

Keysight Technologies

Simplify Validating a Battery's Capacity and Energy Ratings

Technical Overview



A key part of determining a mobile device's run time is validating the battery's capacity and energy ratings.

If you determine a device's run time based solely on a manufacturer's data sheet without validating the battery's capacity and energy ratings, your results are bound to be inaccurate. The stated capacity is often based on ideal conditions and represents the maximum charge you might obtain from the battery.

Actual capacity will usually end up being less when you verify it in your application.

Battery capacity is the amount of charge in ampere-hours (Ah) or milliamp-hours (mAh) the battery is specified to hold. This is different from the battery's energy rating, which is in watt-hours (Wh). You can determine the energy rating by taking the product of the battery's capacity (Ah) times its stated nominal voltage (V). As the

battery's actual energy content can be more a factor in a mobile device's run time than the battery's capacity, it is important to validate both of these values.

Temperature and battery age also affect how much charge might be obtained from the battery, so you also need to consider these factors when you determine the run time that can be expected for the mobile device.

Validating a battery's stated capacity and energy ratings requires accurate voltage and current logging under precisely controlled conditions.

Very small differences in charging (for rechargeable batteries) and discharging conditions can lead to large differences in the capacity and energy obtained from a battery. That is why it is paramount to precisely replicate and control all conditions for achieving good results. One key condition is the discharge rate, usually stated as a con-

stant current discharge at some ratio of the AH capacity rating, referred to as the C rate. A manufacturer may specify a discharge C rate of 0.3, for example, as higher discharge rates lead to lower capacity and energy delivered from the battery. A C rate of 0.3 would theoretically fully discharge the battery in 3.33 hours. For a 2-Ah battery, a C rate of 0.3 would be 0.6 A constant current discharge. It is also worth noting that the measured energy rating can differ from that based on the stated nominal voltage, as the actual battery run down voltage profile may lead to a slightly different result. Precisely controlling test conditions while accurately logging both the battery's current and voltage assures accurate and consistent results when determining the battery's capacity and energy ratings.

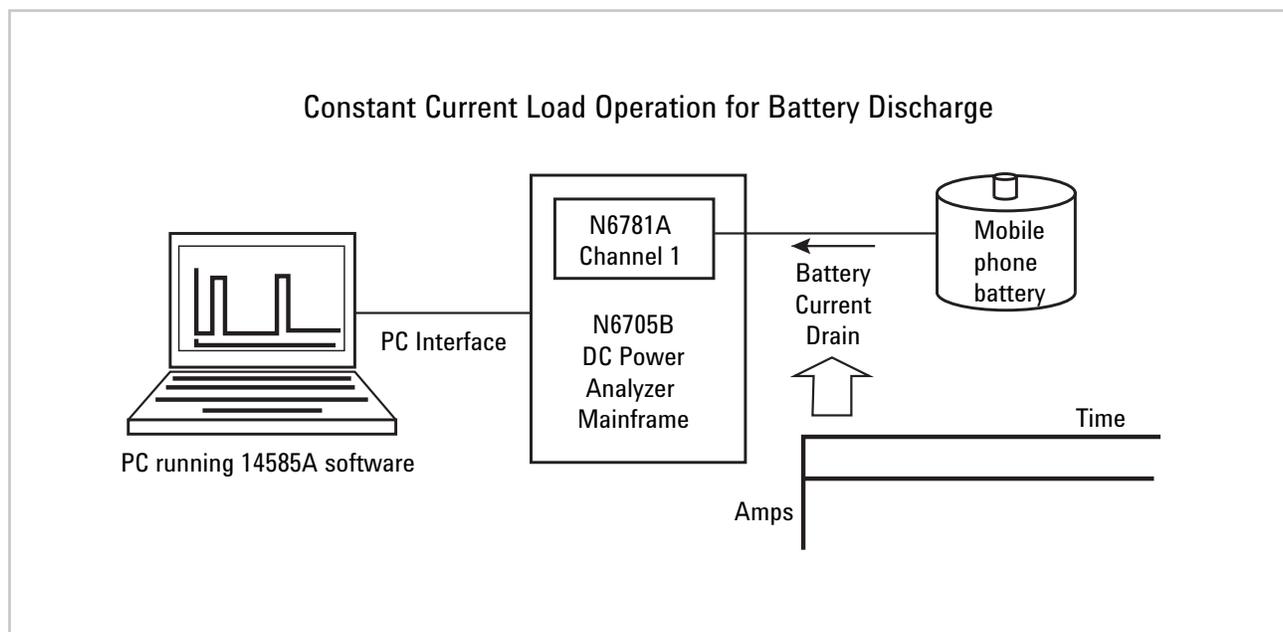


Figure1: Using a constant current load to discharge a battery at a fixed C rate.

Example of validating a battery's capacity and energy ratings:

We used the setup depicted in figure 1 to discharge a rechargeable mobile phone lithium ion battery at a fixed C rate. The full 2-quadrant capability on the Keysight Technologies, Inc. N6781A source/measure unit makes it well suited for use as a precision high-performance electronic load as well as a precision DC source. A constant current discharge of 0.3 A with 3.0-V cutoff voltage and long-term data logging for validating the capacity and energy ratings were quickly set

up and displayed using the companion Keysight 14585A software. The results of validating the capacity and energy ratings the battery are shown in Figure 2. Placing measurement markers at the start and cutoff voltage points on the data log revealed the battery delivered 879 mAh and 3.32 Wh. Both of these values were notably lower than 1 Ah and 3.6 Wh ratings obtained from the battery's data sheet. The next steps are to identify what factors lead to the difference and then assess if additional capacity can be extracted from the battery or not. As can be seen, it is best not to assume the battery's rated

capacity and energy are what you will get, making it important to validate them as part of determining run time for your product.

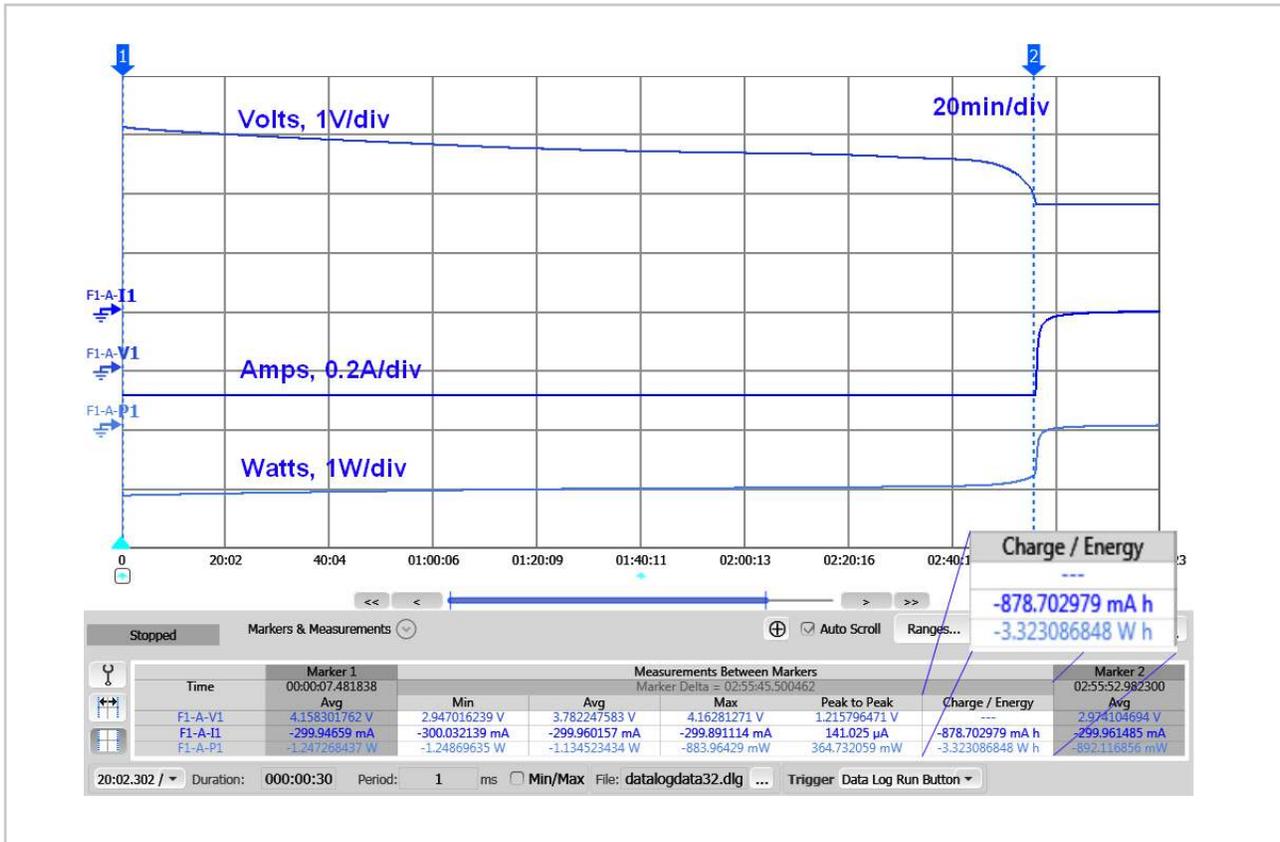


Figure2: Measuring a battery's capacity and energy using the 14585A software.

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