

Keysight Technologies

# Simplify Validating a Battery's Capacity and Energy for End-Use Loading Conditions

Application Brief



*A key part of determining a mobile device's battery run time is validating the battery's capacity and energy under dynamic end-use loading conditions.*

Once you have validated a battery's stated capacity and energy ratings based on data sheet conditions, you also need to validate them under dynamic loading conditions that reflect the actual end-use. Just as higher constant current discharge rates lead to reduced capacity and energy obtained from a battery, high peak pulsed dynamic discharge currents also yield lower capacity and energy compared to an equivalent constant current discharge having the same average value. The amount of peak pulsed discharge that can be tolerated is highly dependent on the battery's design. Because of

this, you must validate the capacity of the battery under consideration under dynamic loading conditions reflecting the actual end-use as part of optimizing the battery run time of a mobile wireless device.

*Validating a battery's capacity and energy for end-use loading conditions requires you to accurately log voltage and current while reliably recreating the dynamic end-user loading conditions.*

Just as with static charging and discharging, small differences in dynamic loading conditions for discharging can lead to large differences in the capacity and energy obtained from the battery. Non-linear time-variant battery

behaviors will yield different capacity and energy results, which are caused by differences in dynamic loading. Consequently, you need an accurate dynamic load profile for discharge. Using the actual mobile device provides the most realistic dynamic loading profile but has some drawbacks. Often it is difficult to reliably create the necessary conditions for the device to have it operate in the desired fashion, and usually there can be significant variance when doing this on a repeated basis. A solution for doing this on a repeatable basis is to capture the device's dynamic current drain over an appropriate period and then play it back with an electronic load that will support this type of operation, to discharge the battery.

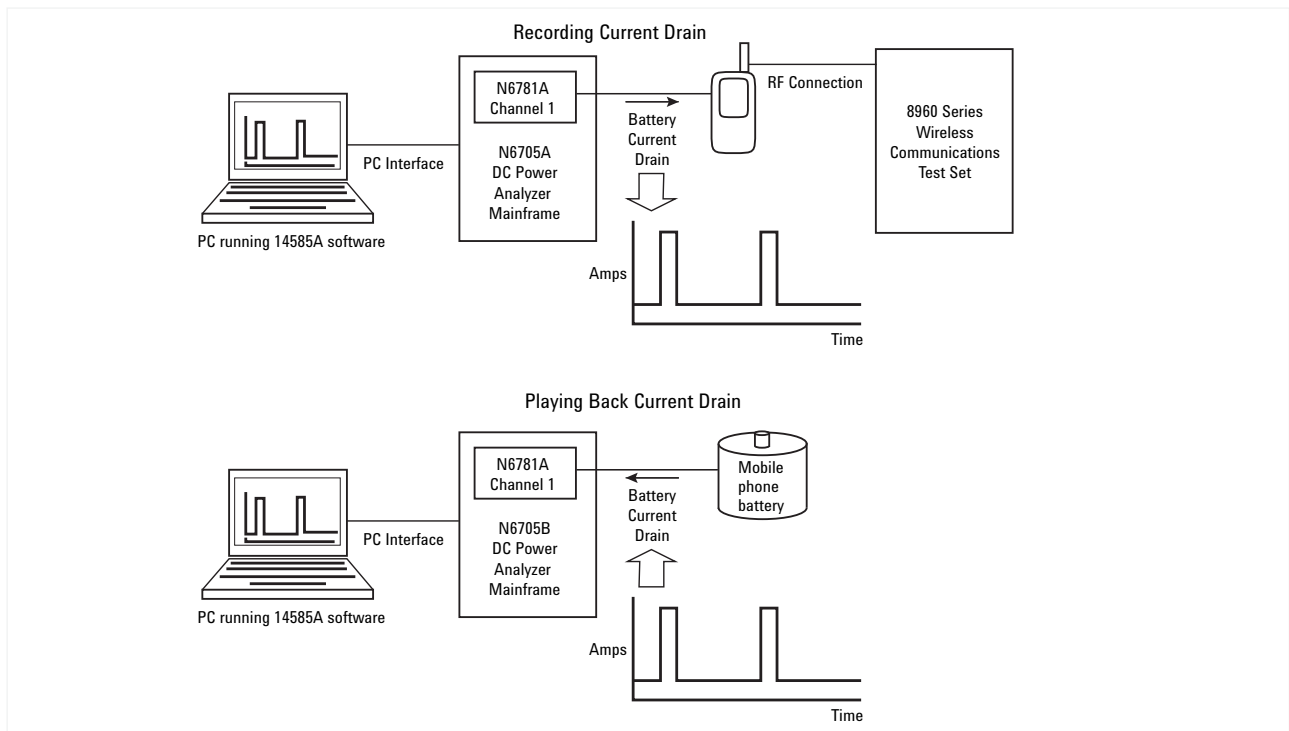


Figure1. Recording and playing back a device's current drain to discharge a battery.

*Example of validating a battery's capacity and energy ratings by recording and playing back end-use load conditions.*

We used the setup depicted in Figure 1 to first power and capture an active-mode current drain profile on a GPRS smart phone and then play the captured profile back as a dynamic current load over an extended period to discharge a battery. We used the Keysight Technologies, Inc. N6781A source/measure unit as it features full 2-quadrant operation making it useful as a both a high-performance DC

source and electronic load, addressing both steps of this application. Its biggest benefit, however, comes from being able to digitize its output current profile when sourcing power and then use this same profile as a dynamic arbitrary waveform input when it is operated as a load. Utilities in the N6705B DC Power Analyzer mainframe and 14585A software further simplify and streamline this task.

We then validated a rechargeable Lilon battery rated for 1-Ah and 3.6-Wh. You can see the results in Figure 2. The resultant 0.856-Ah capacity and 3.22-Wh energy values

obtained by playing back the 2-A peak, 0.3-A average current drain profile captured on the mobile phone were slightly lower than the 0.879-Ah and 3.32-Wh values obtained using an equivalent 0.3-A constant current discharge. The battery's pulsed capability is well matched to its intended end-use. The impact becomes much more prominent with higher peak discharge rates and with many high-energy-density primary (non-rechargeable) batteries. As you can see validating the battery under end-use loading conditions is a key part of determining the run time of a mobile device.

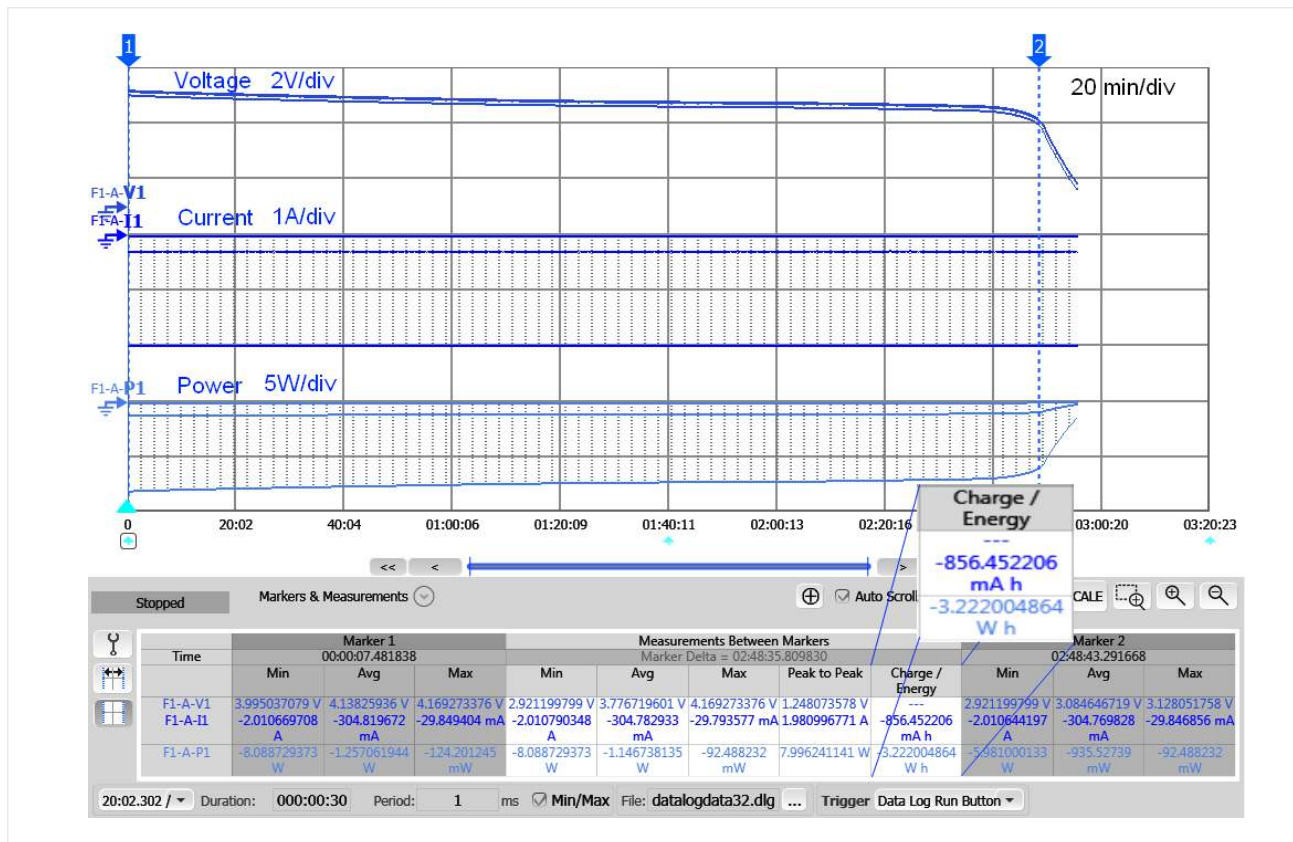


Figure 2. Measuring battery capacity under end-use pulsed loading condition.

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