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DESIGN AND CONSTRUCTION OF A SELF OPERATED SINGLE PHASE CHANGE OVER SWITCH WITH VOLTAGE LEVEL MONITOR AND PHASE SELECTION AND ALARM SYSTEM

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ABSTRACT

Power supply in Nigeria and most developing countries of the world is anything but stable. This has adverse effects on the consumers of the electricity and the equipment that are operated from the mains sources of electricity supply in these parts of the world [1]. The main aim of any electric power

Introduction

Electrical power interruptions are quite common in every place especially after heavy down pour or a serve storm. In response to frequent power outage, a power inverter provides economical noiseless and emission free alternative source of electricity.

Considering the epileptic power supply in Nigeria and other developing countries today, a high demand of an alternative service is required. A single-phase automatic change over switch from the public mains supply to the auxiliary supplies (single phase ac generator) and vice-versa has been developed. The design was realized using

supply in the world is to provide uninterrupted power supply at all times to all its consumers. Although, in developing countries like Nigeria, the electric power generated to meet the demands of the growing consumers of electricity is insufficient, hence power instability or outage. Power instability and outage in general does not promote development in the public and private sector of the country's economy. The investors do not feel secure to come into a country with constant power failure. These limit the development of industries, in addition, there are processes that cannot be interrupted because of their importance for instance, surgery operation in hospitals, transfer of money between banks and lots more. Power instability and outage in Nigeria creates a need for alternative source of power to back up the mains supply. A microcontroller-based automatic power changeover finds a wide application scope wherever the reliability of electrical supply from the utilities is low and it is used in areas wherever continuity of power supply is necessary, for switching to an alternative source from main supply and vice versa. This project is a design and construction of a microcontroller-based automatic power changeover, that means the automatic changeover switch will change to an alternative power supply (generator), and back to the main supply when it is restored. In this paper, we provide an automatic switching mechanism that transfers the consumer loads to a power source from a generator in the case of power failure in the mains supply. It automatically detects when power has been restored to the mains supply and returns the loads to this source while turning off the power from the generator set. This mechanism has been tested and we recorded a great result. It thus holds an important key in the provision of a continuous power supply through a near seamless switching between the mains

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supply and an alternative standby source like the generator set. The purpose of this project is to maintain constant supply to the main circuit that is being supplied by making-up for the time lapse or delay that usually accompanies the manual switching from one source to another. But every system has its pros and cons. Our proposed system is easy to implement and understand.

Keywords: *Power Supply; Alternative Power Source; Direct current; IEEE; Change-over Switch; Generator, Microcontroller*

major components like a step-down transformer (220V-12V dc), atmega8 microcontroller, rectifiers, voltage regulators, 555 timers, relays, circuit breaker and others like resistors, diodes, and capacitors. The device automatically switches from public mains to an auxiliary whenever there is an outage in the public mains. This device also detects the public main power supply when available and switches from auxiliary power supply to the mains with a delay period of 4 seconds in starting and switching off the generator. The device has been constructed successfully, and it demonstrated a tendency to automatically switch from mains to the auxiliary source and vice-versa without human interception. Because of electric power supply interruptions, many electrical equipment can either develop problems or even stop working This has crippled many businesses thereby affecting even the economy of many countries such as Nigeria. Also, there is increase in occurrence of power supply disturbance, which can be viewed as a form of power pollution. High voltage spikes and momentary voltage drops are therefore common. This power disturbance may affect the performance of sensitive equipment in private and corporate organizations causing critical loss of data and even damage to equipment.

According to the recommendation made by the institute of Electrical Electronics Engineering (IEEE), the supplies that should be available for use should be continuous, uninterrupted. with constant frequency and within the load determined in terms of voltage and current. These requirements have become even more relevant in view technological equipment in use today.

The progress made in developing alternate source of energy over the last decades has shown that independent power systems are not only possible but also very practical. In fact, a wide variety of generating equipment is now available to allow individuals take advantage of just any renewable source of energy, lot a number of reasons, however, most of these systems produce only direct current (DC) and often do so only at low voltages.

Nonetheless, it is generally agreed that the greatest and most useful form of current is the Alternating Current (AC), since these exist in the vast majority of homes.

Therefore, there arises the need to be able to convert Direct Current (DC) to an Alternating Current (AC) that will be of as constant frequency and also be used to power electrical circuits either in homes or in industries. Such an electrical device is called an INVERTER.

Surpassing the use of generators, solar and more recently the inverters Is both the self-charging inverter. The most adverse problems are the need to recharge the inverters battery after use.

A self-charging power inverter serves not only as a back-up for power failure but as an uninterrupted supply of electricity for 24/7 on daily basis. It is a device used to convert direct (DC) to alternating current (AC) by converting 12 volts DC power source into 220 V AC 50 HZ.

A few applications of 1KA inverter includes television sets, microwaves, printers, radio sets and other household appliances, charging of phones, laptops and running power tools from a 12 V battery on jobsite where electricity isn't available.

It is worthwhile that AC operated with this appliance is nothing comparable to the AC generated by big generators. This is so because the voltage and power are less in terms of AC generation duration. This appliance is therefore suitable for short time replacement for the real AC generation especially in the remote areas and installed where electrical appliances are sold and the need might arise for it to be tested and certified good.

Another main area where this equipment can be greatly utilized is in communication system. in a situation where there is constant AC power supply failure e.g. in offices, inverter is needed as a light source.

The construction is simple, cheap. easy to operate and portable. The usefulness of this device and function cannot be over emphasized especially following our economic situation.

[2] found out that emergency power systems were used as early as World War II on naval ships. In combat, a ship may lose the function of its steam engines which powers the steam-driven turbines for the generator. In such a case, one more diesel engine is used to drive backup generators. Early changeover switches relied on manual operation: two switches would be placed horizontally in line and the “ON” position facing each other, a rod placed in between, in order to operate the changeover switch, one source must be turned off, the rod moved to the other side and the other turned on.

According to [3] manual changeover switch system still remains the oldest changeover switch box used by majority of the electricity consumers. Manual changeover switch box separates the source between a generator and public supply. Whenever there is power failure, change-over is done manually by an individual and the same happens when the public power is restored. This is usually accompanied by a loud noise and electrical sparks.

The mention of electricity and its technological advancement in the field of Electrical/Computer Engineering has enlarged its application in various ways hitherto considered impossible. Life seems miserable without electricity. A new home cannot be described as modern if it not connected to electricity supply. This is because most of the items required for making life comfortable in a house function with electricity. For instance, the lighting of homes, heating or cooking, pumping of water, operating of such appliances as fans, radio sets and televisions, desktops, laptops are powered by electricity.

In Nigeria today, the inadequate availability of electricity supply has made her citizens to seek alternative and independent means of power supply. This has resulted in individuals buying wind turbines, solar panels, generating sets of all descriptions, power inverters and so on, in an effort to provide alternative electricity supply for private use. The use of alternative power supply unavoidably requires a means of selecting which power source to be used as at when required.

With advancements in technology, the computer system has become an integral part of the scientific life. The development of software integrated hardware (intelligent hardware) like the microprocessors and microcontrollers has made real time instrumentation controls and measurement to become more accurate, precise and timely.

In sequential logic control of power selection, sequential digital circuits are used to effect the detection and control of the supplied power. Sequential logic control approach involves only an automatic violation of the public power source in the event of power failure, but the generator activation to supply alternative

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power is done manually. In effect the sequential logic control is more efficient then the manual control [4].

[5], the main advantage of the sequential logic control power changeover switch is its simplicity. In addition, the processing of calculations and programs among other advantages are faster and better handled. This project, therefore, is intended to design and build a system device that is interfaced with a microcontroller programmed for phase-voltage monitoring selection and generator starting processes. From various surveys in the industrial sector of Nigeria, it was generally noticed that industries are vulnerable to long and short interruptions (that are considered "reliability issues", in the power system analysis).

The single-phased automatic changeover switch to design is a complete system with various sub-systems and components arranged and linked to function primarily as a means of manipulating the supply of electrical power to any desired load.

A changeover switch can be generally described as a device that allows the conversion from one power source to another (for example, supply from PHCN to supply from a standby generator). The switching obtainable from the changeover switch is usually manual, that is the user has to move a lever to change from one source to another. This is usually associated with time wasting as well as some health hazards like electric shock and trauma.

In order to eliminate this human intervention as well as introduce speed and precision in the changeover operation there is need for an automatic changeover switch. This is typically a switching system whose function is based on the predetermined configuration unit. It selects the available power source without intervention of the user to ensure the availability of supply at the desired times provided from one source to another can only be achieved by device or a system that determines when the change should actually take place and which source to be given preferences to supply the load. This brings about the need for a unique control system.

The basic problem to be addressed here is how to connect two different sources of electrical power simultaneously to a single unit (the automatic changeover switch) that can serve as a link between these power sources and the load or network. Moreover, preference is given to the power source such that one source supplies the load at a time and when the first (mains) source fails, the link immediately connects the second (generator) source to the load.

The major aim of this work is to exploit the ubiquitous microcontroller facilities in bringing about automation of the changeover process. One of the most critical needs of embedded systems is to reduce power consumption, space and time and this is achieved in this work.

The purpose of this work is to provide a very affordable means of automatically switching between the alternative power supply systems and the utility power supply without human intervention.

It has been observed over the years that power instability has caused companies to lose millions of naira each time there is power failure, as a result of the time lag between power failures and when the power is restored. This is evident in hospitals, airports, banks, telecommunication companies, breweries, cold rooms, and abattoirs to mention but a few.

This system is designated to proffer solution to the shortcomings of the already existing manual changeovers by performing power swap from public power to generators automatically and vice versa. The devised system has the ability to eliminate the stress and to reduce time lag of manually switching on the generator where there is public power failure.

This work serves the purpose of saving the electrical appliances in a household and offices from power fluctuation-related damages

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which could be occasioned by overloading of unprotected changeover switches. Such a device protects electrical appliances from possible harmful effects of voltage sag. It provides an average user the comfort of enjoying the use of electrical appliances at home and offices without the interruption of work and switching over between the public power source and alternative power source. Convenience of not having to walk all the way to the alternative power supply source to turn it off or on is also provided. It can also create entrepreneurship opportunity for our teeming unemployed youths of the country owing to the large number of people that use alternative power supply that seek automatic changeover from the public power supply to the alternative power supply.

Considering the high frequency at which the public utility power fluctuates, users in their various homes and offices always require to temporarily stop work to go to their changeover switch box and toggle it as many times as the power fails or get the power restored. They are also expected to go to their generators and turn off as often as the public power supply fails.

Constructing a phase/generator intelligent switching system (automatic changeover system with a microcontroller) that can toggle automatically and then off the generating set, will reduce the time and energy spent in changing over from time to time. This will allow the user more time and concentration to attend the task at hand, the user will, in addition enjoy long term steady and uninterrupted supply of power. It has the following advantages;

- ✓ It minimizes damages lives/equipment since it has its own monitoring system and its switching requires no human contact with the switch, thus eliminating human error.
- ✓ It reduces its changeover timing to the minimum due to its fast response to power outage.

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- ✓ It maintains high quality of service through its fast and prompt response.

The project is to design and construct at a prototype level an intelligent switching device that will toggle between a single-phased public power supply and a self-starting generator. The level of the design will be simple enough for a local technician to understand, particularly during an opportunity to effect repairs. This automatic changeover unit can be operated in single phase system.

Moreover, the size and captivity of the unit will depend upon the load for which it will be used. The unit is portable, easy, convenient and safe to install.

The entire project is arranged in sections to allow proper report presentation and understanding. The section 1 is the introduction; and is the review of related literature which describes briefly the history and various types of automatic changeovers as well as the review of some major components used in the construction of the project. Section 2 throws light on the design details, calculations of the component values in the design and description of how the circuit works. The implementation and testing of the project are contained in section 3. The conclusion, summary of findings and recommendation for further studies on the project completes the write-up for section 4.

Section 2

Methodology

Introduction

With technological advancement globally, maintaining the power, electricity consumers are demanding for. This is because many electrically powered and voltage-sensitive devices like advanced system control, automation precise manufacturing techniques, continuous data processing require uninterrupted power supply. For some of these devices, a temporary disruption or sudden surge of power can cause scrambled data, a frozen mouse, interrupted communication system crashes and equipment failures. Consequent upon this, there is urgent need to have alternative power supply is expected to come into operation immediately there is power seizure from the mains power supply. An efficient steady supply of power is therefore of tremendous advantage both in terms of cost and efficiency.

With adequate power supply base of the nation at the moment, it is almost impossible to supply electricity to consumers at all times. The unreliable public power supply has led many to the alternative power supply sources. In Nigeria today, the use of generators to power businesses and machines have become the norm. According to the Director-General of Centre for Management Development, Dr. Kabir Usman that Nigeria has the highest number of standby generators in Africa, averaging to every 2.5 people has at least one standby generator. He also pointed out that about 60million Nigerians spend 1.6trillion naira on generators annually. Many generators are in use; while some are manually started others are automatically activated.

To ensure the continuity of power supply, many commercial industrial facilities depend on both utility service and onsite generation (generator set). Because of the growing complexity of electrical systems, it becomes imperative to give attention to power supply reliability and stability. Over the years many approaches have been adopted in configuring changeover systems, some of them are discussed below

MICROPROCESSOR-BASED CONTROL

The microprocessor-based control operates control operates through a central processing unit programmed in a software-implemented format and stored in memory; Random Access Memory (RAM) and/or Read Only Memory (ROM) subsequently used to effect controls in real time.

There are two aspects of microprocessor control namely

i. Microcontroller-Based Controls and
ii. Computer-Based Controls

MICROCONTROLLER BASED CONTROLS

In microcontroller-based controls, microcomputers are employed with the resulting systems described as embedded. It gets information like data status from sensors and then issues control commands to actuators. One distinguishing feature of the embedded system from other real-time system is that they are only executing task relative to a fixed and well-defined work load. They do not provide any development environment; they are low-level programmed [6]

COMPUTER-BASED CONTROLS

The computer-based control operates through a computer system employed in a multi-machine-distributed computing environment. Other feature known as real-time software, extensions are provided for programming languages and protocols enabling, such systems to be programmed and checked. These systems are programmed to override the operating system mechanism to control directly the hardware. They are high level language programmed.

This project however is designed and implemented as a microprocessor-based controlled system specifically using the microcontroller as its basic component. It is a dedicated embedded system.

DESCRIPTION OF THE NEW SYSTEM

In view of the limitation of above previous changeover systems, this project proposes and implements a changeover system that drastically reduced the shortcomings, the noise, arching, tear and wear, stress and time wasting associated with manual switch box and sequential logic control are eliminated totally by the introduction of solid-state relay. Digital components are used to make the work more reliable, unlike the previously existing ones that make use of circuit breakers. Also, PIC16F84 microcontroller was also incorporated to help improve the speed of automation. The system is controlled by a software program embedded in the microcontroller. This work I handy and portable compared to the bulky work previously done, it has also some important features like an indicator light to indicate the presence of public power source and over voltage and under voltage monitoring. Economically, this project is of affordable cost because of the use of integrated circuits (ICs) in place of discrete components.

RELATED COMPONENTS IN THE SYSTEM DESIGN

There is a great deal to designing a process control voltage changeover system than just selecting the appropriate interconnecting components and developing the software. There is the need therefore for a review of the technical terms, process and related components.

SWITCH

A switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. Also, can be used to select and ‘ON’ or ‘OFF’ state of a system. In a power system the ‘ON’ state represents power flow while the ‘OFF’ state represents the otherwise situation. Switches are commonly used in power electrical circuitry [7].

The various switching systems used in power systems include.

i. MANUAL SWITCHING
Where a cut-out (an electrical connector device) is used to approximately interconnect and select down the voltage phases by manually plugging in a removable fused connector from one base to the other depending on the one with power. This conventional approach is usually employed in homes often than in industries.

ii. MECHANICAL SWITCHING
Mechanical switching involves using some sort of mechanism for closing and opening a part of current flow. A typical example is the gang switch used in isolating supply lines.

iii. ELECTROMECHANICAL SWITCHING
Electromechanical switching is a form of switching which integrates electrical and suitable mechanism for power flow. In this case, power is supplied to the mechanism using solenoids to activate the switching mechanism.

iv. AUTOMATIC SWITCHING
Automatic switches are those switches that are activated in response to any change in system characteristics (current or voltage). It usually employs relay for detection of change in system characteristics after which a corresponding switching is activated immediately.

v. MICRPROCESSOR CONTROLLED SWITCHING
In the case of microprocessor controlled switching a microprocessor chip is software programmed and stored in its memory unit to b interfaced between the available power source and the connected loads.

SWITCH GEAR

A switch gear is the combinations of electrical disconnect switches, fuses or circuit breakers used to control, protect and isolate electrical equipment. Switch gear is used to both de-energise equipment to allow work to be done and to clear faults downstream. The tumbler switch with ordinary fuse is the simplest form of switch gear and is used to control and protect electrical installations and other equipment in homes. This type of component is important because it is directly linked to the reliability of the electric supply [8].

However, such switch gear cannot be used profitably in high voltage systems

RELAYS

A relay is an electrically operated switch that has two major parts – coil unit and the contact unit. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contact positions.

Relays have two switching positions – the normally closed and the normally open. There is no electrical connection between the coil unit and the contact switching position when energized. The link is only magnetic and mechanical. The operational principle of the relay is basically like that of a switch controlled by electromagnetic force. This magnetic force is generated by flow of current through a coil in the relay. The relay opens or closes a circuit when current through the coil is started or stopped. The circuit symbol of a relay is shown in fig: 1.1 below

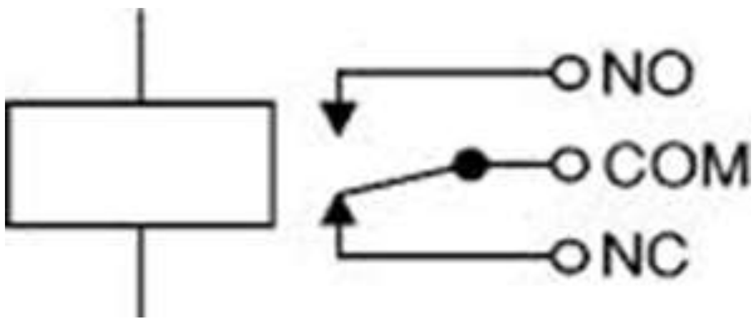

Figure 1 Circuit symbol of a relay

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TRANSFORMERS

A transformer consists of a laminated iron core wound with two coils – the primary and the secondary. The primary coil is connected to a source of alternating voltage which builds up a changing magnetic field setting up a similar type of AC voltage at the secondary. This is done through mutual inductance between the coils by magnetic flux linkage. When the number of turns in the primary is more than that of the secondary, it is called a step-down transformer. It is called a step-up transformer when the reverse is the case [7]. Step-down transformer was used in this project to transform the high voltage to a low voltage output.

The fig. 3 below shows schematic diagram of an iron-core step-down transformer.

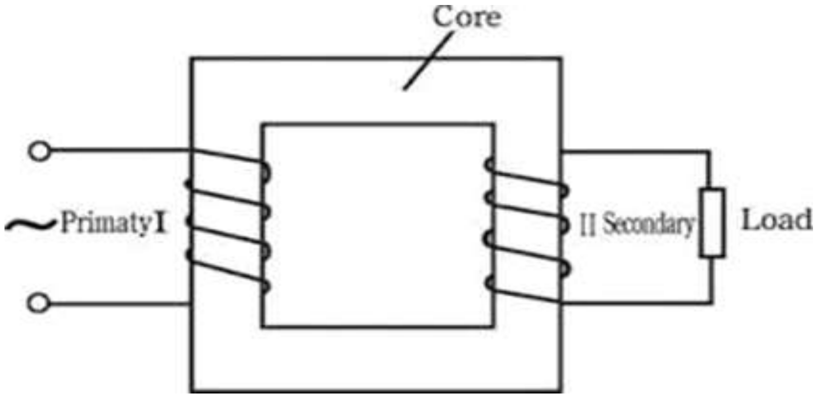

Figure 3 schematic diagram of an iron-core transformer

THE BLOCK DIAGRAM AND FLOW CHART

Systems Analysis the process of investigation of a system's operation with a view to changing it to new requirements or improving its current working.

The analysis stage is the front-end phase of the development process of microcontroller-based systems. This phase constitutes an essential step of the development process and one of the critical issues that determines the quality of the final product. The analysis phase sets the stage for the whole project. The necessary

groundwork for understanding what the project is all about is completed in this phase. We take the strong position that the more effort you put into planning, the smoother the rest of the project will go and the better the quality will be of your final product.
The total design and development of any microcontroller based system typically involves three. Phases. They are as follows

i. Hardware design and development
ii. Software design and development
iii. Prototype implementation and diagnostic testing

Details of the procedure working principles of the various stages are briefly described. The hardware part consist of the biscuit details, design and calculation of various components used in the work including the values of the ones assumed too. While the software part is mainly the programming implementation on the PIC. Summary details are contained in the flowchart block diagram as show below in all, a total of twelve (12) geometrical block shapes were assembled together to achieve the complete design.

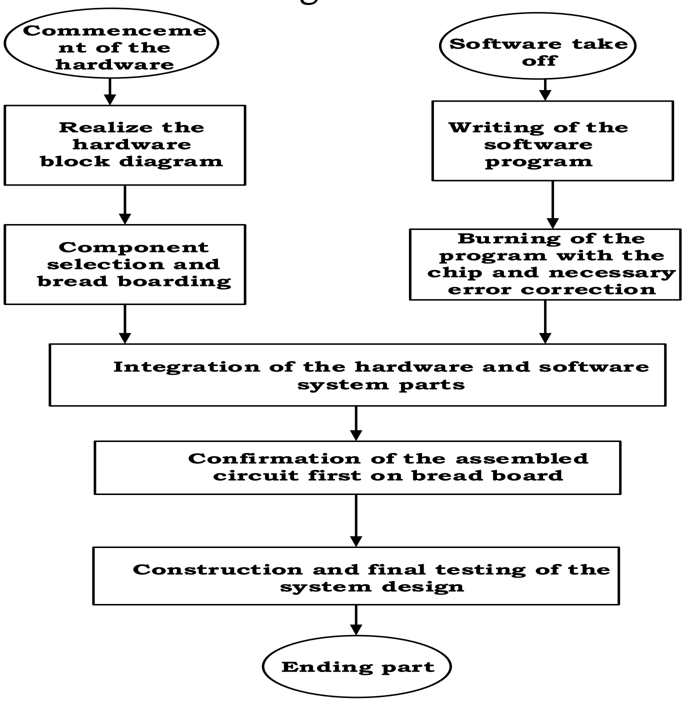

Figure 4a Block Diagram of the Agorithm for Micro-Controller Based System

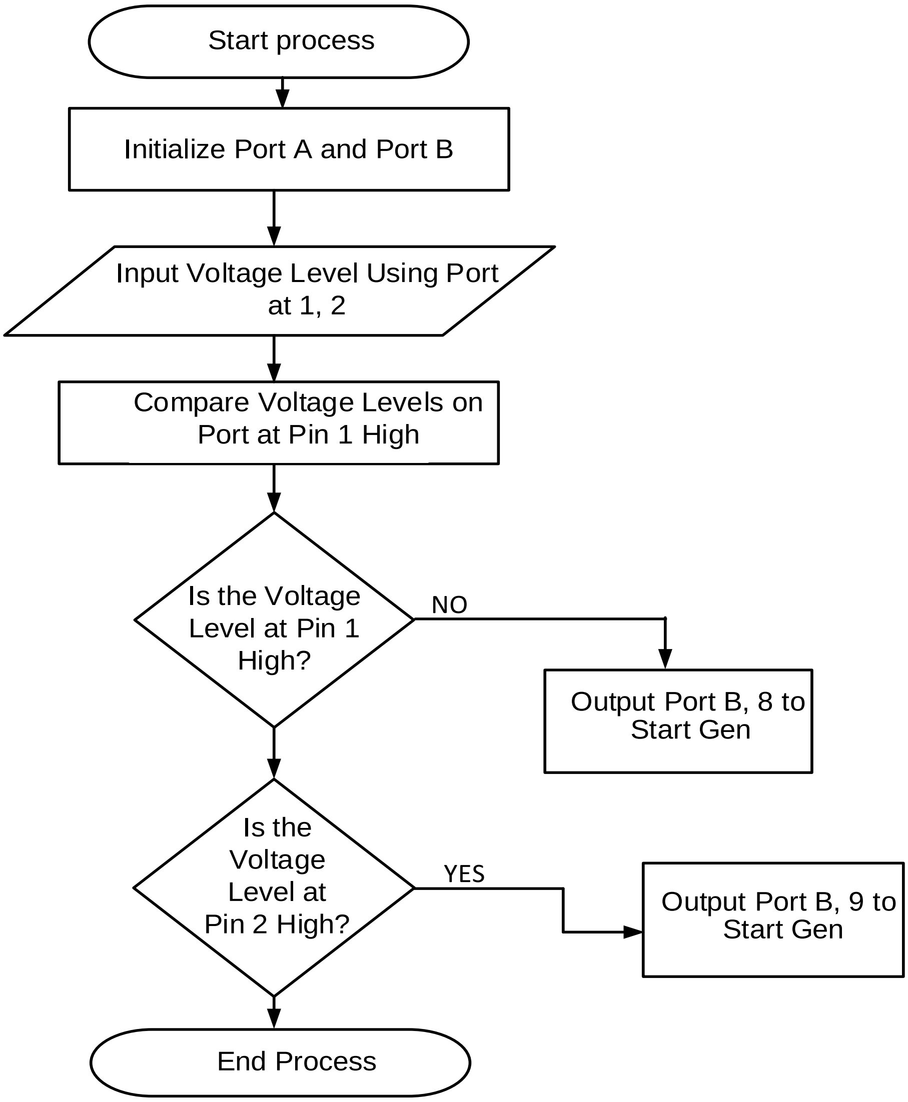

Figure 4b Flow Microcontroller Based System

Hardware Design And Analysis

The complete project work was sectionally achieved in five (5) units they are:

i. The power supply unit
ii. The voltage reference/variable unit
iii. The comparator unit
iv. The microcontroller unit
v. The switching unit

There can be briefly seen in the block diagram of fig 5 below

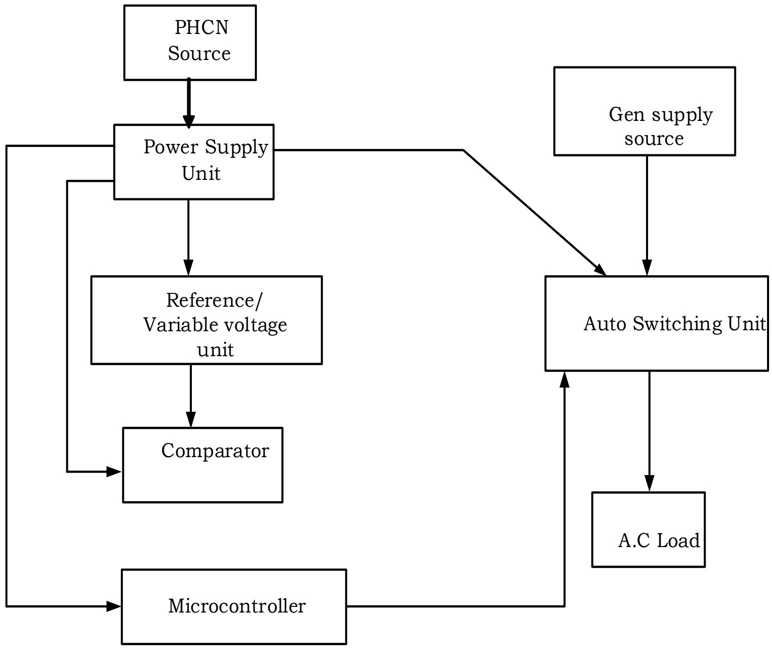

Figure 5 Block Diagram Of The Complete Design

MEDOLOGY & PRINCIPAL OF OPERATION.CIRCUIT DIAGRA AND ITS OPERATION

The Power Supply Unit

The power supply unit has a step down transformer. T1 that reduces the high input voltage of 240 V to as low as 12 V output. It also has a bridge rectifies that converts the low A.C to an equivalent D.C output, though still pulsating in nature. A Low pass filter connected immediately after the rectifies helps to reduce the A.C content bringing out a cleaner increased D.C output. There is a light emitting diode (LED) D_5, connected in series with a resistor and both in parallel with the output D.C to help indicate the process is working as designed.

Derivation of Values

in a design of this nature, some values are decided (assumed) for the smooth working of the components as well as purposeful result to be realised. In this value derivations the assumed ones are stated wherever used.

The voltage measured at the output of the step-down is A.C and in root mean square value (r.m.s) [7]. The required D.C needed for the design is 12 V i.e V_{DC} = 12 V
using the formular

$$V_{max} = V_{DC} \times 1.57$$

where

$$V_{DC} = 12\ V$$
$$V_{max} = V_{DC} \times 1.57 = 12 \times 1.57$$
$$V_{max} = 18.86\ V$$

The input frequency is 50 Hz. This is doubled at the secondary output as seen below

$$f_o = 2 \times f_i = 2 \times 50 = 100\ Hz$$

the peak inverse voltage of the diodes is dependent on the vmax of the power unit.

$$PIV > V_{max}$$

any value greater than 18.86 V as real inverse voltage of the diode will do for the design. Diodes IN4002 has piv of 100 V, hence was chosen for the work

$$d_1 - d_4 = IN4002$$

In the calculation of the capacitor value, the total load resistance and the expected minimum ripple content were chosen as
R_L = 400 Ω = Load Resistance
Ripple Voltage, V_r = 10mV
Capacitor

$$\mathrm{C} \geq \frac{1}{4 \times \sqrt{3} \times V_r \times f_o \times R_l}$$
$$\geq \frac{1}{4 \times \sqrt{3} \times 0.010 \times 100 \times 400}$$
$$\geq 0.000361\ F$$
$$\mathrm{C} \geq 361\mu\mathrm{f}$$

Standard value is used 1000µF, i.e C_1= C_2= C_3= 1000µF
The indicator circuit has a total of 12 V connected to it

$V_s = V_{R1} + V_{LED}$

the forward biased voltage of the LED is 2 V with an operating current of 20mA

.: $V_s = V_{R1} + 2$

Where $V_s = 12$

$12 = V_{R1} + 2$

$V_{R1} = 12 - 2$

$V_{R1} = 10$

$V_{R1} = I_{LED} \times r_1$

$R_1 = \frac{10}{20mA} = \frac{10{,}000}{20}$

$= 500\ \Omega$

Standard value of the resistor chosen was 560 Ω

$R_1 = 560\ \Omega$

The ic voltage regulator (IC_2 7805) has a positive output voltage of 5V even when the input to the ic is 12 V or more this output is connected to the micro controller that requirers 5 V as the maximum voltage supply.

The biscuit diagram is shown below fig. 6

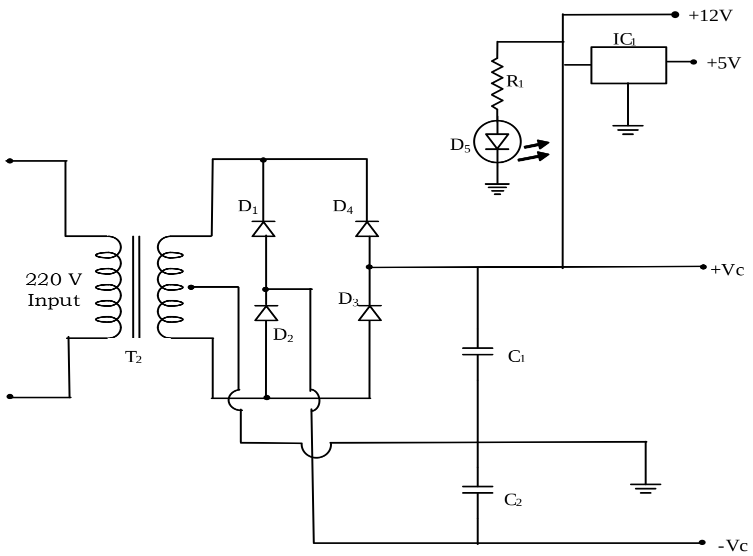

FIGURE 6 CIRCUIT CONNECTION OF THE POWER SUPPLY UNIT

THE REFERENCE/VARIABLE VOLTAGE UNIT

this unit provides the required two voltage values one fixed and the other variable, which are both eventually fed to the comparator unit. It is built around two voltage divides circuits comprising of zener diodes and resistors. The variable voltage is taken across resistor r_2, serially connected with a zener diode D_6 of valu 4.7 V. The fixed voltage is comebued out of the zener diode D_7 with value of 6V. The two resistors r_2 and r_3 are of the same value of 1.8kΩ

$R_2 = R_3 = 1.8k\Omega$

$D_6 = 4.7V$

$D_7 = 6V$

the two voltage values are only possible when the supply input is 220V. The circuit comebuino is shown below.

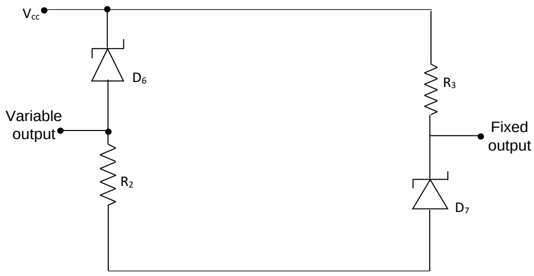

Figure 7 Circuit Connection of The Reference/Variable Voltage Unit

THE COMPARATOR UNIT

the comparator is an operational amplifier integrated biscuit of LM741 connected to produce an output value of high (1) or low (0) when the difference between the two outputs is positive a high output will be produced; but when the difference is negative, a low output will be produced. At a voltage of 220V source input, the voltage value at pin 3 of the comparator op-amp is 6V. The one at pin 2 is 7.3V, the resultant output will be low (0) because the difference is negative [9]

i.e $6V - 7.3V = -1.3V$

But when the supply voltage goes very low to about 190V or below, the voltage at pin 2 reduces far below that of fixed value pin 2 (6V).

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This results to a positive high output(1) at pin 6 of the comparator op-amp. The op-amp requires both positive and negative voltage sources (+12V and -12V) from power supply to function.
The circuit diagram is shown in fig.8 below.

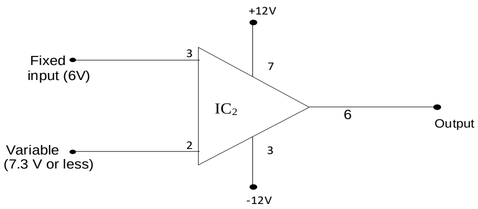

Figure 8 Circuit Connection of the Comparator Unit.

SOFTWARE IMPLEMENTATION

The type of programming language used was a low-level assembly language due to its machine-oriented ability and its electronic circuit friendliness. The peripheral interface microcontroller chosen and used is the PIC16F84, the input/output data setting of the microcontroller was software/program instruction based. MPLAB software (a software program that runs on a PC to develop application for microchip microcontrollers and digital signal controllers) was installed in a high definitive dual core HP system unit. This made an easy access and running of a micro plan text assembler – MPASMWIN (an executable file that helps in programming a microcontroller chip with assembly program) that has already been installed in the system. With the flowchart established earlier on during the design process, inputting of data was not as difficult as envisaged.
After the data writing and formatting on the system software, it was run on the MPASMWIN text assembler for error-free confirmatory test. When it was confirmed error-free, the program was now burn into microcontroller integrated circuit (IC) that is used in the project which is PIC16F84.

THE MICRO CONTROLLER UNIT

The micro controller unit has three major components

i. IC_3 =PIC16F84

ii. C_3-C_4=27pF ceramic capacitor
iii. Xtal=Crystal Oscillator (4mHz)

The micro controller used, pic 16f84 has a total number of 18 external pin terminals, only eight terminals were physically implemented. Pin 14 is for the power supply (+5V)

The microcontroller used, P1C16F84 has a total number of 18 external pin terminals, only eight terminals were physically implemented. Pin 14 is for the power supply (+5V) and pin 5 is grounded. The IC has two ports, port A and port B. Port A which houses the input data and port B for bringing out the output data. At port A, pin 1 and 2 are used for the input data destination while at port B, pins 8 and 9 are connected as output terminals. The configuration of the micro controller is at a frequency of 4MHz made possible through the use of external oscillator a crystal oscillator connected between pin 15 and 16. The two terminals of the crystal oscillator are grounded from each side with a non - polarized capacitor C_3 and C_4. The table 1 below shows the pin types, their assignments as well as designated names [10].

Table 1

NO	PIN NAME	PIN NUMBER	PIN TYPE	PIN DESCRIPTION
1	OSCI/CLK IN	1 5	I	Oscillator crystal input/external clock source input
2	OSCI/CLK OUT	1 6	O	Oscillator crystal output
3	R A 2	1	I	Plot A, Input 1
4	R A 3	2	I	Plot A, Input 2
5	R B 2	8	O	Plot B, Output 1
6	R B 3	9	O	Plot B, Output 2
7	V D D	1 4	P	Positive, Supply Source
8	V S S	5	P	Ground Terminals
LEGEND				
I=Input				
O=Output				
P=Power				

The system software development starts with problem specification and design of a suitable flow chart as shown in figure below. This is to accomplish very easily the design task and implement the specifications. A successful structured flow chart will ensure good flow of signal. This is done before the implementation of the program writing in a low level assembly language was used in implementing the program writing of this project.

The programmers language was used to transfer the written program into the chip. In other words, the programmers language was used to convert the assembly language into machine code for the actual consumption of the chip (PIC16F84). One logic set up is that once pin 1 is high, pin 8 output terminal is programmed to be high too when pin 2 terminal is high, pin 9 output terminal will be high as well. The circuit connection is as shown in the figure below. The program is made up of the main program and the delay sub routine. A list of assembly system program could be seen in the appendix attached at the ending part of chapter five, but the main program flow chart is shown below in fig. 9

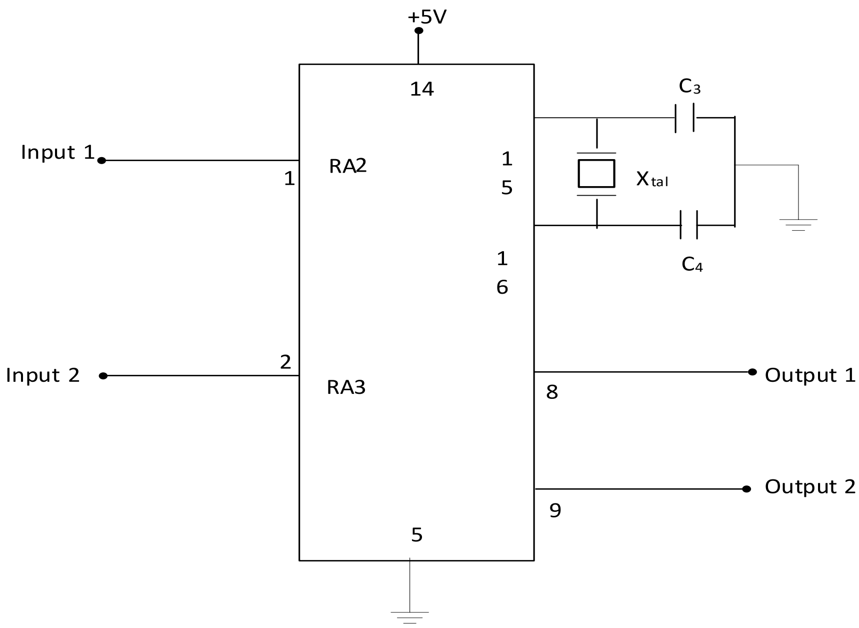

Fig 9 Circuit Connection of the PIC16F84 Microcontroller

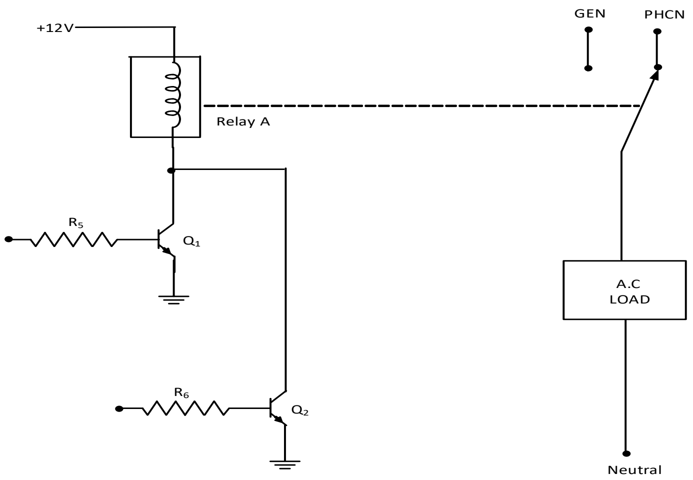

Figure 10 Program Flow Chart for the Microcontroller IC

Any of the two transistors Q1 or Q2 IN fig. 10 can be biased into conduction thereby grounding the relay to be energized. This causes an automatic switch over to the GEN or generator supply from the PHCN source. The only time the phcn source is constantly to the load is when the two transistors are at off positions and that happens when the supply is available, at the same time up to the standard value require for the A.C load. The complete circuit diagram is shown in the fig. 6.

Section 3

DISCUSSION AND RESULT

INTRODUCTION

The implementation of this project was carried out in stages, starting from breadboarding, Veroboarding up to the final stage of arrangement and packaging even the soldering exercise was carefully and skillfully carried out to avoid damage of the components.

Primarily, it was in three parts– the software programming, the hardware assembling and the combination of both parts as one unit on a Veroboard.

DISCUSSION

Breadboarding is simply a stage when all the electronic hardware components including the PIC16F84 are carefully assembled on a construction base using the designed circuit diagram as a guide. When this has been carried out, the initial results gotten were not as expected. For instance, the reference voltages were adequately confirmed as inputs to the comparator integrated circuits (ICs), but there was no output coming out from them, even when there was noticeable power presence from the input public supply. A correction was immediately effected by changing all the voltage reference components – the Zener diodes of D_6 and D_7 (Chapter three circuit diagram).

The circuit was powered again. This time there was output voltages as inputs (high and low values) to the comparators and with the presence of the input voltage to the comparator, expected outputs were measured at their outputs. Thus, a successful transfer of assembled components from breadboard to Veroboard was done with the desired result gotten.

METHOD OF TESTING

The following stages of testing were carried out in the testing process

STAGE I:

An input supply of 220V was connected to the circuit, the output of the comparator was measured to give zero (0) value, the pin terminal of the PIC16F84 was also low. As a result, the switching circuit transistor was at cut-off, but the voltage at pin1 of the controller was high, making it produce low output at its pin8 terminal.

STAGE II:

Input voltage was reduced to a lower value by the variation of the potentiometer. The comparator output went high, transistor Q_2got

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biased because the pin9 of the microcontroller went up. This caused relay A to energise, closing up on the generator to come ON.

STAGE III:

When there was no output supply at all from PHCN pin1 and pin8 terminals of IC_3 went high and low respectively causing transistor Q_1 to be switched into saturation mode. Thus, the relay once again got energized as a result the generator is switched ON once again. The implication is that the generator only came ON when either the public supply was very low or not available at all.

CASING AND PACKAGING

This project is a prototype set target, therefore set of 100 watts bulbs, A.C voltage powered, were connected to the output load.

The Veroboard containing the soldered components is housed inside a rectangular shaped box. All the external switches, the A.C bulb, circuit breakers and the cut-out fuses were mounted externally on the box. Care was taken during all connections; the rectangular box was made from a good quality plywood, painted with a high quality colour paint.

RESULT

The result from the design project as can be seen from the experimental set shows the performance evaluation of this proposed gadget when operated and corresponding outcome obtained. Effort was put in here to checkmate and mitigate the effect of low voltage supply, since all other changeover devices only switch over to generator when the supply is absent the testing of the designed system shows that it worked as designed. The result from the experimental test shows that this design does not only automatically change over to generator as input supply to the load, but through the intelligence of the programmed microcontroller, switch over to the generator at a time the supply is dangerously low.

Section 4

FINDINGS

After a research work on the existing changeover devices through the use of cut-out fuses, a normal switching system and even automatic coil-energised changeovers, a step-further was taken to put in place active component monitors to provide as input data to a microcontroller software programmed chip in controlling the time and method of switching over to a standby generator once there is low or no supply from public power supply. It makes the design highly sensitive to avoid damaging effect of low voltage in particular or instant changeover to the alternative source for a continuous supply to the load uninterrupted.

CONTRIBUTION TO KNOWLEDGE

- ✓ There was problem of inconsistent power supply during the design stages. This caused mostly the delays as well as unstable data values, more so when the device was power input based.
- ✓ Cost financing of the project seriously affected the progress of the work.
- ✓ Sourcing for components was also a constraining factor as it led to going to distant cities such as Lagos and Port Harcourt in order to purchase some major components of the project.

RECOMMENDATIONS & CONCLUSION

- The level of this project achieved is only at a prototype level and is therefore unsafe for installation as a household device except the various power ratings of the components are upgraded.

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- System design of the project can be enhanced for a multi-phase-based input instead of the single-phased input.
- All connections at various stages of the circuit design should be carefully re-examined before the introduction of the high input voltages. This can be disastrous if ignored

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