

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

by Timothy Sourdif

## 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.

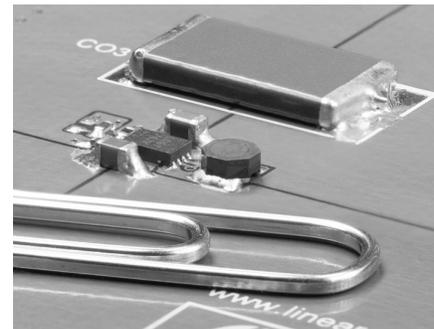


Figure 1. A complete PCMCIA-powered, low profile solution for GSM transmitters

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 x

## 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 IDEAS

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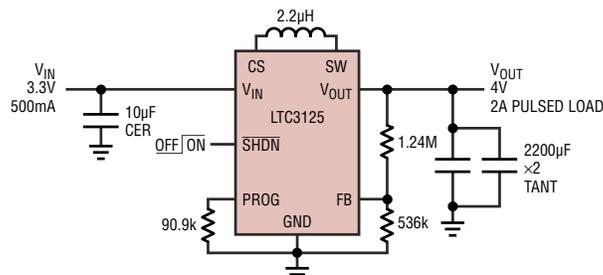


Figure 2. PC Card or CompactFlash (3.3V/500mA max) 4.0V output, GSM pulsed load

3mm × 0.75mm DFN package. The 1.5MHz switching frequency provides a compact and low profile design solution for pulsed load applications (Figure 1). The high accuracy (±5%) of the programmable input current limit allows the designer to efficiently use the maximum available source current. To accommodate a variety of card standards, the input current limit can be set to any value from 200mA to 1A by an external programming resistor. Output disconnect ensures that the output is completely discharged in shutdown. The LTC3125 also eliminates inrush current during start-up, maintaining control of the current seen by the input supply when low ESR reservoir capacitors are being charged. Additional features include antiringing control for EMI suppression, short-circuit protection, automatic Burst Mode operation, soft-start and thermal overload protection.

Recent developments in ultra- or super-capacitors as well as high value tantalum capacitors have vastly increased the available capacitance for a given volume while achieving very low ESR. Low profile bulk output capacitors are available to supply the energy to the load and maintain the output voltage within the specified limits during the high current pulses. High capacitance and low ESR can lead to instability in typical internally compensated step-up DC/DC converters. The internal loop compensation of the LTC3125 is optimized for use with any output capacitor value greater than 500µF. Figure 2 shows the LTC3125 powered from a

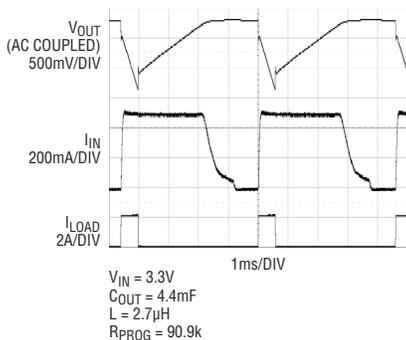


Figure 3. Waveforms of input current and  $V_{OUT}$  for a pulsed load current

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standard 3.3V/500mA PC card port. The 500mA input current limit is set by  $R_X$ . Here, two 2200µF, low profile, Vishay TANTAMOUNT solid tantalum capacitors provide power to the load during pulsed load events. Given the magnitude and the duration of the pulsed load current, the capacitors are chosen to meet the output voltage droop specification, typically 300mV. Neglecting the input current supplied by the source, the total output voltage droop is given by:

$$V_{DROOP} = I_{PULSE} \left( R_{ESR} + \frac{t_{PULSE}}{C_{OUT}} \right)$$

Where  $V_{DROOP}$  is the change in output voltage,  $I_{PULSE}$  and  $t_{PULSE}$  are the peak pulse current and duration respectively,  $R_{ESR}$  is the capacitor ESR and  $C_{OUT}$  is the output capacitance.

During and after the load pulse the LTC3125 will draw the maximum input current set by  $R_{prog}$  to charge the reservoir cap until the desired terminal output voltage is reached.

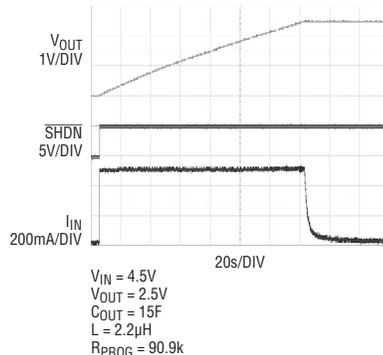


Figure 4. Waveforms of input current and  $V_{OUT}$ , charging large  $C_{OUT}$  from 0 volts

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:

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

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