Op amps and counter form low-cost transistor curve tracer

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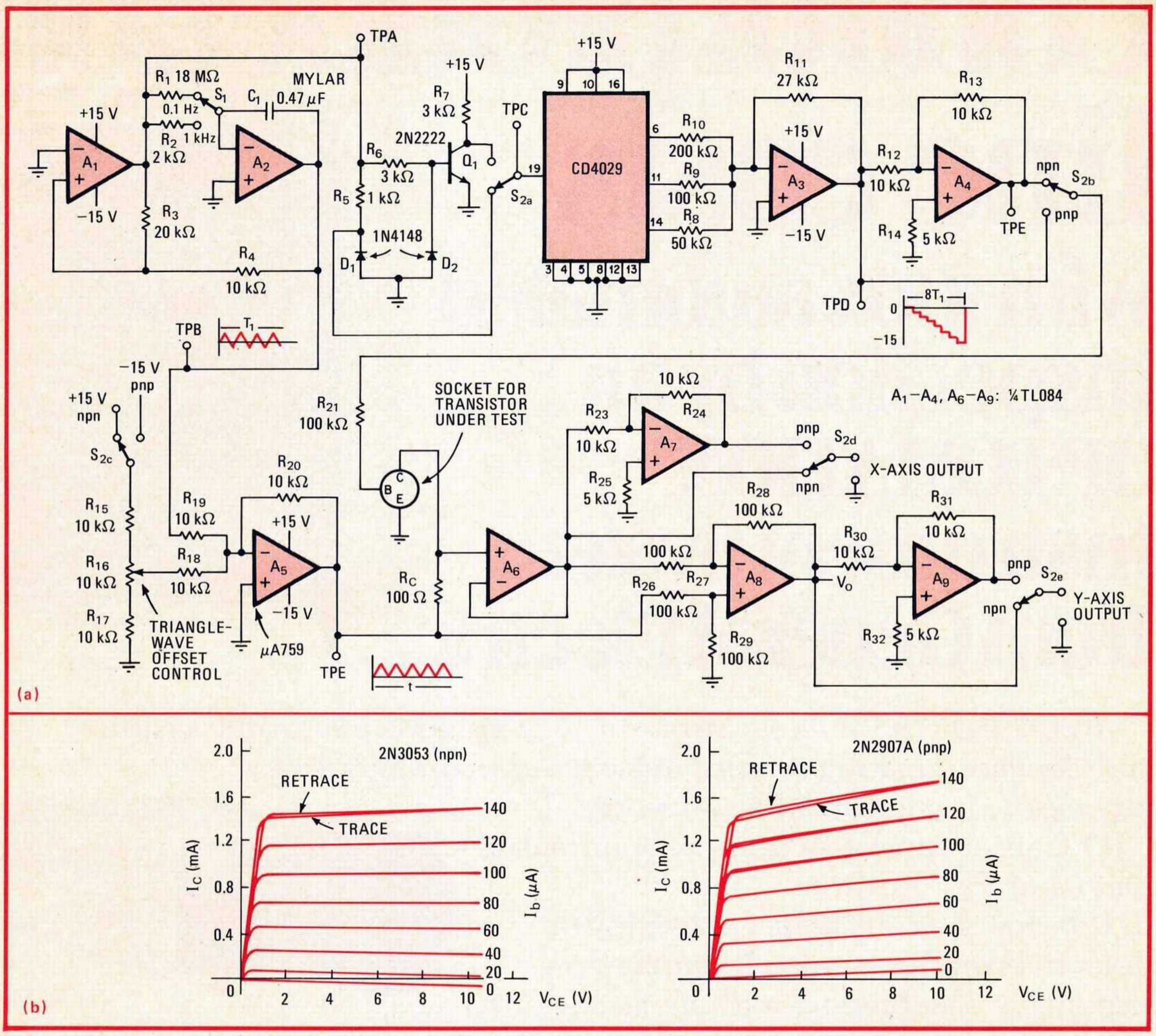
For a curve tracer, this relatively simple circuit is unusually inexpensive. Used to test small-signal bipolar transistors as well as junction diodes, it generates the waveforms needed to display or plot their characteristic curves on an oscilloscope or X-Y plotter, interfacing directly with either. Operational amplifiers, one transistor, and a single binary counter are the only active devices needed.

Central to the circuit is a current generator made up of an op amp driven by the counter. It supplies eight levels of base current in sequence to the transistor under test. Op amps A_1 and A_2, with the aid of the R_1-R_2-C_1 timing network, initially produce both square and triangular waves at test points A and C (TPA and TPC), respectively. S_1 selects the waveform frequency—either 1 kilohertz for output onto an oscilloscope or 0.1 hertz for plotting with an X-Y recorder.



Current family. Tracer produces set of eight curves of collector current vs collector voltage from npn or pnp transistor under test. Diodes may also be checked in circuit's pnp-transistor mode (a). Representative curves are plotted using X-Y recorder (b). Note temperature effects seen on the retrace portion of curves for higher values of I_b and I_c.

The waveform at TPA is then shaped by D_1–R_5 or D_2–R_6 into a clock pulse suitable for the 4029 binary counter. The signals emanating from the Q_a, Q_b, and Q_c ports of the counter, when fed into a binary-weighted summation network (R_8–R_{11}), produce an eight-step staircase waveform at the output of A_3 or A_4, depending upon whether a pnp or npn transistor is under test. The actual base current value is determined by appropriate selection of R_{21}. The collector current can be calculated from $I_c = V_o/R_c$.

Both the collector-biasing voltage for the transistor under test and the linear-deflecting voltage for the X-axis output to the scope are derived from the triangle wave. The first voltage is obtained by using S_{2c} and R_{16}, which permit the proper dc component to be added to the triangle signal.

Note that the Y axis is stepped at one eighth of the rate at which the X axis is scanned. Thus, if the sampling rate is 1 kHz, each of the eight current levels is swept at a rate 125 Hz, well above the rate at which flicker is detectable on a scope.

The circuit is easy to use. Simply place ganged switch S_2 into whichever position is correct for the type of transistor being measured (npn or pnp); place the transistor into the test socket; and apply circuit power. To test a diode, insert its anode and cathode leads into the emitter and collector sockets, respectively, and put S_2 in the pnp mode.

Figure lb shows two representative families of curves the circuit produced on an X-Y recorder for the two types of bipolar transistor. □

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