Auto Power Supply Control from four Different Sources using Microcontroller to Ensure Uninterrupted Power.

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Declaration

We certify that the research/project based thesis titled, "**Auto Power Supply Control from four Different Sources using Microcontroller to Ensure Uninterrupted Power**" is completely our group work. All sources and knowledge for this paper which were found by other researchers are acknowledged by reference. Materials of work such as images,figures,tables and citations in this paper are accepted by our supervisor We hereby declare that this thesis has not been previously submitted either in whole or in part, for any other degree or publication.

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Certification

This is to certify that this project entitled "**Auto Power Supply Control from four Different Sources using Microcontroller to Ensure Uninterrupted Power**" is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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Abstract

The uninterrupted power supply using four different power sources is essential to our country. In our century we need the electricity for all our needs. So, we face many power issues. In our country different locations get the power supply from different power plants. If the power plants break down in the specific location of our country that area faces a power cut problem. Some power plants depend on weather, the solar power plant is based on sun light, wind power plant on wind and hydropower plant based on rain. In our country if the weather changes suddenly, power plant works with low efficiency. Some kind of power plants based on raw materials. An Example is the coal plants based on coal. Sometimes the plant is affected by the high cost in purchasing or importing coal. If the coal import goes low, the power slows down. The specific locations of base by the specific power plants create same problems. Our project is the solution to these problems. Our uninterrupted power supply switches the supply from one source to another source. If the specific location gets a power cut at a specific time, the uninterrupted power supply connects another highly efficient power source with supply line of that location. After that, it disconnects the connection from the power source and connects it to the specific power source. Then the specific power plant becomes high efficiency. We believe our project and introduce technology for electrical supply will improve the services in our country.

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INTRODUCTION

1.1 Introduction

The outline of the project is selection of supply from Solar power, PDB power, REB, Generator automatically by using microcontroller concept. 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. In this project we are having 4 switches which we consider as 4 different sources of supply. When we press any of the switches it shows the absence of that particular source which is connected to microcontroller as input signals. Here we are using 8051 family microcontrollers. The output of microcontroller is given to acts as a relay driver. This can drive up to 7 relays. The relays which are used hear are 12V relay. The output can be observed using lamp and fan which is getting uninterrupted power supply from other means if main supply is cut off. The power supply consists of a step-down transformer 230/12V, which steps down the voltage to 12V AC. This is converted to DC using a Bridge rectifier. The ripples are removed using a capacitive filter and it is then regulated to +5V using a buck converter which is required for the operation of the microcontroller and other components. Automating feature is now the need of the day. It is user friendly and easy to use. It saves time too. This project is also a proto-type to automation of the system. In the earlier days (even today at some places) the manual operations are frequent. When the main supply goes off the person manually turn on the generator. In case of the electrical appliance control using automation causes more safety. This project is a prototype for the same which is auto change over to generator when main supply fails. In this system we are designing an embedded circuit to control this. In case there are four phases, then the switching will be in the default phase. Four relays are there to control the switching. The phases will be shown by the operation of switch that is on /off. According to the conventional model of current flow originally established by Benjamin Franklin and still followed by most engineers today, current is assumed to flow through electrical conductors from the positive to the negative pole. In actuality, free electrons in a conductor nearly always flow from the negative positive pole

1.2 Problem Statement

The regular activities of people may get postponed or cancelled when the electrical power is dropped electrical Power Supply. In the daily usage, voltage is 240V AC voltage. In our country

demand for electrical power is very high. Now in our country the specific areas get electricity from separate power sources. The electricity does not go from all power plants to one specific area. Therefore, if the specific power plant breaks down the specific place also faces electricity problem. If we consider the whole country, similarly, these electricity issues affect all areas in the country. Because the specific power plants supply the electricity for specific areas.

They do not supply current for all areas of the country. But we cannot connect all power plants. It creates different problems in the distribution side. Because the distance is a problem and if we provide the supply is controlled from one power plant; the efficiency of the source comes down. In this case our automatic power system helps to solve these problems. We connect the all power plants with one automatic control unit and supply from that unit This automatic system switches the power sources base on the current, voltage and power differences. Not only these differences but also the climate differences make this automation an uninterrupted power supply.

1.3 Background of the Study:

Nowadays the supply of electricity is very important to the people. Uninterrupted power supplies are needed in almost every area of our lives for home applications, research centers, hospitals etc. Due to the increasing demand for energy and the widespread use of natural resources, which are naturally limited, there is a need. From conventional energy production methods to a better approach using hybrid systems to economically exploit conventional and unconventional resources. This project deals with the automatic switching between different sources in order to obtain uninterrupted power supply and to arrive at low cost savings. Many sources increase system reliability and the system is extremely resilient to power failures and errors. The project uses a circuit based on a small controller with transmitters to facilitate the automatic switching of the power supply from various available sources.

1.4 Objective

- To ensure uninterrupted power supply in modern life in everywhere using different sources namely SOLAR Power, PDB Power, REB Power, Generator Power are used to provide uninterrupted power supply.
- To provide automation that makes the job faster, more reliable, more efficient, and less human effort.

1.5 Methodology

This uninterruptible power supply control system operates on the principle of automatic selection to switch over load to another available source without interruption or switch off. This project uses 4 different supply sources that drive the load and provide uninterrupted power supply. All four sources are connected in the same way as shown in the block diagram. Sequence of power sources by main SOLAR power, PDB power, REB power, Generator power respectively which means that the most important are supplied to the solar power. The main reason for choosing this job is that there are many industries and household appliances that work to provide high quality and expensive electricity. And some appliances need regular or uninterrupted or continuous electricity in order to function properly for a longer life. Many electrical systems are very sensitive which may interfere with the moment of the power supply line. In a power supply system there is a high probability that it can be disrupted at any time such as death / power outage, faults etc. To avoid such problems these project plans are best to take electricity from four different sources and switch between them. using a microcontroller. The suitability of this work is that they are reliable and economical.

2. THEORY

2.1 Introduction to uninterrupted power supply (ups) systems:

Uninterruptible power supply (ups) is an electrical apparatus that provides emergency power to a load when the input power source, typically the main electrical supply, fails. An ups differs from an auxiliary or emergency power system or standby generator in that it provides near-instantaneous protection from input power interruptions by supplying energy. The runtime ofmost ups systems is relatively short (a few minutes) but sufficient to start a standby power source or properly shut down the protected equipment.

2.2 Importance of ups systems in ensuring continuous power supply:

An ups provides immediate backup power during a blackout, ensuring that critical systems remain operational. brownouts and voltage sags are temporary reductions in voltage levels that can cause equipment to malfunction or shut down. An ups can compensate for these fluctuations by providing stable power. In environments where data integrity is crucial, such as data centers, hospitals, and financial institutions, a sudden loss of power can result in significant data loss or corruption. An ups allows for a controlled shutdown of systems, preventing data loss, voltage spikes and surges can damage sensitive electronic equipment. An ups can filter out these anomalies, providing clean and stable power. Frequency variations in power system can affect the performance of electronic equipment. An ups ensures a consistent frequency, protecting the equipment. For businesses, downtime can be costly. An ups ensures that critical operations can continue without interruption, minimizing the impact of power outages on productivity and revenue.In many industries, continuous power is not just a convenience but a regulatory requirement. For example, healthcare facilities must ensure that life-support systems and other critical medical equipment are always operational. An ups helps in meeting these regulatory requirements.By providing a consistent and clean power supply, an ups can enhance the performance and extend the lifespan of connected equipment, reducing the need for frequent repairs or replacements.

2.3 Role of Microcontrollers in UPS Systems:

A microcontroller plays a crucial role in an Auto UPS (Uninterruptible Power Supply) system that integrates power from different sources. It acts as the brain of the system, ensuring seamless switching between power sources, monitoring system parameters, and protecting the load. Below are the key roles of a microcontroller in such a system.

3.STUDY FOR DESIGN AND DEVELOPMENT

3.1 Introduction:

This chapter will focus on how the different components of the build have been constructed and assembled. For the purchased components, product type and performance data will be reviewed. The two points of emphasis will be hardware and software. Among the components used in this projects are arduino microcontroller (uno), relay module, lcd buck regulator, transformer, lamp,ic (7805, 7809),diodes, variable resistor, leds, capacitors,resistors,bread board. To figure out the most effective way to implement the project, a proper schematic diagram is created. Hardware implementation and synchronized server operation define the actual procedure of the research project. The present form of the protection system was developed by analyzing several pieces of literature based on this criterion.

3.2 Multi meter:

An instrument designed to measure Electric Current, voltage, Frequency, Capacitance and Resistance.

Two type of Multi meter available such as being:

3.2.1 Digital Multi meter

3.2.2 Analog Multi meter



Figure: 3.1 Multimeter [1]

3.3 Combination Pliers:

Pliers are a hand tool used to hold objects firmly, possibly developed from tongs used to handle hot metal. They are also useful for bending and compressing a wide range of materials.



Figure:3.2 Combination Pliers [2]

3.4 Star Screw Driver:

Electrical works a lot of importance to star screw driver. Without star screw driver it is impossible to connect a lot circuitry. Many sizes are available in the market for star screw driver. There are used depending on the work. There for a lot of importance to screw driver.



Figure:3.3 Star Screw Driver [3]

3.5 Flat Screw Driver:

Electrical works a lot of importance driver. Flat screw driver used in some electrical circuit. All goods that's required for the flat screw driver. Flat screw driver in a variety of market depending on the use for their work. There for a lot of importance of flat screw driver.



Figure:3.4 Flat Screw Driver [4]

3.6 Phase or Line Tester:

Phase or Line Tester is a tool which is used to identify or test the Phase/Live/Hot or Positive wire/Conductor. Phase or Line Tester is also called Neon Screw Driver or Test Pin.

(Good to Know: Phase, Line, Hot, Live and Positive are the same terms)

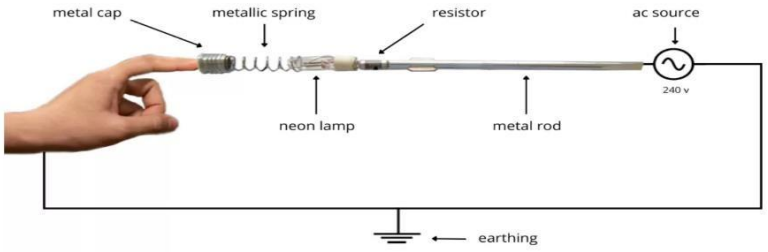


Figure:3.5 Line Tester [5]

3.7 Solar Power:

Bangladesh has a geographical fitting condition for solar power that receives an average daily solar radiation of (4-6.5) kWh/m2.



Figure:3.6 Solar System [6]

Solar panels are the medium to convert solar power into the electrical power. Sun beam is absorbed with the panel materials and electrons are emitted from the atoms that they are bounded. This release current thus solar power is converted into electrical power. When PV cells are joined physically and electrically and placed into a frame they form a solar panel or PV module. Panels joined together form a solar array. The sunlight impinging on panels, i.e. irradiance or insulation (incoming solar radiation), is measured in units of watts per square meter (W/m2). We can use only 25% of sunlight radiation for PV module. The PV system power output (DC) has approximately a linear relationship to the insulation. Using the solar radiation available on the tilted surface the hourly energy output of the PV generator can be Calculated according to following equation:

$P = A \cdot x2 + B \cdot x + C$ (in Watts) (1)

Where, x= solar radiation, P=power generation, and A, B, C are constants, which can be derived from measured data by using above formula, we can predict solar power generation at any solar radiation.

Equipment of solar system

- Solar panels
- Inverter
- Racking
- Performance monitoring
- Storage option (battery or grid connection)

3.8REB Power:

It seems like you're referring to the **Rural Electrification Board (REB)** of Bangladesh. The REB was established in 1977 to electrify rural areas and improve access to electricity. It works alongside the Power Development Board, which manages urban electricity distribution. The REB also oversees Palli Bidyut Samities, which act as consumer cooperatives. The REB (Rural Electrification Board) power system in Bangladesh focuses on expanding electricity access to rural areas through a network of distribution lines, substations, and power plants. The REB, a government organization, is responsible for rural electrification and is the largest power distribution organization in Bangladesh. It utilizes a variety of technologies and approaches to ensure reliable and efficient power delivery to consumers.

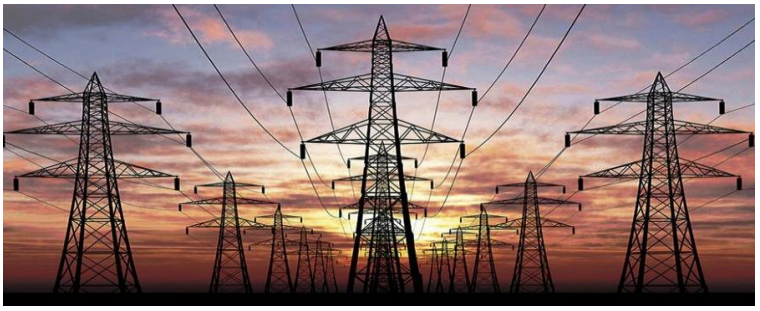


Figure:3.7 REB [7]

REB Components:

The Rural Electrification Board (REB) of Bangladesh has several key components that contribute to its operations and objectives:

- **Palli Bidyut Samities (PBSs):** These are rural electric cooperatives that distribute electricity to rural areas. They operate under the REB's guidance and are crucial for implementing electrification programs.
- **Power Distribution Infrastructure:** REB constructs power distribution lines and substations to ensure reliable electricity supply. By 2011, it had energized over 120,947 km of distribution lines**.**
- **Consultants**: Both local and foreign consultants assist in feasibility studies, load surveys, and system improvements. They help design and maintain the power distribution system.
- **Training Programs**: REB provides extensive training for engineers, workers, and managers to ensure efficient operations.
- **Performance Target Agreement (PTA)**: This agreement encourages PBSs to improve their performance by setting annual targets. Bonuses or penalties are applied based on their achieve

3.9Generator:

In electricity generation, a generator is a device that converts mechanical power into electrical power for use in an external circuit. Sources of mechanical energy include steam turbines, gas turbines, water turbines, internal combustion engines and even hand cranks. The first electromagnetic generator, the Faraday disk, was built in 1831 by British scientist Michael Faraday. Generators provide nearly all of the power for grids. The reverse conversion of electrical energy into mechanical energy is done by an electric motor, and motors and generators have many similarities. Many motors can be mechanically driven to generate electricity and frequently make acceptable manual generators.

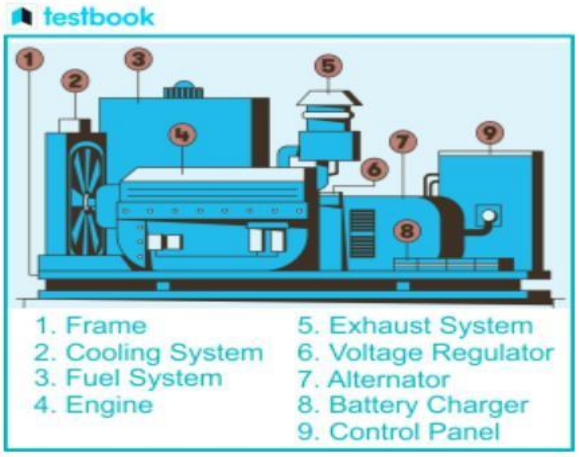


Figure:3.8 Generator with parts name [8]

Types of Generators:

These convert mechanical energy into electrical energy. Types include:

1. **Diesel Generator** – Uses diesel fuel; common for backup power.
2. **Gasoline Generator** – Portable and used for light loads.
3. **Natural Gas Generator** – Cleaner and quieter; used in homes and industry.
4. **Hydroelectric Generator** – Uses water flow to generate electricity.
5. **Wind Turbine Generator** – Converts wind energy into electricity.
6. **Solar Power Generator** – Uses solar panels and batteries.
7. **Steam/Thermal Generator** – Uses steam from boilers or nuclear power

3.10 Designed Flow chart:

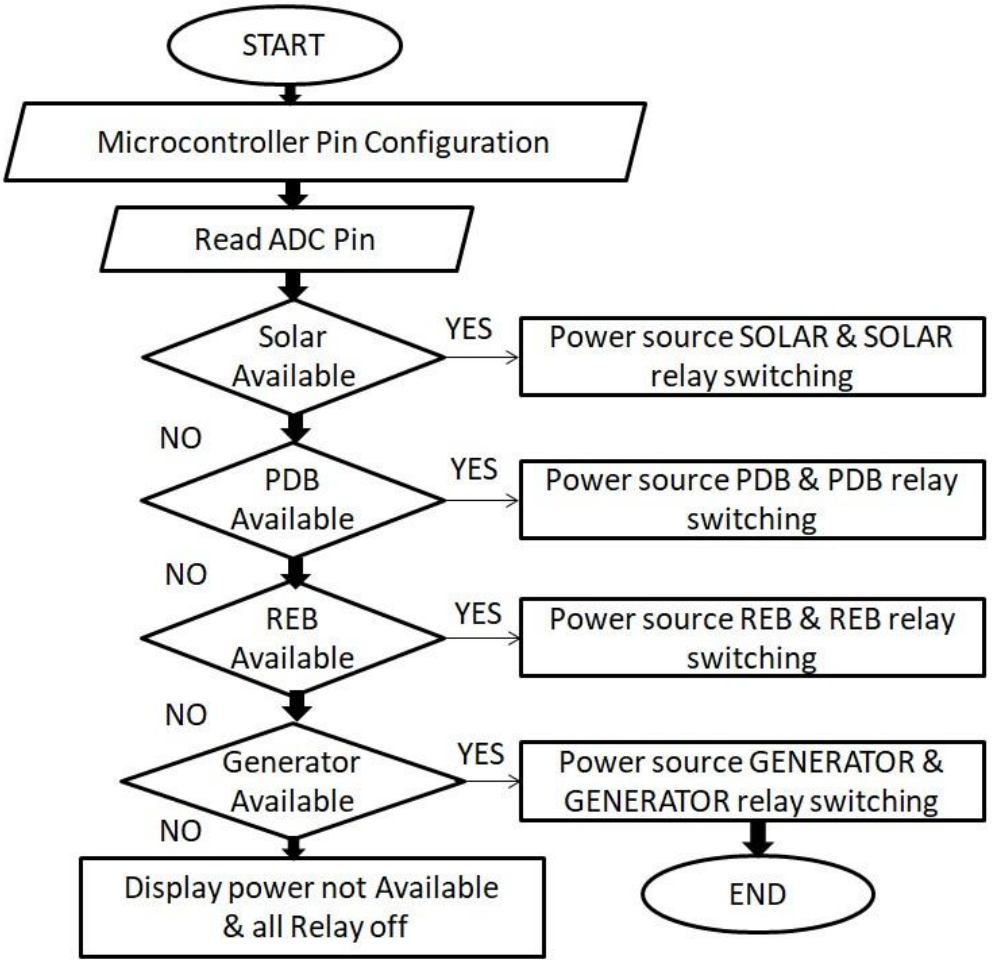


Figure:3.9 Designed Flow chart diagram of this project

3.11 Circuit Diagram:

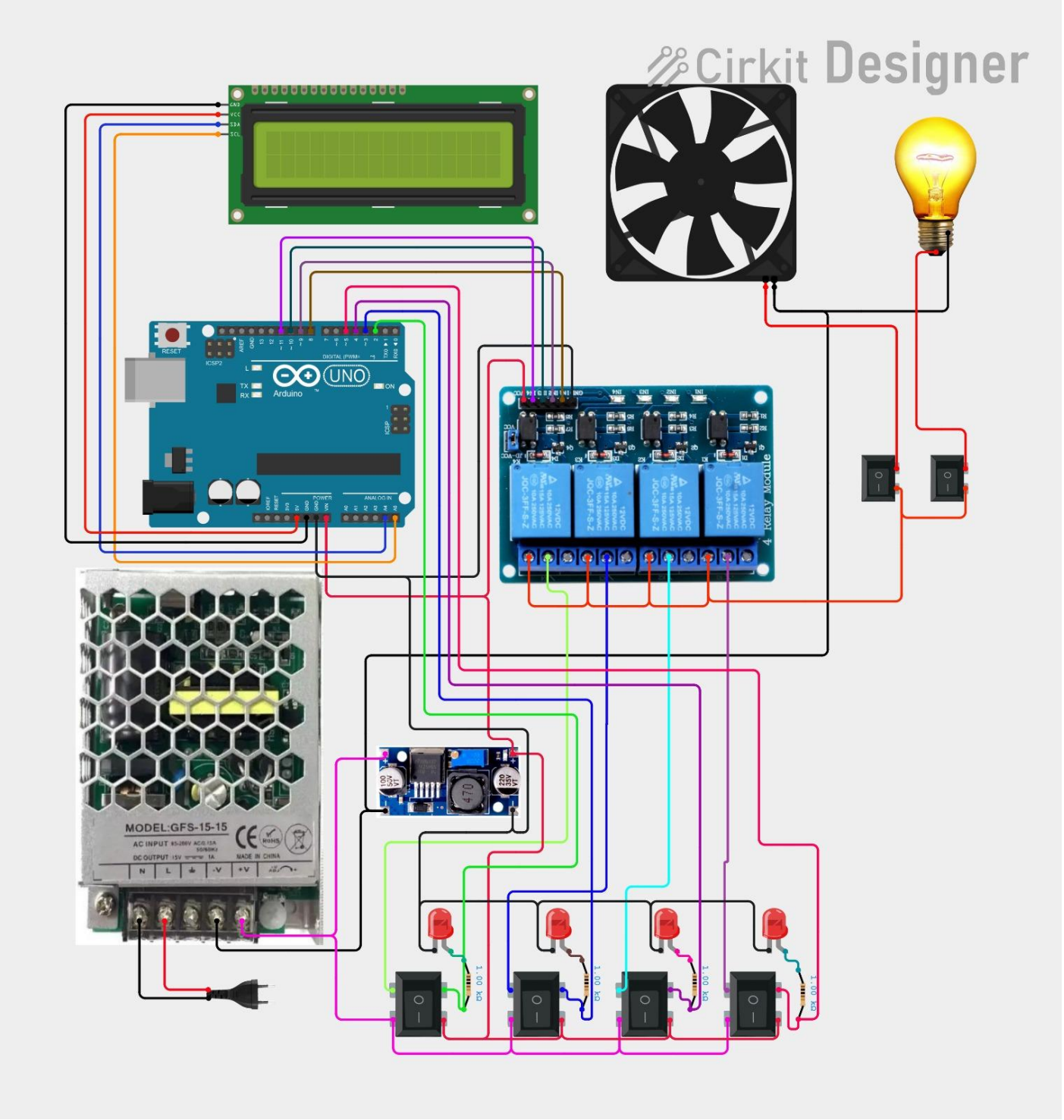


Figure:3.10 Circuit diagram

3.12List of hardware components:

- ARDUINO Microcontroller (UNO)
- Relay Module
- LCD (20*4)
- Buck regulator
- Transformer
- Lamp
- IC (7805, 7809)
- Diodes
- Variable resistor
- LEDS
- Capacitors
- Resistors
- Bread board

3.13 Arduino Uno

In a nutshell, the Arduino Uno is an open-source microcontroller board based on the ATmega328P microcontroller, which is shown in Various expansion boards or shields, and other circuits can be interfaced with the board's digital and analog input/output pins. A type B USB cable is required to program the board using the Arduino IDE (Integrated Development Environment). It has 6 Digital pins and 12 Analog pins. An external 9-volt battery can be used to power it, or a USB cable can be used. It is also similar to the Arduino Nano and Leonardo. It can be downloaded from the Arduino website and distributed under the Creative Commons Attribution-Share Alike 2.5 license. Various layouts and production files are also available.

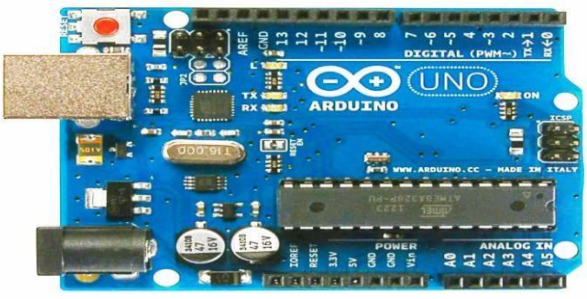


Figure 3.11 Arduino Uno [9]

This initial release of the Arduino Software was given the name "Uno" for its Italian meaning. Arduino Uno was the first of a series of USB-based Arduino boards, and the Arduino IDE and Uno together were the first releases of Arduino software. A bootloader is already preprogrammed into the ATmega328, allowing programmers to upload new code without an external hardware programmer. It is the first board not to include the FTDI USB-to-serial driver chip while using the STK500 protocol as its communication protocol. The USB-to-serial converter uses the Atmega16U2 (Atmega8U2 up to version R2) as an analog input [14].

Arduino (UNO) Details

The Arduino Uno is one of the most popular and beginner-friendly microcontroller boards in the Arduino family. It is based on the *ATmega328P* microcontroller and is widely used for electronic projects and prototyping.

Key Features:

1. **Microcontroller:**

ATmega328P (8-bit AVR RISC-based microcontroller).

Clock Speed: 16 MHz

2. **Input / Output Pins**:

14 Digital I/O Pins: Can be used as input or output (pins 0–13).

6 PWM Pin: Pin 3, 5, 6, 9, 10, 11.

6 Analog Input Pin A0–A5

Maximum current per pin: 40 mA.

3. **Memory:**

Flash Memory: 32 KB (0.5 KB used by the bootloader).

SRAM: 2 KB.

EEPROM: 1 KB.

4. Power Supply:

Operating Voltage: 5V.

Can be powered via USB (5V) or an external power source.

5. Communication:

USB interface for programming and communication with a computer.

Supports UART (serial), SPI, and I2C communication protocols.

On-board USB-to-Serial converter chip: ATmega16U2 (on newer models).

6. Physical Characteristics:

Dimensions: 68.6 mm × 53.4 mm.

Weight: ~25g.

Pin headers allow connection to sensors, modules, and shields.

7. Software:

Programmed using the Arduino IDE, which uses a simplified version of C/C++.

Compatible with a wide range of libraries for various sensors, modules, and components.

8. Special Features:

Reset Button: Resets the microcontroller.

LED Indicators:

Power LED.

Built-in LED on pin 13.

TX and RX LEDs for serial communication activity.

Applications:

Robotics.

Home automation.

IoT projects.

LED control and light displays.

Sensor data acquisition and processing.

Educational projects and prototyping.

3.14 Liquid Crystal Display (LCD):

LCD stands for Liquid Crystal Display, a type of flat-panel display technology commonly used in various electronic devices such as televisions, computer monitors, smartphones, calculators, and digital clocks. It works by using liquid crystals to modulate light. Here's an overview:

How LCD Works:

1. Backlight or Reflective Light: LCDs rely on an external light source (a backlight or reflected ambient light) because liquid crystals do not emit light themselves.

2. Liquid Crystal Layer: Liquid crystals are sandwiched between two layers of glass or plastic. These crystals align when an electric current pass through, controlling the passage of light.

3. Polarizers: Polarizing filters on either side of the liquid crystal layer regulate the light,

enabling or blocking it based on the alignment of the crystals.

4. Color Filters: In color displays, red, green, and blue filters create color by combining these primary colors in varying intensities.



Figure 3.12 LCD Display [10]

3.15 SMPS:

A Switch Mode Power Supply (SMPS), also known as a switching power supply, is an electronic power converter that efficiently transforms electrical power by using switching regulators to convert AC to DC or DC to DC.

Here's how it works:



Figure:3.13 SMPS [11]

Switching regulators are employed in SMPS devices to maintain & regulate the output voltage by turning on or off the load current. The mean value between on and off is the appropriate power output for a system. The SMPS reduces depletion strength because, in contrast to the linear power supply, it carries transistor switches between low dissipation, full-on as well as full-off phases and spends significantly fewer seconds in high dissipation cycles.

- In the initial stage, a rectifier and filter are used to process the AC power that comes in into DC.
- Because the SMPS operates at high frequencies, the DC signal is processed by a high-frequency switch to produce a medium-frequency pulsating DC signal.
- A power transformer reduces the high-voltage DC output to the proper level of DC signal.
- Reversing and filtering the stepped-down DC signal results in a constant steady DV output.
- To guarantee a constant output stream of the intended voltage, the control circuitry continuously monitors the generated voltage and modifies the high-frequency switch.

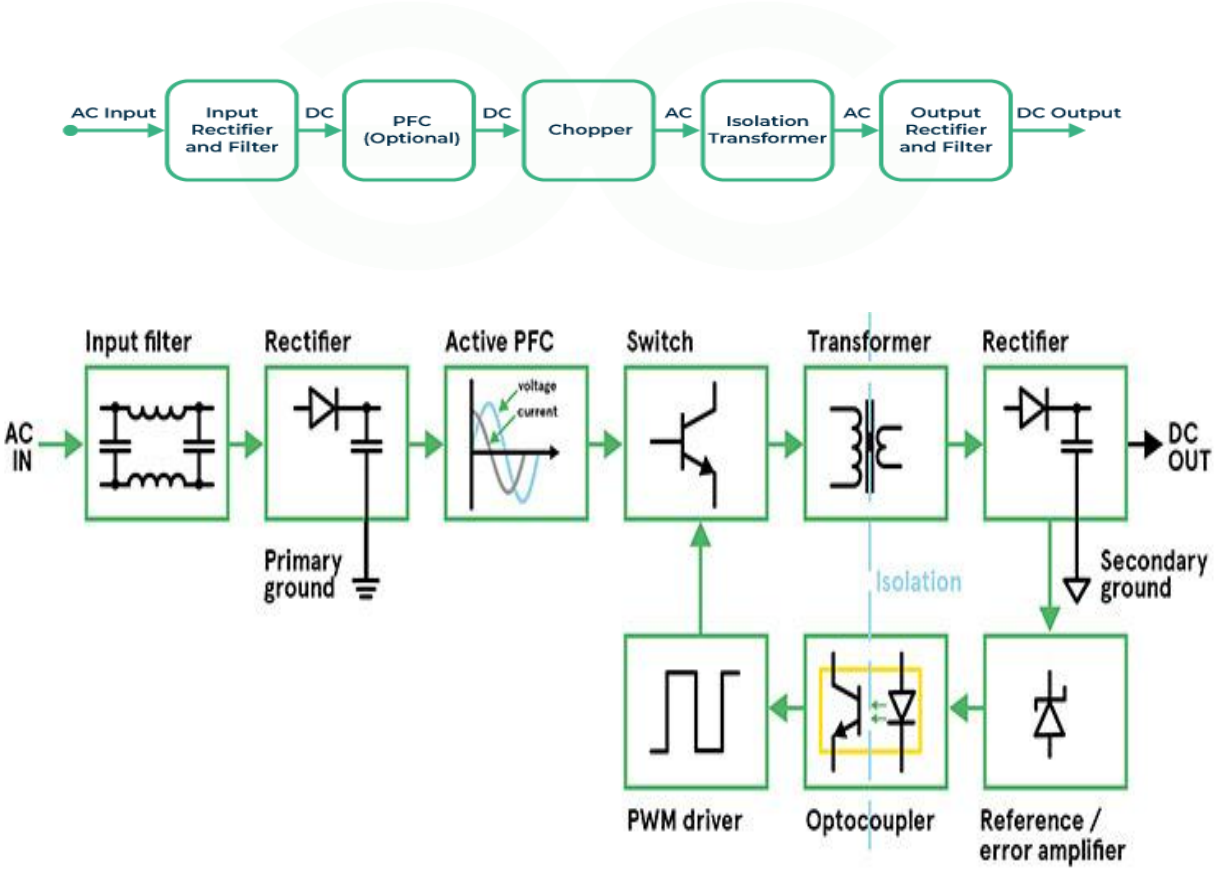


Figure:3.14 Switch Mode Power Supply [12]

3.16 BUCK REGULATOR:

A **buck converter** (**step-down converter**) is a DC-to-DC power converter which steps down voltage (while stepping up current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter).

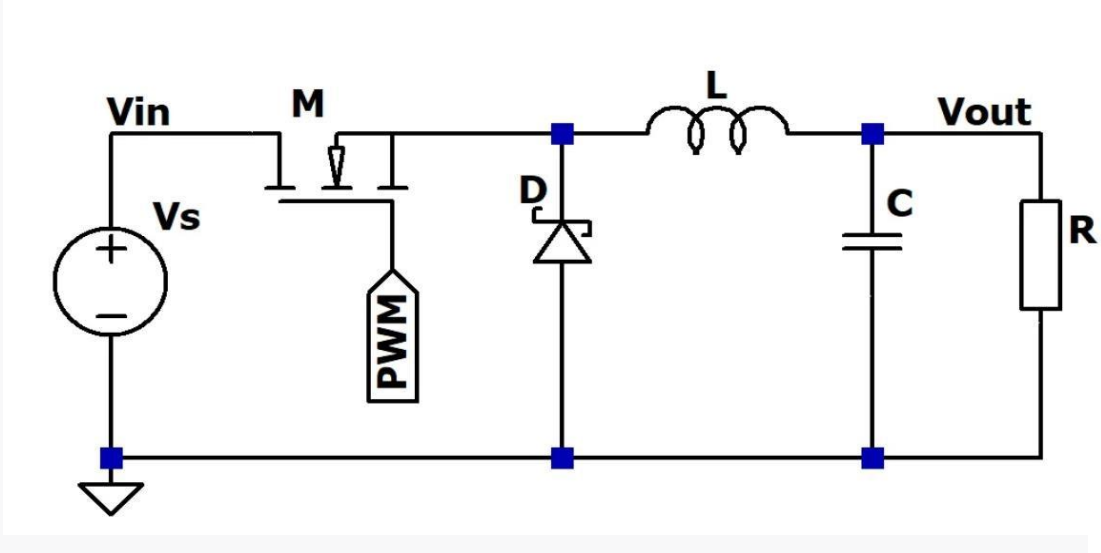


Figure:3.15 Buck Converter Circuit Diagram [13]

Switching converters (such as buck converters) provide much greater power efficiency as DC-to-DC converters than linear regulators, which are simpler circuits that lower voltages by dissipating power as heat, but do not step up output current.

Buck converters can be remarkably efficient (often higher than 90%), making them useful for tasks such as converting a computer's main (bulk) supply voltage (often 12V) down to lower voltages needed by USB, DRAM and the CPU (1.8V or less)



Figure:3.16 Buck Regulator [14]

Operation of buck converter: A buck regulator operates using a combination of switching and filtering components:

1. Switch (MOSFET/Transistor): Rapidly switches on and off to control the flow of current.

2. Diode (or synchronous MOSFET): Provides a path for current during the off phase of the switch.

3. Inductor: Smooths the pulsating current generated by the switching action, storing energy and releasing it steadily.

4. Capacitor: Filters out any remaining ripple to deliver a smooth DC output.

5. Controller Circuit: Regulates the switching action to maintain a stable output voltage.

3.17 Relay Module:

The Arduino Relay module allows a wide range of microcontroller such as Arduino, AVR, PIC, and ARM with digital outputs to control larger loads and devices like AC or DC Motors, electromagnets, solenoids, and incandescent light bulbs. This module is designed to be integrated with 2 relays that it is capable of control 2 relays. The relay shield use one QIANJI JQC-3F high-quality relay with rated load 7A/240VAC,10A/125VAC,10A/28VDC.The relay output state is individually indicated by a light-emitting diode.



Figure:3.17 Relay Module [15]

Features of Relay Module

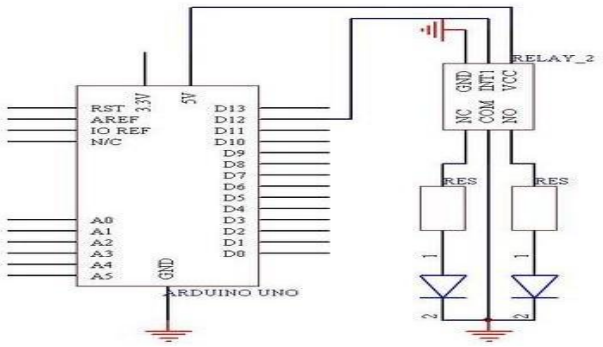
- Number of Relays: 2
- Control signal: TTL level

- Rated load: 7A/240VAC 10A/125VAC 10A/28VDC
- Contact action time: 10ms/5ms

Pin Definition

- COM- Common pin
- NC- Normally Closed, in which case NC is connected with COM when INT1 is set low and disconnected when INT1 is high
- NO- Normally Open, in which case NO is disconnected with COM1 when INT1 is set low and connected when INT1 is high.
- Terminal 2 is similar to terminal 1, except that the control port is INT2
- INT 1- Relay 1 control port
- INT 2- Relay 2 control port

Block Diagram of Relay Module



Relay Principle

A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it).Here are two simple animations illustrating how relays use one circuit to switch on a second circuit.

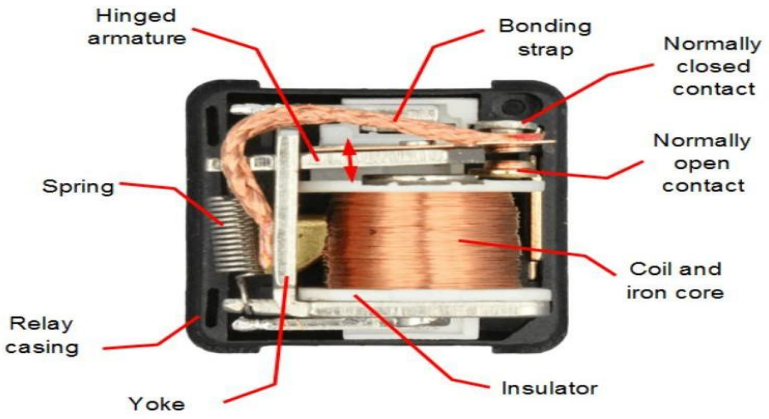


Figure:3.18 Relay Module [16]

When power flows through the first circuit (1), it activates the electromagnet (brown), generating a magnetic field (blue) that attracts a contact (red) and activates the second circuit (2). When the power is switched off, a spring pulls the contact back up to its original position, switching the second circuit off again.

3.18 LED:

LED (Light Emitting Diode) is a semiconductor device that emits light when an electric current pass through it. LEDs are widely used in various applications due to their energy efficiency, long lifespan, and versatility. Here's an overview of their characteristics, types, and uses.

LEDs Working principle:

Principle: LEDs operate on the principle of electroluminescence, where a material emits light when an electric current flow through it.

Structure: LEDs consist of a semiconductor material (typically gallium arsenide or gallium phosphide) with a p-n junction. When voltage is applied, electrons and holes recombine, releasing energy in the form of light.

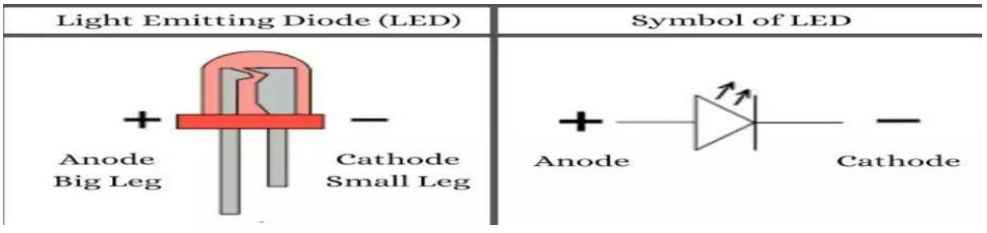


Figure:3.19 LED [17]

3.19 Resistor:

A **resistor** is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, **resistors** are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.



Figure:3.20 Resistor [18]

3.20 Jump wire (connector):

A **jump wire** (also known as jumper, jumper wire, jumper cable, DuPont wire, or DuPont cable – named for one manufacturer of them) is an electrical wire or group of them in a cable with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.



Figure: 3.21 Jump wire [19]

3.21 Bread board:

A breadboard is a tool used in electronics to prototype and test circuits without the need for soldering. It provides a platform to connect and experiment with electronic components in a

reusable and flexible way.

Key Features of a Breadboard:

1 Layout: Divided into sections with rows and columns of small holes.

Bus Strips: Parallel lines along the edges for power and ground connections.

2. Connectivity:

Holes in each row are electrically connected in groups.

Vertical lines (bus strips) are for power supply (+ and -).

Horizontal lines (terminal strips) are grouped in blocks of 5 for connecting components.

3. Material:

Made from a plastic body with a grid of metal clips underneath to hold and connect components.

4. Types:

Solderless Breadboard: Most common; no soldering needed.

Stripboard or Vero board: Requires soldering; used for more permanent circuits.

Power Breadboard: Includes built-in power supply connections.

5. Size: Available in various sizes (e.g., full, half, and mini breadboards) to accommodate different circuit complexities.

6. Markings:

Labelled rows (letters: A-J) and columns (numbers) for easy reference.

How to Use a Breadboard?

1. Insert components like resistors, capacitors, and ICs into the holes.

2. Use jumper wires to make connections between components.

3. Connect power and ground to the bus strips.

Limitations:

- Not suitable for high-frequency circuits due to stray capacitance and inductance.

- Connections can be less reliable for long-term use.

Applications:

Learning and teaching electronics.

Prototyping and testing circuits.

- Debugging and experimentation in circuit design.

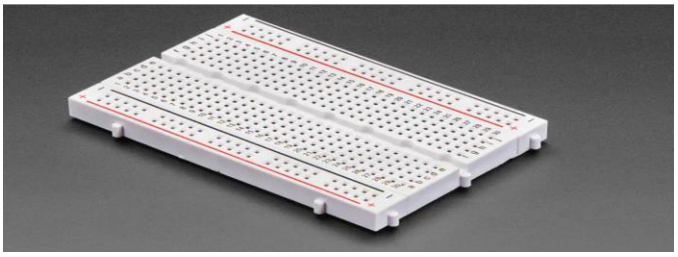


Figure:3.22 Bread board [26]

3.22 Diode:

A diode is an electronic component that allows current to flow in one direction only, while blocking current flow in the opposite direction. It is one of the simplest and most fundamental components in electronics. Diodes are typically made from semiconductor materials like silicon or germanium.

Key Characteristics of a Diode:

3.22.1 Unidirectional Current Flow

3.22.2 A diode has two terminals, a) Anode (positive terminal), Cathode (negative terminal). Current flows from the anode to the cathode (forward bias) and is blocked in the reverse direction (reverse bias).

3.22.3 Forward Bias: When the anode is connected to a positive voltage relative to the cathode, the diode conducts electricity. A small voltage threshold (e.g., ~0.7V for silicon diodes) must be surpassed for current to flow.

3.22.4 Reverse Bias: When the anode is connected to a negative voltage relative to the cathode, the diode blocks current flow. However, in high reverse voltages, some diodes may experience "breakdown," where current flows uncontrollably

Types of Diodes:

1. Rectifier Diodes: Used in power supplies to convert AC to DC.
2. Zener Diodes: Operate in reverse bias for voltage regulation.
3. Light Emitting Diodes (LEDs): Emit light when current flows through them.

4. Schottky Diodes: Have a low voltage drop and are used for fast switching.
5. Photodiodes: Generate current when exposed to light.

Applications of Diodes:

Rectification: Converting alternating current (AC) to direct current (DC).

Protection Circuits: Prevent reverse polarity damage to sensitive components.

Signal Modulation: In communication systems.

Voltage Regulation: Using Zener diodes.

Light Emission: In LEDs for displays, indicators, and lighting. In summary, diodes are essential for controlling current in electronic circuits and are widely used in various applications due to their simple and **reliable functionality**.

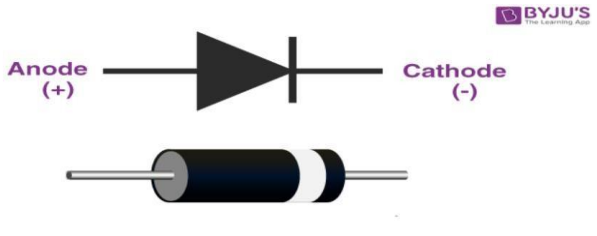


Figure: 3.23 Diode [23]

3.23 Pin header (rail):

A **pin header** (often abbreviated as *PH*, or simply **header**) is a form of electrical connector. It consists of one or more rows of male pins typically spaced 2.54 millimeters (0.1 in) apart, but 5.08 millimeters (0.2 in), 5.00 millimeters (0.197 in), 3.96 millimeters (0.156 in), 2.00 millimeters (0.079 in), 1.27 millimeters (0.05 in) or 1.00 millimeters (0.04 in) are common as well.[1] The distance between pins is commonly referred as *pitch* in the electronic community. In the past, a pin header was known as a Berg connector, but the term fell out of favor because pin headers are manufactured by many companies Pin headers are often associated with ribbon cable connectors, pin headers often also function as recipients for jumpers.

The most common jumper spacing is 2.54 millimeters (0.1 in), though 2.0 millimeters

(0.079 in) is sometimes used in smaller products.

Pin header connectors are thus "male" connectors ("female" counterparts do exist, but these are normally just called **female header** (*FH*) or **header connector**, without "pin") and are mostly used inside equipment, rather than being used as a connector on the outside of the device.



Figure:3.24 Pin Header [25]

3.24 Variable Resistor:

A variable resistor is the type of resistor which changes the flow of current in a controlled manner by offering a wide range of resistances. As the resistance increases in the variable resistor the current through the circuit decreases and vice versa. They can also be used to control the voltage across devices in a circuit.A typical variable resistor has 3 terminals. Out of the three, two are fixed terminals at the ends of a resistive track. The terminals are made of conducting metal. The other terminal is a moving terminal, mostly known as the wiper. It is the position of this terminal on the resistive track that decides the resistance of the variable resistor.

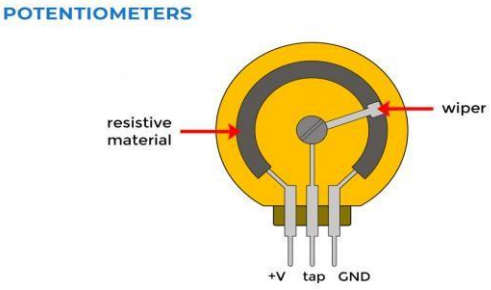


Figure:3.25 Terminal of Variable Resistor [24]

These resistors offer a different resistance value, which means their resistance values can be adjusted to different values so as to provide the necessary control of current and/or voltage.

3.25 IC-7805:

IC 7805 is a **5V Voltage Regulator** that restricts the voltage output to **5V**and draws 5V regulated power supply. It comes with provision to add heat sink.The maximum value for input to the voltage regulation is 35 V. It can provide a constant steady voltage flow of 5V for higher voltage input till the threshold limit of 35V. If the voltage is near to 7.5V then it does not produce any heat and hence no need for heat sink. If the voltage input is more, then excess electricity is liberated as heat from 7805.It regulates a steady output of 5V if the input voltage is rage of 7.2V to 35V. Hence to avoid power loss try to maintain the input to 7.2V. In some circuitry voltage fluctuation is fatal (for e.g. Microcontroller), for such situation to ensure constant voltage IC7805 Voltage Regulator is used.



Figure:3.26 IC 7805[21]

7805 IC Rating

Input voltage range 7V- 35V, Current rating $I_{c=}$ 1A, Output voltage range $V_{max=5.2}$, $V_{Min=4.8V}$

3.26 7809 IC

7809 is a voltage regulator integrated circuit (IC) which is widely used in electronic circuits. Voltage regulator circuit can be manually built using parts available in the market but it will take a lot of time to assemble those parts on a PCB. Secondly, the cost of those parts is almost equal to the price of 7809 itself so professionals usually prefer to use 7809 IC instead of making a voltage regulator circuit from scratch. Before you start using 7809, you will need to know about the pin structure of IC 7809. Apparently, it looks like a transistor. It has three pins. For a better understanding, I have given an image of 7809 bellow. Please take a look.

You can easily see the V in and V out pins as well as the ground pin. It is really easy to use 7809 for voltage regulation purposes. I have also included a circuit diagram of 7809 so that you may learn how to use it in a circuit diagram.

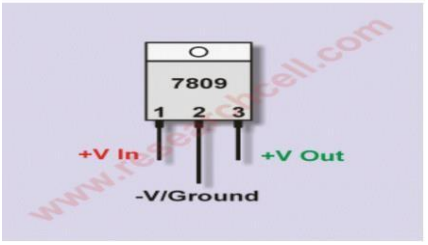


Figure:3.27 IC-7809 [20]

It is wise to use two .1uF capacitors on both input and output sides to filter any ripple or distortion in voltage but it is not necessary. In the image, you can see that 12V are being supplied on the input side of 7809 but the output side of 7809 is outputting Regulated 9V. As long as the input voltage remains above 9V, output voltage of 7809 will remain smooth and regulated.Please note that input voltage of 7809 can be up to 23V but under my experience, it is wise to avoid input over 15V. 7809 is claimed to output 9V and almost 1.5A Current but again, I have experienced that we should not put a load over 9V and 1A on it. Since we are using it in power supply, the transfer of power will result in heat output. We will need to use a heat sink with 7809 otherwise this heat can damage it. It is advised to use a 1A fuse on the output side of 7809 and a 1.5A fuse on the input side of 7809 to avoid damage in case of short circuit.

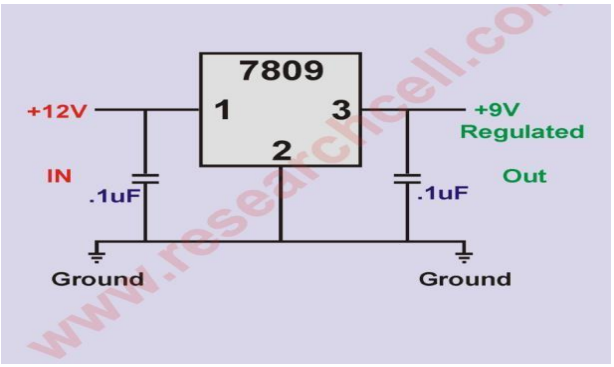


Figure: 3.28 IC-7809 Connection Diagram [20]

3.27 LDR

An LDR or light dependent resistor is also known as photo resistor, photocell, Photoconductor. It is a one type of resistor whose resistance varies depending on the amount of light falling on its surface. When the light falls on the resistor, then the resistance changes. These resistors are often used in many circuits where it is required to sense the presence of light. These resistors have a variety of functions and resistance. For instance, when the LDR is in darkness, then it can be used to turn ON a light or to turn OFF a light when it is in the light. A typical light dependent resistor has a resistance in the darkness of 1MOhm, and in the brightness a resistance of a couple of KOhm

Working Principle of LDR



Figure:3.29 LDR [22]

This resistor works on the principle of photo conductivity. It is nothing but, when the light falls on its surface, then the material conductivity reduces and also the electrons in the valence band of the device are excited to the conduction band. These photons in the incident light must have energy greater than the band gap of the semiconductor material. This makes the electrons to jump from the valence band to conduction.

These devices depend on the light, when light falls on the LDR then the resistance decreases, and increases in the dark. When a LDR is kept in the dark place, its resistance is high and, when the LDR is kept in the light its resistance will decrease.

4 RESULT AND DISCUSSION

4.1Introduction

In this chapter, we will present the tangible results and observations obtained from our system's operation. We will discuss how our integrated system effectively monitored and responded to potential.

4.2Result

In the Results section, we present the outcomes of our project's implementation, showcasing the successful integration of **Auto Power Supply Control from four Different Sources using Microcontroller to Ensure Uninterrupted Power.**



Figure:3.30 Project Picture

4.3System Functionality:

Seamless Power Switching: The system successfully switches between multiple power sources (e.g. SOLAR power, PDB power, REB power, GENERATOR power) without interruption.
Automatic Source Selection: The Arduino microcontroller automatically selects the optimal power source based on availability, priority, or predefined logic (e.g., SOLAR first, then PDB, then REB, then GENERATOR).
Battery Charging and Management: The system efficiently charges the backup battery when the primary power source is available and switches to battery power during outages.

4.4Performance Metrics:

Response Time: The time taken to switch between power sources is measured (e.g.<100ms for seamless transition).
Battery Backup Duration: The duration for which the system can provide uninterrupted power using the backup battery is calculated (e.g., 2 hours for a 12V 7Ah battery).

4.5Hardware Integration:

Sensor Accuracy: Voltage and current sensors used to monitor power sources provide accurate readings (e.g., ±0.1V accuracy).
Relay Performance: The switching mechanism (relays) operates reliably without overheating or failure.
Arduino Control: The Arduino microcontroller effectively processes input data and controls the system as intended.

4.6Software Logic:

Algorithm Effectiveness: The logic implemented in the Arduino code (e.g. priority-based source selection) works as expected.
Error Handling: The system handles edge cases, such as all power sources being unavailable, gracefully (e.g. shutdown procedure).

4.7User Interface:

Simulated Power Failures: The system is tested under simulated power outages to ensure uninterrupted power supply.
Load Testing: The system is tested with different loads to verify its capacity and stability.

4.8Result Summary:

The UPS control system using an Arduino microcontroller successfully achieved seamless switching between four power sources. The system demonstrated a response time of <100ms during power source transitions and provided uninterrupted power for up to 2 hours using a 12V 7Ah battery. The Arduino-based control logic efficiently managed power source selection, while the hardware components like sensors, relays, operated reliably under varying load conditions. Future improvements could include integrating IoT for remote monitoring and adding more renewable energy sources

This structure ensures a comprehensive and professional presentation of the project's results.

5 CHALLENGES, IMPROVEMENTS, LIMITATION & FUTURE SCOPE

5.1Challenges and Improvements:

Challenges Faced: Issues such as voltage spikes, relay delays, or battery overcharging are documented.

Improvements Suggested: Potential enhancements, such as adding more power sources improving efficiency, or integrating IoT for remote monitoring, are proposed.

5.2Limitations of the Work:

Hardware Limitations:

1. Power Handling Capacity:

Arduino microcontrollers Uno, are not designed to handle high power loads directly. They can only control low-power signals, so external components like relays, MOSFETs, or transistors are required to switch high-power sources. The relays or switching components must be carefully chosen to handle the voltage and current of the power sources.

2. Voltage and Current Limitations:

Arduino boards typically operate at 5V or 3.3V logic levels. If the power sources (e.g., solar, grid, battery) have higher voltages, additional circuitry like voltage dividers, optocouplers, or level shifters is needed to interface safely with the Arduino.

3. Heat Dissipation:

Switching between power sources can generate heat in the relays or MOSFETs, especially if the load current is high. Proper heat sinks and cooling mechanisms may be required.

4 Component Reliability:

5 Relays and MOSFETs used for switching may wear out over time due to frequent switching, leading to system failure.

6 **Software Limitations:**

1. Limited Processing Power:

Arduino microcontrollers have limited processing power and memory. Complex algorithms for power management or advanced decision-making may be challenging to implement.

2. Real-Time Constraints:

The system must respond quickly to changes in power availability (e.g., solar power dropping due to clouds). Arduino's single-threaded nature may limit its ability to handle multiple tasks simultaneously.

3. Algorithm Complexity:

Implementing efficient algorithms to prioritize power sources (e.g., solar > grid > battery) and manage transitions smoothly can be difficult with limited computational resources.

6 System-Level Limitations:

1. Power Source Compatibility:

Different power sources (e.g., solar, pdb, reb, generator) may have varying voltage levels, frequencies, and characteristics. Ensuring compatibility and smooth transitions between them can be challenging.

5.3Lack of Advanced Communication Protocols:

Arduino boards may lack support for advanced communication protocols (e.g., Modbus, MQTT) required for integration with smart grids or IoT systems.

5.4Safety Concerns:

Switching between power sources must be done safely to avoid short circuits, voltage spikes, or back-feeding into the grid. Proper isolation and protection circuits are essential.

5.5Scalability:

The system may not scale well for larger applications (e.g., industrial or commercial use) due to the limited capabilities of Arduino microcontrollers.

5.6Cost and Maintenance Limitations:

1. Cost of Components:

High-quality relays, sensors, and power management components can increase the overall cost of the system.

2. Maintenance Requirements:

Regular maintenance may be required to ensure the reliability of the system, especially for components like relays and batteries.

3. Dependency on External Libraries:

Arduino relies on external libraries for many functionalities. If these libraries are not well-maintained or compatible with your hardware, it can lead to issues.

5.7 User-Related Limitations:

1. Technical Expertise:

Designing and implementing such a system requires a good understanding of electronics, programming, and power management. Beginners may find it challenging.

2. User Interface:

Providing a user-friendly interface for monitoring and controlling the system may require additional hardware (e.g., LCD displays) and software development.

5.8 Regulatory and Compliance Issues:

1. Grid-Tied Systems: If the system is connected to the grid, it must comply with local regulations and standards for safety and power quality.

5.9 Certification:

The system may require certification for use in certain applications, which can be time-consuming and costly.

5.10 Future Scope:

The future scope of auto power supply control using an Arduino microcontroller to ensure uninterrupted power is vast and promising, driven by advancements in IoT, renewable energy integration, and smart grid technologies. Below are some key areas of development and opportunities.

1. Integration with Renewable Energy Sources.
2. Smart Grid and IoT Integration.

- Real-Time Monitoring: Arduino can be used to monitor power consumption, source availability, and load requirements in real-time, enabling dynamic switching between power sources.
- Remote Control: With IoT integration, users can monitor and control the power supply system remotely via smartphones or computers.
- Data Analytics: Collecting and analyzing data from the system can help optimize energy usage and predict power requirements.

3. Energy Storage and Management.

- Battery Management Systems (BMS): Arduino can be used to manage battery charging/discharging cycles, ensuring efficient use of stored energy.
- Peak Load Shaving: The system can switch to battery power during peak load times to reduce grid dependency and lower electricity costs.

4. Microgrid Development.

5. Enhanced Automation and AI Integration.

CONCLUSION

The "Auto Power Supply Control from Different Sources Using Arduino Microcontroller to Ensure Uninterrupted Power" project successfully demonstrates an efficient and reliable system for managing power supply from multiple sources by utilizing the Arduino microcontroller, the system intelligently switches between power sources based on availability and priority, ensuring uninterrupted power supply to critical loads. This project provides a practical and innovative solution to address power supply challenges, ensuring uninterrupted electricity in various scenarios. It highlights the potential of microcontroller-based systems in energy management and paves the way for further advancements in smart grid technologies. This conclusion effectively summarizes the project's goals, achievements, limitations, and future scope, providing a comprehensive wrap-up of the work done.

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6.2 APPENDIX-1

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
// Initialize the I2C LCD (I2C address, columns, rows)
LiquidCrystal_I2C lcd(0x27, 16, 2); // Change 0x27 to your LCD address if different
// Relay pins
const int solarRelayPin = 8;
const int pdbRelayPin = 9;  const
int rebRelayPin = 10;  const int
generatorRelayPin = 11;
// Digital input pins for power source detection
const int solarPin = 2;// Digital pin for Solar
const int pdbPin = 3;// Digital pin for PDB const
int rebPin = 4;// Digital pin for REB
const int generatorPin = 5;// Digital pin for Generator
void setup() {
  // Initialize LCD
  lcd.init();
  lcd.backlight();
  lcd.print("Power Source:");
// Set relay pins as output
  pinMode(solarRelayPin, OUTPUT);
  pinMode(pdbRelayPin, OUTPUT);
  pinMode(rebRelayPin, OUTPUT);
  pinMode(generatorRelayPin, OUTPUT);
// Set power source detection pins as input
  pinMode(solarPin, INPUT);
  pinMode(pdbPin, INPUT);
  pinMode(rebPin, INPUT);
  pinMode(generatorPin, INPUT);
 // Initialize relays to OFF
  turnOffAllRelays();
```

```
}
void loop() {
  // Read the status of each power source
  bool solarAvailable = digitalRead(solarPin);
  bool  pdbAvailable  =  digitalRead(pdbPin);
  bool rebAvailable = digitalRead(rebPin);
  bool generatorAvailable = digitalRead(generator Pin);
 // Determine the power source
  if (solarAvailable) {
  selectPowerSource("Solar", solarRelayPin);
  digitalWrite(pdbRelayPin, LOW);
  digitalWrite(rebRelayPin, LOW);
  digitalWrite(generatorRelayPin, LOW);
  } else if (pdbAvailable) {
  selectPowerSource("Pdb", pdbRelayPin);
  digitalWrite(solarRelayPin, LOW);
  digitalWrite(rebRelayPin, LOW);
  digitalWrite(generatorRelayPin, LOW);
  } else if (rebAvailable) {
  selectPowerSource("reb", rebRelayPin);
  digitalWrite(solarRelayPin, LOW);
  digitalWrite(pdbRelayPin, LOW);
  digitalWrite(generatorRelayPin, LOW);
  } else if (generatorAvailable) {
  selectPowerSource("Generator", generatorRelayPin);
  digitalWrite(solarRelayPin, LOW);
  digitalWrite(pdbRelayPin, LOW);
  digitalWrite(rebRelayPin, LOW);
  } else {
    // No power source available
    lcd.clear();
     lcd.setCursor(0, 0);
    lcd.print("Power Source:");
    lcd.setCursor(0, 1);
```

```
    lcd.print("No Power Source");
    turnOffAllRelays();
  }
  delay(1000); // Check every second
}
void selectPowerSource(String sourceName, int relayPin) {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Power Source:");
  lcd.setCursor(0, 1);
  lcd.print(sourceName);
  digitalWrite(relayPin, HIGH); // Turn on the selected relay
}
void turnOffAllRelays() {
  digitalWrite(solarRelayPin, LOW);
  digitalWrite(pdbRelayPin, LOW);
  digitalWrite(rebRelayPin, LOW);
  digitalWrite(generatorRelayPin, LOW);
}
```