Charge Cycling Test

User Manual

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1. INTRODUCTION

1.1. WHEN THE TEST WILL TAKE PLACE

The Charge Cycling Test will be done two times. Once before the vibrational test and once after the vacuum test.

1.2. IMPORTANCE

You perform a charge cycling test to evaluate the performance of the battery, predict their lifespan, and assess their durability in real world conditions. The purpose of this test is to apply a constant current to batteries, super capacitors, or electrode materials in order to charge and discharge between defined voltage limits. This will allow you to see how a material or cell's capacity, efficiency, and similar parameters are affected as a function of cycle number.

1.3. WARNING

Never leave a lithium-ion battery unattended during the test. In case of swelling, venting, or rapid temperature increase (>45°C in < 10 Seconds), immediatly stop the test and remove the abttery to a fire safe location.

2. EQUIPMENT

- Voltmeter

This tool is used to measure voltage and potential difference between two points in a circuit

- Programmable Power Supply

This is the device that is going to doing the actual charging and discharging of the Lithium Ion battery

- Battery Analyzer

This tool is used to monitor and evaluate the performance of a battery during repeated charge and discharge

- Thermal sensor or thermocouple

This tool is used to monitor the batteries temperature during the charging and discharging

- Protective casing (if required)

This is used to enhance the performance, stability, and safety of the battery

- Datasheet for reference

3. PROCEDURE

3.1. SET UP

Connect the battery leads to the test station. Like the multimeter, connect the red lead to the positive lead and the black lead to the negative lead. Attach a thermocouple to monitor battery surface temperature. A thermocouple is a sensor that measures temperature. It consists of two different types of metals joined together at one end. When the combination end of it is heated there is a current that flows through the thermoelectric circuit. Then your going to configure the parameters on the analyzer. The necassary parameters are listed below.

3.2. PARAMETERS

Parameters are used to control and monitor the charging and discharging of a battery over a period of time.

- Voltage
  - Average Working : 4.2V
  - Charging Voltage : 3.7V at 0.2C rate
  - Capacity : 1260 mAh
  - Internal Resistance : r = (E/I) - R
  - Energy Density : 4884 (Wh/L)
    - Energy Density (Wh/L) = battery capacity (mAh) x 3.2 (V) or 3.7 (V)/thickness (cm)/length (cm)
  - Discharge Current : 1.0C
  - Charge Current : 1.0C
  - Cycle Life : ≥500 cycles, more than 80% at 0.5C rate discharge
- Cycle Profile
  - Charge to 4.2V:
    - Constant Current : 0.5C So, 660 mA for this 1320 mAh battery
    - Constant Voltage : Hold at 4.2V until current drops below 0.05C (66 mA)

3.3. CHARGE CYCLING TEST

Begin the automated charge-discharge cycle. Ensuring to log the following data: Voltage(V),Current(mA), Temperature(°C), Capacity (mAh), and Internal resistance.

Rest for 30 minutes after charge Then you are going to discharge to 3.0V using the Constant Charge method. Discharge at 0.5C (660 mA). Then rest the battery again. Repeat this cycle greater than or equal to 500 cycles.

3.4. MONITOR AND OBSERVATION

Make sure to watch for any temperature rises. If the battery reaches a temperature greater than 45°C then stop the test. Watch for capacity drops and any swelling, venting, or irregular behavior.

3.5. DATA ANALYSIS

After a certain amount of cycles it is important to do quality checks on the battery to see how it is performing in between the test. Recommended analysis points include the initial cycle (Cycle 0), an early cycle (Cycle 10), ongoing checks (Every 25 to 50 Cycles), half-life cycle (Cycle 250), and the End-Life Cycle (Cycle 500). The key metrics to assess include capacity, internal resistance (IR), and State of Health (SoH).

- Capacity (mAh) : Decreases
- Internal Resistance (IR) : Increases
- State of Health (SoH) : Calculated using this formula
    - SoH = ((Measured Capacity/Nominal Capacity)x100%)

  Nominal Capacity : Rated capacity of the battery

  Measured Capacity : Obtained during testing

This analysis ensures accurate monitoring of the battery’s health and longevity across its lifespan.

4. RESULTS

After this test (about 300-500 cycles), the batteries capacity should decrease but remain above 80% of its nominal value (Find using the SoH equation). Internal Resistance is expected to increase slowly indicating the wear on the battery is normal. Charge and discharge voltage profiles should be consistant between cycles. The temperature should typically stay below 60°C. There should be no signs of physical damage such as swelling, leakage, or deformation. All of these results together confirm wether the battery is performing as expected.