Department of Electronic and Telecommunication Engineering
University of Moratuwa

EN2110

Electronics - III

LEAD ACID BATTERY CHARGER (24V, 8A)

PROJECT PROPOSAL

Anushka I.A.M.	190044V
Epa Y.H.A.	190166V
Silva G.B.N.M.	190592X
Thenuwara T.A.	190639T

GROUP 11

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Overview

In our day to day lives batteries play a vital role. Among them Lead acid batteries play another major contribution. Though it is a important source of power, its hazardous ingredients, specially the "Lead" will bring a negative image on it. So the re-usage of those obsolete batteries is a thriving topic in the Energy industry. Since this a raising problem for years we can observe different approaches for charging the Lead batteries. Nowadays we can see many commercially available products in the market. They were built based on variance techniques. Due to that reason, each type of battery charger can affect different key factors of Lead acid battery chargers in different ways. These are the some key factors that we should consider relating to the rechargeable batteries.

- **Charging time**
  - This is about the total time taken to fully charge the battery. If this time is very large it will affect the battery's life negatively.
- **Temperature during Charging**
  - If the temperature inside of the battery is risen above a considerable amount it will cause to occur even explosions inside the battery
- **Overcharging**
  - This will happen when the battery reaches its maximum capacity and then it kept charging with a higher. This will course to decompose the substances inside the battery, specially in the electrolyte.
- **Undercharging**
  - This will occur when the battery charger is fed with low voltage. The end result will be erosion of metallic plates.

The above mentioned battery charging approaches will make different impacts on above key factors. Some may affect positive manner and others in the negative way. So the final attempt should be to recharge the battery without altering its original Capacity and the life span.

As the next step, let's talk about some common battery charging techniques.

- **Constant Current Charging**
  Here a current which is less than rated current will supply to the battery as the charging current. But it will cause to overheating situation.
  - Advantages
    - Charging will terminate when it reaches to maximum voltage.
  - Disadvantages
    - Decrease of the lifetime
    - Increase of charging time
- **Two Step Current Charging**
  Here as it name suggests, the charging process is undergoing as two stages. In the first round a charging current will flow until the voltage is risen to a given threshold. Then pulse charging current will be fed to the battery. These pulse current will help to reduce the self discharge. Still the heating is an issue.
  - Advantages
    - Over charging is avoided
    - grid corrosion is reduced.
  - Disadvantages
    - Decrease of the lifetime
    - Increase of charging time

- **Constant Voltage Charging**
  Constant voltage is given to the charger rather than giving a constant current. An issue with this approach is that, its initial charging current.
  - Advantages
    * Temperature rising is reduced.
    * grid corrosion is reduced.
  - Disadvantages
    * Overcharging
    * Grid Corrosion
    * Initial high current issues

- **Two Step Method**
  Here also there are two phases. In the first phase a constant current will flow until it reaches a threshold voltage. Then it will remain under constant voltage where it reaches the full level by reducing the current.

- **Pulse Method**
  This is comprising with two stages as previous ones. In first mode, charging mode it feeds high positive current flows to the battery. In the second stage it feeds no current.
  - Advantages
    * Increased lifetime
    * Less harm for the electrolyte.
  - Disadvantages
    * poor efficiency.

There are some other methods too such as Negative Pulse Discharge method, Superimposed Pulse Frequency Method and Intermittent Charging method. Though they have much more efficient way to charge the battery the higher cost of them will dilute the higher level performance capability.

1 Market Research

- **Constant current charging**
  - PST-3PA3015 also known as PST-3P30-A3015
    https://www.powerstream.com/SLA-12V20R.htm
    Rated Input Voltage - 90-264 V AC, 50/60 Hz
    Battery Voltage - 12 V nominal
    Charging Current - 2 A or 2000 mA
  - Super Lite battery charger from SNV Power Solutions
    https://m.indiamart.com/proddetail/constant-current-battery-charger-1
    html
    Charging Voltage - 160 V DC
    Charging Current - 20 A

- **Constant Voltage Charging**
  - PST-APS-100
    https://www.powerstream.com/charger-low-noise-high-power.htm
  - Marshal Lead Acid Battery Constant Voltage Charger Battery
    https://m.indiamart.com/proddetail/constant-voltage-charger-battery-2
    html
    Capacity - 7.5 Ah
    Battery Voltage - 12 V

- **Pulse Charging**
  - 400W 30A 12V/24V Automatic Car Battery Charger Smart Pulse Repair Boat Trickle Eu Plug
    https://www.daraz.lk/products/400w-30a-12v24v-automatic-car-battery-charg
    html
    Battery Voltage - 12 V / 24 V
    Charging Current - 30 A
    Rated Power - 400 W

We could observe battery chargers which are capable of charging different battery sizes ranging from 6V-25V. In the same time the current also ranging from 0.5A to 25A. We could observe Charging techniques like "Two-step" method as a prominent implementation. And the most importantly the prizes also changing from $25 to $600.

After considering the above products and the market research we have selected an approach to solve the problem.

2 Approach

2.1 Strategy

Since we have gone through thorough research about this section we have come up with the suitable path to solve the problem. We have decided to use constant current - constant voltage method as the charging method.
As a brief explanation about the task, we can identify these two key sections in our project. They are,

- Wave Rectifier
- Charging section

When we consider the wave rectifying we have to consider the full wave rectifier to have more efficiency and hence reduce the time. This is the sub sections that we can identify in this section.

- First we have to step down the voltage
- Then we have to regulate the voltage
- Regulate the voltage

Then reduce the ripples in the feeding current to battery charger we have to have a capacitor.
After that we have to consider the Charging section. Basically we can observe three sub stages under this approach " Two Step method".

- Constant current charge
  - In this stage constant current will feed to the charger until it reach some threshold value. (70%).
- Topping charge
  - The rest of the capacity will be filled using this method. In this phase the voltage will kept on the flat value while the current will reduced.
- Float Charge
  - Then the gap will be filled slowly.

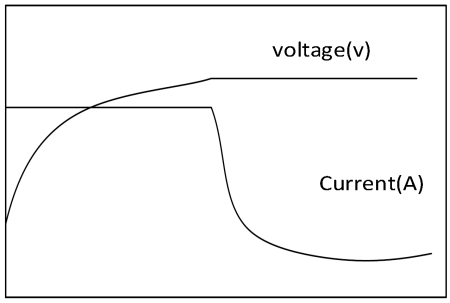
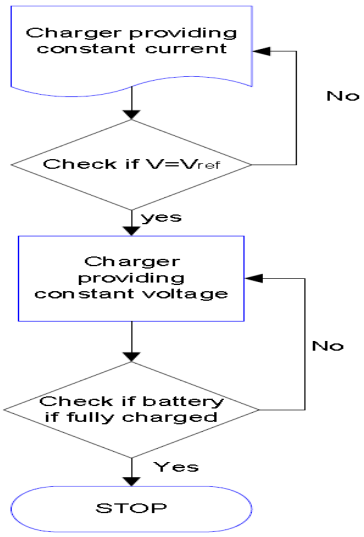
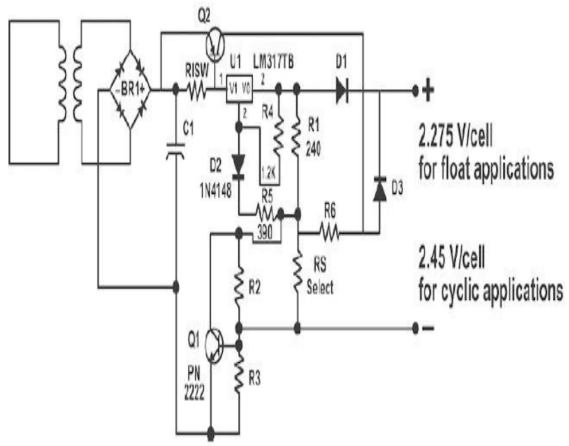


Fig. 4. Battery voltage and current waveforms at two-step charging method.



2.2 Circuit diagram

This is the circuit that we would expect to implement at the end of this project. There may be some variations to this because this is an only first glance approach.



2.3 Components

Based on the above circuit we have picked some essential components. But they are without any specific values.

- **Step down Transformer 0-15V AC**
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- **Bridge Rectifier**
  Convert Ac power supply inyo DC supply
- **Resistors**
- **Capacitors**
- **Diodes**
- **LM317T**
  Voltage Regulation
- **SCHOTTKY diode MBR1545**
  protect Battery and circuit from Reverse Current and Reverse polarity connections.

3 Specification

3.1 General Specification

General-purpose of our product is to charge the rechargeable Lead-acid batteries by minimizing the destruction of the quality of the batteries. Our charger is not a Multi-Bank charger. Because it can charge only one battery at once. And it is And also we can't charge the other kind of batteries with this battery charger. This type of charger is commonly used and important. Nearly this type of charger sells 50$ in the international market. Still, Sri Lanka couldn't design this type of battery charger and most of them are imported from China. Our battery charger power source is an AC power source but we can modify this battery charger for different input power sources like solar power, DC power.

3.2 Performance specification

- **Battery charger input voltage (AC)**
  230V, 50/60Hz
  Our battery charger power source is an AC power source.
- **Battery charger input current (AC)**
  5-13 A
- **Battery charging voltage (DC)**
  24V
  A lead-acid battery, DC voltage between 2.30 volts per cell(nominal) and 2.50 volts per cell(fast). Depending on the state of charge (SoC), the cell may temporarily be lower after discharge than the applied voltage.
- **Battery charging current (DC)**
  8A
- **Power consumption (W)**
  330W
- **Operating temperature**
  We can't guarantee temperature without testing. If we use the proper set of components then we can maintain the temperature. Normal lead-acid battery chargers high temperature +40°C, Features OK and lower temperature -20°C, Features OK.

- **Storage temperature**
  We can't guarantee temperature without testing. Normal lead-acid battery chargers +70°C, Work normally after recovery under normal temperature for 2 hours and -40°C, Work normally after recovery under normal temperature for 2 hours.

- **Charge time (s)**
  We can't guarantee this time interval without the testing.

3.3 Batteries/Cells charged specification

Let's get some idea of allowing batteries for this battery charger. Lead-acid batteries are rechargeable batteries that represent about 60% of all batteries sold worldwide. All lead batteries work on the same set of reactions and use the same active materials. At the positive electrode, lead dioxide (PbO2) is converted to lead sulfate (PbSO4) and at the negative electrode, sponge metallic lead (Pb) is also converted to lead sulfate (PbSO4). The electrolyte is a dilute mixture of sulfuric acid that provides the sulfate ion for the discharge reactions. Lead-acid batteries are separated in two ways: application and construction. The major applications are starting (automotive), deep-cycle, and dual-purpose (marine). The major construction types are flooded (wet), gel cell, and Absorbed Glass Mat (AGM).

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3.4 Other Specification

- **Humidity**
  5-95% With the package (nominal).

- **Altitude**
  3000m, Work normally.

- **Cooling**
  Heat sink, Fan cooling

- **Dimensions & Weight**
  Not decided yet.

- **Housing material**
  Aluminium and steel

- **LED indicator**
  Some LEDs are used to indicate the charging status.

- **Cost**
  Around Rs 10,000 - 15,000

References

- Power Sonic web site https://www.power-sonic.com/blog/how-to-charge-a-lead-acid-battery/

- Lead Acid Battery Charger Circuit https://www.electronicshub.org/lead-acid-battery-charger-circuit/

- How To Make Automatic Battery Charger? https://www.electronicshub.org/automatic-battery-charger-circui

- lead-acid battery charger - a two-stage design to enable fast charging without reducing the battery's lifespan https://www.elektormagazine.com/magazine/elektor-198406/45244