Building your own digital voltmeter

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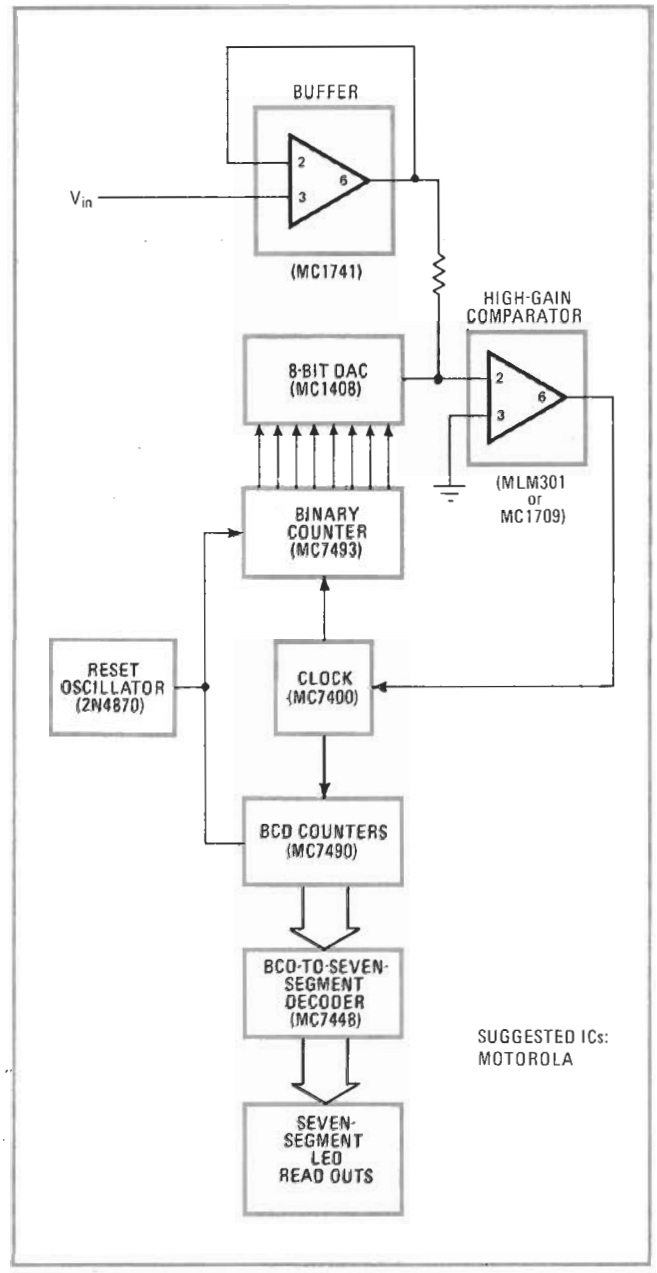
Currently available low-cost digital-to-analog converters are making it possible to design digital voltmeters that are inexpensive and yet that are reasonably accurate. Here's a suggestion for building a 2-2/3-digit (0 to 255 counts) DVM for approximately $35.

The meter is a closed-loop system that uses a clocked binary counter feeding a digital-to-analog converter to produce a staircase ramp function. The output of the converter is compared to the unknown input signal, and the clock pulse is terminated when the input signal level and the staircase function level are equal.

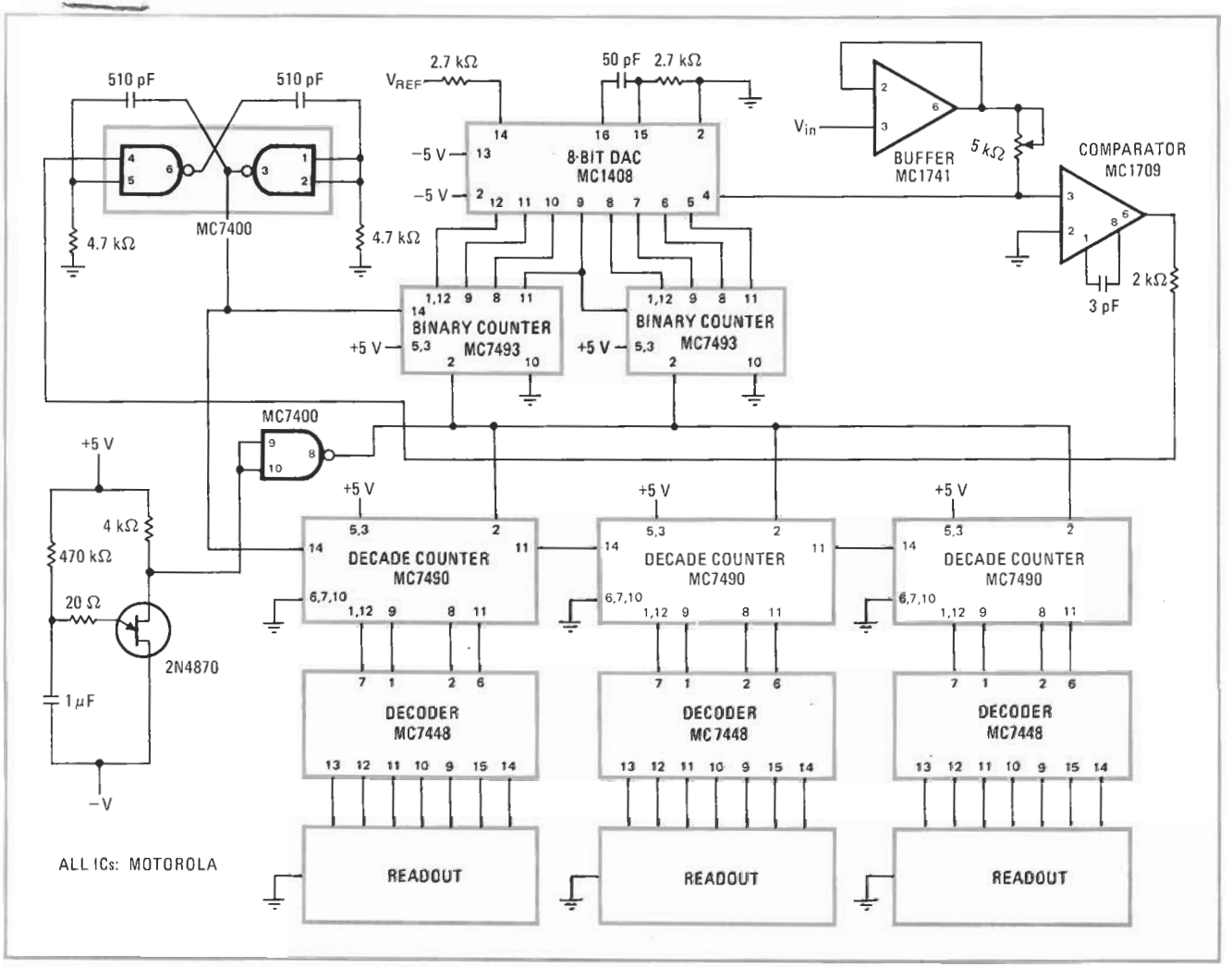
Clock pulses are generated by two cross-coupled TTL NAND gates. The clock frequency is set for 330 kilohertz so that a maximum of 256 counts is provided in less than a millisecond. A high-speed clock like this allows the counting to be done without being detected in the display by the human eye. A fast clock also avoids the need to have latches store the previous total count while the system is sampling and counting. The clock pulses are applied to two sets of counters—a binary counter chain in the feedback loop that controls the converter, and a binary-coded-decimal counter chain that provides an easy interface with the seven-segment digital readouts.

The d-a converter generates an output sink current that is proportional to the value of the applied digital word. The maximum full-scale value of this current, which is typically 2.0 milliamperes is set by a reference voltage and a reference resistor. The converter's output current is compared with the current from an input buffer amplifier. This buffer amplifier provides the meter with a high input impedance while supplying an output current of up to 2.0 mA for comparison with the converter output.

A second amplifier acts as a high-gain comparator to stop the clock when the current ramp from the conver-



DVM outline. Economical but accurate 2-2/3 digit voltmeter takes advantage of today's low-cost digital-to-analog converters.



DVM details. Unknown input signal is compared to the output current from the digital-to-analog converter. When these two signals are equal, the clock is stopped. The same clock is used to drive the converter's binary counters and the display's BCD counters.

ter exceeds the current from the input buffer amplifier. A unijunction-transistor oscillator is used to reset both sets of counters so that the unknown voltage is resampled about every 0.5 seconds. And BCD-to-seven-segment decoders convert the outputs of the BCD counters to the proper format for the seven-segment light-emitting-diode displays.

For the components used here, the meter can measure up to 2.55 V (to within ±5 millivolts) in 10-mV steps. Different full-scale values can be obtained by using suitable input voltage dividers or by providing a fixed-gain, rather than a unity-gain, input buffer. □