Sudan University of Science and Technology

Final Year Project

Department of Electrical Engineering

AUTO POWER CONTROL OF FOUR DIFFERENT SOURCES TO ENSURE NO POWER BREAK

التحكم الذاتي في الطاقة في اربعة مصادر للطاقة لضمان عدم انقطاع الامداد الكهربي

A project Report Submitted to The Department of Electrical and Nuclear Engineering in The Full Fulfillment of The Requirements of BSc. Electrical Engineering

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DEDICATION

We dedicate this work to

Our loving mothers

Their strong and gentle souls who taught us in Allah, believe in hard work and that so much could be done.

Our fathers

Who provided an honest life for us, who taught us to believe in our selves

-

ACKNOWLEDGEMENT

First, all praise gratitude belong to Allah, today we fold the day, not only for given us life, but also for making life beautiful for us by knowledge.

We would like to express our deepest gratitude to our supervisor Dr. AlFadel Zakareya Yahya for his continues support, patience, motivation and immense knowledge throughout this research. Working under his supervision was a very great experience.

ABSTRACT

The main objective of this project is to provide uninterrupted power supply to a load, by selecting the supply from any source out of 4 such as main power supply, generator, solar, and wind power supply automatically in the absence of any of the source. The demand for electricity is increasing every day and frequent power cuts is causing many problems in various areas like industries, hospitals and houses. An alternative arrangement for power source is a serious matter.

In this project we used four switches to demonstrate the respective failure of that power supply. When any of the switches is pressed it shows the absence of that particular source, switches are connected to microcontroller as input signals. A microcontroller of ATMEGA-32 family is used. The output of microcontroller is given to the relay driver IC, which switches appropriate relay to maintain uninterrupted supply to the load. The output shall be observed using a lamp drawing power supply from main supply initially. On failure of the main supply (which is actuated by pressing the appropriate switch) the load gets supply from the next available source, say the solar. If the solar also fails it switches over to the next available source and so on. The current status, as to which source supplies the load is also displayed on an LCD. As it is not feasible to provide all 4 different sources of supply, one source with alternate switches are provided to get the same function, Taking in consideration the use of the source whose cost is the lowest then, the higher cost sources and so on.

المستخلص:

الهدف الاساسي من البحث هو توفير امداد دائم للطاقة الكهربائية بالنسبة للحمل وذللك باختيار مصدر الامداد تلقائيا من بين اربعة مصادر وهي (المصدر الرئيسي ، مصدر الطاقة الشمسية،مصدر طاقة الرياح ومصدر المولد الكهربائي) في حالة فشل أوفقدان اي من المصادر المذكورة سابقا، ان مشكلة انقطاع الكهرباء المتكررة تسبب العديد من الخسائر يوميا في مختلف المجالات الصناعية والزراعية والصحية لذلك لابد من اتخاذ اجراءات احتياطية بالنسبة لنظام الطوارئ الكهربائي لتفادي وتقليل الضرر الناجم عن مشكلة الانقطاع الكهربائي .

في هذا المشروع مثلنا المصادر الاربعة باستخدام اربعة ريلايات كل ريلاي متصل بمفتاح ليمثل العطل الذي قد يطرأ في احد المصادر الاربعة، يتم التحكم في هذة الدائر بواسطة الميكروكنترولر حيث يتم عرض البيانات في شاشة عرض من النوع ال سي دي فيها يوضح المصدر الذي يتم عبره الامداد الكهربائي للحمل الذي هو مصباح 220 فولت،تتم عملية التبديل بين المصادر بسرعة فائقة بحيث لاينقطع الامداد عن الحمل.

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LISTOF ABBREVIATIONS

- UPS: Uninterruptable Power Supply.
- EMI: Electromagnetic Interface.
- RFI: Radio Frequency Interface.
- MED: Ministry of Electricity and Damps.
- DC: Direct Current.
- AC: Alternative Current.
- LED: Light Emitting Diode.
- IC: Integrated Circuit.
- NO: Normal Open.
- NC: Normal Close.
- V: Voltage.
- LCD: Liquid Crystal Display.
- R: Resistor.
- AVR: Alf and Vegard's RISC processor.
- ADC: Analog to Digital Convertor.
- EEPROM: Electrical Erasable Programmable Read Only Memory.
- SPI: Serial Peripheral Interface.
- USART: Universal Synchronous and Asynchronous Receiver and Transmitter.

CHAPTER 1

INTRODUCTION

1.1 Overview

As a matter of fact the problem of electricity cut is affecting daily human activities every day , specially here in Sudan the demand for electricity is increasing day by day and frequent power cuts are causing many problems in various areas like industrial areas , hospitals , banks ,companies and houses. So, an alternative arrangement for the power source must be made in order to avoid the damage caused by the power cut. An important requirement of electric power distribution systems is the need for automatic operation. In particular, the rapid and reliable transfer of the power supply system from one power source to another during certain system events is important in achieving the reliability goals for such systems and the facility serves. However, the design of such an automatic transfer system is all–too-often considered “less important” than many other aspects of the overall power system design. Nowadays, electrical power supply is one of the important elements in human being's needs. The most of the human activities is dependent on electrical power supply. In other words, without electrical power supply, almost the whole activities are become postponed or worse cancelled. For usage of daily routine, voltage supplied is within 220V ac. The need for power supply is paramount for the growth of a country, access to electricity as the basic form of energy supply to the masses is vital for the development of a nation's economy. The strategic role and policy of generation electricity in the development of an economy has always been appreciated by most developed nations, with the likes of

France, Germany, and Italy. All these mentioned countries are well and truly developed countries that sustain the supply of energy to it environment for the purpose of industrial development. The power sector provides a platform for economic development; electricity has brought about development in all area of productions and services. Electricity has become indispensable to socio-economic and industrial development of any nation. Using uninterrupted power supply in an automated mode, we always have a substitute arrangement as backup to take place of main power supply in case of power-cut in an emergency case, where the power cut cannot be avoided [1].

1.2 Problem statement

In fact power cut or interruption is a real problem facing countries which having a lack of power generation, or power shortage issues. This problem is really affecting human life in so many aspects costing people a lot of money in industrial areas, trading companies and banks. Not only this but also, putting human life in danger as interruptions happen also in hospitals. It is obvious that power cut problems complicate human's daily life as electricity is involved in most of human activities. Moreover, a lot of emergency power systems do not provide an uninterruptable power supply to the load. Thus, a special arrangements for the power emergency systems need to be made.

1.3 Objectives

- To solve the power cut or power shortage problem.
- To design an emergency system that ensures the continuous supply of power to any specified load even during fault conditions.
- To minimize the delay in the process of shifting the supply source from the main supply to the alternative back up source to the smallest possible value.
- To reduce the power bill by setting a selecting sequence of sources which will select the lowest at first then, the higher cost and so on.

Thesis Layout

This project is organized into five chapters:

Chapter one gives the introduction to the project and the project objectives, Chapter two is the literature review which discusses the use of solar and wind energy, their advantages and disadvantages and their use here in Sudan. Chapter three gives the design methodology and the complete description of the project components. Chapter four shows the project simulation and the design results. Chapter five gives the conclusion of the whole project, the future scope and outlines both appendices and references used.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In fact there are several types of emergency power systems being used all over the world, one of the most used types is the UPS system, also known as an uninterruptible power supply which is an electrical apparatus that provides emergency power to load when input source, typically the main source power fails. It provides near-instantaneous protection from input power interruptions by supplying energy stored in batteries.

The disturbances which normally occur in commercial supply are as follows:

1. Transients – occur due to lightning, switching of power network which may result in instantaneous rise of voltage.
2. Momentary over- and under- voltage which may be due to large changes of loads in power systems.
3. Generation of harmonics or distortion of waveforms.
4. Electromagnetic interference (EMI) or Radio frequency interference (RFI) or noise are introduced in the supply line due to lighting, power network switching, continuous switching by some equipment like static inverters.

The uninterruptible power supply (UPS) is the best solution to power conditioning for critical loads, such as real-time data processing computers, air route traffic, control centers, industrial process control system because they are very sensitive to the nature of power supply for their operation,

protection of the equipment and continuity of a process or transfer of information.

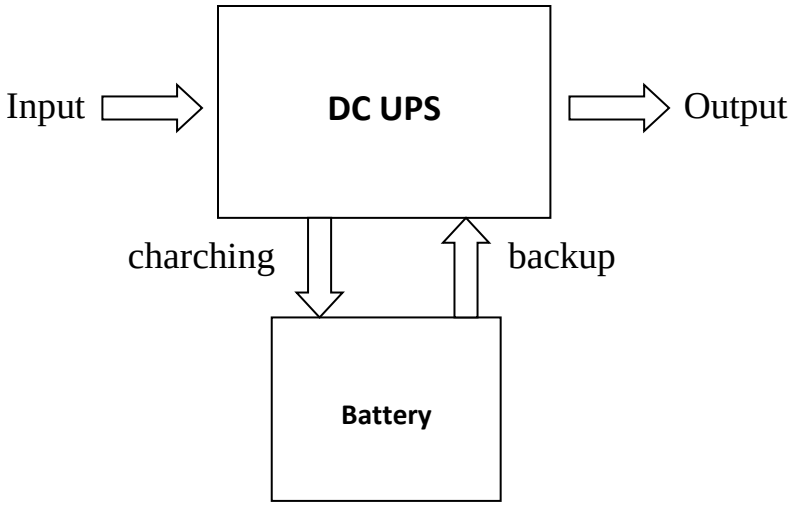

Figure 2.1: shows simple UPS system

The difference between the circuit that we are about to design is that the UPS's main function is to protect critical loads against the different types of disturbance which may occurs with the power sources by shifting the supply to the backup rechargeable battery. So, the load will have an uninterruptable power supply of power. On the other hand, our project aims to have no interruption on power being supplied to the load by shifting the supply to the backup solar, wind and a generator sources as well as to reduce the financial cost of using such an emergency power system, and that by using the solar and wind power supplies as backup sources because they have low operating cost. Although, the circuit we are attempting to design will work effectively during faults and not in response to small disturbances of power source, but also it has a noticeable benefits.

2.1 Background

In this project we are attempting to solve the power interruption problem as it is a serious matter here in Sudan, like most of the oil importing countries Sudan suffered a lot from sharp increase of oil prices in the last decades, as this country is having a power shortage problem we introduced the use of renewable energy like solar and wind power supplies as a solution.

Solar and wind are all clean renewable energies with a huge amount of resource and a great potential of electricity generation .nowadays there is a real need to develop renewable energy for so many reasons:

- First, they are inexhaustible compared to the other types.
- Second, they are clean and don't cause any type of air or environmental pollution.
- Third, they are safe and cause no threat to human life unlike the nuclear energy.

2.2 Review in solar and wind energy

2.2.1 Solar:

Solar energy is derived from the sun's radiation. The sun is a powerful energy source. Did you know that the energy that it provides to earth for one hour could meet the global energy needs for one entire year? We are able to harness only 0.001 percent of that energy.

There is a reason why solar energy has become a trending topic when talking about renewable energies .While it has been popularly criticized for being expensive or not very efficient, solar energy has

now proved to be very beneficial not only for the environment but also financially speaking. Additionally, due to the higher demand the technology has been improved considerably, turning into a very efficient source of clean energy [2].

2.2.2 Advantages of solar energy

- Renewable source of energy.
- Reduces electricity bills.
- Divisive applications
- Low maintenance cost.
- Technology development

2.2.3 Disadvantages of solar energy

- Installation cost is quite high.
- Whether dependant.
- Solar energy storage is expensive.
- Require a lot of space.

2.3 Wind energy

Wind energy offers many advantages, which explains why it's one of the fastest growing energy sources in the world. Wind has a powerful mechanical energy able to drive large shafts of electricity generators providing clean energy and in somehow solving the planet pollution issue [2].

2.3.1 Advantages of wind energy

- The wind is free and with modern technology it can be captured efficiently.
- Once the wind turbine is built the energy it provides does not cause green house gases or other pollutants.
- Although wind turbines can be very tall each takes up a small plot of land. This means that the land below can still be used. This is specially the case in agricultural areas as farming can still continue.
- Many people find wind farms an interesting feature of landscape.
- Remote areas that are not connected the electricity power grid can use wind turbines to produce their own supply.
- Wind turbines have a role to play in both the developed and third world.
- Wind turbines are available in a range of sizes which means a vast range of people and businesses can use them single households to small towns and villages can make good use of range of wind turbines available today [2].

2.3.2 Disadvantages of wind power

- The strength of the wind is not constant and it varies from zero to storm force. This means that wind turbines do not produce the same amount of electricity all the time. There will be time when they produce no electricity at all.

- Many people feel that the countryside should be left untouched, without these large structures being built. The landscape should left in its natural form for everyone to enjoy.

- Wind turbines are noisy. Each one can generate the same level of noise as a family car travelling at 70 mph.

- Many people see large wind turbines as unsightly structures and not pleasant or interesting to look at. They disfigure the countryside and are generally ugly.
- When wind turbines are being manufactured some pollution is produced. Therefore wind power does produce some pollution.

- Large wind farms are needed to provide entire communities with enough electricity. For example, the largest single turbine available today can only provide enough electricity for 475 homes, when running at full capacity. How many would be needed for a town of 100 000 people? [2].

2.4 Comparison between wind and solar:

- Solar power is only available during the day while wind power is available even at night.
- Wind power is mechanical while solar power can be mechanical or purely electrical.
- Solar power can be extracted at minute amounts while the same cannot be done with wind power.
- Solar power can be used with vehicles but not wind power.
- Wind power does not take up as much land as solar power [3].

2.5 Renewable energy in Sudan

Sudan is an agricultural country with fertile land, plenty of water resources, livestock, forestry resources and agricultural residues. Energy is one of the key factors for the development of national economies in Sudan. An overview of the energy situation in Sudan is introduced with reference to the end uses and regional distribution. Energy sources are divided into two main types; conventional energy (biomass, petroleum products, and electricity); and non-conventional energy (solar, wind, hydro, etc.). Sudan possesses a relatively high abundance of sunshine, solar radiation and moderate wind speeds, hydro and biomass energy resources. Application of new and renewable sources of energy available in Sudan is now a major issue in the future energy strategic planning for the alternative to the fossil conventional energy to provide part of the local energy demand. Sudan is an important case study in the context of renewable energy. It has a long history

of meeting its energy needs through renewable energy. Sudan's renewable energy diverse, due in part to the country's wide range of climates and landscapes. Like many of the African leaders in renewable energy utilization, Sudan has a well-defined commitment to continue research, development, and implementation of new technologies. Sustainable low-carbon energy scenarios for the new century emphasize the untapped potential of renewable resources. Rural areas of Sudan can benefit from this transition. The increased availability of reliable and efficient energy services stimulates new development alternatives. It is concluded that renewable environmentally friendly energy must be encouraged, promoted, implemented and demonstrated by full-scale plant for the use in remote rural areas [4].

2.6 Wind energy in Sudan

Acknowledging the huge potential for renewable energies in Sudan, the Ministry of Electricity and Dams of Sudan (MED) intends to develop renewable energy power projects in order to promote sustainable development. In the initial stage, MED has foreseen to focus on wind energy projects and awarded a contract to Lahmeyer International as consultant for the development of the first three wind farms:

Nyala, located in "Darfour" state in western Sudan, capacity: 20 MW

Dongola, located in the north of Sudan, where Lahmeyer International performed on-site wind measurements in 2001 and 2002, capacity: 100 MW

Red Sea Cost, capacity: 180 MW [5].

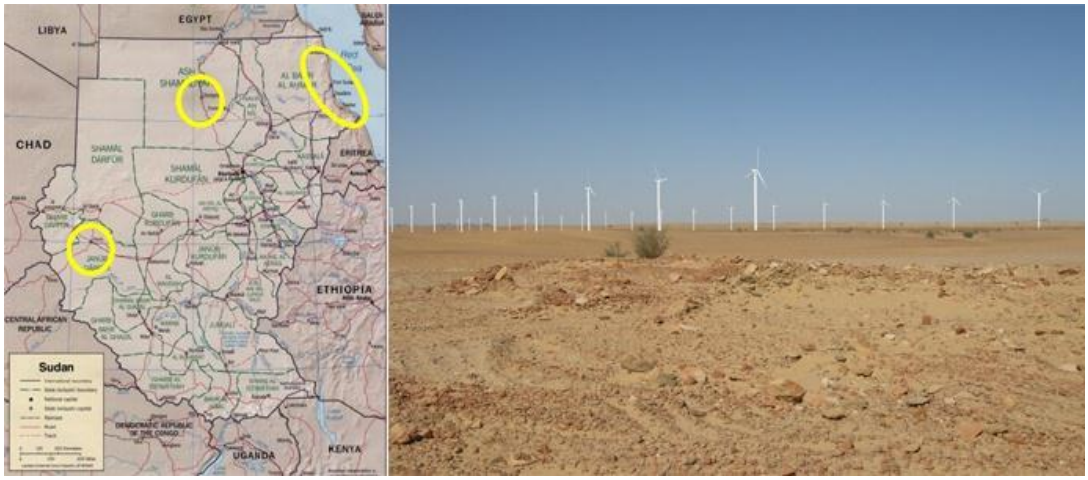

Figure 2.2: shows wind power plant places in Sudan

2.7 Solar energy in Sudan

Solar energy-powered pumps project for irrigation in the Northern State: The idea behind the project is to replace the diesel-powered water pumps currently used in agricultural schemes with solar energy- powered ones whose lifespan is now roughly 25 years without having operation costs, such as fuel and spare parts. The project will also reduce emissions of carbon dioxide resulting from the burning of diesel fuel [6].

Figure 2.3: shows a solar power project in northern Sudan

2.8 Previous studies

Robert Douwona [7] found out that emergency power systems were used as early as World War II on naval ships. In combat, a ship may lose the function of its steam engines which powers the steam-driven turbines for the generator. In such a case, one more diesel engines are used to drive backup generators. Early changeover switches relied on manual operation: two switches would be placed horizontally in line and the "ON" position facing each other, a rod placed in between, in order to operate the changeover switch, one source must be turned off, the rod moved to the other side and other turned on. With adequate power supply base of the nation at the moment, it is almost impossible to supply electricity to consumers at all times. The unreliable public power supply has led many to the alternative power supply sources. In Nigeria today, the use of generators to power businesses and machines have become the norm. According to the Director-General of Centre for Management Development, Dr. Kabir Usman that Nigeria has the highest number of standby generators in Africa, averaging to every 2.5 people has at least one standby generator. He also pointed out that about 60million Nigerians spend 1.6trillion naira on generators annually. Many generators are in use; while some are manually started others are automatically activated.

According to Jonathan [8], manual changeover switch system still remains the oldest changeover switch box used by majority of the electricity consumers. Manual changeover switch box separates the source between a generator and public supply. Whenever there is

power failure, change-over is done manually by an individual and the same happens when the public power is restored. This is usually accompanied by a loud noise and electrical sparks. According to him there are some of the limitations in the manual change over switch i.e. manual changeover is time wasting whenever there is power failure, it is strenuous to operate because a lot of energy is required, it causes device process or product damage, it has the potential to cause fire outbreak and it is usually accomplished by a lot of noise which may sometimes be psychologically destabilizing.

According to Mbaocha [9], Manual changeover maintenance is frequent because the changeover action causes tear and wear.

According Katz R and Boriella [10], the main advantage of the sequential logic control power changeover switch is its simplicity. According to them there are some of the disadvantages in sequential logic control system i.e. the main possible clock rate is determined by the slowest logic path in the circuit, otherwise known as the critical path. Every logical calculation, from the simplest to the most complex must be complete in one clock cycle, so logic paths that complete their calculations quickly are idle much of time, waiting for the next clock pulse. The clock signal must be distributed to every flip-flop in the circuit. As the clock is usually a high frequency signal, this distribution consumes a relatively large amount of power and dissipates much heat. Even the flip-flop that is doing nothing consumes a small amount of power, thereby generating waste heat in the chip.

According to ShanmukhaNagaraj and Ramesh [11], in sequential logic control of power selection, sequential digital circuits

are used to effect the detection and control of the supplied power. Sequential logic control involves only an automatic violation of the public power source in the event of power failure, but the generator activation to supply alternative power is done manually. In effect the sequential logic control is more efficient then the manual control.

CHAPTER THREE

DESIGN METHODOLOGY

3.1 Introduction

When the supply from all the sources (Mains, Solar, wind and generator) are ready, first "Normally open" switch is pressed then the main gets failed and the supply automatically shifts to solar. To proceed further, second normally open switch is pressed then the solar get failed and supply is provided from wind and so on. Priority is assigned to each power source in the order of Mains, solar, wind and Generator. In case the mains power supply fails, the supply should automatically shift to the solar but if solar also fails at the moment then the supply will automatically shift to next priority source. Figure below explains the construction of the Auto power supply of four different sources. As shown in the diagram the four sources are Mains, solar, wind and Generator, four "Normally open" switches are used to show the failure of each supply source, four relays are used to provide protection at each respective output. This output can be used to drive any load such as a lamp or motor. LEDs are used to display the source of supply. Other case is when the power switches from one source to another, say solar fails and supply shifts to wind, if the mains come back then the supply will automatically reach back to mains power instead of switching to solar. At the output of microcontroller, each output port is connected to positive DC voltage. Relays are used in contact with the output port to provide switching at the output.

3.2 Working Principle

The project uses an arrangement where four different sources of supply are channelized to a load so as to have an uninterrupted operation of the load. As it is not practicable to get four sources of supply such as mains supply, generator supply, wind supply and solar supply, we used relays only. The source of 220-v supply is used and assumed as if being fed from four different sources by connecting all the four incoming sources in parallel as seen in the block circuit diagram. The AC source to the lamp is connected to relay 1, relay 2, relay 3 and relay 4 by making the entire "NO" (normally open) contacts parallel and all the common contacts in parallel. Four selecting switches representing failure of corresponding supply such as mains, solar, wind and generator respectively connected to pin 0,1, 2,3 on port "C" in the ATMEGA32 microcontroller, The port pins are pulled up with 10k resistors for reliable operation of achieving high and low logic by the program. It is so written that initially the relay driver IC ULN2003 pin number 1 gets a logic high from microcontroller port "D" pin 1 that results in pin number 16 of the ULN 2003 going low to activate the relay 1 which results in the load i.e., lamps gets the supply through relay 1 "NO" contacts. While the selecting switch meant for mains is pressed that represents failure of mains supply resulting in port "D" pin 2 going high along with ULN2003 pin 2 (pin number 15) goes low and pin 16 of ULN2003 going high. These results in pin number 16 of ULN2003 going low while pin number 15 goes high simultaneously. This causes relay 2 to switch „ON" that represents supply source from generator, thus the lamp gets supply now from the solar in the event of mains fail. After that if both main button and generator

buttons are pressed meaning both mains and generator supply fail to the micro controller input that results in port “D” pin 3 to go high at that time pin 1 and 2 go to low. Accordingly pin14 of ULN2003 goes low leaving pin16 and 15 to high such that the relay 3 is switched on while relay 1 and 2 remain in switched off condition. As the relay 3 corresponds to solar supply the lamp now gets the supply from solar. If the solar selecting button is pressed along with the main and solar button that simulates failure of main, generator, solar resulting in microcontroller pin no 4 going high leaving port 1, 2, 3 low which enables the ULN2003 pin no 13 to go low leaving pin no 16, 15, and 14 high such that relay 4 is switched ON that gets supply from the wind source. If the wind button is pressed together with main, solar, wind simulating failure of all the supply sources results in port “D” pin 1,2,3,4 which results in pin no 13,14,15,16 of the ULN2003 going high together with. Thus all the relays are off leaving no supply to the lamp. One 16 x 2 lines LCD is used to display the condition of the supply sources and the load on real time base.

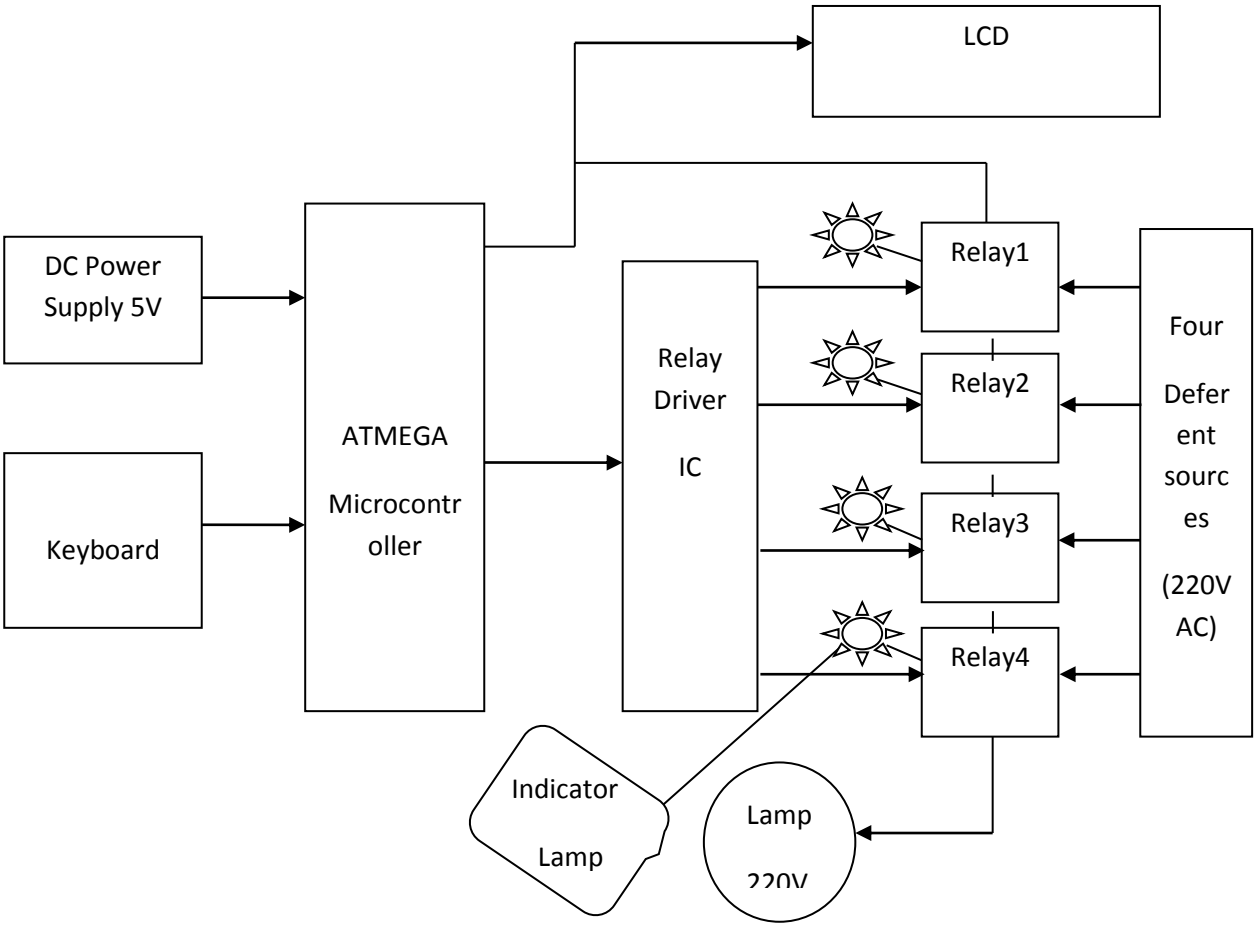

Figure 3.1: shows the project block diagram

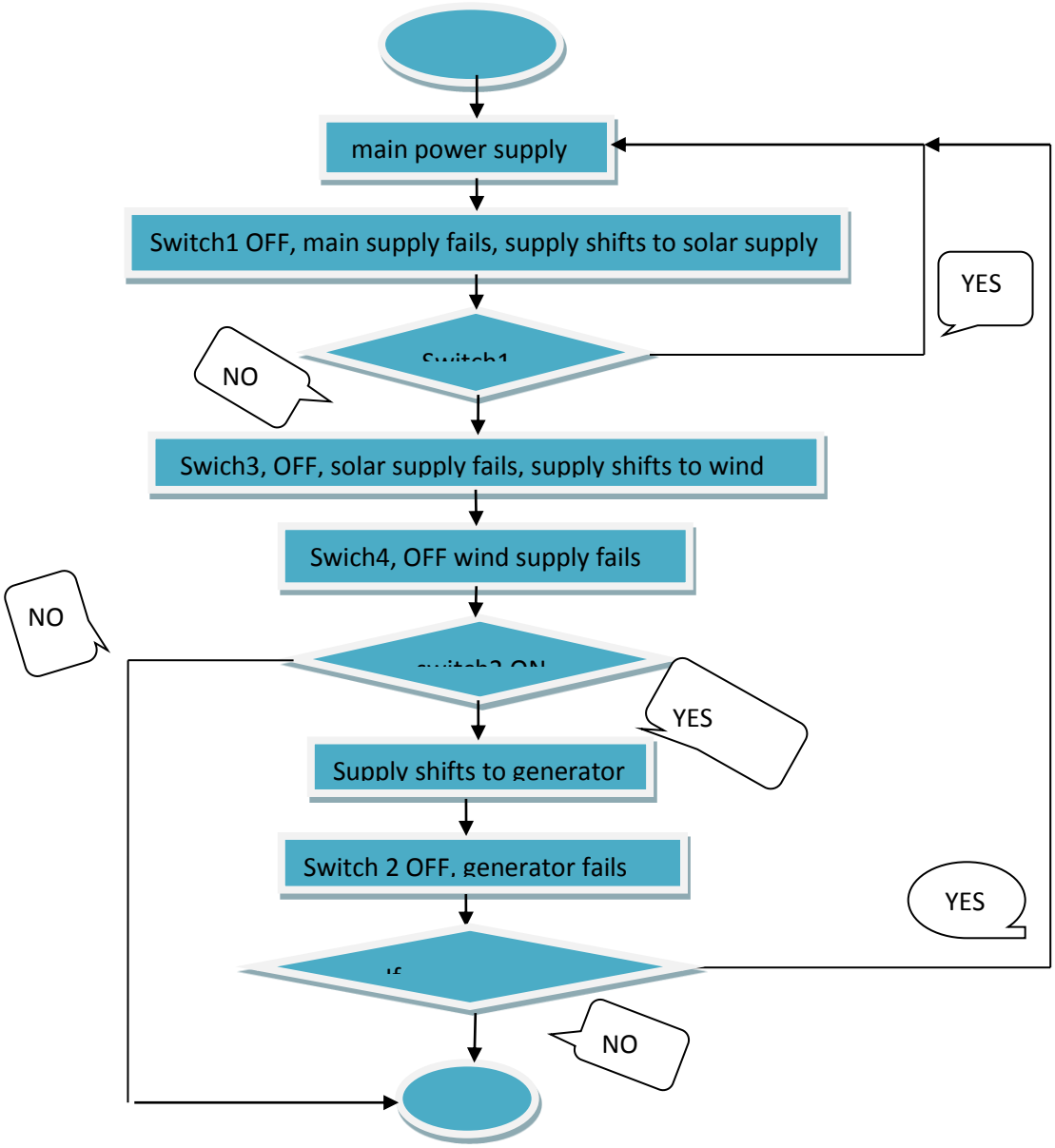

Figure 3.2: shows the project flow chart program

3.3 Hardware Equipments

3.3.1 Atmega32 8bit microcontroller

It is the control unit of the whole circuit. Which gives the command signals depending on a C program which been installed in it already.

Background

In our days, there have been so advancement in the field of Electronics and many cutting edge technologies are being developed every day, but still 8 bit microcontrollers have its own role in the digital electronics market dominated by 16-32 & 64 bit digital devices. Although powerful microcontrollers with higher processing capabilities exist in the market, 8bit microcontrollers still hold its value because of their easy-to-understand-operation, very much high popularity, ability to simplify a digital circuit, low cost compared to features offered, addition of many new features in a single IC and interest of manufacturers and consumers.

Today's microcontrollers are much different from what it were in the initial stage, and the number of manufacturers are much more in count than it was a decade or two ago. At present some of the major manufacturers are Microchip (publication PIC microcontrollers), Atmel (publication AVR microcontrollers). Our interest is upon ATmega32. It belongs to Atmel's AVR series micro controller family. Let's see the features [12].

PIN count:

Atmega32 has got 40 pins. Two for Power (pin no.10: +5v, pin no. 11: ground), two for oscillator (pin 12, 13), one for reset (pin 9), three for providing necessary power and reference voltage to its internal ADC, and 32 (4×8) I/O pins [12].

About I/O pins:

ATmega32 is capable of handling analogue inputs. Port A can be used as either DIGITAL I/O Lines or each individual pin can be used as a single input channel to the internal ADC of ATmega32, plus a pair of pins AREF, AVCC & GND (refer to ATmega32 data sheet) together can make an ADC channel [12].

No pins can perform and serve for two purposes (for an example: Port A pins cannot work as a Digital I/O pin while the Internal ADC is activated) at the same time. It's the programmers are responsibility to resolve the conflict in the circuitry and the program. Programmers are advised to have a look to the priority tables and the internal configuration from the datasheet [12].

Digital I/O pins:

ATmega32 has 32 pins (4portsx8pins) configurable as Digital I/O pins.

Timers:

3 Inbuilt timer/counters, two 8 bit (timer 0, timer 2) and one16 bit (timer1).

ADC:

It has one successive approximation type ADC in which total 8 single channels are selectable. They can also be used as 7 (for TQFP packages) or 2 (for DIP packages) differential channels. Reference is selectable, either an external reference can be used or the internal 2.56V reference can be brought into action. There external reference can be connected to the AREF pin.

Communication Options:

ATmega32 has three data transfer modules embedded in it. They are

- Two Wire Interface
- USART
- Serial Peripheral Interface

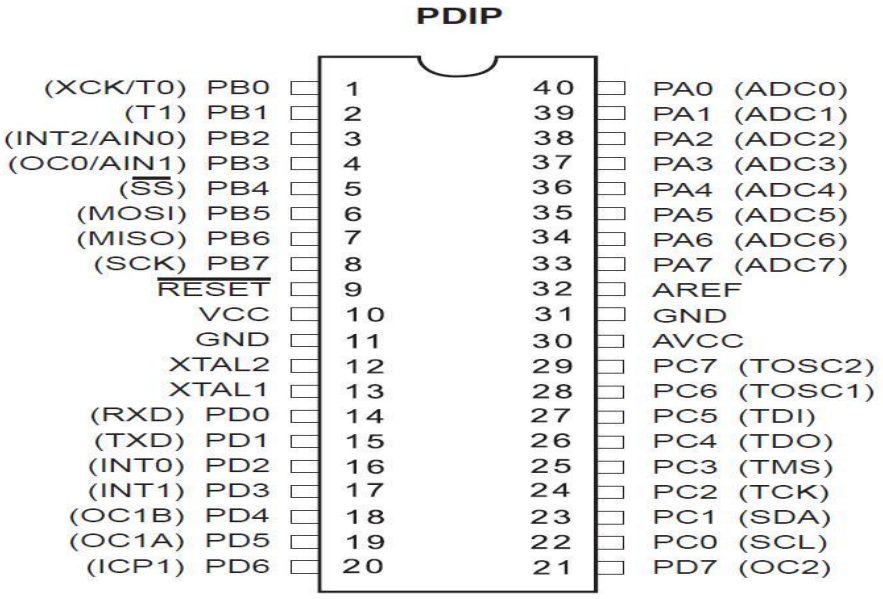

Figure 3.3 shows Atmega32 pin diagram

Analog comparator:

On-chip analog comparator is available. An interrupt is assigned for different comparison result obtained from the inputs.

External Interrupt:

3External interrupt is accepted. Interrupt sense is configurable.

Memory:

It has 32Kbytes of In-System Self-programmable Flash program memory, 1024 Bytes EEPROM, 2Kbytes Internal SRAM. Write/Erase Cycles: 10,000 flash / 100,000 EEPROM.

Clock:

It can run at a frequency from 1 to 16 MHZ. Frequency can be obtained from external Quartz Crystal, Ceramic crystal or an R-C network. Internal calibrated RC oscillator can also be used.

More Features:

Up to 16 MIPS throughput at 16 MHz .Most of the instruction executes in a single cycle. Two cycle on-chip multiplication. 32 × 8 General Purpose Working Registers

Programming:

Atmega32 can be programmed either by In-System Programming via Serial peripheral interface or by Parallel programming. Programming via JTAG interface is also possible. Programmer must ensure that SPI programming and JTAG are not being disabled using fuse bits; if the programming is supposed to be done using SPI or JTA [12].

ATMEGA block diagram:

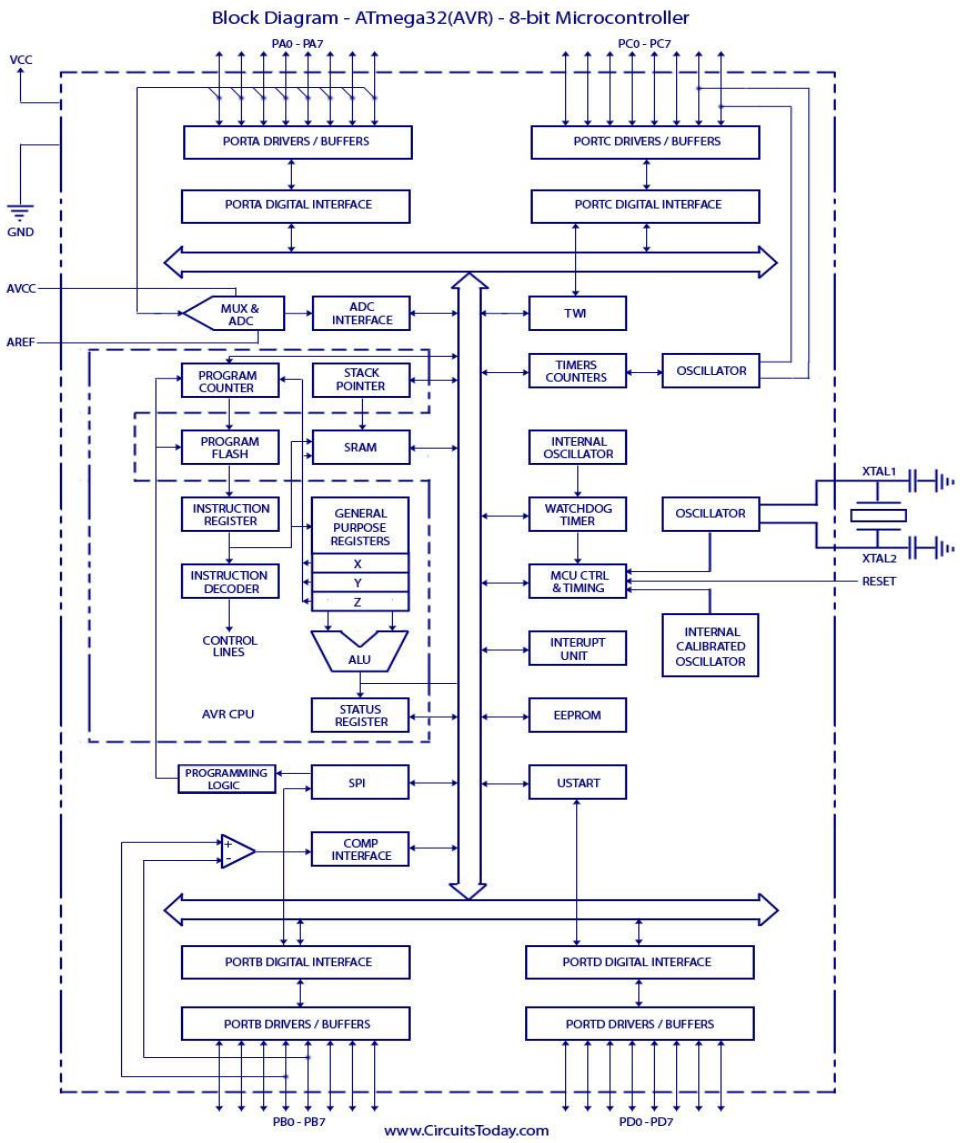

Figure 3.4: shows the ATMEGA block diagram

3.3.2 Relay

- It is an electromagnetic switch.
- Used to control the electrical devices.
- Copper core magnetic flux plays an important role here.

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches.

The relay's switch connections are usually labeled COM (POLE), NC and NO, COM/POLE= Common, NC and NO always connect to the moving part of the switch. NC = Normally Closed, COM/POLE is connected to this when the relay coil is not magnetized. NO = Normally Open, COM/POLE is connected to this when the relay coil is magnetized and vice versa.

A relay shown in the picture is an electromagnetic or mechanical relay.

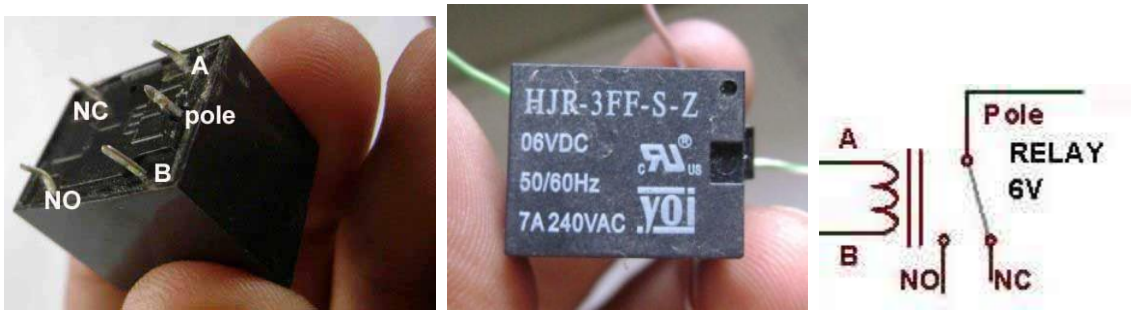

Figure 3.5: shows the actual relay and the relay circuit

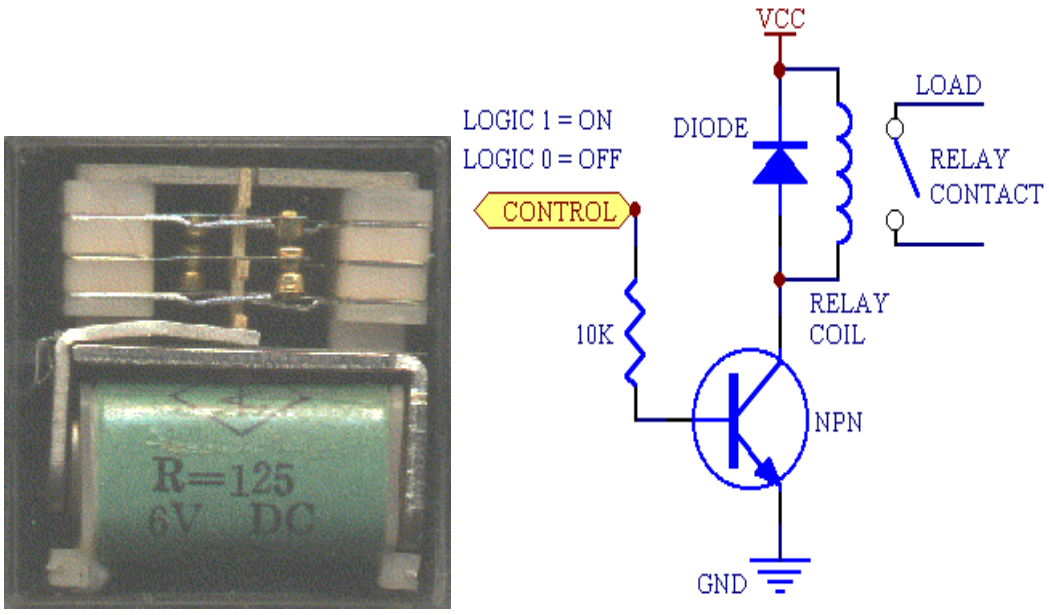

Figure 3.6: shows actual relay internal construction and internal circuit

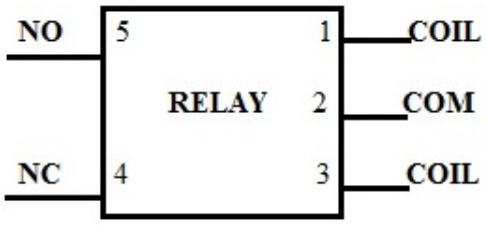

Figure 3.7: shows the relay block diagram

3.4.1Relay derive

- The ULN functions as an inverter.

- If the logic at input 1B is high then the output at its corresponding pin 1C will be low.

The **ULN2003A** is an array of seven NPN Darlington transistors capable of 500m.A, 50 V output. It features common-cathode fly back diodes for switching inductive loads. It can come in PDIP, SOIC, SOP or TSSOP packaging [13].

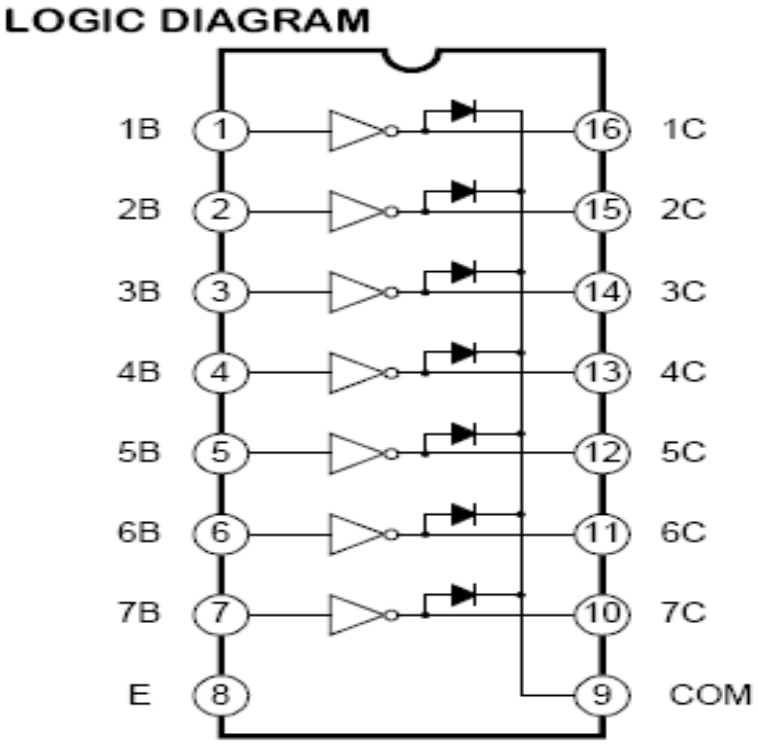

Figure 3.8: shows the relay derive IC

3.3.3 LED

LEDs are semiconductor devices are made out of silicon. When current passes through the LED, it emits photons as a byproduct. Normal light bulbs produce light by heating a metal filament until its white hot.

LEDs present many advantages over traditional light sources including lower energy consumption, longer lifetime, improved robustness, smaller size and faster switching. They do dozens of different jobs and are found in all kinds of devices. Among other things, they form numbers on digital clocks, transmit information from remote controls, light up watches and tell you when your appliances are turned on. Collected together, they can form images on a jumbo television screen or illuminate a traffic light [14].

Figure 3.9: shows actual LEDs

3.3.4 Liquid crystal LCD

- Most common LCDs connected to the microcontrollers are 16x2 and 20x2 displays.
- This means 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.
- The standard is referred to as HD44780U, which refers to the controller's chip which receives data from an external source (and communicates directly with the LCD.

LCD (Liquid Crystal Display) is an electronic display which is commonly used nowadays in applications such as calculators, laptops, tablets, mobile phones etc. 16×2 character LCD module is a very basic module which is commonly used by electronic hobbyists and is used in many electronic devices and project. It can display 2 lines of 16 characters and each character is displayed using 5×7 or 5×10 pixel matrix. Interfacing 16×2 LCD with Atmega32 Atmel AVR Microcontroller using Atmel Studio is bit complex as there is no built in libraries. To solve this difficulty we developed a LCD library which includes the commonly used features. Just include our header file and enjoy. You can download the header file from the bottom of this article. 16×2 LCD can be interfaced with a microcontroller in 8 Bit or 4 Bit mode. These differ in how data and commands are send to LCD. In 8 Bit mode character data (as 8 bit ASCII) and LCD command are sent through the data lines D0 to D7. That is 8 bit data is send at a time and data strobe is given through E of the LCD. But 4 Bit mode uses only 4 data lines D4 to D7. In this 8 bit data is divided into two parts and are sent sequentially through the data lines. The idea of 4 bit communication is

introduced to save pins of microcontroller. 4 bit communication is bit slower than 8 bit but this speed difference has no significance as LCDs are slow speed devices. Thus 4 bit mode data transfer is most commonly used [15].

Figure 3.10: shows actual LCD

3.6.1 LCD connections

- If an 8-bit data bus is used the LCD will require 11 data lines (3 control lines plus the 8 lines for the data bus).
- The three control lines are referred to as EN, RS, and RW.
- EN=Enable (used to tell the LCD that you are sending it data).
- RS=Register Select (When RS is low (0), data is treated as a command) (When RS is High (1), data being sent is text data).
- R/W=Read/Write (When RW is low (0), the data which written to the (LCD) (When RW is low (0), the data reading to the LCD) [15].

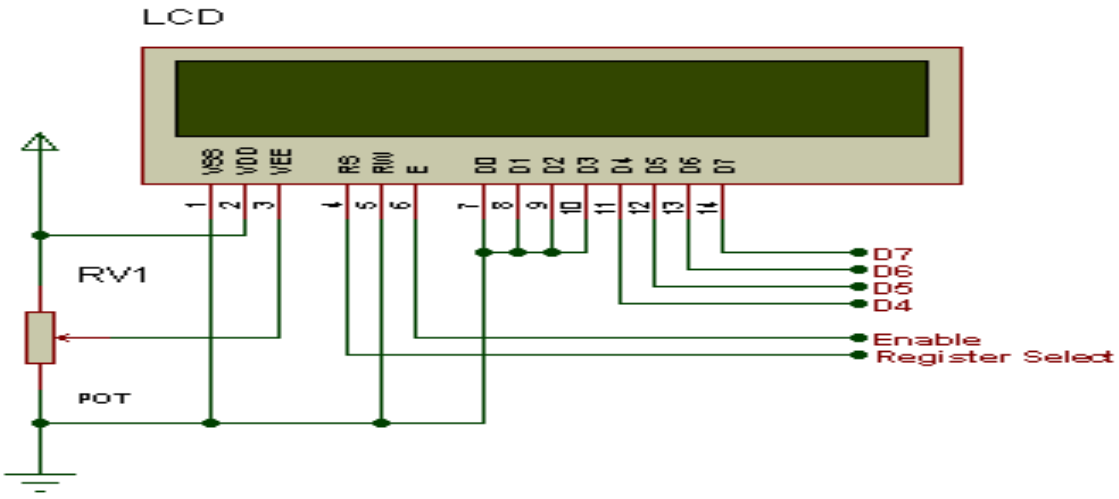

Figure 3.11: shows LCD's connections

8 mode interfacing

Circuit diagram:

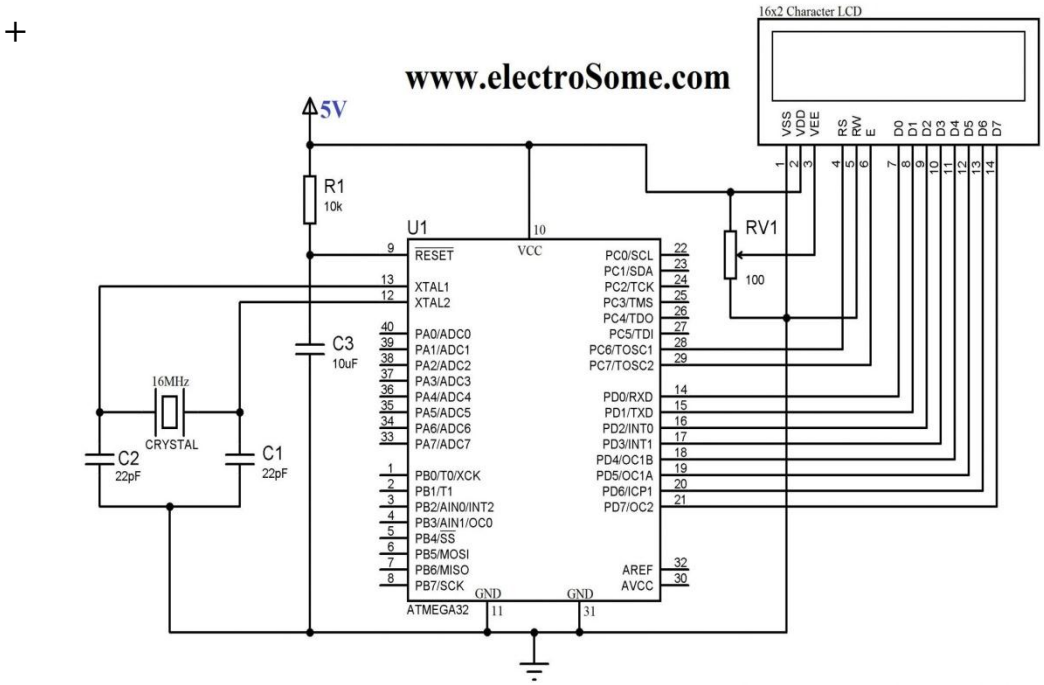

Figure 3.12: shows LCD's 8 mode interfacing

4 Bit Mode Interfacing

Circuit Diagram

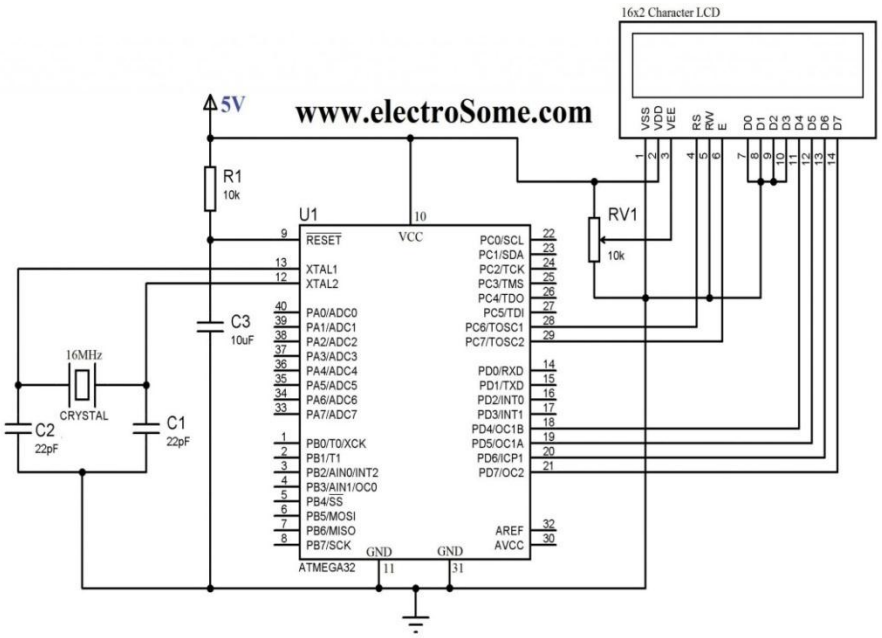

Figure 3.13: shows LCD's 4 mode interfacing

CHAPTER 4

RESULTS, CIRCUIT OPERATION AND SIMULATION

4.1 Practical Model Result

Figure 4.1: shows the practical circuit result

4.2 Project Simulation

4.2.1 First, initial state:

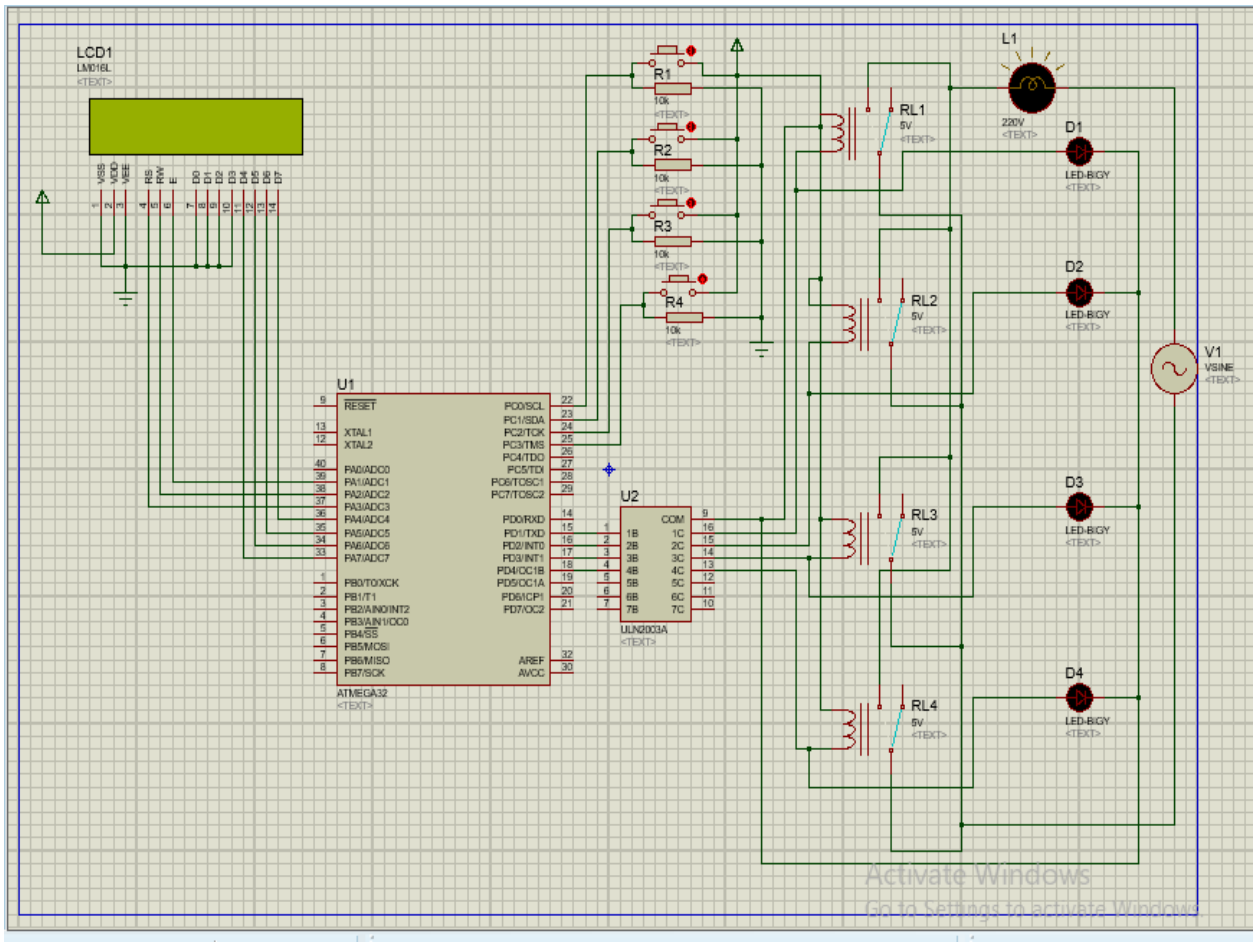

Figure 4.2: shows the project simulation when all switches are OFF

It is clear that when all switches are OFF there's no power being supplied to the load or the (220V) Lamp.

4.2.2 Second, when the main supply is active:

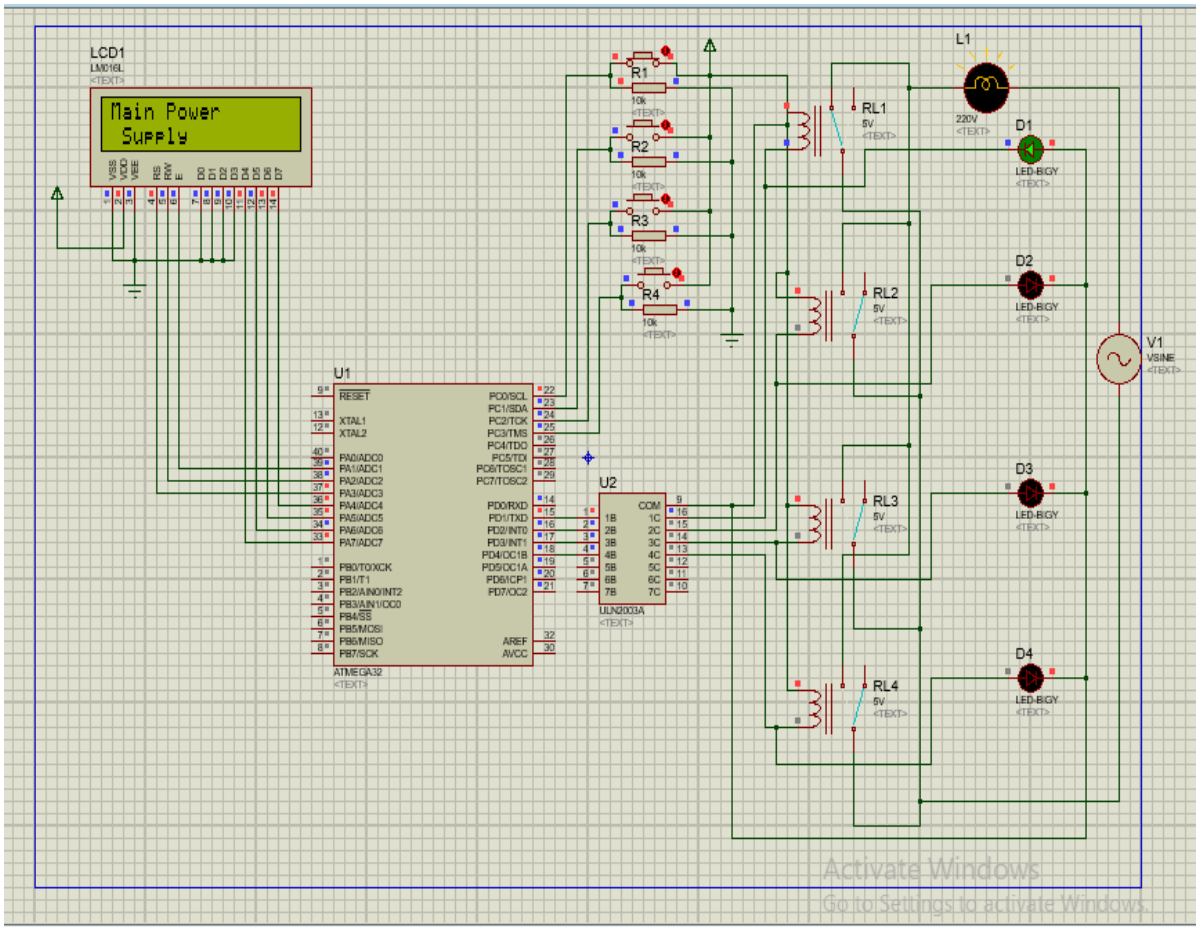

Figure 4.3: shows the project simulation when switch 1 is ON

It is obvious that when switch (1) is ON the active source is the main power supply as shown in the screen. The indicator lamp (D1) as shown in figure (12) above, indicates that the relay which supplying power to the (220V) lamp is the relay which representing the main supply source.

4.2.3Third, the main supply fails:

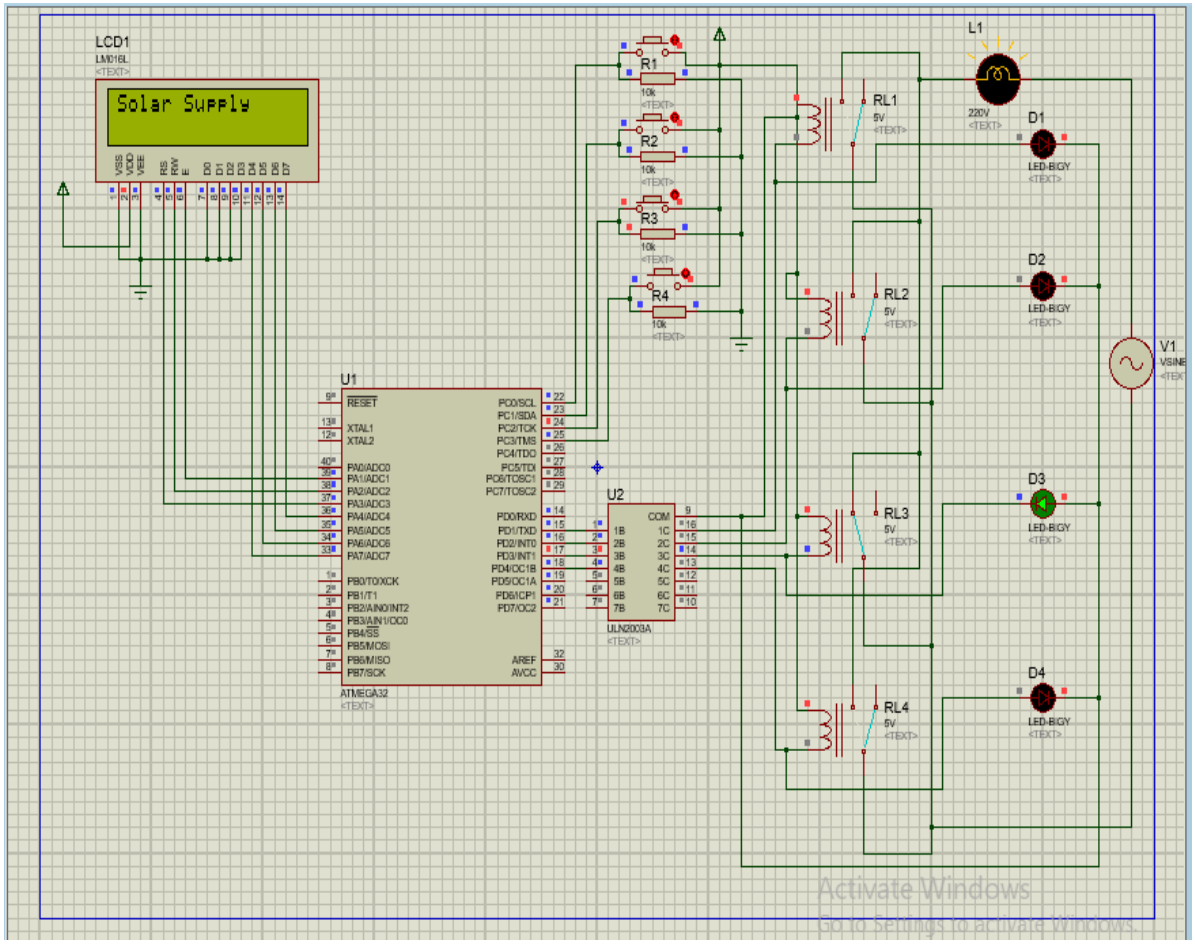

Figure 4.4: shows the project simulation when the solar supply is active

As switch (1) is OFF, this represents a fault being happening within the main power supply. So the circuit shifts immediately to the solar supply, the screen status and the indicator lamp (D3) as shown in figure (13) above, indicates that the (220V) lamp is being fed from relay (2) which representing the solar supply.

4.2.4 Fourth, when the solar supply fails:

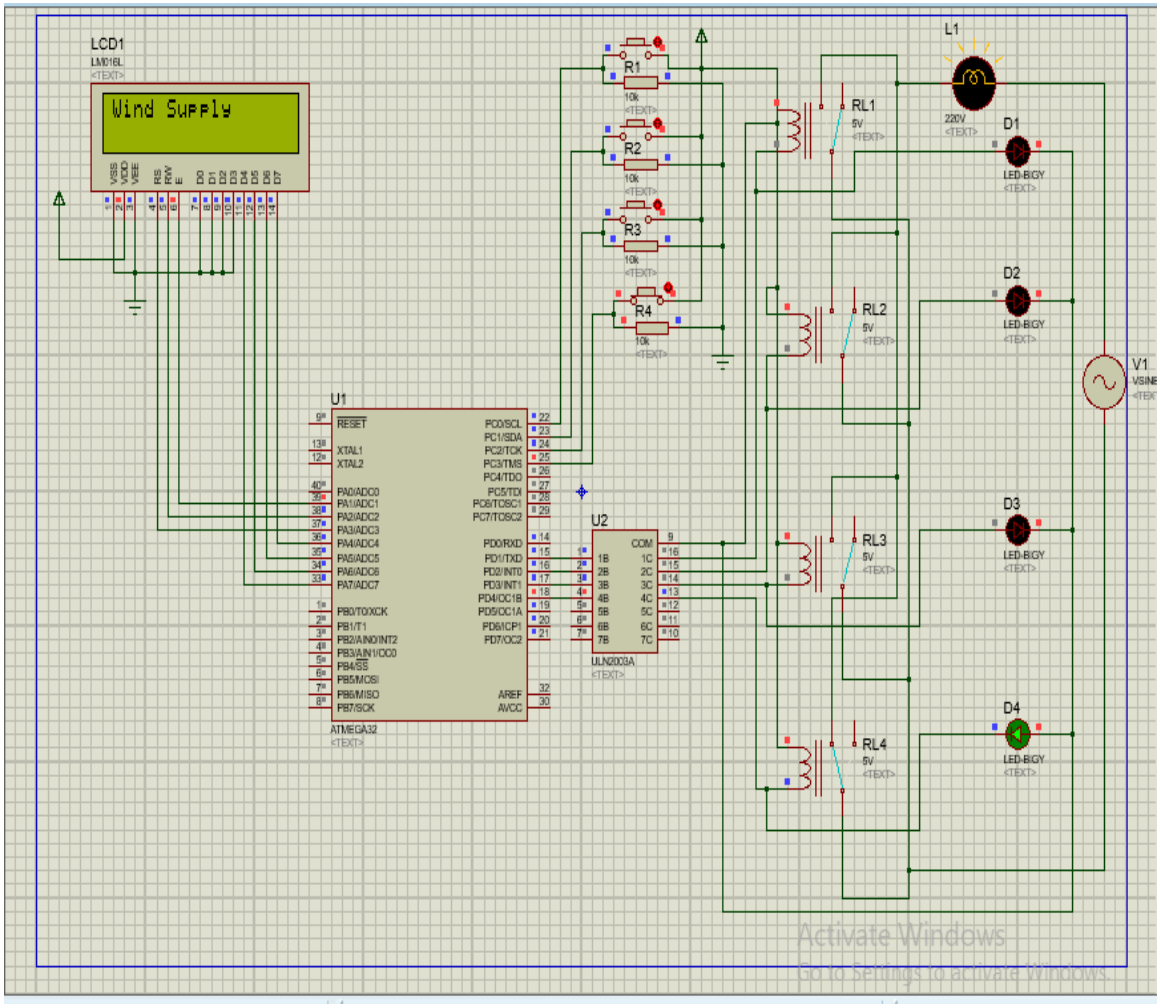

Figure 4.5: shows the state when the solar supply fails

Similarly, when switch (3) which is representing the solar supply is OFF, it is considered as a fault occurring with the solar supply or a battery outage situation. Thus, the supply shifts immediately to the wind supply. And the screen status as well as the indicator lamp (D4) as shown in figure (14) above, indicates that the (220V) lamp is being fed from the wind supply.

4.2.5 Fifth, when the wind supply fails:

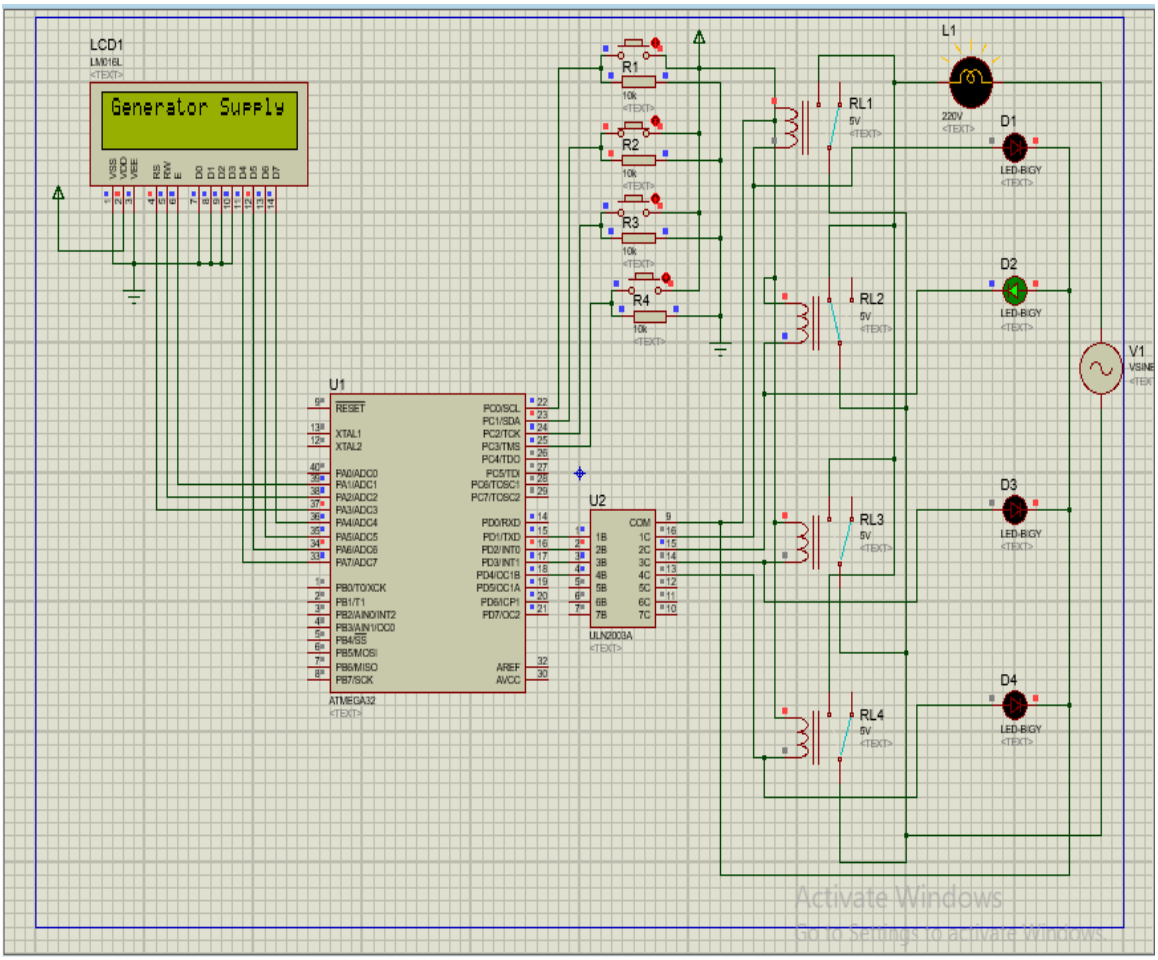

Figure 4.6: shows the state when the wind supply fails

When switch (4) is OFF, this represents a fault occurring within the wind supply or a battery outage situation. So, the supply will shift to the generator supply only if switch (2) is ON. As shown in the figure (15) above the screen status and the indicator lamp (D2) indicates that the (220V) lamp is being fed from relay (2) which represents the generator supply.

4.3 Circuit Operation

From the previous simulation it's clear that, this circuit we've designed shifts between the supplies both automatically and manually as every switch is connected to a certain relay, and all the relays are connected in parallel to the load which means the load can be fed separately from any source. Thus, if we want the circuit to shift automatically between the sources all the backup sources need to be switched ON, and if all the switches were turned ON the load will be fed from the first order source typical to the sequence being set in the "C" language "code", in other words if all the switches were turned ON say, (switch 2, 3, 4) only the relay related to the switch on top of the sequence will be energized feeding the load which is relay (2) .The sequence we used in shifting between the different sources is as follows: (The main power supply, the solar supply, the wind supply and the generator supply). First of all, we put the generator supply at the tail of the sequence because of its high operating cost when being compared with the other sources, because of the increasing cost of fuel which is needed to run the generator. Secondly, although the generator is in the tail of the sequence but, the switch which representing the generator is the second switch after the main supply switch, because in the case of emergency the generator need a time give a stable output. So, the generator switch will be kept always opened and the circuit will not run the generator automatically, but it will jump to the solar or the wind supply and as we know solar and wind power will not remain for a long time but it will give the user sufficient time to turn ON the generator and keep the load's power uninterrupted.

As we mentioned earlier in this report, we have used a microcontroller from “ATMEGA 32” family which can be programmed in many ways. Thus, we used a “C” language program so as to make the microcontroller controls the circuit as we need. Through this program or code we can control what will appear in the screen, what sequence we want to use in the control process. In other words, the code which will be burnt at the microcontroller will determine every single step that would be taken during the control process.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This project intended to design an auto power control of four different sources circuit, the main scope of this paper is to provide a continuous power supply to the load through any of the sources in the absence of any source. Taking in consideration the use of the source whose cost is the lowest then, the higher and so on.

The first stage was to provide the four different sources, as it's not practicable to do so at the moment we connected four lines to a particular load which is a 220-V lamp each line connected to a 5-V relay representing the four sources. The second stage was to control the circuit with the aid of ATMEGA-32 microcontroller by burning a C language program into the ATMEGA-32. To sum up, the objectives which were stated in the first chapter were met successfully.

The significance of this paper lies in its various advantages and wide places of applications where this project can be used efficiently.

5.2 Recommendation

Although this paper went along way on designing some sort of an uninterruptable power supply but there are some important elements which are needed to be added .The circuit can be further enchanted by adding battery tracker so as to show the power level in the battery in order to help in the control arrangements. In addition to GSM which can be used as a remote control as well as to know the power status from outside the home or company which put our circuit in use. Also the circuit can be provided by a voltage monitoring system so the circuit can respond not only to faults but also to small voltage interruptions i.e. over and under voltage, harmonics, sages and etc.

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Appendix A

The project “c” language program “code”:

```
/**********************

#include <stdio.h>

#include <mega16.h>

#include <io.h>

#include <alcd.h>

void main(void)

 {

// Alphanumeric LCD initialization

// Connections are specified in the

// Project|Configure|C Compiler|Libraries|Alphanumeric LCD menu:

// RS - PORTA Bit 3

// RD - PORTA Bit 2

// EN - PORTA Bit 1

// D4 - PORTA Bit 7

// D5 - PORTA Bit 6
```

```
// D6 - PORTA Bit 5
// D7 - PORTA Bit 4
// Characters/line: 16
DDRC=0x00;
PORTC=0x00;
DDRD=0xff;
PORTD=0x00;
lcd_init(16);
lcd_clear();
while (1)
      {
      if(PINC.0==1)
      {
      lcd_gotoxy(0,0);
      lcd_puts("Main Power     ");
      lcd_gotoxy(1,1);
      lcd_puts("Supply         ");
      PORTD&=~(1<<2);
      PORTD&=~(1<<3);
```

```
PORTD&=~(1<<4);
PORTD|=0x02;
}
else if(PINC.1==1)
{
lcd_gotoxy(0,0);
lcd_puts("Generator Supply");
lcd_gotoxy(1,1);
lcd_puts("                ");
PORTD&=~(1<<1);
PORTD&=~(1<<3);
PORTD&=~(1<<4);
PORTD|=0x04;
}
else if(PINC.2==1)
{
lcd_gotoxy(0,0);
lcd_puts("Solar Supply      ");
lcd_gotoxy(1,1);
```

```
lcd_puts("                ");
PORTD&=~(1<<1);
PORTD&=~(1<<2);
PORTD&=~(1<<4);
PORTD|=0x08;
}
else if(PINC.3==1)
{
lcd_gotoxy(0,0);
lcd_puts("Wind Supply      ");
lcd_gotoxy(1,1);
lcd_puts("                ");
PORTD&=~(1<<1);
PORTD&=~(1<<2);
PORTD&=~(1<<3);
PORTD|=0x10;
}
else
{
```

```
lcd_clear();
PORTD=0x00;
}
}
}
```