CASE STUDY

Implantable Medical Device Customer

Improving the Battery Life of Implantable Medical Devices

Technology evolves rapidly in the field of implantable medical devices. The need for ever smaller devices, increasing intelligence and monitoring capabilities, and minimal battery power for in situ operation drives that evolution. In addition, 100% compliance with stringent standards is essential to ensure patient safety, eliminate patient injury and legal liability, and instill trust in the device and brand. Analyzing the battery drain of an implantable medical device is essential to understanding its operating life. This analysis is a critical factor in reducing patient anxiety and inconvenience. It also helps healthcare professionals deliver optimum care to patients.

The Key Issues: Accurate Measurement and Analysis of Battery Drain Current

A battery contains a defined amount of energy, specified in watt hours, and capacity, specified in amp hours. If you know how much power you need to operate your device, you can estimate the battery life. Some medical device designers calculate battery life based on expected or measured active, sleep, or hibernate currents. In the real world, however, battery life is typically shorter than expected. One reason for this is that battery capacity changes depending on the average discharge current and the most important “on” usage pattern and current profile. Continuous and pulse currents affect the battery discharge capacity in different ways.

Company:

- Implantable medical device designer

Key Issues:

- Constant understanding of device power consumption in conjunction with new product capabilities
- Multiple sourcing of Li-Ion batteries
- Patient safety and comfort

Solutions:

- Keysight N6705C/ N6781A/14585A battery drain solution

Results:

- Increased engineer productivity to meet demanding device designs and new technologies
- Increased patient safety and comfort
- Lower legal liability
- The ability to continually address leading-edge application needs over time

KEYSIGHT TECHNOLOGIES

1,000 mAh Li-ion cell, 3V Cut-off Voltage

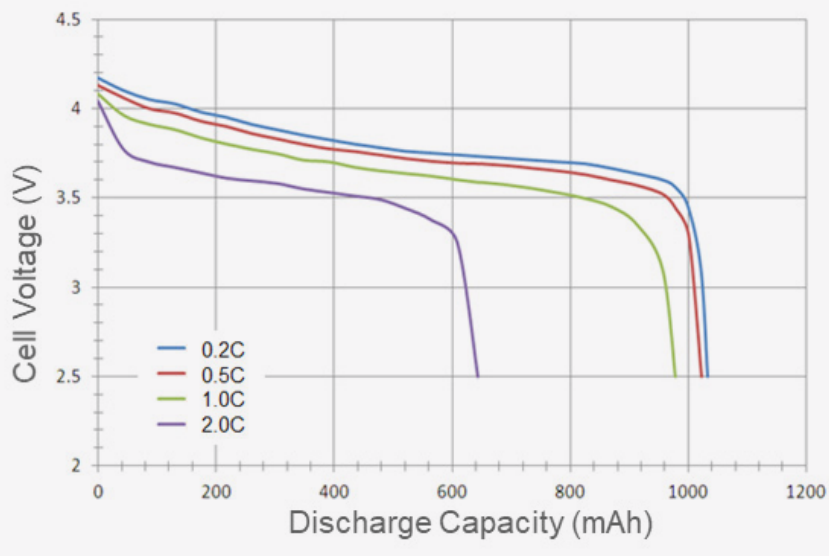
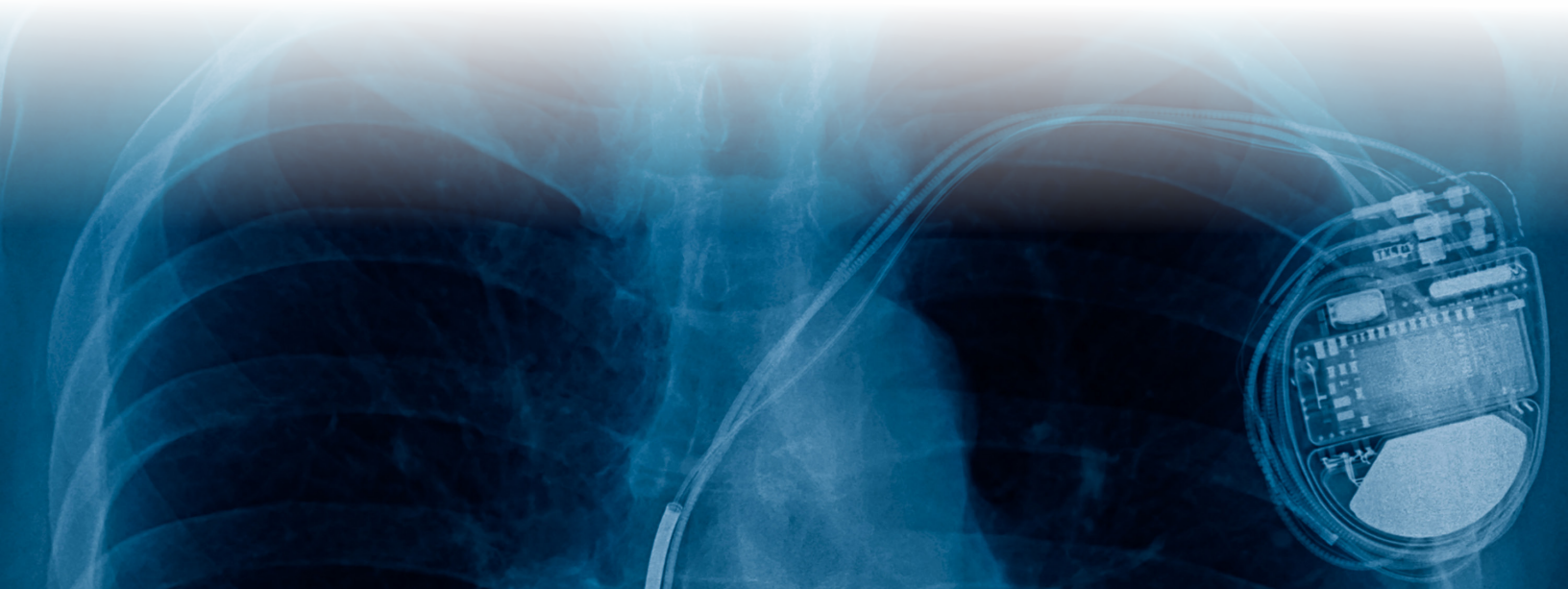


Figure 1. Lithium-ion discharge profiles

As a result, gauging an implantable device's drain on its battery requires equipment that can measure extremely low currents when the device is in hibernate mode and higher currents when the device is in active mode. Ideally, you should be able to do this measurement in one sweep. That places high expectations on the equipment to accurately measure both low and high currents without the need to change ranges. When using a power source to replace the battery during testing, the power source must be able to emulate the battery profile. Output voltage and resistance must be reprogrammed to simulate the effects of state-of-charge and battery aging.



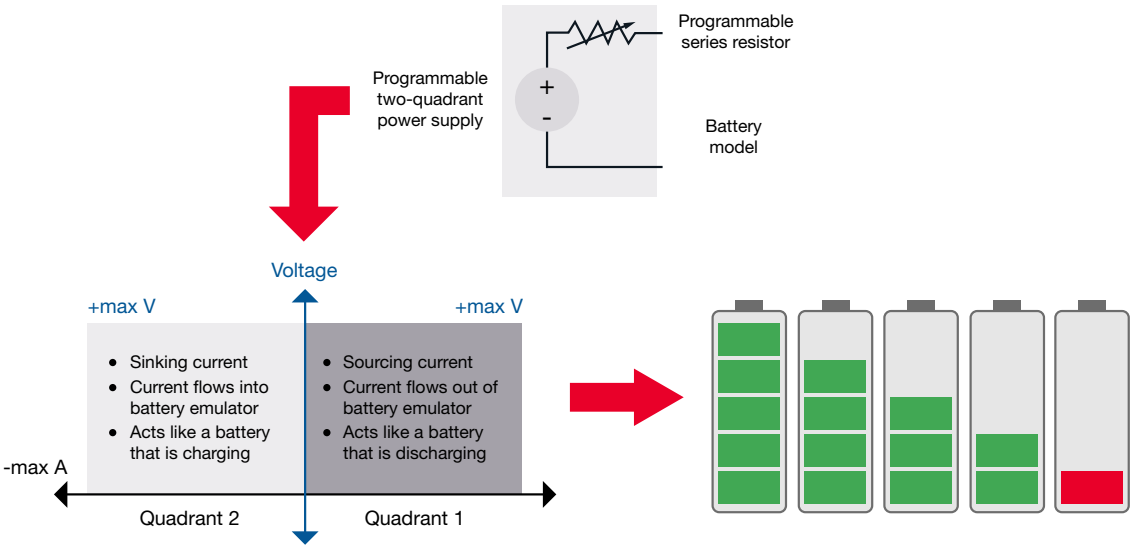


Figure 2. Battery emulator functionality diagram

Finally, the equipment needs to be able to capture voltage and current over time to simulate the full operating spectrum or use model of the device while it is implanted.

The Solution: An Integrated Keysight Solution Leveraging Patented Technology

A Keysight application engineer worked with the design engineering team at the implantable medical device manufacturer to recommend a solution consisting of hardware and software for battery drain analysis. The equipment has the core measurement capability built-in, while the software provides measurement visualization and analysis. The hardware consists of an R&D-friendly mainframe that can accommodate up to four battery-drain source / measure unit (SMU) modules.

Key solution components are as follows:

- The award-winning Keysight N6705C DC power analyzer and N6781A 2-quadrant SMU for battery drain analysis
- Keysight's 14585A control and analysis software

Solution capabilities designed for battery drain analysis met the customer's needs. In addition, Keysight provided custom software that expands battery emulation and analysis capabilities. Key capabilities that delighted this customer include the following:

- Keysight-patented Seamless Measurement ranging
  - Allows measurements of current from milliampere to ampere levels at 200 kHz with 28-bit resolution and in one sweep
- Built-in data logging
- Programable resistance for battery emulation
- Automation of battery drain test scenarios

From the customer's perspective, Keysight offered additional strength in three key areas: excellence in electronic test and measurement, an innovative product design focused on the specific test need, and exceptional application support for its current and future needs.

The Results: Trustworthy Battery Drain Analysis

The implantable medical device manufacturer is successfully using Keysight's battery drain solution in its development lab. The solution eliminated the need to specify and integrate multiple instruments that would accomplish only a subset of the necessary measurements and analyses. It has developed a battery discharge predictive model that can detect low charge with sufficient lead time and warning to reduce patient stress and frequency of doctor visits. Because Keysight's solution accurately characterizes device battery drain even for complex operating models, the manufacturer has confidence in the battery life specifications of its device. Plans include equipping labs in other locations with Keysight's battery drain analyzer solution.

Figure 3. N6705C DC power analyzer, 14585A control and analysis software, and N6781A battery drain analysis SMU module

Going Forward

Battery drain analysis is crucial to ensure that implantable medical devices have maximal battery life and predictable battery charge and replacement cycles. For companies designing complex devices for markets where real-life consequences of improper testing can lead to end-customer injury, using proper instruments and techniques to measure, test, and qualify device operation is critical.

This implantable medical device company chose the N6705C battery drain analyzer system because it can measure battery current drain with unprecedented accuracy over time. The solution's patented Seamless Measurement capability and data logging functionality provide that accuracy. The manufacturer is confident that it is detecting all levels of device power consumption under various modes of operation. As a plus, the built-in analysis capability reduced engineer time to answers, facilitating reduced project time lines. As the manufacturer's devices change or emerging technologies drive new designs, this Keysight solution will continue to empower them for the future.

Additional Resources

- **Web:** N6705C DC Power Analyzer; N6781A 2-Quadrant Source/Measure Unit for Battery Drain Analysis
- **Data sheet:** Keysight N6780 Series Source/Measure Units (SMUs), publication 5990-5829EN
- **Application note:** Five Tips for Optimizing Battery Drain on IoT Devices, publication 5992-2718EN

Learn more at: www.keysight.com

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