University of Moratuwa

Department of Electronic & Telecommunication Engineering

EN1190 - Engineering Design Project

Report

Solar Wifi Router

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THIS REPORT IS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MODULE

EN1190 - Engineering Design Project

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Abstract

We build a Wi-Fi and LED UPS system to work in power cut times or an out place that we can't get an A/C current source. We design it in a proper way to handle it easily. We provide a 12 V rechargeable battery to charge with an A/C current (converting 230V to 12V) or with a 12 V solar grid power. we use relay to perform in power cut times that convert the power line to direct battery line. From this process, we can work with Wi-Fi and LED continuously. When we get a direct current line from any sources (A/C or solar) relay automatically convert battery line to power line. Real time we can charge the battery also is one of the benefit from this device. We can manage this process with the switches according to our required function. PCB design with the simple electronic components and enclosure is very user friendly to handle.

Introduction

1. Problem Validation

Due to the economic crisis in our country, there are several problems facing by students & employees. With regard to this fuel crisis, all schools and universities are closed and the studies and works are going on the online platform. Most of students and employees are using Wi-Fi routers for access to the internet. People face many inconveniences because of sudden Wi-Fi disconnectivity caused by momentary power cuts. So, the students and workers are can't attend the online classes, and can't do their examinations and online submissions due to the lack of power in their devices (laptops, phones, E-tablets). And also, during the power cut hours, they can't get proper coverage and can't access the internet.

2. Problem Description

Wi-Fi is a major service that people rely on daily to fulfil both personal and work-related duties. Currently, as the world has moved on to a norm of working from home, people rely on the home Wi-Fi connection for all their work-related needs. People face many inconveniences because of sudden Wi-Fi disconnectivity caused by momentary power cuts. Some of these inconveniences are listed below.

- Restarting of the router during the switch over to the generator or sudden power comebacks.
- Disconnecting from important meetings or lectures.
- Halting of time-critical tasks.

We conduct a survey on our product design, what difficulties do u face when the power cut occurs, and also, we mainly focused take a survey on the students to identify what are the difficulties they face when power cut. Because they are mainly using online studies while the covid 19 pandemic situation after that our country encountered fuel shortage and as a result of that we have to face several hours of a power cut, so we planned to make product afterward conducting survey what many of them suggest and also what are the alternate methods also they suggest we considered them

By considering the responses, we came up with a product, which supplies power, up to 3 hours during power cut. Working time will increase furthermore, if solar panel output voltage is sufficient. In our country we can produce the power not only with fuel and coal but also there are many renewable energies to produce the power. So, we discussed this and came to a final decision to use solar power to produce electric power. Even though the majority prefer to use solar energy, by considering the cost and the availability of solar panels, we concerned about the 2nd option, home main current too. So we came up to design a product, which works with main current and solar current. When the output voltage of the solar panel is insufficient, it will work with the main current, even though if there is not a solar panel, it will work. So the solar panel is optional. We decided to add a darkness-sensitive LED light, which will automatically on during power cut and in darkness.

Components

We use basic electronic components to build the PCB to work with this system

1. LM317T Regulator:

15V – 0 – 15V Transformer 15-0-15 1A Centre Tapped Step Down Transformer is a general purpose chassis mounting mains transformer. Transformer has 230V primary winding and centre tapped secondary winding. The transformer has flying colored insulated connecting leads (Approx. 100 mm long). The Transformer act as step down transformer reducing AC - 230V to AC - 15V.

The Transformer gives outputs of 15V, 15V and 0V. The Transformer's construction is written below with details of Solid Core and Winding.

The transformer is a static electrical device that transfers energy by inductive coupling between its winding circuits. A varying current in the primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic flux through the secondary winding. This varying magnetic flux induces a varying electromotive force (E.M.F) or voltage in the secondary winding. The transformer has cores made of high permeability silicon steel. The steel has a permeability many times that of free space and the core thus serves to greatly reduce the magnetizing current and confine the flux to a path which closely couples the winding.

Specifications of 15-0-15 1A Centre Tapped Transformer: -
Input Voltage: 230V AC
Output Voltage: 15V, 15V or 0V
Output Current: 1Amp
Mounting : Vertical mount type

2. Regulator (24V – 14.8V)

24V to 14.8V Converter using LM317T IC, 7812 , 7824
24V-to-14.8V-Converter-using-LM317T-ICPower-Supply

So ever wondered how come some circuit takes a 24V input but is internally driving LED's Microcontrollers and other low voltage peripherals which are not even designed for such a high voltage? For a newbie, the first thought might be making a voltage divider circuit and thus supplying the desired voltage as such, but this is not how it's done.

The losses in a voltage divider circuit and the uncertainty of a load that does not have a fixed resistance makes this hardly the best possible way to tackle it. So that is where a regulator IC comes in such as the infamous 317T.
The 317T is used a lot in circuits with a minimum footprint required to convert their voltage from a higher level to 5V. The component list is very small and is great for hobby and semi-professional to professional-grade projects in general. So let's get started!

2. Zener diode (6.8V)):

Features:

Standard 6.8V Zener Diode
Nominal Zener Voltage (Vz): 6.8V
Maximum Regulator Current (Izm): 0.055A
Max. Reverse Leakage Current (Ir): 0.1µA
Forward Voltage Drop (Vf): 1.5V
Total Power Dissipation (P tot): 500mW

Description:

The 1N754 Zener Diode is a standard 6.8V Zener Diode with a low leakage current and accurate working voltage. The 1N754 is ideal for use in clamping applications and protection circuits.

3. Rectifier Module (1A)

In the electronics industry, one of the most popular applications of semiconductor diodes is to convert alternating current (AC) signal of any frequency, which is typically 60 or 50 Hz, to a direct current (DC) signal. This DC signal can be used for powering electronic devices, rather than batteries. The circuit which converts the AC into DC signal commonly consists of a particular arrangement of interlocked diodes and is known as a rectifier. In power supply circuits, two types of rectifier circuits are commonly used — half-wave and full-wave. Halfwave rectifiers only permit one-half of the cycle through, whereas fullwave rectifiers permit both the top half and bottom half of the cycle through, while converting the bottom half to the same polarity as the top.

Between the two types, the full-wave rectifier is more efficient as it uses the full cycle of the incoming waveform. There are two types of full-wave rectifiers — the centre-tapped fullwave rectifier, which requires a centre-tapped transformer, and the bridge rectifier, which does not need a centre-tapped transformer.

4. Relay Module (24V, 12V)

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 thereof. 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 relays using other operating principles have also 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.

5. Purpose of switch

Switches are used for manually control LED and Wi-Fi router. You can use this device in power off times manually.

6. Other Components

listed the other components we have used except the components listed above

Table 1: Components and Values

Component	Value	Quantity
3 core wires	16/0.20 mm	2m
Plug top		1
IC	7824	1
	7812	1
Switch		2
LED strip		1
Resistor	2.2 KΩ	2
	1 KΩ	2
	240 Ω	1
	100 Ω	1
Preset resistor	1 KΩ	1
	200 KΩ	1
IN 4007 diode		5
Li-ion Battery	3.7V	4
Capacitor	2.2mF	1
	0.33μF	3
	0.11μF	3
Transistors	C828	1
	D400	1
	BD 139	1
LED	Red	1
	Green	1

Method

1. How to Work with the Device

1. Keep the device on your table or hang it on the wall properly.

2. Connect the 230V A/C adapter to the pin labeled "A/C power in."

3. Connect the Wi-Fi router cable to the Wi-Fi pin.

4. (Optional) Connect the Solar Panel cable to the solar panel pin (if available).

2. Configuring the device

Connect your devices (LED, Wi-Fi) and power on your A/C power in, while working, your battery will charge with the use of solar energy and in the case of output voltage is not sufficient it will automatically charge from main current. So, solar panel is optional and user can use this product without solar panel. When charging, the green LED will on and, red LED will indicate battery is fully charged. The Wi-Fi and 12V LED is now working on using A/C power in.

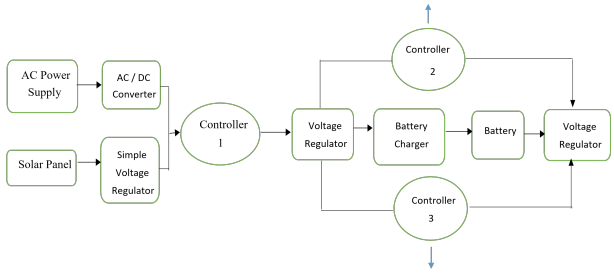
PCB Design

The schematic of the circuit was drawn first, and the PCB was designed accordingly using Altium. To optimize space, the PCB was made as small as possible. Lines were routed on both the top and bottom layers. For power lines, a thickness of 2mm was used for 24V, and 1.5mm for 12V. Other lines were routed around 0.75mm.

Finalized Sketch of the Enclosure (3D)

Initially, an enclosure was designed to physically connect the components, ensuring that the circuit worked as intended. Afterward, the focus shifted towards creating a user-friendly interface. The final enclosure design was made to be straightforward, resembling normal electronic devices. A significant effort was put into providing an easy-to-use interface so that anyone can handle the device effectively.

PRODUCT ARCHITECTURE



Technical Aspects

1. Controller 1

During optimal sunshine, the relay gets sufficient power from the panel and remains switched ON with its N/O contacts activated. If the solar panel's output voltage is insufficient, RL2 relay will automatically give power to the circuit using the main current. So this product will work without a solar panel too.

2. Voltage Regulator

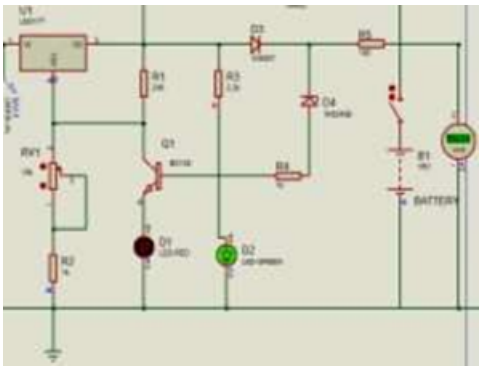
Since the output of the solar panel is unregulated DC voltage, LM317T IC (U1) is used to provide regulated DC voltage.

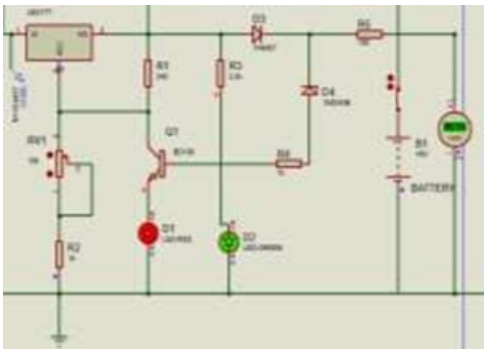
LM317T

The LM317T is a positive adjustable voltage regulator designed to supply more than 1.5 A of load current with an output voltage adjustable over a 1.2 to 37 V range. The nominal output voltage is selected by means of only a resistive divider.

For this circuit, the input voltage of the LM317T is about 18V, and the output voltage is adjusted to 14.8V (since we are using a 14.8V battery). A potentiometer (10k) is used to adjust the output voltage of this voltage regulator LM317.

3. Battery Charger





When the battery voltage is below 14.8V, current from LM317 IC flows through the resistor R5 and diode D3 to the battery, and the Zener diode will not conduct.

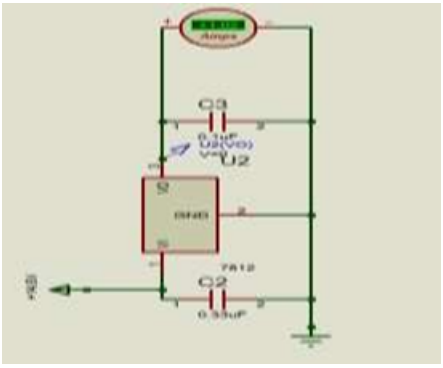
Green LED is indicating the charge of the battery. Resistor R3 is used to protect the green LED from high voltages.

When the battery voltage rises to 16V, the current flow to the battery stops, and the Zener diode gets sufficient breakdown voltage, allowing the current through it.

Now the base of the transistor gets sufficient current to turn on, and the Red LED will turn on. The Red LED indicates that the battery is fully charged.
Diode D3 is used to avoid the discharge of the battery when the output from the solar panel is very low.

4. Battery Voltage Regulator

Since the output voltage of the battery is unregulated, the 7812 voltage regulator is used to get a steady 12V voltage.



7812 voltage regulator

The 7812 is a fixed voltage linear regulator that can output 12V at up to 1A current with an input voltage range of 14–35V.

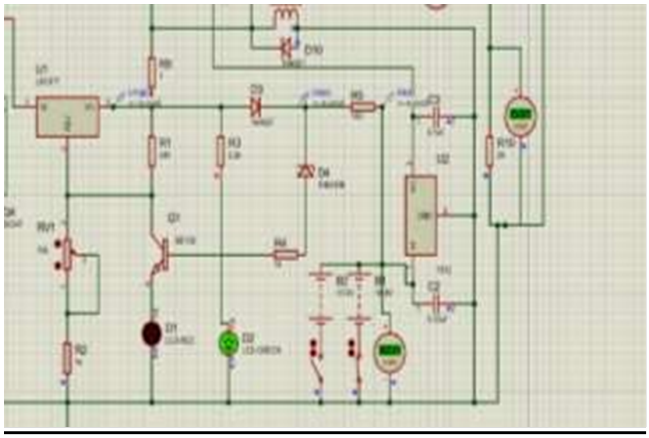
R8 is used to reduce the current from 1A to 0.5A.

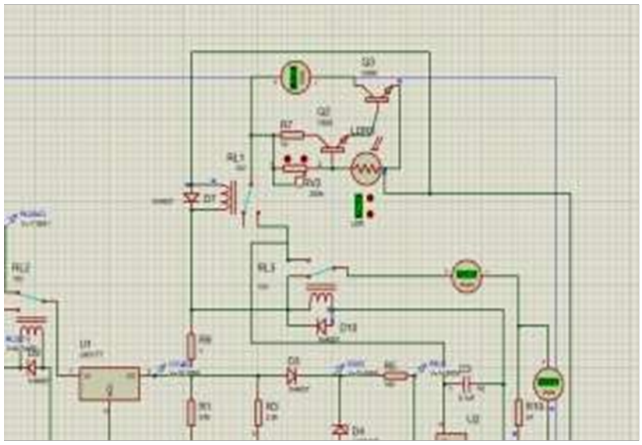
5. Controller 2

When sufficient solar voltage or main current is available, Wi-Fi and LED (LED is controlled by RL1) are activated; otherwise, it will automatically connect to the battery. This operation is controlled by RL3 relay. Since the output voltage of LM317T is 14.8V, the 4.7 Ohm resistor R9 is used to drop the voltage from 14.8V to 12V.

6. Darkness Sensitive Circuit

This circuit is used to automatically turn on the LED during power cut times (controlled by RL1) and in darkness (controlled by LDR). As mentioned above, the A-B point will get 12V voltage only in power cut times, and

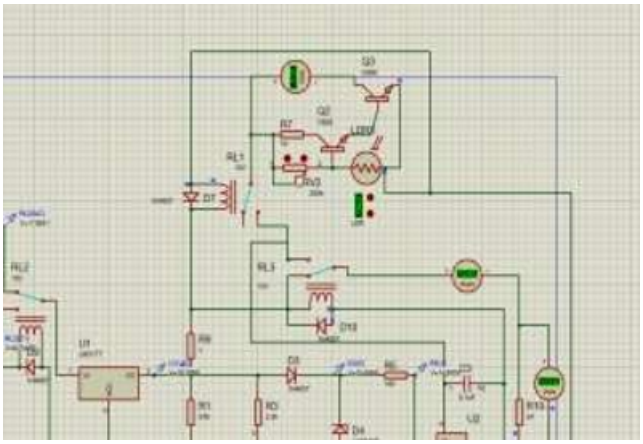


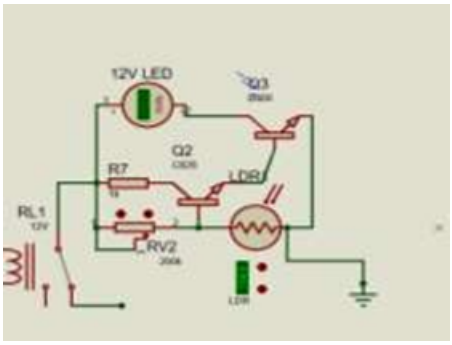


LDR resistance is very high in the darkness, causing the LED to turn on. By using the RV2 variable resistor, the operating darkness can be adjusted.

Technical Specifications

1. Key Features of Our Product:
   - Real-time working
   - Efficient power providing and easy to handle
   - Can be used automatically and manually
2. Weight: 300g
3. Physical Dimensions:
   - Height: 120mm
   - Width: 90mm
   - Length: 180mm
4. Working Time: 3 hours
5. Charging Time: 1 hour
6. Power Consumption: 6W

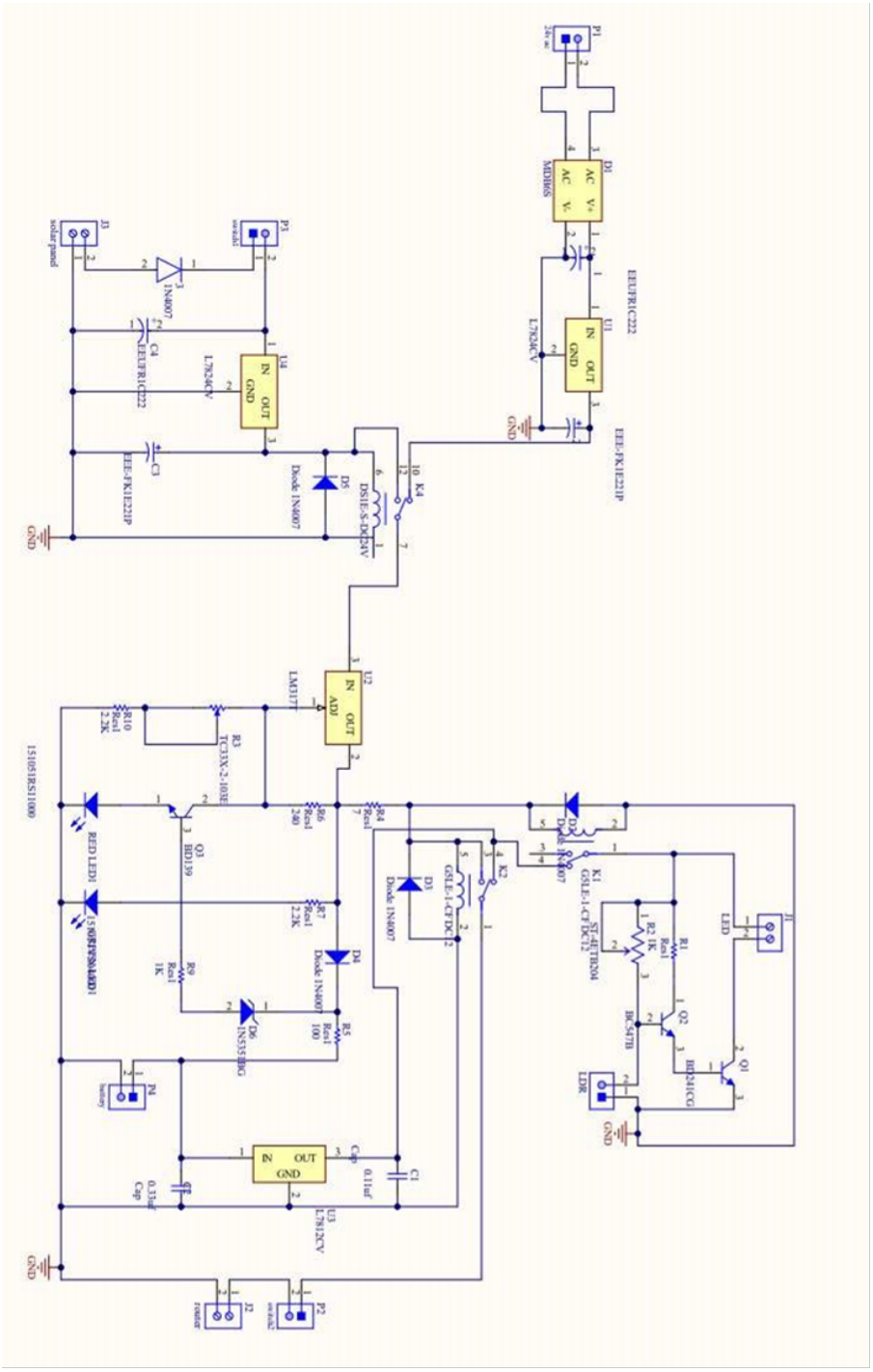




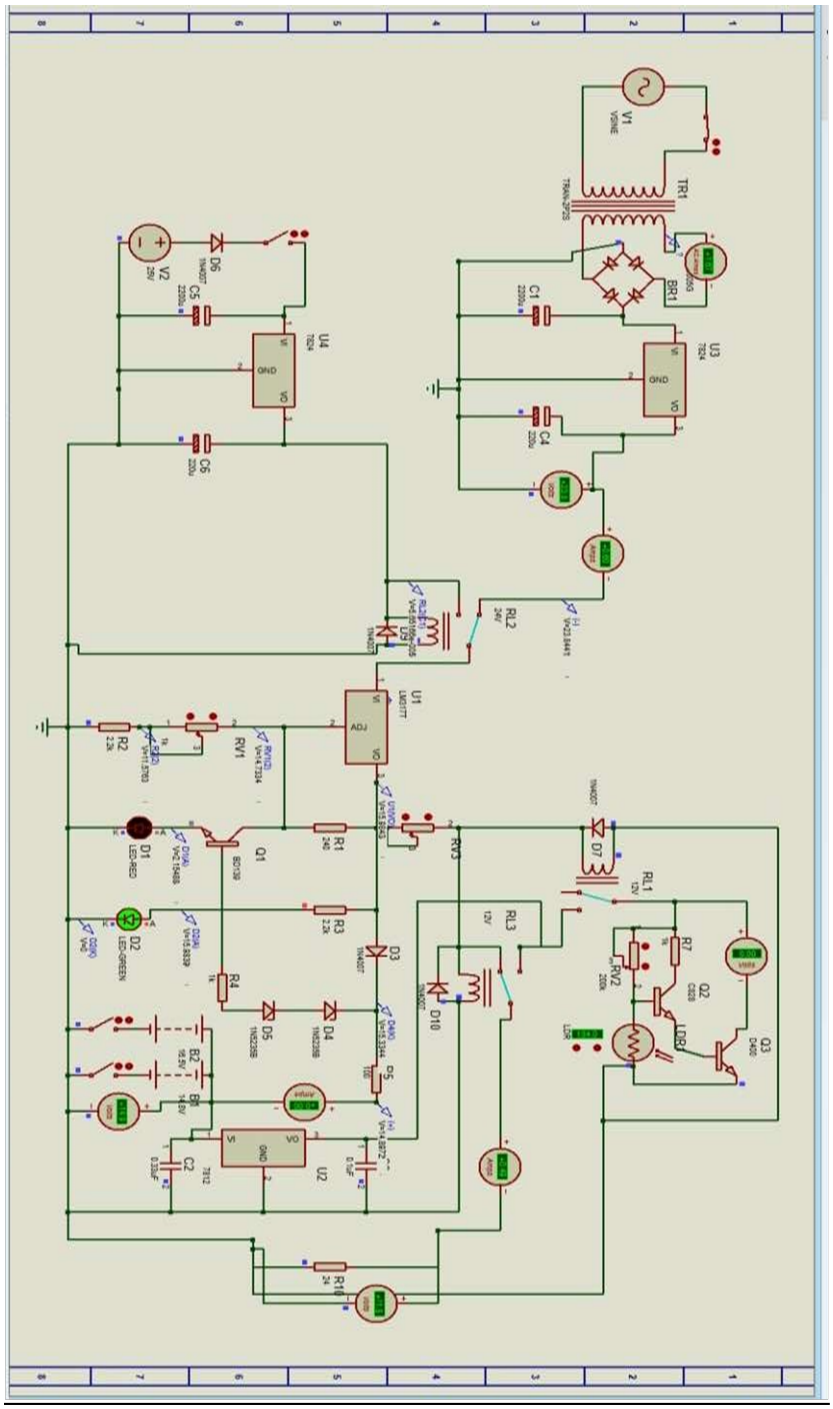
7. Warranty: 1 year
8. Life Time: 4-5 years

Appendix

Circuit Design



Proteus Simulation



3D Enclosure

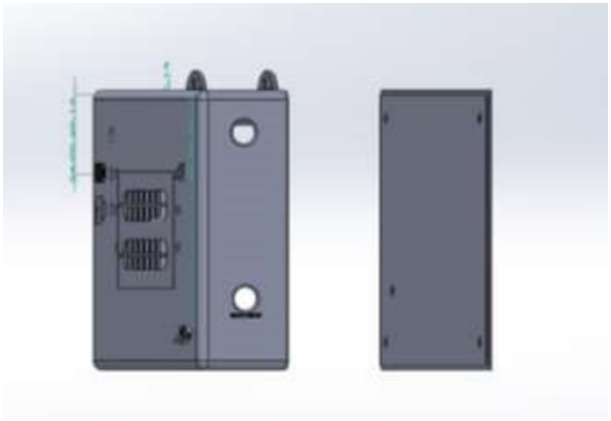


Figure 1: Side View

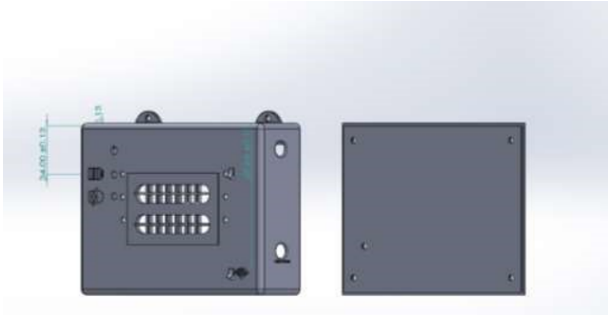


Figure 2: Front View

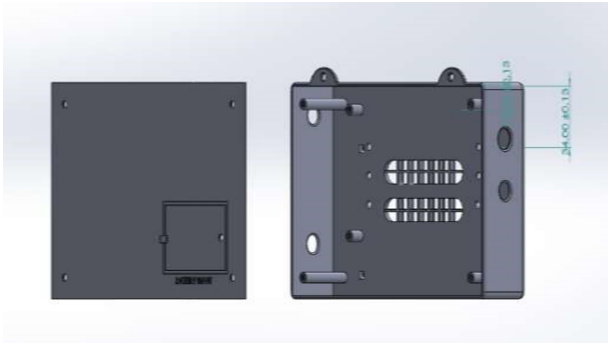


Figure 3: Back View

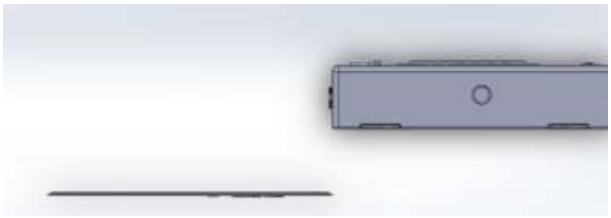
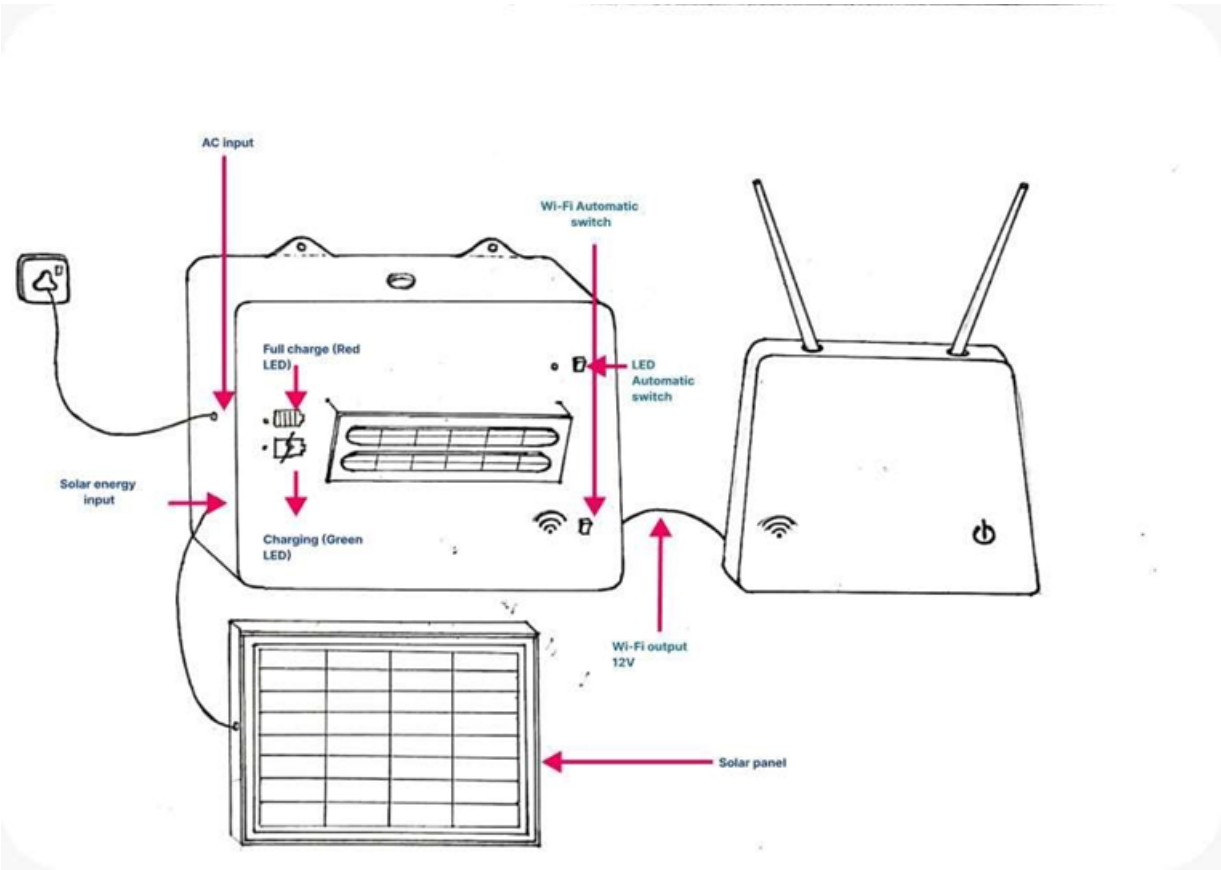
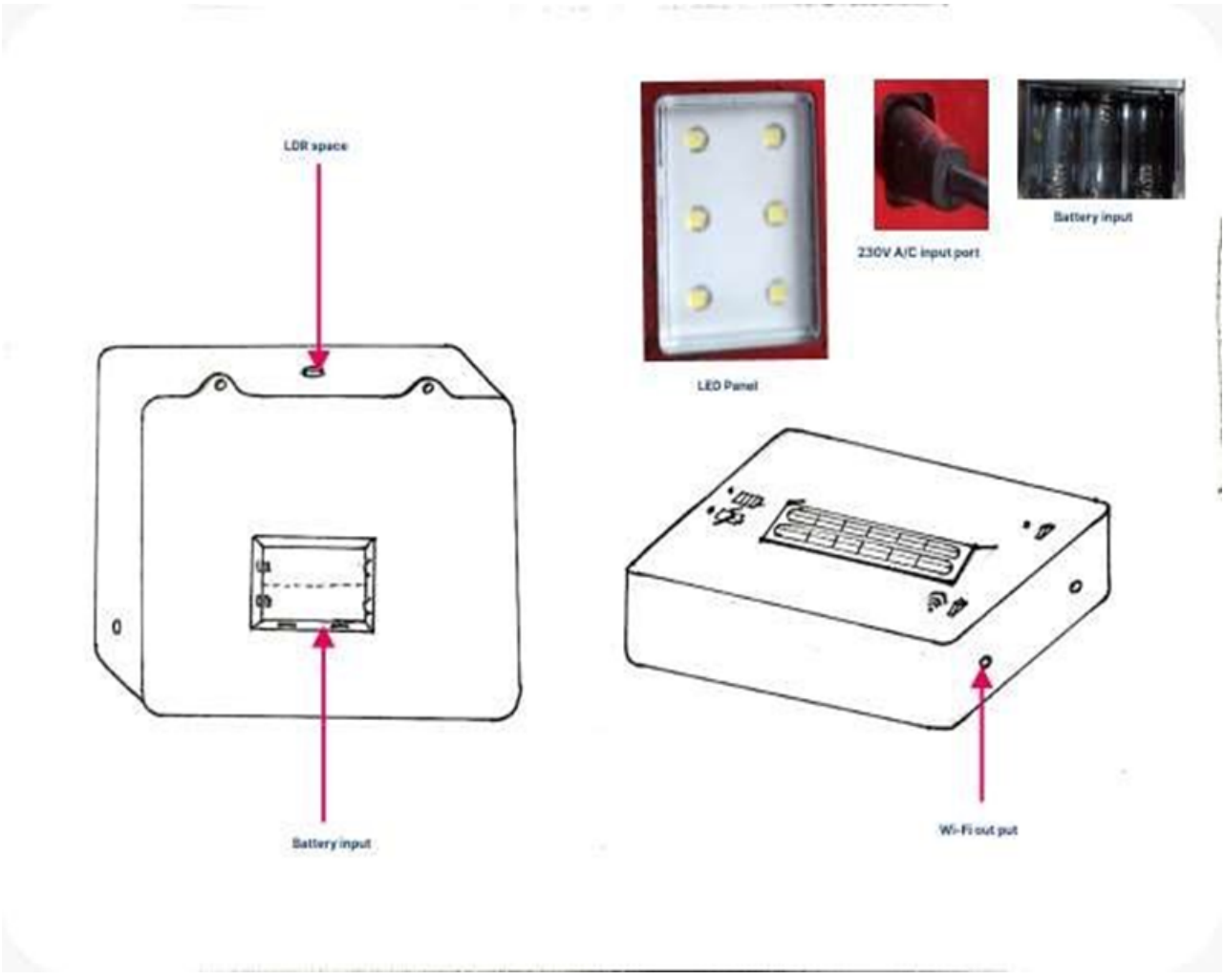


Figure 4: Up View




LDR space
Battery input
LED Panel
230V A/C input port
Battery input
Wi-Fi out put

PCB Layout (Altium Design)

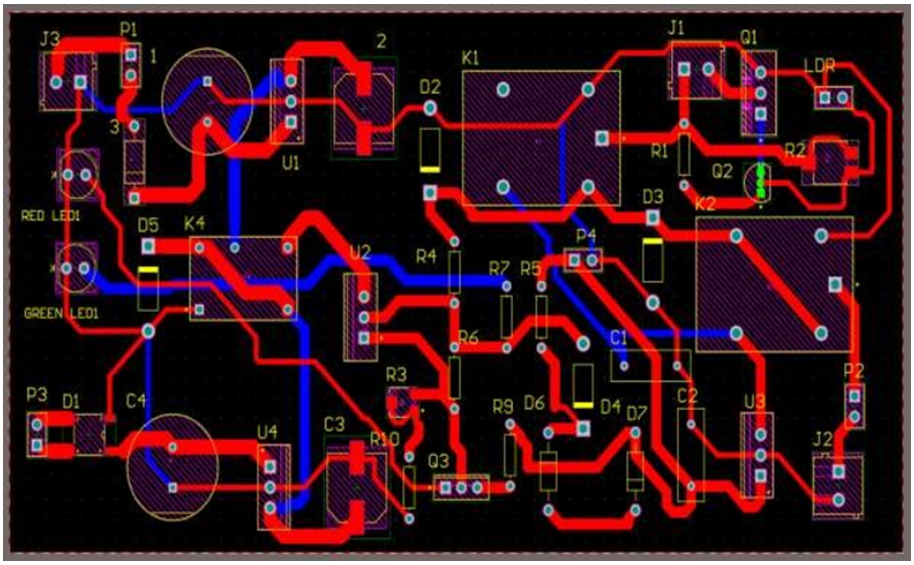


Figure 5: Top Layer

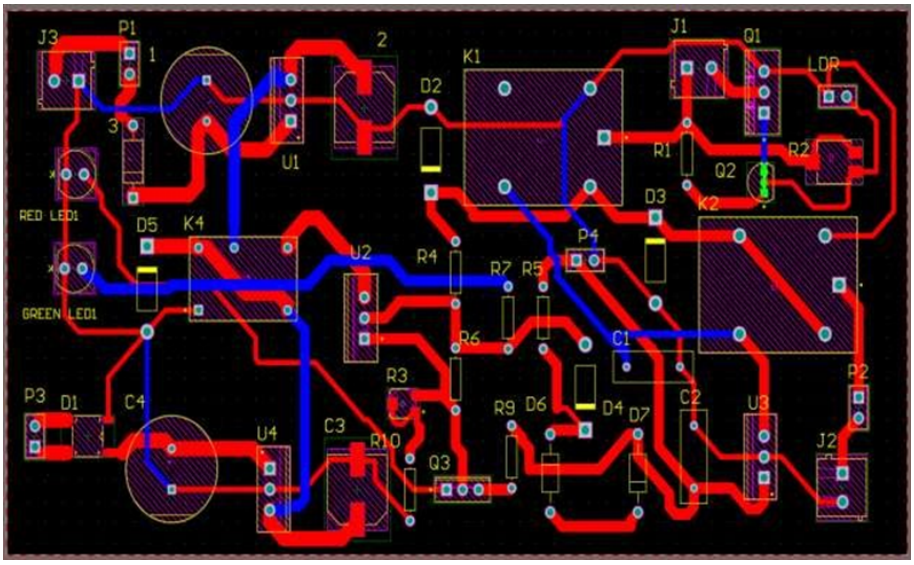
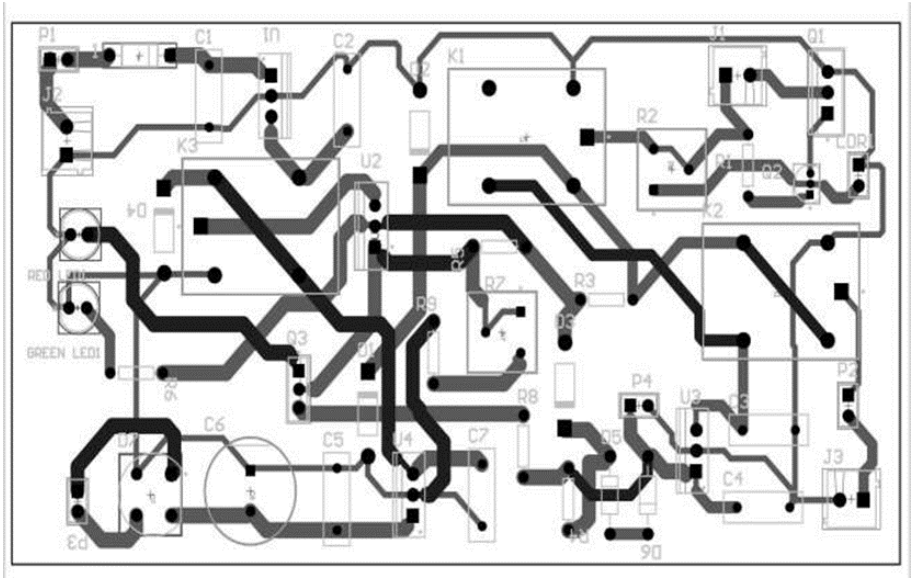
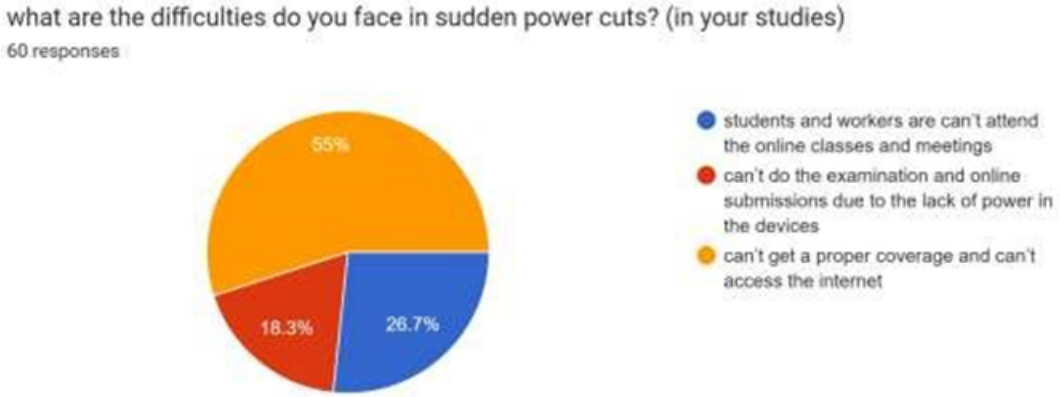


Figure 6: Bottom Layer



Survey Results



in this sudden powercut do you prefer a automatic wi-fi system to keep your internet access continuosly?

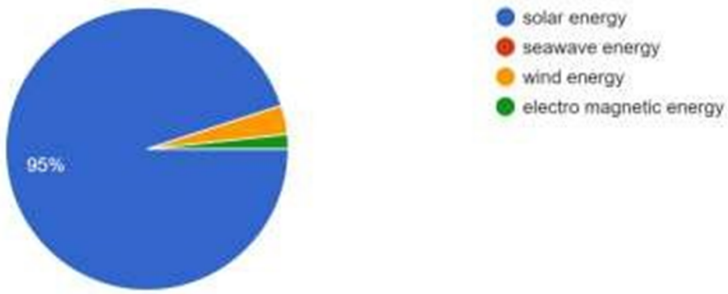
60 responses

how long do you want a power to your wi-fi router to finish your important work after sudden power cuts?

60 responses

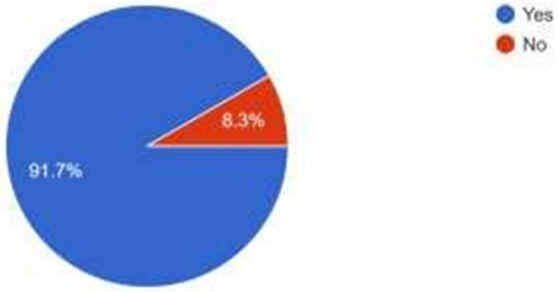
what is the renewable energy do you get easily when you use this system in your home or a workplace?

60 responses



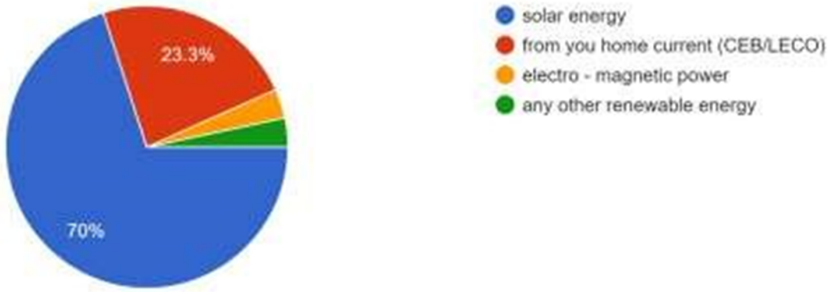
do you prefer a automatic LED light to use in sudden power cut time?

60 responses



due to this fuel crisis , what do you prefer to charge a battery to distribute power to wi-fi router?

60 responses



if you think this product is must useful in this current situation?

60 responses