Build Pink Noise Generator Tests Your HI-FI

Built around a single IC, this device is used to test the response of a hi-fi system and to set up a graphic equilizer

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A VITAL COMPONENT IN ANY SOPHISTICATED AUDIO SYSTEM IS A graphic equalizer. This device allows you to taper the frequency response of a system to fit a particular need. An equalizer is used most often to match the audio system to room acoustics to achieve an overall flat response. Minor variations can also be made to please individual tastes or to correct for equipment deficiencies.

A typical equalizer can have as few as five or as many as 30 individual controls per channel depending upon the division of the audio frequency spectrum. Each control has a frequency range that follows a regular pattern. The most common pattern is an octave equalizer, in which each control covers the next octave, or doubling of frequency, from the one before it. Some equipment owners consider a graphic equalizer as a "super tone control" unit and often set the controls in an undefined or even random fashion. However, a more consistent, technical approach is needed for the instrument to be used as a room equalizer. One method for checking system response is to use a spectrum analyzer. Since most of us do not own (or cannot borrow) a spectrum analyzer, there is a less expensive alternative: a pink-noise generator that can be built for less than $10.

The color of sound

Pink noise and white noise are terms that describe a complete mixture of all frequencies in one signal. The difference between the two terms lies in the relative amplitude of each frequency. White noise is characterized by equal energy per bandwidth. This means that there is an equal amount of energy, or loudness, in the frequencies between 20 to 40 Hz as between 40 to 60 hz or 1000 to 1020 Hz.

Pink noise, on the other hand, is characterized by equal energy per octave. Since an octave doubles the frequency, this means that there would be the same volume in the frequencies between 20 to 40 Hz, 40 to 80 Hz, or 640 to 1280 Hz. This is why pink noise is used in setting up an octave equalizer, whose controls follow this doubling pattern—the bandwidth (range of frequencies) of each control also increases by a factor of two.

Incidentally, it is a popular misconception that the noise generated between stations on an FM tuner is pink noise. This is not so. Interstation noise more closely resembles white noise, but not successfully.

Room equalizing

By feeding the pink-noise signal into an audio system through an equalizer, we can measure the overall response (including speaker and room acoustics) at each octave, or whatever bandwidth each control has. If the system is flat, equal loudness is obtained from the bandwidth of each equalizer control. Therefore, if you pass the pink noise through each control band separately and measure the volume from the speakers, you can set the response to be flat (or any other desired curve).

First, selectively isolate each equalizer filter. For a bandpass-type equalizer, as shown in Fig. 1, each filter section passes only those frequencies within its passband and the equalizer control varies the output from each filter. If the controls work to ground as shown in Fig. 1-a, you can isolate one filter section by placing all the other controls to their minimum position. If the controls are located somewhere else in the circuit, you can add switches to turn each individual filter on and off, as shown in Fig. 1-b or Fig. 1-c.

Figure 2 shows a "cut-and-boost" type of equalizer, in which each filter passes all frequencies with the appropriate effect only on the frequencies within its band. Thus, there is no way actually to isolate each filter separately. However, placing all but one control to their minimum position (−12 dB, for example) can effectively single out one audio-frequency band. Whatever effects that "bleed over" from the other filter sections have remain constant and do not affect the relative measurements.

The second requirement for effective room equalization is a means to pick up the sound from the speakers and display its relative amplitude on a meter. Most hi-fi systems have a tape recorder with a microphone input and a record-level meter. However, if this equipment is not available or you want a more accurate indication, you can construct a simple relative-volume indicator, as shown in Fig. 3.

Circuit

The design of a pink-noise generator is greatly simplified by

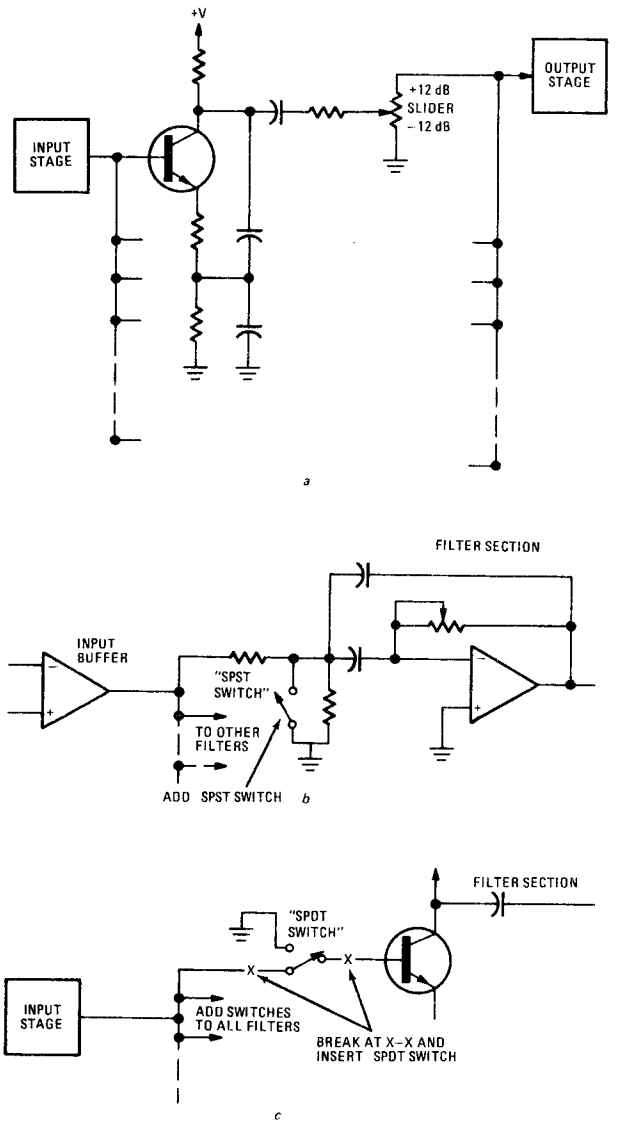
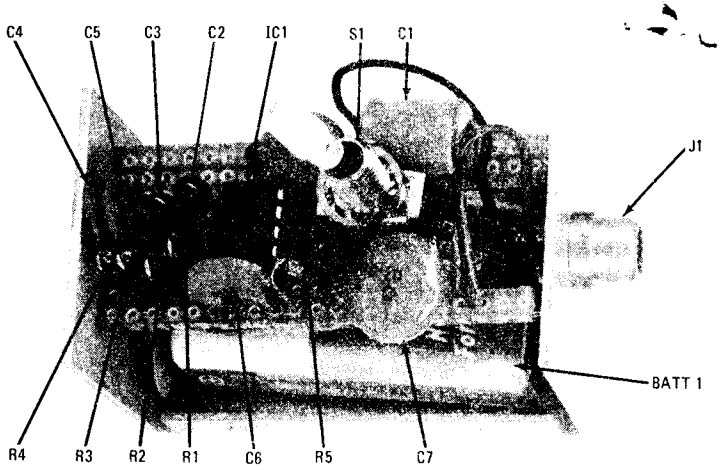


FIG. 1—TYPICAL BANDPASS-TYPE EQUALIZER designs. With the arrangement at *a*, filter circuit is cut out when slider-type level control is at the minimum-gain or ground end. Partial circuits at *b* and *c* show how switches can be added to ground the input to the filter section.



INSIDE THE PINK-NOISE GENERATOR. Its few parts are mounted on a small piece of perforated circuit board and connected by point-to-point wiring. The IC is in a socket.

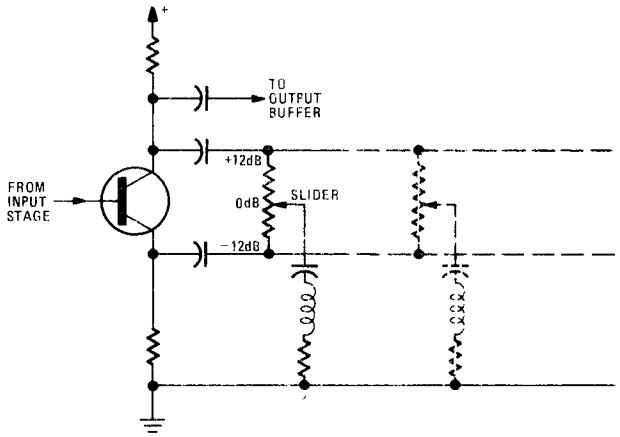


FIG. 2—IN THE CUT-AND-BOOST TYPE equalizer, you can't isolate each filter but you can minimize effects of the unwanted sections by turning them all the way down.

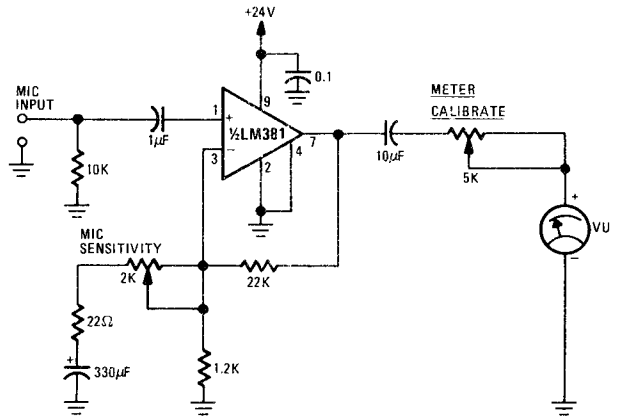


FIG. 3—SIMPLE RELATIVE-VOLUME INDICATOR can be made using one IC and a few parts, including an inexpensive meter.

the availability of a single-IC white-noise source, the MM5837. All this IC needs is power to start generating white noise. To get pink noise, it is necessary to recall the relationship between white and pink noise. Since white noise has equal energy per bandwidth, and since the bandwidth per octave doubles, the use of white noise produces double the energy per octave. Thus, the white noise must be passed through a filter that will reduce the signal amplitude by 3 dB-per-octave. Figure 4 shows how this is done.

Construction

A pink-noise generator is simple to construct. You can assemble the components on perforated board, and the entire unit can be mounted inside the equalizer and connected to its power supply. To prevent spurious signals from leaking into the system, provision should be made to apply power to the generator only when it is in use.

The generator can be housed in a small box with just an on-off switch and a phono jack for the output. Since the MM5837 is a MOS device, handle it with the usual precautions during construction.

Using the generator

Simply turn the generator on and connect it to the input of your system. If the unit has been installed inside the equalizer, connect it to the equalizer input. If the generator is used externally, feed the signal into the AUX, TAPE or other high-level input. In a stereo system each channel is equalized separately. Figure 5 shows for a typical arrangement.

Since all controls are adjusted relative to each other, one control can be arbitrarily set anywhere. For convenience, the middle control is chosen (or the control that affects frequencies of around 1000 Hz), and set to its center or flat position. All other controls are set to their minimum positions or switched off. To get a relative volume reading, place the microphone in a normal listening position and connect it to the tape-recorder input or level meter. Adjust the input level to O VU. Then, turn the middle control down and the first control up. Adjust this control for the same O VU reading. Mark the position of the

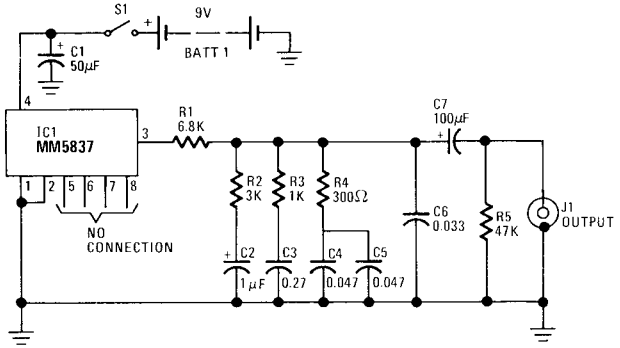


FIG. 4—SCHEMATIC DIAGRAM of the pink-noise generator. When installed inside the equalizer, its output is fed to the equalizer input. The battery can be replaced by any supply voltage between 7 and 24 volts DC.

PARTS LIST

All resistors are ¼ watt, 5%, unless noted.
All capacitors 10%, with voltage rating greater than supply voltage.

R1—6800 ohms
R2—3000 ohms
R3—1000 ohms
R4—300 ohms
R5—47,000 ohms
C1—50 μF
C7—100 μF
C2—1 μF
C3—0.27 μF
C4, C5—0.047 μF
C6—0.033 μF
IC1—MM5837 (National) digital noise source (or S2688 from AMI)
J1*—phono jack (optional)
S1*—SPST switch
BATT1*—9-volt battery (optional)
Misc.—battery clip*, 8-pin IC socket, case.*

The following parts are available from West Side Electronics, Box 636, Chatsworth, CA 91311.

Complete kit of parts including perforated circuit board, resistors and capacitors and excluding those marked by an asterisk, No. PNG-C, $9.95, postpaid.

Complete kit of parts, less battery, silk-screened case, No. PNG-K, $13.95, postpaid.

Assembled and tested kit, No. PNG-W, $19.95, postpaid.

California residents add state and local taxes as applicable.

slider with a pencil on the equalizer and return this control to its minimum position. Turn up and adjust each control in this manner. If the microphone frequency response is known, then the equalizer can be adjusted to this curve and the true response will be flat. Otherwise, the accuracy of the procedure will depend on the response of the microphone.

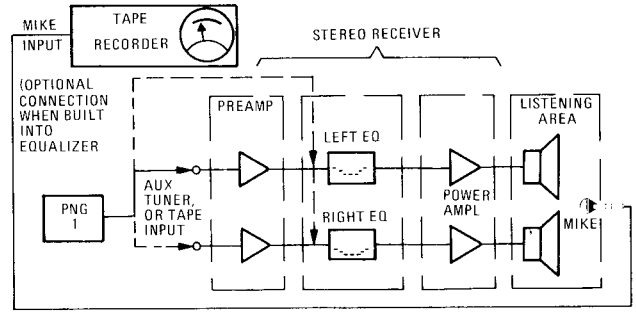


FIG. 5—CHECKING A TYPICAL STEREO SETUP. Mike is in normal listening position. Each channel is equalized separately.

When all controls have been set properly, disconnect the unit and place all sliders in their marked positions. At this point, the position of the controls marks the flat response setting for the room. You can now make minor alterations to the response to suit personal taste or to compensate for deficiencies such as poor highs from a tape recording.

Some other uses

There are several other uses for pink noise. There have been claims for the soothing and pain-relieving effects of pink noise although the extent of this use is questionable. Music synthesizers and recording artists sometimes use pink-noise generators. By using your pink-noise generator and equalizer, you can create the sounds of wind, rain, surf, etc. In addition, since the MM5837 is a digital noise source, the pink-noise generator can be used as a pseudorandom sequence generator.

Room acoustics

Any changes made to the listening area alters the room acoustics. For example, closing the drapes in a large room could drastically affect system response and necessitate re-equalization. You might consider placing several marks on the equalizer to account for these varying conditions. You must also remember that the response will be slightly different in different places in the room. Thus, it is not necessary to set the controls exactly—±1 dB is sufficient. Finally, on the odd chance your equalizer controls do not cover equal octave ranges, don't give up. If the bandwidth of each control is known, you can use this measurement to determine at what meter level each control should be set. For example, if the middle control covers one octave but the low-frequency controls cover ½ octave, then set these controls for a reading that is 3-dB below the reference setting. **R-E**