555 as switching regulator supplies negative voltage

by S.L. Black
Western Electric Co., Columbus, Ohio

Latest addition to the 555 IC timer's seemingly endless bag of tricks is its use to generate a negative dc biasing voltage from a positive source. A current of well over 10 milliamperes can be delivered, and a form of switching regulation is employed to assure a constant output voltage. All of this is done with little more than an npn transistor and the 555 integrated circuit.

The 555 is operated in the astable mode, with the pulse width and frequency controlled by resistors R_1 and R_2 plus capacitor C_1. These parameters can be selected for maximum regulation at the output voltage level desired. Terminal 3 of the IC is connected to a network consisting of C_2, C_3, and diodes D_1 and D_2. Series capacitor C_2 causes the pulse train to lose its ground reference, so that D_1 and D_2 can rectify the signal and capacitor C_3 can filter it into a negative dc output voltage. The magnitude of this output voltage depends on the amplitude and repetition rate of the pulses coming from the IC.

To regulate the output voltage, the 2N2222 transistor varies the control voltage of the 555, increasing or decreasing the pulse repetition rate. Resistor R_3 acts as a collector load for the transistor; the base is driven from potentiometer R_4, which compares the output voltage to the supply voltage. If the output voltage becomes less negative, the control voltage goes closer to ground, causing the repetition rate of the 555 to increase so that C_3 recharges more frequently. If the output voltage becomes more negative, the control voltage goes closer to the positive supply voltage, so the repetition rate decreases, and C_3 is recharged less often.

The output voltage can be set to any level from 0 to -10 volts by means of potentiometer R_4. With the components shown in the figure, this circuit supplies -10 V from a 12-V source. Regulation is less than 5% at a current of 10 mA and less than 0.05% at 0.2 mA. □

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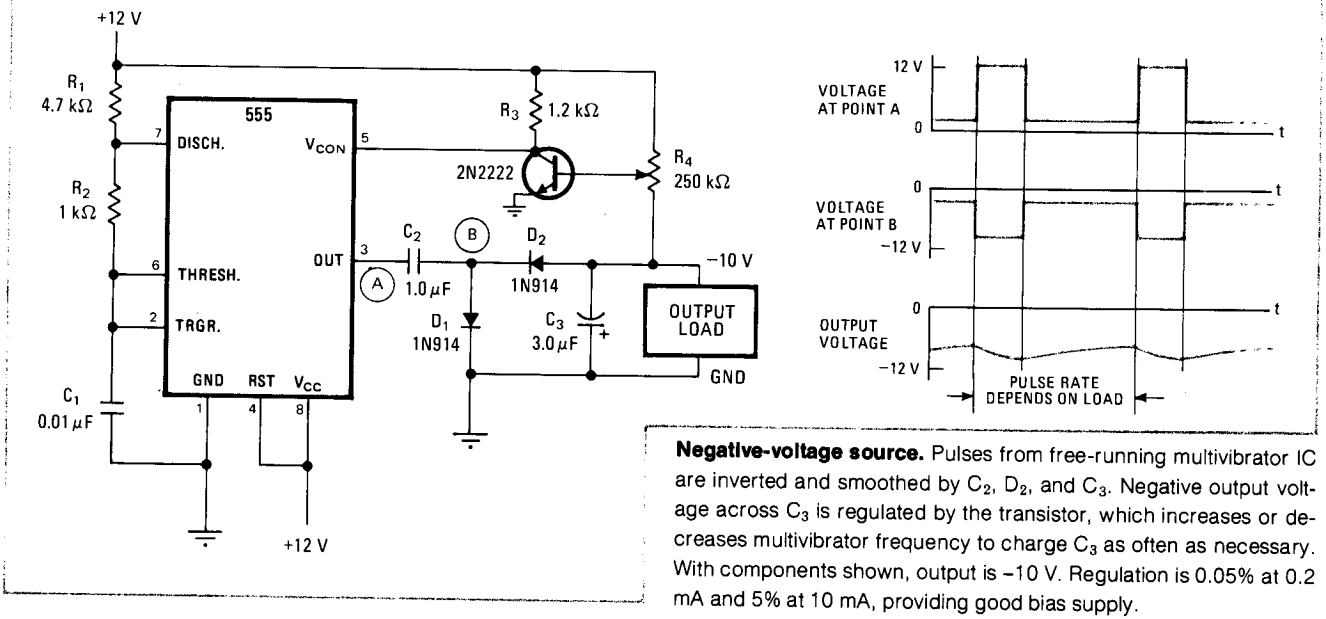

Negative-voltage source. Pulses from free-running multivibrator IC are inverted and smoothed by C_2, D_2, and C_3. Negative output voltage across C_3 is regulated by the transistor, which increases or decreases multivibrator frequency to charge C_3 as often as necessary. With components shown, output is -10 V. Regulation is 0.05% at 0.2 mA and 5% at 10 mA, providing good bias supply.