Generating triangular waves in accurate, adjustable shapes

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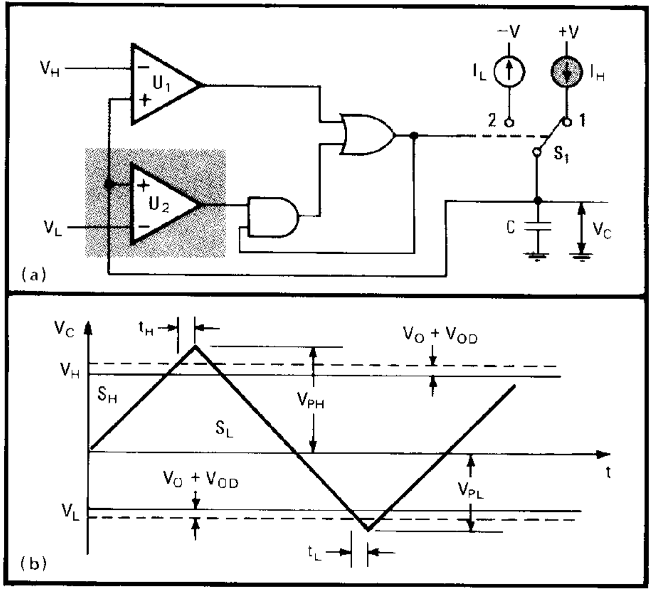
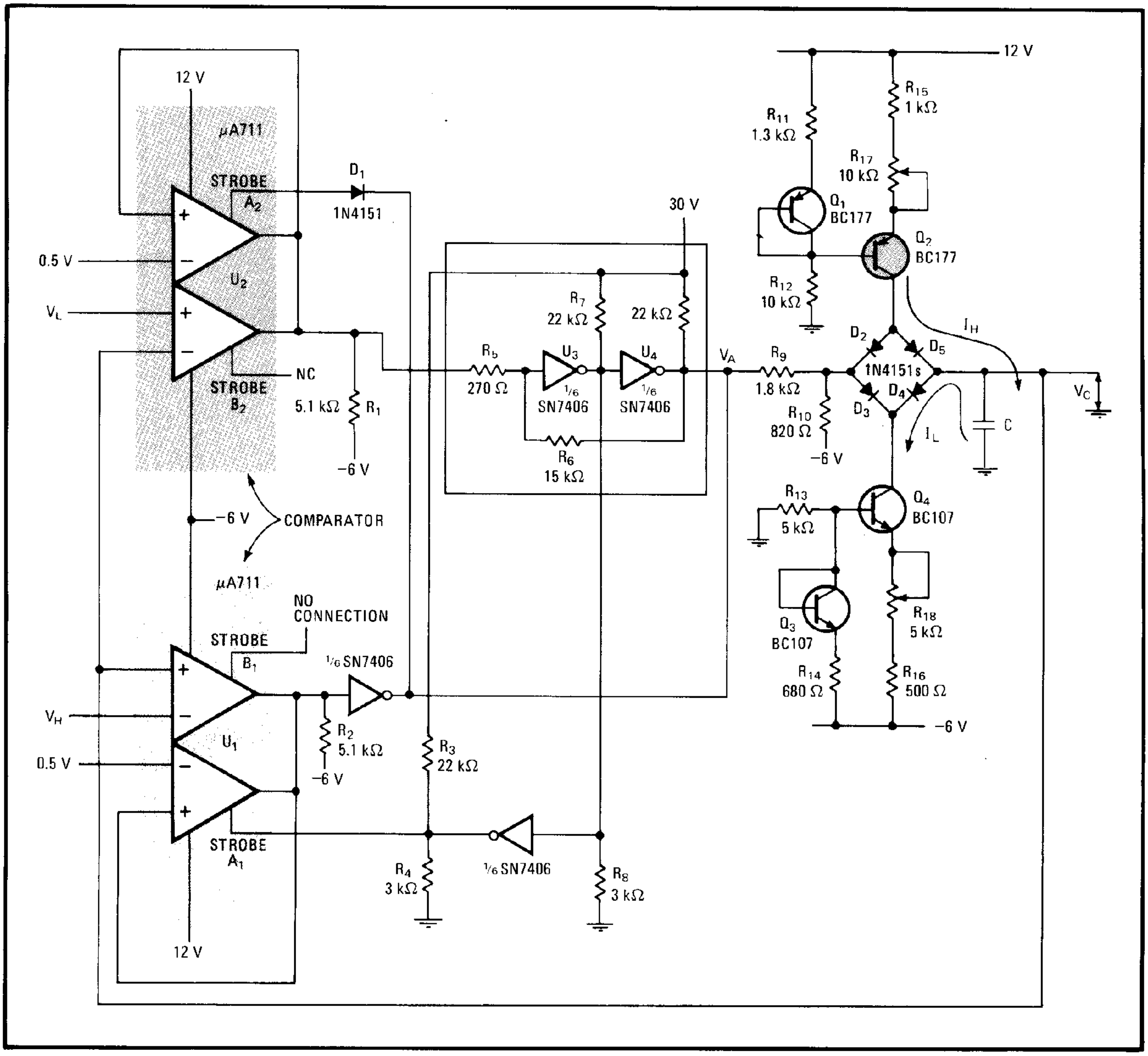
Many precision instruments and generators require adjustable and well-defined triangular waveforms that have very accurate peak values. However, most of today's triangular-waveform generators lack features permitting simple parameter modification. This circuit allows these generators to overcome this shortcoming and provides the means for high resolution and speed



1. Precision. The circuit (a) built with comparators U_1 and U_2, constant current sources, and switch S_1 generates a triangular waveform (b) whose peak value, rise, and fall can be selected. The comparators determine the charge and discharge of capacitor C.



2. Adjustable generator. High speed and resolution, in addition to peak values that can be controlled, are obtained for this triangular-waveform generator by dual voltage comparators U_1 and U_2, which have positive feedback. Charging and discharging of capacitor C is controlled through strobe A_1 and strobe A_2. Inverters U_3 and U_4 are used to improve the switching time.

along with controllable peak, rise, and fall values.

Comparators U_1 and U_2 (Fig. 1a) having threshold voltages V_h and V_l, respectively, determine the charge and discharge rates of capacitor C. When switch S_1 is in position 1, the constant current I_h charges C. In position 2, the capacitor discharges current I_l. The resulting triangular waveform (Fig. 1b) shows that the peak, rise, and fall of V_c can be easily varied through the adjustment of threshold levels V_h and V_l and I_h and I_l.

The resultant error for V_h and V_l, respectively, is $e_h \leq V_o + V_{od} + t_h S_h$ and $e_l \leq V_o + V_{od} + t_l S_l$, where V_o is the input offset voltage of the comparators, t_h and t_l are the settling times for the high and low states corresponding to an overdrive voltage V_{od}, and S_h and S_l represent the slopes of V_c.

A dual voltage comparator μA711 having positive feedback provides high resolution and good propagation times (Fig. 2). When input voltage V_c goes above V_h, comparator U_1 is switched to a high state and remains in it, irrespective of the value of V_c, until a low level is applied to strobe input A_1. In this high state, current source Q_2 charges C with current I_h.

As a result, U_1 lowers the value of V_a, which, in turn, causes the capacitor to discharge I_l through transistor Q_4. While the capacitor is in the course of discharging, comparator U_2 switches to the low state because the voltage at strobe A_2 is low.

The discharge process continues until V_c drops below V_l. Once this drop occurs, comparator U_2 goes high. As a result, the output voltage of U_2 and consequently V_a will go high again. Thus the cycle repeats. Inverters U_3 and U_4 are connected as a Schmitt trigger to improve switching time, and D_2 through D_4 serve as a switch. Diode D_1 limits the strobe voltage when V_a is high. ☐