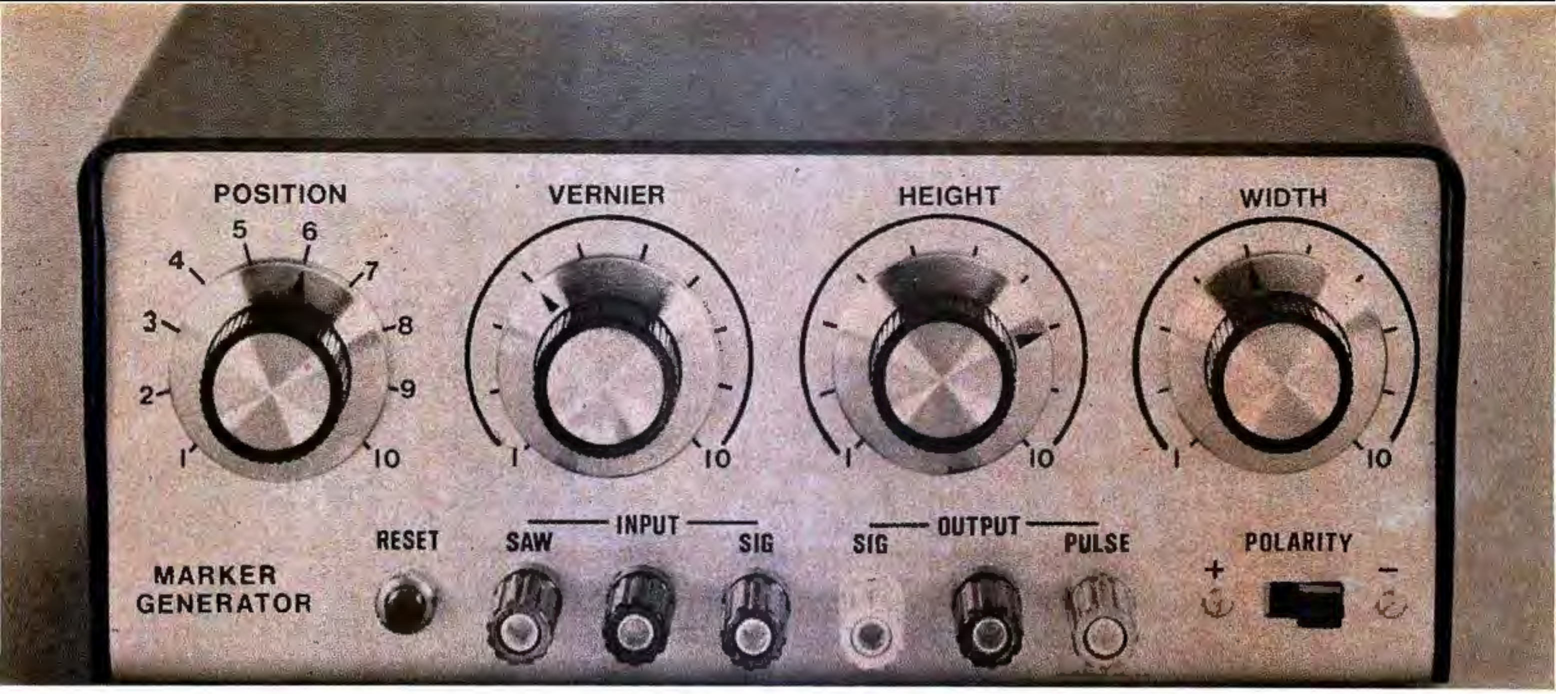



BUILD AN
# AUDIO SWEEP MARKER GENERATOR

*Now you can easily identify any frequency on an audio swept waveform display.*

BY JON PAUL

THE USE of a sweep generator is practically a necessity in any serious testing of audio equipment. Some sweep generators are not sufficiently calibrated however (especially for a logarithmic sweep) to provide an easy identification of an unusual response at a particular frequency. This can be easily remedied by mixing the output of a marker generator with the sweeper's output. Then, when the signal is displayed on a scope, a particular frequency can be identified.

The audio sweep marker generator described here provides two approaches to marker display. One is a sharp vertical pulse as shown in Fig. 1, which can be positioned on the scope at the frequency of interest. Or the pulse can be fed through the scope's intensity axis to generate a bright spot on the display. The marker automatically covers the same range as the sweeper being used, and the only condition required is that the sweeper's main sawtooth be available.

**How It Works.** The sawtooth output from the audio sweeper (the waveform within the sweeper that is performing the actual frequency sweep—not a sawtooth audio output) is coupled to the marker generator through *BP1* as shown in Fig. 2. This signal is buffered in *IC1* and fed to *IC2* and *IC3*, which form a peak detector.

As the input rises in voltage, *IC2* places a charge on *C2* through *D1*. When a peak value is reached and the signal drops to zero, the output of *IC2* goes negative and *D1* is reverse biased. However, *C2* remains charged at the peak value of the sawtooth ($V_{peak}$). When RESET pushbutton *S1* is depressed, *C2* discharges through *R3* so that, on the next sweep, a new value of $V_{peak}$ is detected. Integrated circuit *IC3* is a unity gain buffer that prevents succeeding circuitry from loading *C2*. The output of *IC3* goes to *IC2* to supply the feedback necessary for the peak detection process. It is also applied to two adjustable voltage dividers—*R4*, which is used as a VERNIER control, and the resistor network associated with *S2*.

The voltages selected by *S2* and *R4* are mixed in *R14* and *R15* so that the input to *IC4* can be selected to be between 0 and 90% of $V_{peak}$ in 10% steps with the vernier providing smooth adjustment between steps.

The output of *IC4* is applied to two comparators—*IC5* and *IC6*. Transistor *Q1* develops a constant current (I) in *R21* to produce an offset at the input to *IC5*. Thus one input to *IC4* is $V_{ref}$ (from *IC4*) + (R21xI). The other input is $V_{sweep}$ from *IC1*. The output of *IC6* switches when $V_{sweep}$ equals $V_{ref}$ and the output of *IC5* switches slightly later due to the offset provided by *R21*.

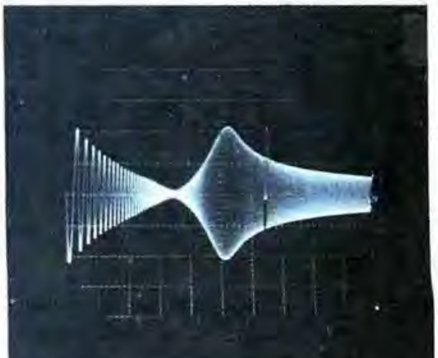


*Fig. 1 Photo of marker "pip" on a typical scope display.*

Diodes *D5* and *D6* and resistor *R27* form an AND gate whose output is negative only when *IC5* and *IC6* have negative outputs. This generates a

## PARTS LIST

BP1 to BP6—Five-way binding post
C1,C6—0.001-µF ceramic capacitor
C2—47-µF, 20-volt tantalum capacitor
C3,C5—33-pF ceramic capacitor
C4—3.3-pF ceramic capacitor
C7,C8—150-pF ceramic capacitor
D1 to D9—1N914 diode
IC1—741 op amp
IC2 to IC6—301A op amp
Q1—2N4250 transistor
Q2—2N3642 transistor
Following resistors are ¼W, 10% unless otherwise noted
R1,R30—4700 ohms
R2,R18—8200 ohms
R3—10,000 ohms
R4—10,000-ohm linear potentiometer
R5 to R13—1000-ohm, 1% carbon-film
R14—2-megohm, 1% carbon-film
R15—221,000-ohm, 1% carbon-film
R16—200,000 ohms
R17,R27—2200 ohms
R19—2-megohm linear potentiometer
R20—160,000 ohms
R21 to R24, R34—22,000 ohms
R25,R26—10 megohms
R28,R29—27,000 ohms
R31—6800 ohms
R32—20,000-ohm linear potentiometer
R33—100,000 ohms
S1—Spst normally open pushbutton
S2—10-position, single-pole rotary switch
S3—Spdt switch
Misc.—Suitable enclosure, knob (4), dry transfer lettering, mounting hardware, etc.
Note—The following is available from MITS Inc., 6328 Linn, N.E., Albuquerque, NM 87108: complete kit including prepunched board and cabinet (MG-1K) at $98; complete kit without cabinet and hardware (MG-1P) at $71; pc board alone (MG-PC) at $8; assembled unit, with 90-day warrantee (MG-1A) at $138. Add $5 for postage and handling on all items except for pc board alone.

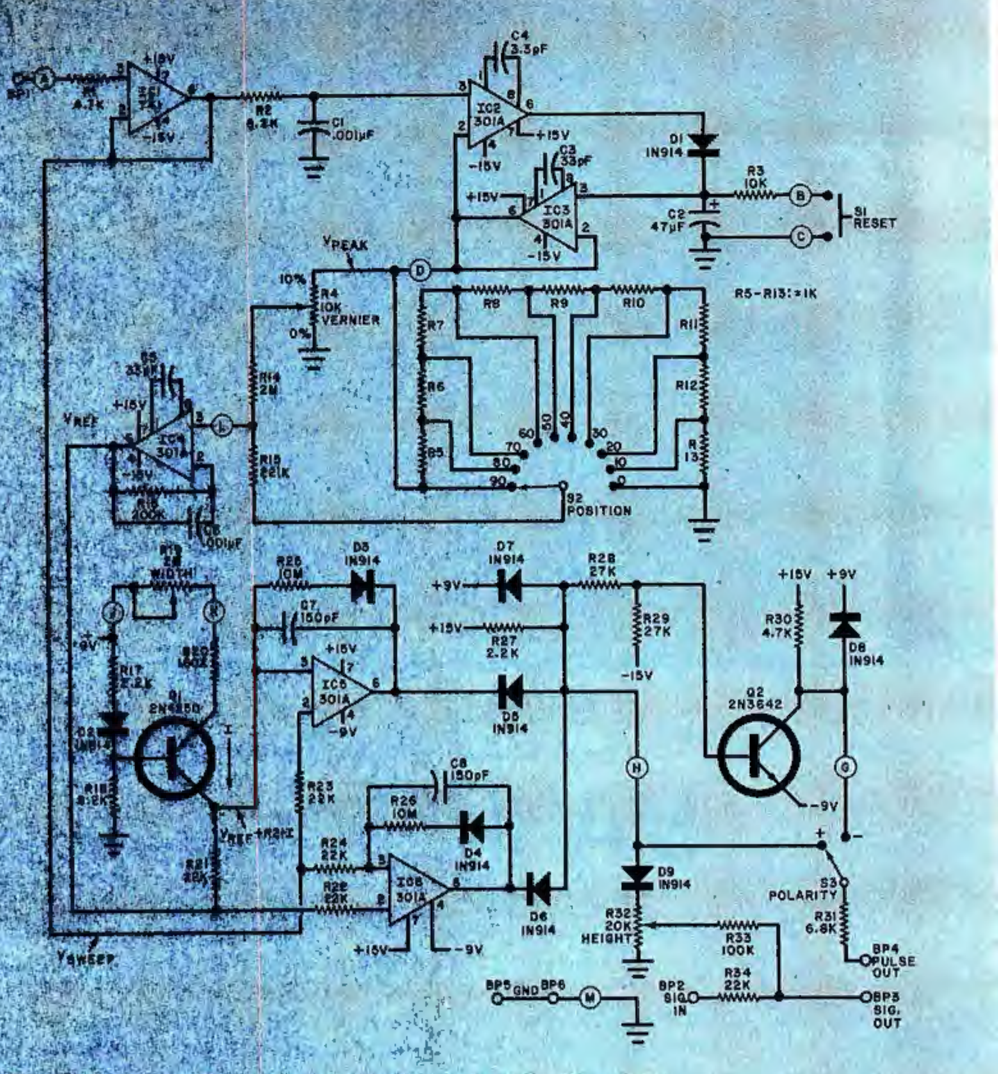



*Fig. 2. Position of marker pulse is determined by S2 and R4, while width and height are controlled by R19 and R32.*

pulse which is negative only when $V_{sweep}$ is greater than $V_{ref}$ but less than $V_{ref}$ plus the offset. The width of the pulse is proportional to I. Since the current is determined by the setting of *R19*, the setting controls the width of the pulse. The various waveforms involved are shown in Fig. 3.

The pulse from the AND gate is applied to the base of *Q2*, which is an inverter. POLARITY switch *S3* can then select either a positive or an inverted pulse. The mixed marker is formed by adding a variable-amplitude pulse (from *R32*) to the swept audio signal connected to *BP2*.

**Construction**. The circuit can be built on a pc board such as that shown in Fig. 4. Be sure to obtain proper orientation of the diodes, the IC's and *C2*.

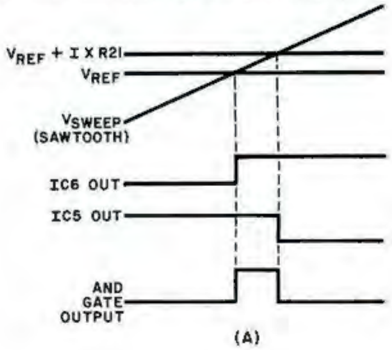
The marker generator requires four power sources: ±9 and ±15 volts. These may be available in the sweep generator (as they are in the unit described in the October 1973 issue of POPULAR ELECTRONICS). Or small separate supplies can be constructed. The two 15-V sources can be unregulated and any value between 13 and 17 V. The 9-V sources should be regulated (using zener diodes) and can be derived from the 15-V supply.

The front panel of the chassis should be large enough to accommodate the POSITION switch *(S2)*, the VERNIER potentiometer *(R4)*, the HEIGHT control *(R32)*, the WIDTH control, *(R19)*, the RESET switch *(S1)*, the POLARITY switch *(S3)*, and six input and output connectors.

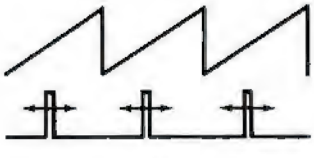
The vernier potentiometer should be calibrated for 1% increments by measuring its resistance in 10% steps. The switches and connectors should also be marked as shown in the photograph.

**Operation and Use**. No calibration of the circuit is necessary since the peak detector works automatically.

Connect the sweep and marker generators to the unit being tested and the scope as shown in Fig. 5. The marker's POLARITY switch determines the type of intensity modulation (bright or dark marker), while the HEIGHT control varies the marker am-




(A)



(B)

*Fig. 3. Pulse is generated as shown at (A). Position can be varied as shown at (B).*

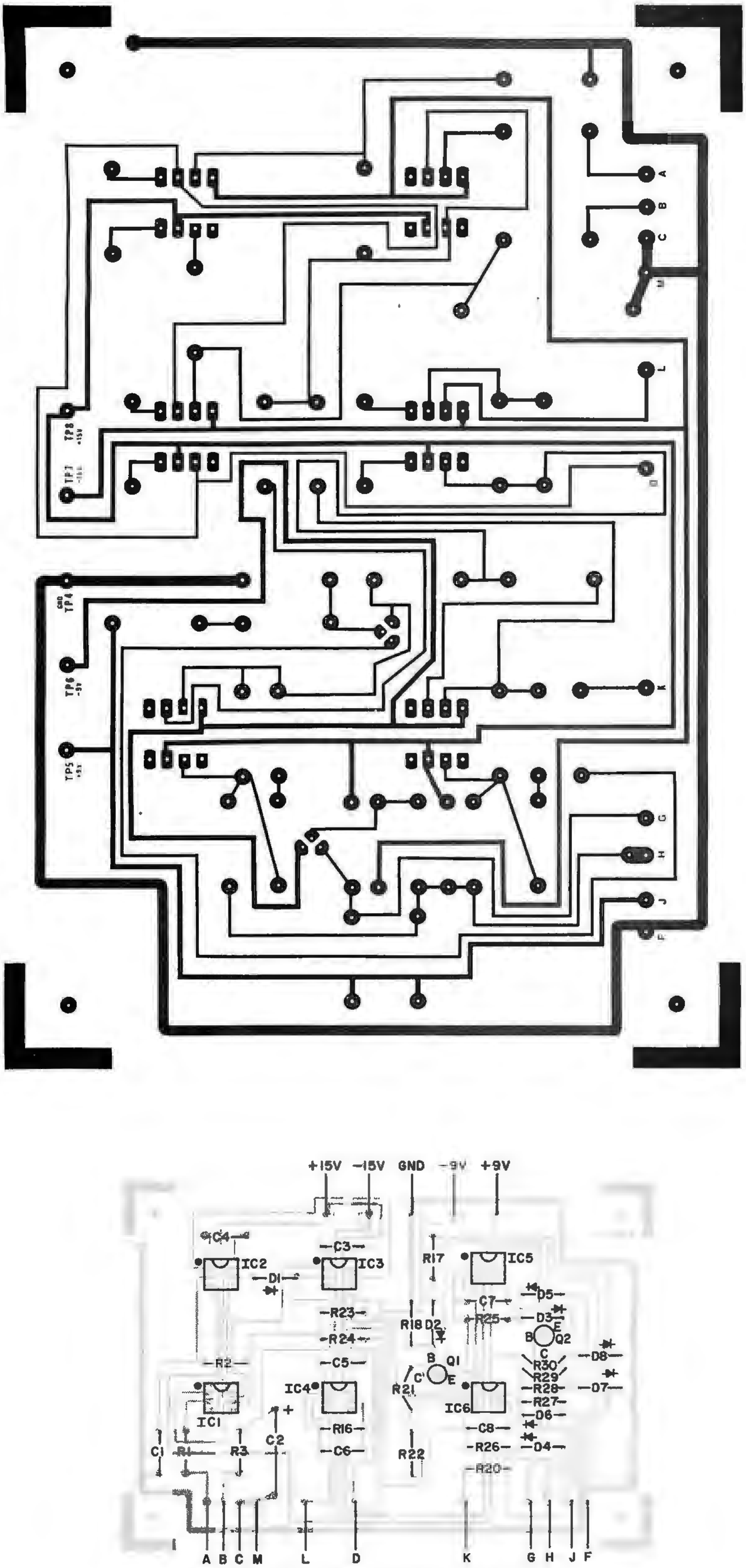



*Fig. 4. Actual-size foil pattern is at top; component layout below. Lettered pads correspond to those on schematic and are used for interconnections.*

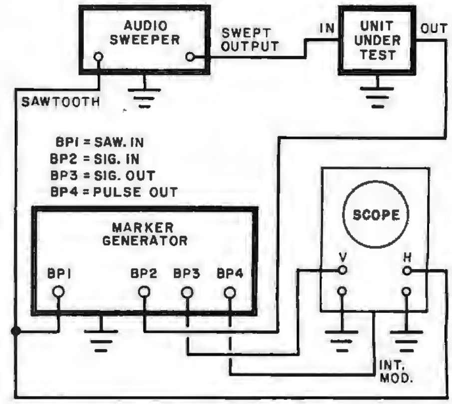



*Fig. 5. Interconnections for setting up a test.*

plitude. Three types of display are shown in Fig. 6.

The accuracy of the marker generator is determined by the matching of *R5* through *R13* (all 1% resistors). The sweep linearity of the scope, however, will rarely be better than 2%.

RESET pushbutton *S1* is rarely used. If the marker suddenly shifts position on the display, or if high-value markers cannot be displayed, a noise pulse

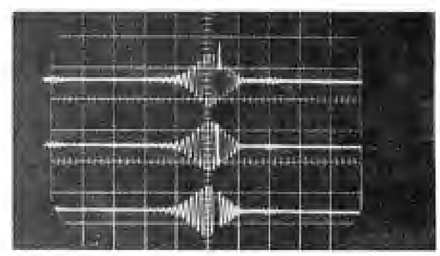


*Fig. 6. Pip marker is at top. Bright and dark intensity markers in display at center and bottom.*

has probably disturbed the peak detector. In this case, depress *S1* so that the circuit will automatically recalibrate itself on the next peak.

Assuming that the sweep generator is set to operate in the linear mode between 0 and 10,000 Hz and you want to determine the frequency of a "glitch" near the center of the display, proceed as follows. Set the marker generator for the type and amplitude of marker desired and adjust the POSITION switch until the marker is just below the frequency of interest. Then adjust the VERNIER to refine the position. If the POSITION switch is at 5 and the VERNIER at 7, the marker frequency is 57% of the swept frequency, or 5700 Hz.

Note that there are no "frequency" dials on the marker generator—only percentages of swept frequency. ◈