Building Better Power Sources for Modern Embedded Systems

Miniaturisation of electronics has created numerous modern form factors where a conventional battery does not fit any more. Thus you may need to go for a different battery to power your new mobile design. This article helps you in selecting the one for your next-generation embedded system

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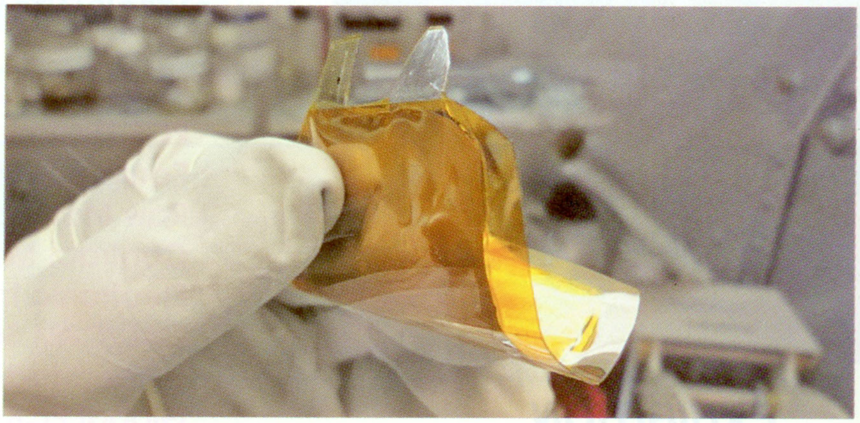
As the most popular portable energy source for embedded systems, batteries are paving their way through mainstream applications as the primary power source of choice. An increasing number of designs are being made where a device is designed around the battery, thus having an increased effect on the design's form factor.

While much of these design decisions are simple, there are cases where a purposefully over-engineered device might need a higher current support than its conventional power source could deliver without affecting user experience. It is for such cases that engineers usually ponder over the inclusion of a bigger battery at the cost of sheer bulk, or include energy-harvesting features that increase cost and complexity.



Flexible thin-film polymer Li-ion battery

Power sources and the applications they suit

The decision to select a power source for a commercial product is primarily based on the environment it is being designed for, the device's power requirements, its size and form factor, as well as targeted cost of the final product.

Power consumption by a device would determine what type of batteries need to be used (such as rechargeable or use-and-throw type), as well as the size of battery to be included in the design. If rechargeable batteries are to be used, a recharging facility may be required to be built into the system. In such a case, the designer could go ahead and make the device dual-powered, since the required components already exist in its system design. This is mostly true for an embedded system which is to be stationed at one place for most of the time, or if it is a piece of equipment designed to be always on. An example of this is a gaming laptop.

Solar power is used in areas where availability of continuous electric power is an issue, as in case of remote data loggers. Energy-harvesting methods are used for mobile applications where there is no space to include a battery, such as in RFID, NFC tag and card readers. Energy harvesting can be done from radiated energy (RFID and NFC) or the audio port (card readers).

Criteria to be considered

In general, the most important parameters to be considered when you select a power source are voltage and current capacity. Once this is decided, the next step is to select watt-hour or milliampere-hour capacity. Next is the size of battery, solar-panel or any other source of power. This selection would be constrained by the earlier mentioned parameters.

Cost is also an equally important consideration, especially when we consider the percentage of over-engineering required, like extra high current support.

Size and weight of battery or panel. The size of the battery includes its height, width and depth. These are some of the defining characteristics that are first looked at while selecting the power source for a device. This is based on the targeted size of the device, and the size of the circuitry that has already been designed.

Once a rough idea of the target device size is formed, the designer can source batteries from retailers by selecting the closest dimensions possible out of their inventory.

Online vendors such as element14

and Mouser allow engineers to select the height, width and depth they require so as to provide the closest dimensioned battery possible. The same is done while selecting solar panels as well.

Ratings and capacity. For selecting battery as a power source, attention must be given to its discharge capacity (1C and 2C) and energy rating such as (1000mAh or so).

For solar power, you can select small panels by considering their power rating, maximum power voltage, number of cells and other specs. Besides this, care must be taken in providing polarity proofing and recharging facility inside the device itself. Below is an example of battery selection for a microcontroller-based circuit that Knewron worked on, where 3.3V was the minimum necessary requirement and the device was to be run for 5 to 6 hours at one go.

"With approximate peak current consumption of 25mA, we chose a power source of 160mAh capacity delivered by a small LiPo battery that would meet these requirements. Due to its light-weight nature and small form factor, this LiPo battery was the correct choice," explains T. Anand, principal consultant, Knewron.

Terminals. Connectors are selected based on the need for a compact solution, or even for ensuring that the final device is tightly packed. Most off-the-shelf batteries come with different kinds of termination styles for battery connectors, such as PCB pins, pressure contacts or snap contacts to name just a few. However, certain applications might also require custom-designed battery connectors.

Some of the main factors affecting connector selection is surface-mount technology, compression style, through-hole interface to your PCB, different circuit sizes and battery pack orientation on the product.

Chemical composition. The designer will have to select battery technology based on its chemistry and also ensure that it does not have any substance of very high concern (SVHC). Most countries are very specific about Restriction of Hazardous Substances (RoHS) Directive and the EMI/EMC norms of the equipment. In such cases, even the certification stamp on the power supply/type of components used matters for the final design to be approved.

If we need a compact and portable battery, a Li-ion battery is chosen. These batteries are so common because they are some of the most energetic rechargeable batteries available and have a high energy-to-weight ratio. Comparing the different technologies is beyond the scope of the article, but we have featured two very new technologies targeting wearable electronics in the next section.

Battery technology for the Internet of Things

Internet of Things and wearable electronics both have one thing in common—unorthodox device form factors. In devices like watches, where cell batteries were traditionally used, the current generation of smart watches require something that can pack much more punch. With this in mind, vendors have started coming out with batteries that allow designers to custom-build their own batteries for specific sizes.

Solicore is an embedded power solutions vendor, who has a range of very thin 3D printed batteries with lifetime recharging capability, customisable shape option and high energy density with no toxic materials inside.

This solves the problem of the shape, size and overall form factor for a portable electronic device. The lack of toxic materials makes it an easy choice for use in wearable electronics without attracting the ire of the final user.

Imprint Energy is another firm that enabled the creation of rechargeable zinc-based ultra-thin batteries without the safety concerns of other battery technologies. Considering the importance that manufacturers of wearable electronics place on user experience, this could be a must-have technology for the next generation of miniature electronics.

If you are using an ultra-low-power chip in your design, you stand to gain from the availability of computing chipsets that can function at a thermal

An Innovative Photovoltaic Touch Panel Design

The US Patent and Trademark Office granted Apple, Inc. a rather interesting patent, which shows the innovative use of current technologies to enable a truly untethered device.

It takes the idea of a solar glass to a different level, where the photovoltaic panel is placed behind the glass (in this case a touchscreen display), so that the user can continue using his device while the solar panel absorbs energy and trickle charges the battery. Lithium-polymer batteries which are used inside these devices, are probably designed to withstand these constant-use cases and still deliver standard performance.

Optimising Your Power Source For Manufacturing

Designing for functionality is only half the problem solved, if its cost will balloon upon going into production. Getting a battery-powered device successfully to market requires the involvement of cost at different levels including design engineering, tooling, prototyping and production.

Designing depends on the type of application for which the battery is manufactured, therefore both high-power and low-power batteries are designed separately.

In high-power batteries, complex systems integration is required along with special safety considerations to prevent accidental damage and electrical and physical abuse. These high-power batteries are basically designed for the electrical vehicles (EVs) which force the designers to include both forced cooling and heating circuits.

On the contrary, low-power batteries require designing of precise-section plastic parts and the associated complex moulding tools. Most modern battery packs also have in-built battery management systems that require designing of integrated circuits (ICs) on a printed circuit board (PCB).

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design power of just 3W. With such an efficient computing platform, one popular application is to use solar-powered wireless devices for bolstering surveillance through hidden sensors in the field.

Ensuring reliable power source designs

A battery requires protection from different electrical conditions such as discharge, overcharge and short circuit. In the absence of adequately protected batteries, your design might turn into a ticking bomb.

The Li-ion battery pack that is used in almost all portable electronic devices, starting from a small mobile phone to a laptop, has two to three main levels of protection.

The first is the IC level of protection that is done by the battery management unit (BMU). This BMU is responsible for managing charging and discharging of the battery, and it is also the primary protection level. So if something happens and the battery goes too high on voltage or current, it would turn the pack off.

Then there is a secondary level of protection that is made compulsory by the Underwriters Laboratories (UL) test standards so as to ensure that the faults left in the primary level can be removed at the secondary level of protection. Many companies work to provide battery protection, especially for the Li-ion batteries, either at the primary level or at the secondary level.

At these different levels, the types of protections available for the Li-ion batteries are as follows:

1. PTC. A secondary level of protection that is used for automatic reset. It is considered to be a special type of fuse that protects against overcurrent and overheating.

2. CID/pressure valve. Again a secondary level of protection that disables the cells permanently in case of high pressure that may be created due to overcharging.

3. PCB protection. A primary level protection that protects against overcharging, overdischarging and even overcurrent.

Like the other types of batteries and cells, solar cells need to be protected too. Solar cells need fuses called solar fuses, which need to be certified either by UL or International Electro Commission (IEC). IEC certification is now more prominent in India. In IEC, if a fuse is tested for 135 per cent on overload, it should continue working till 60 minutes. On the other hand, in UL it should go on at 145 per cent for 60 minutes. Although certification ensures that the solar fuses are safe to be used with the solar cells, there is a requirement of a perfect material for the fuse that would make it more robust to support the cell in extreme conditions.

Industries are now coming up with a melamine-based fuse that can resist even high hot temperatures and low cold temperatures, thus allowing the solar cells to work with the same efficiency all around.

New tools to spruce up designing

A number of tools have been introduced recently that can help simplify the design process in numerous ways.

Interactive battery power design tool. This is a powerful tool that helps device developers and designers predetermine the battery power requirements for the product being designed.

This tool helps determine the parameters such as size of the battery required, battery life and energy harvesting, all with respect to the application where the device would be used.

It helps product designers and developers predetermine the battery power requirements for new products. Users are allowed to select a pre-configured product scenario or build their own use case using the defaults provided.

Wattson by Logic PD. Wattson is an application to measure power, to monitor performance and to deliver real-time feedback of the battery-powered device. It helps in minimising power and maximising the battery life for the end product by enabling the engineers to analyse data through a graphical feedback system, without having to use external oscilloscopes or digital multimeters.

Spy on batteries. This is a device that can help to keep a check on the actions of the lithium ions inside a nano battery. This data can, in turn, be used to develop improvised batteries that would last longer, and can also be used to power all applications—starting from an electric vehicle to a small cell phone. As lithium batteries have been so popular, this device can bring a revolutionary enhancement in the market. Designers would not have to restrict their product design because of the battery to be used. ●

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