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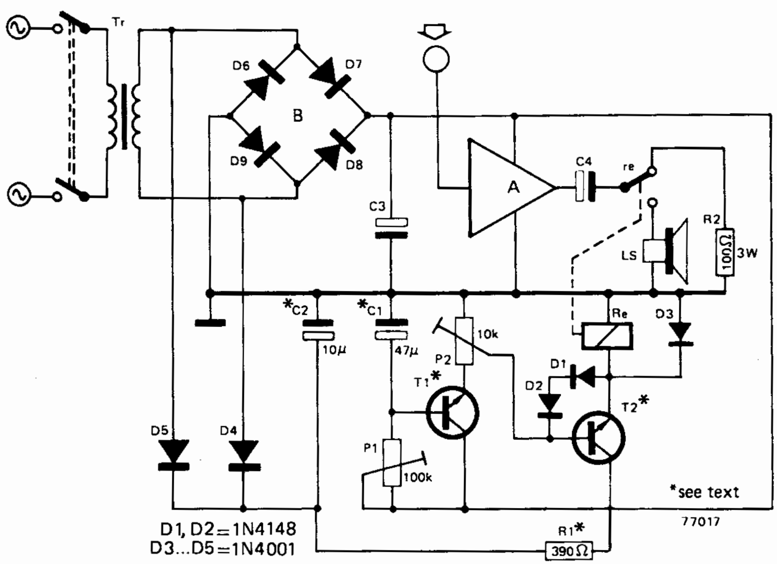
loudspeaker delay circuit

J. Rongen



D1, D2 = 1N4148
D3...D5 = 1N4001

Many owners of hi-fi equipment are plagued by switch-on and switch-off thumps which, while they rarely cause actual damage to the loudspeakers, are nonetheless very annoying. The simple solution is to switch the loudspeakers into circuit after the amplifier has been switched on and has settled down, and to switch them out of circuit before the amplifier is switched off.

This can be done manually, but there is always the chance that the user will forget, so an automatic switch seems the best answer. This can be achieved in a very simple manner. The circuit consists basically of a delay circuit and a relay that is energised to switch in the speakers a few seconds after the amplifier is switched on.

The DC supply to the relay has a very short time constant (much shorter than that of the amplifier power supply) so that when the amplifier is switched off the relay immediately drops out, disconnecting the speakers before a switch-off thump can occur.

The circuit functions as follows: at switch-on C2 charges from the amplifier power transformer, thus providing a collector supply to T2. However, T2 is initially turned off and relay Re1 is not energised. C1 charges slowly from the amplifier supply rail via P1. When the voltage on C1 exceeds about 0.6 V T1 starts to conduct and its emitter voltage follows the voltage on C1. When the voltage on the slider of P2 reaches 0.6 V T2 starts to conduct and its emitter voltage rises until the pull-in voltage of Re1 is reached, when the relay will energise and the loudspeaker will be switched in. When the amplifier is switched off the voltage on C2 will decay rapidly and Re1 will drop out, disconnecting the loudspeaker before the amplifier supply voltage has decayed and thus eliminating the switch-off thump.

The switch-on delay can be set by means of P1. P2 can be used to set the final voltage across Re1 to just above its pull-in voltage. This means that the relay voltage is not critical and any relay with a pull-in voltage less than the amplifier supply voltage may be used.

If the amplifier output is capacitor coupled then a 100 Ω 3 W resistor should be connected between the normally closed contact of the relay and ground to charge the output capacitor before the loudspeaker is connected. One set of relay contacts is, of course, required for each channel of the amplifier.

The ratings of transistors T1 and T2 should be chosen to suit the amplifier supply voltage. Medium power transistors such as BC142's should be adequate in most cases.

DESIGNER'S NOTEBOOK

ROBERT GROSSBLATT

Audio overload protection

IN ANY CONTEST TO RATE THE MOST popular areas of electronics, audio circuits and projects would undoubtedly be among the top ten. There is probably more home "tinkering" done in the areas of equalization, noise reduction, amplification, and so on than in any other field. And, as we all know, hardly a day goes by without an announcement from one semiconductor manufacturer or another about a new audio IC.

Each successive generation of audio IC has more features packed into it than its predecessor and can handle really mind boggling amounts of power. For instance, it wasn't long ago that an LM386 driver-amp blew everybody away because, with just a handful of external parts, it could output a ½ watt of continuous power into an 8-ohm load. These days, however, IC power-amps need virtually no external components, and one with more than 10 watts of power-handling capability can be held on the end of your little finger!

Every amplifier (regardless of type) has maximum power ratings. If those limits are exceeded, the amplifier and any associated components may be destroyed, so you must be careful. (Remember overloading can cause lots of trouble.) Overloading is hard to guard against because a typical audio signal can have a really wide dynamic range—sometimes more than 30dB.

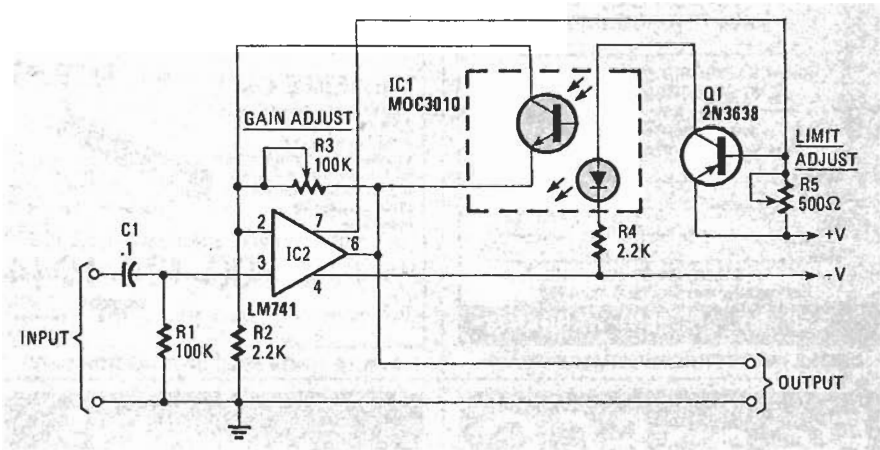


FIG. 2

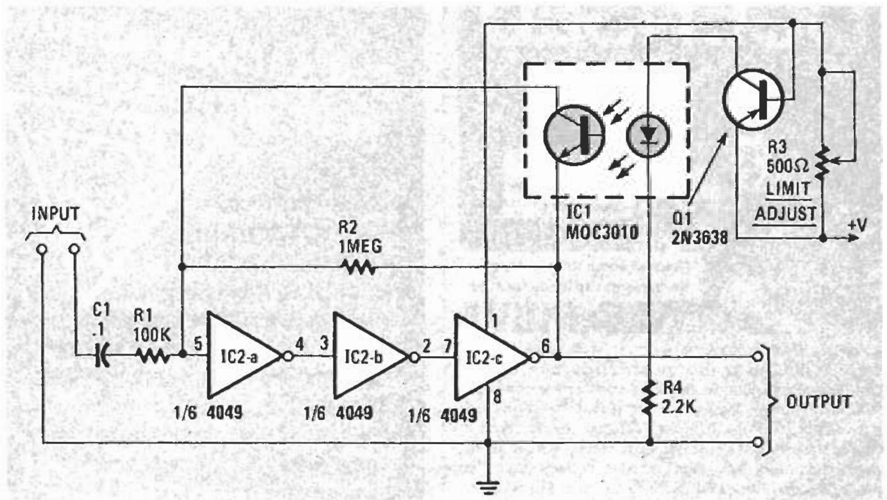


FIG. 3

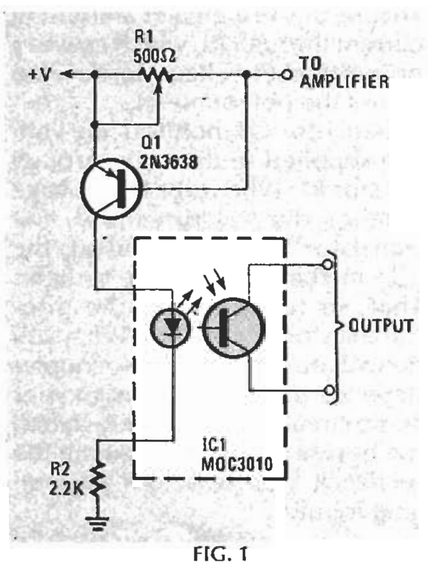


FIG. 1

Overload protection scheme

Protecting audio circuitry against overload (accidental or otherwise) is an important consideration, and should be on the mind of any serious audio-circuit designer. The best place to guard against overload is in the early stages where signal levels are low. The further along you are in the audio chain, the "beefier" the signal becomes, and the harder it is to add some type protection scheme. To complicate matters, overloads in the final power stages stand a much greater chance of "smoking" some expensive parts.

The circuit shown in Fig. 1 is the beginning of a protection scheme that can be made from a few common components. It's capable of monitoring circuit gain, and will also make sure that signal levels stay within the pre-set range. (The original circuit used a nonstandard optocoupler or optoisolator constructed from readily available parts, which we'll tell you how to make a little later.)

The best place to put the circuit is either in the feedback loop or shunted across the preamp input. Although the circuit tends to limit the gain of a preamp, keep in mind that it's meant to show you one way to approach the problem, and is by no means the only way to get the job done. Once you try it and become familiar with how it works, there are several "offshoots" of that design, which you can make following the same basic idea.

Figure 1 shows a 500-ohm potentiometer (R1) sitting right on the line feeding power to the preamp. When the audio signal is increased, the preamp draws more power to handle the larger signal. That results in a greater amount of current through R1, which causes a proportionate voltage to develop across the potentimeter.

Transistor Q1 monitors the voltage supplied to the amp through resistor R1. Whenever that voltage reaches the V_{CE} threshold, the transistor turns on, causing the LED in the optocoupler to light. That, in turn, causes the phototransistor to conduct. What you do with output of the optocoupler depends on how you design your audio circuit but (as already stated) the best place for it is either in the feedback loop or across the preamp input.

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Overload protection and transient elimination

THIS CIRCUIT is suitable for use with d.c. coupled audio power amplifiers, and combines protection against current overloads with delayed switch-on for the elimination of output transients. Transistor Tr_5 is initially turned off, and C_2 charges via R_{10}. After a delay of about 1.5s the relay switches on which closes S_1 and connects the load to the amplifier. If a large current flows in Tr_1 or Tr_2 of the amplifier output stage, Tr_3 or Tr_4 will turn on. This turns on Tr_5 and the relay switches off. The circuit is reset by switching off the amplifier until the supply has dropped to a few volts, and Tr_5/Tr_6 are no longer saturated.

Capacitor C_1 reduces the susceptibility to spurious operation, and D_5,D_6 provide protection for Tr_7 and Tr_8. Point A is a virtual earth summing junction so other amplifier channels can be accommodated. The circuit can also be modified for different supply voltages, overload currents and delay times.

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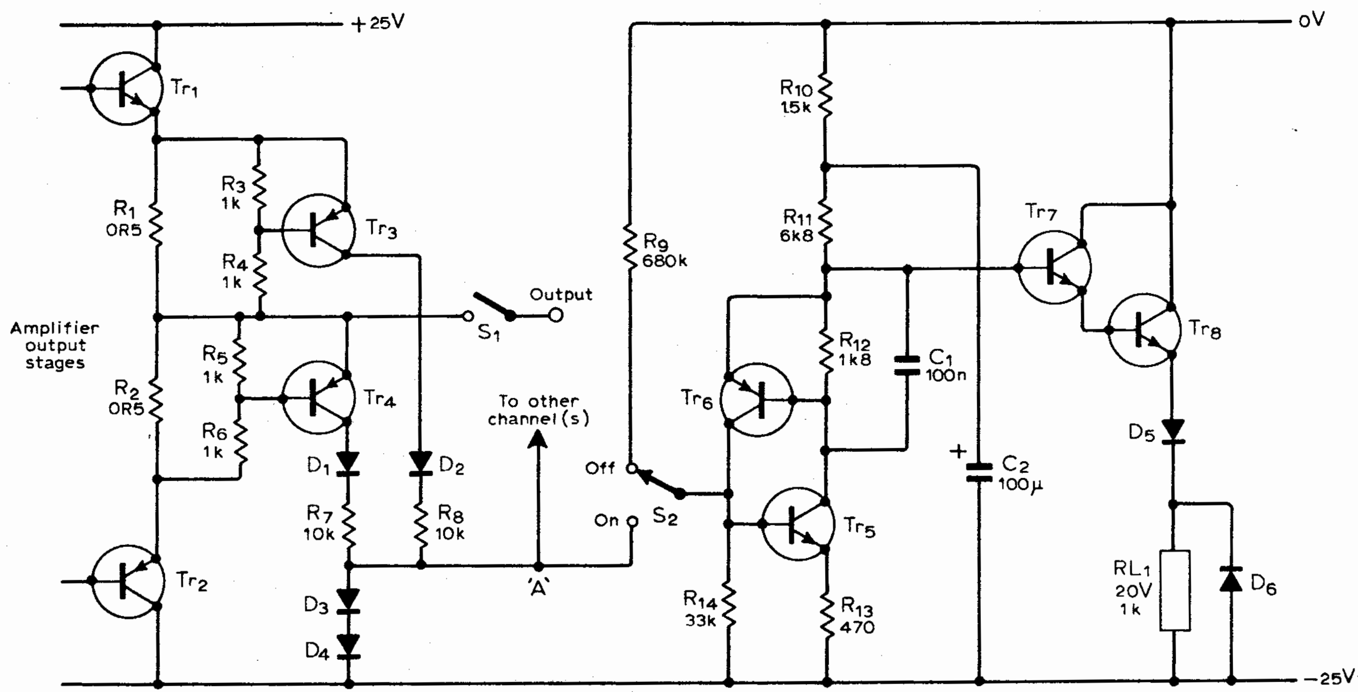

Amplifier output protection

Most power transistor protection circuits are a compromise because they have to limit the dissipation of each transistor and, at the same time, not limit the capabilities of the amplifier when driving a reactive loudspeaker load. This circuit avoids such a compromise.

During continuous a.c. drive into a normal load, R_1 draws current from C_1, via D_1, in opposition to R_5. Full drive into an 8Ω load will give an average V_{C1} and V_{C2} of about 0.12V which is sufficient to enable full drive into a load of $4\sqrt{2} \pm j4\sqrt{2}\Omega$. Continuous drive into a short-circuit will produce an average V_{C1} and V_{C2} of about 0.55V which will limit the average current in each output transistor to about 1.1A (2.2A peak). Diodes D_3 and D_4 ensure that C_1 and C_2 do not have a reverse voltage of more than 0.2V. Diodes D_5 and D_6 are necessary to prevent current flowing from the base to collector of Tr_1 and Tr_2.

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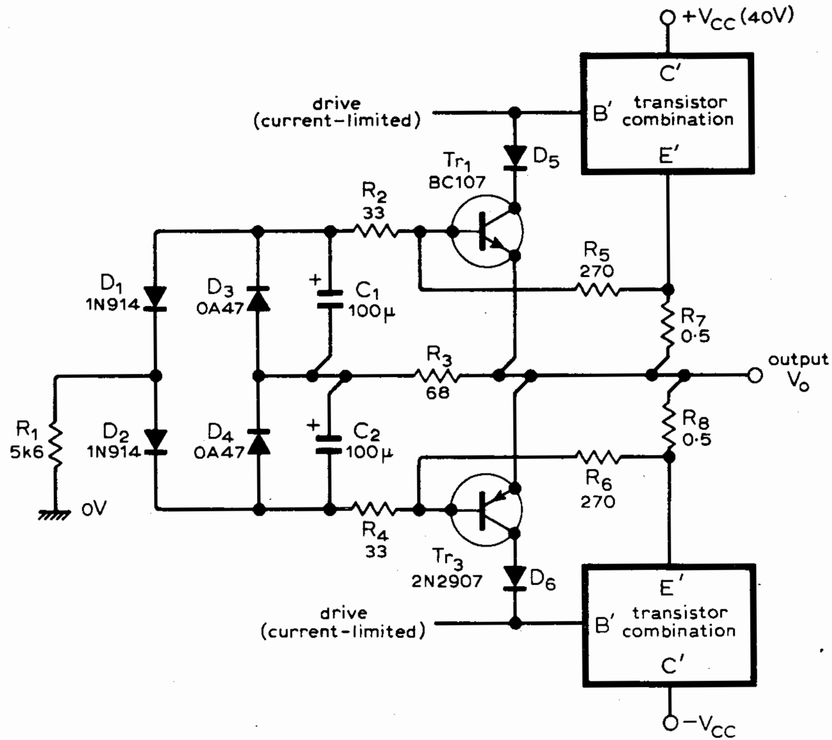

BY JERALD M. COGSWELL

Protection for DC-Coupled Speakers

Direct coupling of the output stages of an audio amplifier has its advantages, but speaker system protection should be provided.

DIRECT-COUPLED output stages are commonly found in contemporary audio amplifiers. Although there are definite advantages associated with dc coupling, there is also a danger—a collector-to-emitter short in an output transistor will impress the full power-supply voltage across the speaker terminals. Under such conditions, a speaker's voice coil will quickly burn out. The project presented here can save your speakers from destruction by removing

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ac power from the amplifier if a dc level appears across the speaker outputs.

Technical Details. The relatively simple circuit of the speaker protector is shown schematically in the diagram. Output signals from the amplifier are coupled to the protector by *R1* and *R2*. A symmetrical audio (ac) signal will not cause *C1* or *C2* to accumulate any steady-state, unbalanced charge. However, a positive dc level will cause *C1* to charge to a given voltage. A negative dc level will similarly cause *C2* to acquire a charge. Diodes *D1* and *D2* protect the electrolytic capacitors from reverse-polarity voltages.

An unbalanced charge results in a positive or negative voltage across the series connection of *C1* and *C2*. This voltage is applied to the noninverting input of *IC1* via *R3*. The amplified voltage appearing at the output of the op amp triggers thyristor *Q1*, which conducts and energizes the coil of relay *K1*. The relay then interrupts the flow of current from the ac power source to the amplifier. A LED is also included to act as a visual indication that the circuit has been activated. Diode *D3* protects the LED from inductive spikes generated as the relay is activated.

The author has selected a triac as the device controlling relay current for two reasons. First, the latching characteristic of the thyristor keeps the relay coil energized even after power has been removed from the amplifier. To reset the circuit, current flow from the +12-volt source to the triac must be interrupted.

Secondly, although the device need only conduct in one direction (implying the suitability of an SCR), it must be able to latch on when triggered by either a positive or negative pulse of gate current. This the SCR cannot do, but is a fundamental property of the triac. That's why this application, which involves a power amplifier having a bipolar power supply, dictates the use of a triac.

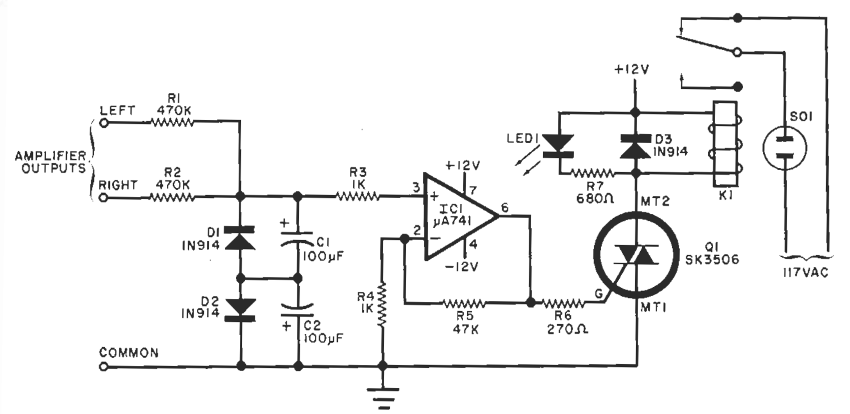
Construction. The project can be assembled using printed circuit, point-to-point, or Wire-Wrap techniques. Use appropriate sockets for the op amp and relay. The project board and a suitable power supply should be mounted in a suitable enclosure, taking care to avoid shock hazards. A barrier strip or push-button terminals can be mounted on the enclosure to simplify connections to the speaker outputs of the power amplifier.

You will note that *C1* and *C2* are specified in the parts list as tantalum capacitors. This was done to avoid the wide tolerances (−50%, +100%) of common aluminum electrolytic components which could disturb the symmetry of the input circuit. Tantalum capacitors are typically rated at ±20% or better, but you might have a hard time finding components with the specified capacitance. This can be easily overcome by paralleling smaller values, say, two 47-µF capacitors. However, it is not critical to have 100 µF of capacitance. Smaller values will work well, but will reduce the time constant of the RC input network.

Checkout and Use. After you have finished building the speaker protector, examine it for cold solder joints, incorrect wiring, and semiconductors and electrolytic capacitors with reversed polarity. Then plug an incandescent lamp into socket *SO1* and apply power to the circuit. The lamp will glow. Using two flashlight batteries in series, apply 3 volts dc across either the left or right channel protector inputs. After three to five seconds, the relay will be energized, a click will be heard, and the lamp will darken. The glowing LED will also indicate that the triac has been triggered.

Next, disconnect the speaker protector from its power supply, remove the batteries from the input and discharge *C1* and *C2*. Reverse the polarity of the batteries, connect them to the same input as before, and apply power to the protector circuit. After a short delay, the same sequence of events will occur as described earlier. Repeat this test procedure for the other channel's input.

You have now verified proper circuit behavior, and the speaker protector is ready for use. Remove the test lamp's power plug from *SO1* and replace it with that from your audio amplifier. Interconnect the amplifier's speaker outputs and the input barrier strip of the speaker protector with lengths of zipcord. Be sure to observe proper phasing. Do not attempt to test the circuit while the speakers are connected because flashlight batteries cannot deliver their rated voltage into such a low impedance. ◇



An unbalance across capacitors C1 and C2 triggers Q1 and energizes K1 to shut off the amplifier power.

PARTS LIST

C1,C2—100-µF, 35-volt tantalum capacitor (see text)
D1,D2,D3—1N914 silicon diode
IC1—µA741CV operational amplifier
K1—12-volt dc relay, 10-ampere contacts, 600 ohms max. coil resistance (Radio Shack 275-208 or equivalent)
LED1—20-mA light emitting diode
Q1—SK3506 (RCA) triac or equivalent.
The following are ¼-watt, 10% tolerance carbon-composition resistors:
R1,R2—470,000 ohms
R3,R4—1000 ohms
R5—47,000 ohms
R6—270 ohms
R7—680 ohms
SO1—117-V ac power socket
Misc.—Printed circuit or perforated board, ±12-volt regulated power source, suitable enclosure, barrier strip, IC socket, relay socket (included with *K1*), line cord, strain relief, hookup wire, hardware, etc.