cap-XX APPLICATION BRIEF 1011

Powering GPRS Class 12 Devices on PCMCIA Cards with cap-XX Supercapacitors

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Outline

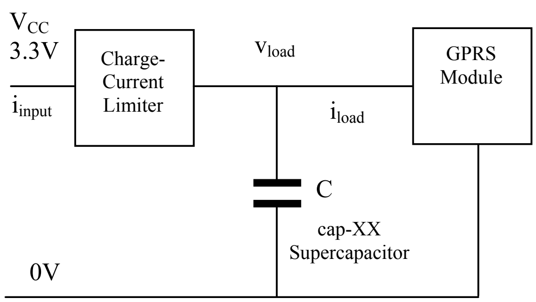
GPRS modems are now being designed into PCMCIA cards for use in notebook PCs and other products. However, the PC Card specification limits the current drain of the card to much less than a typical GPRS transmitter requires. This application brief describes a solution to this problem, using a cap-XX supercapacitor to power the transmitter without exceeding the peak input current requirement. This improves the efficiency, while reducing costs when compared with typical solutions utilising tantalum capacitors with a DC-DC converter.

The Problem

The PC Card specification limits the peak current drawn by the card to 1Amp, while most GPRS transmitters need 1.5A to 2A to transmit at full power at 3.3V. For example, when transmitting in class 12 using a maximum of four of the eight 577µs time slots, the pulse duration is 2.308ms and the period 4.616ms. Clearly, it is not possible for the card to operate within the specification without special design measures. The relatively high duty cycle imposes a limit on the current the transmitter can draw.

The cap-XX Solution

The diagram below shows a typical design using a cap-XX supercapacitor that solves the problem of delivering the power needed by a GPRS transmitter, while keeping the peak current drawn from the PC Card interface within specification.



The cap-XX supercapacitor has high capacitance and low ESR (equivalent series resistance), so delivers large current pulses without much change in load voltage. Because the ripple voltage on the load is small, this load-leveling effect means current drawn from the supply (the host device) during the load pulses can be under the maximum allowed by the PC Card specification. The most important criterion in selecting the supercapacitor is low ESR, because ESR typically contributes the most to the voltage ripple in high-C supercapacitors.

When the card is first plugged into the host, the supercapacitor is typically in a discharged state. To prevent the supercapacitor's charging current from overloading the host, a simple current-limit circuit is used, as shown above. For further information, please refer to Application Note 1002, *Start-Up Current-Limiters for Supercapacitors in PDAs and Other Portable Devices*, from cap-XX, available as a free download from the cap-XX web site.

The Benefits

The low-ESR cap-XX supercapacitor enables a transmitter to operate even though its current drain would usually exceed the value allowed by the PC Card specification. This is done with virtually 100% efficiency, instead of the lower efficiency of a DC-DC converter, and the supercapacitor does not generate EMI. The amount of energy that the host can deliver in a typical pulse period can be compared with the energy required by the load by performing a simple energy balance, as illustrated below.

If the load has a duty cycle of D (where $0<D\leq 1$) and the load current has a continuous component of i_{steady} and a pulse of i_{peak} (in addition to the steady current), then the average power drawn during one cycle is:

$$P_{ave} = V_{CC}(i_{steady} + D\cdot i_{peak})$$

The maximum average power that may be drawn from the supply is given by

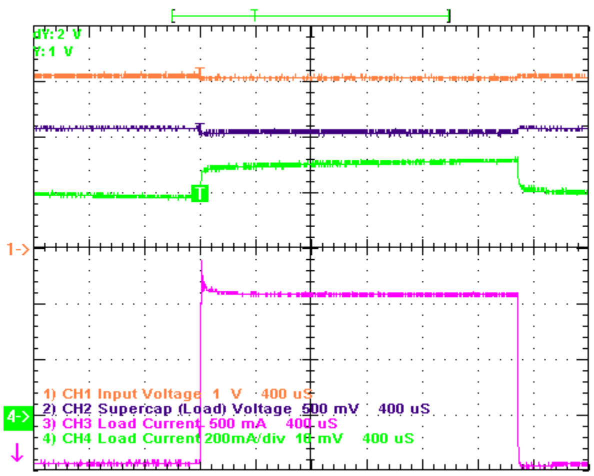
$$P_{ave,max} = V_{CC}\cdot i_{max}$$

where i_{max} is given by the PC Card specification as 1A. P_{ave} must be less than $P_{ave,max}$ for the load to function. Combining the above equations, we need the following:

$$i_{steady} + D \cdot i_{peak} < i_{max}$$

This equation is true for an ideal, infinite capacitor, so some margin must be allowed for voltage ripple in a real device. ***Example:*** Is it possible to run a transmitter in class 12 mode on a PC Card, using four slots out of eight (50% duty cycle), if it draws 100mA continuously plus 1.8A peak pulse transmission current? ***Answer:*** $i_{steady} + D \cdot i_{peak}$ = 0.1 + 0.5·1.8 A = 1.0A, which is at the 1A peak current limit. This ignores losses, so a 1.8A pulse is the maximum that could be supported in an ideal circuit. In a real circuit, the pulse load that can be supported will necessarily be less, such as 1.5A. (A 1.5A pulse results in an average of 0.85A, which leaves some headroom and allowance for losses.)

Running a simple simulation can also be helpful in verifying that a load will function successfully. Spreadsheets published by cap-XX on its web site enable one to simulate pulsed loads powered by sources with supercapacitors connected in parallel.



The oscilloscope image shows the traces from a test with a cap-XX supercapacitor, rated 0.48F, 20mΩ. The source voltage (V_{CC}) was modeled with a 3.3V supply and 200mΩ source impedance. A 33Ω resistor was used to create the 100mA continuous load, and an electronic load imposed a 1.5A pulse for 2.308ms every 4.616ms, to simulate a class 12 (4-slot) transmission. The traces (top to bottom) are input voltage, load voltage, current drawn from host and current drawn by the GPRS module. (Zero for CH2 and CH3 is the bottom graticule). Note that the host current does not exceed the 1A peak current specification and the load voltage remains above 3V. Adding extra source resistance can reduce the maximum current drawn from the source, but it is not advisable in applications in which the load voltage is close to the minimum.

The table below contains a list of some cap-XX supercapacitors that would work in the above example with a 1.6A maximum load current. Care should be taken to keep trace resistances to the minimum, particularly on the load side of the supercapacitor, if it is important to keep the operating voltage of the load above 3V. The lower the resistances and the ESR of the supercapacitor used, the better the ripple voltage will be and the more voltage headroom there will be. Two devices in series are required when using those with 2.3V ratings. (Contact cap-XX for information on voltage balancing.) Besides the standard devices, cap-XX is able to manufacture products to custom designs as well, when required.

C, Farads	ESR, mΩ	Voltage, V	Footprint, mm	Thickness, mm	Type No.
0.45	24	4.5	39 x 17	3.9	GS205
0.95 (each)	12 (each)	2.3	39 x 17	1.91	GS105 (2 req'd)
1.4	20	4.5	39 x 17	4.99	GS208
2.7 (each)	10 (each)	2.3	39 x 17	2.46	GS108 (2 req'd)

Further Information:

cap-XX will be pleased to supply detailed data and design information. For further details, please use the contact information listed at the foot of this page.

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