DESIGN AND CONSTRUCTION OF AN AUTOMATIC CHANGE OVER SWITCH

ND PROJECT REPORT

BY

UMAR ALHASSAN
N/[illegible]796

Department Of Electrical Electronics
Engineering Technology
School Of Engineering
Nuhu Bamalli Polytechnic Zaria

NOVEMBER 2007

DESIGN AND CONSTRUCTION OF AN AUTOMATIC CHANGE OVER SWITCH

NATIONAL DIPLOMA PROJECT REPORT

BY

UMAR ALHASSAN
N/EET/05/6796

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY SCHOOL OF ENGINEERING
NUHU BAMALLI POLYTECHNIC,
ZARIA KADUNA STATE,
NIGERIA

NOVEMBER, 2007

DESIGN OF CONSTRUCTION OF AN AUTOMATIC CHANGE OVER SWITCH

NATIONAL DIPLOMA PROJECT REPORT

BY

UMAR ALHASSAN
N/EET/05/6796

THIS PROJECT IS SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING TECHNOLOGY, NUHU BAMALLI POLYTECHNIC, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF NATIONAL DIPLOMA IN ELECTRICAL AND ELECTRONICS ENGINEERING DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY
SCHOOL OF ENGINEERING

NUHU BAMALLI POLYTECHNIC, ZARIA
KADUNA STATE,
NIGERIA

NOVEMBER, 2007

DECLARATION

I hereby declare that this research project has been conducted solely by me under the guidance of my supervisor Mal. Ayuba Biye of the department of electrical and electronics engineering Nuhu Bamalli Polytechnic, Zaria Kaduna, I have neither copied from anybody nor has someone else copied from me.

Umar Alhassan
Student's Name

Signature

11/3/2008
Date

APPROVAL PAGE

This is to certify that this thesis titled "Design and Construction of an Automatic Change Over Switch" by Umar Alhassan meets the standard, expected for the award of Diploma in Electrical and Electronics Engineering Technology at the Department of Electrical and Electronics Engineering Technology, Nuhu Bamalli Polytechnic, Zaria.

Mal. Ayuba Biye
(Project Supervisor)

12/3/2008
Date

Engr. Abubakar Maude
(Head of Department)

Date

External Supervisor

Date

ACKNOWLEDGEMENT

In the name of Allah the beneficent, the most merciful, all praise be to Allah who guide me throughout my study and completion of this project.

I am greatly indebted to Allah for guide and health given for me to achieved the blessing. My special gratitude and prayer goes to my parents, my brother Abdulsalam Idris, Ja'afar Idris, Ayuba Idris and Habiba Idris, also to my sister Umi Idris.

I also want to express my sincere appreciation to my supervisor who guided and assisted me throughout my project and my H.O.D may Allah reward them and his external mercy grant them success (Amen).

TABLE OF CONTENTS

Chapter four

Chapter five

ABSTRACT

An automatic change over switch capable of providing auto switch from NEPA to generator and vice-versa. This thesis present design and construction details of the automatic change over switch box was made up of a plastic which are locally available raw – materials. The circuit was powered by a step-down transformer 12 – 0 – 12v which gives 24v and was rectified and filtered. The stable regulated 12v d.c. was fed to the relays which are design to give a required auto – mechanical switch over. The unit was tested with generator and a single 60w bulb at the consuming end and it was found satisfactory.

LIST OF FIGURES

LIST OF FIGURES

CHAPTER ONE

1.0. INTRODUCTION

Automatic change over switch refers to an automatic switch capable of switching from generator to private power source, it also provides an automatic switch off of the generator without human intervention.

1.1.0 STATEMENT OF THE PROBLEM

Problems used to arise in some companies like, telecommunication. Companies e.g. MTN, ECONET, GLO, MTEL and NITEL, and also in theatre room of a hospital due to frequent on and off of a power supply. Such problem can easily be solved through this research work of the automatic switch over where relays are manipulated to form a tremendous switch over within some fraction of seconds without human intervention.

1.2.0 AIMS AND OBJECTIVES OF THE PROJECT

This project aims and objectives are to:

a. Develop (design and construct) a simple, portable, reliable and an efficient automatic change over switch, that will ease a number of problems ½ related to power failure

b. Provide a design that is affordable compared to the imported type of an automatic change over switch.

c. Select appropriate material (local material) suitable for the construction of the automatic change over switch

d. Provide solution to the traditional practice of hand/manual change over which involve a lot of human labour

e. Provide continuous production of such gadget

1.3.0 SIGNIFICANT OF THE PROJECT

In recent years there had been calls by different administration in Nigerian and NSE (Nigerian Society of Engineers) and COREN (Council of Registered Engineers of Nigeria) urge in developing designs that are capable of reducing human labour for the well being of its citizens. This significant gave a roots to the design and construction of this project.

1.4.0 SCOPE AND LIMITATION OF THE PROJECT

This project research work can only provide automatic change over from generator to private power source and vise – versa.

CHAPTER TWO

2.0. LITERTURE REVIEW

Atomization level of generation is limited when it highly depends on human operation. Thus a lot of research work has been done to put the key word "automatic change over" together.

For this project research work, all controls are via relays, that provides the required change over were necessary.

2.1. POWER SUPPLY

According to Basil and Galen (1993), power supply universally refers to a system for converting a.c. (50 – 60Hz) to d.c. with suitable voltage and current ratings. There are two classes of power supply, these are called:

i. Linear and

ii. Switching supplies

This consideration shall be limited to the linear supplies consist of four segment.

2.1.1 BACKGROUND INFORMATION

A block diagram consisting of different parts of a typical power supply unit and the voltage waveforms at various points is show in fig. 2.1 below

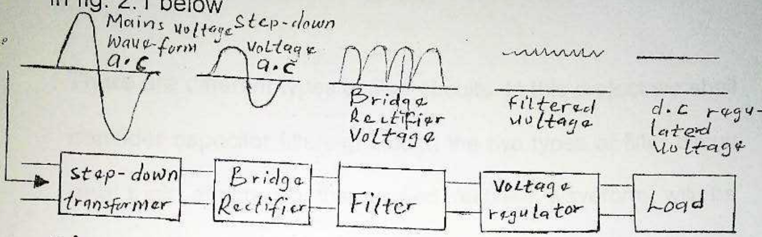
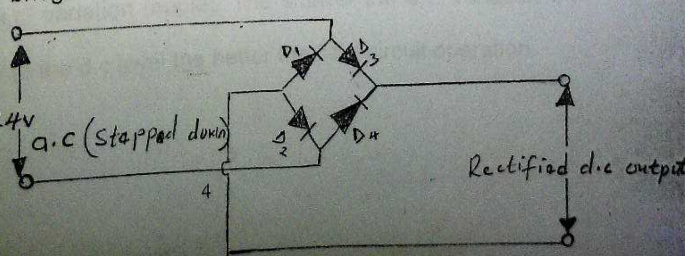


Fig 2.1.0 (a) Block and waveform diagram showing Parts of a Power Supply Unit

The above voltage typically 220v runs (root means square) is connected to a transformer which steps it down to the level for desired a.c. output. In this project, the transformer used has a stepped – down voltage ratings of 12 – 0 – 12.

A diode rectifier (full – wave) bridge type built around for in 4001 diodes are used to provide a full – wave rectified voltage which is applied to a filter to smoothen the varying voltage. The full wave bridge rectifier used in this project is shown in fig. 2.1.6



There are different types of filter circuits. In this project we shall consider capacitor filtering, though the two types of filter circuit and their effects on the applied rectified waveform will be discuss. The filter circuits in view are shown in fig. 2.1.0 (c) and (d) below

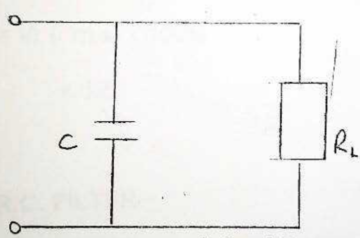


Fig 2.1.0 (c) Capacitor Filter

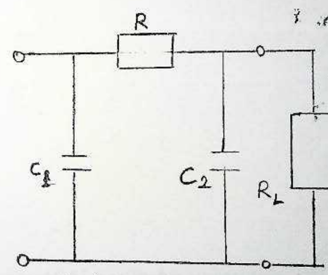


Fig 2.1.0 (d) Rc Filter Circuit

CAPACITOR FILTER

Fig. 2.1.1 below shows a typical filter output voltage. It can be observed that the output voltage waveform has a d.c. value and some a.c. variation (ripple). The smaller the a.c. variation with respect to the d.c level the better the filter circuit operation

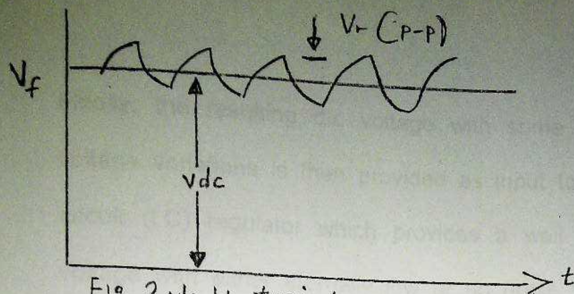


Fig 2.1.1: typical output voltage Capacitor filter circuit

Form the above waveform, we can determine the ripple of the filter output using the relation.

r = ripple = ripple voltage (r.m.s)

d.c. voltage

= Vr (r.m.s) x 100%

v.d.c

R.C. FILTER

It is possible to further reduce the amount of ripple by using the R.c filter circuit shown in fig 2.1.0 (d). There is a price to pay for this improvement. This includes a lower d.c. output voltage due to the d.c voltage drop across the resister, R.

Finally, the resulting d.c voltage with some ripples or a.c voltage variations is then provided as input to an integrated circuit (I.C) regulator which provides a well – defined d.c voltage with either eternally low or no ripple voltage over a range of load.

2.2.0 TRANSFORMER

The transformer is its simplest form consists f two inductive coils which are electrically separated but magnetically linked through a part of low reluctance. A changing current in one winding induces a changing in magnetic field in the core which links the same or another winding and induces a changing in electromotive force (EMF) in that winding.

If one coil is connected to a source of alternating voltage, an alternating flux is set up in the laminated core, most of which is linked with the other coil in which it produces mutually induced EMF. If the second circuit is closed a current flows in is transected. The first coil is called the secondary winding. This is shown in fig. 2.3.0 below.

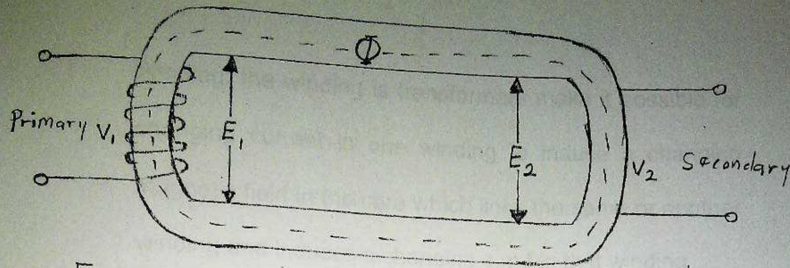


Fig: 2.3.0 A typical Step down transformar

2.3.1 USES OF TRANSFORMER

1. To step – down or step – input a.c voltage to lower or higher voltages respectively.
2. To isolate the electronic device from the power line for safety
3. As a matching device
4. Transferring of power from one stage to another, this is termed transformer coupling
5. To supply two or more load with different voltage requirements simultaneously from one source through the use of more than one secondary

2.3.2 CLASSIFICATION OF TRANSFORMER

Transformers are classified according to their physical size, power rating, winding, core type, function and so on.

i. Winding: the winding is transformers make it possible for changing current in one winding to induce a changing magnetic field in the core which links the same or another winding and induces a changing e.m.f in that winding

a. Auto transformers: this is a single wound transformer with intermediate tapping as shown in fig 2.3.2 below

b. Double – wound transformer: as the name suggest, it has two windings, the primary and the secondary windings. It has electrical isolation between its windings

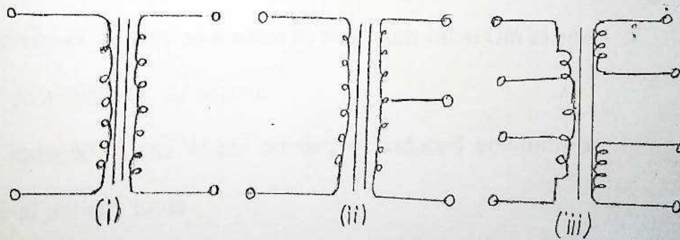


Fig: 2.3.2

i. Double wound transformer

ii. Double wound transformer with centre tapped secondary

iii. Double wound transformer with separate secondary and multi tapped primary winding

2.3.3 EMF EQUATION OF A TRANSFORMER

Let N1 = no of turns in primary winding

N2 = no of turns in secondary winding

Qm = max. flux in core in weber

= BMA

F = frequency of AC input

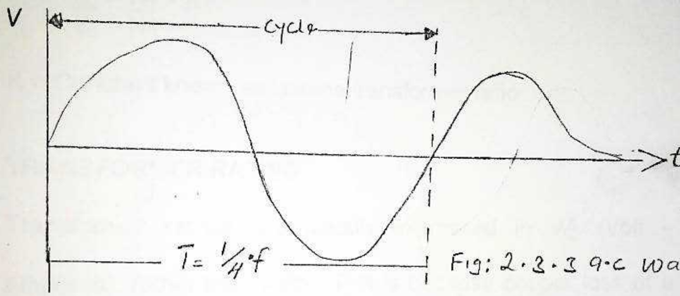


Fig: 2.3.3 a.c wave-form

Flux increases from its zero value to maximum value Qm in one quarter of a cycle i.e. ¼f second.

:. emf induced in the whole primary = (induced emf/turn) x number of primary turns

$E_1 = 4.44f\ N_1\ Qm = 4.44f\ N_1\ BmA$ .... (1)

Similarly, the value of the induced emf in the secondary is;

$E_2 = 4.44f\ N_2\ Qm = 4.44f\ N_2 BmA$ .... (2)

It is seen from equation (1) and (2) that

$E_1/N_1 = E_2/N_2\ \ 4.44f\ Qm$ .... (3)

Equation (3) means that emf/turns is the same in both the primary and secondary windings. In an ideal transformer, on no – load, $v_1 = E$, and $v_2 = E_2$ where v_2 is the terminal voltage as in fig 2.30 above.

From equation (1) and (2) got

$$\frac{E_2}{E_1} = \frac{N_2}{N1} = K$$

K = Constant known as voltage transformer ratio

2.3.4 TRANSFORMER RATING

Transformer ratings are usually expressed in VA (Volt – amperes), rather than watts. This is because copper loss of a transformer depends on current and iron loss an voltage. Hence total transfer loss depends on (VA) and not on phase angle between voltage and current.

For power transformer the multiple of KVA and MVA are used. Hence, transformer rating in VA = V_2 I_2 (FL) where I_2 (FL) is the full load secondary current.

2.3.5 POWER LOSS IN TRANSFORMER

The amount of power that can be drawn from a secondary winding is always less than the power supplied to the primary windings this is because energy is lost as heat in winding and care. The losses experienced in transformer include:

1. Copper loss: this is as a result of the resistance of the wire used in transformer windings. It is sometimes called I^2R losses

2. Hysterics loss: this is as a result of a magnetic particles changing polarity in step with the induced voltages. Sometimes called molecular frictions

3. Eddy – current – losses: this is as a result of small circulating electric current induced in the care materials. The current depends on the maximum value of magnetic flux and rate of change of flux in the care.

2.3.6 TRANSFORMER EFFICIENCY

The efficiency of a transformer for a particular load is given by:

Efficiency = output power/input power

Efficiency = input power/input power

Efficiency = 1 – losses/input power

Where: output power = $I_2R_2 + I_1R_1$

2.4. DIODES

These are two terminal semi – conductor devices that make the rectifying circuit possible. The device offer low resistance to current flow from anode to cathode but infinitely high resistance to current flow in the reverse direction. Diodes are used in power rectification, inversion, voltage regulation stabilizing and components protection.

2.4.1 LIGHT EMITTING DIODES (LED)

Light emitting diodes are employed for the purpose to indicate that the circuits is on or off.

In the forward biased, free electrons cross the junction and fall into holes. When they recombine, these electrons radiate energy goes off as heat. But in an LED the energy radiates as light

By using elements such as gallium arsenic and phosphorus, a manufactured, green, yellow, orange and infrared (invisible) rays. LEDS that produce visible radiation are used in instrument displays, calculators, digital matches etc. that infrared LED finds application in remotes, burglar alarm system and other area requiring invisible radiation.

The advantages of an LED over an incandescent lamp are long life (more, than 20 years), low voltage (1 – 2v) and fast on – off switching (nano seconds).

The symbol is as in the figure below

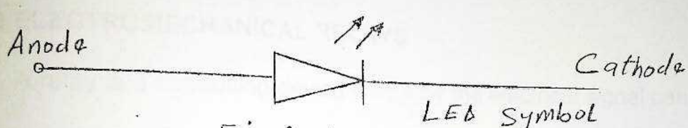


Fig: 2.4.1

2.5.0 RESISTOR

The flow of charge through any materials encounters an opposing force. This opposition due to collision between electrons and other atoms in materials, which convert electrical energy into heat is called the ohm (Ω). Hence, resistor can simply be understood as a component with a known predetermined resistance, which has wide applications in electronics. It is characterized by its resistance R = V/I. There are two types of resistors fixed value resistor (colour band) and variable resistor.

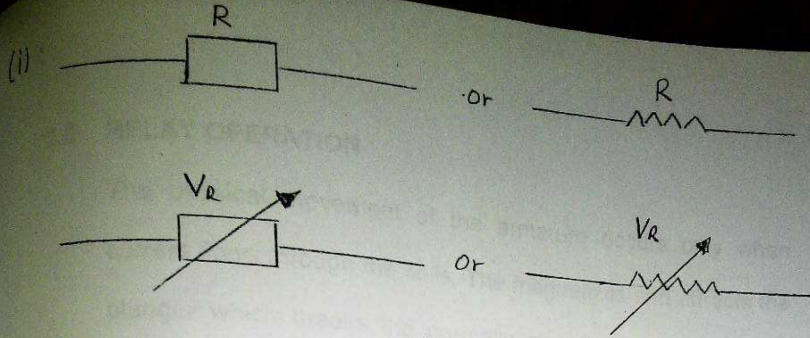


Fig 2.5 (i) symbol of fixed value resistor

Fig 2.5 (ii) symbol of variable value resistor

2.6.0 ELECTROMECHANICAL RELAYS

A relay is a controlling device where by the electrical signal can be used to isolate one or more electrical system. Relays are grouped as follows:

i. Control relays

ii. Power relays

For this project research work, a control relay was used. These are used to control the automatic change over switch from generator to power source and vice-versa. Control relays fluid number of application in auto-mechanical circuits, whereby a small electric signal sets off a chain of reaction of successive relays. Relays performed various functions.

CHAPTER THREE

3.0. GENERAL OPERATION DETAILS

The main circuit of the project is made up of two stages. The powering stage from the source to a transformer (step – down) 12 – 0 – 12v to bridge rectifying circuit, to filtering and voltage regulating. The output of the power is delivered to the next stage which comprises of three control relays.

3.1. MODE OF OPERATION OF THE PROJECT

The complete circuit diagram of the automatic change over switch is shown in fig. 3.1.0 (a) the power supply is protected by a fuse, which is fed from 220v a.c. supply and step down to 24v by a 12v centre tapped transformer.

The secondary side (output) of the transformer gives 24v. This 24v is the rectified by using bridge rectifier, which consists of four diodes normally connected in bridge form. Hence, the smoothing capacitor C_1 in the circuit is used to filter the d.c ripples flow into the circuit, so that almost perfect direct current (d.c) is obtained at the output.

Complete block diagram of an automatic change over switch.

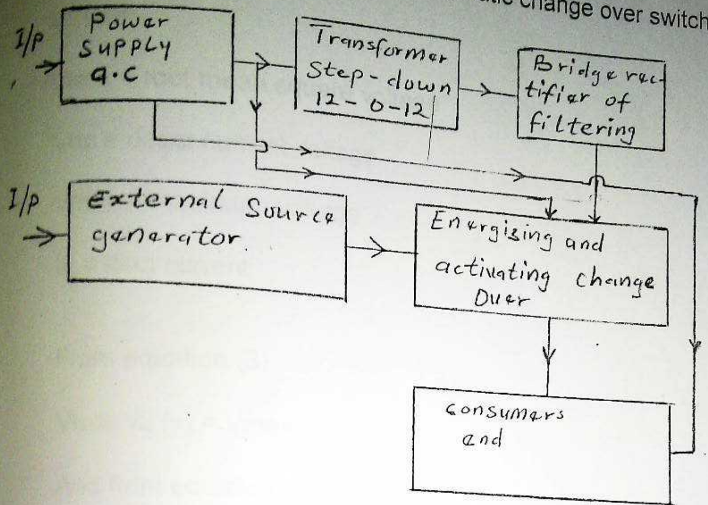


Fig. 3.1 (b) complete block diagram of an automatic change over switch

3.1.1 DESIGN CALCULATION

Choice of transformer, for this project work a 220v/2Vmax step - down transformer is choosing based on its maximum current, taking voltage drop across rectifying diode and transformer winding into consideration.

Transformer rating = Vrms x IL .... (1)

Vdc = 0.636 Vmax .... (2)

Vrms √2 (v) = Vmax .... (3)

IL = Load Power/Load volage .... (4)

Where:

Vrms = root mean square voltage

Vdc = direct current voltage

Vmax = maximum voltage

IL = load current

From equation (3)

Vrms √2 (v) = Vmax

And from equation (2)

Vdc = 0.636 Vmax (v)

But Vdc = 12v (from the transformer used)

12 = 0.636 x Vmax

Vmax = 12/0.636

Vmax = 18.86v

From equation (3) above

Vrms/√2 = Vmax

Vrms = 18.86 x √2

= 18.86 x 0.707

Vrms = 76.66v

From equation (4)

IL = P/V

= 26.66/12 = 2.22D

From equation (1)

Transformer rating = Vrms x I2

26.66 x 2

= 53.32VA

Therefore 500MA x 24V transformer was used.

3.2.0 RECTIFYING DIODES

The bridge rectifier use (4) diodes with peak voltage (P.I.V) twice the output peak voltage of the transformer. Peak inverse voltage (P.I.V) 2 x Vmax

P.I.V = 2 x 18.86

= 37.72v

And current rating

I = 1.5 x IFL

= 1.5 x 2

= 3A

Thus preferred rectifier diodes are in 400L.

3.2.1 D.C FILTERS

The ripple can be chosen in the range of 0.1 – 0.5, but the higher the value, the smoothen the output voltage, so we choose 0.375.

From the equation

Rf = ½V f Cl

Where Rf = ripple factor

Cl = ½ x 12 x 50 x 0.375

= 1/450

= 2.22×10^{-3}f

= 2220φf

So, 2200φf is the nearest available one, so it was used.

3.5.0 RELAY

A 12v d.c, 10A, 400Ω is used and is used to provide the necessary switch over

CHAPTER FOUR

4.1.0 This chapter gives the practical actualization of the project specification along with components layout. The design testing and packaging are also discussed.

4.2.0 CONSTRUCTION

The construction of the project was realized by following the design block as earlier shown in chapter three one by one. First the different blocks were mounted on the bread board so that adjustment, changes and measurement were effected easily.

These components from the power supply filter together, using were connectors. A permanent construction was then made by soldering the different component on vero – board.

4.3. COMPONENT LAYOUT

The actual and physical allocations of the component, their values and connections were illustrated in fig. 4.5 below and that of chapter three (3).

4.4. TESTING

Before and after the complete assembly, series of test were carried out as follows

a. Wiring test

b. individual component test

c. Complete system test

4.4.1 WIRING TEST

The wiring of the circuit was done on vero – board, short circuited and open circuit multimeter. The wiring was found satisfactory.

4.4.2 INDIVIDUAL COMPONENT TEST

Before making use of the component, they were subjected to various test to confirm their well being.

a. Relay: The short and open circuit test were applied to know the stable of their coil winding. Terminals identification test were carried out to know the No (normally open) and Nc (Normally closed) position.

b. The diode: the diodes were subjected to test ascertain their forward and reversed biased characteristics

c. The transformer: the transformer undergo positive to centre tapped to negative terminal test and positive to negative terminal test.

d. Resistors and capacitors: these were similarly given. Their respective tests to know whether they were in good operational conditions.

4.5 COMPONENT REQUIREMENTS

S/No	COMPONENT	DESCRIPTION	QUANTITY
1.	Transformer	12 – 0 – 12v	1
2.	Capacitor	2200φF, 35v	1
3.	Diodes	IN 4001	4
4.	Ceramic capacitor	100n (104)	2
5.	Regulator	7812	1
6.	Resistor	330Ω	1
7.	LED	RED	1
8.	Relays	12v, 5pins	3
9.	Sinker	Heat sink	1
10.	Vero board	Small size	1
11.	Jumpers	Conductors	9yrds
12.	Code	Radio code	1
13.	Power switch	SWI	1
14.	Fuse	3A	1
15.	Fuse jacket	Small size	1

4.5.1 PACKAGING

Due to the presence of 220v in the construction, a compact, adequate and efficient casing was done with plastic so as to discourage conduction.

4.5.2 RESULT

The gadget was tested by fixing a generator at its one input (white terminals) and power source at the other input (red terminals) specified by it, blue terminals are connected to the generator power switch while the green terminals are connect to the consumers, where a single bulb was used. All connection with respect to the specified colours of terminals assigned were found successfully and excellent.

4.5.3 DISCUSSION

The result obtained was marvelous because the gadget simply eliminates human labour at very low cost.

4.5.1 PACKAGING

Due to the presence of 220v in the construction, a compact, adequate and efficient casing was done with plastic so as to discourage conduction.

4.5.2 RESULT

The gadget was tested by fixing a generator at its one input (white terminals) and power source at the other input (red terminals) specified by it, blue terminals are connected to the generator power switch while the green terminals are connect to the consumers, where a single bulb was used. All connection with respect to the specified colours of terminals assigned were found successfully and excellent.

4.5.3 DISCUSSION

The result obtained was marvelous because the gadget simply eliminates human labour at very low cost.

CHAPTER FIVE

5.1. SUMMARY

This project write up has been carefully arranged in such a way to reflect the conception of ideas from the general knowledge then to the specific. The first chapter presents an overview of the intended project and its necessity. The second chapter discuses the individual components that make up the design based on engineering concepts adopted while in the third chapter, the actual system design analyzed, and the fourth chapter presents the construction procedures, the construction procedures as well as tests, results and packaging.

Few problems were encountered in the course of this project work such as the fact that calculated component values are not commercially available. Thus approximated values are used which leads to not exactly to the general adjustment of the components.

Few component were damaged during soldering due to inexperience in handling components. This type of problem is gradually overcome by consistent trials.

5.2. CONCLUSION

The main objectives of this project are aimed at designing, constructing and testing of an automatic change over switch. Apart of the main objective of the project, the initial purpose of the project was to use locally available material/components to design a cheap, affordable, reliable , maintainable and functional automatic change over and also to give me the true knowledge and basic skill in solving engineering problems.

5.3. RECOMMENDATION

In any electrical work its perfection depends on time, working tools, and availability of parts and skills. Automatic change over is not exempted. Since its short coming involved in the availability of parts such as a relay on that note the following recommendations were made.

i. in any engineering work an early exposure to the laboratory practice and technicalities is necessary for electrical system installation and testing.

ii. The circuit should be improved, so that microprocessors (programmed IC's) will be use for faster and low power consumption.

REFERENCE

1. Boylestad, R & Nashelsky, L.E Electronic Devices and Circuit theory. Practice – Hall, New Jersey, 1987, pp 670 - 683

2. D.C Ramsey (1978), Engineering Instrumentation and Control System, 2nd edition pp 215 and 315

3. Havill, R.L & Walton, A.K. Elements of Electronics for Physical Scientists. ELBS & Macmillan, London, 1978 pp 34 – 39

4. Paul Horowitz and Winfield Hill (1989), The art of electronics 2nd edition Cambridge University Press. Pp 42 – 45, 329 – 331