Build isolated power supply using capacitors

By Chris Cokayne and Ben Wolde, Maxim Integrated Products Inc.

Isolated power is usually generated with a transformer, but it can also be generated using capacitors. For some systems, the constraints of size and cost may favour capacitors.

In **Figure 1**, the IC (MAX256) is an integrated primary-side controller and H-bridge driver for isolated power-supply circuits.

Its oscillator, protection circuitry, and internal FET drivers usually provide up to 3W of power to the primary winding of a transformer. In this case, the device drives a pair of capacitors that substitute for the transformer in providing isolation and power transfer.

The IC's adjustable switching frequency (100 kHz to 1 MHz) allows the use of small isolation capacitors, as illustrated below by an equation giving the capacitor impedance at 1 MHz. Losses are negligible at low output power:

$$X_c = 1/(2\pi fC) = 1/(2 \cdot 3.14\mathrm{x}10^6 \cdot 0.45\mathrm{x}10^{-6}) \approx 0.35\ \Omega.$$

Complementary square-wave drive signals from the IC (ST_1 and ST_2) are coupled by the isolation capacitors and full-wave rectified by the diodes to produce an isolated output voltage. The high switching frequency also allows use of a small output capacitor. Ignoring switching losses, the output voltage is:

$V_{out} = V_{in} - 2V_{cap} - 2V_{diode}$, where $V_{cap} = I_{out} \cdot X_c$.
Assuming $I_{out} = 500$ mA, then $V_{out} = 5 - 2(0.5 \cdot 0.35) - 2(0.5) = 5 - 0.35 - 1 \approx 3.7$ V.

This circuit suits applications for which the potential difference across the isolation barrier is fixed. (Capacitors provide

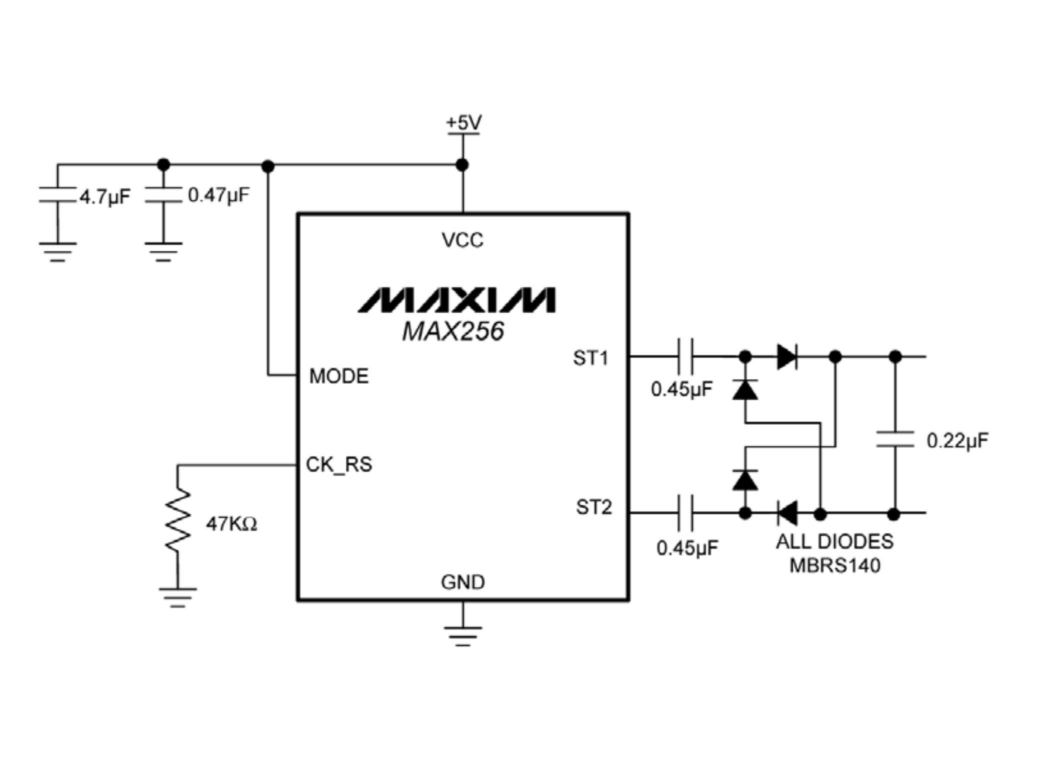

Figure 1: This simple circuit generates a capacitively isolated output voltage.

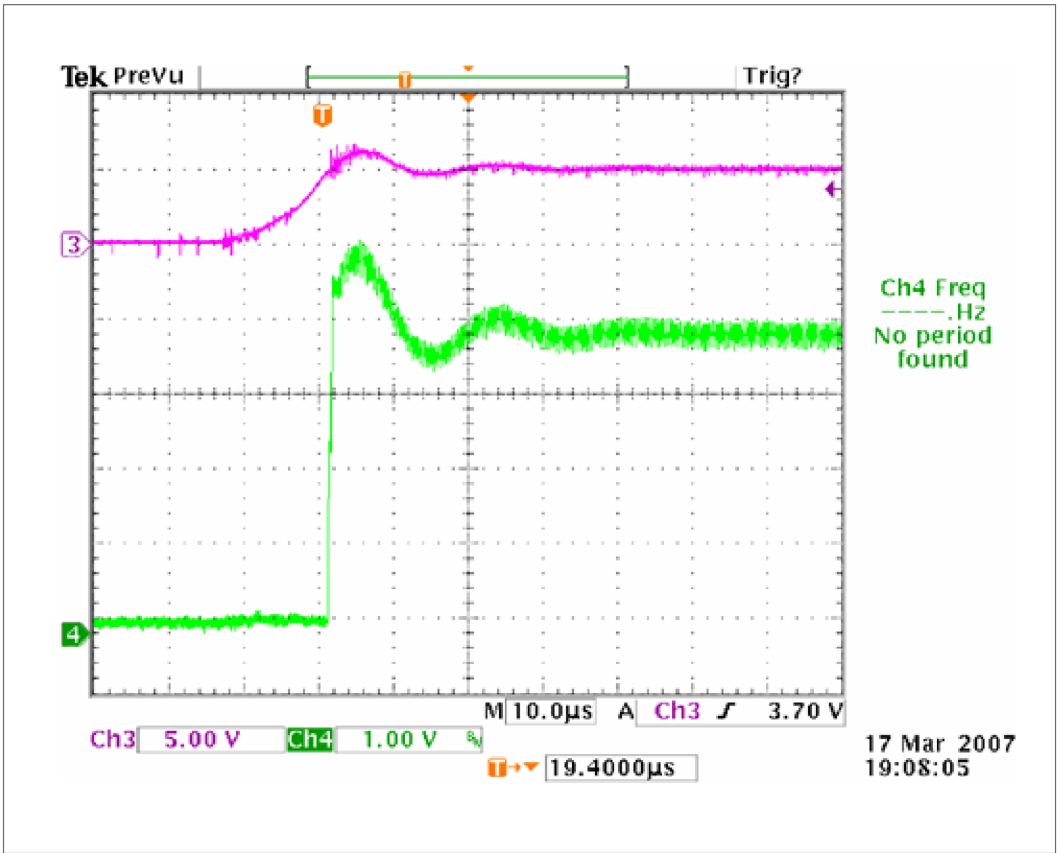

Figure 2: Power-up response of the circuit of Figure 1 with 8-Ω load

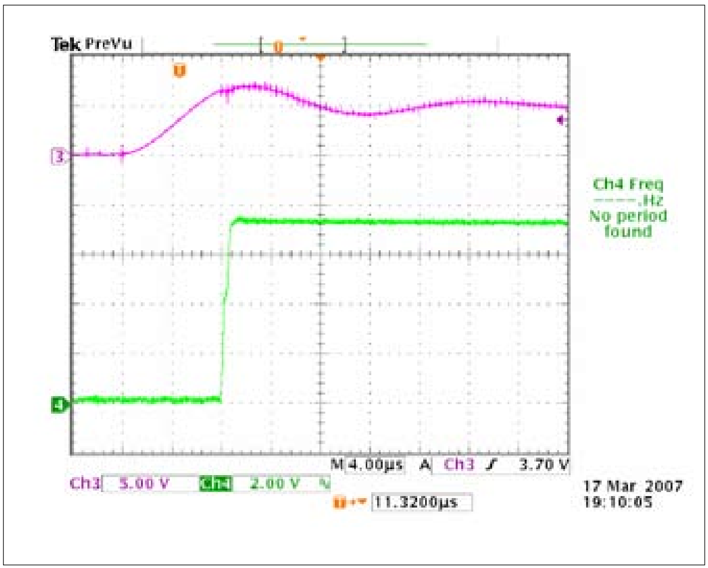

Figure 3: Power-up response of the Figure 1 circuit with no load.

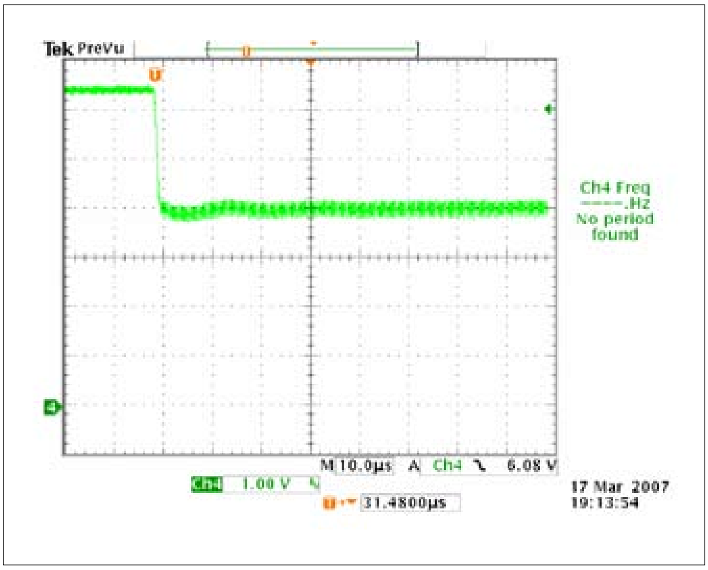

Figure 4: Load-transient response of the Figure 1 circuit, switching from no load to 8-Ω load

isolation at dc, but not for ac signals.) With the component values shown and a 500 mA load, ripple voltage is about 10% of the dc output level.

You can reduce this ripple by increasing the value of the output capacitor. Other circuit performance includes the power-up response with 8 Ω (~0.5 A) load (**Figure 2**), the no-load power-up response (**Figure 3**), and the load-transient response obtained by connecting 8 Ω to an unloaded output (**Figure 4**). In the figures, Channel 3 is the +5 V supply (V_{CC}), and Channel 4 is the voltage across the output capacitor.

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