DESIGN AND CONSTRUCTION OF A REGULATED VARIABLE POWER SUPPLY UNIT WITH DIGITAL READOUT (0-9V).

BY

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AUGUST, 2003

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A RESEARCH PROJECT PRESENTED TO THE DEPARTMENT OF

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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

AUGUST 2003.

CERTIFICATION

This is to certify that SANI LAOUALI 98/7759EE carried out the project work presented in this report under my supervision.

....

ENG. M.N. Nwohu Date

Head of Department

8/4/04

....

Mr Emmanuel.E Date

Project Supervisor

....

External Examiner Date

....

Signature of student Date

Sani Laouali

17-10-2003

DECLARATION

I declare that this project presented for the award of Bachelor of Engineering Degree has not been presented either wholly or partially for the award of any other degree elsewhere.

DEDICATION:

This project is dedicated to my beloved parents Mr.SANI GARBA and Mrs. MARIA IDI.

ACKNOWLEDGEMENT

Thanks be to Allah, by whose mercy and guidance I am able to undertake this project work successfully. I praise Him for His generosity and ask for His peace and divine mercy on prophet Muhammad (S.A.W).

May Allah rewards those who He has made to play positive roles in the course of my educational development such as my parents, my lecturers (specially my project supervisor Mr. Emmanuel .E.), my brothers and sisters.

My thanks go to My Entire Niger Republic brothers and sisters of F.U.T Minna for their positive contribution during my educational development.

Special thanks go to the Director of LOGICGATE COMPUTER VENTURES Mr. M. Bello and his brother Eng. M.Musa and to all LOGICGATE COMPUTER VENTURES staff.

I can't also forget Miss Funkey who helped me in typing my project and Mr. Dangayi Mounkaila who helped me in editing and printing of this project.

ABSTRACT

This project presents the design and construction of a regulated variable power supply with digital readout. The project incorporates all the important features of and ideal power supply system thus making it suitable for powering a wide variety of small electronic equipment.

The whole system is designed around TTL ICs together with a few components to make the summer, the differentiator, the square wave generator, the counter, the decoder\ driver and the display circuits. All that constitutes the whole system unit of an ideal regulated variable power supply with a digital readout.

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CHAPTER ONE

1.0 INTRODUCTION

In modern times, electrical power for use is often derived from central alternating current systems. Many systems however require direct current for operation. The process of conversion of the alternating power to unidirectional power is therefore an important aspect of system design. This allows eliminating of non-cost effective batteries for numerous electrical systems such as radio, television, etc, where they would otherwise exist.

Batteries have the advantage of probability and complete absence of a.c. components in their operation. However, there is a danger of leakage, which may endanger hundreds of many circuitries through corrosion damage. Also, the electromotive force (emf) of the batteries is not usually constant through its life span.

To overcome such disadvantages, the most commercial circuits are usually powered from the mains in order to avoid battery replacement and ensure constant performance at all times. Thus, a circuit must be designed to convert the a.c voltage to d.c voltage of a desired value. Such a circuit is called **power supply unit.** Rectification which is the process of converting a.c to d.c .voltage of a desired value can either be static or dynamic. Static rectification utilizes non-rotating components to achieve the conversion while dynamic rectification employs rotating machinery. Various types of diodes have been used for rectification. These included, the vacuum diodes, selenium diodes, semi-conductor diodes (Ge and Se).The semi-conductor diodes, to the great extent dominate most application due to its comparatively low forward voltage drop, typically a few volts and the absence of filament heaters.

Their principal limitations in the current carrying capacity and voltage rating have gradually become a historical significance with current advancement in semi-conductor devices research

The function of power supply unit is to provide the necessary d.c voltage and current with low level of a.c ripple and good stability and regulation. In other words it must provide a stable d.c output voltage and current even if there are changes in the main input voltage and in the load current.

A further important requirement of a modern power supply circuit is that it should be able to limit available output current in the event of overload (current) and also limit the maximum output voltage. Damage to sensitive components such as integrated circuit in the instrument can easily occur if excessive voltage appears on the power supply lines. Today, two types of d.c power supply unit exist: *STABLE* and *VARIABLE*.

The one we are dealing with in this design is the **variable d.c power supply with digital readout**. Nowday, we realize that the power supply unit constitutes one of the important units of all electronic components. Sometimes, we want a non standard regulated voltage (say +9v, to emulate a battery) and can't use 78xx type fixed regulator. Or perhaps you want a standard voltage, but set more accurately than ±3% accuracy typical of fixed regulators.

To overcome, this problem, we us "adjustable" 3-terminals regulator. These wonderful integrated circuits are typified by the classic LM317 (used in this design).This regulator have no ground terminal; instead, it adjusts V_{out} from 1.25volts up to 35volts.

1.1PROJECT MOTIVATION:

The objective of this project is to design and construct a **regulated variable power supply unit with digital readout**. The reason behind that is because some electronic appliances (DeskJet printer, radio receivers, televisions, etc.....) are using different ranges of d.c voltage. So, as a future engineer, who intends to work on electronic appliances, it's good to have a regulated variable power supply unit.

To make it easier to use, I decide to incorporate a digital readout so that you can directly read the rating of voltage you choose.

CHAPTER TWO

2.0 LITERATURE REVIEW OF POWER SUPPLY UNITS

2.1 PRINCIPAL METHOD OF OBTAINING STABILIZED POWER SUPPLY.

Two major methods are commonly used in obtaining a stable d.c voltage from a.c mains. The first one is the linear stabilizer methods and the second, is the switching mode stabilizer method. This switching mode power supply unit a relatively new innovation and find its main use in high power applications.

The linear stabilized power supply unit is comprised basically of four stages as shown in fig.2.0, namely:

a) Transformer stage.

b) Rectifier stage.

c) Filter stage.

d) Regulation stage.

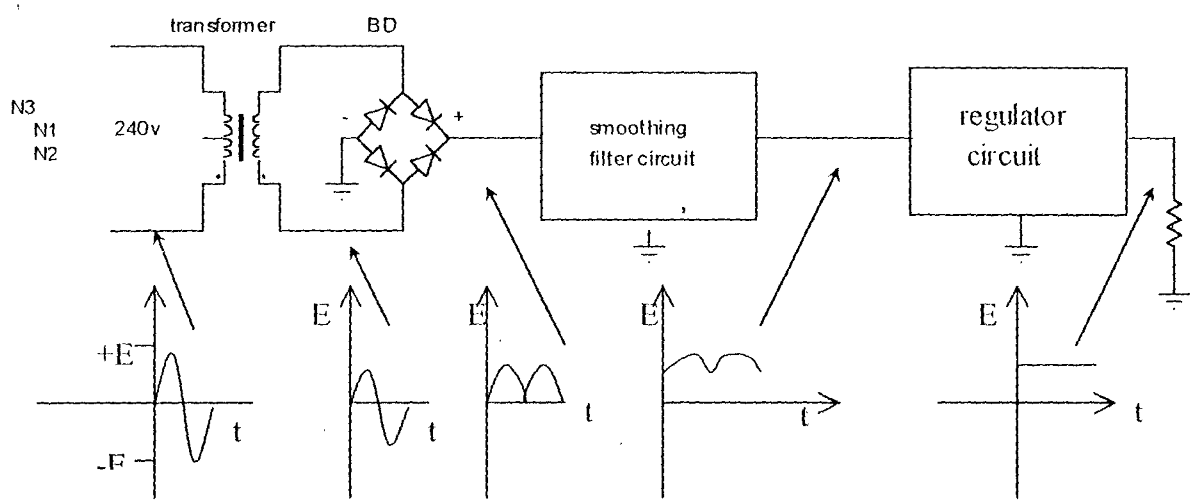
Transformer serves two main purposes. It switches the equipment d.c power lines from the main supply and it changes the level of a.c mains voltage to some desired values. Thus, we have step-up and step-down transformers. The one we are using in this design is a step-down transformer (240/15volts).

The rectifier unit corrects the a.c voltage from the transformer secondary windings into pulses of unidirectional current. Three types of rectifier circuits are used for single phase rectification. There are:

-Half wave,

-full wave,

-bridge full wave rectification, the one used for this design.



In the half-wave rectifier, a single diode conducts only on one half cycles, though a simple circuit; it has the main disadvantage of low efficiency which cannot be greater than 50%.

The full-wave rectifier has two diodes each conducting on alternating half cycles to give much higher efficiency. However, to achieve this, a transformer with a centre tapped secondary winding is necessary. This means that twice the number of turns is required on the secondary winding. This circuit was common when valve rectifiers were transformers than to use more valves.

The full-bridge wave form rectifier, now the circuit of choice for this design, uses four diodes to achieve rectification over the whole cycle. The four (4) diodes can now be obtained in one encapsulated unit, which is more convenient and some how cheaper than using four separate diodes.

However, should one part of the encapsulated bridge circuit fails, the whole unit then has to be replaced.

The filter circuit unit serves to smooth out the pulses received from the rectifier circuit. The circuit can have either the capacitor or an inductive input filter. The inductive filter or choke input filter is more commonly used when the power unit has to supply a large load current.

On low power equipment, such as design study, a capacitor input filter is more typical. The input capacitor called "Reservoir" is used as storage device for electrical charges. The value of the ripple amplitude depends upon the size of the capacitor and the load resistance.

To achieve low value of ripple, a high value electrolytic capacitor is used.

The regulator circuit is used to keep the output voltage constant, irrespective of changes in the load current. The two main types of circuits for regulation are:

- Linear regulation
- Load regulation

All linear regulators comprise a control unit, a reference element and an error amplifier. In operation, the circuit compares a portion of direct current output voltage with reference voltage. Any difference between the two values or levels, is amplified by the error amplifier and the output is fed to the control unit. The stability and regulation of the output depends upon the stability of the reference element and the gain of the error amplifier.

The main advantage of linear regulators is that the output is continuously controlled to give good stabilization against main input changes.

The limitation in the linear regulation circuits is that inefficiency. Power dissipated and loss in the series control transistor and this power loss increase with load current. Generally, some form of protection is given to the whole circuit design using a common form of standard fuse which services to disconnect the unit from the mains supply when an over load or short circuit occurs.

2.2 MODE OF REGULATION:

The d.c output voltage of a power supply tends to decrease when the load current increases. Also, the root mean square of the a.c (I_{rms}) input level may vary.

Regulation in power supply is used for keeping the d.c voltage output constant inspite of variations in either the d.c load current or the alternating current input voltage.

i.Zener diode regulation

With the reverse breakdown voltage across zener diodes, the output voltage is constant for a wide range of current values.

ii. Voltage regulation power transformer:

This is a special transformer designed to provide constant a.c input to rectifier. Regulation is accomplished by saturation of the iron-core.

iii. Feedback regulation:

In this type of circuit, a sample of d.c output is feedback to a stage that can control the amount of output voltage. When a sample indicates too little voltage, the output is increased. The output is lowered when a sample voltage is too high. An adjustment to maintain the d.c output voltage at a specific level is usually provided. Any of these three methods of regulation can be used in a regulated power supply unit.

In this design, we consider the feedback type of regulation method. This is divided into shunt and series type of feedback regulations. For more efficiency, the feedback regulation is being used.

2.3 REGULATION STABILIZATION

The output d.c current, output voltage, Vo, depends on the input regulated d.c voltage Vi; load current I_l and temperature T. The change ΔVo in the output voltage of a power supply can be expressed as:

$$\Delta Vo = (dVo/dVi)\ \Delta Vi + (dVo/dIl)\ \Delta Il + (dVo/dT)\ \Delta T$$

Or $$\Delta Vo = K_1\ \Delta Vi + R_0\ \Delta Il + K_2\ \Delta T$$

Where the three coefficients are defined as:

Stability factor, K_1.

Output resistance, R_0.

Temperature coefficient, K_2.

Hence the power supply would have better regulation if each of these three (3) coefficients is kept to a minimum value.

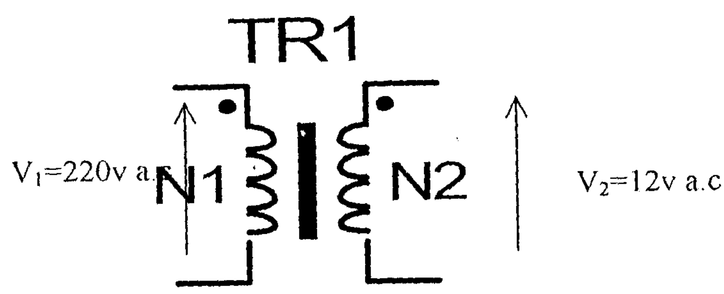


Fig: 3.2.1 transformer winding.

3.3. RECTIFICATION AND FILTERING CIRCUIT
3.3.1 RECTIFICATION DESIGN

As majority of electronic circuits, rely for their operations on the availability of sources of d.c power, it then becomes necessary to derive d.c power from a.c source, is called rectification.

The advantage of d.c power obtained from rectification is neat and cheaper than from the battery (in long run). Besides, this method ensures continuous and regular supply of d.c power.

There are a number of ways through which rectification can be achieved. In this design we shall consider the bridge rectification as shown in fig.3.3.1 below.

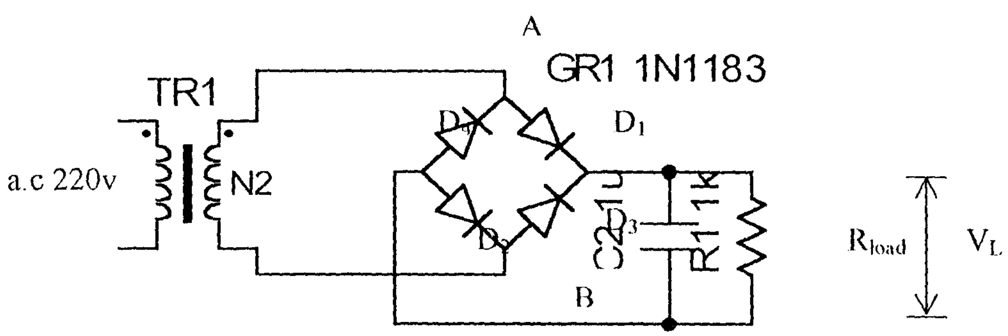


Fig. 3.3.1. a. Full bridge rectifier.

When point A is positive with respect to point B(positive half cycle), current flows from A through D1, load R_L and trough diode D2 to point B. During the negative half cycle, when B is positive with respect to A, current flows by way of diode D3, RL and to point A.

The frequency in the load is again twice the frequency of the a.c source but the PIV (peak inverse voltage) is the peak voltage value of a.c source, not twice.

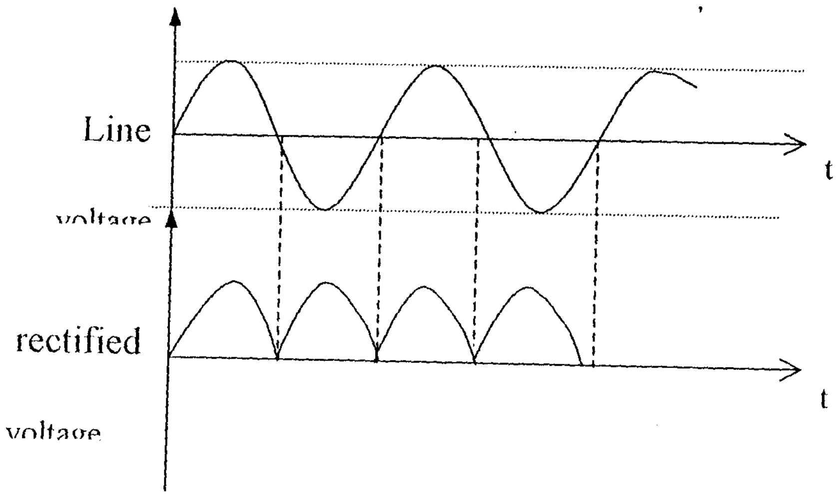


Fig. 3.3.1.b the output voltage waves form.

Analysis:

- The mean load current.

$$I_m = 1/2\pi \int^{2\pi} V_m/R_L \sin\theta d\theta$$

$$= 2V_m/\pi R_L$$

- D.C voltage Vd.c.

$$V_{d.c} = \frac{2V_m}{\Pi} = 0.636 V_m$$

- D.C current Id.c.

$$I_{d.c} = \frac{2 I_m}{\Pi} = \frac{V_{d.c}}{RL}$$

- D.C power

$Pd.c = I^2 d.c * R_L$.

- Rectification efficiency:

$$\eta = \frac{D.C.load.power}{A.C.power.on} * 100\%$$

3.3.2 FILTER CIRCUIT:

It is clear that from fig 3.3.1.b the process of passing the alternating current through diodes results only in the removal of the negative section of the current. To get the resulting wave forms to look like d.c, some form of smoothing needs to be done. The circuit employed in doing this, is called **smoothing circuit.** Their main work is to reduce the ripple voltage and improve the regulation. Capacitor filter used in this design.

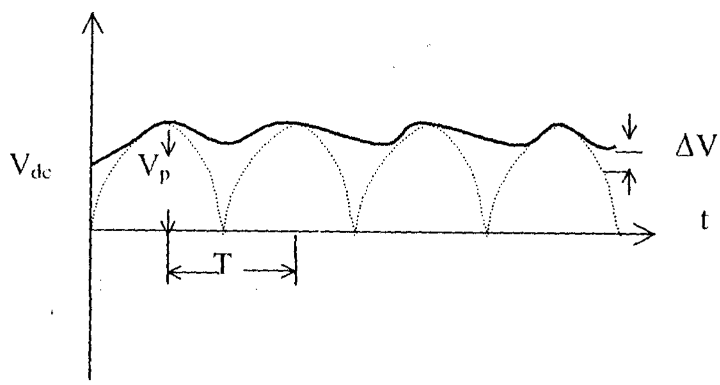


Fig.3.3.2.a filtered voltage wave form.

When the circuit is switched on, the capacitor charges through D1, D2 to peak voltage Vp. It then discharges, through the load R_L, exponentially, with time constant $C*R_L$. This process repeats itself after every half cycle with the output wave form taking the shape shown in fig 3.3.2.a, provided that R_L*C is greater than T, the output period.

Analysis:

Ripple voltage, $V = \frac{IL}{fc}$

$$Vd.c = V_P - \frac{IL}{2fc} = V_p - \Delta V/2$$

The equation above shows that the larger the value of the capacitor, the more the improvement there is in the ripple as well as in the regulation.

3.4 ADJUSTABLE REGULATION CIRCUIT:

The function of the voltage regulator is to provide a stable d.c voltage for powering other electronic circuits. A voltage regulator should be able of providing substantial output current.

Nowadays, it exists fixed voltage regulator and variable types. For this design, adjustable voltage regulator (LM317) is used. This regulator has no ground terminal; instead, it adjusts Vout to maintain a constant 1.25 volt (band gap) from the output terminal to the adjustment terminal. The regulator puts 1.25 volts across R1 (fig 3.4.a) so that 5mA flows through it. The adjustment terminal draws very little current (500-100ma) so, the output voltage is correct.

$$V_{out} = 1.25\left(1+\frac{R2}{R1}\right) \text{ volts}$$

In this case, the output voltage is adjustable from 1.25 to 25volts.

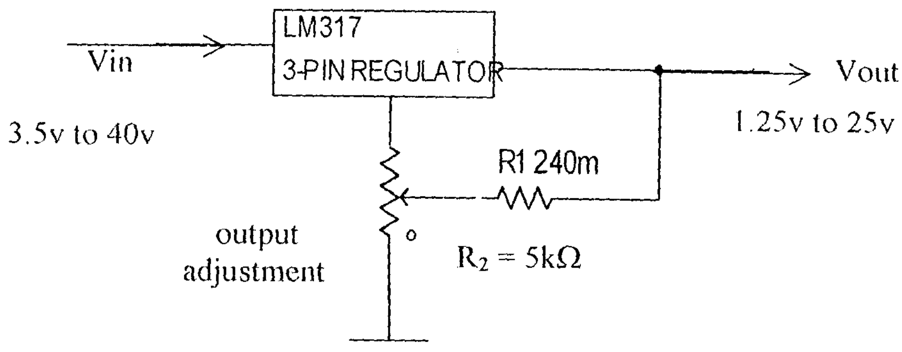


Fig 3.4.a .Variable voltage regulator (LM317).

$V_{out} = 1.25V_{in}\,(1+R_2/R_1)$

3.5. SUMMING CIRCUIT DESIGN

The summing circuit provides an output voltage proportional to or equal to the algebraic sum of two or more input voltages each multiplied by a constant gain factor. The output is phase inverted.

The op-amp used for this design for the summing purpose is the uA741 IC.

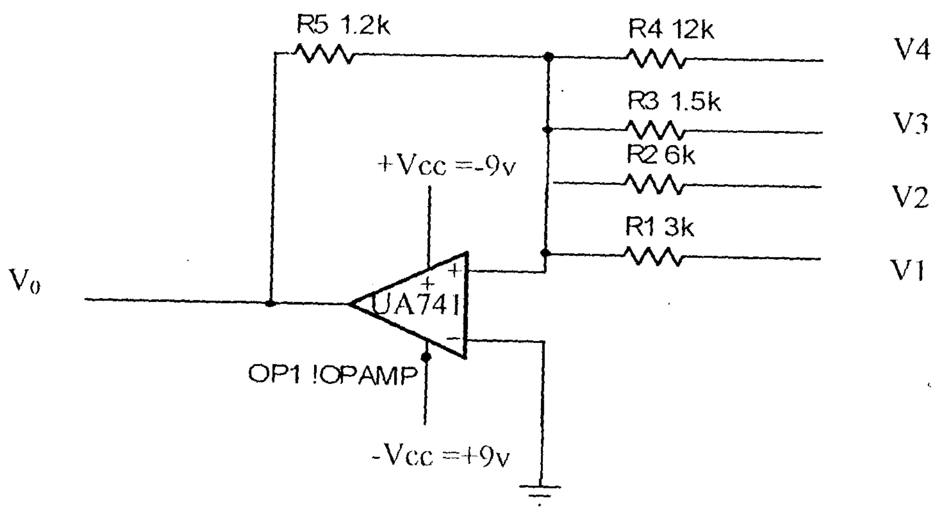


Fig.3.5. a summer circuit.

Analysis:

Point A will be treated as virtual ground.

$$I_1 = \frac{V1}{R1} \qquad I_2 = \frac{V2}{R2}$$

$$I_3 = \frac{V3}{R3} \qquad I_4 = \frac{V4}{R4}$$

$$I = -\frac{V0}{Rf}$$

Applying KCL to point A, we get:

$$I_1 + I_2 + I_3 + I_4 + (-I) = 0$$

Or $$\frac{V1}{R1} + \frac{V2}{R2} + \frac{V3}{R3} + \frac{V4}{R4} + (-\frac{V0}{Rf}) = 0$$

Or $-\left(\frac{Rf}{R1}V1+\frac{Rf}{R1}V2+\frac{Rf}{R3}V3+\frac{Rf}{R4}V4\right)$

$$V_0 = -(K_1V_1 + K_2V_2 + K_3V_3 + K_4V_4)$$

The overall negative sign is unavoidable because we are using the inverting input terminal.

3.6 DIFFERENTIATOR CIRCUIT DESIGN

The uA741 operational amplifier is used as differentiator in this design. It has 8 pins and they are numbered counter clock wise from pin 8, beginning with pin 1. Pin 1 is called the inverting input terminal and pin 3 is the non inverting input terminal, pin 6 is the output terminal and pin 7 and 4 are the power supply terminals labeled V+ and V- respectively. Terminal 1 and 5 are used for offset. The pin 8 marked NC indicates no connection.

The V^+ and V^- power supply terminals are connected to two d.c. Sources. The V+ is connected to the positive terminal of one source and V- is connected to the negative terminal of the other source as illustrated in fig.3.6.a where the two sources are +9 and -9volt. The powers supply voltage for uA741 range from ±5volt to ±22volt.

From fig 3.6.b, we can see that when Vin from the summer, the output of the differential amplifier should be equal to zero volt. But, when one is greater than another, it will be a difference, then the output should not be equal to zero volt and it will be feed into the control logic circuit.

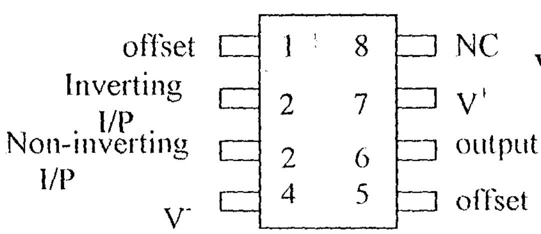


Fig 3.6.a UA741 pin configuration

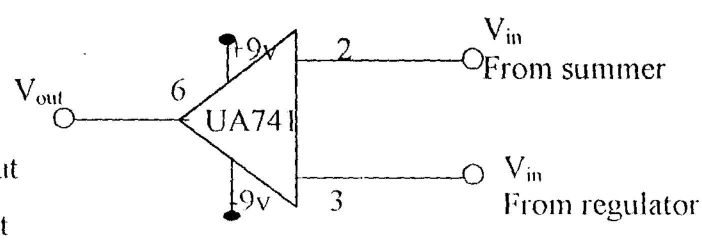


Fig 3.6.bsymbol of UA741

3.7 TIMING CIRCUIT DESIGN

555 timer (IC) is used in this design as a square wave generator. It is the most useful linear IC used in electronics where, oscillator, pulse generator, ramp and square wave generator, mono-shot multi-vibrator, burglar alarm, traffic light control and voltage monitor are used. Fig 3.7.a shows the pin configuration of 555timer IC.

Function of each pin (terminals):

- Vcc (pin 8) is supply voltage terminal (voltage range from +5V to + 15 V).
- GND (Pin 1) is the supply-voltage return line.
- Discharge (pin 7) is the active – low output when the discharge transistor is turned off, the output is essentially an open circuit.
- Output (pin 3) is a totem-pole output capable of sourcing or sinking up to 200 MA. When Vcc is 5 V, the output line can drive TTL circuits directly. The output stage is actually an inverter /buffer driver.
- Reset (pin 4) is an active –low input used to turn the discharge transistor on.
- Trigger (Pin 2) is an active-low input that is enabled when the voltage reaches a low of 1/3 Vcc.
- Threshold (pin 6) is an active-high input that enabled when the voltage reaches a high of 2/3 Vcc.
- Control logic voltage (pin 5) is an input that controls the threshold input voltage level when the control voltage is not being used to modulate the threshold-input voltage, is normally connected to a 0.01 μF capacitor whose other lead is grounded. In this manner, the upper resistor (R=560 Ω) connected to Vcc in fig 37.b below and 0.01 μF capacitor form a decoupling circuit that prevents power supply noise from altering the threshold input voltage.

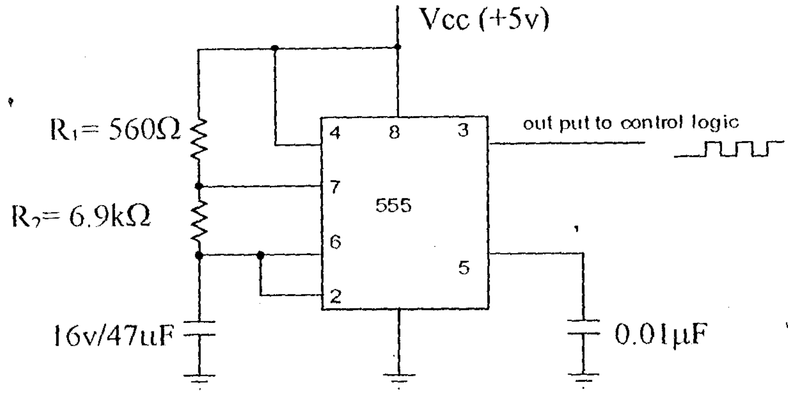


Fig 3.7.b. 555 timer circuit design.

The figure 3.7.c below shows one cycle of the output voltage with respect to ground V_0 and a capacitor voltage V_c.

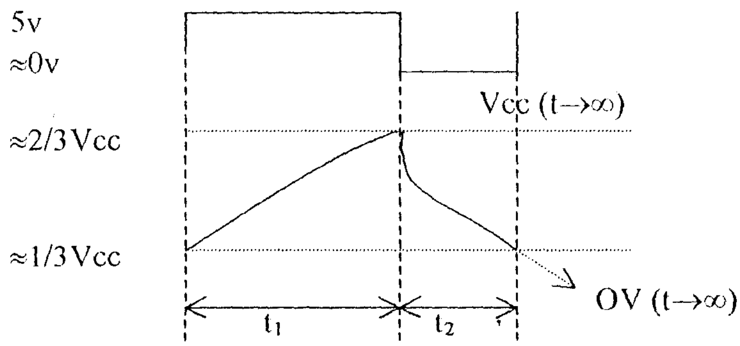


Fig. 3.7.c wave form analysis for one cycle.

Calculations:

The value of t_1, and t_2, the frequency and the duty cycle, can be obtained for the 555 timer using the general equation for charge or discharge of a capacitor through a Resistor.

$Vc = V_F - V_I\,(1-e^{-t/\tau}) + V_I$

Where:

Vc = voltage across a capacitor at a particular time.

V_F = final voltage across a capacitor, if capacitor continues to charge (or discharge) and t approaches infinity.

V_I = Initial value of voltage across capacitor

τ = time constant RC.

t = time in question.

Charge time $= 2/3Vcc = (Vcc-1/3Vcc)(1-e^{-t1/(R1+R2)c}) + 1/3Vcc$

$t_1 = 0.693\,(R_1+R_2)\,C$

$R_1=560\,\Omega$ $R_2=6.9K\Omega$ $C=100\mu f$

$t_1 = 0.693(56+6.900)*100^{-6}$

$t_1 = 0.5169$ sec

Discharge time $= \frac{1}{3}Vcc\ (O-\frac{2}{3}Vcc)(1-e^{\ t2/R2*C}) + \frac{2}{3}Vcc$

$t_2 = 0.693*R_2*C$

$= 0.693*6.900*100*10^{-6}$

$= 0.4781$ sec

$$\text{Frequency (f)} = \frac{1}{t1+t2} = \frac{1}{T}$$

$$= \frac{1}{0.693(R1+R2)*C}$$

$$= \frac{1}{0.693(560+6.900)*100*10-6}$$

$$= \frac{1}{0.9951}$$

$f = 1.00$ Hz

$$\text{Duty cycle} = \frac{t1}{t1+t2} = \frac{R1+R2}{R1+2*R2}$$

$$= \frac{560+6.900}{560+2*6.900} = 0.5$$

3.8, COUNTING CIRCUIT DESIGN:

The counter (7490) used in this design may be adopted to measure the frequency of unknown periodic signal and also to measure the period of each cycle of a periodic wave form.

Both applications are achieved by gating the counter, or turning it on for a specified time interval, thus permitting it to count the number of pulses that appear on its input during that interval. The block diagram in Fig 3.8.a shows how an AND gate (7408 IC) may be used for gating the counter.

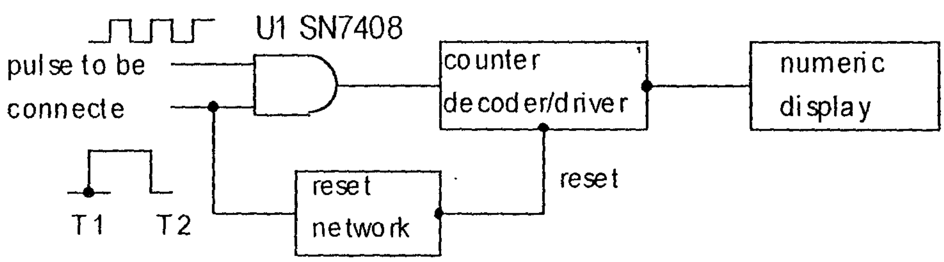


Fig 3.8.a Block diagram of AND gate (7408) used for gating 7490.

The AND gate (7408) permit driving pulses to appear at the input of counter when coincide in time with the appearance of an enabling pulse T1 T2. The counter then adds the pulses passed on by the coincidence (AND gate) during the interval T1T2 and, displays them numerically.

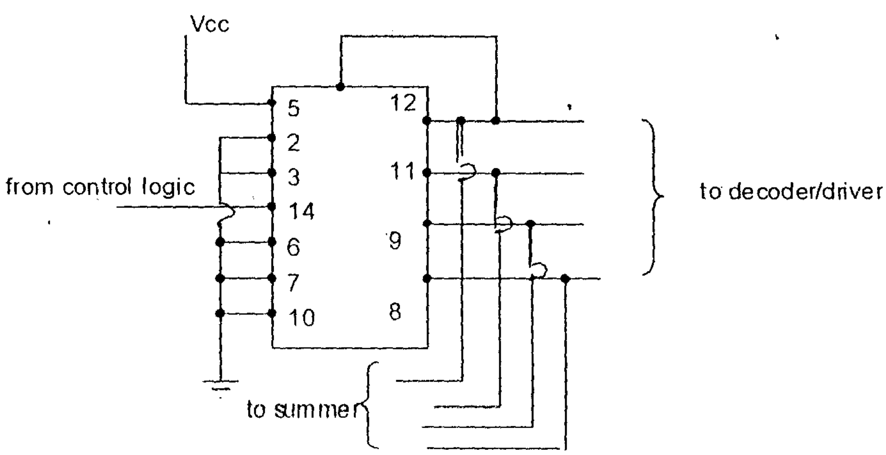


Fig 3.8.b Circuit diagram for 7490 counter.

3.9 DECODER/DRIVER AND SEVEN-SEGMENT DISPLAY

3.9.1 Decoder/Driver

The output from the counter circuit needs to be decoded. To accomplish this, 7448 IC is used as decoder/driver for that purpose.

Each of the segments of the LED display requires a specific current to drive it. This current may be supplied by individual driver transistors whose input is supplied by the decoder and whose amplified output drives specific line segments. To avoid the use of external transistor, in this design we decide to use IC decoder (7448) that, contain built in drivers. The circuit diagram of the 7448 is shown below.

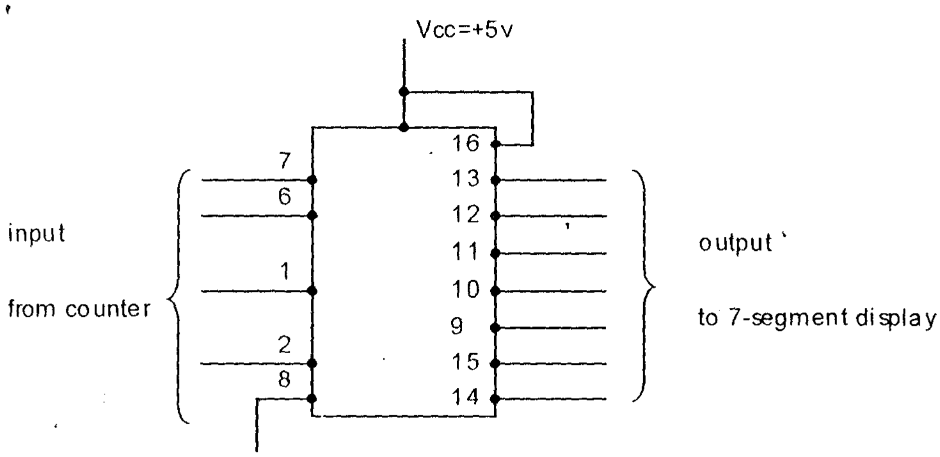
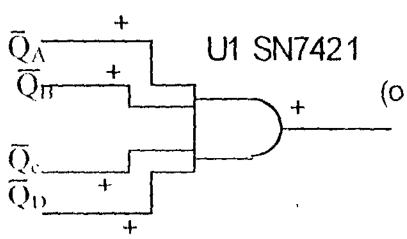
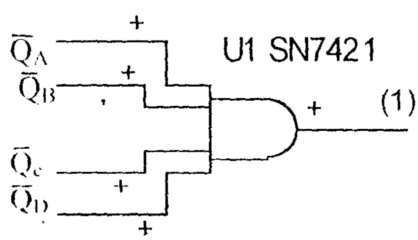


Fig.3.8.c Circuit diagram of the 7448 decoder/driver.

Ten four-input AND gates can be used to illustrates how the decoder decode what it receive from the counter. Each of which develops an up output uniquely for one of the decimal.





$\bar{Q}_A Q_B \bar{Q}_c Q_D = 2$

$\bar{Q}_A Q_B Q_c \bar{Q}_D = 6$

$Q_A Q_B Q_c \bar{Q}_D = 3$

$Q_A Q_B Q_c \bar{Q}_D = 7$

$Q_A \bar{Q}_B Q_c \bar{Q}_D = 4$

$Q_A \bar{Q}_B Q_c Q_D = 5$

$\bar{Q}_A \bar{Q}_B \bar{Q}_c Q_D = 8$

$Q_A \bar{Q}_B \bar{Q}_c Q_D = 9$

3.9.2 SEVEN-SEGMENT DISPLAY

a) 7-Segment LED Display

After a binary number, stored in a counter, has been decoded, that is, after it decimal equivalent has been determined by automatic electronic deciphering gates, it is desirable to display the result as a decimal number. To accomplish this, we use the most common display. As evident from Fig 3.9.2.a, this numerical display, consist of seven line segments arranged in the form of the numeral 8.

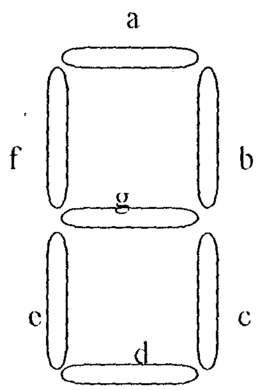


Fig 3.9.2.a Seven segment LED display (FND 360).

Each of the line segments is an LED, which lights up along it entire length when activated. By activating and lightning the correct combination of segments 'a' through 'g', the individual decimal digits 0 through 9 may be formed.

Seven-segment LED display are either the common anode or common cathode type. Each one of them has it own decoder/driver. For power economical reason, in this design, we use the common cathode type, so, it does not need any power as the common anode needs (+5v).

When we wish to light up a particular segment, we connect its anode through a current-limiting resistor to the output of the decoder/driver. The current-limiting resistors are required to protect the LED from burning out. To activate any segment, the output of the decoder/driver must be approximately (+5v) and a current of 10mA. Hence, we can calculate the current- limiting resistor value.

CALCULATIONS:

Since, the voltage drop across each activated LED is approximately 1.7v, hence the voltage across R is:

$$V_R = (+5v - 1.7v)$$

$$= 3.3v$$

Then the resistor value is:

$$R = \frac{3.3V}{0.01A}$$

$$R = 330\Omega$$

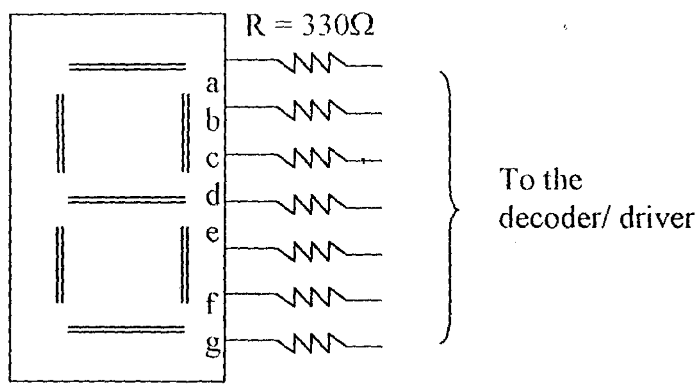


Fig 3.9.2.b common cathode 7-segment with current limiting resistors

b) Digital display system:

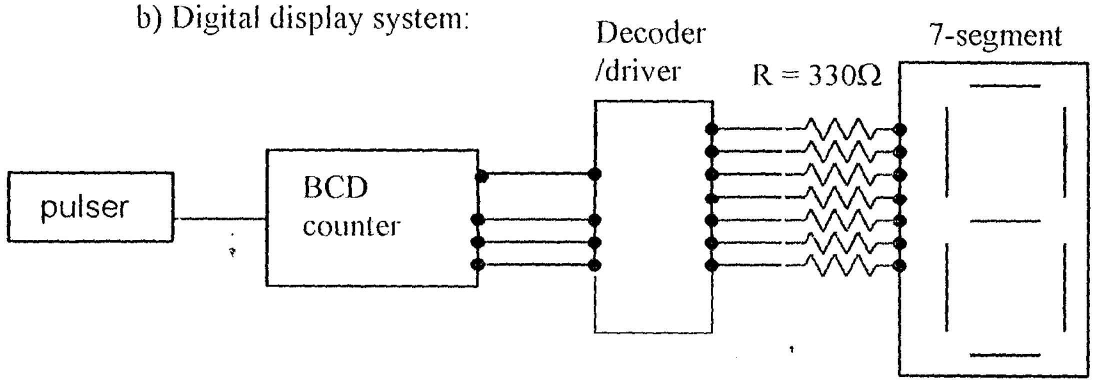


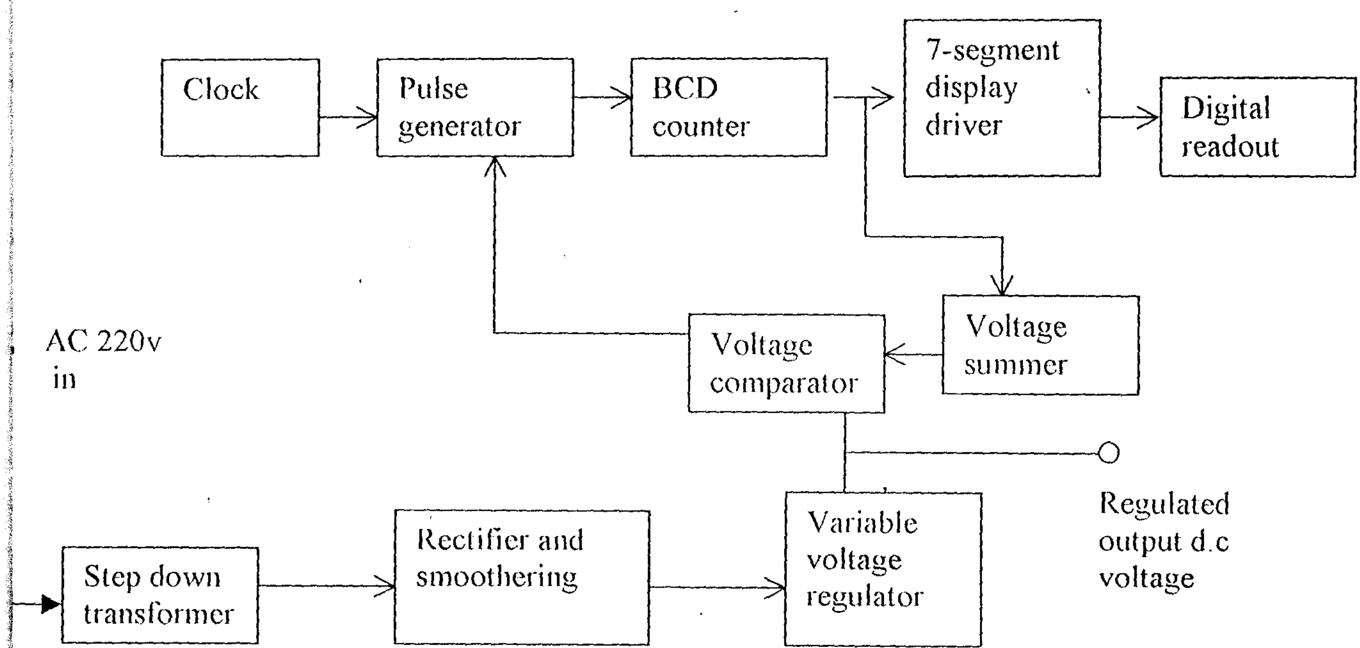
Fig 3.9.2.c.block diagram of a simple digital display system.

Fig 3.9.2.c shows a block diagram of a simple digital display system. This include a pulser as signal source, a BCD counter, a decoder/driver and a seven-segment LED Readout.

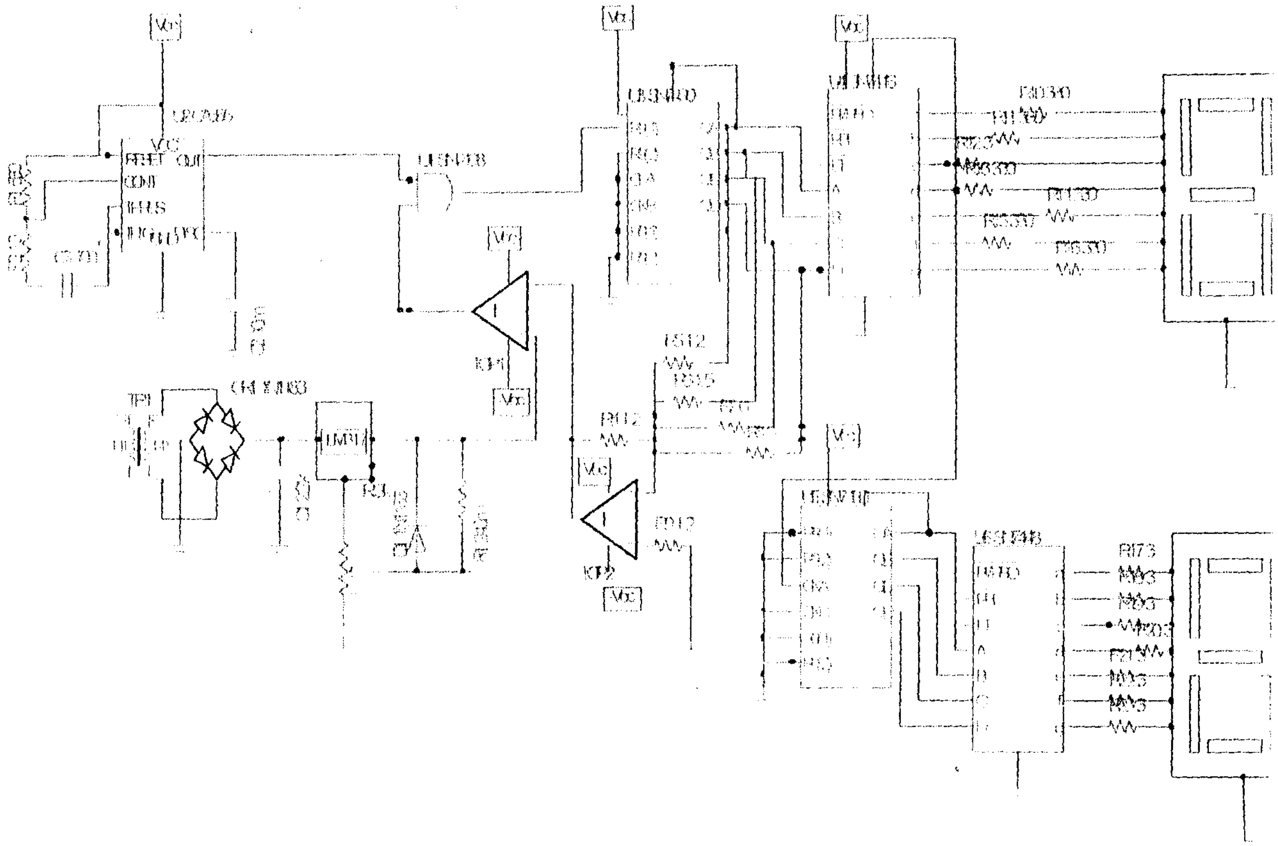
The counter receives serial pulses and is triggered by the negative edge of these pulses. The outputs of the J-K flip-flop in this counter hold a unique weighted binary number, which corresponds to the number of pulses received and counted. This, the weight of Q_A is 1, Q_2 is 2, Q_C is 4, and Q_D is 8. Because this is a BCD counter, the output of Q_A through Q_D on the tenth pulse is 0. There are seven output terminals on the decoder/driver, lettered a though g, each of which is connected to a resistor R to the anode of the corresponding line-segment LED on the seven-segment display.

On the count of 1, that is after the first pulse is entered into the counter, line segments b and c must light to setup the numeral 1. This main that the outputs b and c of the decoder/driver, must go low (0); to complete the electrical circuit for these segment, so that they can light. All other outputs of the decoder/driver must be light, that is the output of the decoder/driver at a, d, c, f and g must be +5v (approximately). The generation of the nine numerals may be explained similarly.

Block diagram of a regulated variable power supply with a digital readout



CIRCUIT DIAGRAM OF A REGULATED VARIABLE POWER SUPPLY WITH A DIGITAL READOUT



CHAPTER FOUR

CONSTRUCTION AND TESTING

4.0CONSTRUCTION

The construction of regulated variable power supply with a digital readout has been carried out as follows:

After the purchasing of all components being used in this design, a test has been carried out in order to make sure that all the components are in good condition of use. For this matter a digital meter has been used.

The second stage of this design is that, the components layout for the system has been designed. Then components were mounted on the bred-board which makes it possible to make some changes as the need arise and it makes easier to locate bugs.

Having being satisfied with the behavior of the circuit, it was then transferred to the Vero-board; carefully the components were soldered'by mean of soldiering iron and lead.

A 16-pin, 14-pin 8-pin dual in line IC sockets was used to plug ICS into the circuit. This way of connecting the IC is of vital importance because it helps in troubleshooting enormously as the IC is removed when making checks.

The power supply unit was the first unit. That has been soldered.

Making sure and being satisfied by the voltages from the power supply unit (+5v, ±9v) including the variable voltage (0 to 9 volt), the timing circuit (using 555 timer) was soldered followed by the display circuit.

Light emitting diode (LED) has been used for indication when the system is powered on.

A 5kΩ variable resistor has been connected together with the LM3/7T Variable from 0 to 9v positive.

For functionality reason, 1.2kΩ resistor from the summing circuit has been changed to 10kΩ variable resistor in order to set the voltages that can be displayed.

For easy troubleshooting, the power supply unit was constructed a part on a single piece of circuit board and then different power were taped from it and powered the various components in need.

Also, the signal circuit, which comprises, the timing circuit, the counting and decoding circuit were soldered on another piece of circuit board. The display unit was constructed on a small piece of circuit board for easy fixing on the case of the whole circuit.

After the soldering has been completed, the entire circuit was carefully housed in a wood case (compartment) the case is ventilated by drilling of the holes on the transformer side to avoid system generating abnormal temperature, which can have effect on the component and its performance.

4.1 TESTING

When all the soldering is over, the circuit was traced and retraced to ensure that there is no short or open circuit anywhere. Digital meter is used to test the continuity of the circuit. Being sure that the circuit has been soldered correctly, then power has been passed through it for testing purpose. The LED lights up showing that the power supply is ready for use. Then, the 10kΩ variable resistor was set so that the display should be form 0 to g volts while the 5kΩ variable resistor was set at is minimum value. After that, the reset switch is pressed in order to reset the display at 0 volt. So, to get the different values of the output voltage, the 5kΩ variable resistor is control from 0 to 5kΩ and then the corresponding output voltages were obtained.

4.2 RESULTS

The table below gives us the different output voltages for a given value of the 5K variable resistor.

RESISTOR(kΩ)	OUTPUT VOLTAGES(V)
0.5	0
1	1
1.5	2
2	3
2.5	4
3	5
3.5	6
4	7
4.5	8
5	9'

5.2 REFERENCES

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