

DESIGN SHOWCASE

Convert 3V to 5V without inductors

Charge-pump ICs can either invert or double an input voltage (3V to -3V or 6V, for example). The charge pump operates without inductors, but it doesn't regulate the output and it doesn't easily boost 3V to an intermediate level such as 5V. By adding a comparator and reference (IC2 in **Figure 1**) you can generate arbitrary outputs (such as 5V) and regulate them as well.

The charge pump (IC1) has an internal oscillator whose 45kHz operation transfers charge from C1 to C2, causing the regulated output to rise. When the feedback voltage (pin 3 of IC2) exceeds 1.18V, the IC2 comparator output goes high and turns off the oscillator via Q1.

Comparator hysteresis—easily added at IC2—is set to zero because the control loop requires no hysteresis. The oscillator generates only two cycles after turn-on, which is always enough to drive V_{OUT} slightly above the desired level before feedback turns the oscillator off again. The resulting

output ripple depends mainly on the input voltage and the output load current (**Figure 2**).

You can reduce output ripple at the expense of circuit efficiency by adding a small resistor of about 1Ω (not shown) in series with C1. Ripple also depends on the value and ESR associated with C1; smaller values of C1 transfer less charge to C2, producing smaller jumps in V_{OUT} .

For those not afflicted with inductorphobia, Maxim offers various inductor-based switching regulators for boosting 3V to 5V. They include the MAX731, MAX741, MAX756, MAX856, and others.

(Circle 2)

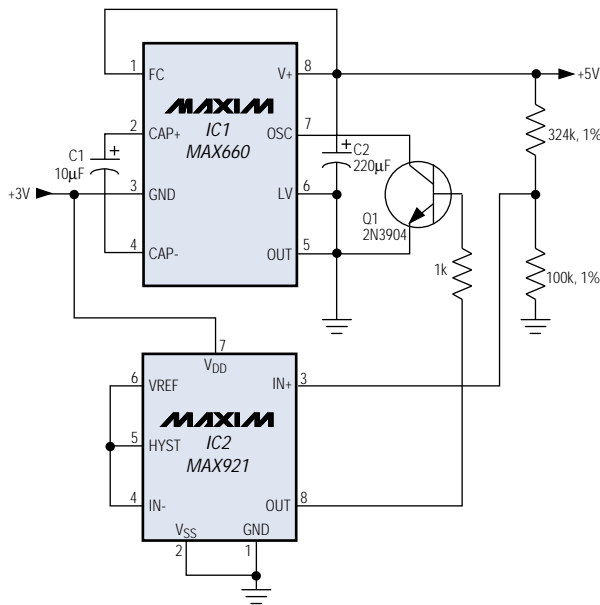


Figure 1. By configuring a comparator and transistor to control the oscillator in a charge pump, you enable the pump to generate a regulated output of any reasonable value.

LOAD RESISTANCE (Ω)	OUTPUT VOLTAGE (V)	OUTPUT RIPPLE (mVp-p)
∞	5.00	30
10k	5.00	35
1k	5.00	100
100	4.96	100
50	4.59	150

(a) Supply = +3.0V

LOAD RESISTANCE (Ω)	OUTPUT VOLTAGE (V)	OUTPUT RIPPLE (mVp-p)
∞	5.01	55
10k	5.01	55
1k	5.01	55
100	4.98	170
50	4.90	170

(b) Supply = +3.3V

LOAD RESISTANCE (Ω)	OUTPUT VOLTAGE (V)	OUTPUT RIPPLE (mVp-p)
∞	4.98	10
10k	4.98	25
1k	4.98	25
100	4.64	70
50	4.29	90

(c) Supply = +2.7V

Figure 2. Output ripple in the Figure 1 circuit depends on the input voltage and load current.