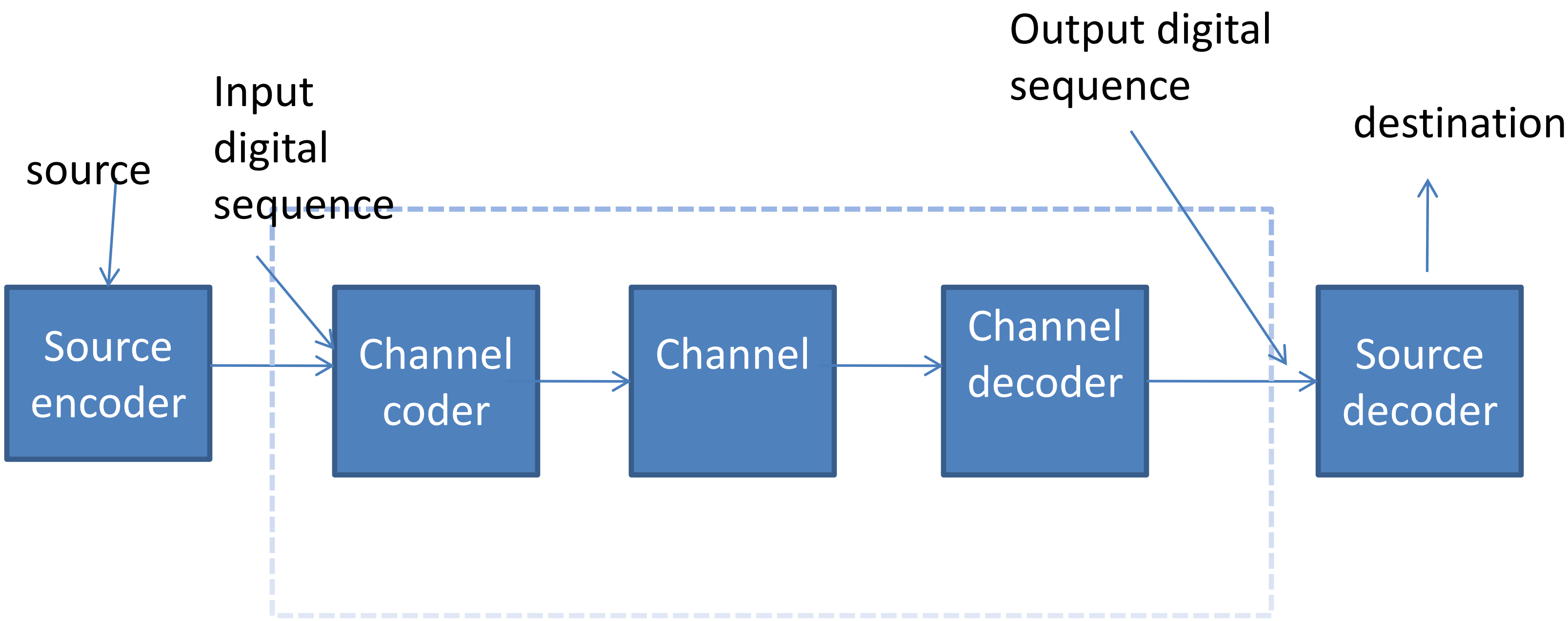
# Advantage of digital communication

- Compatibility
- Flexibility
- Economy available
- Reliability
- Operational speed
- Miniaturization
- Operational and maintenance is simple

- Baud : unit of signaling speed
- represents the speed of the communication channel
- No of code elements per seconds

# Elements of digital communication




Elements of digital communication system

- simplex
- Half duplex
- Full duplex
- 8000 samples /sec

# Digital base band signal

- Digital base band signal are logically transmitted signal (logic ones and zero)
- Two level of voltages or current
- 0 or 1
- Simple to generate ,detect and use

- Let $m_n$ denotes the message signal produced by the source during the nth interval [nT,(n+1)T]
- sequences of message to be send to the reciever is $(m_n)$=---$m_{-1}$,$m_0$,$m_1$,$m_2$---
- If source o/p in the nth interval is K,$m_n$=K
- transmitted signal $s_k(t-nT)$
- single wave form V(t)

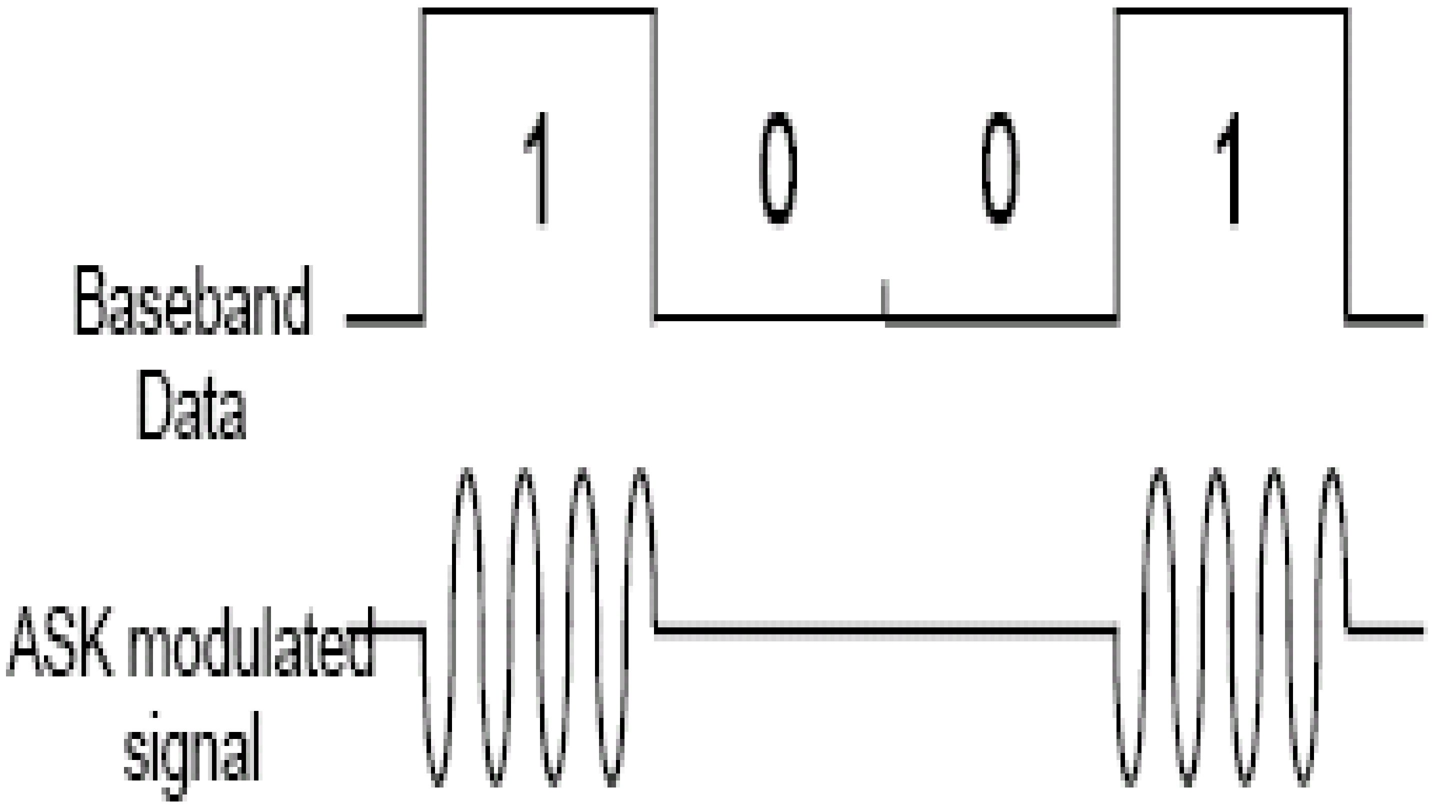
$$s(t) = \sum_{n=-\infty}^{\infty} A b_n \nu(t - nT)$$

*bn* is represented by message sequence of data variables

# Digital modulation technique

- Amplitude shift keying(ASK)
- Phase shift keying
- QPSK
- BPSK

# Amplitude Shift Keying (ASK)



$$e = E_c \sin(\omega_c t + \phi)$$

$$then$$

$$s(t) = a(t).E_c \sin(\omega_c t + \phi)$$

BAND WIDTH OF THIS TYPE OF SYSTEM IS TWICE THE HIGHEST FREQUENCY PRESENT

# QUADRATURE ASK

- Two wave form out of phase of 90 degree
- Each of the two  component of the signal is an ASK signal with pulse duration Ts

$$s(t) = a_1(t)E_c \sin(\omega_c t + \phi) + a_2(t)E_c \cos(\omega_c t + \phi)$$

# PHASE SHIFT KEYING

180Degree phase shift and zero phase shift

Band width is 2fb

Transmitted wave is a sinusoidal is of amplitude A

Power $Ps=1/2\ A^2$

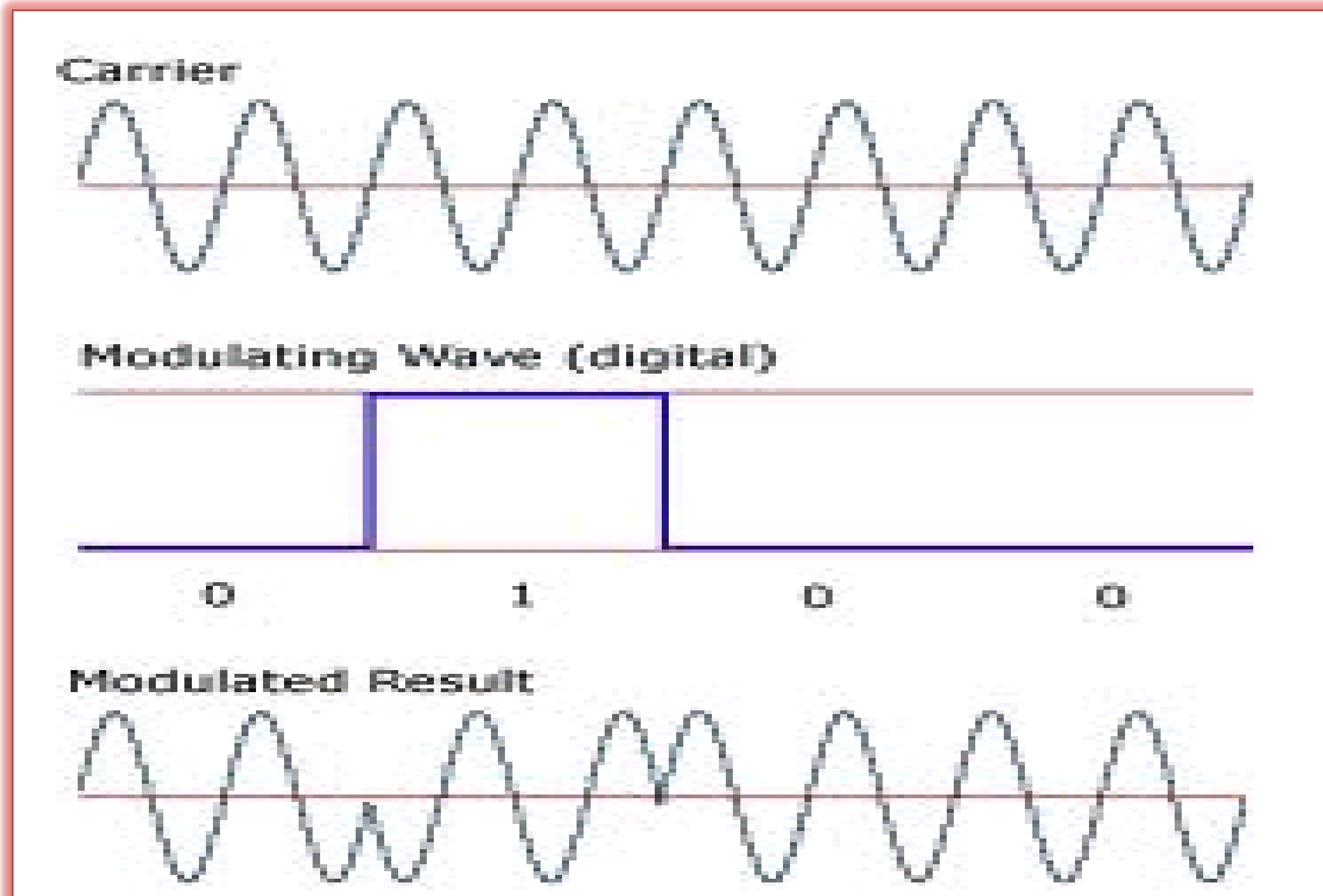
$A=\sqrt{2Ps}$

$Sbpeak= \sqrt{2Ps}\cos(wct)$

$Sbpeak= \sqrt{2Ps}\cos(wct+\pi)=- \sqrt{2Ps}\cos(wct)$

$=bt\cos(wct)$

BINARY PHASE SHIFT KEY



# System Digital Link Design

- Energy per bit to noise density
- Eb/No  is dimensionless
- Figure of merit is bit error rate—bit error probability (BER = SNR)
- Bit error --thermal noise ,external interference, inter-symbolic interference
- In case only thermal noise symbol error rate

or  symbol error probability is considered

- Energy per symbol /No in measured  in the IF bandwidth at the demodulator input
- Higher the value of Es/No, the lower is SER

- Suppose that during one symbol interval $T_b$
- Transmitter has the power C watt
- If energy received is $E_b$
- $E_b = P_t T_b$
- Where, $T_b = 1 / f_b$
- $E_b = P_t / f_b$ ……………….(1)
- $F_b$ = symbol rate in symbol / sec
- Noise density $N_o$= received power N/IF band width B(at demodulator input)
- $N_o = N / B$ …………………….(2)
- For Equation 1 & 2 -
- $C/N = (E_b / N_o) (f_b / B)$

- C/N= (Eb/No)(fb/B)
- Eb represents the bit energy & f b represents the bit rate
- Power limited region
- Band limited region
- Es/No --- ideal error bit performance of various digital modulation scheme

| Modulation technique | Idea bit error performance |
|---|---|
| MSK,BPSK/QPSK | $P= 1/2 erfc\sqrt{(Eb/No)}$ |
| DPSK | $P=1/2 \exp(-Eb/2No)$ |

# TDM

- $T_p < (T_s/M) - \Delta t = 1/2Mf_m - \Delta t$
- T1 24 –channel system
- 1+8*24=193
- 193 bits ---125μs