DESIGN AND CONSTRUCTION OF A SINGLE PHASE AUTOMATIC POWER CHANGE OVER SWITCH.

BY

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(2004/18821EE)

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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MINNA, NIGER STATE.

DECEMBER 2009.

DEDICATION

I dedicate this project work to my creator ALLAH, the ever living, the one who sustains and protects all that exist. Neither slumber nor sleep overtake Him.

To my parents Dr & Mrs Ibrahim Abdul for their parental responsibilities and support.

To my friends Mustapha Musa and Ibrahim Aminu both of blessed memory who died during the cause of struggle to become great in life may their soul rest in peace.(Amin)

DECLARATION

I Ibrahim Abdul Abdulrahman, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the federal university of technology Minna.

Ibrahim Abdul Abdulrahman

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Name of student

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Signature and date

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Project supervisor

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Signature and date

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Signature and Name

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Name of external examiner

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Signature and Name

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ABSTRACT

Power failure or outage in general not promote development to public and private sector. The investors do not feel secure to come into a country with constant or frequent 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. This paper presents the design and construction of a single phase automatic power change over switch that switches power supply from public mains supply to generator with rating of 7KVA once there is a failure from the mains and it does this automatically. It comprises of four units namely: power supply unit, battery –charging unit, controlling unit and switching unit. All these units work together to ensure constant power supply.

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CHAPTER ONE

INTRODUCTION

1.1 GENERAL INTRODUCTION

Power failure or outage in general does not promote development to public and private sector. It is no longer news that electricity provides a means of satisfying the widest spectrum of human needs through its uses as labor saving devices in medicine, agriculture, engineering and industry for comfortability, improve standard of living and home preservation.

In addition, investors do not feel secure to come into a country with constant or frequent power failure. These limit the development of industries. On the strength of this, power supply can be claimed to be a measure of standard of living. In developed countries, it is constant and has held them to a higher standard of living by placing a limit on their power failure at odd time. On the contrary, developing countries like Nigeria face problem of power generation, transmission and distribution, perhaps because of mismanagement on the part of the leaders and lack of commitment by distrustful followers. This has contributed, to a great extent, to the socio-economic and financial losses. To solve the problem of this power failure resulted in finding means of constant power supply by generating companies (GENCO) and distributing companies (DISCO).

Long before now switching was carried out manually to strike a balance between constant power supply and power outages. As the years gone by, the problem associated with this method of switching gave rise to the need for designing of a switch which would be capable of automatically switching the circuit from the mains (PHCN) lines to generator sets when there is a power failure. In the light of these problems, this project aims at DESIGN AND

CONSTRUCTION OF A SINGLE PHASE AUTOMATIC POWER CHANGE OVER SWITCH.

It helps a lot in places like industries, hospitals, large companies, homes, economic and financial institutions and government establishments.

The Encarta 2009 defines the terms automatic, change-over and switch .Automatic is defined as started, operated or regulated by a process or mechanism without human intervention. Change-over to replace one system, method or product with another. Switch a mechanical or electronic device that opens, closes or changes the connections in the electrical circuit [5]. By paraphrasing an automatic change –over switch is that electrical devise that changes from a system or method of working of a generation company to that of an auxiliary power supply to ensure constant power supply in the process of change or development without human influence.

It consists of a step down transformer, bridge rectifier, voltage monitoring, an automatic push switch circuit, a relay; mains operated battery charger, a micro controller and LED indicators, Analog-to-Digital converter.

This project work is fully dependent on the operations of the relays. As such the energy supply from the mains is used for their operation. Consequent upon the mains supply, a change-over from generator supply line to generator line takes place immediately the supply goes off. The output in this case, is the supply from the generator. Which involves digitizing and the operation of a voltage monitoring unit is designed for the purpose of monitoring the generator to ensure that it start within the specified time. An analog-to-digital converter is used to achieve the monitoring.

The transfer switch continually monitors the incoming utility power. Any anomaly such as voltage sags, spikes or surges will cause the internal circuitry to command a generator when additional switch circuitry determines the generator has the proper voltage and frequency when utility power returns or no anomalies have occurred for a set time/the transfer switch will then transfer back to utility power and command the generator to turn off, after another specified amount of cool down time with on load on the generator.

This project work is capable of checking for both under voltage and overvoltage with active display. When the supply from the mains is less than 140V, it will automatically switch over to generator that is the load will be connected to the generator. Also when the supply from the mains is 270V it will also disconnect the load from the mains and automatically trigger the generator to avoid damage of the appliances.

The LEDs indicator displays "green" when the load is connected to the mains, displays "orange" when the load is connected to generator and displays "red" when the mains fails and generator fails to start due to technical fault.

1.2 AIMS AND OBJECTIVES

The aims and objectives of this project are to design and construct an electronic device using microcontroller that is capable of carrying out the following functions.

1. To sense the failure from the mains.
2. To initiate the generator solenoid to start the generator.
3. To ignite the generator.
4. To sense the restoration of the mains after failure.
5. To direct the circuit from the generator to the mains (PHCN) again.
6. To stop the generator after the mains has been loaded.

7. To monitor the voltage to avoid over and under voltage to protect the load from damage.

1.3 SCOPE AND LIMITATIONS

The project focus on the construction of a device that automatically switches to an auxiliary power supply immediately the supply from PHCN is not available. The load remains connected to the auxiliary supply as long as the auxiliary supply is in good condition and it switches back once the AC mains are restored. It is designed for domestic, industrial and commercial use.

Although there exist two-phase automatic change-over switch as well as well as three-phase, but a single-phase automatic change-over switch is that within my capability.

This project is a modification of already existing work, the modification include over and under voltage monitor and an LED indicating the various sources of power and error indicator in case the auxiliary power fails to start or the AC mains outage.

CHAPTER TWO

2.1 LITERATURE REVIEW.

A switch is a mechanical or electrical devise that opens, closes or changes the connections in the electrical circuit to withstand excess current. It does not however provide protection against excess current as fuses and circuit breakers do. This implies that the period of operation and breaking of excess current flow of fuses and circuit breakers must be such that the switch in the circuit in which it operates must be able to withstand the excess current[6].

Over the years, the power change-over switch has widely used for both domestic and industrial purpose. Before the introduction of the electro-mechanical devise known as power change-over switch, there had been other local means of changing the phase from the mains (PHCN) to generator set whenever there is power failure. This was of course very cheap and simple.

Dated back late 1800s, the use of a knife switch was imprecise for starting and stopping of motors when they were first introduced for industrial uses. For some reasons, a knife switch remained, undoubtedly, a famous means of connecting and disconnecting line voltage directly to motor terminals.

First, the open knife switch is known to have exposed parts which presented fatal electrical hazard to operators. Secondly the inability of operator to quickly open or close the switch, eventually, results in rapids wear and outright replacement owing to arcing and pitting of the contacts. Thirdly, the material from which they were made also contributed to their problems. Specifically, most knife switches were made of soft copper which demanded replacement after continuous arcing, heat generation and mechanical fatigue.

There arouse the need to improve on the acceptability of the knife switch as controller because of the demand for more electric motors at the end of the century.

First, there was provision to protect the switch and the operator using a steel case and in insulated external handle respectively. Second, since the speed of opening and closing the contacts was determined solely by the operator, an operating spring is attached to the handle of the enclosure to assure quick opening and closing of the knife blade. Third, the introduction of double-break contacts necessitated the discontinued use of the knife blade as a controller.

Unlike single-break contacts, a devise could be designed to have higher current rating using double-break contacts. Example of such devise is the manual contactor. When No (normally open) double-break contacts are energized, the movable contacts are forced against the two stationary contacts to ensure the completion of electrical circuit. Practically, this movable contact is in the form of a shorting bar between the two stationary contacts. What follows the re-energization of the manual contact is the opening of the circuit when the movable contacts. With the NC (normally close) double-break contacts, the above procedure is reversed. [7].

Following the advent of the industrial revolution, many manually done jobs were replaced by some automatically controlled devices. This ensured standard, security, safety and durability.

David parkinson, a 29 years old engineer at Bells laboratories was busy in 1940 designing an automatic line recorder which used which used the position of the recorder pen. Parkinson conceived in a dream the scheme of using the feedback potentiometer to aim antiaircraft guns.[6]

Invented early before 1868 was automatic control systems intuitively. Because there was no real understanding of the word automatic to increase the accuracy of control systems is to slowly attenuate transient oscillations. In 1868, concerned with systems performance, J.C Maxwell propounded a mathematical theory regarding control systems by using a differential equation model of a governor.[6].

Automatic transfer switches continually monitor the incoming utility power. Any anomaly such as voltage sags, brownouts, spikes or surges will cause the internal circuitry to command a generator to start and will then transfer to the generator when additional switch circuitry determines the generator has the proper voltage and frequency when utility power returns or no anomalies have occurred for a set time, the transfer switch will then transfer back to utility power and command the generator to turn off, after another specified amount of cool down time with on load on the generator.

2.2 THEORETICAL BACKGROUND OF THE PROJECT

The operational principles to be considered here are those operations of a regulated power supply unit, a zero crossing detector unit, controlling unit and the relay or switching unit. The block diagram of figure 2.1 illustrates the principle

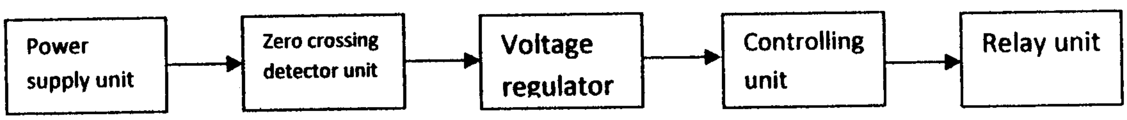

Fig 2.2.1 Block diagram illustrating the various operational units of the project

2.2.1 REGULATED POWER SUPPLY

An unregulated power supply can be converted into a regulated power supply by adding a voltage regulating circuits, which consist of the following components. A step down transformer, a rectifier, a filter (capacitor) and a voltage regulator.[2].

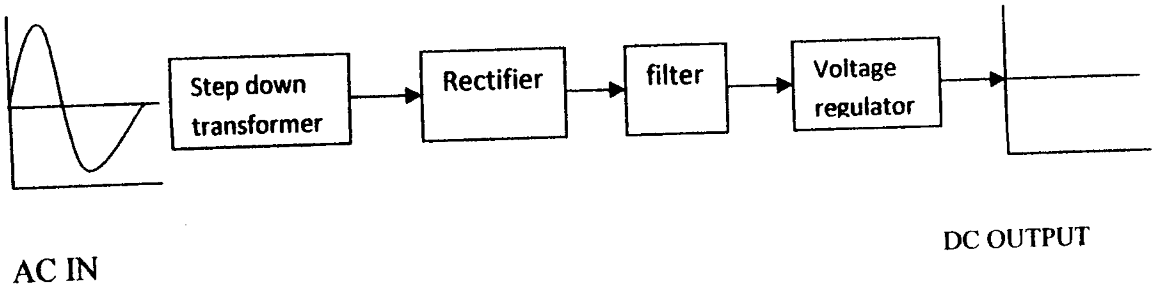

Fig 2.2.2 Regulated power supply

The step down transformer is a power transformer used in solid state circuit. It transforms electric power in one circuit into electrical power of the frequency in another circuit. It also provides isolation from the supply line an important safety consideration. In this project work, a step down transformer employed to step down the AC supply voltage from $240V_{rms}$ to $15\ V_{rms}$.

Rectifier (full bridge type) converts AC voltage into pulsating DC voltage. A full wave bridge rectifier was employed for the purpose.[2]

Filter:- the fluctuation at the output of the rectifier are later removed with the aid of a capacitor.

Voltage regulator:- to keep the terminal voltage of the DC supply constant a 7805 voltage regulator is employed. It is a fixed positive linear voltage regulator.

2.2.2 ZERO CROSSING DETECTOR UNIT.

This units consist of a resistor, capacitor and a transistor. It is use to detect weather they is PHCN or not. It is capable of detecting the availability and outage of PHCN. It generates an output pulse every half cycle, if PHCN disappears the pulse disappears. It is connected to pin 12 and 13 of the microcontroller. A program is written so that every time the pulse goes low the microcontroller will be interrupted.

2.2.3 CONTROLLING UNIT

A microcontroller is used to coordinate the switching, voltage digitizing and failure outage detector. A different kind of integrated circuit, a microcontroller, is a complete computer on a chip, containing all of the elements of the basic microprocessor along with other specialized functions.

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash erasable and programmable read only memory (EPROM).

2.2.4 RELAY UNIT

A relay is a device that switches electronic circuits on or off, and then provides control. It controls the operation of other devices in the same or other circuit. It consists of coil wound around a soft iron core and a movable armature. When current is passed through the coil, the soft iron becomes magnetized and attracts the armature; the armature in turn closes the switch contacts.[6].

The relay employed here is a DC type [6 V, 10A] relay. Basically, it is a mechanical switch whose operation is determined by a magnetic coil. The magnetic coil can open or close the contacts from mill volts to several hundred volts.

Relay allow switching from a primary power source to a secondary or tertiary power source and are employed in some electrical power distribution systems. Most often transfer switches can be seen where emergency power generators are used to back up power from the utility source.

CHAPTER THREE

3.1 DESIGN AND IMPLEMENTATION

The single phase changeover switch system embodied the following subsystems:

1) Dual source power supply

2) 8-bit analog-to-digital converter

3) 8-bit 89C51 microcontroller

4) 256 bytes electrically erasable programmable memory (24C02)

5) Current-limited lead acid battery charger

6) Motor/stator control relays

7) PHCN/GENERATOR selector relay.

3.1.1 DUAL SOURCE POWER SUPPLY

Due to the requirement for standalone operation a dual source system power supply was utilized; i.e system power was derived from a battery (externally connected) and the PHCN/GEN inputs. The power supply was combined as shown below.

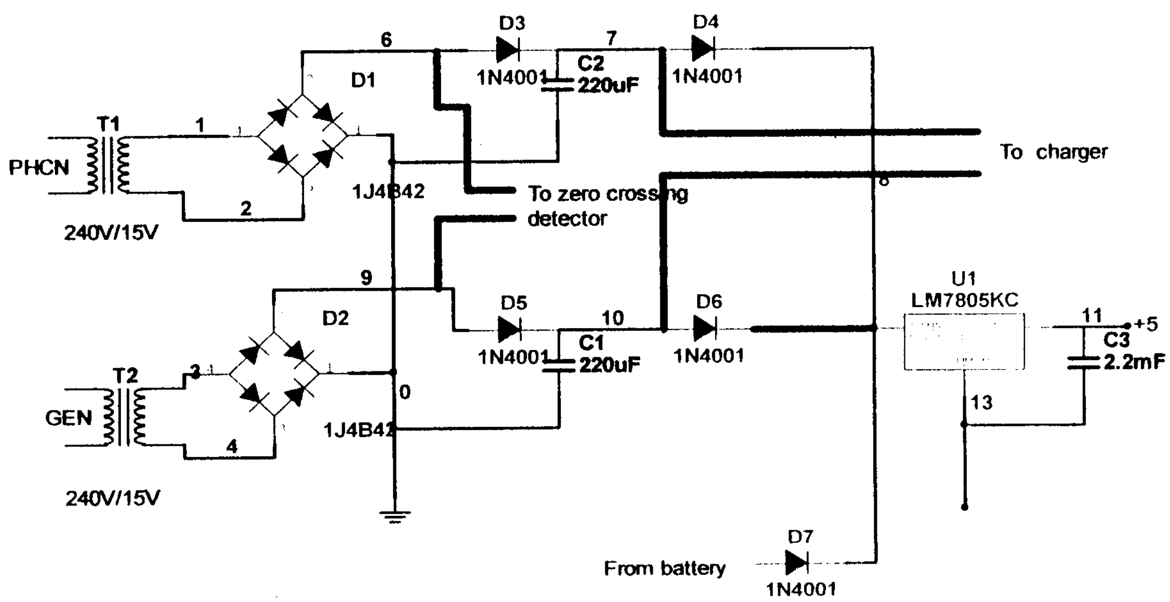

Fig 3.1 Mains derived power supply/Battery supply.

A 240V/15V,0.5A, 50Hz step-down transformer was used on both PHCN/GEN inputs. This implies that whenever 240V a.c mains supply is applied to the primary of the transformer, a 15V a.c will be obtained at the secondary of the transformer.

The voltage transformation ratio(k) can be calculated as follows:

$$k = \frac{Primary\ voltage(Vp)}{secondary\ voltage(Vs)} \ldots\ldots\ldots\ldots\ldots\ldots 3.1$$

Where K is the transformation ratio, V_s is the primary voltage= 15V and V_p is the secondary voltage= 240V

$$K = \frac{240}{15} = 16V$$

The 15V secondary voltage was rectified into a DC potential of amplitude given by the relation:

$V_{dc}=V_{rms}\sqrt{2}-1.4$..3.2

Where V_{dc} is the Direct current voltage and V_{rms} is the root mean square voltage

For a 240V input, the rectified DC voltage assumed a value of

$15\sqrt{2}-1.4 = 19.7V$

This voltage was smoothened by capacitances deduced from the expression

$C = \frac{Q}{dV} = \frac{It}{dV}$..3.3

I =maximum load current

dV= maximum allowable peak-to-peak AC ripple voltage

C= capacitance

$= \frac{1}{F} = \frac{1}{2F}$ (full wave rectified)..3.4

= frequency

= time

The peak-to-peak ripple voltage was determined by the minimum input voltage requied by 7805 device to sustain a regulated output. From the device's datasheet, a 2-volt overhead was required to maintain a regulated 5-volt output, thus, the minimum input voltage is 7V. on a 19.7V DC supply, this translates into a peak-to-peak ripple voltage of 19.7−7=12.7V.

The maximum load current was largely influenced by the changing current and the relay currents. The changing current was fixed at 1.25A. The relay current was calculated based on the coil voltage and the coil resistance.

The measured coil resistance was at a coil voltage of 12V

Therefore Relay current= $\frac{V_{COIL}}{R_{COIL}} = \frac{12}{150} = 80mA$ ……………………………..3.5

Where V_{coil} = coil voltage

R_{coil} = resistance coil

The total relay current, therefore was $3\times\frac{12}{150} = 0.24A$

Inserting the deduced parameter into the equation for the capacitance yielded

$$C = \frac{0.24}{12.7} = 0.018899F$$

A value of $2200\mu F$ was used on both inputs for improved system performance.

3.1.2 8-BIT ANALOG-TO-DIGITAL CONVERTER

For the translation of analog DC voltage into a binary value, an ADC0804 device was incorporated. The device was interposed between the attenuated replica of the PHCN supply and the microcontroller. The ADC enabled the conversion of the main voltage to a digital value that is then checked for overvoltage and under voltage against the values stored in the non-volatile memory. Voltage monitoring was not implemented on the generator input since it is assumed that the control electronics on the generator output at/within the specified voltage output level.

The ADC0804 was interfaced with the controller over port 1(P1). The control signals were taken from P3.0 AND P3.1 respectively, being the chip-select and / write respectively.

The device was run off a clock source of about 910KHz, determined by the values of the frequency determining components connected to pins 19 and 4 as shown in fig 3.2.

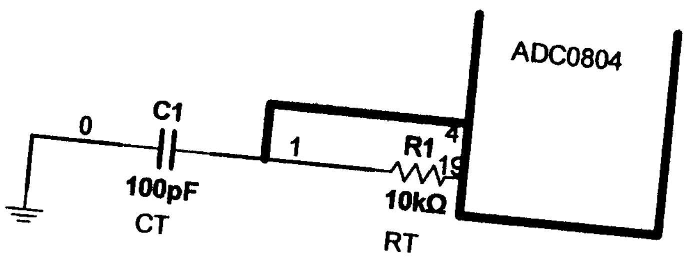

Fig 3.1.2 ADC CLOCK SOURCE.

R_T was anominal 10KΩ resistance by the manufacturer. For shortest conversion time, a high clock frequency was selected. A 200PF capacitance was conneted between pin 4 and ground.

Evaluating the converter clock frequency yielded

$$F_{CLK} \cong \frac{1}{1.1 R_T C_T} \quad \text{......3.6}$$

F_{clk} is the clock frequency

R_T is resistance

C_T is capacitance

$$F_{CLK} = \frac{1}{1.1 \times 10^4 10^2 10^{-2}} \cong 910KHz$$

A conversion was made once every 20msecs using a software timer. Before each conversion, the states of the AC mains (PHCN) is checked by reading the timeout flag which is set by T1 overflowing.

The zero crossing information on the PHCN supply is fed into the INT1 interrupt input. As long as PHCN is available, timer 1 is continuosly reset every 10ms, and the timeout flag cleared. However, when PHCN fails, T1 overflows and sets the timeout flag, indicating AC power loss. The control software delays for a second and retests the flag to preclude the event of a voltage dropout.

This implementation prevents the software from initiating conversion when the AC power is already lost.

The ADC was interfaced with the controller as shown in fig 3.3.

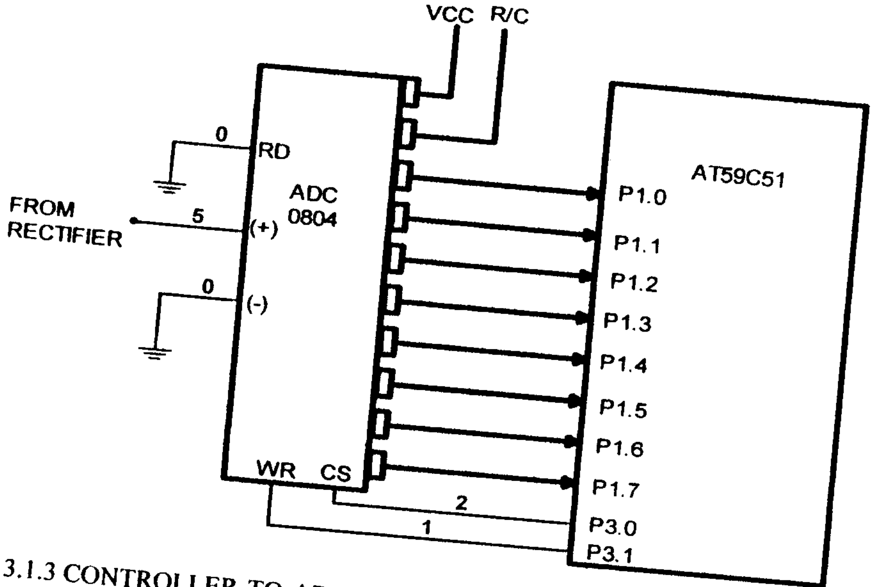

Fig 3.1.3 CONTROLLER-TO-ADC INTERFACING

The ADC'S write and chip select inputs were moved to P3.1 and P3.0 respectively. A conversion is initiated by taking CS and WR low in sequence. WR is taken high and CS minored sequence. Conversion data is then ready about 100μs later. The data is read over P1 into the controller where it is manipulated as desired.

The ADC input voltage was derived from a potential divider across the full wave rectified output of the local AC supply as in fig 3.3.

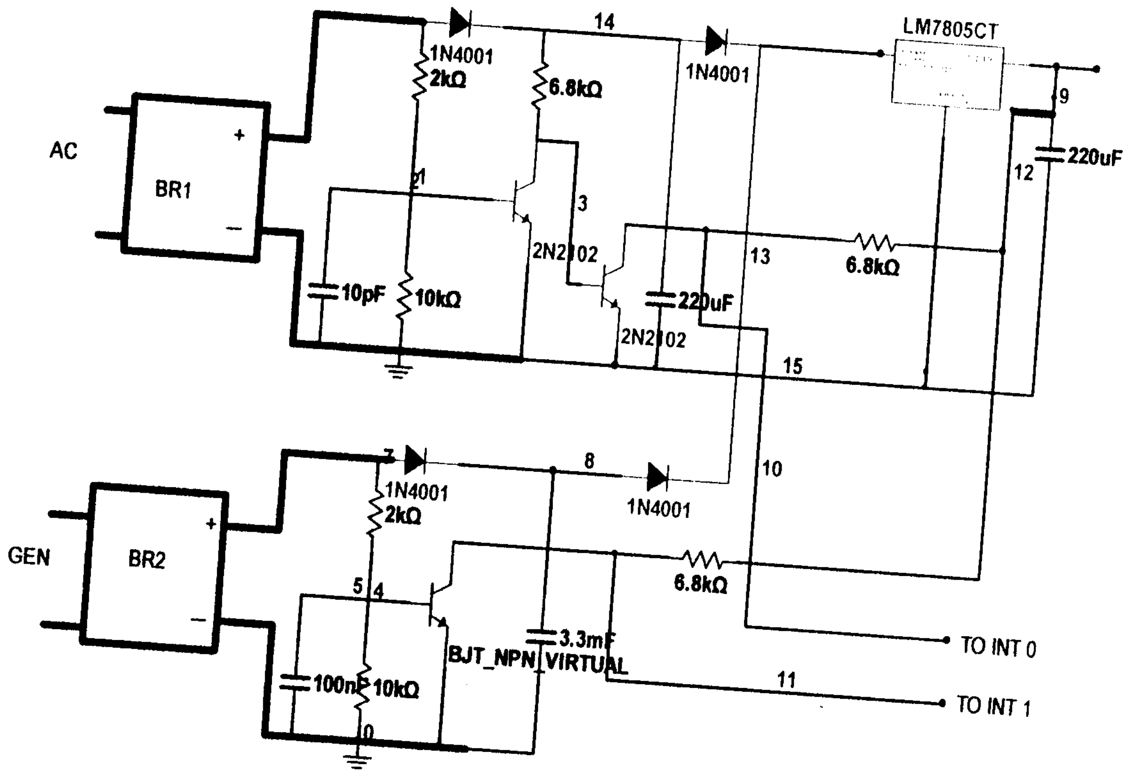

Fig 3.1.4 power supply/ADC take-off voltage

A 50kΩ potencial across the stabilized supply was adjusted to yield the derived voltage into the non-inverting input of the ADC. This voltage reflects the AC input into the system from the mains. Any fluctuation in the voltage level at this point is correspondingly translated to a voltage variation on source input.

The AC voltage was compared with preset values to check for overvoltage or undervoltage before initiating a source switching over via electomechanical relays.

3.1.3 ZERO CROSSING DETECTOR

To monitor the presence, or otherwise, of both the AC utility input and generator supply, zero crossing detectors were used.

A zero crossing detector is a circuit that produces an output whenever the excitation at its input terminals crosses the zero level. For a ZCD with AC inputs excitation, the ZCD produces an output whenever the AC voltage crosses the X-axis or returns to zero, in the case of a rectified but pulsating DC input.

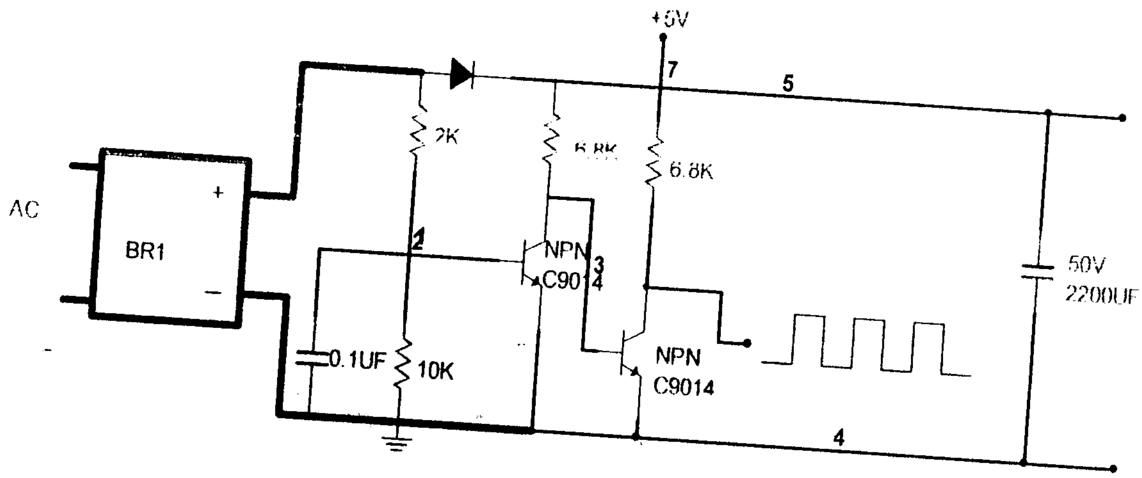

Fig 3.1.5 ZERO CROSSING DETECTOR(S)

Q1 and Q2 are common –emitter ON/OFF switches. The input circuit is fed from the pulsating output of the rectifier.

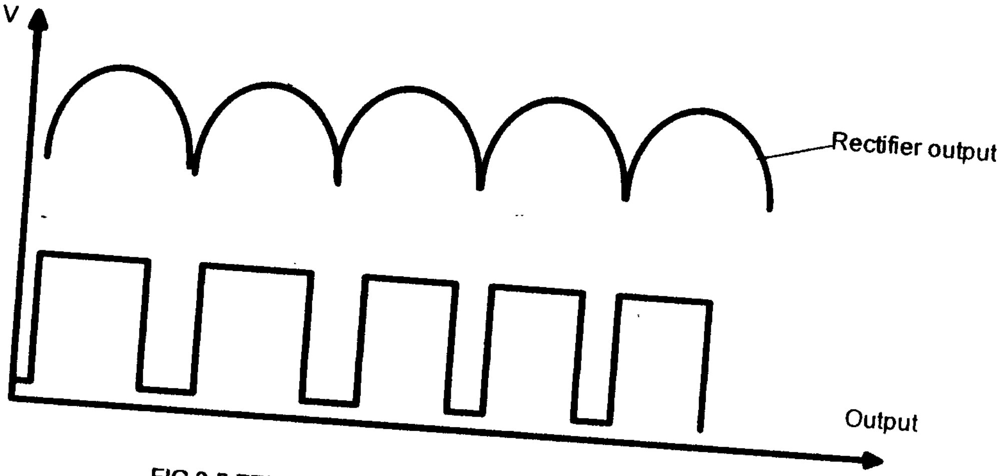

FIG 3.5 ZERO CROSSING WAVEFORM

D1 is biased on hard when the rectified voltage is about 24V(the transformer stepdown ratio is 16:1), i.e a 240/15V Transfromer was used.

This value is calculated as shown below

Hence, whenever the AC input voltage crosses the 2.4V level, an output square wave is generated. Q_2 swings the output pulses between OV and +5V before feeding the INT 0 input on the controller.

A similar scheme, but without Q_2, was employed on the generator input line with output feeding INT1. When the AC supply fails, the output pulses disappear. Internally, a counter overflows signaling supply voltage loss.

The ZCD on the generator input was used to monitor generator startup for automatic retries if it fails to startup after the control software goes through the startup sequence.

3.1.4 ADC REFERENCE VOLTAGE

The converter was supplied with a reference voltage determined by the [illegible] network shown below.

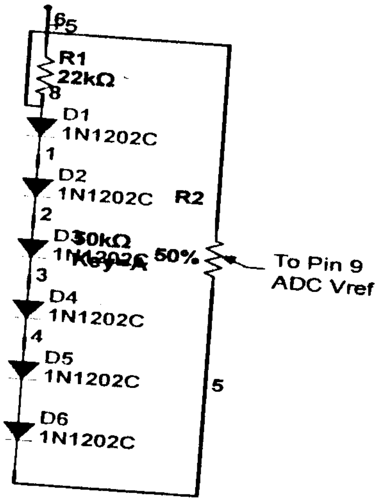

FIG 3.1.7 ADC V_{REF}

The V_{REF} establishes the relationship between the anolog input voltage into the ADC and the digital output of the ADC. The V_{REF} can be adjusted from 0V-2.3V.

3.1.5 SYSTEM POWER SUPPLY

A 7805 device was used to provide a regulated power supply which was fed by three input voltages as shown below.

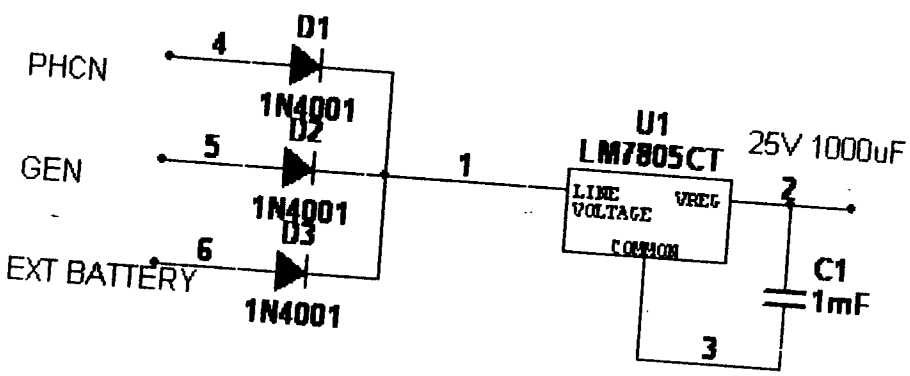

Fig 3.1.8 Three input voltages fed into voltage regulator

The 5V supply was buffered by a 1000μF capacitance against fluctuations.

3.1.6 BATTERY CHARGER

For automatic startup, an external DC source is required to initiate the startup sequence. The external DC battery was refreshed by an on-board current-limited charger on the system board. The charger is shown below.

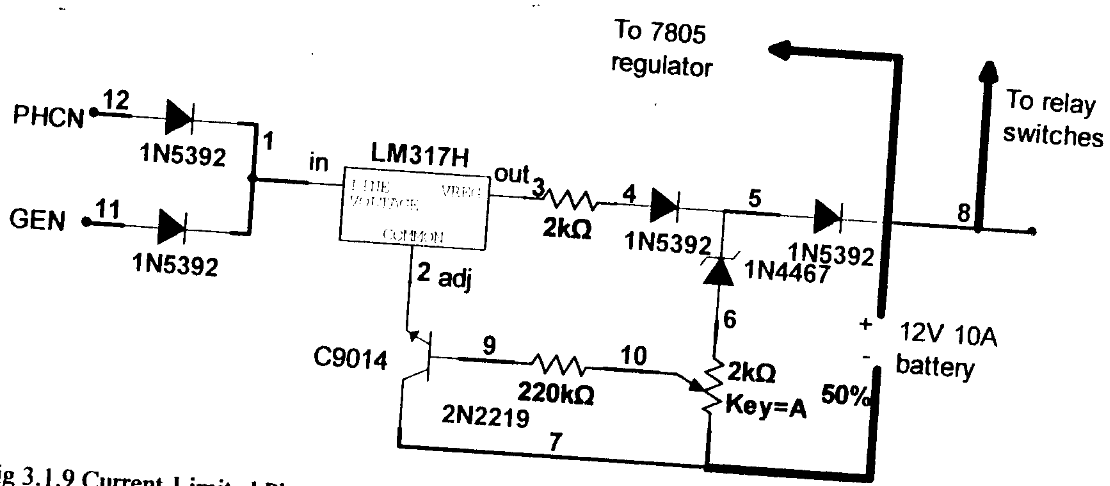

Fig 3.1.9 Current-Limited Pb-acid battery charger.

3.1.7 GENERATOR START-UP SUBSYSTEM

A software-driven generator start-up subsystem was implemented on the switch over. The start-up unit comprises of a motor driver and a startup feature embodies, at the barest minimum,

1) A motor and

2) A stator.

The two units, i.e motor and stator, are driven separately from the +12V battery supply.

A typical startup sequence consists of:

1) Applying 12VDC to the motor

2) Delaying for a manufacturer specified time

3) Applying 12VDC to the stator

The shutdown can be any sequence, i.e. either motor or stator can be turned off in any order.

The voltage switching subsystem employs 12V 30A DC change-over relays to make or break the necessary connections.

The switching subsystem is diagramised in fig 3.7

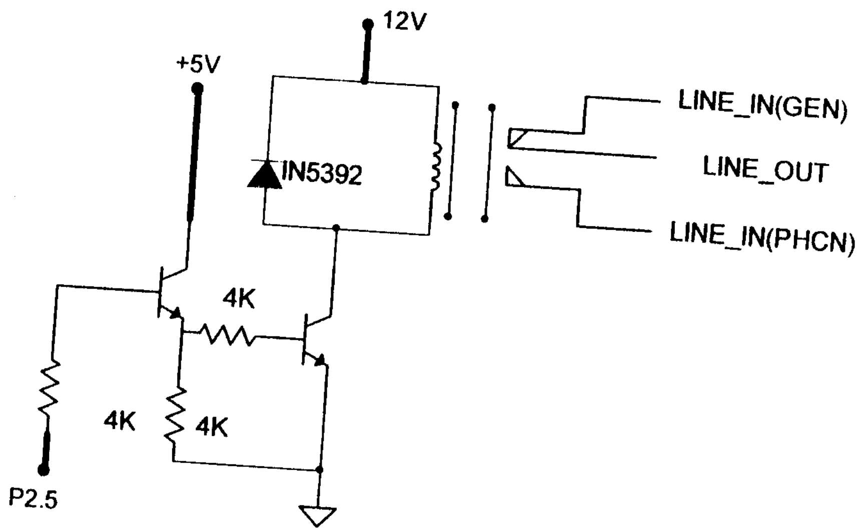

Fig 3.2.0 Switching subsystem

3.1.8 SYSTEM STATUS INDICATOR

To indicate the system state, three LEDs were used, viz

a) A red LED indicating ERROR condition, i.e AC power deselected and generator not running;

b) A green LED indicating local AC power selected.

C) An orange LED indicating local AC power deselected, and generator running.

The three LED were interfaced to $P_{2.0}$,P21 and $P_{2.2}$ respectively.

CHAPTER FOUR

4.1 TESTS,RESULTS AND DISCUSSION.

4.2 INTRODUCTION

For proper implementation purpose, the construction of this project involves the assembly of various components on a bread board and testing of the bread-boarded model to ascertain satisfactory operation of the circuit and the model. The components were then assembled on a Vero board and enclosed in a proper casing for protection and safety.

The electronic components used are a step-down transformer (240/15V), a full bridge rectifier, resistors, 5V voltage regulator, transistors, analog-to-digital converter, 12MHZ crystal oscillator, a non-volatile memory, an Atmel 8951 microcontroller, capacitors, LEDS, IN4001 and IN5392 diodes, 12V DC relays.

4.3 TEST

Various test were carried out in the course of this project work to ensure that the designed parameters were achieved, since they are necessary for a reliable performance of the project. Test was carried out on different stages of the circuit and units as they were designed. Positive results were obtained at each stage between compared with the expected result and the required adjustments were made to meet the specification.

The power supply unit was designed and a 15V step-down transformer was first mounted and connected to the main supply and its output voltage measured with a multimeter. The output was observed to be 15V AC form. The AC output voltage was fed to a full bridge rectifier which then converts the AC voltage into DC form at the same voltage level of 15V. The DC voltage obtained was fed into a zero crossing detector circuit which detect weather the PHCN is restored or not, it also generates an output pulse every half cycle. The output of the zero crossing detector circuit was fed into a filter to remove the remaining ripples in the system. The output of the filter was also measured to know it values and was found to be approximately 15V.

The required +5V needed to power the Analog-to-digital converter and micro controller was obtained by soldering a 5V regulator integrated circuit.

The mounting of the ADC, microcontroller, relays was done accordingly and a separate 12V battery was mounted to provide a backup to the circuit to initiate the generator solenoid to start when the mains fails.

4.4 RESULTS.

When all the soldering had been completed on the Vero board the whole circuit was traced to ensure no short or open circuit.

The output of the power supply unit which powers the ADC, microcontroller and the relays was tested.

The circuit has the ability to withstand the test of using two power sources; one representing generator and the other the mains supply source in the absence of generator.

The ability of the circuit to make a source changing and initiating the generator when the mains fails which is done by the relays with accuracy provided by the use of an ATMEL 8951 microcontroller programmed using an assembly language.

4.5 PROBLEMS ENCOUNTERED

The voltage across the regulator was not up to the required 5V when measured due to fluctuations of power from the mains.

Due to the cost of components initially a seven segment display was intended to use but later an LED indicators was used to indicate the various sources of power and error display when the mains fails and generator refused to start.

4.6 PREVENTIVE MEASURES TAKEN

1) The various components used were independently tested before use to ensure that they are all in good working condition.

2) Polarities of the components were considered before connecting them to prevent components damage and ensure proper sequence of operation.

3) The normally open and normally close of the relay were identified with the aid of a digital meter to avoid wrong connection.

4) The circuit was prevented from getting in contact with water and moisture.

5) Necessary portions of the overboard were isolated to avoid continuity which may result in short circuit.

6) Badly soldered joints were avoided by applying a little solder into the joints.

The unit was designed and calibrated as designed for i.e. for an under voltage of 140V and over voltage of 270V.

A valuable output transformer (240/15V) was connected to the mains input. Switching was observed at the specified voltages. The generator input was replaced by a stabilizer output. The load output was connected to a 60 watt bulb.

The indicator meters gave precise indication of the AC levels on both power inputs i.e. local supply of generator.

CHAPTER FIVE

5.1 CONCLUSION

The design, construction and testing of a single phase automatic power change over switch with battery charger and LED indicators for medium-sized generators has been properly handled in this project work, with negligible error. The objective of this work has been achieved to a satisfactory extent. The system so produced has the ability to sense mains failure, initiate the generator solenoid to start the generator, sense the restoration of the mains, direct the circuit from the generator to mains, and stop the generator. It is meant to provide constant power supply to equipments mostly during operations in places like industries, cyber café, homes, hospitals, offices, business centers and government establishments.

A microcontroller is used to coordinate the switching, failure outage detector, and over and under voltage monitor.

The relays are employed in this project to switches the circuit on or off, and then it provides control as well.

This project single phase automatic power change over switch is suitable to be used for both domestic and industrial purposes.

Therefore, this project work offers a better means of changing from one power source to the other without human intervention.

5.2 RECOMMENDATION

Though, this design is base on single phase, but the real situation can be used for three phase and the alternative means of supply can be a generator, solar energy, battery est. and it depends on the rate of the capacity of the appliances.

This project has clearly demonstrated the necessity for all engineering students, technicians and contractors to have a fore knowledge and proper understanding of the change-over switch and improve on it. This is due to the fact that the success of any power supply is to avoid interruption of main source.

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APPENDIX

FIG 3.2.1 CIRCUIT DIAGRAM OF A SINGLE PHASE AUTOMATIC POWER CHANGE OVER SWITCH