A Simple Solution to Low Noise, Isolated Power Conversion

by Tom Sheehan

Introduction
The LT3439 is a DC transformer driver tailored for applications that require an efficient, low noise isolated step-up or step-down power supply, such as noise sensitive medical instruments and precision measurement equipment. The LT3439 includes a proprietary technique for reducing conducted and radiated electromagnetic interference (EMI) that shortens the design cycle time and saves costs.

To maximize efficiency in power supplies, switch transitions are designed to occur as quickly as possible. Most EMI produced by a power supply is caused by the high speed slewing of currents and voltages. The result is input and output ripple that contains numerous harmonics of the switching frequency. Also, fast edges couple through circuit parasitics to nearby signal lines causing sensitive circuitry performance to be corrupted. Typically, mechanical shielding and careful layout is required to control the effects of EMI, but this can be an expensive and time consuming effort involving multiple PCB layout iterations.

The LT3439 gives the user the ability to reduce the EMI at the source of the noise. Switch current and voltage slew rates are programmable with a single resistor. Reducing the switch transition times can yield a large improvement in EMI with only a minor reduction in efficiency. Expensive shielding and filtering are not required and system performance is less sensitive to circuit layout. Also, the noise performance of the final system can be adjusted and tested by changing only one resistor.

Circuit Operation
The LT3439 DC transformer driver has two 1A internal switches which drive each end of a center tapped transformer. The two switches are turned on out of phase at 50% duty cycles. The input voltage is applied across the primary side of the transformer. The voltage on the secondary side is simply the input voltage times the turns ratio. Rectifiers on the secondary side generate the DC output voltage. The output capacitor is for hold up and filtering. If required, an additional inductor and capacitor can be added to reduce the output noise even further.

Control of the voltage and current slew rate is maintained via two control loops. One loop controls the output switch dV/dt and the other loop controls the output switch dl/dt. Output slew control is achieved by comparing the two currents generated by these slewing events to a current set by the external resistor RsL.

The frequency of the internal oscillator can be set from 20kHz to 250kHz with an external resistor and capacitor, RT and CT. Each output switch is driven at half the frequency of the oscillator. The SYNC pin can be used to synchronize the switching to an external clock. A SHDN pin can be used to place the part into shutdown mode where the part draws less than

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Figure 1. Dual output isolated step-up converter has well-controlled EMI
Many single supply powered applications require amplifier output swings within millivolt or even sub-millivolt levels of ground. Amplifier output saturation limitations normally preclude such operation. Figure 1’s power supply bootstrapping scheme achieves the desired characteristics with minimal component addition.

A1, a chopper stabilized amplifier, has a clock output. This output switches Q1, providing drive to the diode-capacitor charge pump. The charge pump output feeds A1’s V– terminal, pulling it below zero, permitting output swing to (and below) ground. If desired, the negative output excursion can be limited by either clamp option shown.

Reliable start-up of this bootstrapped power supply scheme is a valid concern, warranting investigation. In Figure D2, the amplifier’s V– pin (Trace C) initially rises at supply turn-on (Trace A) but heads negative when amplifier clocking (Trace B) commences at about mid-screen.

The circuit provides a simple way to obtain output swing to zero volts, permitting a true “live at zero” output.

Figure 1. Single rail powered amplifier has true zero volt output swing. A1’s clock output switches Q1, driving diode-capacitor charge pump. A1’s V– pin assumes negative voltage, permitting zero (and below) volt output swing.

Figure 2. Amplifier bootstrapped supply start-up. Amplifier V– pin (trace C) initially rises positive at 5V supply (trace A) turn-on. When amplifier internal clock starts (trace B, 5th vertical division), charge pump activates, pulling V– pin negative.

Low Noise Step-up Converter Produces ±15V at 100mA from a 5V Input

Figure 1 shows a design that provides regulated ±15V at 100mA outputs from a 5V±5% input. Output ripple is less than 150μV or 0.001% of VOUT measured at full load. Efficiency of the supply is approximately 71% measured at full load.

The LT1964-BYP and the LT1761-BYP linear regulators regulate the output to within 0.1% of nominal over the full line and load range.

Conclusion

The LT3439 DC Transformer Driver greatly simplifies the design of efficient low noise isolated power supplies. By reducing a major source of the EMI with voltage and current slew control, designs using the LT3439 avoid expensive shielding and filtering requirements and save the cost and time incurred by multiple iterative layouts.

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