APPLICATON BRIEF

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Supercapacitors in Smart Meters

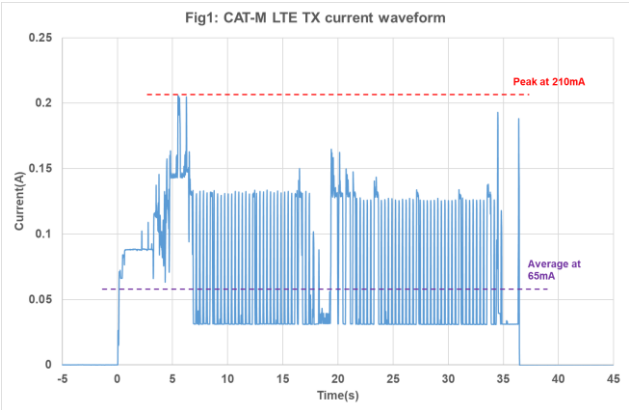
The adoption of smart meters has enabled utility companies to read the information remotely, providing near real time data and removing the need for meter readers. Water and gas meters are either too expensive or not safe to wire to mains power, so use a battery to power the meter and data transmission. The very long life high energy batteries used cannot deliver the peak power for data transmission, particularly in the sub zero temperatures of northern winters. CAP-XX supercapacitor's excellent power density complements the battery providing the peak power needed for wireless data transmission.

Supercapacitor in battery powered smart meter

Smart meter utilises low power, low data rate wide area wireless protocol to transmit meter information to the parent utility company. The amount of data and update rate for smart meters is very low by today's standards. Protocols such as LoRa, NB-IOT are ideal for this task.

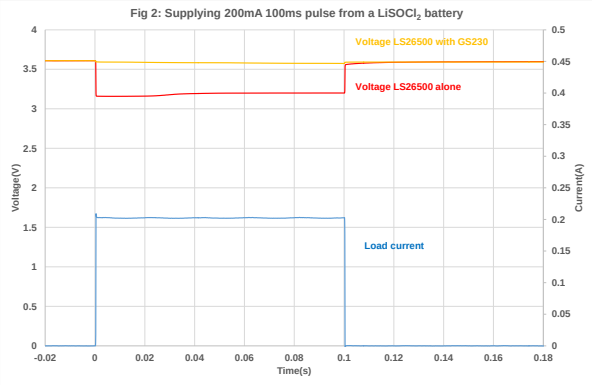
Water and gas meters are either too expensive or not safe to wire to mains power. They use a very high capacity primary battery with long life combined with extremely low power electronics to operate the meter over 10 – 15 years.

Fig 1 is the current waveform during transmission of 1 data packet using a CAT-M LTE module. The transmission lasted over 37s as the unit needed to register with the carrier and handshake before transmitting the data. Whether the unit registers before every transmission or remains logged on to the network between transmissions depends on the interval between transmissions.



If it is less than a certain interval it will be more efficient to remain connected to the network. A 7.7Ah LS26500 $LiSOCl_2$ battery contains enough energy for over 11,900 transmission like that shown in Fig1. Ignoring quiescent current that is over 32 years if transmitted once a day. To extract all the available energy from this type of battery the discharge current needs to be kept as low and as constant as possible.

CAP-XX supercapacitors are the ideal power buffer to help enable pulse transmission and significantly extend battery life without sacrificing any features. Adding a GS230 (1.2F 25mΩ) across the battery allows the supercapacitor to provide the pulse power. Fig 1 shows the peak current was 0.2A. Fig2 below shows the voltage drop with the $LiSOCl_2$ battery supplying 0.2A with and without a GS230 supercapacitor supporting the battery.



The voltage drop without supercapacitor support is 0.45V but with the GS230 supporting the battery, the voltage drop is only ~20mV. This is with a new battery – as the battery ages the battery impedance increases and the voltage drop is worse. Also note that the peak current for an NB IoT or CAT-M LTE module could be up to ~0.5A, resulting in a battery voltage droop ~1.1V without a supercapacitor and ~50mV with. With a supercapacitor the only battery supplies average current, if transmission occurs 1/day this = 28µA, or if 1/hr = 670µA. This ensures that all the energy is extracted from the battery and maximises battery life. See CAP-XX's new range of supercapacitors, DMF low ESR high power, DMT long life high temperature.

For more information please refer to Coupling a supercapacitor with a battery.

The other key attribute of CAP-XX supercapacitors that make them ideal to place across a battery is their very low leakage current (IL), ~1µA/F. The GS230 supercapacitor across a $LiSOCl_2$ battery in Fig 2 has a typical IL of ~1µA. A dual cell supercapacitor requires a cell balancing circuit, see Cell Balancing. CAP-XX can provide a true balance circuit that maximises life and only draws ~700nA. Leakage + balancing current is drawn from the battery continuously so it can be a significant drain on energy. The total 1.7µA current drains only ~15mAh/yr or only 0.2% of the charge of the 7.7Ah LS26500 battery.

Supercapacitor in a smart meter with energy harvesting

It is possible to incorporate energy harvesting in smart meter by converting some mechanical energy from the flow of fluid through the meter. A micro turbine used for flow measurement can extract small amount of power without impacting the metering function and store the harvested energy in a supercapacitor to power the radio transmission and other functions. This allows use of a smaller primary battery or a re-chargeable battery to increase meter life.

Sizing your supercapacitor

Supercapacitors, which can deliver high power due with their low ESR and 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 a low power battery and/or energy harvester and a data transmission module. See Powering Pulse Loads for guidance on supercapacitor sizing and selection. CAP-XX can assist in your supercapacitor circuit design.

Inrush Current Limiting

A CAP-XX supercapacitor, with its very low ESR, will try to draw very high inrush current when initially charging from 0V. In many cases the battery's internal impedance will act as a sufficient current limit, but if inrush current limiting is required to protect the battery, then see Current Limiting for Supercapacitors.