



Author
Bob Zollo,
Keysight Technologies, Inc.



HOW TO CHOOSE THE RIGHT BATTERY FOR YOUR NEXT WIRELESS APPLICATION

Finding the right battery to achieve the right runtime for your wireless device is not a simple topic. By no means does this article claim to be an exhaustive treatment of every detail of every step, but this article will provide an overview to the entire subject so that you can use it as a template for your selection process.

First, you must consider the power demands of the device and the desired runtime.

By taking the average current you expect to draw from the battery and multiplying it by the number of hours of desired runtime, you can calculate the capacity of the battery you will need.

Note that this is only a rough estimate. Actual performance conditions, such as operating temperature, peak current, and duty cycle (ratio of peak current to quiescent current), will impact how much total energy (i.e., capacity) the battery will deliver to the device and therefore impact runtime.

In other words, even though a widely varying dynamic current can be represented by a single average current, the capacity that the battery delivers in response to a widely varying dynamic current will not be the same capacity that the battery delivers in response to a constant current equal to the mathematical average of the dynamic current.

For example, if your device requires 180 mA average current, and you want it to run for 10 hours, you would need a 1800 mAh (milliamp-hour) battery. If your device pulls 1.7 A peak currents for 10% of the operating time and 10 mA for the remaining 90% of the time, while this averages to 180 mA, you may not achieve that same 10 hours of runtime from an 1800 mAh battery (depending on the battery chemistry and discharging duty cycle timing).

The next step is to select a candidate battery based on the manufacturer's data sheet for the battery.



Then, you would need to evaluate how well a battery performs relative to its data sheet. Depending on the battery and the manufacturer's quality control processes, you may find that there are inconsistencies within and between batches of batteries. The manufacturer may not specify this spread in performance, so you may have to set up a standard suite of tests to verify the battery spec sheet for a sampling of batteries. From this statistical data, you can determine the range of variation. You should select a battery based on the worst case capacity out of the samples analyzed. Any battery you receive with greater than worst case capacity will just mean extra runtime for your device.

In addition to testing across batches, you will probably want to test at various conditions (discharge rates, recharge rates, and temperatures) to create profiles of how the battery will respond under different operating conditions. It is relatively easy to find test equipment to implement a standard suite of tests on a battery. Specialized battery test systems provide turnkey software that allows you to set up typical tests to measure battery performance and capacity. (See **figure 1**.)

The test data is stored in a database that allows you to generate the statistics needed to look at variation within and across samples. This testing will yield your own verified version of the manufacturer specs.

TYPICAL BATTERY TESTS PERFORMED BY TURNKEY BATTERY TEST SYSTEMS

Voltage vs state of charge
This is typically a family of curves with each curve generated at various discharge rates while holding temperature constant
-OR-
with each curve at a specific temperature while holding discharge rate constant

Capacity vs temperature
This is a family of curves at various temperatures holding discharge rate constant

Capacity vs discharge rate
This is a family of curves at various discharge rates holding temperature constant

Capacity vs number of charge-discharge cycles
This is also known as a cycle life chart and is a curve generated at a given charge rate, discharge rate, and temperature

Internal resistance vs number of charge-discharge cycles
This is a curve generated at a given charge rate, discharge rate, and temperature

Internal resistance vs state of charge
This is a curve generated at a given temperature

What is most important is how the battery will operate under the real world conditions that it will experience when it is used in the final device as it is operated in the user's real use case.

Of course, there may be multiple use cases for the wireless device. For example, if the device is a smartphone, the real use case will vary by user, so it is up to the device designer to create one or more appropriate use cases. Each case would include a sequence of talking, texting, accessing webpages, streaming video, playing games, and listening to music. The amount of time spent on each task would vary between use cases, resulting in some use cases that have high current demand and some that are less demanding.



Figure 1 List of typical battery tests performed by turnkey battery test systems

This kind of testing to see how the device will really deplete the battery is known as a battery rundown test. This is the most difficult test to implement. To perform a battery run down test under real world conditions, you have two options.

1 You can test the battery in the real operating environment while it is providing power to the wireless device. In this test, the wireless device is operated in the desired use case and the battery is run down starting with a fully charged battery. During the test, you continuously measure and log current flow between the battery and the wireless device and continuously measure and log voltage across the battery. With these two measurement waveforms, you can see the real dynamic current flowing from the battery and you can see the resulting battery voltage as it runs down during wireless device operation. This will give you the most realistic assessment of battery runtime.

2 Similar to option 1, except in this case you can test the battery using a simulation of the wireless device to run down the battery. The wireless device is simulated by an electronic load that is continuously reprogrammed to draw the same dynamic waveform as the wireless device would draw during the specific use case that you are trying to test. While this is just a simulation and may not give the most realistic assessment of runtime, this method gives you the most flexibility as the simulation can be easily reprogrammed to simulate different use cases.

See **figure 2** for an example of an instrument that can perform either of the above battery rundown test options.



Figure 2 The Keysight N6705C DC Power Analyzer, outfitted with a Keysight N6781A Battery Drain Analyzer module and BV9201B PathWave BenchVue Advanced Power Control and Analysis Software, provides a complete instrumentation solution for performing battery rundown tests.

In summary, battery selection consists of finding the right battery, verifying its specs to understand variability within and across batches and across manufacturers, and finally measuring its actual runtime under real world conditions.

To learn more about Keysight N6705C DC Power Analyzers and N6781A Battery Drain Analyzer [CLICK HERE](#)