THE DESIGN AND CONSTRUCTION OF AN AUTOMATIC ELECTRONIC DISPLAY BOARD

BY

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SUBMITTED TO

ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD
OF
BACHELOR OF TECHNOLOGY (B.TECH. HONS) IN ELECTRICAL AND
COMPUTER ENGINEERING.

NOVEMBER 2004

CERTIFICATION

We hereby certify that this project was carried out by Mr DONATUS ASUELIMEN as his final year project of the department of electrical and computer Engineering, Federal University Of Technology, Minna.

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DEDICATION

This project report is dedicated to my Elder sister Mrs BEATRICE OSOBA and my Elder brother Mr EDWARD ASUELIMEN for their moral and financial support towards the successful completion of my programmed and to my parents for the wards of encouragement and to the most High God the father of all creations who at his will and mercy made it possible for me to have the zeal and strength to carry this project from the beginning to the end.

ACKNOWLEDGEMENT

My most gratitude goes to Almighty God who has given me life, good health and the ability to carry out this challenging project successfully.

My deep appreciation goes to my project supervisor, Engr. J. Kolo Whose constructive critisms and assistance were invaluable in the course of this project work.

I also wish to express my gratitude to my elder sister and her husband Mr. & Mrs. Osoba and my elder brother and his his wife, Mr. & Mrs. Eddy A. for their moral and financial supports to make this project a success.

Also I am indebted to my younger brothers, Mr. Tony Asuelimen, Mr. Peter A. and Mr. Clement Urieto. My younger sister, Miss Eunice Asuelimen, Maria A., Ann A. Ilobe Kelemen for their moral support and the words of encouragement is highly recognized and appreciated.

This acknowledgment will not be complete without the mention of my colleagues the council of elders, Sinco, Darlington My friends, Ufoma, Ema Okoye, Ajayi Monsuru. My Head of department Alhaji Albudulah, my department lecturers, Engr. Romala, Engr. Shehu, Engr. Attah, for the support, orientation and assistance given to me.

Finally, my greatest appreciation goes to my parent to Mr & Mrs. Boniface Asuelimen for their moral and financial support, may God bless you all.

ABSTRACT

The automatic electronic display board (sign post) is to display "FUT MINNA, ELECTRICAL AND COMPUTER DEPARTMENT, You are welcome" and lighting the border lines which comprises, red and green colours LED.

The mode of operation is to switch "ON" and "OFF" in three seconds each word one after the other after which it will rest and start all over again. The border line and "you are welcome" take another sequence, which is operated from another circuit configuration, this circuit is configured at 0.7second to switch "ON" and "OFF". The circuit spell out "You are welcome" letter after letter and the border line switch from Red to Green LEDs of the border line.

The operation of a counter is controlled by a continuous pulse signal or clocking signal of about 40Hz. These pulsed are generated by a 555 timer configured in an astable made to clock the counter.

The words to be displayed are constructed on a cardboard using LEDs which have suitable properties to match the operational condition of the over all design including environmental condition. A driver is coupled to each output in order to drive (boost the current) of the loads on the display board.

Power supply is also constructed via transformer through an automatic switching circuit to power all the integrated circuit components and also for biasing discrete components which are used in the design.

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CHAPTER ONE

1.1 INTRODUCTION

Electronics display boards have been in existence for centuries to create a very important and simple way of spreading information to the general public. Thus it is important to design a display board that will easily attract the attention of people to read the best that is displayed on the board.

Electronics display boards are use as marketing tools (i.e. advertising products, services etc).thus these boards have a very important role to play in the advertisings industry.

The electronic board used before now were expensive to construct and very high power was needed to drive (operate) them. It is to this disadvantage that the electronic boards used now have become preferable in recent years due to its relative low cost of production also they posses an attractive quality that makes them easy to read and understand. This project involves the design and construction of an electronic board which will go a long way in solving the problems encountered in the advertising industry. Electronic display ('Electronic sign post') as a project was conceived a long time ago as a secondary school student when an organization wanted to construct electronic display for their organization using students of my school. Although I wasn't part of the class, but due to my thirst for electronics and considering the challenge given to my colleague then, I've decided to modify their project redesign it and carry out its construction on a small scale and also improve on it .also the project is embarked upon to reflect the states of this great citadel of learning as a university of technology to the outside world.

1.2 AIM AND OBJECTIVES

The main aim of this project is to design and construct an automatic electronic board to display "F.U.T MINNA ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT you are welcome" all enclosed in a switching border line.

Objectives

1. To spell out F U.T.MINNA word after word.
2. To display 'F.U.T MINNA' at once.
3. To spell out 'ELECTRICAL & COMPUTER ENGINEERING DEPARTMENT' word after word.

4. To display `ELECTRICAL & COMPUTER ENGINEERING DEPARTMENT` at once.
5. To display `F.U.T MINNA ELECTRICAL & COMPUTER ENGINEERING DEPARTMENT` at once.
6. To spell out `you're` at once and spell out `welcome` letter after letter.
7. To automatically switch ON at night (i.e. dark) and switch OFF in the day time (bright).

The arrangement of what to be display on the Automatic Electronic Display Board is shown below

F.U.T MINNA ELECTRICAL & COMPUTER ENGINEERING DEPARTMENT You're Welcome

1.3 SIGNIFICANT OF STUDY

This project is found useful and applicable in various advertising industry, organization to display, organization's name, logo, time schedule and warning signal, most especially at night and in a very dark environment.

1.4 SCOPE OF STUDY

The design will be using discrete LEDs (light emitting diode) as the display component and not seven segment LED to aid simplicity of the design. Also IC (integrated circuit) components are used mostly in the design to aid stability of performance and reliability. The design have an automatic switch to automatically switch OFF at day time and switch ON at night, even though it's a prototype design, as they will say `what worth doing is worth doing well`.

1.5 METHOD OF STUDY

The tool of carrying out this project comes in various forms at various stages of the design.

At a time, review of past experiments, related projects and scrip on the design was carried out and at some other time, library work was also done to verify the appropriate components and devices required to carry out the design. Browsing internet should not be left out because it serves a great deal in this project work.

Group discussion was also arranged to share experiences of people on the behavior of the components used for the design.

CHAPTER TWO

LITERATURE REVIEW

The electronic display board used before now consumes more power compared with today's display board. In early 19ths to be specific Raymond Hull in 1929 made use of the "electronic newscaster. The electronic newscaster is machine for displaying news bulleting whether reports and advertisements on a long illuminated screen. The screen itself is made of row of filament lamps which are illuminated in sequence so that the displays move along the screen from left to right. The message to be displayed is first punched on to a long strip of strengthened paper which is then joined to form continues loop. The loop is next loaded on to machines, which read the information from the strip and control the light as the screen. There are two of these machines, one for the news tapes and the other one for the advertising tapes and the newscaster reads from each one in turn.

Nowadays, the electronic display board consumer less power because of the present of integrated circuit (IC) such as 555 timber, decade counter, voltage regulator etc. to make it more effective and reliable and most of the display units use light emitting diode (LEDs) which made it more usually attractive at night. Some of the electronic display board that used ICs can still use lamp as there display unit, such project was design and construction by a student of electrical department FUT. MINNA.

Some other board suing programmable ICs, this take more message to be display and its more portable, it uses LEDs for there display units some companying that used such are banks (for the exchange rate board) Mr. Biggs (for welcoming customers) most of the Saba cafe (internet) café shops (e.g EDF LINK, matrix café both in Abuja) this make it easily to communicate with customer. The electronic display board will go a long way of solving the problem of advertising in the society. It is applicable for the promotion of goods and services. They are also used in schools, hotels, restaurant etc.

This literature review will not be completed if I did not talk about the literature review "theory" of some of the components used to construct this project work.

Literature review (theory) of some of the components is as shown below.

2.2 INTEGRATED CIRCUIT

Briefly as integrated circuit (IC) is just a packaged electronic circuit. It is also a complete electronics circuit in which both active and passive components are fabricated on an extremely tiny single silicon chip. It consists of a large number of these components that are working dependently to give a fast and accurate response.

2.2.1 Types of IC

Classification of ICs by structure

1. monohybrid ICs
2. thick film ICs
3. Hybrid ICs

Classification of ICs by function

1. linear ICs
2. Digital ICs

Linear ICs contain several amplifier circuits for either audio or of signals while digital ICs contain array of public switching circuit to perform logic function.

2.2.2 ADVANTAGES OF ICs

i. ICs has an extremely small physical size

ii. ICs are very cheap due to reduction in size and weight

iii It has a very small weight which render it very important in military and square applications

iv. ICs are extremely reliable

vi. They consume very low power

vii. They are suitable for small signals operation

2.2.3 DISADVANTAGES OF ICs

1. Coil and industries cannot be fabricated in IC form
2. They can handle only a very limited amount of power
3. They cannot withstand rough highly or excessive heat

2.3TIMING CIRCUIT

In any electronics project where switching is necessary it is quite very important to generate a pulses signals that will be able to change between two voltage level (if the circuit is digital) so that one level will be for switching "OFF" (logic 0) and the other for switching "ON" (logic 1)

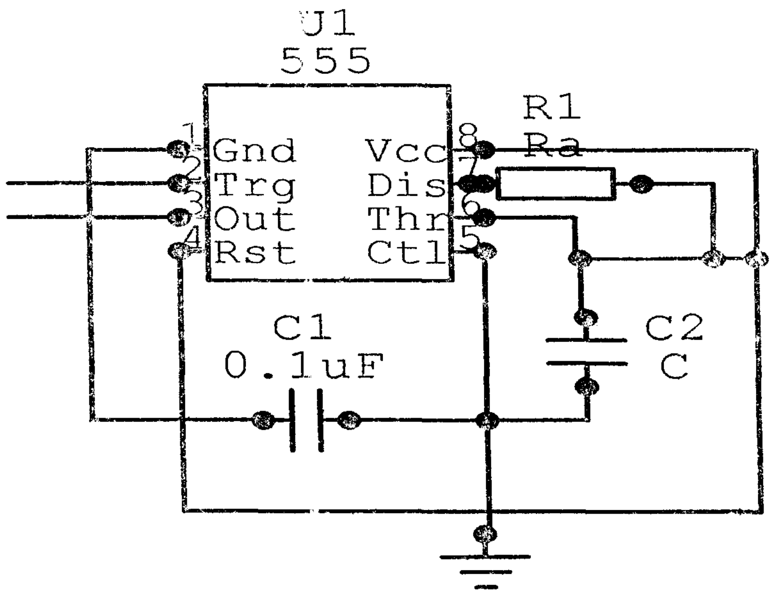
In this project a continuous pulse is required for clocking the counter so that it can change its output stage for each clock input, depending on whether the counter requires a negative going or positive going transition for its operation. The pulse will be generated using a 555 timer configure in stable manner.

2.3.1 THE 555 TIMER

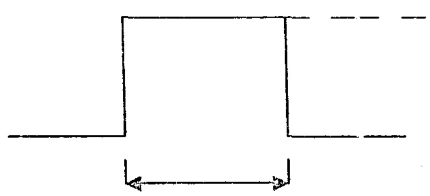
The 555 timer is a monolithic circuit package in various way i.e. 8 pin- mini-DIP and has been found very useful in many electronics systems. It is more favoured for timing circuits because of its negligible drift with the supply voltage and its output current is about 200MA.

2.3.2 CONFIGURATION OF A 555 TIMER

We have many configuration of 555 timer this depend on the function of the 555 timer in the circuit, here we will talk about monostable or one shot multivibrator and Astable or square wave clock multivibrator. Monostable mode of operation of 555 timer will not be discussed extensively as it is irrelevant to this project designs only the configuration, the time width of the output to be at a logic "1" and the output wave form will be given as shown in figure 2.1 below.



(a) Monostable multivibrator



t= 1.1Rac-------------------------------2.10

(b) Output wavelength

Fig 2.1 (a) monostable multivibrator (b) its output wavelength

2.3.3 ASTABLE MULTIVIBRATOR

The principle of operation of an astable multivubrator can be explained using the diagram in figure 2.2 below.

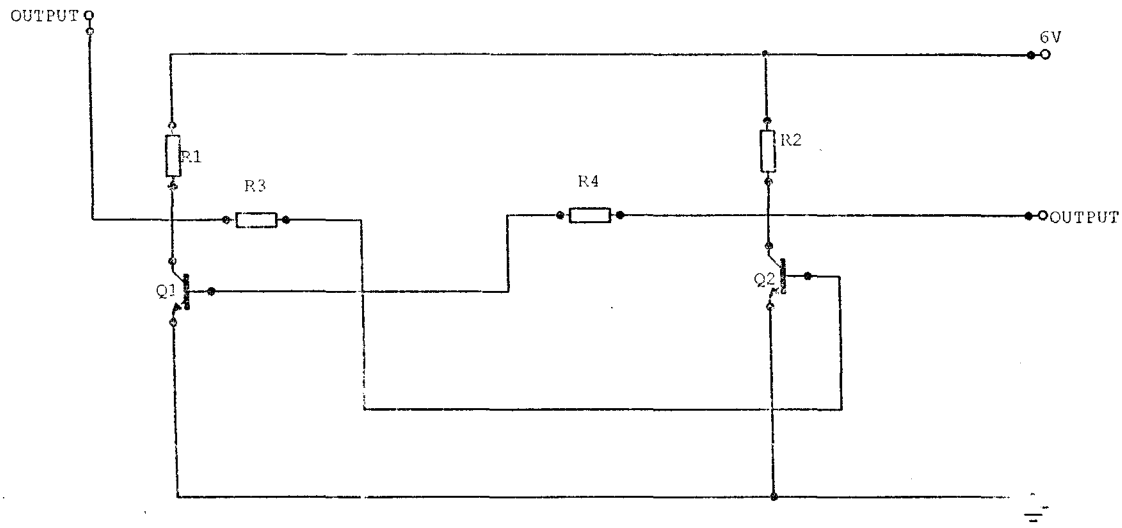


Fig 2.2 A biastable multivibrator using discrete component

When the supply is switch on Q1 turns on first as suppose when it is saturated, its collector will be within 0.3V of earth. This means no current will flow through resistor R3 into the base of transistor Q2, because it takes about 0.6V to obtain significant conduction in the silicon junction.

Therefore Q2 will remain off. Note that as along as Q2 is off,

Its collector is up at 6V so that current is flowing via resistor R4 into the base of Q1 maintaining status quo, the circuit is in a stable state.

Now, if the base of Q1 is momentarily short to earth starving it of base current, its collector current will fall to zero and collector voltage rise to +6V, Q1 has turned off but Q2 on. Q2 saturated with its collector near zero volts, thus preventing any current flowing into Q1 base even when the short is removed. Once more the circuit is in a stable state, but this time Q2 is on.

As the name suggest, the bistable multivibrator after two states which makes it to be a basic building block in digital circuit being employed in contents and memories in digital circuit it is called a flip-flop.

2.3.4 ASTABLE CONFIGURATION OF 555 TIMERS

The astble configuration of a 555 timer is as shown below in figure 2.3(a) and the output waveform in figure 2.3(b)

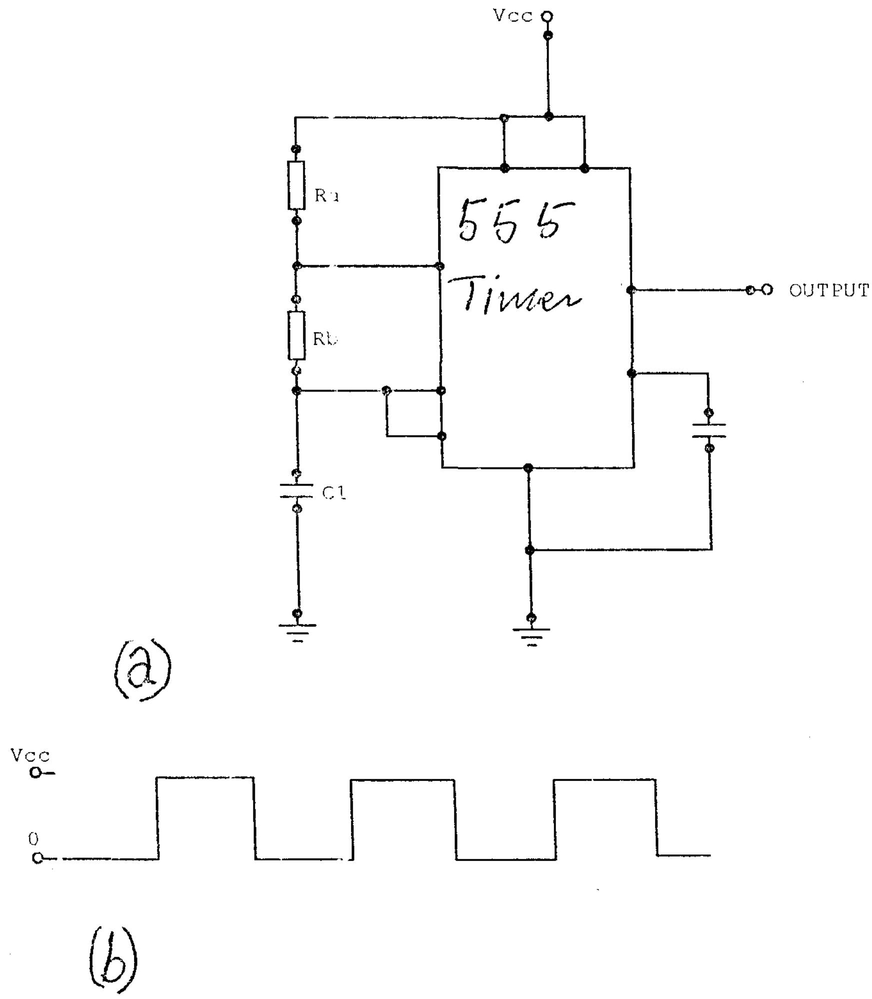


Fig 2.3(a) Astable 555 timer (b) output waveform of an astable 555 timer.

A 555 timer configured as an astable multivibrators is a continuous pulse generator for operating most digital circuit the operation of the 555 timer depends on the external resistors Ra and Rb and the capacitor C.

When the supply voltage is applied the capacitor C changes through Ra and R_b to the third of supply voltage and this effect makes the upper comparator inside the 555 timer to trigger the flip-flop which in turn causes the capacitor to start discharge through R_b. When the discharge reaches one-third of supply voltage, the lower comparator is trigged and a new cycle is started.

Charging time $t_1 = 0.693[R_a + R_b]C$ 2.1

Discharging time $t_2 = 0.693 R_bC$ 2.2

Period T = $0.693\,[R_a + 2R_b]C$ 2.3

Frequency of operation f = 1/T = $\frac{1.443}{(R_a + 2R_b)\,C}$ 2.4

2.4 **DUTY CYCLE**

This determines how the pulse shaping of the output pulse will look like. The duty cycle (D) of a recurring pulsed is defined as the ratio of the On time to the total cycle.

$$D = t_{i/T} = \frac{R_a + R_b}{R_a + 2R_b} \qquad 2.5$$

$$\%\text{ duty cycle} = \frac{R_a + R_b}{R_a + 2R_b} \qquad 2.6$$

When R_a is made very small as compared to Rb, then D= ½ x 100% = 50% meaning that the "ON" time t_1 is equal to "OFF" time t_2 and hence a symmetrical square wave can be obtain. However, if R_a is made so large that it cannot be ignored, then a duty cycle higher then 50% will be obtain meaning that the "ON" final is greater then "OFF" time.

2.5 **COUNTERS**

A counter is a digital circuit that consist of n-flip-flop connected in cascade whose functions is to count the number of pulses applied to its input terminals (pins). The maximum number of possible 1 and 0 state is know as the modules of the counter and this cannot be greater than 2^n.

2.5.1 **TYPES OF COUNTERS**

1. Asynchronous or Ripple counter – it is counter that the outputs of the flip-flops are not in exact synchronism with the input pulse; i.e the clock will trigger the first flip-flop. The output of which will trigger the seconds flip-flop etc.
2. Synchronous or parallel counters- the outputs of the flip-flops change state immediately the pulse or clock is received. The advantage of this counter over asynchronous one is that all the flip-flops change states simultaneously in parallel thereby reducing the propagation delay to an appreciable value.

2.5.2 **KIND OF COUNTERS**

1. Pure binary counter – it is a counter that follows the normal binary counting sequence till 2^n -1 before it resets where n is the number of flip-flops.

2. Binary counter- It is a counter that follows the normal binary counting order till 2^N before it resets, where n is the number of flip-flops.
3. Decade counter – Also known as BCD counters when it counts in sequence from 0000 to 1001, is a counter that has 10 distinct states no matter what the sequence is. In most cases, it consists of four flip – flops connected asynchronously or synchronously (depending on the maker and type) to count in binary from 0 to 9. The mode of counting is as given in the table 2.1 below.

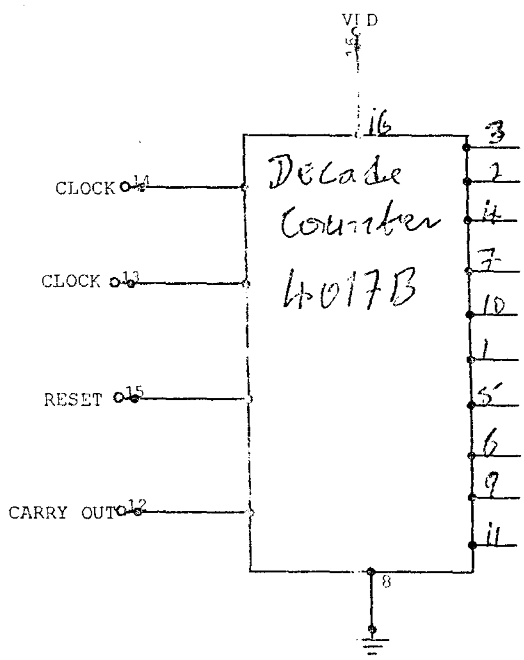
count	Output			
	QD	QC	QB	QA
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

Table 2.1 Output sequence of a decade counter.

2.5.3 **IC DECADE COUNTERS.**

There are series of IC chips that can be configured to work as a decade counter, example are DM741390, TTL and HCC4017B CMOS IC. But HCC4017B will be talked about in this project work. HCC4017B is a monolithic circuit available in 16-lead dual in line plastic package. It consists of 5 (five) stage Johnson counters having 10 decoded outputs respectively. Input included a CLOCK, a RESET and a clock INHIBIT signals. Schmitt bragger action in the clock input circuit provides pulse shopping that allows unlimited clock input pulse rise and fall times. The counter is advanced are count at the positive clock signal transition if the clock inhibit signal is low, counter advance via the clock line is inhibit when the clock inhibit signal is high and a reset signal clears the counter to its zero count. HCC4017B permits high speed operation, 2 inputs decimal decoded gating and spike free decoded outputs. Anticlock gating outputs are normally low and go high only at their respective decode time slot.

Each decoded output remains high for one full clock cycle. A carry out signal completes one cycle every 10 clock input cycles. The pin layout and circuit configuration of 4017B is shown below.



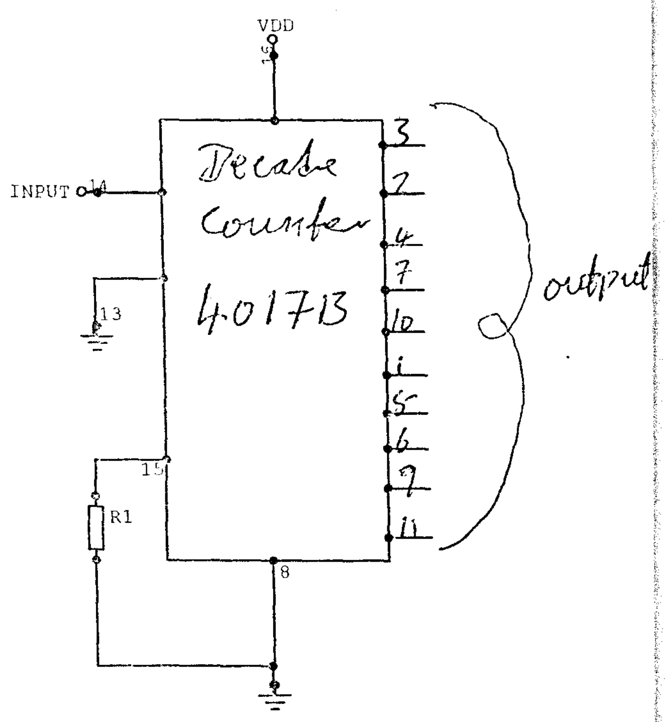


Fig 2.4 (a) 4017B pin out (b) circuit configuration of 4017B

2.6 RELAY

Most relays are electromechanical switches that work on the effect produced by current flowing through a coil.

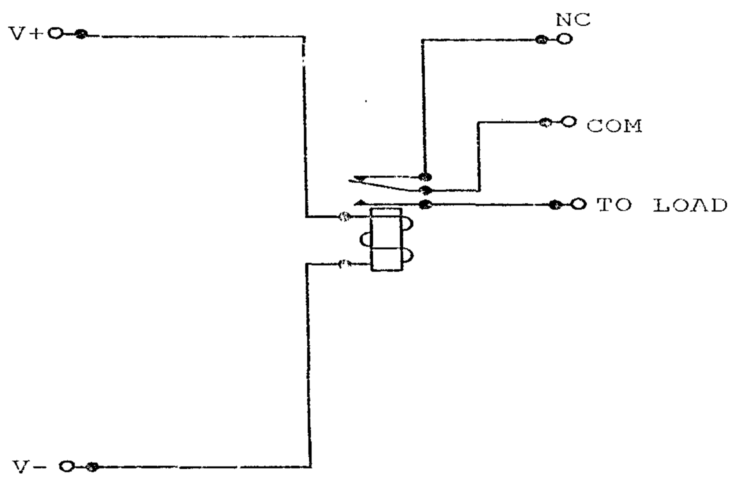


Fig 2.5 Typical structure of a relay

A signal current flowing through the coil magnetizes a bar of soft iron armature C which is drawn to the coil and opens and closes contact NC and No respectively.

The advantages of a relay are that it enables a large current to be controlled by a small current and also enables the control circuit to be isolated from the controlled circuit.

The opening and closing of contacts by a small current is made possible owing to the large number of turns on the coil which create a very large magnetomotive force according to the equation 2.7 below

Magnetic field strength $H = IN/L = F/L$--------------- 2.7

I = is the current flowing in the coil

N = is the number of turns of the coil

F = is the magnetizing force

L = is the length of the coil

Hence,

$F = I N$ ------------- --------------------------------------- 2.8

2.7 DISPLAY COMPONENTS

Choice of electronics display components.

The choice of electronics display components depends on so many factors. The basic ones being considered in the selection of display component are as given below.

i. type and amount of information to be displayed

ii. operating environment

iii. power availability

The consideration of these factors should be able to answer the following questions.

i. What do you want to display?

ii. Where do you want to display it?

iii. How much power do you have to give the display?

In terms of the environmental factor, the display components should be of the brightest type if it is suppose to be in high ambient environments the outside, in the sun.

2.7.1 LIGHT EMITTING DIODES (LED)

The junction of certain semi conducting compounds notably gallium phosphide and gallium arsenide, emit light when forward biased. Forward current from 5mA to 80mA are usual, a series resistor being used to limit the current drawn. LEDs are available in red, green and yellow, give ample brilliance for use as indicators.

LEDs are used for various purposes because of their characteristics of being able to operate under a very harsh environmental condition ie very high ambient temperature, high or low pressure, intermittent change in environmental temperature etc and also because of its lower power consumption and voltage of about 10mW and 2volts respectively. due to easy connection of LEDs in series or parallel, it can be use for display in sign post, disco light, running message display, and adjustable dancing lights.

In circuits a series resistor is connected to the LEDs to limit the current drawn and the value of which is given to equation 2.9

$$Rs = \frac{V - Vf}{If} \qquad \text{---------------------------} \; 2.9$$

Where,

V = supply voltage

Vf = forward voltage

If = forward current

The forward voltage and the forward current of the LEDs can be found in the data book of the LED.

2.8 TRANSFORMERS

A transformer is a piece of electrical apparatus which consists of two or more electrical circuits (primary and secondary windings) interlinked by a common magnetic field for the purpose of transferring energy between the windings. The windings are wound on a magnetic core, which ensures that there is high magnetic flux linkage between the windings. An alternating voltage across one winding will induce alternating voltage in the other and the induced voltage depends on the number of turns on the windings.

When the number of turns on the secondary winding is more than that on the primary we have a step- up transformer but when it is the reverse (vice - versa), we have a step – down transformer. The relationship between voltage windings and current is as given in equation 2.10

$$\frac{V_p}{V_s} = \frac{N_p}{N_s} = \frac{I_s}{I_p} \quad \text{---------------------------- } 2.10$$

Where, Vp, Np and Ip are the primary voltage, number of turns on the primary winding and current in the primary winding respectively while Vs, Ns and Is are the voltage, number of turns in the secondary winding and the current in the secondary winding respectively.

There are two general types of construction of transformer namely core type and shell type transformer.

2.8.1 CHOOSING AND SPECIFYING TRANSFORMERS

A transformer is specified according to its power, voltage and current rating of the secondary winding and the regulation. Power rating is the product of voltage and current of the secondary winding which can be neglected once the voltage and current rating have been specified.

Regulation specifies the degree to which the secondary voltage varies with the load. This has to be considered when working out the maximum voltage rating of the smoothing capacitor.

Once the required voltage is known, it is only necessary to pick a transformer which gives the output at the required current rating.

Transformer maximum voltage is given as

$$V_{TX\,max} = \frac{V_{TX}[1 + Reg_{TX}(1 - I/I_{TX}) + REg\ mains]}{100} \quad \text{------------- } 2.$$

Transformer minimum voltage is given as

$$V_{TX}\,min = \frac{V_{TX}\,[\,1 + Reg_{TX}\,(1 - I/I_{TX}) - Reg\ mains]}{100} \text{ -------------2.12}$$

Where,

V_{TX} = stated transformer voltage

I_{TX} = stated transformer current

I = current drawn from the transformer

Reg_{TX} = stated transformer regulation factor = 13%

Reg mains = stated mains regulation factor = 6%

It is important to note that transformer minimum voltage evaluated at full load is used for selection of transformer; maximum voltage evaluated at zero loads is used to calculate the smoothing capacitor working voltage; maximum voltage evaluated at full load is used to determine regulator power dissipation.

2.9 CAPACITOR

It is a passive components for storing electric charges and has a capacitance which is the ability of a dielectric to store electric charge.

$$C = Q/V \text{ ----------------------------2.13}$$

Capacitor functions in many electronics circuit as a decoupler and as well as a smoothner. In a circuit where both ac and dc is present, it is used to eliminate ac ripple, mostly in dc power supply i.e. smoothing the peaks and through of the voltage by working on the reservoir principles – it charges the capacitor during the peaks and discharges during the through to give an over all smoothed output.

The value of a smoothing capacitor is determined using equation 2.14 below.

$$C = \frac{IT}{Vpeak - Vreg} \text{ ------------------- 2.14}$$

I = current draw

T = period

Vpeak = maximum voltage

Vreg = regulated voltage

Note Vripple = Vpeak – Vreg ---------------------------------2.15

2.10 DIODES

Semiconductor diodes act on the basis of PN junction. It is constructed by combining a P types and N type semiconductor materials. A diode in most cases acts as a switch because it can only pass current in one direction within a specified limit. When the diode is reverse biased, and it conducts a very little current until it reaches a certain voltage called the breakdown voltage. A diode constructed to act in this region of breakdown voltage is called a zener diode.

2.10.1 diode Application

Diodes are used in the following circuits

1. rectifier circuit
2. clipping circuit
3. clamping circuit
4. voltage doublers circuit
5. over voltage and current regulation circuit

On this project work we are going to discuss rectifiers. Rectification is a process of changing AC voltage or current to a DC voltage or current.

2.10.2 TYPES OR RECTIFICATION

1. Half wave rectifier
2. Full wave rectifier – a (bridge rectifier)

In this project report, full wave bridge rectifier will be discuss

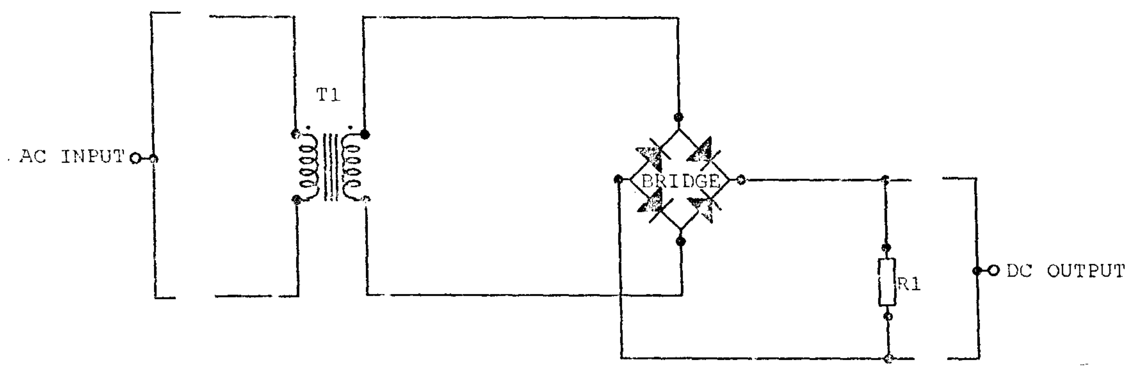


Fig. 2.6 full wave rectifier with resistive loade

The output wave form of full – wave rectifier is shown below

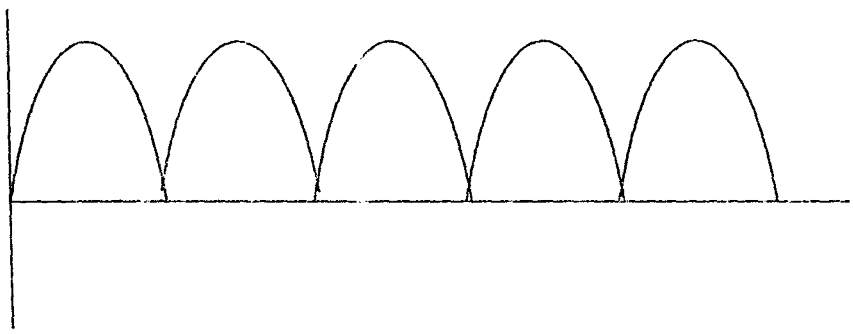


fig 2.7 (a) full – wave rectifier output wave form

The output wave form of the filter is shown below

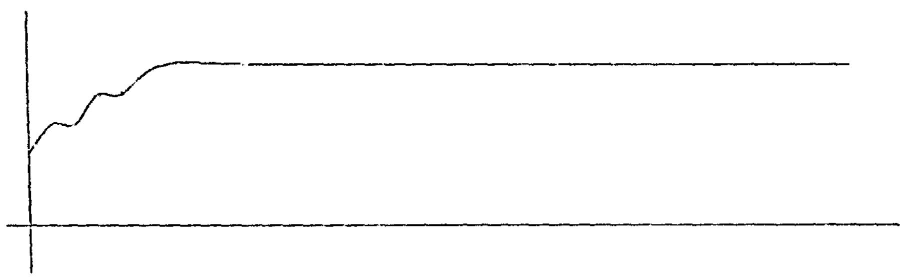


fig 2.7(b) filter output wave form

The mathematical expression of diode is shown below

$V_I = Vm \text{ Sin } wt$ -- 2.16

$I_1 = Im \text{ Sin } wt$ -- 2.17

$Irms = \frac{1}{2}\pi \, S^{2\pi}_0 \, I^2 d\,(wt) = Im/\sqrt{2}$ -------------- 2.18

$Vrms = \frac{1}{2}\pi \, S^{2\pi}_0 \, V_1 \, d\,(wt) = Vm/\sqrt{2}$ ------------2.19

$Idc = \frac{1}{2}\pi \, S^{2\pi}_0 \, I \, d(wt) = 2Im/\pi$ -------------------2.20

$Vdc = 1/2\pi \, V_1 \, d(wt) = 2Vm/\pi$------------------- 2.21

With a resistive load

$Vdc = 2\sqrt{2}/\pi Vrms = 0.9 \, Vrms$ -------------------------2.22

$Idc = 2\sqrt{2}/\pi Irms = 0.9 Irms$----------------------------2.23

With a capacitive filter

$Vdc = 1.47\ Vac$ -- 2.24

$Idc = 0.62\ Iac$ --2.25

Due to the diode voltage drop Vd

$Vdc = 1.42\ Vac - Vd$ ------------------------------------2.26

2.10.3 PEAK INVERSE VOLTAGE

This is the minimum voltage to which the diode can be subjected to and it is Vmax for bridge rectifier. Other components use in realizing this project work that are not discuss here are transistor and connecting wires.

2.11 RESISTORS

Resistors are used in electronic circuit to provide specific path for electric currents and to serve as circuit element that limits the current to some desirable value. Resistors limit the currents in a circuit by conr ecting the flow of electron into heat.

2.11.1 TYPES OF RESISTORS

I. Fixed resistors: it has a fixed i.e. constant resistance value which cannot be changed.

II. Variable Resistors: This type of resistor may be adjusted mechanically with a screw driver, or have a resistance which depend on light or pressure.

2.11.2 PHOTO RESISTORS

Photo resistors are light- controlled variable resistors. A photo resistor is usually very resistive (in mega ohms) when placed in the dark. When it is illuminated, it resistance decreases significantly; it may drop as a few hundreds ohms, depending on the light intensity. It is used in light and dark activated switching circuit and light sensitive detective circ its.

CHAPTER THREE

DESIGN ANALYSIS AND CALCULATIONS

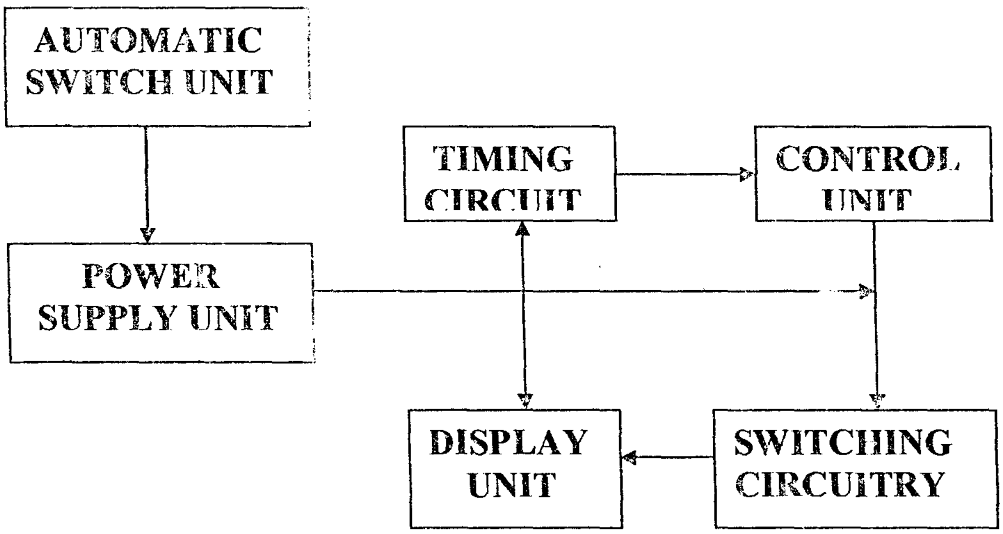


Fig 3.1 Block diagram of automatic electronic display board.

3.1 AUTOMATIC SWITCH DESIGN

The automatic switch is designed using bark activated switch circuit. This circuit will activate a relay when it is dark. The light sensor used is light dependent resistor (LDR). In bright light the resistance of the LDR can be as low as 80ohm and at 8'olux (darkness) the resistance increases to over 1M ohm. Op – amp is used to sense the voltage difference between pins 2 and 3. The variable resistor (VR) is used to adjust or provide a wide range for light intensities. In the day time the output of the op – amp is about 2 volts.

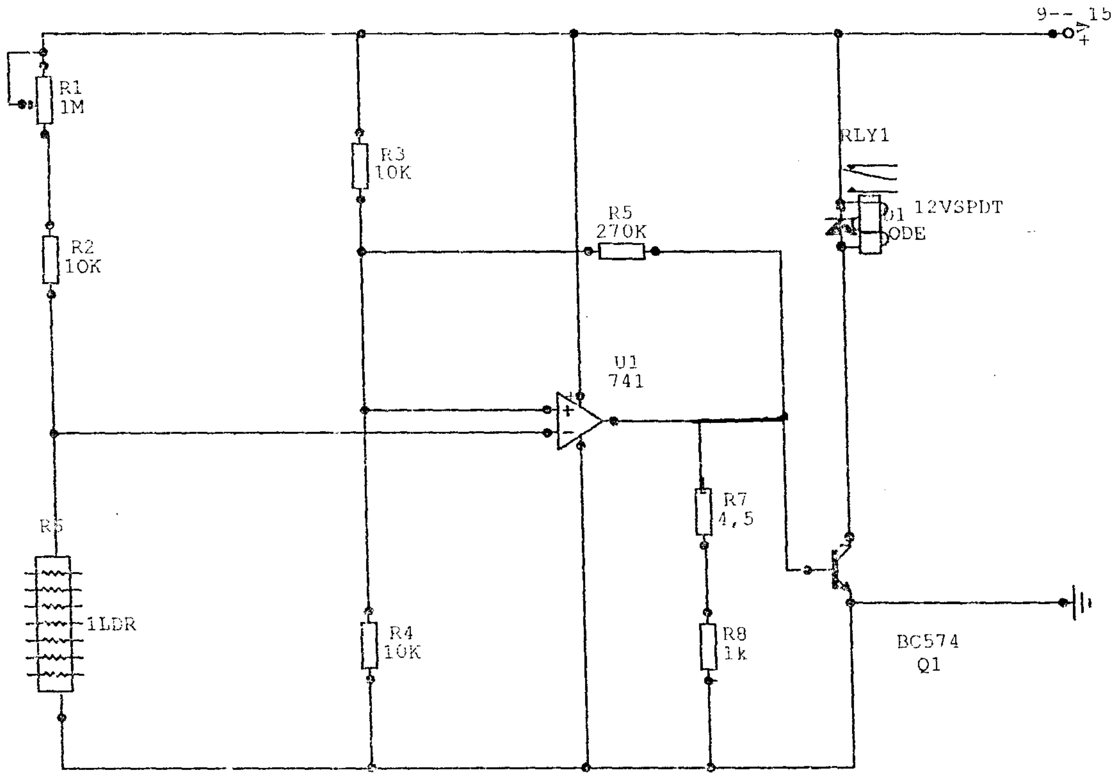


Fig 3.2 Automatic switch circuit diagram

When it is dark, the resistance of the LDR increases and the difference in input voltage is amplified by the op – amp, the output will swing towards full supply and drive the transistor which drives the relay. The 270k resistor provides a small amount of hysteresis, so that the circuit switches on and off with slightly different light levels. This eliminates relay chatter.

3.2 POWER SUPPLY DESIGN CALCULATION

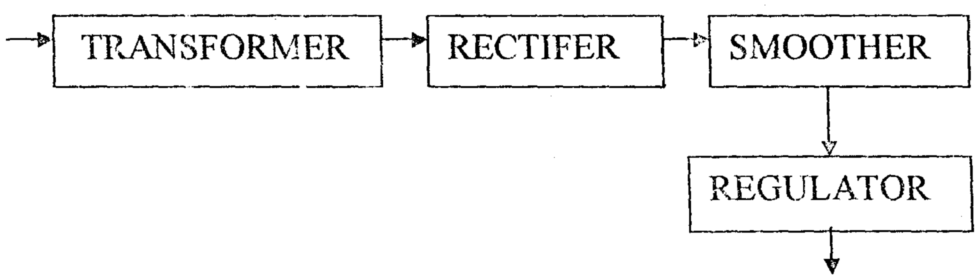


Fig 3.3 Block diagram of power supply

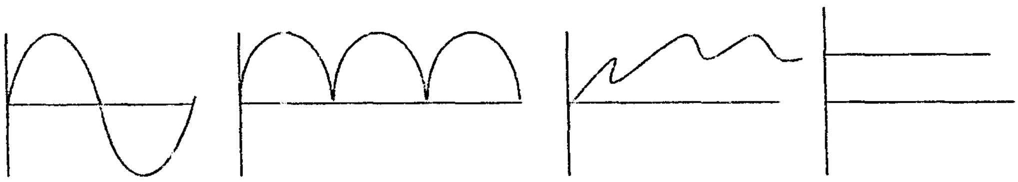


Fig 3.4 Output waveforms of the stages of power supply unit

A 5v and 9v power supply is to be designed choosing suitable transformers, rectifier and regulator is quite easy since specified values of this components are already available. Hence 15V, 2A transformer was chosen, also 5V and 9V regulator (7805 and 7809 respectively) were selected for regulation. The minimum regulators input voltage is +7v and +11v according to data book.

Minimum transformer output voltage and current are as given by equation 2.24 and 2.25 in chapter two respectively.

$V_{dc} = 1.414\ V_{ac}$ ---2.4

I.e. $V_{ac} = V_{dc}/1.414$

$I_{dc} = 0.62\ I_{ac}$ ---2.5

I.e. $I_{ac} = I_{dc}/0.62$

Due to the diode voltage drop Vd, the Vdc is given by the equation 2.6

$V_{dc} = 1.414V_{ac} - 2V_d$ ---2.6

Therefore, $V_{ac} = V_{dc}/1.414 + 2V_d$

Where $V_d = 0.7$

For 5V and 9V dc supply the minimum regulator input voltage (+7 and +11) is used for the calculation.

Then $V_{ac}\ (5V) = [7 + 2\ (0.7)]/1.414 = 5.94V$

$Vac\ (9V) = [12 + 2\ (0.7)]/1.414 = 9.48V$

$I_{ac} = 1/\ 0.62 = 1.667A$

15volt transformer was chosen to provide not less than calculated minimum voltage of the regulators.

$V_{TX}\ (min) = 15\ [1 + 13\%\ (1 - ½) - 6\%]$

The equation used is equation 2.2

$$V_{TX}\ min = V_{TX}\ [1 + Reg_{TX}\ (1 - I/I_{TX}) - Reg\ mains] \text{ --------------------------------- } 2.2$$

Using 15v secondary voltage, 2 Amps transformer

$V_{TX}\ min = 15\ [1 + 0.13\ (1 - ½) - 0.06] = 15.1$ volts

$Vpeak = 1.414\ V_{TX}\ min - 2Vd$

$= 1.414\ (15.1) - 2\ (0.7) = 19.81$

$Vpeak = 19.81$

Smoothing capacitor value is calculated using equation 2.7

$C = I\ T/(Vpeak - Vreg)$

$I = 1Amp$

$T = 0.01$

$Vpeak = 19.81$

$Vreg = 7v$ and $11v$

The capacitor value

$C = 1 \times 0.01/(19.81 - 11)$

$= 1135$ uf (for 9 volt regulator)

Capacitor working voltage is

$V_{TX}\ (max) = 15\ [1 + 13\%\ (1 - 0/1) + 6]$

= 15 (1 – 013 (1) + 0.06) = 17.85v

Vpeak = 1.414 x 17.85 – 2(0.7) = 23.84V

The working voltage is rounded up to be 25V

The ripple factor δ is also considered, which should be kept minimum – say 0.04.

For δ to be 0.04

F = 50Hz

Vrms = 15V, Vmax = √2 Vrms = 21.21V

Idc = I_A

Therefore, a suitable filter capacitor value can be calculated as:

0.04 = 1/ (4 x √3 x 50 x C x 21.21)

C = 1/(4 x √3 x 50 x C x 21.21 x 0.04) = 3403uf

Capacitor C2 and C3 were specified in the data sheet to be 220nf and 45nf respectively.

The circuit diagram of the power supply is shown below. In the circuit, 1uf, 160V capacitor was fitted at the output of the regulator to keep the output resistance of the circuit constant at high frequency.

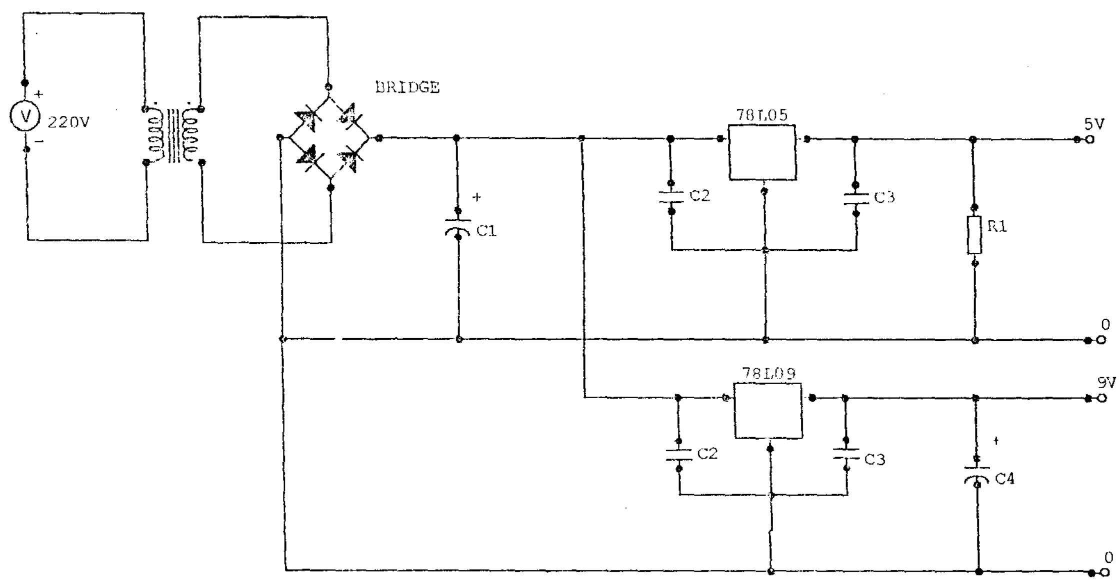


Fig 3.5 full diagrams of the power supply.

3.3 TIMING CIRCUIT CALCULATION AND DESIGN

The period of the output waveform is chosen to be three minute and lass than one second for the two timing circuit respectively.

Timing circuit A

10uf timing capacitor C was selected, resistor (timing resistor) R8 and R9 are choosing so as to achieve a duty cycle of about 50% that is R8 >> R9

$T = t1 + t2 = 3S$

Duty cycle $D = t1/T$

$t1 = 1.5S$

But $t1 = 0.693\,(R9 + R8)\,C$

$t2 = 0.693\,(R8)\,C$

Selecting $R9 = 10{,}000\Omega$

Since

$t1 = 1.5 = 0.693\,(R9 + R8)\,C$

$= (1.5/0.693C) - R9$

$= (1.5 / 0.693 \times 10 \times 10^{-6}) - 10{,}000$

$R8 = 206450\,\Omega$

Frequency $1/T = 1/3 = 0.33Hz$

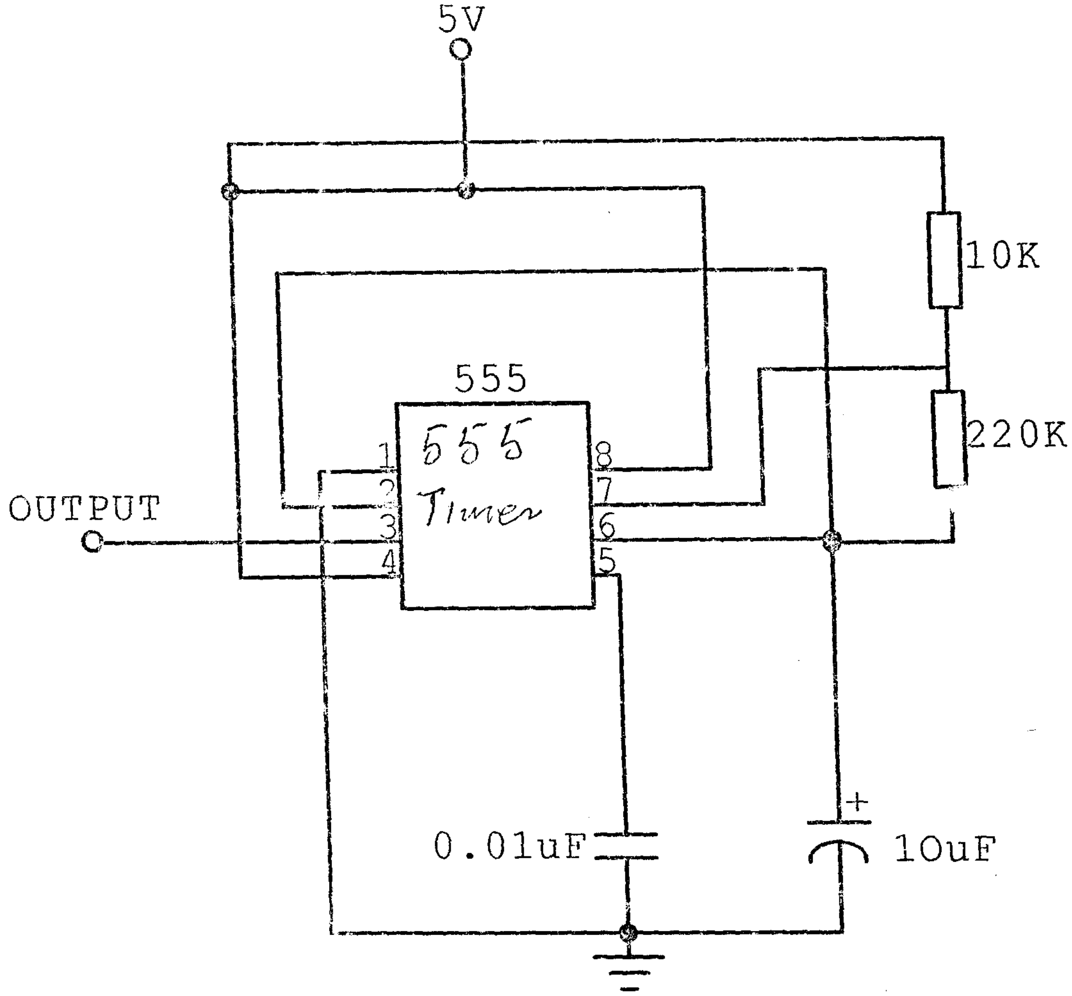


Fig.3.6 Timing circuit (A) diagram

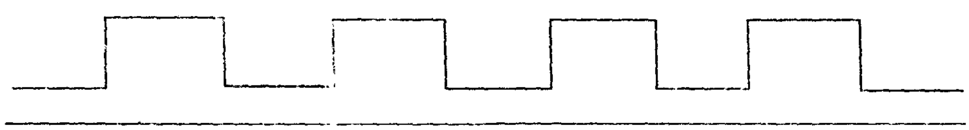


Fig 3.7 output wave of the timing circuit

Timing circuit B

470uf timing capacitor was selected. The timing resistor R7 and R6 are 1k Ω and 500 Ω

$$t1 = 0.5 = 0.693\ (R7 + R6)\ C2$$

$$= (0.5/0.693 \times 470 \times 10^{-6}) - R7$$

$R6 = (0.5/0.693 \times 4?0 \times 10^{-6}) - 1000\ \Omega = 535\ \Omega$

$R6 = 535\Omega$

But for a time less than a minute 400 Ω resistor was chosen and used i.e. the time T = 0.693 (R7 + 2R6) C

$T = 0.693\ (1000 + 2 \times 400) \times 470 \times 10^{-6} = 0.58$ seconds

The period of the output waveform is 0.58seconds which is less than 1 minute

Frequency $1/T = 1/0.47 = 1.7Hz$

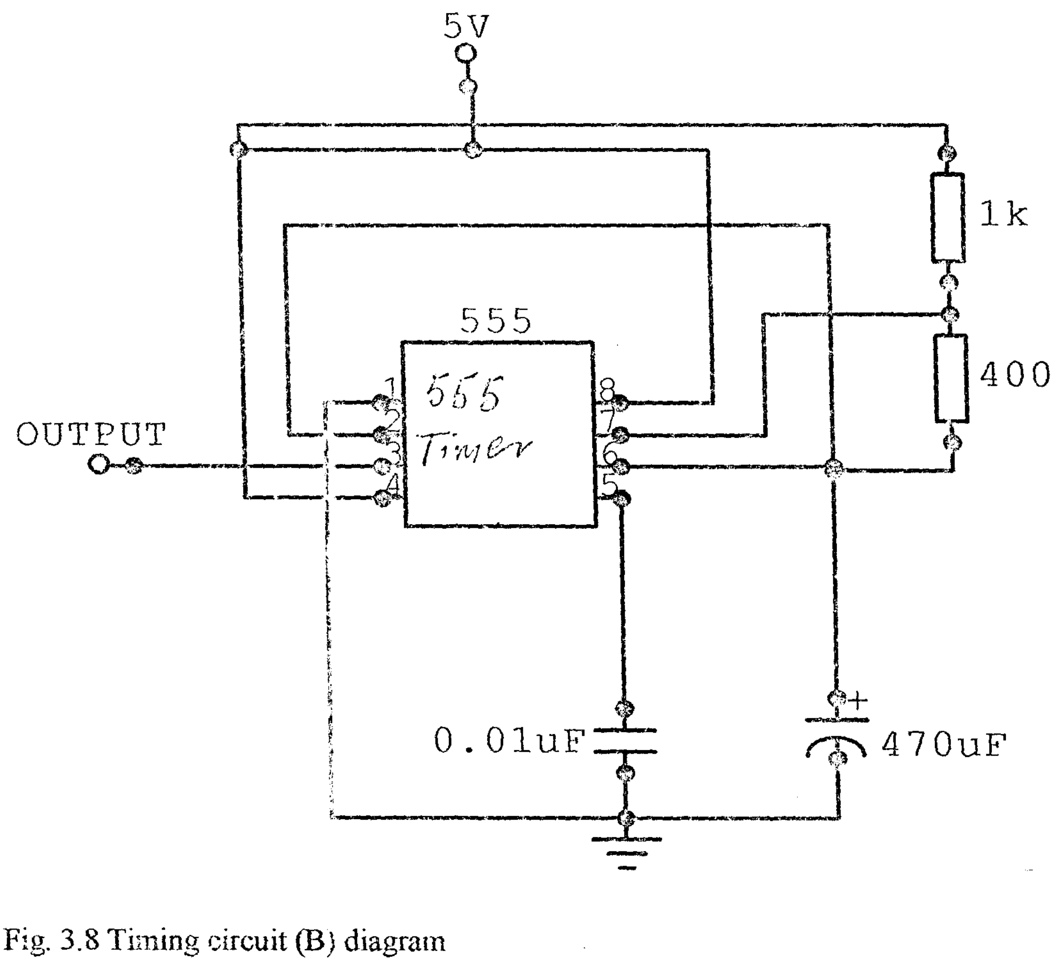


Fig. 3.8 Timing circuit (B) diagram

3.4 DESIGN OF CONTROL UNIT

From the data book, R11 and R10 which connect the pin 15 of the counters to the ground are to be selected between 10K Ω and 2n Ω.

Diode D2 – D46 are employed because of the characteristics that it allows the flow of current in only one direction. These diodes prevent the flow of current back to the counter.

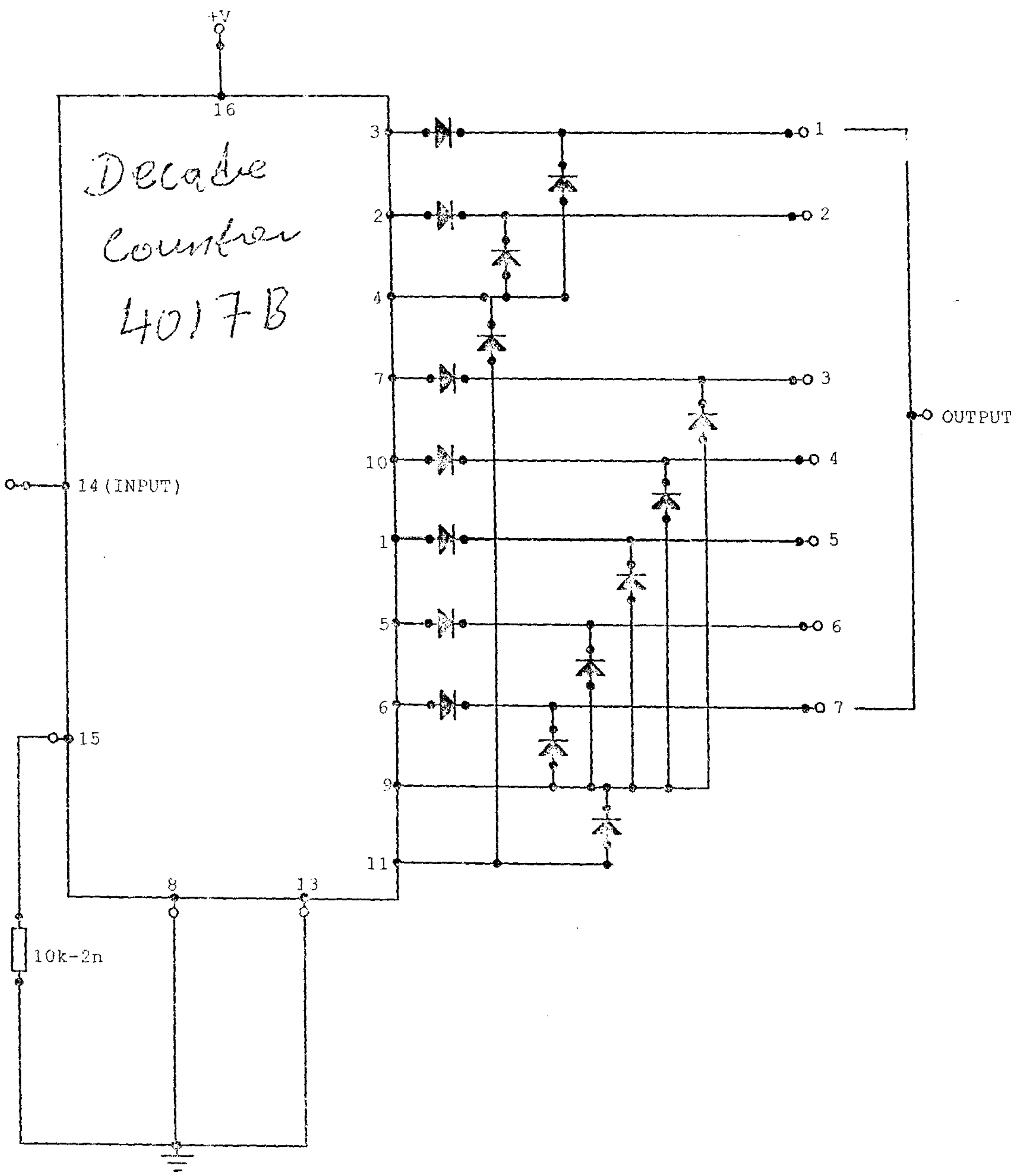


Fig 3.9 Control unit (A) circuit diagram

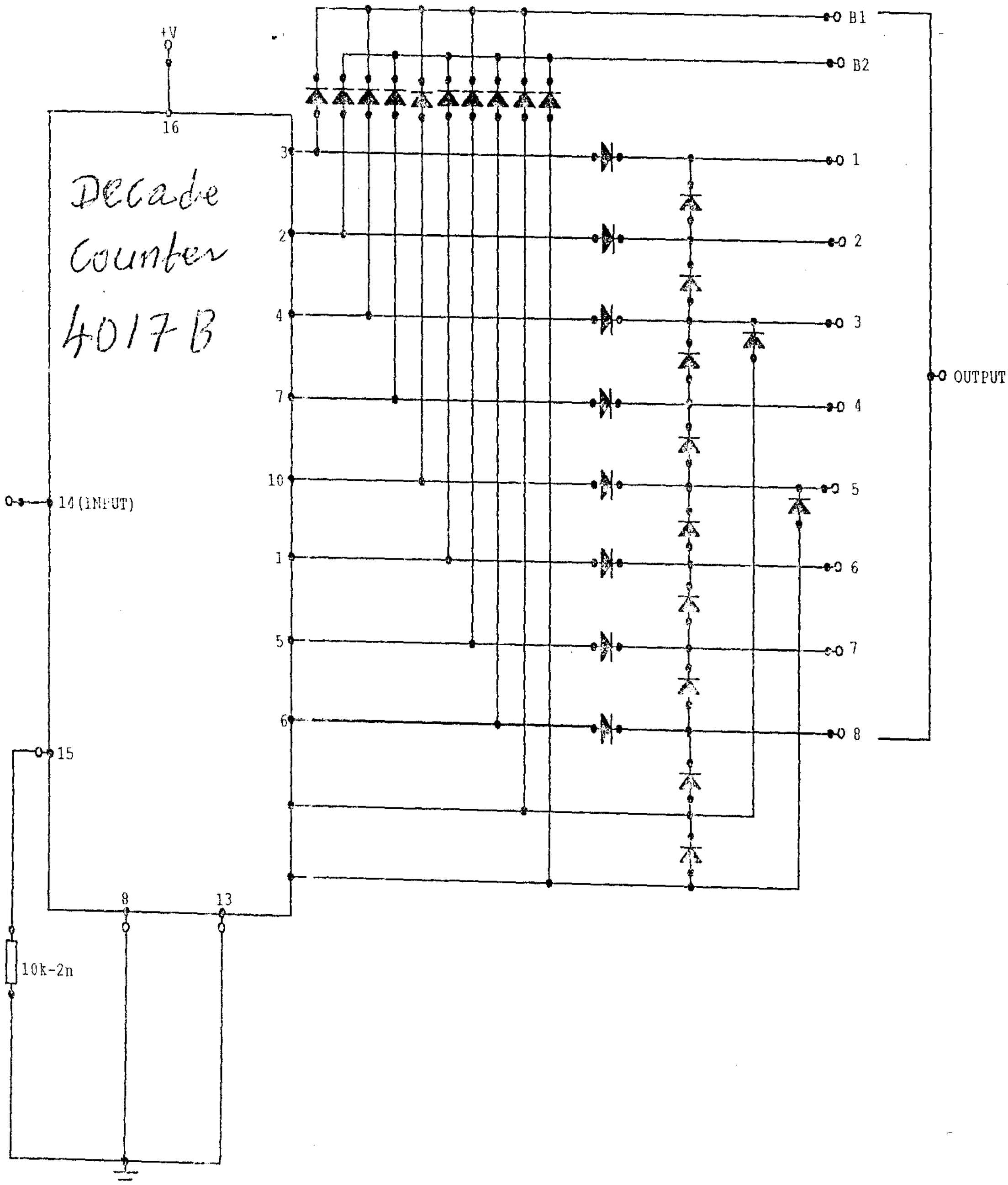


Fig. 3.13 Control unit (B) circuit diagram.

3.5 SWITCHING CIRCUIT

The transistor (a driver) which is required to boost the signal at the output in order to compensate for the drop as designed using 1k Ω resistor as the base resistor and the relay resistance of 100 Ω as the collector resistance.

Since R12-28 = hfc sat Rc

Where hfc sat = 10

R12-28 = 10 x100 = 1k Ω (the base resistor)

Hence R12-28 = 1k Ω

A general purpose transistor was selected for the switching.

6V relays were to control the supply to the display unit (load). The coil transient suppression which is a problem with relay relates to the collapsing magnetic field of the relay coil generating a transient or e.m.f voltage is protected using D47 – D63 which is connected in parallel with the coil.

This voltage if unsuppressed will destroy the transistor.

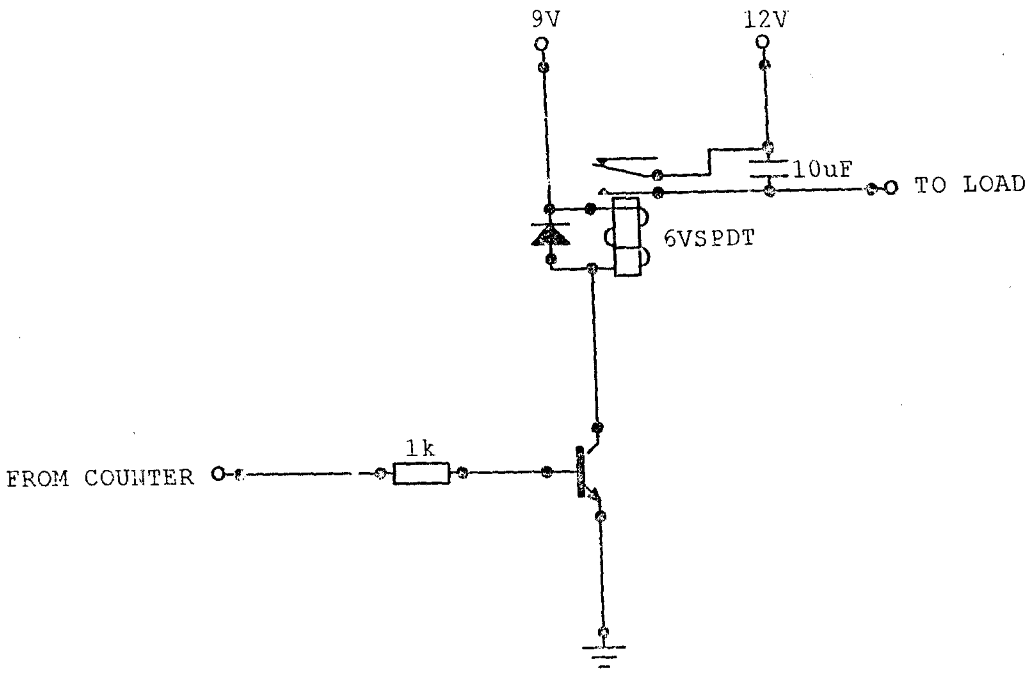


Fig 3.10 switching circuit diagram

The diode becomes forward biased as a result of the induced reversed voltage of the coil and the diode remains ON until the induced voltage drops to less than 0.6V.

Also 10uf, capacitor was used to suppress the arcing or spark discharge at the contacts. DC arcing or spark discharge causes metal to transfer from the negative contact to the positive contact.

Contact shunting or arc suppression is used to eliminate contact arcing when switching the load.

The capacitor value is given by $C = I^2/10$

Where

I = circuit current (A) = 10A

C = capacitance (uF)

$$C = 10^2/10 \times 10^{-6} = 10uF$$

The input of the switching circuits is connected to each of the control unit outputs (decade counter).

3.6 DESIGN OF THE DISPLAY UNIT

The design unit of this electronic display board is 5ft 7inches by 2ft 8inches. The casing is made of a metal pan with a reflective tinted glass at the front of the casing. The words are displayed with LEDs on a wooden board. This was realized using dot matrix format in writing the words.

On the 1st row `FUT MINNA` is displayed

The 2nd row displays `ELECTRICAL AND COMPUTER`

The 3rd row displays `ENGINEERING DEPARTMENT`

The 4th row displays ` You're Welcome`

These words are displayed with Red colour LEDs with orange colour LEDs at the middle of every letter. Also a boarder line is displayed in two lines using Red colour LEDs and Green colour LEDs the display circuit layout is shown below.

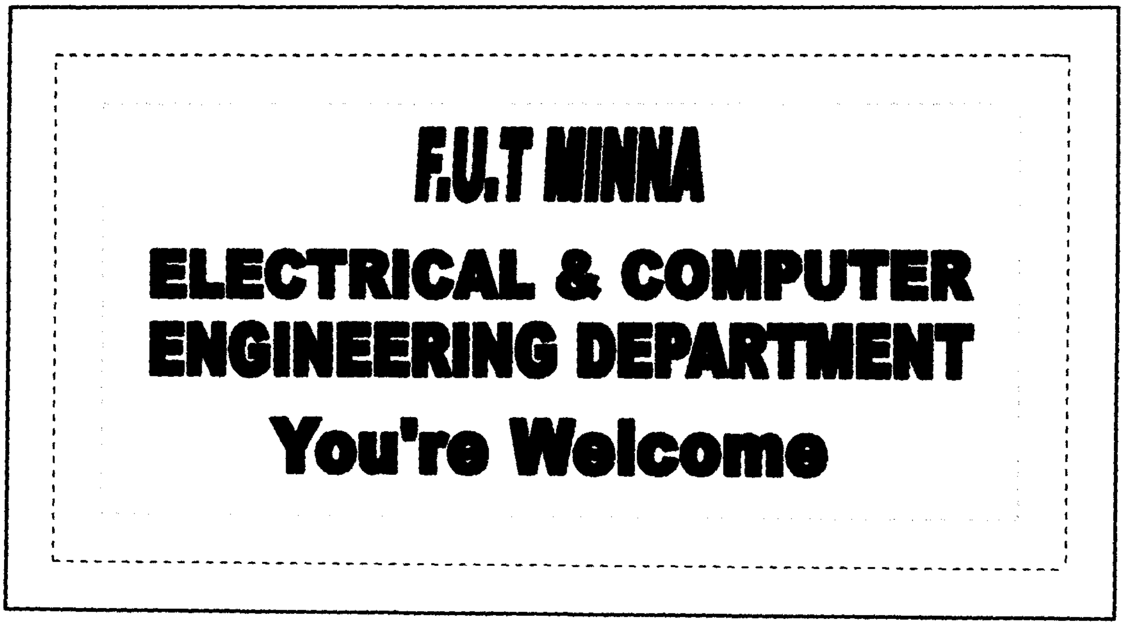


Fig 3.11 display circuit layout

The number of LEDs use for each load (letter or word)

Are as follows-

F.U.T	112 LEDs
MINNA	202 LEDs
ELECTRICAL	252 LEDs
& (AND)	28 LEDs
COMPUTER	243 LEDs
ENGINEERING	325 LEDs
DEPARTMENT	304 LEDs
YOU	31 LEDs
`re	20 LEDs
W	21 LEDs
E	10 LEDs

L	7 LEDs
C	7 LEDs
O	8 LEDs
ME	24 LEDs
Border line	484 LEDs

The LEDs are connected in parallel to form a letter or word. This is done by connecting the anodes of the LEDs together and the cathode together and soldered. About 2100 LEDs was used in this project for the displaying of the letters and the border line. Each letter was generated using dot matrix format as shown in fig below.

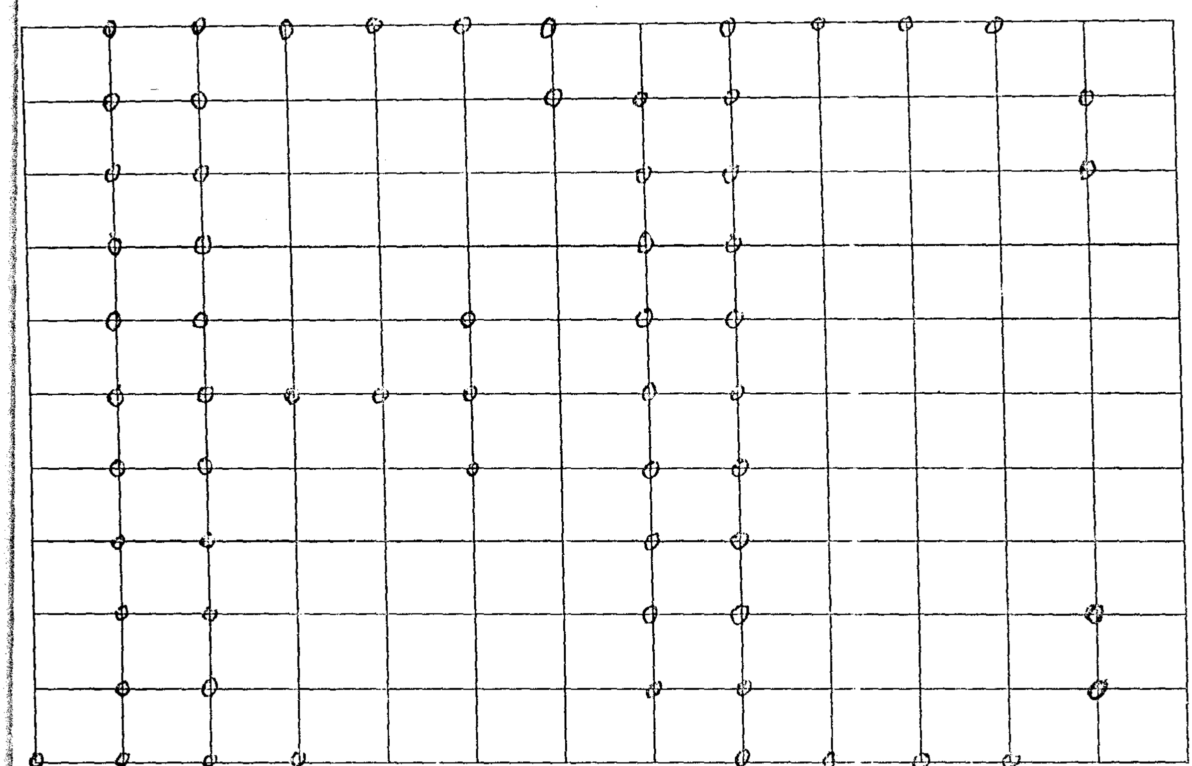


Fig 3.12 example of letters (FC) generated in matrix form with LEDs.

3.6.1 CURRENT LIMITING RESISTOR FOR THE LOADS

To protect the load from excessive current a resistor is placed in series with the loads (LEDs). The value of the resistor depends on the forward voltage Vf of the LEDs, the supply voltage V and the desired forward current If. This is given by equation below.

$$Rs = (V - Vf)/ If$$

The desired forward current to each LED = 20mA.

Supply voltage = 12V.

Forward voltage Vf = 3V

For each load the series resistor was calculated as shown below.

$$Rs = (V - Vf)/ N\ If$$

Where N = number of LEDs in a load.

In FUT we have Rs = (12 - 13)/ 112 x (20mA) = 4.016 = 4 Ω

MINNA: Rs = (12 – 13)/ 202 (20mA) = 2.227 = 2.2 Ω

ELECTRICAL: Rs = (12 – 3) / 252 (20mA) = 1.786 = 2.2 Ω

AND: Rs = (12 – 3)/ 28(20mA) = 16.071 Ω = 16 Ω

COMPUTER: Rs = (12 – 3)/ 243(20mA) = 1.852 Ω = 2.2 Ω

ENGINEERING: Rs = (12 – 3)/ 325(20mA) = 1.385Ω = 2.0Ω

DEPARTMENT: Rs = (12 – 3) / 304(20mA) = 1.480Ω = 2.0Ω

DEPARTMENT: Rs = (12 - 3) / 304(20mA) = 1.480Ω = 2.0Ω

BORDER LINE 1 = Rs = (12 – 3)/ 228(20mA) = 1.991Ω = 2.2Ω

BORDER LINE 2: = Rs = (12 – 3)/ 228(20mA) = 1.991Ω = 2.2Ω

You: Rs = (12 – 3)/ 31(20mA) = 14.516Ω = 15Ω

Are: Rs = (12 – 3)/ 20(20mA) = 22.5Ω = 23Ω

W: Rs = (12 – 3)/ 21(20mA) = 21.4Ω = 22Ω

E: Rs = (12 – 3) 10(20mA) = 45Ω

L: Rs = (12 – 3) 7(20mA) = 64.3Ω =64Ω

C: Rs = (12 – 3) / 7(20mA) = 64.3Ω = 64Ω

O: Rs = (12 – 3)/ 8(20mA) = 56.25Ω = 56Ω

Me: Rs = (12 – 3)/ 24(20mA) = 18.75Ω = 19Ω

CHAPTER FOUR

TESTING AND CONSTRUCTION

4.1 CONSTRUCTION

The implementation of this project was first modified on the breadboard and then transferred to the vero board.

The construction was done in two stages: the soldering of the circuits and the coupling of the entire project to the casing. After soldering the components on the vero board the modules of the design were securely held to a flat board.

4.2 TESTING OF THE OUTPUT OF EACH STAGE AND THEIR RESULTS.

After construction, various stages were initially tested for continuity and correct output using a multimeter to ensure that there was no short circuit or open circuit.

The different modules were tested one after the other:

i. Output of the power supply unit
ii. Output of the automatic switch
iii. Output of the timing circuit
iv. Output of the relay circuit and driver
v. The display unit
vi. The whole circuit

4.2.1 OUTPUT OF THE POWER SUPPLY UNIT

Next, the output of the power supply after the smoothing capacitors was observed using a 15v bulb, which gave a steady supply. The regulators were connected and tested using a multimeter. The output of 7805, 7809, and 7812 were 5v, 9v and 12v respectively. The test was done by placing the probe of the multimeter on the output terminal and the negative probe to the ground

4.2.2 OUTPUT OF THE AUTOMATIC SWITCH

The automatic switch which was powered with 12v was tested in the dark and light (brightness) to determine the efficiency of the switch. The switch was taken into a dark room at this time the relay was triggered (switched to the normally open). When the light in the room was put ON, the circuit automatically switched off the relay (switched to the normally close). The sensitivity of the switch was at this time adjusted.

4.2.3 OUTPUT OF THE TIMING CIRCUIT

After configuring the 555 timers in this circuit the output was tested using an LED and multimeter. This was done by connecting the LED at the output terminal and ground of the configured 555 timer. For the timer 1, the output which was calculated to be 3 (three) seconds (i.e. the period) was confirmed using the timer ON and OFF of the LED with stop watch. The time ON of the LED used for testing was 1.5 seconds and the time OFF was also 1.5 seconds, therefore the period is 3 seconds.

For the timer 2, the output is also measured using the same method. The time ON of the LED was less than ½ a second and the time OFF also less than ½ a second. The period was calculated as 0.58 second; therefore the period is less than 1 second. This timer 2 supply pulse to the switching border lines and **"you're welcome"**.

The frequently (f) of oscillation of the two timer was also measured using frequency meter.

4.2.4 OUTPUT OF THE COUNTER

After testing the 555 timers they were used to clock the decade counters. The output of the two decade counters. Were tested using multimeter and LEDs. The LEDs where connected at each ten output pins of the counters. The flashing of the LEDs (display time was observed and noted).

For the timer 1 and 2, the LEDs flashes at the interval of 3 seconds and approximately 1 second respectively for the two timers and switches to another output pin (LED) which light for the same time intervals.

After these testing, multimeter was used to measure the output voltage of the counter which was less than 5v.

4.2.5 OUTPUT OF THE RELAY CIRCUIT AND DRIVER

The output of the driver was measured using multimeter which confirmed that there was an increase in current after the driver. The outputs of the drivers were connected to the relays. When the circuit was powered, it was observed that each relay switched from normally close to normally open as designed and desired. LEDs were connected to the normally open and the ground was observed. The displays of the LEDs were as designed.-This gives the final testing of the first four stages of the project.

4.2.6 THE DISPLAY UNIT

On the completion of the display unit, various loads were initially tested for continuity, short circuit and open circuit using multimeter. Also the circuit was tested for proper connection of the LEDS i.e. that the LEDs which are connected in parallel do not have their poles interchanged.

During testing, some LEDs were found to be bad and were replaced. The other circuits were connected to the display unit after the test for continuity; short circuit and open circuit, etc were carried out.

The whole circuits were powered, after which the regulator (9v) and the transformer used was observed to be very hot. Also, the relays where not derived very well because of the low voltage supply from the NEPA through 9v regulator.

Hence another power supply was designed and constructed for the display unit only. This (power supply) supplies 12v to the display unit. The designed and construction was done using 12volts transformer 1 amp bridge rectifier, 33300uf – 25v smoothing capacitor etc

$$V = 12[(1+ 13 (1- 1/1) – 6)/100] = 11.28V$$

$V_{peak} = 1.414V_{Tmin} – 2Vd$

$$= 1.414 (11.28) – 2 (0.7) = 14.55V$$

$C = 1T/ (V_{peak} – V_{reg}) = 1 \times 0.01/ 14.55 – 7 = 1325 \times 10^{-6}$

C = 1325uf.

Smoothing capacitor working voltage is

$V_{TXMAX} = 12 [1+13(1 – 0/1) + 6/100] = 14.28V$

Vpeak equals 18.78V

Smoothing capacitor working voltage is

$V_{TXMAX} = 12\,[1+13(1-0/1)+6/100] = 14.28V$

Vpeak equals 18.78V

Ie

$1.414 \times 14.28 - 2(0.7) = 18.79$

The circuit diagram is included in the general circuit of the project. Also the 9v regulator was replaced with 12v regulator for the relayed to be derived well even when there is very low voltage and current supply from the NEPA.

4.3 MOUNTING AND TESTING OF THE WHOLE CIRCUIT (SYSTEM)

The whole circuit was mounted on a metallic casing after testing each unit of the system. Final wiring, soldering, packing etc were done carefully so that the system would not be subjected (their leads) to unnecessary strain like twisting and bending. The front and back of the casing were covered with tinted glass (5mm) and metallic pan respectively. In mounting the circuits and components, repairing, servicing and maintenance were taken into consideration, hence, the transformers and the heating components/circuits were mounted on the metallic casing of the system very close to the vent. The packing of the system was done in a way that it can be easily open for repair and maintenance.

When all these were done, the system was plugged to the electricity (220v AC) in the day time and was observed. It was observed. In the afternoon when the system was powered the system remain OFF until in the evening at about 6.45pm (in the dark), the system came ON automatically and worked until in the

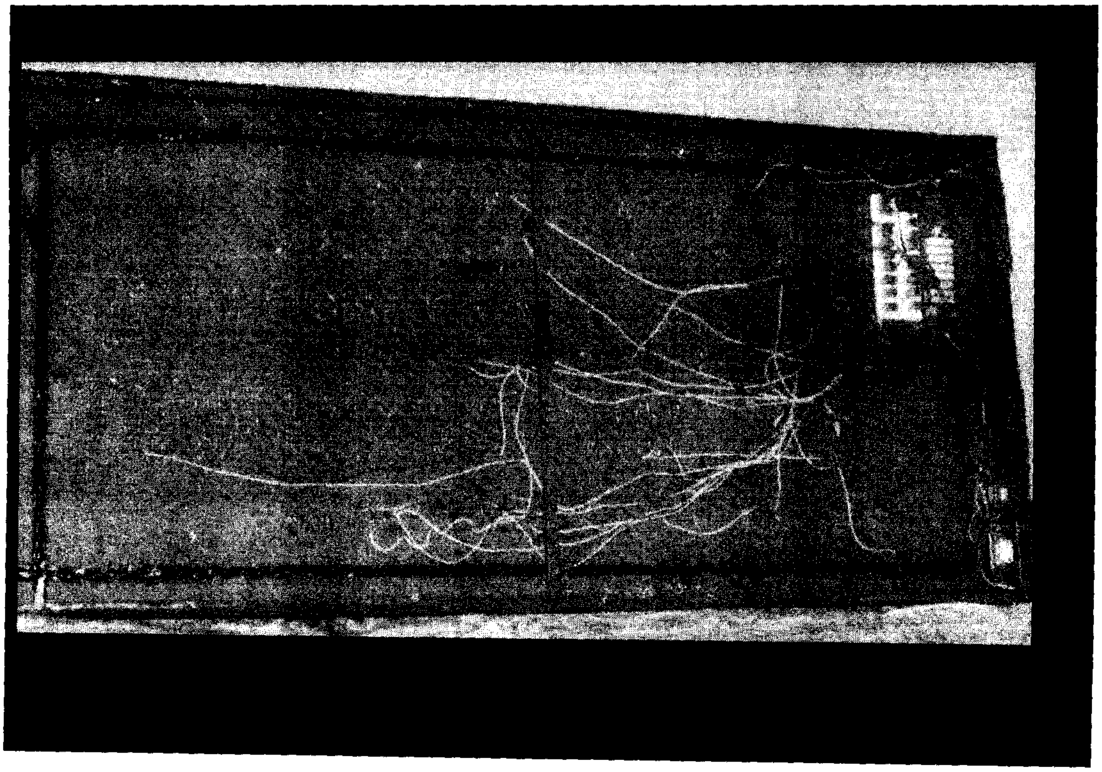


Fig. 4.1 the system circuit.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATON

5.1 CONCLUSION

Automatic Electronic display boards play important role in advertisement. Electronic displays play important role in monitoring of digital signals and frequency measurement of such digital signals. Due to the fact that this project is realized with relatively low production cost and digital circuit components, it makes it universally acceptable and environmentally friendly. This project is interesting because it's easy to design and construct, easy to read and understand more visually attractive, low power consumption, portable e.t.c.

This project has given me a broad knowledge of using digital component C I (s) and analogue components to design and construct digital base electronics works. In conclusion the project was successful, lots of experiences practically were gained and this project report will also serve as guide to prospective students who care to work on similar project as this.

5.2 RECOMMENDATION

Although this project has been designed to specification, there are still other things that need to be incorporated into the design. Some of these are: -

i. The design should be improved upon to be a moving (scrolling) digital display system.

ii. The design should be improved by using traic instead of relays for the suiting circuit.

iii. The audio sound of the display work can be incorporated into the design

iv. Group of students (more no of student) should be allowed to improve on this project to a computerized scrolling display system.

I hence give my full recommendation as regards a medium of good digital base project training for the electrical students.

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APENDIX 2: ENGINEERING PART LIST

ITEM NO	DESCRIPTION	QUANTITY
1	4.7KΩ (1/4)WATT RESISTORS	1
2	1KΩ (1/2) WATT ,,	23
3	2.2Ω (10) ,, ,,	5
4	4Ω (10) ,, ,,	1
5	20Ω (2) ,, ,,	2
6	16Ω ,, ,, ,,	1
7	15Ω ,, ,, ,,	1
8	23Ω ,, ,, ,,	1
9	22Ω ,, ,, ,,	1
10	45Ω ,, ,, ,,	1
11	64Ω ,, ,, ,,	2
12	56Ω ,, ,, ,,	1
13	19Ω ,, ,, ,,	1
14	270KΩ (1/2) WATT RESISTOR	1
15	4KΩ ,, ,, ,,	1
16	220Ω ,, ,, ,,	1
17	[illegible]0KΩ ,, ,, ,,	4
18	[illegible]00Ω ,, ,, ,,	1
19	1MΩ VARIABLE RESISTOR	1
20	LDR LIGHT DEPENDANT RESISTOR	1
21	3300uf/35V ELECTROLYTIC CAPACITOR	1
22	2200uf/35V ,, ,,	1
23	1uf/16V ,, ,,	2
24	470uf/16 ,, ,,	1
25	10uf / 16V ,, ,,	18
26	0.01uf CERAMIC DISC CAPACITOR	2
27	220nf TANTALIUM CAPACITOR	2
28	470nf ,, ,,	2
29	1N4001 DIODE	64
30	7805 IC REGULATOR	1
31	7809 ,, ,,	1
32	7812 ,, ,,	1
33	CD4017B DECADE COUNTER	2
34	NE555 TIMER	2
35	741 OP-AMP.	1
36	SPST 6V RELAY	17
37	SPDT 12V RELAY	1
38	BC574 TRANSISTOR	18
39	15V TRANSFORMER	1
40	12V ,,	1
41	LIGHT EMITTING DIODE 3V 20mA	2200
42	1A FUSE	2
43	13A ,,	1