

# A tracking differentiator has noncapacitive input

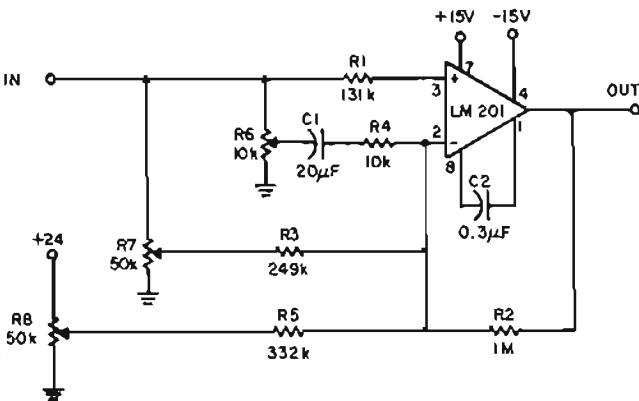
The major advantages of this circuit (see figure) over conventional ones are its noncapacitive input, and its independent gain, offset, and differentiating time constant adjustments.

Since the amplifier in the circuit will set the output, the summing point will track the input and the current through feedback resistor  $R_2$  will be the sum of the currents through  $C_1$ ,  $R_3$ , and  $R_5$ . The output is the voltage across  $R_2$  plus the input.

The differentiating constant is calibrated by disconnecting  $R_3$  and  $R_4$  and reading the difference between the output and the input.

The output of a test unit, with the values shown, was found to drift 10mV per day and 0.25mV/°C.

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High offset stability is achieved in this noncapacitive differentiator. Gain, offset and differentiating time constant are independently adjustable.

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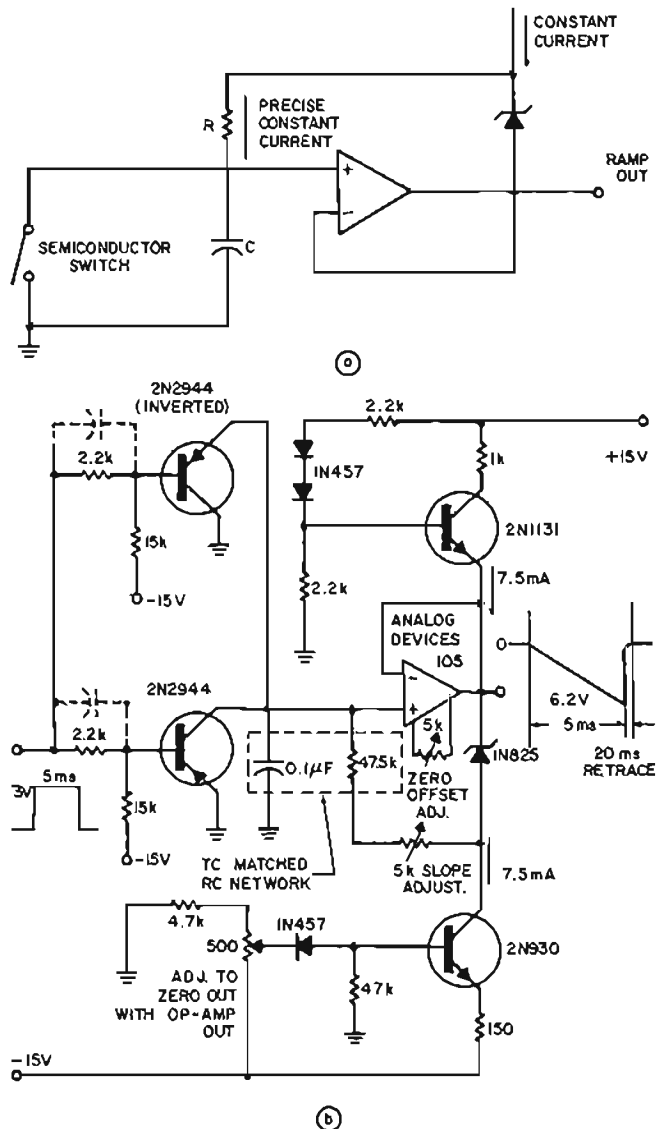
# An op amp and a chopper give precision ramp generator

Operational amplifier integrator circuits are often used to produce precise ramp voltages. They suffer, however, from the excessive time needed to discharge the feedback capacitor during the retrace time. This problem can be eliminated using the configuration shown in Fig. 1a. Here one side of the capacitor is connected to ground so that a simple semiconductor switch can discharge the capacitor. The operation of the circuit is as follows:

The capacitor is charged by a constant current obtained in this case from a resistor-zener combination which is referenced to the output of the op amp voltage follower in a bootstrap fashion.

With a high-gain, high-input-impedance op amp, and stable resistors, capacitors and compensated zeners (if necessary in an oven or thermo-electric bath), the degree of linearity is only limited by the switch. With two chopper transistors in parallel, one to assure fast discharge of the capacitor, the other in an inverted configuration to provide complete discharge, it is possible to obtain switch levels and leakage currents on the order of 1 millivolt and 10 nanoamps, respectively. An actual circuit is shown in Fig. 1b. It puts out a 5-ms negative-going ramp, linear to about 0.01%. The linearity check showed no deviation from a straight line within the limits of its 1mV tolerance.

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1. A simple switch (a) permits discharge of the capacitor quickly during the ramp generator's retrace time. Detailed schematic of the circuit is shown in (b).

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