A Checklist for Switching Regulator Designs

1. The most common problem area in switching designs is the inductor and the most common difficulty is saturation. An inductor is saturated when it cannot hold any more magnetic flux. As an inductor arrives at saturation it begins to look more resistive and less inductive. Under these conditions the current flow through it is limited only by its DC copper resistance and the source capacity. This is why saturation often results in destructive failures. Figure C1 demonstrates saturation effects. The pulse generator drives Q1, forcing current into the inductor. The diode and RC combination form a typical load. Figure C2 shows results. The voltage at Q1's collector falls when it turns on (Trace A is pulse generator output, Trace B is Q1's collector). Trace C, the inductor current, ramps in controlled fashion. When Q1 goes off, current falls and the inductor rings off. In Figure C3, drive pulse width is longer, allowing more inductor current buildup. This requires the inductor to store more magnetic flux. Its ramp waveform is clean and controlled, indicating that it has the necessary capacity. Figure C4 brings some unpleasant surprises. Drive pulse width has been increased. Now, the inductor current departs from its ramp characteristic into a nonlinear slope. The nonlinear behavior starts between the third and fourth vertical divisions. This curve shows a rapidly increasing current characteristic. These conditions indicate that the inductor is entering saturation. If pulse width is increased much more, the current will rise to destructive levels. It is worth noting that some inductors saturate much more abruptly than this case.

Figure C1. Inductor Saturation Test Circuit

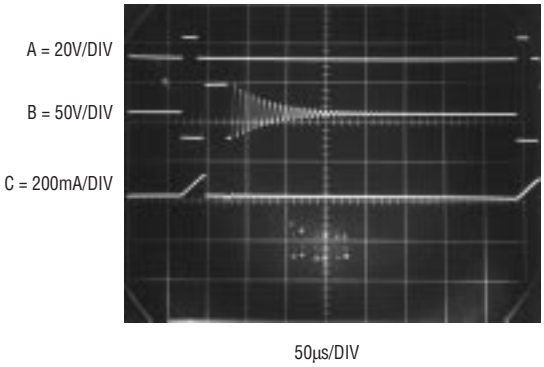

Figure C2. Normal Inductor Operation

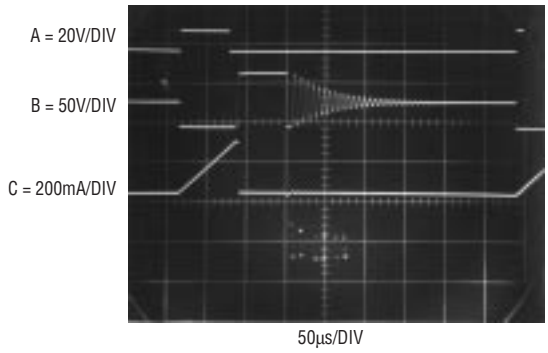

Figure C3. Normal Inductor Operation at Increased Current

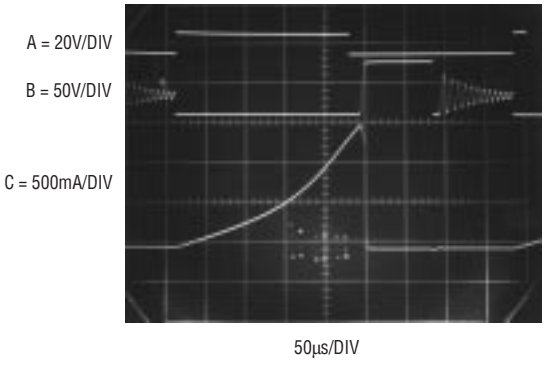

Figure C4. Inductor Being Driven into Saturation