Circuit detects rapidly falling signals and rejects noise

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Detecting a rapidly falling signal over some threshold is important for ultrasonic or location equipment as well as for seismology systems. You can combine a rail-to-rail operational amplifier with a Schmitt-trigger logic gate to perform this function (**Figure 1**). This example works well in an ultrasound machine. It controls a sample-and-hold amplifier that sets the gain of an AGC (automatic-gain-control) system.

The circuit works only with positive signals, so the signal must pass through a full-wave rectifier before it is applied to the circuit input. You configure the main part of the circuit, op amp IC_1, as a comparator with hysteresis. It produces a high-level output when an input signal is higher than the specified threshold. The output goes to a low level when the input signal begins to fall but only when the input falls faster than an established rate of change or if the level of the input signal will be lower than the established threshold of sensitivity. This circuit detects the moment when a signal is above the established threshold and the falling signal—or a mix of the signal and noise—has higher-than-specified speed.

R_1 and C_1 form an input lowpass filter to smooth the input signal. You set the values of R_1 and C_1 to create a filter roll-off for the input signal you are processing. Resistors R_3 and R_4 establish a small hysteresis, which is necessary so that slow signals with noise don't cause the output to change state. You set the threshold level with voltage divider R_6 and R_7. D_1, R_5, and C_2 form a peak detector. R_5 establishes a time constant of the discharge of C_2 and provides sensitivity to a falling signal's rate. You establish the circuit's sensitivity to a falling signal's rate of change using the time constant, which the values of C_2 and R_5 set. Hysteresis resistor R_4 is more than a decade larger than R_5, so the effect of resistors R_3 and R_4 is negligible.

A rising input signal greater than the threshold charges C_2 to approximately the level of the input signal. The output amplifier is at a high level because the

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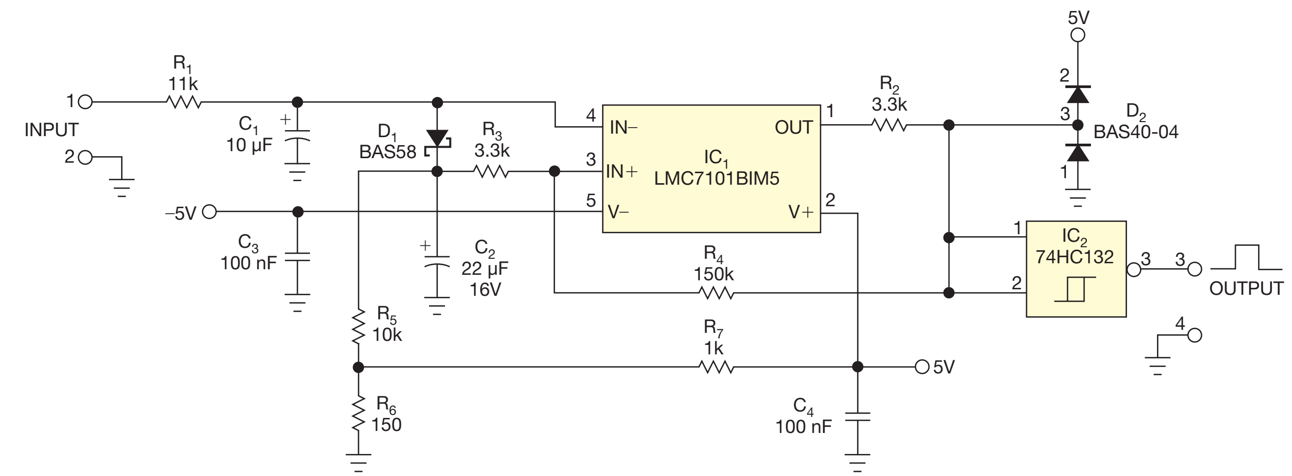

Figure 1 This circuit detects signal excursions higher than a set threshold and rejects noise and recognizes fast falling signals.

voltage on C_2 is always lower than the value of the rising input signal due to D_1's voltage drop. When the input drops faster than C_2 can discharge through R_5, the output level of the device changes to a low level because the voltage on C_2 is higher than the value of the falling input signal. If the input signal falls more slowly than the discharge of C_2 through resistor R_5, the output remains high. Schottky diode D_1 prevents the discharge of C_2 through the input. R_2 and D_2 clamp the amplifier's output to positive values. Feed the clamped signal to Schmitt-trigger logic gate IC_2 to give a logic-level output with fast transitions (**Figure 2**). EDN

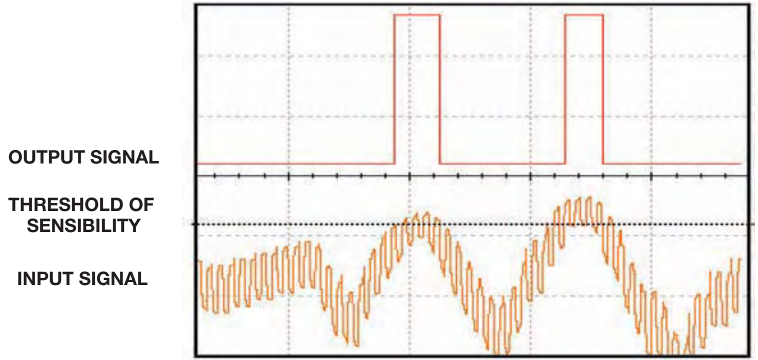

Figure 2 The circuit recognizes a pulse when it falls; noise is exaggerated for clarity.