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A COMPARATIVE SURVEY OF COMBINATIONAL LOGIC CIRCUITS AND SEQUENTIAL LOGIC CIRCUITS

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Abstract - In this day's Technology is advancing, Modern technology play a very important role which help in growth of advanced integrated logic circuits(ICs) that perform complex logical operations. Digital circuits have the capability to solve the real time complex problem. Every electronic device like cell phones, computers use logic gates. In this paper we present a detailed study of Combinational Logic Circuits and Sequential Logic Circuits with their strengths and weaknesses over each other based on their performance. In this paper, we have provided a fair comparison between summary on what is Combinational Logic Circuits and what is Sequential Logic Circuits. Different device like multiplexers, de-multiplexers, encoders, decoders, half adder, and full adders used to implement combinational logic circuits.

Keywords - Combinational Logic Circuits, Sequential Logic Circuits, Digital circuits, counter

I. INTRODUCTION

There are two basic types of electronic circuits systems analog and digital, In analog circuits operate on continuous valued signals, which deal with input signal is analog, i.e. the circuit directly performs various logical operation and procedure analog output, No conversion of input signals are required before processing. Analog circuits are hard to design. There is no loss of information that is available for processing. Analog circuits are mostly custom made.

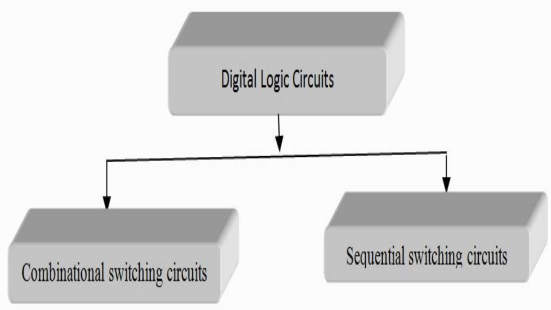


Figure 1: classification of logic circuits

Digital circuits operate on binary signals. Digital circuits are easy to design since automation technique can be applied at various levels of circuit design [1]. The input signals are converted from analog to digital form before it is processed and produces output which is again converted back from digital to analog signals [8]. Due to the conversion process at the input side and at the output side, some amount of information is lost during the conversion process. Digital circuits have high degree of flexibility.
Digital circuits also known as switching circuits. Switching circuits are of two kinds combinational switching circuits and sequential switching circuits [7]. Combinational circuits is one in which the output is only dependent on the present input i.e. output is only dependent on present input, whereas sequential switching circuits is just opposite to it the output depends upon the present input but also it depends upon the previous output. So the sequential switching circuits is something in which the output depends on the present input as well as previous output

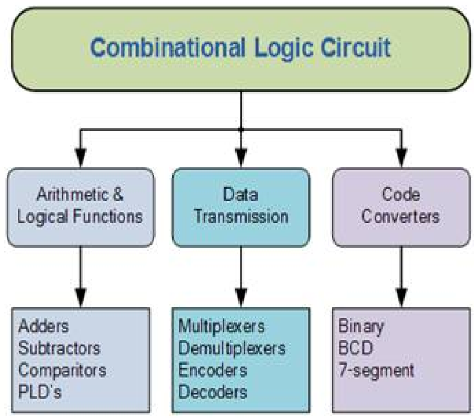


Figure 2: classification of combinational switching circuits

A block diagram of a sequential circuit is shown in the below figure. It consists of a combinational circuit to which memory elements are connected to form feedback path. The memory elements are devices capable of storing binary information within them.
Applications of combinational circuits are:
1. Multiplexer
2. Demultiplexer
3. Encoder
4. Decoder
5. Seven Segment Decoder
6. Half Adder
7. Full Adder

II. RELATED WORK

Electronic circuits system in digital circuit system, combinational logic is a type of digital logic which is implemented by Boolean circuits [4], where the output is a pure function of the present input only.

This is in contrast to sequential logic, in which the output depends not only on the present input but also on the history of the input. In other words, sequential logic has memory while combinational logic does not. Combinational logic is used in computer circuits to perform Boolean algebra on input signals and on stored data.

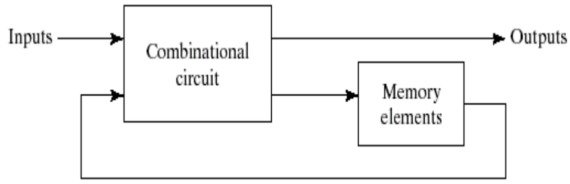


Figure 3 : Block Diagram of Sequential Circuits.

In typical sequential circuit applications, the outputs of the memory devices have to be used as inputs to the same circuit in order to generate the next state of the system[2] as shown in Figure below:.

Adder is a Combinational circuits, so in adder it is very simple, if we are adding a single bit,if we are adding one with zero then what we are going to get ,we are going to get one. Is there any use of the previous output in this adder, definitely not, there is no need of the previous output in this particular addition, so adder is satisfying our condition that the output is only dependent on present input, but we say about counter is sequential circuits in our stop watch or in our devices like which count the time what happens, it just add one or increment one to the previous output, it increment one to the previous output for example if it is counting five then it means that the previous output was four, it added one to it to make it five, similarly if the previous input was three it added one to go get four, so for its operation it required the information of the previous output whereas in the combinational circuits we do not require any information about the previous of output, so how this information the previous output is stored in the sequential circuits. it is done by a memory element that we call as the flip-flop which is a very important thing in digital electronics.

In sequential circuits we need memory element because we need to store the previous output and it is stored in memory which is flip-flop actually so it goes the output into the memory element and fo memory element it goes back as one of the input, so depending upon this input and this input from the memory element the output is generated and again the output is stored in this memory element, so there is a positive feedback, this is the feedback going from the memory element to the sequential circuits in the feedback. so there is a positive feedback in sequential circuits which is very important thing and also there is a memory element involved so only difference between combinational circuits and sequential circuits is that there is feedback involved which is positive feedback and also a memory element to store the previous output and the next output is generated depending upon the feedback from the memory element and present input so what we say that the output is only dependent on the present input whereas in sequential circuits it depends upon the present input as well as the output from the previous input[3]

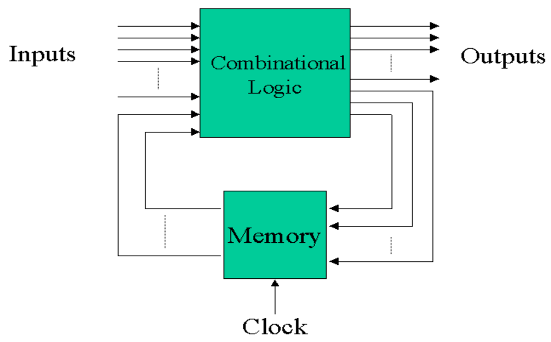


Figure 4: Sequential Circuit Typical Architecture

Half Adder

Half adders perform a simple binary addition of two one-bit numbers producing two outputs, the sum bit (y) and carry bit (c).

Figure 5: Block diagram for a Half Adder Circuit

Flip flops & Latches

A flip-flop is a bi-stable device (It is a circuit having two stable conditions (states); it can be used to store binary symbols) with inputs, that remains in a given state as long as power is applied and until input signals are applied to cause its output to change. The major differences among various types of flip-flops are in the number of inputs they possess and in the manner in which the inputs affect the binary state.
Flip-flops are connected together in various configurations to form, among other things, registers, which store and manipulate multi-bit data, and counter**s** which count the number of bits applied to their input terminals.

The nature and complexity of the operations performed by a digital system require that some means by provided to synchronize the many operations which are performed. This is function of the master clock, which provides a train of carefully regulated. The flip-flops are usually arranged so that they change state only upon application of clock pulse. How they change, if at all depends on their inputs before the clock pulse arrives.

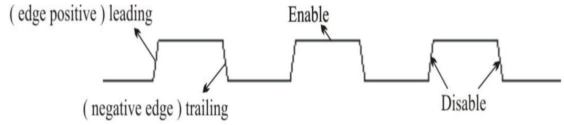


Figure 6: Timing Diagram of Clock Pulses.

It is often convenient to think of a sequential system as one clock period. A clock system as just described is called synchronous. The alternative, in which combinational operations trigger other operations as they occur, is called asynchronous operation.

Basic Flip-Flop Circuit

The flip-flop circuit can be constructed from two NAND gates or two NOR gates[6]

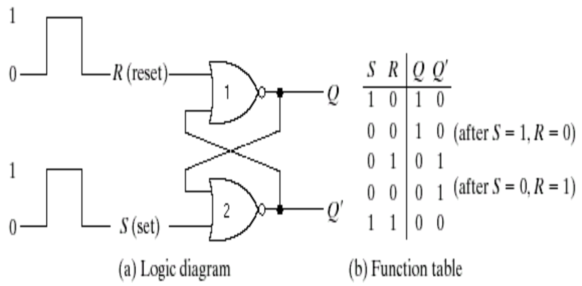


Figure 7: Basic Flip-Flop with NOR gates.

We can analyze the operation of the circuit of figure as follows:-

As a starting point, assume that the set input is 1 and reset input is 0. Since gate 2 has an input of 1, its output Q' must be 0, which puts both inputs of gate 1 at 0, so that output Q is 1. When the set input is returned to 0, the outputs remain the same, because output Q remains a 1, leaving one input of gate 2 at 1. That causes output Q' to stay at 0,which leaves both inputs of gate number 1 at 0, so that output Q is a 1. In the same manner, it is possible to show that a 1 in the reset input changes output Q to 0 and Q' to 1. When the reset input returns to , the outputs do not change.

When a 1 is applied to both the set and the reset inputs, both Q and Q' outputs go to 0. this condition violates the fact that outputs Q and Q' are the complements of each other. In normal operation, this condition must be avoided by making sure that 1's are not applied to both inputs simultaneously.

A flip-flop has two useful states. When Q = 1 and Q' = 0, it is in the set state (or 1-state). When Q = 0 and Q' = 1, it is in the clear state (or 0-state). The outputs Q and Q' are complements of each other and are referred to as the normal and complement outputs, respectively. The binary state of the flip-flop is taken to be the value of the normal output.

Under normal operation, both inputs remain at 0 unless the state of the flip-flop has to be changed.

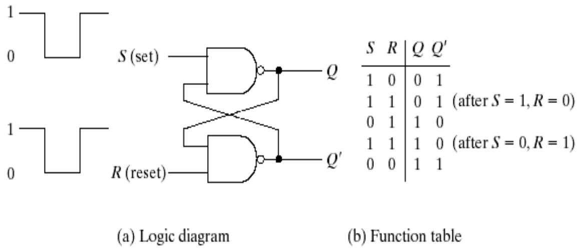


Figure 8: Basic Flip-Flop with NAND gates.

The NAND basic flip-flop circuit of above figure operates with both inputs normally at 1 unless the state of the flip-flop has to be changed.

Latches vs. flip-flops:-

- Latches are flip-flops for which the timing of the output changes is not controlled.
- For a latch, the output essentially responds immediately to changes on the input lines (and possibly the presence of a clock pulse).
- A flip-flop is designed to change its output at the edge of a controlling clock signal.

D-Type Latch

D-Type Latch is the simplest type of storage device, The D-Type Latch is in fact a special case of the S-R Latch, For both the S-R and D-Type Latches, the stored value responds to any input change for the whole time the clock is high. This can cause problems. For proper synchronization, we build a modified latch which is edge-triggered. This is known as a Flip-flop.

D Flip Flop

One way to eliminate the undesirable condition of the indeterminate state in the RS flip-flop is to ensure that inputs S and R are never equal to 1 at the same time. This is done in the D flip-flop shown in figure. The D flip-flop has only two inputs: D and C. The D input goes directly to the S input and its complement is applied to the R input. As long as the pulse input is at 0, the outputs of gates 3 and 4 are at the 1 level and the circuit cannot change state regardless of the value of D. The D input is sampled when C = 1. If D is 1, the Q output goes to 1, placing the circuit in the set state. If D is 0, output Q goes to 0 and the circuit switches to clear state.

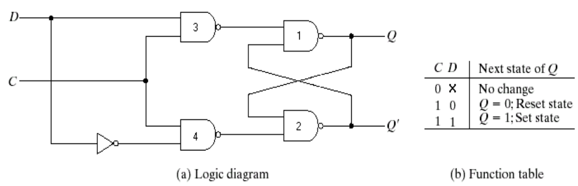
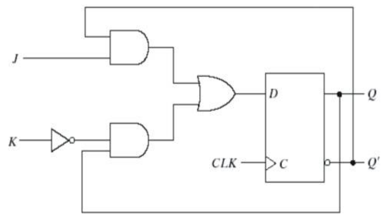


Figure 9: D Flip-Flop.

JK flip-flops

A JK flip-flop is a refinement of the RS flip-flop in the indeterminate state of the RS type is defined in the JK type. Inputs J and K behave like inputs S and R to set and clear the flip-flop, respectively. The input marked J is for set and the input marked K is for reset. When both inputs J and K are equal to 1, the flip-flop switches to its complement state, that is, if Q = 1, it switches to Q = 0, and vice versa



(a) Logic Diagram

J	K	Q(t+1)
0	0	Q(t)
0	1	0
1	0	1
1	1	Q'(t)

(b) Function Table

Figure 10: JK Flip-Flop.

A counter is a sequential circuit that goes through a prescribed sequence of states upon the application of input pulses. The input pulses (count pulses) of the counter is clock pulses, or from some external source, and may occur at prescribed intervals of time.

Classification of counters:

Digital counters are available in a variety of styles. Their characteristics, features, differences, and modes of operation should be observed.

1. Asynchronous vs. synchronous.
2. Binary vs decade.
3. Up vs down.
4. Presetable.
5. Asynchronous load vs synchronous load.
6. Asynchronous clear vs synchronous clear.
7. Cascading.
8. Counters as binary dividers.
9. Divided by N.

CONCLUSIONS

We conclude that combinational circuits do not allocate any memory to the elements, whereas sequential circuits allocate memory to the elements. Due to this combinational circuits are easy to design and faster than sequential circuits. We described various applications of combinational circuits like half adder, full adder, half subtract, full subtract, Demultiplexers, Multiplexers, Comparators, and Decoders etc. We also described various applications of Sequential circuits like flip flop, counter; shift register etc. We also analyzed when to use sequential circuits and combinational circuits.

REFERENCES

[1] R. C. Jaeger, T. N. Blalock, Microelectronic Circuit Design, 3rd ed. McGraw-Hill, 2000, pp. 1–32.

[2] Stephen Brown and Zvonko Vranesic, “Fundamentals of Digital Logic with Verilog Design”, second edition, Tata McGraw-Hill Publishing Company Limited, New Delhi,2008.

[3] John F.Wakerly, “Digital Design, principles & practices, third edition, prentice Hall of India Private Limited (EEE),2005.

[4] Randal E Bryant, "Graph-based algorithms for Boolean function manipulation.", IEEE Transactions on Computers, (1986), Vol.100, no. 8, 677-691.

[5] B, Raghu Kanth; B, Murali Krishna; G, Phani Kumar; J, Poornima, “A Comparative Study of Reversible Logic Gates”, International Journal of VLSI & Signal Processing Applications, vol.2, Issue 1, Feb 2012, (51-55), ISSN 2231-3133 (Online).

[6] John P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998. ISBN 10: 0070273553 / ISBN 13: 9780070273559

[7] Raymond E.Miller. (1966): Switching Theory, Vol. I, John Wiley & Sons, pp.8-9.

[8] Richard F.Tinder, “Engineering Digital Design”, Second Edition, Academic Presss,2000.

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