

IC timer and voltage doubler form a dc-dc converter

by Todd Gartner
 Motorola Inc., Automotive Research & Development, Franklin Park, Ill.

A dc-dc converter in which an IC timer serves as a free-running relaxation oscillator is ideal for powering op amps in battery-operated equipment or whenever a single positive supply is all that's available. Furthermore, the converter develops an output voltage of -15 V that is regulated to within $\pm 1\%$ for load currents of up to 30 milliamperes. The circuit's no-load current is 11 mA.

The free-running frequency of the timer is determined by resistors R_A and R_B and capacitor C_T . The output from the timer is used to drive the voltage-doubler network consisting of diodes D_1 through D_4 and capacitors C_1 through C_4 .

Without the feedback connection between the output of the voltage doubler and the reset input of the timer, the circuit's output under a no-load condition will float to about 30 V minus four diode voltage drops. With the feedback connection, the voltage divider formed by diodes D_5 and D_6 and resistors R_1 and R_2 places a 0.7-V

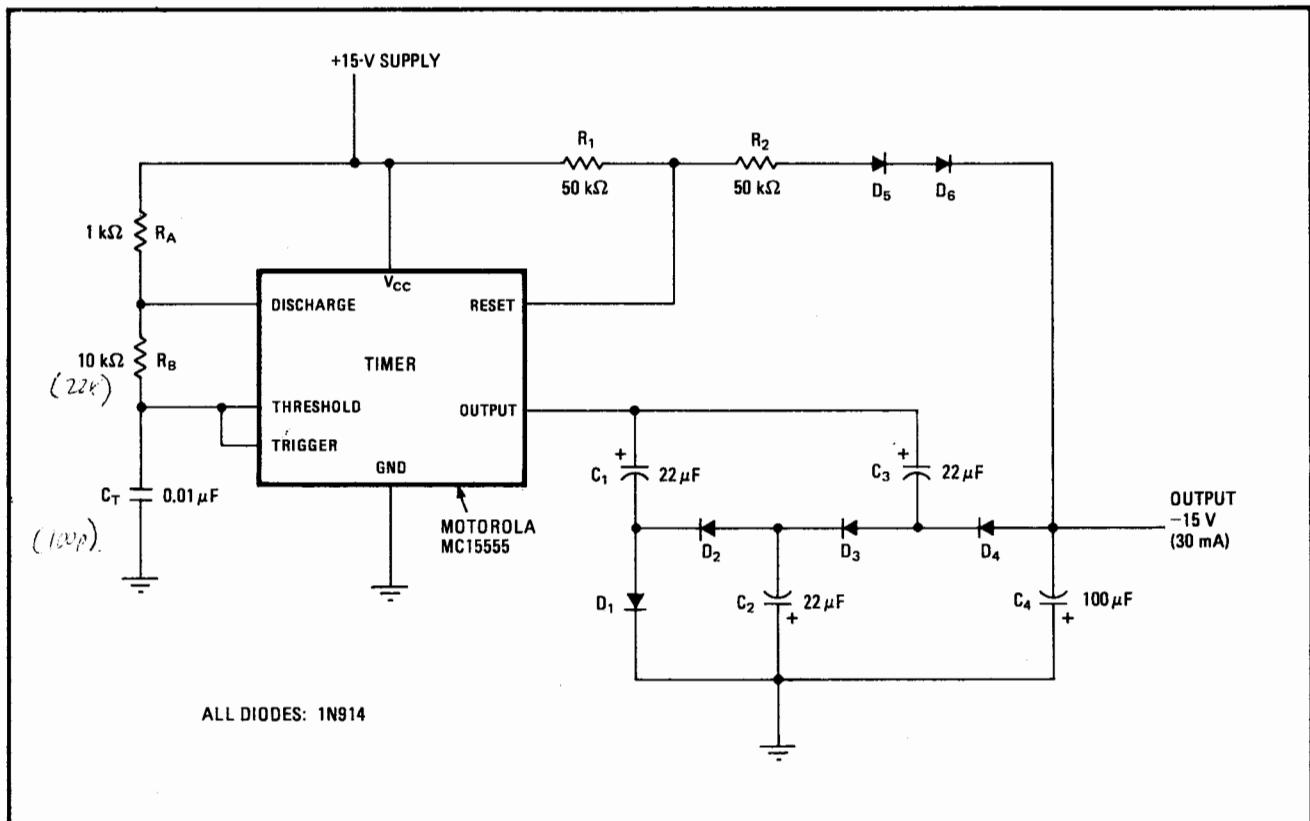
voltage at the timer's reset input when the negative output voltage equals the positive input supply voltage in magnitude.

If the output voltage becomes more negative than -15 V, the timer's oscillation is inhibited, and therefore, the drive signal to the voltage doubler is removed. This type of circuit action provides switching-mode regulation of the output voltage.

The voltage doubler deserves a closer look because it may not be immediately apparent how it works. When the timer's output goes positive, capacitor C_1 is charged through diode D_1 , and diode D_2 is reverse-biased. When the timer's output becomes negative, some of the charge on capacitor C_1 is transferred to capacitor C_2 through diode D_2 , and diode D_1 is now reverse-biased.

As the output from the timer swings positive again, capacitor C_3 charges through capacitor C_2 and diode D_3 to approximately twice the supply voltage. For the timer's negative output swing, this charge is transferred to capacitor C_4 via diode D_4 , doubling the output voltage from the timer. Such a voltage-doubler arrangement requires the driving source to supply, as well as sink, current.

The output voltage of the dc-dc converter will track the input supply voltage with reasonable accuracy. If resistors R_1 and R_2 are replaced by a single 100-kilohm potentiometer, the output voltage can be made contin-



For op amps. This dc-dc converter produces a -15-volt output from a +15-V supply input. The IC timer, which is wired as a free-running relaxation oscillator, drives a voltage doubler. The timer is reset so that its output is inhibited if the converter's output tries to go more negative than -15 V. The converter's output is regulated to within $\pm 1\%$ for load currents of up to 30 milliamperes.