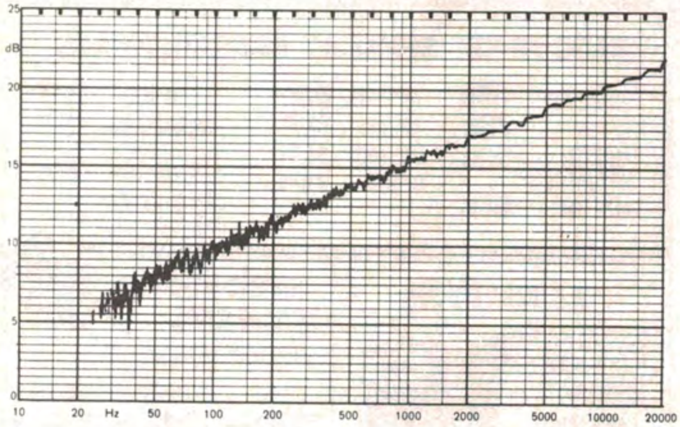
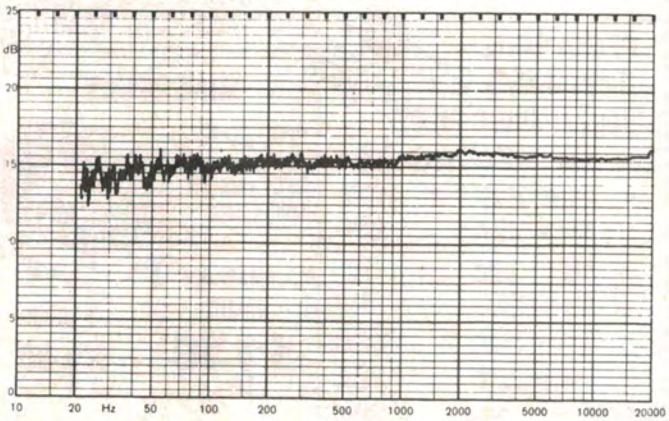
Audio 'white noise' generator employs digital technique

This project has many and varied applications, from a test signal source for audio systems through to a noise source for a 'sound effects' unit.



Measurement of the amplitude of white noise versus frequency as measured with a one-third octave filter set.



Measurement of the amplitude of pink noise versus frequency as measured with a one-third octave filter set. To the ear, pink noise appears to have more bass content.

WIDEBAND, or 'white', noise is a curious phenomenon, as it is a signal that contains a very wide spectrum of randomly distributed frequencies, all with random amplitudes, but it has equal amounts of energy in equal bandwidths over the total frequency range of interest. If you measured the noise energy in the band between 100 Hz and 200 Hz, for example, it would be the same as the energy between 3000 Hz and 3100 Hz, or 10 000 Hz and 10 100 Hz. That is, when the energy in a particular band is averaged over a reasonable unit of time it will have the same power as that in the same bandwidth anywhere else in the spectrum.

The basic sound of white noise resembles that of steam escaping from a valve. Electronic 'steam train' effects employ a white noise source to generate the basic sound. Electronic music synthesisers include a white noise generator that can be employed to generate a variety of effects with suitable modification.

White noise and 'pink' noise are used for audio system testing in a variety of ways, which we don't have space to go into here. Pink noise is a modified version of white noise, where the signal is filtered to produce noise that has equal energy per percentage change in bandwidth. For example, the energy in the band 100 Hz to 200 Hz would be equal to that between 3 kHz and 6 kHz — a 100% change in bandwidth in each case.

To hear it, pink noise appears to have more bass content than white noise and also appears to the ear to have a more uniform output level in audio testing. To change white noise to pink noise, a filter is required that rolls off with decreasing frequency at 3 dB per octave (10 dB per decade).

As this project has application in a variety of areas we have not provided details of housing the board as it may be built into some existing or planned equipment, used on its own, or used with filters and attenuators to suit your particular application.

Making noise

There are several ways to generate white noise. Mother nature provides us with many sources in the electronic world, and an often-used source is the noise generated by a zener diode. We used this technique in the ETI-441 Audio Noise Generator (Jan. '76). However, it has the drawback that the output level is low and results vary widely from diode to diode.

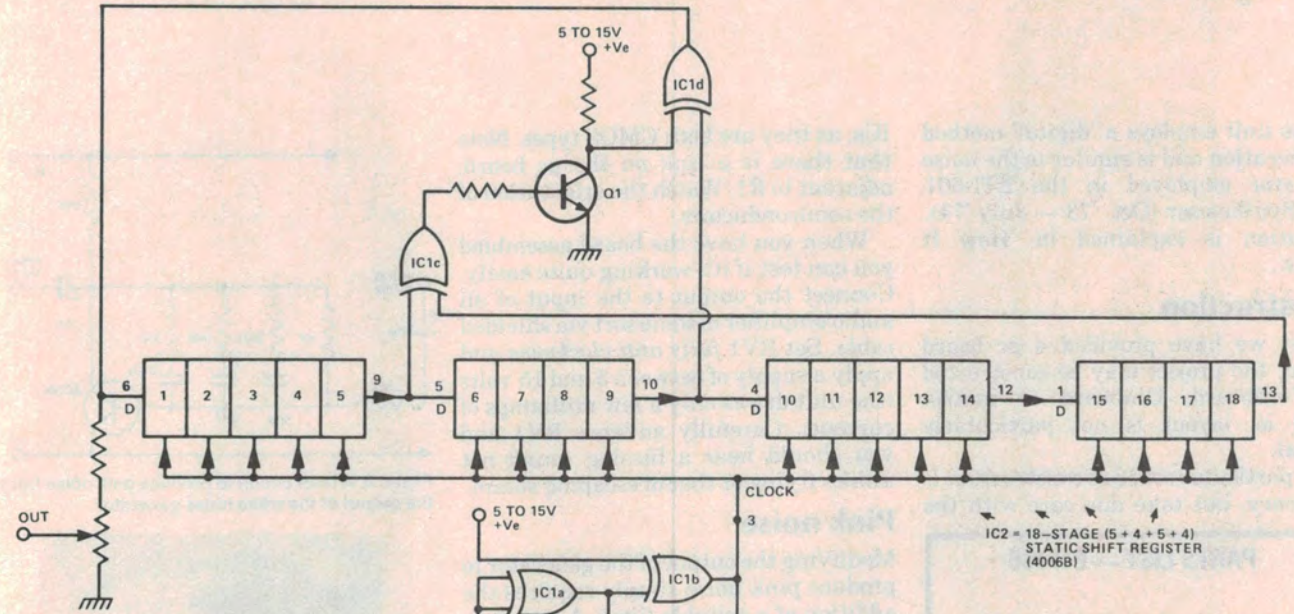
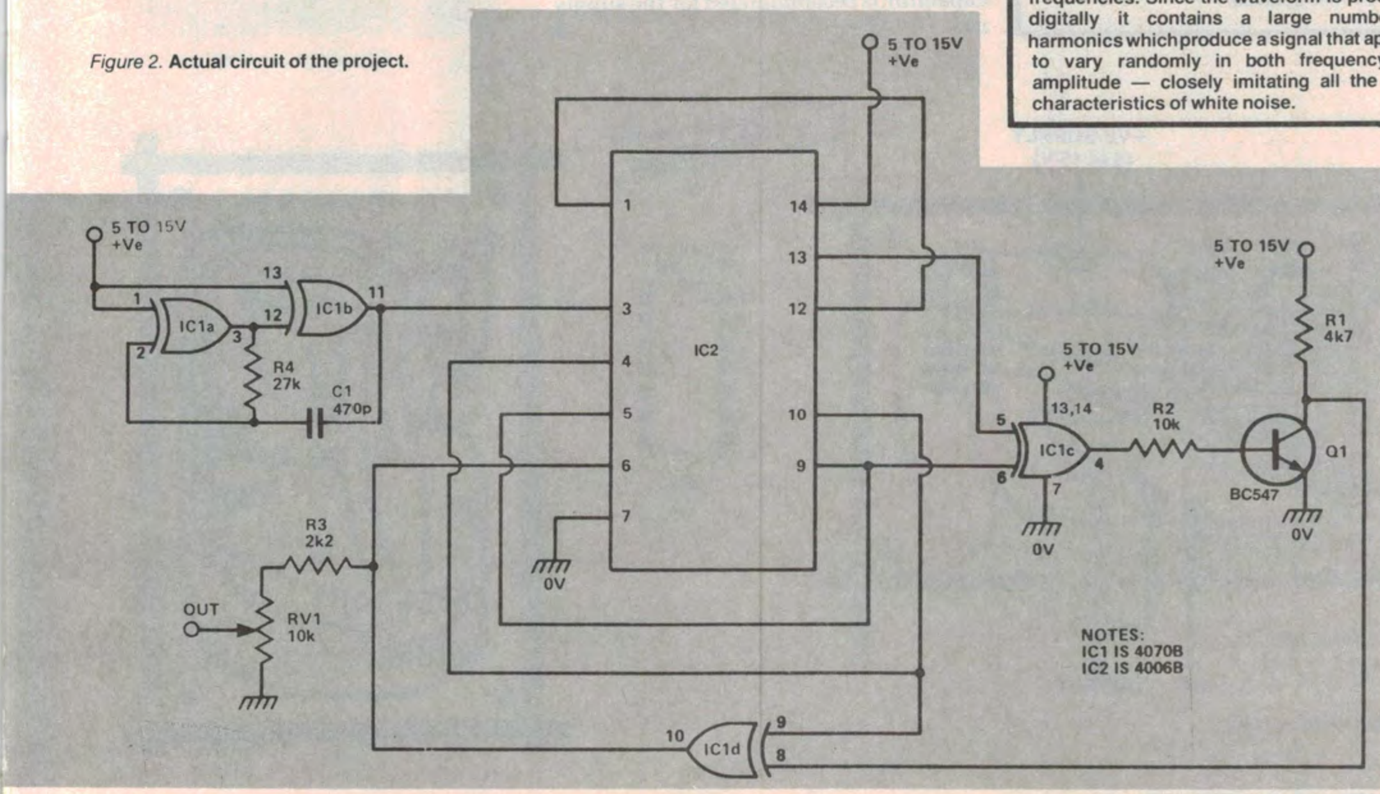


Figure 1. **Theoretical circuit, illustrating the operation of the shift register.**

Figure 2. **Actual circuit of the project.**



HOW IT WORKS — ETI 596

A theoretical circuit of the generator is shown in Figure 1. IC2 is an 18 stage (5+4+5+4) static shift register, in which the logic (0 or 1) information on the data (D) terminal is fed forward one step on the arrival of each pulse from a 60 kHz oscillator, IC1a-IC1b. Exclusive-OR gates IC1c-IC1d are used in conjunction with an inverter, Q1, to feed various outputs of IC2 back to the first data terminal in such a way that the data feeds through the register in an apparently random or jumbled fashion.

In reality, a complex sequence of 0s and 1s flows through the register, repeating once every few seconds and producing the apparently random jumble of fundamental frequencies. Since the waveform is produced digitally it contains a large number of harmonics which produce a signal that appears to vary randomly in both frequency and amplitude — closely imitating all the basic characteristics of white noise.

Project 596

This unit employs a 'digital' method of generation and is similar to the noise generator employed in the ETI-601 4600 Synthesiser (Oct. '73 — July '74). Operation is explained in 'How It Works'.

Construction

Whilst we have provided a pc board design, the project may be constructed on Veroboard, Uniboard or matrix board as layout is not particularly critical.

No particular order of construction is necessary, but take due care with the ICs, as they are both CMOS types. Note that there is a link on the pc board, adjacent to R1. Watch the orientation of the semiconductors.

When you have the board assembled you can test if it's working quite easily. Connect the output to the input of an audio amplifier of some sort via shielded cable. Set RV1 *fully anti-clockwise* and apply a supply of between 5 and 15 volts (the unit draws only a few milliamps of current). Carefully advance RV1 and you should hear a hissing sound not unlike frying or that of escaping steam.

PARTS LIST — ETI 596

Resistors	all ½W, 5%
R1	4k7
R2	10k
R3	2k2
R4	27k
Potentiometer	
RV1	10k
Capacitor	
C1	470p ceramic
Semiconductors	
IC1	4070B
IC2	4006B
Q1	BC547, BC107 etc.
Miscellaneous	
ETI-596 pc board.	

Pink noise

Modifying the output of the generator to produce pink noise simply requires the addition of a suitable filter. A circuit to do this is shown in Figure 3. A filter network with the appropriate characteristics (roll-off of 3 dB per octave above 20 kHz) is connected in the negative feedback circuit of a simple common emitter amplifier stage employing a BC548. Tantalum capacitors are recommended for the two polarised capacitors shown at the input (25u) and the output (1u). They should be rated at 16 V or more. The white noise input should be taken from the wiper of RV1 in the noise generator. Layout is not critical. A 220u/16 V electrolytic bypass capacitor is recommended for the supply rail. ●

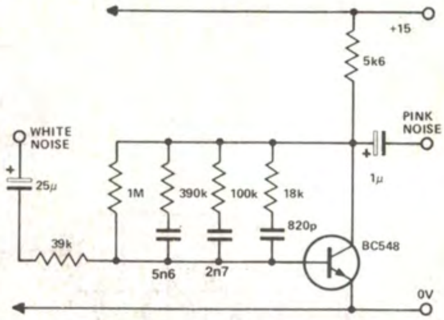
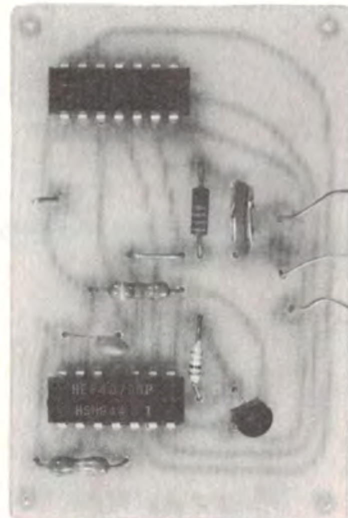
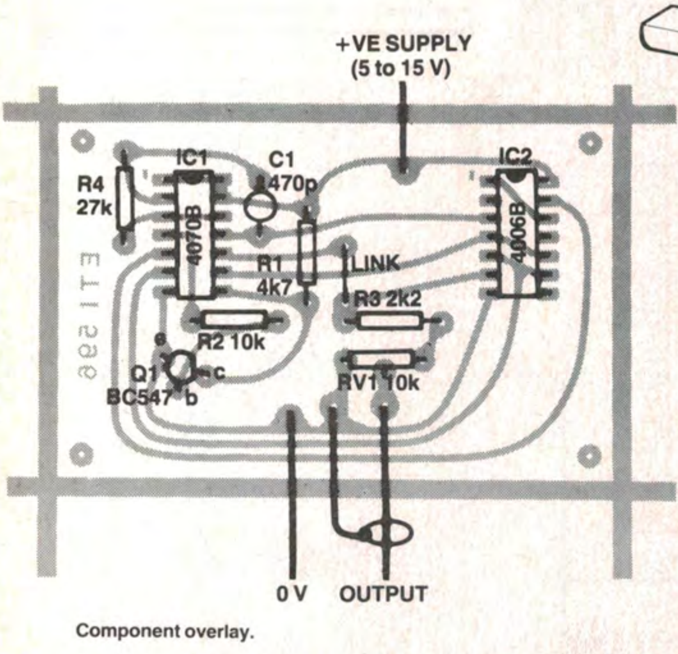


Figure 3. **A filter circuit to produce pink noise from the output of the white noise generator.**





Component overlay.