

# Physics Behind Digital Technology

K.Sreelatha, <sup>1</sup>

Dept of Physics- Ch.S.D.St Theresa's (A) College For Women, Eluru – W.G.Dt,A.P

Mailed: srilatha.prathap@gmail.com

K.Showrilu,

Dept of Physics- Ch.S.D.St Theresa's (A) College For Women, Eluru – W.G.Dt,A.P

Mailed: kondaveetishowri@gmail.com

**ABSTRACT:** Tomorrow's future depend on today's physics – Mark Jackson. Physics is the science of world. The world that consists of matter and energy. Matter in all its states, energy in all its forms. It has strong presence not only in all the other branches of science including medical, but also in economics and stock market trading. Physicists proposed and evolved various theories relating to variety of fields. Generally speaking radios (including WiFi) and amplifiers are analog, whereas computers, CDs and digital watches are digital. Analog electronics have been around since 20<sup>th</sup> turn of the century; digital electronics have flourished only in the last 50 years. Most any modern device (e.g., "digital" television is in fact a blend of both analog and digital technologies. Digital electronics reaches its ultimate complexity (and hence useless) in microprocesors(e.g., the intel chip that powers most PCs). Designing microprocessor-based circuits requires both computer programming(often in assembler) and digital electronics.

Keywords: Boolean algebra – laws, properties; Digital Electronics – Basics, Applications

**Introduction:** Technology is the application of the principles of physics for all practical purposes. The technological development of the society is deeply related to physics and other branches of science. Physics is second only to mathematics in the purity of its principles. Physics describes how the natural world works through applied mathematical formulas.

A digital circuit is typically constructed from small electronic circuits called logic gates that can be used to create combinational logic. Logic gates constitute the foundation blocks for digital logic. Digital technology is a base two process. The information is recorded in binary code of combinations of the digits 0 and 1, also called bits. All the words, numbers, audio, video

and images are represented in the form of bits. Digital technology enables immense amounts of information to be compressed on small storage devices that can be easily preserved and transported. Digitization also quickens data transmission speeds. In every aspect of digital technology the physics play a vital role. Starting from conversion of the physical entities into zeros and ones, storing them in a retrievable form and to transmit them through a variety of media, physics is the backbone of all the processes.

Logic gate constitute the foundation blocks for digital logic. Each logic gate is designed to perform a function of Boolean logic when acting on logic signals. The output of a logic gate can in turn control or feed into near logic gates. Digital signals contain a series of ones and zeros, otherwise known as binary. Computers understand this language perfectly. The electric current (flow of electrons) varies to represent these ones and zeros. But just to confuse things, digital signals can also be sent using electromagnetic radiation. This is usually done through a communication technology called fiber optics.

## Basics of Digital electronics

Digital electronics represents signals by discrete bands of analog levels, rather than by a continuous range. There are only two signal levels 0 or 1(binary) circuits which work on this is called as logic circuit. Circuits need design which can be done by same set of equations called as Boolean equation. A variable is called as Boolean variable. Example: A represent 1 and  $\bar{A}$  represent 0. Various operations can be done with these variables, which are called as OR(+), And(.), NOT(basic operations). NOR, NAND, XOR, XNOR are derived from the basic operations.

Digital Circuits perform the binary arithmetic i.e. operations with binary digits 1 and 0. These operations are called logic functions and logical operations. The algebra used to symbolically describe logic function is called Boolean algebra. Boolean algebra is a set of rules and theorems mathematically. As with the ordinary algebra, the letters of alphabets(e.g. A,B,C) can be used to represent the variables. Boolean algebra differs from ordinary algebra in that Boolean constant and variables can have only two values 0 and 1.

(i) Equals sign (=): the equal sign in Boolean algebra refers to standard mathematical equality. In other words, the logical value on one side of the sign is identical value on the other side of the sign. Suppose we are given two logical variables such that  $A=B$ , then if  $A=1$ , then  $B=1$  and if  $A=0$  then  $B=0$ .

(ii) Plus Sign (+): The plus sign in Boolean algebra refers to logical OR operation. Thus, when the statement  $A+B=1$  appears in Boolean algebra, it means A OR with B equals 1. Consequently, either  $A=1$  or  $B=1$  or both equal 1.

(iii) Multiply sign (.): The multiply sign in Boolean algebra refers to logical AND operation. Thus, when the statement  $A.B=1$  appears in Boolean algebra, it means A AND with B equals 1. Consequently, either  $A=1$  and  $B=1$ , the function  $A.B$  is often written as  $AB$ .

Bar sign (-): The bar sign in Boolean algebra refers to logical NOT operation. The NOT has the effect of inverting (complementary) the logical value. Thus, if  $A=1$  then  $\overline{A}=0$ .

**Laws of Boolean algebra:** Boolean algebra uses a set of laws and rules to define the operation of a digital logic circuit. As well as the logic symbols '0' and '1' being used to represent a digital input or output, we can also use them as constants for a permanently open or closed circuit or contact respectively.

#### Properties of Boolean Algebra:

- Commutative: The commutative property says that binary operations AND and OR may be applied left to right or right to left.
- Associative: The associative property says that given three Boolean variables, they may be ANDed or ORed right to left or left to right.
- Distributive: The distributive property says that given three Boolean variables. The first AND the result of the second OR the third is the same as the first AND the second OR the first AND the third. Also, the first OR the result of second AND the third is the same as the first OR the second, AND the result of the first of the second.
- Identity: The identity property says that any value A AND the OR identity always returns A and that any value A OR the AND identity always returns A.

- Complement: The complement property says that any value AND the compliment of that value equals the OR identity and that any value OR the compliment of that value equals the OR identity.

Digital circuits are sometimes more expensive, especially in small quantities. An advantage of digital circuits when compared to analog circuits is that signals represented digitally can be transmitted without degradation caused by noise.

## Applications of Physics in Digital technology:

With the advent of new age digital technologies, the global scenario has undergone a radical transformation with industry after joining the digital bandwagon. Needless to say, the telecom industry has not remained untouched either. Marrying together the right strategy and process design with digital technology has resulted in the emergence of new business models in the telecom sector.

Some ways Telecom companies can leverage Digital technologies:

**Smart Metering:** Smart meter systems are electronic measurement devices which operate by transmitting information wirelessly to communicate information for billing customers and operating their electric systems. They are based on a two way communication and data system commonly referred to as advanced metering infrastructure (AMI).

**Infrastructure Management using IoT:** Iot has a pivotal role to play in terms of infrastructure in telcos. It serves as an intelligence platform to achieve energy savings and provide an improved workplace experience. Contrary to the traditional approach of devices functioning in isolation, IoT provides a unified console to manage several devices connected across the telecom network in an integrated manner.

**Digital VAS (Value Added Services):** Telecom service providers are today able to provide an enriched single-window experience to consumers for discovering digital content related to information, services, news, entertainment and much more. The more traditional versions of

SMS based value added services are giving way to digital infotainment services, mobile advertising, mobile TV and much more.

**Outage Management Systems:** Modern digital outage management systems implemented in the telecom industry today can accurately predict size and duration of outages, raise alarms, calculate estimated restoration times and manage crew assisting in restoration.

Different forms of storages such as floppy disk, Hard disk, Compact disk, apply the concepts of Magnetism, Laser Physics and Optics. The concepts in Semiconductor physics and Quantum mechanics paved the way for the development of integrated circuits. Due to the invention of Giant Magneto Resistance, it has been possible to miniaturize hard disks so radically in recent years. Sensitive read-out heads are needed to be able to read data from the compact hard disks so radically in recent years. Sensitive read-out heads are need to be able to read data from the compact hard disks used in laptops and some music players.

In a compact disc, an infrared laser is focused onto the metallic disc to denote 'pits' and 'lands' represents the '0' and '1'. The return signal is converted by a photodiode sensor. A scanner divides the photo into small pixels. It produces an array of binary digits, each representing the brightness and colors (RGB) of a pixel. On display devices, the concepts of cathode ray tubes, Liquid crystals and Plasma physics play a vital role.

Basing mainly on physics principles there are amazing new advances in imaging technology. These are enabling doctors to peer inside a body to watch vital organs at work, identify blockages and growths and even detect signs of diseases not yet developed all without the trauma of exploratory surgery. The term given was machine vision. As a result, tremendous progress has been taking place in diagnosing ailments in the history of medical sciences.

Image processing is a technique for analyzing, enhancing, compressing, and reconstructing images. Pattern recognition is an information-reduction process. The assignment of visual or logical patterns to classes is based on the features of these patterns and their relationships. This technique is widely used in astronomy, medicine, industrial robotics and remote sensing by satellites.

Digital memory and transmission systems can use techniques such as error detection and correction to use additional data to correct any errors in transmission and storage.

On the transmission of digital signals optical cables which use the concept of total internal reflection are used in an extended manner. Other techniques such as microwaves transmission and IR transmission also depend of the basic concepts of Physics. Their capability to transmit the amount of data is judged based on the limitations imposed by the principles of Physics.

The computers used to send and receive the signals work on physical principles. They turn analog radio waves into digital signals represented by electrons whizzing along boards. GPS navigation sensitive to nanosecond calculation derived from Einstein general theory of relativity. PET Scan use 3D body- imaging made possible by particle physics. Even the World Wide Web serving you was a creation of Physics conceived by Tim Berners –Lee as CERN to transfer large Physics data files.

**Conclusion:** The future of science can no longer be solely determined behind lab doors and at private galas. The next generation will suffer from today's lack of vision. Still government funding for science is fickle. Today's technology is so rooted in Physics that our way of life depends upon it. The increased computational power and higher standard of living derived from physics-based technology allows us to pursue a deeper understanding of Physics, again leading to improved technology-and soon. Physics contributes to the technological infrastructure and provides trained personnel needed to take advantage of scientific advances and discoveries. Physics is an important element in the education of chemists, engineers and computer scientists, as well as practitioners of the other physical and biomedical sciences. Physics is the backbone of all technologies, especially the digital technology. Having a deep understanding of the subject and developing technology and new materials for the industrial requirement would contribute to the welfare of the nation.

References:

- 1) <https://study.com/academy/lesson>
- 2) [www.physicshandbook.com](http://www.physicshandbook.com)
- 3) Maths online-Edurite.com

- 4) Electronics-course.com>logic-gates.
- 5) Fundamentals of Digital Electronics \_Prof Barry Paton, Dalhousie University
- 6) [https:// singularityhub.com](https://singularityhub.com)