Comparator IC forms 10-bit a-d converter

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This analog-to-digital converter uses an integrated-circuit comparator to provide an accurate 10-bit representation of an analog signal in 1 millisecond or in 100 microseconds, depending on the clock rate. The circuit, which costs only $13 to build, is accurate over the temperature range from 15°C to 35°C.

In addition to low cost, advantages include low parts count, low power drain, immunity from power-supply fluctuations, and capability to transmit data over two wires. Disadvantages include the necessity for a stable clock (although one clock can serve many converters), and dependence upon a capacitor for stability. The circuit may be sensitive to noise, but a small RC filter can be used for noise suppression.

Operation over extended temperature ranges is not recommended. If such use is necessary, however, capacitor C (Fig. 1) should consist of a 0.03 silver-mica capacitor in parallel with a 0.01 polystyrene capacitor.

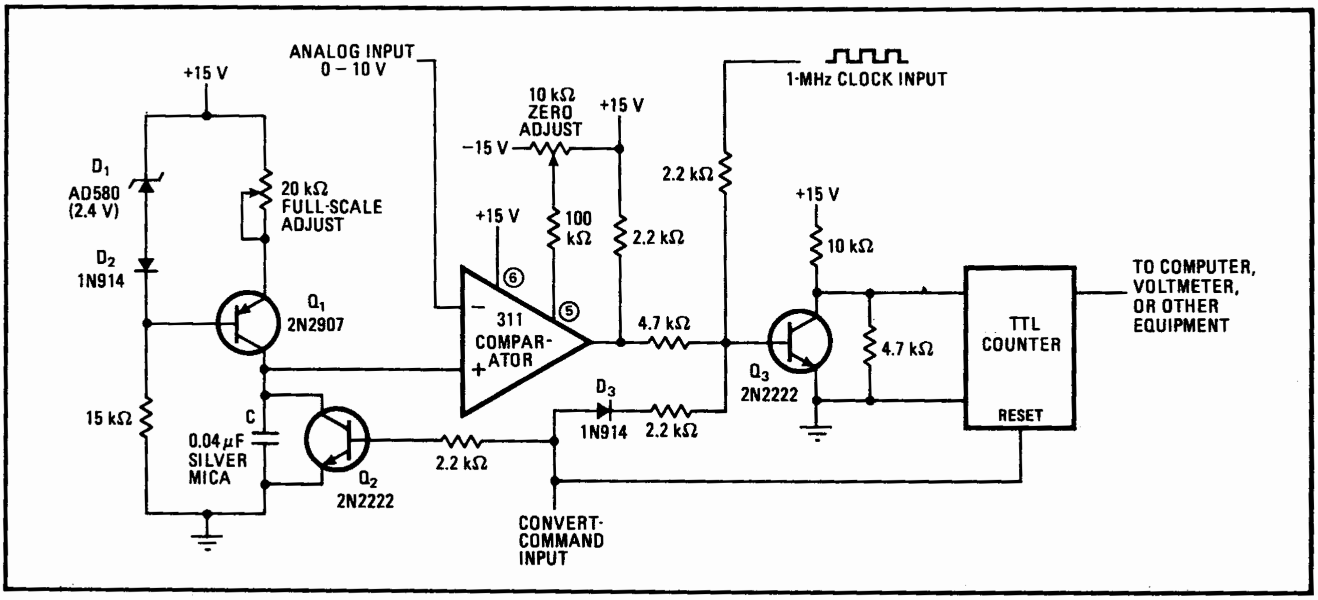
The digital output from this converter is the number of clock pulses counted during the time required for the capacitor to charge up to the level of the analog voltage. As the circuit diagram in Fig. 1 shows, the analog input can be any voltage from 0 to 10 V. This voltage and the voltage across the capacitor are compared in the IC. As long as the analog voltage is greater than capacitor voltage V_C, the comparator allows a counter to count clock pulses. But when V_C reaches the level of the analog voltage, the counting is stopped. The total number of pulses counted is a measure of the analog input. The charging rate of the capacitor is set so the pulse count is proportional to the voltage; e.g., 1,000 pulses corresponds to 10 V.

The detailed operation of the a-d converter in Fig. 1 is straightforward. Transistor Q_1, diodes D_1 and D_2, and the resistors constitute a constant-current source for charging capacitor C. The 2.4-V zener D_1 stabilizes the source against power-supply variations, and the voltage drop across D_2 matches the emitter-to-base voltage in Q_1, despite any temperature changes.

The type 311 IC compares the input voltage to the capacitor voltage V_C and controls transistor Q_3. The input voltage is applied to the inverting (–) input of the comparator, and V_C is applied to the noninverting (+) terminal. At quiescence, V_C is about 12 V, so the 311 output is high. This high signal keeps Q_3 on, so that the data line into the counter is grounded and no clock pulses are counted.

When a convert-command pulse is applied, transistor Q_2 turns on and discharges C, so that the 311 output goes to zero. Diode D_3 and the 2.2-kilohm resistor keep Q_3 on, however, so that no pulses can be counted during the convert command. On the falling edge of the command pulse, Q_1 begins to charge C linearly, and D_3 ceases to hold Q_3 on.

Now, because the output of the comparator is low, the clock pulses can turn Q_3 on and off, so that clock-frequency pulses are delivered to the counter. The combination of the 10-kilohm resistor and the 4.7-kilohm resistor makes the level of these pulses compatible with



1. A-d converter. Integrated-circuit comparator permits counting of clock pulses only while capacitor is charging up to level of analog voltage. With 1-MHz clock shown, conversion of 10-volt analog voltage to 10 bits (1,000 counts) takes 1 millisecond. If clock rate is 10 MHz, and C is 0.004 μF, conversion is accomplished in 100 microseconds.