BUILD A LOW-COST
1-Hz to 1-MHz Frequency Counter

Sophisticated, low-cost counter with 3-digit readout uses state-of-art CMOS chips.

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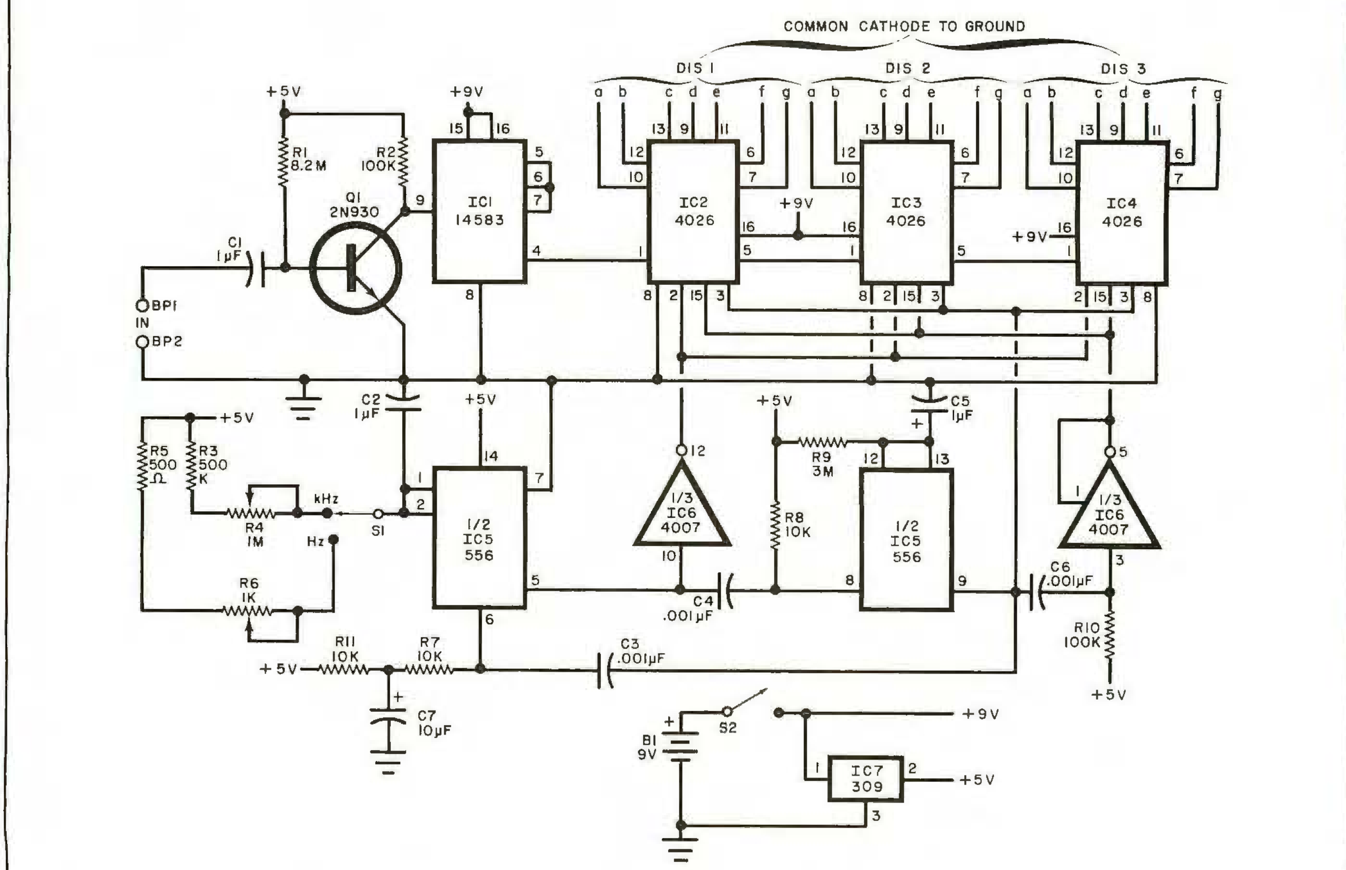
A FREQUENCY counter can be as useful in working with electronic equipment as an oscilloscope, yet it is often the last piece of test gear the hobbyist and experimenter buys. The main reason for this save-for-last attitude stems from the fact that commercially made counters are relatively high priced. Now, however, the easy availability of inexpensive "surplus" IC's and low-current LED displays makes it possible for you to build a low-cost, three-digit frequency counter with a range from 1 Hz to about 1 MHz). By shopping carefully (see the ads at the back of this magazine), you should be able to build your frequency counter for just about $25 to $30.

Circuit Operation. A frequency counter consists of a wave shaper that should have a reasonably high input impedance and a series of decade counting units. The wave shaper "conditions" the input signal to give it the clean-edged waveform necessary to trigger the decade counting units. The outputs of the counters drive numeric displays. The entire operation is controlled by a time base that enables the counter for a precise period of time. During the enable in-



PARTS LIST

B1—9-volt alkaline battery
BP1,BP2—Binding post (one red, one black)
C1,C2,C5—1-μF ceramic, Mylar, or polystyrene capacitor
C3,C4,C6—0.001-μF disc capacitor
C7—10-μF, 16-V, electrolytic capacitor
DIS1 through DIS3—Common-cathode 7-segment LED display (Motorola HEK-5 or similar)
IC1—14583 Schmitt trigger IC
IC2,IC3,IC4—4026 decade counter IC
IC5—556 dual timer IC
IC6—4007 dual complementary pair and inverter IC
IC7—5-volt regulator IC (LM309 or similar)
Q1—2N930 or similar transistor
Following resistors are ¼ watt:
R1—8.2 megohms
R2,R10—100,000 ohms
R3—500,000 ohms
R5—500 ohms
R7,R8,R11—10,000 ohms
R9—3 megohms
R4—Subminiature 1-megohm potentiometer
R6—Subminiature 1000-ohm potentiometer
S1—Spdt switch
S2—Spst switch
Misc.—Perforated board; IC sockets (optional); battery holder; small Bakelite or plastic case; machine hardware; hookup wire; solder; etc.

terval, all events present at the input are counted and totalized. At the end of the count interval, the counts are stored and displayed. The counter is then inhibited from accumulating more counts until the display period ends. Then the frequency counter is reset and a new count cycle begins.

The complete circuit of the frequency counter is shown in the schematic. The input circuit can be modified according to the availability of components. Just keep in mind that the input should have a reasonably high impedance and that the input of the *IC2* decade counter should have a clean positive-going leading edge.

Integrated circuit *IC1* is a Schmitt trigger that conditions the input signal and converts it to logic levels suitable for the *IC2* through *IC4* counter chain. The tenth input count to *IC2*, at pin 1, generates a "carry" pulse at pin 5 to toggle *IC3*. At the instant the carry pulse is generated, *IC2* causes *DIS1* to display a 0, while *IC3* causes *DIS2* to display a 1. When a tenth input pulse is applied to the input of *IC3*, a carry pulse toggles *IC4* and *DIS2* displays a 0 and *DIS3* a 1. In this circuit, the carry output of *IC4* (pin 5) can be used to turn on the decimal point of *DIS1* to indicate an overrange condition.

The timing starts with half of the dual timer (*IC5*). Switch *S1* enables either a 1-s or a 1-ms timing interval. During this interval, the second half of *IC5* generates a 2- or 3-second display interval during which the counters are disconnected from the input and the display system is unblanked. At the end of the display, a reset pulse initiates the timing/counting interval.

Construction. Except for the input binding posts, switches, and displays, the entire circuit can be assembled on a piece of perforated board using point-to-point wiring. The only critical area of assembly is around *Q1* and the input of *IC1*, where high-frequency signals will be present. Mount *Q1* and *IC1* at the end of the board nearest where the input jacks will be mounted on the case.

The displays, switches, and input binding posts should mount on the front of the enclosure. Mount the displays side by side in a slot just large enough to accommodate them and cement them in place. Then mount the binding posts and switches and complete circuit wiring according to the schematic diagram.

Calibration. You can use any frequency counter of known accuracy and a signal generator to make all frequency adjustments. Simply set *S1* to the Hz position, drive the counter with some fairly low-frequency signal, and adjust the setting of *R6* for the correct indication. If you are using a highly accurate frequency counter to monitor the output of the signal generator, adjust *R6* so that the displayed numbers on both counters are the same. Repeat the procedure with a high-frequency signal.

If you do not have access to a highly accurate frequency counter, you can calibrate the dial of any audio signal generator using a 60-Hz source and Lissajous pattern (on an oscilloscope). Then use the outputs as a reasonably accurate signal source to calibrate the frequency counter.

If you have an older signal generator whose dial has a high degree of inaccuracy, you can build the low-cost frequency counter into it. Then you will always know at exactly what frequency the generator is operating. ◈