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Comparator detects position of peaks and valleys in a waveform

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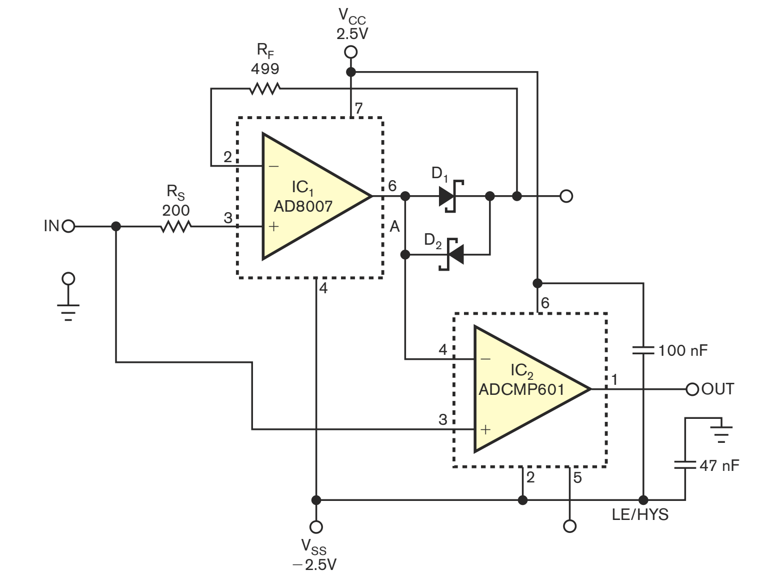
The recent advent of Analog Devices' (www.analog.com) ADCMP60x family of comparators has filled a gap between the less-than-1-nsec-response comparators consuming 100 to 200 mW and those exhibiting approximately 1-µsec response, requiring about one-thousandth that power. The ADCMP60x comparators exhibit a low value of the product of propagation-delay-by-supply-current drain; possess rail-to-rail input and output operation; and offer a variety of options for hysteresis, latch-mode operation, and shutdown mode. Some of them also have inherent level-translating capability. Moreover, the ratio of propagation delays for the positive and negative transitions at the output is close to the ideal value of 1 within 8% tolerance for the ADCMP600, ADCMP601, ADCMP602, and ADCMP603 and with in a 6.7% tolerance for the ADCMP608 and ADCMP609 members of the family (**Reference 1**).

This ratio is important in applications in which both positive- and negative-output-level transitions are equally significant. **Figure 1** shows one such circuit. Voltage-level transitions at the output of the detector indicate changing of the sign of the first derivative of the input signal; in other words, the circuit detects time positions of peaks and valleys in the input-voltage waveform. The detector circuit uses an ADCMP601 for IC_2, and IC_1 is an Analog Devices AD8007 current-feedback amplifier. IC_1 connects as a voltage follower with an antiparallel combination of Schottky-barrier switching diodes, D_1 and D_2, between the output and the inverting input of the amplifier. Comparator IC_2's inputs connect to the source of the input voltage and to the output of the current-feedback amplifier. This configuration enhances the voltage difference of $V_{IN}-V_A$ between inputs of the comparator. It performs this enhancement in a steplike manner at the instant, or region, at which the sign of slope of the input signal changes. This voltage difference is a measure of the double-forward voltage of diodes D_1 and D_2 at their forward current, which you derive from V_{IN}/R_F.

You use a current-feedback amplifier as IC_1 because a dynamic current flows into its inverting input even when you



NOTE: D_1 AND D_2 ARE HSMS-282Ls OR HSMS-282Cs.

Figure 1 Comparator IC_2 produces an output that switches state at the positive and the negative peaks of the input-voltage waveform.

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connect it as a voltage follower. The values of the R_S and R_F resistors are those that **Reference 2** recommends for a gain of 1. You needn't worry about instability due to the presence of antiparallel diodes in the feedback path of the current-feedback amplifier. These diodes increase the value of feedback resistance to more than 499Ω. Whenever the input voltage is only approximately 0V, the frequency-gain response of IC_1 for an R_F value greater than 499Ω remains flat.

An analysis of the response of the voltage follower in **Figure 1** to a harmonic input voltage uses ω/ω_T and $\omega=2\pi f$, where f is the input-voltage frequency and ω_T is the radial transition frequency of the amplifier. At the radial-transition frequency, the ratio of Z_M (the magnitude of the amplifier's transimpedance) to R_F drops to one. This simplification leads to an **equation** for the delay, t_D, in **Figure 2**:

$$\Delta\varphi = 2\sqrt{\frac{V_F}{V_m}\times\frac{R_F}{r_{m0}}},$$

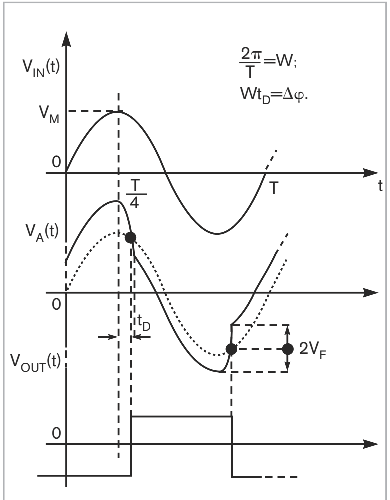

Figure 2 The output of comparator IC_2 switches a slight time delay, t_D, after the positive and the negative peaks of the input voltage.

where V_F is the forward voltage of diode D_1, V_m is the amplitude of input voltage, R_{m0} is the dc transresistance of the current-feedback amplifier, and $\Delta\phi$ is the electrical-error angle in radians. The period of input harmonic voltage, T in **Figure 2**, represents 2π radians. The final error of the detector is $\Delta\phi$, which decreases by a factor of $\sqrt{2}$. This reduction occurs because the necessary operating overdrive over the midpoint of the steplike transition in the $V_A(t)$ voltage that the comparator requires is more than an order of magnitude less than the value of V_F. **EDN**

REFERENCES

1 "Rail-to-Rail, Very Fast, 2.5V to 5.5V, Single-Supply TTL/CMOS Comparators," ADCMP600/ADCMP601/ADCMP602 Preliminary Data Sheet, Analog Devices, March 2006, www.analog.com/UploadedFiles/Data_Sheets/378991928ADCMP600_1_2_prra.pdf.

2 "Ultralow Distortion High Speed Amplifiers," AD8007/8008 Data Sheet, Analog Devices, 2003, www.analog.com/UploadedFiles/Data_Sheets/AD8007_8008.pdf.