Emergency eCall – Available When You Need It!

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Background

Electronic systems must continue to remain operational, regardless of its external operating conditions. Said another way, any glitch in its power supply, whether momentary or seconds or even minutes, must be taken into account during its design process. The most common way of dealing with such circumstances is to use uninterruptible power supplies (UPS) to cover these brief downtimes, thus ensuring high reliability continuous operation of the system. Similarly, many of today's emergency and standby systems are used to provide backup power for building systems to provide assurance that safety systems and critical equipment can maintain their operation during a power outage – whatever its cause.

Another obvious example can be readily found in the ubiquitous handheld electronic devices which are used in our everyday lives. Because dependability is paramount, handhelds are carefully engineered with lightweight power sources for reliable use under normal conditions. But, no amount of careful engineering can prevent the mistreatment they will undergo at the hands of humans. For example, what happens when a factory worker drops a bar code scanner, causing its battery to drop out? Such events are electronically unpredictable and important data stored in volatile memory would be lost without some form of safety net – namely a short-term power holdup system that stores sufficient energy to supply standby power until the battery can be replaced or the data can be stored in permanent memory.
These examples clearly demonstrate the need for an alternative form of power source to be available, just in case there is an interruption of the primary power source.

In automotive electronic systems there are many applications that require continuous power even when the car is parked, such as remote keyless entry, security and even personal infotainment systems, which usually incorporate navigation, GPS location and eCall functionality. Maybe it is hard to understand why these systems have to remain on even when the car is not moving, but the GPS aspect of this system has to be "always-on" for emergency and security purposes. This is a necessary requirement so that rudimentary control can be employed by an external operated when needed.

By way of explanation, an eCall system is a safety feature that is becoming more pervasive in newer automobiles, with many manufacturers already rolling it out across their ranges. It's a pretty simple bit of technology: in the event of a collision in which a car's airbags are deployed, eCall automatically contacts the emergency services. It uses GPS to relay the time, your location, what type of car you're in and what fuel it uses to the authorities, while a microphone in the car allows you to speak directly to call handlers when the system is activated.

The eCall system also shares what direction you were travelling in when the incident occurred, allowing authorities know which side of the freeway they need to head to in the event of a collision. All this allows ambulance, police and fire crews to reach you as quickly as they can following an accident, armed with as much information as possible. An individual can also activate eCall by pressing a button, so if someone becomes ill (or has been injured in a collision in which the airbags haven't deployed), help can still be easily summoned.

Storage Mediums

Having acknowledged the need for backup power for any given system, the question then arises: what can be used as a storage medium for this power? Traditionally, the choices have been capacitors and batteries.

I think that is it fair to say that capacitor technology has played a major role in power transmission and delivery applications for multiple decades. For example, traditional thin film and oil-based capacitor designs performed a variety of functions, such as power factor correction and voltage balancing. However, in the past decade there has been substantial research and development which has led to significant advances in capacitor design and capabilities. These have been called supercapacitors (also known as ultracapacitors) and they are ideal for use in battery energy storage and backup power systems. Supercapacitors maybe limited in terms of their total energy storage; nevertheless, they are "energy dense." Furthermore, they possess the ability to discharge high levels of energy quickly and recharge rapidly.

Supercapacitors are also compact, robust, and reliable and can support the requirements of a backup system for short-term power-loss events such as the ones already described above. They can easily be paralleled, or stacked in series or even a combination of both to deliver the necessary voltage and current demand by the end application. Nevertheless, a supercapacitor is more than just a capacitor with a very high level of capacitance. Compared to standard ceramic, tantalum or electrolytic capacitors, supercapacitors offer higher energy density and higher capacitance in a similar form factor and weight. And, although supercapacitors require some "care and feeding," they are augmenting or even replacing batteries in data storage applications requiring high current/short duration backup power.

Furthermore, they are also finding use in a variety of high peak power and portable applications in need of high current bursts or momentary battery backup, such as UPS systems. Compared to batteries, supercapacitors provide higher peak power bursts in smaller form factors and feature longer charge cycle life over a wider operating temperature range. Supercapacitor lifetime can be maximized by reducing the capacitor's top-off voltage and avoiding high temperatures (>50°C).

Batteries, on the other hand, can store a lot of energy, but are limited in terms of power density and delivery. Due to the chemical reactions that occur within a battery, they have limited life with regard to cycling. As a result, they are most effective when delivering modest amounts of power over a long period of time, since pulling many amps out of them very quickly severely limits their useful operating life. Table 1 shows a summary of the pros and cons between supercapacitors, capacitors and batteries.

Parameter	Supercapacitors	Capacitors	Batteries
Energy Storage	W-sec of energy	W-sec of energy	W-Hr of energy
Charge Method	voltage across terminals i.e. from a battery	voltage across terminals i.e. from a battery	current & voltage
Power Delivered	rapid discharge, linear or exponential voltage decay	rapid discharge, linear or exponential voltage decay	constant voltage over long time period
Charge/Discharge Time	msec to sec	psec to msec	1 to 10 hrs
Form Factor	small	small to large	large
Weight	1-2g	1g to 10kg	1g to >10kg
Energy Density	1 to 5Wh/kg	0.01 to 0.05Wh/kg	8 to 600Wh/kg
Power Density	High, >4000W/kg	High, >5000W/kg	Low, 100-3000W/kg
Operating Voltage	2.3V – 2.75V/cell	6V – 800V	1.2V - 4.2V/cell
Lifetime	>100k cycles	>100k cycles	150 to 1500 cycles
Operating Temp	-40 to +85°C	-20 to +100°C	-20 to +65°C

Table 1. Supercapacitor Comparison vs. Capacitors & Batteries

New Backup Power Solutions

Now that we have established that either supercapacitors, batteries and/or a combination of both are candidates for use as a backup power supply in almost any electronic system, what are the IC solutions available? It turns out that Linear Technology has a broad range of ICs which were specifically designed to address this application need.

The LTC4040 is a complete lithium battery backup power management system for 3.5V to 5V supply rails that must be kept active during a main power failure. Batteries provide considerably more energy than supercapacitors, making them superior for applications which require backup for extended periods of time. The LTC4040 uses an on-chip bidirectional synchronous converter to provide high efficiency battery charging as well as high current, high efficiency backup power. When external power is available, the device operates as a step-down battery charger for single-cell Li-Ion or $LiFePO_4$ batteries while giving preference to the system load. When the input supply drops below the adjustable Power-Fail Input (PFI) threshold the LTC4040 operates as a step-up regulator capable of delivering up to 2.5A to the system output from the backup battery. During a power fail event, the device's PowerPath™ control provides reverse blocking and a seamless switchover between input power and backup power. Typical applications for the LTC4040 include fleet and asset tracking, automotive GPS data loggers, automotive telematics systems, toll collection systems, security systems, communications systems, industrial backup and USB-powered devices. See Figure 1 for a typical application schematic.

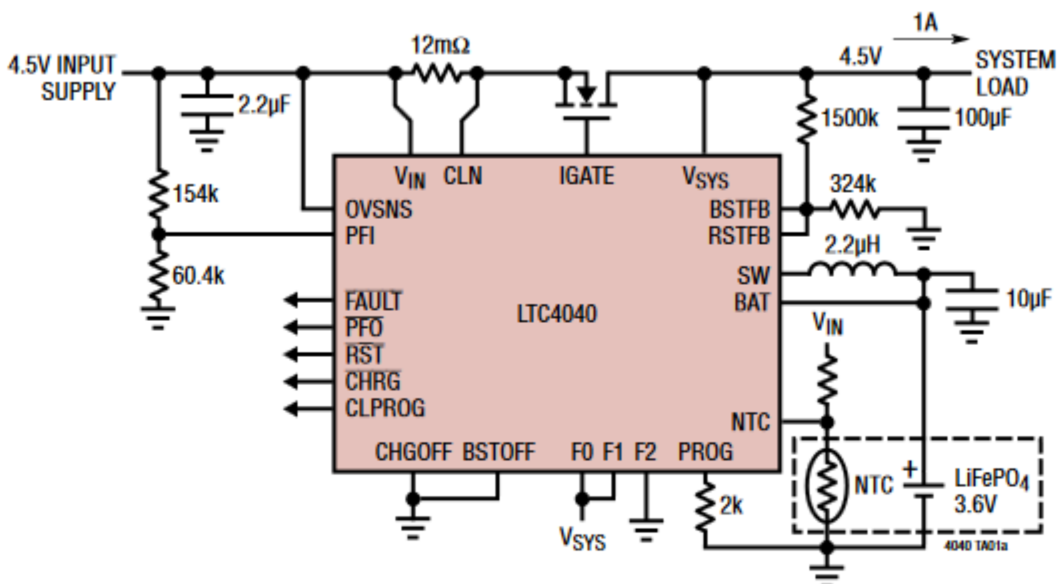

Figure 1. 4.5V Backup Supply with a 4.22V PFI Threshold

The LTC4040 also includes optional overvoltage protection (OVP) which protects the IC from input voltages greater than 60V with an external FET. Its adjustable input current limit function enables operation from a current limited source while prioritizing system load current over battery charge current. An external disconnect switch isolates the primary input supply from the system during backup. The LTC4040's 2.5A battery charger provides eight selectable charge voltages optimized for Li-Ion and $LiFePO_4$ batteries. The device also includes input current monitoring, an input power loss indicator and a system power loss indicator.

Conclusion

Whenever a design requires a system to be always available even if the primary power source should fail, it is always a good idea to have a backup power source. Fortunately, there are many IC options, just like the LTC4040, that can allow an easy backup power supply, whether that storage medium is a Supercapacitor, an electrolytic capacitor or even a battery. Clearly, in the case of an eCall system in an automotive environment; having it functional if an accident occurs where the main battery is disconnected can be a life-saver. So make sure you have a good backup plan for your eCall users.