CONSTRUCTION OF A MICROCONTROLLER BASED T-JUNCTION TRAFFIC LIGHT CONTROLLER

BY

ANI CHUKWUEBUKA NNAMDI

EE/2008/274

DEPARTMENT OF ELECTRICAL/ELECTRONIC ENGINEERING,

FACULTY OF ENGINEERING,

CARITAS UNIVERSITY, AMORJI-NIKE, ENUGU.

AUGUST, 2013

TITLE PAGE

CONSTRUCTION OF A MICROCONTROLLER BASED T-JUNCTION TRAFFIC LIGHT CONTROLLER

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ANI CHUKWUEBUKA NNAMDI
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BEING A PROJECT SUBMITTED TO THE
DEPARTMENT OF ELECTRICAL/ELECTRONIC ENGINEERING,
FACULTY OF ENGINEERING,
CARITAS UNIVERSITY, AMORJI-NIKE, ENUGU.

IN PARTIAL FULFILLMENT FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG)
IN ELECTRICAL ELECTRONICS ENGINEERING

AUGUST, 2013

CERTIFICATION

This is to certify that this project title “Design and construction of a microcontroller based T-junction traffic light controller” was conducted by ANI CHUKWUEBUKA NNAMDI with registration number: EE/2008/274, in partial fulfillment of the requirement for the Award of Bachelor of Engineering Degree, in Electrical/Electronic Engineering.

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Engr V. A. OCHI	**DATE**
(Project Supervisor)	

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Engr C.O. EJIMOFOR	**DATE**
(Head of Department)	

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External Examiner	**DATE**

DEDICATION

I humbly dedicate this project to Almighty God, for his guidance, protection and direction throughout the course of the execution of this project as well as my entire stay in Caritas University.

ACKNOWLEDGEMENT

I would like to express my gratitude to my mum, Mrs. PATRICIA ANI, for her tireless motherly care and support in ensuring that this project yielded a meaningful end, not forgetting my siblings GINIKA ANI and NKEM ANI, whose encouragements also served as a source of motivation. I also appreciate my project supervisor Engr. V. OCHI, whose assistance and technical support gave me the courage to carry on with this work until realization. I also extend my regards to my H.O.D, Engr. C.O. EJIMOFOR and other lecturers of the department whose academic training gave me the required skills and experience to actualize this project. My warm gratitude goes to my colleagues and friends who were a source of encouragement, during the course of the research. Above all I give the Almighty God all the glory, for his protection, provision and His direction through the Holy Spirit.

ABSTRACT

T-junction traffic light controller is such a device that will play a significant role in controlling traffic at junctions, to ease the expected increased rush at such junctions and reduce to minimum disorderliness that may arise, as well as allowing the pedestrians a right of the way at intervals rather than being struck down when in a hurry to cross the roads. Such an electrical system with a touch of electronics that control the flow of traffic in a pre-determined sequential pattern at a junction, has its diagram comprising of different components. The power supply unit provides the control unit with specified voltage from primary source. The pulse generator consisting of a timer generates pulse for the system. The clock or counter moderates the signal that enters the decoding logic system. The display unit of each stand consists of led, the first is red in colour, the second is amber in colour and the last is green in colour.

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INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The traffic on our roads, especially intra-city traffic due to increasing number of cars grow by the day and unless adequate steps are taken to control the situation, we shall soon meet with circumstances we do not bargain for. That the innumerable traffic junctions in the country by far out-number the staff strength of the traffic wardens available and that the traffic wardens even where they are enough to control all the junctions cannot do so throughout the day is not in doubt. Traffic control at T.junctions or elsewhere ensures orderliness of movements of vehicles, goods and pedestrians while its absence strongly indicates chaos and most at times leads to accidents.

In the light of the above, it is imperative to recognize the need to compliment the physical exhausting efforts of the traffic wardens. In doing so, steps to be taken should assume permanence in nature rather than any ad-hoc exercise. Such is the role expected to be played by an installed operational road junction traffic controller. This project –DESIGN AND CONSTRUCTION OF A THREE WAY JUNCTION TRAFFIC LIGHT CONTROLLER is such a device that will play significant role in controlling traffic at junctions to ease the expected increased rush at such junctions and reduce to minimum such disorderliness that may arise as well as allowing the pedestrians a right of the way at intervals rather than being struck down when in a hurry to cross the roads.

Such an electrical system with a touch of electronics that controls the flow of traffic in a pre-determine sequential pattern at a junction has its diagram below with blocks representing distinct units.[1]

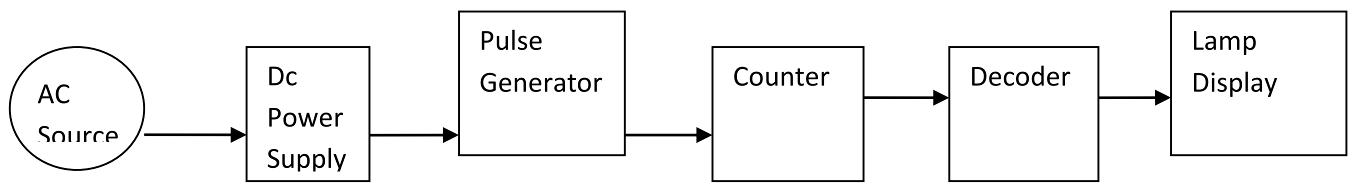


Fig 1.1: *Traffic Light Control System*

The power supply unit provides the control unit with specified dc voltage from primary source, which is a 240v, 50Hz ac supply, from public power system. The pulse generator containing a timer generates pulse for the system. The clock or counter moderates the signal that enters the decoding logic system.

The display unit of each stand consists of three bulbs Red in colour showing STOP, three bulbs Amber in colour showing GET READY and three bulbs Green in colour showing MOVE.

1.2 OBJECTIVE OF THE PROJECT

The main objective of the study includes:

5 To investigate the practicality of the theoretical knowledge about these components to be used.

6 To experiment on the compatibility of the working relation between components to be used.

7 To investigate the extent to which the design and construction of the control unit can be useful to mankind.

8 To investigate the immediate usefulness of the control system as complimentary to traffic wardens.

1.3 SCOPE OF THE STUDY

The scope of this project is to enlighten all electronics students on the use of microcontroller base traffic light (3-ways) and timer system in T-junction. On the practical usage it is limited to the laboratory used for reference purpose. The larger application of this project work is found in most of our mega cities like Abuja, Lagos, Calabar, Enugu etc, to control and manage heavy traffic congestion.

1.4 PROJECT REPORT ORGANIZATION

This report is structured to follow the history and origin of traffic light system all through the design and implementation phase. The report takes into account the step-by-step process followed in order to arrive at the final design.

Chapter one of this report introduces the concept of the Traffic light system and its objectives. Chapter two centers on the literature review, the origin and history of Traffic light systems and its basic functionality. Chapter Three explains the components which make up the Traffic light system and their basic functionalities/mode of operation. Chapter Four discusses the design procedure, construction, steps and packaging.

Chapter five handles the tests and results as well as conclusion and recommendation.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The tremendously increased number of vehicles on our roads and the overwhelming army of pedestrians on road sideways call for great concern. The numerous avoidable accidents at junctions be it T-junction, 4-way junction is acknowledged not only by Government but also by the people themselves. The services of our traffic wardens as well as that of the policemen no longer contain adequately the situation more so when they cannot carry out a twenty-four hour duty. This situation calls for remedy or assistance of some sort, not only to save lives but also to ensure orderliness in our everyday life. Electronic devices, which can do services, round the clock, throughout dry or rainy seasons, winter or summer are called into play this indispensable role. Attempt will be made to design, and construct a three-way traffic light controller system.

Traffic lights, also known as traffic signals, traffic lamps, signal lights, and robots, are signaling devices positioned at road intersections, pedestrian crossings and other locations to control competing flows of traffic. Traffic lights were first installed in 1868 in London, and are now used all over the world.

Traffic lights alternate the right of way accorded to road users by displaying lights of a standard color (red, amber, and green) following a universal color code. In the typical sequence of color phases:

- the green light allows traffic to proceed in the direction denoted, if it is safe to do so
- the yellow/amber light denoting prepare to stop short of the intersection, if it is safe to do so
- the red signal prohibits any traffic from proceeding

On 10 December 1868, the first traffic lights were installed outside the British Houses of Parliament in London to control the traffic in Bridge Street, Great George Street and Parliament Street. They were promoted by the railway engineer J. P. Knight and constructed by the railway signal engineers of Saxby& Farmer. The design combined three semaphore arms with red and green gas lamps for night-time use, on a pillar, operated by a police constable. The gas lantern was turned with a lever at its base so that the appropriate light faced traffic.[2]

Although it was said to be successful at controlling traffic, its operational life was brief. It exploded on 2 January 1869, as a result of a leak in one of the gas lines underneath the pavement, injuring or killing the policeman who was operating it.

With doubts about its safety, the concept was abandoned until electric signals became available.

The first electric traffic light was developed in 1912 by Lester Wire, an American policeman of Salt Lake City, Utah, who also used red-green lights. On 5 August 1914, the American Traffic Signal Company installed a traffic signal system on the corner of East 105th Street and Euclid Avenue in Cleveland, Ohio.[3] It had two colors, red and green, and a buzzer, based on the design of James Hoge, to provide a warning for color changes. The design by James Hogeallowed police and fire stations to control the signals in case of emergency. The first four-way, three-color traffic light was created by police officer William Potts in Detroit, Michigan in 1920. In 1922, T.E. Hayes patented his "Combination traffic guide and traffic regulating signal" [4]. Ashville, Ohio claims to be the location of the oldest working traffic light in the United States, used at an intersection of public roads until 1982 when it was moved to a local museum.

The first interconnected traffic signal system was installed in Salt Lake City in 1917, with six connected intersections controlled simultaneously from a manual switch[5]. Automatic control of interconnected traffic lights was introduced March 1922 in Houston, Texas. The first traffic lights in England were deployed in Piccadilly Circus in 1926. In 1923, Garrett Morgan patented his own version. The Morgan traffic signal was a T-shaped pole unit that featured three hand-cranked positions: stop, go, and an all -directional stop position. This third position halted traffic in all directions to give drivers more time to stop before opposing traffic started. Its one "advantage" over others of its type was the ability to operate it from a distance using a mechanical linkage[6]. Toronto was the first city to computerize its entire traffic signal system, which it accomplished in 1963

Countdown timers on traffic lights were introduced in the 1990s. Though uncommon in most American urban areas, timers are used in some other Western Hemisphere countries. Timers are useful for drivers/pedestrians to plan if there is enough time to attempt to cross the intersection before the light turns red and conversely, the amount of time before the light turns green[7]

2.2 PRE-EMPTION AND PRIORITY

Some regions have signals that are interruptible, giving priority to special traffic usually emergency vehicles such as fire apparatus, ambulances, and police squad cars. Most of the systems operate with small transmitters that send radio waves, infrared signals, or strobe light signals that are received by a sensor on or near the traffic lights. Some systems use audio detection, where a certain type of siren must be used and detected by a receiver on the traffic light structure.[8]

Upon activation the normal traffic light cycle is suspended and replaced by the "preemption sequence": the traffic lights to all approaches to the intersection are switched to "red" with the exception of the light for the vehicle that has triggered the preemption sequence. Sometimes, an additional signal light is placed nearby to indicate to the preempting vehicle that the preempting sequence has been activated and to warn other motorists of the approach of an emergency vehicle. The normal traffic light cycle resumes after the sensor has been passed by the vehicle that triggered the preemption.

In lieu of pre-emptive mechanisms, in most jurisdictions, emergency vehicles are not required to respect traffic lights, but must activate their own emergency lights when crossing an intersection against the light, in order to alert oncoming drivers to the preemption.

Unlike preemption, which immediately interrupts a signal's normal operation to serve the preempting vehicle and is usually reserved for emergency use, "priority" is a set of strategies intended to reduce delay for specific vehicles, especially mass transit vehicles such as buses. A variety of strategies exist to give priority to transit but they all generally work by detecting approaching transit vehicles and making small adjustments to the signal timing. These adjustments are designed to either decrease the possibility that the transit vehicle will arrive during a red interval or decrease the length of the red interval for those vehicles that are stopped. Priority does not guarantee that transit vehicles always get a green light the instant they arrive like preemption does.[9]

2.3 SPECIAL PROVISIONS

Traffic light failure in most jurisdictions in both drive-on-the-left Australia and some states of the mainly drive-on-the-right Europe must be handled by drivers as a priority-to-the-right intersection, or an all-way stop elsewhere, pending the arrival of a police officer to direct traffic. Some jurisdictions, however, have additional right-of-way signs mounted above, below or next to the traffic lights; these take effect when the lights are no longer active. In the UK and parts of North America, drivers simply treat the junction as being uncontrolled when traffic lights fail, giving way as appropriate, unless a police officer is present. In much of the United States failed traffic signals must be treated as all-way stop intersections.

In Italy as well as some jurisdictions in the US, traffic lights inactive at nighttime emit an yellow-colored flashing signal in directions owing priority while the intersecting street emit a flashing red light, requiring drivers to stop before proceeding. In Germany the priority directions will not be illuminated while the intersecting streets will be shown a flashing yellow signal.

After a dummy light was knocked down by a truck in 2010, the city of Coleman, Texas decided to preserve and refurbish its last two pedestal mounted dummy lights as part of its historic district preservation efforts.

In 2011, The Arkansas Historic Preservation Program nominated the last remaining pedestal mounted signal in Arkansas, located in Smackover, AR, to be listed in the National Register of Historic Places.

Increases in traffic flows have prompted calls for these types of traffic lights to be removed due to safety concerns, but their historic value has kept these landmarks at their original locations. To serve historic district applications, Teeco Safety Systems of Shreveport, Louisiana, still manufactures replacement fixed 4-way traffic signals for pedestal and overhead span wire installations.[10]

2.4 TECHNOLOGY

2.4.1 OPTICS AND LIGHTING

Traditionally, incandescent and halogen bulbs were used in constructing traffic lights. Because of the low efficiency of light output and a single point of failure (filament burnout) municipalities are increasingly retrofitting traffic signals with LED arrays that energy consumption of LED lights can pose a driving risk in some areas during winter. Unlike incandescent and halogen bulbs, which generally get hot enough to melt consume less power, have increased light output, last significantly longer, and in the event of an individual LED failure, still operate with a reduced light output. With the use of optics, the light pattern of an LED array can be comparable to the pattern of an incandescent or halogen bulb.

The low away any snows that may settle on individual lights, LED displays using only a fraction of the energy, remain too cool for this to happen.[11]

2.4.2 CONVENTIONAL LIGHTING SYSTEMS

Conventional traffic signal lighting, still common in some areas, utilizes a standard light bulb. Typically, a 67 watt, 69 watt, or 115 watt medium-base (household lamp in the US) light bulb provides the illumination. Light then bounces off a mirrored glass or polished aluminum reflector bowl, and out through a polycarbonate plastic or glass signal lens. In some signals, these lenses were cut to include a specific refracting pattern. Crouse-Hinds is one notable company for this practice. In the 1930s throughout the 1950s, they utilized a beaded prismatic lens with a "smiley" pattern embossed into the bottom of each lens.[12]

2.4.3 LIGHT DESIGN

In the United States, traffic lights are currently designed with lights approximately 12 inches (300 mm) in diameter. Previously the standard had been 8 inches

(200 mm), however those are slowly being phased out in favor of the larger and more visible 12 inch lights. Variations used have also included a hybrid design, which had one or more 12 inch lights along with one or more lights of 8 inches (200 mm) on the same light. For example, these "12-8-8" (along with 8-8-8) lights are standard in most jurisdictions in Ontario, Manitoba, and British Columbia (that, is, the red light is 12 and others 8, making the red more prominent).

In the United Kingdom, 12 inch lights were implemented only with Mellor Design Signal heads designed by David Mellor. These were designed for symbolic optics to compensate for the light loss caused by the symbol. With the invention of anti-phantom, highly visible SIRA lenses, lights of 8 inches (200 mm) could be designed to give the same output as plain lenses, so a larger surface area was unnecessary. Consequently lights of 12 inches (300 mm) are no longer approved for use in the UK and all lights installed on new installations have to be 200 millimeters (8 inches) in accordance with TSRGD (Traffic Signs Regulations and General Directions). Exemptions are made for temporary or replacement signals.[13]

2.4.4 TECHNOLOGICAL ADVANCEMENTS

With technologies in developed countries continuing to advance, there is now an increasing move to develop and implement smart traffic lights on the roads. These are basically more intelligent systems that try to communicate with cars to alert drivers of impeding light changes and reduce motorists' waiting time considerably. Trials are currently being conducted for the implementation of these advanced traffic lights but there are still many hurdles to widespread use that need to be addressed; one of which is the fact that not a lot of cars yet have the required systems to communicate intelligently with these lights.

2.5 CONTROL AND CO-ORDINATION

The normal function of traffic lights requires sophisticated control and coordination to ensure that traffic moves as smoothly and safely as possible and that pedestrians are protected when they cross the roads

2.6 DESIGN LAYOUT AND OPERATION SITE

The traffic controller was constructed using gates, counters, timers and pulse generator. The pulse generator generates the clock pulses and the counter provides the clocking signal for the stages of the output is the total circuit diagram.

The letters on the device are R, A and G meaning:

R - Red ordering traffic to STOP

A - Amber advising traffic to Get Ready

G - Green urging traffic to Move On.

CHAPTER THREE

DESCRIPTION OF SYSTEMS

3.1 THE POWER SUPPLY

A 5V-dc power requirement will be used as input supply to the system of the three-way junction traffic light controller. The choice of using a transformer is due to the low voltage requirement of the system. A transformer of 240/12V in conjunction with a regulator will be able to provide the needed input 5Vdc.

This means that the r.m.s value of the transformer secondary is Vrms = 12V a.c.

The whole section of the project is powered from a 5V dc power source. To achieve this 5-volt output, a variable output adapter is used. The adapter takes in 240V a.c and gives out from its variable tapped output V d.c, 4.5Vdc, 9Vdc, 12Vdc, the output to the required 5Vdc, the output of the adapter is passed through the 7805 regulator that makes sure that at any point in time, the output it gives is 5V. For convenience, we tap the output of the adapter and hence the input to the regulator at 6Vdc.[14]

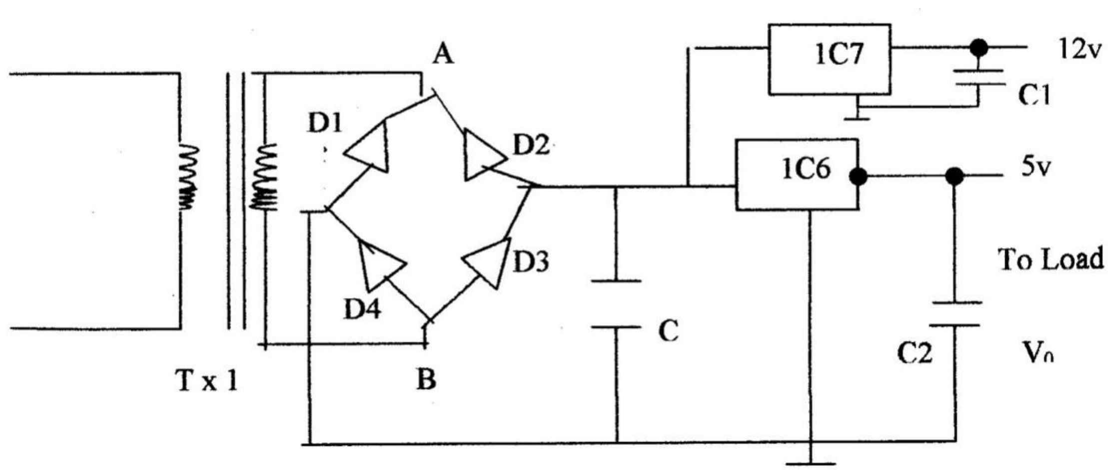


Fig 3.1 *Regulated Power Supply*

3.2 THE VOLTAGE REGULATOR

A **voltage regulator** is designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedbackcontrol loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

3.2.1 IMPORTANT PARAMETERS

- **load regulation: This** is the change in output voltage for a given change in load current (for example: "typically 15 mV, maximum 100 mV for load currents between 5 mA and 1.4 A, at some specified temperature and input voltage").
- **line regulation** or **input regulation: This** is the degree to which output voltage changes with input (supply) voltage changes - as a ratio of output to input change (for example "typically 13 mV/V"), or the output voltage change over the entire specified input voltage range (for example "plus or minus 2% for input voltages between 90 V and 260 V, 50-60 Hz").
- **Temperature coefficient: The temperature coefficient** of the output voltage is the change with temperature (perhaps averaged over a given temperature range).
- **Initial accuracy**: The initial accuracy of a voltage regulator (or simply "the voltage accuracy") reflects the error in output voltage for a fixed regulator without taking into account temperature or aging effects on output accuracy.

- **Dropout voltage: This** is the minimum difference between input voltage and output voltage for which the regulator can still supply the specified current. A low drop-out (LDO) regulator is designed to work well even with an input supply only a volt or so above the output voltage. The input-output differential at which the voltage regulator will no longer maintain regulation is the dropout voltage. Further reduction in input voltage will result in reduced output voltage. This value is dependent on load current and junction temperature.
- **Absolute maximum ratings:** are defined for regulator components, specifying the continuous and peak output currents that may be used (sometimes internally limited), the maximum input voltage, maximum power dissipation at a given temperature, etc.
- **Output noise** (thermal white noise) and **output dynamic impedance:** may be specified as graphs versus frequency, while output **ripple** noise (mains "hum" or switch-mode "hash" noise) may be given as peak-to-peak or RMS voltages, or in terms of their spectra.
- **Quiescent current: The quiescent current** in a regulator circuit is the current drawn internally, not available to the load, normally measured as the input current while no load is connected (and hence a source of inefficiency; some linear regulators are, surprisingly, more efficient at very low current loads than switch-mode designs because of this).

- **Transient response:** is the reaction of a regulator when a (sudden) change of the load current (called the load transient) or input voltage (called the line transient) occurs. Some regulators will tend to oscillate or have a slow response time which in some cases might lead to undesired results. This value is different from the regulation parameters, as that is the stable situation definition. The transient response shows the behaviour of the regulator on a change. This data is usually provided in the technical documentation of a regulator and is also dependent on output capacitance.
- **Mirror-image insertion protection:** This means that a regulator is designed for use when a voltage, usually not higher than the maximum input voltage of the regulator, is applied to its output pin while its input terminal is at a low voltage, volt-free or grounded. Some regulators can continuously withstand this situation; others might only manage it for a limited time such as 60 seconds, as usually specified in the datasheet. This situation can occur when a three terminal regulator is incorrectly mounted for example on a PCB, with the output terminal connected to the unregulated DC input and the input connected to the load. Mirror-image insertion protection is also important when a regulator circuit is used in battery charging circuits, when external power fails or is not turned on and the output terminal remains at battery voltage.[15]

3.2.2 ELECTRONIC VOLTAGE REGULATORS

A simple voltage regulator can be made from a resistor in series with a diode (or series of diodes). Due to the logarithmic shape of diode V-I curves, the voltage across the diode changes only slightly due to changes in current drawn or changes in the input. When precise voltage control and efficiency are not important, this design may work fine.

Feedback voltage regulators operate by comparing the actual output voltage to some fixed reference voltage. Any difference is amplified and used to control the regulation element in such a way as to reduce the voltage error. This forms a negative feedbackcontrol loop; increasing the open-loop gain tends to increase regulation accuracy but reduce stability (avoidance of oscillation, or ringing during step changes). There will also be a trade-off between stability and the speed of the response to changes. If the output voltage is too low (perhaps due to input voltage reducing or load current increasing), the regulation element is commanded, *up to a point*, to produce a higher output voltage–by dropping less of the input voltage (for linear series regulators and buck-switching regulators), or to draw input current for longer periods (boost-type switching regulators); if the output voltage is too high, the regulation element will normally be commanded to produce a lower voltage. However, many regulators have over-current protection, so that they will entirely stop sourcing current (or limit the current in some way) if the output current is too high, and some regulators may also shut down if the input voltage is outside a given range [16]

3.3 CRYSTAL OSCILLATOR

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. This frequency is commonly used to keep track of time (as in quartz wristwatches), to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators, but other piezoelectric materials including polycrystalline ceramics are used in similar circuits.

Quartz crystals are manufactured for frequencies from a few tens of kilohertz to tens of megahertz. More than two billion crystals are manufactured annually. Most are used for consumer devices such as wristwatches, clocks, radios, computers, and cellphones. Quartz crystals are also found inside test and measurement equipment, such as counters, signal generators, and oscilloscope

A crystal is a solid in which the constituent atoms, molecules, or ions are packed in a regularly ordered, repeating pattern extending in all three spatial dimensions.

Almost any object made of an elastic material could be used like a crystal, with appropriate transducers, since all objects have natural resonant frequencies of vibration. For example, steel is very elastic and has a high speed of sound. It was often used in mechanical filters before quartz. The resonant frequency depends on size, shape, elasticity, and the speed of sound in the material. High-frequency crystals are typically cut in the shape of a simple, rectangular plate. Low-frequency crystals, such as those used in digital watches, are typically cut in the shape of a tuning fork. For applications not needing very precise timing, a low-cost ceramic resonator is often used in place of a quartz crystal.

When a crystal of quartz is properly cut and mounted, it can be made to distort in an electric field by applying a voltage to an electrode near or on the crystal. This property is known as electrostriction or inverse piezoelectricity. When the field is removed, the quartz will generate an electric field as it returns to its previous shape, and this can generate a voltage. The result is that a quartz crystal behaves like a circuit composed of an inductor, capacitor and resistor, with a precise resonant frequency.

Quartz has the further advantage that its elastic constants and its size change in such a way that the frequency dependence on temperature can be very low. The specific characteristics will depend on the mode of vibration and the angle at which the quartz is cut (relative to its crystallographic axes). Therefore, the resonant frequency of the plate, which depends on its size, will not change much, either. This means that a quartz clock, filter or oscillator will remain accurate. For critical applications the quartz oscillator is mounted in a temperature-controlled container, called a crystal oven, and can also be mounted on shock absorbers to prevent pertur [17]

3.3.1 ELECTRICAL OSCILLATOR

The crystal oscillator circuit sustains oscillation by taking a voltage signal from the quartz resonator, amplifying it, and feeding it back to the resonator. The rate of expansion and contraction of the quartz is the resonant frequency, and is determined by the cut and size of the crystal. When the energy of the generated output frequencies matches the losses in the circuit, an oscillation can be sustained.

An oscillator crystal has two electrically conductive plates, with a slice or tuning fork of quartz crystal sandwiched between them. During startup, the controlling circuit places the crystal into an unstable equilibrium, and due to the positive feedback in the system, any tiny fraction of noise will start to get amplified, ramping up the oscillation. The crystal resonator can also be seen as a highly frequencyselective filter in this system: it will only pass a very narrow sub-band of frequencies around the resonant one, attenuating everything else. Eventually, only the resonant frequency will be active. As the oscillator amplifies the signals coming out of the crystal, the signals in the crystal's frequency band will become stronger, eventually dominating the output of the oscillator. The narrow resonance band of the quartz crystal filters out all the unwanted frequencies.

The output frequency of a quartz oscillator can be either the fundamental resonance or a multiple of the resonance, called an overtone frequency.

High frequency crystals are often designed to operate at third, fifth, or seventh overtones. Manufacturers have difficulty producing crystals thin enough to produce fundamental frequencies over 30 MHz. To produce higher frequencies, manufacturers make overtone crystals tuned to put the 3rd, 5th, or 7th overtone at the desired frequency, because they are thicker and therefore easier to manufacture than a fundamental crystal that would produce the same frequency—although getting the desired overtone frequency requires a slightly more complicated oscillator circuit. A fundamental crystal oscillator circuit is simpler and more efficient and has more pullability than a third overtone circuit. Depending on the manufacturer, the highest available fundamental frequency may be 25 MHz to 66 MHz.

A major reason for the wide use of crystal oscillators is their high Q factor. A typical Q value for a quartz oscillator ranges from 10^4 to 10^6, compared to perhaps 10^2 for an LC oscillator. The maximum Q for a high stability quartz oscillator can be estimated as $Q = 1.6 \times 10^7/f$, where f is the resonance frequency in megahertz.

One of the most important traits of quartz crystal oscillators is that they can exhibit very low phase noise. In many oscillators, any spectral energy at the resonant frequency will be amplified by the oscillator, resulting in a collection of tones at different phases. In a crystal oscillator, the crystal mostly vibrates in one axis, therefore only one phase is dominant. This property of low phase noise makes them particularly useful in telecommunications where stable signals are needed, and in scientific equipment where very precise time references are needed.

Environmental changes of temperature, humidity, pressure, and vibration can change the resonant frequency of a quartz crystal, but there are several designs that reduce these environmental effects. These include the TCXO, MCXO, and OCXO (defined below). These designs (particularly the OCXO) often produce devices with excellent short-term stability. The limitations in short-term stability are due mainly to noise from electronic components in the oscillator circuits. Long term stability is limited by aging of the crystal.

Due to aging and environmental factors (such as temperature and vibration), it is difficult to keep even the best quartz oscillators within one part in 10^{10} of their nominal frequency without constant adjustment. For this reason, atomic oscillators are used for applications requiring better long-term stability and accuracy.[18]

3.4 PAPER CAPACITOR

A paper capacitor is a class of fixed capacitor, which is made of flat think strips of metal foil conductors that are separated by waxed paper (the dielectric material). Paper capacitors usually range in value from about 300 picofarads to about 4 microfarads. The working voltage of a paper capacitor rarely exceeds 600 volts.

Paper capacitors are sealed with wax to prevent the harmful effects of moisture and to prevent corrosion and leakage. Many different kinds of outer coverings are used on paper capacitors, the simplest being a tubular cardboard covering.

Some types of paper capacitors are encased in very hard plastic. These types are very rugged and can be used over a much wider temperature range than can the tubular cardboard type.

3.5 THE MICROCONTROLLER

A microcontroller (sometimes abbreviated **µC**, **uC** or **MCU**) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.[19]

3.5.1 OTHER MICROCONTROLLER FEATURES

Microcontrollers usually contain from several to dozens of general purpose input/output pins (GPIO). GPIO pins are software configurable to either an input or an output state. When GPIO pins are configured to an input state, they are often used to read sensors or external signals. Configured to the output state, GPIO pins can drive external devices such as LEDs or motors.

Many embedded systems need to read sensors that produce analog signals. This is the purpose of the analog-to-digital converter (ADC). Since processors are built to interpret and process digital data, i.e. 1s and 0s, they are not able to do anything with the analog signals that may be sent to it by a device. So the analog to digital converter is used to convert the incoming data into a form that the processor can recognize. A less common feature on some microcontrollers is a digital-to-analog converter (DAC) that allows the processor to output analog signals or voltage levels.

In addition to the converters, many embedded microprocessors include a variety of timers as well. One of the most common types of timers is the Programmable Interval Timer (PIT). A PIT may either count down from some value to zero, or up to the capacity of the count register, overflowing to zero. Once it reaches zero, it sends an interrupt to the processor indicating that it has finished counting. This is useful for devices such as thermostats, which periodically test the temperature around them to see if they need to turn the air conditioner on, the heater on, etc.

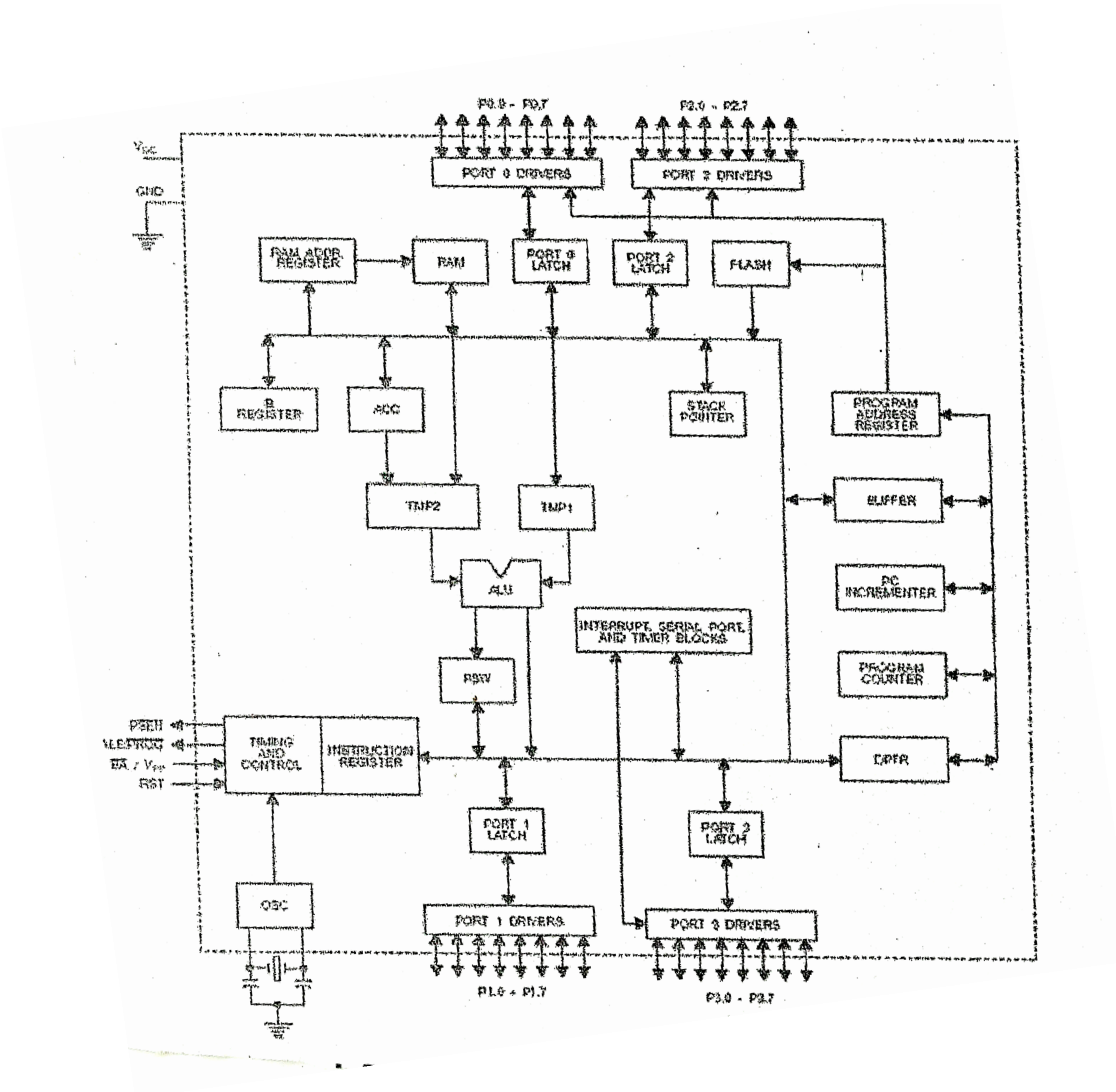


Fig 3.5 The AT89C51 microcontroller circuit

3.5.2 TRIGGER AND THRESHOLD TERMINALS:

Pin 2 is the trigger terminal, while Pin 6 is the threshold. These two pins determine the two possible operating and memory states. The trigger input is compared by a second comparator with a lower threshold voltage V_{LT} that is equal to $V_{CC}\sqrt{3}$. The threshold input is compared with a higher threshold voltage V_{UT} that is equal to $2V_{CC}\sqrt{3}$. Each input has two possible voltage levels of either below or above its reference voltage. Thus with two inputs there are three possible combinations that will cause three possible operating states.[20]

3.5.3 RESET TERMINAL:

Pin 4 is the reset terminal and allows the 555 to be disabled and permits an overriding command signal on the signal input. When not in use, the reset pin is connected to $V_{CC.}$ If it is grounded or its potential reduced below 0.4V, the output terminal, pin 3 and the discharge terminal pin 7 are approximately at ground potential. If the output was high, a ground on the reset terminal immediately forces the output low.[21]

3.5.4 DISCHARGE TERMINAL:

Pin 7 is the discharge terminal. It is used to discharge an external timing capacitor during the time output is low. When the output is high, pin 7 acts as an open circuit and allows the capacitor to charge at a rate determined by an external resistor or resistors and capacitor.

3.5.5 OUTPUT TERMINAL:

The output terminal, Pin 3 can either be the source or the sink current. The maximum sink or source current is about 40mA. The high output is about 0.5V below V_{CC} while the low output voltage is about 0.1V above ground for load current below 25mA.

3.5.6 CONTROL VOLTAGE:

The control voltage terminal, Pin 5, maybe used to change both the threshold and trigger voltage levels when an external voltage is applied to it. Usually a filter capacitor of value 0.01F is connected from the control voltage terminal to the ground and this bypass noise and/or ripple voltages from the power supply to minimize their effect on threshold voltage.

3.5.7 POWER SUPPLY TERMINAL:

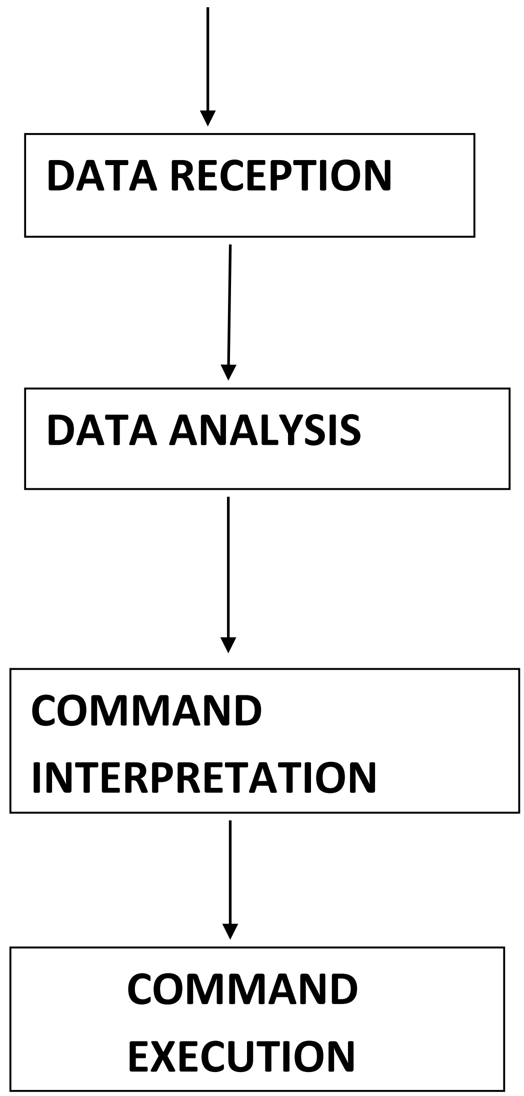
Pin 8 is the positive voltage supply terminal and can take in any voltage between +5V and +18V.

3.6 SYSTEM FLOW DIAGRAM

The system operates following series of stages which is highlighted by the diagram in fig 3.1. The system is constantly polling for data from lane sensors. As soon as the system receives data from the "r" it analyzes the data to know how to manipulate sensors to correspond to the input received, the system interprets the command which could be (to turn ON or OFF a given indicator), and then executes the command.[22]

Fig 3.6 ***System flow diagram***

DATA POLLING STAGE



3.7 LIGHT INDICATOR STAGE

This stage of the system consists of a series of light emitting diodes (LEDs) that display when executing the operation. Because we are designing 3-way traffic light, the connection of the LED should be phase to each other (angle 90^0). Each phase consists of three patterns of LEDs. The upper one which is Green indicates GO command, the middle one which is Yellow (amber) indicates ready command, while the down one which is Red indicates stop command.

3.7.1 PRINCIPLE OF OPERATION OF LIGHT EMITTING DIODE

Light emitting diode (LED) is a semiconductor device that operates in forward bias. It consists of two pins, the long pin which is positive and the short one which is negative.

3.8 TRANSISTORS

A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits.

The transistor is the fundamental building block of modern electronic devices, and is ubiquitous in modern electronic systems. Following its development in the early 1950s, the transistor revolutionized the field of electronics, and paved the way for smaller and cheaper radios, calculators, and computers, among other things.

3.8.1 TRANSISTOR AS A SWITCH

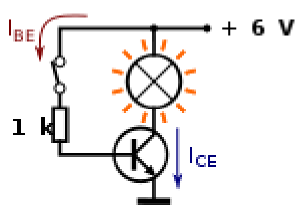


Fig 3.81 Transistor as a switch

BJT used as an electronic switch, in grounded-emitter configuration.

Transistors are commonly used as electronic switches, both for high-power applications such as switched-mode power supplies and for low-power applications such as logic gates.

In a grounded-emitter transistor circuit, such as the light-switch circuit shown, as the base voltage rises, the emitter and collector currents rise exponentially. The collector voltage drops because of reduced resistance from collector to emitter. If the voltage difference between the collector and emitter were zero (or near zero), the collector current would be limited only by the load resistance (light bulb) and the supply voltage. This is called saturation because current is flowing from collector to emitter freely. When saturated the switch is said to be on.[23]

Providing sufficient base drive current is a key problem in the use of bipolar transistors as switches. The transistor provides current gain, allowing a relatively large current in the collector to be switched by a much smaller current into the base terminal. The ratio of these currents varies depending on the type of transistor, and even for a particular type, varies depending on the collector current. In the example light-switch circuit shown, the resistor is chosen to provide enough base current to ensure the transistor will be saturated.

In any switching circuit, values of input voltage would be chosen such that the output is either completely off, or completely on. The transistor is acting as a switch, and this type of operation is common in digital circuits where only "on" and "off" values are relevant.

In a typical transistor switch, when the mechanical switch is open, there is no base current; therefore there is no collector current, the lamp is off.

When the switch is closed, the base rises to value equal to VBE, now current flows in the collector of the transistor; in this case, the transistor is a closed switch. This is the basis of operation of transistors.[24]

3.8.2 CAUTIONS TO BE OBSERVED WHEN DESIGNING TRANSISTOR SWITCHES

1. Choose the base resistor conservatively to get plenty of excess base current, especially when driving lamps, because of the reduced beta to low VCE. This is also good idea for high speed switching because of capacitive effects and reduced beta at very high frequencies. A small “speed up” capacitor is often connected across the base resistor to improve high-speed performance.
2. If the load swing belowground for some reason (e.g. it is driven from a.c. or it is inductive), use a diode in series with the collector (for a diode in the reverse direction to ground or to prevent collector-base conduction on negative swings.
3. For inductive loads, protect the transistor with a diode across the load, without the diode the inductor will swing the collector to a large positive voltage when the switch is opened, most likely exceeding the collector-emitter breakdown voltage as the inductor tries to maintain its “on” current from VCC to the collector.[25]

Transistor switches enable us to switch very rapidly typically in a small fraction of microsecond. Also you can switch many different circuits with a single control signal. One further advantage is the possibility of remote cold switching in which only dc. Control voltages snake round through cables to reach front panel switches rather than electronically inferior approach of having the signals themselves traveling through cables and switches. If the signals are run through cables, it is likely to get capacitive pick up as well as signal degradation.

In the project, the output from the decoder is used to bias the transistor to its conduction, then the transistor functions as a closed switch conducting VCC to the load. The lamp will then show “on”. If there is no signal from the control unit into the transistor base, the transistor functions as an open switch and conducts no current to the load the lamp will not show “ON”. The VBE of the transistor is 0.8V, this means that the output signal from the control unit must meet the requirement of up to 0.8V to base of the transistor else the transistor will not conduct.

The transistor type used is D313 medium power NPN transistors. In order to control the lightening of 12V bulbs using TTL logic level signal, an electronic switch is required. Since the bulbs used are dc bulbs, medium power transistors (D313) in switching configuration are chosen;

Life (min) = 50

VCE (sat) = 0.2V

Rating of bulbs = 12V, 0.3A

IC (max) = 0.3A

Is (min) = 0.3 / 50 = 0.006A

= 6mA.

Hence, the current drive output capability required of the decoding state is 6mA.

Since TTL chips can comfortably source 6mA of current, no buffer is therefore required between the decoding stage and the transistor switches.

The logic state of the output of the decoding stage controls the lighting of bulbs. Since NPN transistors as used, logic 1 output causes the transistor to go into saturation, thus behaving as a short circuit.

It then allows the 12V voltage source to be connected directly across the bulb. This causes the bulb to light.

A logic zero at the output of the decoding stage puts the transistor in the cut-off region. The transistor in this state behaves just like an open circuit.

By changing of logic state of the control units' output, it can control the ON/OFF sequence of the bulb to give the desired traffic control effect.[26]

Although several companies each produce over a billion individually packaged (known as discrete) transistors every yearthe vast majority of transistors are now produced in integrated circuits (often shortened to IC, microchips or simply chips), along with diodes, resistors, capacitors and other electronic components, to produce complete electronic circuits. A logic gate consists of up to about twenty transistors whereas an advanced microprocessor, as of 2009, can use as many as 3 billion transistors (MOSFETs). "About 60 million transistors were built in 2002 ... for [each] man, woman, and child on Earth.[27]

The transistor's low cost, flexibility, and reliability have made it a ubiquitous device. Transistorized mechatronic circuits have replaced electromechanical devices in controlling appliances and machinery. It is often easier and cheaper to use a standard microcontroller and write a computer program to carry out a control function than to design an equivalent mechanical control function.

3.9 RESISTORS

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element.

The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law:

$$I = \frac{V}{R}$$

Where*I* is the current through the conductor in units of amperes, *V* is the potential difference measured across the conductor in units of volts, and *R* is the resistance of the conductor in units of ohms.

The ratio of the voltage applied across a resistor's terminals to the intensity of current in the circuit is called its resistance, and this can be assumed to be a constant (independent of the voltage) for ordinary resistors working within their ratings.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel-chrome). Resistors are also implemented within integrated circuits, particularly analog devices, and can also be integrated into hybrid and printed circuits.

The electrical functionality of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. When specifying that resistance in an electronic design, the required precision of the resistance may require attention to the manufacturing tolerance of the chosen resistor, according to its specific application. The temperature coefficient of the resistance may also be of concern in some precision applications. Practical resistors are also specified as having a maximum power rating which must exceed the anticipated power dissipation of that resistor in a particular circuit: this is mainly of concern in power electronics applications. Resistors with higher power ratings are physically larger and may require heat sinks. In a high-voltage circuit, attention must sometimes be paid to the rated maximum working voltage of the resistor.

Practical resistors have a series inductance and a small parallel capacitance; these specifications can be important in high-frequency applications. In a low-noise amplifier or pre-amp, the noise characteristics of a resistor may be an issue. The unwanted inductance, excess noise, and temperature coefficient are mainly dependent on the technology used in manufacturing the resistor. They are not normally specified individually for a particular family of resistors manufactured using a particular technology. A family of discrete resistors is also characterized according to its form factor, that is, the size of the device and the position of its leads (or terminals) which is relevant in the practical manufacturing of circuits using them.

3.10 BRIDGE RECTIFIER

A bridge rectifier makes use of four diodes in a bridge arrangement to achieve full-wave rectification. This is a widely used configuration, both with individual diodes wired as shown and with single component bridges where the diode bridge is wired internally.

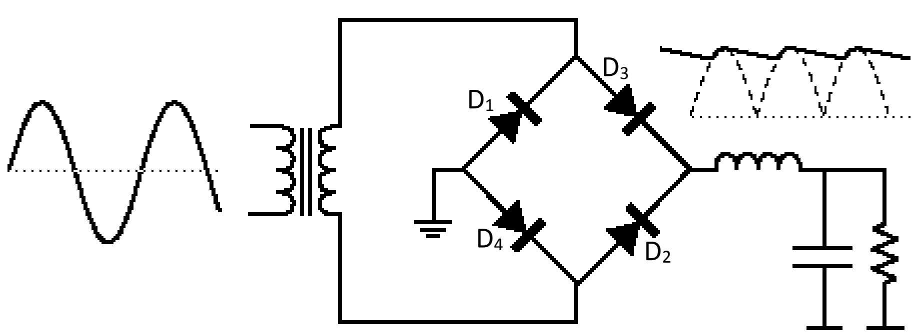


Fig 3.10 The bridge rectifier

3.10.1 CURRENT FLOW IN THE BRIDGE RECTIFIER

For both positive and negative swings of the transformer, there is a forward path through the diode bridge. Both conduction paths cause current to flow in the same direction through the load resistor, accomplishing full-wave rectification.

While one set of diodes is forward biased, the other set is reverse biased and effectively eliminated from the circuit.

The Bridge rectifier is a circuit, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The Bridge rectifier circuit is shown in the figure. The circuit has four diodes connected to form a bridge. The ac input voltage is applied to the diagonally opposite ends of the bridge. The load resistance is connected between the other two ends of the bridge.

For the positive half cycle of the input ac voltage, diodes D1 and D3 conduct, whereas diodes D2 and D4 remain in the OFF state.

The conducting diodes will be in series with the load resistance R_L and hence the load current flows through $R_{L.}$

For the negative half cycle of the input ac voltage, diodes D2 and D4 conduct whereas, D1 and D3 remain OFF. The conducting diodes D2 and D4 will be in series with the load resistance R_L and hence the current flows through R_L in the same direction as in the previous half cycle. Thus a bi-directional wave is converted into a unidirectional wave.[28]

3.11 ELECTROLYTIC CAPACITOR

An electrolytic capacitor is a capacitor that uses an electrolyte (an ionic conducting liquid) as one of its plates to achieve a larger capacitance per unit volume than other types, but with performance disadvantages. All capacitors conduct alternating current (AC) and block direct current (DC) and can be used, amongst other applications, to couple circuit blocks allowing AC signals to be transferred while blocking DC power, to store energy, and to filter signals according to their frequency. Most electrolytic capacitors are polarized; hence, they can only be operated with a lower voltage on the terminal marked "-" without damaging the capacitor. This generally limits electrolytic capacitors to supply-decoupling and bias-decoupling, since signal coupling usually involves both positive and negative voltages across the capacitor. The large capacitance of electrolytic capacitors makes them particularly suitable for passing or bypassing low-frequency signals and storing large amounts of energy. They are widely used in power supplies and for decoupling unwanted AC components from DC power connections.

Super capacitors provide the highest capacitance of any practically available capacitor,[1] up to thousands of farads, with working voltages of a few volts. Electrolytic capacitors range downwards from tens (exceptionally hundreds) of thousands of microfarads to about 100 nanofarads—smaller sizes are possible but have no advantage over other types. Other types of capacitor are available in sizes typically up to about ten microfarads, but the larger sizes are much larger and more expensive than electrolytics (film capacitors of up to thousands of microfarads are available, but at very high prices). Electrolytic capacitors are available with working voltages up to about 500V, although the highest capacitance values are not available at high voltage. Working temperature is commonly 85°C for standard use and 105° for high-temperature use; higher temperature units are available, but uncommon.

Unlike other types of capacitor, most electrolytic capacitors require that the voltage applied to one terminal (the anode) never become negative relative to the other (they are said to be "polarized"), so cannot be used with AC signals without a DC polarizing bias (non-polarized electrolytic capacitors are available for special purposes).

Leakage current, capacitance tolerance and stability, equivalent series resistance (ESR) and dissipation factor are significantly inferior to other types of capacitors, and working life is shorter. Capacitors can lose capacitance as they age and lose electrolyte, particularly at high temperatures. A common failure mode which causes difficult-to-find circuit malfunction is progressively increasing ESR without change of capacitance, again particularly at high temperature. Large ripple currents flowing through the ESR generate harmful heat.

Two types of electrolytic capacitor are in common use: aluminum and tantalum. Tantalum capacitors have generally better performance, higher price, and are available only in a more restricted range of parameters. Solid polymer dielectric aluminum electrolytic capacitors have better characteristics than wet-electrolyte types—in particular lower and more stable ESR and longer life—at higher prices and more restricted values.[29]

3.12 STEP DOWN TRANSFORMER

What is a step down transformer: is one whose secondary voltage is less than its primary voltage. It is designed to reduce the voltage from the primary winding to the secondary winding. This kind of transformer “steps down” the voltage applied to it.

As a step-down unit, the transformer converts high-voltage, low-current power into low-voltage, high-current power. The larger-gauge wire used in the secondary winding is necessary due to the increase in current. The primary winding, which doesn’t have to conduct as much current, may be made of smaller-gauge wire.

3.12.1 STEP DOWN TRANSFORMER CONSIDERATIONS

It is possible to operate either of these transformer types backwards (powering the secondary winding with an AC source and letting the primary winding power a load) to perform the opposite function: a step-up can function as a step-down and visa-versa. One convention used in the electric power industry is the use of “H” designations for the higher-voltage winding (the primary winding in a step-down unit; the secondary winding in a step-up) and “X” designations for the lower-voltage winding.

One of the most important considerations to increase transformer efficiency and reduce heat is choosing the metal type of the windings. Copper windings are much more efficient than aluminum and many other winding metal choices, but it also costs more. Transformers with copper windings cost more to purchase initially, but save on electrical cost over time as the efficiency more than makes up for the initial cost.

3.13 SEVEN SEGMENT DISPLAY

A seven-segment display (SSD), or seven-segment indicator, is a form of electronic display device for displaying decimal numerals that is an alternative to the more complex dot matrix displays.

Seven-segment displays are widely used in digital clocks, electronic meters, and other electronic devices for displaying numerical information.

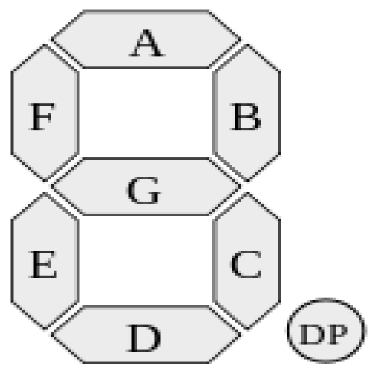


Fig 3.13 The individual segments of a seven-segment display

The seven elements of the display can be lit in different combinations to represent the arabic numerals. Often the seven segments are arranged in an *oblique* (slanted) arrangement, which aids readability. In most applications, the seven segments are of nearly uniform shape and size (usually elongated hexagons, though trapezoids and rectangles can also be used), though in the case of adding machines, the vertical segments are longer and more oddly shaped at the ends in an effort to further enhance readability.

The numerals 6, 7 and 9 may be represented by two or more different glyphs on seven-segment displays, with or without a 'tail'.

The seven segments are arranged as a rectangle of two vertical segments on each side with one horizontal segment on the top, middle, and bottom. Additionally, the seventh segment bisects the rectangle horizontally. There are also fourteen-segment displays and sixteen-segment displays (for full alphanumerics); however, these have mostly been replaced by dot matrix displays.

The segments of a 7-segment display are referred to by the letters A to G, where the optional DP decimal point (an "eighth segment") is used for the display of non-integer numbers.

Seven-segment displays may use a liquid crystal display (LCD), a light-emitting diode (LED) for each segment, or other light-generating or controlling techniques such as cold cathode gas discharge, vacuum fluorescent, incandescent filaments, and others. For gasoline price totems and other large signs, vane displays made up of electromagnetically flipped light-reflecting segments (or "vanes") are still commonly used. An alternative to the 7-segment display in the 1950s through the 1970s was the cold-cathode, neon-lamp-like nixie tube. Starting in 1970, RCA sold a display device known as the Numitron that used incandescent filaments arranged into a seven-segment display.

In a simple LED package, typically all of the cathodes (negative terminals) or all of the anodes (positive terminals) of the segment LEDs are connected and brought out to a common pin; this is referred to as a "common cathode" or "common anode" device. Hence a 7 segment plus decimal point package will only require nine pins (though commercial products typically contain more pins, and/or spaces where pins would go, in order to match standard IC sockets. Integrated displays also exist, with single or multiple digits. Some of these integrated displays incorporate their own internal decoder, though most do not: each individual LED is brought out to a connecting pin as described.

Multiple-digit LED displays as used in pocket calculators and similar devices used multiplexed displays to reduce the number of I/O pins required to control the display. For example, all the anodes of the A segments of each digit position would be connected together and to a driver circuit pin, while the cathodes of all segments for each digit would be connected. To operate any particular segment of any digit, the controlling integrated circuit would turn on the cathode driver for the selected digit, and the anode drivers for the desired segments; then after a short blanking interval the next digit would be selected and new segments lit, in a sequential fashion. In this manner an eight digit display with seven segments and a decimal point would require only 8 cathode drivers and 8 anode drivers, instead of sixty-four drivers and IC pins. Often in pocket calculators the digit drive lines would be used to scan the keyboard as well, providing further savings; however, pressing multiple keys at once would produce odd results on the multiplexed display.

A single byte can encode the full state of a 7-segment-display. The most popular bit encodings are gfedcba and abcdefg, where each letter represents a particular segment in the display. In the gfedcba representation, a byte value of 0x06 would (in a common-anode circuit) turn on segments 'c' and 'b', which would display a '1'.

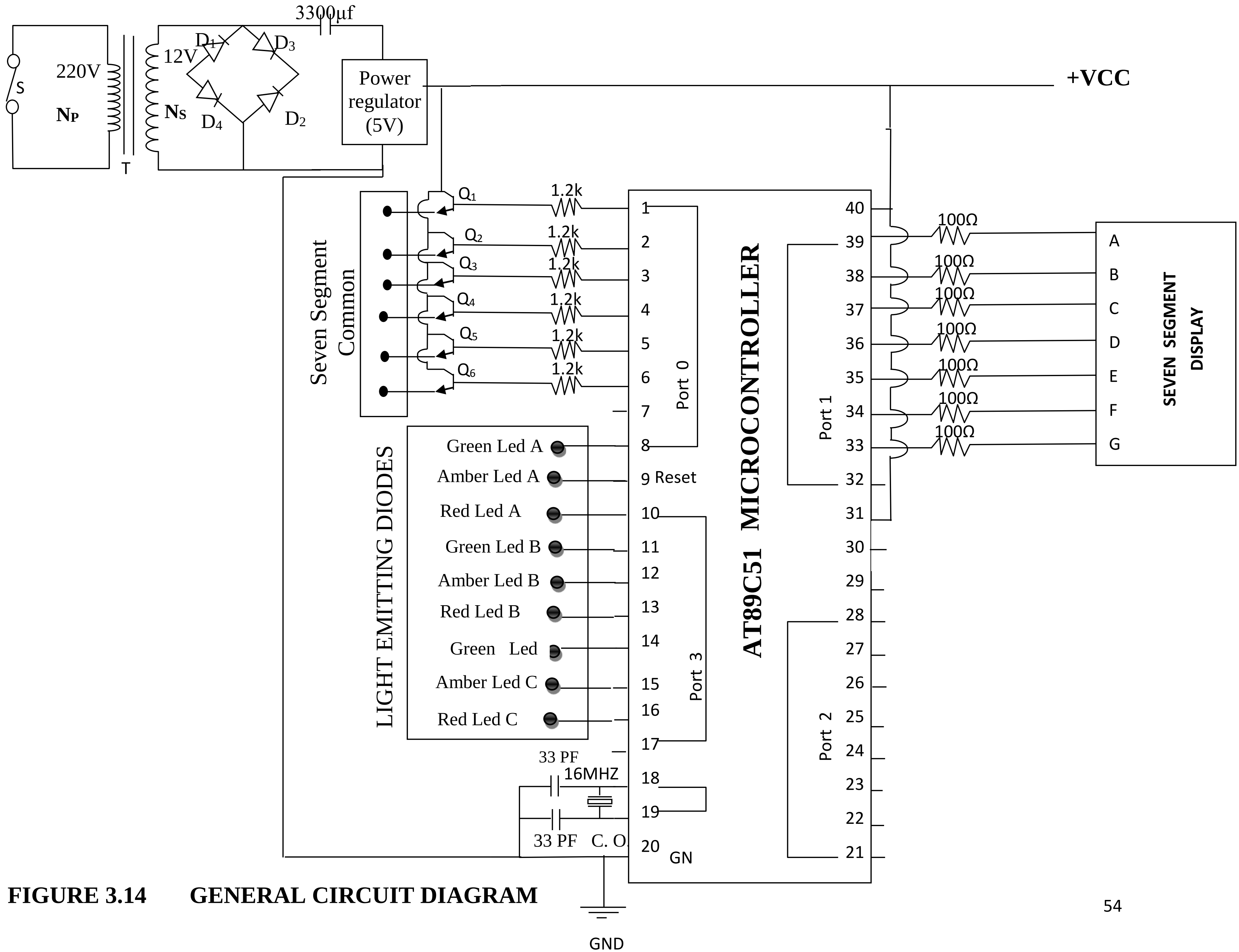


FIGURE 3.14 GENERAL CIRCUIT DIAGRAM

CHAPTER FOUR

SYSTEMS OPERATIONAL UNITS

4.1 THE CONTROL UNIT

The control unit of a traffic light control is a device that provides a sequence that controls the signalling of the unit. The sequences are predetermined pattern that the traffic on the road junction has to abide by according to the nature of the road junction. The control unit might be remote from the signally point depending on what is required.

The control unit encompasses stages, which joins together to be the control unit as a whole. The stages are pulse generator stage, counter stage, the decoding unit stage. The stages are represented by the block diagram of fig 4.1. Note that the control unit works with other stages to produce its sequential output.

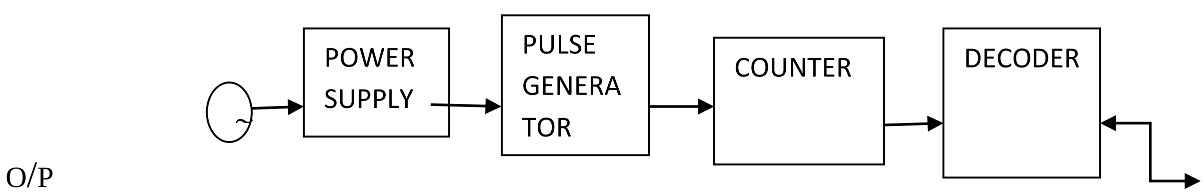


fig. 4.1 *Block Diagram of a Control Unit*

To power the control unit, a 5V/12V power supply is used. This power supply provides the control unit with the required amount of power at specified voltage from a primary source, which can be A.C mains. The electrical characteristics of the power supply must depend on the control unit to be powered.

4.2 SYSTEM ANALYSIS

The design layout and analysis of the different components and units of any developing system is first represented with block diagrams. This does not only allow the designer to have an overview of the configuration of the system but also enables the designer to recognize and assess unitary compatibility of components within each block as well as with other blocks.

This design and construction of traffic light controller will start with the analysis of the power unit, pulse generator, timer and counter.

4.3 CHOICE OF COUNTER

From the design the choice of counter needed should not be more than a decade counter, this is because there are six outputs. Since in the world of decade counter we have 74LS192 whose compatibility and reliability is high. I chose this IC for easy and accurate precision.

Another counter which is still of the same compatibility is 74LS193. This IC has the same pin configuration with 74LS192, it equally has the same mode of operation. The only difference is that while 74LS193 counts up to sixteen, 74LS192 counts up to ten, hence a decade counter. This IC is equally used in digital clock where the expected output is ten. It should be noted that 7473JK bistable counter can be used while 74LS293 and 74LS193 will also work.

From the description of the traffic route one is imposed with a responsibility of deciding which path should have the right of the way and for how long, necessitates the logic.[30]

4.4 THE INTERFACE UNIT

The interface unit is a unit that interfaces the control unit with signaling unit. The unit functions as a switch, which means that the switch switches on as determined by the output of the control unit. There are different types of switches, namely; the triac as a switch, the thyristor as a switch and the transistor switch. The switch that is used in this project is the transistor switch.

4.5 TEST AND RESULT

The following results were obtained when the circuit was powered;

Table 4.5

Led Colour Sign	Duration (Sec)	Total Count Time (Sec)
GREEN A	5	0-5
AMBER A	3	5-8
RED A	5	8-13
GREEN B	5	8-13
AMBER B	3	13-16
RED B	5	16-21
GREEN C	5	16-21
AMBER C	3	21-24
RED C	5	24-29

4.6 OBSERVATION

From the test carried out on the circuit, it is observed that the leds with the same color have equal timing, and that each pole of the three traffic light controlling poles, switches sequentially and repetitively until the circuit is disconnected from power.

4.7 PACKAGING

The plywood (7.6 by 6 cm), which contains all the components and materials used was demarcated with a trunk pipe (1/2 inch) and then set. The circuit which was designed on a vero board (dot-type), was enclosed in an adaptable box (6 by 6 inch) which was then coupled to the board. Then connecting wires (1mm), were linked from the adaptable box to the seven segment display and leds, which were enclosed in a pvc pipe (25 mm), firmly held to the board by the pvc pipe coupler (25 mm). The adaptable box was perforated, from which the toggle switch was linked out and fixed on the surface.

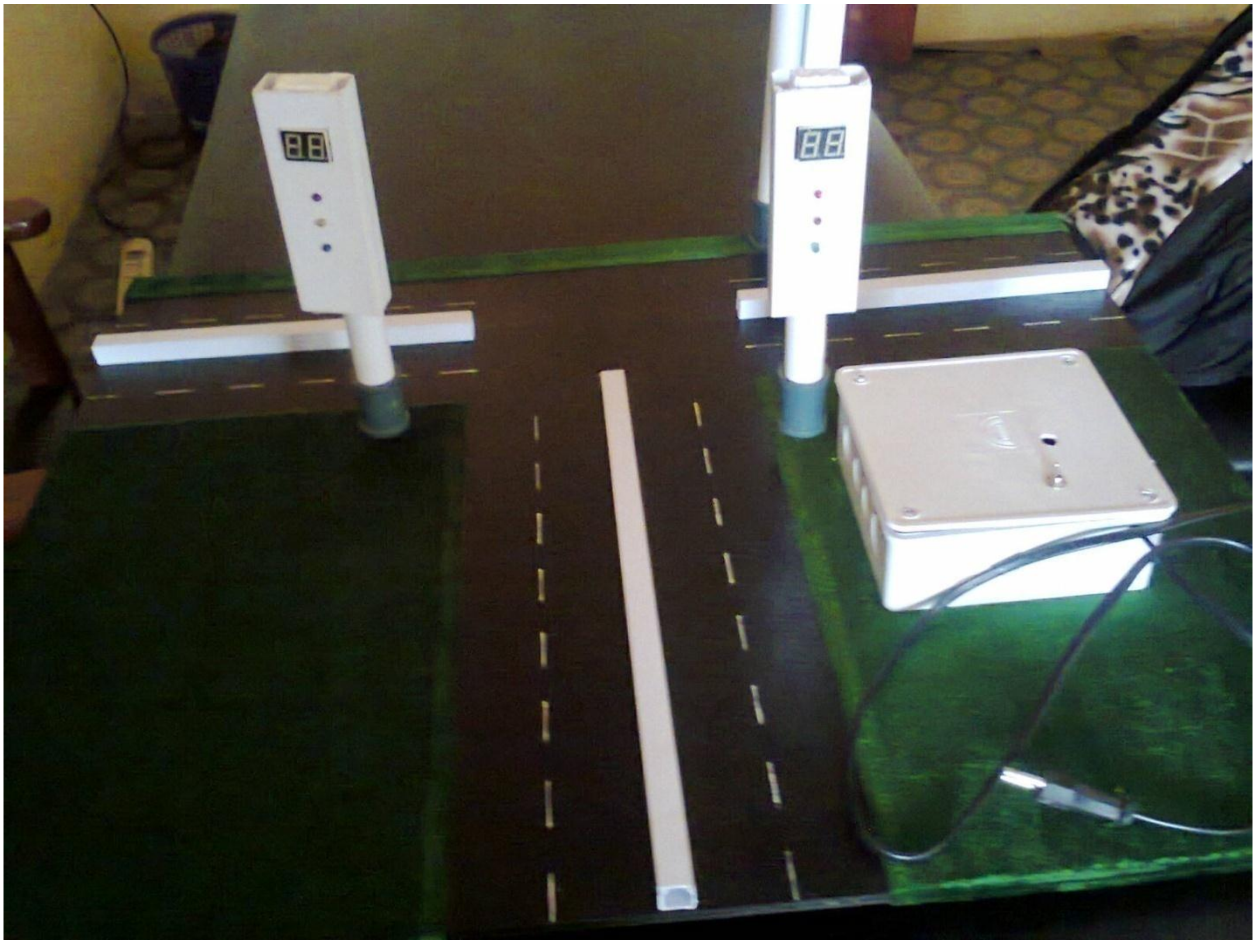


Fig 4.7 Project Package Photograph

4.8 BILL OF ENGINEERING MEASUREMENT AND EVALUATION

The project was chosen with the hindsight of scarcity of components and relatively low cost of the individual components. An estimated cost of sourcing the whole components and installation are summarized below:

TABLE 4.8

Components	Quantity	Unit Price (N)	Total Amount (N)
LED/12V bulbs	22	10.00	220.00
Transformer (12V)	1	250.00	250.00
AT89C51 (MC)	1	2,300.00	2,300.00
555 Timer	3	80.00	240.00
2 Speakers	1	120.00	120.00
Regulator (7805)	1	50.00	50.00
Switch	2	30.00	60.00
IN4001	4	20.00	80.00
74LS04	1	150.00	150.00
74LS192	2	150.00	300.00
74LS08	1	150.00	150.00
74LS32	1	150.00	150.00
3.3k (R7,R10, R11)	3	10.00	30.00
2.2k (R5)	1	10.00	10.00
10k (R4, R6)	2	10.00	20.00
500k (R9)	1	10.00	10.00
100k (R1,R3,R8)	2	10.00	20.00

1.5k (R2)	1	10.00	10.00
1000NF (C2)	1	10.00	10.00
100MF (C2)	1	10.00	10.00
2.3MF(C6)	1	10.00	10.00
0.1MF (C3)	2	15.00	30.00
0.33MF (C8)	1	10.00	10.00
10μF (C4,C5,C1)		10.00	20.00
Casing		500.00	500.00
TOTAL			N4,770.00

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

From the design and construction of a T-junction traffic light controller, carried out in the course of this project, it is obvious that such a system which is used to reduce the human stress of standing under favourable or unfavourable weather conditions and controlling the movement of vehicles at T-junctions as well as pedestrians, can be developed by indigenous human resources. This would reduce the spending of huge sums of money that could have been spent on the maintenance of manpower or importation of expatriates to carryout and maintain the installation, since it can be conducted internally.

Generally, this research work is aimed at producing an indigenous traffic control system, which is easy to maintain, affordable and efficient.

5.2 RECOMMENDATIONS

1. Our various governments should establish research and development centers equipped with modern facilities and with effective Internet connectivity to encourage our scientists and engineers to do their research work with ease.

2 The importation of foreign made traffic control systems should be discouraged since the dependence on mispractice is detrimental to our economic growth.

3. Engineering and technology students in our colleges of technology and universities of technology should be encouraged by giving some special allowances to undertake experimental research work such as this. They should also be given scholarship for further studies.

4. Our various governments in alliance with colleges of technology and manufacturers should establish special centers for the design and manufacture technological infrastructures such as this.

5.3 SUGGESTIONS FOR FURTHER RESEARCH

1. Further studies should be carried out in the area of microprocessor-based traffic control system. This will add a lot of functionality and flexibility to the system.

2. Because of the epileptic nature of our power supply system, it is necessary to carry out further research on solar-powered traffic control system.

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