Keywords: DAC-Powered Charge Pump Varies Negative Rail

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APPLICATION NOTE 1071

DAC-Powered Charge Pump Varies Negative Rail

The circuit shown in **Figure 1** provides a low-current, adjustable negative supply rail suitable for use as a sensor bias, liquid-crystal-display (LCD) contrast bias, or voltage-controlled-oscillator (VCO) tuning supply. By operating a charge-pump doubler from the output of a buffered digital-to-analog converter (DAC), the circuit avoids the customary approach involving clumsy level shifters based on op amps and discrete components.

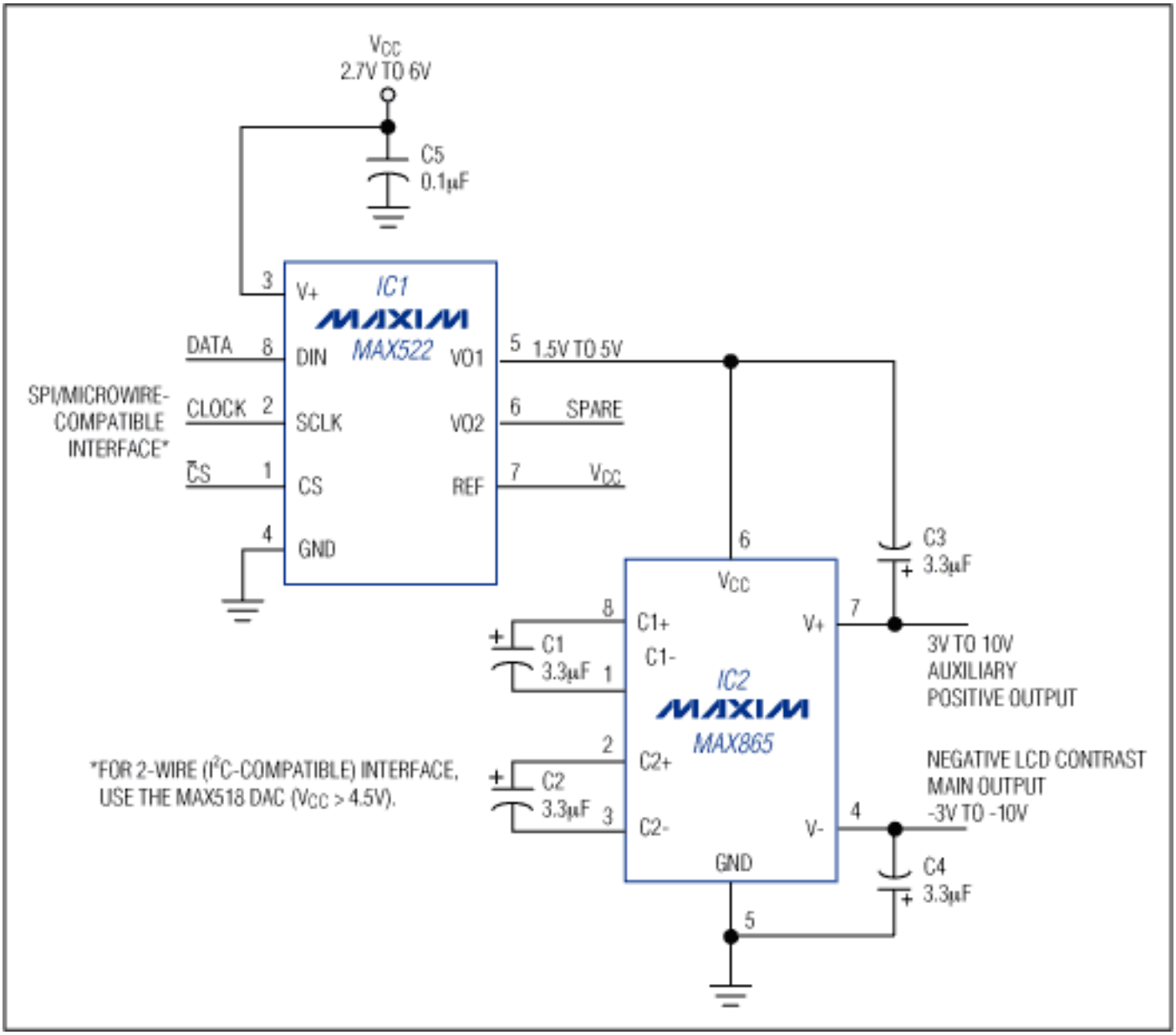

Figure 1. This adjustable negative supply consists of an inverting-doubler charge pump controlled by an 8-bit, serial-input DAC.

IC1 is a dual, 8-bit DAC with serial input and buffered voltage outputs. Output impedances are 50Ω; therefore, the DAC output in use drops about 50mV while providing the 1.1mA typically drawn by the IC2 charge pump. As the input code varies from 0 to 255, the DAC output ranges rail-to-rail, changing approximately 40mV per step.

With a +5V input (V_{CC}) applied to IC1 and a -3V output from IC2, the code that produces the minimum allowable voltage to the charge pump (1.5V) is 80 (decimal). The charge pump draws 0.6mA and generates ±2 times the voltage at its V_{CC} terminal, producing ±3V to ±12V as its input ranges from 1.5V to 6V. (The positive and negative outputs can be used simultaneously.) The main power can go as low as 2.7V, producing a negative output slightly over -5V. The minimum code for this condition is about 140 (decimal).

To shut down the supply, simply write zeros to the DAC. The DAC itself has a shutdown mode that draws only 1µA. To ensure a reliable start-up when bringing the system out of shutdown, write a value that powers the charge pump with a minimum of 2V. Note that a microcontroller (µC) with a pulse-width-modulation (PWM) output can eliminate the DAC altogether. For example, you can provide a variable V_{CC} to the charge pump by filtering a 20kHz PWM signal with a 270Ω/3.3µF lowpass network. Be sure the µC's port pin can supply the current with an acceptable voltage drop; if not, buffer it with a CMOS buffer or inverter such as the 74HC04.

A related idea appeared in the 7/21/97 issue of Electronic Design.

Application Note 1071: http://www.maxim-ic.com/an1071

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