# DESIGN AND CONSTRUCTION OF A DIGITAL TOLL GATE COUNTER

BY

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# DEDICATION

I'm dedicating this project to Lord God almighty for his love, mercy and protection throughout my stay in school. To my mother MRS Paulina Denis for her motherly love and support throughout my stay in school. To my late father MR Denis Clement for his fatherly love . And finally to my lovely sister Miss Agnes Denis for been there for me. I love you all.

# DECLARATION

I hereby declare that this work was done by Mr. Denis Jonathan Danjuma under the supervision of Mr. Nathaniel Salawu and to the best of my knowledge has not been presented anywhere else for the award of a degree. All other works cited have been duly acknowledged in my references. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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To my sweetheart miss Marlyn Daniel and my baby Bomcy. I love you all. Finally to my father in heaven (GOD), for protection throughout my stay in school

# ABSTRACT

This project is the design and construction of a digital toll gate counter which is a counting device that enables cars to be counted at a given location without stress.

Toll gate counter is an external device that consist of two counters,two decoders and a display which displays the present count.

The successful implementation of this project involved the careful plan and layout of the circuit components such that troubleshooting and repairs could be carried out with relevant ease.

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# CHAPTER ONE

## 1.0 Introduction.

Electronics have come along way over the past century to add to the development of man. In virtually every area of human endeavor electronics have found its place; reducing tedious work practices, saving working time, increase efficiency with productivity and accomplishing jobs, that would otherwise have taken a life time to Completely execute.

In accounting for instance, computation and record keeping can be done using a Computer and an ordinary calculator. Furthermore, records of actual figures can also be taken a particular time and stored cross referencing and record keeping. In Nigerian society today, electronics is fast finding its way into every home, office, even within the transport system employed by various individuals and corporate bodies. For example, the number of cars that ply our roads at a given time can easily be known with the use of electronic counter.

In this project, the actual number of cars that use the Federal roads over a specified period of time is gotten. This is to aid its accounting department in getting the actual figure to serve as a reference for the income generated over a set period. Through careful observation, the Federal government employs the use of a toll gate counter via which money is remitted to the sector for the maintenance of our roads. Most cars prefer to pay cash for the roads service whenever needed. In this way funds go unaccounted for, hence the reduction in the actual income to be generated. In order to solve this problem the project comes to be.

The electronic circuit primarily counts the number of cars that use the road, which compels personnel's response to revenue collection to balance income with the number of cars that use the roads. By this, even the normal collection of money by the toll gate assistance can be employed.

### 1.1 Aim and Objective of the Project.

The primary aim of this project is to detect and count the number of cars in a given location. The toll gate counter has a number of economic advantages aside from its primary aim and objective. Some of which are

- keeping track of vehicles in a given location for road traffic analysis
- keeping track of cars through a car lot
- keeping track of records of payment made at various car pay points.

### 1.2 Methodology.

The set of methods and principles used in achieving the circuit can be referred to as the down-top methodology. The actual state of entrance, which coincides with the exit of the cars was noted. Counting is to be down in one direction, in order to eliminate double counting; thus, two-switch system was employed. The switches are connected in such way that a pulse is sent only if they are triggered in one direction. This resulted to the introduction of- a transistor for its switching ability. But, even in triggering the transistor it was observed that there would be a time delay in the triggering of the switches; hence, the introduction of a resistor/capacitor time delay combination. The output of the transistor is now connected to the trigger of a display driver, which in turn connected to a seven segment display. Now, the principles mentioned above are as follows:

I. switches

II. Switching device.

III. Display.

Details of each of these components would be given next chapter,

## 1.3 Scope of the Project.

The range of this project includes the following:

I. The designed circuit is meant to count in one direction using two switches, making it suitable for counting where every car is restricted to one used both for entry and exist.

II. It gives a graphical display of its present count making clear its result at any given point in time.

III. The reset is easy to accomplish because it is only the display that counts and recorded on. Hence, the reset button of the display is the only reset used.

IV. The powering of the circuit is from the display and its driver is powered directly from the battery to ensure constant power supply. Also, the other circuitry is connected through a time delay circuit to the ignition of the bus. In this way, once the ignition is turned on the process of powering the counting circuit begins,

V. The maximum count here is 99.

## 1.4 Application and limitation of the project

This method of counting finds its usefulness everywhere the entry and exist is limited to one point, which could be seen in hotel rooms, elevators, executive board rooms toll gates etc.

Limitations encountered both in design and implementation of the project include;

i) How to get a two way circuitry which gives a delay when the ignition key is turned on before energizing the counting circuit.

iii) Another delay circuit that delays the cut of power from the counting circuitry after the ignition key is turned off.

iii) Availability of CMOS drive for seven segment display in our local environment therefore was restricted to TTL ICs. This introduced some constraint due to voltage and current matching.

iv) Choosing the minimum time between cars was rather difficult, because cars for various reasons move at different pace.

# CHAPTER TWO

## BACKGROUND INFORMATION

### 2.1 HISTORICAL BACKGROUND

One would not truly appreciate the electronic means of counting that is all around us today, if there is no knowledge of how counting evolved. Man actually was the first counting machine that existed, from his basic small counting he discovered that the number of thing lie needed to number increased. This is why he needed help. The first counting equipment made is believed to be Abacus. The Abacus is an ingenious counting device bused on the relative positions of two sets of beads moving on parallel strings, the first set contains five beads on each string and allows counting from 1 to 5, while the second set has only two beads per rising representing the numbers 5 and 10. The Abacus system seems to be based on a radix of five. Using a radix of five makes sense since humans started counting objects on their fingers. [1]

Another interesting invention is *Napier's bones*, a clever multiplication tool invented in 1617 by mathematician John Napier (1550-1617), of Scotland. The bones are a set of vertical rectangular rods, each one divided in 10 squares. The top square contains a digit and the remaining squares contain the first 9 multiples of the digit. Each multiple has its digits separated by a diagonal line. [2] When a number is constructed by arranging side by side the rods with the corresponding digits on the top, then its multiple can be easily obtained by reading the corresponding row of multiples from left to right while adding the digits found in the parallelograms formed by the diagonal lines. No Wonder John Napier is also the inventor of the logarithms, a concept used to change multiplication into addition.[3]

The first calculating machines were built by gifted mathematicians moved by an intense desire to simplify the repetitive nature of arithmetical operations, the first known adding machine was made by Wilhelm Schickard (1592-1635), In 1623,Schickard, a polymath and then professor at the University of Tubingen in Wuerttemberg, now part of Germany, designed and constructed a mechanical device which he called the Calculating Clock. Able to add and subtract up to six-digit numbers, the artifact was based on the movement of six dented wheels geared through a "mutilated" wheel which with every full turn allowed the wheel located at the right to rotate $1/10^{th}$ of a full turn, an overflow mechanism rang a bell. The adding feature was devised to help performing multiplication with a set of Napier's cylinders included in the upper half of the machine. According to his notes, a prototype of this machine was destroyed by a fire. It seems that another prototype existed at the time but it has never been found. [4]

Finally, Herman Hollerith is widely regarded as thefather of modern automatic computation. He chose the punched card as the basis for storing and processing information and he built the first punched-card tabulating and sorting machines as well as the first key punch., and he founded the company that was to become IBM, Hollerith's designs dominated the computing landscape for almost 100 years.[5]

The standard punched card, originally invented by Herman Hollerith, was first used for vital statistics tabulation by the Baltimore Board of Health. After this trial use, punched cards were adopted for use in the 1890 census. Hollerith wasn't working in a vacuum. His idea for using punched cards for data processing came after he'd seen the punched cards used to control Jaquard looms.[6] These machines reduced a ten-year job to three months (different sources give different numbers, ranging from six weeks to three years), saved the 1890 taxpayers five million dollars, and earned him an 1890 Columbia PhD[1]. This was the first wholly successful.[7] He won the competition by proposing a manual cardpunch with mechanical counting (tabulating) dials.[10] From this point onward, electromechanical and electronic counting took over the counting world,

**2.2 Literature review**

Presently, not much has been done using a normal electronic counter in the area of digital toll gate counter and information collection. But in several ways basic electronic counters are used.

A theatre monitoring system: Design to give information on the number of persons within the hall during a film section to know either the theater is full or not; employs the use of up/down counter, which increment when the switches are stepped on in descending order and decrement when stepped on in the reverse order.

Another application is in a hall that has two doors, one for entry and the other for exit, In this case, a switch placed either at the entry or exit and thereby number of persons that used that hall will be known.

An automation room light here once a person enters the room and the circuit registers a count (increments) it enables the light while if that same person leave, meaning there is no person in the room, the counters data is decreased by one and causes the light to switch off. [11]

In most cases one switch is used because there is an entry separate from the exit door or the number of persons within a location at anytime is desired, therefore an up/down counter is used. But if restricted to one door for entry and exit some modification-has to be done. Like in this case two switches were used in place of one .both connected through different pins of a switch which decide whether the counter should count or not. In this way it is needless to count every person at the time of entry and exit then divide by two to get the number of passengers.

The advantages of this circuit above existing ones (if any) is that, it is designed with full knowledge of the way cars operate, therefore the possibility of double counting is reduced to very near zero.

**2.3 THEORETICAL BACKGROUND**

Generally speaking, the project centers on how cars are counted as they make use of the monitoring devices. To achieve this, component ranging from simple resistors to small scale integrated circuits, neatly arranged to give a count for each car

For a good understanding of the circuit to be discussed in the next chapter there is need to know the theory behind the various component used to achieve it.

Engineers classify logic circuit into two main groups. The first being the combinational circuit using, AND, OR, and NOT gates (no memory). The other group of circuits is classified as sequential circuits (devices with memory). [2, 3] Sequential circuits involve timing and memory devices. This group actually makes the digital life really interesting. The basic building block for the combinational logic circuits is the gates, while that of the sequential logic circuits is the Flip flop (FF)- [2]

Flip Flops are generally wired in two broad ways, synchronous in their operation (That is all FF that have a clock input) or Asynchronous where the basic input are preset (PS) mid clear (CLR). Use operation will be discussed later. The various types of FF available are the RS-Flip Flop, the D-FIip Flop and the J-K Flip Flop.

For the purpose of this material, we will be considering the J-K FF, the J-K FF is considered as the "universal" FF, having the features of all the other types of FF. Its logic symbol is shown in fig la. The input labeled J and K are the data inputs. The inputs labeled CLK, is the clock input. The customary normal (Q) and complimentary (Q) are the outputs. A truth table for a J-K FF is shown in fig 1b, when the J-k inputs are 0, the

FF is in the hold mode. In the hold mode the data input has no effect on the output 7'he output "hold" the last data input.

Table 2.1 truth Table of a J-K FF

| ode of operation | | Input | | Output | | ffect on output Q |
|---|---|---|---|---|---|---|
| | Clock | J | K | *Q* | Q | Effect on output Q |
| Mold | | 0 | 0 | No | change | No change disable |
| Reset | | 0 | I | 0 | 1 | Reset or clear to 0 |
| Set | | 1 | 0 | I | 0 | Set to 1 |
| | | | | | | Changes to opposite |
| Toggle | | 1 | 1 | | | |
| | | | | Toggle | | state |

Line *2* and 3 of the truth table shows the reset and set conditions for the output. Line 4 illustrates the useful toggle position of the J-K FF. when both data inputs J and K are at 1; repeated clock pulse causes the output to turn off-on-off-on, and so on.

The off-on action is like a toggle switch and is called toggling. For commercial purpose, additional inputs PS and CFR are added which are the asynchronous input. The truth table is .illustrated in table 2.1., The asynchronous inputs override the synchronous inputs. The asynchronous inputs are active in the first three line of the truth table. Interestingly this simple device forms the bases of most counting circuits.

### 2.3.1 COUNTERS

"Almost any complex digital system contains several counters. *A* counter's job is the obvious one of counting events or period of times or putting events into sequence. Counters also do some not to obvious jobs like dividing frequency, addressing and serving as memory units". [2].

Counters are basically of two types which we shall look at one after other. Firstly, ripples counter. These counters are the simplest type of binary counters, since they require the lowest components to produce a given counting operation. They do, however, have one major drawback, which is caused by their basic principle of operation; each FF is triggered by the transition of the preceding FF because of the inherent propagation delay time (tpd) of each FF; this means that the second FF will not respond until a time tpd after the first FF receives an active clock transition (that is a complete cycle, two pulses), the third will not respond until a time 2sec.tpd after a clock transition and so on. In other words, the propagation time of the FF accumulates so the FF will not respond until a time N*tpd after the clock transition occurs. [2] The above operation can be seen through the truth table in fig 2.1

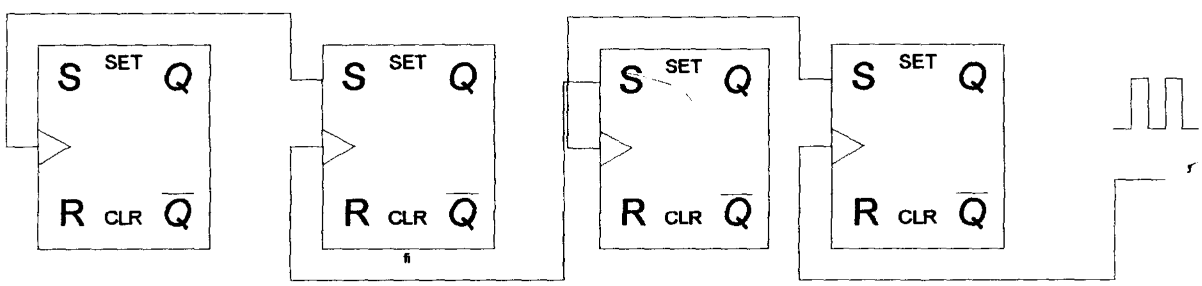


Fig 2.1 Asynchronous ripple counter

## ASYNCHRONOUS RIPPLE COUNTER

The problem encountered with ripple (asynchronous) counters is associated with the fact that FF does not all change state simultaneously in synchronism with the input pulse. These limitation can be overcome with the use synchronous or parallel counters in which all of the FFs are triggered simultaneously (in parallel) by the clock input pulses. Since all the inputs are applied at the same time, a means of control has to be in place to ensure that each FF toggles only when it suppose to.

This is accomplished by using the J and K inputs as illustrated in fig 2.2 for a 4-bit (number of binary). MOD I6 (having 16 different combination) synchronous counters, Note, if the diagram of the asynchronous and synchronous counter are carefully analyzed, It can be seen that the synchronous counter is more complex, requiring additional AND gate to control. The .S and R input of (The first I'T[1] are permanently at a high level while the clock input of all the FFs are connected in parallel.

For the circuit in fig. 2.2 to count properly, on a given negative transition of the clock, only those FFs are supposed to toggle on the negative transition should have J=K=1 when that negative transition occurs.

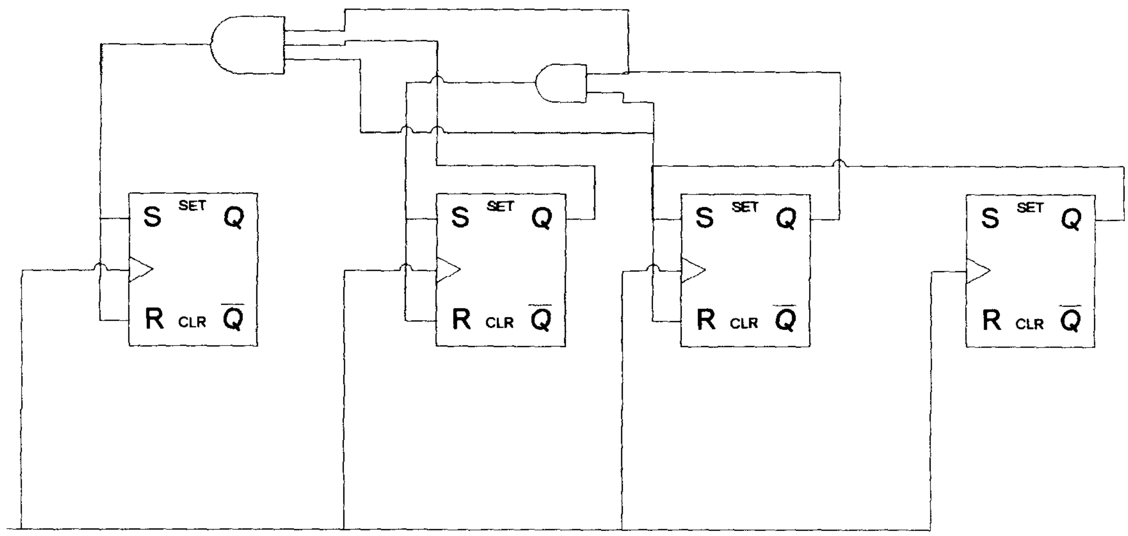


Fig 2.2 Synchronous counter

Synchronous counter [5]

The counting sequence shows that a FLIP- FLOP must change at negative transition of the input clock for this reason its J and K input are put permanently at high level while the output of A is connected to J and K input of B making B to toggle only when the output of A is 1, it has to changed to negative transition.

The counting sequence shows that FLIP-FLOP must change states on each negative transition that occurs while A =B=1. For example, when the count is 0011, the next must toggle to the O state; and so on. By connecting the logic signal AB to FF C's J and K inputs, this FF will toggle only when A=B=1.

### 2.3.2 ELECTRONIC SWITCHING

Electronic switching generally involves semiconductor component that when set in particular ways can control the flow of current or voltage with the use of relatively smaller current or voltage. Just like relay which is an electromechanical switch that makes or breaks the flow of current while keeping the source electrically isolated.

Semiconductors could be configured to act in similar way such as the transistors and multivibrators.

A transistor which is a three terminal device can act in a non linear mode, as voltage or current switches when a transistor operates as a switch; a small voltage or current is used to control the flow of current between the terminals of the transistor in an on-off fashion.

Fig 2.3, depicts the idealized operation of the transistor as a switch, suggesting that the switch to close (on) whenever a control voltage or current is greater than zero and open (off) otherwise. [2]

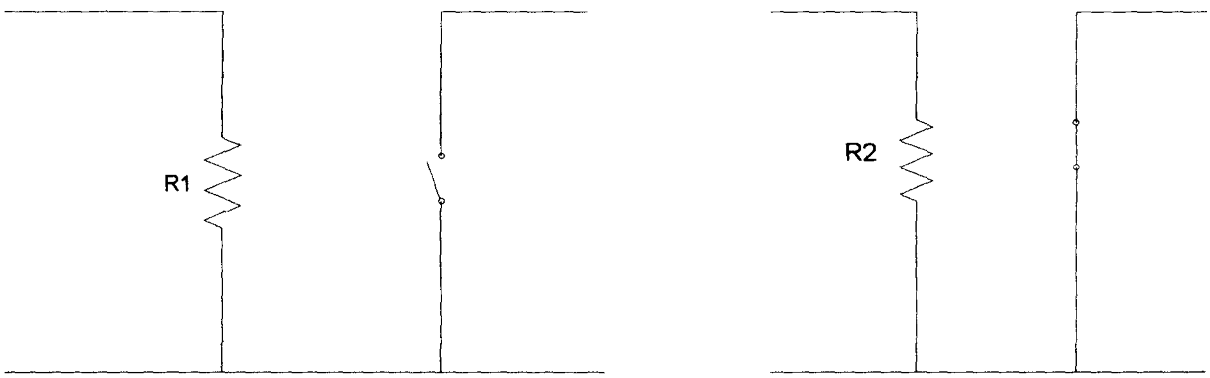


Fig 2.3 Current controlled switch

Multivibrators are devices consider more as pulse generating, storing and countering circuit. They are basically two stage amplifier to the input of the other of these devices there are two types, the non-driven type (Astable multivibrator) and the driven type (mono-stable and bi-stable multivibrator). [4]

Just for the noting, astable multivibrator has a stable sate but only two quasi-state (half stable) stales. It is only known as relaxation oscillator.

The mono-stable has one stable state, once triggered it goes to its unstable position and after a predetermined lime returns to its original position.

The bi-stable multivibrator has two stable state that is either logic high (1) or low (0). Once switch to either of the two state, remains there until external pushed to the alternate state.

The things discussed stand as (the basic theory guiding the operation of the circuit to be discussed in the next chapter).

**2.3.3 TRANSFORMER**

A transformer is a static (or stationary) piece of apparatus by means of which electric power in one circuit is transformed into electric power of the same frequency in another circuit. It can be to raise or lower voltage in a circuit but with a corresponding decrease or increase in current. The physical basis of a transformer is mutual induction between two circuits linked by a common magnetic flux. [4]

A simple transformer is shown in figure 2.4. Worthy of notes is the voltage transformation ratio of a transformer which is given by the equation.

$$\frac{E_2}{E_1} = \frac{N_2}{N_1}$$

Where $E_2$ = Voltage in the secondary winding

$E_1$ = Voltage in the primary winding

$N_2$ - Number of turns in the secondary winding

$N_1$ = Number of turns in the primary winding

Primary

Secondary

**2.3.4 RECTIFIER CIRCUITS**

Since a diode has the characteristics of having a much greater conductivity in one direction than in the other, it will produce a direct component of current when connected in series with an alternating voltage and a load.

This process is known as rectification and is the main use to which diodes are put. There are numerous applications for rectification, e.g. driving a d.c motor from a,c, mains and the production of direct-voltage for electronic devices. [2]

The various types of rectifiers include;

1. Single-phase half wave and full wave rectification.
2. Three- phase half wave and full wave rectification.
3. Full wave bridge circuit rectification and others.

We will consider the full wave bridge circuit rectifier. This type normally comes as a single IC. The analysis of the bridge rectifier is simple to understand by visualizing the operation of the rectifier for the two half cycles of the AC waveform separately. The diodes $D_1$ and $D_2$ conduct during the positive half cycle, while diode $D_3$ and $D_4$ conduct during the negative half cycle. Because of this structure of the bridge, the flow of current through the resistor is in the same direction (from c to d) during both halves of the cycles, hence, the full wave rectification of the waveform. [6]

2.3.5 **SMOOTHING**

Although the conventional and bridge full wave rectifier circuits effectively convert AC signals that have zero average, or DC value to a signal with a non-zero average voltage, either rectifiers output is still and oscillating waveform. rather than provide a smooth, constant voltage, the full wave rectifier generates a sequence of sinusoidal pulses at a frequency double that of the original AC signal.

The ripple, that is, the fluctuation about the mean voltage that is characteristic of these rectifier circuits - is undesirable if one desires a true DC supply.A circuit that converts the ripple (pulsations) into a very steady DC level is known as filter because it filters out or smoothens out the pulsation in the output.

# OPERATIONAL MANUAL FOR THE TOLL GATE COUNTER

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## STEP 1

Plug the device to a power supply (5v) and switch on the device by pressing the on/off button.

## STEP 2

The display shows "85" press the reset pin to reset the count to "00".

## STEP 3

Press switch 1 and then press switch 2 within 2 seconds to initiate a count. Once switch 1 is pressed and switch 2 is not pressed within 2 seconds a count is not initiated.

There are several popular filter circuits but we will consider the series capacitor filter. Here a capacitor is connected from the output of the diode in parallel with the intending resistive load. The principle applied here is that capacitors charges during the positive half cycle and to discharge during the non-conducting half cycle. In this way during the non-conducting half-cycle, the capacitor discharges to the load thereby providing a very stable DC voltage supply to the resistive load.

NOTE: A capacitor has the basic property of opposing changes to voltage; hence, a bigger capacitor would tend to reduce the ripple magnitude. It has been found that increasing the capacitor size: increases DC voltage towards its limiting value; reduces the magnitude of ripple voltage; reduces the time of flow of current pulse through the diode; and increases the peak current in the diode. [4]

### 2.3.6 SEVEN SEGMENT DISPLAY

A Seven-segment display is a very convenient device for displaying digital data; the display is shown in figure 2.7. Operation of a Seven-segment display requires a decoder circuit to light the proper combination of segments (LEDs) corresponding to the desired decimal digit.

# CHAPTER 3

## DESIGN AND 1MPLEMENTATION

The realization of the main objectives of counting the numbers of cars that pass through a toll gate over a period of time by the Federal Road Maintenance Agency scheme is illustrated in

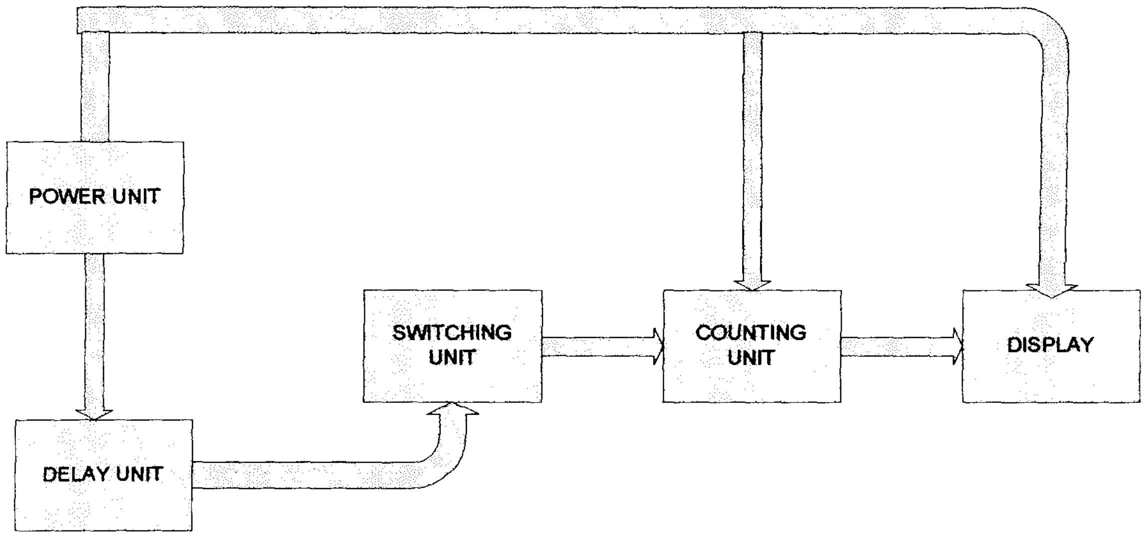



Fig 3.1 Block diagram representation of the toll gate counter

The modules (units) will be explained in details in the coming text after which the actual circuit diagram will be looked at. Designing of a prototype for an in house demonstration has some constrains. This will induce some modification of the circuit from the actual operation of the circuit in the toll gate counter. The modular description is explained thus.

### 3.1 POWER UNIT

This unit consists of the following; step down transformer, a voltage regulator, and a power delay circuit. Therefore, the need to reduce the incoming power according to the circuit requirement.

The battery is connected to voltage regulator as shown in figure 3.2

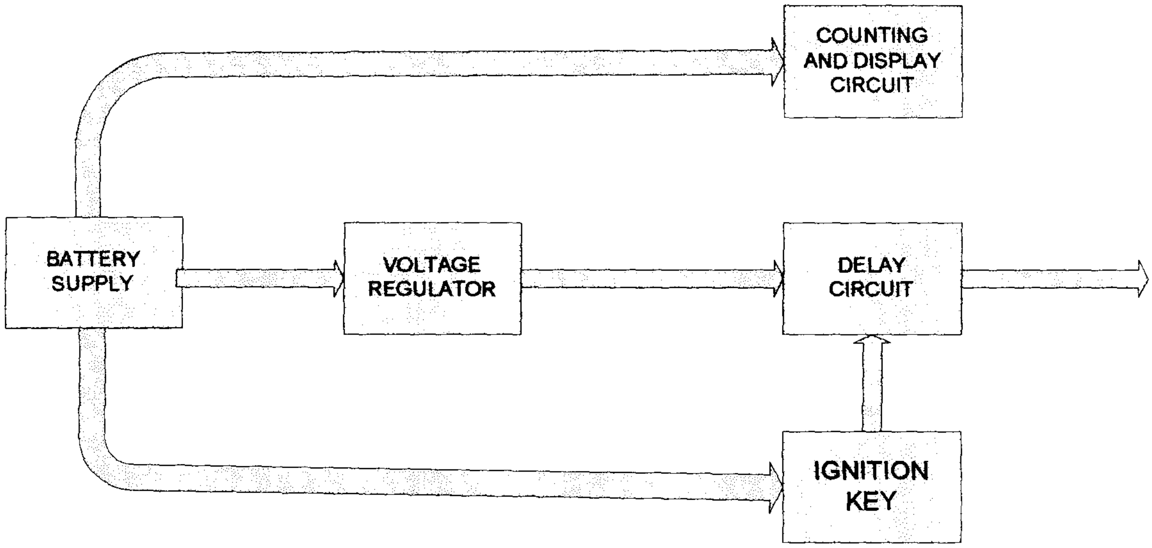



Fig 3.2 Practical application of power supply in the counter

The voltage regulator reduces the voltage to 5V and keeps it constant at that point, dissipating the excess power as heat (Reason for the reduction of voltage to 5V was a result of inability to get a CMOS driver for the display unit restricting the circuit to TTL), From this point supply is connected to two different points. The first is to the counting and displaying unit. This is to ensure that the data stored in the counter is not lost when the parts of the circuit is turned off. While the other goes to a delay circuit that has its trigger as the ignition key, the output thereof is connected to the main circuit,

Another means of realizing this power unit (particularly for in-house presentation) requires little modifications.

- A transformer is used to step-down the supply mains of 240, 50Hz to 12V, 50Hz supply. (The transformer employed is a 240/12V 1000mA),
- The 12V AC supply is then passed through a rectifier circuit which normally comes in the form of a single chip of 4 pins. The rectifier converts the AC to DC of equivalent voltage (except for the 0.6V reduction due to the forward voltage drop of a diode.)

- This now is connected to a filler circuit, in this case is in parallel with the resistive load (main circuit). The type of filter employed is a series-connections filter which uses a large capacitor in parallel with the resistive load. To calculate the approximate value of the capacitor that will give a ripple factor of less or equal to

Where $I_{ve}$ = The total current to the resistive load

F - Frequency

Y = ripple factor

V - Circuit operating voltage.

**555 IC**

The 555 timer IC was first introduced around 1971 *by* the Signetic Corporation as the SF555/NH555 and was called "The IC Time Machine" and was also the first and only commercial timer ie available.[13]

The 8-pin 555 timer must be one of the most useful chips ever made and it is **used** in many projects. With just a few external components it can be used to build many circuits, not all of them involve timing.

The 555 timer has many application modes which include mono stable, astable and bi stable. In this project, the mono stable mode of operation shall be used. Which has pulse duration in the unstable state given by,

Time period. $T = 1.1 \times Rl \times C1$

T = time period in seconds (s)

Rl = resistance in ohms (U)

Cl = capacitance in farads (F)

The maximum reliable time period is about 10 minute

Therefore the duration of pulse used in this work

$T= 1 \text{ x } 1 \times 98.7uf \times 10k\Omega = 1.1$ seconds

RC delay circuit shown in figure 3.3 works on the simple principle that a capacitor takes some time to get fully charged after which on discharging take another time. The relationship used for the discharge time of such a circuit is given as

$t = R \times C$

In the ease of this circuit a 2 sec delay is desired there for a capacitor of 200ul' and resistor of 10kΩ was chosen here

$t = 200x\ 10^{-6}x\ 10x\ 10^{3}$

=2sec

## 3.2 DELAY UNIT

The delay unit comprises of the following, a push button (normally closed) switch, a 555 timer and combinational simple circuit of a capacitor-resistor as shown in figure 3.3

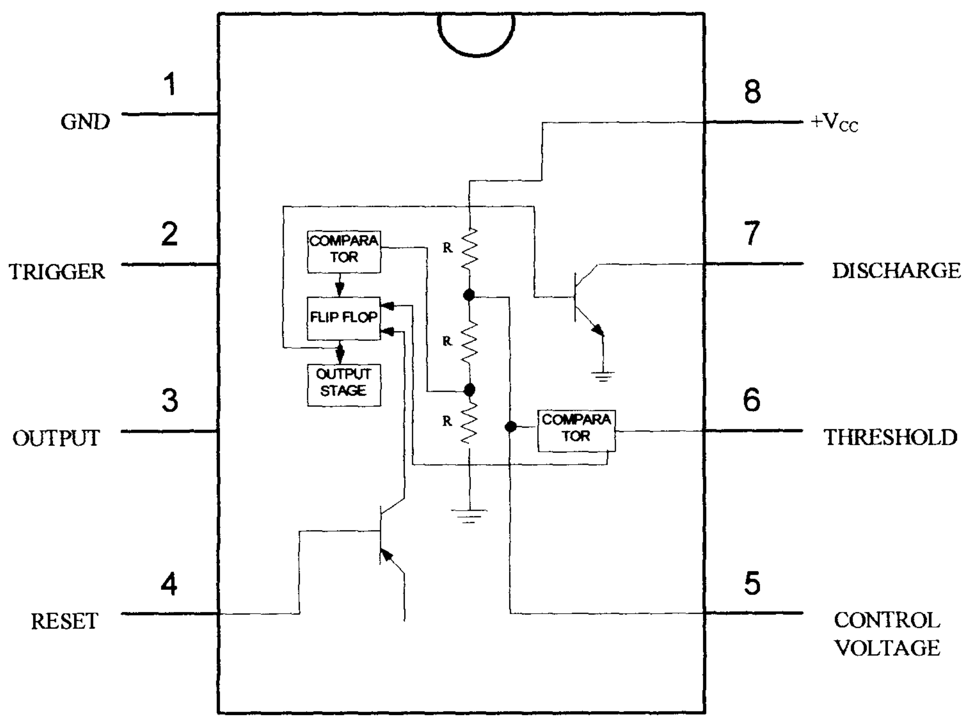



Fig 3.3 The 555 timer

The diode is placed in between the 555 timer and the capacitor for two reasons,

- To act as a protective device for 555 timer a
- And to force the capacitor to discharge in one direction, offering very resistance in the other direction.

### 3.3 SWITCHING UNIT

This unit is the centre of this whole circuit, which I call the decision section. Here it is expected to differentiate between a pulse that should be counted and those that should not. Looking at the characteristic of an AND gate that in high (1) when the two inputs are high (1) that can be seen in table I. I

Table 3. 1: Truth Table of an AND gate

| A | B | OUTPUT |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

By varying the time of each pulse reaching (he AND gate, one can discriminate between the input A and 13 being high or alternating.

This variation was achieved through the use of a transistor. Here the transistor acts as a switch. Working in a common emitter mode with input current (base current) coming from the delay circuit and a shape pulse coming from a push button switch to the collector terminal. It could be seen in figure 3.4 that, the duration of the pulse that comes from the switch two is much shorter than that which comes from the input of the base terminal. In this way once the 200uF capacitor is charged it begins to discharge gradually through the transistor to the ground. But if during that discharge a pulse comes from the collector, only then will an output be seen at $V_{out}$. This is to say if the switch two is pushed first; the pulse comes into the collector and goes to the ground because there is no base current to complete the switching process.Whereas if the switch in the 555 timer is triggered first then it charges the delay circuit that would hold enough charge to complete the switch at the arrival of the collector current.

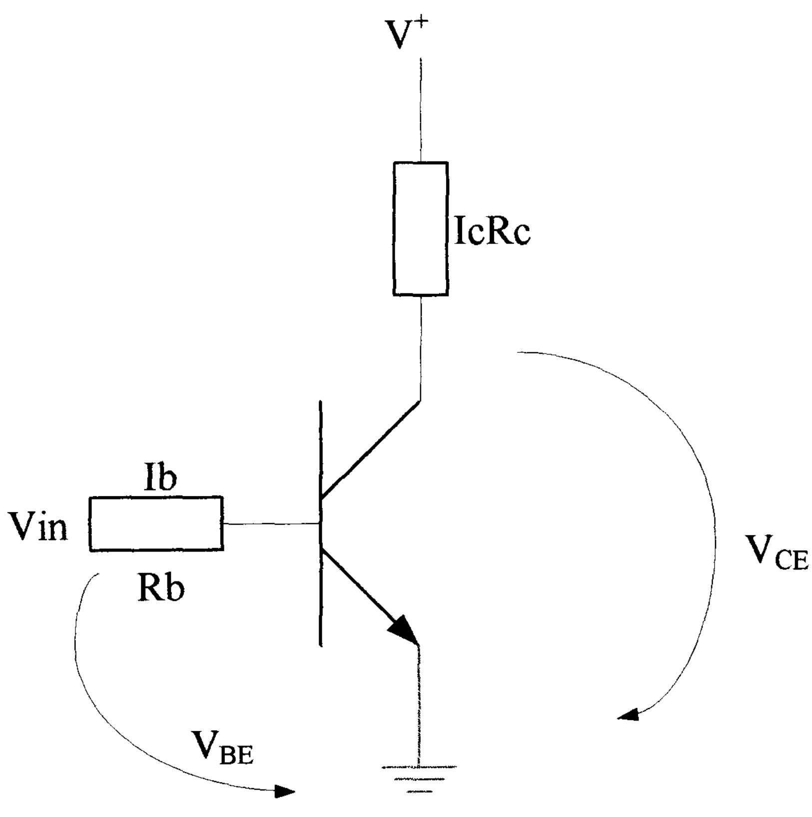



Fig 3.4: A Transistor Switch

The resistor $R_2$ = 330 ohms acts as a pull down resistor dropping the internal voltage of the counter to less than 0.8 from its original value of 1.6V,

The transistor used has the following characteristics. The 2N2222 is shown in

Table 3.2: 2N2222 characteristics

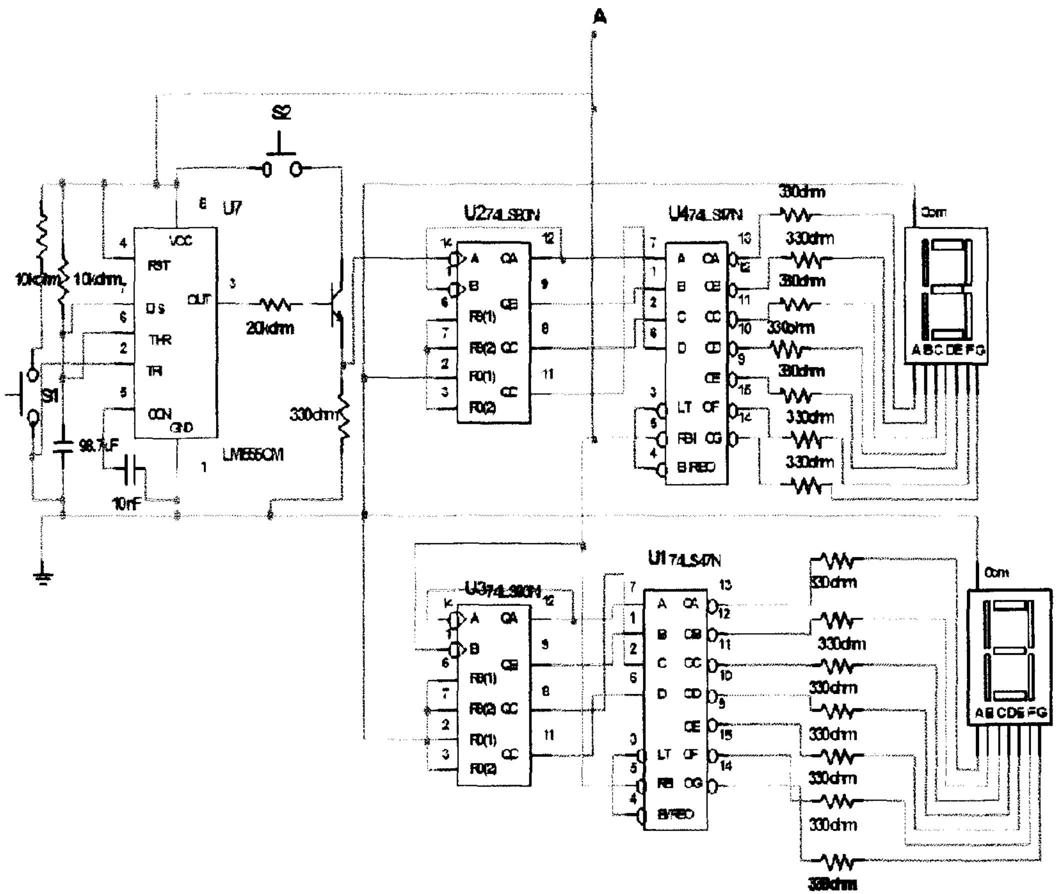
| Parameter | Test Conditions | Min | Type | Max | Unit |
|---|---|---|---|---|---|
| VCEO | | | | 30 | V |
| $I_e$ (Com) | | | | 0.5 | A |
| $H_{fe}$ | @) 1 0/0. 15 ($V_{Ce}$/$F_e$ | 100 | | 300 | |
| F | | | 250m | | |
| P.5 | | | | 0.5 | |

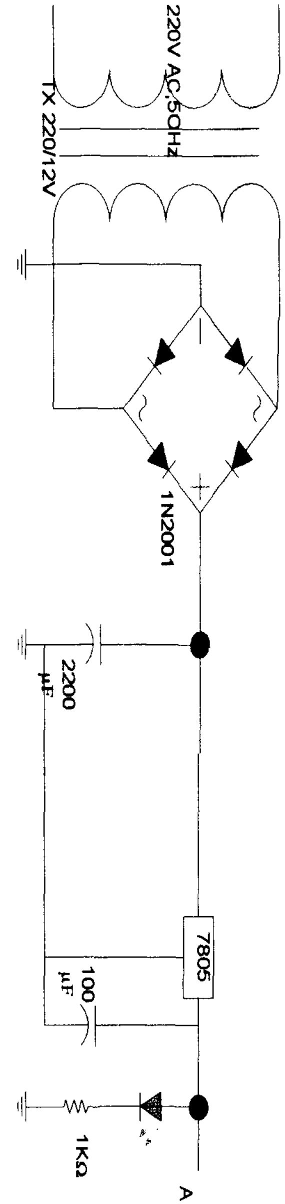
### 3.4 COUNTING UNIT

It is expected to keep track of event in (his case every pulse that comes out of $V_{out}$ of the transistor and to achieve this two counters were employed; primarily to give *a* two digit count (up to 99),

**THE 74192 UP/DOWN DHCADH (0-9) COUNTER**: This belongs to the family of 74LS (low power schottky) that uses TTL (Transistor-Transistor logic) circuitry, which is fast but requires more power than other members of the family. *(12)*.This is a synchronous counter that has two separate clock inputs for counting up and down. The count increases as the up clock input becomes high (on the raising-edge).

The count decreases as the down clock input becomes high (on the raising-edge). In both cases the other clock input should be high.




COMPLETE CIRCUIT DIAGRAM OF THE CAR MONITORING DEVICE

## 3.5 DISPLAY UNIT

This gives a visual image of the present count of the 74192 1C making it to be easily understood by man. The type of display used is a seven-segment display; alongside it required a decoder driver. The decoder driver chosen for this job is the 74LS274 due to unavailability of the second 7447 and other driver which is an equivalent of 7447 was taken, the 74LS247 to complete the two decodes that is need for a full two digit display. As could be seen the TTI, family was employed for this task mainly due *to* unavailability of the CMOS equivalent which is much more flexible than the TTL with CMOS, the need for a regulator would have not been.

## 3.6 DESIGN CALCULATION

Across the *555* timer,

Total external resistance = 10k + 10k

= 20k

Voltage across the resistor = 5V

Therefore, current flow to the 555 timer, $I_1 = V/R$

$I_1 = 5/20k - 25m$ A.

The current drop across (the pull down resistor of 330 ohm, for a voltage drop of 1,6V,

$I_2 = 1.6/330 - 4.848mA$

The current drop across one of the resistor connecting the output of the decoder to the anode of seven segment display receiving a voltage drop of 5V is

$I_3 = 5/330 = 0.0\ 15$ A.

Since there are seven connected in such a manner for each of the two decoder (meaning R x 14) .

$I_{3T}$ =l3Xl4

= 0.015x14

=0.212A

$I_{3T}$ =212mA.

Being that the TTL, IC family requires low milli-watt to operate, current through the IC is negligible. Hence, total current within the circuit $I_T$ will be given as:

$I_T$ = 212m + 4.8m 25m

= 241.8mA.

With the knowledge of the expected circuit current consumption, the filter capacitor to be used is calculated using the formula given below:

$$C = \frac{I_{DC}}{4\sqrt{F}V_{IP}}$$

= 241.8m/(4√3x50x5x0.07)

= 1.994x $10^{-3}$

For which 2200uF

Recap:

1. The choice of 10k resistor between Pin 7 and source for the 555 along side the 98,7 x $10^{-3}$ F was to achieve a delay of one second in the conducting part:

T = 1.1 × 10k x 98.7 x $10^{-3}$

= 1.085 7 see.

2. The delay made by the resistor-capacitor circuit will offer a delay of T = R % C. where, R = 20kohms and C - 1 x $10^{-4}$ F

Therefore; T = 20k x $10^{-4}$

=2 seconds.

# CHAPTER FOUR

## TEST, RESULT AND DISCUSSION

In this chapter we shall examine this device in terms of its packaging; the tests carried out, and discuss the result and offer opinion based on the result

### 4.1 Packaging

For the purpose of a small in-house presentation, a card board was chosen. The packaging is made up of eight exterior parts, which are indicated by the thick lines and dimensions. The internal design of the physical casing is shown in fig 4.2; the flat card board is used for the external casing, and is held firmly to a structure of board connected along the edge perpendicular to the horizontal ground. Air vents are provided for aeration, to avoid over-heating due to extreme temperature prevalent in this period of the year.

The display on the other hand was put at the right side of the prototype; mainly to case presentation and to avoid exposed wires connecting the display lo the firmly fixed display drivers mounted on the Vero board.

### 4.2 Testing

The method of testing used for this work is the simple use of a multi-meter to measure voltage and resistance at some points, alongside observing the behavior of each component to see if it matches the function to which it was put together. The following tests were carried out:

1. After plugging the 74192 1C (the decade counter) and the corresponding driver 7447: display test input (Pin 3) was given low (()} and all the seven segment of the display came on. Showing all the drivers are in good working conditions,
2. The counting sequence was observed to jump in some instances. This was expected because a de-bouncer was not used.

3. The time delay for each clocking was manually taken and it showed that the value of the resistor/ capacitor was more than needed for a two second delay. Hence, a downward review of these values. Other parameters tested and their results are stated in Table 4.1

Table 4.1 Tests and results

| Component | Test | Result | Remark |
|---|---|---|---|
| 555 timer 1C | | 4.22 | Good |
| Diode | | 3.55 | Good |
| Counter | | 1.7 | Good |

### 4.3 Discussion of Result

Test result shows that the circuit seems good for the immediate purpose of counting cars, which actually passed through a particular toll gate. The switch employed for testing was actually not ideal for this situation.-

The value of the voltage supply exceeded the expected value only by a small fraction (0.6V), which poses no problem.

### 4.4 Short Comings

The only one noticed was an occasional irregular jumping experienced when the switch is activated wrongly, such as sparks on contact, gradual change in voltage levels instead of the shape pulse in purely digital system.

# CHAPTER FIVE

## 5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

Initially, the idea that counting the number of cars that enter the toll gate can only be achieved with complex circuit due to all it constraints have been proven wrong. The fact that there is only one gate for entry and exit of the car, cars at times behave radically (entering only to leave the next minute), and cannot be properly counted have also been proven wrong.

It is possible to achieve an accurate count of all the cars that enter the toll gate, and thereby, provide data upon which proper accounting can be effected.

Given the constraint upon which this work was carried out, some additional features can be included to give better and more precise count. Switching Unit

- A delay connected to the ignition to start the switch minutes after the cars start moving.
- A delay connects also to the ignition to stop the flow of energy to the switch and switching unit is disabled from counting.
- An increase in the number of cascaded counter to cover for hundreds or thousands of count.
- The addition of a de-bouncer to avoid any form of skipping.

Finally, I will recommend the use of this device only when workers are properly remunerated at when due. And a proper reward system is put in place for the benefit of all stakeholders.

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# DESIGN, CONSRUCTION AND TESTING OF 500VA SOLAR INVERTER

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