Nomadic products put power sources to the test

Power sources substituting for batteries must respond unlike conventional supplies.

By Alex Mendelsohn, Contributing Technical Editor -- Test & Measurement World, 3/1/2008

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Cellphones and other wireless communications devices can be difficult to test because of the dynamic requirements they place on their batteries. To conserve power, these devices rapidly switch into high-power operation and then drop back into lower-power idle, power-down, or hibernation sleep modes. As a result, the power sources that substitute for batteries during test and evaluation need features that often aren't available in general-purpose supplies.

Laboratory power supplies can act as substitutes for electrochemical power sources during tests, but because battery-charger circuits also need to be evaluated, programmable sources are a must. In addition, specialty power supplies offer features such as intelligent control of output voltage ramp-up and ramp-down, datalogging, and waveform generation, as well as the features of instruments such as precision ammeters and voltmeters. You may also need a programmable electronic load in order to evaluate battery discharge characteristics.

Circuits respond to a fully charged battery differently from the way they respond to one that has a low level of charge or is completely discharged. "The trend is toward lower-voltage circuitry and longer operation between recharge," said Bob Green, senior market development manager at Keithley Instruments. "It's driving designers to decrease the minimum voltage at which devices will operate before they automatically turn off to prevent damage."

"You can no longer simply select any convenient bench supply that provides the right mix of voltage and current," said Green. "You need supplies optimized to operate with resistive loads. General-purpose power supplies, even if they're designed to operate across a range of loads, aren't suitable."

Dynamic loads

Capturing waveforms, such as a cellphone's voltage levels during a start-up sequence, also requires instrumentation that can record and display rapidly changing voltages and currents as well as transients. Determining the type of current pulses a battery-powered device under test (DUT) draws is essential. In most cases, pulse magnitude, rise times, fall times, and frequency need to be measured. "A supply's voltage droop and recovery must be ascertained, based on the amount that will cause a DUT to fail the test or shut off," noted Green.

Cellular telephones, in particular, impose burdens on a power source's dynamic response. The North American IS-54 cellular standard uses frequency-division multiple access (FDMA) and time-division multiple access (TDMA), with RF transmissions allocated in time slots of 6.67 ms. European GSM FDMA/TDMA cellphones transmit in slots as short as 576 µs.

For both standards, when a cellphone switches from standby to full power, its current draw can increase by as much as 1000%. Unfortunately, conventional supplies are usually specified for about a 50% change in current. What's more, while a battery's voltage will decrease slightly by the value of the IR drop across the battery's internal resistance, a conventional bench supply can cause a greater internal voltage drop, sometimes more than 1 V.

For circuits that operate at full power for short intervals, such as a cellphone's power-amplifier stage, a full-power event can be over before a conventional power supply recovers. If the supply can't recover quickly, the performance of the DUT can be compromised.

"Many bench supplies can take milliseconds to recover to their original voltage level," said Green. "If the supply voltage drops below the threshold of a cellphone's low-battery detection circuitry for a sufficient amount of time, for example, the phone may turn off during testing. That would give a false indication of a failed device."

Control and power monitoring

To get around those kinds of problems, instrumentation companies offer specialized power sources. Keithley, for one, has a number of GPIB-equipped power supplies providing both voltage control and power monitoring. Keithley's dual-channel Model 2306-VS battery/charger simulator, for example, with external triggering, can be used for development as well as high-speed production testing of DC battery-operated products such as cellphones, RFIC power amplifiers, and other precision components that require a DC voltage supply. The 2306-VS is priced at about $3500.

Intended for testing battery-operated products, Keithley's dual-channel externally triggered Model 2306-VS battery/charger simulator has ultra-fast transient response to provide output characteristics identical to actual batteries delivering pulsed loads.
Courtesy of Keithley Instruments.

Similarly, the company's multichannel Series 2600 System SourceMeter instruments are scalable, high-throughput power sources that deliver precision DC, pulses, and low-frequency AC. Keithley claims its Series 2600 instruments, which carry price tags of about $4000 to $5000 per channel, operate from two to four times the test speed of typical supplies used in I-V functional test applications.

These automated supplies can be used to test devices that undergo substantial load changes for short time intervals. They can simulate a battery's response during a large load change by minimizing drops in voltage and then recovering to within 100 mV of the original voltage in 40 µs or faster. They can also simultaneously measure short-pulse load currents.

Some of Keithley's programmable DC sources, with internal resistance values that can be set from a dead short to 1 O, can also simulate a battery's internal resistance. Onboard analog-to-digital converters, used to measure voltage across precision internal shunts, also do double duty as external digital multimeters (DMMs). Keithley's multi-quadrant instruments, able to source both positive and negative voltage and current, can also sink current, taking on the characteristics of a discharged rechargeable battery to support test of battery-charger circuits.

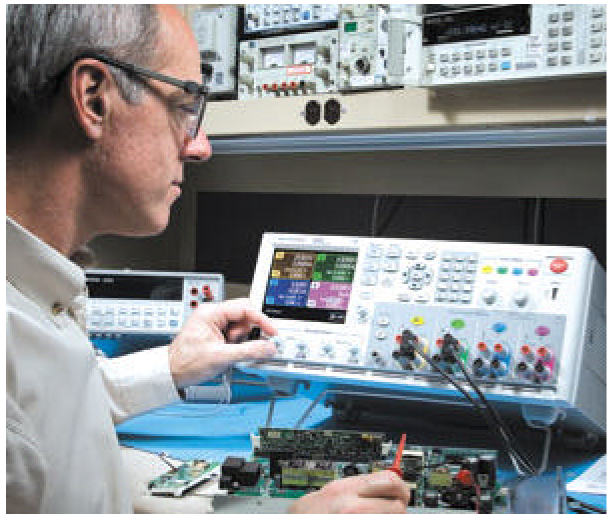
Running embedded test script processors (TSPs), the Keithley systems are designed to lower GPIB traffic. Test scripts are available for sweeping, pulsing, and generating waveforms, as well as for performing common component tests. These Basic-like sequences run in real time on microprocessors within the instruments, rather than on host computers, although users can customize the canned routines by using a PC-hosted Keithley tool called Test Script Builder.

Keithley's instruments include nonvolatile storage that can save up to 50,000 lines of TSP code and more than 100,000 readings. A single TSP, running on a master unit, can also control and acquire data on as many as 32 channels in larger test suites.

No user programming required

Some vendors eschew user-programming or manual setup entirely. Agilent Technologies, for example, has an extensible DC power analyzer that performs DC sourcing and measurement without the need for any coding. The $6500 N6705A analyzer is intended to streamline setup and shorten the time it takes to view critical sequences such as turn-on and turn-off timing and startup or in-rush current.

The instrument, which can measure applied DC voltage and current draw of a DUT, combines up to four DC power-supply modules, a DMM, a recording oscilloscope, an arbitrary waveform generator, and a datalogger. The N6705A displays voltage or current over time, and its front panel gives the user access to sourcing and measuring functions. Outputs are selected with color-coded pushbuttons, and output terminals are color-coded, as is the display.



Requiring no programming, the N6705A combined analyzer and power source from Agilent Technologies measures DC voltage and current draw of battery-powered products. The instrument houses multiple power-supply modules, a DMM, a recording oscilloscope, an arbitrary waveform generator, and a datalogger. Courtesy of Agilent Technologies.

Built-in logging features can store a few seconds-worth of data, to as long as days or even weeks of data. The analyzer can throttle ramp-up and ramp-down rates, for example, or generate transients and disturbances to see how a device might respond under stressed or worst-case conditions.

Bob Zollo, manager for power products at Agilent's Basic, Emerging, and System Technologies Division, explained that because the N6705A includes so many instrument functions, it simplifies test-system setup: Users don't have to cobble together a test system based on a datalogger or DMM, and they don't need to gather shunts and transducers, cable the system, connect it to a PC, and then program it. He observed that if you built your own test system, "You could spend more time creating the software and debugging the equipment than you would running your tests."

Agilent's analyzer is based on 1U-sized multiple-output programmable switch-mode supplies. These can change voltage in 160 µs and deliver DC with just 5-mVp-p noise. An N6705A can accept from one to four power modules ($450 to $2250 each), totaling up to 600 W. The auto-ranging analyzer also includes 50-kHz 4000-point digitizers for measurement purposes.

Agilent's power analyzer and source is also compliant with LXI Class C specs and can be driven across any 10/100BaseT Ethernet LAN through a Web browser. Agilent's product can also be connected directly to a PC using USB 2.0 or GPIB.

Built-in processing

Some vendors rely on built-in processing horsepower, rather than host computers, to handle battery analysis. Kepco's switcher-based BOP series of instruments, for example, are four-quadrant programmable voltage and current supplies.

Equipped with graphical LCDs, the BOP power supplies can handle as much as 1-kW of DC power bidirectionally. The six models in the series accommodate voltages from ±10 V to as high as ±100 V and are useful for testing higher-powered systems such as portable tools or automotive electrical systems.

The BOP architecture simultaneously clocks three microprocessors. One is dedicated to the instrument's user interface, another accommodates GPIB, RS-232/RS-485, and multi-instrument IEEE 1118 bus transactions, and the third oversees analog functions. All three communicate internally over a 56-kbps full-duplex optically isolated serial bus.

BOP sources, priced at about $2100, are equipped with 320x240-pixel monochrome displays that dynamically depict analog and digital representations of output voltage and current. As four-quadrant supplies, they can source and sink current, so they're suitable for exercising batteries as well as for characterizing devices such as photovoltaic arrays.

Azimuth Systems is another company offering hardware and software to measure power, specifically for battery-powered WiFi devices. The company's Azimuth Battery Life Performance Test, priced at about $6000, works with its W-Series hardware platform.

Azimuth's hardware and software lets you test the time it takes a battery to run to exhaustion. In operation, you can put a DUT into different operational modes during a test run of realistic scenarios. The software will help determine how a battery-powered product such as a cellphone will actually be used, delivering metrics revealing actual standby and talk times.

Electronic loads

In some cases, test executives and automated test systems can be overkill. For many tests, all that's needed to ascertain battery suitability is a controllable load. Xantrex Technology and B+K Precision count among companies making electronic loads.

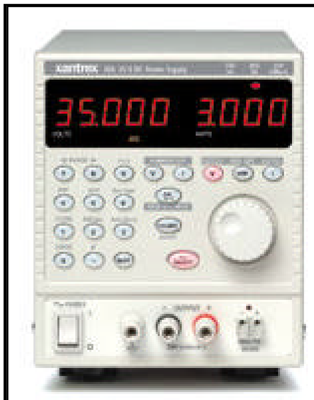
Programmable DC loads can be used for power-supply, battery, and DC-to-DC converter testing and calibration. The Model 8500 from B+K Precision can load a circuit between 0 and 120 V DC, sinking from 1 mA to as much as 30 A. Courtesy of B+K Precision.

B+K Precision's Model 8500 DC load, selling for about $1000, is programmable across an RS-232 or optional USB interface. Equipped with a vacuum-fluorescent display, the Model 8500 can be set anywhere between 0 and 120 V, sinking from 1 mA to as much as 30 A, under a 300-W maximum profile. The instrument is overcurrent, overvoltage, over-power, and overtemperature protected.

For higher power levels, Xantrex offers the SL Series Sorensen-brand loads in modular and rack-mount configurations that can dissipate as much as 1.8 kW. These loads lend themselves to battery and battery-charger testing as well as to characterization of high-power fuel cells, inverters, AC-to-DC and DC-to-DC converters, and voltage-regulator circuits.

Like Kepco's BOP sources, the SL Series loads can be operated from the front panel, via GPIB or RS-232 links, or under analog control. Pricing for chassis housing multiple modules starts below $5000.

For applications that require low noise and programmability, Xantrex offers its XDL linear sources, which typically exhibit less than 0.35-mV RMS voltage noise and less than 0.2-mA RMS current noise. For production line testing, XDL boxes can store up to 10 setups in nonvolatile memory, with preset overvoltage and overcurrent trips. XDL Series supplies also offer remote sensing, which can be useful when measuring heavy currents.



As quiet linear sources, remote-sensing power supplies from Xantrex exhibit less than 0.35-mV RMS voltage noise and less than 0.2-mA RMS current noise. Courtesy of Xantrex Technology.

Xantrex product marketing director Jason Lee said that for power levels ranging from 1.2 kW to 3 kW, customers typically choose switchers as alternatives to heavier and more costly linears. Some Xantrex switchers cost less than $1300. Based on so-called zero voltage switching (ZVS) technology, these moderately priced sources are claimed to exhibit ripple and noise comparable to linear supplies, and they respond rapidly to transient loads. Xantrex also offers the DLM line, which includes 600-W models that deliver outputs adjustable from 0 to as high as 300 VDC, at currents adjustable from 0 to as much as 75 A.

While ordinary lab supplies can sometimes substitute for batteries, today's programmable power sources, with intelligent features and built-in instruments, can simplify and speed up testing. Simulating a battery's performance accurately requires power supplies with bandwidth sufficient to minimize voltage drops during large current transients, as well as circuitry capable of emulating the impedance of a battery. Voltage and current stability, including freedom from oscillation, overshoot, and undershoot, are essential ingredients that the latest generation of power sources can deliver.

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