Op amps and counter form low-cost transistor curve tracer

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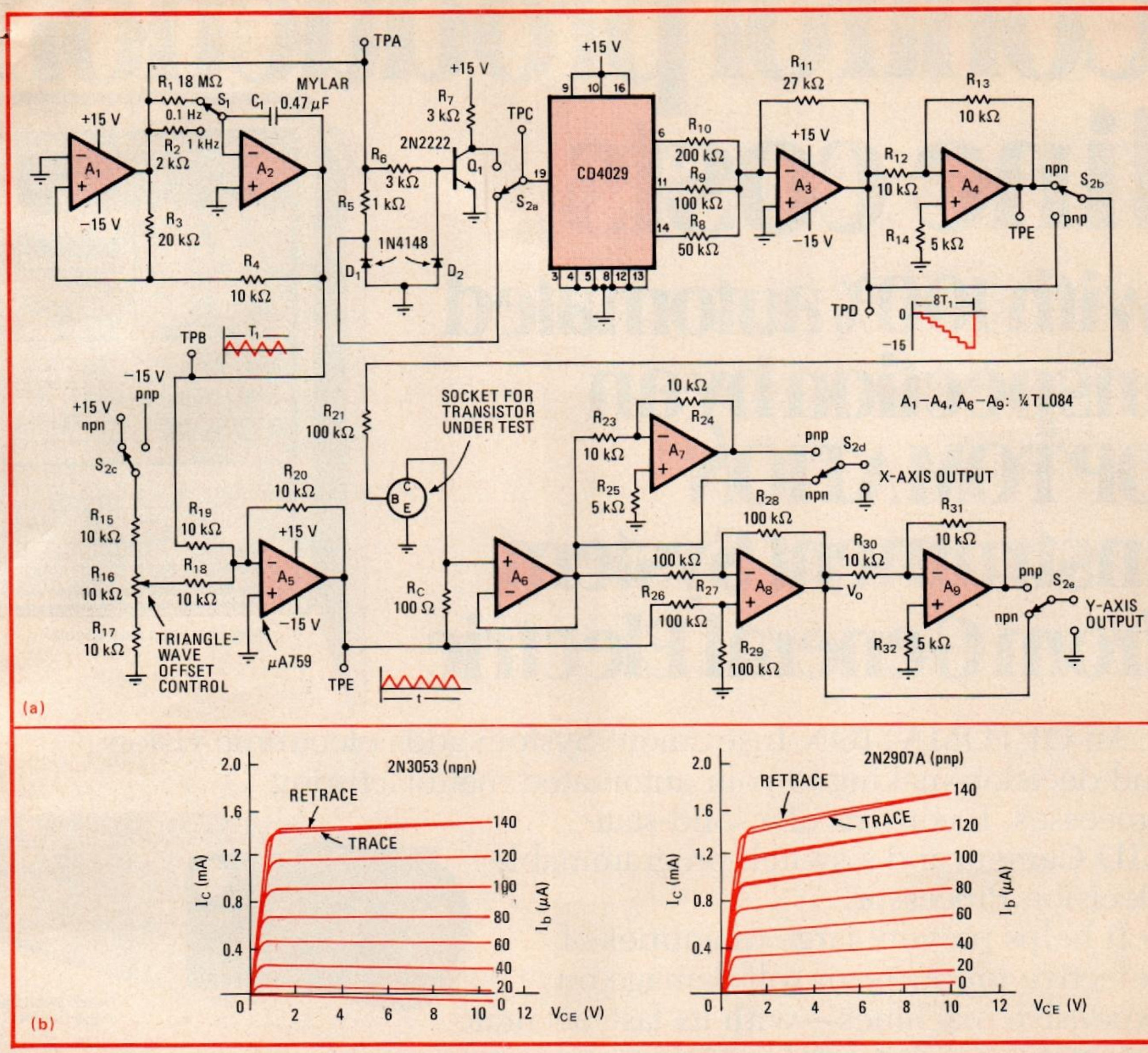
For a curve tracer, this relatively simple circuit is unusually inexpensive. Used to test small-signal bipolar transistors as well as junction diodes, it generates the waveforms needed to display or plot their characteristic curves on an oscilloscope or X-Y plotter, interfacing directly with either. 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



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.

1 kilohertz for output onto an oscilloscope or 0.1 hertz for plotting with an X-Y recorder.

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 1b 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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