iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** XII **Month of publication:** December 2019

DOI: http://doi.org/10.22214/ijraset.2019.12004

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue XII, Dec 2019- Available at www.ijraset.com

Logic Gates: Development, Applications and Failure

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Abstract: In this paper, technical applications of various elementary logic gates has been studied. Along with the application we will also analyze their failures and causes of the failures of these logic gates based technical applications. Logic gates are used in various technologies to ease the working of the technology and make it more efficient. In this paper we will observe various technological applications and possible causes of failures of logic gates, Case study of failure of logic gates and further scope of enhancement of the applications of logic gates and making the application more efficient and beneficial.

I. INTRODUCTION

Logic gates are basic logic devices which take inputs in binary numbers(0 or 1), consequently their outputs are also obtained in binary. They work on binary logic and hence are efficient. Some devices have only one logic circuit which is imperative for their working while some devices like microprocessors consist of millions of logic gate circuits of numerous logic gates is done for the completion of a logic circuit for complex logical circuits. Thousands and millions of logic gate circuits are combined for complex applications or complex logic circuits. To determine the maximum number of logic gates in a circuit we divide the size of the chip being used with the size of the logic gates. It is known that transistors make the major logic gates in computer processors hence smaller transistors mean complex and faster operation. Logic gates are primarily used in microprocessor chips that are used in various digital devices. Logic gates are of utmost importance in digital electronics. Almost all the operations are carried out by Logic Gates. Logic gates also find their uses in conditional switches. Logic gates find their use a tester for integrated circuit ICs. Logic gates make the ease of testing the IC extremely high and convenient . ZIF socket or zero insertion force socket is a type of socket used in electronic devices which is designed not to stress or damage the devices. The IC under testing is placed on the ZIF socket and the microcontroller then prompts the user to give inputs relating to the IC number of the chip. After entering the IC number the microcontroller checks the same according to the truth table which is stored in the ROM. Each pin of the IC is checked and the output detail is obtained. Like “Gate 2 is bad”, “Gate is good”, “Counter 1 is good” etc The microcontroller. is a device which is programmed in such a way that it can behave as a large number of logic gate circuits and hence opens a large number of possibilities for working. Logic gates in microcontrollers has a large range of operation in opening and closing of gates of hydroelectric power plants and have served to be revolutionary in improving the working of various synchronous machines. Logic Gates are also extensively used in Nanoelectromechnical switches which are similar to mechanical semiconductor switches and the operation is also similar to an extent. However it is seen that they are extremely efficient in comparison to semiconductor switches due to the presence of logic gate circuit.. The failure rate of nanoelectromechanical switches is much less than semiconductor switches. They also possess zero isolation leakage. In this paper will evaluate the efficiency and application of logic gates in various avenues.

II. REVERSIBLE LOGIC GATES AND THEIR AND THEIR IMPLICATION

In the field of computing reversibility means that information about the computational states can never be lost so we can get to any of the earlier stages by computing backwards or un computing the results. This process is called logical reversibility. However it is seen that the advantages of logical reversibility can only be enjoyed by first applying physical reversibility.

Physical reversibility is a process which releases no energy or heat. A hundred percent physical reversibility is practically unachievable .Computing system dissipates heat when voltage level goes from negative to positive value, or bits shift from 0 to1.Most of the energy required for the change is given out in the form of heat. Instead of changing the voltage from value to another to another, the reversible circuit elements will transfer charge from one node to the next. By this energy not worth more than a minute is expected to be lost by these logic designs. Reversible logic elements are required for the recovery of the state of inputs from the outputs. Eventually, these will also have to be reversible to provide optimal efficiency. The foremost problem that is seen in the existing technology energy dissipation. In high technology circuits energy dissipation due to information loss is commonly

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue XII, Dec 2019- Available at www.ijraset.com

seen. The most appreciable application of reversible logic lies in quantum computers. A quantum computer will be viewed as a quantum network (or a family of quantum networks) composed of quantum logic gates; Its applications can be seen in various research areas such as quantum computing and DNA computing.

Quantum networks are made up of quantum logic gates; each gate performs an elementary unitary operation on one or more two–state quantum systems which are called qubits. Each qubit is a representation of an elementary unit of information; corresponding to the classical bit values 0 and 1. Every unitary operation can be reversed so quantum networks that effect elementary arithmetic operations such as addition, exponential and multiplication cannot directly be deduced from the normal Boolean expressions. Thus it is important to build quantum arithmetic using reversible logical components.

Reversible computation can be performed in a system only if the system has reversible gates. A gate is called reversible if the input vector is uniquely recovered from the output vector. There should also be one-to-one correspondence between its input and output assignment.

III. APPLICATION OF LOGIC GATE IN MICROCONTROLLER

Logic gates in microcontrollers are used for carrying quality control tests for correct operation. During this process a truth table of the integrated gate is verified In the begining two inputs are fed with the first value in the truth table (00). Post that the output value is verified. further it is ensured that the output relating to the input is correct.

The digital integrated circuit (IC) tester is implemented by the usage of the ATmega32 microcontroller.The work of the microcontroller is to process the inputs and outputs hence displaying the results on a Liquid Crystal Display(LCD). The latest designed models can test ICs having 14 pins. Because of the setup being programmable a numerous amount of ICs can be tested. In the process necessary inputs are applied to each stage of the IC, the outputs are monitored closely at each stage and are compared with the output in the truth table. If any discrepancy is observed the functioning of the IC results in a fail indication and the faulty and good gates are identified on the LCD. The testing is completed by the help of keypad keys present on the main board design. The test has been accomplished with most commonly used digital IC's, mainly belonging to the 74 series. Digital IC tester tests three samples of IC's (NAND, NOT, NOR). The design is flexible . We can add extra IC bases and subroutines to test any other IC in the 74 series.

IV. CAUSES OF FAILURE OF LOGIC GATES

It is seen that logic gates have a large number of applications so it is important that if failure occurs a diagnosis should be undertaken. This is imperative for electronic applications as a large number of ICs make use of logic gates as their fundamental. A failure of logic gate however is a physical defect that takes place in one or more of its components which may lead to a malfunction of the entire system. It can be so dangerous that may even cause permanent damage. The cause of the above is usually an error while production of the logic gate element or sometimes even by the aging of the component.

While studying temporary malfunctions it is seen that they are usually caused by badly synchronized structures or asynchronous structures. It is observed that this is due to varying disturbances caused by internal noise or sometimes external influences. Temporary malfunctions if unattended will become permanent with time. They are usually observed in digital systems, discrete systems or integrated circuits. Multiple malfunctions although rare are sometimes seen. A malfunction may also be indicated when the logic gate gives no output.[2]

V. NEMS

NEMS refer to nanoelectromechanical systems. These are sensors that sense actuation of signal into physical entries Technically speaking NEMS switch is base on the process of electrostatic actuation of cantilever beam. A fairly simple design of logic gates is used in NEMS. It usually consists of dual input logic gates such as NAND or NOR. Two NEMS switches are used to implement the NAND gate. The output of such a circuit is transferred to ground terminal. This technology finds its use in the continuous improvement of the efficiency of electronic components. This is realized by continuously making the transformer smaller in size. The limitations related to physical factors of the existing technology lead to the research of other alternative methods for specific applications especially to be used in military and space research where the size of the components needs to be small. The NEMS or nano electromechanical switches logic gate is a NEMS device which is capable of performing Boolean logic functions and is a technology similar to solid state logic gates. EMS switches are substitute for CMOS transistors in terms of resulting in higher efficiency, high isolation, near zero sub threshold leakage, extremely low sub threshold swing values. It also offers flexibility of making digital interface in the NEMS structure itself and thus reduces the difficulty of realizing NEMS based SoC (system on chip) system.[1]

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VI. CONCLUSION

It can be concluded by this paper that logic gates have a lot of varied applications and large number of uses. Failures of logic gates were also analyzed and it was observed that there may exist a huge number of flaws in logic gates which may lead to a large number of problems in the circuits. To overcome these problems we also analyzed NEMS as an alternative to logic gate and were found more efficient to logic gate circuits.[2]

VII. ACKNOWLEDGEMENTS

We would like to express our special thanks of gratefulness to Dr. Anand R. Bhalerao, Principal and Dean, Bharati Vidyapeeth Deemed (to be) University College of Engineering, for his able guidance and support for completing my research paper. We would also like to thank Dr. D. S. Bankar, Head, Department of Electrical Engineering, Bharati Vidyapeeth Deemed (to be) University College of Engineering and faculty members of the department of electrical engineering who helped us with extended support.

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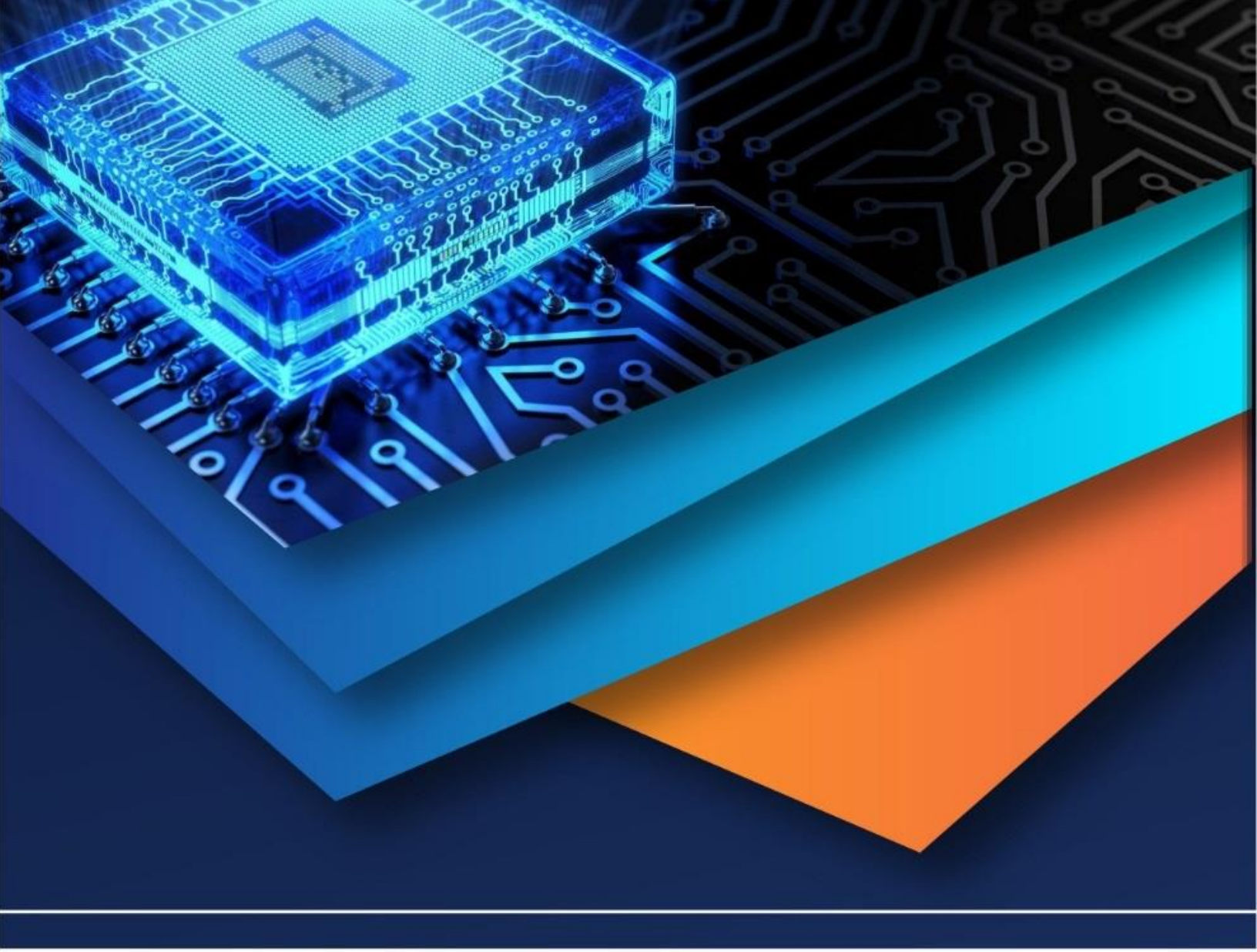

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