New Energy Storage Devices Optimized for Energy Harvesting to Drive Expansion of IoT Applications

As long-range wireless communication services are being launched successively, the use of Internet-of-Things (IoT) devices is rapidly spreading to a broader range of applications. Going forward, we can expect IoT devices with data collection and transmission functionality to extend beyond homes and factories. This includes outdoor applications such as bridges and agriculture applications. Given the diversity of applications in which IoT devices can be installed, suppling power is an issue that needs to be considered. The creation of maintenance-free IoT devices hinges on power generation and consumption, including power generated from the-environment (energy harvesting). NICHICON's SLB Series of new energy storage devices supports the realization of ideal IoT devices. It provides the high power output and capacity required for energy harvesting, and can be repeatedly charged and discharged. IoT-powered devices continues to spread to a broad range of fields, such as the gauging monitoring of factory equipment operation, the monitoring of aging road infrastructure, and the collection of data on crop growth in agricultural fields.

Low power wide area (LPWA: low-power, low-cost, long-range wireless communication) services are also being introduced. 2020 will see the launch of services compatible with the fifth generation wireless technology for digital cellular networks (5G), enabling high-capacity and low-latency connectivity based on a massive number of connection points. This makes 5G an ideal wireless communication standard for IoT devices. The commercial launch of such long-range wireless communication services is expected to function as a trigger that will accelerate growth in IoT usage scenarios.

Future expansion in IoT application fields depends on one more factor that cannot be overlooked, the power supply. Collecting, processing, converting, and wirelessly transmitting data through IoT devices requires a considerable amount of power. The need to supply power to IoT devices or to frequently exchange batteries for such devices undermines the ability to fully take advantage of advances in wireless communication. The ideal solution would be to employ a power source that supplies power to IoT devices, regardless of where they are installed and requires zero maintenance. Energy harvesting, which sources power from the surrounding natural environment through the conversion of sunlight, vibration, sound, temperature differences, and electromagnetic waves has come to the spotlight as a power source technology.

Optimized for Energy Harvesting

NICHICON's SLB Series of small lithium-ion rechargeable batteries offers high power output and high capacity, and can be repeatedly charged and discharged. Their small size form factor is achieved by technologies developed in the manufacturing of aluminum electrolytic capacitors (**Figure 1**).

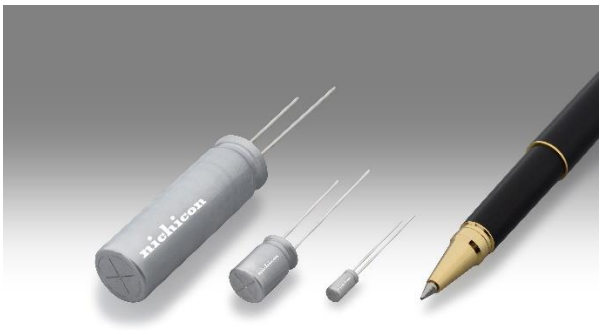

Figure 1 ：SLB Series of Small Lithium-ion Rechargeable Batteries

The combination of these features makes the SLB batteries an ideal match for energy harvesting, where they can be effectively utilized due to the power generated by individual power generating devices used in energy harvesting is extremely small, at 1μW–1W. The main usage for energy harvesting is to generate and store energy during standby time, and consume the stored power in one burst. The SLB Series of batteries have lower internal resistance than ordinary lithium-ion rechargeable batteries. This allows recharging using minute amounts of electric current and instantaneous discharging of large amounts of electric current possible. The SLB batteries have a rated capacity of 0.35mAh in an ultra-compact form factor (diameter: 3mm, length: 7mm), which cannot be replicated by ordinary lithium-ion rechargeable batteries.

Rechargeable batteries degrade with repeated charges and discharges, and battery durability determines the service life of IoT devices used with energy harvesting. The capacity of ordinary lithium-ion rechargeable batteries is reduced to roughly 80% after several hundred to several thousand charge/discharge cycles at a rate of 1C. In contrast, the capacity of SLB Series batteries remains above 80% after 25,000 charge/discharge cycles at a rate of 10C (10 times higher) **(Figure 2)**.

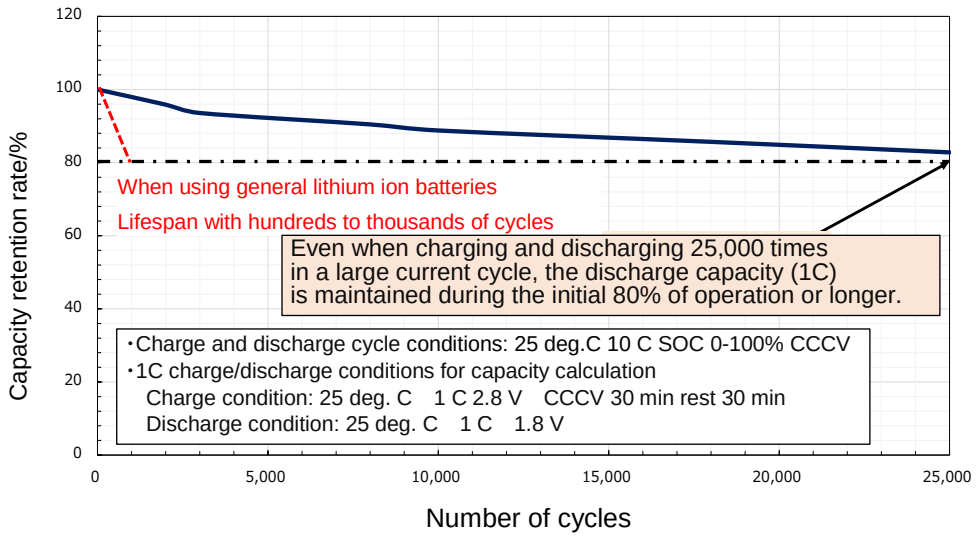

Figure 2: Charge and discharge cycle characteristics

Batteries for IoT devices installed outdoors or in important locations, are required to be highly reliable and safe. SLB Series batteries employ lithium titanate (LTO) for the anode, a non-combustible material with higher thermal stability than the carbon material generally used in other products. Because LTO does not react with the electrolytic solution even in high temperature ranges, makes it less susceptible to thermal runaway. In conditions where lithium ions are released, the LTO assumes a near-insulating state. Even if a short circuit occurs in some parts of the battery, it does not spread throughout the battery, which means exothermic reactions are greatly suppressed.

SLB Series batteries can operate at a temperature of -30°C. In low-temperature environments, lithium does not accumulate on the LTO anode, so capacity does not deteriorate with repeated charging and discharging. Another important feature of SLB Series batteries is their extremely low risk of causing fires or smoke because they are designed to inhibit accumulation of lithium metal (even when overcharging), which is the main cause of short circuits and battery degradation. The SLB Series batteries should be considered an excellent match when developing IoT-powered devices used with energy harvesting.