Mask the sounds that irritate

by COLIN DAWSON

Noise Simulator

Sick of being woken by noisy neighbours or traffic? Fed up with barking dogs? The EA Noise Simulator provides a soothing noise, like rain on the roof or waves on the beach, to mask the sounds that irritate.

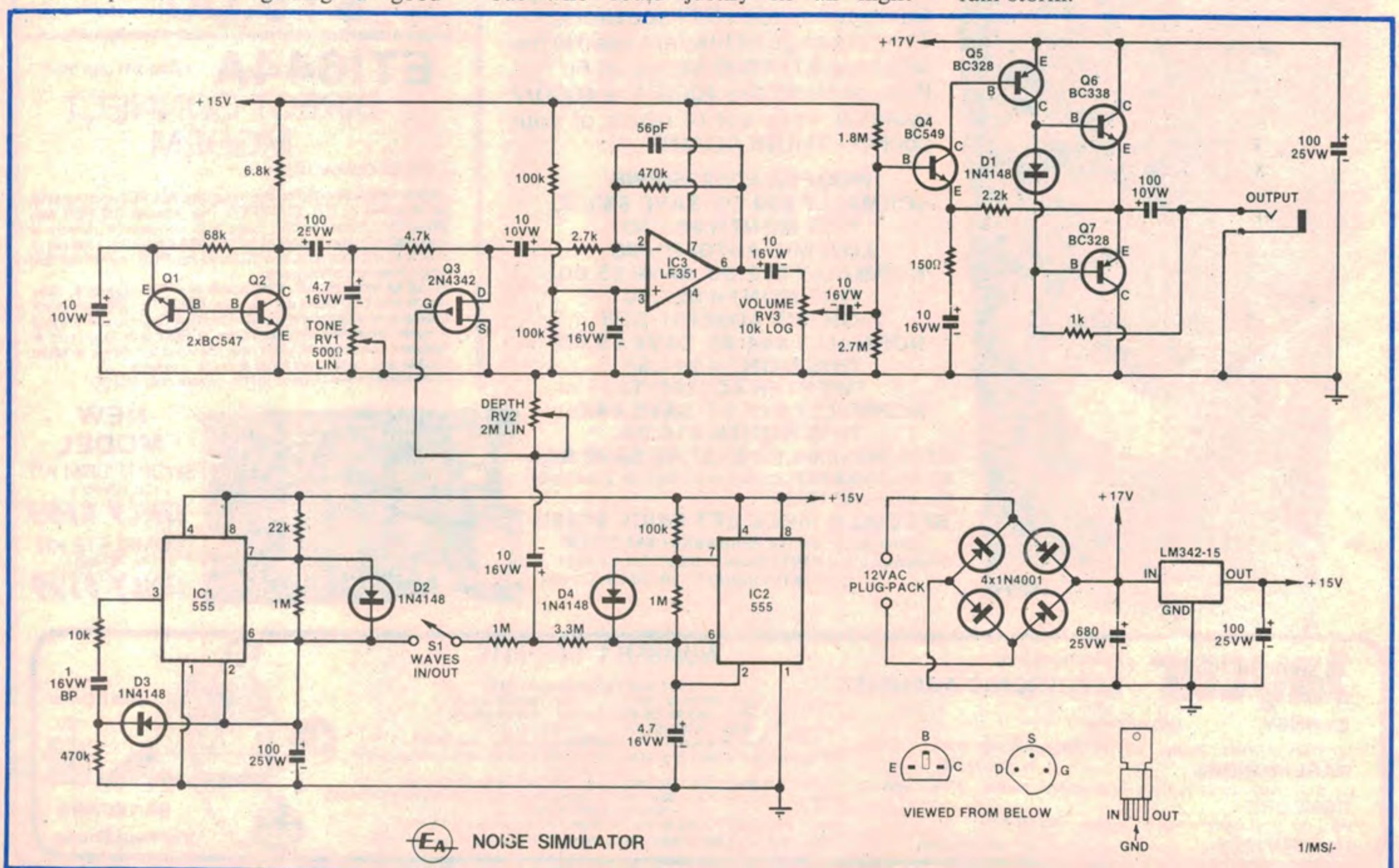
As many flat dwellers will know, modern high density residentials tend to have poor sound proofing. Between the numerous TV sets, stereo systems, tomcats, and noisy vehicles in the vicinity, the devotee of serenity can be driven to the point of distraction. Of course, some people have a high level of tolerance for noise pollution but, for those unfortunates who resort to stuffing their ears with cotton wool at 2am so that they can get some peace, the Noise Simulator may be a more pleasant solution.

The problem of getting a good "night's" sleep is more acute for shift workers who may in fact be trying to sleep during the day. And tinnitus sufferers, no matter when they are trying to sleep, have to put up with continual ringing in their ears. Both groups of people could benefit from a Noise Simulator.

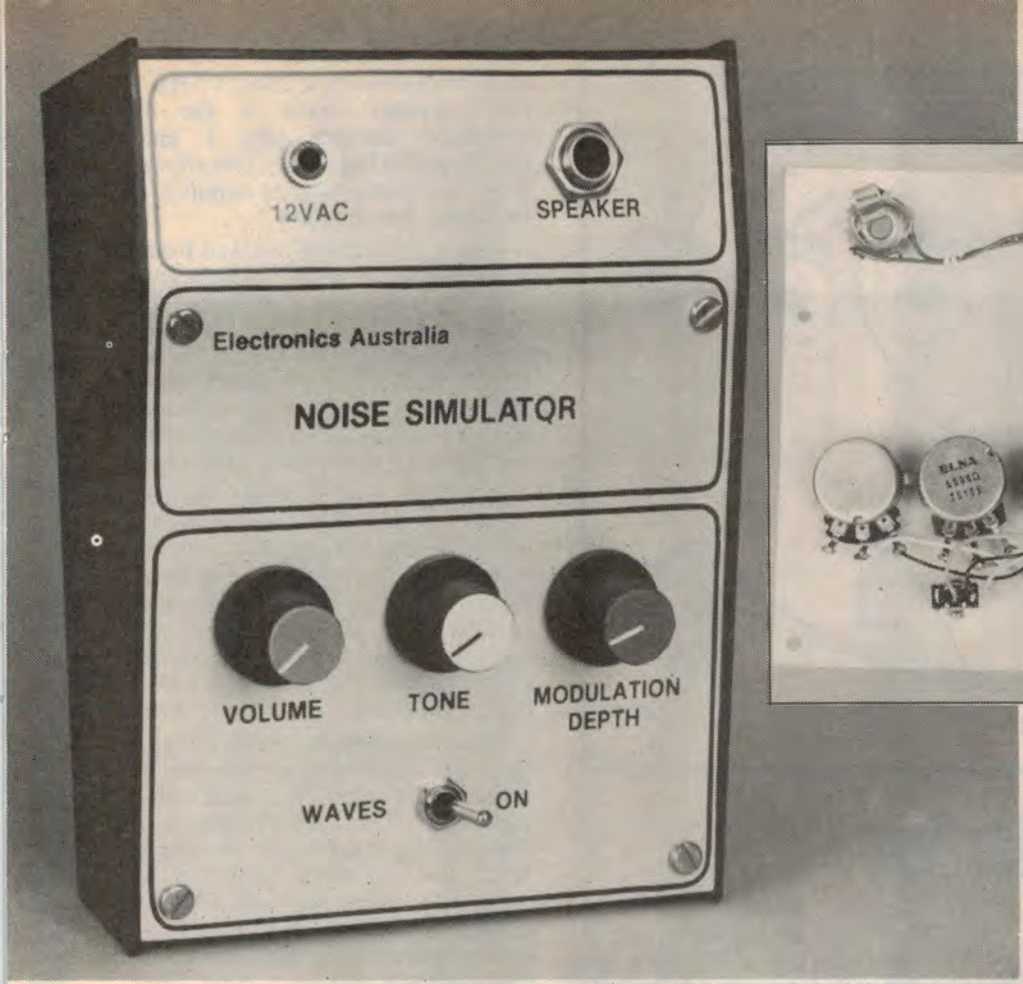
There are, of course, other ways to mask irritating sounds. An air conditioner provides a useful pseudo white noise source but is certainly not viable in this capacity alone. Similarly, a TV set tuned between stations may help but who could justify its all night operation. A radio tuned between stations can be quite acceptable — provided it has a tone control and can be powered from the mains. It should preferably have a large speaker (15cm or more). If your radio doesn't quite fit the bill, or is not portable, then a Noise Simulator may be a better solution.

There is another aspect of the Noise Simulator's operation which diverges slightly from the original concept. The noise can be modulated. In fact the design incorporates two modulation circuits which can provide a number of familiar sounds. The most startling is the surf simulation — sounds just like the beach with a high surf. This may be useful as a sound effect for recording or theatrical effects.

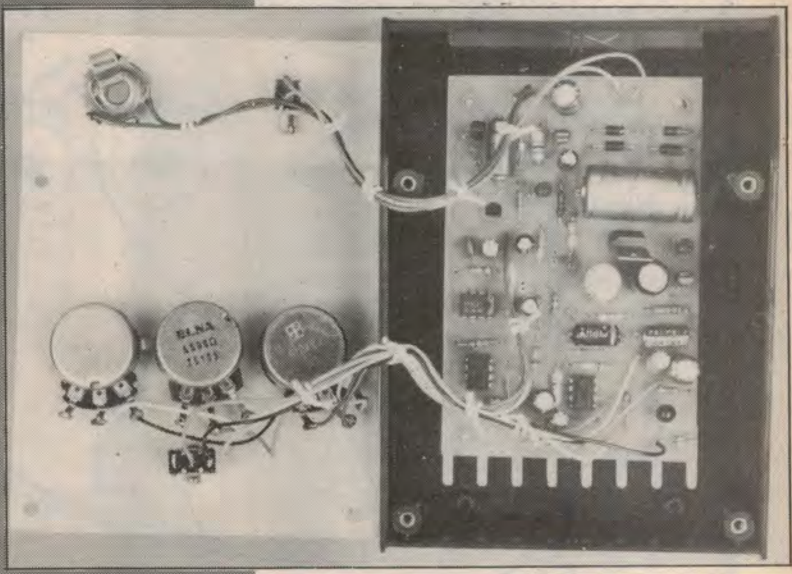
The depth of modulation can be adjusted so that the sound is more like that of a beach in the distance. Or the "waves" can be switched out to leave a simple repetitive modulation more like a rain storm.



NOISE SIMULATOR



Left: the finished unit and, below, interior shot showing board assembly and controls.



We estimate that the current cost of components for this project is approximately

$30

This includes sales tax but not the cost of a plugpack.

Part of the inspiration for this project came from an advertisement in an overseas magazine. We had already decided to design a modified white noise generator as a sound masker. We were undecided with respect to the surf simulation, until the advertisement. This described a device almost identical in concept, except that it had surf, rain and waterfall simulation. Besides noise masking, there was a claimed increase in "Alpha" sleep (we suppose that's an advantage — we're not too sure what "Alpha" sleep is!).

We are certain, however, that sleeping is preferable to lying in bed pondering the most satisfying form of retribution to the various noisy miscreants.

White noise

Actually, "white" noise — an equal distribution of sound energy across the audio spectrum — is not ideal for the function of noise masking. It tends to sound too urgent and irritating, like a tyre being deflated rapidly. Far more acceptable is a modified white noise, ie, with some of the high frequency content removed. The Noise Simulator has a tone control which provides an adjustable amount of treble cut. This can vary the sound from a hiss (useful for the surf simulation) to a rumble.

To mask irritating sounds, a rumble is the preferred noise. Most people will quickly become oblivious to this and hopefully the offending sounds will be relegated to "background" where they are not so troublesome.

As well as the big "breakers", we found that small fill-in waves were needed. It just doesn't sound right to have a thunderous wave arriving periodically with virtual silence in between. The circuit is designed so that the "big" waves and "little" waves can interact, producing a moderate amount of irregularity in the sound.

How it works

The most important parts of the circuit are the white noise generator and the amplifier. This accounts for about half of the components. The rest are used to derive the control necessary for the "effects" — it turns out that a convincing wave sound requires a surprising circuit complexity.

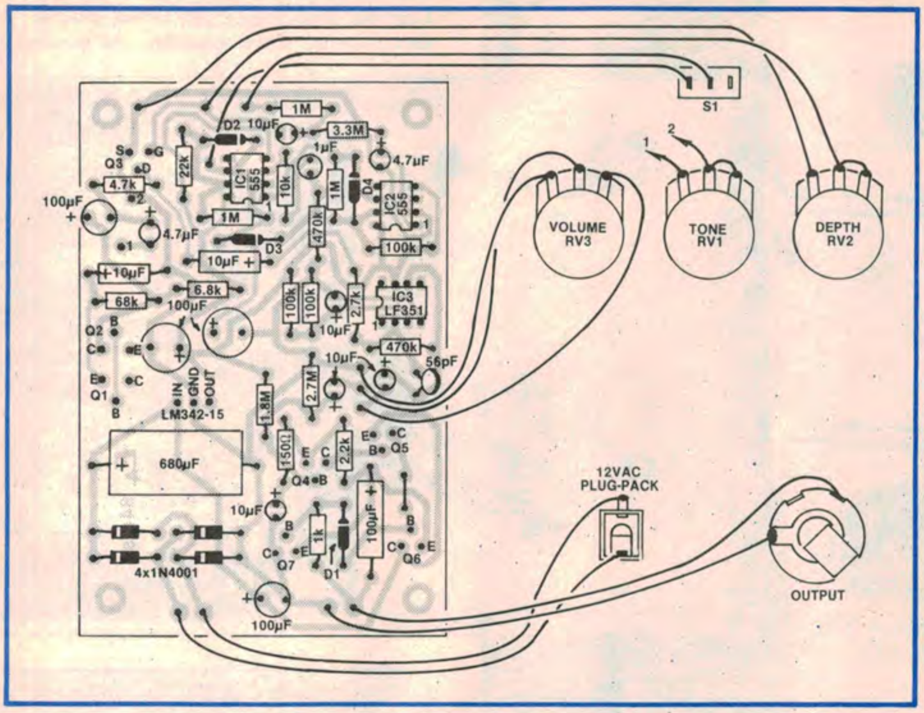
The white noise is actually generated by a reverse biased BC547 (Q1). Initially, various diodes were tried in this role but the BC547 proved more suitable for low voltage operation. Even with this device, a useful amount of white noise cannot be generated with a power supply of much less than 11V.

Given that the project may be operating for hours at a time, and the voltage limitation of the BC547, batteries are clearly out. Instead, a 12VAC plugpack is used. In fact, the output of these plugpacks will frequently be closer to 13V for this circuit, yielding 18V after rectification. Only the power amplifier section of the circuit operates directly from this "raw" supply. The rest of the circuit is powered via a 15V regulator.

Amplification of the white noise is provided by Q2, another BC547. About 600mV of signal will appear at its collector. This is fed to the tone control which consists of a 4.7μF capacitor and 500Ω potentiometer. Quite severe treble cut can be achieved with this control, providing the desired rumble.

The modified white noise is taken from the tone control and fed to the amplifier section of the circuit. The amount of noise reaching the amplifier can be affected by the modulation circuitry, but for the moment, assume that this is not working. A steady level of noise would therefore reach the inverting input (pin 2) of IC3. This is a FET input op-amp (LF351 or TL071) configured as an inverting amplifier with a gain of 37.

From IC3, the signal is fed to a 10kΩ volume control and subsequently to a four transistor power amplifier. With the tone control set for maximum treble cut, much of the sound energy has been removed from the signal. Consequently, quite high volume settings may be needed for a large room.



Noise Simulator

Only low volume settings will be needed when the tone control is set for minimum treble cut. This is particularly so if the "Waves" effect has been selected, since a certain amount of signal boost (above the normal level) will occur. This can be a problem with plugpacks limited to a few hundred milliamps output. Due to their inherently poor regulation characteristics, some plugpacks may not be able to maintain sufficient output voltage for the regulator to operate. This will introduce large amounts of hum into the signal at very high sound levels.

Q4, Q5, Q6 and Q7 form a simple direct-coupled audio amplifier. Q4 sets the output stage DC conditions and drives PNP transistor Q5. Q5, in turn, drives Q6 and Q7 which form a complementary output stage. The AC voltage gain is set to around 15 by the ratio of the 2.2kΩ and 150Ω resistors in the feedback network, while the 10µF capacitor in series with the 150Ω resistor curtails the frequency response below 100Hz.

Modulation

Let's take a look now at the modulation circuitry. The only interface between this and the generator/amplifier circuit is through the 2N4342 P-channel FET (Q3). This connects via a 4.7kΩ resistor to the tone control and, in conjunction with the "Modulation Depth" pot, provides a shunt path to ground for the signal.

No DC voltages are applied to any of the FET terminals and, in this mode, the drain/source path functions as a variable resistor, its exact value determined by the gate/source voltage. In this case, the latter is an AC voltage, from the modulation generators, and is applied to the gate via the 2MΩ Depth pot. As this voltage varies, so does the signal level from Q2 as applied to IC3.

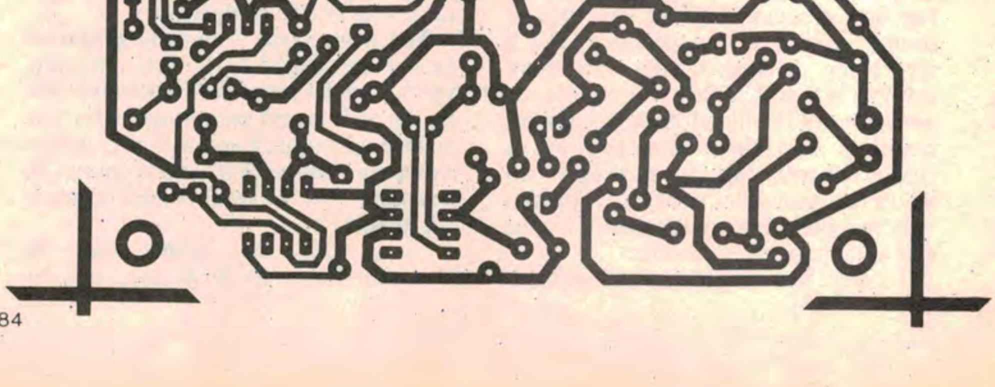
Each of the modulation circuits is based on a 555 IC operating as an oscillator with an asymmetic duty cycle. Consider the oscillator incorporating IC2 first, as this is the simpler of the two. It is basically a conventional 555 astable oscillator (operating at about 0.5Hz). The only unusual aspect is the diode connected between pins 7 and 6 (discharge and threshold). This allows the IC to oscillate so that its output is high for longer than it is low.

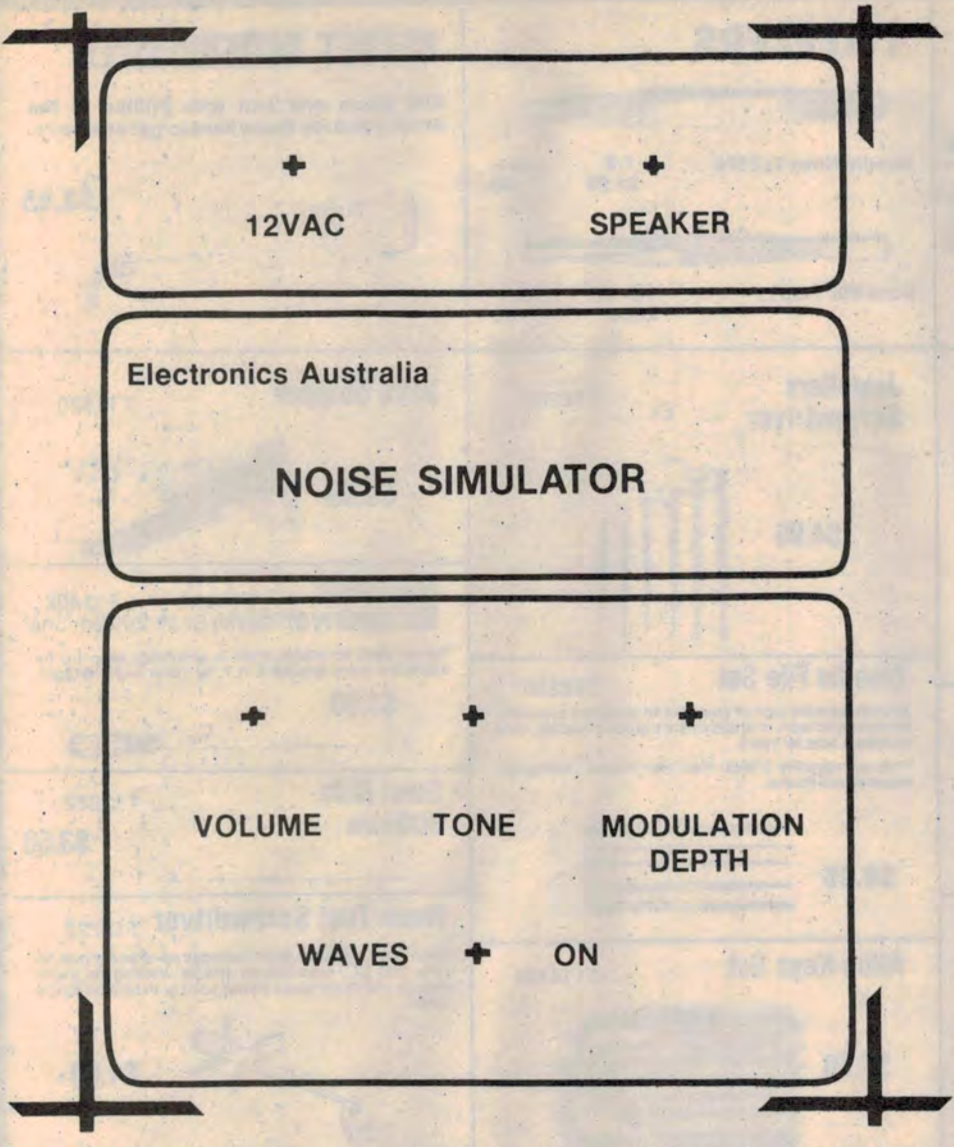
Output from the IC is taken from the 4.7µF timing capacitor which gives a sawtooth waveform. This control signal from IC2 is fed via a 3.3MΩ resistor and 10µF capacitor to the gate of the FET. Hence the FET is continually modulated to simulate a rain storm or small waves, the depth of modulation dependant upon the setting of the depth control (RV2).

IC1 also has a diode connected between its discharge and threshold pins and its output is similarly taken from the timing capacitor (100µF in this case). Notice, however, that there are several additional components around pin 3 (output). These are another diode, a 470kΩ resistor, 10kΩ resistor and 1µF bipolar capacitor.

These components bleed off charge from the 100µF timing capacitor for a brief period after the peak of the waveform. This corresponds to the crashing of a breaker and the very high initial decay of sound level. The bleed capacitor is referenced to pin 3 instead of ground so that it is effective only for a brief period after the peak of the 100µF charging cycle.

Here's how it works. Assume initially that the 100µF capacitor is charging towards 2/3 Vcc (ie, pin 3 of IC1 is high). During this time, D3 is forward biased. When the charge on the 100µF capacitor reaches 2/3 Vcc, pin 3 goes low and hence the cathode of D3 is also forced low via the 1µF bipolar capacitor. The 100µF capacitor now partially discharges via D3 and charges the 1µF capacitor. Once this has occurred, the circuit stabilises and reverts to the normal discharge mode.





PARTS LIST

- 1 PCB, 72 x 110mm, code 84ms4
- 1 plastic project box (Bimbox No. 6005 or similar)
- 1 6.5mm panel socket (mono)
- 1 6.5mm jack plug (mono)
- 1 3.5mm panel socket (mono)
- 1 3.5mm jack plug (mono)
- 3 knobs to suit potentiometers
- 1 SPST toggle switch

Semiconductors

- 2 BC547 NPN transistors
- 1 BC549 NPN transistor
- 1 BC338 NPN transistor
- 2 BC328 PNP transistors
- 1 2N4342 P-channel FET
- 1 LF351 or T1071 FET input op-amp
- 2 555 timer ICs
- 1 LM342-15 or LM340-15 regulator
- 4 1N4001 diodes
- 4 1N4148 diodes

Capacitors

- 1 680µF/25VW axial electrolytic
- 4 100µF/25VW PC electrolytics
- 1 100µF/10VW axial electrolytic
- 5 10µF/16VW PC electrolytics
- 2 10µF/10VW axial electrolytics
- 2 4.7µF/16VW PC electrolytics
- 1 1µF/16VW bipolar electrolytic
- 1 56pF ceramic

Resistors

1 x 3.3MΩ, 1 x 2.7MΩ, 1 x 1.8MΩ, 3 x 1MΩ, 1 x 470kΩ, 4 x 100kΩ, 1 x 68kΩ, 1 x 22kΩ, 1 x 10kΩ, 1 x 6.8kΩ, 1 x 4.7kΩ, 1 x 2.7Ω, 1 x 2.2kΩ, 1 x 1kΩ, 1 x 150Ω, 1 x 2.2MΩ log potentiometer, 1 x 10kΩ log potentiometer, 1 x 500Ω linear potentiometer.

The operation of IC1, then, is as follows: about once every 15s, the wave begins to build up. This takes only three or four seconds whereupon the wave breaks. For about 0.5s immediately after the break, a very rapid decay occurs. After this period, decay continues more slowly until the beginning of the next build-up.

Switch S1 in the output circuit of IC1 allows the sound of the large waves to be switched in or out of circuit as required. Since the output of IC1 is coupled to the FET gate circuit via a 1MΩ resistor, compared to the 3.3MΩ coupling resistor of IC2, it has a far greater effect on the sound.

Construction

The printed circuit board (PCB) is coded 84ms4 and measures 72 x 110mm. There is one wire link to be mounted on the board — this should be done first. The other components can then be mounted, starting with the small horizontal devices such as resistors and diodes.

We have prepared a Scotchcal front panel label which suits the plastic sloping front project box. If you intend to use this label apply it first so that it can be used for a template for drilling the front panel.

When mounting the input sockets, make certain that the 12VAC input and the speaker output do not share a common earth. This means that, with a metal front panel or Scotchcal label, one of the sockets (preferrably the 12VAC socket) should be insulated. This can be done by placing a short length — about 2mm — of plastic tubing over the shaft of the socket and placing an insulated washer under the retaining nut.

To test the Noise Simulator, set the volume to near minimum, the tone to low and the waves to Off. After applying power there will be a delay of about 2 to 4 seconds before any sound is produced (it takes that long for the white noise generator to become operative). Once the sound begins, vary the controls to verify the operation. Remember that only one wave occurs every 15 seconds.