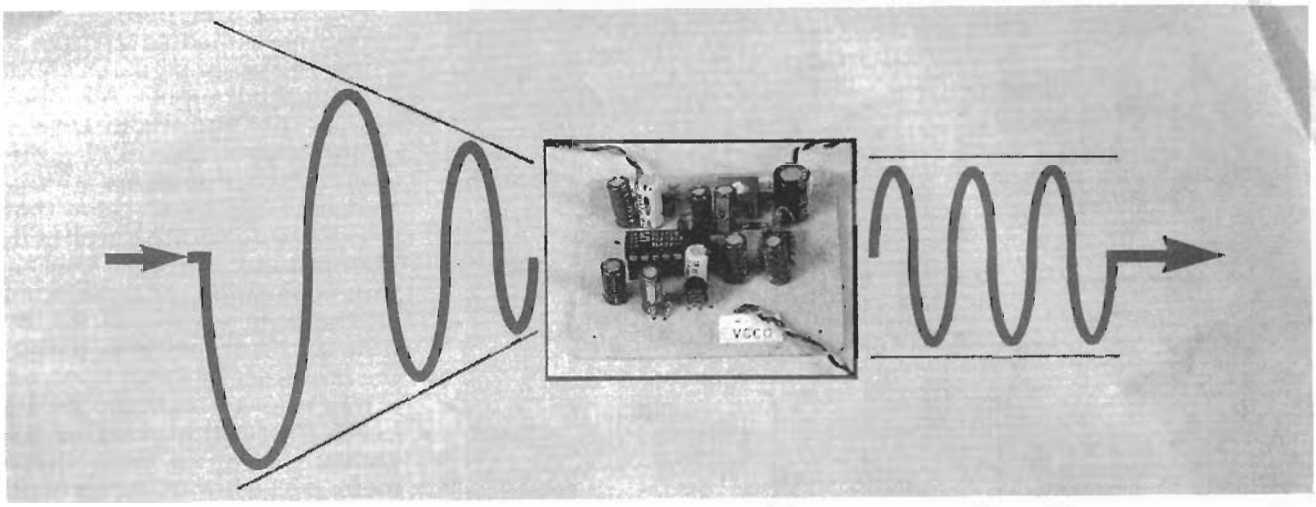


AUDIO LEVEL CONTROLLER

Build this programmable audio-level controller to tame your receiver's input and keep it in your ear's comfort zone.

STEVE SZABO, N1AYO

HAVE YOU EVER BEEN STARTLED when the audio from your radio receiver went out of control and nearly blasted you out of your chair? Maybe you just turned up the volume in an effort to hear a distant station or a soft voice, and within seconds an unwanted burst of sound overwhelmed you. If your answer is yes, you need an automatic audio level controller.

Not all transceivers and scanners—even the most expensive high-end products—have automatic volume control circuits. Now you can build the Audio Leveler module to keep your receiver's audio volume constant, regardless of incoming signal strength. It will work in your ham receiver, scanner, marine or other mobile transceiver, television set, or stereo system.

The Audio Leveler is independent of the host receiver's volume control. You set its volume to a comfortable level, and the Audio Leveler locks in on that setting. It amplifies desired low-level audio signals while discriminating against background noise and attenuating strong random signals.

Circuit description

The heart of the Audio Leveler is a Signetics NE577, a programmable, low-power integrated circuit called a compandor. The NE577, shown as a simplified block diagram in Fig. 1, is packaged in a 14-pin DIP. The first question you might well ask is: What is a compandor, and what does it have to do with audio leveling? The answer is that it's a circuit capable of compressing and expanding an input signal to remove noise in a communications channel, and one of its sections can be organized to control audio input signal level. The term is derived from a contraction of the two words *com*pressor and ex*pandor*.

The compandor was developed as a discrete component circuit for telecommunications applications, primarily to reduce unwanted noise. The input signal is fed to a compressor stage which rectifies and conditions it so that the input signal level always remains above the noise level. The conditioned signal is then fed to the expandor stage which restores it to its initial volume level—any noise is expanded below the audible level.

The NE577 has both a compressor and an expandor stage, but the Audio Leveler uses only the compressor stage which is configured as a programmable automatic level control (ALC). The ALC accepts a range of input signals, and produces a constant AC output level. The host equipment can have a volume control, but with the Audio Leveler in your receiver, you will only have to set the receiver's volume control once.

Figure 2 is the schematic for the programmable Audio Leveler. Only the compressor section pins on IC1, the NE577, are used; pins 1 to 3 in the expandor section are not used. The ALC function is configured with the rectifier at RECT_{in} pin 10 and $\text{GAINCELL}_{\text{in}}$ at pin 9 forming a closed loop around the internal op amp. Because the AC output level of the ALC can be programmed, you can choose a resistor value for a desired output level.

The audio signal is fed simultaneously to both pins 10 and

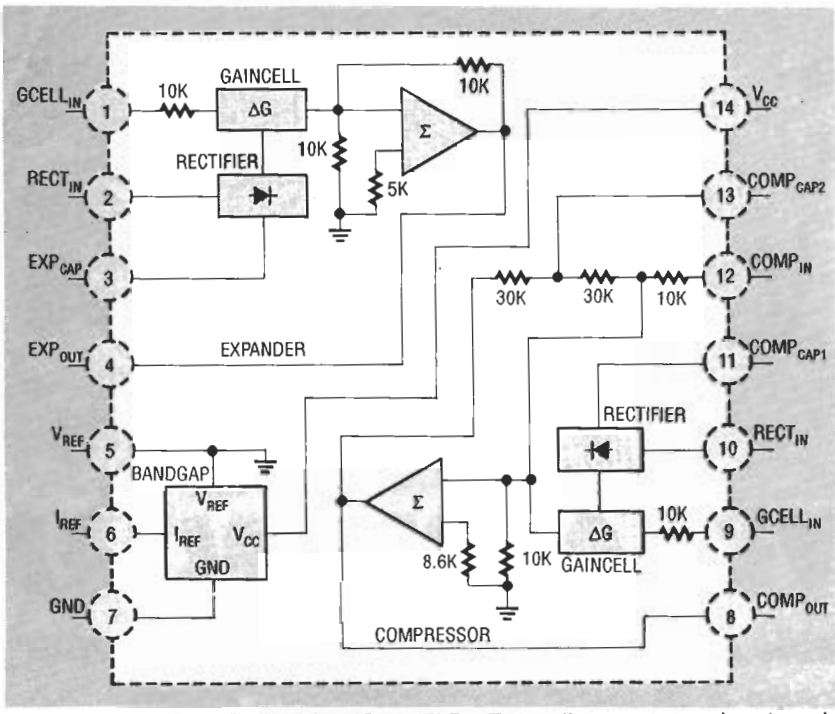


FIG. 1—SCHEMATIC FOR THE AUDIO LEVELER. The audio output stage is not needed if you can use the host receiver's audio amplifier stage.

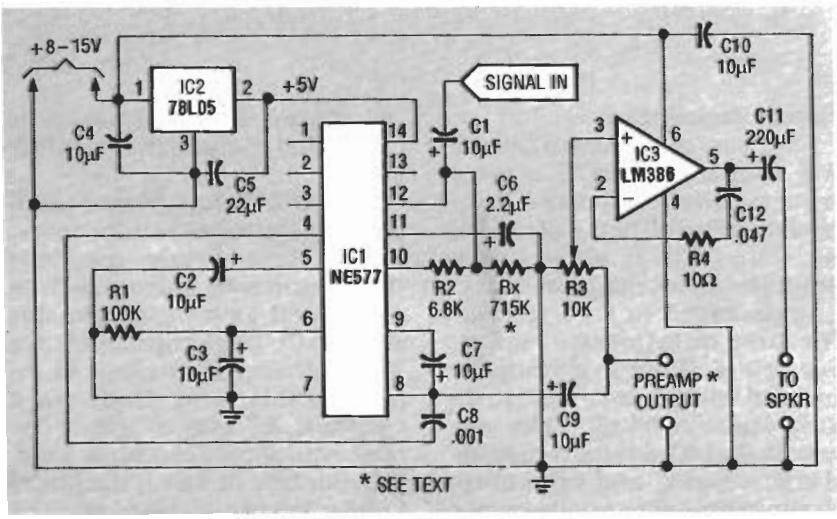


FIG. 2.—BLOCK DIAGRAM OF THE NES77 LOW-POWER COMPANDOR. This IC compresses the input signal to eliminate noise and control range, and then expands it again for normal listening

12. At pin 10, resistor R2, with a value of 6.8 K, is shunted by programmable resistor R_X, which limits maximum gain to prevent amplification of background noise. If resistor R2 is 6.8 K, R_X can be selected so that an input signal below 10 millivolts will not be amplified with a gain greater than 10. The circuit's output remains at a constant 100-millivolt (rms) level for the range of input voltages shown in Table 1.

The value of resistor R_X can vary from 64.3 K to 715 K, depending on input signal conditions. A value of 715 K for R_X was obtained in the prototype by connecting a 680 K resistor in series with a 33 K resistor.

If the input is 10 millivolts (rms) and R_X is 715 K, the maximum circuit gain is limited to 10 for an output of approximately 100 millivolts. Increasing the value of resistor R2 will increase circuit gain and output level, but reducing R_X will reduce the threshold level.

The crossover point of this circuit is defined as that point where the input signal is equal to the output signal. All input signals into the Audio Leveler circuit above the unity gain-level crossover point are attenuated, while all signals below that crossover point are amplified. The optimum threshold level for your application can be selected by choosing a value of R_X, by trial and error methods, within the limits set by Table 1.

Where practical, the Audio Leveler circuit should be installed within its host equipment enclosure in series with its volume control. Your receiver or scanner might not have enough space within its enclosure to accommodate the Audio Leveler, but do not alter the layout of the circuit board to fit a confined space unless you have enough experience to solve any interference, insulation, or thermal problems that might arise.

TABLE 1
DYNAMIC RANGE WITH DIFFERENT X RESISTOR VALUES

For a 100-millivolt rms output for different values of gain:
(1) Set input voltage, and
(2) Set RX as follows:

Input (volts,rms)	R_X (K ohms)	Gain (approx.)
1.0	6.43	1
0.050	136.0	2
0.100	715.0	10

Circuit construction

Conventional electronic circuit construction practice should be followed in building the Audio Leveler. The circuit can be built on standard perforated circuit board with a 0.1-inch grid, but a circuit board is strongly recommended. A foil pattern is provided in this article if you want to make the board. Alternatively, it can be purchased as a separate item from the source given in the Parts List. Regardless of your choice, be sure to drill holes in the corners of the board at the right locations for fastening it

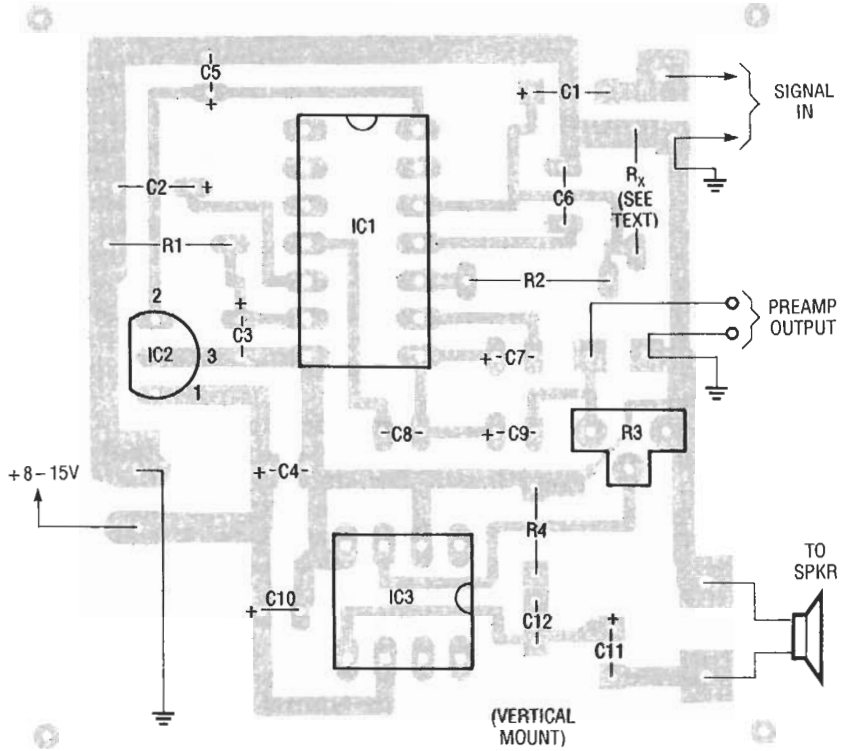


FIG. 3—PARTS PLACEMENT diagram for the Audio Leveler. If the module is bundled with the host receiver, the output stage might not be needed.

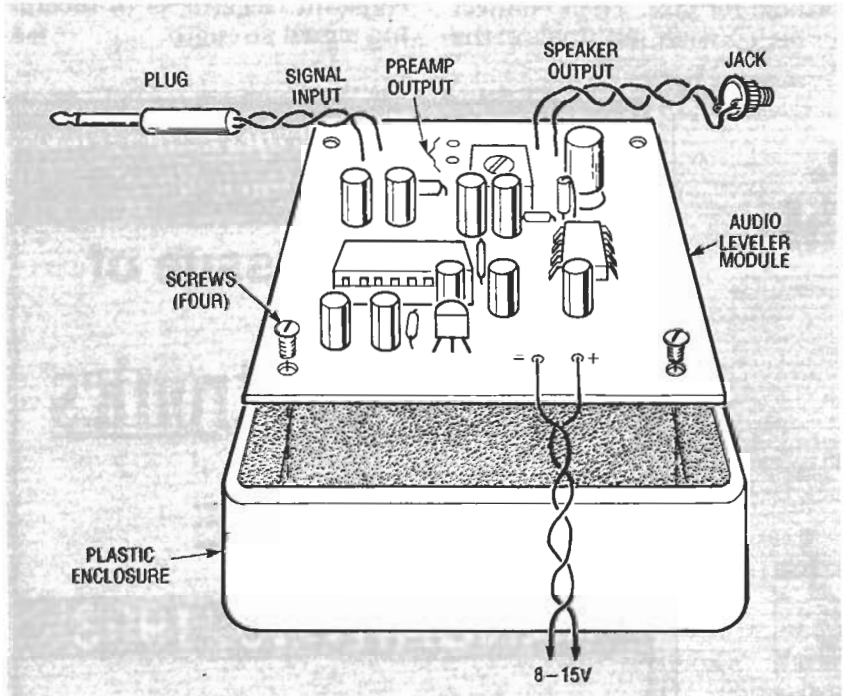


FIG. 4—MODULE ASSEMBLY AND TEST diagram. The stand-alone module can be placed in a separate plastic enclosure with a battery for power.

within your intended enclosure (host cabinet or separate plastic box) before starting assembly work.

Refer to the parts placement diagram, Fig. 3. Insert all resistors and capacitors in their proper places. (Two resistors in series might be required to obtain the desired value of R_X.) Then insert a recommended socket for IC1. Insert the ends of all input, output and power cable or twisted wires at the terminals shown in Fig. 4.

Carefully check the module for mistakes and inadvertent solder shorts, and make all corrections before inserting and soldering IC2 and IC3. The Au-

PARTS LIST
All resistors are ¼-watt, 5%

R1—100,000 ohms
R2—6800 ohms
R3—10,000 ohm, potentiometer, PC board mount
R4—10 ohms
R_X—715,000 ohms, 680,000 ohms in series with 33,000 ohms

Semiconductors

IC1—NE 577 unity-gain, programmable low-power compandor (Signetics) or equivalent
IC2—LM78LO5ACZ 5-volt voltage regulator (National Semiconductor) or equivalent
IC3—LM386 audio power amplifier (National Semiconductor) or equivalent

Capacitors

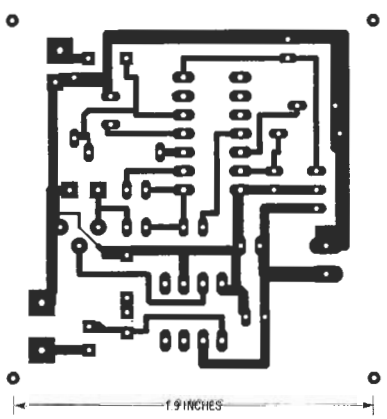
C1-C4,C7,C9, C10—10 µF,16 volts, electrolytic
C5—22µF, 10 volts, electrolytic
C6—2.2µF, 10 volts electrolytic
C8—0.001µF
C11—220µF, 16 volts, electrolytic
C12—0.047 µF,

Miscellaneous: circuit board, experimenter's plastic enclosure (optional), power source (see text), twisted-wire pairs or audio cable, solder, jacks and plugs as required.

Note: The following parts are available from C & S Electronics, P.O. Box 2142, Norwalk, CT 06852-2142, phone or fax: (203) 866-3208

- Formed and drilled PC board—$12.95
- Complete kit of parts excluding power supply and cabinet—$24.95.
- An assembled and tested module (Model ALC225C)–$32.95.

Please send check or money order only. Connecticut residents add 6%. tax. Add $3.00 for postage and handling.



FOIL PATTERN for the audio leveler project

dio Leveler is a low-level audio circuit, so trim all leads as short as possible to minimize noise interference. Then insert IC1 in its socket.

The twisted-wire pair from the prototype module's SPEAKER OUTPUT terminals was terminated with a ¼-inch open-frame jack, and the pair from the SIGNAL INPUT terminals was terminated with a ¼-inch plug. The 8 to 15 volts DC are supplied over a twisted pair. Select jacks and plugs that interface directly with those on your receiver or scanner.

If you plan to install the module within a receiver enclosure and do not need the output audio stage, omit the LM386 audio power amplifier, IC3, and related components R4, C11 and C12, and use the PREAMP OUTPUT terminals for the circuit output.

If you plan to use the Audio Leveler as a stand-alone accessory, put it in a separate plastic experimenter's enclosure as shown in Fig. 4. If you want to power the module with a battery, select an enclosure that will accommodate both.

Circuit testing

Connect the completed module to an 8- to 15-volt DC power source such as a battery or universal AC-to-DC adapter with a 100-milliampere rating. (If you plan to omit the power amplifier stage, only 10 milliamperes will be required. A standard 9-volt transistor battery will meet this requirement.)

Set an audio signal generator at any frequency up to 1 kHz, turn its output level to the minimum setting, and connect it to the SIGNAL INPUT terminals. Then place an AC voltmeter or oscilloscope across the PREAMP OUTPUT terminals (see Figs. 2, 3, and 4, two drilled pads next to trimmer R3) to observe the instrument's output.

Connect the SPEAKER OUTPUT of the module to an 8-ohm speaker. Set trimmer R3 to an audio output level that is comfortable for you. Then connect the SIGNAL INPUT terminals of the module to the external speaker jack of your receiver, turn the volume control to a minimum level, and slowly increase the setting until no further change is noticed. To change audio volume, only trimmer R3 need be set. As you increase the output amplitude of the signal generator, observe the circuit's output on the AC voltmeter or oscilloscope. Any change in volume will be slight if the circuit is operating satisfactorily.

Amplifier not used

If you omit the output amplifier stage, connect the module in series with the input wire of the host receiver's volume control—*not the wiper*. (If you can gain access to the host equipment's power supply, you can also omit a separate power source.) The host receiver's volume control should remain fully functional after the installation. The volume level of the host receiver will stay nearly constant, regardless of incoming signal strength. **R-E**