



NNAMDI AZIKIWE UNIVERSITY, AWKA

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035983

Do Not
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MarginBinary DigitsDigital & Analog Quantities

Electronic circuits can be classified into digital Electronic Circuit and Analog Electronic circuit. The digital Electronic circuit bases digital quantities which have discrete values while Analog Electronic circuits bases Analog quantities which have continuous values.

An analog quantity which have continuous values can be felt all 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 continuous and infinite values would be obtained. On the other hand rather than monitoring an analog signal continuously over a period of time, samples of the signals can be taken at certain intervals say every 1 hour. These sampled values at discrete 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 quantity can be used by a digital circuit if it can be sampled at intervals and converted to binary codes to become a digital quantity.

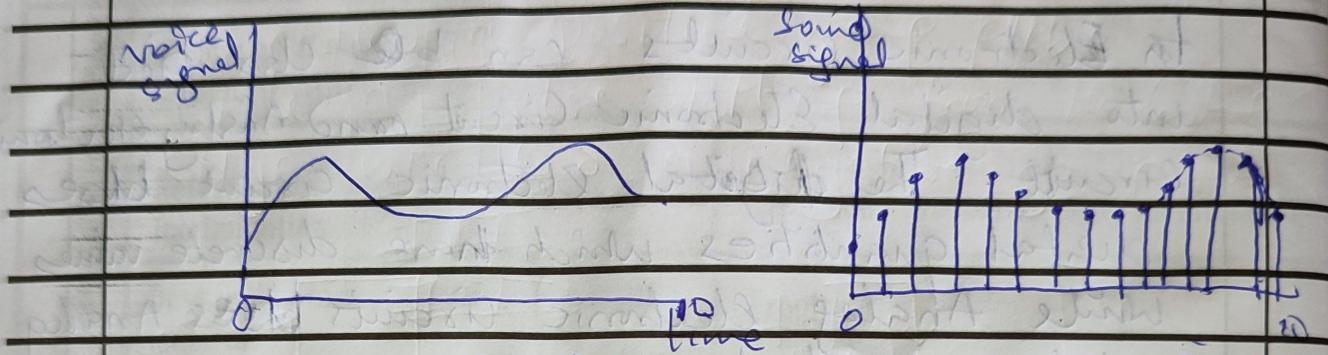


Fig 1: Continuous Analog signal Fig 2: Sampled Analog signal

Advantage of digital data over Analog data

Representing 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 stored more easily since it can be stored & 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 electronic circuit systems are either Analog or Digital. But most ~~of~~ 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 -

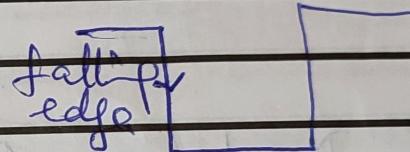
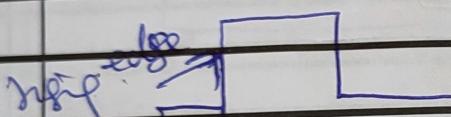
The Digital circuits or systems, only two possible states are obtainable. Two states number system are called binary and they are 0 or 1. In electronic systems these two states can be referred to as high or low and used to represent different logic levels such as obtained from variables such as voltage, current etc. These two states can be used to represent a large range of logic levels. say e.g. from 0V - 0.8V ass for 0 (low) from 2V to 3.3V ass for 1 (high).

Where Logic 1 takes the low and logic 0 takes a high Digital waveform. It is referred to as negative logic.

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.

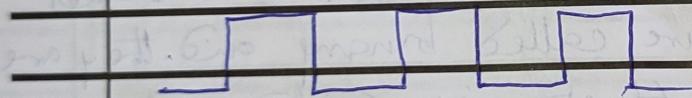
Periodic waveforms repeats itself at intervals while non periodic waveforms does not repeat itself.

Note 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 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 waveform 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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waveforms 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.

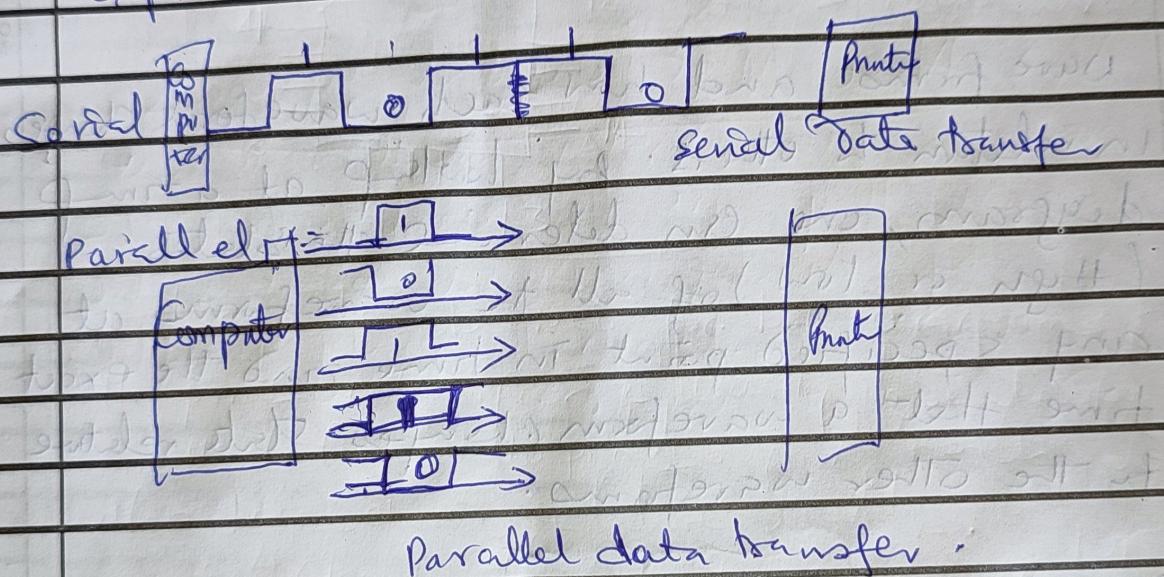
Data Transfer

Data is usually transferred 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 transfer of bits one bit at a time along a single line.

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

To transfer the digits 10110 both serially and in parallel, a diagrammatical explanation is shown below.



Serial vs Parallel Data transfer

The clock time required to transfer a parallel date is equal to ~~a~~ a single clock time while for serial data transfer it takes 5 clock intervals & serial data transfer 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) Minimizes size (2) low power consumption
- (2) Low cost (3) High reliability.

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

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

Programmable logic IC, 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

dual in line Packages

DIPs and the shrink small

outline packages (SSOP) have their numbering illustrated here.

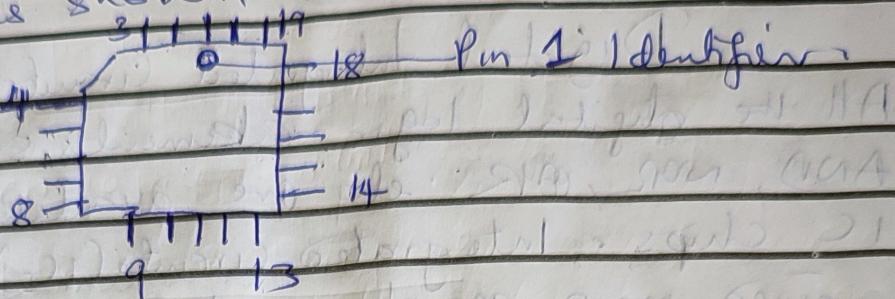
Pin Identifier notch



chip
fig & number
for DIP or SSOP

- numbers

Chip numbering for PLCC (Plastic Leaded Chip Carriers) or LCC (Leadless Ceramic Chip) is as shown below



It can be observed from both diagrams that the pin 1 identifier is usually indicated by a small dot next to pin 1. A notch also helps determine 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 punch 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 Integration (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 1000 to 100,000 equivalent gates per chip.

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

NOTES ON Error Detection Codes.

Codes : Digital codes can be numerical or Alphanumeric.

(1) BCD : This is known as Binary Coded Decimal. This code represents 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 digits 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 decimal characters.

This ~~pose~~ 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	0	1100
1	0001	1	1101
2	0011	2	1111
3	0110	3	1110
4	0110	4	1010
5	0111	5	1011
6	0101	6	1001
7	0100	7	1000

(B) Alpha Numeric codes

Alpha numeric codes as the name indicates is used to represent Alphabets, numbers and also symbols and various instructions necessary for conveying 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

unspecified situations of 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 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1336, 1337, 1338, 1339, 1330, 1331, 1332, 1333, 1334, 1335, 1336, 1337, 1338, 1339, 1340, 1341, 1342, 1343, 1344, 1345, 1346, 1347, 1348, 1349,



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extra bits to accommodate symbols, i.e

$$2^6 = 64 \text{ & } 64 - 36 = 28$$

∴ There are 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 commands for control purposes e.g escape (ESC) as found in computer keyboard. The range is from 0 to 128 or 00 to FF 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 characters 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 multi lingual text, mathematical symbols, or other technical characters.

ERROR DETECTION CODES

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(a) i

(i) PARITY METHOD for ERROR Detection.

This involves adding a single bit of either 0 or 1 before the MSB (most significant bit) in order to make the no. of ones (1_s) in the groups of bits either positive (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 (1_s) in a group of bits to be transmitted is odd in addition to the parity bit. (The parity bit inclusive).

Even parity requires the number of 1s to be even, the even parity bit inclusive.

	Code for transmission	Odd parity	Even parity
e.g.	<u>0011</u>	<u>10011</u>	<u>00011</u>
	<u>1100</u>	<u>11100</u>	<u>00011</u>

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

The drawback of the parity bit method is that it ^{cannot} detect a double change in the bit transmitted. We 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 communication 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 simple parity check.