INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY

HYDERABAD

Designing a Portable Mobile Charger with Rectifier

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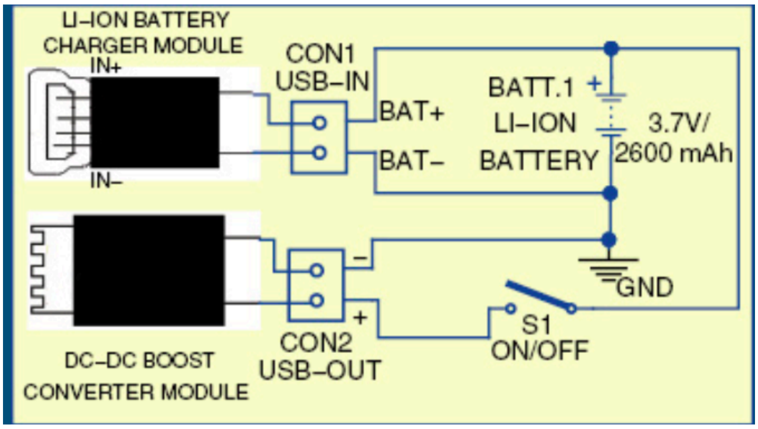
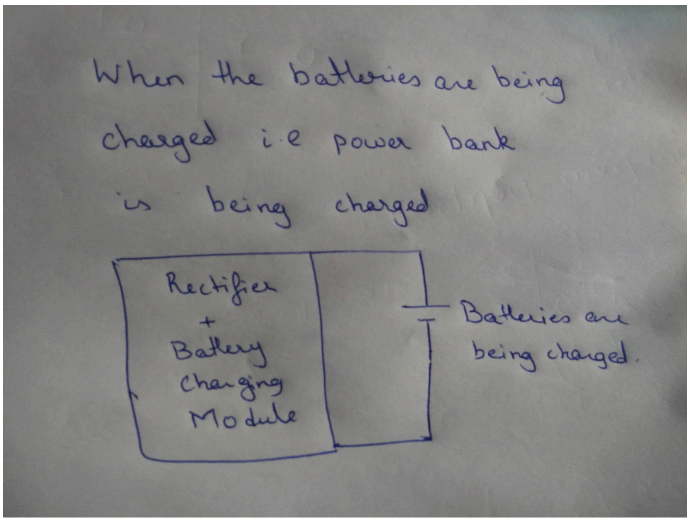
1 Introduction

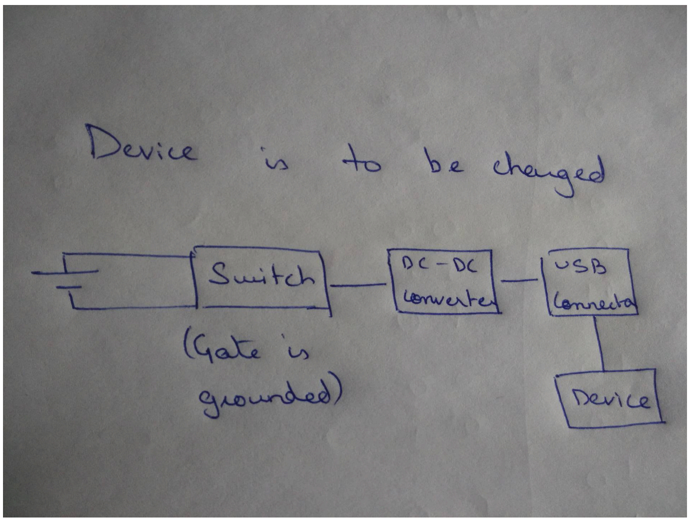
In this report, we will be discussing and detailing how we implemented a basic level portable mobile charger along with a rectifier i.e a power bank along with the adapter, using the components available.

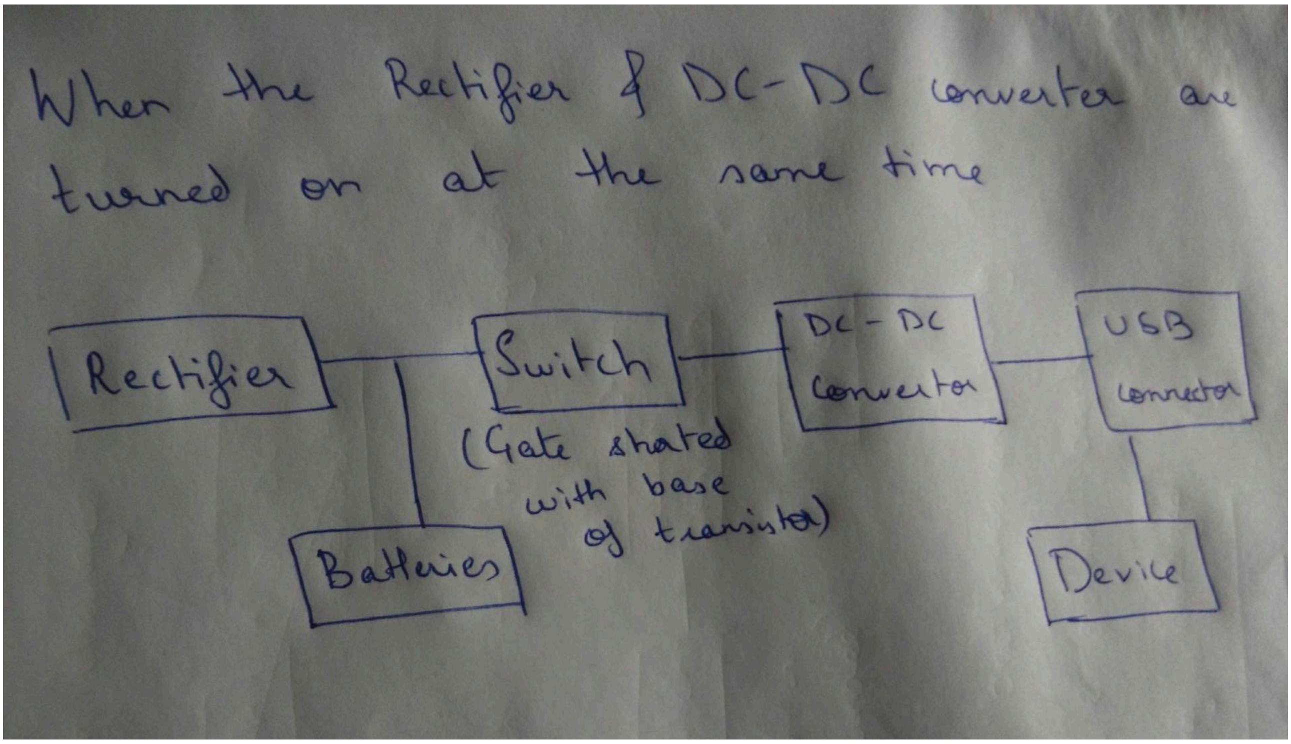
A portable mobile charger, usually called a power bank is a portable device that can supply USB power using stored energy in its built-in batteries. Power Banks are rechargeable. There are comprised of rechargeable batteries with a special circuit to control power flow. They allow you to store electrical energy(deposit it in the power bank) and then later use it to charge up a mobile device or any other electronic device(withdraw it from the bank). Power banks are good for almost any USB-charged devices.

2 Power Bank with Adapter: Design





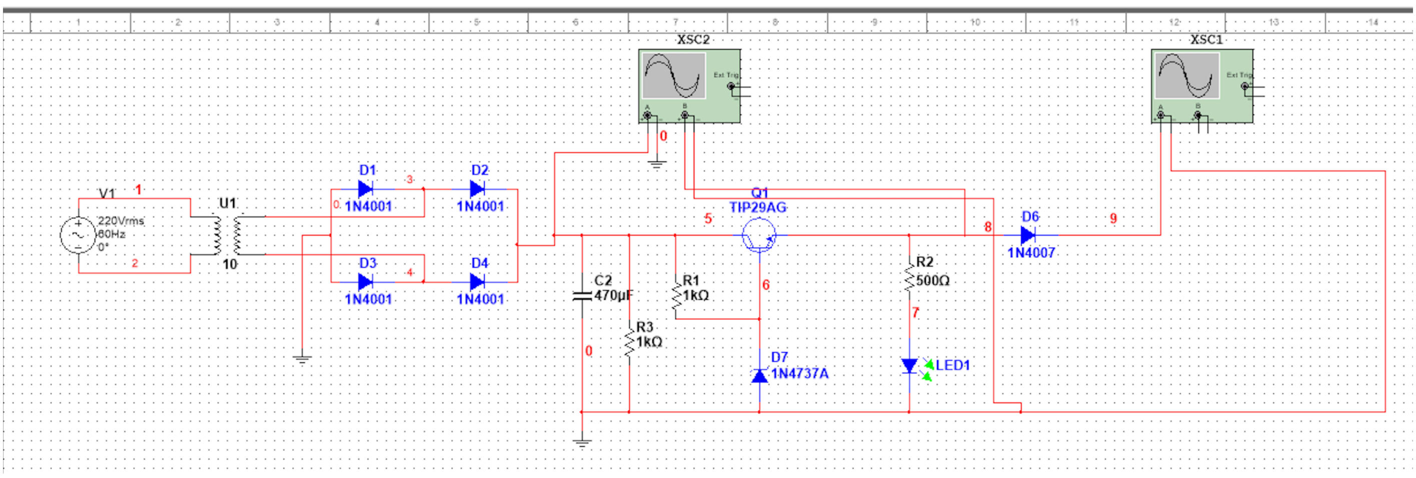




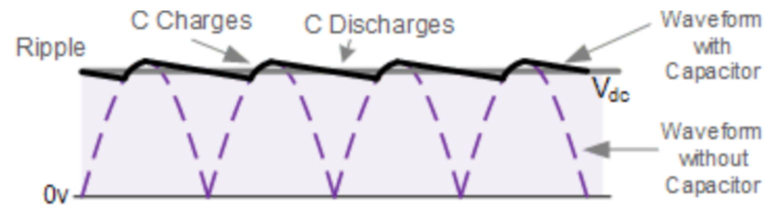
3 Implementation Details and Results

3.1 Full wave bridge rectifier with Battery Charging Module

We used a 9-0-9 transformer and supplied it with the regular 220V AC supply. The output of this transformer is connected to a full-wave bridge rectifier. This type of single phase rectifier uses four individual rectifying diodes connected in a closed loop “bridge” configuration to produce the desired output. After the full-wave bridge rectifier, we



connected a smoothing capacitor of 470µF. We connected an NPN - transistor to maintain the current through the two branches connected. The resistor R1 is to control the current and bias the transistor. Resistor R3 is being used to increase the discharge rate of the capacitor so as to decrease its effect on the switch. The zener diode of 7.5V is connected to maintain the voltage. The green LED is connected just to check if the current is flowing and the voltage drop in the circuit. If it glows, it implies that the circuit is working. The 1N4007 diode is connected in the end to avoid reverse current passage through circuit which might damage it i.e. even if the batteries are connected in reverse polarity, there will be no reverse current passage through circuit. And as already mentioned, the batteries are connected between the diode and ground with the positive terminal at the diode's cathode.

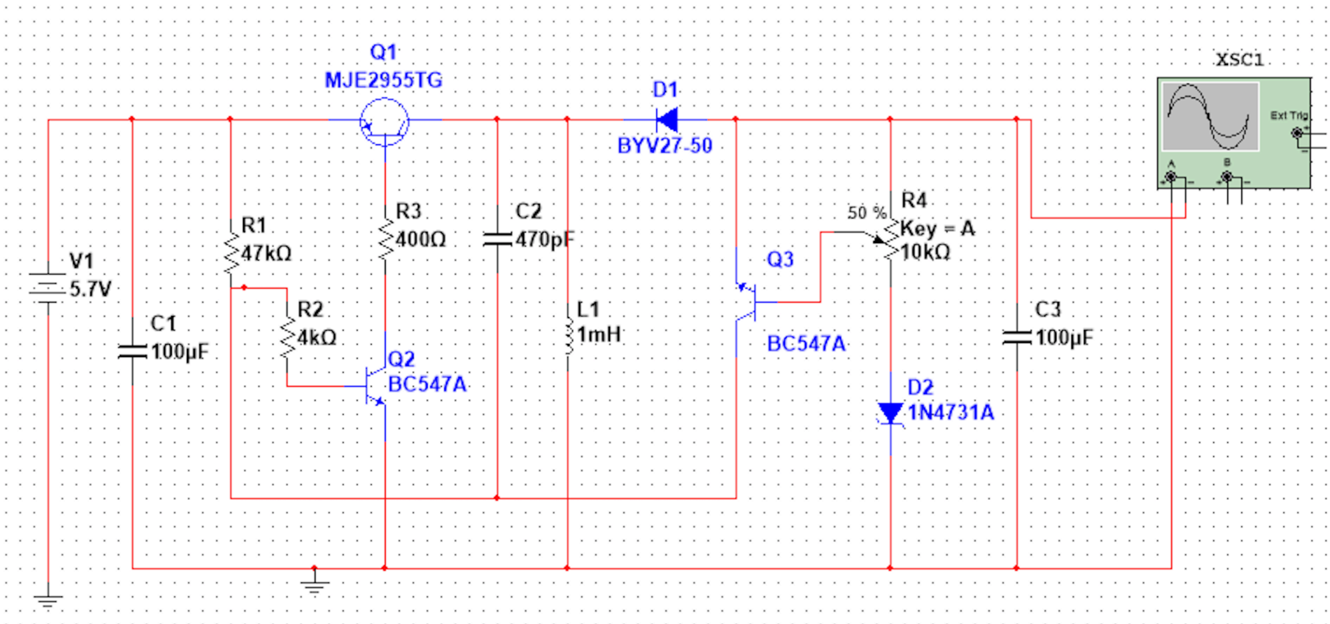


Resultant Output Waveform

We are getting an output of 7V, a constant current of nearly 160mA current and are charging 6V batteries with this circuit.

Components used - 9-0-9 Transformer, 4 1N0041 diodes in the full wave bridge rectifier, TIP29A NPN Transistor, 1N4737A (7.5V) Zener diode, Green LED, 1N4007 diode, 470µF capacitor, 2 1kΩ resistors, 500Ω resistor

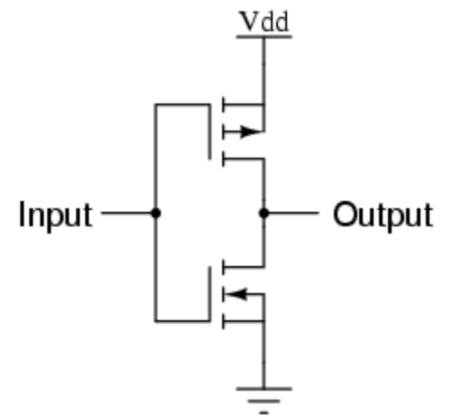
3.2 Inverting DC-DC Buck Boost Convertor



The DC-DC converter used is inverting, i,e., it gives negative voltage at the output. The DC-DC Buck Boost converter includes psuedo-darlington switch which, as said by the name, acts as a switch in the circuit. The output voltage of the converter is maintained at 5V by the use of a 4.3V zener diode. For an input of 3V-6V, the output of the DC-DC converter gives an output of constant 5V. The output of the DC-DC convertor needs to be constant at all times so as not to damage the device being charged.The output current maintained in the circuit for charging the device is approximately 120mA. Though batteries require less than 2A current to be charged, we have maintained less current so as not to damage the components of the circuit.

<u>Components used</u> -2 BC547 NPN Transistors, MJET2955T PNP Transistor, BYV27 diode, a 10kΩ potentiometer, 1mH inductor, 1N4731A (4.3V) Zener diode, 22kΩ resistor, 100Ω resistor, 30Ω resistor, 200μF capacitor, 2nF capacitor, 100μF capacitor

3.3 Switch

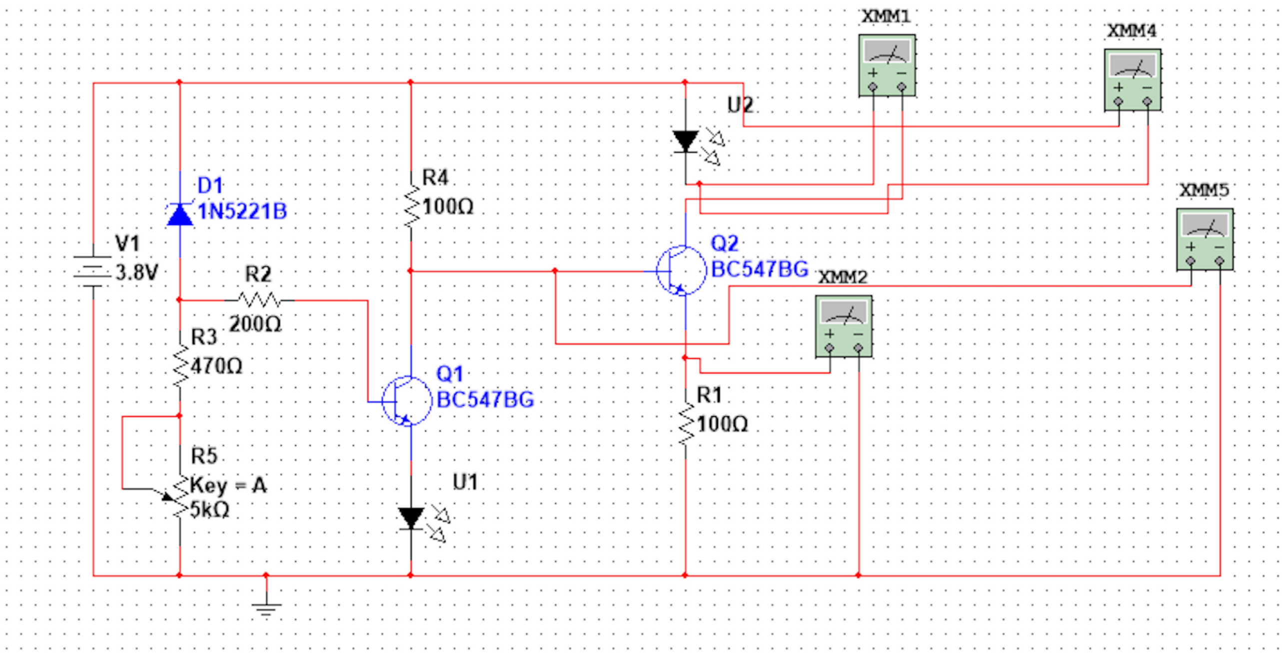


There is a switch connected between both the modules. This is because we don’t want the Pass Through Charging feature in our power bank. In Pass Through Charging, Power Bank charges and discharges at the same time. During Pass Through Charging, an inward and an outward current flows through the batteries at the same time which may destroy the batteries and hence the power bank. So, for that we need to make sure that if the Power bank is charging any device and at the same time it is also connected for charging then it should stop charging other device. So in our project, if we are powering up the device using Power bank and then we start charging the Power Bank then Power Bank will stop charging the device.

<u>Components used</u> - IRF540N nMOS, IRF9630 pMOS

3.4 Battery Level Indicator

This is the circuit of the Battery Level Indicator we included in our project. In the relatively simple circuit that we have designed, the green LED,U1, glows in a 2.5V-5V range while both the LEDs glow if the charge is above 5V and none of them glow if the voltage of the batteries is less than 2.5V. The 1N5221B zener diode is used to indicate to the circuit if the

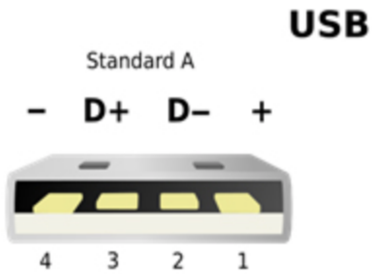


voltage is below or above 2.4V while the transistors maintain the current and voltage and restores are used for biasing. Because of this zener diode, the transistor will be on and the yellow will glow if the input voltage(i.e, the voltage of the batteries) is greater than 5V as yellow LED requires a minimum of 1.8V to glow.

<u>Components used</u> - Green and yellow LEDs, 5kΩ potentiometer, 2 BC547 NPN Transistors, 1N5221B (2.4V) Zener diode, 200Ω resistor, 2 100Ω resistors, 470Ω resistor

3.5 USB Connector

As we have used an inverting DC-DC converter, the outputs of the converter are connected in reverse polarity with the USB connector, i.e the -ve output of the DC-DC converter is connected to the +ve terminal of the USB connector and vice versa.Only one data line(D+) is connected, in pull down configuration along with a resistor, so as to make sure that it will detect if any device is connected to it or not. If that data line is not connected then connector won't detect if the device is connected.



<u>Components used</u> - Standard A USB connector, 200 kΩ resistor

4 Conclusion

We used various components with external heat syncs, resistors and capacitors of various values based on theoretical calculations, Multisim simulation and practical implementation to design the power bank. We kept the current levels to a minimum in our circuits because beyond a certain range, the components were tending to get extremely heated up or damaged.

We faced quite a few challenges while designing and implementing the circuits such as negative effect of the slow discharge rate of the capacitor in the battery charging module on the switch, an instant drop of voltage across the batteries after connecting the device to be charged mainly due to internal resistance of the batteries, etc. We managed to overcome them by making small tweaks in the circuits by using simple concepts such as RC circuits, buffer using op-amp, etc.

There is still scope for improvement in the project. The charging rate can be increased, it would be more efficient if we could charge the power banks using natural resources like sunlight, etc.