Acoustic protector damps telephone-line transients

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By limiting the transients on telephone lines, this acoustic shock protector prevents those sudden high sound levels that can damage the ear badly enough to cause loss of hearing. It holds the maximum peak-to-peak voltage at the receiver of a telephone headset to 50 millivolts.

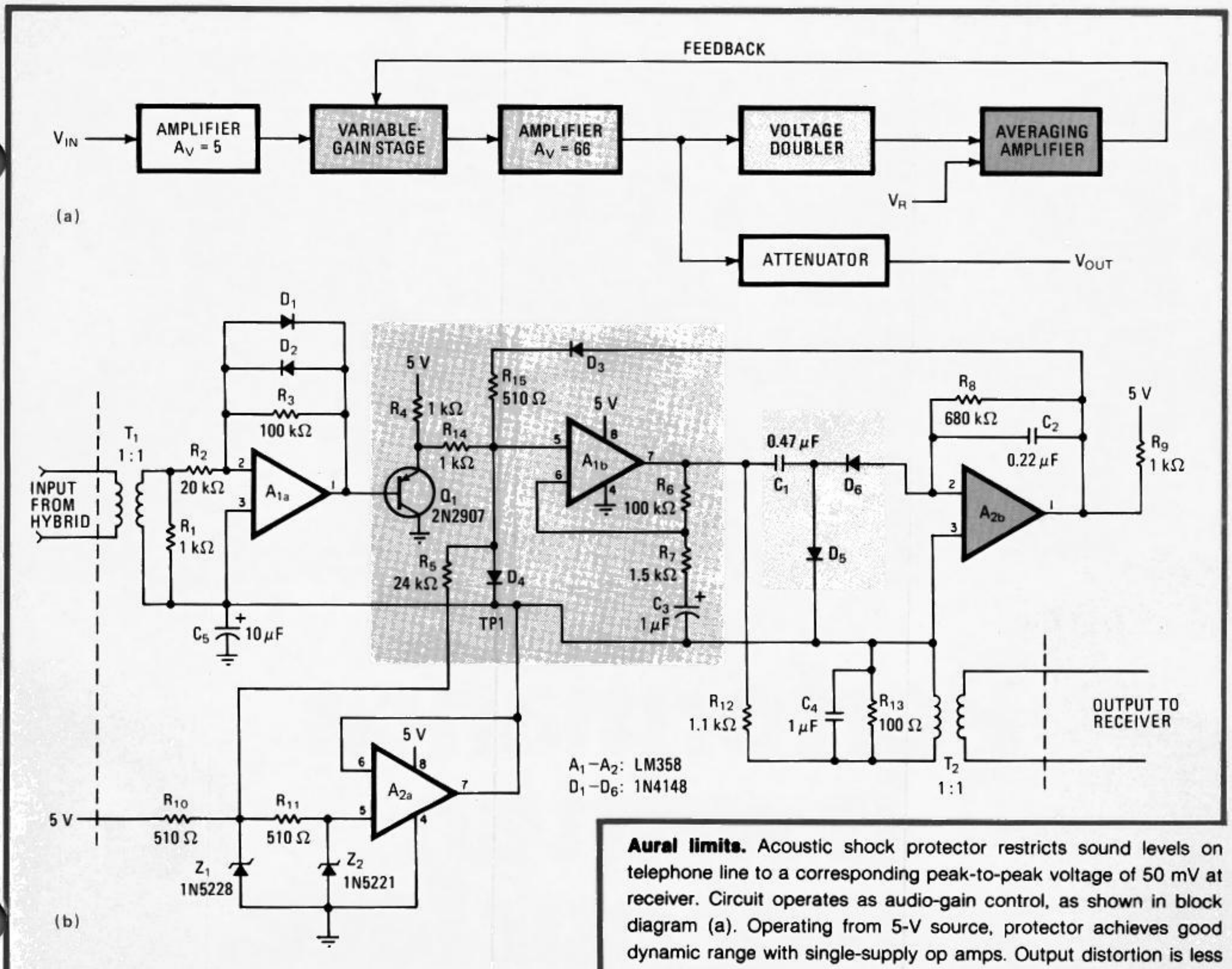
A four-terminal device, the shock protector is inserted between the receiver side of the telephone hybrid and the receiver proper. A block diagram of the circuit, which operates from a single 5-volt supply, is shown in (a). Input signals are amplified by a factor of 5 and applied to a voltage-controlled, variable-gain stage. Because this stage also attenuates the signal to the degree indicated by the actual level of a feedback signal, further amplification may be needed, and is available, to retain the loop's gain margin. A voltage doubler then converts the amplifier signal to a dc voltage. This voltage is compared with a preset reference at the inputs of an averaging amplifier.

The output of the averager, which is essentially an integrating network, is connected to the variable-gain stage. As the input voltage from the hybrid becomes greater, so does the feedback voltage, and thus still more attenuation is provided for the variable-gain stage.

As for the actual circuit (b), transformers T_1 and T_2 isolate the protector from the floating telephone line, so that the circuit operates from a 5-V supply referred to ground. A_{1a}, one half of an LM358 operational amplifier, provides the required amplification of the input signal. D_1 and D_2 clamp A_{1a}'s output to 0.7 V and introduce the signal to buffer Q_1. This transistor, along with R_4–R_7, R_{14}, D_4, A_{1b}, and C_3, make up the variable-gain stage.

Zeners Z_1 and Z_2 and op amp A_{2a} bias A_{1a} and A_{1b} so that input signals to those stages swing about a quiescent point of 2 V. The circuit thus provides maximum dynamic range. Note that most op amps require a 12-V supply to achieve a comparable range.

Q_1's output is converted to a current with the aid of R_{14}. Current flows through D_4, which operates as a current-controlled variable resistor. D_4 is biased through



Aural limits. Acoustic shock protector restricts sound levels on telephone line to a corresponding peak-to-peak voltage of 50 mV at receiver. Circuit operates as audio-gain control, as shown in block diagram (a). Operating from 5-V source, protector achieves good dynamic range with single-supply op amps. Output distortion is less than 4% for inputs up to 150 mV.

R_5 such that its nominal resistance is 500 ohms.

The voltage at the noninverting input of A_{1b} is amplified and applied to the voltage doubler (C_1, D_5, and D_6). A_{2b} and its associated circuit perform the averaging function that provides a feedback current to the variable-gain stage. The gain from input to output is unity until the amplifier's input threshold—set at 50 mV—is exceeded. The acoustic shock protector then operates as an automatic gain control for inputs up to 150 mV. The output distortion up to that point does not exceed 4%. Beyond 150 mV, however, the protector simply clamps the output to 50 mV p-p without regard to distortion.

Because the phone receiver is an inductive device, its impedance increases with frequency. C_4 is placed across R_{14} to compensate for this rise in impedance. The overall gain of the acoustic shock protector is thus held flat to within 1 decibel from 300 hertz to 3 kilohertz so long as the output of A_{1b} is below 600 mV or so. □