DESIGN AND IMPLEMENTATION OF ANDRIOD BASE AUTOMATIC PHASE SELECTOR AND OVERLOAD PROTECTOR USING GSM

(Case study: Juba Teaching Hospital)

Final year project report submitted to Kampala international university in partial fulfillment of the requirement for the award

Of

Bachelor of Science in Electrical Engineering

By

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EXPLORING THE HEIGHTS

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DEPARTMENT OF ELECTRICAL, TELECOMMUNICATION AND COMPUTER ENGINEERING

AUGUST 2019

DECLARATION

I hereby declare that the project title **AN ANDROID BASED AUTOMATIC PHASE SELECTOR AND OVERLOAD PROTECTOR** was carried out by me and produced to the best of my own understanding as a prerequisite for the award of a Bachelor of Science in Electrical Engineering. I also certify that this report has never been submitted elsewhere for any professional award in any institution of higher learning.

ATENY GABRIEL AGUTO

Signature……

Date…….

APPROVAL

This is to certify that **ATENY GABRIEL AGUTO** is presenting a final year project entitled the "design and implementation of an android based automatic phase selector and overload protector using GSM" under the Supervision of:

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DEDICATION

I dedicate this piece of work to my brother **PETER MAMER AGUTO** and his Wife **YAR ISAIAH MALEK** for their endless support towards my education. MAY GOD BLESS YOU ABUNDANTLY!

ACKNOWLEDGMENT

I thank the Almighty God for giving me all the necessary strength, knowledge, wisdom, financial support and moral ability to complete this project report.

I sincerely wish to express my heartfelt gratitude to everyone who has assisted me to complete this project report in one way or another. My primary obligation is to thank Kampala International University, my Supervisors ADABARA IBRAHIM for his useful comments, criticisms, and suggestions on the original manuscript of this project report.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATION OR NOMENCLATURE

APS	Automatic phase selector
V_{CC}	Supply voltage to DC component
GND	Ground terminal
RX	Receiver
TX	Transmitter
GSM	global system for mobile communication
LED	Light Emitting Diode
LCD	LIQUID CRYSTAL DISPLAY
AVR	ALF EGIL BOGEN & VERGAND WOLLAN RISC
SMS	Short Message Service
PCB	Printed Circuit Board
Ω	Ohms
µ	Micro
AC	Alternating Current
DC	Direct Current
D	Diode
R	Resistor
C	Capacitor
A	Ampere
KIU	Kampala International University
F	Faraday
JTH	Juba Teaching Hospital
Q	Transistors
Hz	Frequency
IoT	Internet of Things

ABSTRACT

The project is designed to automatically supply continuous power to a load through one of the three sources of supply that are: solar, mains and generator or to combine the sources to supply the load all together at the same time.

The three socket outlets represent the three sources. The sockets outlets are connected to three step down transformers which reduce the input 230V or 240V to 12Vac. These 12Vac are rectified and regulated to 5Vdc which act as an input to the microcontroller. Once the microcontroller recognize the present of a given source, a relay module is switch to an ON position. In case all the three sources are available, an android app is used to select the source of choice. When the amount of load demand increases beyond what can be handle by one source, a mobile app is used to bring on board another of the remaining two sources so as to meet the load demand. A filament bulbs were used as a load for demonstration purpose which draws power from solar. When solar fails to supply power, automatically the source will shift to main grid and if main grid fail, the load will automatically be supply by generator. But if solar come back when any one of the two sources is ON, the system will automatically shift to solar. The output of any source is connected to voltage stabilizing circuit which stabilize the voltage to 220Vac by a mean of an auto-transformer which has many taps. When there is any fluctuation in the input voltage, the voltage sensor will activate the relays to switch between the taps of an auto-transformer so as to either reduce or increase the incoming voltage so that the load voltage requirement is met. From the stabilizing circuit, the load is connected through an overload protector circuit which monitor the amount of current drawn by the load. Once the current goes beyond normal value, the last load connected is automatically isolated from the source while leaving the original part of the circuit connected. At the same time a message is sent to the operator by GSM notifying that the circuit is overloaded. The operator can decide to operate the loads by mean of GSM or by sending a text message "normal" to restore the system operation to use an android app.

CHAPTER ONE

INTRODUCTION

1.0 INTRODUCTION

An important requirement of electric power distribution systems is the need for automatic operation and consistency in power supply. In particular, the rapid and reliable transfer of the system from one power source to another during certain system events is important to achieving the reliability goals for such systems and the facility and equipment safety. [5] Therefore, this project report presents the design and implementation of an android based automatic phase selector and overload protector using Atmega 328 and GSM modules.

1.1 BACKGROUND OF THE STUDY

An automatic phase selector and overload protector is an electrical device that is capable of alternating and transferring a load from one source of power supply to another and to bring on board all or some sources in case one source is incapable to supply the load. The basic function of a phase selector switch is to make and break from one source of power supply to another or bring all sources on broad in case one source is incapable to supply the entire load. It can also serve to stabilize power sources in the event of undervoltage, overvoltage thus preventing voltage surge and overload protection therefore, protecting the source from over drain especially when using battery bank.

A manual operation of transfer switch requires the availability of electrical personnel to operate the switch. Thus, it cannot be used in some industrial and commercial applications where absence of power for a certain period of time could have serious implications in terms of life, financial losses due to loss of production, data storage and products. In order to eliminate the time delay between changing over from one source to another, and outage of power due to voltage variation, there is therefore a need for a phase selector with voltage stabilizer and overload protection.

An automatic phase selector (APS) serves as an interface between power sources in order to maintain a continuous supply of electricity to the load. The selector automatically senses power failure from solar power, and supply the load with either grid or generator for startup. At that moment, the phase selector disconnect the solar power and then transfer the load to any of the available power source, thereby restoring power to the load. The phase selector will continue to monitor the condition of the solar power source until it is restored. Also in the event of voltage variation and overload, this device will protect both the consumers and producers equipment. [4]

1.2 STATEMENT OF THE PROBLEM

The conventional electrical system in South Sudan and other part of the world today is based on more than one source at the generation, though one source is placed at consumers end. This system demands to appoint a persons to monitor the continuity at the interconnection station. This is exhaustive procedure, which involves a lot of human time effort but still does not produce accurate results .There is a lot of complaints regarding to continuation in power supply and equipment damaging. My aim was to solve this problem and provide uninterrupted power supply and safety operation of the equipment.

Also the electrical parameters supplied by the various electrical generating stations have slightly different in their parameters such as voltage depending on the manufacturer specifications and design, this may cause damage to the appliances when connected to non-stabilize sources, hence it was wish to design a system that can protect the appliances in case of any fluctuation in the supplies parameters, and maintain continuous supply of power without any source interruption.

Also in case the system is overloaded which may cause damage to personal and utility equipment, it appropriate to protect the supplier to avoid the replacement of any equipment before their schedule date.

Furthermore, in case one source is incapable of supplying the entire load, it is appropriate to bring onboard another source or all sources at the same time to meet the load requirement, therefore maintaining the continuous supply to the load.

1.3 OBJECTIVES OF THE STUDY

1.3.1 General Objective

The main objective of this project is to design and implement an effective android based automatic phase selector with voltage stabilizer and overload protector.

1.3.2 Specific objectives

1. To design automatic Phase Selector circuit.
2. To design an automatic voltage stabilizer circuit.
3. To design an automatic overload protector circuit.
4. To interface the Atmega 328 with Bluetooth and GSM modules.
5. To validate the design of automatic phase selector system.

1.4 RESEARCH QUESTIONS

1. How to design automatic Phase Selector circuit.
2. How to design an automatic voltage stabilizer circuit.
3. How to design an automatic overload protector circuit.
4. How to interface the Atmega 328P with Bluetooth and GSM modules.
5. How to validate the design of automatic phase selector system.

1.5 SIGNIFICANCE OF THE PROJECT

This project system was cost-effective, compact and easily maintainable system that solves the problem of employing so many workers for system monitoring purposes in power interconnected systems.

Also, it's maintain a continuous supply of power to the load in case there is power outage or bring all sources onboard in case one or two sources are incapable to supply the existing load.

It is user friendly as the system is autonomous; continuously monitoring the voltage range of any source and overload protection that may result from any extra load connected to the system.

Furthermore, most of the client tend to hide the actual loads that are to be connected to a particular system network, which later after the installation is completed they then add more equipment to the system which were not catered for

in the actual design. Hence, it is the responsibility of the overload protection circuit to isolate the load from the supply such that utility equipment such as transformers, cables and other devices are protected. Therefore, the technicians and engineers are protected from been taken to court for negligence and poor design of the system.

1.6 PROJECT JUSTIFICATION

In most part of the world, power demand, power outages, voltage surge and overload are major problem faced due to the under-utilizing of other energy sources and increased demand of electricity due to the ever growing population, industrialization, and domestic use. Therefore, this system ensures uninterrupted power supply, voltage stabilizing & overload protection to the load and integral utilization of other sources of energy like solar and generator power supplies.

1.7 SCOPE OF THE PROJECT

1.7.1 Time scope

This project is based on both theoretical and methodological data, thus it is approximated to take a maximum of four (4) months.

1.7.2 Context scope

This project is aimed at developing system based on sensing for the instrumentation of many parameters. The aim was to develop a system that will monitor and switch on the source that is available when the solar power is off, and maintain the output parameters, that is, under and over voltage at the recommended level, and protect the system against overload. This system is also capable to combine more than one source to power the load at the same time.

This system can be implemented in homes, offices, hospitals, industries and learning institutions. In Juba Teaching Hospital (JTH), the blood bank is powered by three power sources that is, main grid, solar and generator. In the event of one power outage, the electrician has to go and turn on the other available sources using a manual changeover switch. This delay in the change of power sources can put the reserved blood at risk hence there is a need for an android based automatic phase selector with voltage stabilizer and overload protector.

1.7.3 Geographical Scope

The study of the project was carried out of Kampala International University but in Juba-South Sudan in particular Juba Teaching Hospital (JTH).

1.8 ASSUMPTIONS AND LIMITATIONS

The assumptions taken during the development of this project include;

i. Three socket outlet with power in them were provided to get the same function of the three different sources since it was not feasible to provide all four different sources of supply.

The limitations of this system include;

a. This project system has a limitation in that there was no variac device that could regulate the voltage between undervoltage, normal voltage and overvoltage.
b. It requires qualified personnel to reprogram the microcontroller in case of malfunction in the system.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION.

It is well known that electrical power generation systems is generated by number of different sources or mean that has to be interconnected as single unit. It is necessary to interconnect these sources properly so as to function as one system under the same parameters. This chapter summarizes all the related literatures about existing automatic transfer switch or automatic changeover switch, concept of their operation, their limitation gaps and techniques used.

But in this chapter we are also going to concentrate on materials that were used to build an android based automatic phase selector with voltage stabilizer and overload protection.

2.1 CONCEPTS, DEFINITIONS AND DESCRIPTIONS.

2.1.1 Automatic phase selector

An automatic phase selector is a device that detect the present of a particular source and connect the load to that source. It enable more than one source to supply the load one after the other or both of energy sources at the same time depending on the load demand. ATS is an automatic change over switch that use ATMEGA 328P microcontroller and DC power supply (5Vdc) as a sensor with single pole relays to accomplish the inter-switching action between the generation energy sources.

2.1.2 Voltage Stabilizer

In the generation of an electrical energy, there is always voltage fluctuation in both the transmission and distribution lines. This voltage variation can either be under or over voltage which may affect our equipment and cause damages. This fluctuation can be cause by either lightening, electromagnetic discharge, electrostatic charges, switching surges etc. Due to this variable voltages, it is not necessary to disconnect our load from the source but to solve this voltage problem by introducing an auto transformer that can subtract or add some voltage to the incoming voltage source, thereby stabilizing the voltage.

2.1.3 Overload protector

An overload is a phenomenon where by the connected load draw more current than the actual or design value. This overload can be a result of an extra load added to the main circuit or due to ground fault. Therefore, this overload is dangerous to both the utility and personal equipment, hence it has to be clear immediately by isolating the load from the main supply so as to protect the equipment.

2.2 RELATED LITERATURE OR EXISTING TECHNOLOGY

According to (Jonathan, 2007), 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 the generator and the mains supply. Whenever, there is power failure, changeover is done manually by an individual and the same happens when the ac mains power is restored. This is usually accompanied by a loud noise and electrical sparks.

According to him, these are some of the limitations in the manual changeover switch, i.e;

- Manual changeover switch is time wasting whenever there is a power failure.
- It is strenuous to operate because it requires a lot of energy.
- It causes device processes or product damage.
- It has potential to cause fire outbreak because it's usually accompanied with electrical sparks.
- It is usually accompanied with a lot of noise which may be psychologically destabilizing.

According to (Robert Douwona, 2008), made research about multiple power supply and found out that emergency power systems were used as early as world war two on naval ships. During combat, a ship would lose the function of its steam engines which powers the steam driven turbines for the generators. In such a case, one more diesel engines were 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, rod placed between, in order to operate the changeover switch, one source must be turned off, the rod moved to the other side and other source turned ON.

With increase demand of power today, it has become impossible to supply electricity in accordance to the demand and this has led to many alternative power supply sources. In Uganda today, the use of generators to power homes, businesses and machines is increasing every day. Some standby generators used today are manually started while some are started automatically.

According to (Mboacha, 2012), manual changeover require frequent maintenance because the changeover actions causes wear and tear. The modern system used in various industries and utility companies are called automatic changeover systems, they majorly consist of a control and power circuit which uses a transfer switch.

The operation of transfer switch is to electrically switch a load between two sources (i.e. usually ac mains and generators). We have manual transfer switches which require the operator to manually transfer the switch and the other type is the automatic transfer switch which automatically trigger when the main source gains or losses power. Backup generator is usually installed alongside an Automatic Transfer Switch so the latter can temporary provide power if the mains fail.

All electrical power consumed by the circuit, equipment, or system connected to the transfer switch output is defined as the load. A typical transfer sequence includes these steps:

- The transfer sequence starts when there is power failure in the main power source usually ac mains power supply.
- Then the transfer switch shifts the electrical load to the emergency power source only when power from the generator or the backup utility feed is stable and within prescribed voltage and frequency tolerances. The transfer can either be executed automatically or manually depending on the facility's needs and preference.
- Finally, the transfer switch shifts the load back from the emergency power source to the main power source when the utility feed is restored. This can be carried out automatically or manually depending on the operation mode of the transfer switch and its types (Charlie Hume, 2015 & Ryan Ishino, 2015).

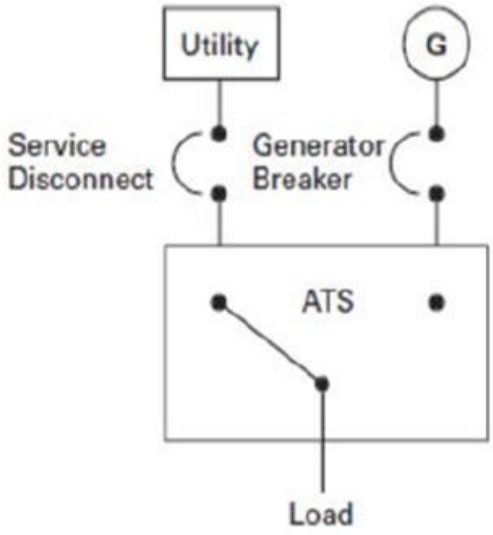


Figure 1: showing one-line drawing of basic elements of a transfer switch

According to (Amanyire Ronald, Kaumba Muteba, Abdurrahman S Hassan and Adabara I, October-December 2017); the design of an automatic tranfer switch was to solve the use of an existing manual change over switch which is time consuming and damages to the equipment due to sparking cause during the changeover.

This project was designed to automatically supply continuous power to a load through one of the four sources of supply that are: solar, mains, thermal, and wind when any one of them is unavailable. The four switches represent the four sources. The switches were connected to an 8051 microcontroller of which they provide input signals. Whenever a switch is pressed, it shows the absence of that particular reference. A relay driver is used that receives microcontroller generated output and switches that specific relay to provide continuous power supply. When the primary fails to supply power, automatically next available source was used like thermal. If thermal fails then the next one is used and so on. This system lack equipment protection and communication system.

According to (Lanre Olatomiwa, Rasheed Olufadi, 2014), a low cost automatic transfer switch (ATS) with an over-voltage protection was designed using Arduino and 555 timer. The man objectives on the designed was sensing of the primary/main source of power supply when restored, startup the secondary source (generator) when main power fails, shutdown the generator when the main source

is power restored as well as automatic transfer of load to the available power source, thereby making the entire process easy and reliable. In order to achieve the objectives, the utility power supply (main source) considered in this the study is single phase power supply and the device it made to operate on a 5KVA single phase (key operated) generator set. The controller uses an embedded microcontroller to monitor utility and generator voltages which are interfaced to a user interface for operator instructions at the operator interface. This design has a limitation in that, there was no overload protection system.

According to (Uchechukwu Innocent Ezirim, Uchenna Bright Oweziem, 2015), designed an Automatic Power Phase Selector using microcontroller. This design focuses on the design of a phase selector using automatic switching mechanism. During its operation, it transfers the consumer's loads to the available power source in the case of power failure in the power supply from the national grid and automatically detects when power is restored to the failed phase and returns the loads to this source. This system did not consider voltage variation, overload protection and the use of GSM.

According to (F. U. Nweke and R. C. Iwu, 2015), Designed an Automatic Three Phase Power System Selector. In this system, the device automatically switches over to the alternative phase that has current when there is power outage or extremely low current in the phase which the load is connected without the power being off. The selector links the load and the other phases and relay switches allowing the usage of the remaining phases where there is outage on the mains source without disturbing or interrupting the load. It maintains constant power supply to the load by automatically activating the phases when the need arises. This safeguards the electronics system from being damaged and burnout as a result of voltage instability, collapse, insistent outages which are paramount in under developed and developing countries. This system did not put into consideration the overload protection, voltage surge and the use of internet of Things.

According to (Ayan Ghosh, Shamik Chattaraj, Snehashis Das and Kaustav Mallick, 2016), an Automatic Phase Selector from Any Available Three Phase Supply was designed using a microcontroller. They noticed that power interruption in

distribution system is about 70% for single phase faults while other two phases are in normal condition. Thus, in any commercial or domestic power supply system where 3 phases is available, an automatic phase selector system is required for uninterrupted power to critical loads in the event of power failure in any phase. There is no requirement of backup power supply in that case. Also there is no time consumption as the phase is changed automatically within a few seconds. This system did not consider the need for another source in the event if there is a total failure in the original three system.

According to (Mr.Lalit Patil, Shiwali Sonawane, Nisha Thakur and Komal Nagare, 2016), designed an automatic phase selector using micro-controller 89C52. They have released that, in three phase equipment's, if supply voltage is low in any of the one phase and there is need to run all the equipment properly. This equipment will help to rescue this situation. However proper rating fuse need to be used in three phase i.e. R, Y, and B inputs lines. Where the correct voltage is available that time. Other low voltage phase shift to correct voltage in same manner, to run all the equipment on the single phase in the building. The circuit consist of relay comparator, transformer. This design did not put into consideration a backup source that can run the system in case of total back out. Also there is no additional protection schemes in the design that can protect the equipment from voltage surge and overcurrent.

According to (Himadri Sil and Sayan Denath, 2016), Designed an automatic phase selector from any available with use of logic gate and relay driver. They found out that power failure is a common problem. It hamper production of industries, construction of new plant and building. It can be overcome by using a backup power such as generator. But it is cost effect and time consuming as adequate time is required to switch on the generator manually. It is often notice that power disturbances in distribution system is 70% for single phase while other two phases remain normal. Thus, in any domestic or commercial power supply where three phase is available, an automatic phase selector is required for uninterrupted power to critical load in the event of power failure in any phase. There is no requirement of backup power in any case. Also there is no time consuming as phase is changed

automatically within few second. This system did not put into consideration the electrical equipment that operate on three phase voltage. Once there is power failure, machine such as three motor will fail to operate hence there is need for a backup power to take over and power the three phase equipment in case of power failure.

According to (Mr.Shahaji Dudhate, Mr.Amol Attargekar, Mr.Dhanaji Desai, Prof. Mrs.Aditi Patil, 2016), designed a Power Supply Control from Different Sources. The main purpose of this project is to provide continuous power supply to a load, by selecting the supply from any of the four sources namely solar, inverter, main and generator automatically in case if one the source is absent. The need of electricity is increasing day by day and the frequent power cuts of electricity are causing many problems in different areas like banks, colleges/schools, hospitals, houses and industries. Thus there is requirement for an alternate arrangement of power supply. This arrangement was designed by using ARM7 microcontroller and relays. When a source, say mains fails the supply automatically shifts to next priority source generator and so on. LEDs (Light emitting diodes) can be used to show that which source is used to provide the supply**.** In this designed, voltage surge, overload and communication were not model into the design. This provide a big threat to the component in case if there is voltage surge and overcurrent in the system.

According to (Nirbhay Singh, Nitesh Kumar and Amrish Kumar, 2017), designes an automatic active phase selector for single phase load from three phase supply. According to them, Phase absence is a very common and cause severe problem in any industry, home or office. Many times one or two phases may not be live in three phase supply. Because of this, many times, some electrical appliances will be on in one room and OFF in another room. This creates a big disturbance to our routine work. This controller continuously checks for live condition of all phases connected to it, and the controller connects the load to the active phase using a Relay. This relay is driven with a transistor. If two or three phases are live, the load will be connected to phase I only. This project failure to address the connection of electricity in an apartment where each apartment uses its own meter. Secondly,

there is protective system in cooperated in the design which post major threat to electrical equipment.

According to (Mr. Prasad Salunkhe, Digvijay Raut, Madhuri Patil, Poonam salunkhe and Mohd Yusuf, 2017), designed automatic phase selector using micro-controller at89c51. This project was designed to check the availability of any live phase, and the load will be connected to the particular live phase only. Even a single phase is available, the load will be in ON condition. This project was designed with ATMEL89c51 MCU. This controller continuously checks for live condition of all phases connected to it, and the controller connects the load to the active phase using a Relay. This system did not consider the use of GSM to enable the control of sources or phases when the operator is unavailable. Also there is protection scheme built into the system.

According to (Alexander Kyereh1, & Gyimah Kopri2, 2017), designed an automatic phase selector for multisource power supply. This project was designed to fully automatic select the most economic and reliable source for a single phase electrical load from one of the three different sources. The system was designed a digital phase selector using logic gates in combination with power electronic devices, and providing means of prioritizing a selected source that is the most reliable and cost effective to be connected to the load. Being a reliable piece of equipment, the designer did not consider protection scheme into the system, neither did they consider communication mean such IoT and GSM.

According to (OFUALAGBA G & E.E. UDOHA, 2017), designed an Automatic Phase Selector and Changeover Switch for 3-Phase Supply. The idea was to the design and construction of automatic phase selector and changeover switch for 3-phase power supply. It provides a means of switching from one phase of AC mains to another in the case of failure in the existing phase; it also change over to generator if there is failure in all the three phases of the AC mains. The circuit also senses the restoration of any or all the three phases of the mains and changeover without any notice of power outage. This design has been improved on the existing types of electromechanical device that has being in use over the years. Hence this has been achieved by the use of 1- of - 4 analogue multiplexers (CD4052), analogue

to digital converter (ADC0804), AT89C51 microcontroller and relay switches. Being a comprehensive system, it does lack the protection system and communication mean.

According to (Md Atiqul Islam, 2017), designed an automatic phase changer. The idea was to simulate the design using Proteus 8. Automatic Phase Changer (APC) automatically changes the phases. In three phase power system 3 inputs of APC circuit are connected to three phases of the system and its three outputs are connected to three different loads. These three loads always need their normal rated voltage for proper operation. Results observed that if voltage of any phase goes below the nominal rating, the loads may malfunction. Here, Automatic Phase Changer comes into action. When a phase voltage goes below its nominal rating, APC provides correct level of voltage to the load connected to that phase. Though it does maintain a continuous supply to the load, the system has no communication and protection capability.

According to (Ihedioha Ahmed C, 2017), designed a microcontroller based automatic three phase selector. The construction of this automatic three phase selector was interesting, stimulating and challenging but only in its efficient performance and reliability can any real level of success be measured. The functionality values of the work make it desirable to be developed especially in all residential and small commercial buildings using three phase. It saves resources like time, energy and even lives while ensuring automatic and efficient domestic power load sharing from the consumer end. This system does not put into consideration the need for other sources that act as a backup in case of total brown out of the entire supply. In addition, no protection and communication system provided.

According to (Vipula Tippa, Ankita Kedar and Karuna Nikum, 2017), designed an Automatic Phase Changer. According to them power stability in developing countries creates a need for automation of electrical power generation. This automation is required as the rate of power outage becomes predominantly high. Most industrial and commercial processes being dependent on power supply, if the processes of change-over are manual, serious time not wasted but also creates devices or machine damage from human error during the change-over connections, which could bring massive losses. This change over switch box separate the source

between the generator and public supply when there is power supply outage from public supply, someone must go and change the line to generator. Thus, when power supply is restored someone must put OFF the generator and then change the source line from generator to public supply. In this system, in the process of change over from on source to the other, there may result some voltage surge which may damage the electronics and electrical equipment. This protection system was not consider in the design making this system ineffective for use.

According to (Kunal Jagdale & A.Siddhartha Rao, 2017), designed an Over current Protection of Transmission Line using GSM and Arduino. This Project was about designing the controls of an Over current relay using a microcontroller. The microcontroller used in the relay provides much flexibility of operation through the use of above-mentioned components in the electrical system. A simple relay wouldn't contain such characteristics. Microcontroller based relays use the controller to read the load current. If the current is greater than the pickup value, then the relay is being sent a signal which then operates to send a tripping signal to the circuit breaker which then opens the circuit. IDMT characteristics of the relay can also be realized. IN this design, voltage protection with a backup source were not provided in the design. Therefore, in case of voltage fluctuation, the equipment may get damage and in the loss of supplying source, there will be no another source to back it up.

According to (Prof. Praful Kumbhare , Pramod Donode, Mahesh Nimbulkar, Harshada Kale, Mayur Waghamare & Akansha Patil, 2018), designed an Auto Selection of Any Available Phase in 3 Phase Supply System. This project was designed to check the availability of any live phase, and the load will be connected to the particular live phase only. This project was designed with ATMega328. This controller continuously checks for live condition of all phases connected to it, and the controller connects the load to the active phase using a Relay. This relay is driven with a transistor. If two or three phases are live, the load will be connected to Phase 1 only. The system has no provision of voltage and overload protection scheme. Also no provision of communication such GSM and IoT has been provided. This make the system undesirable for application where protection is need.

2.3 INSTRUMENTATION/ MAJOR COMPONENTS USED.

2.3.1 Bluetooth module (hc-05).

Bluetooth is one of the popular wireless communication technologies because of its low power consumption, low cost and a light stack but compensates on range. Having a connection between the Bluetooth module and the android application requires a smartphone with a Bluetooth and this can be checked by navigating the wireless networks under settings, the HC-05 Bluetooth transceiver. To use HC-05 module connections will be made i.e. V_{CC} to 5V output of the circuit, GND to ground, RX to TX of the microcontroller and vice versa. Since RX pin is designed for 3.3v signals, a voltage divider will be used to ensure no damages are made to the Bluetooth module.

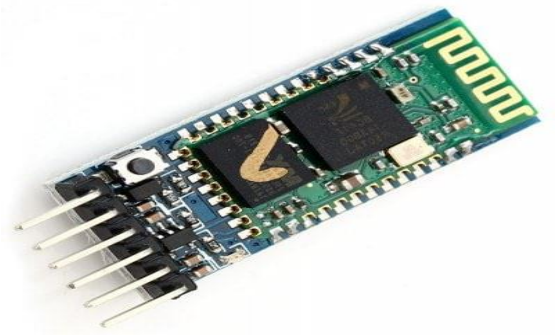


Figure 2: Showing Bluetooth module HC-5A

2.3.2 GSM SIM900A

Figure 3: Showing GSM module SIM900A

GSM is a mobile communication modem; it is stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell Laboratories in 1970. It is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.

GSM system was developed as a digital system using time division multiple access (TDMA) technique for communication purpose. A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its own particular time slot. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates. There are various cell sizes in a GSM system such as macro, micro, pico and umbrella cells. Each cell varies as per the implementation domain. There are five different cell sizes in a GSM network macro, micro, pico and umbrella cells. The coverage area of each cell varies according to the implementation environment.

SIM900A Modem is built with Dual Band GSM/GPRS based SIM900A modem from SIMCOM. It works on frequencies 900/ 1800 MHz SIM900A can search these two bands automatically. The frequency bands can also be set by AT Commands. The baud rate is configurable from 1200-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. SIM900A is an ultra-compact and reliable wireless module. This is a complete GSM/GPRS module in a SMT type and designed with a very powerful single-chip processor integrating AMR926EJ-S core, allowing you to benefit from small dimensions and cost-effective solutions.

Specification

- Dual-Band 900/ 1800 MHz
- GPRS multi-slot class 10/8GPRS mobile station class B
- Compliant to GSM phase 2/2+
- Dimensions: 24*24*3 mm
- Weight: 3.4g

- Control via AT commands (GSM 07.07 ,07.05 and SIMCOM enhanced AT Commands)
- Supply voltage range : 5V
- Low power consumption: 1.5mA (sleep mode)
- Operation temperature: -40°C to +85 °

2.3.14 Acs712 current sensor

Acs712 is Hall Effect based current sensor. It can measure both direct current and alternating current. It is a linear type sensor. This is very a famous integrated circuit designed by Allegro . It has features of noise cancellation, very high response time. Output error is about 1.5 percent but it can tackled with some intelligent programming and multiplying measured value with standard error of sensor. If you give dc current to its input, it will give proportional dc voltage at the output of sensor and if you give ac current at the input of acs712, it will give you proportional ac voltage at the output. Proportional term depends on the output sensitivity of the sensor.

Figure 4: showing current sensor

Working of acs712 current sensor

This acs712 sensor consists of a linear Hall Effect circuit along with copper conduction path. Copper conduction path is located around the surface of the die. When ac or dc current passes through a copper conduction path, it produces magnetic field. This electromagnetic field interacts with Hall Effect sensor. Hall Effect circuit converts this electromagnetic filed into proportional voltage either ac or dc depending on input current type. This output voltage is measured with the help of

Arduino or any microcontroller. After measuring this voltage, we convert it back into current using sensitivity equations.

Pin diagram of acs712 Hall Effect current sensor

Pin out of acs712 current sensor is given below. Pin number 1, 2 and 3, 4 are used for current sampling. In other words. These pins are connect in series with the load of which current you want to measure.

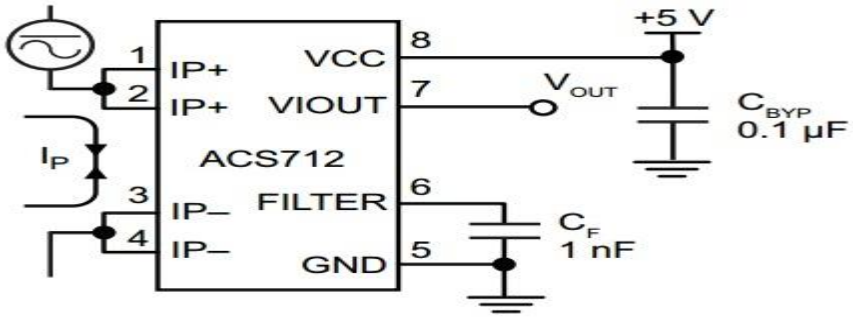


Figure 5: Showing current sensor pin out

Pin number 5 is ground connection of 5 volt power supply and pin number 6 is used to connect filter capacitor. One terminal of filter capacitor should be connected with pin number 6 and other terminal should be connected with ground. Similarly pin number 8 vcc is a power supply pin and you should connect dc 5 volt with it. Pin number 7 is the output pin of acs712 current sensor. From output pin, we will measure voltage with the help of arduino and we will see later on how to do it. Make sure to not connect your load in parallel with IP+ and IP+ it will damage your device and can also harm you if you are dealing with AC power supply or AC load.

Number	Name	Description
1 and 2	IP+	Terminals for current being sampled; fused internally
3 and 4	IP–	Terminals for current being sampled; fused internally
5	GND	Signal ground terminal
6	FILTER	Terminal for external capacitor that sets bandwidth
7	VIOUT	Analog output signal
8	VCC	Device power supply terminal

Table 1: Showing current sensor pin out and their description

2.3.3 Microcontroller.

A microcontroller is a computer-on-a-chip used to control electronic devices. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general- purpose microprocessor. A typical microcontroller contains all the memory and interfaces needed for a simple application. A microcontroller is a single integrated circuit with the following key features: Central processing unit - ranging from small and simple 8-bit processors to sophisticated 32- or 64-bit processors, input/output interfaces such as serial ports, peripherals such as timers, RAM for data storage, ROM, EEPROM or Flash memory for program storage, clock generator often an oscillator for a quartz timing crystal and resonator or RC circuit. This integration drastically reduces the number of chips and the amount of wiring and Printed Circuit Board (PCB) space that would be needed to produce equivalent systems using separate chips.

ATMEGA328P is high performance, low power controller from Microchip. ATMEGA328P is an 8-bit microcontroller based on AVR RISC architecture. It is the most popular of all AVR controllers as it is used in ARDUINO boards.

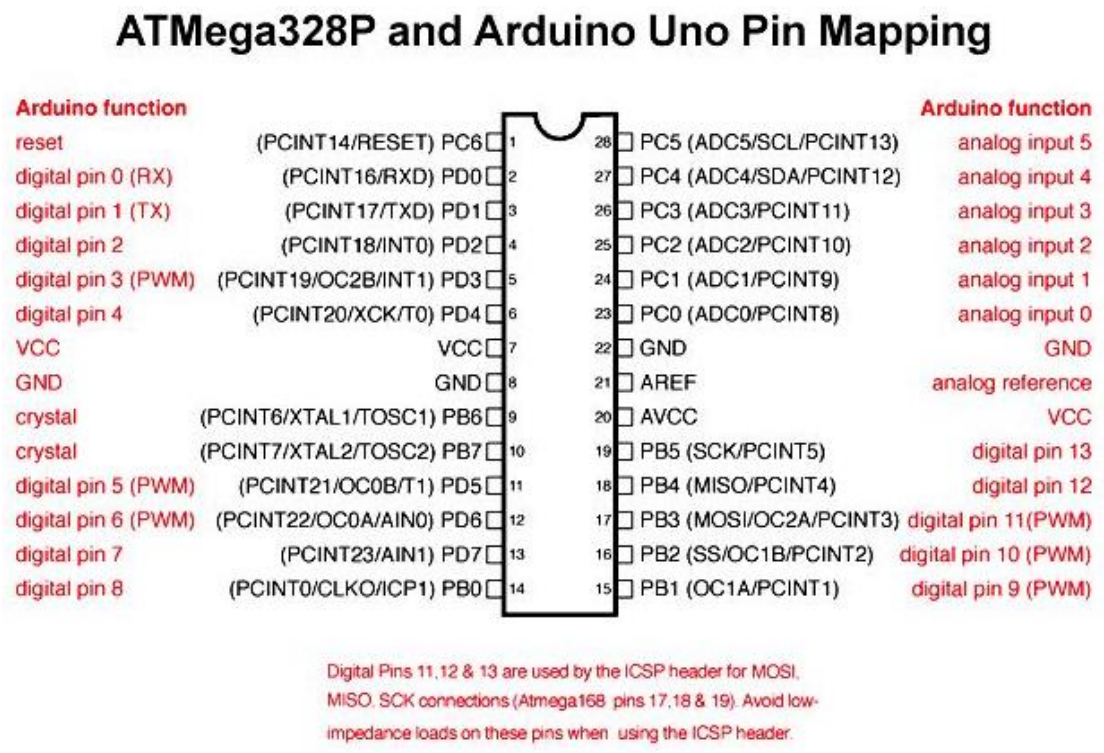


Figure 6: Showing ATMEGA 328P pin layout

2.3.4 Liquid Crystal Display

An Lcd Jhd162a is a flat panel, an electronic visual display that uses the light modulating properties of liquid crystals. Liquid crystal does not emit light directly. The working of LCD depends on two sheets of polarizing material with a liquid crystal solution in between them. When an electric current is passed through the liquid, it causes the crystals to align so that it blocks out light and does not allow it to pass. Each crystal behaves like a shutter; it either allows light to pass through or blocks the light.

It can function properly in the temperature range of -10°C to 60°C and has an operating lifetime of longer than 50000 hours (at room temperature without direct irradiation of sunlight).

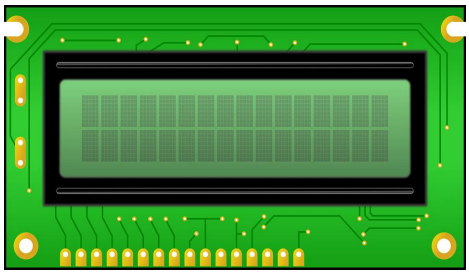


Figure 7: Showing lcd 16×2

Mode operation of the liquid crystal display.

LCD in 4-Bit means 4 Lines of data bus are used instead of using 8 Line data bus. In this Method, Data is splinted in Nibbles. If a Microcontroller is successfully interfaced with LCD with 4 Pins. Then 4 Lines of Microcontroller can be saved, which pins can be used for other purpose.

LCD Pin Description in 4bit mode

Pin No	Symbol	I/O	Description
1	Vss	-	Ground
2	Vcc		+5V
3	Vee		Contrast Control
4	RS	Input	Command/Data Register
5	R/W	Input	Read/Write Register
6	E	Input/Output	Enable
7	DB0	Input/Output	Not Used in 4-Bit Mode
8	DB1	Input/Output	Not Used in 4-Bit Mode
9	DB2	Input/Output	Not Used in 4-Bit Mode
10	DB3	Input/Output	Not Used in 4-Bit Mode
11	DB4	Input/Output	Data Bus in 4-Bit Mode
12	DB5	Input/Output	Data Bus in 4-Bit Mode
13	DB6	Input/Output	Data Bus in 4-Bit Mode
14	DB7	Input/Output	Data Bus in 4-Bit Mode
15	Vcc	-	For LCD Back Light
16	Vss	-	For LCD Back Light

Table 2: Showing LCD pin and their function

2.3.5 Step-Down Transformer

Transformers convert AC electricity from one voltage to another with little loss of power.

In this project, we used a step-down transformer so as to reduce AC voltage. Therefore, this power supply uses a step-down transformer to reduce the dangerously high voltages to safer low voltages.

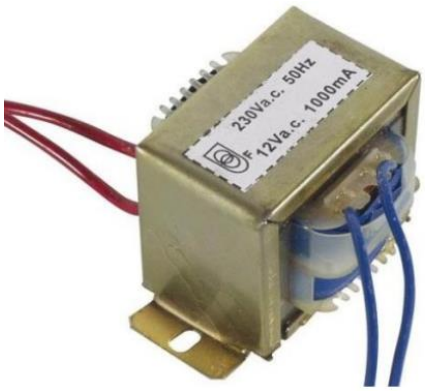


Figure 8: showing typical transformer

In this case, the step-down transformer reduces 230VAC to approximately 12VAC depending on the turn's ratio.

$TURNS\ RATIO = (Vp/Vs) = (Np/Ns) = (Is/Ip)$

Where; Vp is primary voltage

Vs is secondary voltage

Np is number of turns on the primary

Ns is number of turns on the secondary

Ip is primary current

Is is secondary current

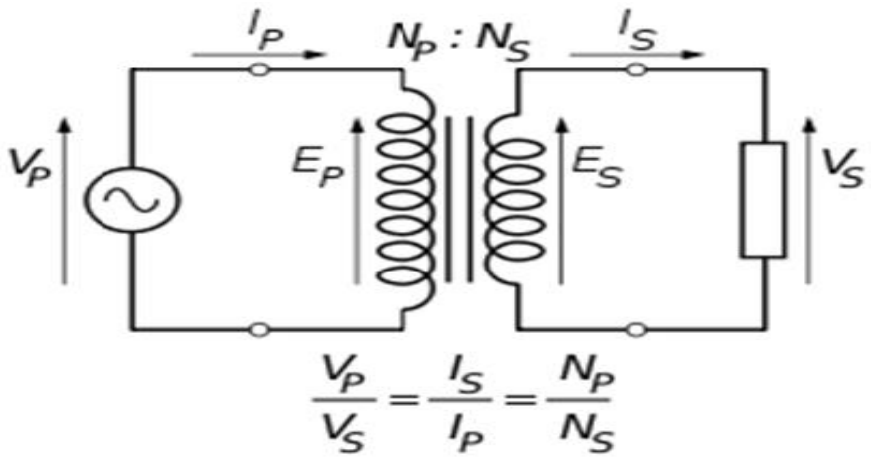


Figure 9: showing an ideal transformer

2.3.6 Voltage regulator LM7805

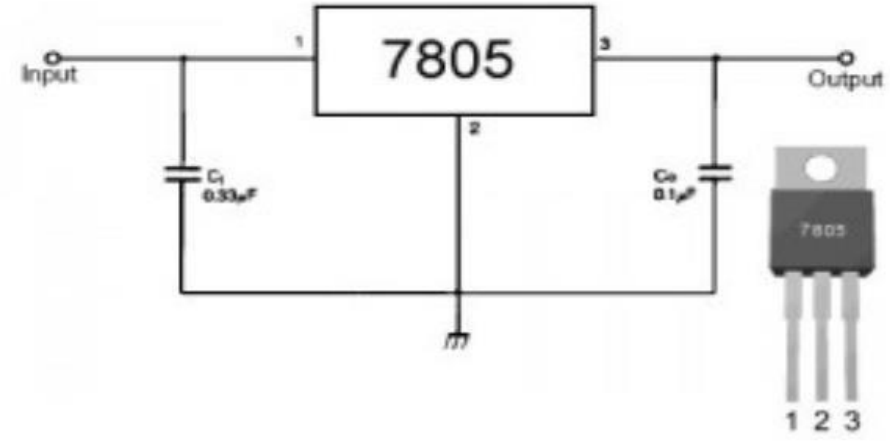


Figure 10: showing a voltage regulator LM7805

Features of voltage regulator LM7805

- Output current up to 1A
- Output voltage of 5V
- Thermal overload protection

- ❖ Short circuit protection
- ❖ Output transistor safe operating Area protection

Description

The LM7805/LM7805A is one of the series of three-terminal positive regulators that was used in this project and produces a fixed output voltage of 5V depending on the input voltage and rating. The LM7805 regulator employs an internal current limiting up to 1A, thermal shutdown and safe operating area protection, making it essentially indestructible.

Internal block diagram of LM7805

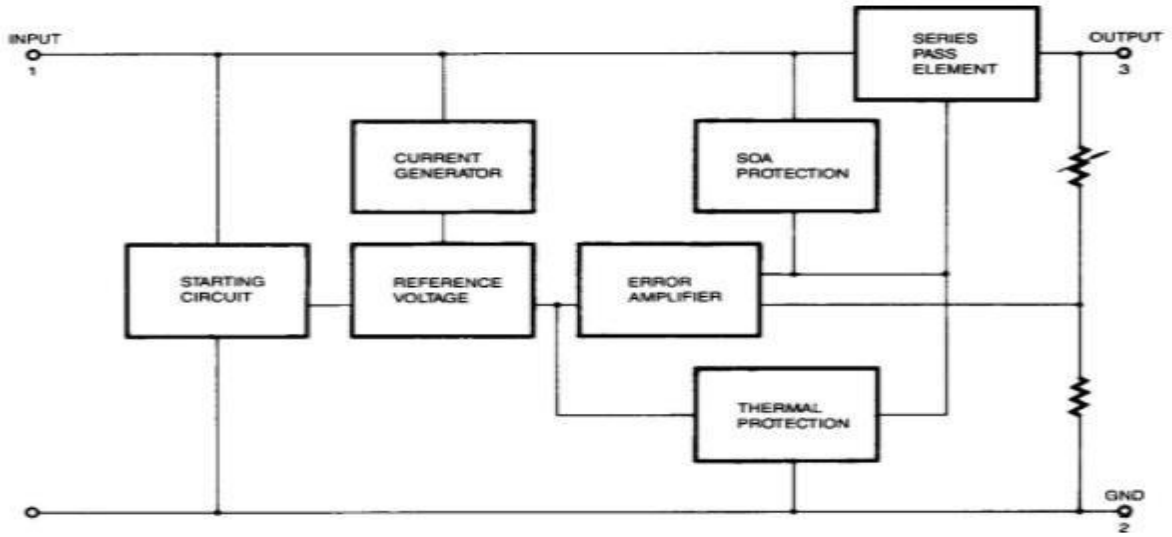


Figure 11: showing block diagram of a voltage regulator

2.3.7 Bridge Rectifier

The bridge rectifier converts alternating current (AC), which periodically reverses direction to direct current (DC), current that flows in only one direction.

The bridge rectifier is fed by the output of the transformer and converts AC to pulsating DC. In this project, the bridge rectifier was used because of its merits like good stability and full wave rectification, that is to say, in positive half cycle, only two diodes (1 set of parallel diodes conducts), in the negative half cycle, the remaining two diodes also conduct and they only conduct in forward bias direction.

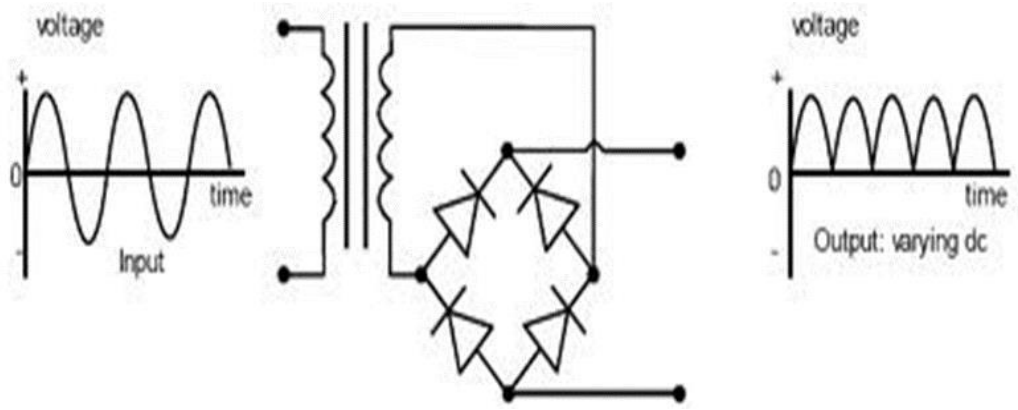


Figure 12: full wave rectification

2.3.8 Filters

Capacitive filter in this project is used to remove the ripples from the output of rectifier and smoothens the DC output. The DC output received from this filter is constant only if mains voltage and load is maintained constant.

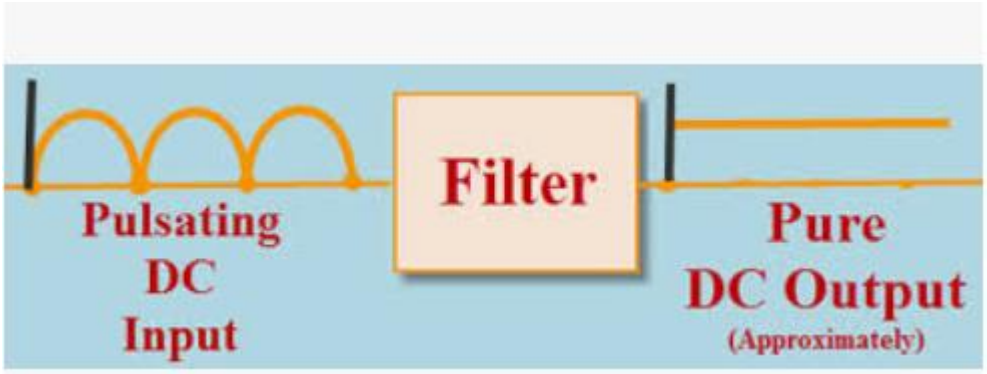


Figure 13: showing resultant full wave form

2.3.9 Relay

A relay is an electrically operated switch that uses an electromagnet to operate a switching mechanism mechanically. Relay is used in this project to control a circuit by low power signal (with complete electrical isolation between control and controlled circuit) or where several circuits must be controlled by one signal.

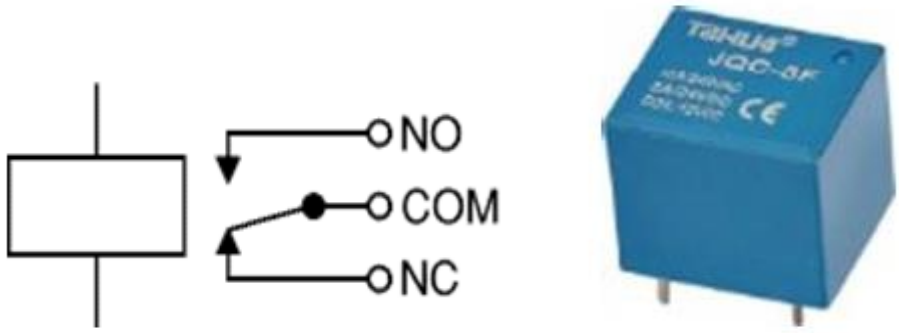


Figure 14: showing single pole relays

These relays allow one circuit to switch a second circuit which is completely separate from the first, i.e. a solar circuit uses a relay to switch a 230V AC mains circuit.

2.3.10 Light Emitting Diodes (LEDs)

LED is a semiconductor device made of silicon that emits photons as a byproduct when current passes through it. LEDs are based on semiconductor diode, when diode is forward biased (switched on), electrons recombine with the holes and energy is released in the form of light.

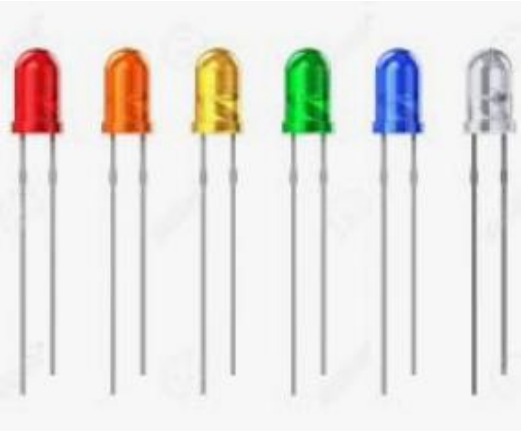


Figure 15: showing LEDs

2.3.11 Diodes (IN4007)

Diodes were used to convert AC to DC. These may be used as half wave rectifiers or full wave rectifier.

The IN4007 used in this project has the following characteristics

- Maximum forward current capacity
- Maximum reverse voltage capacity
- Maximum forward voltage capacity

Figure 16: showing IN4007 diode

2.3.12 Resistors

A resistor is a two terminal electronic component designed to oppose an electric current by producing a voltage drop between its terminals in proportion to the current, that is, in accordance with Ohm's law ; V = IR

Where; V is applied voltage across the terminals of a resistor

I is current flow through the resistor in direct proportion to the applied voltage

R is the Resistance

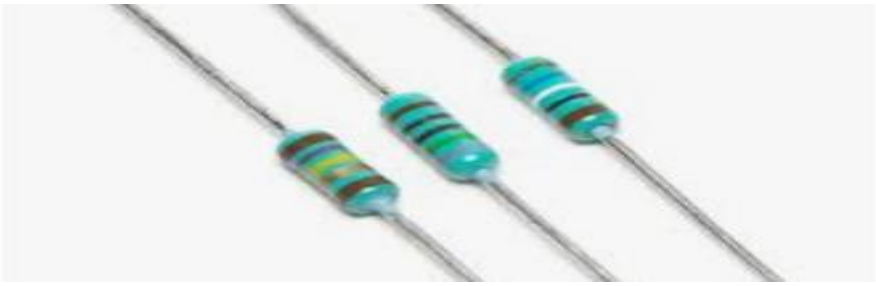


Figure 17: showing resistors

2.3.13 Capacitors

A capacitor or condenser is a passive electronic component consisting of a pair of conductors separated by a dielectric. When a voltage potential difference exists between the conductors, an electric field produces a mechanical force between the plates. The effect is greatest on wide, flat, parallel, narrowly separated conductors. Capacitors in filter networks are used for smoothening the output of power supplies and are also used in electronic circuits for blocking direct current while allowing alternating current to pass.

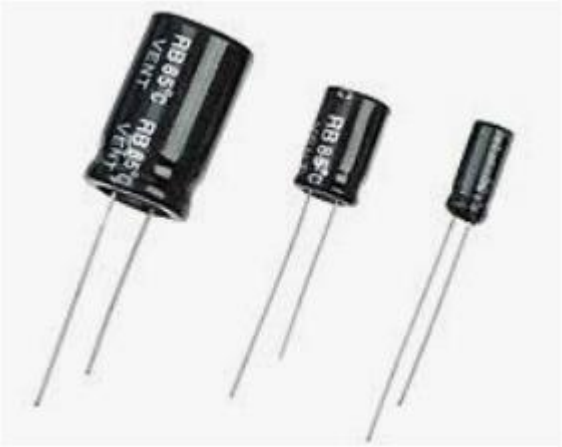


Figure 18: showing capacitor

2.4 OBSERVATIONS IN THE MOST RECENT PROJECT.

I have learnt that automatic phase selector has been done in the above elaborated ways and the most recent project of implementing using an 8051 microcontroller which use single pole switches to designate the respective sources. Some of the ATS were incorporated with voltage protection which switches off the source in case of voltage surges.

2.5 WEAKNESS OF RECENT PROJECTS.

The major challenge normally faced by technicians in their areas of operation is the manual changeover from one source of power to another. This changeover causes time delay since the process of change over has to be done by human hand which expose the operator to the risk of spark in the event of operation. There will be lost of production especially if manual changeover is install in an industry.

We know very well that this manual system is also affected by weather such as rain and snow, these event will not allow an operator to quickly move to where the device has been installed.

It has also been observed that most of the automatic tranfer switches in the market do have voltage protection which automatically disconnect the load from the source. This will also affect the production incase this system is installed in an industry.

Furthermore, in the recent project there was no provision of and overload protection to the equipment and the device itself. This may result in serious damage in an event of over load.

Also, with the available ATS, they could not allow an operation of two or more energy sources at the same time. This will affect production since most of machines will not be connected to the available source.

Therefore, all the above problems are solve by the design of automatic phase selector with voltage stabilizer and overload protector. This device will solve the following problems

- manual changeover,
- it will stabilize the voltage in case of voltage surge,
- protect the equipment against overload, and
- Connect two or more sources to power the load at the same time.

2.6 ADVANCEMENT OF THE PROJECT.

The improved system can be operated in two different modes that is to say; manual mode that is mostly used during installations of automatic phase selector. This is facilitated by the android application where a user sends commands to turn relays to the present sources, however, in this mode it will again requires a technician to switch on the available source by mean of a Bluetooth app so as to switch on the load. On the other hand, when the system is set to auto mode which is always done after installation, it can be put to operate on automatic mode due to the program code in the microcontroller.

It is well known that ATMEGA 328P microcontroller is an accurate device which only execute the program that has been download into it. This system will operate in an automatic mode as long as the program is running.

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

This chapter describes the details of the system's study, design, implementation, system testing and validation that were employed to accomplish the objectives intended for the project.

3.1 Research Design

The requirements were based on the useful literature that was obtained from the relevant sources. This system mainly focuses on ensuring continuous power supply in automated mode using ATEMGA 328P microcontroller and GSM.

i. Literature Review

The library books, e-books and the internet were some of the sources of relevant literature. These were used to obtain some of the requirements of the system. Relevant textbooks contained in the university library and the different data from the web pages, journals, research papers and newspapers obtained from the internet were also used.

ii. Observation

This method was used to critically study the kind of automatic power supply systems, commonly used in hospital and other institutions.

iii. Interviews

For the best results of this system, involvement of third parties like JTH electricians, technicians, and computer laboratory attendants to explain to me the detailed operation of their system and technical difficulties they face during operation of the system.

iv. Consultations

I wasn't so conversant with all it takes time to build such an improvement to the existing system, so a couple of consultations were from my fellow colleagues, academicians and engineers that were of help to the development of the system.

3.1.1 Data Interpretation and Analysis

This aimed at extracting the requirements from all the collected data and to give it meaning for designing the system utilizing both the qualitative and quantitative analysis techniques. The data collected was analyzed basing on the objectives of the study. Data was analyzed or studied for consistency basing on the concepts of the literature review and interpreted to provide requirements for designing an automatic phase selector with voltage stabilizer and overload protection.

3.1.2 Development of the Project Design.

In this chapter, the design process of an automatic phase selector with voltage stabilizer and overload protection using an ATMEGA 328P microcontroller was met and explained. The project focused on designing ATS with three different sources using an ATMEGA 328P for the entire project process.

The project was categorized into six major parts;

a) The power supply circuit.
b) Automatic phase selector circuit; which comprises of phase sensors, Bluetooth, ATMEGA 328P microcontroller, relay module and lcd.
c) Sets of relay modules to combine three sources into on source.
d) Voltage stabilizer circuit; which comprises of voltage sensor, stepdown transformer (240/25Vac) and autotransformer (0/210/240/276Vac).
e) Overload protection circuit; which comprises of current sensor, Bluetooth, GSM (SIM900) and lcd.
f) Loads connected to relay module.

Different sections of the project design were designed separately and then combined to produce the final complete project. The designed circuits were then simulated using proteus 8 professional software where it was to be tested and analyzed to verify if it meets the desired requirements of the project system.

This embedded project prototype was tested on a bread board and then transferred to the Printed circuit board (PCB) where physical measurements will be made.

Block Diagram of Automatic Phase Selector with Voltage Stabilizer and Overload Protection Using Arduino

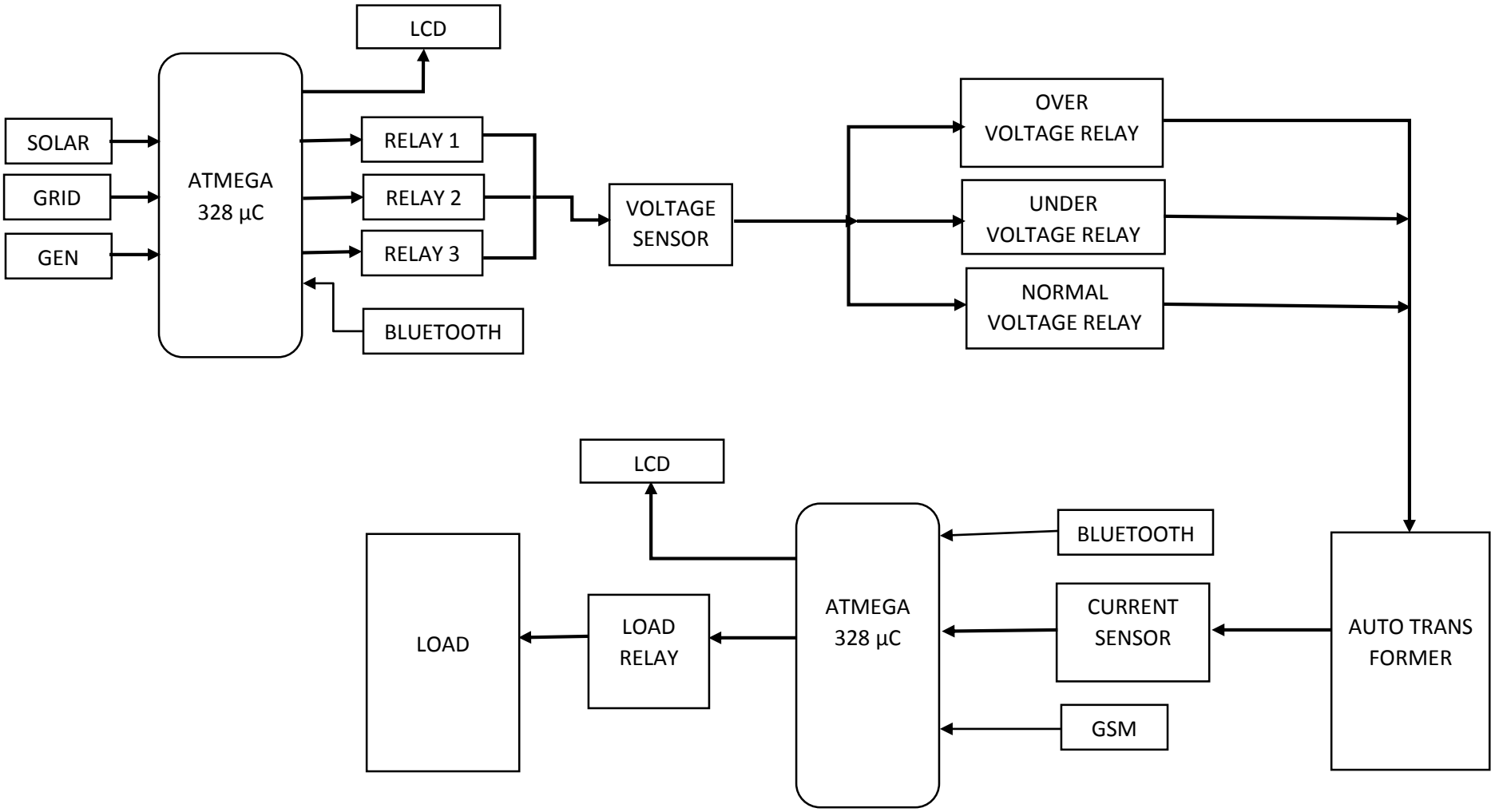


Figure 19: Block diagram of Automatic phase selector and voltage-Overload protection

Automatic Phase Selector Circuit Daigram

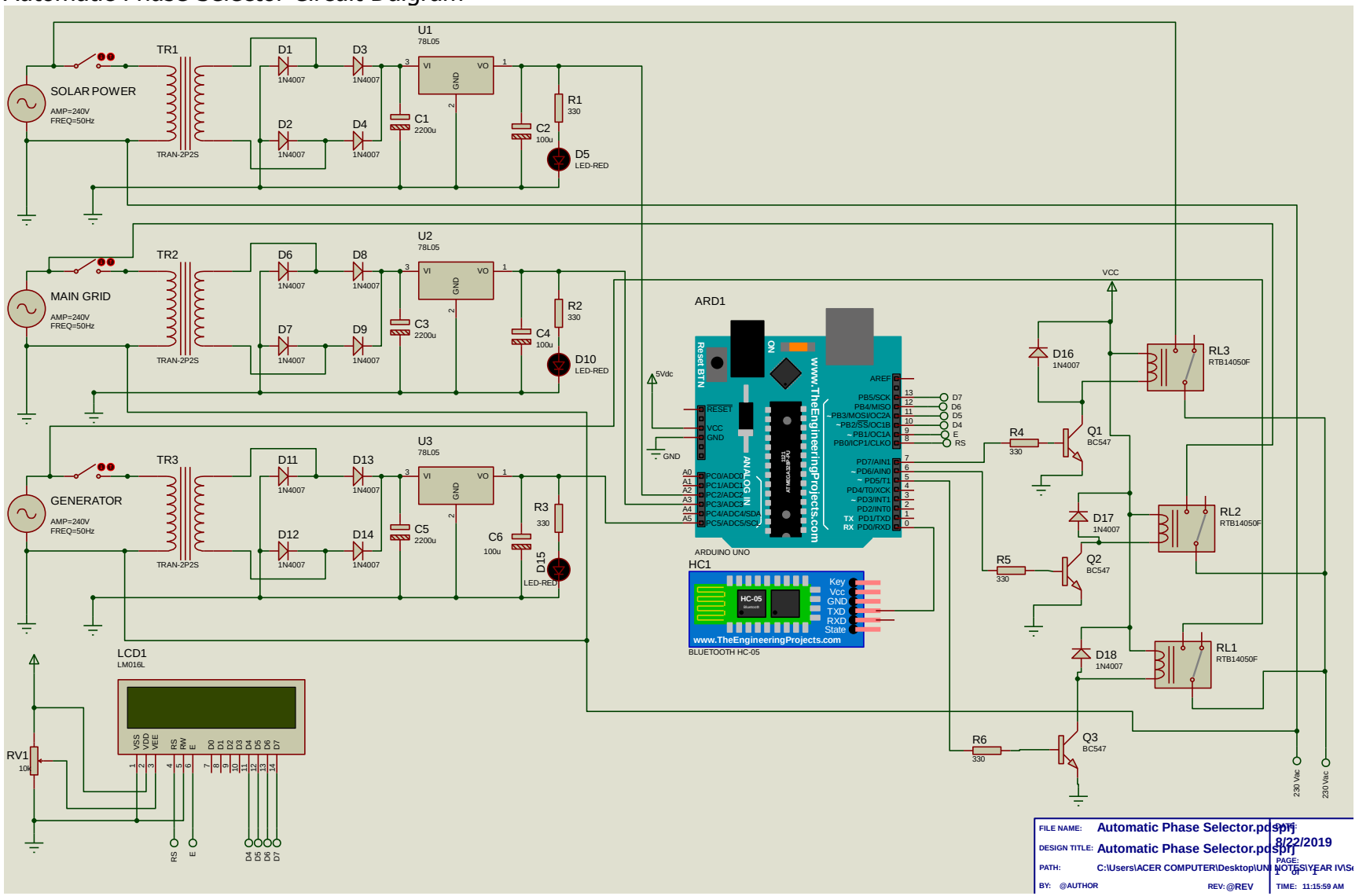


Figure 20: Circuit for Automatic Phase Selector

Principle of operation

Three power supplies of 5Vdc each are used as the voltage sensor to the microcontroller. The sequence of operation is such that the prime power source is solar second is main grid, third is generator or genset. When all the power sources are available, the system was program in such a way that only solar power will supply the load while the other sources will be isolated from the load by the microcontroller due to the program in it. If solar power is lost, then main grid line will supply the load isolating generator from the load. This process will continue until it reach generator. When generator is on, it indicate that all the other sources are unavailable.

Incase solar come when either of main grid or generator is on, then the microcontroller has to switch the load to solar and isolate the other sources.

Sequence of operation;

In case the load has increase such that solar cannot supply it, a Bluetooth device with an android app is used to bring on board all the sources depending on the load demand.

Automatic Voltage stablizer Circuit Daigram

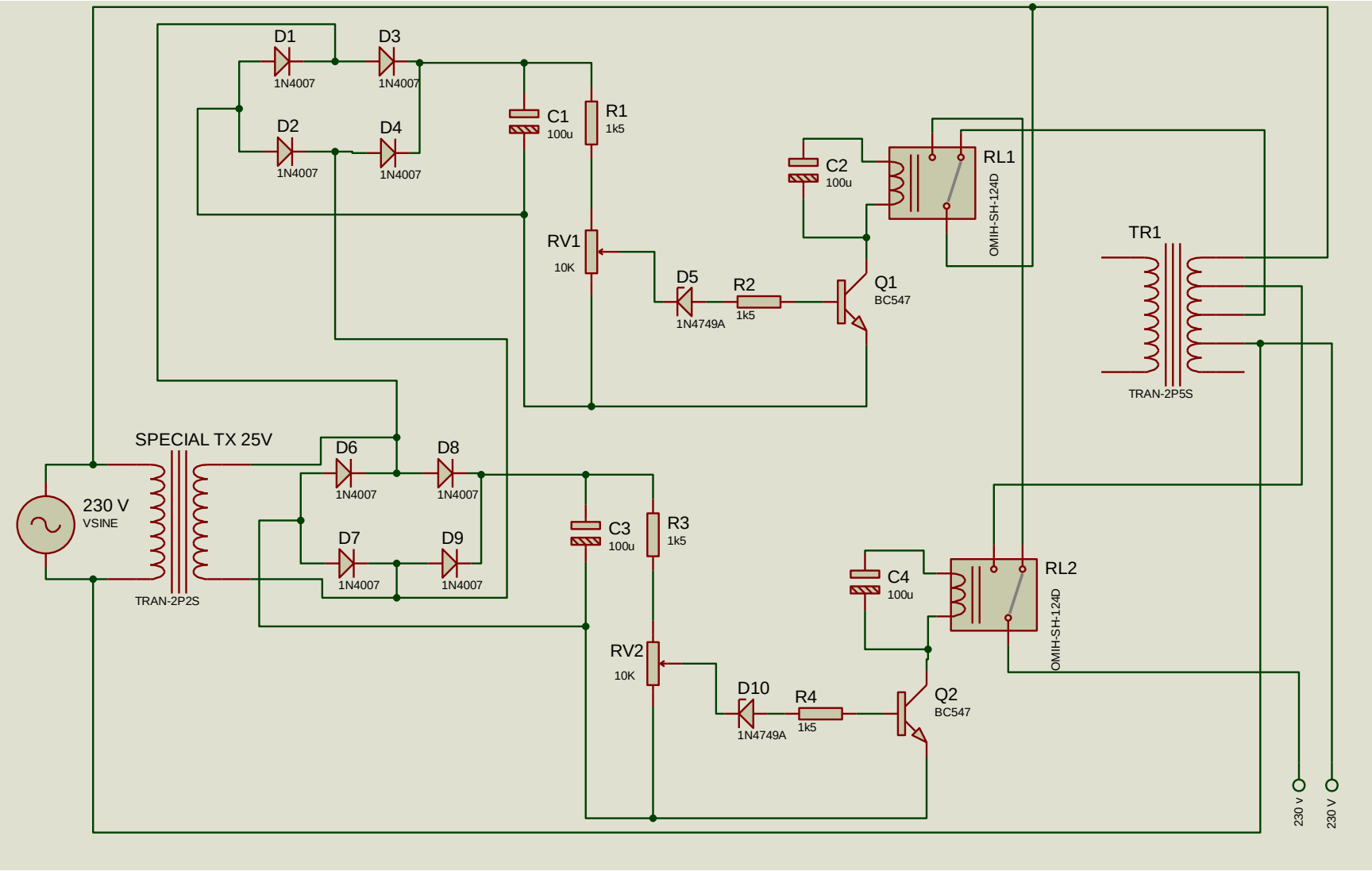


Figure 21: Circuit diagram of automatic voltage stabilizer

Principle of operation

The input voltage from different sources was passed through a voltage sensor which monitor the voltage parameters and stabilizes the output voltage by switching between the relays that are connected to the autotransformer of many taps. The transformer taps are of a readings 0V, 220V, 240V and 274V.

When the input voltage from the sources is less than the normal voltage say 190V, the sensor will stabilize the voltage by adding an extra voltage such that such that the output is maintain at stabilize level of 220V.

When the output of the different sources is more than the normal voltage say 260V to 270V, the sensor will switch to 220V of the auto transformer such that the output voltage is still normal to the load.

This stabilizing circuit enable the load to be powered no matter what the input voltage may be. Therefore, instead of switching off the source in case of voltage fluctuation, the stabilizing circuit with an auto-transformer will stabilize the voltage to the required level hence keeping the load connected power sources under normal condition.

Automatic Overload protector Circuit Daigram

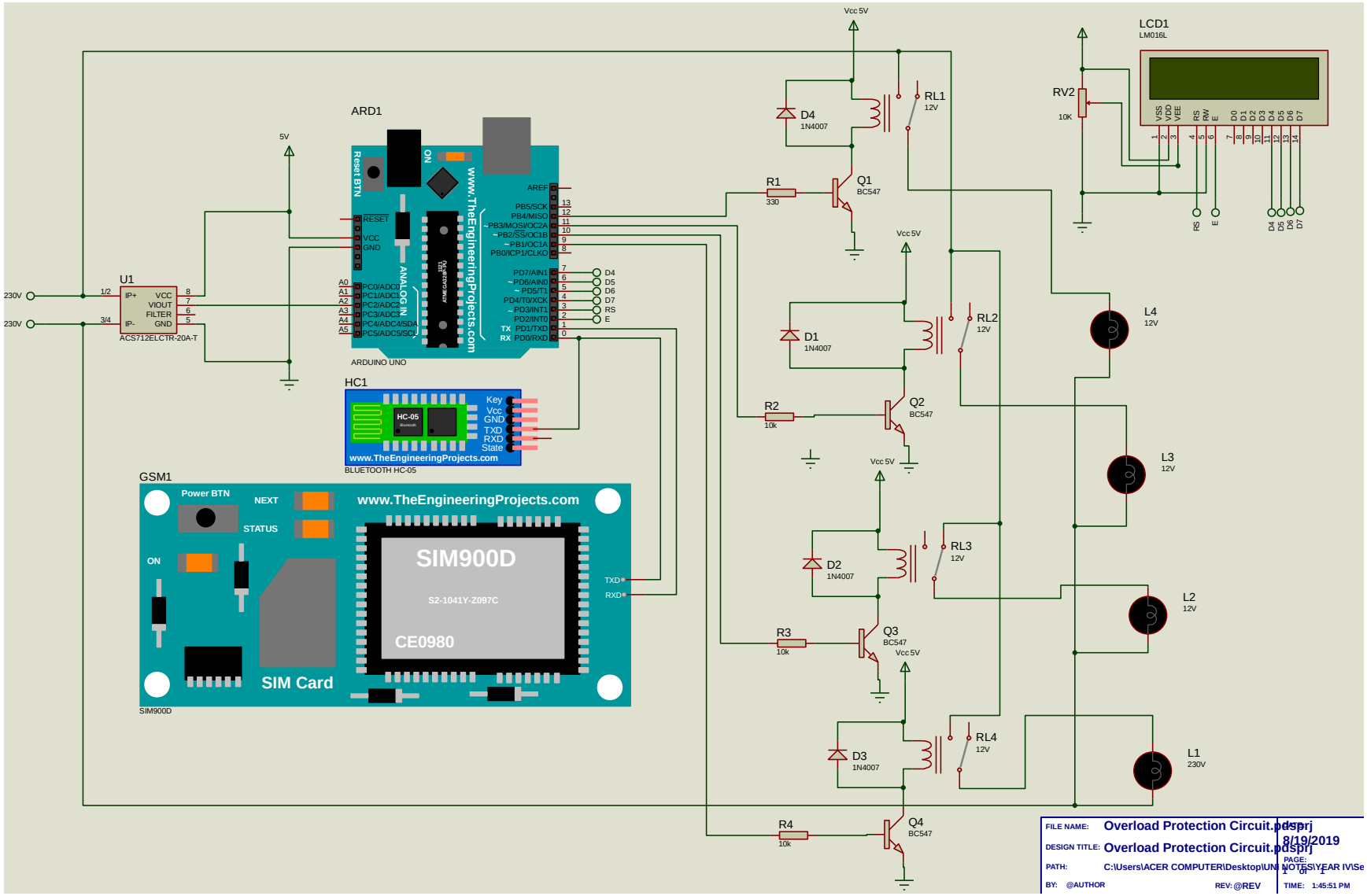


Figure 22: Circuit diagram for an automatic overload protector

Principle of operation

The stabilize power source 220Vac, is then connected to the load through an overload protection system. This system measured the current drawn by the load and determine whether the system is overloaded or not.

The loads are switch on using an android app which operate by mean of Bluetooth. This system does not need the operator to be there in person to switch on the load, but to be at some distance away from the load source such that the Bluetooth will be within the range of connectivity. This avoid the operator to be expose to the switch surges and spark which may cause injury to the personnel.

When the operator is within the range, the mobile device is connected to the Bluetooth device in the circuitry. Once the connectivity is established, the operator can switch on the loads while the current sensor measure the amount of current drawn by the load.

Before turning on any load, the system initially draw a current of 0.04 amps, this amperes was consider in the design of the system. When load 1 & 2 were switch on, the current sensors record the current valve and was read on the lcd, at the same time a green led was turn on indicating that the system is normal. When load-3 is on, the system is at its maximum capacity and this was indicated by turning on the blue led while green led is was switch off. At this point, the current through the load is the one the system can handle without any problem.

When the fourth load was switch on, the system is overloaded, blue led was turn off and the red led is the switch on indicating that the system is under overload condition. The system will then isolate the fourth load automatically and activate the GSM to send the message "circuit overloaded" to the operator. The operator will response the message "all-loads-off" and all the loads will be turn off. After the loads are turn off, the operator can send another message "normal" so as to return the system to be control again by Bluetooth device.

3.2 Power Supply Circuit

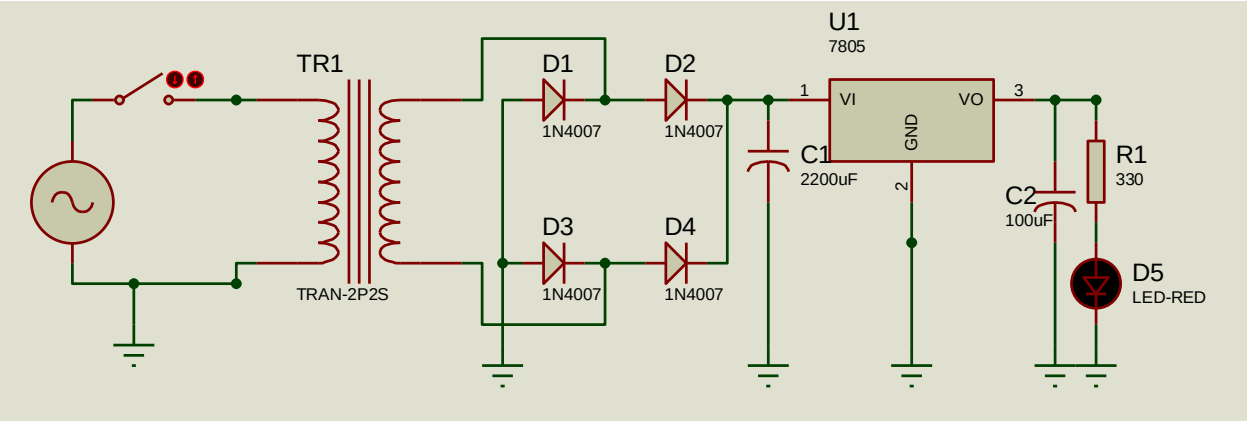


Figure 23: Regulated power supply circuit

3.2.1 Transformer

This system uses a step down transformer which converts 230V AC to 12V AC with less power loss depending on the $turns$ ratio.

The input ac varies in the event of input ac at 230V AC section varies from 160V to 270V in the ratio of the transformer primary voltage Vp to Secondary Voltage, Vs governed by formula; $(Vp/Vs) = (Np/Ns)$

Thus, if the transformer delivers 12V at 220V input, it will give;

At 160V; $(160/Vs) = (220/12)$

$Vs = (160 \times 12)/220 = 8.72V$

A 270V; $Vs = (270 \times 12)/220 = 14.72V$

Therefore, a step down between 8V to 15V was sufficient since current limitation was handled by the regulator.

3.2.2 Bridge Rectifier

Next stage was the AC/DC conversion process that involved inverting the negative cycles of the AC input. The process required the use of a full wave rectifier diode bridge and required specific bridge rectifier that would be able to handle a peak voltage of 20V and 2A. The 2W04G rectifier was used for simulation process.

At 220V; $input\ voltage\ Vs = 12V$

$Output\ dc\ voltage = 0.9Vs = 0.9 \times 12 = 10.8V$

The bridge rectifier delivers pulsating DC

$Ripple\ factor$ = √{$(Vrms/Vdc)$^2 − 1}=√{(12/10.8)^2 −1}^0.5=0.66

$Efficiency = Pdc/Prms$×100% = (10.8/12)×100% = 90%

3.2.3 Filter Capacitor

The capacitance value was needed to minimize the voltage ripple. The output of the transformer was 12V AC at 50Hz. The required minimum capacitor value can was calculated from the formula;

$C = I_{out}/(2\times f\times RF\times V_{in})$

$Iout = Imax = 2A$, since it is the maximum forward rectified/output current of the of the bridge rectifier (refer to data sheets).

C= 1/(2×50×0.66×12)≅1000μF

Therefore, an electrolytic capacitor of about 470$\mu F\ to$ 1000μF to filter the output DC from the bridge rectifier.

3.2.4 Voltage Regulator LM7805/LM7805A

Since the filtered DC being unregulated, IC LM7805 was used in simulation process to get 5V DC at its pin number 3 irrespective of input DC varying for 8V to 15V and the regulated output from the LM7805 remains at 5V constant.

The regulated 5V DC was further filtered by a small electrolytic capacitor of 10μF for any noise generated by the circuit.

3.2.5 Resistor

One LED was connected to the 5V point in series with a current limiting resistor of 330Ω to the ground i.e., negative voltage to indicate 5V power supply availability.

A 330Ω was connected in series to limit the flow of electric current through the LED by producing a voltage drop between its terminals in accordance to the current since, the LED has a forward voltage of 2.2V and full drive current of 10mA.

From ohm's law; I=V/R=5/330=15mA

Therefore, a 330Ω was sufficient to produce a full drive current of 15mA required by the LED.

3.3 Logic design

The project basically supplies continuous power to a load in automated mode through one of the three sources of supply that are: solar, main grid, and generator when any one of them is available.

Three power supplies connected to three different socket outlets are used for three respective sources. The output of these three power supplies are connected to the Atmega 328P microcontroller and they act as sensors to the analog input to the microcontroller. When a socket outlet is turn on, a 240Vac is step down to 14Vac which is rectified and regulated to 5Vdc. This regulated voltage act as an input to the microcontroller. Once there is an input of 5Vdc to the analog terminal of the microcontroller, a relay switch is turn on to supply the load with an AC voltage. Lamps rate 100W were used as a load for demonstration purpose which draws power from main.

The system was program in such a way that, when all the sources are available, solar power take the lead and supply the load. When solar fails to supply power, next source available is automatically used say main grid and so on. But If solar come back, it will take the lead of all the other sources.

In case the load is more the capacity of one source, a Bluetooth is used to bring one or more sources on board so as to meet the load demand.

The output of the ATS is then connected to the voltage regulation circuit which has an in build voltage sensor to detect under or overvoltage. In case of any variation in the supply, the sensor will activate the responsible relay to select an appropriate tap on the auto-transformer thus maintaining a constant output voltage.

From the voltage regulating circuit, a load is connected through an overload protection system. This will isolate the load from the supply in case of overload and send message to the engineer/ technician so as to control the load by mean of GSM messages.

Flow chart For Automatic phase Selector.

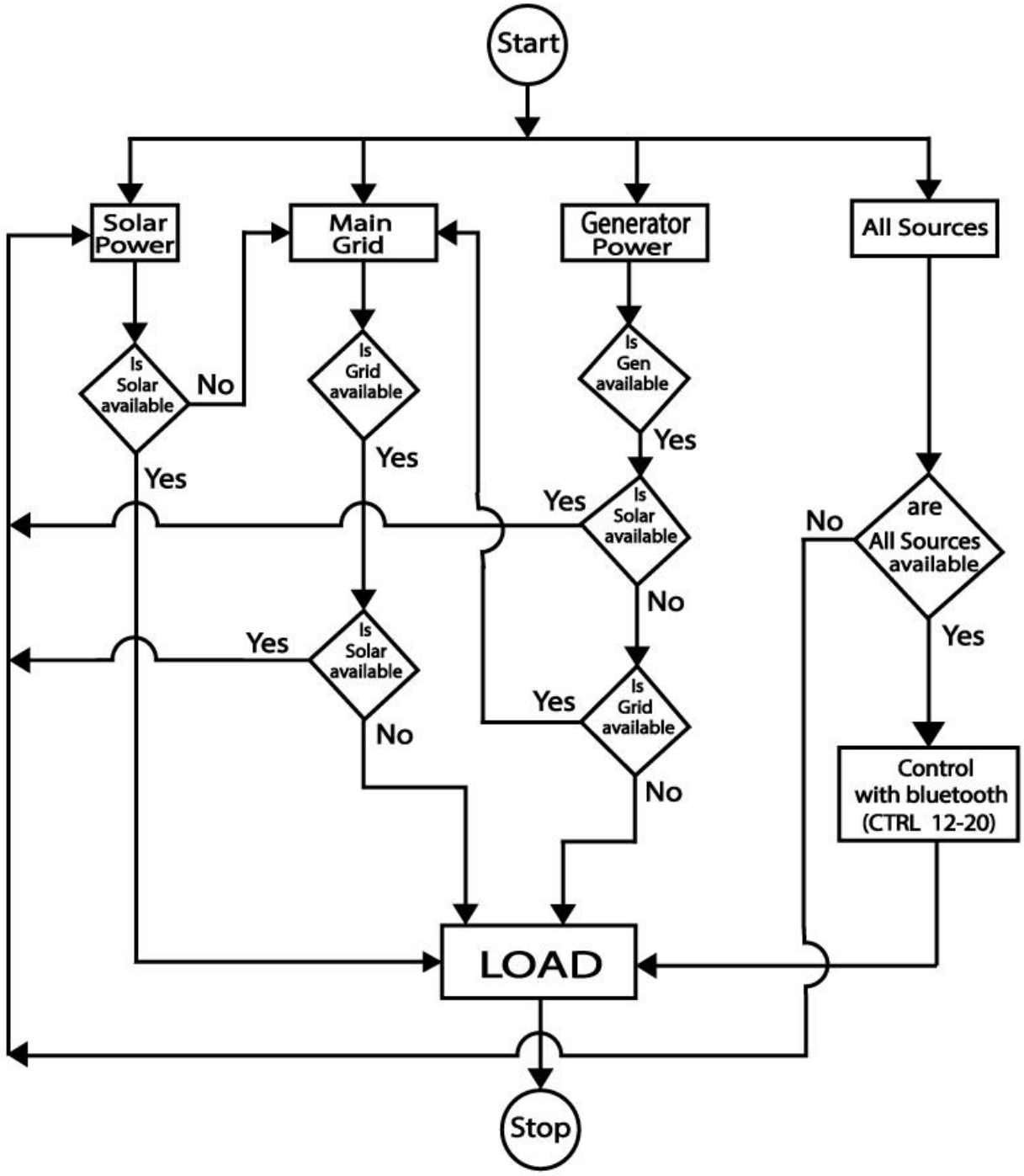


Figure 24: Flow chart for an automatic phase selector

Flow chart For Automatic voltage stabilizer.

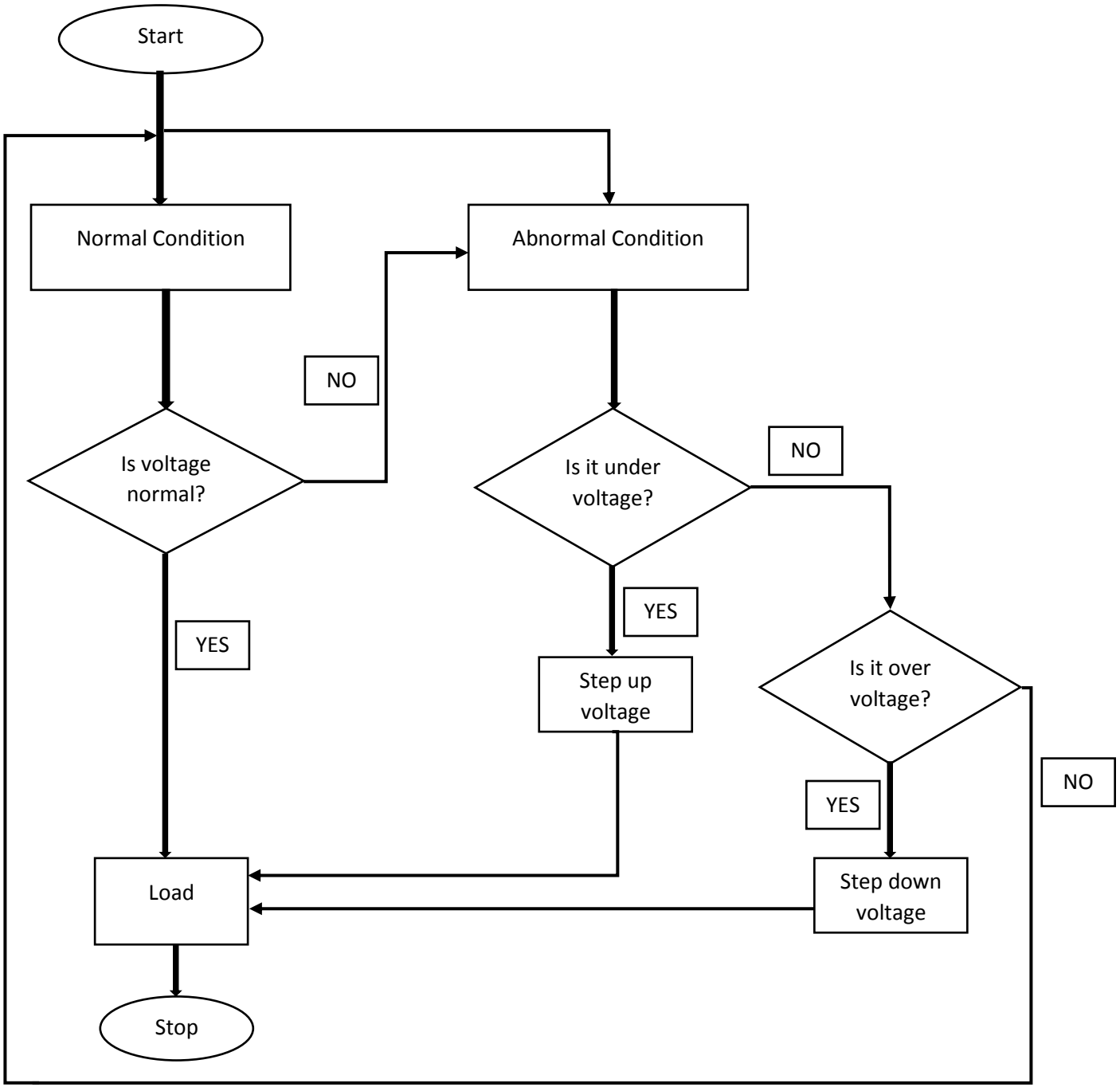


Figure 25: Flow chart For Automatic voltage stabilizer.

Flow chart For Automatic overload protector.

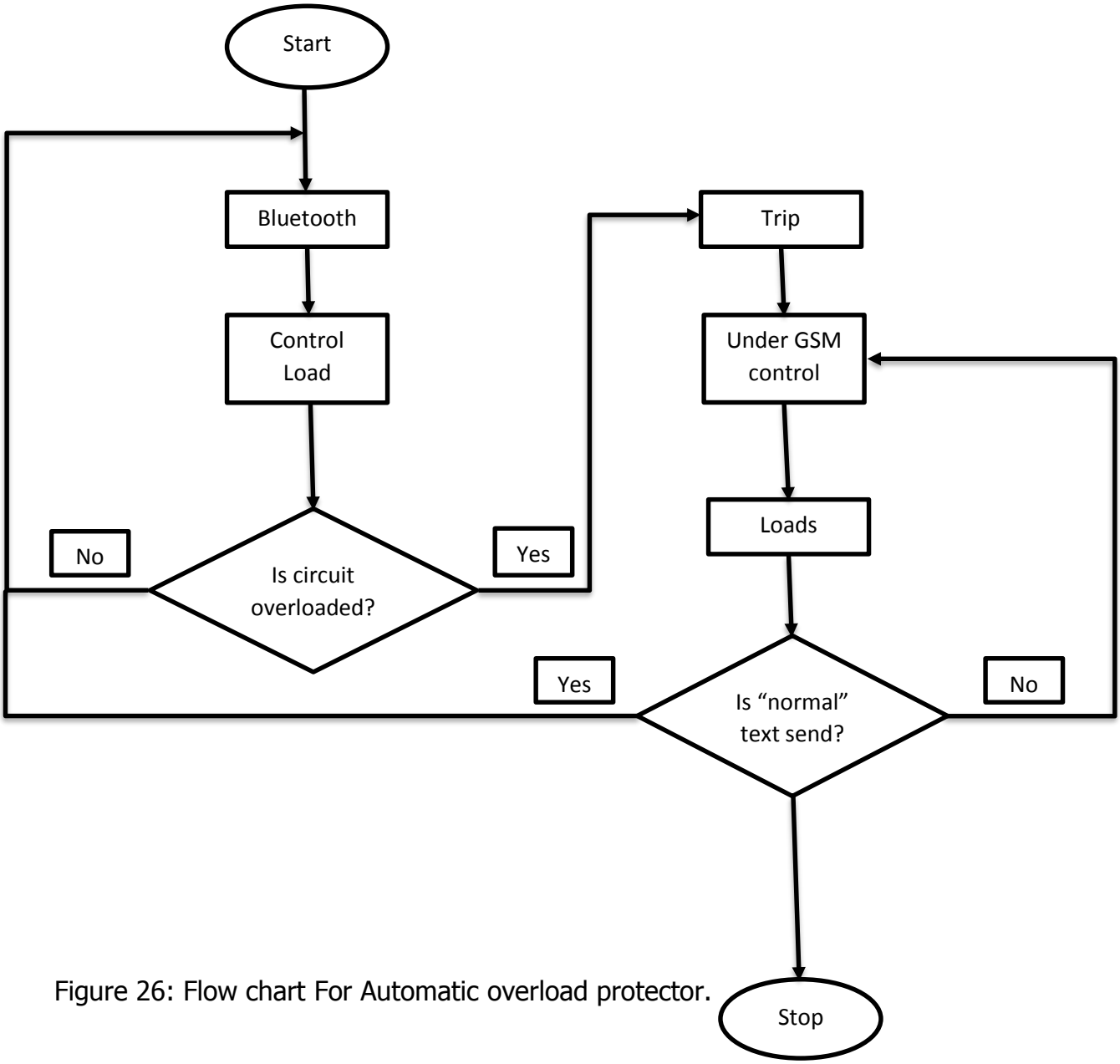


Figure 26: Flow chart For Automatic overload protector.

CHAPTER FOUR
TESTING, RESULTS AND DISCUSSION

4.1 HARDWARE TESTING

4.1.1 Continuity Test

Continuity test was carried out to check if there was current flow in the project circuitry and was aimed at finding circuit open paths in the circuitry after completing soldering and configuration. A multimeter was used to perform continuity test on the electric circuit by measuring electric current flow.

Procedures

I. A multimeter was kept in buzzer mode.
II. Then it is connected to the ground terminal of the multimeter then to the ground.
III. Finally both terminals are connected across the path that needs to be checked and there is continuity in the path, a beep sound would be produced by the multimeter.

4.1.2 Power on Test

Power on test was performed to check whether the voltage at different terminals is according to the requirements or not. A multimeter was switched to voltage mode, note that, this test was performed without the microcontroller to avoid damage to the microcontroller due to any excessive voltages.

The output of the transformer was checked and measured and the required 12V AC voltage was obtained, which was then applied to the power supply circuit and the terminal voltages of 12.00V and 0.00V, DC voltage at positive, negative terminals. AC1 and AC2 of the bridge rectifier were measured respectively. This voltage was then applied to the 2200uF capacitor, and the voltage at the anode terminal and cathode of the capacitor was 12.00V and 0.00V respectively. Then this voltage was applied to the

voltage regulator LM7805, i.e., an input of 12VDC and output of 4.96VDC were obtained according to the requirements.

The 5V DC voltage was then given to the 7th pin and ground to 8th pin of the microcontroller.

4.2 RESULTS

4.2.1 DC power supply

Output of the bridge rectifier	Input into the voltage regulator	Output of voltage regulator	Input into the microcontroller (Vcc)
11.7Vdc	10.2Vdc	4.96Vdc	4.96Vdc

Table 3: showing results of DC power supply circuit and microcontroller

4.2.2 Automatic Phasor Selector Controlled by Automatic Mode

Power source	Input of the power source (VAC)	Switch status	LCD Display
Solar	220V	ON	SOLAR ON
Solar	220V	OFF	SOLAR OFF
grid	220V	ON	GRID ON
grid	220V	OFF	GRID OFF
Generator	220V	ON	GENERATOR ON
Generator	220V	OFF	GENERATOR OFF
All source	220V	ON	CONTROL BY BLUETOOTH (CTRL WITH 12-20)

Table 4: showing Sources status when control by automatic mode.

4.2.3 Automatic Phasor Selector Controlled by Android (Bluetooth) Mode

Power source	Input of the power source (VAC)	Input to the app	Switch status	LCD Display
Solar	220V	12	ON	SOLAR ON
	220V	13	OFF	SOLAR OFF
Grid	220V	14	ON	GRID ON
	220V	15	OFF	GRID OFF
Generator	220V	16	ON	GENERATOR ON
	220V	17	OFF	GENERATOR OFF
All sources	220V	18	ON	ALL SOURCES
	220V	19	OFF	NO POWER
Automatic controlled	220V	20	ON	ANY SOURCE AVAILABLE

Table 5: showing Sources status when control by Bluetooth

4.2.4 Automatic Voltage Stabilizer

Input Voltages (V)	Relays	Relay Status	Output Voltage (V)
190	Relay 1	ON	220
260	Relay 2	ON	220

Table 6: Showing status of voltage stabilizer.

4.2.5 Automatic Overload Protector Controlled Using Bluetooth

Loads	Input of the power source (VAC)	Input to the app	Switch status	LCD Display
All Load OFF	220V	Nothing	OFF	CTRL WITH 1-10
Load-1	220V	1	ON	LOAD-1 ON
	220V	2	OFF	LOAD-1 OFF
Load-2	220V	3	ON	LOAD-2 ON
	220V	4	OFF	LOAD-2 OFF
Load-3	220V	5	ON	LOAD-3 ON
	220V	6	OFF	LOAD-3 OFF
Load-4	220V	7	ON	LOAD-4 ON
	220V	8	OFF	LOAD-4 OFF
ALL LOADS ON	220v	9	ON	GSM CONTROL (circuit overloaded)

Table 7: Showing status of loads been controlled by Bluetooth

4.2.6 Automatic Overload Protector Controlled Using GSM

Loads	Input of the power source (VAC)	GSM Messages	Switch status	LCD Display
Load-1	220V	Load1_on	ON	LOAD-1 ON
	220V	Load1_off	OFF	LOAD-1 OFF
Load-2	220V	Load2_on	ON	LOAD-2 ON
	220V	Load2_off	OFF	LOAD-2 OFF
Load-3	220V	Load3_on	ON	LOAD-3 ON
	220V	Load3_off	OFF	LOAD-3 OFF
Load-4	220V	Load4_on	ON	LOAD-4 ON

	220V	Load4_off	OFF	LOAD-4 OFF
All loads on	220v	All_loads_on	ON	GSM CONTROL (OVERLOAD STATUS)
All loads off	220V	All_loads_off	OFF	ALL-LOADS-OFF
Set to Bluetooth control	220V	normal	OFF	CTRL WITH 1-10

Table 8: showing loads status Controlled by GSM

4.3 Discussion

This project prototype was implemented, tested and integrated before testing the entire system. The input from the three sources was given to the microcontroller and the output of the microcontroller is given to the relay which maintains continuous power supply to the load through the voltage stabilizer.

Finally, the system status of the available sources and load characteristic are displayed on the LCD, the following modes of operation were obtained as shown by figures below.

Figure 27:: showing snapshot of the entire project system

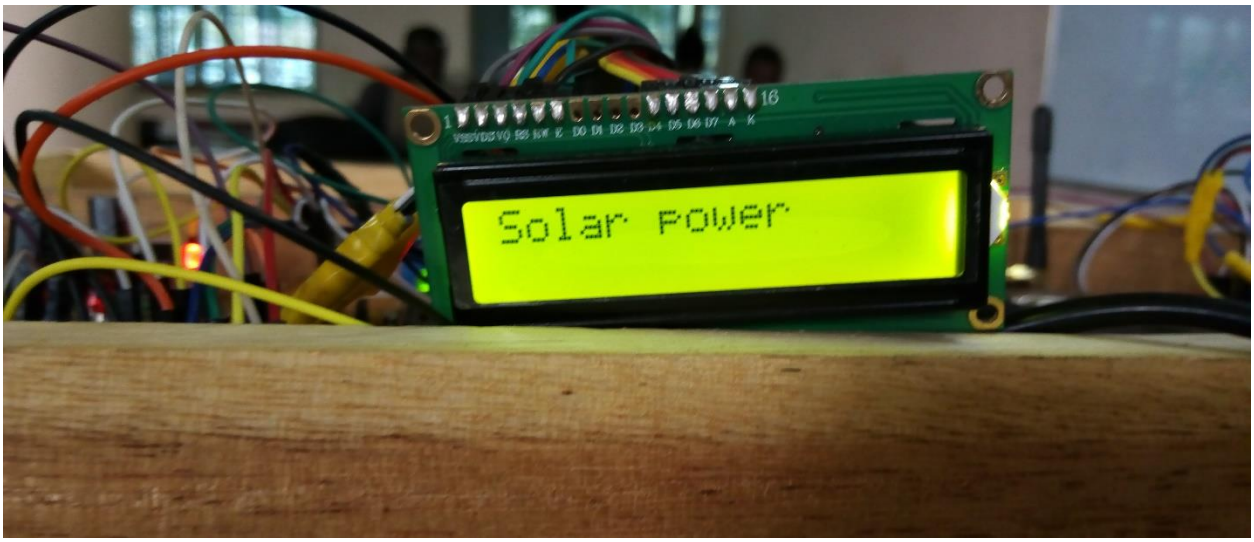


Figure 28: showing snapshot of the automatic phase selector powered by solar power

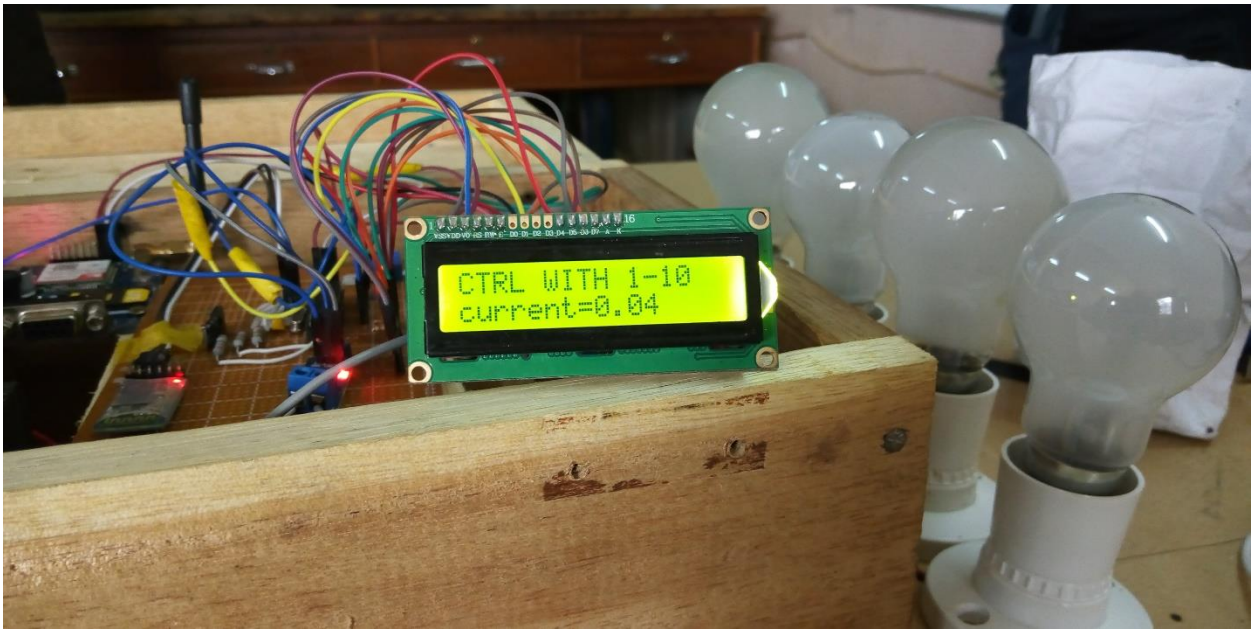


Figure 29: showing snapshot of the overload system using an app (CTRL WITH 1-10)

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.0 Conclusions

This project of **AN ANDROID BASE AUTOMATIC PHASE SELECTOR AND OVERLOAD PROTECTOR USING ATMEGA 328P MICROCONTROLLER AND GSM** is used to handle power supply from solar, grid and generator most effectively and to stabilize voltage to the load with an addition of overload protection.

The outline of the project is the selection of supply from solar, main grid and generator automatically using microcontroller and android concept. This project also protect the load against voltage variation and overload. This protection schemes are not found in the current developed systems, hence make APS and overload protector superior than all of them.

The significance of this project lies in the various and wide places of applications such as; power generation plant, schools, hospitals, and most especially manufacturing industries and mining industries where continuous supply of power is important.

5.1 RECOMMENDATIONS

This project can be integrated with power grid synchronization failure system which enable to sense frequency or voltage beyond acceptable range, since this project consumes power from different sources which may vary in either frequency or voltage.

This project can be further be modified or enhanced using a IOT, other sources like biomass power supply considering their cost can also be integrated into the system to make the fourth source.

The system can also be modified by developing a SCADA base software for system monitoring.

CHAPTER SIX

REFERENCES

1) Amanyire Ronald[1], Kaumba Muteba[2], Abdurrahman S Hassan[3] and Adabara I[4] (2017); Indo-Iranian Journal of Scientific Research (IIJSR). Volume 1, Issue 1, Pages 123-131.
2) Amol Prabhakar Patil (2017), "Auto power supply from different sources". International Journal of Research in Electrical Engineering. Volume 04: Issue 02: pp 160-162.
3) Mr.Shahaji Dudhate, Mr.Amol Attargekar, Mr.Dhanaji Desai, Prof. Mrs.Aditi Patil (2016), "Power Supply Control from Different Sources". International Journal of Scientific & Engineering Research, Volume 7, Issue 1, pp 484-487
4) Mr. Shahayi Dudhate, Mr. Amol Attargeka, Mr. Dhanaji Desai, Prof. Mrs. Aditi Patel (2016), "power supply control from different sources". International journal of scientific & Engineering Research, Volume 7, issue 1. PP 484-487
5) Charlie Hume (2015), "Transfer switch 101: an introductory guide to picking the right transfer switch for your environment, White paper WP140001EN." Retrieved from: www.eaton.com/ecm/group/public/@pub/@electrical/documents/.../wp140001en.pdf.
6) Lanre Olatomiwa, Rasheed Olufadi (2014), "automatic transfer switch (ATS) with an over-voltage protection". Journal of Multidisciplinary Engineering Science and Technology (JMEST) Vol. 1 Issue 4, pp 190-196.
7) Lanre Olatomiwa, R. O. (2014, November). Design and development of a low cost automatic transfer switch (ATS) with an over-voltage protection. Journal of Multidisciplinary Engineering Science and Technology, Vol. 1(Issue 4), 190.
8) Shanmukha Nagaraj and Ramesh S (2013), "Programmable Logic Controlled Circuits." International Journal of Research in Engineering and Technology Vol.1, issue 2, July 2013; PP 111-116.

9) L.S. Ezema, B.U. Peter, O.O. Harris (2012), "Design of Automatic Change Over Switch with Generator Control Mechanism." Electrical Power and Electronic Development Department, Projects Development Institute (PRODA), Enugu: Natural and Applied Science, Vol.3, No.3. November, 2012. PP 125 – 130.
10) Mbaocha C. (2012), "Smart Phase Changeover Switch using AT89C52 Microcontroller." Journal of Electrical and Electronics Engineering vol.1; Issue 3: PP 31-44.
11) Robert Dowuona-Owoo (2008), "Design and construction of three phase automatic transfer switch." A thesis presented at regent university college of science and technology Ghana. PP100-120.

APPENDICES

APPENDIX A: SOURCE CODE.

APS Source code

```
#include <LiquidCrystal.h> //LCD Library
LiquidCrystal LCD( 9, 10,11,12, 13, 14);

int val=0;
int solarPin=A2;             //set solar pin to A0
int gridPin=A3;            //set grid pin to A2
int genPin=A5;             //set gen pin to A3

int solarRelay=8;       //set solar relay at pin 10
int gridRelay=6;       //set grid relay at pin 8
int genRelay=5;       //set gen relay at pin 7

float solarValue;       //declearing solar value
float gridValue;      //declearing grid value
float genValue;      //declearing generator value
float voltage=1015; //value read from analog pin

void setup()
{
   LCD.begin(16, 2);
   LCD.setCursor(0,0);
   LCD.print("PHASE SELECTOR");
   LCD.setCursor(0,2);
   LCD.print("SWITCH");
   delay(5000);
```

```
   LCD.clear();

  Serial.begin(9600);          //start serial port
  pinMode(solarPin,INPUT);    //solar pin set as an input
  pinMode(gridPin,INPUT);   //grid pin set as an input
  pinMode(genPin,INPUT);   //gen pin set as an input

  pinMode(solarRelay,OUTPUT);    //solar relay set as an output
  pinMode(gridRelay,OUTPUT);   //grid relay set as an output
  pinMode(genRelay,OUTPUT);   //gen relay set as an output

  digitalWrite(solarRelay,HIGH);
  digitalWrite(gridRelay,HIGH);
  digitalWrite(genRelay,HIGH);
  }

void loop()
{
automatic_mode();
  }
void automatic_mode()
{
   solarValue=analogRead(solarPin);     //analog read voltage input at pin A0
   gridValue=analogRead(gridPin);     //analog read voltage input at pin A2
   genValue=analogRead(genPin);      //analog read voltage input at pin A3
   Serial.print("genValue= ");
   Serial.println(genValue);
```

```
 Serial.println();


  if(solarValue<voltage && gridValue<voltage && genValue<voltage)
 {
  LCD.clear();
  LCD.setCursor(0,0);//initial cursor position
  LCD.print("No Power");

  digitalWrite(solarRelay,HIGH);   //solar relay pin turn off
  digitalWrite(gridRelay,HIGH);  //grid relay pin turn off
  digitalWrite(genRelay,HIGH);  //gen relay pin turn off
  delay(200);
 }
 if(solarValue>=voltage && gridValue<voltage && genValue<voltage)
{
     LCD.clear();
   LCD.setCursor(0,0);//initial cursor position
  LCD.print("Solar power");
  digitalWrite(solarRelay,LOW);    //solar relay pin turn on
  digitalWrite(gridRelay,HIGH);  //grid relay pin turn off
  digitalWrite(genRelay,HIGH);  //gen relay pin turn off
  delay(200);
 }
  if(solarValue>=voltage && gridValue>=voltage && genValue>=voltage)
{
        LCD.clear();
```

```
   LCD.setCursor(0,0);//initial cursor position
   LCD.print("Solar power");
   digitalWrite(solarRelay,LOW);    //solar relay pin turn on
   digitalWrite(gridRelay,HIGH);  //grid relay pin turn off
   digitalWrite(genRelay,HIGH);  //gen relay pin turn off
   delay(200);
   for(;;)
   {
    manual_mode();
   }
  }
  if(solarValue>=voltage && gridValue<voltage && genValue>=voltage)
 {
     LCD.clear();
    LCD.setCursor(0,0);//initial cursor position
   LCD.print("Solar power");
   digitalWrite(solarRelay,LOW);    //solar relay pin turn on
   digitalWrite(gridRelay,HIGH);  //grid relay pin turn off
   digitalWrite(genRelay,HIGH);  //gen relay pin turn off
   delay(200);
  }
   if(solarValue<voltage && gridValue>=voltage && genValue<voltage)
  {
 LCD.clear();
    LCD.setCursor(0,0);//initial cursor position
   LCD.print("Grid power");
   digitalWrite(solarRelay,HIGH);   //solar relay pin turn off
```

```
    digitalWrite(gridRelay,LOW);   //grid relay pin turn on
    digitalWrite(genRelay,HIGH);  //gen relay pin turn off
   }
   if(solarValue<voltage && gridValue>=voltage && genValue>=voltage)
   {
    LCD.clear();
     LCD.setCursor(0,0);//initial cursor position
    LCD.print("Grid power");
    digitalWrite(solarRelay,HIGH);   //solar relay pin turn off
    digitalWrite(gridRelay,LOW);   //grid relay pin turn on
    digitalWrite(genRelay,HIGH);  //gen relay pin turn off
    delay(200);
   }
    if(solarValue<voltage && gridValue<voltage && genValue>=voltage)
   {
    LCD.clear();
     LCD.setCursor(0,0);//initial cursor position
    LCD.print("Gen_set power");
    digitalWrite(solarRelay,HIGH);   //solar relay pin turn off
    digitalWrite(gridRelay,HIGH);  //grid relay pin turn off
    digitalWrite(genRelay,LOW);   //gen relay pin turn on
    delay(200);
   }
}
void manual_mode()
{
  if (Serial.available()>0)
```

```
{
  val = Serial.parseInt();
  switch(val)
  {
    case 12:
          LCD.setCursor(0,0);//initial cursor position
          LCD.print("Solar on");
          LCD.setCursor(0,2);//initial cursor position

          digitalWrite(solarRelay, LOW);//LAMP ONE SET ON
          delay(2000);
          LCD.clear();
          break;
    case 13:
          LCD.setCursor(0,0);//initial cursor position
          LCD.print("Solar off");
          LCD.setCursor(0,2);//initial cursor position
          digitalWrite(solarRelay, HIGH);//LAMP ONE SET OFF
          delay(2000);
          LCD.clear();
          break;
      case 14:
          LCD.setCursor(0,0);//initial cursor position
          LCD.print("Grid_on");
          LCD.setCursor(0,2);//initial cursor position
          digitalWrite(gridRelay, LOW);//LAMP THREE SET ON
          delay(2000);
```

```
      LCD.clear();
      break;
case 15:
      LCD.setCursor(0,0);//initial cursor position
      LCD.print("Grid_off");
      LCD.setCursor(0,2);//initial cursor position
      digitalWrite(gridRelay, HIGH);//LAMP THREE SET OFF
      delay(2000);
      LCD.clear();
      break;

case 16:
       LCD.setCursor(0,0);//initial cursor position
       LCD.print("Generator_on");
       LCD.setCursor(0,2);//initial cursor position
       digitalWrite(genRelay, LOW);//LAMP FOUR SET ON
       delay(2000);
       LCD.clear();
       break;
case 17:
        LCD.setCursor(0,0);//initial cursor position
        LCD.print("Generator_off");
        LCD.setCursor(0,2);//initial cursor position
        digitalWrite(genRelay, HIGH);//LAMP FOUR SET OFF
        delay(2000);
        LCD.clear();
        break;
```

```
 case 18:
       LCD.setCursor(0,0);//initial cursor position
        LCD.print("All sources_on");
        LCD.setCursor(0,2);//initial cursor position
        digitalWrite(solarRelay, LOW);//LAMP ONE SET ON
        digitalWrite(gridRelay, LOW);//LAMP THREE SET ON
        digitalWrite(genRelay, LOW);//LAMP FOUR SET ON
        delay(2000);
        LCD.clear();
        break;


 case 19:
       LCD.setCursor(0,0);//initial cursor position
        LCD.print("All sources_off");
        LCD.setCursor(0,2);//initial cursor position
        digitalWrite(solarRelay, HIGH);//LAMP ONE SET OFF
        digitalWrite(gridRelay, HIGH);//LAMP THREE SET OFF
        digitalWrite(genRelay, HIGH);//LAMP FOUR SET OFF
        delay(2000);
        LCD.clear();
        break;
case 20:
   for(;;)
   {
    bluetooth();
   }
```

```
            break;

        default:
         LCD.print("Ctrl Power");
         LCD.setCursor(0,2);//initial cursor position
         LCD.print("with >> 12-20");
         delay(1000);
         LCD.clear();
    }
  }
  else
  {
     LCD.setCursor(0,0);//initial cursor position
     LCD.print("Ctrl Power");
     LCD.setCursor(0,2);//initial cursor position
     LCD.print("with >> 12-20");
     delay(1000);
     LCD.clear();
  }
}

void bluetooth()
{
  LCD.clear();
    LCD.setCursor(0,0);//initial cursor position
     LCD.print("SYSTEM SET..");
     LCD.setCursor(0,2);//initial cursor position
```

```
     LCD.print("TO AUTO MODE");
     delay(5000);

      for(;;)
           {
            auto_mode_2();
           }
}
void auto_mode_2()
{
   solarValue=analogRead(solarPin);    //analog read voltage input at pin A0
   gridValue=analogRead(gridPin);    //analog read voltage input at pin A2
   genValue=analogRead(genPin);     //analog read voltage input at pin A3
   Serial.print("genValue= ");
   Serial.println(genValue);
   Serial.println();


    if(solarValue<voltage && gridValue<voltage && genValue<voltage)
   {
    LCD.clear();
    LCD.setCursor(0,0);//initial cursor position
    LCD.print("No Power");

    digitalWrite(solarRelay,HIGH);   //solar relay pin turn off
    digitalWrite(gridRelay,HIGH);  //grid relay pin turn off
    digitalWrite(genRelay,HIGH);  //gen relay pin turn off
```

```
 delay(200);
 }
 if(solarValue>=voltage && gridValue<voltage && genValue<voltage)
{
    LCD.clear();
  LCD.setCursor(0,0);//initial cursor position
 LCD.print("Solar power");
 digitalWrite(solarRelay,LOW);    //solar relay pin turn on
 digitalWrite(gridRelay,HIGH);  //grid relay pin turn off
 digitalWrite(genRelay,HIGH);  //gen relay pin turn off
 delay(200);
 }

 if(solarValue>=voltage && gridValue>=voltage && genValue>=voltage)
{
       LCD.clear();
  LCD.setCursor(0,0);//initial cursor position
 LCD.print("Solar power");
 digitalWrite(solarRelay,LOW);    //solar relay pin turn on
 digitalWrite(gridRelay,HIGH);  //grid relay pin turn off
 digitalWrite(genRelay,HIGH);  //gen relay pin turn off
 delay(200);
    }
 if(solarValue>=voltage && gridValue<voltage && genValue>=voltage)
{
    LCD.clear();
  LCD.setCursor(0,0);//initial cursor position
```

```
  LCD.print("Solar power");
  digitalWrite(solarRelay,LOW);    //solar relay pin turn on
  digitalWrite(gridRelay,HIGH);  //grid relay pin turn off
  digitalWrite(genRelay,HIGH);  //gen relay pin turn off
  delay(200);
 }
      if(solarValue<voltage && gridValue>=voltage && genValue<voltage)
 {
LCD.clear();
   LCD.setCursor(0,0);//initial cursor position
  LCD.print("Grid power");
  digitalWrite(solarRelay,HIGH);   //solar relay pin turn off
  digitalWrite(gridRelay,LOW);   //grid relay pin turn on
  digitalWrite(genRelay,HIGH);  //gen relay pin turn off
 }
  if(solarValue<voltage && gridValue>=voltage && genValue>=voltage)
 {
  LCD.clear();
   LCD.setCursor(0,0);//initial cursor position
  LCD.print("Grid power");
  digitalWrite(solarRelay,HIGH);   //solar relay pin turn off
  digitalWrite(gridRelay,LOW);   //grid relay pin turn on
  digitalWrite(genRelay,HIGH);  //gen relay pin turn off
  delay(200);
 }
  if(solarValue<voltage && gridValue<voltage && genValue>=voltage)
 {
```

```
    LCD.clear();
     LCD.setCursor(0,0);//initial cursor position
    LCD.print("Gen_set power");
    digitalWrite(solarRelay,HIGH);   //solar relay pin turn off
    digitalWrite(gridRelay,HIGH);  //grid relay pin turn off
    digitalWrite(genRelay,LOW);   //gen relay pin turn on
    delay(200);
   }
}
```

Overload protection Source code

```
#include <SoftwareSerial.h>
SoftwareSerial gsm(2, 3); //SIM900 Tx & Rx is connected to Arduino #7 & #8

#include <LiquidCrystal.h> //LCD Library
LiquidCrystal LCD( 5,6, 7, 8,9, 10);
int input_1=16;
int input_2=17;
int input_3=18;
int input_4=19;

int redPin = 11;
int greenPin = 13;
int bluePin = 12;
void setColor(int red, int green, int blue)
{
  #ifdef COMMON_ANODE
```

```
    red = 255 - red;
    green = 255 - green;
    blue = 255 - blue;
  #endif
  analogWrite(redPin, red);
  analogWrite(greenPin, green);
  analogWrite(bluePin, blue);
}

 void timer_read()
 {
  LCD.clear();
  LCD.setCursor(0,0);
 LCD.print("Under gsm");
  LCD.setCursor(0,2);
 LCD.print("control..");
 delay(5000);
 for(;;)
 {
  receive_message();
 }
}
String incomingData;   // for storing incoming serial data
String message = "";   // A String for storing the message
/*CURRENT SENSOR VARIABLES*/
const int analogchannel = A0; //Connect current sensor with A0 of Arduino
int sensitivity = 185; // use 100 for 20A Module and 66 for 30A Module
```

```
float adcvalue= 0;
int offsetvoltage = 2500;
double Voltage = 0; //voltage measuring
double ecurrent = 0;// Current measuring
float voltage=240;
float energy_cum,avgamps,totamps,energy,watt,amphr;

int val = 0;//setting the iniatial value for val
void setup() {
   LCD.begin(16, 2);
    LCD.setCursor(0,0);
    LCD.print("OVERLOAD");
    LCD.setCursor(0,2);
    LCD.print("PROTECTOR");
    delay(5000);
    LCD.clear();
  Serial.begin(9600);
  gsm.begin(4800); //Begin serial communication with Arduino and SIM900
  gsm.println("AT"); //Handshaking with SIM900
  gsm.println("AT+CMGF=1"); // Configuring TEXT mode
  LCD.setCursor(0,0);
  LCD.print("starting modem..");
  delay(20000);
  gsm.println("AT+CNMI=1,2,0,0,0"); // Decides how newly arrived SMS messages
should be handled
  LCD.clear();
pinMode(redPin, OUTPUT);
pinMode(greenPin, OUTPUT);
```

```
pinMode(bluePin, OUTPUT);
pinMode(input_1, OUTPUT);
pinMode(input_2, OUTPUT);
pinMode(input_3, OUTPUT);
pinMode(input_4, OUTPUT);

digitalWrite(input_1,HIGH);
digitalWrite(input_2,HIGH);
digitalWrite(input_3,HIGH);
digitalWrite(input_4,HIGH);
}
void loop()
{
  bluetooth_read();
}
void bluetooth_read()
{
   if (Serial.available()>0)
  {
    val = Serial.parseInt();
    switch(val)
    {
      case 1:
            LCD.setCursor(0,0);//initial cursor position
            LCD.print("LOAD_1 ON");
            LCD.setCursor(0,2);//initial cursor position
            current_sensing();
```

```
        delay(200);
        digitalWrite(input_1, LOW);//LAMP ONE SET ON
        delay(2000);
        LCD.clear();
        break;

case 2:
        LCD.setCursor(0,0);//initial cursor position
        LCD.print("LOAD_1 OFF");
        LCD.setCursor(0,2);//initial cursor position
        current_sensing();
        delay(200);
        digitalWrite(input_1, HIGH);//LAMP ONE SET OFF
        delay(2000);
        LCD.clear();
        break;

case 3:
        LCD.setCursor(0,0);//initial cursor position
        LCD.print("LOAD_2 ON");
        LCD.setCursor(0,2);//initial cursor position
        current_sensing();
        delay(200);
        digitalWrite(input_2, LOW);//LAMP TWO SET ON
        delay(2000);
        LCD.clear();
        break;
```

```
case 4:
    LCD.setCursor(0,0);//initial cursor position
    LCD.print("LOAD_2 OFF");
    LCD.setCursor(0,2);//initial cursor position
    current_sensing();
    delay(200);
    digitalWrite(input_2, HIGH);//LAMP TWO SET OFF
    delay(2000);
    LCD.clear();
    break;

case 5:
    LCD.setCursor(0,0);//initial cursor position
    LCD.print("LOAD_3 ON");
    LCD.setCursor(0,2);//initial cursor position
    current_sensing();
    delay(200);
    digitalWrite(input_3, LOW);//LAMP THREE SET ON
    delay(2000);
    LCD.clear();
    break;

case 6:
    LCD.setCursor(0,0);//initial cursor position
    LCD.print("LOAD_3 OFF");
    LCD.setCursor(0,2);//initial cursor position
```

```
      current_sensing();
      delay(200);
      digitalWrite(input_3, HIGH);//LAMP THREE SET OFF
      delay(2000);
      LCD.clear();
      break;

case 7:
       LCD.setCursor(0,0);//initial cursor position
       LCD.print("LOAD_4 ON");
       LCD.setCursor(0,2);//initial cursor position
       current_sensing();
       delay(200);
       digitalWrite(input_4, LOW);//LAMP FOUR SET ON
       delay(2000);
       LCD.clear();
       break;

case 8:
        LCD.setCursor(0,0);//initial cursor position
        LCD.print("LOAD_4 OFF");
        LCD.setCursor(0,2);//initial cursor position
        current_sensing();
        delay(200);
        digitalWrite(input_4, HIGH);//LAMP FOUR SET OFF
        delay(2000);
        LCD.clear();
```

```
        break;

case 9:
        LCD.setCursor(0,0);//initial cursor position
        LCD.print("ALL LOADS ON");
        LCD.setCursor(0,2);//initial cursor position
        current_sensing();
        delay(200);
        digitalWrite(input_1, LOW);//LAMP ONE SET ON
        digitalWrite(input_2, LOW);//LAMP TWO SET ON
        digitalWrite(input_3, LOW);//LAMP THREE SET ON
        digitalWrite(input_4, LOW);//LAMP FOUR SET ON
        delay(2000);
        LCD.clear();
        break;

case 10:
        LCD.setCursor(0,0);//initial cursor position
        LCD.print("ALL LOADS OFF");
        LCD.setCursor(0,2);//initial cursor position
        current_sensing();
        delay(200);
        digitalWrite(input_1, HIGH);//LAMP ONE SET OFF
        digitalWrite(input_2,HIGH);//LAMP TWO SET  OFF
        digitalWrite(input_3, HIGH);//LAMP THREE SET OFF
        digitalWrite(input_4,HIGH);//LAMP FOUR SET  OFF
        delay(2000);
```

```
            LCD.clear();
            break;

        case 11:
           for(;;)
           {
            receive_message();
           }
           break;

        default:
         LCD.print("SEND COMMAND");
         LCD.setCursor(0,2);//initial cursor position
         current_sensing();
         delay(1000);
         LCD.clear();
  }
}
else
{
   LCD.setCursor(0,0);//initial cursor position
   LCD.print("CTRL WITH 1-10 ");
   LCD.setCursor(0,2);//initial cursor position
   current_sensing();
   delay(1000);
   LCD.clear();
}
```

```
}
void current_sensing()
{
 long milisec = millis(); // calculate time in milliseconds
 long duration=milisec/1000; // convert milliseconds to seconds
 unsigned int temp=0;
 float maxpoint = 0;
 int i=0;
 for(i=0;i<500;i++)
 {
 if(temp = analogRead(analogchannel),temp>maxpoint)
 {
 maxpoint = temp;
 }
 }
 adcvalue = maxpoint;
 Voltage = (adcvalue / 1024.0) * 5000; // Gets you mV
 ecurrent = ((Voltage - offsetvoltage) / sensitivity);
 ecurrent = ( ecurrent ) / ( sqrt(2) );
 if(ecurrent>=1.70)
 {
  LCD.clear();
  LCD.setCursor(0,0);
 LCD.print("CIRCUIT");
   LCD.setCursor(0,2);
 LCD.print("OVERLOADED!!");
 digitalWrite(input_4, HIGH);//LAMP FOUR SET OFF
```

```
 setColor(0, 255, 255);  // red
 delay(2000);
 sendmessage();
 timer_read();
delay(1000);
 }
 else if((ecurrent>0.00)&&(ecurrent<=0.49))
 {
 LCD.setCursor(0,2);
 LCD.print("current=");
 LCD.print(ecurrent);
  setColor(0, 0, 255);//green
  delay(200);
 }
 else if((ecurrent>0.45)&&(ecurrent<=0.9))
 {
 LCD.setCursor(0,2);
 LCD.print("current=");
 LCD.print(ecurrent);
  setColor(255, 255, 0);//blue
  delay(200);
 }
 else
 {
  LCD.setCursor(0,2);
 LCD.print("current=");
 LCD.print(ecurrent);
```

```
 delay(200);
 }
}
void sendmessage()
{
  LCD.setCursor(0,0);
  LCD.clear();
  LCD.println("SENDING TEXT...  ");
  gsm.println("AT+CMGF=1"); // set the SMS mode to text
  delay(2500);
  gsm.write("AT+CMGS=");
  gsm.write(34); //ASCII of "
  gsm.write("+256779012288");
  gsm.write(34);
  gsm.write(13);
  gsm.write(10);
  delay(2500);
  gsm.print("circuit overloaded!!");
 delay(2500);
 gsm.write(26);
 gsm.write(13);
 gsm.write(10);//Ascii code of ctrl+z to send the message
 delay(5000);
}
void receive_message()
{
  if (gsm.available() > 0)
```

```
  {
    incomingData = gsm.readString(); // Get the data from the serial port.
    LCD.clear();
    LCD.setCursor(0,0);//initial cursor position
   LCD.print("CTRL WITH SMS");
    LCD.setCursor(0,2);//initial cursor position
   current_sensing();
  delay(200);
  }
else if(incomingData.indexOf("Load1_on")>=0)
  {
   message = "Load1_on";
    LCD.clear();
        LCD.setCursor(0,0);
    LCD.print(message);
    current_sensing();
    delay(200);
  digitalWrite(input_1, LOW);
    delay(2500);
  }
  else if(incomingData.indexOf("Load1_off")>=0)
  {
   message = "Load1_off";
    LCD.clear();
    LCD.setCursor(0,0);
    LCD.print(message);
    current_sensing();
```

```
  delay(200);
  digitalWrite(input_1, HIGH);
  delay(2500);
}
else if(incomingData.indexOf("Load2_on")>=0)
{
 message = "Led is turned ON";
  LCD.clear();
  LCD.setCursor(0,0);
  LCD.print(message);
  current_sensing();
  delay(200);
  digitalWrite(input_2, LOW);
  delay(2500);
}
  else if(incomingData.indexOf("Load2_off")>=0)
{
 message = "Load2_off";
  LCD.clear();
  LCD.setCursor(0,0);
  LCD.print(message);
  current_sensing();
  delay(200);
   digitalWrite(input_2, HIGH);
  delay(2500);
}
   else if(incomingData.indexOf("Load3_on")>=0)
```

```
{
 message = "Load3_on";
  LCD.clear();
  LCD.setCursor(0,0);
  LCD.print(message);
  current_sensing();
  delay(200);
   digitalWrite(input_3, LOW);
  delay(2500);
}
 else if(incomingData.indexOf("Load3_off")>=0)
{
 message = "Load3_off";
  LCD.clear();
  LCD.setCursor(0,0);
  LCD.print(message);
  current_sensing();
  delay(200);
  digitalWrite(input_3, HIGH);
  delay(2500);
}
     else if(incomingData.indexOf("Load4_on")>=0)
{

  message = "Load4_on";
  LCD.clear();
  LCD.setCursor(0,0);
```

```
  LCD.print(message);
  current_sensing();
  delay(200);
  digitalWrite(input_4, LOW);
  delay(2500);
}
 else if(incomingData.indexOf("Load4_off")>=0)
{
  digitalWrite(input_4, HIGH);
  message = "Load4_off";
  LCD.clear();
  LCD.setCursor(0,0);
  LCD.print(message);
  current_sensing();
  delay(200);
  digitalWrite(input_4, HIGH);
  delay(2500);
}
 else if(incomingData.indexOf("All_loads_on")>=0)
{
  message = "All_loads_on";
  LCD.clear();
  LCD.setCursor(0,0);
  LCD.print(message);
  current_sensing();
  delay(200);
   digitalWrite(input_1, LOW);
```

```
  digitalWrite(input_2, LOW);
  digitalWrite(input_3, LOW);
  digitalWrite(input_4, LOW);
  delay(2500);
}
else if(incomingData.indexOf("All_load_off")>=0)
{
  message = "All_loads_off";
  LCD.clear();
  LCD.setCursor(0,0);
  LCD.print(message);
  current_sensing();
  delay(200);
   digitalWrite(input_1, HIGH);
  digitalWrite(input_2,HIGH);
  digitalWrite(input_3, HIGH);
  digitalWrite(input_4, HIGH);
  delay(2500);
}
  else if(incomingData.indexOf("normal")>=0)
{
     while(1)
 {
  bluetooth_read();
 }
}
   else
```

```
  {
    LCD.setCursor(0,0);//initial cursor position
   LCD.print("CTRL WITH SMS");
    LCD.setCursor(0,2);//initial cursor position
  current_sensing();
delay(200);
LCD.clear();
  }
}
```

Appendix B: Gantt chart showing the Project Timeline

Table 1 showing the project timeline

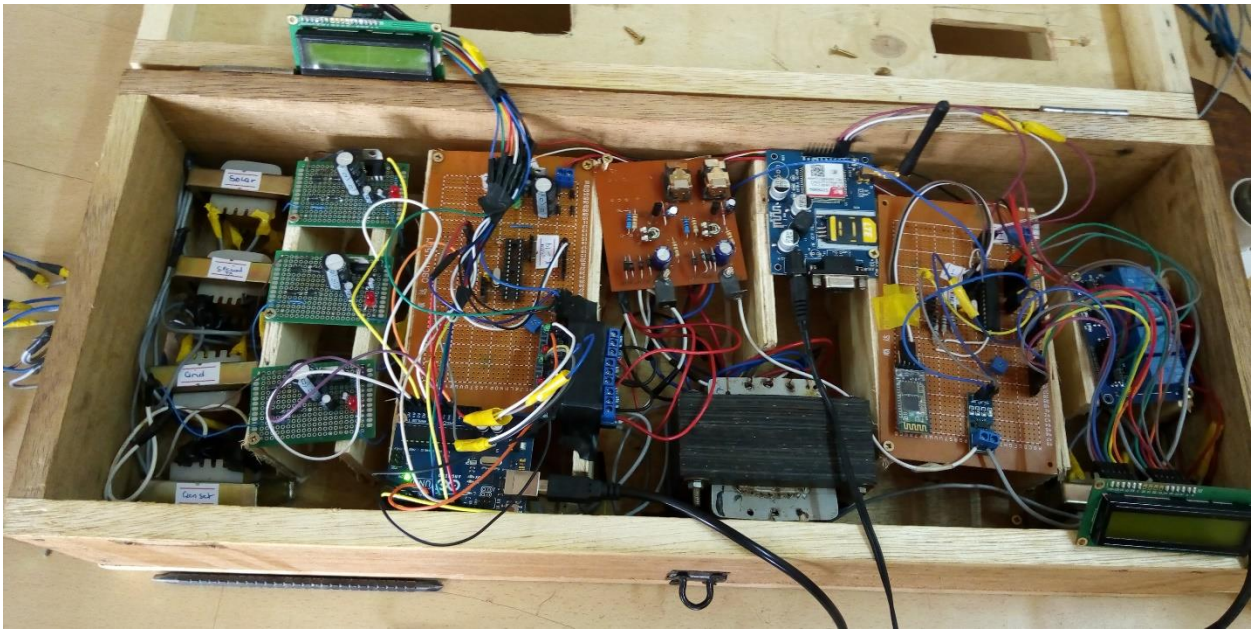
ANDROID BASED AUTOMATIC PHASE SELECTOR AND OVERLOAD PROTECTOR	**MAY**	**JUNE**	**JULY**	**AUG**
DEFFENDING PROPOSAL				
SIMULATION				
GATHERING OF COMPONENTS				
DESIGNING A PROGRAM				
PUTTING TOGETHER HARDWARE COMPONENTS				
TEST				
IMPLEMENTATION				
PRESENTATION				

Table **Gantt chart showing the Project Timeline**

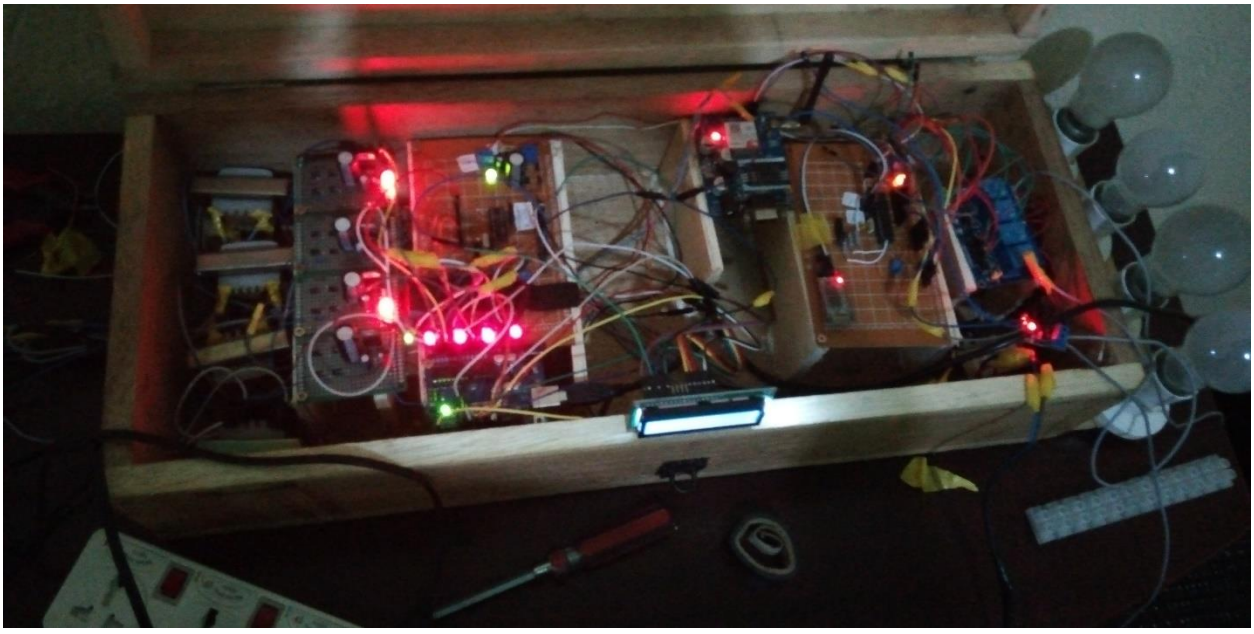
APPENDIX C: PROJECT BUDGET

Item No.	Item Description	Type	Quantity	Unit Price UGsh	Total Cost UGsh
1	Microcontroller Embedded Module Board	ATMEGA 328P	2	15,000	30,000
2	Bluetooth module		1	40,000	40,000
3	GSM	SIM900A	1	150,000	150,000
4	Current sensor	ACS712ELECTR-20A-T	1	35,000	35,000
5	Voltage sensor	Design circuit	2	35,000	70,000
6	Light Emitting Diodes (LED's)	RED	5	500	2500
7	Voltage Regulator	7805V	4	5,000	20,000
8	Diodes		16	1,000	16,000
9	Capacitor		16	2,500	40,000
10	LCD Module		2	25,000	50,000
11	Screws		20	100	2,000
12	Auto-transformer	0V, 220V, 240V & 270V @ 2A	1	60,000	60,000
13	Stepdown transformer	230V -12Vac	4	15,000	60,000
14	Stepdown transformer	230V-25Vac	1	15	15,000
15	Relays (single unit)	10A, 230Vac	3	10,000	30,000
16	Relay module	10A, 230Vac	1	35,000	35,000
17	ATMEGA 328P socket	28pins	2	10,000	20,000
18	Strip board (big size)	14 × 9 cm	2	3,500	7,000
19	Strip board (small size)	4 × 6 cm	3	2,000	6,000
20	Jumper wires		40	500	20,000
21	Soldering lead		2 m	5,000	10,000
22	Electrical cables		10 m	1000	10,000
23	Lamp holder		4	2,000	8,000
24	Bulbs		4	2,500	10,000
25	Resistors	330 Ω	10	500	5,000
26	Supply Cables		5	3,000	15,000
27	Arduino UNO		1	60,000	60,000
28	Casing		1	70,000	70,000
29	Miscellaneous		1	100,000	100,000
				Total	**Sh996,500**

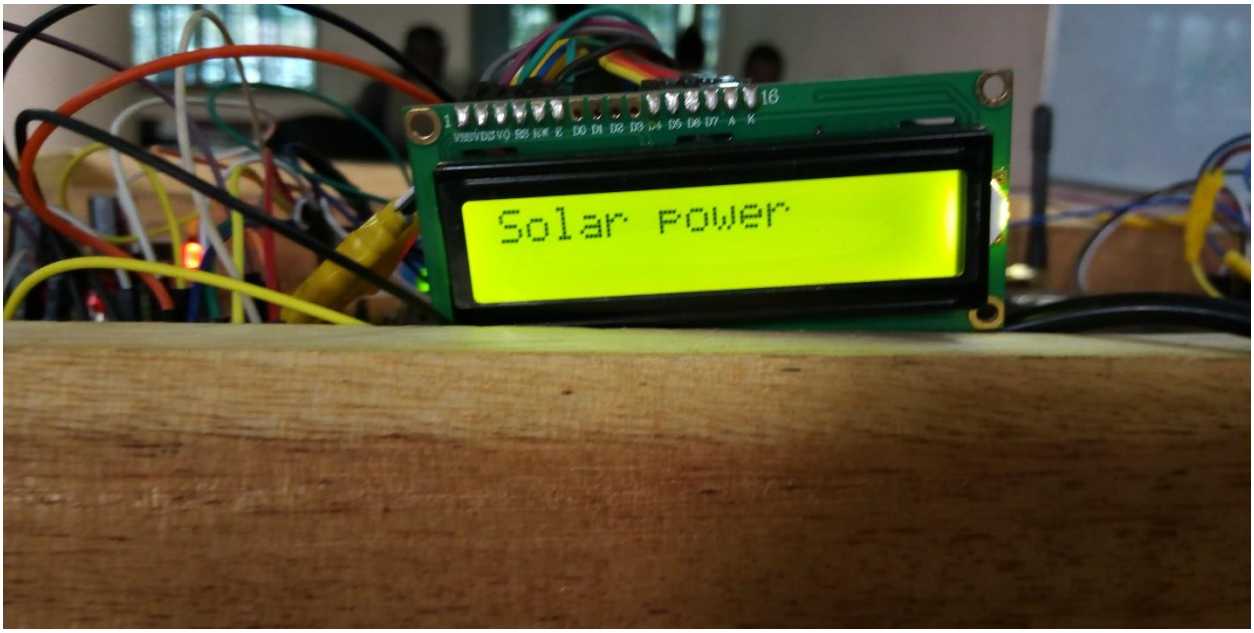
APPENDIX D: SOME PHOTOS SHOWING PROJECT RUN



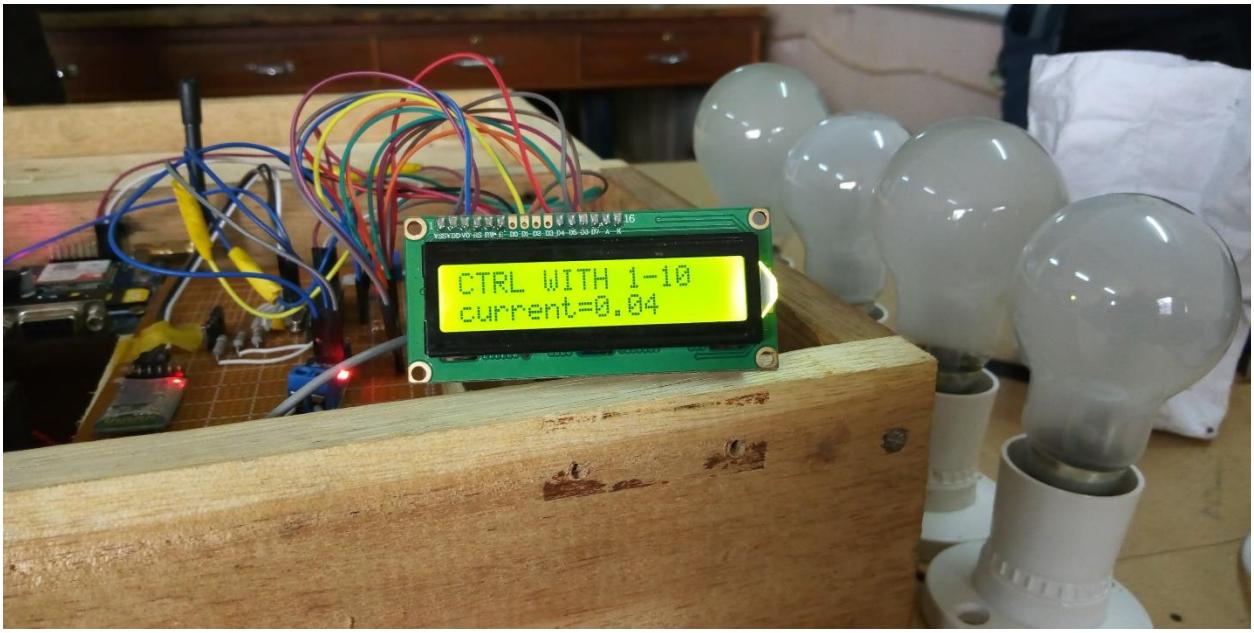
Circuit without DC power



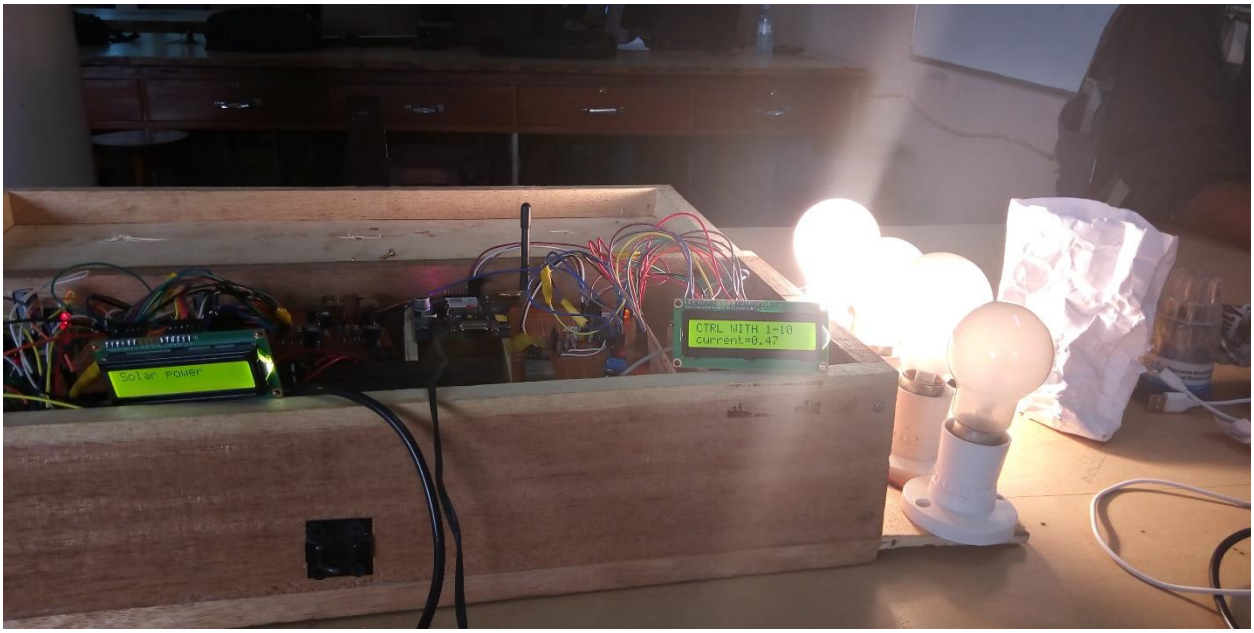
: Circuit supply with DC power



Circuit power by solar power



Loads control using Bluetooth but in off state.



Loads switch on using Bluetooth