APPLICATION NOTE

Keysight Solution for Power Storage and Conversion Testing

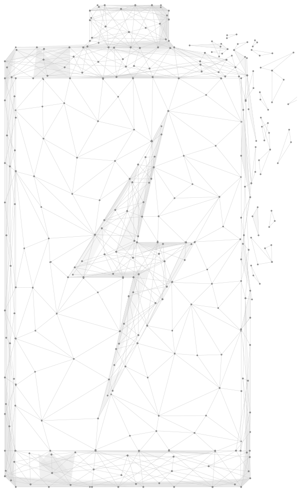
Introduction

The world is experiencing an evolutionary transformation in power storage and power conversion. These developmental changes will impact the technology that surrounds us — from electric cars to portable medical devices to IoT smart devices. Every electronic device you use shares two standard processes — power storage and power conversion.

Power originating at your local power plant traverses the grid and arrives at your wall outlets at home. Your wall chargers transform the AC power into energy stored inside batteries. These batteries could be high capacity used in electric vehicles or low capacity found in a wireless baby monitor. The process of power conversion now takes over.

The energy from the battery is converted and distributed to various power functions within the device. For example, this conversion makes it possible for your vehicle to drive autonomously. The processes of power storage and power conversion are the fundamental building blocks to enable power storage technology, whether it is a simple LED flashlight or an autonomous vehicle.

A walk through an airport terminal explains why power storage and power conversion are taking center stage in the tech world. The travelers in an airport crowding the charging stations and wall outlets indicates that today's devices lack a robust battery life. Our portable smart devices can stream and download HD movies seamlessly in a matter of seconds with 5G. Despite this speed, most of these devices still cannot last 24 hours on a single charge.



While streaming rates and download speeds have improved tremendously, power has not improved. Engineers are currently researching new techniques and technology to increase power, efficiency, power conversion, and storage. Power is essential to the design of any portable electronic device across all industries. Significant improvements in power storage technology such as battery capacity and improving the efficiency of power conversion processes will improve the performance and functions of today's devices.

Devices

Battery-powered devices such as fitness trackers, wearable medical sensors, and smartphones are at the core of this evolutionary transformation. The improvement in power storage and power conversion means a new generation of devices with robust batteries will be available.

Imagine a smartphone that runs for an entire week on a single charge while performing power-intensive processes such as downloading high-definition (HD) movies over 5G. Wireless medical sensors that run for days or even weeks — the doctor can monitor the patient due to sensors that never go offline. How about envisioning an electric car that can travel 1,000 miles on a single charge? These are just a few examples of future possibilities.

Power and Storage

A test solution that helps you to measure and analyze data with uncompromising ease and accuracy is key to power storage and conversion advancement. Batteries and DC-DC converters are bidirectional devices that can source and sink power. You need an advanced test solution with integrated sourcing and sinking capabilities to refine your design further.

Figure 1 shows a typical test setup for a DC-DC converter with a power supply connected at the input and an electronic load connected at the output. These two connections are necessary, so you know how the input conditions affect the output conditions.

It is a simple yet powerful cause and effect analysis. For example, an observation that a specific converter operates at near 100% efficiency with the input at 80% of input voltage rating could significantly improve the design of your device. This might lead to power efficiency gains that outperform all market competition. An advanced bidirectional power test system is the fundamental building block to achieve this level of insight.

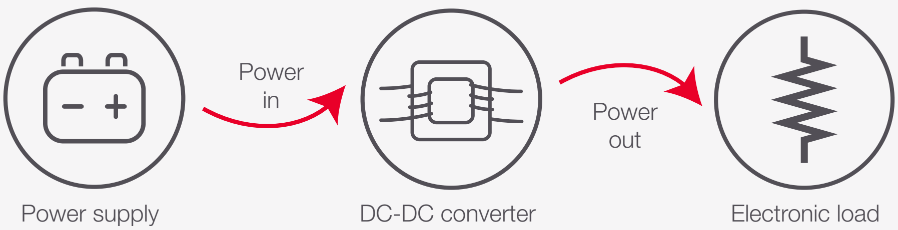


Figure 1. Basic DC-DC converter test setup — the power supply provides power at the input while the electronic load pulls power at the output

Key Challenges

Bi-directional power

There are simply not enough bidirectional power test solutions available that sources and sinks. A traditional test setup requires two distinct sets of test equipment: a programmable power source and a programmable load. The power source is an entirely different instrument than the electronic load. For example, instruments by several vendors may communicate through different interfaces or command languages. Also, two different instruments often take up more bench or rack space.

Timing and synchronization

Timing and synchronization are challenging while programming a source and a load from two different instruments. For example, cycling a battery follows a sequence of events that involves the source and loading instruments to recognize when to turn on / off in an alternating protocol. Testing a DC-DC converter demands a similar level of synchronization. This process requires the input source to undergo a unique sourcing pattern, and the load needs to recognize when this process occurs.

Simultaneously controlling two separate instruments is difficult even when the source and load reside in a single platform with standard communication interfaces. Performing this process with the source and load as two different instruments that host different communication interfaces and incompatible programming languages is challenging.

Sequence workflow

You can create a test sequence workflow to automate the process hundreds or thousands of times. This test allows you to assess how the capacity of a battery will change over time through hundreds of charge cycles. Understanding how the specific chemistry of the battery is affected by the charge cycles is essential to improve your battery storage.

For example, in a small device like a smartphone, there are dozens of DC-DC conversions processes happening at any given time. Automation plays a crucial role in decreasing the amount of time to configure the instrument and to test each conversion process. This means a power test solution must provide advanced hardware functions, including software and automation options.

Solution

The Keysight N6705C DC power analyzer (Figure 2) offers both programmable power supplies and electronic loads in a single 4U bench platform. This bench mainframe provides five instrument functions in a single instrument: power supply, voltmeter / ammeter, oscilloscope, arbitrary waveform generator, and data logger. The N6705C offers over 30 power supply modules and two electronic load modules to give you the flexibility to create a customized test system. Power supply modules offer a wide range of performance levels from basic to advanced. The 100W (N6791A) or 200W (N6792A) electronic load modules offer four modes of operation: constant voltage, constant current, constant power and constant resistance. The platform also comes in a 1U mainframe for an automated system test.

The N6705C DC power analyzer makes source and sink testing easy because both power and load instruments are in a single integrated platform. You can easily program the N6705C power analyzer with a power source and electronic load. You can efficiently charge and discharge a battery, analyze the efficiency of a DC-DC converter, or measure the transient recovery on a power supply.

Figure 2. Keysight N6705C DC power analyzer provides five instrument functions in a single instrument — power supply, voltmeter / ammeter, oscilloscope, arbitrary waveform generator, and data logger

Once the test sequence is final, the entire process is automated using the Keysight BV9200B advanced power and control analysis software. The software's design provides fast and easy access to the advanced sourcing and measurement capabilities of the N6705C DC power analyzer. It also offers an automation feature that allows tasks such as data capture and output waveform creation to be automated. Once a test routine is determined, the test engineer can use the API library to recreate and run the test routine numerous times without any user intervention.

Figure 3 shows the source and sink function of the N6705C DC power analyzer with a power supply in channel 3 (blue trace) and a load module in channel 4 (pink trace). In this setup, a supercapacitor connects to both the power and load modules. The software controls both charge and discharge cycles. The Keysight BV9200 advanced power and control analysis software captures voltage and current measurements at both the power supply and load.

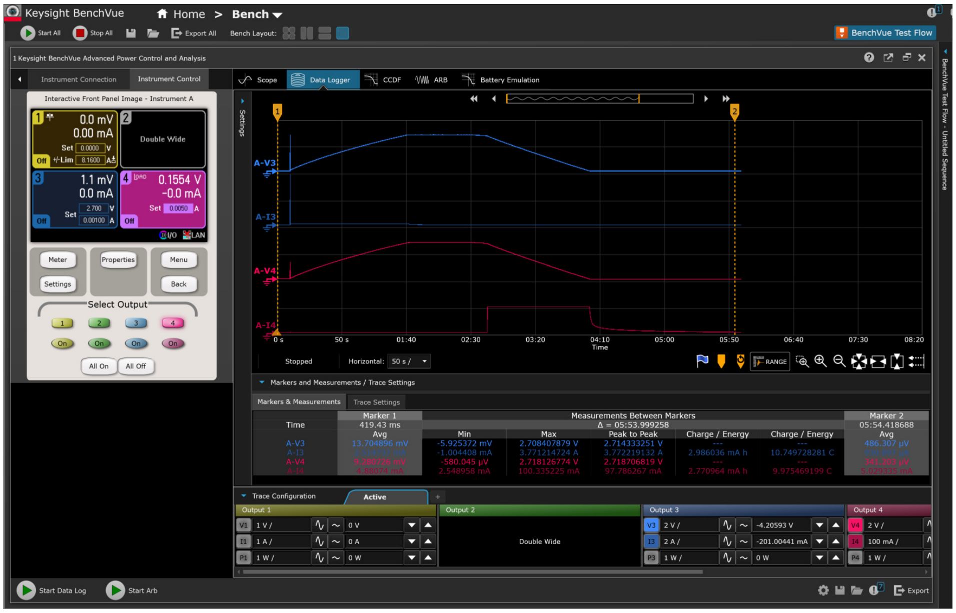


Figure 3. Keysight's BV9200 advanced power and control analysis software captures voltage and current measurement during the charging and discharging sequence of a supercapacitor connected to the Keysight N6705C DC power analyzer

The power system offers a standard SCPI command set consistent between both power and loading operations. The N6705C DC Power Analyzer meets the most demanding test challenges necessary for your future innovations.

To learn more, please read

Keysight N6700 Modular Power System Family – Data Sheet

Easily Test DC-DC Converters Using the Keysight DC Power Analyzer – Applicate Note

How to Optimize Power Supply Testing Using the Keysight N6790 Series – Application Note

Electronic Load Fundamentals – White Paper

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