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~~Binary Digits~~

Digital & Analog Quantities

~~to~~ Electronic circuits can be classified into digital Electronic Circuit and Analog electronic circuit. The digital electronic circuit uses digital quantities which have discrete values while Analog electronic circuits uses Analog quantities which have continous values.

An analog quantity which have continous values can be ~~felt~~ all ~~around~~ around us as most of nature is Analog e.g Atmospheric pressure, temperature, humidity, time, sound etc.

When an analog signal is monitored and graphed, a continous and infinite values would be obtained. On the other hand rather than monitoring an analog signal continously over a period of time, samples of the signals can be taken at certain intervals say every 1 hour. These sampled values at discretes points in time can now represent a digital quantity if assigned a digital code (with 0s and 1s).

The foregoing implies that since nature is analog, an analog signal or qty can be used by a digital circuit if it can be sampled at intervals and coverted to binary codes to become a digital quantity.

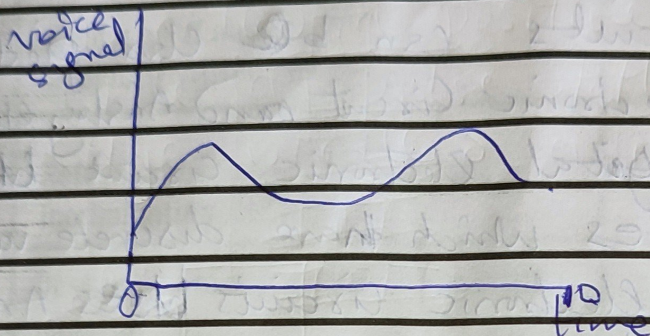

Fig 1: Continuous Analog signal

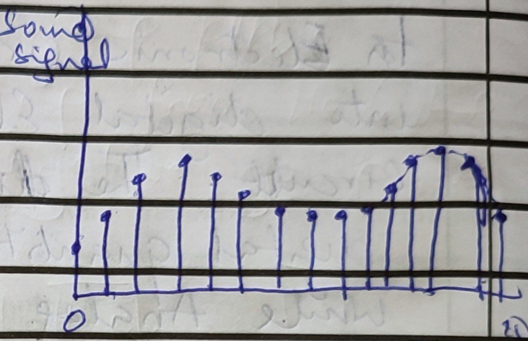

Fig 2: Sampled Analog signal

Advantage of digital data over Analog data

Representing a data in a digital format has a lot of advantage over its Analog format:

(1) It can be processed ~~more efficiently~~ and transmitted more efficiently.

(2) It can be ~~more~~ stored more easily since ~~it can be~~ and be reproduced with greater accuracy and clarity than in analog form.

(3) Noise does not easily affect a digital quantity as it easily does to Analog data.

It should be noted that most electronics circuit/system are either Analog or Digital. But ~~Most pr digital~~ Electronic systems ~~that~~ are digital are more predominant.

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Also ~~Most~~ Most digital systems houses an Analog circuit within it because they are essential to the system especially Analog to Digital converters. These are used to obtain the Analog quantities predominant in nature.

Digital logic Levels.

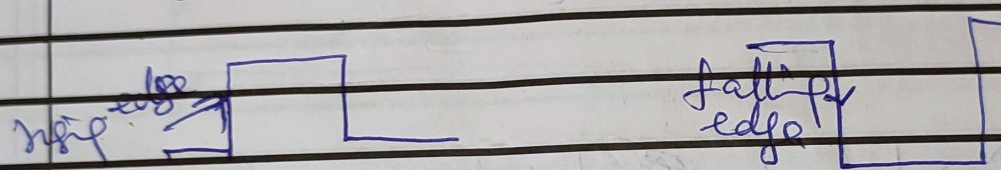
The Digital circuits or systems, only two possible states are obtainable. Two states number systems are called binary and they are 0 or 1. In electronics systems these two states can be referred to as high or low and used to represent different logic levels ~~such as~~ obtained from variables such as voltage, current etc. These two states can be used to represent a ~~log~~ range of logic levels. say/eg. from 0V – 0.8V assign 0 (low) from 2V to 3.3V assign 1 (High). Where Logic 1 takes the low and logic 0 takes a High it is referred to as negative logic

Digital waveform.

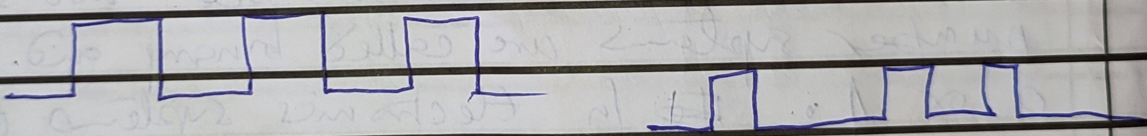
A digital waveform is a series of ~~voltage~~ pulses indicating the logic levels of a signal. such as voltage. These pulses can be classified as either periodic or non periodic

Periodic waveforms repeats itself at interval while non periodic waveforms does not repeat itself.

NB: A pulse ~~can be~~ comprise of the rising edge and the falling edge. ~~the~~ A pulse that starts from the rising edge is called a positive going ~~pulse~~ pulse while a pulse starting from the falling edge is called a negative going pulse



(a) A positive going pulse (b) A negative going pulse.



(c) Regular/periodic pulse (d) Non periodic pulse

Importance of a Digital waveform

① **As The Clock**

A Clock is a periodic timing waveform or pulse used to synchronise events in a digital system. A ~~clock~~ change in event in a digital system can happen at the positive or negative edge of the clock signal.

(2) **As Timing Diagrams**

This is a graph of the digital waveform showing the actual relationship of two or more

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wave forms and how each waveform changes in relation to others. By looking at a timing diagram, one can determine the states (High or low) of all the waveforms at any specified point in time and the exact time that a waveform changes state relative to the other waveforms.

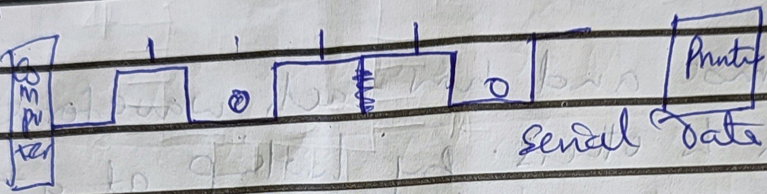
Data Transfer

Data is usually transfered from one circuit to another within a digital system or from one system to another for either processing or storage. Two methods are used to transfer these data:

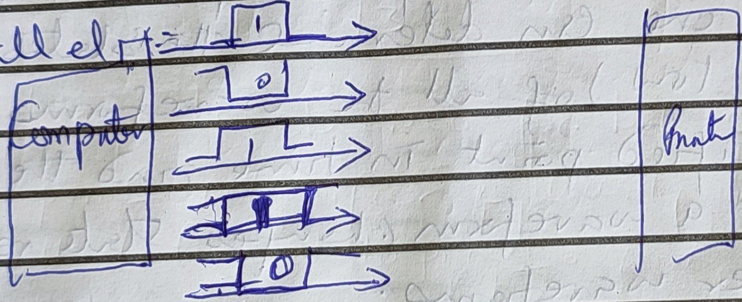
(1) Serial Method: This involve the ~~bafer~~ transfer of bits one bit at a time along a single line.

(2) Parallel method: This involves transferring all the bits in a group on separate (individual) lines at the same time.

To tranfer the digits 10110 both serially and in parrallel, a diagrammatic explanat is shown below.

Serial 

Serial data transfer

Parallel 

Parallel data transfer.

Serial vs Parallel Data transfer

The clock time required to transfer a parallel data is equal to a single clock time or latency, while for serial data transfer it take 5 clocks intervals or Serial data trunffer requires only one line while parallel transfer takes more lines.

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Digital Integrated Circuits

All the digital logic elements such as AND, NOR, OR etc are available in IC chips. Integrated Circuits (ICs) have gained more acceptance because of the following Advantages:

(1) Miniature size (3) low power consumption
(2) Low cost (4) High reliability.

Each IC has pins and one should know how they are numbered and also classified.

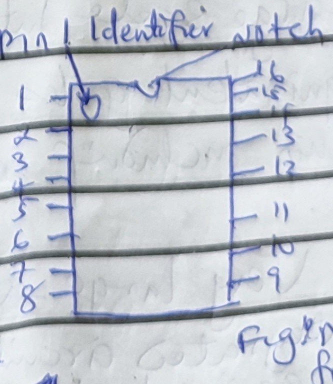
Fixed function IC; When An IC chip has all the components such as transistors, diodes, resistors, capacitors all in one chip, ~~it is~~ to perform a specific logic function it is refered to as a fixed function IC.

Programmable logic IC's are the category of digital IC that its function can be altered especially through programming of the instructions.

Pin Numbering of IC chips

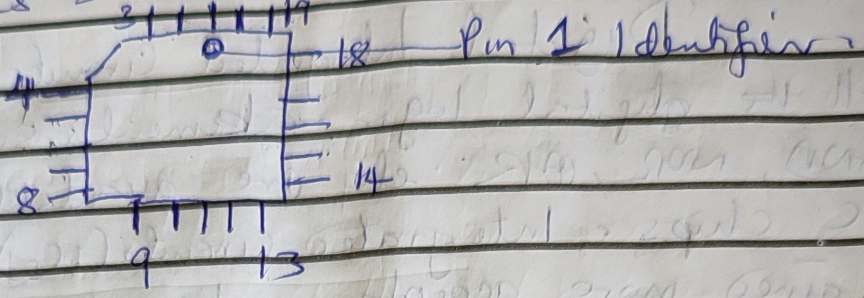
~~Based on how they the~~

dual in line Packages DIPs and the shrink small outline packages (SSOP) have their numbering illustrated here.



Chip Fig: numbering for DIP or SSOP

Chip numbering for PLCC (Plastic leaded chip carrier). or LCC (Leadless Ceramic Chip) is as shown below



It can be observed for both diagrams that the pin 1 identifier is usually indicated by a small dot next to pin 1. A notch also also help deteremine where pin 1 is.

Classification of Integrated Circuits

- Small Scale integration: This has an ~~equivalent~~ of up to ten gates ~~on a chip~~ such as basic gates & flip-flops on a single chip. It is also a fixed funct chip.

- Medium scale Integration (MSI): This comprises of 10 to 100 equivalent gates on a chip. They include logic gate functions such as ALU, encoders, decoders, counters, memories etc

- Large scale Integrat (LSI): This encompasses equivalent gates of between 100 to 10,000 per chip including memories

- Very large scale integration (VLSI): Describes integrated circuits with more than 10,000 to 100,000 equivalent gates per chip.

- Ultra Large-Scale Integration (ULSI) : This describes very large memories, larger microprocessors & larger single chip computers with complexities of more than 100,000 equivalent gates per chip.

NOTE ON [redacted] Codes.

CODES: Digital codes can be numeric or Alphanumeric.

(IV) BCD : This is known as Binary Coded Decimal. This code represent each decimal digit (0-9) with 4 bit of binary codes.

0	1	2	3	4	5	6	7	8	9
0000	0001	0010	0011	0100	0101	0110	0111	1000	1001

Therefore decimal digit 10 to 15 are not used in BCD.
It finds its Application in digital thermometers, Digital clocks and digital meters.

(2) Gray Code
For Gray code, the Binary numbers are not weighted and it exhibits a single bit change from one code to another in the sequence. It is a 4 bit code used to represent 0 to 15 in dec

characters

This ~~prope~~ ability to change only one bit is important in many applications, such as shaft position encoders, where error susceptibility increases with the number of bit changes between adjacent numbers in a sequence.

Decimal Nums	Gray Code	Decimal	Gray
0	0000	8	1100
1	0001	9	1101
2	0011	10	1111
3	0010	11	1110
4	0110	12	1010
5	0111	13	1011
6	0101	14	1001
7	0100	15	1000

(3) Alpha Numeric codes

Alpha numeric codes as the name indicates is used to represent Alphabets, numbers and also symbols and various instructions necessary for ~~convey~~ of ~~ext~~ information. Therefore they represent at a minimum 0 to 9 ~~and~~ (10 decimal digits) and the 26 letters of alphabets. Therefore totally 36. To represent in binary, a total of 36 items, 6 bits must be used, Making room for

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extra bits to accommodate symbols, ie

$2^6 = 64$; $64 - 36 = 28$.

∴ There 28 symbols or instructions in addition to 36 (Alphabet+numbers) that can be represented with a typical alphanumeric codes. ∴ a typical alphanumeric code must use a minimum of 6 bits.

(a) ASCII code: This is an Alphanumeric code capable of representing 128 characters and symbols. ASCII is short for American Standard Code for Information Interchange. It is also used to represent non graphical command for control purposes e.g 'escape' (ESC) as found in computer keyboard.

The range is from 0 to 128 or 00 to 7F in hex

(b) The Extended ASCII Characters: This is an unofficial standard code. and requires 128 additional characters to the 128 standard ASCII characters. It uses 8 bits to represent character ranging from 00 to 7F to 80 to FF. It is used to represent foreign alphabetic character etc.

(c) UNICODE: Uses the first 128 characters of ASCII but consists of about 100,000 characters. It provides the ability to encode all of the characters used for written languages of the world. It is applicable in computer applications dealing with multilingual text, mathematical symbols, or other technical characters

ERROR DETECTION CODES

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~~[illegible]~~ i

(1) PARITY METHOD for ERROR Detect.

This involves adding a single bit of either 0 or 1 before the MSB (most significant Bit) in order to make the no of ~~bits~~ ones (1s) in the groups bits either ~~positive~~ ~~(for~~ even (for even parity) or odd (for odd parity).

Odd parity method of error detection requires one to ~~add~~ make sure that the no of ones (1s) in a group of bits to be transmitted is odd in addition to the parity bit. (The parity bit inclusive).

While

Even parity requires the number of 1s to be even, ~~[illegible]~~ the even parity bit inclusive).

	code for transmission	Odd parity	Even parity
eg	0011	$\bar{1}$ 0011	$\bar{0}$ 0011
	1100	$\bar{1}$ 1100	$\bar{0}$ 0011

The bits with a dash (‾) above it represents the parity bit.

The drawback of the parity bit method is that it ~~does not~~ cannot detect a double change in the bit transmitted. It can only detect a single bit change.

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5) Cyclic Redundancy Check.

CRC is used for one and two bit transmission errors when digital data is transmitted on a communicat link. If it is properly designed, the CRC can also detect multiple errors for a number of bits in sequence. In CRC, a certain number of check bits, called checksum, are appended to the end of the data bits that are being transmitted. The transmitted data is tested by the receiver for errors using the CRC. Not every possible error can be identified but the CRC is much more efficient than just a a simple parity check.