DESIGN AND CONSTRUCTION OF A MICROCONTROLLER BASED SIX – WAY TRAFFIC LIGHT CONTROLLER

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DEDICATION

This project is dedicated to God, the lion of the tribe of Judah, who fought every of my unseen and seen battles, my God and the lifter of my head, he did not put me to shame, the I am that I am, for he says a thing and it is established, my rock of ages, the unchangeable changer, my redeemer and the God of all flesh.

DECLARATION

I, Bimbo Olukoya, 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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To the priceless and most highly cherished gift in my life, my parents, Pastor/Engr. and Mrs. Olukoya, for your prayers, support in all areas, love, just to mention a few, I'm lost for words but full of gratitude, you will never regret having this child, the presence of the lord shall envelop you forever.

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Formally, I want to show my appreciation to a principled and knowledgeable man, my supervisor, Mallam Bala, who guided me so immensely and patiently during the period of this project, sir, I must say, you are the man for the job because I learnt a great deal from you and I don't regret having you as my supervisor. May God reward you sir.

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You are not the last, but it's you I always fall back to after the whole hustles and bustle of the day, Olumide Solanke, always and forever.

ABSTRACT

The project is a model of a six – way cross junction traffic control system which is controlled majorly by a PIC16F913 microcontroller, for broad roads in highly congested areas to control traffic flow. The circuit is segmented into; Power Supply Unit, Control Unit, and Display Unit. The power supply unit supplies a transformed, rectified, filtered and regulated, positive five (5) voltage. The control unit is now activated using this voltage to produce the logic ones and zeros at the appropriate pins for the required seconds. The display unit which represents the light emitting diodes (LEDs) now comes on with logic one for the appropriate Green, Yellow or Red. The involved lightning (LEDs) is an improvement of the usual high power consumption and relatively short life halogen lamps.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

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].

According to Oxford Advanced Learner's Dictionary, Traffic Light is defined as, "an automatic signal that controls road traffic, especially where roads meet at a cross, by means of red, orange and green lights".

Also it can be defined as a road signal for directing vehicular traffic by means of colored lights, typically red for stop, green for go, and yellow or amber for proceed with caution.

During the horse and buggy days, traffic in big cities was often heavy. Police officers had to be stationed full time directing traffic at busy intersections.[2]

The advent of motor vehicle brought about the traffic congestion and higher rate of accident have been recorded in the past years. Traffic congestion causes delay of activities and undue stress while accident causes loss of property, health and even life.

There are many variations in the use and legislation of traffic lights, depending on the customs of a country and the special needs of a particular intersection. There may, for example, be special lights for pedestrians, bicycles, buses, trams (a small vehicle on rails used to carry coal and other materials in a coal mine), etc, light sequences may differ, and there may be special rules, or sets of lights, for traffic turning in a particular direction. Complex intersections may use any combination of these. Traffic light technology is constantly evolving with the aims of improving reliability, visibility, and efficiency of traffic flow.

The first means of reducing traffic was by using traffic wardens, they stay at different intersections and wave their hands to indicate either "stop" or "go". After a while, it was realized that it wasn't easy to control large number of cars, also the warden in charge is compelled to stay under the sun for a long period of time but the warden cannot perform his or her duty under the rain.

The thought of a traffic light system was conceived, designed and constructed to ease the stress encountered by wardens. Different designs have been made from manually operated traffic light to automatic controller.

The first traffic light was installed in London and the modern electric traffic light is an American invention.[1]

1.2 MICROCONTROLLER

The microcontroller is a exciting new device in the field of electronics control. It is a complete computer control system on a single chip. Microcontrollers include EPROM program memory, user RAM for storing program data, timer circuits, an instruction set, special function registers, power on reset, interrupts, low power consumption and a security bit for software protection. Some microcontrollers like the 16F818/9 devices include onboard A to D (analogue to digital) converters.

The microcontroller because of its versatility, ease of use and cost will change the way electronic circuits are designed and will now enable projects to be designed which previously were too complex. Additional components such as versatile interface adapters (VIA), RAM, ROM, EPROM and address decoders are no longer required.

The block diagram of the microcontroller system is shown below;

Fig. 1.1 The basic microcontroller system

1.2.1 PIC 16F9X MICROCONTROLLER

The PIC16F9X from Microchip Technology is a family of low-cost, high-performance, 8-bit, fully static, Flash based CMOS (Complementary Metal Oxide Semiconductor) microcontrollers.

It employs a RISC architecture with only 35 single-word/single-cycle instructions. All instructions are single cycle except for program branches which take two cycles. The PIC16F9X delivers performance an order of magnitude higher than its competitors in the same price category. The 14-bit wide instructions are highly orthogonal resulting in 2:1 code compression over other 8-bit microcontrollers in its class. The easy-to-use and easy-to-remember instruction set reduces development time significantly.

The PIC16F9X products are equipped with special features that reduce system cost and power requirements.

The Power-on Reset (POR) and Device Reset Timer (DRT) eliminate the need for external Reset circuitry. There are eight oscillator configurations to choose from:

1. EC – External clock with I/O on OSC2/CLKOUT,

2. LP – 32 kHz Low-Power Crystal mode.

3. XT – Medium Gain Crystal or Ceramic.

4. Resonator Oscillator mode. HS – High Gain Crystal or Ceramic Resonator mode,

5. RC – External Resistor-Capacitor (RC) with FOSC/4 output on OSC2/CLKOUT,

6. RCIO – External Resistor-Capacitor (RC) with I/O on OSC2/CLKOUT,

7. INTOSC – Internal oscillator with FOSC/4 output on OSC2 and I/O on OSC1/CLKIN,

8. INTOSCIO – Internal oscillator with I/O on OSC1/CLKIN and OSC2/CLKOUT.

The PIC16F9X products are supported by a full-featured macro assembler, a software simulator, a low-cost development programmer and a full featured programmer.

TABLE 1.1 PIC16F9X Family Of Devices

Devices	**PIC16F913**	**PIC16F914**	**PIC16F916**	**PIC16F917**	**PIC16F946**
Program Memory Flash (words/bytes)	4K/7K	4K/7K	8K/14K	8K/14K	8K/14K
Data Memory SRAM (bytes)	256	256	352	352	336
Data Memory EEPROM (bytes)	256	256	256	256	256
I/O	24	35	24	35	53

The high performance of the PIC16F9X family can be attributed to a number of architectural features commonly found in RISC microprocessors. To begin with, the PIC16F9X uses a Harvard architecture in which program and data are accessed on separate buses. This improves bandwidth over traditional von Neumann architecture where program and data are fetched on the same bus. Separating program and data memory further allows instructions to be sized differently than the 8-bit wide data word. Instruction opcodes are 14-bits wide, making it possible to have all single word instructions. A 14-bit wide program memory access bus fetches a 14-bit instruction in a single cycle.

A two-stage pipeline overlaps fetch and execution of instructions. Consequently, all instructions (35) execute in a single cycle except for program branches.

All program memory is internal. The PIC16F9X can directly or indirectly address its register files and data memory. All Special Function Registers (SFR), including the program counter, are mapped in the data memory. The PIC16F9X has a highly orthogonal (symmetrical) instruction set that makes it possible to carry out any operation on any register using any Addressing mode. This symmetrical nature and lack of special optimal situations make programming with the PIC16F9X simple, yet efficient. In addition, the learning curve is reduced significantly.

1.2.2 PIC16F913 BASED TRAFFIC LIGHT CONTROLLER

This project work is concerned with providing various time delays for a complete sequence of 70 seconds. The lights and signs can be turned ON by providing logic "1" and OFF by providing logic "0" to appropriate data bits of the outputs ports of the PIC.

Green light is for vehicle, indicating go while pedestrians stop. Yellow light is for vehicle to get ready and Red light is for vehicle to stop and pedestrians walk sign.

At the T - junction, there are traffic lights controlling each of the junctions. The PIC is programmed in such a way that, three different traffic lights at their junction can come on at a time without any collision of vehicles. This makes effective use of the road and avoids unnecessary delay.

1.3 AIMS AND OBJECTIVES

- To assist motorist at an intersection to have orderly traffic movement.
- To help pedestrian know when to cross at a T - junction without colliding with vehicles.
- To write a program with assembly language using MPLAB IDE (Microchip Lab integrated development environment) for a PIC 16F913 Microcontroller for LEDs connected to know when to go high or low at the appropriate timing.
- This project will show how different electrical and electronic components are coupled together to produce traffic light signals, Green, Yellow, and Red.

1.4 METHODOLOGY

The six traffic poles are labeled,

Traffic1 = A1 Traffic4 = B2

Traffic2 = A2 Traffic5 = C1

Traffic3 = B1 Traffic6 = C2

To allocate the timing for the above labeled traffic lights, it will be best illustrated in a tabular form;

Table.1.2 Time allocation for the traffic lights

A1 (secs)	A2(secs)	B1(secs)	B2(secs)	C1(secs)	C2(secs)
G – 20	R – 20	R – 20	R – 20	G – 20	G – 20
G – 20	G – 20	G – 20	R – 25	R – 15	R – 20
R – 20	R – 20	G – 20	G – 15	R – 25	G – 20
Y – 10	Y – 10	Y – 10	Y – 10	Y – 10	Y – 10

The total timing will now be 70 seconds for each of the pole as shown below;

Table.1.3 Total timing for the traffic lights

A1 (secs)	A2(secs)	B1(secs)	B2(secs)	C1(secs)	C2(secs)
R – 20	R – 40	R – 20	R – 45	R – 40	R – 20
Y – 10	Y – 10	Y – 10	Y – 10	Y – 10	Y – 10
G – 40	G – 20	G – 40	G – 15	G – 20	G – 40

A truth table of the operation of the lights is probably a better aid to a solution rather than a flowchart.

Table 1.4 Traffic light truth table

TIME	A 1			A2			B1			B2			C1			C2		
(secs)	R	Y	G	R	Y	G	R	Y	G	R	Y	G	R	Y	G	R	Y	G
15	0	0	1	1	0	0	1	0	0	1	0	0	0	0	1	0	0	1
5	0	0	1	1	1	0	1	1	0	1	0	0	0	0	1	0	0	1
5	0	0	1	0	0	1	0	0	1	1	0	0	0	1	0	0	1	0
15	0	0	1	0	0	1	0	0	1	1	0	0	1	0	0	1	0	0
5	0	1	0	0	1	0	0	0	1	1	1	0	1	0	0	1	1	0
15	1	0	0	1	0	0	0	0	1	0	0	1	1	0	0	0	0	1
5	1	1	0	1	0	0	0	1	0	0	1	0	1	1	0	0	0	1

1.5 SCOPE OF WORK

The PIC is programmed to light up the LEDs of a six-way motor traffic system. The motor traffic lights which are located on six of the junctions in a T - junction, control the order of movement of cars in six direction. Making the total number of light displayed to be eighteen (18).

The involved circuit component uses a PIC 16F913 microcontroller used to drive LEDs, an improvement of;

i. The combinational logic using gates, counters, decoders and Astable and Monostable Multivibrators etc, [24].

ii. Also using a Transistor-Transistor Logic (TTL) integrated circuit with a BCD decade counter and the output of 1-of-10 BCD decoder/driver [25].

iii. The usual high power consumption and relatively short life halogen lamps [4].

1.6 LIMITATION(S)

It is a model or prototype of the real traffic light, which limits its implementation on an actual road. Also a six-way traffic that controls car movements in all the six directions in a T – Junction therefore it cannot be implemented in a cross-junction, which is an eight – way.

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORICAL BACKGROUND

The traffic signals increase the traffic-handling capacity of most intersections on the motor ways. They can work independently on timers, or connect to a computer-controlled system that operates over several intersections. In a computerized system, traffic detectors are placed at several locations----generally in the pavement. A computer continuously scans the traffic information from each detector. The computer then selects the best timing for each signal to reduce traffic congestion and minimize delays.

Traffic signals often allow certain types of vehicles, such as ambulances, fire trucks, and police cars, to trigger light changes. This control over signals helps speed emergency vehicles along while reducing the chances of collisions with other traffic in intersections [2].

The modern traffic light came into being due to the advancement in the first known signal device for regulating traffic light by different inventors across the globe.

The world's first traffic light came into being before the use of automobiles, and traffic consisted of only pedestrians, buggies (horse-drawn vehicle or carriage), and wagons. It was installed outside the British house of parliament in London on 10th December 1868 [1,3,6,7], it was a revolving lantern with red and green signals. Red meant "stop" (this stops vehicles and horses but allows 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) [8]. The lantern, illuminated by gas, was turned by means of a lever at its base so that the appropriate light faced traffic. On January 2, 1869, this crude traffic light exploded, injuring the policeman operating it. [1,3,7].

Earnest sirrine of Chicago, Illinois patented perhaps the first automatic street traffic system in 1910. Sirrine's system used the non illuminated words "stop" and "proceed" [8].

In 1912, a contender for "Invention of the first electric traffic light" [6], Lester Wire of Salt Lake city, a police officer invented the first electric traffic light (unpatented) [4,8]. This 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 manually operated by a policeman [5].

The modern electric traffic light is an American invention [1]. On August, 5th 1914, the American traffic signal company installed Red and Green traffic lights and a buzzer (to provide a warning for color changes), at each corner of intersections of a street in Cleveland, Ohio [1,6]. The installation was patterned (decorated with pattern) after the design of James Hoge [9,12] which has two colours, Red and Green for STOP and GO respectively plus a bell to warn the drivers of colour change [6].

The world's first three colours (Green-go, Red-stop and Amber-clear the intersection), four – direction traffic light was installed in Michigan in October, 1920 [6]. It was designed by a police officer named William L. Potts using about thirty-seven (37) dollars worth of wires and electrical control but were also manually operated [7]. This signal remained in operation till 1924 and became a part of the world's synchronized signal system [6].

Garette Morgan in 1922, in his own research came up with the traffic light using three colours, but Morgan's signal had no yellow light, instead a third positioned light that displayed the word 'STOP' in all directions was invoked before allowing traffic to proceed in any one direction, thereby providing extra time for the intersection to clear.

The development on the above 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 was in the 1950s and in Canada [1].

In the mid 1990s, cost effective traffic light lamps using Light Emitting Diodes (LED) were developed, prior to this time, traffic lights were designed using incandescent of halogen light bulbs. The following advantages were noticed: [3]

LEDs have much greater efficiency,

- They have longer life span between replacements, measured in years rather than months,
- The ability to display multiple colours and patterns from same lamp,
- They switch faster.

The traffic light is now embraced all over the world based on the three colour codes; the green, red, and amber (yellow) to resolve traffic jams and to travel more safely and efficiently without wasting human power.

2.2 THEORETICAL BACKGROUND

2.2.1 TYPES OF TRAFFIC CONTROL

Traffic control systems include laws and procedures, electronic and physical devices such as radar, radio, buoys and markers, signs and signals, and people such as vehicle operators and traffic controllers. The system varies depending on its location and the type of transportation it controls. For example, cities and busy harbors have complex traffic control systems compared to small towns and the open sea. The types of traffic controls are; Highway Traffic Control, Air Traffic Control, Rail Traffic Control, Marine Traffic Control [2]. This project is based on the first type, that is highway traffic control.

2.2.2 . HIGHWAY TRAFFIC CONTROL

1. Traffic Signs

Traffic signs are the most extensively used form of traffic control in the United States. More than 55 million traffic signs line the nation's roadsides. They provide information about speed limits and road conditions. They direct traffic along certain routes and to specific destinations. By using signs, traffic control planners tell drivers what to do, what to watch for, and where to drive.

Uniform pictorial signs were adopted first in Europe so that drivers could understand road regulations even if they did not understand the local language. The United States adopted the signs in the 1970s and developed a set of national standards for sign color, shape, and usage [2].

2. Pavement Markings

Pavement markings separate opposing streams of traffic and direct vehicles into proper positions on the roadway. For example, pavement markings delineate turn lanes at intersections and establish no-passing zones. White and yellow paint is customarily used for pavement markings. Reflective devices are more visible at night and are used in some locations to mark lanes and other significant places on the road [2].

3. Traffic Signals

The signal light is probably the most easily recognized traffic control device. At a busy intersection in a large city, a traffic signal may control the movements of more than 100,000 vehicles per day. More than 60 percent of all miles driven each year are on roadways controlled by traffic signals. Traffic signals direct streams of vehicles and pedestrians when to go, stop, or proceed with caution [2].

4. Priority Control

In one of the oldest methods of traffic control, one form of transportation is given priority by restricting or banning other forms of transportation. In the 1st century BC, Roman emperor Julius Caesar banned wheel traffic from Rome during daytime, which allowed pedestrians and horse riders to move more freely around the city. Some modern cities ban or restrict truck travel through certain neighborhoods. Bus lanes and high-occupancy vehicle (HOV) lanes exist in many urban areas. Only specified types of vehicles—primarily those carrying several occupants—can use these lanes. By giving priority to high-occupancy vehicles, transportation planners encourage carpooling and reduce congestion [2].

5. Restraints

As an alternative to banning traffic, traffic control planners use devices to discourage heavy use of a route. Islands built in the centers of intersections force drivers to proceed slowly. Speed bumps discourage high-speed commuting through residential neighborhoods. Concrete median strips prevent vehicles from making turns except at intersection.

There are different kinds of traffic regulating systems that can be classified based on their mode of operation and how they are regulated (mode of control).

2.2.3 TRAFFIC SIGNAL CONTROL SYSTEM BASED ON MODE OF OPERATION

The mode of operation is based on the following [25]:

i **Pre – timed traffic controlled system:** This control system employs a timer, each phase of the signal (i.e. stop, ready to go, and go) lasts for a specific interval before the next phase occurs. This pattern is repeated continuously. This mode of operation is the one considered in this project work.

ii **Vehicle actuated traffic control system:** This is more sophisticated than the previous one. It uses an electronic sensor (e.g. a metal detector) buried in the pavement to detect the presence of traffic (vehicles in most cases) waiting at the light. The idea behind this is to avoid giving the green light to an empty road. It has a timer as a backup in case the sensor fails to detect automobiles like motorcycles and bicycles causing them to wait forever.

2.2.4 TRAFFIC SIGNAL CONTROL SYSTEM BASED ON MODE OF CONTROL

Although there are solar controlled traffic lights, most are electrically controlled. The electrically-controlled ones are grouped into two:

i. **Sequential Logic Traffic Control System:** These are traffic control system that are designed using combinational logic (e.g. gate, flip-flops, counters, decoders, integrated circuits, and so on) as their building block [7].

ii. **Programmed Traffic Controlled System:** They are microcontroller based design but also have a sequential drive circuit which have programs in the Electrically Programmable Read Only Memory (EPROM). This type of design can be such that the different phases have different timings depending on the programmer. This is the system this project will use.

2.3 TRAFFIC SIGNAL PLACEMENT

The placement of traffic light signal (i.e. positioning) varies from place to place, the most important thing is for the traffic signal to be placed such that it will be visible to the drivers and other road users [13]. It may be mounted on poles horizontally or vertically depending on the location. In Nigeria, the signals are mounted vertically on the poles in the following order from top: Red, Amber (yellow), and Green. This is the method this design is adopting.

2.4 TRAFFIC LIGHT AND THE LAW

In all jurisdiction, it is a legal offence for road users to disregard the commands of the traffic light signal. The enforcement of this traffic light law varies from one jurisdiction to the other [14]. It is extremely strict in some places while no serious punishment is attached to such offence in other places. An example of traffic light laws include, motorist and the likes should stop at the red and yellow signal and move when it indicates green, disregard of this is an offence.

2.5 ADVANTAGES OF TRAFFIC LIGHT

1. They reduce the frequency and severity of accidents along the road.
2. They are employed to interrupt heavy traffic at intervals to permit pedestrians to cross.
3. It is easily understood by people in all spheres of life.
4. They provide for orderly movement of traffic.

2.6 DISADVANTAGES OF TRAFFIC LIGHT

The following disadvantages occur due to ill – design, ineffective placement of the traffic light, improper operation, and poor maintenance.

1. Significant increase in the frequency of collision.
2. They could result in unnecessary delay.

3. It can sometimes lead to accidents if it stops functioning.

CHAPTER THREE

3.1 DESIGN AND CONSTRUCTION

The design consists of PIC16F913 microcontroller which stores the written program for the project. Quartz crystal was used to generate clock pulse for the microcontroller to execute its instruction, while the output is displayed through a Light Emitting Diode (LED). The whole project is powered by a 12V transformer which was regulated to 5V. This chapter explains the hardware and software of the project. the design was done in three modules namely; Power Supply Unit, Control Unit, Display Unit, as illustrated in the block diagram below.

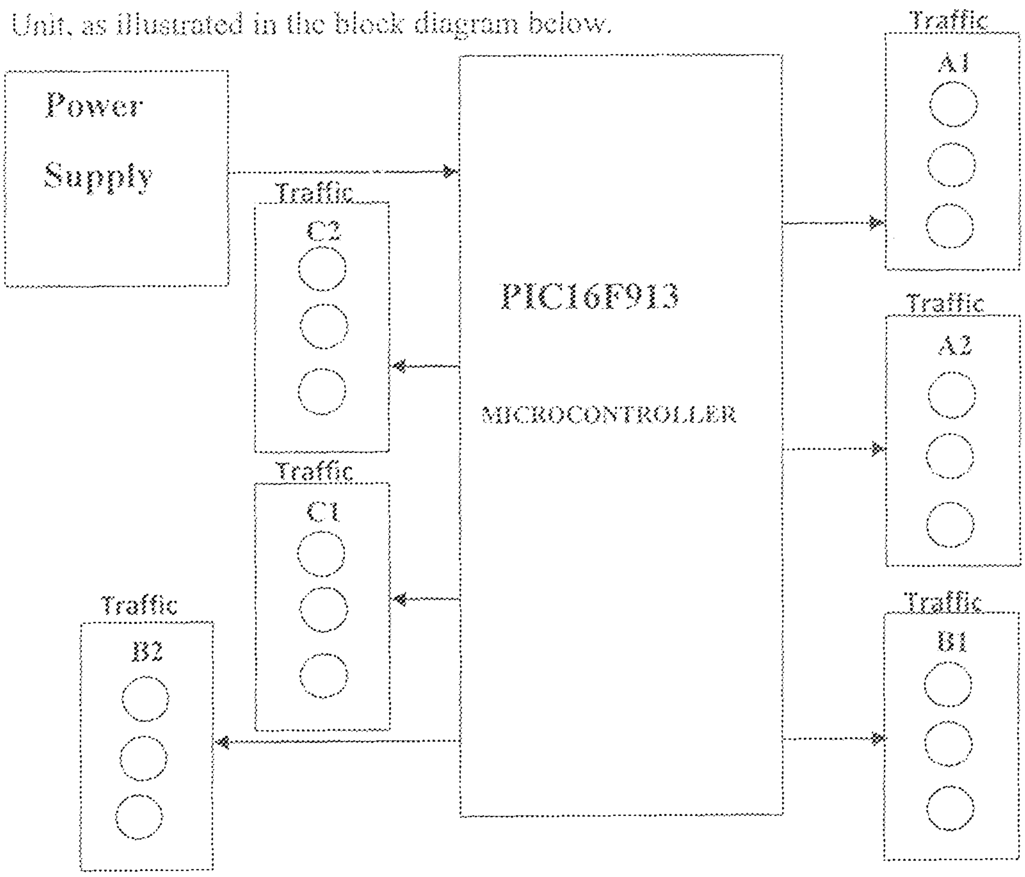


Fig. 3.1 Block diagram of traffic light control system.

The control unit is majorly the microcontroller, and the display consists of the 18 LEDs, A1 through C2.

The design is segmented into the stages as shown below;

- Power Supply Unit

The power supply unit comprises of;

I. Transformer
II. Fuse
III. Bridge Rectifier
IV Capacitor
V. Voltage Regulator
VI. Power Indicator

- Control Unit (Microcontroller)

It comprises of;

I. Pulse Generator / Timing circuit
II. Memory
III. Oscillator Configuration
IV. Reset
V. Input and Output ports
VI. CPU

- Display Unit (Output Light Indicator)

3.2 POWER SUPPLY UNIT

This is the first and most important aspect of any electronic design, though simple, care must be taken in determining the required voltage rating so as not to damage any of the components. A typical power supply is shown below:

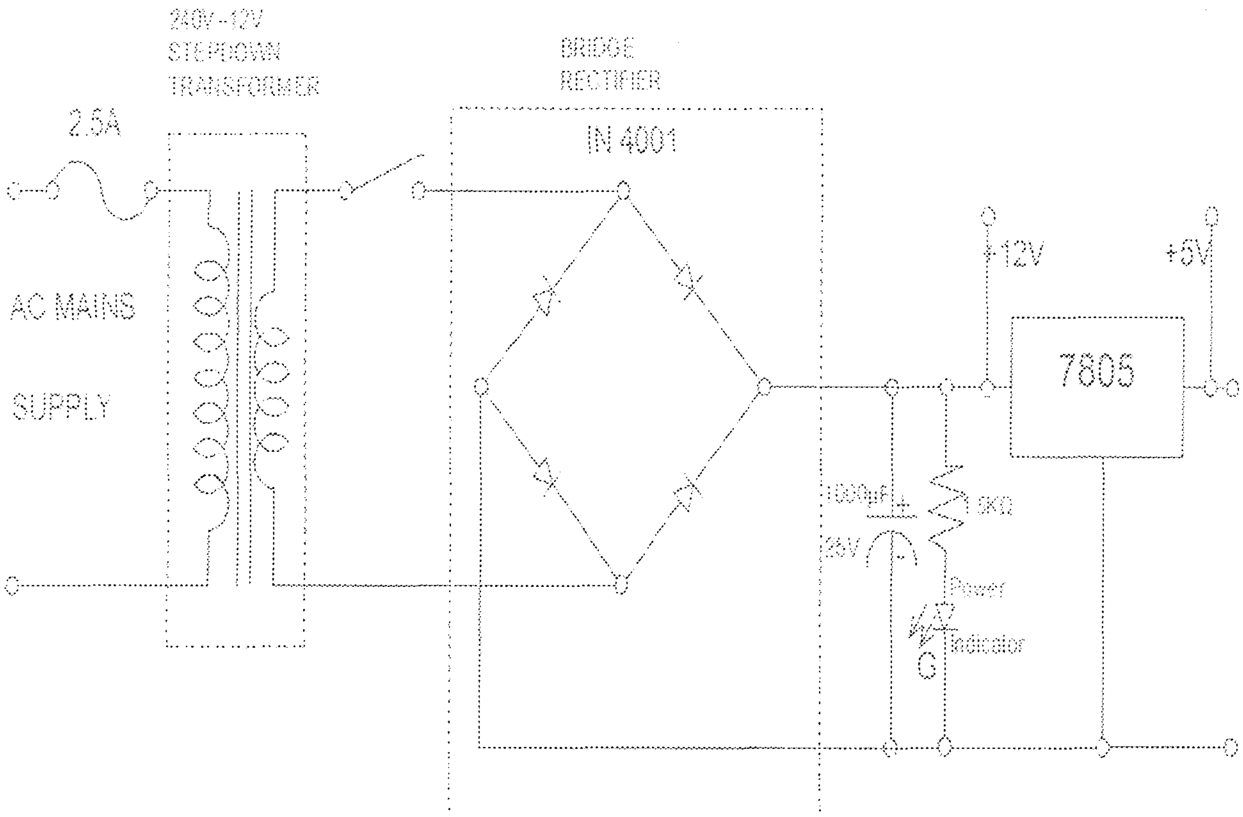


Fig. 3.2 Parts of a power supply

A power supply provides the proper voltage and current for electronic apparatus.

Most power supplies consist of several stages:.

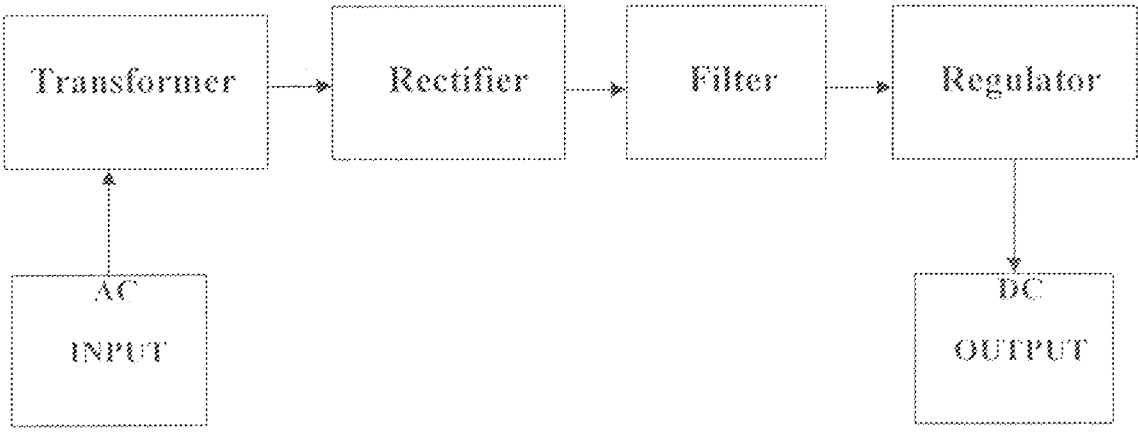


Fig. 3.3 Block diagram of a power supply. (Sometimes a regulator is not needed.)

First, the ac is fed into a transformer that steps the voltage down from 240V to 12V. Second, the ac is rectified, so that it becomes pulsating dc with a frequency of either 100 Hz for the full wave. This is almost always done by one or more semiconductor diodes. Third, the pulsating dc is filtered, or smoothed out, so that it becomes a continuous voltage having either positive or negative polarity with respect to ground.

Finally, the dc voltage needs to be regulated. The microcontroller is finicky, insisting on just the right amount of voltage all the time.

Power supplies that provide more than a few volts must have features that protect the user (that's you!) from receiving a dangerous electrical shock. All power supplies need fuses and/or circuit breakers to minimize the fire hazard in case the equipment shorts out.

3.2.1 TRANSFORMER

The most convenient and economical source of power is the domestic AC supply, but the AC value is usually between 220 – 240V which is too high for this circuit. The question now is how do we get the required 12V from this large value?

Transformers are devices that transfer energy of same frequency from one circuit to another by means of a common magnetic field. It can raise or lower the voltage in a circuit but with a corresponding decrease or increase in current [19]. In all cases except autotransformers, there is no direct electrical connection from one circuit to the other [27].

When an alternating current flows in a conductor, a magnetic field exists around the conductor, if another conductor is placed in the field created by the first conductor such that the flux lines link the second conductor, then a voltage is induced into the second conductor. The use of a magnetic field from one coil to induce a voltage into a second coil is the principle on which transformer theory and application is based [27]. The two inductive coils which are electrically separated but magnetically linked are connected with one end 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 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 number of turns of the windings. A turn is the number of times the wire (coil) is wound round a core. When the number of turns on the secondary winding is more than that of the primary, then we have a step-up transformer, but if it is vice versa, it is a step-down transformer [19].

The voltage, number of turns and the current are related by the following equation;

$$\frac{Vp}{Vs} = \frac{Np}{Ns} = \frac{Is}{Ip} \qquad (3.1)$$

Power supplies can be dangerous. This is especially true of high-voltage circuits, but anything over 12 V should be treated as potentially lethal. A power supply is not necessarily safe after it has been switched off. Filter capacitors can hold the charge for a long time. In high voltage supplies of good design, bleeder resistors of a high ohmic value are connected across each filter capacitor, so that the capacitors will discharge in a few minutes after the supply is turned off. But don't bet your life on components that might not be there, and that can and do sometimes fail [28].

3.2.2 FUSE

A fuse is a piece of soft wire that melts, breaking a circuit if the current exceeds certain level. Fuses are placed in series with the transformer primary (Fig.3.4). Any Component failure, short circuit, or overload that might cause catastrophic damage (or Fire!) Will burn the fuse out. Fuses are easy to replace.

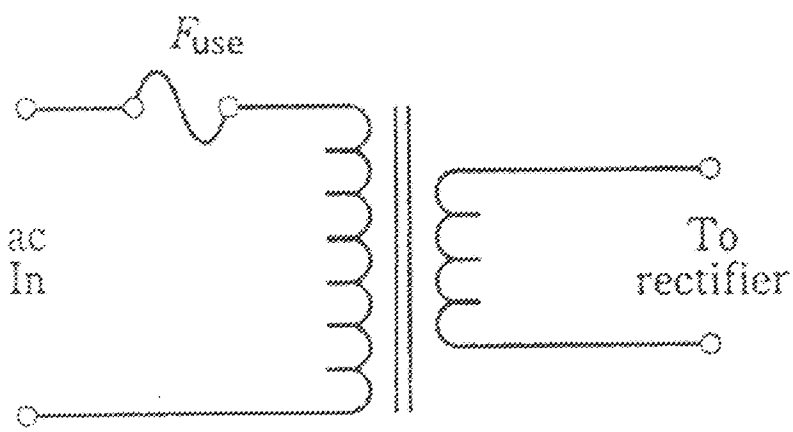


Fig. 3.4 A fuse, f, in series with the ac input (protects the transformer and diode, in case of overload.)

If a fuse blows, it must be replaced with another of the same rating. If the replacement fuse is rated too low in current; it will probably blow out right away, or soon after it has been installed. If the replacement fuse is rated too high in current, it might not protect the equipment.

3.2.3 RECTIFIER

The hallmark of a rectifier diode is that it passes current in only one direction. This makes it useful for changing ac to dc. Generally speaking, when the cathode is negative with respect to the anode, current flows; when the cathode is positive relative to the anode, there is no current. The constraints on this behavior are the forward break over and avalanche voltages.

The rectifier converts the stepped down 12V AC signal to a pulsating 12V DC signal, in other words it rectifies. Rectification is the process of converting an alternating current which flows back and forth in a circuit to direct current which flows only in one direction. A rectifier which permits current to flow only in one direction, effectively blocking its flow in the other direction, is inserted into this circuit. IC RS508 was used to achieve full wave rectification.

The point is that part of the ac wave is either cut off, or turned around upside-down, so that the polarity is always the same, either positive or negative.

3.2.4 CAPACITORS

The 12V output of the rectifier contains both AC (DC harmonics) and DC components, the essence of the capacitor is to filter (smoothen) the DC harmonics (ripples) but the capacitor here only minimizes the DC harmonics.

Electronic equipments and even microcontrollers do not like the pulsating DC that comes straight from a rectifier. The harmonics (ripples) must be smoothed out so that pure, battery-like DC is supplied. The simplest filter is one large-value capacitor, connected in parallel with the rectifier output. Electrolytic capacitor (polarized) was used in the circuit and it was hooked up in the right direction, with a value of 1000µF.

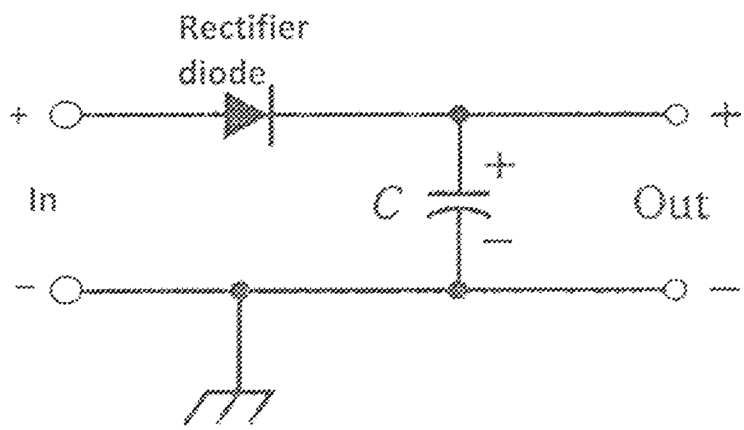


Fig. 3.5 A simple filter (The capacitor, C, should have a large capacitance)

The more current drawn, the more capacitance is needed for good filtering. This is because the load resistance decreases as the current increases. The lower the load resistance, the faster the filter capacitors will discharge. Larger capacitances hold charge for a longer time with a given load. Filter capacitors work by "trying" to keep the dc voltage at its peak level (Fig. 3.6). This is easier to do with the output of a full-wave rectifier (shown at fig. 3.6) as compared with a half-wave circuit. The remaining waveform bumps are the ripple. With a half-wave rectifier, this ripple has the same frequency as the AC, or 60 Hz. With a full-wave supply, the ripple is 120 Hz. The capacitor gets recharged twice as often with a full-wave rectifier, as compared with a half wave rectifier. This is why the ripple is less severe, for a given capacitance, with full-wave circuits.

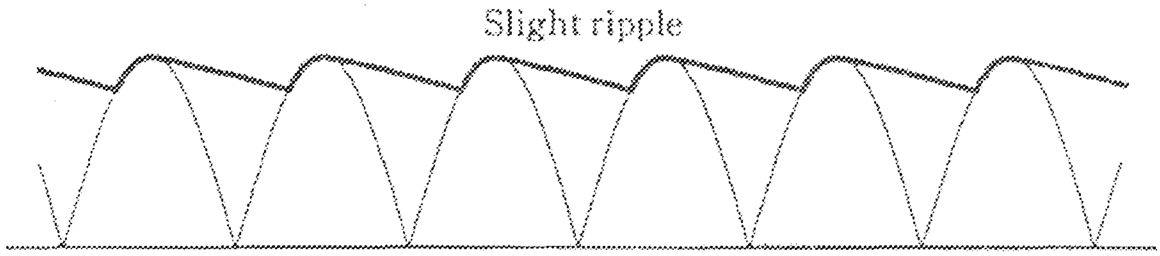


Fig. 3.6 Filtered output for full-wave rectification

3.2.5 VOLTAGE REGULATOR CIRCUIT

A voltage regulator is an electronic device which is capable of providing a nearly constant DC output voltage even when there are variations in load or input voltage. In recent years, voltage regulators have become available in integrated-circuit (IC) form. You just connect the IC, perhaps along with some external components, at the output of the filter. This method provides the best possible regulation at low and moderate voltages. Even if the output current changes from zero to maximum, the output voltage stays exactly the same, for all practical purposes [28].

An integrated circuit, 7805, a three terminal, fixed regulator, with a positive output, was used to effect charging of the integral secondary cell. The voltage regulator has three pins;

Pin 1 is the input that accepts the rectified, filtered, unregulated voltage,

Pin 2 is the ground and

Pin 3 is the output that gives out the +5, rectified, filtered, and regulated voltage to the pin 20 (V_{DD}) of the microcontroller.

3.2.6 HEAT SINK

Attached to the voltage regulator is the heat sink that protects it from excessive heat by absorbing the excess. This is due to the resultant voltage not supplied out, because it accepts 12V and supplies 5V, which is much work done by the voltage regulator.

3.2.7 POWER INDICATOR

As the name implies the power indicator is used to determine if the power section of the circuit is functioning, the green LED comes on and stays on so long as voltage is applied to the AC terminals. It is connected in series with a current limiting resistor of 1.5 KΩ to protect it from the high current in the circuit.

3.3 CONTROL UNIT

3.3.1 PULSE GENERATOR / TIMING CIRCUIT

All microcontrollers have timer circuits onboard, some have 4 different timers. These timers run at a speed of ¼ of the clock speed. So if we use a 4MHz crystal the internal timer will run at ¼ of 4,000,000Hz i.e. 1,000,000Hz. If we want to turn an LED on for say 1 second we would need to count 1,000,000 of these timing pulses. This is a lot of pulses! Fortunately within the microcontroller there is a register called an OPTION Register, that allows us to slow down these pulses by a factor of 2,4, 8, 16, 32, 64, 128 or 256. Setting the prescaler, as it is called to divide by 256 in the OPTION register [26].

3.3.2 MEMORY

Inside the microcontroller the program we write is stored in an area called EPROM (Electrically Programmable Read Only Memory), this memory is non-volatile and is remembered when the power is switched off. The memory is electrically programmed by a piece of hardware called a programmer. The instructions we program into our microcontroller work by moving and manipulating data in memory locations known as user files and registers. This memory is called RAM, Random Access Memory. PIC Microcontrollers are 8 bit micros, which means that the memory locations, the user files and registers are made up of 8 binary digits shown in Figure 3.7.

Bit 0 is the Least Significant Bit (LSB), and Bit 7 is the Most Significant Bit (MSB).

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
1	0	1	1	0	0	1	0
MSB							LSB

Figure 3.7 User file and register layout

When you make an analogue measurement, the digital number, which results, will be stored in a register called ADRES. If you are counting the number of times a light has been turned on and off, the result would be stored as an 8 bit binary number in a user file called, say, COUNT.

The PIC16F91X/946 has a 13-bit program counter capable of addressing a 4K x 14 program memory space for the PIC16F913/914 (0000h-0FFFh). Accessing a location above the memory boundaries for the PIC16F913 and PIC16F914 will cause a wrap around within the first 4K x 14 space. The Reset vector is at 0000h and the interrupt vector is at 0004h.

3.3.3 OSCILLATOR CONFIGURATION

The Oscillator module has a wide variety of clock sources and selection features that allow it to be used in a wide range of applications while maximizing performance and minimizing power consumption. Clock Source modes can be classified as external or internal.

• External Clock modes rely on external circuitry for the clock source. Examples are: Oscillator modules (EC mode), quartz crystal resonators or ceramic resonators (LP, XT and HS modes) and Resistor-Capacitor (RC) mode circuits.

• Internal clock sources are contained internally within the Oscillator module. The Oscillator module has two internal oscillators: the 8 MHz High-Frequency Internal Oscillator (HFINTOSC) and the 31 kHz Low-Frequency Internal Oscillator (LFINTOSC).

The system clock can be selected between external or internal clock sources via the System Clock Select (SCS) bit of the OSCCON register. Clock sources can be configured from external oscillators, quartz crystal resonators, ceramic resonators and Resistor-Capacitor (RC) circuits. In addition, the system clock source can be configured from one of two internal oscillators, with a choice of speeds selectable via software. Additional clock features include:

• Selectable system clock source between external or internal via software.

• Two-Speed Start-up mode, which minimizes latency between external oscillator start-up and code execution.

• Fail-Safe Clock Monitor (FSCM) designed to detect a failure of the external clock source (LP, XT, HS, EC or RC modes) and switch automatically to the internal oscillator.

The Oscillator module can be configured in one of eight clock modes.

1. EC – External clock with I/O on OSC2/CLKOUT.

2. LP – 32 kHz Low-Power Crystal mode.

3. XT – Medium Gain Crystal or Ceramic Resonator Oscillator mode.

4. HS – High Gain Crystal or Ceramic Resonator mode.

5. RC – External Resistor-Capacitor (RC) with FOSC/4 output on OSC2/CLKOUT.

6. RCIO – External Resistor-Capacitor (RC) with I/O on OSC2/CLKOUT.

7. INTOSC – Internal oscillator with FOSC/4 output on OSC2 and I/O on OSC1/CLKIN.

8. INTOSCIO – Internal oscillator with I/O on OSC1/CLKIN and OSC2/CLKOUT.

Clock Source modes are configured by the FOSC<2:0> bits in the Configuration Word register (CONFIG). The internal clock can be generated from two internal oscillators. The HFINTOSC is a calibrated high-frequency oscillator. The LFINTOSC is an uncalibrated low-frequency oscillator.

3.3.4 RESET

The PIC16F91X/946 has a host of features intended to maximize system reliability, minimize cost through elimination of external components, provide power-saving features and offer code protection. It differentiates between various kinds of Reset:

a) Power-on Reset (POR)

b) WDT Reset during normal operation

c) WDT Reset during Sleep

d) MCLR Reset during normal operation

e) MCLR Reset during Sleep

f) Brown-out Reset (BOR)

Some registers are not affected in any Reset condition, their status is unknown on POR and unchanged in any other Reset. Most other registers are reset to a "Reset state" on: Power-on Reset, MCLR Reset, MCLR Reset during Sleep, WDT Reset, Brown-out Reset (BOR).

The PIC16F91X/946 has two timers that offer necessary delays on power-up. One is the Oscillator Start-up Timer (OST), intended to keep the chip in Reset until the crystal oscillator is stable. The other is the Power-up Timer (PWRT), which provides a fixed delay of 64 ms (nominal) on power-up only, designed to keep the part in Reset while the power supply stabilizes. There is also circuitry to reset the device if a brown-out occurs, which can use the Power-up Timer to provide at least a 64 ms Reset. With these three functions-on-chip, most applications need no external Reset circuitry. The Sleep mode is designed to offer a very low-current Power-down mode. The user can wake-up from Sleep through:

•External Reset

• Watchdog Timer Wake-up

• An interrupt

Several oscillator options are also made available to allow the part to fit the application. The INTOSC option saves system cost, while the LP crystal option saves power.

3.3.5 INPUT AND OUTPUT PORT

The PIC16F913 includes several 8-bit PORT registers along with their corresponding TRIS registers and one four bit port:

- PORTA and TRISA
- PORTB and TRISB
- PORTC and TRISC
- PORTE and TRISE

PORTA, PORTB, PORTC and RE3/MCLR/VPP are implemented on all devices. The ANSEL(Analog Select bits) register (Register 3-1) is used to configure the Input mode of an I/O pin to analog. Setting the appropriate ANSEL bit high will cause all digital reads on the pin to be read as '0' and allow analog functions on the pin to operate correctly. The state of the ANSEL bits has no affect on digital output functions. A pin with TRIS clear and ANSEL set will still operate as a digital output, but the Input mode will be analog. This can cause unexpected behavior when executing read-modify-write instructions on the affected port. For instance,

bit 7-0 ANS<7:0>: Analog Select bits

Analog select between analog or digital function on pins AN<7:0>, respectively.

1 = Analog input. Pin is assigned as analog input(1).

0 = Digital I/O. Pin is assigned to port or special function.

Setting a pin to an analog input automatically disables the digital input circuitry, weak pull-ups, and interrupt-on-change if available. The corresponding TRIS bit must be set to Input mode in order to allow external control of the voltage on the pin.

From the circuit the output pins are; 6,7,11,12,13,14,15,16,17,18,21,22,23,24,25,26,27,28, pins 9 and 10 are connected to the crystal, pins 8 and 19 are the Vss (connected to ground). The input pin is 20 V_{DD} (positive voltage supply pin). More of the configuration is shown in the appendix section.

3.3.6 CENTRAL PROCESSING UNIT

High-Performance RISC CPU. Only 35 instructions to learn, all single-cycle instructions except branches. CPU uses the Special Function Registers and peripheral functions for controlling the desired operation of the device.

Parameter Name	Value
Program Memory Type	Flash
Program Memory (KB)	7
CPU Speed (MIPS)	5
RAM Bytes	256
Data EEPROM (bytes)	256
Timers	2 x 8-bit,1x16bit

ADC	2
Temperature Range (C)	-40 to 125
Operating Voltage Range (V)	2 to 5.5
Pin Count	28

Features

Up to 60 LCD segments

7KB Flash Program Memory

256B Data EEPROM

Internal 32kHz to 8MHz oscillator

Low-power nano Watt Technology

25mA Source/Sink current I/O

Two 8-bit Timer (TMR0/TMR2), One 16-bit Timer (TMR1)

Extended Watchdog Timer (EWDT)

Wide Operating Voltage (2.0V- 5.5V)

Brown-Out Reset (BOR) with Software Control

In Circuit Serial Programming (ICSP)

Programmable Low Voltage Detect (PLVD)

Wake on change.

3.4 OUTPUT / DISPLAY UNIT

The output is basically the LEDs' which directs the traffic movement after the PIC 16F913 has been programmed, this enables the display to come on at their various timing. The LED used here is known as high intensity LED it is different from the regular LED in that it has a higher light output.

3.5 CIRCUIT DIAGRAM

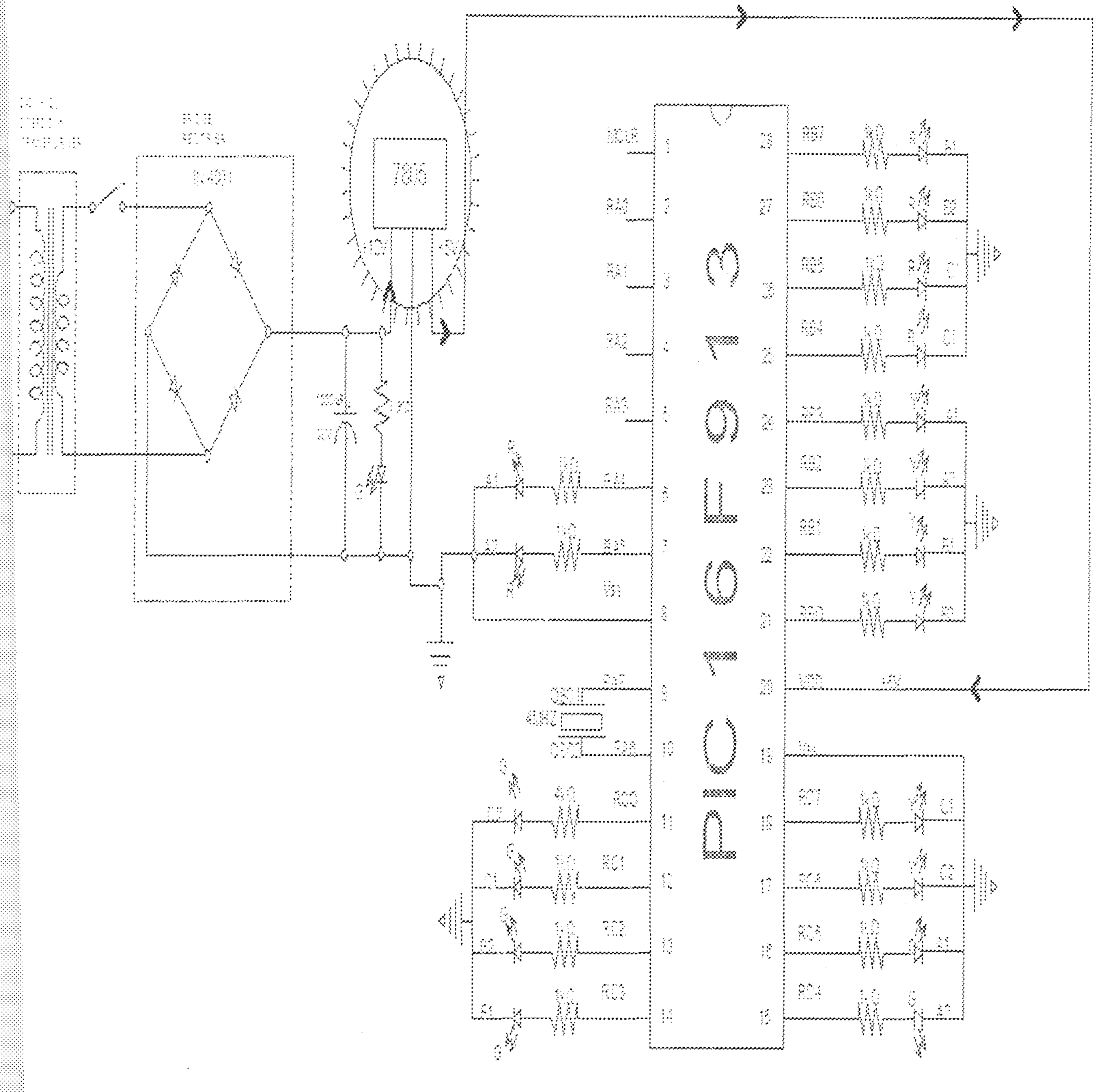


Fig 3.8 Circuit Diagram Of A Six – Way Traffic Light Controller

3.6 CALCULATION

The transformer T1 is used to step down the mains supply voltage of 240Vac to 12Vac. Assuming the system should deliver 500mA at 5V.

The transformer T1 power rating can be calculated as shown below

Let P = power rating of transformer

V = secondary voltage

I = secondary current

Current rating of transformer If = 500mA

$P = VI = 12 \times 0.5 = 6VA$

To account for losses, the power rating is multiply by a factor 1.11

$P = 6 \times 1.11$

$P = 6.66VA$

To get the peak voltage of the transformer the power rating is multiply by a factor 1.414

Transformer voltage $V_t = V_{r.m.s} = 12V$

Peak Output Voltage $= \sqrt{2} \times V_{r.m.s} = \sqrt{2} \times 12 = 16.970V$

Therefore voltage at rectifier is

$16.97 - 1.4 = 15.568V$

This is due to diode voltage drop of the rectifier.

Therefore, the output voltage of the rectifier is approximately 16V. The capacitor C reduces the ripple of A.C component of the D.C. output without reducing the output voltage and capacitor has ability to store charges. Now, when 16V appears across capacitor C it charges the capacitor and acquire charge Q.

For capacitor, $Q = CdV = IT$ ……………………………………………………………(3.2)

Where Q = charge stored

C = capacitance of the capacitor

V = voltage across the capacitor

T = duration of time current flows into the capacitor

I = current flow due to voltage (v) across the capacitor

$C = \frac{(I.T)}{v}$ ……………………………………………………………(3.3)

The full wave rectifier has frequency twice the input voltage frequency

$F = 2 . 50Hz = 100Hz$

Therefore the time can be calculated as

$T = \frac{1}{100} = 0.01sec$

Hence, $C = \frac{(T.I)}{v}$

$C = \frac{(0.01 \times 0.5)}{16}$ $C = 312.5\mu F$

Therefore the minimum value of capacitor C1 is 312.5μF but the preferred value is 1000μF and from the equation 3.3 it is seen that the higher the capacitance the lower the ripple voltage, so 1000μF electrolytic capacitor is chosen as the smoothing capacitor.

Design for light emitting diode (traffic)

For limiting resistor (R)

$$R = \frac{Vcc - Vd}{Id} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4)$$

Where Vcc = applied voltage

Vd = voltage drop across the LED

Id = desired current Id = 10mA

Vd = 1.7V

$$R = \frac{5 - 1.7}{10 \times 10^{-3}} = 330\Omega$$

The minimum value of resistor needed is 330Ω but 1KΩ is used in the circuit to enhance the reliability and quality of the system.

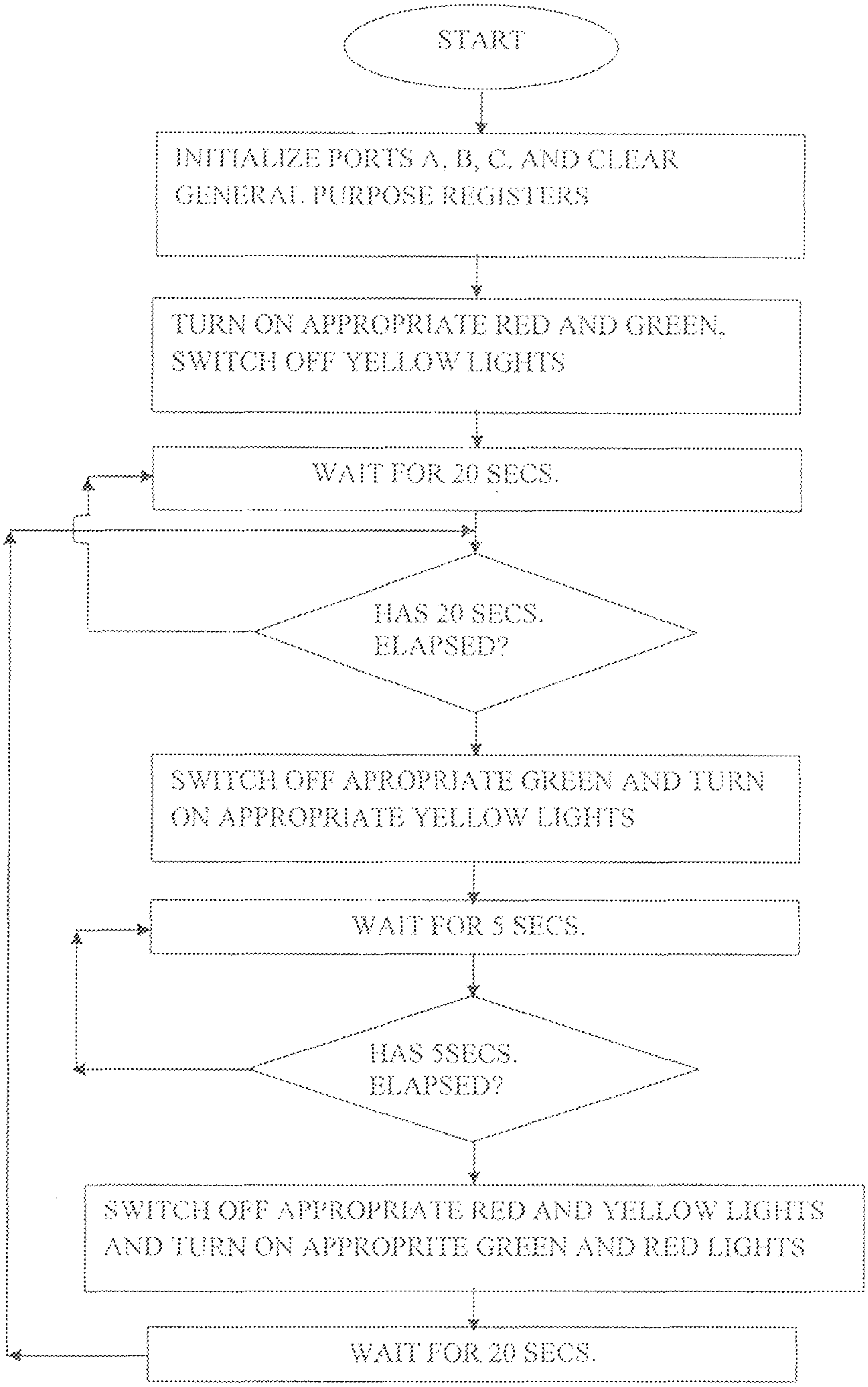
Design of the power indicator;

Where V = 12 – 1.7 = 10.3

Maximum current to an LED = 10mA

Therefore required resistor value is; $R = \frac{V}{I} = \frac{10.3}{10 \times 10^{-3}} = 1{,}030\Omega$ We therefore use 1.5KΩ which is more appropriate.

3.7 FLOW-CHART



3.8 PROGRAM CODE

```
#include        <p16f913.inc>     ; processor specific variable definitions

; '__CONFIG' directive is used to embed configuration data within .asm file.

; The labels following the directive are located in the respective .inc file.

; See respective data sheet for additional information on configuration word.

;*******************************************************************

counter1 EQU   0x40

counter2 EQU   0x41

counter3 EQU   0x42

counter4 EQU   0x43

counter5 EQU   0x44

counter6 EQU   0x45

counter7 EQU   0x46

counter8 EQU   0x47

counter9 EQU   0x48
```

```
counter10 EQU   0x49

counter11 EQU   0x4A

;************************************************************************

        ORG                 0x00                ; processor reset vector

        goto    start                       ; go to beginning of program


delay

    nop

    nop

    nop

    nop

    nop

    nop

    nop

    nop

    nop

    nop
```

```
    nop
    nop
    nop
    decfsz  counter1,f
    goto    delay
    movlw   .250
    movwf   counter1
sub1
    decfsz  counter2,f
    goto    delay
    movlw   .250
    movwf   counter2

sub2
    decfsz  counter3,f
    goto    delay
    return
```

```
start

  bsf     STATUS,RP0
  bcf     STATUS,RP1
  movlw   b'00000000'
  movwf   TRISC
  movwf   TRISB
  movlw   b'10001111'
  movwf   TRISA
  movlw   B'00000000'
  movwf   ADCON1
  bcf     STATUS,RP0
  bsf     STATUS,RP1
  bcf     LCDCON,4
  bcf     STATUS,RP0
  bcf     STATUS,RP1
  movlw   B'01000001'
  movwf   ADCON0
```

```
  clrf    PORTC
  clrf    PORTB
; initialization
init
    clrf  counter1
    clrf  counter2
    clrf  counter3
    clrf  counter4
    clrf  counter5
    clrf  counter6
    clrf  counter7
    movlw  b'00100011'
    movwf  counter8
    movlw  b'00111111'
    movwf  counter9
    movlw  b'00011100'
    movwf  counter10
```

```
clrf  PORTA

clrf  PORTB


movlw  .250

movwf  counter1

movlw  .250

movwf  counter2

movlw  .15

movwf  counter3


delay_15sec1

movlw  .15

movwf  counter3

bcf   PORTA,4

bsf   PORTA,5


movlw b'11000000'
```

```
    movwf PORTB
    movlw b'00100011'
    movwf PORTC
    call  delay

delay_5sec1
    movlw   .5
    movwf   counter3
    bcf   PORTA,4
    bsf   PORTA,5

    movlw b'11000110'
    movwf PORTB
    movlw b'00100011'
    movwf PORTC
    call  delay
delay_5sec2
```

```
movlw   .5
movwf   counter3
bcf   PORTA,4
bcf   PORTA,5


movlw b'01000000'
movwf PORTB
movlw b'11111000'
movwf PORTC
call  delay
delay_15sec2
movlw   .15
movwf   counter3
bcf   PORTA,4
bcf   PORTA,5


movlw b'01110000'
```

```
    movwf PORTB

    movlw b'00111000'

    movwf PORTC

    call  delay


delay_5sec3

    movlw    .5

    movwf    counter3

    bcf    PORTA,4

    bcf    PORTA,5


    movlw b'01111101'

    movwf PORTB

    movlw b'01001000'

    movwf PORTC

    call  delay
```

```
delay_15sec3

    movlw   .15

    movwf   counter3

    bsf   PORTA,4

    bsf   PORTA,5


    movlw b'00100000'

    movwf PORTB

    movlw b'00001101'

    movwf PORTC

    call  delay


delay_5sec4

    movlw   .5

    movwf   counter3

    bsf   PORTA,4

    bsf   PORTA,5
```

```
movlw b'00101011'

movwf PORTB

movlw b'10000001'

movwf PORTC

call  delay

goto  delay_15sec1

end
```

CHAPTER FOUR

CONSTRUCTION, TESTING AND DISCUSSION OF RESULTS

4.1 CONSRUCTION PROCEDURE

Construction simply means the practical aspect, which involves the assembly of the components and testing. The project work consists of both the outputs and casing.

The casing consists of the power supply unit and the control unit, which is the microcontroller.

All these were constructed one after the other with the power part first the control unit all soldered and connected on a veroboard, as designed and analysed in the design aspect of this project (Chapter Three).

After all the calculations and design completed, the components with the preferred values were brought, then the components were arranged on the board starting with the power supply unit or modulus, then up to final stage on the circuit diagram which is the required display (output).

Initially, the circuit was implemented on a breadboard. The problem encountered when using breadboard is that, connection on the breadboard is temporal, and it is fragile in the sense that any of the component can may remove while on transit and this can lead to undesirable effect(s).

The function of the breadboard is for prototyping purposes, as it allows components to be added and removed with ease without soldering.

Obtaining a uniform result with the breadboard circuit proved to be very difficult but was finally accomplished, so the next best solution before developing a full PCB was to use a Vero board.

A Vero board requires soldering and has copper interconnection tracks making it less prone to noise. The entire unit was arranged in a casing. The majority of the noise was eliminated by using the Vero board and it ensured firm grip of the components and the interconnecting wires.

4.2 MATERIAL USED

4.2.1 MATERIAL USED FOR THE POWER SECTION AND POWER INDICATOR UNIT

i. Transformer (240/12V)

ii. Switch

iii. Fuse (2.5A)

iv. IC RS508 Rectifier

v. Capacitor (1000μf)

vi. Resistor (1.5KΩ)

vii. LED (Green)

viii. 7805 Voltage Regulator

ix. Heat Sink

4.2.2 MATERIALS USED FOR TRAFFIC LIGHT CONTROL CIRCUIT

i. 18 Resistors (1KΩ)

ii. 18 LEDs (6 green, 6 yellow, 6 red)

iii. Quartz Crystal (4MHz)

iv. PIC 16F913 Microcontroller

v. PVC covered tinned copper wire

vi. Vero Board

4.3 PREVENTIVE MEASURES TAKEN

1. Polarity of the components (where applicable) were considered before connecting them to prevent damage of bridging and ensure proper sequence of operation.
2. All the components were independently tested before use, to ensure that they are all in good conditions.
3. Water and moisture were prevented from coming in contact with the circuit constructed.
4. Badly soldered joints were avoided by applying a little soldering lead into the joints.
5. Necessary portions of the electronic board (Vero board) were isolated to avoid continuity which may result in short circuit.

4.4 TESTING

The whole circuit was traced and tested to ensure that there was no short or open circuit when all soldering were completed.

4.5 PROJECT CASING

After the construction was completed and tested, a container was used to protect the prototype project on the Vero board. The casing serves as a housing for the circuit which consists mainly of the power part to protect it from mishandling and to keep the components intact.

The casing unit of the project constructed is made of a square plastic.

.6 DISCUSSION OF RESULT

The project consists of three different colour LEDs: Red, Yellow and Green.

In the traffic control, Red signifies "STOP", Yellow means "GET READY" and Green means "GO". The waveform of the output is displayed below;

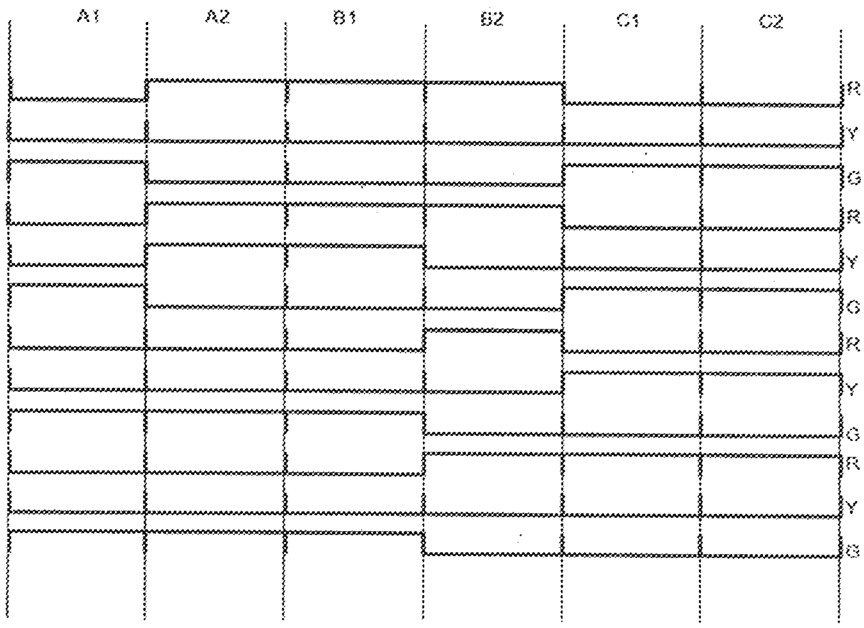


Fig. 4.1. Wave Form Of Traffic Light Output

Table 4.1 Traffic control activities

Stage	RED LED (R)	YELLOW LED (Y)	GREEN LED (G)
1st	1	0	0
2nd	1	1	0
3rd	0	0	1
4th	0	1	0
5th	1	0	0

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

This project (Design and construction of microcontroller based 6 – way traffic light) is a means of controlling traffic congestion with three colures (Red-STOP, Yellow- GET READY TO STOP or GO as the case may be and Green –GO).

It consists of a programmed PIC16F913 microcontroller which is the heart of the project and eighteen light emitting diode (Red, Yellow and Green). The design is simple and cost effective.

5.2 CONCLUSIONS

Based on this design, the maximum time a vehicle can move is for 20 seconds this is not realizable on a real road because of heavy traffic where it will be say 80 – 100s.

It has now been well established that the microcontroller being an embedded system can function in so many circuits thereby making the work of an engineer easy.

The objective of this project (Automatic traffic controller) has been achieved (with negligible error) to a very satisfactory extent. The design was tested with the various LEDs (Red, Yellow and Green) and it worked according to the specified constraints as controlled by the microcontroller.

5.3 LIMITATIONS

Since this project is designed for a T - junction road, it can't work for an intersection. Another major limitation is the fact that once there is no power supply for a long time, the battery cannot be charged and the system will not function.

5.4 RECOMMENDATION

Based on the above construction, the work can be improved on by inserting a metal detector on the highways so that it can give proper timing to the roads as the need arises, for better and more reliable alternative source of power supply, I recommend solar energy.

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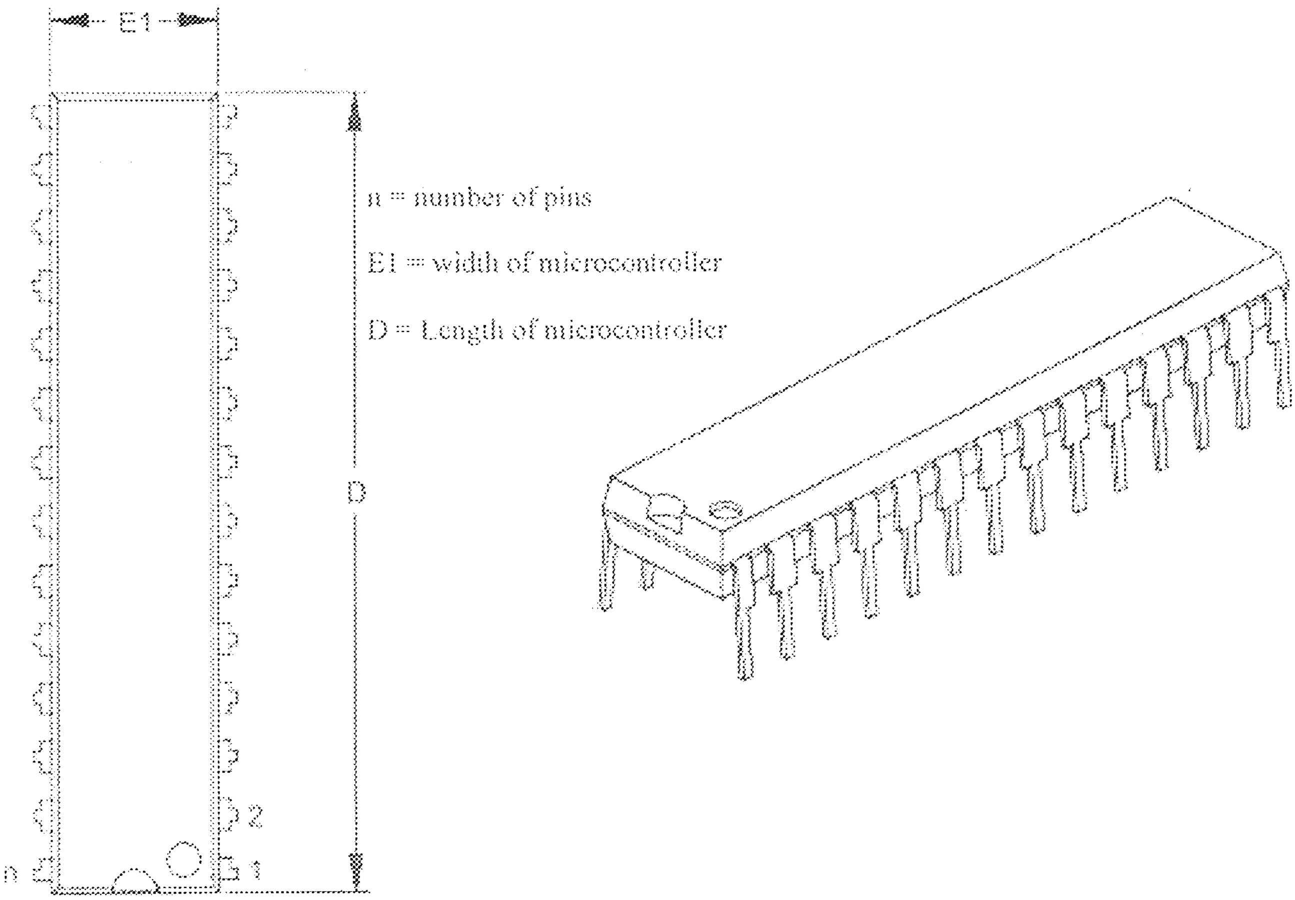
APPENDIX 1

Decimal	Binary	Hexadecimal
0	00000000	00
1	00000001	01
2	00000010	02
3	0000011	03
4	00000100	04
5	00000101	05
8	00001000	08
15	00001111	0F
16	00010000	10
31	00011111	1F
32	00100000	20
50	00110010	32
63	00111111	3F
64	01000000	40
100	01100100	64
127	01111111	7F
128	10000000	80
150	10010110	96
200	11001000	C8
250	11111010	FA
251	11111011	FB
252	11111100	FC
253	11111101	FD
254	11111110	FE
255	11111111	FF

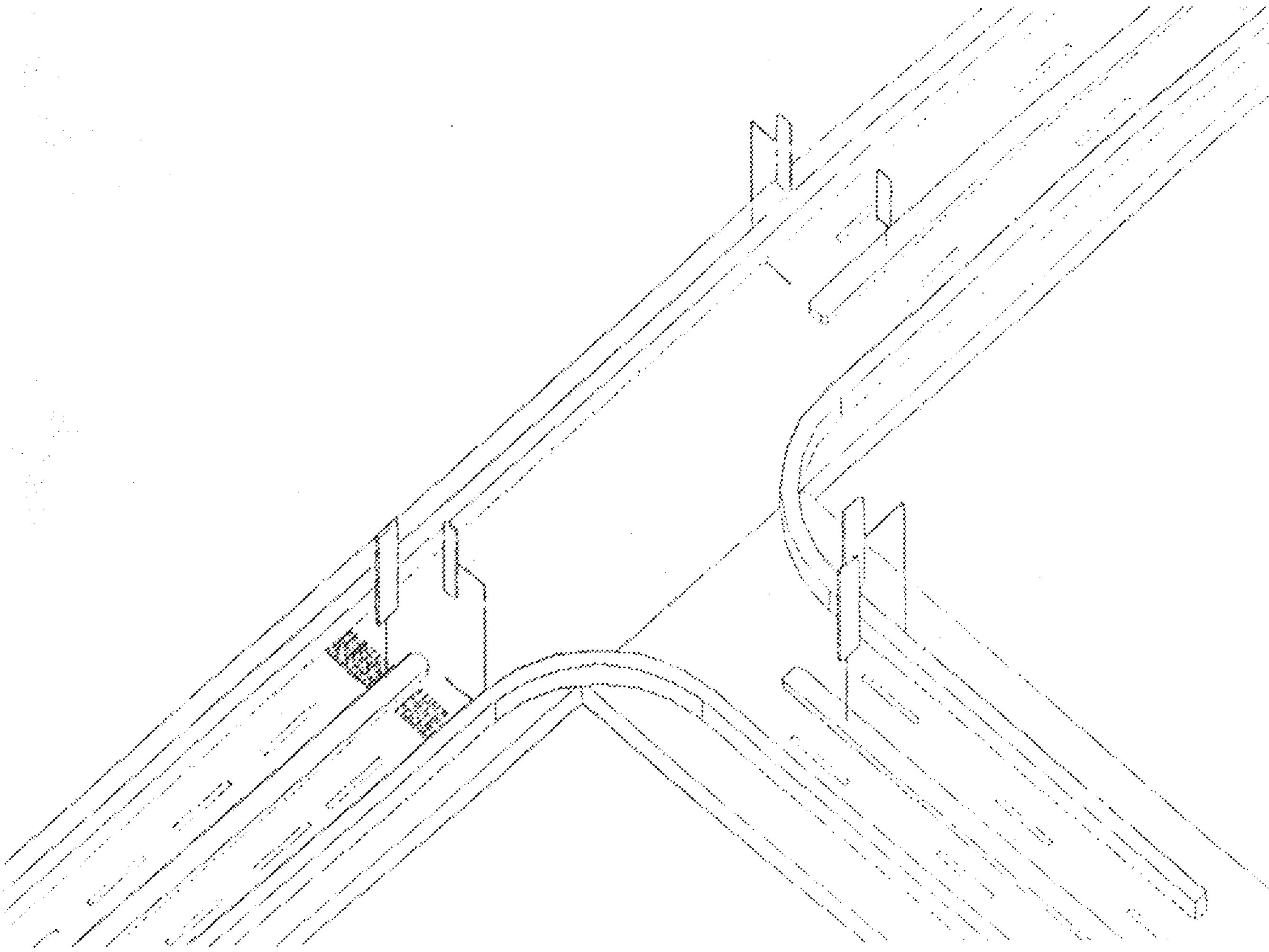
A Table of Decimal, Binary and Hexadecimal

APPENDIX 2



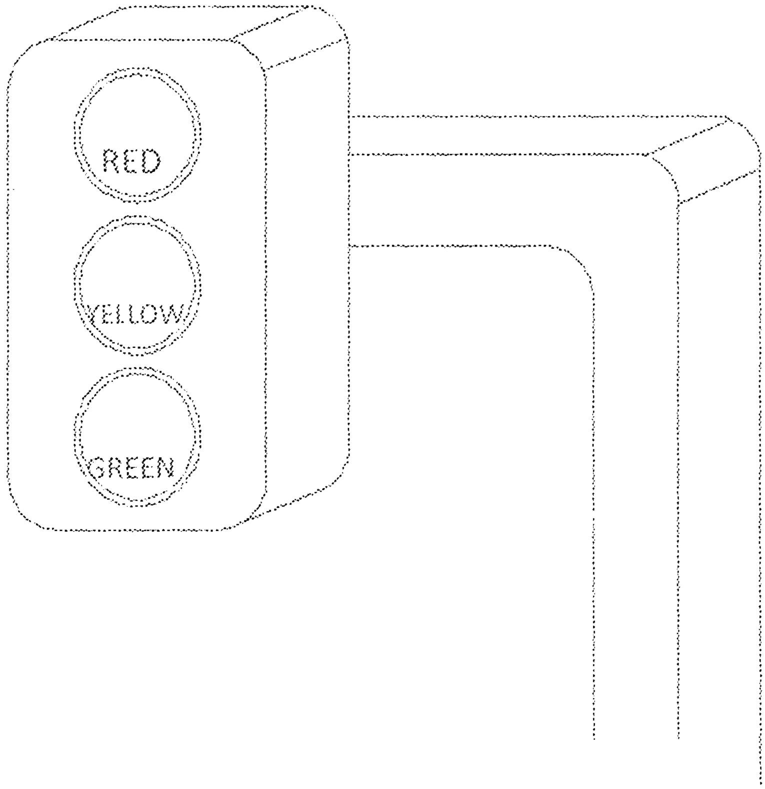
Pin Layout of 16F913 Microcontroller

APPENDIX 3



A traffic arrangement at a T- Junction

APPENDIX 4



A Traffic Light