

# Low-cost autoranger scales DVM over four decades

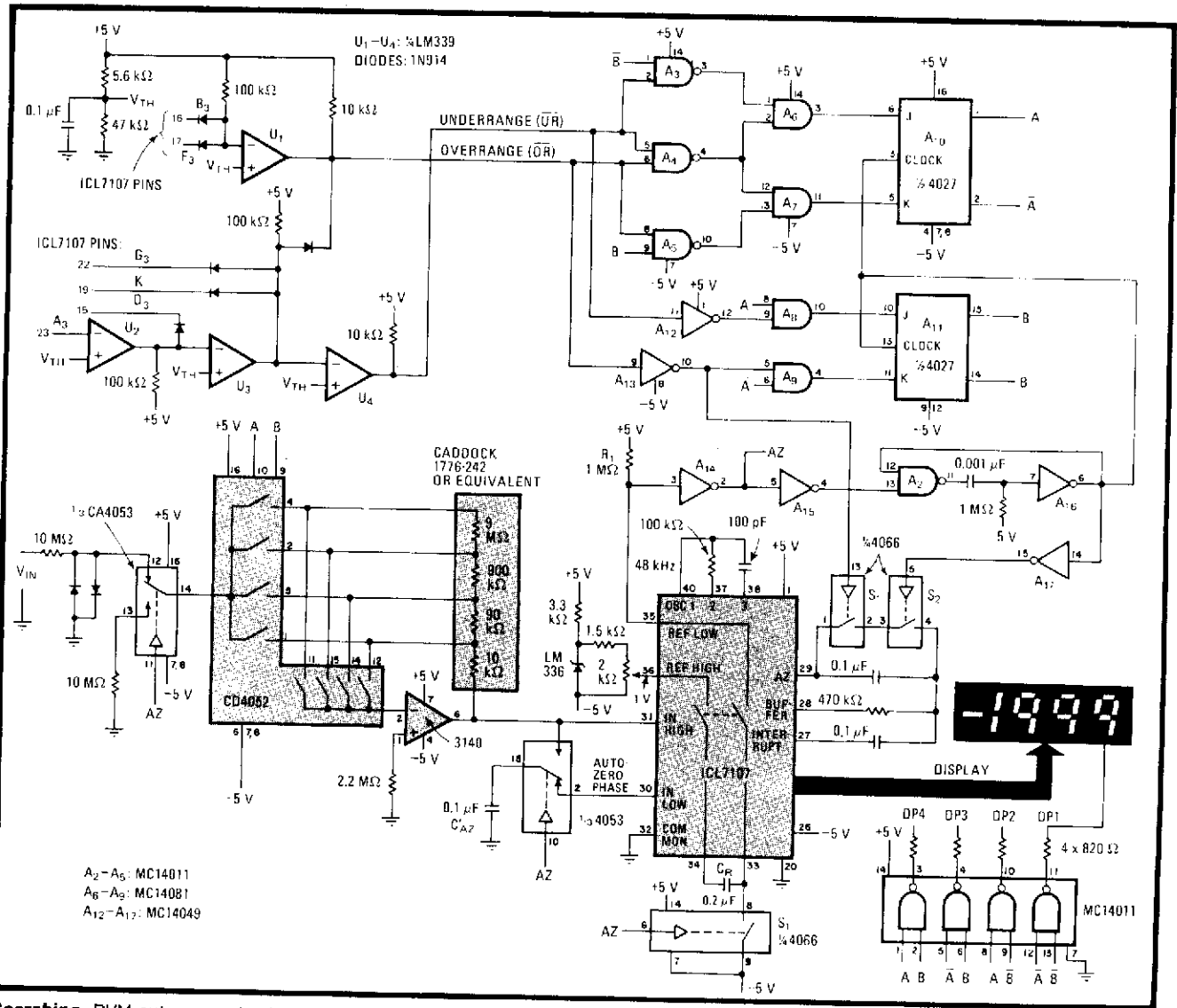
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Autoranging capability can be added to a digital volt-meter with this circuit, which costs less than \$25. Built around a dual-slope integrating analog-to-digital converter to ensure greatest measurement accuracy, the unit scales a 3½-digit voltmeter over a range of four decades ( $\pm 1$  to  $\pm 1,000$  volts dc) without the need for complex feedback circuitry.

In operation (see figure), signals to the input are applied to the ICL7107 a-d converter through the range switch formed by the 4052 multiplexer and the attenuator that includes the CA3140 comparator and its accompanying decade resistor network. During each 333-

millisecond measurement cycle, the converter proceeds to eliminate the error caused by the comparator's offset (autozero phase), stores the input voltage (integrating phase), and displays the difference, in terms of a voltage, between the integration time and the time required to discharge a reference potential from capacitor  $C_R$  (display phase). The autorange circuit ( $A_3$ - $A_{13}$ ) that follows tracks both underrange and overrange conditions with the aid of a suitable detection circuit. It generates the appropriate signals for controlling the range switch and thus the gain of the attenuation network.

The autorange circuit determines underflow or overflow at the initial portion of the autozero phase. During this time, the voltage on pin 35 of the converter drops momentarily. The drop switches gate  $A_{14}$  and thereby closes switch  $S_1$ , an action that brings pin 35 to logic 0 and completes the charging cycle for  $C_R$ . The rising edge of the AZ signal that clocks the range switch is delayed about 1 millisecond by  $A_2$  and  $A_{16}$ , providing sufficient time to stabilize the display and to check for the under-range and overrange conditions.



**Searching.** DVM autorange circuit uses  $A_3$ - $A_{14}$  to detect underflow and overflow conditions by examining the output state of ICL7107 a-d converter, then sets gain of input attenuator network over four decades through 4052 range switch. Circuit cost is under \$25.