Why Automotive Lithium-Ion Batteries Need Peak Power Capability Testing

Lithium-ion batteries are widely used in many fields with their advantages of high voltage, low self-discharge and long cycle life. Especially high specific energy battery materials make them the most promising candidates for electric vehicles (EV).

In automotive applications, the Battery Management System (BMS) is critical important to maintain best battery performance and correspondingly extend its lifespan. An excellent BMS must have the ability to estimate the State of Charge (SoC) or the State of Health (SoH), which has been widely discussed. Accurate State of Available Power (SoAP) estimation is also one of the most challenging tasks in practical applications, as it is necessary to determine the currently available power to meet EV acceleration, regenerative braking and gradient climbing power requirements without having to worry about the battery being operated outside the safe operating area make it over-charging or over-discharging to shorten the battery lifespan.

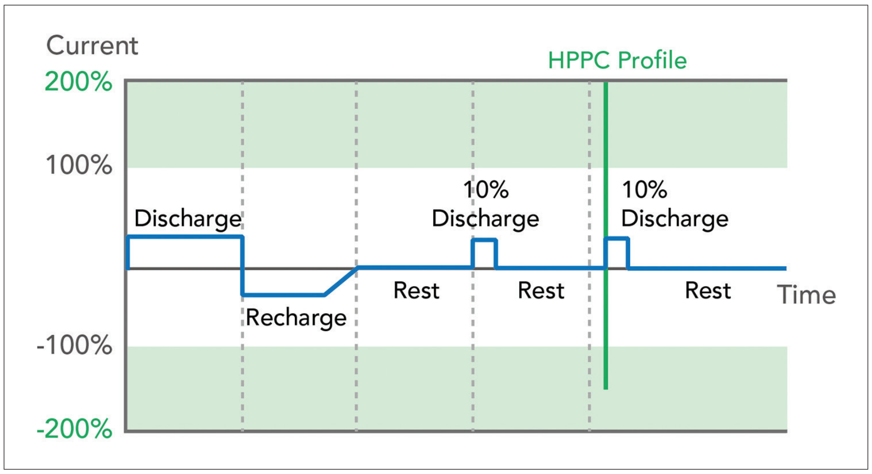

Figure (1) Hybrid Pulse Power Characteristic (HPPC) Current Profile

A common method to evaluate the peak power capability of automotive batteries is the Hybrid Pulse Power Characterization (HPPC) proposed by the Idaho National Engineering & Environmental Laboratory, which is the most advanced method [1], shown in Figure (1) is used to determine the static peak power of batteries in a laboratory environment. This method is to apply a maximum pulse current and a specific rest time to the battery in a specific SoC, and identify the battery open circuit voltage and direct current internal resistance by measuring the current and voltage data. The exact maximum discharge and regeneration available peak power is then derived from the following equation:

$$\text{Discharge Pulse Power Capability} = V_{min\_pulse} \cdot \frac{OCV_{dis} - V_{min\_pulse}}{Rdis} \quad (1)$$

$$\text{Regen Pulse Power Capability} = V_{max\_pulse} \cdot \frac{V_{max\_puls} - OCV_{regen}}{R\_regen} \quad (2)$$

In practical application, the power fade occurs during the battery life that is the internal resistance of the battery is increased and it will limit the vehicle to input or output the maximum current capability of battery. Therefore, the internal resistance of the battery is regarded as an important aging indicator of the battery power supply capability. When the internal resistance of the battery reaches a pre-defined upper limit, that is, the nominal end of life (EoL) value of the battery is reached, the vehicle may not be able to obtain proper discharge or charge power respectively in the low and high SoC ranges. Thus, to evaluate the peak power capability of automotive lithium-ion batteries under different aging conditions is a very important engineering task.

Chroma has developed a solution that meets the peak power capability test of Li-ion batteries. Chroma 17010H battery reliability test system has the ability to short duration output 200% pulse current, providing another cost-effective option for its testing. The following are the characteristics of Chroma17010H test solution:

1. The test channel can output 200% pulse current for 30 sec, and output up to 4800A in parallel.
2. The Battery LEx test software can help the experimenter to edit the HPPC and complete the battery internal resistance calculation and open circuit voltage recording through the software, saving considerable analysis time.
3. Fast current response capability <1.5mS and zero crossover time, it provides more realistic pulse test applications.
4. Multiple current range design to improve the accuracy of small current, the minimum current range is 1:10, and both high and low rate performance tests have suitable ranges.
5. Discharge energy recycling efficiency of 75%, it not only saves operating power and waste heat air conditioning, but also reduces laboratory power distribution capacity.
6. In addition to the built-in voltage upper and lower limit protection function, it also has an independent hardware second level voltage protection function, which can redundantly protect the safety of the DUT during the test. ■

Reference:
[1] Battery Test Manual for Electric Vehicles, U.S. Department of Energy Vehicle Technologies Program, Revision 3.1, 2020.