ABSTRACT

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Title *: Design of Lithium-Ion Battery Internal Resistance Measurement System Using AC Injection Method*

Lithium-Ion batteries play a vital role as the primary energy storage medium in various modern technologies, from portable electronic devices to electric vehicles. To ensure the reliability and safety of the device, monitoring changes in battery internal resistance is crucial because this parameter is a direct indicator of electrochemical degradation and physical conditions within the battery cell. This study aims to determine how the battery internal resistance measurement system is carried out, as well as to analyze changes in battery internal resistance in real-time during the charging and overcharging processes. This measurement system is designed using a 1 kHz frequency AC injection method which is continued to an AC current source circuit (Howland) with a constant current value of 30 mA, combined with an AC coupling circuit as DC Blocking. Test results under normal charging conditions (2.4 Volts to 4.2 Volts) show that the internal resistance value changes non-linearly and is inversely proportional to the cell voltage. The highest internal resistance value is when the battery is empty, reaching 534 mΩ at 2.6 Volts and decreasing drastically to the lowest point of 100 mΩ at 4.2 volts. The internal resistance value of the battery when full is the same as the internal resistance value of the battery in its initial condition. This means that charging at the appropriate voltage will not affect the battery's internal resistance and its health. Meanwhile, during overcharging tests of up to 4.4 volts, the internal resistance failed to decrease to its minimum operational value and remained high, at around 260 mΩ to 270 mΩ. This indicates that the battery has suffered internal damage due to being subjected to excessive voltage.

Keywords: Lithium Ion, Internal Resistance AC Method, *Howland Current Source, AC Coupling Circuit, Overcharging*