具能量回收之可攜式電池診斷平台 A19-161

A Portable Battery Test Platform with Energy Recycling for Lithium-ion Battery

隊伍名稱 具能量回收之可攜式電池診斷平台
A Portable Battery Test Platform
with Energy Recycling for Lithium-ion Battery

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研究領域
電池管理系統、高壓脈衝電源、電力電子應用。

作品摘要

近年由於環保意識的抬升，社會上對以石化燃料為能源之產品標準日漸嚴苛，另外，石化燃料的能源短缺，造成成本不斷的上升，因此，各國皆投入研究替代石化能源之方案，其中，以電池為動力來源之方式獲得青睞，其優點如下，使用的過程中可排除廢氣排放之問題、能減少石化燃料的使用，因此，以電池為動力能源在市場上逐漸受到重視。

目前電池相關的研究，除了材料、電化學領域之外，電池管理系統之研究也成為一個重要的課題，其中包括：電池特性的監測、電池管理系統的設計、電量狀態（State of Charge，SOC）的估測等，以達到電池模組之過電壓、欠電壓、過電流及溫度保護等保護機制。其中，針對電池模組在使用的過程中，由電池模組的特性變化，了解其 SOC 狀況，藉此增加系統對電池模組資訊的掌握程度，並提出相對應之反應機制，以提高電池模組之壽命及安全性。

有鑑於此，本作品提出之電量估測平台包括一種新的 SOC 估測法則，利用 LC 串聯諧振所建構之諧振負載，對電池模組進行交流抽載，其中，不需要花費時間等待電池的電化學反應穩定，並可模擬電池模組於不同負載條件下之電量，亦可於有載狀況下對電池模組進行 SOC 估測，且於估測的過程中，同時具備電量回收之功能。此外，本作品也實現了一套電池管理系統，能夠偵測電池模組內各個電池的電壓，並且對電池模組提供各式保護功能，包含過電壓、欠電壓、過電流、高溫及低溫保護。最後，加入人機介面與電量估測平台進行雙向溝通，除了可將主電路運作的過程中偵測電路所蒐集到之電池模組資料，傳送至人機介面顯示，亦可由人機介面對系統進行控制，另外，可將所蒐集之資訊以 Excel 形式進行儲存，以利使用者進行後續分析。

本作品之特色:

- 於無負載狀況下，可模擬電池模組不同負載下之SOC
- 電池模組抽載時，可即時估測 SOC
- 估測 SOC 過程中，具備電量回收功能
- 具備過電壓、欠電壓、過電流、高溫及低溫保護
- 電量估測平台體積小，具備可攜式之優勢
- 具備雙向溝通功能之人機介面
- 估測資訊可儲存成 Excel 檔案，以利後續數據分析
- 電量回收率最高可達 95%
- SOC估測平均誤差 1.7%

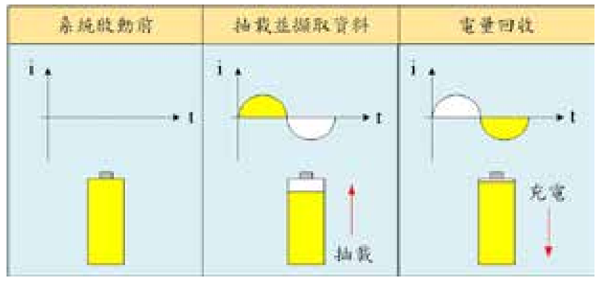

圖 1. 電量回收示意圖

圖 2. 具能量回收之可攜式電池診斷平台實體圖

圖 3. 系統架構示意圖

ABSTRACT

In recent years, due to the rise of environmental wareness, the standards for products using fossil fuels as energy sources have become increasingly stringent. In addition, the shortage of energy for petrochemical fuels has caused rising costs. Therefore, many countries are investigating alternatives to petrochemical energy. The battery is the source of power, and its advantages are favorite in the field of energy sources. The use of the process can eliminate the problem of exhaust emissions and reduce the use of fossil fuels. Therefore, battery-powered energy is gradually gaining importance in themarket.

At present, battery-related research, apart from materials and electrochemistry, battery management system (BMS) research has also become an important topic, including: battery characteristics monitoring, battery management system design, State of Charge (SOC) estimates, etc. To achieve protection mechanisms such as overvoltage, undervoltage, overcurrent, and temperature protection of the battery module. In the process of using the battery module, the characteristics of the battery module are changed, and the SOC condition is known, this will increase the system's mastery of the battery module information, and propose a corresponding reaction mechanism to improve the life and safety of the battery module.

Currently, various methods for detecting SOC areproblematic and need to be overcome. For example, the open circuit voltage method needs to be allowed to stand for a period of time after the battery module is used, and it can be measured after the electrochemical reaction is stable, and it is difficult to achieve an immediate estimation request; secondly, the Coulomb integral method cannot know the initial state of the battery. Moreover, the influence of the charge and discharge current on the electric quantity cannot be considered, and therefore, the SOC estimation is not easy to be performed; further, the internal resistance method has a very high precision due to the extremely small change in the internal resistance of the battery, and the cost and the circuit are required. The volume is large and it is not easy to calculate the correct value.

In the light of this, the SOC estimation platform proposed in this work includes a new SOC estimation method, which uses the resonant load constructed by an LC series resonance to perform AC loading of the battery module, it does not need to wait for the battery to be electrified. The learning response is stable, and can simulate the SOC of the battery module under different loaded conditions, and can also perform SOC estimation on the battery module under the loaded condition, and in the estimation process, the function of power recovery is also provided. This work also implements a battery management system that detects the voltage of each battery in the battery module and provides various protection functions for the battery module, including overvoltage, undervoltage, overcurrent, high temperature and low temperature protection. Finally, the user interface (UI) is added to the SOC estimation platform for bidirectional communication. In addition to transmitting the battery module data collected by the detection circuit during the operation of the main circuit to the UI display, the system can also be faced by UI controlling. In addition, the collected information can be stored in Excel format for the user to conduct subsequent analysis.

Features of this system:

- When no load is in progress, this system can simulate the SOC of battery modules under different C-rate.
- When the battery module is loaded, the SOC can be real-time estimated.
- While measuring the SOC process, this system can recover power to the battery modules.
- This system has protective function with over voltage, under voltage, over current, high temperature and low temperature.
- UI with bidirectional communication function.
- Estimated information can be saved into an Excel file for subsequent data analysis.
- Energy recycling rate up to 95%
- SOC estimated average error 1.7%