White Noise

White noise, similar to the sound of escaping steam, is a rather specialized but still useful feature to add to your test equipment. It can be used for testing room acoustics, reverb lines, tone controls, and synthesizers. For instance, reverb lines have such complex frequency response that sine waves give false readings; the gain is best checked by feeding in white noise. The usual source of white noise in test equipment is a special noise diode or a reverse-biased zener diode; in the schematic shown in **Fig. 7** CMOS logic ICs are used. IC2 is an 18-stage shift register which has a bit clocked through it by IC1; the bitstream is inverted and fed back again. The waveform produced (and its harmonics) simulates the random characteristic of white noise. Q1 can be any general-purpose NPN small-signal transistor. ■

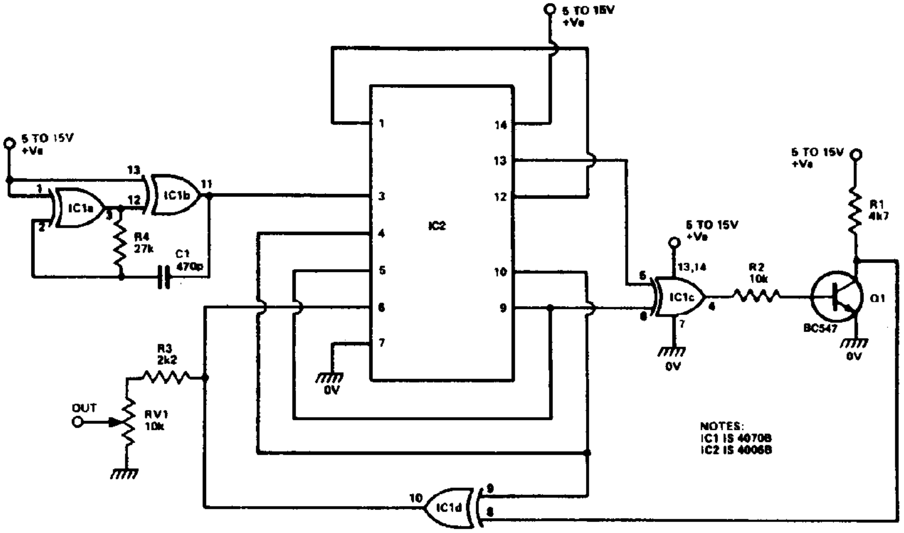

Fig. 7 A digital white-noise generator schematic.

Maximum-length shift register generates white noise

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Using a circuit based on a maximum length sequence generator,[1] this simple unit inexpensively provides a source of white noise over a range of up to 200 kHz. It is far superior to generators that use a reverse-biased base-to-emitter transistor junction, which provides quasi-white noise over a very limited portion of the spectrum. Using two integrated circuits comprising a 25-stage shift register, it can be built for less than $6.

A_1 and A_2 form the n-stage shift register driven by clock G_1–G_2, with A_1 an 18-stage device and A_2 being eight stages in length. A_1 and A_2 are driven simultaneously but out of phase with respect to each other.

The output from stage 7 of A_2 and the last stage of A_1 is applied to G_3 in the feedback loop G_3–G_4, so that a register sequence length of 2^{n-1} clock periods is obtained. Note that G_4 provides signal inversion, so that on power up (the all-zero output state of A_1 and A_2), the noise generator will be self-starting.

It can be shown that the spectrum of the signal at the output of A_2 will contain several discrete frequencies, separated by $f_c/(2^{n-1})$, where f_c is the clock frequency, in this case 200 kHz. Because n is large, the separations between the discrete frequencies become so close (here, it will be 0.006 Hz with a sequence period of 150 seconds), that the spectrum may be considered continuous. So although the noise is pseudorandom because of the method used to produce it, the difference in the spectral properties of the noise as compared with the ideal is minimal.

As for the amplitude of the output envelope, it will vary with frequency as $(x^{-1} \sin x)^2$, where $x = f/f_c$. Here, the −3-dB point will occur at $f = 0.45 f_c$, as shown in the curve at the lower left of the figure.

Q_1 serves as a buffer. The network $R_1R_2C_2$ is a low-pass filter that has been added for an application requiring noise to be confined (bandlimited) to the audio frequencies. Its −3 dB point occurs at 25 kHz. □

References
1. I. H. Witten and P. H. C. Madams, "The Chatterbox-2," Wireless World, Jan. 1979, p. 77.

Spectrum spread. 25-stage shift register creates closely spaced signals of discrete frequency for generating pseudorandom white noise over wide range. Spectral response of source (bottom left) is flat from dc to 0.45 f_c, where f_c is the clock frequency.