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**SECOND SEMSTER**

**A REPORT ON FLIP FLOP APPLICATIONS**

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**CERTIFICATION**

This is to certify that the report is written by Alexis John Abakasanga with matriculation number 17/ENG02/001 in the department of Computer Engineering College of Engineering Afe-Babalola University(ABUAD), Ado Ekiti during the 2019/2020 academic session under my supervision.

Student Signature / Date Supervisor Signature / Date

**DEDICATION**

I would first and foremost like to thank God Almighty for his protection and provision during this trying times. I would also like to thank my family for pushing me to greater heights and also to the school authorities for taking us online and not falling prey to such a drastic change.

**FLIP-FLOP APPLICATION**

Application of the flip flop circuit mainly involves in bounce elimination switch, data storage, data transfer, latch, registers, counters, frequency division, memory, e.t.c.

JK Flip Flop is a universal flip-flop that makes the circuit toggle between two states and is widely used in shift registers, counters, PWM and computer applications.

There are basically four main types of latches and flip-flops: SR, D, JK, and T;

* **SR flip-flop**: Is similar to an SR latch,
* **D flip-flop**: Has just one input in addition to the CLOCK input,
* **JK flip-flop**: A common variation of the SR flip-flop,
* **T flip-flop**: This is simply a JK flip-flop whose output alternates between HIGH and LOW with each clock pulse.

A flip flop is an electronic circuit with two stable states that can be used to store binary data. The stored data can be changed by applying varying inputs. Flip-flops and latches are fundamental building blocks of digital electronics systems used in computers, communications, and many other types of systems.

Major differences in these flip-flop types are the number of inputs they have and how they change state. For each type, there are also different variations that enhance their operations.

Three common methods for synchronizing data between clock domains are: using MUX based synchronizers, using Handshake signals, using FIFOs (First In First Out memories) to store data with one clock domain and to retrieve data with another clock domain.

**Data Storage and Transfer**

Data transfer or transfer is any information that is transferred from one location to another through some communication method. For example, for this page to be visible, all text, images, and other data was transferred over the Internet to your computer. Flip flops can also be used extensively to transfer the data. The data is shifted or transferred one bit at a time, when a clock pulse is applied. The shift register can be used for temporary storage of data. The shift register is used for multiplication and division where bit shifting is required.

**Parallel Data Transfer**

In data transmission, parallel communication is a method of conveying multiple binary digits (bits) simultaneously. It contrasts with serial communication, which conveys only a single bit at a time, this distinction is one way of characterizing a communications link.

Difference between Serial and Parallel Transmission;

1. In Serial Transmission, data is sent bit by bit whereas in Parallel Transmission a byte (8 bits) or character is sent at a time.

(2) A serial communication device transfers data in bits in the same direction. A parallel communication device sends data in multiple bits to the same direction.

(3) In serial communication a word of eight bits in length is sent sequentially, and is received after all eight bits are sent, one at a time.

The similarity is that both are used to connect and communicate with peripheral devices.

**Serial Data transfer**

In telecommunication and data transmission, serial communication is the process of sending data one bit at a time, sequentially, over a communication channel or computer bus. This is in contrast to parallel communication, where several bits are sent as a whole, on a link with several parallel channels. Hold time is the minimum amount of time a synchronous data input should be held steady after the clock event so that the data input is reliably sampled by the clock event. If the input of the sequential logic changes in the setup window (setup time duration) then setup violation occurs. Setup check ensures that the data is stable before the setup requirement of next active clock edge at the next flop so that next state is reached. Similarly, hold check ensures that data is stable until the hold requirement for the next flop for same clock edge has been met so that present state is not corrupted. More simply, the setup time is the amount of time that an input signal (to the device) must be stable (unchanging) before the clock ticks in order to guarantee minimum pulse width and thus avoid possible meta-stability within the latching loop. The problem comes when one has to find the setup time of a flip flop.

To address setup time violations, you can: Use larger/stronger cells to drive paths with high capacitance, which can reduce the time needed to transition on sluggish net. Adjust the skew of the clock to the start or endpoint of the path which is violating. (time borrowing).

**Frequency Division and Counting**

Frequency Division uses divide-by-2 toggle flip- flops as binary counters to reduce the frequency of the input clock signal ... which is 3 bits wide, is a binary count from 0 to 7 for each clock pulse. If you have a binary counter, modulo M = 2^N, where N is the number of flip-flops, then the frequency of the most significant bit (I assume this is what you're referring to with "output frequency") will be f/M = f/(2^N), where f is the input frequency. A Divide by N counter implies that it divides the input clock frequency by N ie; if you cascade four flip-flops then, the output of every stage is divided by 2, if you are taking the output from the 4th flip-flop, then its output frequency is clock frequency by 16. The we can see that MOD counters have a modulus value that is an integral power of 2, that is, 2, 4, 8, 16 and so on to produce an n-bit counter depending on the number of flip-flops used, and how they are connected, determining the type and modulus of the counter.

**MOD Number**

In computing, the modulo operation finds the remainder or signed remainder after division of one number by another. Given two positive numbers, a and n, a modulo n is the remainder of the Euclidean division of a by n, where a is the dividend and n is the divisor.

The modulo (or "modulus" or "mod") is the remainder after dividing one number by another. Example: 100 mod 9 equals 1. Because 100/9 = 11 with a remainder of 1. Another example: 14 mod 12 equals 2. Because 14/12 = 1 with a remainder of 2.

**FREQUENCY DIVISION**

A regenerative frequency divider, also known as a Miller frequency divider, mixes the input signal with the feedback signal from the mixer. Frequency is then amplified and fed back into mixer. A frequency divider is a circuit that takes an input signal of a frequency fin and generates an output signal of a frequency f out, where f out = fin / n and ''n'' is an integer. Frequency dividers are used for both analog and digital applications. Analog frequency dividers are used only at very high frequencies.

**Propagation Delay in Ripple Counters**

Delay time is a time gap between the shot-instant and the start of recording by a seismograph to avoid long, blank sections on a record. It is also used in time-domain induced polarization surveying to allow for the dissipation of transient voltages which have no direct relation to the overvoltage.

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Analog frequency dividers are used only at very high frequencies.

The total delay between clock input and FF3 JK input is up to 2+3+3 = 8ns. Therefore the minimum acceptable time between clocks is 8ns + JK setup time. So long as this timing is met the counter should work correctly, and the propagation delay will be 2ns because Q outputs only change in response to clock inputs.

The **delay** in **circuits** gets decided by how fast the charges can flow. They can never reach the speed of light. ... Factors that influence the speed of charge flow can be any and many (driving voltage, resistance along the path, the size of the capacitance getting charged or discharged e.t.c).

**Synchronous (Parallel) Counters**

In synchronous counter, the clock input across all the flip-flops use the same source and create the same clock signal at the same time. So, a counter which is using the same clock signal from the same source at the same time is called Synchronous counter.

**Circuit Operation**

In electronics, a flip-flop or latch is a circuit that has two stable states and can be used to store state information – **a bistable multivibrator**. The circuit can be made to change state by signals applied to one or more control inputs and will have one or two outputs.

**Advantage of synchronous over asynchronous counter**

The one advantage of synchronous counter over asynchronous counter is that it can operate on higher frequency than asynchronous counter as it does not have cumulative delay because of same clock is given to each flip flop.

Synchronous counter eliminates lots of limitations which arrive in Asynchronous counter. It's easier to design than the Asynchronous counter. It acts simultaneously, no propagation delay associated with it.

Synchronous counters are easier to design than asynchronous counters are all clocked together at the same time with the same clock signal. Due to this common clock pulse all output states switch or change simultaneously. Overall faster operation may be achieved compared to Asynchronous counters, less likely to end up in erroneous states. They are faster as the propagation delay are small as compared to asynchronous counters. There are no counting errors as compared to asynchronous counters. Performance is much better, liable and portable circuit.

The major difference between them lies in their transmission methods, i.e. Synchronous transmissions are synchronized by an external clock; whereas Asynchronous transmissions are synchronized by special signals along the transmission medium.

**Actual IC’s**

ICs are now used in virtually all electronic equipment and have revolutionized the world of electronics. Computers, mobile phones, and other digital home appliances are now inextricable parts of the structure of modern societies, made possible by the small size and low cost of ICs.

The integrated circuit uses a semiconductor material (read chips) as the working table and frequently silicon is selected for the task. Afterwards, electrical components such as diodes, transistors and resistors, etc. are added to this chip in minimized form. The silicon is known as a wafer in this assembly.

Hundreds of integrated circuits are made at the same time on a single, thin slice of silicon and are then cut apart into individual IC chips. The manufacturing process takes place in a tightly controlled environment known as a clean room where the air is filtered to remove foreign particles.

An integrated circuit, or IC, is small chip that can function as an amplifier, oscillator, timer, microprocessor, or even computer memory. An IC is a small wafer, usually made of silicon, that can hold anywhere from hundreds to millions of transistors, resistors, and capacitors.

There are two types of IC manufacturing technologies one is monolithic technology and other is hybrid technology. In monolithic technique, all electronic component and their interconnections are manufactured together into a single chip of silicon. Monolithic ICs are cheap but reliable.

**Counters with MOD numbers**

The Modulus (or MOD-number) of a counter is the total number of unique states it passes through in one complete counting cycle with a mod-n counter being described also as a divide-by-n counter. The modulus of a counter is given as: 2n where n = number of flip-flops.

**STATE TRANSITION DIAGRAM**

A state diagram is a type of diagram used in computer science and related fields to describe the behavior of systems. State diagrams require that the system described is composed of a finite number of states; sometimes, this is indeed the case, while at other times this is a reasonable abstraction.

A diagram consisting of circles to represent states and directed line segments to represent transitions between the states. One or more actions (outputs) may be associated with each transition. The diagram represents a finite state machine.

What is the utility of state transition diagram?

State-transition diagrams are very useful for describing the behavior of individual objects over the full set of use cases that affect those objects. State-transition diagrams are not useful for describing the collaboration between objects that cause the transitions.

**Synchronous Down & Up/ Down Counters**

Counters are used in many different applications. Some count up from zero and provide a change in state of output upon reaching a predetermined value; others count down from a preset value to zero to provide an output state change. The counters are synchronous, but they are asynchronously presettable.

**Presettable Counters**

This means when the LD input is high, then whatever binary value is present on LOAD INPUTS, will be immediately copied to the outputs and stay that way until LD goes low. This enables the counter to begin from any value, e.g count from 6 to 15. Note this only works if the RESET input is low.

**IC Synchronous Counters**

In synchronous counters, the clock inputs of all the flip-flops are connected together and are triggered by the input pulses. Thus, all the flip-flops change state simultaneously (in parallel). The circuit below is a 4-bit synchronous counter. The J and K inputs of FF0 are connected to HIGH.

**Integrated Circuit Registers**

These contain some circuits known as registers that store information. Registers are predetermined memory locations. Each processor has many different types of registers. Permanent registers are used to store the preprogrammed instructions required for various operations (such as addition and multiplication.