Powering the Internet of Things with End-to-End Battery Testing

KEYSIGHT

Introduction

Technology is advancing rapidly, transforming many aspects of society, including how we communicate, navigate, and treat diseases. The Internet of Things (IoT) is growing rapidly as there are more electronics than ever to run accurate diagnostics, more sensors to increase autonomy, and better connectivity to avoid interference. Plus, the miniaturization of semiconductor components and advancement in electronic display technologies enables consumer electronic (CE) devices to become compact.

Moving forward, battery technology will enable further advances in the IoT industry. Today's technology extends a device's battery life by using more sustainable and eco-friendly materials with superfast charging capabilities. Industries such as consumer, digital healthcare, automotive, and even agriculture are pushing the boundaries in battery development, manufacturing, and testing.

According to Precedence Research, the global market projection for IoT batteries in Figure 1 is forecasted to reach $22.7 billion by 2030, growing at a compound annual growth rate (CAGR) of 10.16% from 2022 through 2030.

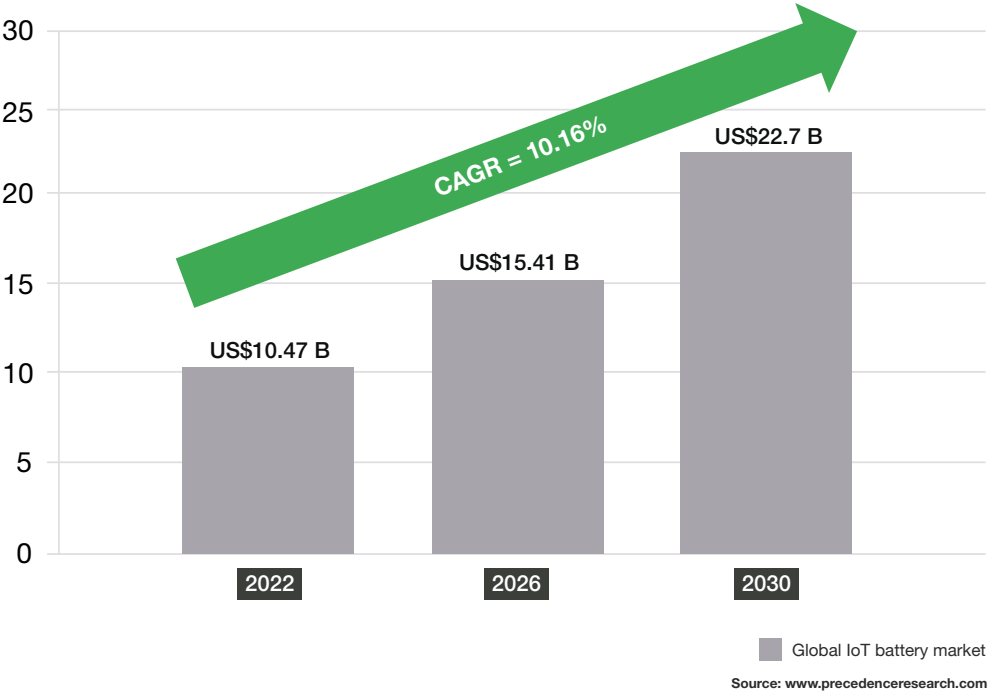This white paper discusses the key trends that are driving smart battery development.

Source: www.precedenceresearch.com

Figure 1. The global IoT batteries market is expected to reach $22.7 billion by 2030

Smart Battery-Specific Trends and Drivers

New applications for battery power

Device manufacturers in segments such as healthcare equipment and consumer electronics are transitioning products over to battery power for portability and convenience. The main drivers of this transition are longer-lasting, safer, higher-capacity, lighter-weight batteries, and more advanced chargers.

The rise of smart batteries

Smart batteries also drive the increase in battery usage in many device designs because they can track their capacity while charging, discharging, or storing. The battery communicates its status information to the device to adjust and conserve power intelligently. Consumers use their portable devices more if they have better control or know the battery level at any given time.

Innovative chemistries

Battery manufacturers continue to innovate battery chemistries to improve specific energy and power specifications to yield a longer life span, deliver better performance, enhance product safety, and lower production costs.

Longer-lasting and faster-charging batteries are always in demand, whether the use case for the device is the military, consumer electronics, healthcare, or automotive industries. The healthcare industry relies heavily on higher-quality batteries to support portable medical equipment, such as blood pressure monitors, hearing aids, cardiac support equipment, and insulin pumps. Military applications may require power in remote areas for extended periods between charges or battery replacement. Meanwhile, the automotive industry has committed to developing batteries that can boost the performance of electric vehicles.

The Power Challenge

Apart from battery manufacturers, IoT device developers must consider battery characterization when designing new devices — from design and prototyping to product development, product testing, and manufacturing. Battery characterization is one of the most important considerations for IoT devices, as it gives them a distinct and marketable competitive advantage.

IoT device manufacturers must characterize and test products in real-world environments like in the lab and network installations. Areas with low network coverage require IoT devices to repeat their transmissions to transfer data successfully. The more repetitions, the higher the power consumption and the faster the battery drain. It is critical to characterize the current consumption of IoT devices in natural operating environments and across all possible operating modes, such as active, idle, sleep, or standby.

Throughout the device design and prototyping process, a device designer keeps in mind the effects of the design and how it can affect the batteries and power consumption. Battery life estimation, done correctly during the first development steps, prevents any unnecessary design modifications in the future.

Create a realistic power management strategy

The first step to prolong battery life is to create a power consumption strategy for the device. Before committing to a design, it is essential to identify the functionality and usage of the new wireless device, recognize the hardware components and specifications, decide on the type of radio connection and thermal management, and consider software scalability, power-up timing, and sequencing. Each of these elements affects the device's design.

Select the battery

The next step is to select the best battery for the device. The device designer needs to know the device's physical dimension and weight, the best battery chemistry for the device, and the appropriate battery connections. Design parameters include the power required to ensure it meets the device's nominal voltage, algorithm, and protocols for wireless transmission.

Characterize

Lastly, it is essential to characterize the chosen battery based on the power strategy and device design. Whether it's the battery's capacity, internal resistance, or open-circuit voltage, the designer must verify these parameters based on the device's design.

Device development

The research and development (R&D) engineer has an equally critical role in extending the battery life of an IoT device.

Emulate: One of the engineer's tasks is to emulate the battery at various states to test it against the device's design, software, and firmware. This test covers various test scenarios with a combination of hardware and software designs without waiting for an actual battery to go through charge and discharge.

Validate: This assessment confirms that the battery's capacity and energy ratings align with the datasheet to verify that the run time meets the device's specification.

Cycle: The R&D engineer determines the battery's age effect on the device performance and reliability under certain pre-defined test conditions.

Test: The R&D engineer also performs a run-down test in various environmental conditions to realistically assess the battery performance in real-life situations.

Certify: Battery certification and compliance ensure the device meets user safety with the Underwriters Laboratories (UL) Certification and Waste Electrical and Electronic Equipment (WEEE) organizations' guidelines.

Power Consumption Tests Comes with Challenges

Design engineers face many challenges in designing and developing IoT devices. For example, a design engineer has to understand how a new device depletes its battery capacity.

Key areas where design teams must characterize current drain include sleep or idle power modes. In these modes, the current is extremely low compared to when the device is active or transmitting. The design engineer must isolate and test specific hardware subcircuits since some must always run in the background to enable the device to function.

The design engineer tests and characterizes the device, its subcircuits, and the battery, both independently and in combination, to ensure the battery fits the use model. Proof of concept is the next step to test and validate the design before moving the device to mass production.

End-to-End Device Battery Test Solutions

How can a device designer accurately measure all transient activities to effectively measure the overall current consumption of the IoT device? How can the design engineer test and validate the impact of the design and algorithm changes against complex consumer use models?

The design engineer requires test equipment that helps them perform battery characterization, emulation, cycling, current drain, and event-based power consumption analysis to optimize and maximize the device's battery life.

Discover more about Keysight's comprehensive solutions for IoT design and test challenges. Keysight offers end-to-end battery testing so design engineers can quickly and accurately test and characterize their device and the battery to make informed trade-offs for optimizing battery run time.

Summary

Battery technology and test tools are advancing rapidly to keep pace with the expectations and requirements of consumers today. Design engineers should capture and analyze battery performance data early in the design and throughout the development process to avoid the costly and time-consuming rework required to fix problems late in the development cycle. The deep insights drawn from battery life testing using advanced test solutions enable better design decisions that can extend and optimize your IoT device's battery life.

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