

Keywords: switch-mode power supply, charge pump, regulated charge pump, inverting charge pump, regulated negative voltage, inverter quadrupler, personal digital assistant, PDA

APPLICATION NOTE 239

Regulated LCD-Bias Generator Requires No Inductor

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Abstract: This design idea shows how a regulated LCD bias generator requires no inductor. A charge-pump design based on the [MAX868](#) regulated, inverting charge pump replaces a switch-mode design to generate a negative voltage for biasing an LCD. A few components in the feedback path of a negative, inverting charge pump produce an inverter-quadrupler circuit.

A similar idea appeared in the March 9, 1998 issue of *Electronic Design*.

A stringent height limitation on the PC boards for personal digital assistants (PDAs) and palmtop computers compels the use of expensive, low-profile inductors in switch-mode power supplies. As an alternative, however, certain switch-mode circuits can be replaced with one based on a charge pump (**Figure 1**). This example generates a regulated negative voltage suitable for biasing an LCD.

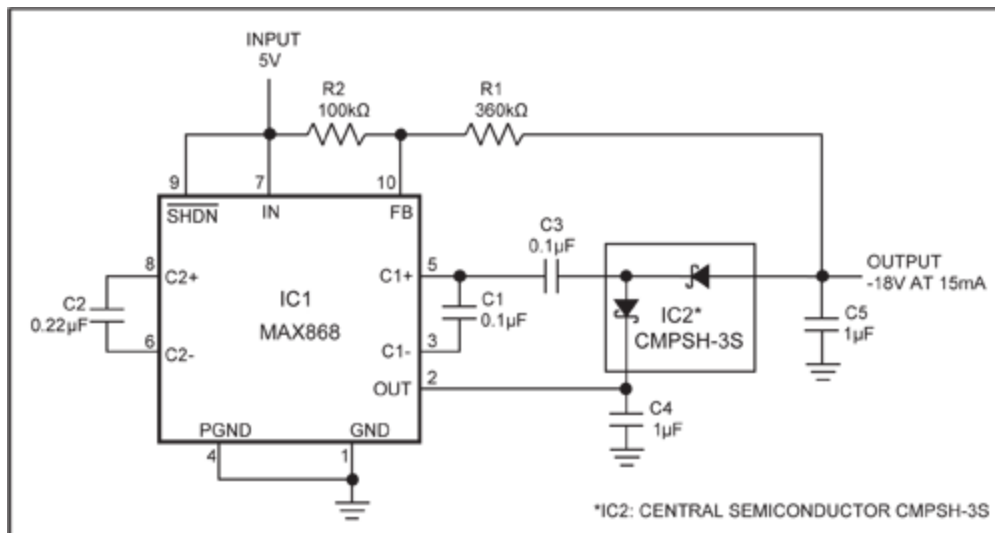


Figure 1. Adding a few inexpensive components in the feedback path of IC1 enables the generation of regulated output voltages nearly as high as $-4V_{IN}$.

IC1 contains a regulated, inverting charge pump that produces output voltages as high as $-2V_{IN}$, in which the supply voltage (V_{IN}) can range from +1.8V to +5.5V. The IC regulates V_{OUT} through pulse-frequency modulation (PFM), with a maximum frequency of 450kHz. The IC's low quiescent current

(30µA) provides excellent light-load efficiency without sacrificing full-load capability.

Inserting an external, discrete charge pump (consisting of C3, C4, and the Schottky diodes) in the feedback path of IC1 produces an "inverter-quadrupler" circuit whose regulated output level is set by the ratio of feedback resistors R1 and R2:

$$V_{OUT} = -V_{IN} (R1/R2)$$

Configured as shown, the circuit provides up to 15mA at $V_{OUT} = -18V$, with 76% efficiency and 60mV of output voltage ripple. Lower V_{OUT} allows higher output currents: $V_{OUT} = -15V$ yields 20mA, and $V_{OUT} = -12V$ yields 30mA.

Related Parts

[MAX868](#)

Regulated, Adjustable -2x Inverting Charge Pump

[Free Samples](#)

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