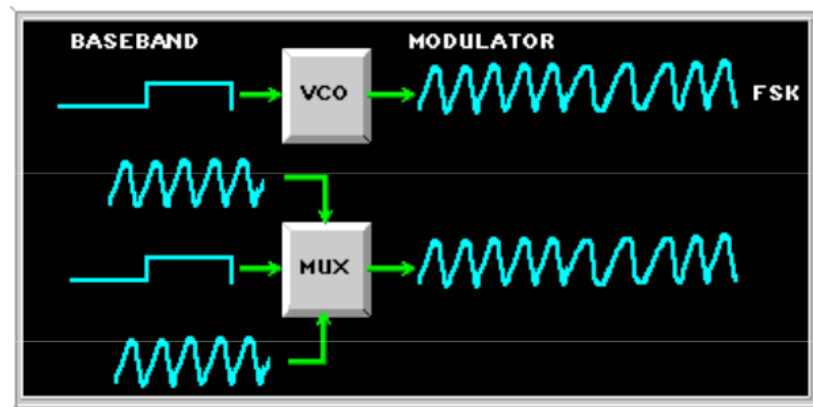
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## In Experiments...

- To emulate two different carrier frequencies (because of FSK),
  - MUX (multiplexer) is used
  - Pass only one signal selected by control signals



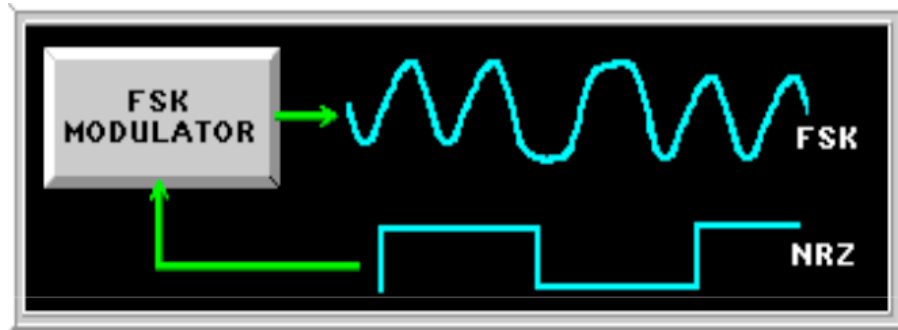
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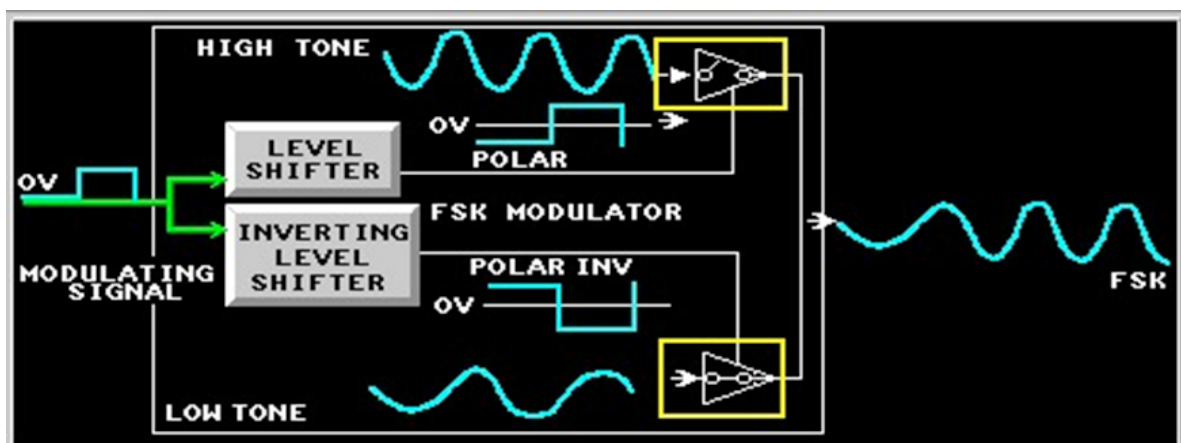
## In Experiments...

- FSK Modulator
  - Digital Input (0: low or 1:high) two different frequencies



## In Experiments...

- In order to emulate FSK, analog switches are used:



## In Experiments...

- Terms:  $M = 2^N$  symbols  $\rightarrow N$  bits/symbol  
Symbol rate:  $F$  symbol/sec (or, baud)  
 $\rightarrow NF$  bits/sec



## In Experiments...

- Possible FSK modulated output

