Pulsing charge pump drives capacitive loads

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The test circuit in **Figure 1** efficiently drives various capacitive loads, such as memory cells and simple capacitors, so that you can observe their leakage effects. Essentially, the circuit is a pulsed and variable current source acting as a charge pump. A pulsed voltage source drives a one-shot oscillator. This one-shot drives two MOSFET switches that convert the 10V rail-to-rail output of the oscillator to the desired rail-to-rail voltage drive—in this case, 15V—for the controlled current mirror with the same voltage- switching polarity. The current mirror drives the variable load.

R_1 and C_1 determine the timing pulses that IC1's one-shot oscillator produces. When IC1's output is high, Q_1 is on, and Q_2 is off. The floating drain of Q_2 causes the emitter and base of Q_3 to have the same potential, so that Q_3 is off. Then, the pnp current mirror of Q_4 and Q_5 turns on to drive the variable load of R_2 and C_2 high. R_3 controls the charge rate of the load. As you make R_3 smaller, the current mirror provides more current to the load to charge it up faster, as required for testing.

When the output of the one-shot is low, Q_1 is off, and Q_2 is on. In this case, the drain of Q_2 is at ground potential, and the base of Q_3 is at a lower potential than its emitter so that Q_3 turns on. Current through Q_3 flows through R_3, causing a voltage rise at the bases of Q_4 and Q_5, which turns them off. Turning off Q_4 and Q_5 disconnects the variable load from its power supply so that the load is free to bleed stored charge through R_2.

This pulsing charge pump has three unique features: It can generate various pulse widths, the variable resistor in the coupled-collector circuit of the pnp cur-

rent mirror provides a variable charging rate, and the circuit accommodates separate voltage drives for the one-shot oscillator and load using MOSFET switches. Any signal-propagation delay or asymmetrical switching effects through the pump cause no adverse latency effects if the pulse periods are on the order of 100 msec or more. Note that you can replace Q_1 and Q_2 with a variable gain buffer follower as **Figure 1** indicates. In this case, one 15V supply drives the follower.

Spice simulations, using models developed in-house and by semiconductor vendors, confirm the circuit's operation (**Figure 2**). (DI #2248)

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Acknowledgment

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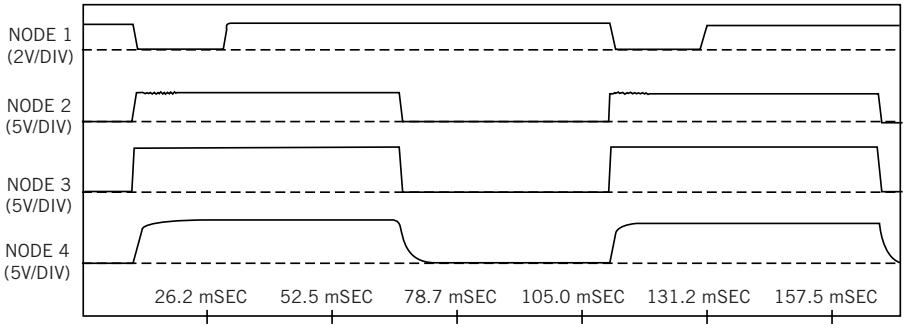
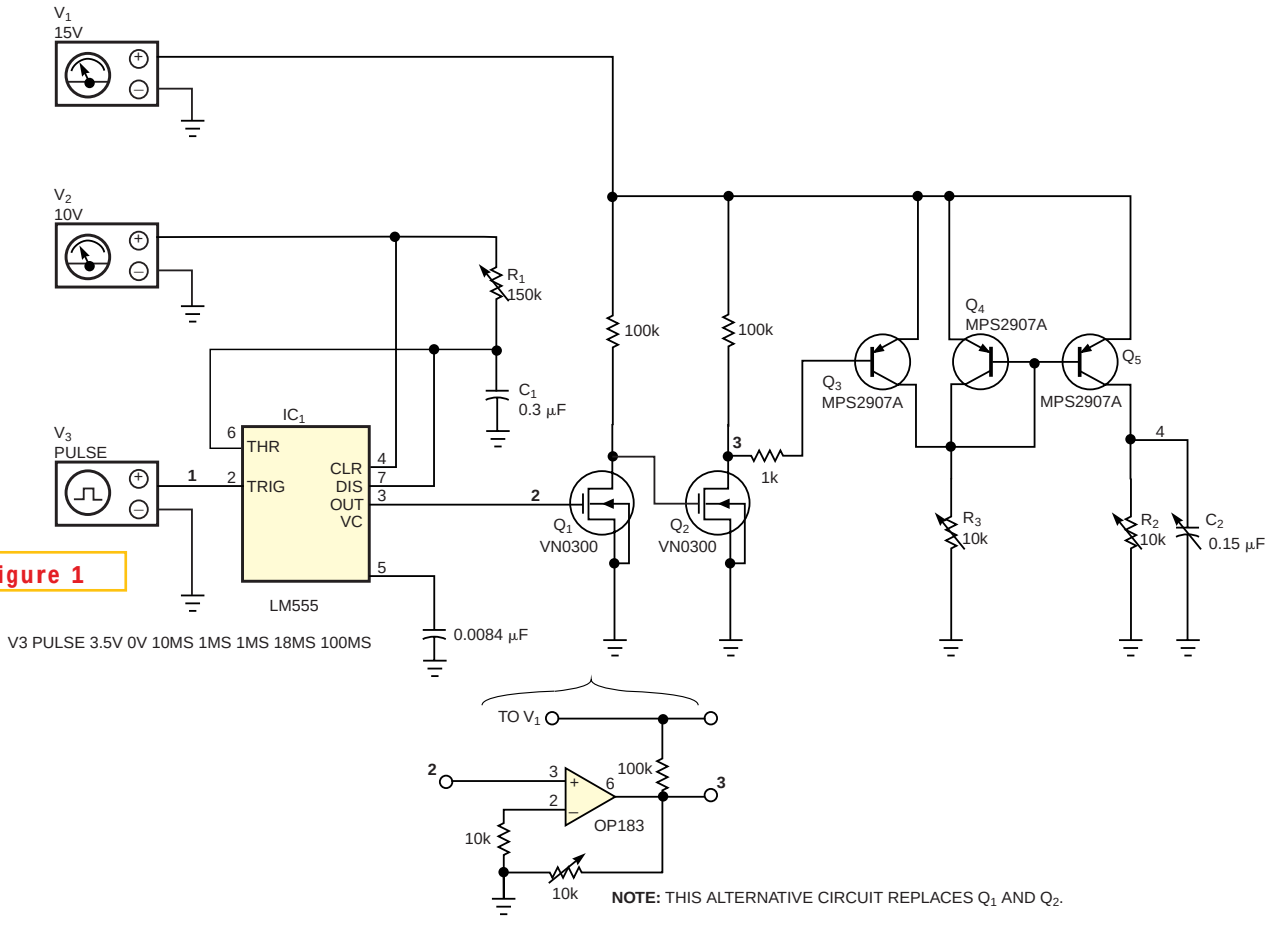
Figure 2



Spice simulations illustrate the waveforms at nodes 1 through 4 in the pulsing charge-pump circuit.

Figure 1



This pulsed and variable current source acts as a charge pump to efficiently drive various capacitive loads.