Video detector stores peak for minutes

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In slow-scan image processing, a video signal often must hold its peak value for longer than the few seconds provided by diode peak rectifiers. But a rectifier that can retain a peak value of a video signal for up to four minutes can be built from two operational amplifiers and two transistors, avoiding the cost and complexity of digital storage for a sample-and-hold circuit.

In the circuit shown in Fig. 1, the CA3100 op amp compares the input signal (between 0 and 6 volts) to the voltage on a 0.47-microfarad plastic capacitor. The output of the CA3100 is an amplified error signal used to adjust the charge on the storage capacitor.

The storage and output sections are conventional. A MOSFET operational amplifier, the CA3130, with the twin assets of low cost and low input bias current, acts as a unity-gain buffer between the capacitor and the output terminal. The 2.2-kilohm resistor lowers the output impedance from the very high level of the 3130.

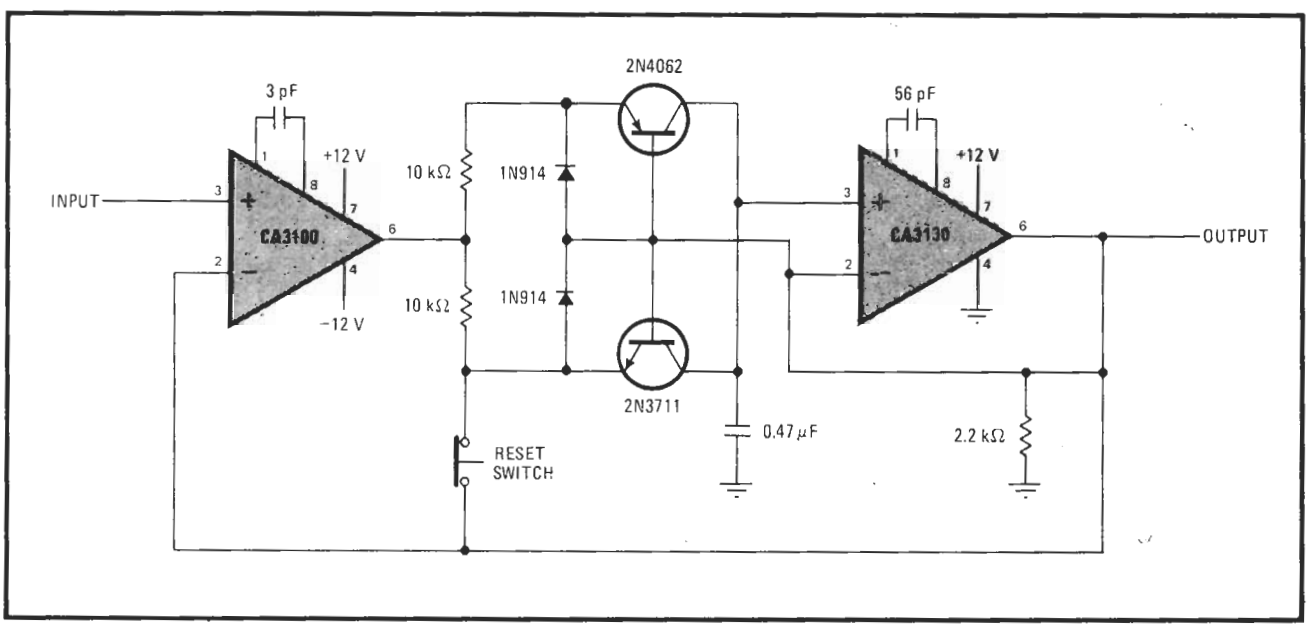
The key feature of the circuit is the unusual method of transferring charge into and out of the capacitor. Normally, a peak rectifier uses a series diode for this purpose. However, the diode has a reverse leakage current that is unpredictable, temperature-dependent, and often on the order of several nanoamperes. To avoid this leakage, the circuit shown uses the base-collector junction of a pnp transistor to transfer charge. The current is injected into the emitter, with the base connected to the output of the buffer amplifier. As a result, the base-collector voltage is close to zero, and collector leakage current is small.

An npn transistor is added to allow the capacitor to be discharged. Normally, this transistor does not conduct because its base-emitter junction is shorted by the switch. Thus, when the switch is closed, the output voltage (which is equal to the voltage across the capacitor) is determined by the most positive level applied to the input terminal. When the switch is open, the output voltage tracks the input signal (Fig. 2).

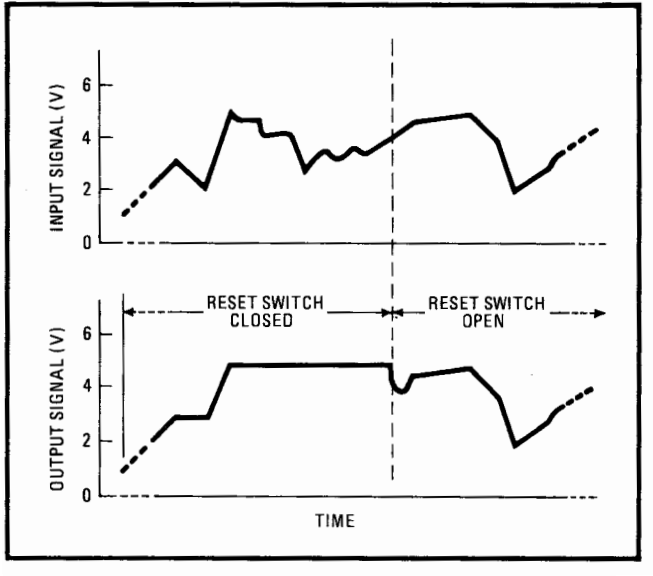
Holding performance of the circuit is quite good. If a 3-V signal is applied and removed, the output decays less than 10 millivolts in 10 minutes. This implies that the total leakage current into the capacitor is less than 10 picoamperes.

A drawback is the low slew rate. The minimum slew rate is set by the 10-kilohm resistors, the 0.47-μF capacitor, and the difference between the maximum output voltage of the CA3100 and the maximum signal voltage. With a 6-V input signal, the slew rate is about 850 V/s.

Several variations on the circuit are possible. The switch could be replaced by an electronically controlled device, such as a relay or a CD4016 complementary-metal-oxide-semiconductor transfer gate. This change



1. Stores maximum level. Peak detector circuit accepts analog input signals of 0 to 6 V in amplitude, provides output level that is maximum value of input. Use of pnp transistor for rectification minimizes charge leakage from capacitor, so peak level can be held for several minutes. Switch and npn transistor allow circuit to be reset. While reset switch is open, output signal follows input signal. If the reset switch is relocated to short the emitter to the base on the pnp transistor, the circuit is a minimum level detector, storing the lowest level of the input signal.



2. Holding the peak. Output from circuit of Fig. 1 is the highest level that has been applied to the input since switch was closed. If switch is opened, output slews down to input level, and then follows input. Circuit was developed for determining dynamic range of low-bandwidth scanning signal from an electron microscope, but is useful for any peak rectifier that requires low decay rate.

would allow electronic control of the reset function.

If the switch is moved to the emitter of the npn transistor, the circuit stores the lowest level of the input signal. If switches are placed in both locations, the circuit can function in four modes: tracking (both switches open), positive peak detector, minimum level detector, and holding (both switches closed).

By using both a positive peak detector and a minimum level detector in a circuit, maximum and minimum voltage levels can be stored for such purposes as setting the gains of variable-gain amplifiers, or storing the levels of transient peaks in a signal. □