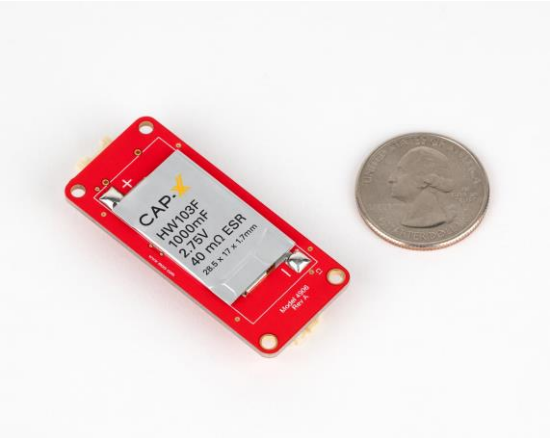
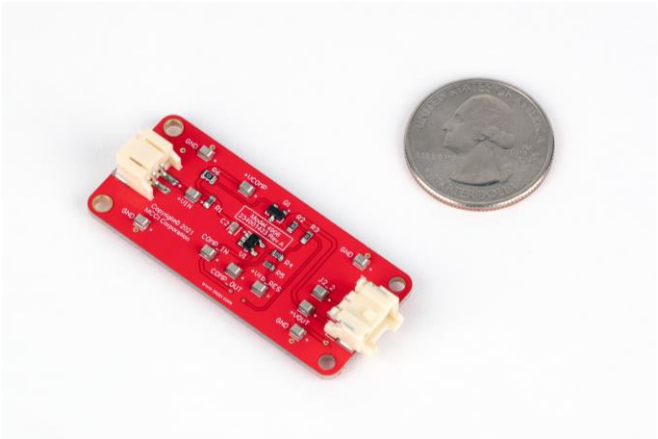
Model 4906 Supercap Feather Wing



The MCCI Model 4906 Supercap Feather Wing is designed to power up a high-power sensors/boards those need high power occasionally.

Today's sensors are often wireless, powered by a battery or an energy harvester for a maintenance free solution. Often due to size or other constraints, such as limited harvestable power, the preferred energy source cannot provide the peak power needs of the system, particularly for data transmission. The Model 4906 uses a supercapacitor to convert steady low power sourced from an energy harvester or battery into the burst power needed for occasional wireless data transmission.

Supercapacitors ("supercaps") are very efficient short-term energy storage devices. Supercaps, like batteries, store charge. Unlike batteries, supercaps store charge on the plates of a capacitor, rather than storing charge chemically. Supercaps won't hold charge nearly as long as batteries; but they charge and discharge much more efficiently, with very little energy lost to heat. Unlike batteries, they don't wear out as they're charged and discharged, are minimally affected by ambient temperature, and have a design life of ten years.

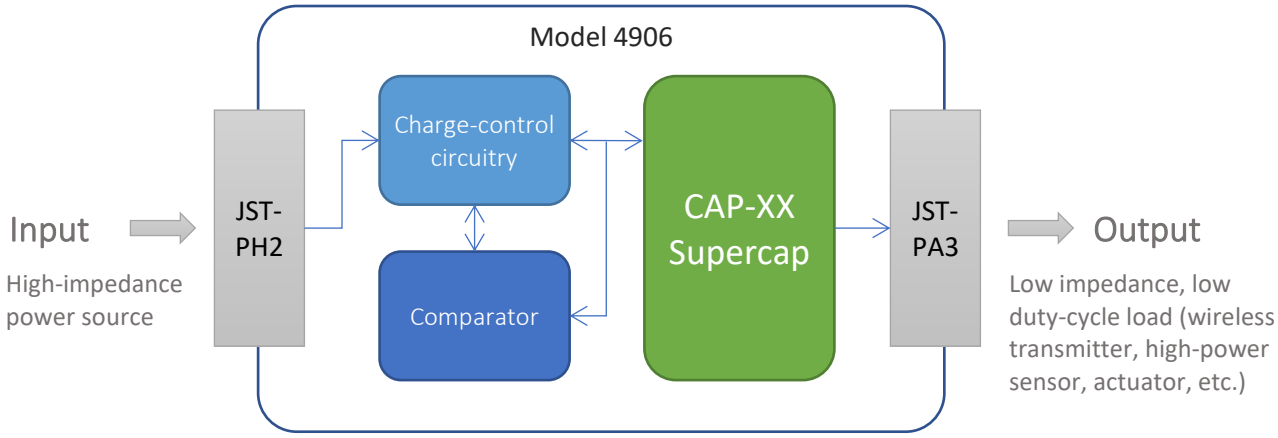


The Model 4906 Supercap Feather Wing includes a 1 farad CAP-XX HW103 supercap, charge-control circuitry to manage the supercap, and a 2.7 V regulator that operates from any 1.8 V to 5 V power supply to create a low-impedance 1.8 V to 2.7 V power supply. In between power bursts, the charge controller trickle-charges the supercap, storing energy while keeping the instantaneous load low. Then, when your load needs to do some intense work, the supercap supplies a burst of power to allow your board to do its work before going back to a low power state.

The output voltage drops as the supercap is discharged, and therefore this module is intended for use with loads that contain efficient boost regulators, such as MCCI's Catena 4801, Catena 4612 and Catena 4618. Such boards can work with input voltages from 1.8 V to 2.7 V.

The form-factor and mounting holes of the Model 4906 match boards designed to the 2" x 0.9" Adafruit Feather form factor for easy mechanical integration.

Block Diagram



Application: LoRaWAN with a Coin Cell

Coin cells are small and have good shelf life and high energy density. Unfortunately, they have high output impedances; and excessive pulse loads can dramatically reduce their capacity. In the US, LoRaWAN uplink radio transmits take about 130 mA at 3V for up to 400 ms. This is only 0.14 mAh per transmit, so the CR2032 could theoretically power around 20k uplinks. Unfortunately, the very high-power pulses stress the CR2032, and the battery very rapidly discharges.

Adding a supercap changes the picture. In our testing, MCCI combined a single CR2032 coin cell, a model 4906, and an MCCI Catena 4801. We were able to do LoRaWAN uplinks as frequently as every six minutes, without subjecting the battery to more than a 1 mA load. Of course, at six-minute uplinks, that's only about 80 days of operating life; but in a more typical application, this gives lots of margin for operating sensors, doing some local calculations, etc. Sending uplinks only every eight hours, for example, allows for transmitting for over 10 years. (Of course, you need to use good low-power practices in your circuit design and your firmware, to keep standby power draw to a minimum.)

Application: LoRaWAN with a Lithium Thionyl Chloride battery

Higher power applications demand high-capacity batteries with good shelf life. Lithium thionyl chloride (LiSOCl2) batteries can provide up to 19 Ah of capacity, around 60 times the capacity of a coin cell. However, they're subject to the same restrictions: they do not tolerate high power pulses very well. The Model 4906 limits the current draw to 1 to 2 mA under normal operating conditions. It also drops the output voltage to a convenient range for a boost regulator. With a 19 Ah battery, you'd have capacity for 1.2 million uplinks – enough to send data every six minutes for 10 years, with lots of margin for temperature variation and occasional bursts of computation.

Application: retrofitting Modbus equipment with LoRaWAN

Many industrial devices come with Modbus interfaces, and have internal power. Although these devices can supply a few extra mA without stress, the extra power required by LoRaWAN transmits can cause the power supply to collapse. Adding a Model 4906 allows periodic uplinks as well as class B operation, provided the firmware limits the uplink duty cycle to stay within the capacity of the supercap. If the industrial device has sufficient extra capacity, the input impedance of the 4906 may be reduced slightly by swapping out the input resistor, to allow up to 10 mA of input current; this would allow for class C operation.

Notes on using the Model 4906

The Model 4906 has a very large capacitor! So, be aware of the following notes.

Safety: Because it's operated at a low voltage, the supercap is not a spark hazard, or directly a safety hazard, but still it should be treated with respect. If shorted out while fully charged, it will discharge quickly, and something is likely to get hot. Since the actual amount of energy stored is much less than a battery, and the voltage is low, it's much less dangerous than shorting out a battery; but still, please treat all energy storage devices with respect!

Convenience: Because the Model 4906 has an input impedance of 1,000 ohms and a capacity of one farad, it takes quite a while for it to charge up. One "time constant" is 1,000 seconds, or about 17 minutes. So, if you apply a 3V power source, it will take 17 minutes to bring the Model 4906 up to 1.8V. Moral: be patient during first startup! Also, please make sure your electronics will power up "the first time" as the voltage rises slowly through the transition region. We've seen boards that draw a lot of power (many mA) during the power-on transition; if the startup current is too great, the system might not start up correctly. Contact MCCI for application assistance.

Specifications and Features

- Dimensions: 2" x 0.9"
- Capacity: 1 farad ±20%
- Input voltage 3 V nominal (1.8V to 5.25V)
- Input impedance: 1k ohms typical
- Output voltage 2.7 V nominal, 2.75 V max, dropping to as the supercap is discharged by output loads < 1k ohms
- Effective series resistance (ESR): 48 mΩ max
- Temperature range: -40 to +85 °C (max continuous operating temperature +70 °C but can withstand excursions to +85 °C)
- Supercapacitor leakage current (at 2.75 V, 23 °C): 1 µA typical, 2 µA max
- Input connector JST-PH2
- Output connector JST-PA3 (center pin no-connect)
- Test points are provided for monitoring performance during prototyping
- Warranty: one year
- Open-source hardware: schematics available on GitHub

For more information, contact MCCI at sales@mcci.com.