Lead Acid Battery Charger

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Abstract

Several methods were investigated during the course of the development of a smart charger for lead acid batteries. They include constant voltage and constant current techniques, in addition to a method based on the estimated maximum number of cells and a couple of others based on the estimated minimum number of cells in the battery. The former two methods are well known. The estimated maximum and minimum methods are presented here. The minimum and maximum numbers of cells are calculated from the measured open circuit voltage. The most suitable and safest one involves determining the minimum number of cells in the battery and using this value to determine the charge voltage. This method takes full advantage of the microprocessor capabilities of current chargers for diagnostic purposes and can be used to charge any size lead acid battery. The details of these methods and their merits and limitations are discussed

Keywords:

A practical lead acid battery charger circuit has been presented which incorporates all of the features necessary to assure long battery life with rapid charging capability. By utilizing special function ICs, component count is minimized, reducing system cost and complexity. With the circuit as presented, or with its many possible variations, designers need no longer compromise charging performance and battery life to achieve a cost effective system.

Introduction:

A battery charger is a device used to put energy into a cell or (rechargeable) battery by forcing an electric current through it. Lead-acid battery chargers typically have two tasks to accomplish. The first is to restore capacity,oftenas quickly as practical. The second is to maintain capacity by compensating for self discharge. Inbothinstances optimum operation requires accurate sensing of battery voltage.When a typical lead-acid cell is charged, lead sulphate is converted to lead on thebattery’s negative plate and lead dioxide on the positive plate.Over chargereactions begin when the majority of lead sulphate has been converted, typicallyresulting in the generation of hydrogen and oxygen gas. At moderate chargerates, most of the hydrogen and oxygen will recombine in sealed batteries. Inunsealed batteries however, dehydration will occur.The onset of over-charge can be detected by monitoring battery voltage. Thefigure on the next page shows battery voltage verses percent of previousdischarge capacity returned at various charge rates. Over charge reactions areindicated by the sharp rise in cell voltage. The point at which over-chargereactions begin is dependent on charge rate, and as charge rate is increased, thepercentage of returned capacity at the onset of over-charge diminishes. For overchargeto coincide with 100% return of capacity, the charge rate must typicallybe less than C/100 (1/100 amps of its amp- hour capacity). At high charge rates,controlled over-charging is typically as quickly as possible.To maintain capacity on a fully charged battery, a constant voltage is applied.The voltage must be high enough to compensate for self discharge, yet not too high as to cause excessive over-charging.

Literature Review:

The research review in the area of the battery diagnostics and prognostics identified three main topics. The construction of a battery model to reflect all the characteristics of battery behavior is the foundational step in understanding what one can do theoretically for model-based diagnostics. Therefore, a review of models was made. The estimation of state of charge remained a difficult task, and numerous attempts have been made to reliably construct a single method to do this. However, a single estimation structure does not exist that works for all battery chemistries and applications. Therefore, are view of state of charge estimation for lead-acid batteries is included here. Finally, it becomes important to understand how batteries age in automotive vehicles today. The natural aging and fault modes were investigated and reviewed.

Methodology:

Proper recharging is important to obtain optimum life from any leadacidbattery under any conditions of use. Some of the rules for propercharging are given below and they are applicable to all types of lead-acid batteries

.1. The charge current at the start of recharge can be any value that does not produce an average cell voltage in the battery string greater than thegassing voltage (about 2.4 V per cell).

2. During the recharge and until 100% of the previous discharge capacityhas been returned, the current should be controlled to maintain a voltagelower than the gassing voltage. To minimize charge time, this voltagecan be just below the gassing voltage.

3. When 100% of the discharged capacity has been returned under thisvoltage control, the charge rate will have normally decayed to thecharge ‘‘finishing’’ rate. The charge should be finished at a constantcurrent no higher thanthis rate, normally 5 A per 100 Ah of ratedcapacity (referred to as the 20-h rate) [19].A number of methods for charging lead-acid batteries have evolvedto meet these conditions. These charging methods are commonly known as:

1. Constant-current, one-current rate.
2. Constant-current, multiple decreasing-current steps.

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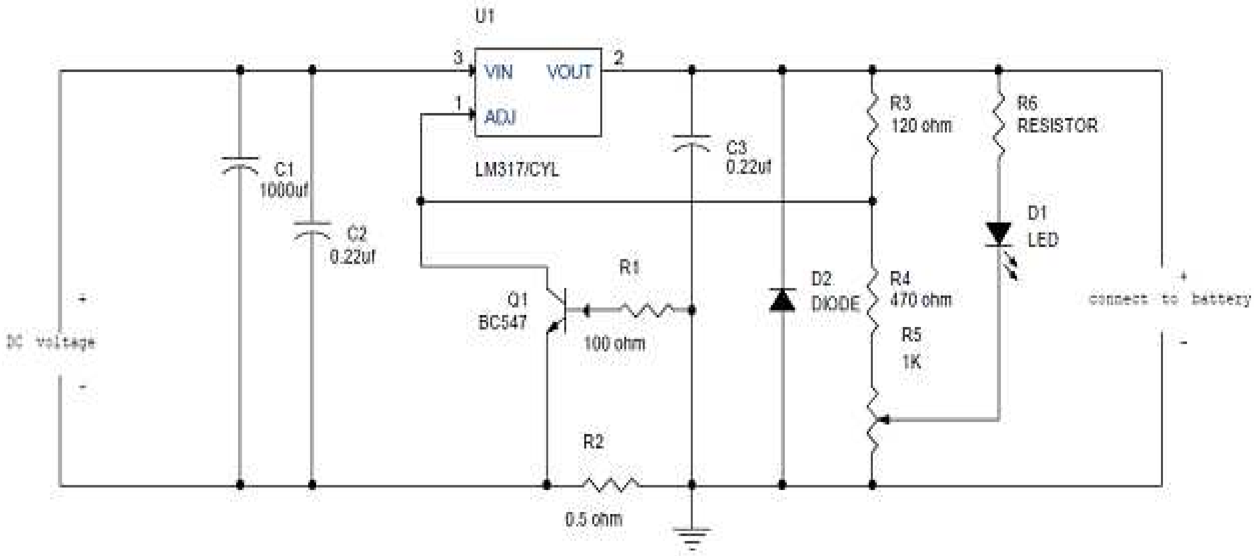
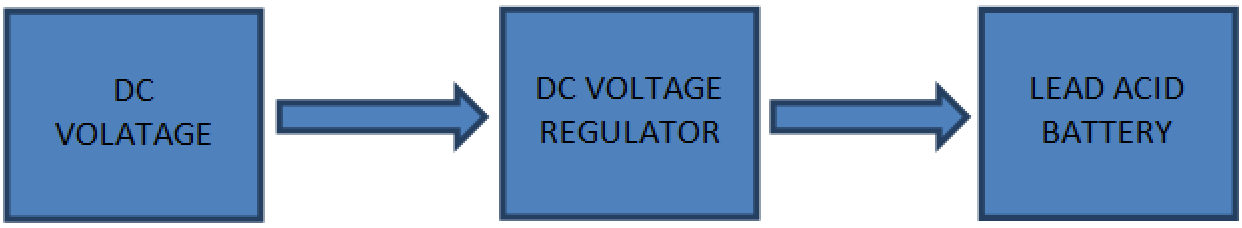
3. Modified constant current.
4. Constant potential.
5. Modified constant potential with constant initial current.
6. Modified constant potential with a constant finish rate.
7. Modified constant potential with a constant start and finish rate.
8. Taper charge.
9. Pulse charging.
10. Trickle charging.
11. Float charging.
12. Rapid charging.

Project Development:





BLOCK DIAGRAM OF CHARGER FOR LEAD ACID BATTERY

Observations:

Nominal capacity: A-hrs @ 25°C to 1.75 V/cell			
1 hr	2 hr	4 hr	8 hr
36 A-hr	45 A-hr	46 A-hr	49 A-hr

Battery capacity:

The quantity *C* is defined as the current that discharges the battery in 1 hour,so that the batterycapacity can be said to be *C* Ampere-hours (units confusion)If we discharge the battery more slowly, say at a current of *C*/10, then we mightexpect that the battery would run longer (10 hours) before becomingdischarged. In practice, the relationship between battery capacity anddischarge current is not linear, and less energy is recovered at faster dischargerates.

Peukert's Law relates battery capacity to discharge rate:

Cp = *Ik t*

Where

C_p = amp-hour capacity at a 1 A discharge rate

I =discharge current in Amperes

t =discharge time, in hours

k =Peukert coefficient

Conclusion:

A simple lead acid battery charger system was designed successfully. The propose charger can work in constant voltage or constant current mode although constant voltage mode is the most preferred. The battery charger has many advantages like successful 3-stage charging, over charge protection, battery discharge protection and a simple design. However the battery charger would be difficult to operate in hotter temperatures. Further we can improve the heatsink to dissipate the heat better and also indicators can be designed to indicate bulk charge and float charge states.