Low Power Boost Regulator with Dual Half-Bridge in 3mm × 2mm DFN Drives MEMS and Piezo Actuators

by Jesus Rosales

Introduction

Advances in manufacturing technology have made it possible for actuators, sensors, RF relays, and other moveable parts to be manufactured at a very small scale. These devices, referred to as MEMS (micro-electro-mechanical systems) or micro-machines, are finding their way into daily life in applications unheard of just a few years ago. MEMS are used in automotive, military, medical and consumer product applications.

Many types of MEMS devices consume very little power to operate and generally require the use of two support circuits, a step-up converter and a dual half-bridge driver. These support circuits must be very small and highly efficient to keep pace with ever-shrinking MEMS applications. To this end, the LT8415 integrates the step-up converter power switch and diode and the dual half-bridge driver in a 12-pin, 3mm × 2mm DFN package. Its novel switching architecture consumes very little power throughout the load range, making it an ideal match for driving low current MEMS.

The LT8415 generates output voltages up to 40V from sources ranging from 2.5V to 16V. The output is then available for the integrated complementary half-bridge drivers and is available via OUT1 and OUT2 (see Figure 1). Each half-bridge is made up of an N-channel MOSFET and a P-channel MOSFET, which are synchronously controlled by a single pin and never turn on at the same time. OUT1 and OUT2 are of the same polarity as IN1 and IN2, respectively. When the part is turned off, all MOSFETs are turned off, and the OUT1 and OUT2 nodes revert to a high impedance state with 20MΩ pull-down resistors to ground.

2.6V–5V Input to 34V Output MEMS Driver

Figure 2 shows a MEMS driver that takes a 2.6V–5V input and produces a 34V output. This circuit draws very little source current when the dual half-bridge is disabled. The input current is only 320µA at $2.6V_{IN}$ and 128µA at $5V_{IN}$. A logic level signal at IN1 and IN2 activates the dual half-bridge switches. Figure 3 shows the turn-on delay and rise time for OUT1 and OUT2 with both half-bridges activated. Figure 4 shows the turn-off delay and fall time with the 200pF and 1nF capacitive loads shown in Figure 2. See the data sheet details for measuring delay time.

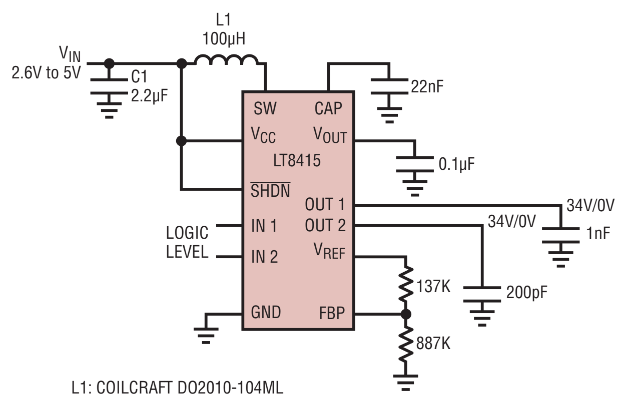

Figure 2. 2.6V–5V input to 34V dual half-bridge boost converter

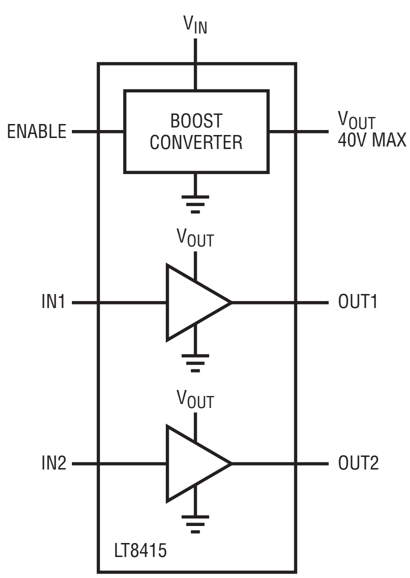

Figure 1. Simplified block diagram of the LT8415

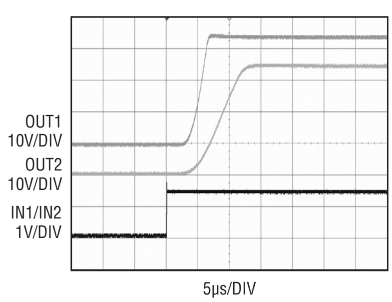

Figure 3. Turn-on delay and rise time for OUT1 and OUT2

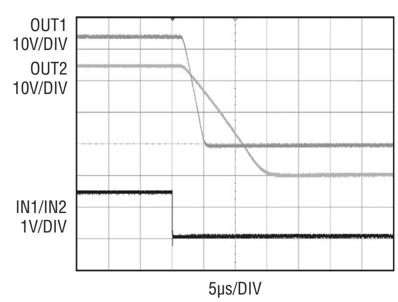

Figure 4. Turn-off delay and fall time for OUT1 and OUT2

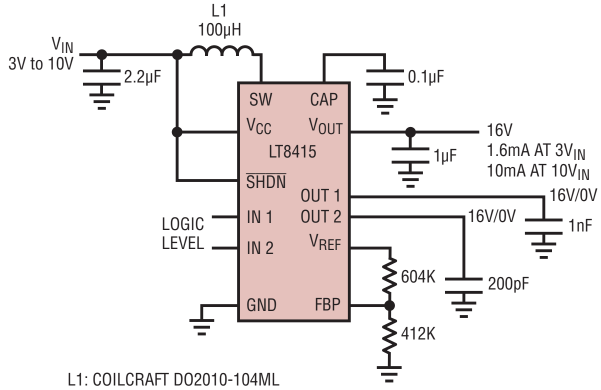

Figure 5. 3V–10V input to 16V dual half-bridge plus 16V output boost converter

3V–10V Input to 16V Output MEMS Driver and Bias Supply

Figure 5 shows a 3V–10V input to 16V output converter, where the output drives the dual half-bridge and also provides bias current for other circuitry. The converter in Figure 2 can be used in a similar fashion, but the current available at the output is reduced as the output voltage is increased. See the data sheet for details about maximum output current.

Integrated Resistor Divider

The LT8415 contains an integrated resistor divider such that if the FBP pin is at 1.235V or higher, the output is clamped at 40V. For lower output voltage levels use R1 and R2, calculating their values as instructed by the data sheet. This method of setting the output voltage ensures the voltage divider draws minimal current from the input when the part is turned off.

Conclusion

The LT8415 is an ideal match for driving low power MEMS. It integrates a step-up converter power switch and diode, a complementary dual half-bridge, and a novel switching architecture that minimizes power dissipation.

LTM4614/15, continued from page 26

to promote good thermal conductivity. Figure 10 shows that thermal dissipation is well-balanced between the two switching regulators.

Output Voltage Tracking

Tracking can be programmed using the TRACK1 and TRACK2 pins. To implement coincident tracking, at the slave's TRACK pin, divide the master regulator's output with a resistor divider that is the same as the slave regulator's feedback divider. Figure 11 shows a tracking design and Figure 12 shows the output. V_{OUT2} tracks V_{OUT1} in master-slave design with both outputs ramping up coincidently. The smooth start-up time is attributed to the soft-start capacitor.

Conclusion

The cumbersome designs typical of multivoltage regulation are a thing of the past. The LTM4614 and LTM4615 µModule multiple-output regulators can be easily fit into space-constrained system boards with far fewer components than discrete solutions. The dual-output LTM4614 µModule regulator and triple-output LTM4615 are small in size, have excellent thermal dissipation and have high efficiency. Independent input and output voltage rails give these µModule regulators unmatched flexibility. They can be used in a variety of input-output combinations, including input and output current sharing, output voltage tracking, and low noise output.

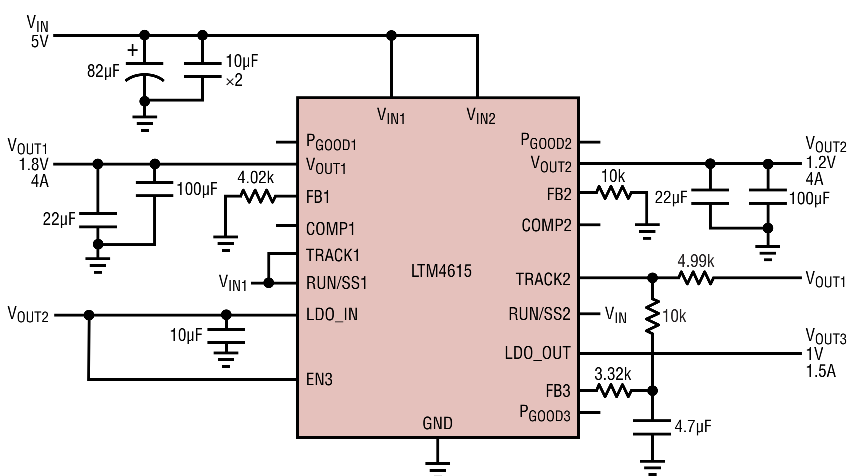

Figure 11. Output voltage tracking design example

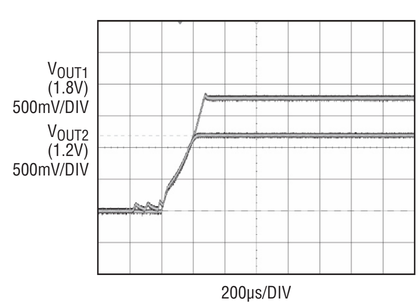

Figure 12. Start-up waveforms for the circuit in Figure 11