APPLICATON BRIEF

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Supercapacitors Support Asset Tracking

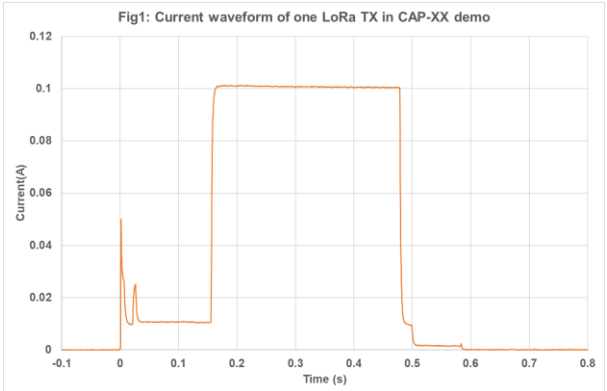
Asset tracking devices often needs to be small, lightweight, long endurance and with wide transmission coverage making the use of energy harvester, or high energy density battery appealing. A supercapacitor effortlessly works with an energy harvester or battery to support the large peak power required for wireless transmission. CAP-XX's ultra low-profile prismatic supercapacitors can be easily integrated into any thin tracker design and our cylindrical cells offer a low cost solution where space is not constrained.

Active asset tracking

From farming to age care, fleet vehicle management to wildlife study, active asset tracking technology greatly reduces resources required to manage important assets.

Today's tracking devices are small and designed for longer life without any maintenance. Low power radio systems such as LoRa and LTE-M enables the data transmission to use minimal energy. The passive nature of GPS and the various inertial sensors that are often included are also very energy efficient. However, to reach the desired operating life of months or even years, a tracking device still requires large amount of energy. The energy is either harvested from the environment e.g. solar cells or vibration transducers ideal for road and rail transport or stored in a high energy primary battery such as Lithium Thionyl Chloride.

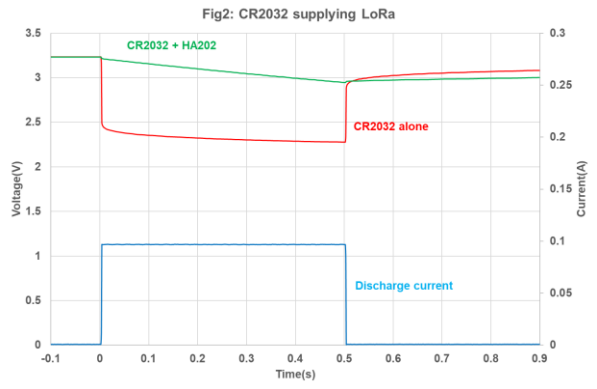
These energy sources have very limited power delivery. They will not be able to supply the required peak power to complete a radio transmission. Fig 1 is the current waveform of a



short data transmission via LoRa radio. The data transmission draws ~100mA peak current.

Supercapacitors complement batteries

The supercapacitor is an ideal power buffer, charged by the energy source at average load current and delivering periodic or sporadic bursts of peak current.



As an example, a tracking device in the shape of a pendant runs on a CR2032 Lithium battery with LoRa radio for data transmission. CAP-XX prismatic supercapacitors such as the DMF low ESR high power, DMT long life high temp or DMH ultra-thin, or HA series are small and thin allowing them to easily fit into the tiny tracker's enclosure. Fig 2 is a 100mA, 0.5s pulse typical of a LoRa transmission drawn from a CR2032 battery alone, and a CR2032 battery paired with a HA202 supercapacitor, 120mF, 120mΩ. A typical CR2032 battery has an internal resistance, Rbatt = ~10Ω. During the 100mA pulse the battery voltage droop is around 1V dropping to 2.25V. This voltage level is approaching the minimum operating voltage for many circuits, and the battery is fully charged. This will likely cause data transmission to fail, especially when the battery is not new and fully charged. However once paired with an HA202 the CR2032, the voltage droop is reduced to only 0.2V, keeping the supply voltage around 3V after one pulse. After the pulse the supercapacitor will be recharged to the battery's open circuit voltage, according to the Rbatt-C time constant, so 95% charged after 3.6s.

Another key attribute of CAP-XX supercapacitors that make them ideal to place across a battery is low leakage current (IL), ~1µA/F. Therefore, the HA202 part across a CR2032 battery in Fig 2 has a typical IL of ~0.5µA. Leakage current is drawn from the battery continuously so it can be a significant drain on energy. With only 0.5µA IL, a HA202 only draws 4.4mAh/yr.

Asset tracking using energy harvester with supercapacitors

The environment can provide effectively infinite energy but at very low power. This makes some asset tracking devices ideal to be powered from an energy harvester coupled with a supercapacitor. The energy harvester can charge the supercapacitor directly or via a PMIC which charges the supercapacitor at very low power, and the supercapacitor provides the peak power burst for the sensors and the radio system. A range of ICs are available to charge supercapacitors from energy harvesters. To select your IC consider the characteristics of your energy harvester(solar, micro-generator, piezo-electric, RF or thermal), the minimum voltage the IC requires to start, if the IC has peak power tracking and the method it uses, min and max power levels and efficiency at those levels.

Sizing your supercapacitor

Supercapacitors, which can deliver high power due to their low ESR, have high C to supply sufficient energy to support the data capture and transmission for its duration, have "unlimited" cycle life, and can be charged at very low current are the perfect power buffer.

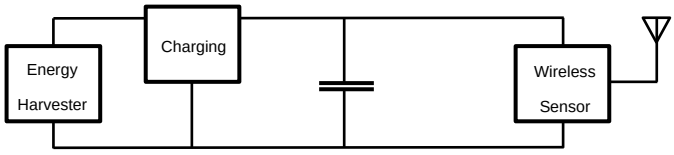


Figure 3: Typical energy harvester Architecture

For more information please refer to Supercapacitor Inrush Current Limiting, Supercapacitor Cell Balancing, Coupling a Supercapacitor with a Battery, Powering Pulse Loads, Charging a Supercapacitor from a Solar Cell, from a Vibration Transducer, Powering LoRa and NBIoT.