Abstract: A -3X voltage inverter is made with a SOT charge-pump IC and diode-capacitor network. Up to -15V at 10mA can be generated from 5V.

This design idea is based on a customer request for a cheap, and not very accurate, negative voltage supply of about -12V to -15V with a low output current of < 5mA and an input voltage of 5V. This application might be used for negative op-amp supply. Figure 1 shows the typical operation circuit with the flying capacitor C1 and C2. The output voltage on pin 1 is -V_IN. Four additional capacitors (C3 to C6) and four additional diodes (D1 to D4) triple the negative output voltage at the OUT pin from -V_IN to -3V_IN. C5 and C6 decreases the voltage with every step by -V_IN. Without any diode voltage drop C3 got -2V_IN and C4 charges ideally to -3V_IN. It is possible to add more of these cascades but with every step the voltage drop of the diodes will reduce the effort.

Figure 1. Triple voltage inverter with MAX871.

The schematic of the design idea has been tested with 4.5V and 5V input voltage. Figure 2 shows load current vs. output voltage. The general voltage drop on V_OUT is caused by the forward voltage of the external diodes of typically 0.3V to 0.4V per diode, depending on the load current. V_OUT is:

\[ V_{OUT} = -3 \times V_{IN} + 4 \times V_D \]
$V_D$: typically 0.3V to 0.4V

$V_{IN}$ is the input voltage on pin 2. $V_D$ is the forward voltage drop of diode D1 to D4. If Schottky diodes are used $V_D$ is typically 0.3V to 0.4V.

![Graph showing load current vs. output voltage](image)

**Figure 2. Load current vs. output voltage.**

### Component List

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 - C6</td>
<td>470nF ceramic</td>
</tr>
<tr>
<td>C input</td>
<td>10µF</td>
</tr>
<tr>
<td>D1 - D4</td>
<td>BAT41</td>
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</table>

A similar version of this article appeared in the October 25, 2001 issue of *Electronic World and Wireless World* magazine.

### Related Parts

<table>
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<tr>
<th>Part Number</th>
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<tr>
<td>MAX871</td>
<td>Switched-Capacitor Voltage Inverters</td>
<td>Free Samples</td>
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