Waveform generator minimizes amplitude dependency

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Engineers have long used function-generator circuits employing analog integrators and high-hysteresis comparators. The outputs of these circuits often depend on variations in temperature, power-supply voltage, load, and parts. However, you can pump new life into the classic triangular/rectangular-waveform generator using the circuit in **Figure 1**. This circuit uses a precision reference-voltage source and the diode network comprising IC_1, IC_2, and IC_6; dual analog SPDT (single-pole/double-throw) switch IC_3; integrator IC_4; and comparator IC_5. The result is a ramp- and square-wave generator that holds its output stable in the face of those variations. Comparator IC_5 uses a switching technique to achieve its stable high hysteresis. **References 1** and **2** provide more details, including how the Schottky-barrier diodes of IC_6 suppress charge injection.

The output of IC_5, an ADCMP601 comparator, is initially low, forcing the ADG736 analog switch, IC_3, to connect a positive reference voltage, V_{REF+}, to IC_5's inverting input. Simultaneously, the S_2 switch connects a negative reference voltage, V_{REF-}, to the integrator's R_1 resistor. As long as the comparator's output is low, the integrator's output, V_{INT}, increases linearly until it reaches V_{REF+}, the comparator's positive-threshold level. At that point, the output of the comparator changes to high, which turns on the B channels of both multiplexers as their A channels turn off.

When the switch positions change, the integrator integrates positive reference-voltage V_{REF+}, and V_{INT} decreases linearly until it reaches the negative threshold V_{REF-}, which the comparator sets. The cycle then repeats. A bipolar reference source comprising IC_1 and IC_2 creates V_{REF+} and V_{REF-}. This part

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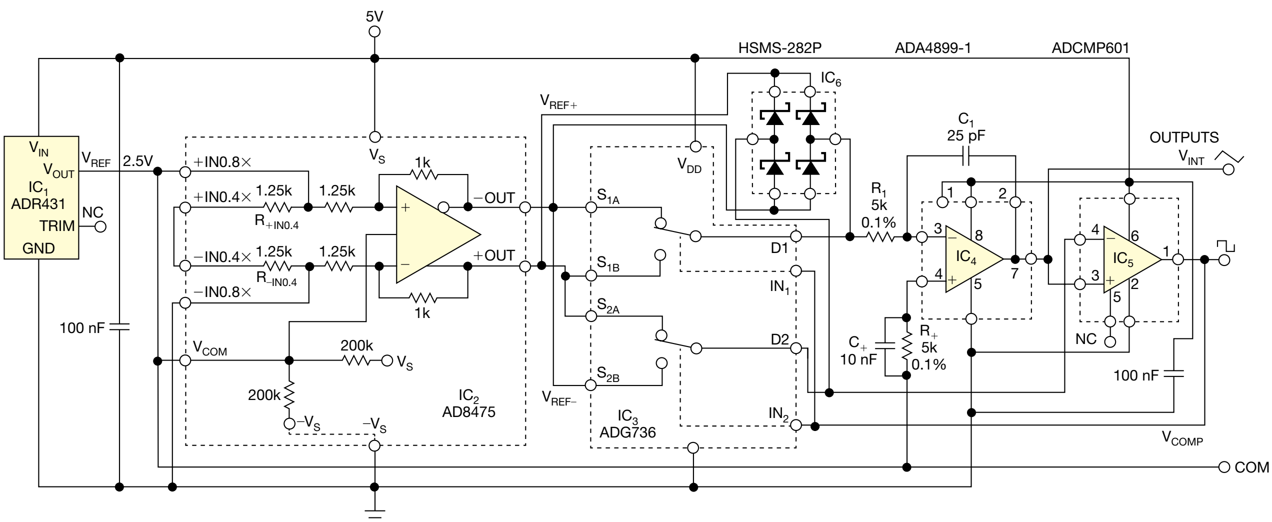

Figure 1 Creating hysteresis by switching precision reference voltages within the waveform generator ensures high insensitivity of the amplitude of triangular waveforms on supply-voltage variations.

of the circuit is a slight modification of the circuit in an earlier Design Idea (**Reference 3**).

As the ramp-up/ramp-down cycle repeats, the integrator produces a symmetrical, triangular waveform of V_{INT}, and a rectangular waveform, V_{COMP}, appears at the output of the comparator. The amplitude of V_{INT} is approximately $(V_{REF+}-V_{REF-})/2$. The duty cycle of the rectangular waveform is close to 50%. The thresholds of the comparator are independent of the output load, and you derive them from a precision source of reference voltages. Thus, the circuit has low sensitivity of the repetition frequency of its output to supply-voltage variations and to load variations. In a simplistic model of the generator, the amplitude of the triangular waveform at the output of the integrator no longer depends on variations of supply voltage.

Experimentally, increasing supply voltage V_S from 5.0365 to 5.437V increases the amplitude of the triangular waveform by 2.85 mV, representing 0.285% of full-scale. Under the same conditions, a classic triangular/rectangular-waveform generator typically shows an 8% increase in amplitude. Thus, this circuit reduces the dependence of amplitude on supply-voltage variation by a factor of about 28.

In testing this circuit, you can expect an output frequency of 1.366 MHz with a supply voltage of 5.0365V. When the supply voltage is 5.437V, the output frequency will be 1.368 MHz. The time constant sets the repetition rate. In this case, the repetition rate is one divided by four times the time constant for an ideal comparator and ideal switches. The comparator's propagation delay and the on/off times of the switches lower the repetition rate to lower than the ideal value. **EDN**

REFERENCES

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3 Štofka, Marián, "Build an accurate bipolar reference," *EDN*, May 12, 2011, pg 42, http://bit.ly/knjieC.