

# What Is Internal Resistance (IR) And How To Test Battery Resistance

A battery can be regarded as an ideal voltage source in series with an impedance, which is called internal resistance. When the battery works, the voltage output is lower than the open-circuit voltage (abbreviated as OCV). The difference is the voltage drop caused by the internal resistance. The internal resistance is measured by ohm ( $\Omega$ ). The value of internal resistance varies depending on multiple factors, such as battery size, cathode electrode, anode electrode, separator, electrolyte, temperature, and state of charge (SOC) of the battery.

The Alternating Current Internal Resistance, commonly called AC Impedance or Impedance, is usually tested with an Impedance Analyzer. Direct Current Internal Resistance, DCIR or DCR can be measured with a battery tester by applying a low current followed by higher current on the battery within a short period, and then record the changes of battery voltage  $\Delta V$  and current  $\Delta I$ . Based on Ohm's Law,  $DCIR = \Delta V / \Delta I$ . The AC Impedance and DCIR both indicate battery's power characteristics while DCIR is more popularly used by battery manufacturers since the test is simple and the results are reliable.

According to IEC61960, the DC resistance can be measured as follows: A DC current step is applied to measure the change in the cell's voltage. Battery resistance is defined as the change in voltage over the change in current when a discharge current of 0.2C is applied for 10s followed by a discharge current of 1C for 1s. The DCIR is calculated by

$$DCR = \frac{V_1 - V_2}{I_2 - I_1}$$

where  $V_1$  and  $I_1$  are the voltage and current values after the 10s 0.2C discharge just before the current step;  $V_2$  and  $I_2$  are the voltage and current values after the 1s 1C discharge.