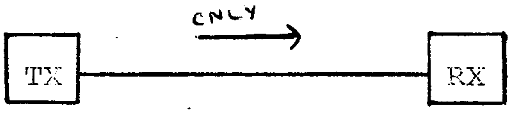
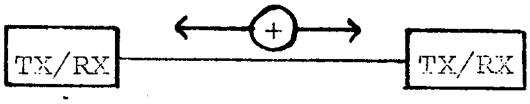
2.0 CLASSIFICATION OF SYSTEMS, AND SIGNALS
(Various Avenues of Classification)

2.1 SYSTEM TYPES
SIMPLE SYSTEM



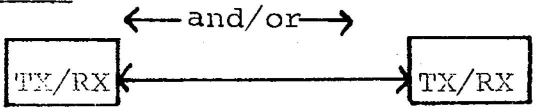
Note: Other Def'ns Available.

HALF DUPLEX



Bl - Directional
Non - Simultaneous

FULL DUPLEX



Bl - Directional
Simultaneous

Data may be transmitted serially or in Parallel.

Lines Could Be Classified As 1 wire, 2 wire, 4 wire, Broadband ETC.

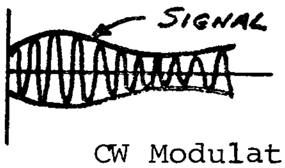
2.2 SIGNAL TYPES

Signals May Be:

Analog
Digital (originally, or converted from analog) This requires Quantization.
Baseband (signal or signals before modulation)
Modulated

2.3 TYPES OF MODULATION

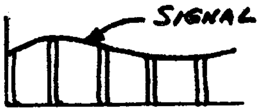
"FDM" ultiplex
(a) AM (Amplitude Modulation)



Amplitude of Carrier = f(signal Amplitude)

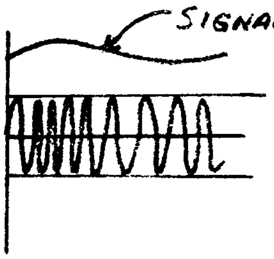
CW Modulation

"TDM"ultiplex



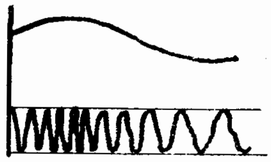
(PAM) Pulse Modulation

(b) FM (Frequency Modulation)



Freq. of Carrier = f (signal amplitude)

(c) PM (Phase Modulation)

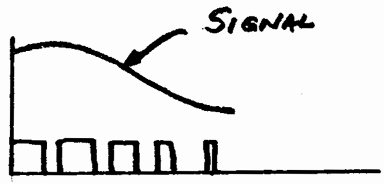


Phase of Carrier
= f (SIGNAL AMPLITUDE)

(d) PPD - (Pulse Position Mod.)

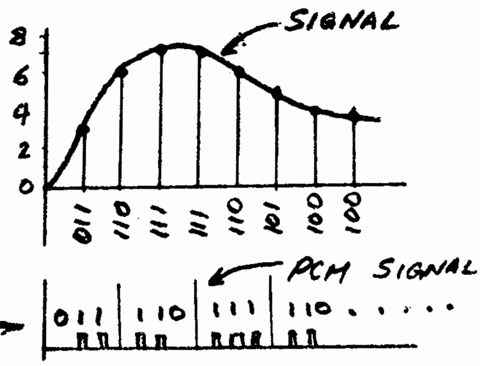
Amplitude and width
Fixed-Delay = fcn of
Mod Signal

(e) PDM (Pulse Duration Modulation)



Amp Fixed, Delay Fixed, Width
Fcn of Mod Signal

(f) PCM (Pulse Code Modulation)
Analog Signal is Quantized
and Discretized (Time Wise)
then each value is represented
by A (usually Binary Code)



Example:
CODE OF THIS FORM →

N.B. 1. Our Prime interest lies with data systems, which implies coded signals. Thses could originate coded, or in analog form. In the later case they would be P.C. Modulated.

2. P.C.M. Signals may be further modulated As

PCM-AM	Amplitude shift keying	ASK
PCM-FM	Frequency " "	FSK
PCM-PM	Phase " "	PSK

3. Several Std. Codes exist for P.C.M. Signals.

2.4 WHY MODULATE

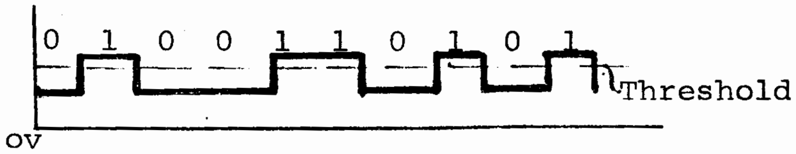
(a) To match signal to communication media.
(b) For ease of radiation
(c) To reduce noise and interference (Particularly PCM)
(d) For Channel Assignment - e.g. one radio can tune several stations.
(e) to overcome equip Limitations. (eg - freq)
(g) Accuracy (Distortion) N.B. PCM

3.0 DIGITAL REPRESENTATION OF INFORMATION

3.1 Codes Data is made up of a finite number of elements eg all letters in alphabet, No's 0-9 Etc.
These elements are normally represented by uniform length codes.
Example: Baudot, four of eight, Ascii Etc.
Different codes having specific advantag4s for error detection etc.
(These codes covered in digital section)

3.2 Waveforms - Various signal forms may be used to represent 2 level (Binary) or multi level codes. The following are representative.

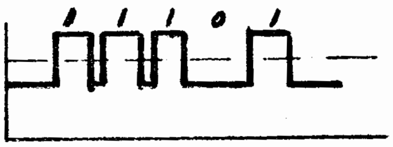
(a)



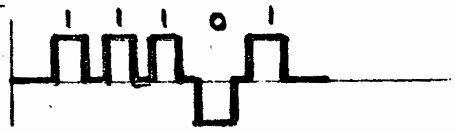
A "1" or "0" (Mark or Space) represented by signal above or below threshold, respectively.

(b) If threshold in (a) is zero volts signal is called "Polar"

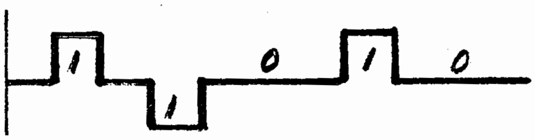
(d) Return to zero (Rz)
Above signal does not return to zero (NRz) between advacent 1's



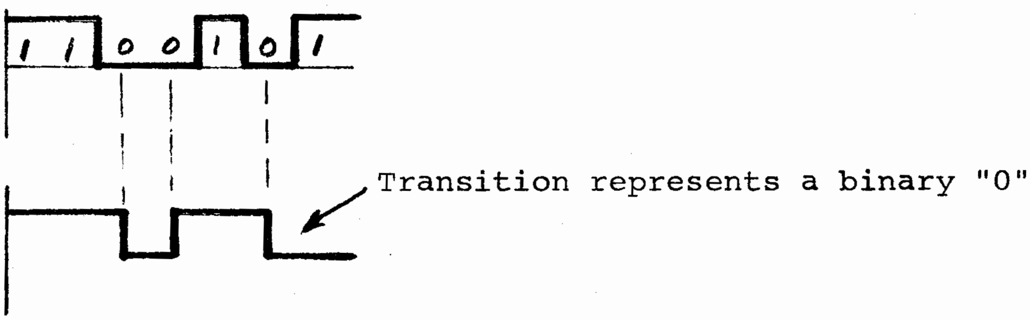
(e) Polar Rz



(f) Bipolar (Eliminates need for D.C. or low frequency)

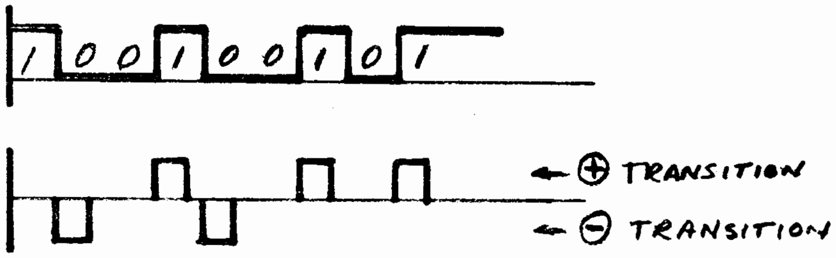


(g) Use of Transitions



Signal Polarity can be inverted with no effect on the code
Code can be detected by comparing amplitude of adjacent bits,
if amplitudees Equal → 1
Unequal → 0

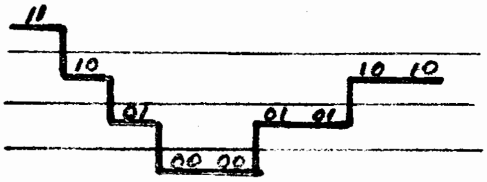
(h) Polar Pulse (Dicode)



Above signal has no D.C. and is suitable for asynchronous operation.

(i) Multi-Level Codes (As opposed to 2level - "Binary")

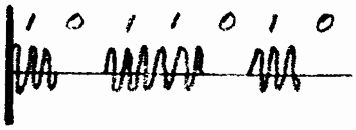
These codes require several threshold levels.



A 4 level code

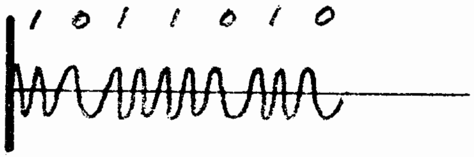
(j) Modulated Codes - Above codes are often modulated by "AM", FM, or PM. Typical waveforms would be as below.

A.M. (By freq. shift keying F.S.K.)

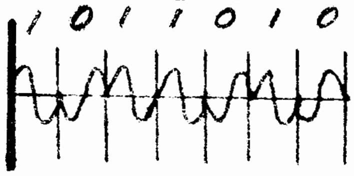


100% Modulation shown

FM (By freq. shift keying F.S.K.)



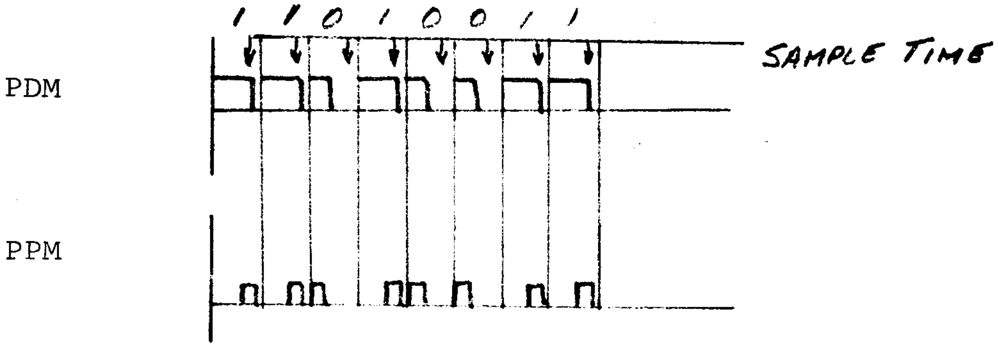
PM (By Phase Shift keying P.S.K.)



"0" and "1" differ by 180°

(k) Codes Represented By Pulse Modulation Methods

Just as analog values may be modulated by "PPM" or "PDM" , so may quantized signals.



Both examples above show two level (Binary) signals. Note that the PDM has only 2 possible widths and PPM has only 2 possible positions.

4.0 Synchronous and Asynchronous Data Transmission

(Serial data transmission is implied)

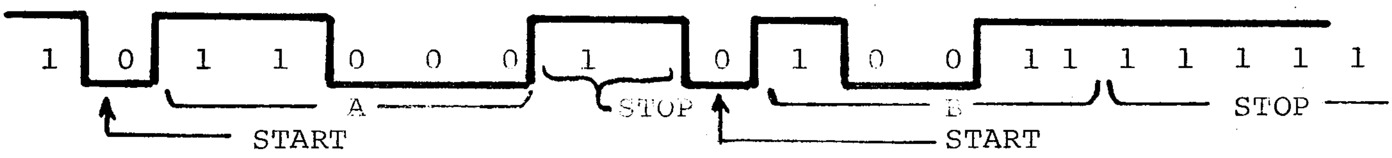
4.1 Asynchronous implies that the signal elements (eg A,B,#, D, $, X) may occur at random times. The sequence may look like AB # D$X

Although the elements do not occur at synchronous times, the bits within the element must be synchronized with a clock. The clock is started at the beginning of an "element", and there must be synchronization between "TX" and "RX". The RX must also know the code length. In order to separate each code element, the element is "Framed" by a "Start" and a "stop" pulse.

Start Pulse - indicates to the "RX" the beginning of a signal element. This is usually of 1 Bit width.

Stop Pulse - A pulse of 1X, 1.42X, 1.5X, or 2X The normal Bit width or greater. This signifies the end of a signal element.

Example: The letters "A-B" in Baudot code could appear as;



4.2 Synchronous Operation

Characterised by the following:

(a) No start stop Bits to sync. each character

(b) Information is sent in an entire block, which could consist of many signal elements with no separation.

(c) The entire block is "Framed" by unique codes which indicate to the "RX" the beginning, end etc. of blocks of information.

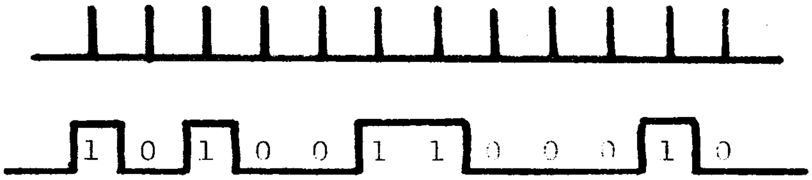
(d) The "RX" must know the code length and be able to recognize the "Unique Codes" which are used to control the "RX".

(e) Every Bit in the "TX" and the "RX" must be syncronized, to a common clock.

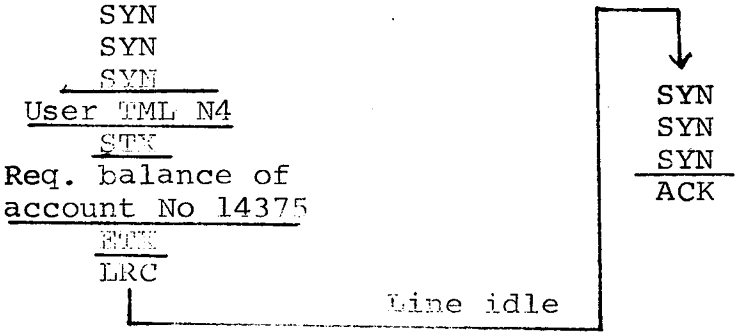
Timing signals are provided in some form along with the data Bits. These indicate to the "RX" when it must sample the data.

Example:

Clock
Data



(f) A typical message may look like



5.0 Adbantages and Disadvantages of Sync's and Async's Transmission

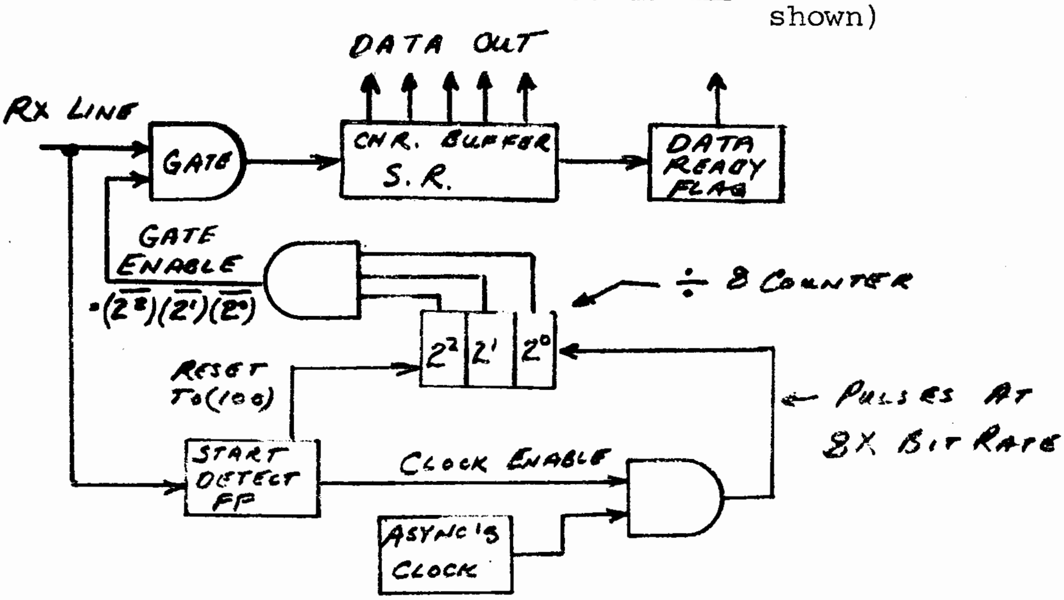
ynchronous

(a) Easily generated mechanically
(b) can easily drive mech. equip.
(c) Suitable for manual operation eg. "Pecking" on a typewriter.
(d) Requires 2 clocks which must "track"
(e) Distortion sensitive-signal provides synch. Info.
(f) Ineffieient- due to start stop Bits required.
(g) Speed limited due to above and due to fact that pulse width margin must be allowed for distortion and timing error.

ynchronous

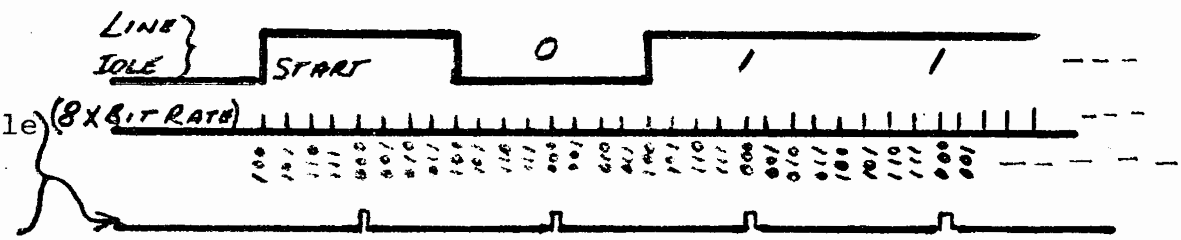
(a) High Efficiency- no Bit Synch required-block framing is required however.
(b) Bit loss can cause whole message to be errorious
(c) Special codes must be detected and control logic provided.
(d) not suitable for mechanical equipment (it cannot stay in sync. with each Bit)
(e) Ideal for fast exchange of large blocks of infO eg. Computer to Computer

6.0 <u>A Typical Asynchronous Receiver</u> (complete details are not shown)



Gate Enable

Pulses



The purpose of the "RX" logic is to assure that incoming pulses are sampled at or near the center. This tends to minimize errors due to distortion of pulses.

Often a high freq. clock (crystal if required) is divided down in frequency to provide pulses at 8 times the Bit rate. If A(÷8) counter is originally set at 4(100), its overflow count (ie 000) can be used to strobe the incoming pulses into the shift register character buffer. At the end of a character the start pulse will overflow and set the chr. Flag. This flag can be used to re-**enitialize** the system. At the beginning of a character, the incoming "start pulse" sets the start of code detector flip flop which enables the clock. Note that the Async's clock can be enabled at any time and strobing can occur at ±½ a clock period away from the center of the code Bit.

In the above system, the "end of code" is detected by <u>counting</u> incoming pulses. This could result in the RX falling out of step with the TX if an extra Bit (Noise) were to get into the system. All following information would be erroneous. The system should therefore include some pulse width testing logic which can separate the wide "stop bit" from the others and assure re-sync. at the end of each signal element.

7.0 Data Concentration - (Computer)

Efficiency of a communication system can be greatly improved by concentrating data into blocks (in memory) and then transmitting the block with all its code elements closely spaced. Usually a block would be sent by synchronous methods.

8.0 Computer Applications

8.1 Interfaces - in general the computer could be interfaced with serial, parallel, synchronous and/or asynchronous "common carrier" facilities. Many signals at different info rates may be used.

Example:

speed	Asynchronous	Synchronous
low 0-300 Baud	electro-mechanical K.B. Printers TTY'S Etc.	Not usually used for low speed
Med 300-5000 Baud	unbuffered TML'S Paper tape RDR's & punches card RDRS, Line printers	buffered TML's CRT Displays Line Printers
High 5000 Baud	Not used often	inter computer

9.0 Multiline RX's

For a few lines, equipment such as the Async's Rx shown in (6.0) would normally be duplicated. As the No. of lines increases, cost and redundant equipment must be minimized.

9.1 Common Memory Systems

Character buffer costs may be reduced by using a memory common to all "RX" lines

eg. (1) Core Memories - high speed, random access, ability to mix high and low speed lines,
- flexible to changes in system.
- Expensive relative to delay line memories.

(2) Delay Line Memories - economical for many lines, falls off rapidly as no. of lines diminish.

With common memory systems line interfaces must still be provided with each line (eg start bit detect, sync, character assembled detect etc).