BUILD THIS

Headroom TEST GENERATOR

Want to know how much undistorted power your hi-fi amplifier can deliver above its continuous power rating? If so, build this inexpensive test accessory that will tell the story.

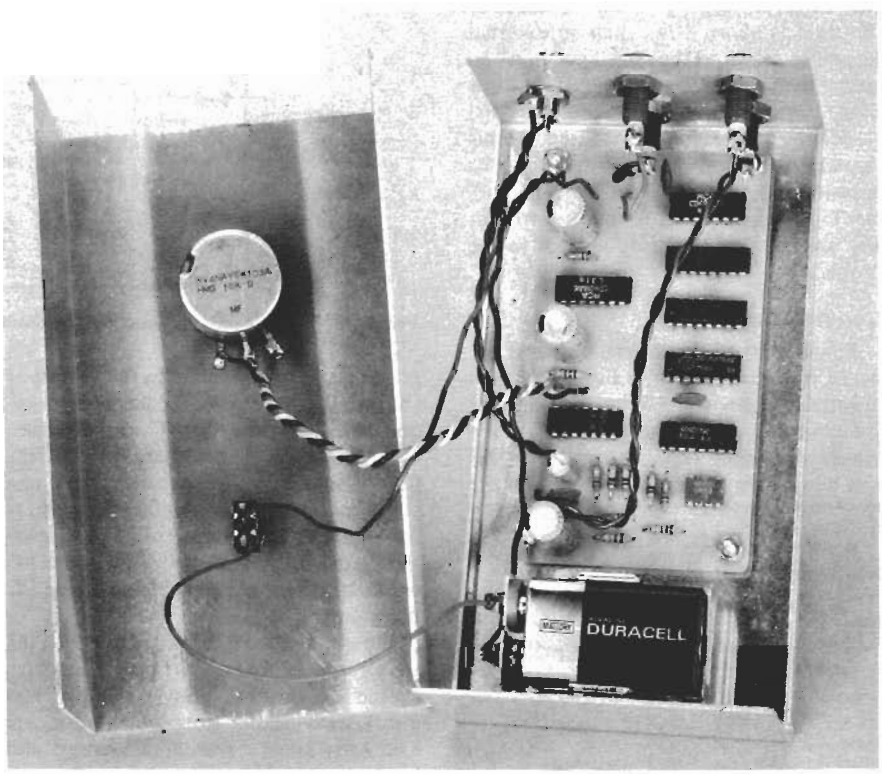
DOUG FARRAR

UP UNTIL NOW, CONTINUOUS POWER HAS been used as the standard measuring stick for all amplifier power ratings. Those in the know have long been aware that most amplifiers can supply undistorted bursts of power beyond the continuous power rating. The question was how to standardize and measure it. A test for measuring what's now called Dynamic Headroom was recently adopted by the Institute of High Fidelity (IHF) that does just that. A 1-kHz sinewave input is adjusted to drive the amplifier to its rated continuous power output for 1980 cycles, and is followed by a 20-cycle burst with the same frequency but higher amplitude. The burst amplitude is adjusted until the output clips. The ratio of the two output voltages is then used to determine the dynamic headroom (DH) as follows:

$$DH = \log \frac{V_2}{V_i}$$

where V_2 is the burst output voltage, and V_1 is the continuous voltage. Well-designed amplifiers will have close to 0-dB dynamic headroom, while less expensive units may have as much as 3-dB (2:1). For a more elaborate presentation, see the December 1978 article in **Radio-Electronics** entitled "Understanding Dynamic Headroom."

The circuit described here, in conjunction with any audio sinewave generator (like the construction project described in the October and November 1978 issues of **Radio-Electronics**), generates the desired waveform. Since total supply current is less than 10 mA, it is powered by a 9-volt transistor radio battery. Low-cost IC's are used throughout, keeping the cost of the total unit easily under $20.



INSIDE THE DYNAMIC HEADROOM GENERATOR. Most parts are on the simple PC board. Parts on the front panel are the switch and burst control.

How it works

The complete schematic is shown in Fig. 1. The 1-kHz sinewave is capacitively coupled to op-amps IC1-a, IC1-b and IC1-c. The first op-amp is a voltage follower (with a gain of 1), the second is a variable-gain amplifier (with a gain of 1 to 11) controlled by potentiometer R12, while the last has a fixed gain of about 11. These three op-amps are biased through R7 by R1, R2 and C1. Operational-amplifier IC1-c drives comparator IC2, which has about 100 mV of hysteresis due to R8 and R10. Thus, the sinewave is converted to a squarewave at the comparator output, which is used as the clock input to the CMOS counter chain.

Integrated circuits IC3 through IC6 are decade counters, but the first is set up to divide by 2, giving a total count of 2000. The count state is decoded such that the output of NOR gate IC7-c is at a logic high level for 20 of 2000 clock inputs. This signal is used as the oscilloscope sync signal and also is inverted by IC7-d, so its output is a logic high for 1980 of the same 2000 clock inputs. These two gate outputs are applied to analog switch network IC8.

Analog switches IC8-a and IC8-b, and IC8-c and IC8-d are wired in pairs for minimum "on" resistance. They switch either unity-gain amplifier IC1-a or variable-gain amplifier IC1-b to the summing point where voltage follower IC1-d buffers it. Since the switches are driven by IC7-c and IC7-d, the final output follows the input for 1980 of 2000 cycles, and is then amplified by variable-gain op-amp IC1-b for the next 20 cycles. The nice thing about this counting technique is that regardless of the input frequency, you get the exact duty-cycle requirements for the dynamic headroom test.

Construction

You can use the PC board pattern shown in Fig. 2 and the parts placement

PARTS LIST

Resistors ¼ watt, 5% unless otherwise specified

- R1-R6—10,000 ohms
- R7-R9—100,000 ohms
- R10, R11—1000 ohms
- R12—10,000 ohms potentiometer, linear taper
- C1-C3—100 μF, 16 volts, electrolytic
- C4—10 μF, 16 volts, electrolytic
- C5-C7—.01 μF, 25 volts, ceramic disc
- IC1—LM324N quad op-amp
- IC2—LM311N comparator
- IC3-IC6—4017 (RCA) decoded decade counter
- IC7—4001 (RCA) quad 2-input NOR gate
- IC8—4016 (RCA) quad analog switch
- BATT1—9 volts, transistor battery
- S1—SPST miniature toggle switch
- J1, J4—banana jack, red
- J2, J5—banana jack, black
- J3—RCA-type phono jack
- Misc.—Metal utility box 6¼ × 3½ × 2 inches, battery holder, knob and hardware.

Note: A full-size photonegative of the PC board foil is available within the U.S. for $5.00 from Noveltronics, P.O. Box 4044, Mountain View, CA 94040.

Foreign residents add $0.50 for extra postage. California residents add state and local taxes as applicable. Allow 2 weeks delay for personal-check clearance time.

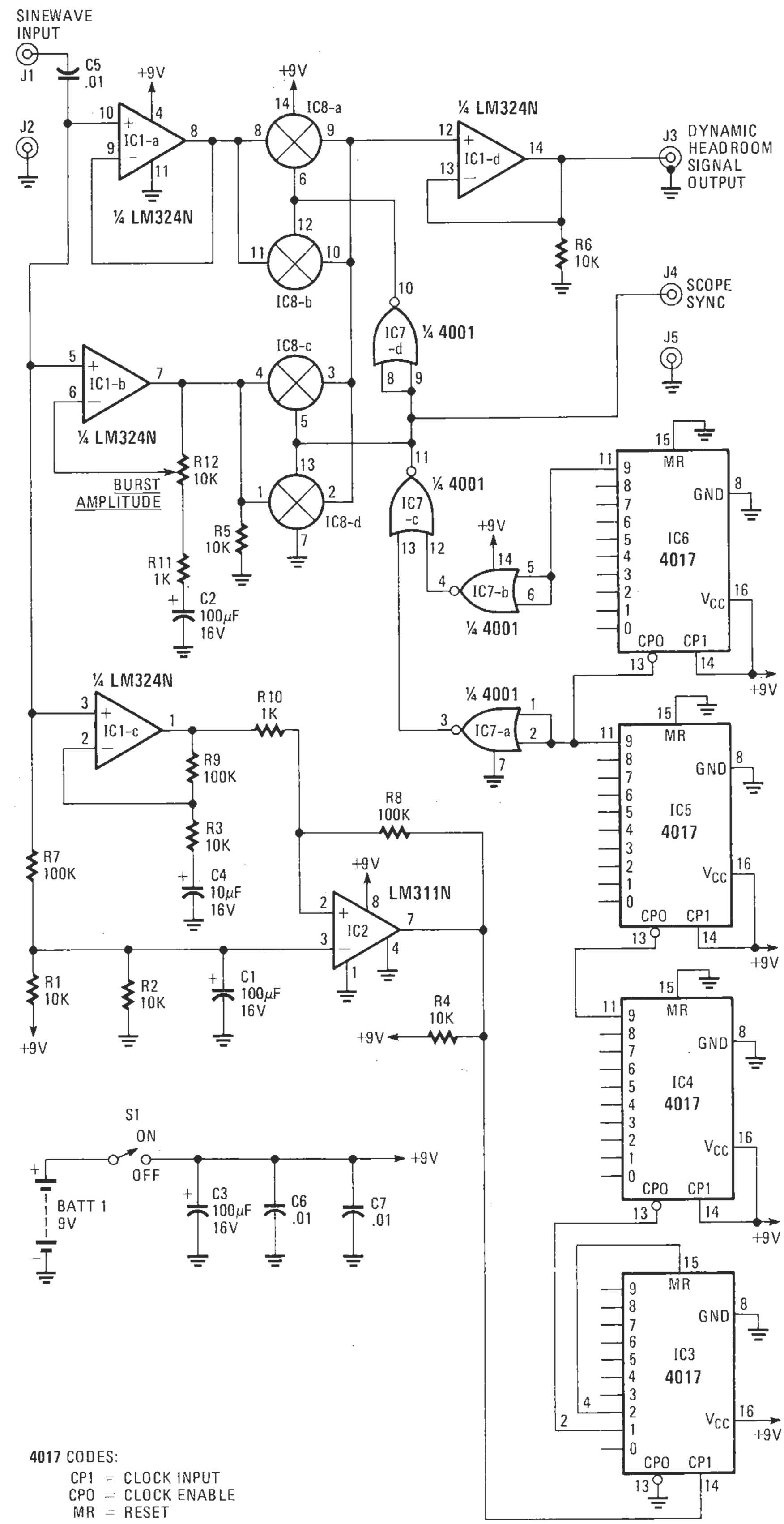


FIG. 1—SCHEMATIC DIAGRAM of the dynamic headroom generator. The circuit takes a 1-kHz input sinewave and develops the high-amplitude 20-cycle burst of signal used for the test.

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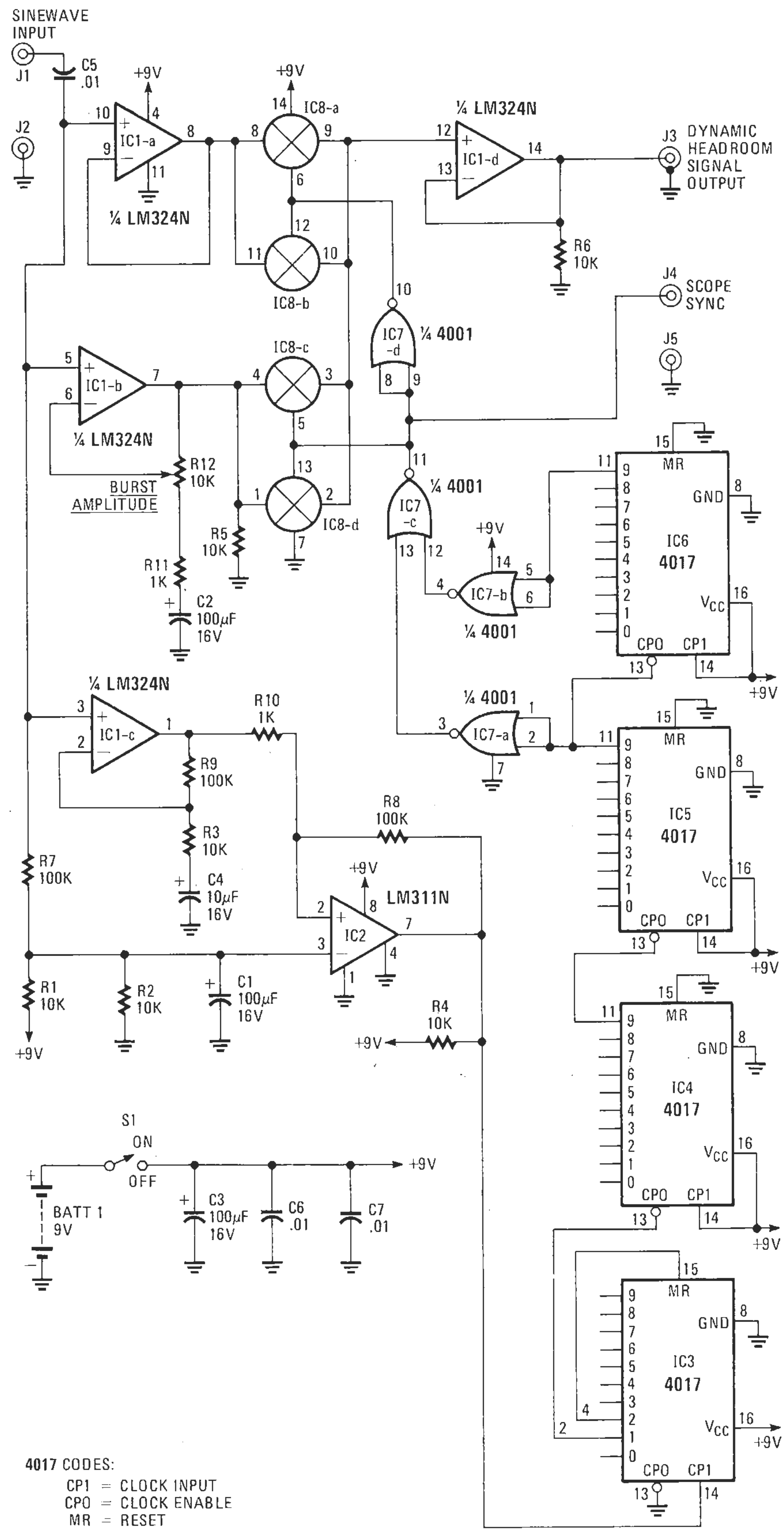

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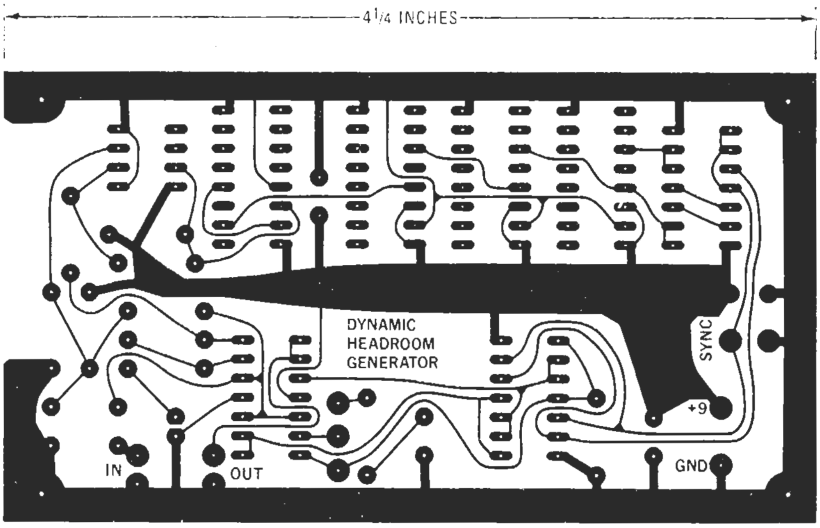


FIG. 2—PRINTED-CIRCUIT FOIL pattern is shown here full-size. A full-size photonegative is available from a source named in the parts list.

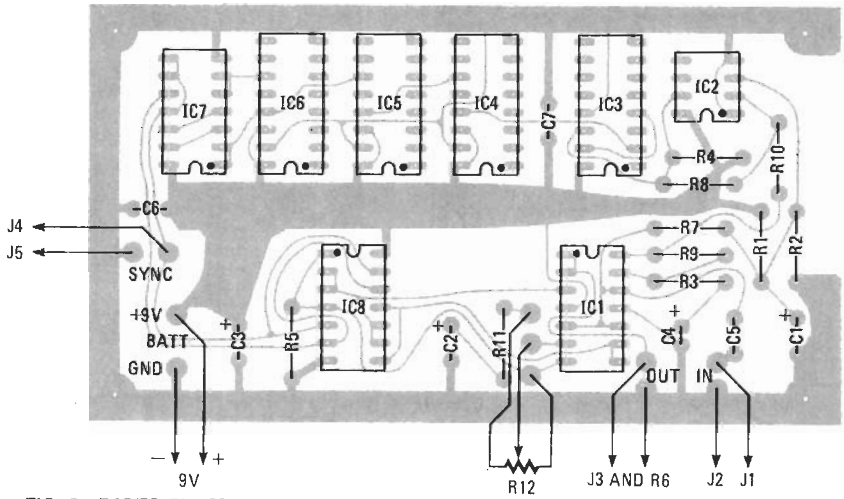
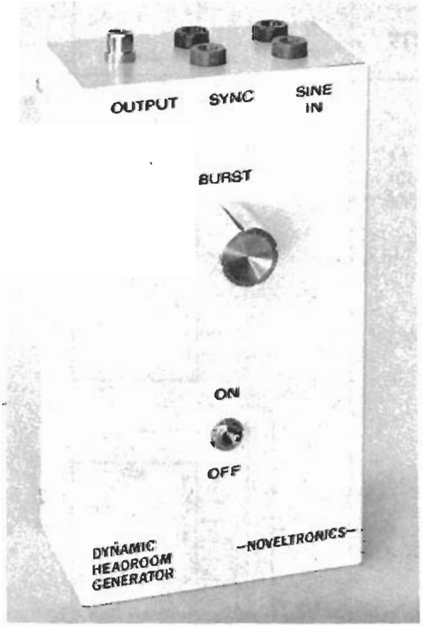


FIG. 3—PARTS PLACEMENT on the PC board. The circuit is relatively simple so IC sockets and wire-wrap can be used in the assembly if you desire.



FRONT VIEW of the headroom generator. Instrument measures 6 × 3 × 2 inches.

diagram shown in Fig. 3 or perforated board for the construction. If you choose the latter, use short wire lengths around IC 1 and IC 2 to minimize chances of oscillation. Place bypass capacitors C6 and C7 near the CMOS IC's to minimize switching transients in the +9-volt supply. For best results, keep the linear and digital circuits physically separated to minimize noise pickup.

How to use it

An input signal with a 10-mV P-P minimum level is required to trigger the dynamic headroom generator. Connect the sinewave source to the input of the unit and its output to your amplifier's input(s). The sync output connects to your scope's EXT SYNC input. Connect a suitable load to the amplifier's output(s) and adjust the sinewave frequency to 1 kHz. Because the signal repeats only once every two seconds, you have to watch the scope trace quite carefully. Adjust the sinewave generator's amplitude until the amplifier's rated continuous output is reached. Now, increase the burst amplitude with the BURST control until you see clipping at the amplifier output. Measure the two amplitudes, apply the DH formula and you'll get the dynamic headroom specification in decibels. Here's hoping your amplifier is as good as you think it is. **R-E**