

IOT BASED AUTO POWER SUPPLY CONTROL FROM FOUR DIFFERENT SOURCES

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Engineering Degree in
Electrical and Electronics Engineering

by

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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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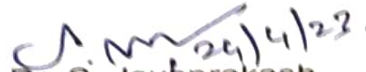
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **SRIDHAR.P** (Register No. 39140055) and **HRITHIK.S** (Register No. 39140703) who carried out the project entitled "**IOT BASED AUTO POWER SUPPLY CONTROL FROM FOUR DIFFERENT SOURCES**" under our supervision from November 2022 to April 2023.


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ABSTRACT

The primary objective of this project is to ensure continuous power supply to a load by selecting the power source automatically from any of the four sources, namely solar, wind, battery, and main power supply. The growing need for electricity in various sectors, including banks, schools, hospitals, and industries, has highlighted the adverse effects of frequent power cuts. This project aims to provide an alternative arrangement for power supply in such situations. The system is designed to utilize an Arduino microcontroller and relays to switch between different power sources automatically. When a source fails, the supply automatically shifts to the next priority source. This feature ensures uninterrupted power supply to the load, even if one of the sources fails. The proposed system is not only cost-effective but also environmentally friendly since it uses renewable energy sources such as solar and wind power. This feature is particularly important given the increasing concerns over the depletion of non-renewable energy sources and the negative impact of conventional energy production on the environment. Moreover, the proposed system can be further enhanced by incorporating monitoring sensors to measure the energy consumption of the load and adjust the power supply accordingly. This will optimize the energy consumption, reduce wastage, and increase the efficiency of the system. In summary, the project aims to address the issues associated with frequent power cuts by providing an alternative arrangement for power supply using renewable energy sources. By incorporating advanced technologies such as microcontrollers, relays, and monitoring sensors, the proposed system can ensure uninterrupted power supply and optimize energy consumption while reducing the overall cost of electricity.

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CHAPTER -1

1.1 GENERAL INTRODUCTION:

The problems of environmental sustainability and energy saving are universal and common to all countries and regions worldwide. The interdependence of climatic and environmental factors is a reality that makes all countries and all citizens equally responsible for the present ecological problems, which will inevitably worsen if we are not all aware and supportive of their mitigation, if not prevention.

The first and possibly most effective measure for reversing the general trend is certainly the informing and mobilization of the public, and especially of the professionals, for a deeper understanding and accountability, leading to systematic interventions for the resolution of these problems.

The awareness of any problems affecting human society is surely proportional to the mobilization capacity of the media, the degree of literacy of the people, the cultural level of the information professionals, and, especially, of the education system's ability to frame and focus the education of the child, adolescent and adult, in this case, on the problems of sustainability and environmental balance.

All these capabilities are still in their infancy in Africa. Therefore, any threat to current life that is not objective, immediate and tangible tends to be perceived by most people as not requiring a short or even long-term change of attitude. The issues of sustainability and climate change are frequently considered as belonging to rich countries. The African continent, despite its low levels of industrialization and consumerism, is in a more vulnerable position than developed and highly industrialized countries. Hyper-consumerism should not be an aspiration for developing countries, which sometimes mistakenly adopt Western trends. There is a latent need not to follow

the bad examples of the [industrialized world](#), and to preserve a quality that can be considered as intrinsic to the lack of financial wealth, which is the ability to recycle and take advantage of existing resources.

For a very long time, power outages, power interrupts and also unexpected routine power line maintenance is one of the major problems faced in industries, hospitals, offices, and homes all over the world. For that case, this project provides an automatic operation of electrical power distribution systems; the rapid and reliable transfer of the system from one power source to another during specific events such as power outages, power interrupts, routine power line maintenance, to achieve the reliability of such systems.

Electrical power supply is one of the primary essential needs of human life today, that is to say, without electrical power supply, most human works become stand still, postponed and even cancelled since most human actions are dependent on the electrical power supply. Furthermore, the need for power supply through access to electricity by the masses of the population of any country, both developed and developing countries is very important to the development of the economy of that particular country. In other words, the power sector plays an essential role in the socio-economic development of any country.

We are implementing these proposed system with the combination of renewable energy , normally now a days were using standard solar only that is cost is high and efficiency also not enough , But in our system we were using hybrid energy sources to improve the efficiency and to provide a continuous power supply , this system will help us to overcome all the damages(Faultages) of power supply.



Fig 1.1 Combination of renewable energy sources

1.2 OBJECTIVES

The main objective of this project is to provide continuous and uninterrupted power supply.

For that we are using our system Solar, wind, battery and main supply.

1.3 MOTIVATION

- (i). To improve the efficiency of the power supply system by using the hybrid renewable energy sources.
- (ii). To avoid the power interrupt and power faults.
- (iii). To obtain the continuous power supply without interruption.

CHAPTER- 2

2.1 INTRODUCTION

A literature survey on “IoT Based Auto Power Supply Control From Four Different Sources” Electrical power supply is one of the primary essential needs of human life today, that is to say, without electrical power supply, most human works become stand still, postponed and even cancelled since most human actions are dependent on the electrical power supply. Furthermore, the need for power supply through access to electricity by the masses of the population of any country, both developed and developing countries is very important to the development of the economy of that particular country. In other words, the power sector plays an essential role in the socio-economic development of any country.

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2.2 LITERATURE SURVEY

Abdurrahman Shuaibu Hassan and et.al (2008)is designed to automatically supply continuous power to a load through one of the four sources of supply in(2008) that are: solar, mains, thermal, and wind when any one of them is unavailable. The four switches represent the four causes. The switches are 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. A lamp or bulb is used as a load for demonstration purposes which draws power from main. When the primary fails to supply power, automatically the next available source is used like thermal. If thermal fails then the next one is used and so on. An LCD is used to show which power supply is on.

John Conscience Ehiabhili and et.al(2008) Over the past decade, there has been drastic improvement and advancement in consumer electronics and embedded systems. Various home appliances such as light bulbs, fans, television sets, CD players etc. are set to realize switching control using a coded smartphone. This has given rise to a home environment where appliances can be connected and controlled at a distance. This project demonstrates the design of an automated system to assist and provide support in order to fulfil the needs of the physically disabled and elderly ones in controlling electrical appliances in homes. The main control system implements wireless Bluetooth technology to provide remote access from our smartphones to a Bluetooth module and then to a control and switching unit. Bluetooth wireless connection enables the system to communicate with a java application on an Android smartphone without cable. The user can easily touch on the screen of the phone to control the home appliances. This portable method is able to assist the disabled, sick and elderly people who have difficulties with locomotion. This system is intended to control electrical appliances and devices in house with relatively low-cost design, user friendly interface and ease of installation.

Jonathan and et.al (2007) is 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 causes. The switches are 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. A lamp or bulb is used as a load for demonstration purposes which draws power from the main. When the primary fails to supply power, automatically the next available source is used as thermal. If thermal fails then the next one is used and so on. An LCD is used to show which power supply is on.

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Potru Sai Krishna (2019) is to provide continuous power supply to a load, by selecting the supply. Power is the most important requirement for all of us. We know that due to large demand for electricity and due to the limited capacity of power plants at generating stations, power cut off is common for all us. Due to limited amount of power generation at power stations and due to shortage of nonrenewable continuous supply sources it brings a biggest challenge in the whole world. If you see all around us you will observe that due to discontinuity of power supply, many problems have been faced by people in their everyday use. This type of power failure creates problems for data centers, hospitals and some research work. This is the biggest reason that every country is researching the work to supply a continuous power with good efficiency and with good regulation. In this project we can combine the renewable and non-renewable energy sources to get the continuous power supply such as mains, solar, battery, adapter. The power cut of these sources can be manually done by switches. The continuous supply to load can be given by automatic operation of relay, relay driver IC with the help of Arduino microcontroller.

L.S. Eczema, B.U. Peter ,O.O. Harris (2019) This has adverse effects on the consumers of the electricity and the equipment that are operated from the mains sources of electricity supply in these parts of the world. In this, we provide an automatic switching mechanism that transfers the consumer loads to a power source from a generator in the case of power failure in the mains supply. It automatically detects when power has been restored to the mains supply and returns the loads to this source while turning off the

power from the generator set. This mechanism has been tested and we recorded a great result. It thus holds an important key in the provision of a continuous power supply through a near seamless switching between the mains supply and an alternative standby source like the generator set.

2.3 PROBLEM STATEMENTS

The problem statement of the proposed IoT-based auto power supply control system is to develop a more efficient and reliable solution to switch over the load to different available sources automatically, ensuring uninterrupted power supply. The existing system requires manual intervention and does not provide information on the energy levels of the sources. The proposed system aims to overcome these limitations by utilizing the latest IoT technology to collect information about different sources, including their availability, and automatically switch to the next available source when the main supply fails. The system also operates in two modes, automatic and manual, and can be controlled using a mobile application. The problem statement, therefore, is to design and implement an IoT-based system that is efficient, reliable, and provides uninterrupted power supply to critical systems.

2.4 CONSTRAINTS & TRADE-OFFS

Based on the information provided, the proposed system has several advantages over the existing system, including the ability to operate the system from different locations, collect information about the different sources, switch between sources automatically, and control the system through a mobile application or switches. However, the proposed system also has some potential constraints and trade-offs that need to be considered, including:

Constraints:**Cost:**

The proposed system may require more expensive components such as IoT technology, cloud services, and Wi-Fi modules, which may increase the overall cost of the system.

Complexity:

The proposed system is more complex compared to the existing system, which may require additional technical expertise to install and maintain the system.

Dependence on technology:

The proposed system depends on technology such as IoT and cloud services, which may experience technical issues or failures that could affect the system's overall reliability and performance.

Power consumption:

The proposed system may consume more power due to the use of additional components such as the Wi-Fi module, which may increase the system's energy requirements.

Trade-offs:**Flexibility vs. Control:**

The proposed system provides more flexibility by allowing users to control the system from different locations. However, this could also mean less direct control over the system, which may increase the risk of errors or miscommunication.

Automation vs. Manual control:

The proposed system provides more automation by switching between sources automatically. However, manual control may still be required in some situations, which could increase the risk of errors or human intervention

Reliability vs. Cost:

The proposed system aims to provide a more reliable power supply by switching between sources automatically. However, this may come at a higher cost due to the use of additional components such as IoT technology and cloud services.

Maintenance vs. Complexity:

The proposed system may require more maintenance due to its increased complexity compared to the existing system. However, this may also result in a more efficient and reliable system in the long term.

Overall, the proposed system has several advantages over the existing system, but it also has some potential constraints and trade-offs that need to be considered before implementing the system. It is important to carefully evaluate the system's requirements, costs, and benefits to determine if it is the best solution for the project.

2.5 STANDARD

The IEEE Standard adapted for this project are

IEEE 1547 - 2011

IEEE 2030 - 2018 and IEEE 1547-2019

2.5.1 TERMINOLOGY

IEEE 1547-2011: This standard specifies the requirements for interconnecting distributed energy resources (DERs) with electric power systems, including multiple sources such as solar, wind, hydro, and fuel cells. It covers various aspects of power quality, safety, and control for DERs, which can be useful for designing an auto power supply system that combines multiple sources.

IEEE 2030-2018: This standard defines the communication protocols and information models for the interoperability of DERs and other grid devices. It supports various types of communication interfaces, such as wired and wireless, and can help facilitate the integration of multiple sources in an auto power supply system.

IEEE 1547-2019: This standard provides guidelines for the design, installation, operation, maintenance, and testing of microgrids, which are self-contained power systems that can operate independently or in parallel with the main grid. It includes requirements for multiple sources, such as renewable energy sources, storage systems, and backup generators, and can be a useful reference for designing an auto power supply system with multiple sources.

CHAPTER - 3

3. AIM AND SCOPE OF THE PRESENT INVESTIGATION

3.1 INTRODUCTION

The availability of a stable power supply is crucial for the smooth operation of critical systems, such as hospitals, data centers, and industrial plants. However, power failures and interruptions are still common occurrences, causing significant financial losses and disruption of essential services. Therefore, developing an automated power supply control system that can provide an uninterrupted power supply to critical systems is vital.

3.2 OBJECTIVE

The objective of this project is to design and develop an automated power supply control system that can switch over to an alternative power source without any interruption to the load. The proposed system will utilize IoT technology, an Arduino microcontroller, and cloud computing to automate the power supply control system's operation.

The system will be designed to provide continuous power supply automatically, switching over to the next available source when the primary power supply fails, ensuring an uninterrupted power supply to the load.

Additionally, the system will include a mobile application for remote control and monitoring, providing real-time data about the power supply status and energy consumption. The proposed system's flexibility and automation will make it an excellent choice for ensuring uninterrupted power supply to critical systems.

3.3 SCOPE OF THE PROJECT

The scope of the auto power supply control system project is to design and develop a reliable and efficient way to switch over the load to other available sources without any downtime or disruption to the load. The proposed system utilizes the latest technology of IoT to operate the system from different locations. The system makes use of an Arduino Microcontroller, Relay drivers, IoT technology, an LCD, and a Load. With this technology, we can collect information about the different sources, including whether the switch is ON or OFF.

The system uses four different sources, namely solar, wind, battery, and mains, and automatically switches to the next available source when the main supply fails. This ensures an uninterrupted power supply. The continuous supply to the load is given by the automatic operation of the relay, relay driver IC, and the Arduino microcontroller.

The system operates in two modes: Automatic and Manual. In Automatic mode, the system operates as per the given commands, and in Manual mode, users can control the system through a mobile application or switches. Cloud technology is used to control or access information about the system from any location, allowing authorized persons to control the process through the mobile application.

The scope of the project includes the following:

Designing and developing the auto power supply control system using an Arduino microcontroller, relay drivers, IoT technology, an LCD, and a load.

Integrating the system with four different sources of power, namely solar, wind, battery, and mains.

Developing the system to automatically switch to the next available source when the main supply fails.

Developing the system to operate in Automatic and Manual modes.

Developing a mobile application for the Manual mode operation of the system.

Using cloud technology to control or access information about the system from any location.

Testing and validating the system to ensure reliable and efficient operation.

Overall, the scope of the project is to design and develop an auto power supply control system that provides a reliable and efficient way to switch over the load to other available sources without any downtime or disruption to the load, ensuring uninterrupted power supply to critical systems.

3.4 METHODOLOGY

Methodology refers to the overall approach or framework you will use to conduct your research or complete your project. It includes the steps, procedures, and techniques you will use to collect and analyze data or information.

Here are some general steps you can follow to develop a methodology for your project:

Define your research question or problem statement:

Start by clearly defining the research question or problem statement that your project aims to address. This will help you to identify the scope of your research and the data you need to collect.

Conduct a literature review:

Conduct a literature review to identify relevant theories, concepts, and previous studies related to your research question. This will help you to identify potential research methods and techniques that have been used in similar studies.

Identify your research approach:

Based on your research question, identify whether your research approach will be qualitative, quantitative, or mixed methods. This will help you to identify the appropriate data collection and analysis techniques.

Select your research participants:

If your project involves collecting data from people, identify the appropriate sample population and determine the sampling method.

Choose your data collection methods:

Choose appropriate data collection methods based on your research question and research approach. These may include interviews, surveys, observations, or experiments.

Analyze your data:

Once you have collected your data, analyze it using appropriate data analysis techniques. These may include statistical analysis, content analysis, or thematic analysis.

Interpret your findings:

Based on your data analysis, interpret your findings and draw conclusions about your research question or problem statement.

Present your results:

Finally, present your results in a clear and concise manner, using appropriate visuals and explanations.

These are some general steps you can follow to develop a methodology for your project. However, the specific methodology you use will depend on the nature of your research question or problem statement, as well as your research approach and data collection methods.

3.5 EXISTING SYSTEM

The auto power supply control system described in this paragraph is designed to switch over the load to other available sources without any downtime or disruption to the load. The existing system uses a microcontroller, relay driver, and selection keys to demonstrate the corresponding failure of the power supply. The selection keys are connected as input signals to the microcontroller, which is an 8051 microcontroller in this system. From the microcontroller, the relay driver IC collects the output. Each source contains one relay that provides access to the source that needs to be activated and the source that is active at that moment. The selection keys are used to change the sources.

The microcontroller in this system always senses all the available sources, and when any source is switched off through the selection keys, the microcontroller shifts the load to the other supply source by sending a signal to the relay driver IC. The relay driver IC then switches on the appropriate load relay, and the entire process is completed in microseconds. During the programming of the microcontroller, the shifted time can be adjusted. In this system, four load relays are used, which are connected in parallel with the load, and four sources of supplies are also connected in parallel with these load relays. These load relays consist of normally open and close contacts and are operated through the relay driver IC.

To test the system, a lamp was connected at the output side as a load. When any interruption takes place during the shifted time, the lamp should blink, but in this system, there is no blinking taking place during the shifted time, indicating that there is no interruption in the power supply to the output side. This auto power supply control system provides a reliable and efficient way to switch over the load to other available sources without any downtime, ensuring that the load always has access to a stable power source.

3.6 DISADVANTAGES OF EXISTING SYSTEM:

- The current working status of our sources is unknown.
- Switching between sources requires the use of selection keys, which consumes manual power and can be time-consuming.
- Accessing these systems becomes impossible if someone is not present at the location.
- The availability of sources cannot be justified, and we are unable to identify which sources have insufficient energy to supply power.
- Fig. 3.1 shows the block diagram of the existing system, which includes a Microcontroller, Selection keys, Relay drivers, LCD Display, Transformer, Rectifier, and four sources.
- When the main power supply fails, the other sources provide power to the load.
- We must use the selection keys to choose which source to use, and this information is sent to the microcontroller.
- The microcontroller then communicates with the relay driver to select the appropriate source and supply power to the load.
- Finally, the LCD display shows which source is currently active.
- However, this system has some limitations, such as the time it takes to switch between sources, the need for manual intervention, and the lack of information on the energy levels of the sources.

3.7 BLOCK DIAGRAM OF EXISTING SYSTEM:

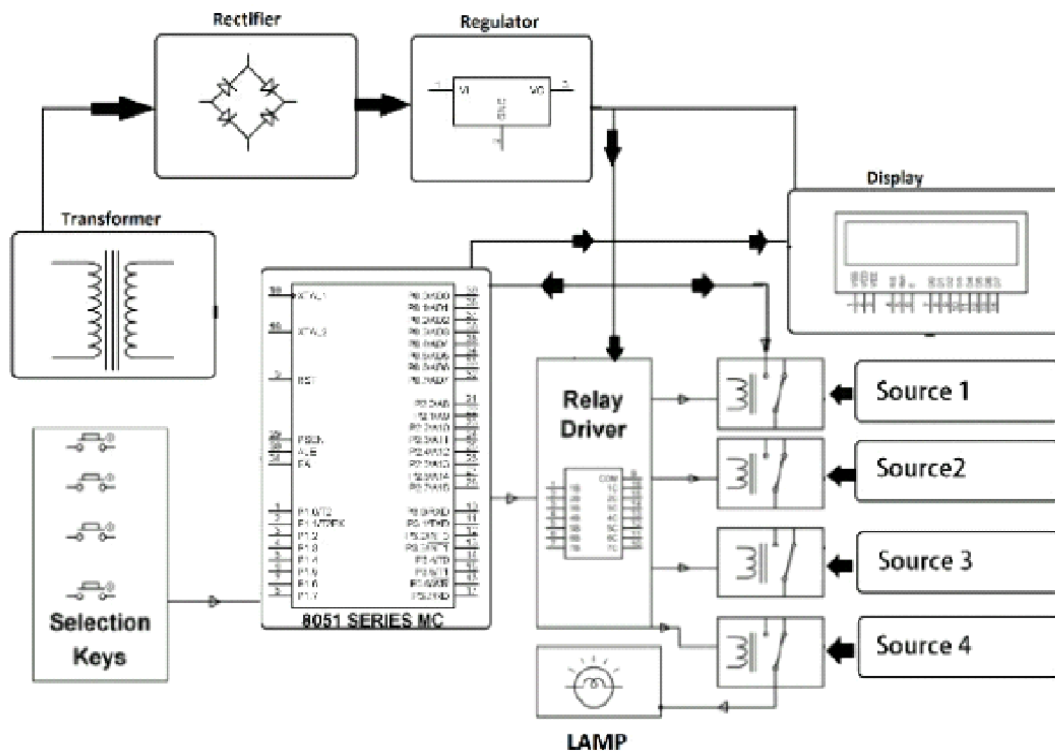


Fig 3.1 Block diagram of existing system

3.8 COMPONENTS USED IN EXISTING SYSTEM:

- Microcontroller
- Relay drivers
- Selection keys
- Load
- Solar Panel
- Adapter
- Battery
- Relays

3.9 PROPOSED SYSTEM:

The proposed system utilizes the latest technology of IoT to operate the system from different locations. The system makes use of an Arduino Microcontroller, Relay drivers, IoT technology, an LCD, and a Load. With this technology, we can collect information about the different sources, including whether the switch is ON or OFF. The output of the Arduino microcontroller is connected to the relay drivers, which activate the correct sources and supply power to the load. The system uses four different sources, namely solar, wind, battery, and mains, and automatically switches to the next available source when the main supply fails. This ensures an uninterrupted power supply. The continuous supply to the load is given by the automatic operation of the relay, relay driver IC, and the Arduino microcontroller.

The system operates in two modes: Automatic and Manual. In Automatic mode, the system operates as per the given commands, and in Manual mode, users can control the system through a mobile application or switches. Cloud technology is used to control or access information about the system from any location, allowing authorized persons to control the process through the mobile application. The current status of which source supplies the load is displayed on an LCD or in the mobile application.

This system is designed to provide continuous power supply automatically, switching over to the next available source when the main supply fails, and ensuring an uninterrupted power supply to the load. The Arduino microcontroller unit controls all the operations of the system, making it efficient and reliable. With the help of cloud technology, authorized persons can control the system and access information about it from anywhere. The system's flexibility and automation make it an excellent choice for ensuring uninterrupted power supply to critical systems.

3.10 BLOCK DIAGRAM OF PROPOSED SYSTEM:

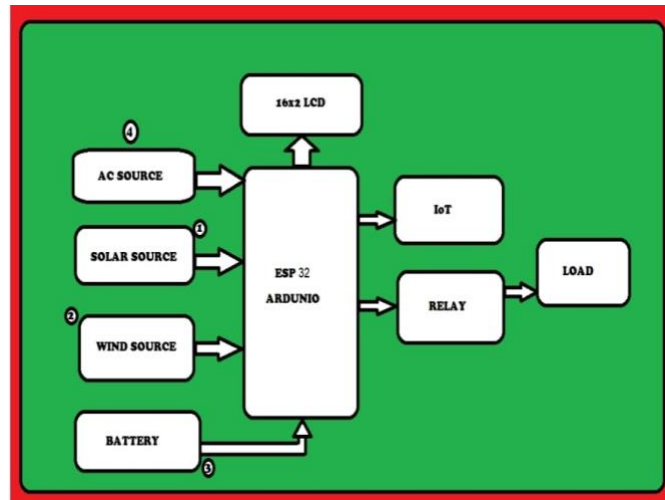


Fig 3.2 Block diagram of proposed system.

Figure 3.2 depicts the block diagram of the auto power supply control system, which uses an Arduino microcontroller along with other essential components. This diagram highlights four different sources, namely solar and wind, battery, and main supply, with each source connected to a relay. The four switches represent these four sources, and they are connected to the Arduino microcontroller, which receives input signals from them. A relay driver is also used in this system to switch the specific relay, which provides a continuous power supply to the load, depending on the output generated by the microcontroller. When one source fails, the system automatically switches to another available source, such as wind energy or the main supply, to ensure uninterrupted power supply to the load.

To control the system, the diagram shows the use of a Wi-Fi module, which is connected to the Arduino microcontroller. Furthermore, the system includes a mobile app that allows the user to select the mode of operation. If the user chooses the manual mode, they can control any resources by themselves, which means that they can switch between different sources as needed. The mobile application has various buttons and indicators, which are only available in manual mode and are used for manual control of the system.

The integration of the Wi-Fi module and mobile app allows for remote access and control of the system, which provides greater convenience and flexibility for the user. With this system, the user can monitor the status of the power supply sources, and they can easily switch between sources as needed, ensuring that the load receives an uninterrupted power supply. This auto power supply control system provides a reliable and efficient solution for power management and is ideal for use in various settings, including homes, offices, and industries.

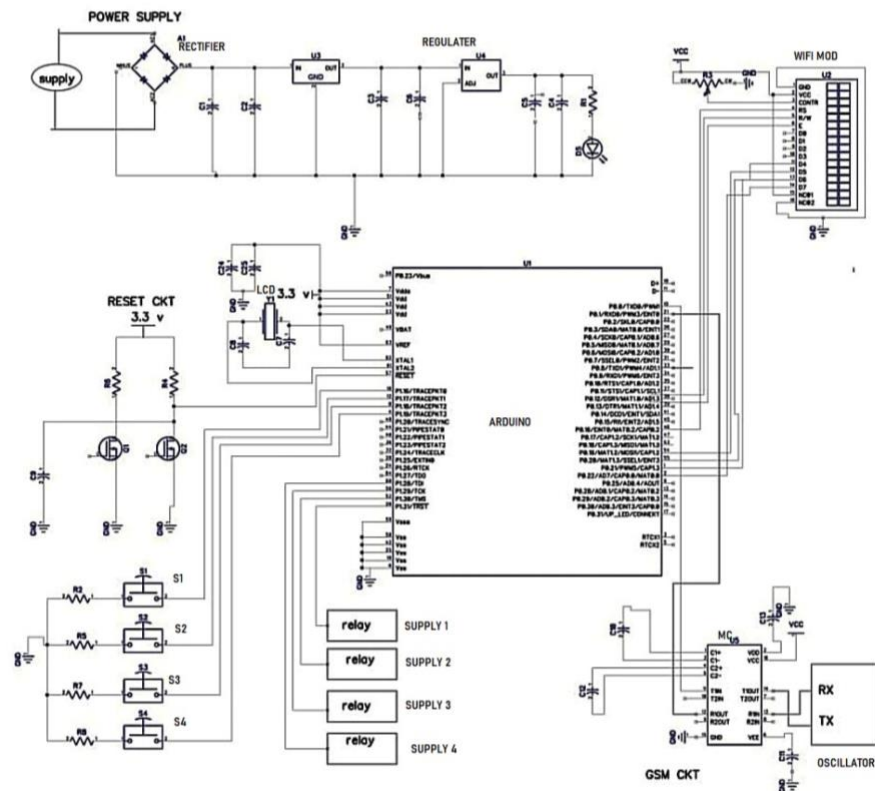


Fig 3.3 circuit Schematic

3.11 COMPONENTS REQUIREMENT

HARDWARE REQUIREMENTS:

- Arduino microcontroller
- Lcd
- Load
- Realy
- Solar panel
- Battery
- Wi-fi module

3.12 SOFTWARE REQUIREMENTS:

- Arduino IDE
- Embedded C
- Proteus

3.13 ADVANTAGES OF PROPOSED SYSTEM.

The advancement of technology has played a significant role in making our lives easier and more convenient. The introduction of IoT technology has revolutionized the way we interact with our devices and gadgets, and it has opened up new possibilities in various industries. One of the key applications of IoT is in the area of power supply control systems. The use of IoT technology in power supply control systems has led to the development of

more advanced and efficient systems that are capable of providing uninterrupted power supply from multiple sources.

The auto power supply control system is an example of a power supply control system that makes use of IoT technology. This system is designed to provide uninterrupted power supply from four different sources: solar, wind, battery, and main supply. The system is controlled by an Arduino microcontroller, which is connected to each source via a relay. The system is designed to automatically switch to the next available source when the main supply fails, ensuring that there is always a continuous supply of power to the load.

One of the key advantages of the auto power supply control system is that it can be controlled remotely using a mobile application. This makes it easy for users to monitor and control the system from any location. The mobile application provides information on which source is currently being used, and allows users to switch between sources manually if required. The system is also designed to operate in two modes: automatic and manual. In the automatic mode, the system operates as per the predefined commands, while in the manual mode, users can control the system using the mobile application or switches.

The auto power supply control system is particularly useful in places where there are multiple sources of power supply, such as solar, wind, and main supply. It is also suitable for use in industries where there is a need for uninterrupted power supply to industrial machines. Compared to traditional electrical ATS panels, the auto power supply control system is more compact, reliable, and cost-effective. With the continued development of IoT technology, we can expect to see further advancements in power supply control systems that will improve their efficiency and reliability, making them even more useful in various industries and applications.

3.14 APPLICATION OF PROPOSED SYSTEM:

- The proposed system is designed to supply uninterrupted power to essential services.
- The system can be used in educational institutes and hospitals to provide uninterrupted power to equipment.
- The system ensures that critical equipment remains functional during power outages, preventing disruption to services.
- In hospitals, the system can be used to ensure that life-saving medical equipment remains operational even during power failures.
- In educational institutes, the system can be used to provide uninterrupted power supply to computers, servers, and other equipment, ensuring that learning is not disrupted.
- The system is designed to switch seamlessly between different sources of power, ensuring that there is always a backup in case of a failure.
- The use of IoT technology and the Arduino microcontroller ensures that the system can be operated remotely, providing greater convenience and control.
- The system is a reliable and cost-effective solution for organizations that require uninterrupted power supply.

CHAPTER - 4

4.1 SIMULATION RESULTS OF PROPOSED SYSTEM:

The Proteus Design Suite is an essential software tool suite for electronic design automation, widely used by electronic design engineers and technicians. This software allows users to create detailed schematics and electronic prints for manufacturing printed circuit boards. Simulating a project before implementation is always a good practice to ensure its proper functioning, and Proteus provides a reliable simulation environment for this purpose. It allows users to virtually verify the working of a project before its actual implementation. One of the significant advantages of this software is that it is simulation-based, and Arduino can be simulated using Proteus. This feature enables users to design and test Arduino-based projects virtually, thereby reducing the risk of errors and saving time and money in the long run. Moreover, Proteus offers various advanced features, such as mixed-mode SPICE simulation, microcontroller simulation, and PCB layout modules, making it a powerful and versatile software tool for electronic design automation.

4.1.1 Simulation of Proposed System:

Fig 4.1 shows the simulation results of the proposed system. When the system is turned on, the LCD display will show the message "IOT Based Auto Power Control", indicating that the system is ready and is providing power supply.

The simulation is an important step in the development of the system as it allows for testing and verification of the system's functionality before it is implemented in the real world.

The simulation can also help in identifying any potential issues or bugs in the system's design, allowing for them to be addressed and resolved before the system is

built. In addition, the simulation can help in optimizing the system's performance and improving its efficiency.

Overall, the simulation is a crucial tool in the development of the proposed system, ensuring its reliability and functionality.

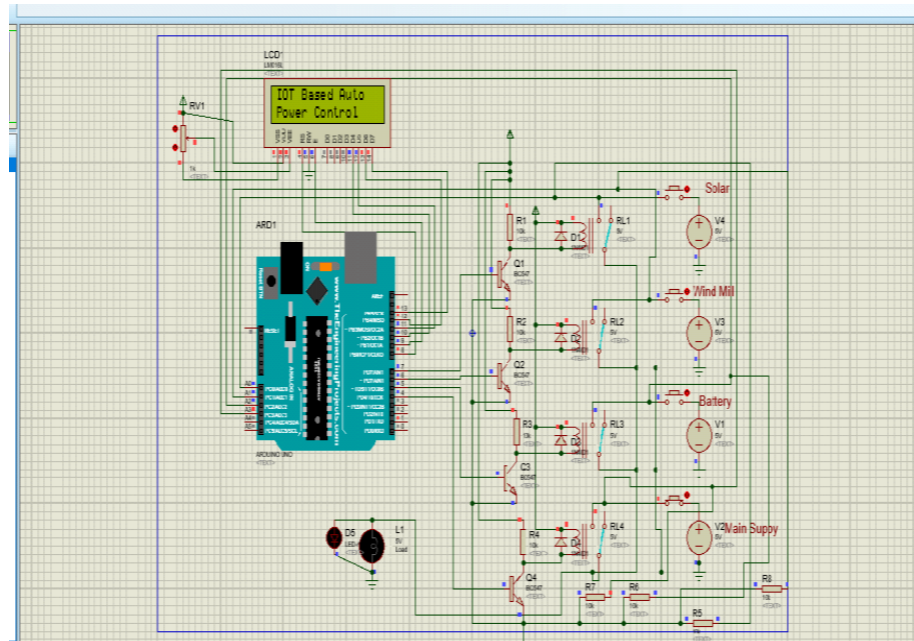


Fig 4.1 Simulation result of proposed system when the system is ON.

4.1.2 THE LOAD IS SUPPLIED BY MAINS:

Fig 4.2 represents the simulation result of the proposed system when the main supply is active and providing power to the load. In this scenario, the LCD display will show which power source is currently active, in this case, it will show "Running on Mains".

This information is useful for the user to keep track of which power source is being used at any given time. The system is designed to automatically switch to a different power source in case of a power outage or failure.

The use of the LCD display provides a clear and user-friendly interface for monitoring the system's status. With the help of Proteus software, the simulation of the

system can be done before the actual implementation, which helps in identifying any potential issues and allows for modifications to be made before deployment.

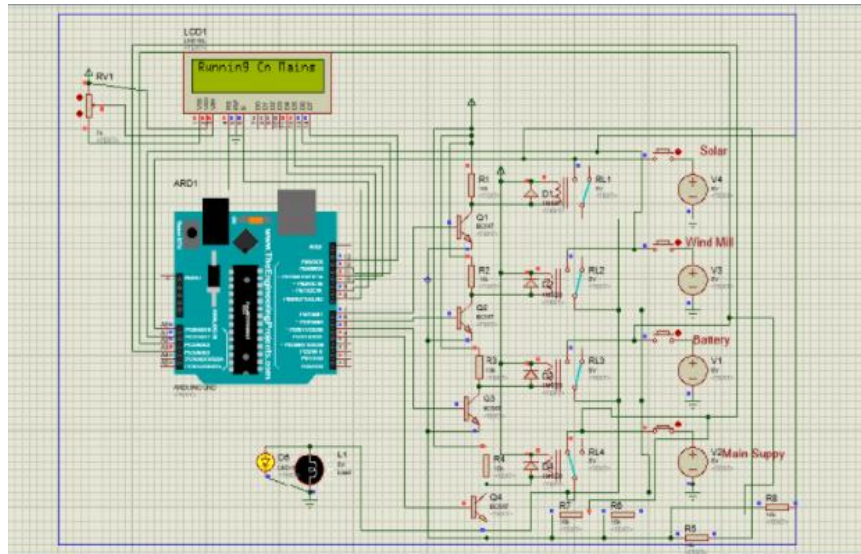


Fig 4.2 Simulation Result when the system is running on Mains

4.1.3 THE LOAD IS SUPPLIED BY BATTERY:

Fig 4.3 shows the software simulation result of the proposed system in case of a mains failure. When the mains supply fails, the system automatically switches to the next available source with high energy, which in this case is the battery.

As a result, the load, represented by a lamp, continues to receive power and it glows. The LCD screen displays the message indicating which source is currently active and providing power to the load. In this case, the message would be "Running on Battery".

This simulation result is an essential aspect of the system as it showcases the ability of the system to provide uninterrupted power supply by switching between different sources automatically.

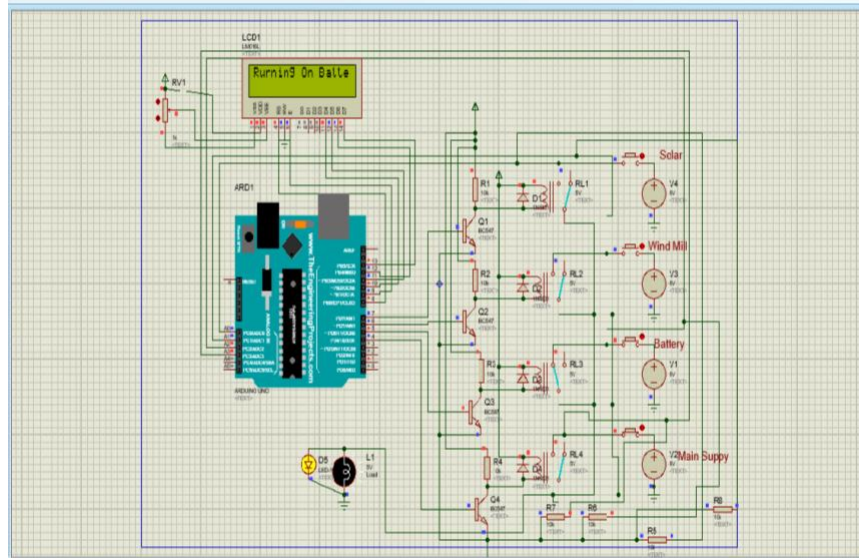


Fig 4.3 Result of software simulation system running on Battery

4.1.4 THE LOAD IS SUPPLIED BY WIND:

Fig 4.4 represents the simulation result of the proposed system when the main supply fails, and the system automatically switches to the next available source with a higher energy source.

In this case, the load (Lamp) continues to receive uninterrupted power supply from the system, and the LCD displays the message indicating which source is currently active and supplying power to the load.

In this scenario, the load is running on wind energy, which is the available source with the highest energy output. The automatic switching feature of the system ensures that there is no interruption in the power supply to the load, and the system continues to operate smoothly without the need for human intervention.

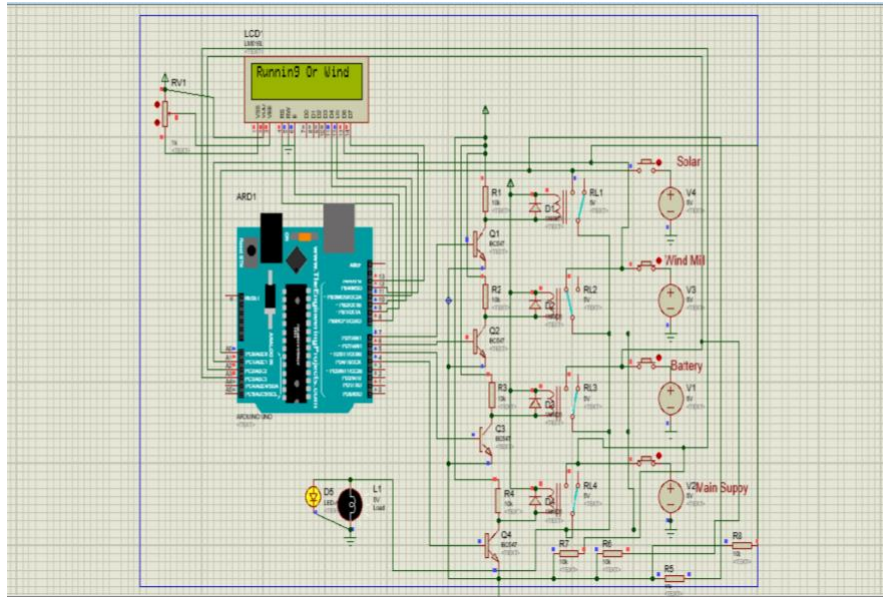


Fig 4.4 Simulation result of system when the load is running on Wind

4.1.5 THE LOAD IS SUPPLIED BY SOLAR

In Fig 4.5, the software simulation result shows what happens when there is a mains failure in the power supply system. The system automatically switches to the next available source which has a high energy output and then supplies the load, which in this case is a lamp.

As the wind energy source has the highest energy output at this point, the load is now running on wind energy. The lamp connected to the load glows, indicating that it is receiving power. The LCD display on the system shows a message indicating which source is active and which source is providing power to the load.

This simulation result demonstrates the effectiveness of the proposed system in ensuring uninterrupted power supply to essential services, even in the event of a mains failure. By automatically switching to the next available source with high energy output, the system ensures that the load continues to receive power without any interruption, thus preventing any potential loss of data or damage to equipment.

The use of a microcontroller and IoT technology, combined with the simulation capabilities of the Proteus Design Suite software, makes the proposed system an efficient and reliable solution for power supply control.

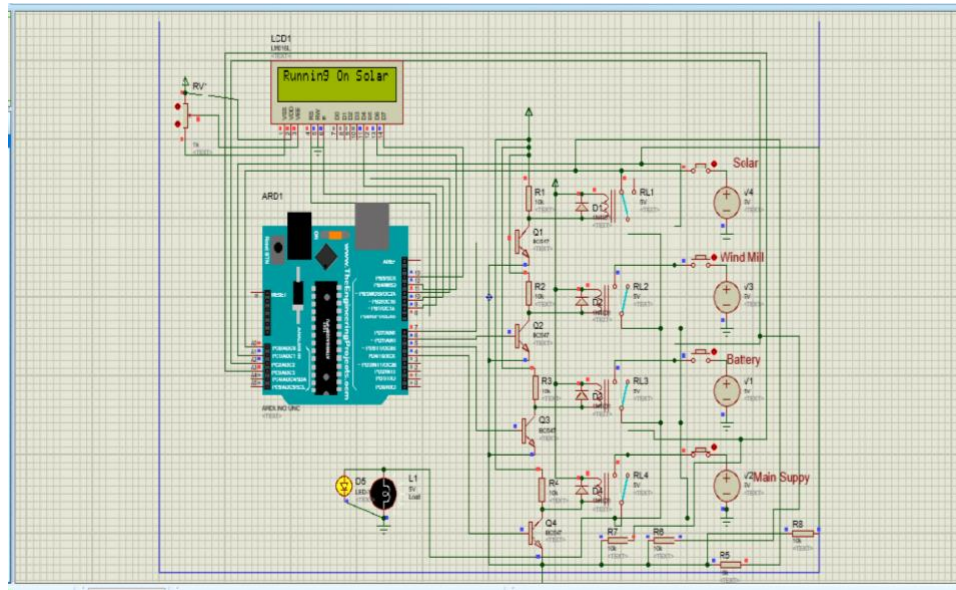


Fig 4.5 Simulation result of system when the load is running on Solar

4.2 CONTROLLING THE FOUR ACTIVE SOURCES USING IOT

The use of IoT cloud data in controlling the four different sources in this system has greatly enhanced its functionality. With the incorporation of four switches for solar, battery, wind and mains, it has become possible to regulate the flow of power to the load.

Furthermore, the system is equipped with the ability to provide information on which source is currently active and which one has failed. This information is automatically stored in the software, making it easily accessible for future reference.

The IoT cloud data plays a crucial role in this process by enabling the system to capture and analyze the logs from the digital input and output. Through this approach, it becomes possible to monitor the performance of each source and ensure that the load

receives uninterrupted power supply. Overall, the use of IoT cloud data has revolutionized the power supply industry, providing a more efficient and reliable means of controlling power sources.

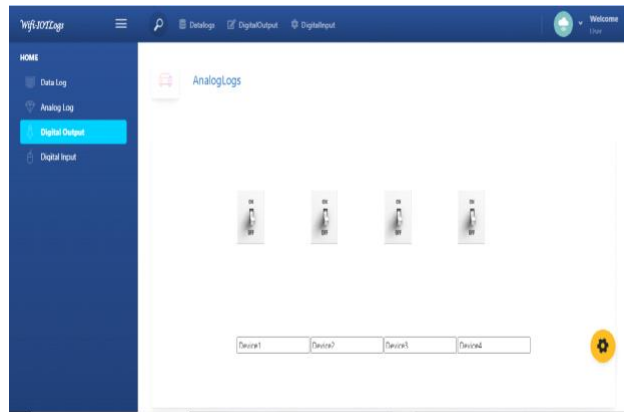


Fig 4.6 Software tool to operate the four Sources using Switches

From diagram 4.6, we can see that four devices are being used in the system. When device 1 is turned on, the mains source will become active and supply power to the load, while the remaining three sources will be at rest.

Similarly, when device 2 is turned on, the battery source will become active, and when devices 3 and 4 are turned on, the solar and wind sources will become active, respectively. This system provides the flexibility to choose from multiple power sources, depending on availability and suitability.

It also ensures uninterrupted power supply by automatically switching to an alternative source in case of a failure or outage. The use of multiple sources also makes the system more efficient and sustainable, as it can reduce dependency on a single source and utilize renewable sources like solar and wind.

Overall, this system offers a reliable and efficient solution for power management in various applications, including homes, industries, and educational institutes.

4.2.1 ACTIVE AND FAILURE MODE INDICATION OF SOURCES

The screenshot shows the 'DataLogs' section of the WifiJOZLogs application. The interface includes a sidebar with navigation options: HOME, Data Log (selected), Analog Log, Digital Output, and Digital Input. The main content area displays a table of log entries. Above the table, there is a 'Show 10 entries' dropdown and a 'Search' input field. A 'CLEARLOG' button is also present. The table has columns for 'LogID', 'DATA', 'Logdate', and 'LogTime'. The 'DATA' column contains text indicating the state of different power sources (Solar, Mains, Battery, Windmill) and their operational status (Running, Failure).

LogID	DATA	Logdate	LogTime
1	Running_On_Solar Mains_Failure	03/02/2021	18:22:41
2	Running_On_Solar Mains_Failure	03/02/2021	18:22:57
3	Mains_Failure Battery_Failure	03/02/2021	18:23:02
4	Running_On_Solar Mains_Failure	03/02/2021	18:23:09
5	Running_On_Solar Mains_Failure	03/02/2021	18:23:13
6	Mains_Failure Battery_Failure	03/02/2021	18:23:19
7	Mains_Failure Battery_Failure	03/02/2021	18:23:25
8	Battery_Failure Windmill_Fail	03/02/2021	18:23:29
9	Running_On_Solar Mains_Failure	03/02/2021	18:23:33

Fig 4.7 Active and failure mode indication of sources

- Fig 4.7 represents the data log that provides crucial information about the system's operation. The log records which source is currently active and which one has failed.
- Additionally, it calculates the time duration for each source when it's working. This information is critical for the system's maintenance and ensures that it operates optimally.
- By analyzing the data log, one can identify any issues or inefficiencies in the system's operation and take corrective measures. This log provides an essential tool for analyzing the system's performance and making informed decisions regarding its maintenance and operation.

CHAPTER- 5

5.1 HARDWARE REQUIREMENTS:

5.1.1 Arduino microcontroller

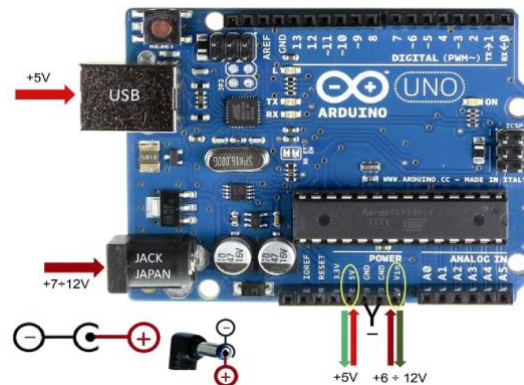


Fig 5.1 Arduino UNO

The Arduino Uno is a versatile and popular open-source microcontroller board that is based on the Microchip ATmega328P microcontroller and was developed by Arduino.cc.

The board is equipped with a set of digital and analog input/output (I/O) pins that can be easily interfaced with various expansion boards, sensors, actuators, and other electronic circuits.

The board's simplicity and ease of use, along with the availability of a vast community and support resources, have made it a popular choice for hobbyists, students, and professionals alike for prototyping and developing various electronic projects.

The Arduino Uno board features 14 digital I/O pins, out of which 6 can be used as PWM (pulse-width modulation) outputs, and 6 analog input pins. Additionally, it has a 16

MHz quartz crystal oscillator, a USB connection, a power jack, an ICSP (In-Circuit Serial Programming) header, and a reset button.

The board can be powered either via the USB connection or an external power supply, and it supports both 5V and 3.3V logic levels, which makes it compatible with a wide range of electronic components and modules.

The Arduino Uno board also supports a simplified programming language based on C/C++, which makes it easy for beginners and non-programmers to start coding and building projects quickly.

Moreover, it is compatible with a wide range of software development tools and environments, including the Arduino Integrated Development Environment (IDE), Atmel Studio, and Visual Studio Code. Overall, the Arduino Uno is a versatile, affordable, and easy-to-use microcontroller board that has become a popular choice for building various electronic projects and prototypes.

5.1.2 LCD

In this project, LCD is used to display which sources are active, providing the user with important information about the system. LCD stands for Liquid Crystal Display and it is a type of flat panel display that uses liquid crystals in its operation.

The display is made up of millions of pixels and the quality of a display is often determined by the number of pixels. Each pixel is made up of three subpixels: red, blue, and green (RGB), which produce different colors when they change color combinations.

By working together, the pixels on a display can produce millions of different colors and create a picture by rapidly switching on and off.

LCDs can be made with either a passive matrix or an active matrix display grid. The passive matrix LCD has a grid of conductors with pixels located at each intersection in the grid.

A current is sent across two conductors on the grid to control the light for any pixel. In contrast, an active matrix LCD has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel.

This means that the current in an active matrix display can be switched on and off more frequently, resulting in a better screen refresh time.

While some passive matrix LCDs have dual scanning, meaning they scan the grid twice with current in the same time it took for one scan in the original technology, active matrix is still considered a superior technology between the two. In this project, the LCD is an important component that helps provide the user with critical information about the active sources in the system.



Fig 5.2 LCD DISPLAY RUNNING MAINS

In Diagram 5.2, the LCD display is shown indicating that the system is working under mains power.

When the corresponding relay is tripped, the mains power is connected to the system and the supply is provided to the load, which in this case is an LED.

The LCD display is an important component in this system as it provides real-time information about the active power source and whether the system is functioning properly or not.

By displaying the current status of the system, it allows the user to easily monitor and troubleshoot any issues that may arise. This is particularly useful in situations where the system is being used in remote locations or in areas where access to the system is limited.



Fig 5.3 LCD DISPLAY RUNNING ON SOLAR

I believe you meant to say "in the diagram 5.3" instead of "at the diagram 5.3." Here's the corrected paragraph:

In the diagram 5.3, the LCD display shows the system working under solar power. The corresponding relay is tripped, connecting the solar power source to the system and supplying power to the load (LED).

The LCD display indicates which source is currently active and providing power to the load.



Fig 5.4 LCD DISPLAY RUNNING ON BATTERY

Diagram 5.4 represents the LCD display when the system is working under battery power. The corresponding relay is tripped, which activates the battery and connects it to the system.

The supply of power to the load (LED) is then transferred to the battery. The LCD display shows which source is active, and in this case, it is the battery. This can be useful in situations where the primary source of power, such as mains or solar, fails, and the battery acts as a backup power source.

The battery can provide power to the load for a limited time until the primary source of power is restored or until the battery is depleted. The LCD display also provides information on the battery's level of charge and alerts the user when the battery needs to be recharged.



Fig 5.5 LCD DISPLAY RUNNING ON MAINS

Diagram 5.5 shows the LCD display when the system is working under wind power. The relay corresponding to the wind power source is tripped, connecting the wind power to the system and supplying power to the load (LED).

The LCD display indicates that the system is running on wind power and which source is active. The LED will glow, indicating that the load is receiving power from the wind turbine.

The system will continue to run on wind power until the wind speed drops below a certain level or another power source becomes available due to a power outage or other issue.

5.1.3 LOAD

An electrical load is a crucial component in any electrical or electronic system. It refers to an electrical device or portion of a circuit that consumes or draws active electric power, such as electrical appliances, lights, motors, and other electronic devices. The term 'load' may also refer to the power consumed by a circuit, which is opposed to a power source, such as a battery or generator that produces power.

In electronics, the term 'load' is used more broadly and refers to any device connected to a signal source, whether or not it consumes power. For instance, if an electric circuit has an output port, a pair of terminals that produce an electrical signal, the circuit connected to this terminal or its input impedance is referred to as the load.

Another example is when a CD player is connected to an amplifier, the CD player is the source, and the amplifier is the load.

In electronic systems, the load's characteristics can affect the performance of circuits with respect to output voltages or currents, such as in sensors, voltage sources, and amplifiers.

The nature of the load can impact the power supply, which can cause fluctuations in the circuit's output voltage or current. For instance, in mains power outlets, appliances connected to the power circuit collectively make up the load, and switching on a high-power appliance can dramatically reduce the load impedance.

This impedance reduction can result in a voltage drop if the load impedance is not very much higher than the power supply impedance. In domestic environments, switching on a heating appliance may cause incandescent lights to dim noticeably.

Therefore, the proper selection and management of the load are essential for efficient and safe operation of any electrical or electronic system. The range and type of load required for a specific system depend on various factors, such as the power rating, voltage, current, and type of power supply.

In the proposed system, we are using an LED as a load, which has a range of 5V. When the main supply fails, the other source in the system takes over and provides power to the load, ensuring uninterrupted power supply.

5.1.4 RELAY

In this project we used a 12v relay for each source. Each source is connected with different relays. In this project we are using four relays. Each relays drive the specific source and then gives the supply to load.

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations therefore.

Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters.

They refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

The traditional form of a relay uses an electromagnet to close or open the contacts, but other operating principles have been invented, such as in solid-state relays which use semiconductor properties for control without relying on moving parts.

Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called protective relays.

Latching relays require only a single pulse of control power to operate the switch persistently. Another pulse applied to a second set of control terminals, or a pulse with opposite polarity, resets the switch, while repeated pulses of the same kind have no effects.

Magnetic latching relays are useful in applications when interrupted power should not affect the circuits that the relay is controlling.

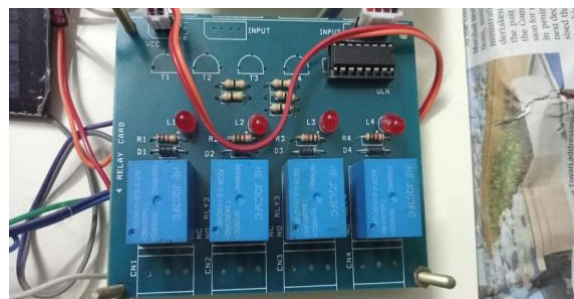


Fig 5.6 Relay unit used in hardware

The RW Series Relay is a highly efficient and versatile component that is widely used across various industries. It is designed to cover switching capacity by 10A, which is impressive considering its miniature size.

This makes it an ideal choice for users who require a wide selection of switching options. In addition, the RWH variant of the relay has been approved by C-UL and TÜV safety standards, which ensures that it meets the highest levels of safety and performance, the relay is highly durable and can withstand harsh environmental conditions. Furthermore, the relay is designed with a complete protective construction that safeguards it against dust and soldering flux.

In addition, a plastic sealed type is available for washing procedures, which enhances its longevity and makes it easy to maintain.

The RW Series Relay has a UL-approved switching capacity of 12A at 120VAC for RW and 12A at 240VAC for RWH. This certification indicates that the relay has been tested and approved to operate at the highest levels of performance and safety.

The reliability of the RW Series Relay makes it an ideal choice for a wide range of applications, including automation control, power supplies, and HVAC systems.

Overall, the RW Series Relay is an essential component that delivers reliable and efficient performance in a compact and versatile package.

5.1.5 SOLAR PANEL

The RW Series Relay is a highly efficient and versatile component that is widely used across various industries. It is designed to cover switching capacity by 10A, which is impressive considering its miniature size.

This makes it an ideal choice for users who require a wide selection of switching options. In addition, the RWH variant of the relay has been approved by C-UL and TÜV safety standards, which ensures that it meets the highest levels of safety and performance.

The RW Series Relay is constructed with high-quality plastic materials that are suitable for use under high temperature conditions and exposure to various chemical solutions.

This ensures that the relay is highly durable and can withstand harsh environmental conditions. Furthermore, the relay is designed with a complete protective construction that safeguards it against dust and soldering flux.

In addition, a plastic sealed type is available for washing procedures, which enhances its longevity and makes it easy to maintain.

The RW Series Relay has a UL-approved switching capacity of 12A at 120VAC for RW and 12A at 240VAC for RWH. This certification indicates that the relay has been tested and approved to operate at the highest levels of performance and safety.

The reliability of the RW Series Relay makes it an ideal choice for a wide range of applications, including automation control, power supplies, and HVAC systems.

The compact size of the RW Series Relay allows it to be used in a variety of space-limited applications. Its versatility also makes it a popular choice for use in both residential and commercial settings.

In addition, the relay is designed for easy installation and is compatible with a wide range of wiring and mounting configurations.

Overall, the RW Series Relay is an essential component that delivers reliable and efficient performance in a compact and versatile package.

Its durability, safety certifications, and wide range of applications make it a valuable addition to any electrical system.

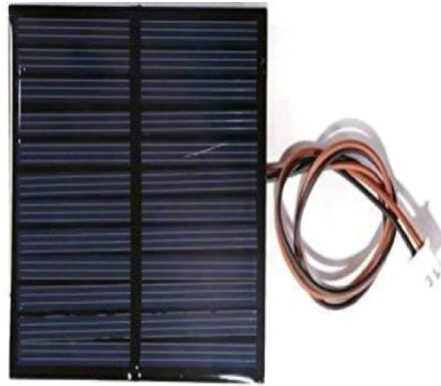


Fig 5.8 SOLAR CELL



Fig 5.7 HARDWARE KIT

The IEEE Standard adapted for this project are IEEE 1547 – 2011, IEEE 2030 - 2018 and IEEE 1547-2019. IEEE 1547-2011: This standard specifies the requirements for interconnecting distributed energy resources (DERs) with electric power systems, including multiple sources such as solar, wind, hydro, and fuel cells. It covers various aspects of power quality, safety, and control for DERs, which can be useful for designing an auto power supply system that combines multiple sources. IEEE 2030-2018: This standard defines the communication protocols and information models for the interoperability of DERs and other grid devices. It supports various types of communication

interfaces, such as wired and wireless, and can help facilitate the integration of multiple sources in an auto power supply system.

5.1.6 WIND ENERGY:

Wind turbines are a highly efficient and sustainable source of energy that have become increasingly popular in recent years. The operation of wind turbines is simple yet effective.

The blades of the turbine are designed to rotate when they are hit by the wind, which can start at a gentle breeze of 3-5 meters per second. The rotation of the blades turns a shaft in the nacelle, which is the box-like structure located at the top of the turbine.

The nacelle contains a generator that is built to convert the kinetic energy from the turning shaft into electrical energy. The electrical energy is then transported through a transformer, which steps up the voltage so that it can be transported on the National Grid or used by a local site.

This process is used across all wind turbines, from micro-turbines for individual houses to enormous offshore wind farms.

Our proposed system incorporates a wind turbine as an alternative power source to provide power to the load when the primary power source fails. If there is enough wind, the turbine will automatically supply power to the load.

By incorporating a wind turbine into our system, we can ensure a more reliable and sustainable source of power for our load. This is particularly useful in areas where the primary power source is unreliable or in emergency situations where backup power is necessary.

In conclusion, wind turbines are an excellent source of renewable energy that can provide reliable and sustainable power to a wide range of applications.

Our proposed system harnesses the power of wind energy to provide a backup power source for our load, ensuring uninterrupted power supply even in the event of primary power source failure.

5.1.7 BATTERY

Batteries are an essential component of modern life, powering everything from small electronic devices to large vehicles and emergency power systems.

They are available in a wide range of shapes and sizes, making them highly versatile and suitable for use in a variety of applications.

Miniature batteries, such as those used in hearing aids and wristwatches, are typically small and compact, while the batteries used in smartphones and other handheld devices are thin and lightweight.

In contrast, large lead-acid or lithium-ion batteries are commonly used in vehicles and industrial settings, providing reliable and long-lasting power.

Despite their widespread use, batteries have a lower specific energy, or energy per unit mass, than common fuels like gasoline.

However, in electric vehicles, this is somewhat offset by the higher efficiency of electric motors in converting electrical energy to mechanical work, compared to traditional combustion engines.

Overall, batteries play a critical role in our daily lives, providing a portable and reliable source of energy that allows us to power our devices and vehicles without being tethered to an electrical outlet.

As technology continues to advance, it's likely that batteries will continue to evolve, becoming more efficient and more powerful, further expanding their usefulness in our daily lives.

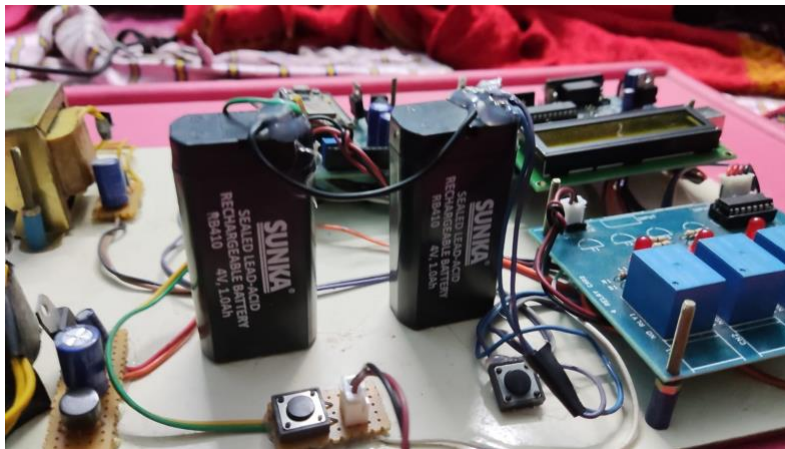


Fig 5.9Battery

5.1.8 WI-FI MODULE

The ESP8266 WiFi Module is a game-changer in the world of microcontrollers and IoT. This small but mighty device is a self-contained System-on-a-Chip (SOC) with an integrated TCP/IP protocol stack that enables any microcontroller to access your WiFi network.

The ESP8266 module has a powerful on-board processing and storage capability that allows it to be integrated with sensors and other application-specific devices through its GPIOs with minimal development up-front and minimal loading during runtime.

One of the most significant advantages of the ESP8266 is its cost-effectiveness. This module is incredibly affordable, making it accessible to a wide range of users, including hobbyists, students, and professionals.

The ESP8266 comes pre-programmed with an AT command set firmware, which means it can be hooked up to an Arduino device and offer as much WiFi capability as a WiFi Shield right out of the box.

Moreover, the ESP8266 has a high degree of on-chip integration, which allows for minimal external circuitry, including the front-end module. This feature ensures that the module occupies minimal PCB area, making it ideal for space-constrained designs.

Additionally, the ESP8266 supports APSD for VoIP applications and Bluetooth coexistence interfaces, has a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.

The ESP8266 has garnered an enormous following thanks to its robust features and impressive performance. There is an almost limitless amount of information available on this module, all of which has been provided by the amazing community support.

In the Documents section, users will find a plethora of resources to aid them in using the ESP8266, including instructions on how to transform this module into an IoT (Internet of Things) solution.

With its low cost, ease of use, and broad community support, the ESP8266 has revolutionized the world of microcontrollers and IoT and opened up new possibilities for innovation and creativity.

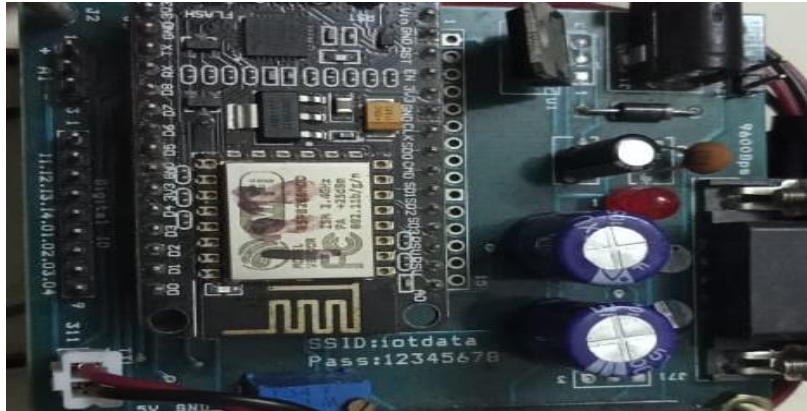


Fig 5.10 WIFI Module

5.2 SOFTWARE EQUIPMENTS

The Arduino IDE (Integrated Development Environment) is the software used to write, compile, and upload code to Arduino boards. It provides an intuitive and user-friendly interface for programming microcontrollers, making it accessible even to those with little to no programming experience.

The IDE includes a code editor with syntax highlighting and auto-completion, a serial monitor for debugging, and a library manager for easily installing and managing third-party libraries.

One of the most significant advantages of using the Arduino platform is the vast library of pre-built code and components available to the user.

The Arduino community has developed numerous libraries for controlling motors, sensors, displays, and other devices, making it easier to incorporate complex functionality into a project without having to write all the code from scratch.

Additionally, the open-source nature of Arduino allows for modifications and contributions to the libraries, enabling the community to improve and expand the platform continually.

Overall, the Arduino IDE and hardware provide a powerful yet accessible platform for creating electronic projects, whether for personal use or commercial applications. With its ease of use, vast community support, and low cost, it has become a popular choice for hobbyists, students, and professionals alike

CHAPTER - 6

6.1 CONCLUSION

In this project, we have successfully implemented an IoT-based auto power control system that can draw power from four different sources. The proposed system has the potential to revolutionize industries that require uninterrupted power supply, such as hospitals and laboratories.

The system is designed to minimize the impact of power shutdowns and ensure that the power demand of essential services is always met.

With the growing demand for energy worldwide, energy generation is low while energy consumption continues to rise. Consequently, electricity companies are unable to satisfy the demand and must explore non-conventional energy systems.

The use of renewable energy in conjunction with non-conventional sources not only increases the system's reliability but also allows for higher power demands to be fed.

To prioritize the various available sources, the selection algorithm can be coded into a microcontroller, which can then automatically shift between different sources using relays through the relay driver.

The priorities for selecting different sources can be decided based on the availability of the source, usage cost, and its effects on the operation of other equipment (noise due to generators, smoke, etc.).

This approach ensures economic utilization of the sources.

The project involves four different sources, each with different parameters to enable the microcontroller to determine the best available source to use. We have also considered and monitored experimental results for various conditions to validate the system's effectiveness.

The same model can be applicable for future developments, and this project presents significant advantages for future developments.

6.2 FUTURE SCOPE

Moving forward, the future work of this project will primarily focus on enhancing the system's reliability and providing uninterrupted power supply to the load at all times by increasing the number of sources.

The new sources will be selected based on their cost of implementation and availability during a particular season.

To further improve the system, more automation via microcontrollers can be provided to minimize noise issues and sparking during the changeover from one source to another.

This will also make the system more user-friendly and easier to operate.

The future scope of this project extends beyond its current application to industries such as hospitals and laboratories. It can be implemented in large-scale applications like standalone hybrid microgrid systems.

This will ensure that the system can provide reliable and uninterrupted power supply to communities, even in remote areas where the traditional power grid is not available.

Moreover, integrating machine learning algorithms can enhance the system's efficiency and enable it to make better decisions regarding the selection and utilization of power sources.

Additionally, it can help predict the energy demand and supply to optimize the utilization of available sources.

In summary, the future work of this project will focus on increasing the reliability and efficiency of the system, making it more user-friendly, and expanding its application to larger-scale systems while exploring new technologies such as machine learning to improve its performance.

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