

# DESIGN NOTES

## Low EMI Synchronous DC/DC Step-Down Controllers Offer Programmable Output Tracking – Design Note 382

Charlie Zhao

### Introduction

The LTC<sup>®</sup>3808 synchronous DC/DC step-down controller packs numerous features required by the latest electronic devices into a low profile (0.75mm) 3mm × 4mm leadless DFN package or a leaded SSOP-16 package. Two similar parts, the LTC3809 and LTC3809-1, are even smaller, but less feature-rich versions of the LTC3808. The LTC3809 family is available in a 3mm × 3mm leadless DFN package or a 10-pin MSOP Exposed Pad package. All three parts can provide output voltages as low as 0.6V and output currents as high as 7A from a 2.75V to 9.8V input range, making them ideal devices for one or two lithium-ion cell inputs as well as distributed DC power systems.

The LTC3808 and LTC3809 also include important features for noise-sensitive applications, including a phase-locked loop (PLL) for frequency synchronization and spread spectrum frequency modulation to minimize generated electromagnetic interference (EMI). The adjustable operating frequency (300kHz to 750kHz) allows the use of small surface mount inductors and ceramic capacitors for compact power supply solutions.

Other features include:

- Low operating quiescent current to improve battery life and light load efficiency
- No  $R_{SENSE}^{TM}$  current mode technology which senses the voltage across the main (top) power MOSFET to improve efficiency and reduce the size and cost of the solution
- Current mode control for excellent AC and DC line and load regulation
- Low dropout (100% duty cycle) for maximum energy extraction from a battery source
- Output overvoltage protection and short circuit current limit protection
- Adjustable or fixed built-in soft-start timer

- Output voltage ramp control and the ability to track other voltage sources (LTC3808 and LTC3809-1)
- PowerGood voltage monitor (LTC3808)

Table 1 compares the features of these three parts.

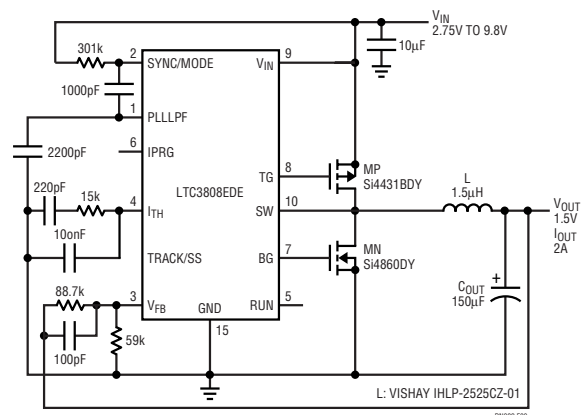
**Table 1.**

	START-UP CONTROL	SPREAD SPECTRUM	ADJUSTABLE FREQ/PLL	POWER GOOD
LTC3808	Internal External Tracking	Yes	Yes	Yes
LTC3809	Internal	Yes	Yes	No
LTC3809-1	Internal External Tracking	No	No	No

### Three Choices for Start-Up Control

The start-up of  $V_{OUT}$  for the LTC3808 and LTC3809-1 is based on the three different connections to the TRACK/SS pin. A typical application is shown in Figure 2. When TRACK/SS is connected to  $V_{IN}$ , the start-up of  $V_{OUT}$  is controlled by the internal soft-start which ramps from 0V to ( $V_{FB}$ ) in about 1ms. A second start up mode allows the 1ms soft-start time to increase or decrease by

**LT**, LTC and LT are registered trademarks and No  $R_{SENSE}$  is a trademark of Linear Technology Corporation. All other trademarks are the property of their respective owners.



**Figure 1. Synchronous Converter with Spread Spectrum Frequency Modulation**

connecting an external capacitor  $C_{SS}$  between the TRACK/SS pin and ground. An internal  $1\mu\text{A}$  current source and the value of  $C_{SS}$  control the ramp time of TRACK/SS from 0V to above 0.6V. In this case, the LTC3808 and LTC3809-1 regulate the VFB to the voltage at the TRACK/SS pin instead of the internal soft-start ramp. The third mode allows  $V_{OUT}$  of the LTC3808 and LTC3809-1 to track an external voltage,  $V_X$ , during start-up if a resistor

divider from  $V_X$  is connected to the TRACK/SS pin. Figure 3 shows the start-up of  $V_{OUT}$  in these tracking modes for the circuit shown in Figure 2.

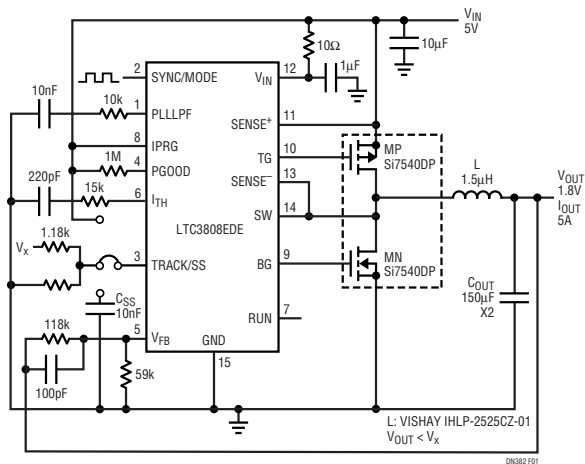
For simplicity, the LTC3809 only offers a 1ms internal soft-start.

### Low EMI DC/DC Conversion

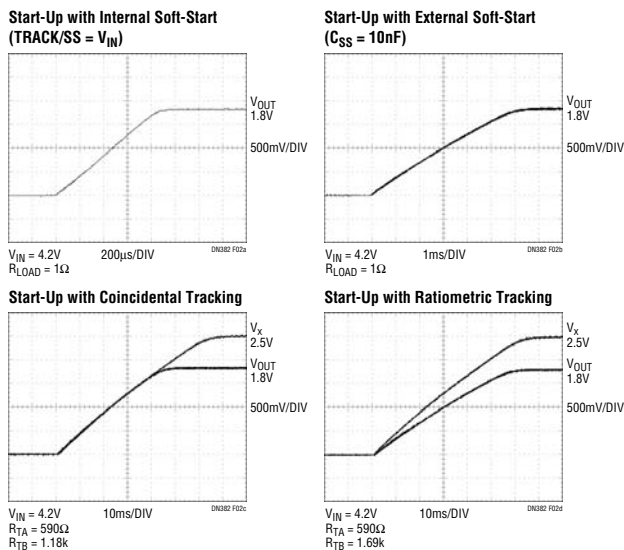
The LTC3808 and LTC3809 minimize the need for EMI shields and filters in applications such as navigation systems, wireless LANs, data acquisition boards and industrial and military radio devices by optionally spreading the nominal operating frequency (550kHz) over a range of frequencies between 460kHz and 635kHz. Spread spectrum frequency modulation is enabled by biasing the SYNC/MODE pin to a DC voltage between 1.35V and  $(V_{IN} - 0.5\text{V})$ . An internal  $2.6\mu\text{A}$  pull-down current source at the SYNC/MODE pin can be used to set the DC voltage at this pin by tying a resistor with an appropriate value between SYNC/MODE and  $V_{IN}$ . Figure 1 shows the application circuit and Figure 4 shows the frequency spectral plots of the output ( $V_{OUT}$ ) with and without spread spectrum modulation. Note the significant reduction in peak output noise (>20dBm) with spread spectrum enabled.

### Conclusion

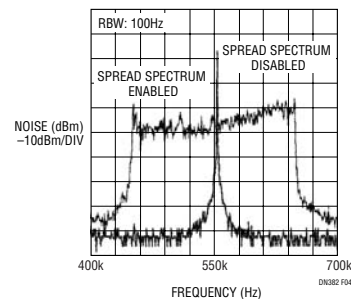
The LTC3808, LTC3809 and LTC3809-1 offer flexibility, high efficiency, low EMI and many other popular features in small thermally efficient packages. They offer excellent solutions for low voltage portable and distributed power systems that require a small footprint, high efficiency and low noise.



**Figure 2. The LTC3808 Offers the Flexibility of Start-Up Control Based on the Three Different Connections on the TRACK/SS Pin**



**Figure 3. Start-Up Output Voltage Tracking Plots for Circuit in Figure 2**



**Figure 4. Comparison of the  $V_{OUT}$  Spectrum with and without Spread Spectrum Modulation Enabled**

[Data Sheet Download](#)

[www.linear.com](http://www.linear.com)

For applications help,  
call (408) 432-1900, Ext. 2759