Compact Power Solution Overcomes Peak Power Limitations in PCMCIA-Based Pulsed-Load GSM and GPRS Applications

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Introduction

In an increasingly wireless world, mobile computing applications are driving the need for web-anywhere enabled notebook computers. PC Card or PCMCIA slot powered GSM/GPRS modems are now the standard for these applications. During GSM transmission peak currents can exceed 2A, well beyond the maximum current capability of the PCMCIA slot. Therefore, the modem must be designed to limit input power and draw on card-based storage for most of the energy required during a transmission cycle.

The LTC3125 is a synchronous step-up DC/DC converter that charges a reservoir capacitor up to the regulated output voltage while directly and accurately controlling the average input current. The LTC3125’s 91% efficiency provides the maximum possible output current to the load without impacting the host. Together with an external bulk or reservoir capacitor, the LTC3125 can interface the GSM/GPRS modem directly to a PCMCIA power bus without overloading it.

Power Demands

Much of the work in GSM/GPRS power supply design revolves around the transmission cycle due to the high current consumption in this mode. Typically the transmitter’s supply current is modulated to 2A pulses, which occupy one or more of the 577µs timeslots from the eight timeslots available.

During a GSM transmission, one timeslot is used for data transmission, the other seven are idle, during which the supply current is reduced to less than 100mA. Therefore, the average current consumed over the 4.6ms window is about 340mA. In the end, the transmitter power supply design must be capable of an average current of 340mA but also be able to handle the 2A transmit burst currents. Higher data rate standards are also popular. For instance, the GPRS Class 10 standard allows for transmission in two of the eight available timeslots for an average current consumption of almost 575mA and 2A burst duration of 1.15ms.

Based on the standard PC card bus power (3.0V to 3.6V) specification, the maximum peak current must not exceed 1A. This is clearly not sufficient for powering these GSM/GPRS applications directly.

The Solution

The LTC3125 is a 91% efficient step-up DC/DC converter in a 2mm × 2mm QFN. The design takes inputs as low as 0.7V and provides a 4V output directly to the pulsed load. The converter’s efficiency allows it to handle the high current burst without overloading the host. Together with an external reservoir capacitor, the LTC3125 can interface the modem directly to the PCMCIA power bus, providing a complete solution for GSM transmitters.

Figure 1. A complete PCMCIA-powered, low profile solution for GSM transmitters

Figure 2. PC Card or CompactFlash (3.3V/500mA max) 4.0V output, GSM pulsed load
During GSM transmission peak currents can exceed 2A, well beyond the maximum current capability of the PCMCIA slot. Therefore, a PCMCIA-based modem must be designed to limit input power and draw on card-based storage for most of the energy required during a transmission cycle.

If the load pulse is periodic, as in the GSM application, it is desirable to insure that the capacitor recharges during the idle timeslots. The time to re-charge the reservoir capacitor(s) is approximately:

$$t_{\text{RECHARGE}} = \frac{C_{\text{OUT}} \cdot V_{\text{DROOP}} \cdot V_{\text{OUT}}}{\eta \cdot I_{\text{INPUT}} \cdot V_{\text{IN}}}$$

Where $t_{\text{RECHARGE}}$ is the time for the LTC3125 to raise the output voltage back to its terminal value, $C_{\text{OUT}}$ is the output capacitance, $V_{\text{OUT}}$ is the average terminal output voltage, $V_{\text{DROOP}}$ is the previously calculated droop, $\eta$ is the fractional converter efficiency ($\eta = 1$ is 100% efficiency), $V_{\text{IN}}$ is the input voltage and $I_{\text{INPUT}}$ is the input current limit.

Both of these factors, voltage droop and re-charge time, ultimately determine the required reservoir capacitor size. The typical pulsed load response for the circuit in Figure 2 is shown in Figure 3.

Charging High Density Capacitors

Larger supercapacitors are commonly used in hold-up power sources where they deliver power in the event of a main power source failure or removal. The LTC3125’s input current limit, soft start feature and its ability to operate with input voltages exceeding the output voltage, make it an ideal converter to safely regulate the voltage across the large output capacitors while still protecting the input power supply. The LTC3125 step-up converter maintains voltage regulation even when the input voltage is above the desired output voltage. Figure 4 shows the response of the LTC3125 charging a 15F, 2.5V super capacitor.

Conclusion

The compact LTC3125 step-up DC-DC converter with ±5% accurate, programmable average input current limit is an optimal GSM/GPRS power supply solution for PCMCIA/PC Card slot powered peripherals. Its high efficiency combined with today’s low profile supercapacitors elegantly solves the pulsed load problem with a compact solution footprint.