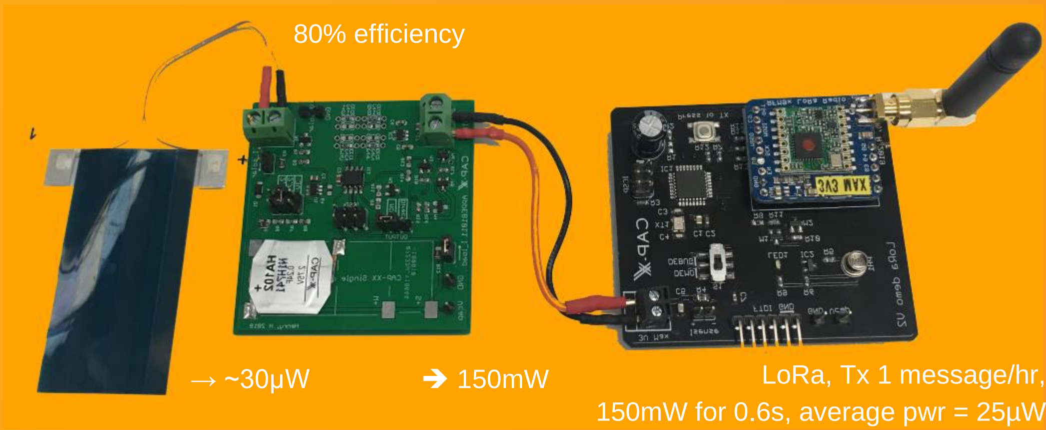
APPLICATON BRIEF

AB1015 Rev 1.3 Apr 2020



Supercapacitors enable micro power energy harvesters to power wireless sensors

Wireless sensors are everywhere with the spread of IoT applications. Powering these sensors is a problem – batteries need replacing and disposal. The environment has abundant energy but a small energy harvester can only deliver it at very low power. A supercapacitor is an ideal power buffer that is charged at low power from the environment and deliver peak power for data collection and transmission.

Powering your Sensor

Wireless sensors are becoming ubiquitous. They are used in applications ranging from HVAC, industrial control, condition monitoring, security monitoring, wearables, medical and location tracking. Providing power to these sensors can be a problem – it is too expensive to wire power to them, and batteries require replacement and disposal. The environment on the other hand, can provide effectively infinite energy but at very low power. These sensor applications usually have a low duty cycle with a high peak power requirement to periodically or sporadically gather and transmit data drawing very low average power. This makes them ideal to be powered from an energy harvester coupled with a supercapacitor. The energy harvester can charge the supercapacitor directly, or supplies a power management IC which charges the supercapacitor at very low power, and the supercapacitor provides the peak power burst for the sensor to collect and transmit data. Some typical applications include:

Sensors reporting over the cloud in the Internet of things. (Supercapacitor Powered BLE, Supercapacitor Powered LoRa, Supercapacitor powered NB IoT LTE CAT-M1, Supercapacitor Powered Wifi IoT).

Solar cells to power sensors (Charging a Supercapacitor from a Solar Cell Energy Harvester) reporting temperature & humidity for HVAC, light levels to control lighting, movement detectors to determine if lights should be switched off / on.

Vibration transducers (micro-generator or piezo electric) to power sensors (Charging a Supercapacitor with Vibration energy harvester) reporting vibration spectra for condition monitoring of rotating machines, for condition monitoring and location tracking of railway rolling stock, location tracking of containers, monitoring stress in structures such as bridges and dams, monitoring vibration and stress in airframes.

RF for rapid wireless charging of a supercapacitor (Wireless Charging) that then enables encrypted card transactions, monitoring reporting user data in wearables.

Figure 1 shows the typical power architecture using an energy harvester and supercapacitor.

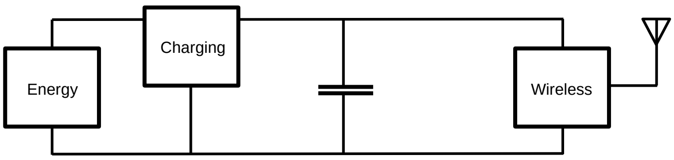


Figure 1: Typical Power Architecture

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 between the energy harvester and sensor (Powering Pulse Loads). Factors to consider when selecting your supercapacitor include:

1. How much energy is required to support the data collection and transmission?
2. What is the peak transmit power?
3. The voltage drop due to Equivalent Series Resistance (ESR) for the supercapacitor = I_{LOAD} x ESR. Many engineers select C = 2E/(V^2init – V^2final), where E is the energy required for the transmit pulse and Vinit and Vfinal are the supercapacitor initial and final voltages. This calculation implicitly assumes supercapacitor ESR = 0 and will undersize the supercapacitor.
4. What is the leakage current? This must be << charging current provided by the energy harvester and charging IC.
5. What space do you have? Many applications require a slim, unobtrusive and elegant form-factor. CAP-XX's thin prismatic supercapacitor range meets the need. Where space is not constrained, lower cost CAP-XX cans can be used.
6. What is the sensor and transmitter operating voltage? If < 3V then you can use a single cell supercapacitor. CAP-XX will soon release 3V prismatic cells and 3V cans are available. If a higher voltage is need, use a dual cell supercapacitor module for up to 5.5V. CAP-XX prismatic dual cell modules have the 2 cells matched by capacitance so they have roughly equal voltages when charged and long life. A low current active balance circuit is required to maintain cell balance.

A range of ICs are available to charge supercapacitors from energy harvesters. To select your IC consider the characteristics of your energy harvesting transducer (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.

See our latest range of supercapacitors, DMF low ESR high power, DMT long life high temp or DMH ultra-thin supercapacitors.

An ecosystem has developed, with energy harvesters, charging ICs and supercapacitors to enable the environment to "indefinitely" power wireless sensors in a wide variety of applications.