Automatic Three Phase Voltage Selector (ATPVS) With Protective Circuit

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DEDICATION

This project is dedicated to the memory of my father who is a mentor, Mr. G.A Jegede.

DECLARATION

I George – Jegede Mercy declare that this work was done by me and has not been presented elsewhere for the award of a degree to the best of my knowledge. I also relinquish the copyright to the Federal University of Technology, Minna.

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My profound gratitude to God Almighty, my dear mother Mrs. Jegede, my Sweetheart Olayemi Samuel, my Supervisor Dr. J. Tsado, my friends Olagunju Adepeju, Aboi Florence, Usifo Ewere, Yunusa Mohammed for their immerse contribution, Mr. Abdulaziz NAMA Abuja for his help in the design, Mrs.C.O. Alenoghena for initiating the idea, Mr. Kolo for his concern during year of study my classmates, Martins who was very helpful in construction. I cannot but mention those who matter dearly to me and have given all round support my lovely sisters Adeola, Omolola, Elizabeth, Aunty Grace and her Husband.

ABSTRACT

Automatic Three Phase Voltage Selector (ATPVS) is implemented to improve availability and reliability of PHCN power supply. To make available power supply to a single phase load, whenever there is supply voltage of not more than 240V in any of the PHCN phases.

This project is achieved using small current values in relays and comparators to control larger voltage values in AC power supply lines. The comparator compares the phases reduced values and the relay switches the phases. The relay is used in the implementation of the power supply unit, to get an output whenever there`s at least one phase with supply voltage. The switcher unit compares the supply voltage with preset voltage value, and then switches to a terminal not connected when the supply voltage is above 240V. The selector unit, which is the final stage of this project, selects the highest supply voltage value amongst available phases and supplies it to the load. Detailed explanation will be discussed in the course of this project.

The ATPS was constructed, tested and found working satisfactorily. The objective of this project is achieved.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 Introduction

Automatic control is the process of maintaining a satisfactory relationship between the input and output of a system without human intervention; it is used in preference to simple manual control in an environment hostile to man. Automatic control systems are now widely used in the Home, Industry, Airspace Vehicles and in Military application [8].

Most alternating-current (AC) generation and transmission, and a good part of use, take place through three-phase circuits. It is a type of polyphase system. Three phase systems may or may not have a neutral wire. A neutral wire allows the three phase system to use a higher voltage while still supporting lower voltage single phase appliances. In high voltage distribution system it is common not to have a neutral wire as the loads can simply be connected between phases (phase-phase connection). Three phase has properties that make it very desirable in transmission and distribution. Firstly all three wires carry the same current. Secondly power transfer into a linear balanced load is constant. Most domestic loads are single phase. Generally three phase power either does not enter domestic houses at all, or where it does, it is split out at the main distribution board.

Phase is a frequently-used term around AC. The word comes from Greek φασις, "appearance," from φανειν, "to appear." It originally referred to the eternally regular changing appearance of the moon through each month, and then was applied to the periodic changes of some quantity, such as the voltage in an AC circuit. Electrical phase is measured in degrees, with 360° corresponding to a complete cycle. A sinusoidal voltage is proportional to the cosine or sine of the phase. Three-phase, abbreviated 3φ, refers to three voltages or currents that that differ by a third of a cycle, or 120 electrical degrees, from each other. They go through their maxima in a regular order, called the phase sequence. The three phases could be supplied over six wires, with two wires reserved for the exclusive use of each phase. However, they are generally supplied over only three wires, and the phase or line voltages are the voltages between the three possible pairs of wires. The phase or line currents are the currents in each wire. Voltages and currents are usually expressed as rms or effective values, as in single-phase analysis. [13]

The domestic use of electricity cannot be overemphasized aside its application in Agriculture, Medicine, Factories/Industries e.t.c. We depend on the availability of electricity in our homes for cooking, preservation and comfort. It is an obvious fact that we turn to the use of electric power to counter negative effects of weather and climate.

In a country like Nigeria which has not attained economic stability, the problem of power outage is prominent. These outages are due to overload, temperature, mechanical stress, equipment failure in power holding company and transient current caused by fluctuation of power systems. These outages cause great discomfort. These discomforts are greatly reduced with the use of different methods of achieving power availability in the homes, factories, farms, hospitals especially in the theater.

The distribution of power to end users in Nigeria is done in three phases and a neutral, the three phases and neutral are taken from a transformer which is feed by three phase transmission lines. The transformer steps the high voltage available in the transmission lines to needed supply in the distribution lines. At often times, power outages do not occur in all three phases at once, there is power supply in at least one of the phases, except for major fault or maintenance, the use of automatic three phase voltage selector will go a long way in the availability of supply as well as reducing cost. The three phase voltage selector is designed having input of three phases and a single phase output, with maximum value of single phase appliance ratings. This device operates using comparators, fed with appropriate inputs to generate a low or high, this comparator output is fed to the coils of a relay through the base of a switching transistor, which determines if the relay makes or not.

1.2 Project Objective

This project is aimed at constructing a working automatic three phase voltage selector with ability to select and supply to load the phase with the highest voltage supply of the three phases which is not above maximum single phase appliance rating of 240V without human aid once there is supply in any of the phases.

1.3 Project Methodology

This project is Designed and constructed such that there is continuous output voltage of 240V and below supplied to the consumer terminal once there is at least one phase with supply within these range. It comprises basically of the DC power supply unit, the switcher and the selector unit.

Each phase is passed through the voltage switcher to avoid high voltage above 240V, when voltage is above 240V the switcher cuts off the supply, till it drops to 240V and below.

In voltage selection, voltage comparators are used. These comparators are fed with rectified voltages which have passed the switcher stage, and then the output of the comparator is used to energize the relay by connecting the output of the comparator to the base of a switching transistor and the collector to the relay supply. The relay has its legs connected to the mains supply. The selector stage has two comparators and two relays, the first comparator has its input as rectified supply from two phases and the first relay connected to the mains supply of these two phases. When the rectified supply of the two phases are compared the comparator outputs is such that it triggers the relay through the swiching transistor to make to the leg corresponding to the higher rectified voltage. For the second comparator, the rectified voltage of the output of the first relay is fed alongside the rectified supply of the third phase to its inputs. the second relay has its normally open and normally closed legs connected to the mains supply of the first relays output and the mains of the third phase respectively. The second comparator output is such that it triggers the relay through the switching transistor to make to the terminal corresponding to the higher rectified voltage, outputting the highest of the three phases.

The power supply unit of the automatic three phase selector is designed to supply regulated DC supply voltage of 9V to power the switcher and selector unit once there is supply in any or all of the phases. This unit uses two relays connected to achieve this aim.

1.4 Project Outline

Chapter one covers the expository introduction, project objectives, project methodology and project outline. Literature review and theoretical background of the components and the work mode are treated in chapter two. The third chapter covers the design calculations and how components work to achieve project objectives in construction. Chapter four enumerates test of project. result and discussion on them. Conclusion and recommendation are stated in chapter five.

CHAPTER TWO

2.1 Historical background

The need for stable supply has instigated different approaches to improve the availability and efficiency of power supply.

2.1.1 Manual Switch Over

In manual switch over, switching from phase under load shedding to another phase with supply or generator set is done manually to keep up supply to load. This approach though with its aim met requires human aid in switching phases or to generator set and involves high cost of maintenance for fueling for a single phase manual switch over.

2.1.2 History of Automation

Automation is the technique of making a machine or mechanized process self-regulation and self-controlling. It involves three basic components a machine, control system and feedback. Machines are taking over more and more task that are boring, unpleasant, dangerous and unhealthy with increase in production and decrease in cost. [9, 10]

An early example was Elmund Lee's (England 1745) who used small pivot windmill to keep a large windmill faced into the wind. [11]

2.1.3 History of Automatic Switching

Almon B. Strowger was an undertaker in Kansas City, USA. The story goes that there was a competing undertaker locally, whose wife was an operator at the local (manual) telephone exchange. Whenever a caller asked to be put through to Strowger, calls were deliberately put through to his competitor. This obviously frustrated Strowger greatly and he set about devising a system for doing away with the human part of the equation!

Strowger developed a system of automatic switching using an electromechanical switch based around electromagnets and pawls. With the help of his nephe(Walter S. Strowger) he produced a working model in 1888 (US Patent No. 447918 10/6/1891). In this selector, a moving wiper (with contacts on the end) moved up to and around a bank of many other contacts, making a connection with any one of them.

Strowger did not invent the idea of automatic switching; it was first invented in 1879 by Connolly & McTigthe but Strowger was the first to put it to effective use. Together with Joseph B. Harris and Moses A. Meyer, Strowger formed his company 'Strowger Automatic Telephone exchange' in October 1891.

In late 1890's Almon B. Strowger retired and eventually died in 1920. In 1901, Joseph Harris licenced the Strowger selectors to the Automatic Electric Co. (AE); the two companies merged in 1908. [6]

2.1.4 Automatic Three Phase Selector (ATPS)

The automatic three phase selector approach is an improvement on the aforementioned approaches though not without its own limitations. The ATPS do not require human aid, relies not only on single phase supply but on the three phases supplied by PHCN and works alongside some of the device aforementioned to achieve supply availability and efficiency.

ASCO three-source systems are designed for automatic switching of loads between the utility source and alternate sources of power. Upon the loss of the utility power source, the system provides an automatic start signal to the alternate sources of power. Once the alternate source has reached proper voltage and frequency, the system transfers the critical load from the utility source to the alternate power source and second alternate power source is added to back up the first if that power source fails. Upon the loss of the utility power source, the system provides all necessary controls to start both alternate power sources. The critical loads are automatically transferred to the first alternate power source that achieves acceptable voltage and frequency. The second alternate power source is then automatically shutdown after a time delay and cooldown period. If the first alternate power source fails, the second alternative power source will be automatically re-started and the load will be transferred from the first alternative power source to the second alternative power source. When the normal power is restored, the controls automatically retransfer the load to the utility power source. [14]

2.2 Theoretical Background

The working of the ATPS with overvoltage protection is based on the mode of operation of the components that form the device circuitry. The mode of operation of these components will be studied in the modules.

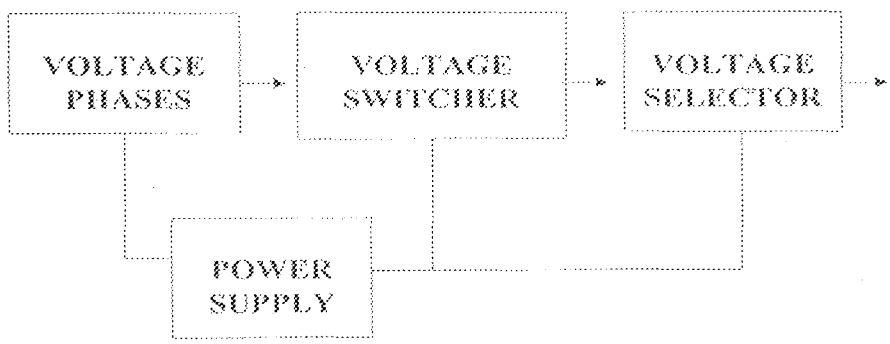


FIG 2.1 Block Diagram of ATPVS

2.2.1 Power Supply

General electronics systems are powered by low DC voltage supply; this is usually obtained from the AC supply voltage from PHCN. The DC power supply module basically consists of the transformer, rectifier, filter and regulator. Below is the block diagram of a simple power supply module.

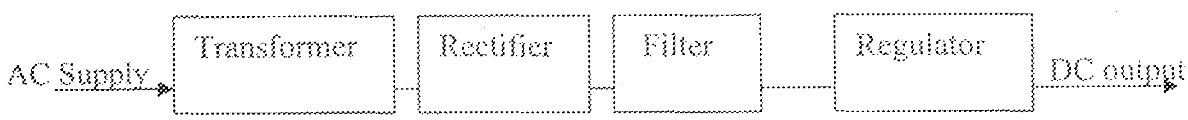


FIG 2.3 Block Diagram of a Simple Power Supply Module

2.2.1.1 Transformer

A transformer is a static piece of apparatus by means of which electric power in one circuit is transformed into electric power of the same frequency in another circuit. It can raise or lower the voltage in a circuit but with corresponding decrease or increase in current.

The physical basis of a transformer is mutual induction between two circuits linked by common magnetic flux. In its simplest form it consists of two inductive coils which are electrically separated but magnetically linked through a path of low reluctance.

The two coils possess high mutual inductance when the primary 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 secondary coil in which it produces mutually-induced EMF (according to Faraday's laws of electromagnetic inductions e=Mdi/dt).When the secondary coil circuit is closed ,a current flows init and so electric energy is transferred from one coil to another magnetically.[1]

Assuming an ideal transformer, that is no magnetic leakage and ohmic resistance.

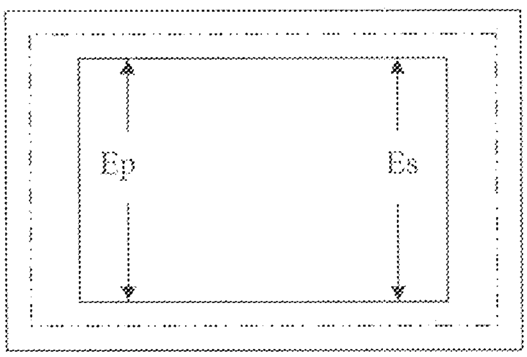


FIG 2.4 Transformer Circuit

Es/Ep = Ns/Np = K

Where E is electromotive force (e.m.f)

N is number of coil turns

s is secondary

p is primary

P is power

I and V are current and voltage respectively

Pp=Ps

IpVp=IsVs

Current ratio Ip/I=Vs/Vp=Ns/Np

For this project the needed Vs<Vp and it is referred to as a step-down transformer.

2.2.1.2 Rectifier

Most electronic circuit need direct current. Alternately current is supplied by the power holding company of Nigeria (PHCN), the purpose of the power rectifier to change AC to DC which flow in one direction unlike the bi-directional AC.Since the diode conducts in only one direction they serve as rectifiers [3].

In the course of this project full wave bridge rectification is needed and this is obtained using four diodes. it is the most frequently used for electronics DC power supply. It is used alongside a transformer which is not centre-tapped with maximum voltage; Vsm [13].The ripple effect of a full wave rectifier is less compared to the half wave rectifier which uses two diodes.

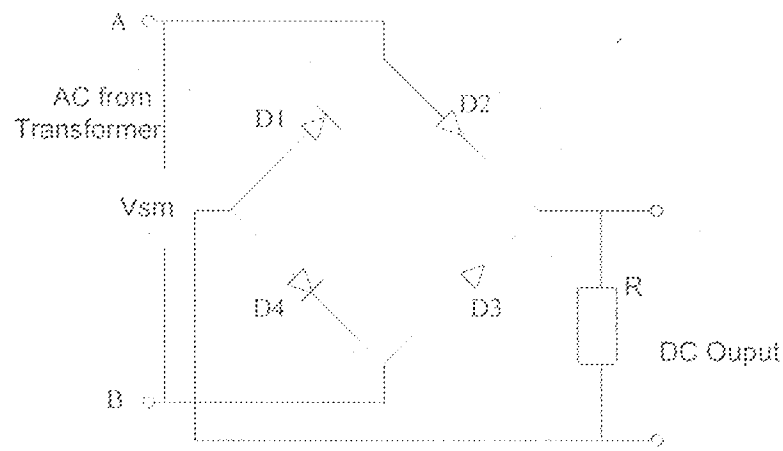


FIG 2.5 Full - Wave Rectifier

When A is positive with respect to B during the first half cycle, D2 and D4 conducts the current takes the path AD2RD4B.On the next half cycle when B is positive with respect to A, D2 and D3 are forward biased and current follows the path BD3RD2A.the current passing through R is unidirectional during both half cycles of the input and varying DC output is obtained. The use of diode is economical [2].

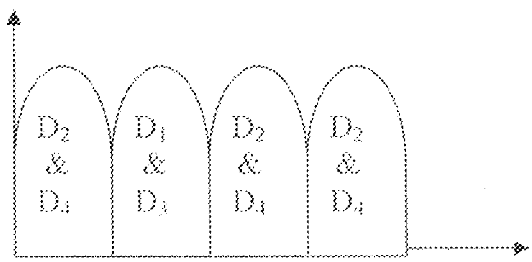


FIG 2.6 Output Waveform of Rectifier

2.2.1.3 Filters

Pulsating direct current which is the output of the rectifier is not directly usable in most electronics circuits, it contains AC component called ripple. Filters are circuits used to remove ripple, they produce output that approach the DC wave form produced by batteries which are appropriate [3]

There are different circuits to achieve this wave form namely

- series capacitor filter
- series inductor filter
- 3.L-C filter or L-type
- 4.R-C filters
- 5. R-L-C filters [1]

The most common technique used for filtering, is a capacitor connected across the output which is employed in this project. Fig 2 shows the output of this filter connected across full wave bridge rectifier output in Fig 2.6

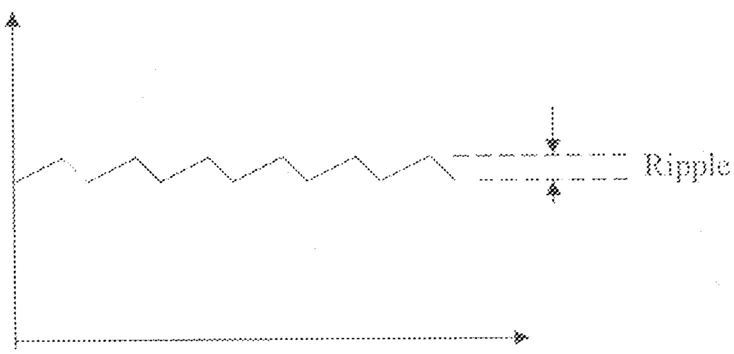


FIG 2.7 Filtered Output of a Full Wave Rectifier

To be effective, a filter capacitor should be only slightly discharged between peaks, this means small voltage change across the load. [3]

2.2.1.4 Regulator

The output of the filter above varies with varying load or input voltage called Unregulated DC supply. A regulator is an electronic control circuit which is capable of providing a nearly constant DC output voltage even where there is varying load and input voltage. [1]

The regulated output can be achieved using linear regulators, switching regulators or integrated circuit form. For this project the IC form is used for compact work. A constant value stipulated on IC is gotten as output once rectified voltage is not less than that value.

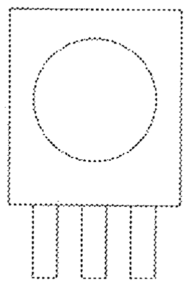


FIG2.8 Regulator IC

2.2.2 Voltage Comparator

A voltage comparator is an operational amplifier with an output that is normally constrained to a level suitable for connection to a digital circuit.

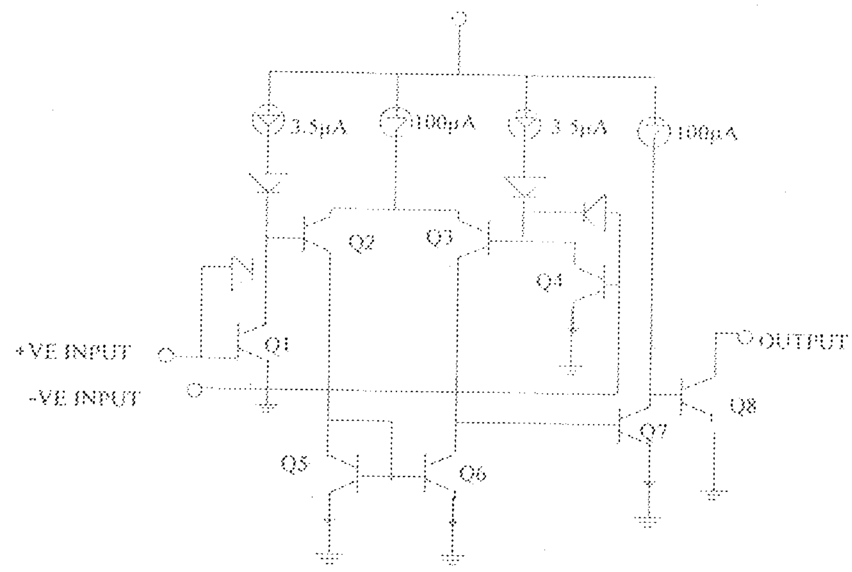


FIG 2.9 ½ Internal Circuitry of an LM339

Voltage comparators can be powered by single supply or dual supply depending o the comparator IC type.

Basic operation of a comparator

Current will flow through the open collector when the voltage at the positive non-inverting input is lower or equal to the voltage at the negative inverting input and this implies a low, L output.

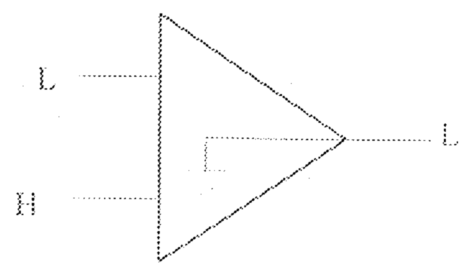


FIG 2.10 Comparator with Low Output

Current will not flow through the open collector when the voltage at the non-inverting input is higher than the voltage at the inverting input and this implies a high,+1 at the output. [5]

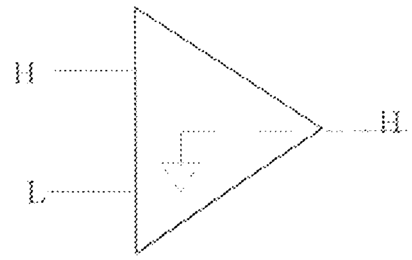


FIG 2.11 Comparator with High Output

In the cause of this project the LM339 Quad voltage comparator and the LM393 Dual voltage comparator will be used. The LM139 Quad comparator series to which the LM339 belongs, consists of four independent precision voltage comparators with an offset voltage specification as low as 2 mV max for all four comparators. These were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground, even though operated from a single power supply voltage.

Application areas include limit comparators, simple analog to digital converters; pulse, square wave and time delay generators; wide range VCO; MOS clock timers; multivibrators and high voltage digital logic gates. The LM139 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, they will directly interface with MOS logic— where the low power drain of the LM339 is a distinct advantage over standard comparators.

The LM193 series consists of two independent precision voltage comparators with an offset voltage specification as low as 2.0 mV max for two comparators which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground, even though operated from a single power supply voltage.

Application areas include limit comparators, simple analog to digital converters; pulse, square wave and time delay generators; wide range VCO; MOS clock timers; multivibrators and high voltage digital logic gates. The LM193 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, the LM193 series will directly interface with MOS logic where their low power drain is a distinct advantage over standard comparators. [4,15]

2.2.3 Switching Transistor

The switching transistor is used to activate or deactivate the relay, switching between cutoff and saturation region. A transistor is normally operated in the linear region with the emitter-base junction forward biased and the collector-base junction reversed biased. When the transistor is reversed biased no collector current flows and it is said to be operated at cutoff region.

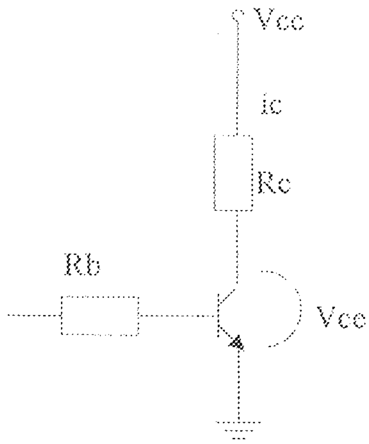


FIG 2.12 Switching Transistor

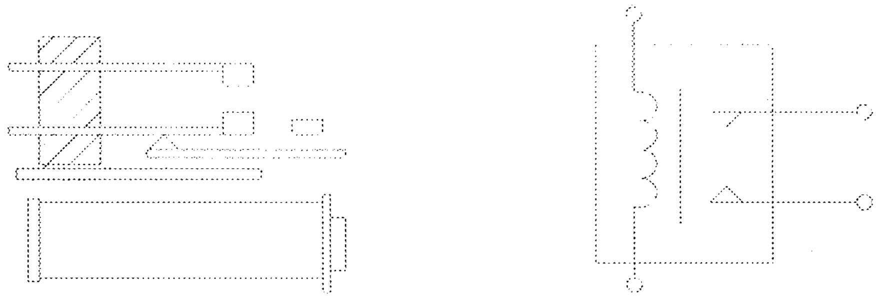
In the cutoff region the transistor acts like an open switch.

$$V_{CE} = V_{CC} - I_C R_C$$

When R_b and R_c values are such that V_{CE} comes to zero, the transistor is said to be operated in saturation region and it acts like a closed switch of negligible resistance. In this state, the collector current is maximum and V_{CC} drops across R_c. The transistor is made to work in two extreme regions, cutoff which leaves the relay at the normally closed leg and saturation which makes the relay to the normally open terminal, this serves the function of the switching transistor.

2.2.4 Relay

A relay is a switch, worked by an electromagnet, it is used when small current in a circuit controls another circuit containing a device such as lamp or electric motor which requires a large current.



(a) Structure of relay (b) Symbol of relay

FIG 2.13 Relay

When the controlling current flows through the coil, the soft iron core is magnetized and attracts the L-shaped soft iron armature, his rocks on its pivot and opens, closes or change over. The current needed to operate a relay is called the pull-in current while the current in the coil when the relay just stops working is called the drop-out current. [16]

This system loses magnetism as current ceases to flow through the coil, relays normally have time integrating block which in must cases are spring, these determine the speed of operation. Relays are available for DC and AC excitation with coil voltage ranging from 5V to 230V.

The primary use of relays is in remote switching because it is important to keep the electronic circuit electrically isolated from the AC power line

CHAPTER THREE

Design Calculation

The block diagram of an Automatic Three Phase Voltage Selector (ATPS) is shown in FIG 3.1 which incorporates the voltage selector module, voltage switcher module and the DC power supply module.

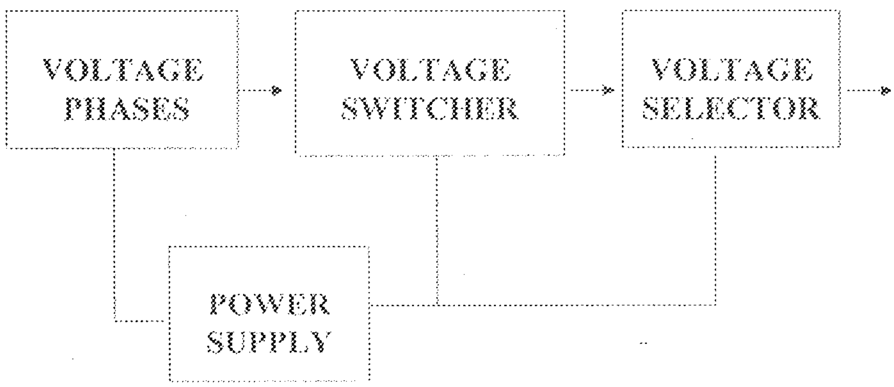


FIG 3.1 Block Diagram of ATPVS

3.1 POWER SUPPLY MODULE

The power supply is designed to power the voltage selector and the voltage switcher modules with regulated DC supply voltage, once there is supply voltage in any of the three phases of AC (PHCN) mains.

3.1.1 Transformer Calculation

For the selector module and the switcher module to be powered, a regulated supply of 9V is required; therefore a regulator IC 7809 is used .At a factor greater than four (4), the regulator IC begins to heat up.

Since the regulator IC 7809 gives 9V

We have maximum regulated voltage, V_{mr}

$$V_{mr} = (9 + 4)\ V$$

$$= 13V$$

Above 13V, the regulator IC7809 begins to heat up. a safe value, V_{sv} of 12V is chosen.

The full wave bridge rectifier has four (4) diodes, with 0.6V across the PN junction of each diode. Therefore voltage drop across rectifier, V_R

$$= 0.6V \times 4$$

$$= 24V$$

Voltage across secondary winding, V_S

$$= V_{SV} + V_R$$

$$= 12V + 2.4V$$

$$= 14.4V\text{peak}$$

The transformer ratings are in rms, the conversion of peak to rms value is done thus,

$$V_S\ \text{rms} = \frac{14.4V\ \text{peak}}{\sqrt{2}}$$

$$= \frac{14.4\ V}{1.4}$$

$$= 10.29V$$

With mains supply from PHCN about 2 20V an available transformer of 220/12V is used.

3.1.2 Rectifier Calculation

Peak inverse voltage (PIV) rating for each of the four diode is;

$$V_{max} = 1.414 \times V\,rms$$

$$= 1.414 \times 12V$$

$$= 16.97V \qquad [12]$$

The 7809 regulator IC requires current value of about 1A. The rectifier is implemented with IN4007/1A/600V given large tolerance voltage.

3.1.3 Filter Calculation

A shunt capacitor filter is employed for this project, to provide good smoothening of the AC ripple component in the DC supply. Assuming 20% ripple voltage, V_R after filtering,

$$V_R = \frac{20}{100} \times 14.4Vpeak$$

$$= 2.88V\ ripple$$

The 20% ripple is assumed to prevent charging up for the compensation capacitor.

Time between half cycle, $dt = \frac{1}{2} T$

$$dt = \frac{1}{2}\, 1/F$$

Where T is period for one cycle

PHCN frequency, F = 50Hz

$dt = \frac{1}{2} \times 1/50$

$= 1/100$

$= 0.01s$

With current, $I = 1A$ from the rectifier

$V_R = 2.88V$

$dt = 0.01s$

Using $I = C\,dv/dt$

Where $dv = VR$

Filtering capacitor, $Fc = C = ?$

$$I = Fc \times \frac{2.88}{0.01}$$

$$Fc = \frac{1 \times 0.01}{2.88}$$

$$Fc = 3472\mu f$$

An available value of 3300µf and a compensation capacitance of 100µf for further smoothening are used.

3.1.4 Switching Transistor

To achieve an output for the supply unit when there is supply voltage in any phase, two relays with switching transistors connected to them are used.

$$Vcc = IcRc + Vcc$$

At cutoff $\quad Vce \approx 0$

$$Vcc = IcRc$$

Where collector resistance, Rc is the resistance of the relay coil

$$Rc = 193\Omega \qquad \text{measured}$$

$$Vcc = 9V$$

$$Ic = \frac{Vcc}{Rc}$$

$$= \frac{9}{193}$$

$$= 0.0466A$$

Transistor gain $h_{fe} = 407 \qquad$ measured

$$h_{fe} = \frac{Ic}{I_b}$$

$$407 = \frac{0.0466}{I_b}$$

$$I_b = \frac{0.0466A}{407}$$

$$= 1.145 \times 10^{-4} A$$

$$V_B = I_B R_B + V_{BE}$$

Voltage drop across PN junction of transistor, V_{BE} = 0.6V

$$R_B = \frac{V_B - V_{BE}}{I_B}$$

Base voltage from regulated supply, V_B = 9V

$$R_B = \frac{9 - 0.6}{1.145 \times 10^{-4}}$$

$$= \frac{8.4}{1.145 \times 10^{-4}}$$

$$= 73362.4\ \Omega$$

Therefore, base resistance for transistor of value 73KΩ is used.

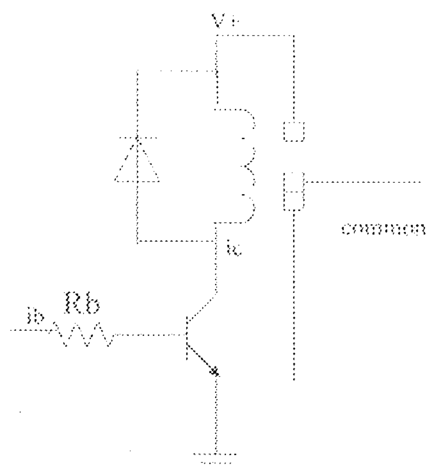


FIG 3.2 Switching Transistors – Relay Connection

3.2 VOLTAGE SWITCHER MODULE

This module is designed using LM339, to safe guard load from overvoltage, by comparing input voltage with preset reference voltage. Voltage supply above this preset value will make the relays common to a leg with no connection.

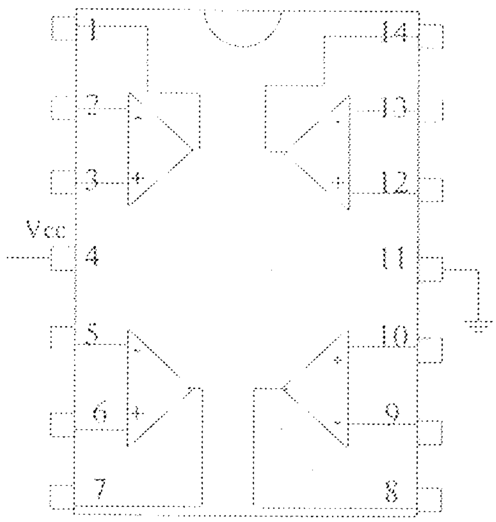


FIG 3.3 Circuitry of LM339

Using a transformer value of 220/12V, a reference voltage of 240V mains AC supply used, because most single phase load can work properly with up to 240V

220V - 12V

240V - X V

$$X = \frac{240 \times 12}{220}$$

$$X = 13V$$

Reference voltage of 13V is used.

3.2.1 Preset Resistor Calculation

The preset resistor is calibrated to give a particular value of unregulated supply that is equal to the value of the regulated supply, when the voltage divider theorem is applied to both supplies.

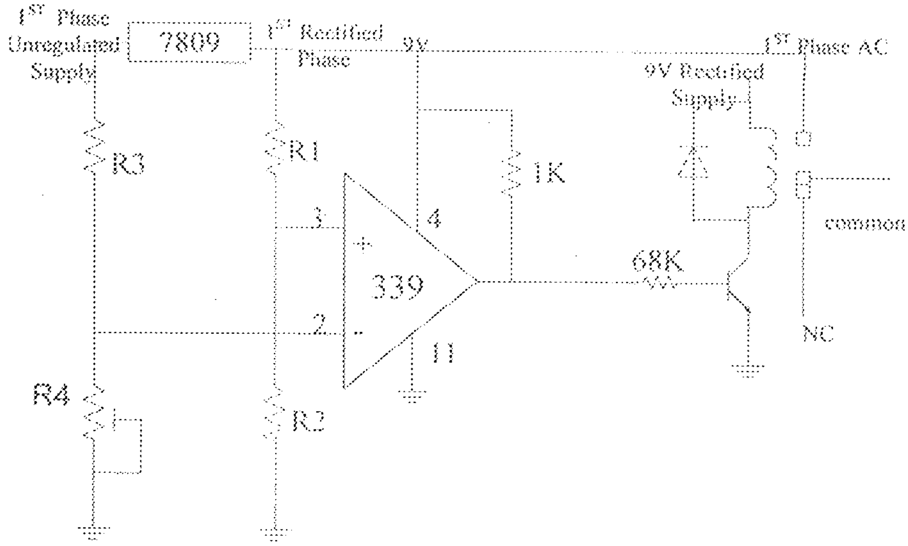


FIG 3.4 Switcher Module

For convenience R1= R2 =1KΩ to have non-inverting input of 4.5V by voltage divider, when regulated supply is 9V. For the inverting input, a preset resistor is calibrated such that at 13V unregulated DC supply, the input is 4.5V. An increase in unregulated supply will increase the inverting input value and gives a comparator output that will make the relay to the no connection leg.

$$4.5V = \frac{13\,R4}{(R4+1K)} \quad \text{------------------------} \quad 3.1$$

$$4.5(R4 + 1K) = 13R4$$

$$4.5R4 + 4.5K = 13R4$$

$$4.5K = 8.5R4$$

R4 = $\frac{4.5K}{8.5}$

= 0.529K

A preferred value of 10K was used for wide varying.

3.3 VOLTAGE SELECTOR MODULE

This module is designed to supply load with the highest of the supply phases that have passed the switcher stage. It is implement using comparators, relays, switching transistors and resistors. A LM393 Dual comparator IC is connected such that the first comparator, compares the first and second unregulated phases, the output determines if the relay will to make to the normally open or remain at the normally close which are connected to the 1^{st} phase and 2^{nd} phase respectively, the output is also taken and compared with the third unregulated phase in the second comparator, to give an output which controls the relay to make to the normally open or remain at the normally close.

The connection of the first and second phase connection is shown below:

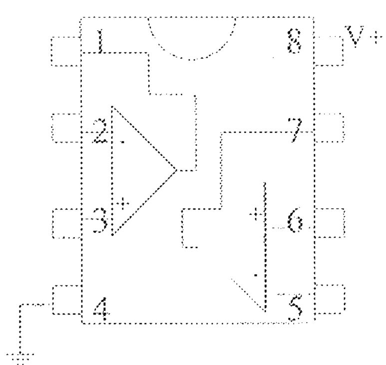


FIG 3.5 a Circuitry of LM393

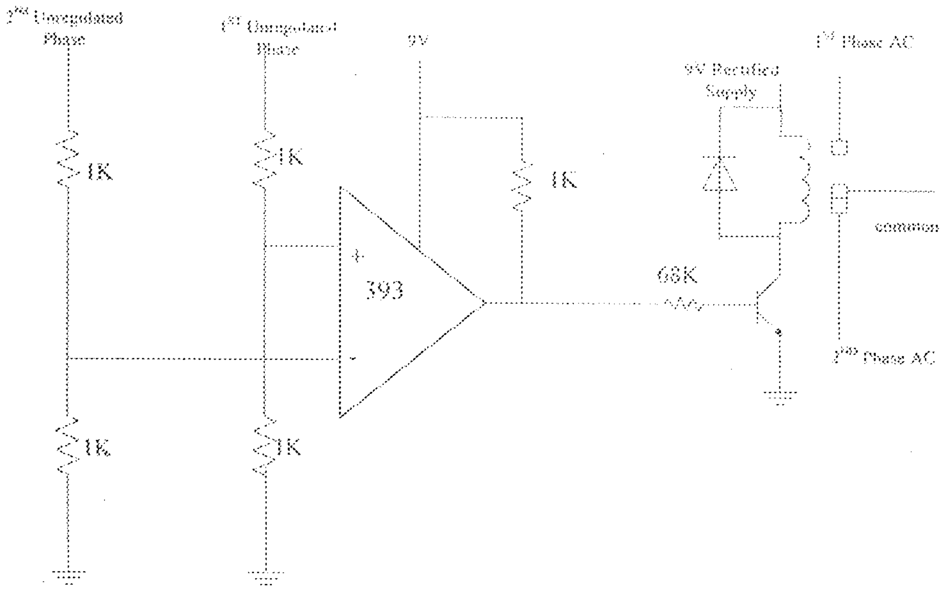


Fig 3.5b Comparator Connection For voltage Selector Module

The 1K resistors are connected to divide the rectified unregulated supply, using divider theorem to get reduced value conducive for the comparator.

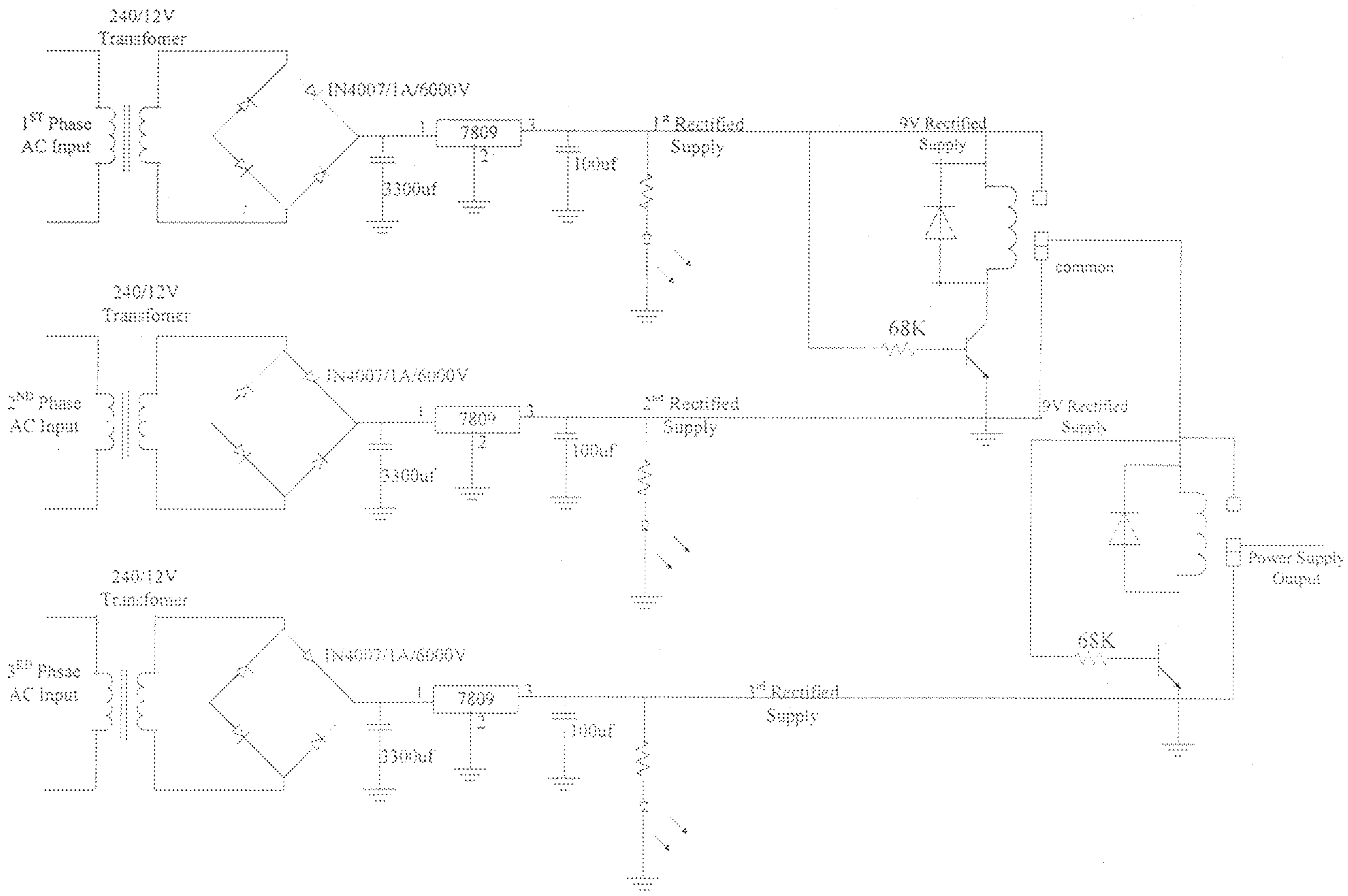


FIG 3.6 DC POWER SUPPLY CIRCUIT

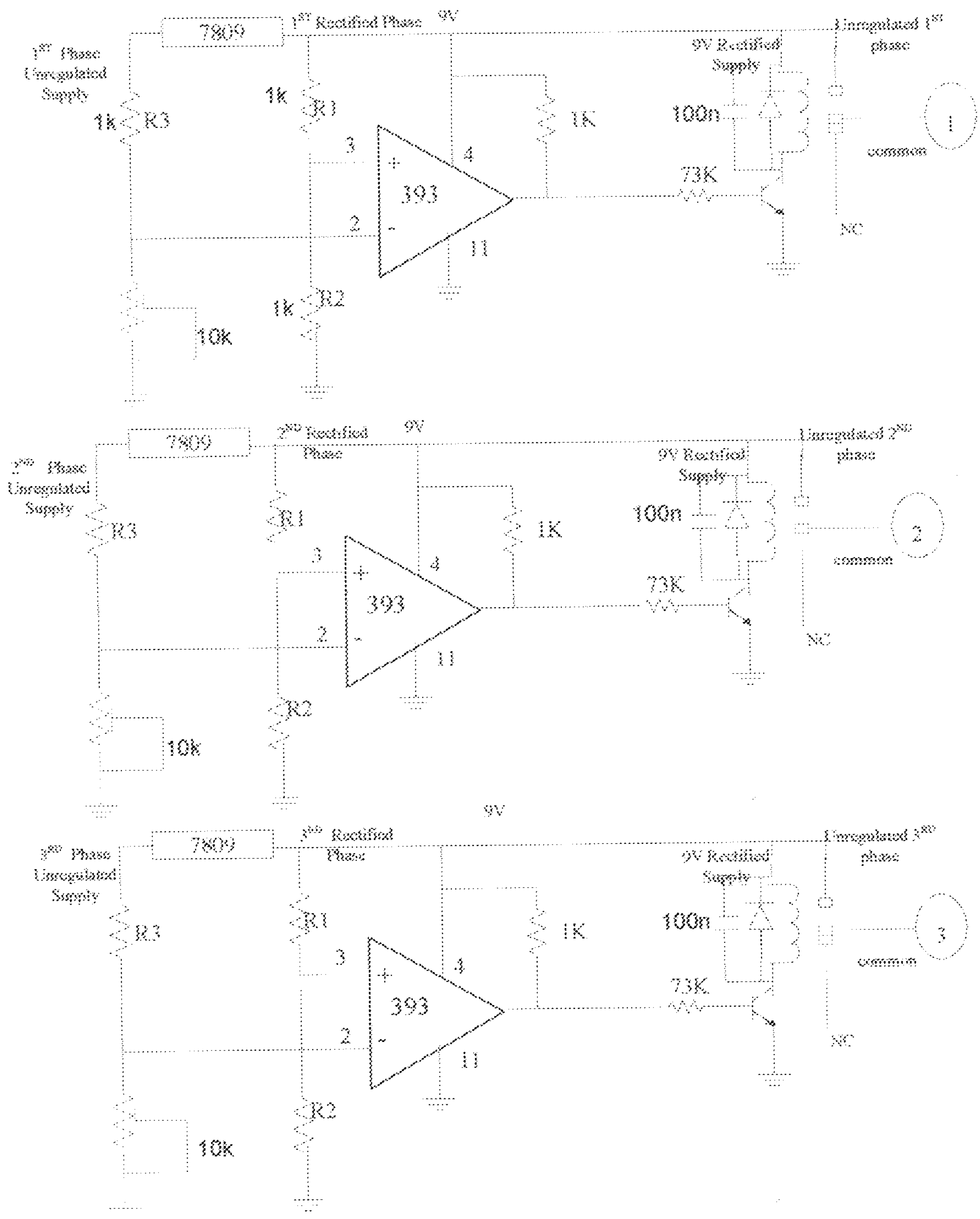


FIG 3.7 SWITCHER STAGE

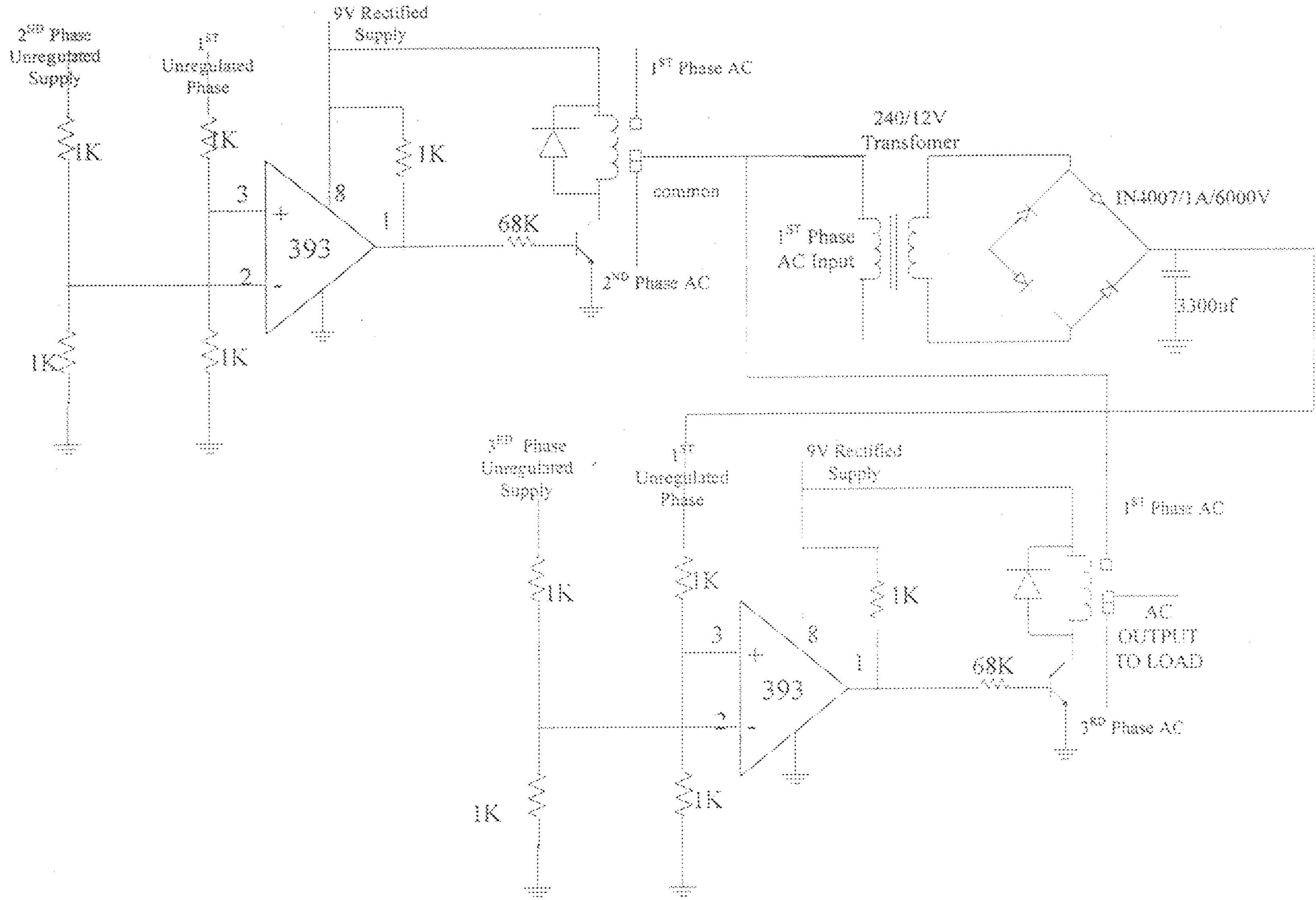


FIG 3.8 SELECTOR STAGE

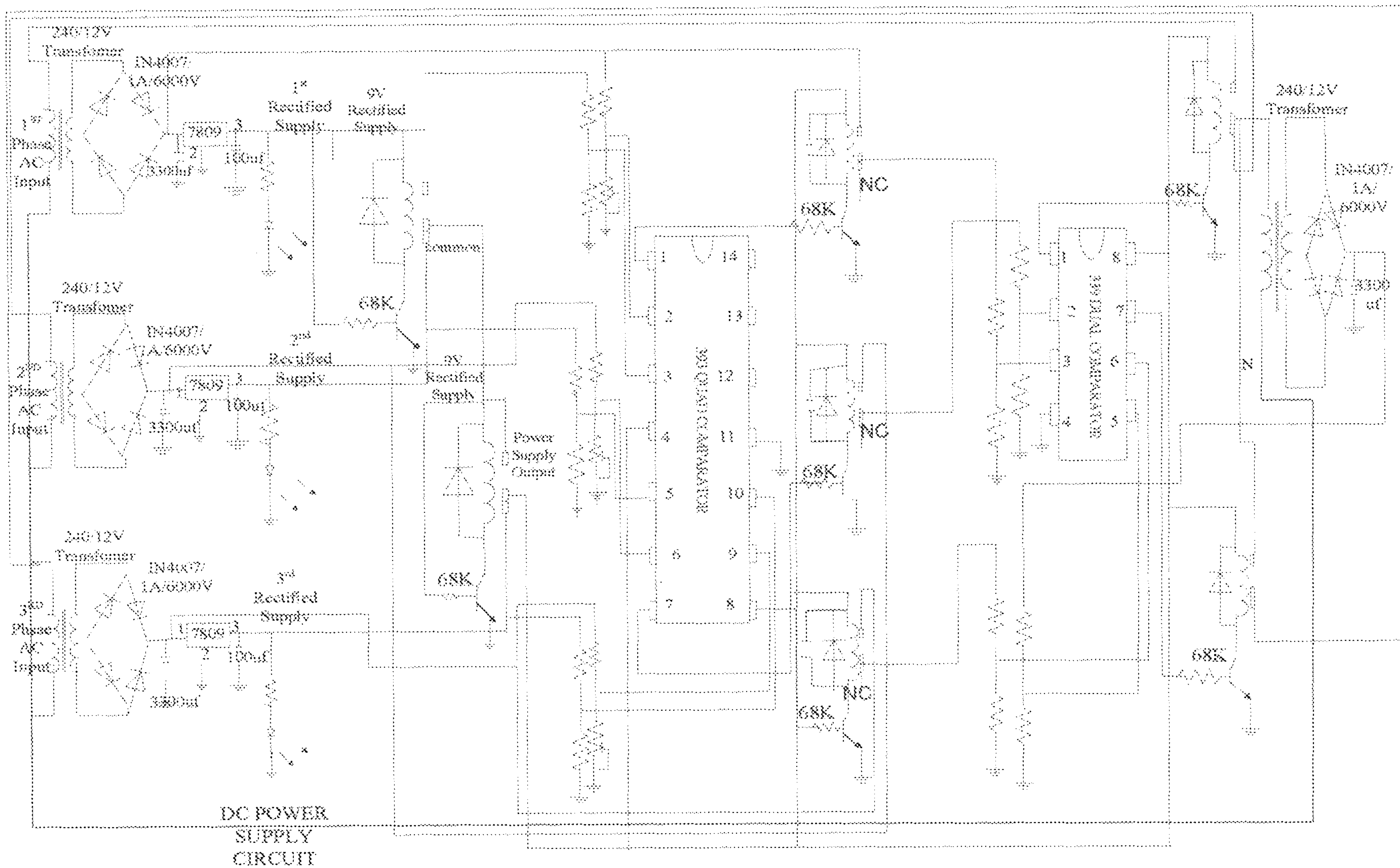


FIG 3.9 ATPVS CIRCUIT

Values of Component Used Are Stated Below

Component	Value	Quantity
Resistor	330K	4
Resistor	1K	17
Resistor	68K	7
Preset resistor	10K	3
Capacitor	3300µf	4
Capacitor	100 µf	6
LED		4
Diode	1A/600V	23
Relay	5A/9V	7
Regulator IC	9V	3
LM339		1
LM393		1
Transformer	220/12V	4

CHAPTER FOUR

4.1 Testing

After all the construction work was done with all components carefully and neatly fitted, a test of reliability and continuity was carried out on the project. The tests were carried out n modules, checking values across components and output of each module to ensure effectual operation of individual circuits.

The test was carried out using supply from PHCN in the absence of a variac. A single phase supply from PHCN was connected to an extension box, power cord were connected to the transformer from the extension box via the live wire, which serves as the three phases, Red, Blue and yellow. The load, an electric bulb was connected, taking live from ATPVS output and the neutral from the extension box. The Three phases and neutral are achieved using one of the two wires of an electric cord with the other terminated.

With all three phases connected the relay makes, LED connected to all three phases at power supply are ON, power supply output is ON and load is ON. When the Red phase is removed, there are clicks in the relays, supply output LED is ON, load is ON but the LED connected to the Red phase regulated supply is OFF. Same happens when any phase is removed that is no supply voltage, when any two phase are removed, their LED's are OFF and the phase that is ON power's the device and load. When all phases are OFF, all LED's are OFF and load is OFF.

The proper working of the device will be obvious using a variac to supply different voltage values to the three transformers as three phases at once.

4.2 Result

The phase which are available and has passed the switcher stage are termed high 1, for phases which are not available or are knock off by the switcher stage are termed low 0. The phases are shown using Red R, Yellow Y, Blue B, the supply unit output green G and Load L. The phases R,Y,B are 1st, 2nd and 3rd phases respectively.

Table 4.1 Test result of ATPVS

RED, R	BLUE, B	YELLOW,Y	GREEN, G	LOAD, L
0	0	0	0	0
0	0	1	1-Y	Y
0	1	0	1-B	B
0	1	1	1-Y	Y
1	0	0	1-R	R
1	0	1	1-Y	Y
1	1	0	1-B	B
1	1	1	1-Y	Y

4.3 Discussion of Result

During tests which were carried out before the tabulated result were gotten, lose pin holes pin holes caused continual switching of relays This could be likened to partial connection between PHCN and ATPVS transformer, through not a common phenomenon.

From the result, the yellow phase supplies the load most often, therefore the Yellow would be connected to the most stable phase of the three phase supply from PHCN and the Red phase which occurs the least, connected to the phase that is prone to faults and line outage.

From the result, the load is supplied constantly with line voltage except for the first case of No supply in all three phases, which is not a common condition. This project is faced with problem of load un-balance, this to be looked into before implementing this project.

CHAPTER FIVE

5.1 Conclusion

The design and construction of an automatic three phase voltage selector has called for thoughtfulness and carefulness in putting together component, which will not cause great damage to the device or load on the event of a component breakdown and supplying load at often times with acceptable voltage supply. This design was not without difficulties/improvement on different stages to achieve the stated goal. In the DC supply stage for an output of wanted value for one, two or all phases available, in cutting off overvoltage while allowing voltages below reference voltage value get to selector stage and available values of component been used.

The aim of this project was achieved with some of its problem solved.

5.2 Recommendation

The working principle of Automatic Three Phase Voltage selector (ATPVS), when implemented say in an estate will lead to load inbalance since the phase with best supply voltage is automatically switched to by ATPVS for consumer using those particular three phases.

This set back must be tackled before implementation, to avoid increasing the problems f aced by PHCN.

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