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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.

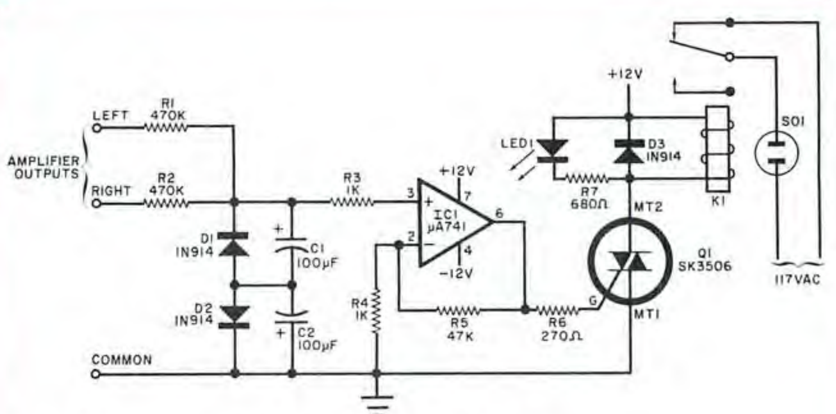
Construction. The project can be assembled using printed circuit, point-to-point, or Wire-Wrap techniques. Use appropriate sockets for the op amp and relay. The project board and a suitable power supply should be mounted in a suitable enclosure, taking care to avoid shock hazards. A barrier strip or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