DESIGN AND CONSTRUCTION OF 8-WAY TRAFFIC LIGHT CONTROLLER.

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DEDICATION

This project is dedicated to Almighty Allah (SWT) for his abundant blessings and mercies on me. I also dedicate it to late Alhaja Kudirat Salau, may her soul rest in peace.

DECLARATION

I Omokanye Shade Khadijat declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, minna.

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ABSTRACT

The project is a model of 8-way cross junction traffic control system which is built around the TTL (transistor transistor logic), for broad roads used in highly populated areas to control traffic. The circuit is adopted from a 20 output sequencing circuit. It has an oscillator (555 timer), a 4 bit decade counter, a logic control unit and output indicator. The oscillator deals with the circuit's timing operation. The 4 bit decade counter generates 10 logic states which is expanded to 20 active low outputs by the logic control unit. The latter unit holds a logically configured network of PN diodes for realizing a particular output lighting sequence. The output involves a set of switching circuit for isolated relatively high current to switch on the output light emitting diodes (LEDs). The involved lighting are light emitting diodes, an improvement of the usual high power consumption and relatively short life halogen lamps.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLE

CHAPTER ONE

1.0 INTRODUCTION.

The project is all about a traffic light system for an 8 way including the cross junctions. A traffic light sometimes called Traffic signal is an outdoor electronic installation positioned at a road intersection, pedestrian crossing or other location for purposes of indicating when it's safe to drive, ride or walk by the application of a conventional color code.[1]. Three colors (Red, Amber and Green) are usually involved in the operation and they follow numerous sequences depending on the part of the world. But, all the signaling sequences are intended for the purposes of an organized traffic flow or movement.

In the course of the design and construction of the leading installation, the main factor of concern is "RELIABILITY". This is because the machine usually takes the place of human traffic officers. And its failure to perform accordingly leads to chaos to the concerned traffic that is entailed to follow its output instruction by law. Moreover, the project is attributed to a simulated lighting sequence. This is mainly achieved by use of Transistor-Transistor Logic (TTL) integrated circuits. Infact, the design is the modified version of Paisley's 20 output sequencing circuit [2].

The leading circuit is adapted for European 4-state light sequence that warns traffic that it will shortly be free to "MOVE" or "STOP" [1]. The 4-state system involves only Red for stop, Red and Amber for about to be free to move, only Green for free to move and lastly only Amber for about to stop as shown in table 1.0 below. The project is aimed at a cross junction which involves eight (8) installations that is used in a densely populated area to reduce hold-ups.

Table 1.0 The European 4-States Light Sequence.

COLOUR COMBINATION	INDICATIONS
RED (R) ● AMBER (A) ○ GREEN (G) ○	STOP
RED (R) ● AMBER (A) ● GREEN (G) ○	GET READY TO MOVE
RED (R) ○ AMBER (A) ○ GREEN (G) ●	GO
RED (R) ○ AMBER (A) ● GREEN (G) ○	GET READY TO STOP

1.1 AIMS AND OBLECTIVES.

The project is aimed at the design and construction of a model traffic light control for 8-way cross junction.

1.2 METHODOLOGY.

The involved circuit is adopted from a 20 output sequencing circuit. The circuit holds an oscillator (555 timers), a 4 bit decade counter, a logic control unit and output indicators. The oscillator deals with the circuit's timing operation. The 4 bit decade counter generates ten logic states which is expanded to twenty active-low outputs by the logic control unit. The latter unit holds a logically configured network of PN diodes for realizing a particular output lighting sequence. The output involves a set of switching circuit for isolated relatively high current switching on the output Light Emitting Diodes (LEDs).

The altogether integrated circuits are Transistor-Transistor Logic (TTL). The use of such logic devices allows for an over-all reliability and low-cost of the project.

1.3 SCOPE OF THE PROJECT.

The project is a model for demonstrating the electronic traffic control of a cross road junction. The involved lighting are Light Emitting Diodes (LEDs), an improvement of the usual high power consumption and relatively short life halogen lamps [3]. And as earlier stated, the involved integrated circuits are Transistor-Transistor Logic (TTL) type.

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORICAL BACKGROUND.

The modern traffic light came into place as a result of advancement in the first known signal device for regulating street light by different inventors from different part of the world.

The first traffic light or signal device for regulating street traffic was installed on 10th of December 1868 in London, designed by engineer JP Knight. [1, 4, 5]. It was a revolving lantern with red and green signals. Red meant "STOP" (for stopping vehicles and horses, and allowing the passage of persons on foot) and Green meant "caution" (for allowing vehicles and horses pass over the crossing with care and due regards to safety of foot passengers) [6]. Unfortunately, this crude traffic light exploded, on January 2, 1869 injuring the policeman operating it, [1, 4].

In 1912, a contender for "Invention of the First Electric Traffic Light" [5], Lester wire of Salt Lake City, a police officer invented the first electric traffic light [3]. The traffic light was a handmade model of a wooden box mounted on a pole with a slanted roof so that rain and snow would fall off. It was operated by a policeman. [2]

On 5th August, 1914, the American traffic signal company installed Red and Green traffic lights at each corner of intersection of a street in Cleveland, Ohio. [1, 5]. The installation was patterned after the design of James Hoge [6, 7] which has 2 colors, Red and Green for Stop-Go respectively plus a bell to warn the drivers of color changes. [5]

The world's first three colors (Green (Go), Red (Stop), Amber (Clear the intersection)). Four (4) direction traffic lights were installed in Michigan in October, 1920. [6] designed

by a police officer, William L. Potts using about thirty-seven (37) dollars worth of wires and electrical control but were also manually operated. [4]. the signal remained in use until 1924 and became a part of the worlds synchronized signal system [5].

Garrett Morgan in 1922 also came up with the traffic light using three colors only that the Morgan's signal had no yellow light instead a "Third Positioned" light that displayed the word STOP in all directions before allowing traffic to proceed in any one direction, hereby providing extra time for the intersection to clear.

The advancement on the above mentioned traffic light control system led to the invention of Automatic controlled interconnected traffic light in March 1922, in Texas, and the first automated traffic light in 1950s in Canada [1].

The traffic light is now used all over the world based on the three color codes; The Green, Red, and Amber (Yellow) to save traffic jams and to travel more safely and efficiently.

2.2 THEORITICAL BACKGROUND.

There are various types of traffic signal control systems which can be classified based on their mode of operation and based on how they are controlled.

2.2.1 TRAFFIC SIGNAL CONTROL SYSTEM BASED ON MODE OF OPERATION.

This is sub-divided into:

a. Pre-timed traffic control system

b. Vehicle actuated traffic control system.

a. Pre-timed Traffic Control System: It's the simplest control system that uses a timer, each phase of the signal lasts for a specific duration before the next phase occurs, and this pattern repeats itself regardless of the traffic.

b. Vehicle Actuated Traffic Control System: This is a more sophisticated control system that uses electronic sensor (e.g. Metal detector) buried in the pavement to detect the presence of traffic waiting at the light, thus can avoid giving the green light to an empty road while motorists on a different route as stopped. A timer is usually used as back-up in case the sensor fails. An additional problem with sensor based system is that they may fail to detect vehicles such as motorcycles with low metal content and cause them to wait forever.

2.2.2 TRAFFIC SIGNAL CONTROL SYSTEM BASED ON MODE OF CONTROL.

Although, there are solar controlled traffic light but most traffic light are electrically controlled. The electrically controlled traffic lights are classified into two groups namely

a. Sequential Logic Traffic Control System.
b. Programmed Traffic Control System.

a. Sequential Logic Traffic Control System: These are traffic control systems that are designed based on simple combinational logic (e.g. gates, flip flops), counters, decoders e.t.c which this project has adopted.[2]

b. Programmed Traffic Control System: They are designed by a simply programming a microprocessor or microcontroller. It also has a sequential drive circuit which has programs in the Electrically Programmable Read Only Memory (EPROM).

2.3 PLACEMENT OF TRAFFIC SIGNAL.

There are significant differences from place to place concerning how traffic light are positioned or placed so that they are visible to drivers or the road users [10]. It may be mounted on poles horizontally or vertically depending on the location, but what matters most is the ability of the road users to see the signal clearly. In Nigeria, the signals are mounted vertically on a pole with Red on top, Amber in the middle and Green below which this project is adopting.

2.4 TRAFFIC LIGHT AND THE LAW.

Virtually, in all jurisdictions, it's a legal offence for motorists to disregard the instructions of traffic lights or other traffic control devices. Enforcement of traffic lights laws varies from jurisdiction to jurisdiction [9], some places are extremely strict while in some places, there is no serious attempts by law enforcement to alter the situation.

2.5 ADVANTAGES/DISADVANTAGES OF TRAFFIC LIGHTS.

2.5.1 ADVANTAGES.

Traffic lights that are properly designed, located, operated and maintained will have one or more of the following.

1. They provide for orderly movement of traffic.

2. They increase the traffic-handling capacity of the intersection if

   a. Proper physical layouts and control measures are used.

   b. The signal operational parameters are reviewed and up-dated.

3. They reduce the frequency and severity of certain types of crashes.
4. They are used to interrupt heavy traffic at intervals to permit other traffic, vehicular of pedestrian to cross.
5. They are coordinated to improve continuous or nearly continuous movement of traffic.

2.5.2 DISADVANTAGES.

Traffic control, even when justified by traffic and roadway conditions can be ill-designed, ineffectively placed, improperly operated, or poorly maintained which can cause or result to one or more of the following.

1. Excessive delay.
2. Excessive disobedience of the signal indications.
3. Increased use of less adequate routes as road users attempt to avoid the traffic control signals.
4. Significant increases in the frequency of collision.
5. For the electrically controlled traffic signal are not reliable since it cannot work without power supply.

CHAPTER THREE

3.0: DESIGN AND CONSTRUCTION

3.1: INTRODUCTION.

The basic electronic components used in the design of the project work (Traffic Light Controller System) are Resistors, Capacitors, Diodes, Transistors and 74LSXX family of Transistor-Transistor Logic Integrated Devices.

The circuit is based on the sequential operation of a BCD decade counter and the output of 1-OF-10 BCD decoder/drivers used to drive light emitting diodes using common emitter output switching circuit made up of transistors (2SC945 and 2SD400).

Figure (3.1) shown below is the block diagram representing the traffic light control system.

3.2: BLOCK DIAGRAM.

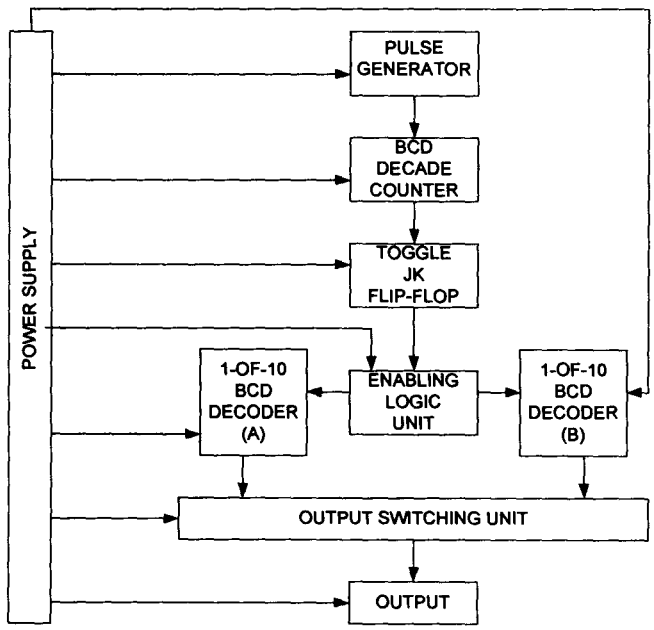


Fig. 3.1: Block Diagram of Traffic Light Control System.

3.3 POWER SUPPLY UNIT.

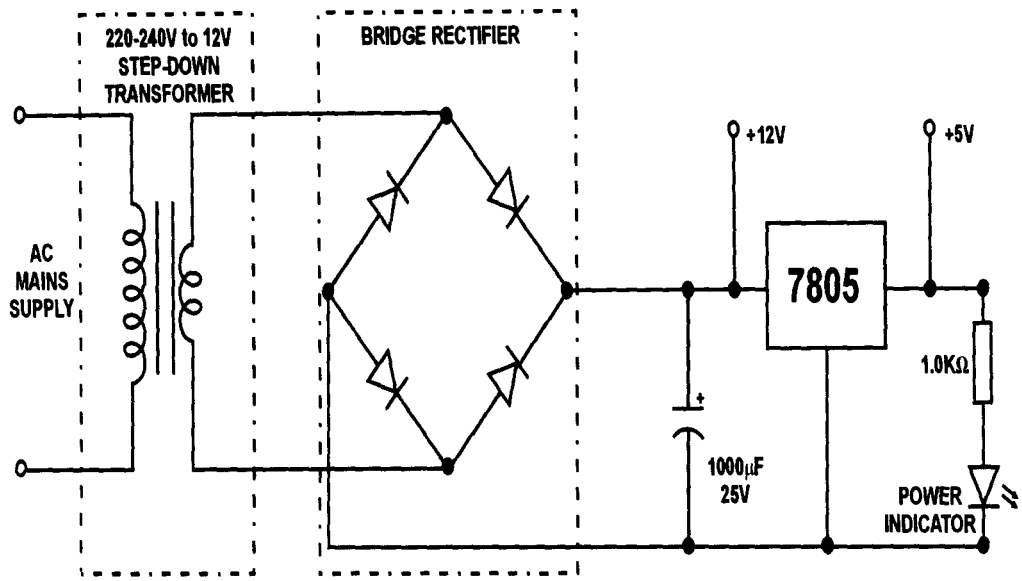


Fig 3.2; power supply unit

Most electronic devices and circuits require DC source for their operation which this project is not an exception.

The power supply functions basically to provide the necessary DC voltage that is ripple free with good stability and regulation.

Since the most convenient and economical source of power is the domestic AC supply, it is advantageous to convert this alternating voltage (usually 220-240V) to DC (smaller in value). This conversion from alternating voltage to DC voltage is achieved with the construction of a power supply unit which consists of 4 stages as shown in the figure 3.3 below.

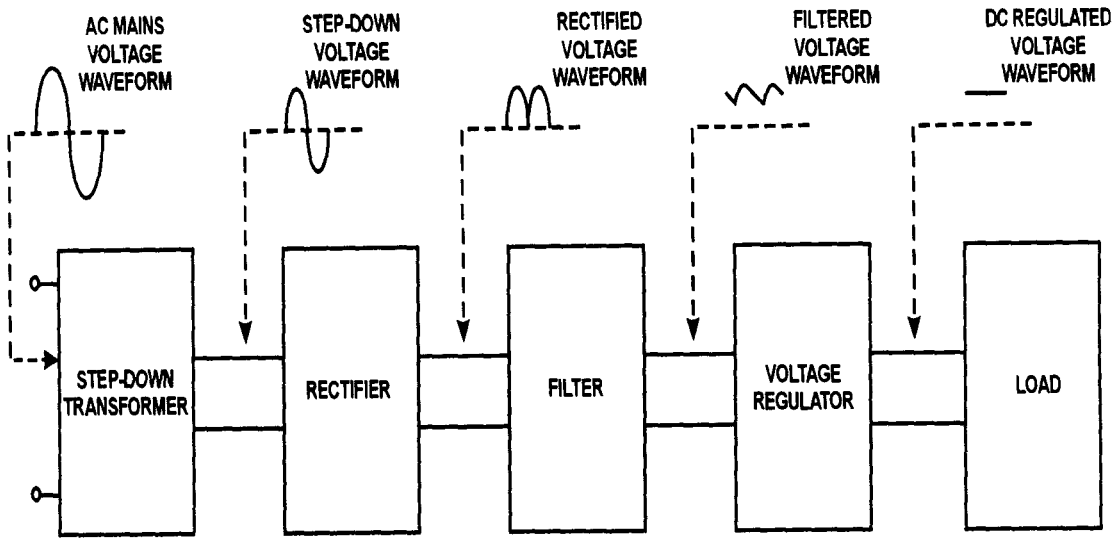


Fig 3.3; Block Diagram of Stages in Power Supply Unit.

3.3.1 TRANSFORMERS.

A transformer is a static 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 raise or lower the voltage in a circuit but with a corresponding decrease or increase in current [15]. It consists of 2 inductive coils which are electrically separated but magnetically linked. If one coil is connected to a source of alternating voltage, an alternating flux is set up in the core which is linked with the other coil and produces induced voltage. The first coil in which the electrical energy is fed from the AC supply mains is called primary winding and the other from which energy is drawn out is called the secondary winding.

The induced voltage is a function of the numbers of turns of the windings. A turn is the numbers of times the wire (coil) is wound around a core. When the numbers of turns on the secondary winding is more than that of the primary, then we have a step-up transformer

while when it is vice versa, it is a step-down transformer [15]. The voltage, numbers of turns and the current are related by equation 3.1

Vp/Vs= Np/Ns= Is/Ip ---------- (3.1)

Where Vp, Np and Ip are the primary voltage, numbers of turns and the currents respectively while Vs, Ns and Is are secondary voltage, numbers of turn and the current of the transformer respectively.

3.3.2 CHOOSING AND SPECIFYING TRANSFORMERS.

Transformers are specified according to the power, voltage and current ratings of the secondary winding and the regulation. Therefore, the choice of the step-down transformer used for the purpose of this power supply unit is based on its voltage and the current of the secondary winding which is accepting 240V AC from the primary winding and stepping it down to 12V AC in the secondary winding.

3.3.3 RECTIFIERS.

It is a circuit which employs one or more diodes to convert the stepped down AC voltage into a pulsating DC voltage.

3.3.4 DIODES.

These are semi-conductor devices having two terminals that allows the flow of current in one direction.[18, 17]. Semi- conductor diodes act on the basis of PN junction. A P-N junction diode is a one-way device offering low resistance when forward biased and behaving as an insulator when reversed-biased. Hence, such diodes are mostly used as

rectifiers i.e. for converting alternating current into direct current. The types of rectifications are half-wave, full wave and full wave bridge rectification.

3.3.5 FULL WAVE RECTITFICATION.

This is most frequently used for electronics DC power supplies. It requires 4 diodes and a non centre-tapped transformer. The full-wave bridge type is employed for this project.

3.3.6 FILTERS.

The main purpose of the filter in the power supply circuit is to minimize the ripple content. It has a DC value and some AC components called Ripples. This type of output is not useful for driving sophisticated electronic circuits which requires a very steady DC output that approaches the smoothness of a battery's output. [11]. The types of filters are:

a. Capacitor filter

b. L-C filter

c. R-C filter

d. R-L-C filter

The filter employed here is the capacitor filter. It is a single capacitor connected across the rectifier to smoothen the varying signal. The value of the capacitor is chosen from the fact that a bigger capacitor tends to reduce the ripple magnitude significantly.

3.3.7 VOLTAGE REGULATION.

3.4 PULSE GENERATOR/TIMING CIRCUIT.

In any electronics project where switching is required, it is very important to generate a pulse signal that will be able to change between two voltage levels (i.e. for digital circuits). So that one will be for "OFF" (Logic O or low) and the other for switching "ON" (Logic 1 or high). It could be vice versa depending on whether the component is active low or active high. In this particular project, a continuous pulse is required for clocking the BCD decade counter so it can change its output stage for each clock input, depending on whether the counter requires a negative or positive going transition for its operation. The pulse was generated using a 555 timer configured in an Astable mode. [12, 13]

3.4.1 555 TIMERS.

The 555 timer is a monolithic circuit packaged in several ways. It has 8 pins. It is mostly used for timing circuits because of its high degree of accuracy and stability. Configurations of 555 timers are:

a. Monostable or single short.

b. Astable multivibrator.

The mode of operation of a monostable configured 555 timer will not be discussed as it's irrelevant to this project design.

3.4.2 ASTABLE MULTIVIBRATOR.

It is also called free-running relaxation oscillator. It has no stable state but two halves state (Quasi-stable) between which it keeps oscillating continuously (to and fro) from one state

to the other to give a square-wave output. The figure below shows the configuration of a 555-timer in astable mode of operation and appendix 1 shows its output waveform. [12, 13, 15].

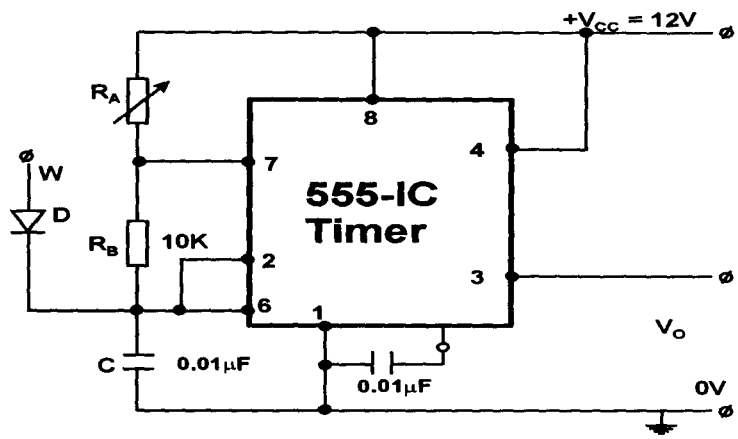


Fig. 3.4 Configuration of a 555-timer in astable mode of operation

3.4.3 FORMULARS.

These are formulas used to control the length of pulse for the 555 timer.

$$Th = 0.7(Ra + Rb) \times C \quad (3.2)$$

$$Tl = 0.7Rb \times C \quad (3.3)$$

$$T = Th + Tl = 0.7(Ra + 2Rb) \times C \quad (3.4)$$

$$F = 1/T = 1.44 / (Ra + 2Rb) \times C \quad (3.5)$$

Where:

Th = Charging time (time at the high period).

T_1 = Discharging time (time at the low period).

T = Total period of the pulse.

F = Frequency of oscillation.

The 555 timer used is LM 555 IC configured in astable mode for the purpose of this project work to generate pulses that drives the BCD decade counter which consequently drives the decoder. The timer has voltage specification of 5-18 Volts input and when operated with a 5 Volts supply as the case here, it is compatible with the integrated circuit of transistor-transistor logic (TTL).

For this project, the period T of each pulse is to be determined by Rb which is 1mΩ variable resistor. To achieve this period, the values of Ra and c were chosen to be 100kΩ and 10μf respectively. Basically, the value of C is chosen between 1μf-10μf.

3.4.4 CALCULATIONS.

Let's assume Rb value of 280kΩ

Therefore, from equation (3.4); we have that the total period of the pulse is;

$T = 0.7(Ra + 2Rb) \text{ X } C$

T can now be calculated as;

$T = 0.7(100{,}000 + 2(280{,}000)) \text{ X } 10 \text{ X } 10^6$

T = 4.62 secs

$T \approx 5$ secs

The ON time can also be calculated as

$Th = 0.7(Ra + Rb) X C$

$Th = 0.7(100,000 + 280,000) X 10 X 10^6$

$Th = 2.66$ secs

OFF time Tl

$Tl = 0.7Rb X C$

$Tl = 0.7 X 280,000 X 10 X 10^6$

$Tl = 1.96$ secs

Note that the higher the value of Rb, the longer the period.

3.5 COUNTERS.

A counter is a digital circuit whose function is to count the numbers of pulse applied to its input terminals. The maximum number of possible 1 and 0 states is known as the modules of the counter and these modules cannot be greater than 2^n. [14, 19]

The two types of counters are;

a. Asynchronous Counter

b. Synchronous counter

Examples of counters are the pure binary counter and decade counters.

3.5.1 DECADE COUNTER.

Also known as BCD counters, when it counts in sequence from 0000 to 1001, it is a counter that has 10 distinct states no matter what the sequence is. It counts in binary from 0-9.The table as shown in appendix 2 is the output counting sequence of a BCD decade counter. There are various IC chips that can be configured to work as a decade counter which includes DM 74LS90 (TTL), HCC 4017B (CMOS) e.t.c

3.5.2 74LS90.

Is a monolithic counter which contains four master flip-flops and an additional gating? It has a gated reset and gated set of nine inputs for use in BCD nine's complement application. To use the maximum count length (decade or four bit binary), the B input is connected to the QA output. [16]. The circuit configuration is shown in fig. 3.5s below and appendix 3.

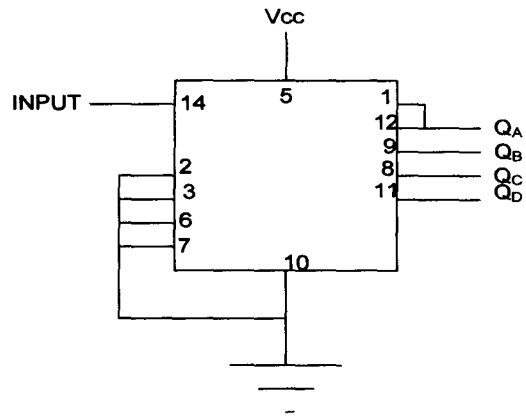


Fig. 3.5 Circuit Configuration of 74LS90.

The 74LS90 has a power dissipation of 45mW and counts frequency of 42MHz; it also works with supply voltage (Vcc) of 5Volts with tolerance of +/- 0.25V.The choice of 74LS90 was made for the purpose of this project to drive 2 BCD 1-of-10 decoder/driver, since 1-of-10 decoder will only decode BCD input to generate its decimal equivalent. It is connected according to the circuit configuration given in figure 3.5 above.

3.6 FLIP-FLOPS.

A flip-flop is an example of a bistable multivibrator that is a device with two stable states, 0 and 1 (Low and high. It is also referred to as "Latch" because of its ability to latch onto the data.[14].

The various types of flip-flops are;

a. SR flip-flop

b. JK flip-flop

c. D flip-flop

d. T flip-flop

JK flip-flop is adopted for this project work since it's the one that suits the purpose.

3.6.1 JK FLIP-FLOP.

This is a type of flip-flop that has J-K direct clear and clock pulse inputs. Output changes are initiated by HIGH-TO-LOW transition of the clock. The basic J-K flip-flop logic circuit is shown in fig. 3.6 and the truth table in appendix 4.

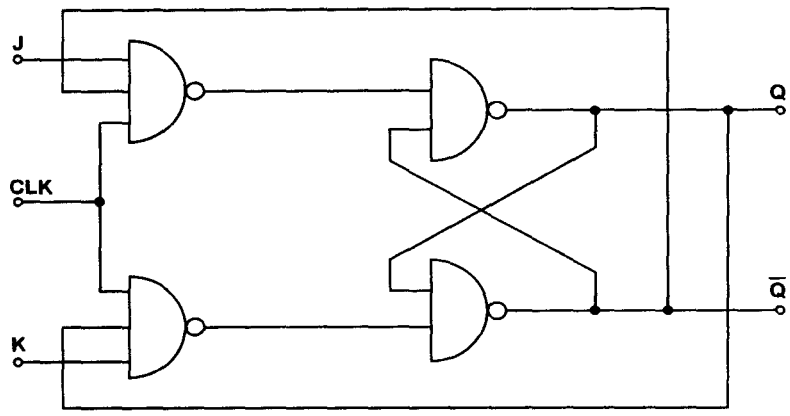


Fig. 3.6 Logic Circuit of JK Flip-Flop

From the table in appendix 3, if J and K are different then the output Q takes the value of J at the next clock edge. If J and K are both low then no change occurs. And if J and K are both high at the clock edge, then the outputs toggle from one state to the other. The J-K flip-flop also has a feature that when both inputs (JK) are connected to the positive, the state of its output Q and $\overline{Q}$ will only change when the clock pulse is changing from HIGH-TO-LOW i.e. (1-TO-0).

There are various integrated circuit chips that are configured to work as a JK flip flop such as 74LS107.

3.6.2 74LS107.

It is a TTL IC with a dual JK flip-flop with individual JK direct clear and clock pulse inputs. The pin connection and the logic symbols are shown in Appendix 5. It has supply voltage rating between 4.5 to 5.0 Volts. [16].

The 74LS107 was chosen for the purpose of this project due to the fact that it has 2 output states (0 or 1) which can create a disallowed or enabling state when connected in a circuit

depending on whether the circuit it is connected to is an active high or low. If active low, the low output of the 74LS107 will enable the circuit while the high output will disable the circuit and vice versa.

The 74LS107 is used in combination with a 4, dual input OR gate (74LS32) to create a disallowed state in one of the two 74LS145 that accepts BCD as input from the 74LS390 output. The way and manner in which the combination of 74LS107 and 74LS32 create the disallowed state in one of the 74LS145 is very logical which must be explained later in this project work.

3.7 ENABLING LOGIC UNIT.

The 74LS32 which is an IC that contains 4 independent 2-input OR gate is used as the enabling logic unit to enable or disable the 74LS145. [16]. The function table, logic symbol and the logic diagram of 74LS32 are shown in appendix 6.

3.8 DECODERS.

These are logic circuit that accepts a set of inputs that represents a binary and activates only the output that corresponds to that input numbers [19}. There are various types of decoders of which are;

a. Binary to octal or 3-line-to 8 line decoder

b. BCD-to-decimal decoder (1 of 10 decoder)

c. BCD-to-seven segment decoder.

Decoders are used whenever an output or group of outputs is to be activated only on the occurrence of a specific combination of inputs. In BCD to decimal decoder, the input combination is from a counter which this project work is employing. Various decoder IC chips are available e.g. 74LS145 (TTL family) e.t.c

3.8.1 74LS145.

It is 1-of-10 decoder/driver designed to accept BCD inputs and provide appropriate output. All output remains off for all invalid binary input conditions. It is an active low device. It has power dissipation of 35mW, fully compatible with all TTL families and supply voltage ranging from 4.75V to 5.25V. [16].The pin connection, logic symbol and the truth table of 74LS145 are shown in appendix 7.

For the purpose of this project work, 2 74LS145 are used to produce 20 step output sequences by decoding the BCD input. The outputs were used in driving LEDs and subsequently the traffic light using common emitter switching circuit designed with 2 transistors (2SC945 and 2SD400).

The circuit logic diagram below in fig (3.7) shows how the BCD outputs of 74LS90 are input into the 2, 1-of-10 BCD decoder (74LS145) using the JK flip-flop (74LS107) and the 4, dual input OR gate (74LS32).

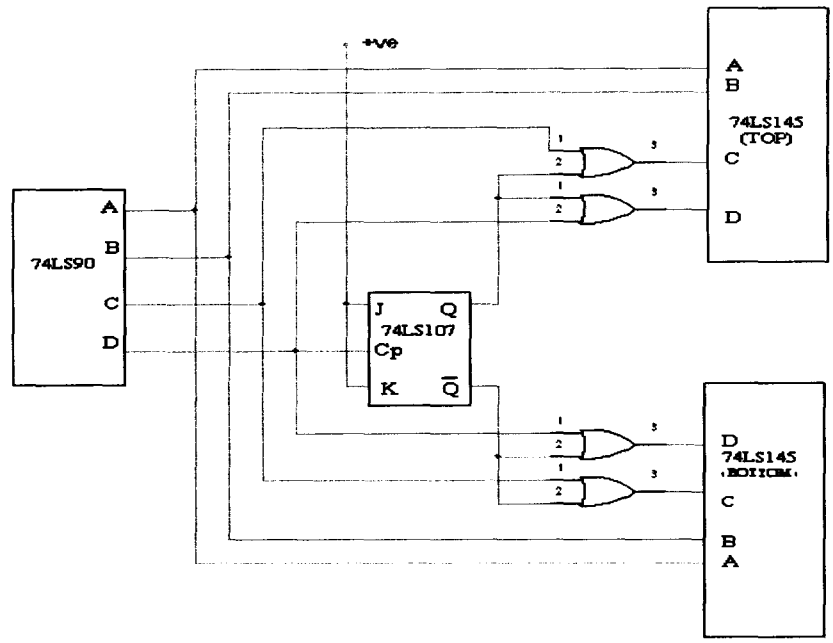


Fig. 3.7 Combinational Circuit of 74LS90, 74LS107, 74LS32, 74LS145.

Using the figure (3.7) above, assuming the JK flip-flop (74LS107) is 1 for output Q and 0 for output $\bar{Q}$ i.e. set state, starting with the first BCD output 0000 for DCBA going into the logic circuit diagram above (figure 3.7). The 74LS107 output remains unchanged. However, the bottom 74LS107 will be activated since the output at the OR logic gate will give a range within which the 74LS145 can decode. But, the top 74LS145 will be de-activated since it will not give a range within which the 74LS145 can decode. The reverse of the above explained will occur if Q is 0 and $\bar{Q}$ is 1 (reset state).

The table 3.1 below gives the inputs to the 74LS145 and the state of their outputs using the logic circuit of figure (3.7), assuming the 74LS107 is in a set state.

Table 3.1

74LS90 OUTPUT				74LS145 (BOTTOM) BCD INPUT				74LS145 (BOTTOM) EQUIVALENT OUTPUT PIN	74LS145 (TOP) BCD INPUT				74LS145 (TOP) EQUIVALENT OUTPUT PIN
D	C	B	A	D	C	B	A		D	C	B	A	
0	0	0	0	0	0	0	0	PIN 1	1	1	0	0	INDETERMINATE
0	0	0	1	0	0	0	1	PIN 2	1	1	0	1	INDETERMINATE
0	0	1	0	0	0	1	0	PIN 3	1	1	1	0	INDETERMINATE
0	0	1	1	0	0	1	1	PIN 4	1	1	1	1	INDETERMINATE
0	1	0	0	0	1	0	0	PIN 5	1	1	0	0	INDETERMINATE
0	1	0	1	0	1	0	1	PIN 6	1	1	0	1	INDETERMINATE
0	1	1	0	0	1	1	0	PIN 7	1	1	1	0	INDETERMINATE
0	1	1	1	0	1	1	1	PIN 9	1	1	1	1	INDETERMINATE
1	0	0	0	1	0	0	0	PIN 10	1	1	0	0	INDETERMINATE
1	0	0	1	1	0	0	1	PIN 11	1	1	0	1	INDETERMINATE

3.8.2 THE 20 SEQUENTIAL OUTPUTS OF 74LS145(S).

The 20 sequential outputs from the 2, 74LS145 were used to design 8-way traffic controller with the help of light emitting diodes and PN diodes based on the fact that diodes only conduct in one direction. The connections of the outputs were made according to the figure (3.10) which is the operation adopted in Nigeria. The output sequences are connected to Green and Amber LED(s) while the Red is enslaved to the Green and Amber. The Green will be ON for 3 periods (3X5secs) since 3 output periods are joined together while the Amber is for 1 period (5 secs).

3.8.3 COMPONENTS AND VALUES.

Resistor = 1KΩDiode = 1N4001, LED = Red, Amber and Green, Vcc = 12V

3.9 OUTPUT SWITCHING UNIT.

It is a common emitter switching circuit designed to make the output of the designed traffic light visible by amplifying the signals from the sequential output. The main components of this unit are transistors used as an inverting buffer. [17].

3.9.1 TRANSISTORS.

These are electronic components that can amplify small output current from a logic chip so that it operate a lamp, relay or other high current device. It can also be used as a switch.

There are 2 types of transistors namely;

a. NPN Transistors

b. PNP Transistors

The configurations of transistors are three which are;

a. Common base configuration

b. Common emitter configuration

c. Common collector configuration

For the purpose of this project work the BJT, NPN transistors configured in the common emitter mode was employed because it gives better performance in the amplification and switching coupled with its simplicity in connecting it.

3.9.2 TRANSISTORS AND INVERTING BUFFER/AMPLIFIER.

Transistors can also act as an inverting buffer to boost a weak signal source (one that is not capable of sourcing or sinking very much current to a load) and in a way acting as amplifiers. This is achieved with the use of 2 transistors in the common emitter configuration as shown in the circuit diagram below in fig (3.8)

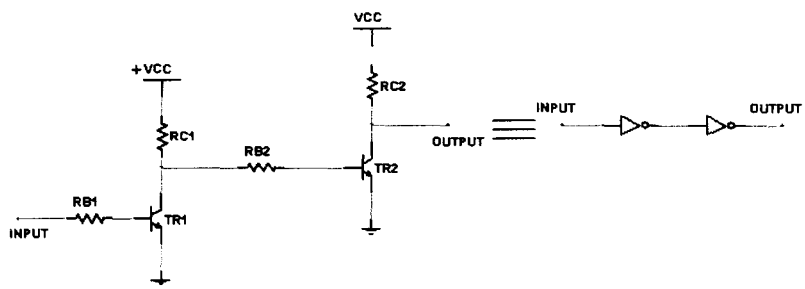


Fig. 3.8. Inverting buffer circuit and its equivalent.

The logic level is unchanged but, the full current sourcing or sinking capabilities of the final inverter are available to drive a load demanding a higher current than the one the circuit could produce. [17]

The choice of transistors is most importantly based on the maximum collector current IC and the current gain life which can be gotten from the technical data sheet of the particular transistors. The transistors used here are 2SC945 (TR_1) and 2SD400 (TR_2)

3.9.3 2SC945.

It is NPN silicon transistor designed for the use in the driver stage of AF amplifier and low speed switching it produces maximum collector current of 400mA and has a current gain of 120 minimum. [18].

3.9.4 2SD400.

It is NPN epitaxial planar silicon transistor whose maximum collector current is about 0.8A ($\approx$ 1A) and current gain life of 200 typical. [18].

The choices of the 2 transistors were made to deliver enough current to drive the output. If 2SC945 alone was to be used, the maximum IC will not be enough to drive the output. More so, if only 2SD400 was to be used, the current from the main circuit will not drive the transistor 2SD400 but the output from 2SC945 will drive 2SD400.

3.9.5 CALCULATIONS.

From the circuit diagram in figure 3.8

Let $R_{C1} = 1K\Omega$, Vcc = 12V

$I_{c1} \approx Vcc / R_{c1}$ ---------- (3.6)

I_{c1} =12 / 1 = 12mA

Current gain hfe = I_{C1} / I_{B1} ---------- (3.7)

But hfe = 120

$I_{B1} = I_{C1} / 100 = 12/120 = 0.1mA$

Measured VB_1 = 3.46V, VBE = 0.6V

$RB_1 = (VB_1 - VBE) / IB_1$ ---------- (3.8)

RB1 = (3.46—0.6) / 0.1 = 28.6KΩ ≈ 22KΩ

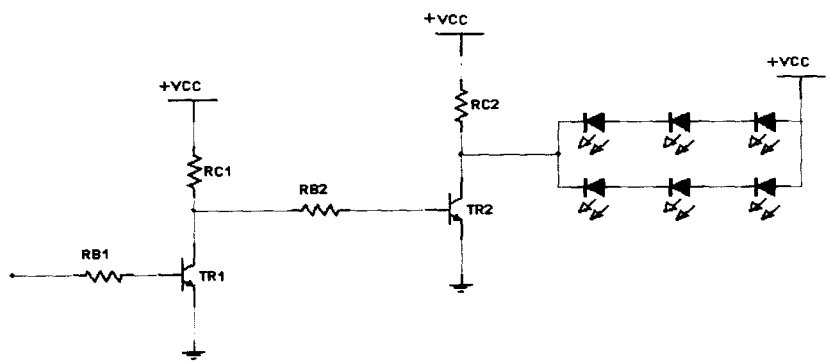


Fig. 3.9 single part of the output stage.

The figure 3.9 above shows the single part of the output stage.

Vcc = 12V

From T_{R2},

R_{C2} is given as;

$$R_{C2} = V_{CC} - V_L / I_L \quad \text{---------- (3.9)}$$

Where R_{C2} = collector resistor of TR2 that is connected in series with the LEDS to limit the current.

Vcc = Supply Voltage

V_L = LEDs Voltage

I_L = LEDs Current

Vcc = 12V

V_L for each LED is approximately 1.75V [17]

Thus, V_L for 6 LEDS, with 3 in series, combined in parallel with other 3 in series is given as,

$V_L = 1.75 \times 3$

$V_L = 5.25V$

I for each LED is roughly 15mA [17].

Thus, for 2, 3 series LEDs in parallel;

$I = 15mA \times 2$

$I = 30mA$

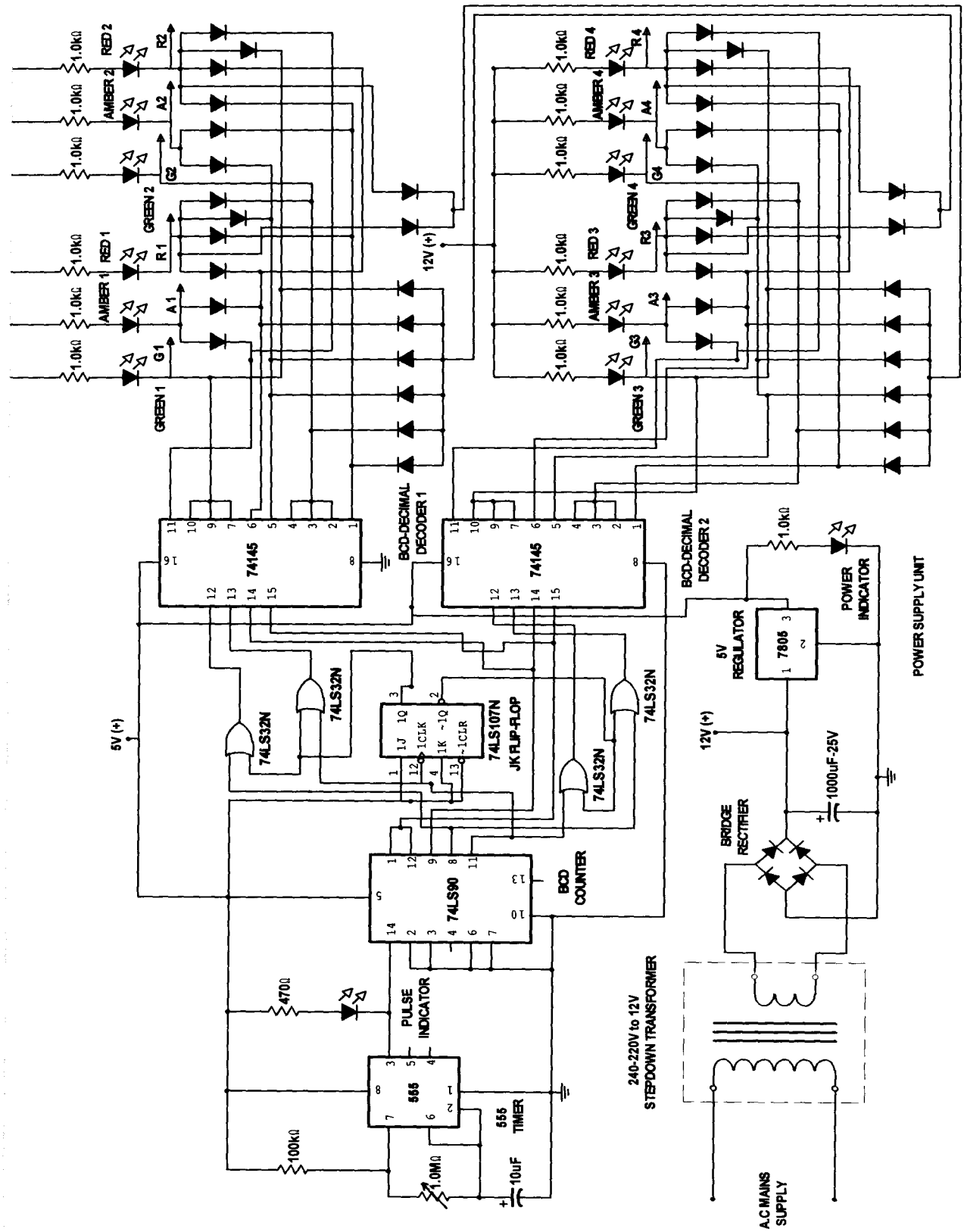


Fig. 3.10.The Main 8-Way Traffic Light Controller Circuit

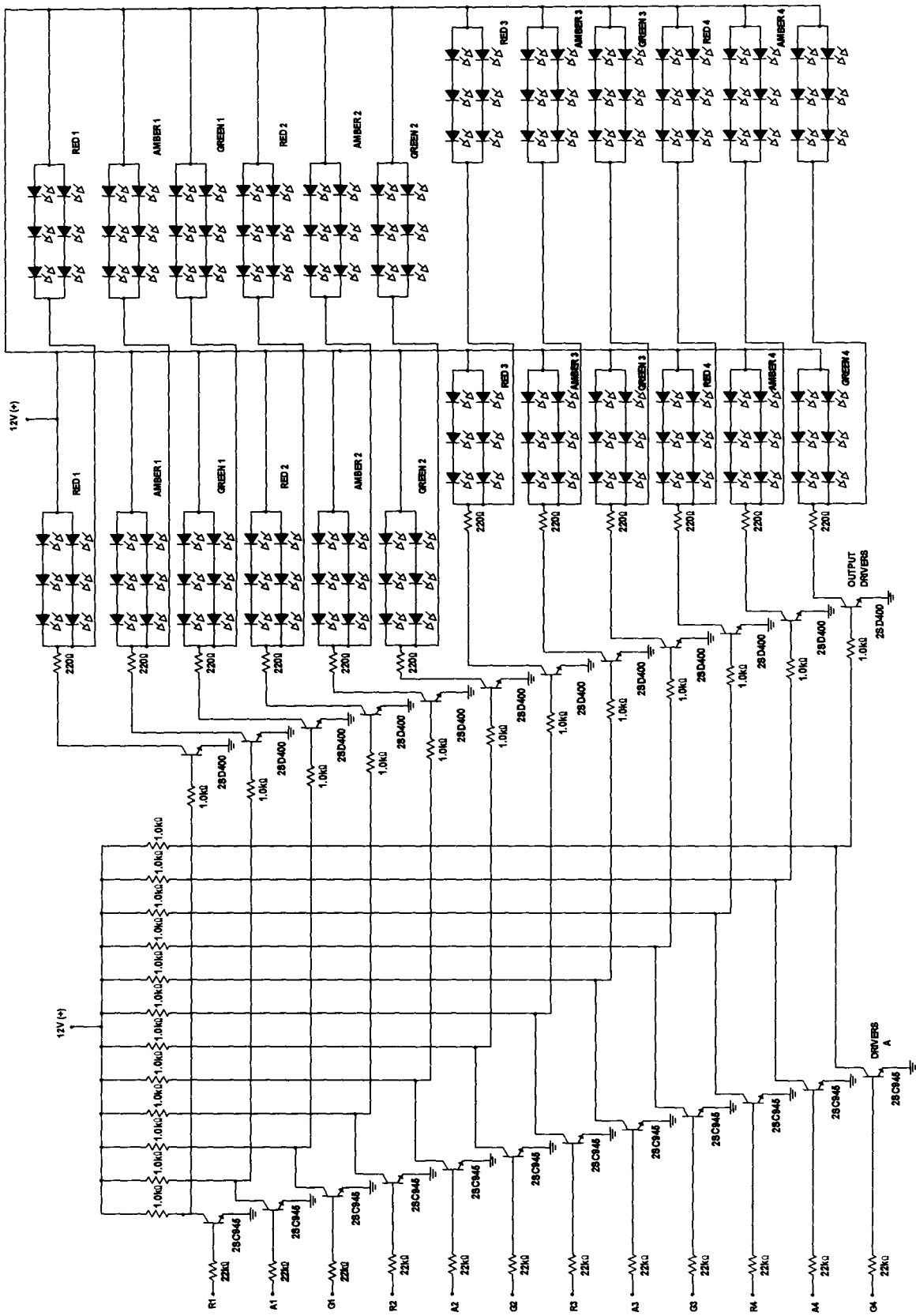


Fig. 3.11.The Switching Circuit for the 8-Way Traffic Controller

CHAPTER FOUR

CONSTRUCTION, TESTING AND DISCUSSION OF RESULTS

4.1 CIRCUIT CONSTRUCTION.

The bread board was first used to build and wire the complete circuit of this project. All components were confirmed to be working as expected on the bread board. The circuit was then carefully built on the Vero-board with IC sockets first inserted where it was necessary and soldered on the Vero-board. Other components were also carefully soldered on the Vero-board with continuity test carried out at every stage of soldering. And finally the ICs were then placed into the IC sockets where the provisions have been made.

4.2 CASING CONSTRUCTION.

The circuit was assembled together to give a complete traffic control system for a 8-way junction. A transparent plastic square box was fabricated using screws and nuts to house the main circuit. The output signals of the main circuit were tapped with audio video cables.

The signals were made of three colours of LEDs for each signal head for the roads. These colours are Red LEDs on top, Amber/yellow LEDs in the middle and Green LEDs at the bottom. These LEDs are mounted on a wood where the road layouts were drawn using plastic stands. A total of 8 signal head for the roads were mounted.

4.3 TESTING.

After ensuring that the coupling was done neatly and properly, the overall circuit was tested by connecting the power supply cable to the AC mains. And it was found working in good condition.

4.4 RESULTS.

The table (4.1) shown below gives the output sequential table and the figure (3.12) shows the road layout.

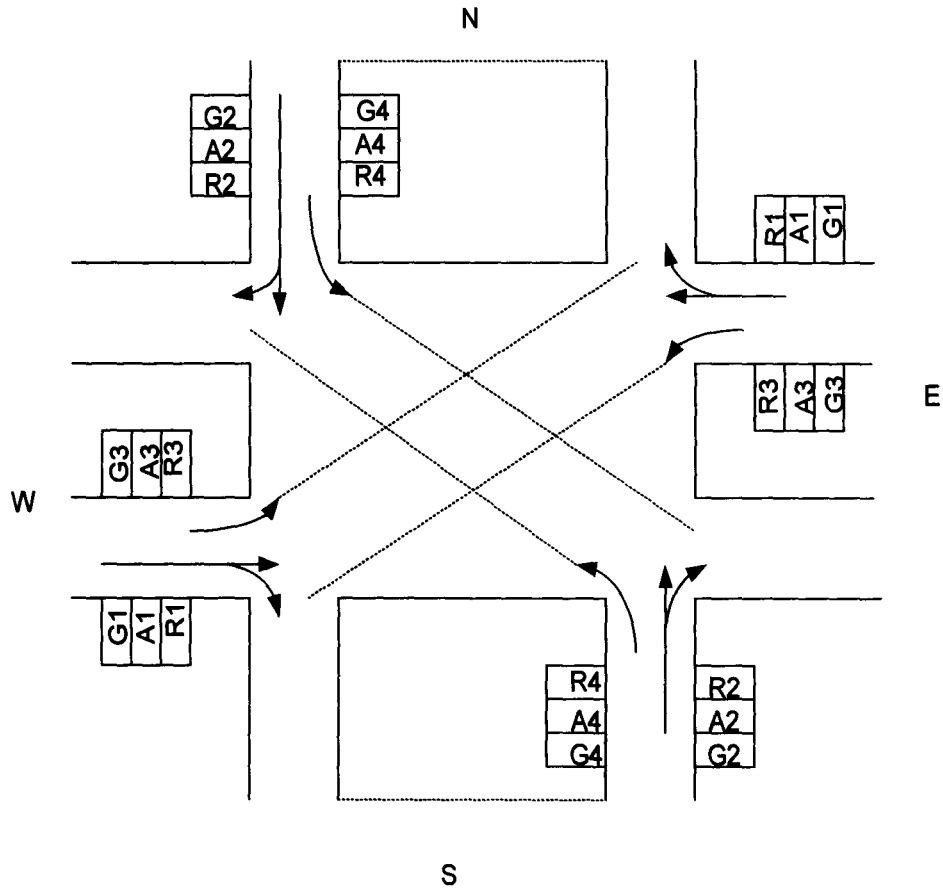


Table 4.1: Output Sequential Table For Top and Bottom 74LS145 Respectively.

NO	OUTPUT OF BCD TO DECIMAL DECODER 74LS145	N	ROAD E	ROAD S	ROAD W	ROAD N	ROAD E	ROAD S	ROAD W	PULSE PERIOD SECS
	0 1 2 3 4 5 6 7 8 9	R2 A2 B2	R1 A1 G1	R2 A2 G2	R1 A1 G1	R4 A4 G4	R3 A3 G3	R4 A4 G4	R3 A3 G3	
0	0 1 1 1 1 1 1 1 1 1	0 0 1	0 1 1	0 0 1	0 1 1	0 1 1	0 1 1	0 1 1	0 1 1	5
1	1 0 1 1 1 1 1 1 1 1	1 1 0	0 1 1	1 1 0	0 1 1	0 1 1	0 1 1	0 1 1	0 1 1	5
2	1 1 0 1 1 1 1 1 1 1	1 1 0	0 1 1	1 1 0	0 1 1	0 1 1	0 1 1	0 1 1	0 1 1	5
3	1 1 1 0 1 1 1 1 1 1	1 1 0	0 1 1	1 1 0	0 1 1	0 1 1	0 1 1	0 1 1	0 1 1	5
4	1 1 1 1 0 1 1 1 1 1	1 0 1	0 1 1	1 0 1	0 1 1	0 1 1	0 1 1	0 1 1	0 1 1	5
5	1 1 1 1 1 0 1 1 1 1	0 1 1	0 0 1	0 1 1	0 0 1	0 1 1	0 1 1	0 1 1	0 1 1	5
6	1 1 1 1 1 1 0 1 1 1	0 1 1	1 1 0	0 1 1	1 1 0	0 1 1	0 1 1	0 1 1	0 1 1	5
7	1 1 1 1 1 1 1 0 1 1	0 1 1	1 1 0	0 1 1	1 1 0	0 1 1	0 1 1	0 1 1	0 1 1	5
8	1 1 1 1 1 1 1 1 0 1	0 1 1	1 1 0	0 1 1	1 1 0	0 1 1	0 1 1	0 1 1	0 1 1	5
9	1 1 1 1 1 1 1 1 1 0	0 1 1	1 0 1	0 1 1	1 0 1	0 1 1	0 1 1	0 1 1	0 1 1	5
	0 1 2 3 4 5 6 7 8 9	R2 A2 B2	R1 A1 G1	R2 A2 G2	R1 A1 G1	R4 A4 G4	R3 A3 G3	R4 A4 G4	R3 A3 G3	
0	0 1 1 1 1 1 1 1 1 1	0 1 1	0 1 1	0 1 1	0 1 1	0 0 1	0 1 1	0 0 1	0 1 1	5
1	1 0 1 1 1 1 1 1 1 1	0 1 1	0 1 1	0 1 1	0 1 1	1 1 0	0 1 1	1 1 0	0 1 1	5
2	1 1 0 1 1 1 1 1 1 1	0 1 1	0 1 1	0 1 1	0 1 1	1 1 0	0 1 1	1 1 0	0 1 1	5
3	1 1 1 0 1 1 1 1 1 1	0 1 1	0 1 1	0 1 1	0 1 1	1 1 0	0 1 1	1 1 0	0 1 1	5
4	1 1 1 1 0 1 1 1 1 1	0 1 1	0 1 1	0 1 1	0 1 1	1 0 1	0 1 1	1 0 1	0 1 1	5
5	1 1 1 1 1 0 1 1 1 1	0 1 1	0 1 1	0 1 1	0 1 1	0 1 1	0 0 1	0 1 1	0 1 1	5
6	1 1 1 1 1 1 0 1 1 1	0 1 1	0 1 1	0 1 1	0 1 1	0 1 1	1 1 0	0 1 1	0 1 1	5
7	1 1 1 1 1 1 1 0 1 1	0 1 1	0 1 1	0 1 1	0 1 1	0 1 1	1 1 0	0 1 1	0 1 1	5
8	1 1 1 1 1 1 1 1 0 1	0 1 1	0 1 1	0 1 1	0 1 1	0 1 1	1 1 0	0 1 1	0 1 1	5
9	1 1 1 1 1 1 1 1 1 0	0 1 1	0 1 1	0 1 1	0 1 1	0 1 1	1 0 1	0 1 1	0 1 1	5

4.5 DISCUSSION OF RESULTS.

Comparing figure 3.10, 3.12 and table 4.1, it could be deduced that the 74LS145 (top) is working with the road ($R_1A_1G_1$) and ($R_2A_2G_2$) while 74LS145 (bottom) is working with Road ($R_3A_3G_3$) and ($R_4A_4G_4$). It is also noted that the $R_2A_2G_2$ North works with $R_2A_2G_2$ south, $R_1A_1G_1$ East works with $R_1A_1G_1$ West, $R_4A_4G_4$ North works with $R_4A_4G_4$ South and $R_3A_3G_3$ East works with $R_3A_3G_3$ West. Also, from table (4.1) and figure (3.12), when the top 74LS145 is decoding, first pulse period will ON, R_2A_2 for both North and south while every other points have their Red turned ON.

The next pulse period will ON the green G_2 for both north and south while other points remain the same. The G_2 is left ON for 3 pulse periods. The fifth period will switch On A_2 for both north and south while others remain unchanged.

In the sixth period R_1A_1 for both East and West are ON while every other points will have their Red turned ON.

The seventh period will ON the green G_1 for both East and West while all other points remains the same. This G_1 remains ON for the next 3 periods before the 74LS145 (top) is disabled and 74LS145 (bottom) is enabled. The operation continues according to the table (4.1).

It could be said that the designed traffic light controller is for 8-way junction whose operation is similar to the British mode of operation of traffic light system as shown in table 1.0

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION.

It can be concluded that a pre-timed traffic control system for 8-way cross junction has been designed and constructed with careful combination of logic circuit. The 8-way traffic control systems designed are used in densely populated area in Nigeria.

5.2 LIMITATIONS AND MERITS OF THE PROJECT.

The first obvious limitation of the work is the model layout. But, the design can be modified for full-scale operation. Also, the design does not consider external sensors for adopting the traffic control to the state of the traffic. The considerations allows for proper organization of traffic flow.

The major merit of the project is the simplicity of the involved circuit. It is quite flexible; the output sequence can be expanded or modified for numerous tasks. As earlier stated, the use of Light Emitting Diodes (LEDs) for lighting is quite an improvement

5.3 PROBLEM ENCOUNTERED.

In the course of designing and constructing this project, the problems encountered includes;

a. Getting the ICs gave some little problems.

b. Difficulty in trying to design the 20 output sequence of the decoders to suit the purpose of the project work.

c. Difficulty in the soldering processes and general troubleshooting of the circuit.

d. Wiring the casing was really a hectic one.

5.4 RECOMMENDATION.

Based on the problems encountered mentioned above, I recommend the following:

a. The student should be given a group project work on design and construction of a particular circuit at the end of every session in other to develop their ability and skills on project design and construction before the final year project to provide acquaintance to such knowledge.

b. Various books on ICs and ICs tester equipment should be made available in the university library and laboratories respectively.

APPENDIX

MANUAL OF OPERATION.

1. Connect the smaller audio-video cable from the display board to the 3 smaller ports on the main circuit box in order of white, yellow and red from the top port.

2. Connect the bigger audio-video cable from the display board (showing the road layout) to the 4 bigger ports on the main circuit box in order of white, red, white and red from the top, making sure that the red cable having 2 dots inscribed on it is at the bottom followed by its corresponding white.

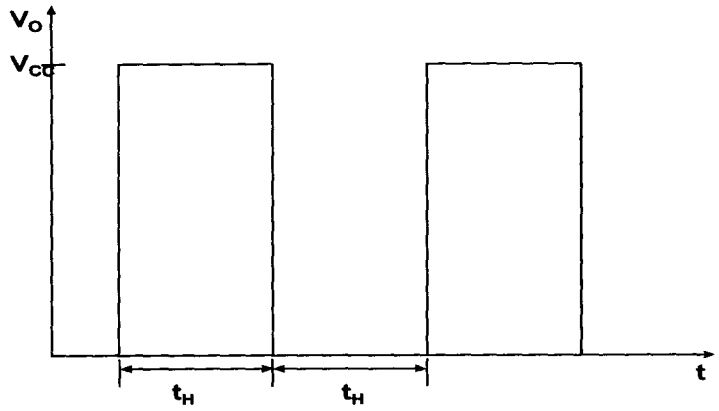
3. Connect the power cable to the point available for it on the main circuit box.

4. Power with 240-220 AC supply.

COST ANALYSIS.

S/NO	QUANTITY	NAME OF COMPONENT	UNIT PRICE (N)	AMOUNT (N)
1	1	240V-12V Step-down Transformer	150.00	150.00
2	44	Diodes (IN4001)	20.00	880.00
3	2	Capacitor (1000F, 10F,25V)	50.00	100.00
4	1	Voltage Regulator	80.00	80.00
5	40	Resistors	5.00	200.00
6	170	Light Emitting Diodes	5.00	850.00
7	1	BCD Counter(74LS90)	150.00	150.00
8	1	4, Dual-Input OR Gate(74LS32)	150.00	150.00
9	1	JK Flip-Flop(74LS107)	150.00	150.00
10	2	BCD Decoder(74LS45)	150.00	300.00
11	12	2SC945 Transistor	20.00	240.00
12	12	2SD400 Transistor	30.00	360.00
13	1	555 Timers	50.00	50.00
14	6	IC Sockets	50.00	300.00
15	3	Vero Boards	100.00	300.00
16	20(Yards)	Jumper Wires	10.00	200.00
17		Casing(In Total)	2500.00	2500.00
TOTAL				**6910.00**

APPENDIX 1.



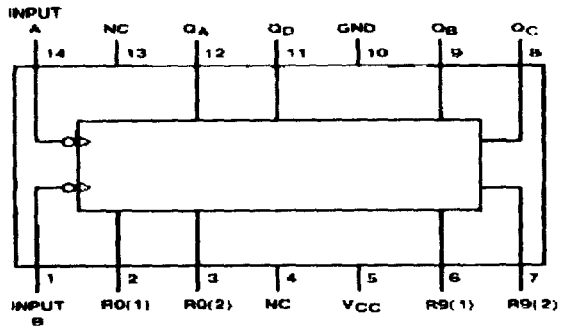
Output waveform of a 555-timer in astable mode of operation.

APPENDIX 2.

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

BCD Counter

APPENDIX 3.



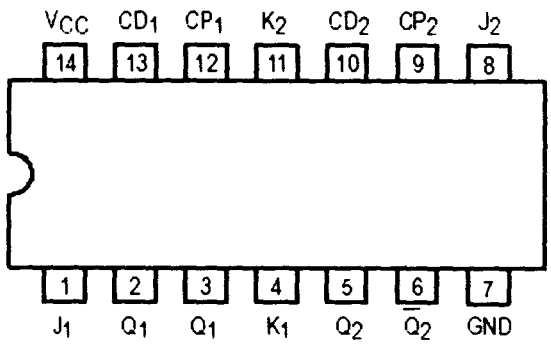
PIN OUT OF 74LS90

APPENDIX 4.

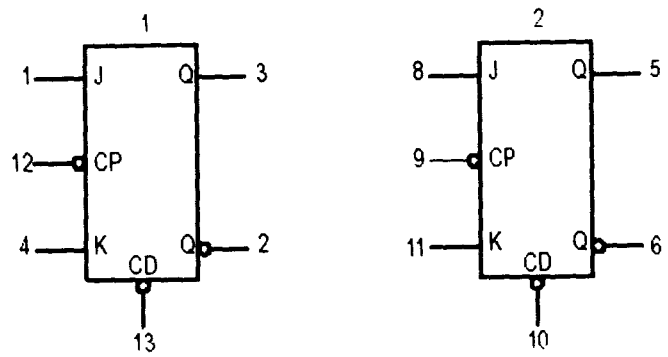
Truth Table of JK Flip-Flop

J	K	CLK	Q	$\bar{Q}$
0	0	↑	NO-CHANGE	NO-CHANGE
0	1	↑	0	1
1	0	↑	1	0
1	1	↑	TOGGLE	TOGGLE

APPENDIX 5.



PIN CONNECTION FOR 74LS107

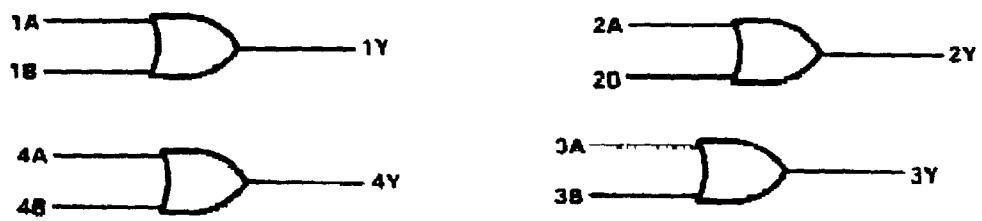


LOGIC SYMBOLS FOR 74LS107

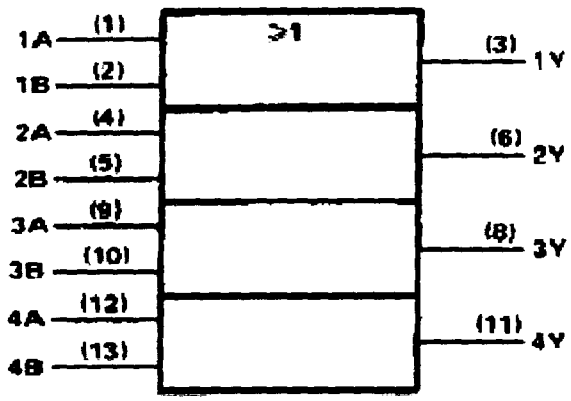
APPENDIX 6.

Function table of 74LS32

INPUT		OUTPUT
A	B	Y
H	X	H
X	H	H
L	L	L

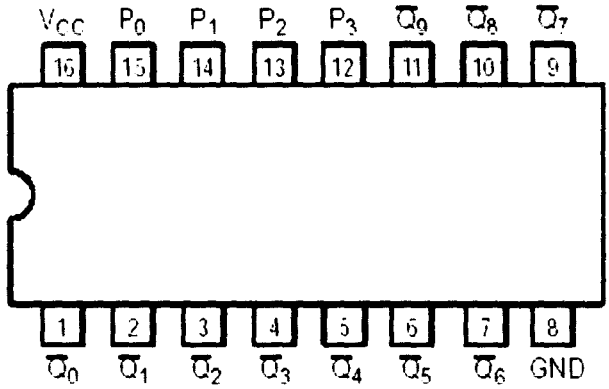


Logic Symbol of 74LS32

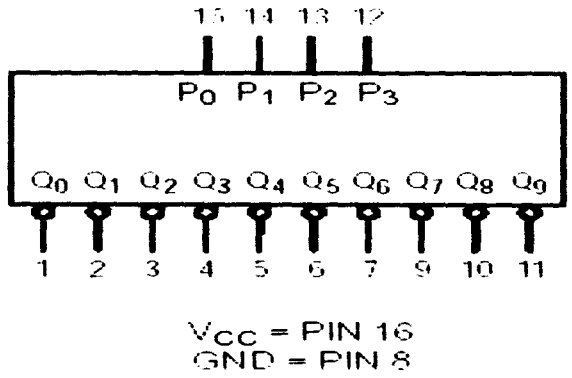


Logic Diagram of 74LS32

APPENDIX 7.



Pin Connection of 74LS145



Logic Symbol of 74LS145

Truth Table of 74LS145

INPUTS				OUTPUTS									
P3	P2	P1	P0	$\overline{Q0}$	$\overline{Q1}$	$\overline{Q2}$	$\overline{Q3}$	$\overline{Q4}$	$\overline{Q5}$	$\overline{Q6}$	$\overline{Q7}$	$\overline{Q8}$	$\overline{Q9}$
L	L	L	L	L	H	H	H	H	H	H	H	H	H
L	L	L	H	H	L	H	H	H	H	H	H	H	H
L	L	H	L	H	H	L	H	H	H	H	H	H	H
L	L	H	H	H	H	H	L	H	H	H	H	H	H
L	H	L	L	H	H	H	H	L	H	H	H	H	H
L	H	L	H	H	H	H	H	H	L	H	H	H	H
L	H	H	L	H	H	H	H	H	H	L	H	H	H
L	H	H	H	H	H	H	H	H	H	H	L	H	H
H	L	L	L	H	H	H	H	H	H	H	H	L	H
H	L	L	H	H	H	H	H	H	H	H	H	H	L

REFERENCES.

[1] http://en.wikipedia.org/wiki/traffic

[2] http://home.cogeco.ca/rpaisely4/circuitindex.html

[3] www.ai/antenergy.com/docs/groups/public/documents/pub/poi332jhcjp.

[4] http://www.ideafinder.com/history/inventions/trafficlight.html

[5] http://www.33.brinkster.com/iiiii/trfclt/.

[6] Edward A. Mueller "Aspect of the History of Traffic Signals", IEEE Transaction on Vehicular Technology Vol. VT-19, no. 1 PP 6-17.

[7] Gordon Sessions, Traffic Devices: Historical Aspect Thereof (Washington DC: Institute of Traffic Engineers; C. 1971)

[8] http://www.dot.state.oh.us/dist1/planning/trafficstudies/trafficsignals.html

[9] NSW RTA Road Users' Handbook.

[10] Emergency Vehicle Traffic Signal Pre-emption System, United State Patent and Trade Mark Office, Retrieved On October 7, 2005

[11] C, O Oroge, A Manual On Laboratory Experiments In Electronics, Clemol Publishers Kaduna, Nigeria 1999, PP 38-48. Power Supply.

[12] C, O Oroge, A Manual On Laboratory Experiments In Electronics, Clemol Publishers Kaduna, Nigeria 1999, PP. 150-156. 555 Timers.

[13] Basi S.S, Semiconductor Pulse and Switch Circuits, John Willey, New York, 1980 pp. 394-395.

[14] Tom Duncan, Adventures With Digital Electronics, John Murray, London 1982 pp. 9, 11, 14, 36, 40 and 44.

[15] B.L and A.K Theraja, A textbook of electrical technology, 23rd edition S. Chand and company limited, New Delhi, India, 2003, pp.(1029-1129), (2191-2193), (1964-1968).

[16] www.datasheet.catalog.com (TTL Logic ICs)

[17] www.tpec.freeuk.com/components

[18] Electronic Data Books of Diodes, Transistors and Thyristors/Datasheet on Transistors

[19] A project titled the design and construction of a 4-way traffic light control system by Onwuanaku B. E (98/7184). November 2004.