Design of Battery Charger Integrating CC And CV Modes

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Abstract- *In this paper, the compensation of internal resistance of the Li-Ion battery is proposed. In recent days getting renewable energy is more complex issues at the same time it produces and affects the environment by gases and solid wastes. An existing vehicle is replaced by electric vehicles. In this regard battery plays very crucial role to charging the electrical vehicles at the same period charging time of the battery also must important. The previous design was proposed by integrating Constant Current (CC) and Constant Voltage (CV) modes. Thus extends the period of the CC mode to charge the battery with a faster speed. Owing to the shifting voltage on the reference voltage, the charger can delay the time that the operation mode from CC mode to CV mode. That is a fast-charging charger can be achieved by a large constant current stored in the battery during a long constant current period.*

Keywords- Li-Ion, Constant Current (CC),Constant Voltage (CV), Battery Management System and Charge Controller.

I. INTRODUCTION

It is well known that Li-Ion batteries have become popular in portable electronic devices. Li-Ion batteries can store more energy than that of Ni-Cd batteries with the as same size and weight. Based on the small size, light weight and the rechargeable characteristics, Li-Ion battery is well suited to portable electronic applications. However, the life cycles of Li-Ion batteries are easily affected by undercharged or over-charged. It is because over-charged damages the physical component of batteries and undercharged could reduce the energy capacity of batteries. Besides, the long charging time is the most severe drawback of Li-Ion batteries. It means a long charging time is taken for Li-Ion batteries to reach full charged status. Therefore, a precise and fast-charging charger is proposed in this paper to overcome the severe issues.

II. BACKGROUND

Generally speaking, the charging process of Li-Ion battery charger is divided into three operation modes, i.e. trickle current mode (TC), constant current mode (CC), and constant voltage mode (CV).The simplified diagram of Li-Ion battery charger is shown in Fig 2.1. At the beginning, the charger detects the initial voltage of the battery V_{BAT}. If voltage V_{BAT} is smaller than the specified voltage (normally 2.5V), the charger operates in TC mode. Once V_{BAT} > 2.5V, the operation mode is switched to CC mode.

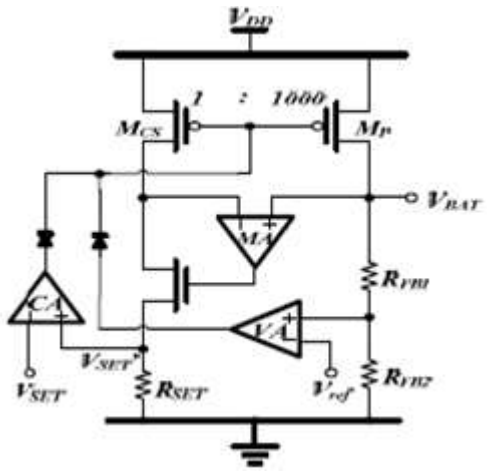

Figure.2.1. The structure of the basic charger circuit.

In the TC mode, the battery is charged by a trickle current. The current is decided by an external resistor R_{SET}. It protects the battery from being damaged by a large current under low battery voltage. When the battery is charged to adequate voltage, the charging process is needed to switch to constant current (CC) mode automatically. The charging current in CC mode is larger than those in TC and CV modes. It means much energy is rapidly stored in battery in CC mode. When the battery voltage reaches a rated voltage like 4.1 or 4.2V, the charging process is switched to CV mode. The charger would keep the battery at steady voltage until the charging time is over. The charging path composed of the power MOSFET MCS and R_{SET} is shutdown and the voltage of V_{SET} gradually decreases to zero.

III. PROPOSED PROGRAMMABLE CHARGE CONTROLLER

A battery charger on Constant Current (CC) and Constant Voltage (CV) modes are proposed. The proposed system proposes to give better performance like reduce the charging time of the battery by CC-CV modes of operation. On CC mode: current is kept at 100A and voltage limits 58.4V and CV mode: Voltage is kept at 58.4V and Current cut off is 5A were obtained.

3.1Constant Current and Constant Voltage mode of Operation

In this project Constant Current (CC) and Constant Voltage (CV) modes are integrated. A CCCV (Constant Current, Constant Voltage) is ideal for small batteries. Initially, the battery is charged at Constant Current. When the battery is nearly full, its voltage reaches the Constant Voltage setting of the charger, and the current decays exponentially as the battery gets a finishing charge.

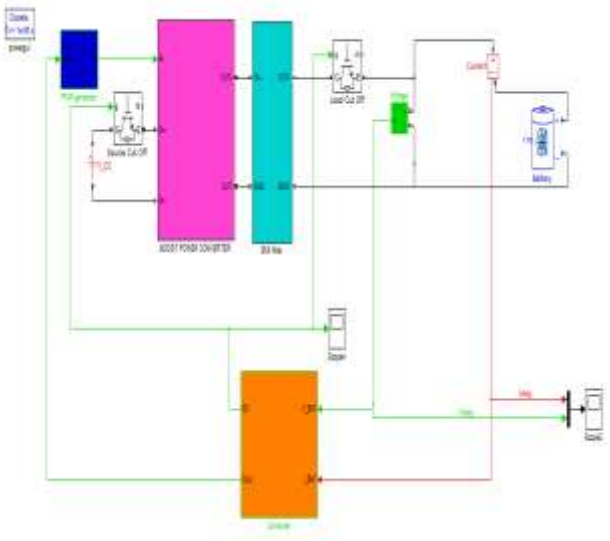

Figure 3.1 Simulation diagram of proposed system

Switching device is IGBT. It is a switch that is used in order to allow power flow in the ON state and to stop power flow when it is in the OFF state. An IGBT works by applying voltage to a semiconductor component, therefore changing its properties to block or create an electrical path. These subsystems provide input signal to the switching devices.

In a small battery, the charger voltage is divided pretty much equally among the cells within it. Constant current / constant voltage (CC/CV) charging mode is an effective way to charge lithium batteries. When a lithium battery is nearly empty, we take constant current to charge it. We need to make sure that charging current should be lower than the max charging current that battery can accepted. With constant charging the voltage of battery is slowly upping, when battery volt reaches the max charging voltage, charger would make sure charging voltage fixed as constant voltage and reduce the charging current. When battery is fully charged this state would be stopped.

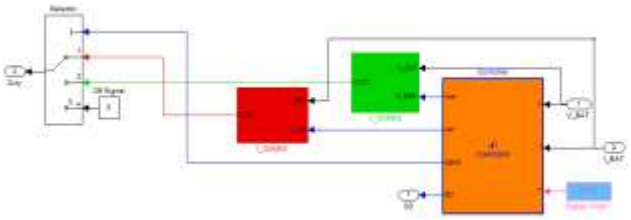

Figure 3.2 Simulation diagram of controller circuit

While the specific control method and algorithm vary among charge controllers, all have basic parameters and characteristics. Manufacturer's data generally provides the limits of controller application such as PV and load currents, operating temperatures, losses, set points, and set point hysteresis values. In some cases the set points may be intentionally dependent upon the temperature of the battery and/or controller, and the magnitude of the battery current. Internal resistance of the battery was reduced (150mΩ into 300mΩ by using MATLAB coding into the controller block.

3.2 Program inside the Charger Block

```
function [Vref,Iref,signal,SD] = CHARGER(V,I,T)
persistent temp_i temp_v temp_signal temp_fault CC CV n ;
if isempty(temp_i)
   temp_i=0.2;
end
if isempty(temp_v)
   temp_v=0;
end
if isempty(temp_signal)
   temp_signal=1;
end
if isempty(temp_fault)
   temp_fault=1;
end
if isempty(CC)
   CC=1;
end
if isempty(CV)
   CV=0;
end
```

```
if isempty(n)
   n=0;
  end
end
signal=temp_signal;
SD=temp_fault;
Iref=temp_i;
Vref=temp_v;
End
```

IV. RESULT

In constant voltage mode, which is sometimes referred to as voltage-controlled mode, a power supply behaves like a voltage source, holding the voltage across the output terminals constant while the current output varies, depending on load conditions. Constant voltage / constant current (CVCC) is a combination of the above two methods. The charger limits the amount of current to a pre-set level until the battery reaches a pre-set voltage level. The current then reduces as the battery becomes fully charged. This system allows fast charging without the risk of over-charging and is suitable for Li-ion and other battery types.

In CC mode: current is kept at 100A and voltage limit is 58.4V were obtained.

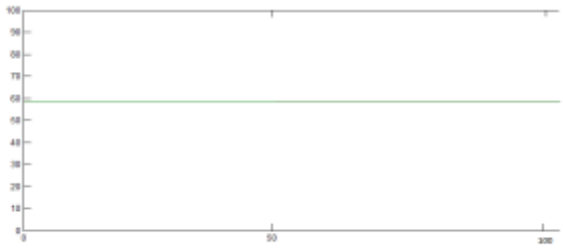

Figure 4.1 Output waveform of simulation model of CC

In CV mode : Voltage is kept at 58.4v and Current cut off is 5A were obtained.

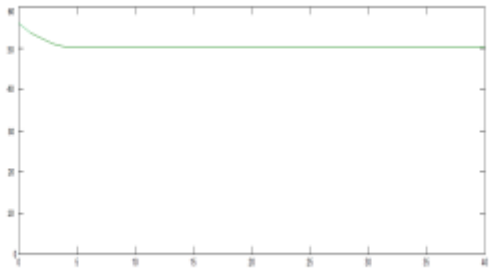

Figure 4.2 Output waveform of simulation model of CV

The proposed system was implemented using MATLAB Simulation. The proposed circuit was drawn in MATLAB and the output was obtained for the CC-CV mode of operation. In CC mode: current is kept at 100A and voltage limit is 58.4V were obtained. In CV mode: voltage is kept at 58.4V and Current cut off is 5A.

V. CONCLUSION

In my project the Constant Current (CC) and Constant Voltage (CV) modes of battery charging was proposed. The extension of CC mode makes the charger charge the battery with a faster speed. Owing to the shifting voltage on the reference voltage, the charger can delay the time that the operation mode from CC mode to CV mode. Thus, a fast-charging charger can be achieved by a longer and large constant current stored in the battery during the CC mode. The operation of the Constant Current (CC) and Constant Voltage (CV) modes is simulated and output is verified by using MATLAB/SIMUINK model.

The proposed method of integration is verified through the result obtained. The proposed method is very suitable for fast charging of an electric vehicles application. In this proposed work performance of the battery charging system is improved and also charging time of the battery is reduced compared to traditional methods.

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