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APPLICATION NOTE 2989

Match the Battery to the Application to Avoid Disappointment

End-customer satisfaction (or dissatisfaction) with portable devices depends largely on battery performance.

The main performance metric for batteries is, of course, battery life. On the surface, this is a simple spec, but in truth it has many dimensions. These include the system's load profile (how much of the time it spends using full load current, a fraction of it, or just microamps); power supply efficiency; system power management; battery type; and charging methods.

Besides being individually important, how these characteristics interact can enhance, or diminish, the end-customer experience. Generally, if a customer becomes aware of the battery, that's bad! The best products make the battery "disappear" with either very infrequent cell replacement (e.g., TV remote controls) or charging, or with unobtrusive charging (electric toothbrushes). To be avoided are situations where customers think about batteries as much as the device's function.

Choosing Battery Chemistry

An often neglected consideration in product design is the interaction between the battery and the system. It is important to match the battery's strengths to the needs of the system. The most common battery types are Alkaline, Nickel Metal Hydride (NiMH), and Lithium-Ion. These are not interchangeable - most products have one "best" choice.

Alkaline

Alkaline cells are non-rechargeable (notwithstanding claims of late night TV ads) but excel due to their very low self-discharge rate and low cost of implementation (no charger or AC power jack is needed). If power requirements are low, alkaline can be a great choice, but to be used properly, quiescent load, or sleep current, must be reduced with religious conviction.

A common mistake is focusing only on the operating efficiency while ignoring "off" or "sleep" current. Even 10s of µA of wasted current can drain cells so that intermittently used products still require frequent cell replacement. Ironically, this design mistake is more common today than it was years ago, since software switches have replaced mechanical switches, which completely disconnected the battery.

Rechargeables

When operating loads are too great for alkaline batteries, rechargeable batteries are required. This is the norm for portable devices like notebooks, PDAs, and cell phones. The trick then is to make the rechargeable battery as unobtrusive as possible. The best start for this is to pick cells that complement (or at least do not detract from) the product.

There are two main rechargeable choices, NiMH or Lithium-Ion.

NiMH, which is lower cost than Li-Ion, can make sense when the product's normal use pattern is not unhealthy for the cells. This consideration is particularly important in low-cost products that are unlikely to include sophisticated charging since NiMH cells prefer full charge/discharge cycles. This is suitable for products that are

frequently used to exhaustion, such as power tools.

Another pattern that fits NiMH is as alkaline "replacements," where cells are removed from the device when depleted, but then charged in an external charger. This is common in digital cameras, but requires a lot of attention from the consumer.

Many portable information products do not conveniently fit this pattern. PDAs and cell phones are charged regularly but drained sporadically. These products need Lithium-Ion batteries. In addition to their power-to-weight ratio, these batteries provide two more important advantages: low self-discharge and no difficulty with small charge-discharge cycles. Consumers thus devote little effort to "battery management" and instead simply use the product and rarely think about the batteries.

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