

# DESIGN NOTES

## LT1777 High Voltage, Low Noise Buck Switching Regulator

Design Note 212

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The LT<sup>®</sup>1777 is a wide input range buck (step-down) switching regulator specially designed for low noise applications. The LT1777 can be beneficial in applications where low noise is critical, such as telecom, automotive cellular and GPS receiver power supplies. The schematic in Figure 1 highlights the capabilities of the LT1777.

The LT1777 can accept input voltages from 7.4V to 48V and has a nominal switching frequency of 100kHz. The monolithic die includes an onboard 700mA peak current switch, oscillator, control and protection circuitry. It uses current mode control that delivers excellent dynamic input supply rejection and short-circuit protection. In order to achieve low noise, the LT1777 is equipped with  $dI/dt$  limiting circuitry that is programmed via a small inductor ( $L_{SENSE}$  in Figure 1) in the power path. It also contains internal circuitry to limit  $dV/dt$  during switch turn-on and turn-off.

Figure 2 shows the  $V_{SW}$  node voltage and switch current for the low noise LT1777. Figure 3 shows the  $V_{SW}$  node voltage and switch current for the high voltage LT1676 buck regulator under the same test conditions (no slew rate limiting). It can be seen from Figures 2 and 3 that the switch node voltage and current waveforms for the LT1777 are more controlled and rise and fall more slowly than those of the LT1676 regulator. Conducted and radiated EMI are dramatically reduced by slowing down the sharp edges during turn-on and turn-off of

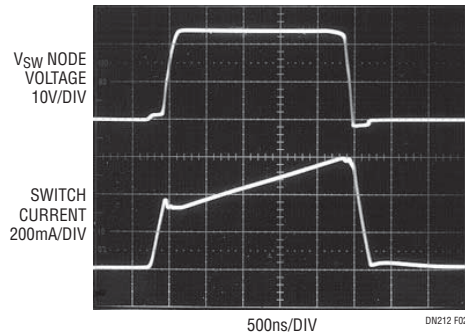


Figure 2.  $V_{SW}$  Voltage and Switch Current for the LT1777

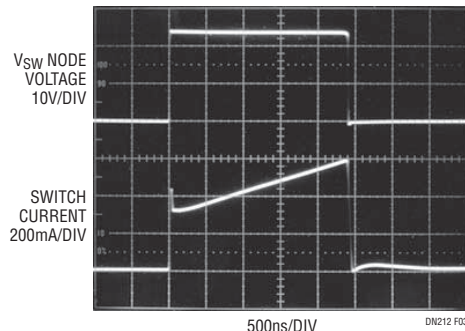


Figure 3.  $V_{SW}$  Voltage and Switch Current for the LT1676 (No Slew Control)

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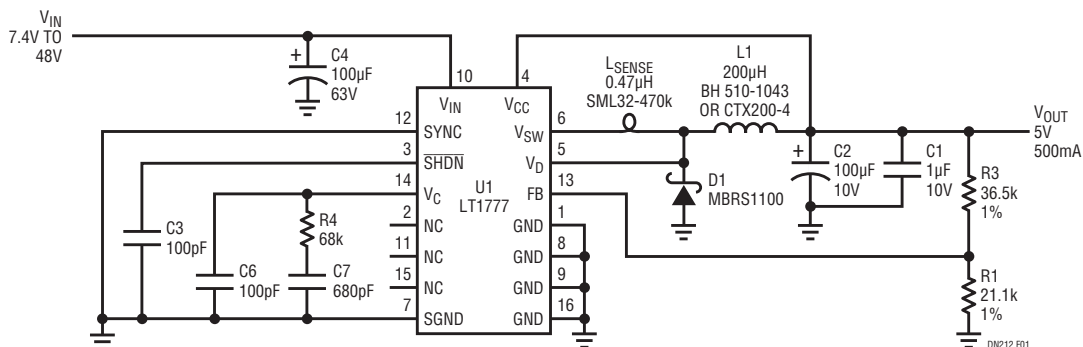


Figure 1. 100kHz Low Noise Step-Down Switching Regulator

the power switch with only modest reduction in conversion efficiency.

Figure 4 shows a spectral analysis of the current wave forms for the LT1777 and the LT1676. The horizontal axis is 2MHz/DIV (0MHz to 20MHz), and the vertical axis is 10dB/DIV. It can be seen from Figure 4, the LT1777 attenuates the high frequency noise by approximately -20dB compared to the LT1676.

The LT1777 can be disabled by connecting the shutdown (SHDN) pin to ground, reducing input current to a few microamperes. For normal operation, decouple the SHDN pin with a 100pF capacitor to ground. The part also has a SYNC pin, used to synchronize the internal oscillator to an external clock, which can range from 130kHz to 250kHz. To use the part's internal oscillator, simply connect the SYNC pin to ground.

Since the LT1777 allows such a wide input range, the internal control circuitry draws power from the  $V_{CC}$  pin, which is normally connected to the output supply. During start-up, the LT1777 draws power from  $V_{IN}$ ; after

the switching supply output reaches 2.9V, the LT1777 uses the output voltage to power its internal control circuitry, thereby reducing quiescent power by hundreds of milliwatts when operating at high line voltages.

Figure 5 shows a typical efficiency curve for the LT1777 using sense inductor,  $L_{SENSE} = 0.47\mu\text{H}$ ,  $V_{IN} = 12\text{V}$  and  $V_{OUT} = 5\text{V}$ .

### Generating Low Noise, Dual-Voltage Supplies

The circuit in Figure 6 shows a cost-effective way to generate 5V and -5V low noise supplies from a single 10V to 28V supply using the LT1777 and a few off-the-shelf components.

L1A and L1B are two windings on a single core, used to generate  $\pm 5\text{V}$ . To minimize coupling mismatches between the two windings, C2 has been added, forcing the winding potentials to be equal and improving cross regulation. Total available current from both outputs is limited to 500mA. Maximum negative supply current is affected by the positive 5V load; a typical limit is one-half of the positive current.

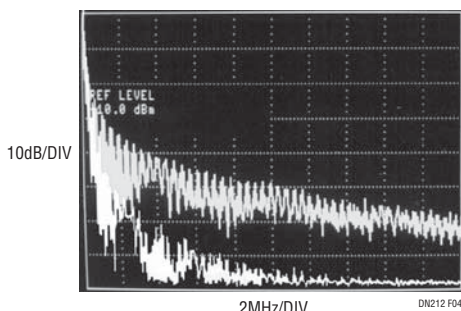


Figure 4. Spectral Analysis of the Waveforms for the LT1676 and the Low Noise LT1777

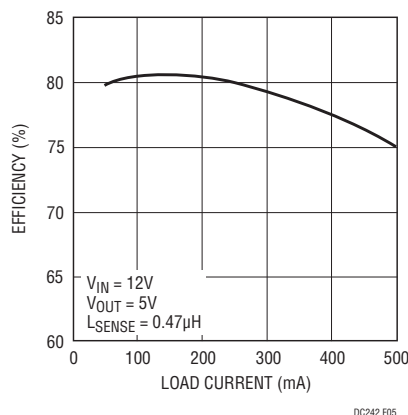


Figure 5. LT1777 Output Efficiency

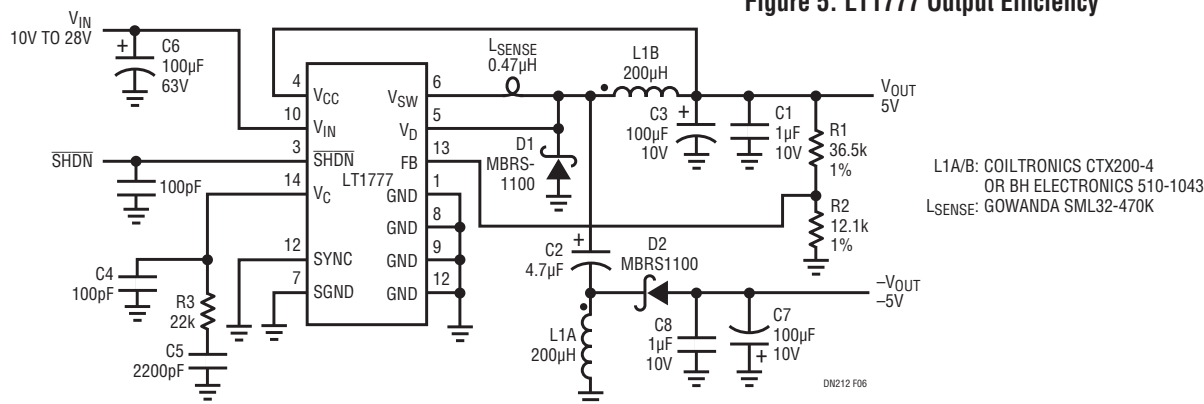


Figure 6. This Cost-Effective Supply Generates  $\pm 5\text{V}$  from a 10V to 28V Input

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