**Department of Electronic and Telecommunication Engineering**

**University of Moratuwa**

EN1190 - Engineering Design Project

Project Report

# Rechargeable Multiplug



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# ABSTRACT

As part of the course module EN1190 - Engineering Design Project, we were instructed to identify a problem we face and implement a solution for that problem. So, we identified daily power cuts as the problem, and we developed a portable rechargeable multiplug to give an uninterrupted power supply during a power cut.

After researching and validating the problem, we designed our product meet our expectations. To further verification we simulated our circuits using LTspice XV|| and used prototypes made on the breadboard. Then the design of Enclosure and PCB was done using Solid works and Altium software at the final stage.

This report contains the detailed explanation of the functionality, challenges faced during development and our final solution.

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# 01.Introduction

## 1.1 Description

Sri Lanka is currently experiencing a serious economic crisis as a result of the corona pandemic last year and long-term indebtedness. due to this a significant dollar deficiency has occurred so, the government faces a very difficult time buying fuel and necessary goods. As a country where electricity majorly depends on fossil fuels most of the time this is a significant impact. As a result, many people are facing daily power outages which interrupt people's daily activities.

## 1.2 Tasks

This is basically a normal Multiplug. In case of power cut situation, it can automatically manage to power lower power consumable equipment such as Wi-Fi router, mobile phone charger. There are 3 socket outlets, and all three socket outlets have 3 switches which can operate separately. These all three switches are touch switches.

A touch panel on/off mechanism system was installed in order to prevent further electric shocks after our survey revealed that many people have experienced many electric shocks as a result of using electrical equipment with damp hands.

# 2.0 Methodology

## 2.1 List of Components used

The list of components used is subcategorized under following main categories.

### 2.1.1 Charging Circuit

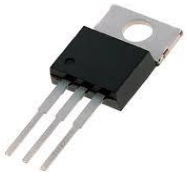
The charging Circuit is the circuit which regulates the input voltage into 5V and connect it to the other circuits. It consists of the following components.

- 15 V step down Transformer

  The normal household power supply is 230V / 50Hz alternate current supply So to obtain the necessary voltage to charge the battery, we utilized a 230V to 15V transformer. The charger circuit is then connected to this transformer. The transformer is shown separately from the charging schematic so that it can be placed in a location with easy access to ventilation and cooling before being wired into the charging circuit.

- 7815 regulating IC

  For the regulation purpose we first try to use Zener diode but the power consumption is high,
  and regulation part become heated so for better regulation and power management we used LM7815 IC



- IN4007 diodes

  To convert the alternate current into direct current we used a junction bridge diode mechanism

- 1000 uF,0.33 uF, 0.1 uF capacitors

  For the smoothing purpose we have used a 100uf large capacitor to minimize the ripple voltage and to supply a near constant voltage

### 2.1.2 Touch Switch Circuit

The touch switch Circuit is the circuit which control ON/OFF states of the switch when user touches the touch panel. It consists of the following components.

- 555 IC
- BC547 transistors
- 2N2222 transistors

### 2.1.3 Inverting Circuit

The inverting Circuit is the circuit which converts DC voltage/current of the battery into AC current/voltage. It consists of the following components.

- 12 V 2 A transformer
- CD4047BE IC
- 7812 IC
- IC IRF3205

The IC4047 get an 12v DC voltage and convert it into a AC voltage (12v peak to peak & frequency of 50Hz) and output that voltage to two ICIRF3205 , those will increase the current gain of the signal and through those to the amplified sin wave will send to the transformer , it will set up the voltage around between 220v-240v.That will consume a high current , therefore we will use six 12v regulators in parallel in order to give the sufficient high current.

### 2.1.4 Battery Pack

It consists of the following components.

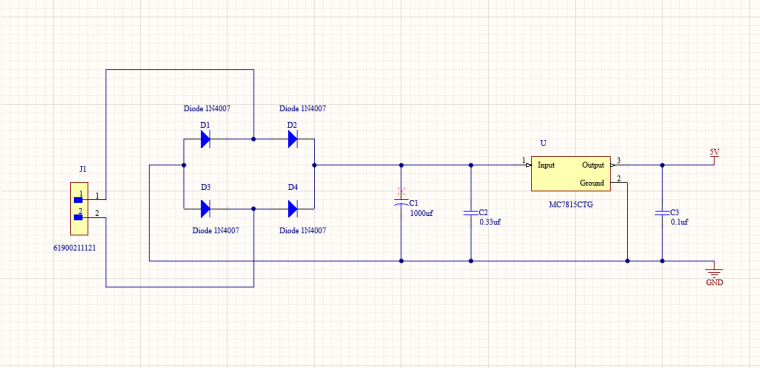
- 3.7 V 4000mAh four batteries

We use four 3.7v,4000mAh Li-ion batteries and connect those in series. Then we can have a single 14.8v,4000mAh battery. We need a battery whose voltage is more than 12v.But we can't use a car battery since the large size. Therefore in order to obtain a high battery lifetime & get a minimum size of space, we have decided to use four Li-ion batteries with 3.7v.

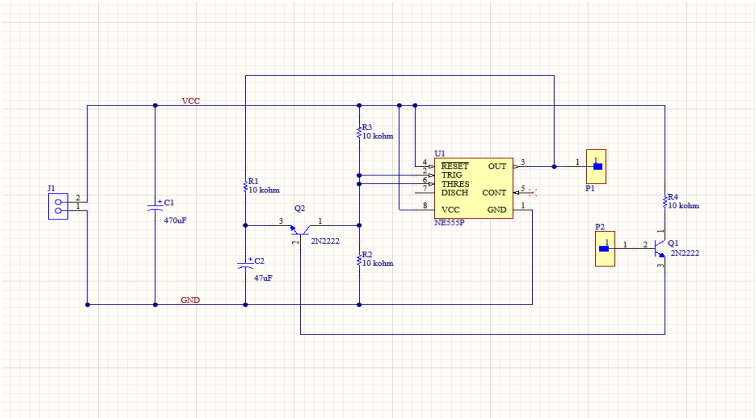
# 3.0 PCB Design

## 3.1 PCB Schematic

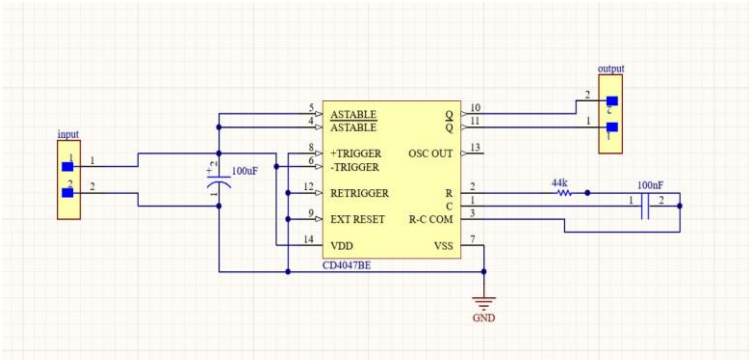
- Charging Circuit




- Touch sensor




- Inverter circuit

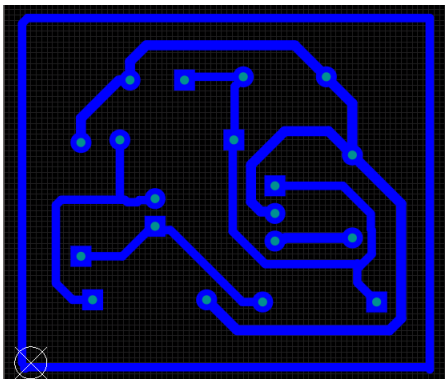


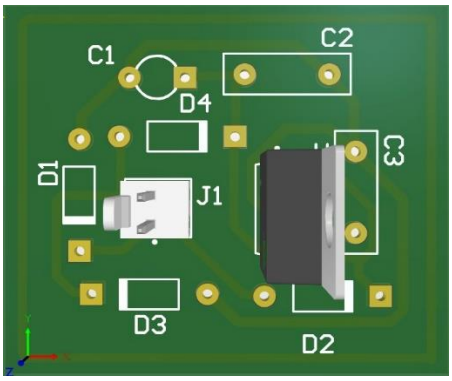
## 3.2 PCB Design Rules

For normal connections we used connection line width as 0.8mm because the current through these lines are low. For power lines such as $V_{cc}$ and ground line connections we used line width of 1.8mm because the current through them is high. We used PCB Trace width calculator to calculate the connection widths for the relevant currents. For drilling purposes, we used via hole size of 0.9mm and via Diameter 0.6mm.

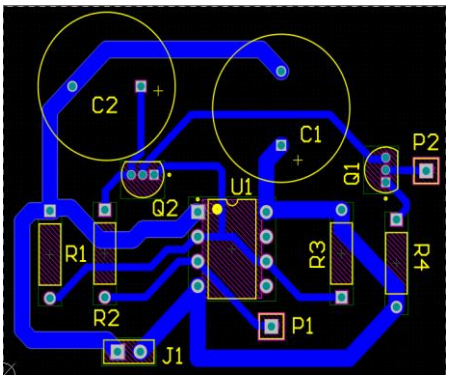
## 3.3 Footprint and 3D model of the PCB

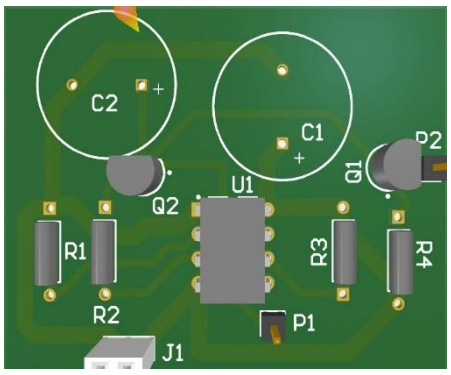
- Charging Circuit



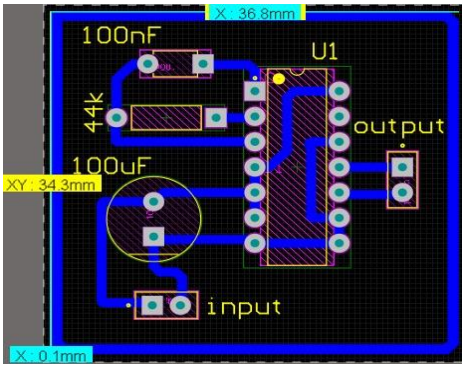


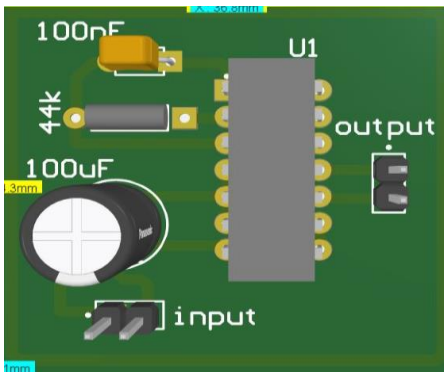

- Touch sensor




- Inverter circuit

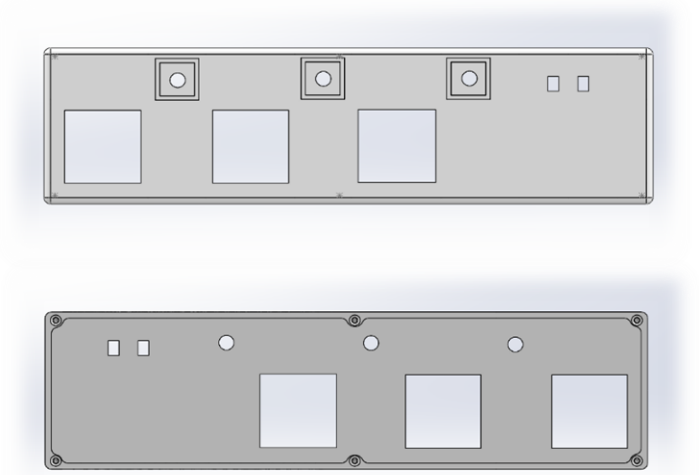


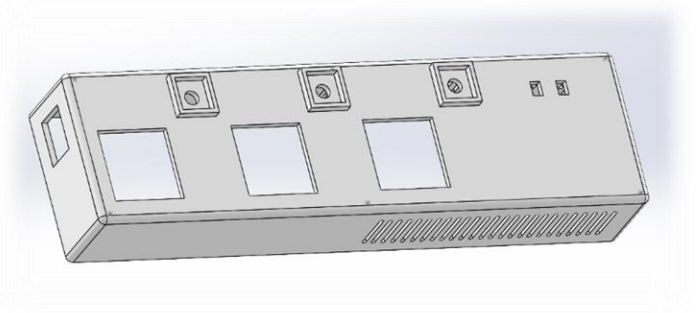
# 4.0 Enclosure Design

Transformer of the inverting circuit is heavy and quite large. we needed more space inside of the enclosure. Thus, we had to keep dimensions and thickness of the enclosure as 28 x 8 x 7cm and 3mm. we identified that transformer and transistors of the inverting circuit is heated up While inverting circuit is working. Therefore, we decided to keep air grills on both walls of the enclosure. After considering the strength of the box, PLA with 40% infill has used as the material of the enclosure.

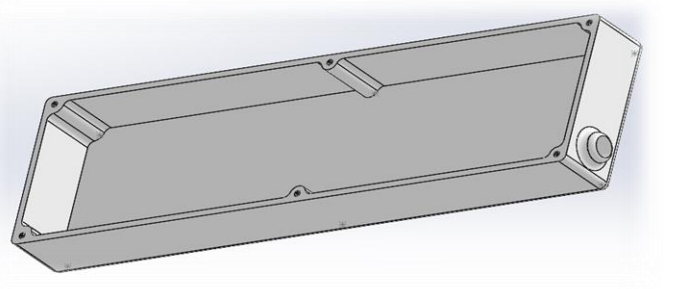
- Top and bottom view of the enclosure lid



- side view of the enclosure lid



- Side view of the enclosure base



# 5.0 Bill of quantities

| component | Price (Rs) |
|---|---|
| 12V , 2A Transformer | 2300 |
| IRF3205 (4) | 1000 |
| CD4047 | 150 |
| Capacitors (10) | 300 |
| Resistors (20) | 40 |
| IC 7815 | 50 |
| IC 7812 (10) | 300 |
| IC 7809 (2) | 60 |
| IC 7805 (2) | 60 |
| 15v,300mA Transformer | 500 |
| IN4007 diode (4) | 20 |
| Double switch | 280 |
| Soldering iron | 300 |
| Heat sink (20) | 200 |
| 12v relays | 60 |
| 9v relays (8) | 480 |
| PCB printing | 500 |
| Enclosure | 2000 |
| | |
| Total | 8560.00 |

## 6.0 Discussion

There were various challenges, which we had to face during the execution of this project. The obstacles we had to go through were stated follow.

- When designing the PCB there were some difficulties because of the lack of experience in PCB designing. We had to learn and follow PCB design rules.
- In the earlier stage, we used 12 V 0.5A transformer for inverting circuit which is quite small. But output current of that inverter is smaller than the value we expected. Therefore, we have to use 12 v 2 A transformer which is large in scale. In that case we have to re design our enclosure.
- According to the current situation, it was very difficult to find components within the country. Also, prices of the components were much higher. So, we had to use alternative components for them

## 7.0 Acknowledgment

Implementing a device with lots of power circuits was a very challenging task within the given period. As this was our first project it was very challenging, and we had learnt lots of concepts and circuit of power electronics. There were lots of people behind this project to make it successful.

First, we would like to pay our gratitude to our lecturer Dr. Ajith Pasqual who always gave the knowledge and encouragement to make this success. The meeting held which was held when we are progressing was very helpful and motivated us and cleared our doubts.

In addition, we would like to convey our sincere gratitude to all the lecturers, seniors, batchmates who were always willing to share their knowledge with us.

Finally, we pay our gratitude to all the personals involved in printing psb's and enclosures.

# 8.0 References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