Strategies for rechargeable lithium-ion battery management system

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Keywords: Lithium-ion battery; battery management system; a charging policy; temperature.

Abstract. This paper mainly research the relationship between the lithium-ion battery management systems and charging policies and temperature. In the introduction of lithium-ion battery characteristics of the premise, the lithium-ion battery protection methods are described, based on a lithium-ion battery protection method in detail its charging policies and to study the effect of temperature on charging policies, compared with good interpretation of the lithium-ion rechargeable battery management system strategy selection and temperature control importance of the lithium-ion battery protection, providing a theoretical basis and ideas for research and specific battery management system.

Introduction

Lithium-ion battery is a lithium metal oxide alloy anode material, graphite as the cathode material, the use of non-electrolyte rechargeable battery. Depending on the anode material, lithium-ion batteries exhibit different characteristics, the most obvious difference between the electrical characteristics of the performance of different nominal voltage on, with the corresponding charge voltage and discharge cut-off voltage is not the same. As lithium battery materials it has many advantages, but also has a very active features highly flammable, and burning caused by high temperatures and the volume expansion tends to cause disastrous consequences, therefore, in addition to the lithium-ion battery itself in the production, storage, transport, the operation to enforce strict specifications, the management and selection policy to charge and discharge its important, in addition, the effect of temperature in the battery management system should not be ignored.

1 lithium-ion battery protection

Lithium-ion batteries in use of the most important is to ensure that it will not be over-charging and discharging. Over charging and discharging of the lithium-ion battery effect is irreparable, even dangerous, excessive discharge may damage its internal structure, combustion or explosion can happen, so the lithium-ion battery protection is very important, lithium-ion battery the protection circuit is mainly to ensure that it does not over-charge and discharge, the current lithium-ion battery protection legislation adopted RT9454 Q1 science and technology, and its main function is to prevent over current and over voltage, realize overcharge and over discharge protection. The protective circuit shown in Fig.1.

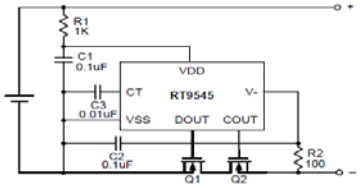


Fig.1. Lithium-ion battery protection circuit

In the protective circuit, since the parasitic diode, and the charging and discharging protection switch can not tube can be achieved with only a two-way protection, so a two-protect switch MOSFET Q1 and Q2 for charging and discharging in the circuit , but also to implement over current detection, when the IC across the switch detects excessive voltage drop, it will force the MOSFET into the off state, thereby closing the flow of current through the battery, protect the battery of purpose, since the current investigation is measured by detecting the voltage difference

across the MOSFET to achieve, in the choice of MOSFET, its on-resistance parameters are also vital.Over voltage and under voltage condition is detected by the voltage detection between VDD and VSS is completed, most of the lithium-ion battery selection 4.35V and 2.5V as the overcharge protection voltage and over-discharge protection voltage.

2 lithium-ion battery strategy

2.1 Relationship between battery capacity and cycle life and charging cut-off voltage

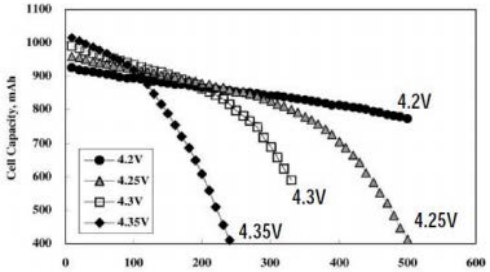


Fig. 2 Lithium-ion battery capacity and cycle life and charging cut-off voltage.

Fig. 2 is a capacity of 950mAh lithium-ion battery capacity and cycle life and charging cut-off voltage. Figure.As can be seen from the figure, alone 4.35V lithium-ion battery protection circuit provides a charge-cutoff voltage, then it's initial capacity is relatively large, but very short cycle life, capacity drops fast.

2.2 Relationship between battery capacity and cycle life and discharge current

Fig. 3 lithium-ion battery capacity and cycle life and discharge current diagram, canbe seen from, for 900mAh lithium-ion battery, 1.0C-rate charging capacity after 500 cyclesof about 78 0mAh, single terms of 2.0 C rate

For charging capacity after 500 cycles of about 500mAh, the trend can be seen from the following graph, with the upgrading of the charging rate, the capacity fading rate is substantially increasing exponentially.

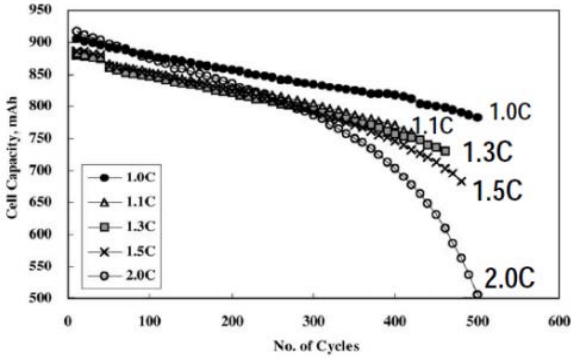


Fig.3 lithium-ion battery capacity and cycle life and discharge current relationship diagram

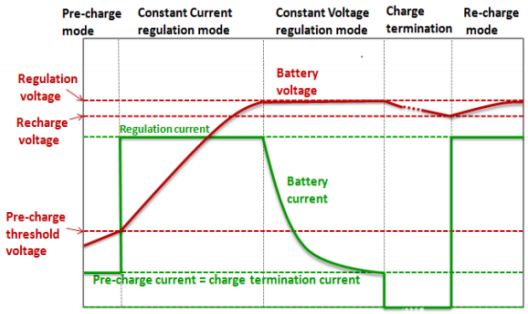
2.3 Lithium-ion batteries Policy

During charging, the charger under external electric field is applied, Li + released from the positive to the negative electrode into the electrolyte in LiCoO2 move, turn into negative electrode graphite, and in that form LiC compound. If the charging too fast, it will make Li + late into the negative electrode grid in the vicinity of the negative electrode electrolyte will gather Li +, which is close to the negative Li + is likely to capture an electron from the negative to metallic Li. Will generate continuous metallic lithium anode piled nearby, grew into dendritic crystals, commonly known as dendrites, another situation, with the full extent of the negative increasingly high, LiC lattice leaving less and less space, from the positive movement over the Li + chance of finding less and less space required more time, if the charging rate does not change, the same may be formed in the surface of the negative local Li + accumulation, therefore, in the second half of the charge must gradually reduce the charge current, dendrites grow up eventually pierce the separator between the positive and negative electrodes, a short circuit, it is conceivable, faster charging more dangerous,

the more dangerous the higher cut-off voltage charging, charging time is longer more dangerous。

Based on the understanding of the characteristics of lithium-ion batteries, the industry has formed a three-stage strategy for the lithium-ion battery charging: pre-charge, constant current charging, constant voltage charging. The significance of the pre-charge state of the battery is adjusted so that it can enter the state of large current charging, constant current charging of the electric energy is stored in the battery in a fast, constant adjustment phase is the last stage, which allows the battery maximize capacity, but the process is carried out in full accordance with its own battery needed, unlike the constant current charging as the battery has a strong electric field force, and any act contrary to the battery characteristics, especially over the battery capacities are too large current or exceed the battery voltage overshoot to the battery life operations will have a huge impact, so any good management program must be carried out in accordance with strict design specifications.

Three-stage strategy view of a lithium-ion battery charging time is shown in Fig.4 .



Fig,4 Three-stage strategy view of a lithium-ion battery charging

Precharge occurs in the battery voltage is relatively low for most lithium-ion battery, this voltage is generally defined in 2.9V-3V or less, when the allowable charging current C / 10 or less. Constant charging current is generally set at about 1C, at constant voltage charging phase, the charging current will gradually decrease the value of the current must be reduced (usually C / 10) later, when the battery is fully charged, the charging process will be closed, Figure 4 displays the last stage is called supplementary stage, it is actually a combination of a constant current stage and constant voltage stage, which is to compensate battery self-discharge capacity and other consumption of the load connected to it caused by falling remedies, this is to ensure that the battery and charging device separate as much as possible is always in full charged state.

3 Summary and conclusions

This paper describes a lithium ion battery characteristics under the premise of the lithium-ion battery protection methods are described, based on a lithium-ion battery protection method, elaborated its three-stage charging policies and to study the temperature of the charge influence policy, better explain the importance of controlling the lithium-ion rechargeable battery management system strategy selection and temperature lithium-ion battery protection. In addition, under the existing IC conditions, open hardware setting section privilege also to develop lithium-ion battery management system provides the direction of thinking.

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