Design Solutions

DESIGN SOLUTION 1

200kHz Switching Regulator Reduces Board Space

by Brian Huffman

The Micrel MIC4574, MIC4575 and MIC4576 are enhanced versions of the popular LM257x family of 52kHz, step-down (buck), switching regulators. They feature a 200kHz switching frequency that reduces the inductor size by a factor of four, freeing up precious board space, and allows conversion from 12V to 5V/1A in under one square inch of board space.

The MIC457x series operates from input voltages ranging from 4V to 24V and a maximum output current of 3A (MIC4576), making the parts ideal for distributed power applications.

Just like their predecessors, these devices are easy to use requiring only four external components to build a complete power supply. The MIC457x series integrates all the control and protection circuitry as well as the power transistor, frequency compensation, and a fixed-frequency oscillator.

A 52kHz design can be upgraded easily by replacing the inductor with one that is one-fourth its value (maintaining dc current rating). No additional changes are required. *Application Note 15* provides design solutions for 45 common power supply designs, greatly simplifying the design of switch-mode power supplies.

The 200kHz switching frequency allows for a complete surface-mount solution without the associated EMI problems that can plague higher switching-frequency designs. Note that radiated emissions increase with the square of the switching frequency. Therefore, a 1MHz switching regulator can generate 25 times more EMI, making it more difficult to meet FCC or European radiated emissions requirements.

Many digital systems require the supply be powered up in a predetermined sequence to avoid either latching the main supply or preventing the microprocessor from coming up in an undefined state. A logic-level signal shuts off the regulator when a “high” is applied to the shutdown input. To disable the shutdown feature, the shutdown pin (SHDN) must be connected to the ground pin (GND), as in Figure 1. In shutdown, the MIC4575 draws less than 200µA of quiescent current.

Many analog systems require a negative supply voltage for powering op-amps. This split-supply requirement can be fulfilled easily by using the standard buck circuit of Figure 1 for the positive supply and the positive-to-negative converter of Figure 2 or Figure 3 for the negative supply.

Although a multiple output flyback topology could be used to produce the split-supply voltages, this would require a linear regulator on the output of the unregulated winding to meet the

MIC4574 / MIC4575 / MIC4576 Summary

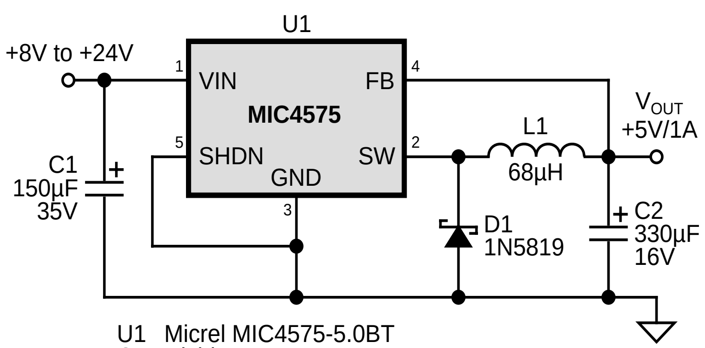
- 4V to 24V input
- 3.3V, 5V, or adjustable output

Features

- 80% efficiency
- 200µA shutdown
- 200kHz PWM control
- Only 4 external components
- Internal frequency compensation
- –40°C to +85°C ambient operating range
- *Application Note 15* for sample designs
- MIC4575 evaluation board available

Applications

- On-card switching regulators
- Positive-to-negative converters
- Low-noise switching regulators
- Split ±5V or ±12V supplies



U1 Micrel MIC4575-5.0BT
C1 Nichicon UPL1V151MPH
C2 Nichicon UPL1C331MPH
D1 Motorola 1N5819
L1 Coiltronics PL52B-68-500

Figure 1. MIC4575 Buck Converter (8V–24V to 5V/1A)

output regulation performance of the positive-to-negative converter. Also, the flyback converter uses a transformer that is not an off-the-shelf component. It must be customized for the particular application, which could add weeks to the design process. Inductors are preferred in many converter designs because they are economical and more readily available.

Figure 2 shows a design that eliminates a level-shifting op amp by connecting the MIC4575 ground pin (GND) to the negative output voltage and the feedback pin (FB) to ground. The only drawback to this scheme is that the shutdown signal is now referred to the –5V output instead of to ground, requiring a level-shifting transistor to implement this function.

If stability analysis of a positive-to-negative converter is not considered during the design process, there almost certainly will be loop stability problems in which the output voltage will oscillate. Oscillation problems are characterized by a nonrepetitive duty cycle and a pseudo-sinewave between 100Hz to 1kHz superimposed on the output voltage. This instability is caused by a RHP (right-half-plane) zero in the transfer function, which makes frequency compensation very difficult.

A discontinuous design, as in Figure 2, eliminates the RHP zero because an RHP zero occurs only in continuous mode. This produces the simplest circuit, although output current is one-half and peak current is about double when compared to a equivalent continuous design.

For a continuous design, as in Figure 3, an RC network must be used to provide enough phase lead to give adequate frequency compensation. This circuit is a little more complex, but produces higher output currents.

For literature on our switching regulators, call **(408) 944-0800**. For application help call **(408) 944-0800. ext. 336**.

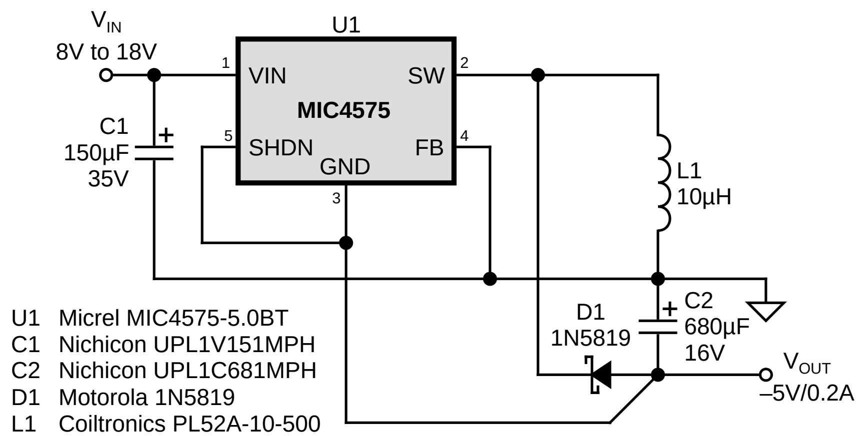


Figure 2. MIC4575 Discontinuous Design (8V–18V to –5V/0.2A)

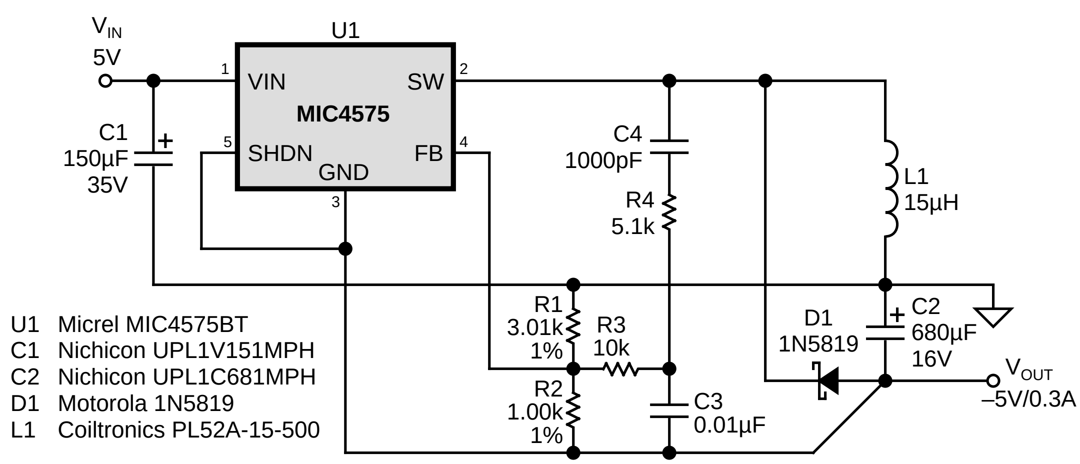


Figure 3. MIC4575 Continuous Design (5V to –5V/0.3A)