

# DESIGN NOTES

## Supply 2A Pulses for GSM Transmission from 500mA USB or PCMCIA Ports – Design Note 307

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### Introduction

GSM modems have become popular as a wireless data transfer solution; however, they frequently require large bursts of current that exceed the maximum input current available to the voltage regulator. Many can be powered from a USB port (4.5V to 5.5V input) or a PCMCIA port (3V to 3.6V input), where 3.xV is required to supply the RF power amplifier that draws current pulses up to 2A. Since the input from the USB or PCMCIA port is current limited to 500mA, a high efficiency Buck-Boost converter with input current limit provides the best power supply solution. High efficiency maximizes the average output power, while a bulk output capacitor is used to maintain the voltage during the high current pulses.

The LTC<sup>®</sup>3440 Buck-Boost converter is a compact and high efficiency solution for GSM modems that can be powered from USB or PCMCIA. It has four integrated switches to provide synchronous Buck-Boost operation and requires only one inductor, saving cost and board space. The IC is available in a tiny 10-pin MSOP package and operates up to 2MHz, allowing the use of tiny surface mount components. Quiescent current is only 25µA in Burst Mode<sup>®</sup> operation. The LTC3440 also disconnects the output from the input during shutdown, which is required for many USB applications.

### Powering GSM Modems from USB or PCMCIA

Figure 1 shows a Buck-Boost converter powered from USB or PCMCIA. The input current limit is implemented by using half of the LT1490A dual micropower op amp. The op amp is configured as a current source which limits the input current to 500mA. The other half of the LT1490A is used as a buffer. Efficiency at the given pulsing load is shown in Figure 2.

The magnitude and duration of the pulsing current, together with the ripple voltage specification, determine the choice of the output capacitor. Both the ESR of the capacitor and the charge stored in the capacitor each cycle contribute to the output voltage ripple. The ripple due to the charge is approximately:

$$V_{\text{RIPPLE\_BULK}} = \frac{(I_{\text{PULSE}} - I_{\text{STANDBY}}) \cdot t_{\text{ON}}}{C_{\text{OUT}}}$$

where  $I_{\text{PULSE}}$  and  $t_{\text{ON}}$  are the peak current and on time during transmission burst and  $I_{\text{STANDBY}}$  is the current in standby mode. The above is a worst-case approximation assuming all the pulsing energy comes from the output capacitor.

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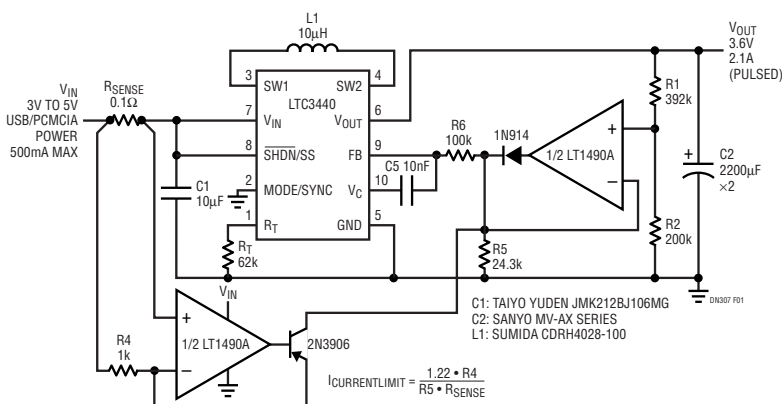


Figure 1. Converter Powering GSM Modem from USB or PCMCIA

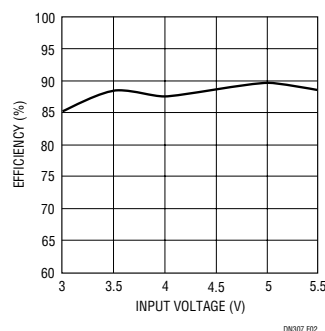


Figure 2. Efficiency of the Converter in Figure 1 (Pulsing Load: 1.2A for 1.15ms, 80mA for 3.45ms, within a Period of 4.6ms)

The ripple due to the capacitor ESR is:

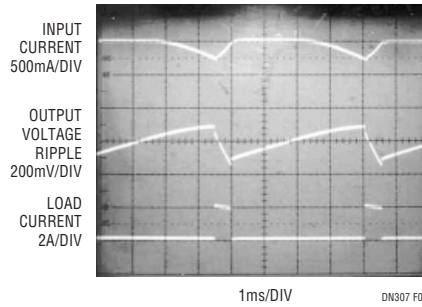
$$V_{\text{RIPPLE\_ESR}} = (I_{\text{PULSE}} - I_{\text{STANDBY}}) \cdot \text{ESR}$$

Low ESR and high capacitance are critical to maintain low output ripple. In this application, two 2200 $\mu\text{F}$  SANYO electrolytic capacitors are used. Each capacitor has less than 38m $\Omega$  ESR. For applications requiring a very low profile, the BestCap™ series from AVX and PowerStor® Aerogel Capacitors from COOPER offer very high capacitance and low ESR in 2mm height packages.

The GSM standard specifies 575 $\mu\text{s}$  transmission burst within a 4.6ms period (1/8 duty factor). The converter in Figure 1 can provide up to 2.1A during each transmission burst and 100mA in standby for input voltages as low as 3V with a maximum of 500mA input current. If the minimum input voltage is higher or the 500mA input current limit is only required for USB input (4.5V to 5.5V), more power is available at output. Figure 3 shows the output voltage ripple along with input and output currents. Other standards (such as GPRS) define a higher data rate. One popular requirement is 1.15ms transmission bursts within a 4.6ms period (1/4 duty factor). The converter can deliver 1.2A pulsing current with 80mA standby current, again assuming 3.0V minimum input voltage with a 500mA current limit. The output ripple is similar to Figure 3 except that the ripple caused by ESR is less due to the lower load step.

### 5V Converter in USB On-The-Go Devices

As portable devices using USB increase in popularity, there is a growing need for them to communicate directly with each other when a PC is not available. The result is USB On-The-Go (OTG). USB OTG is a new supplement to



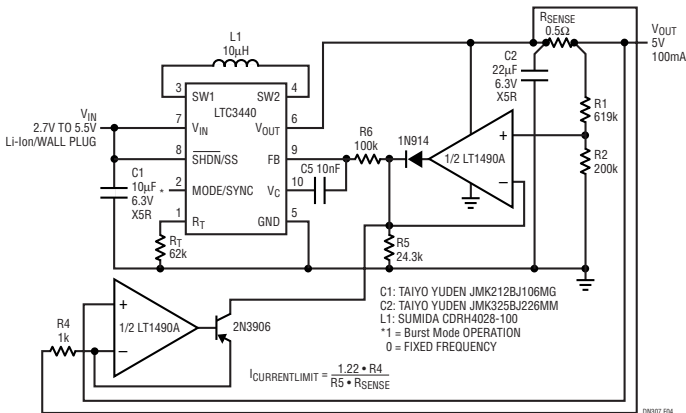
**Figure 3. Waveforms Showing Input Current (Top) and Output Voltage Ripple (Middle) at Pulsing Load (Bottom)**

the USB 2.0 specification that augments the capability by adding a host function for connection to USB peripherals. These USB OTG dual-role devices need a 5V converter to supply USB peripherals. The LTC3440 provides a compact solution with high efficiency, low quiescent current and shutdown disconnect. Accurate current limit can again be achieved by using the LT<sup>®</sup>1490A dual op amp. Figure 4 shows a converter with 100mA current limit. Efficiency is plotted in Figure 5.

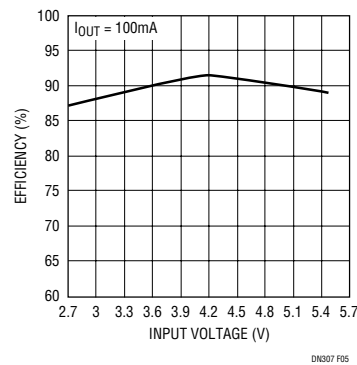
To optimize light load efficiency, the MODE/SYNC pin can be pulled high to enable Burst Mode operation where quiescent current is only 25 $\mu\text{A}$ .

### Conclusion

The LTC3440 synchronous Buck-Boost converter provides an optimal solution for GSM modems and USB OTG devices. Compared with the traditional SEPIC or Boost cascaded with an LDO converter, the LTC3440 converter provides much higher efficiency with fewer components and smaller size.



**Figure 4. Converter Powering USB Compatible Devices**



**Figure 5. Efficiency of the Converter in Figure 4**

#### Data Sheet Download

<http://www.linear.com/go/dnLTC3440>

For literature on our Buck-Boost Converters, call **1-800-4-LINEAR**. For applications help, call (408) 432-1900, Ext. 2759