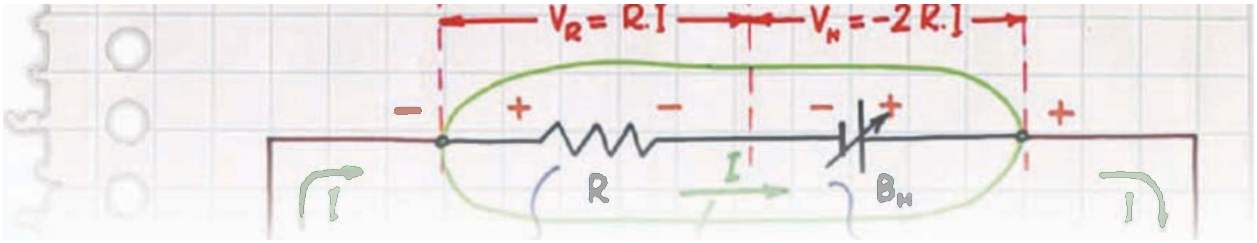


DC Protection for Speakers

By André Aguila (Burkina Faso)

I'm in the process of building myself a single-ended class A MOSFET amplifier consisting of two mono blocks, and I don't want to use a coupling capacitor between amplifier and the speaker. So I needed a circuit that would protect the speaker against DC voltages; I have given it a dual role:

- DC protection in the form of a device to disconnect the speaker in the presence of a DC voltage greater than ±1 V, using an LM358;
- speaker connection delayed by around 5 s after powering the amplifier, using a 555.

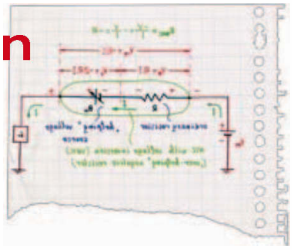
I've drawn inspiration from various ideas gleaned from the Internet, but I don't think this circuit actually exists anywhere in quite this form. Obviously, for a stereo system, you'll need a protection circuit for each channel.

The output signal from the audio amplifier without an output capacitor is applied to the normally-open contacts of relay Re1, and also to the input of the DC voltage detects formed by an RC integrating network and comparators, whose output drives the relay control stage and an LED indicator.

The network R6/C4 is a low-pass filter that heavily attenuates the audio signal but will allow any positive or negative DC component through to the inputs of dual comparators IC2a and IC2b, which are protected from excessive voltage by diodes D1 and D2.

IC2a output goes from +12 V to −12 V when the voltage on its negative input is higher than that on the positive input, while IC2b output goes from +12 V to −12 V when the voltage on its positive input is lower than that on the negative input. The values of resistors R7, R8, and R9 in the potential divider set the DC voltage detection thresholds to around +1 V for IC2a and −1 V for IC2b.

To disable the relay if a positive or negative DC voltage is detected, all that remains to be done is to combine the LM358 outputs. As these are not open-collector outputs, diodes D4 and D6 form a wired-OR gate to avoid short-circuiting them. If there is a positive DC voltage on the amplifier output, IC2a output will go from +12 V to −12 V and disable the relay by turning off T2, while IC2b output remains at +12 V. If a negative DC voltage is present at the input to our protection circuit, the roles of IC2a and IC2b outputs are reversed.



Transistor T1 inverts the output from the 555, wired as a monostable, which is high (here that means ground) for around 5 s after power is applied. T1 is then turned off, as its base is at the same voltage as its emitter, and thus holds T2 off: the relay remains de-energized. At the end of the time delay, the 555 output falls (−12 V), T1 conducts and the relay is energized via T2.

I've carried out a lot of testing and tried several types of relay, finally choosing a high-quality 24 V type designed for speakers, and I'm very pleased with the circuit. Preset P1 makes it possible to adjust the operating threshold of the relay chosen according to its coil resistance. The choice of a 2N1711 for T2 is justified by both its availability and its gain, higher than a BD139, for example. Don't worry if it gets hot, its junction can withstand up to 175 °C.

The protection circuit is mains powered via two symmetrical regulator (IC3 and IC4) which will need to be fitted with small heatsinks of the transformer secondary voltage is high. It should theoretically be between 12 and 25 V, but given the fluctuation in AC line voltage, it's wiser to limit it to a range of 15 to 22 V.

As the power drawn from the transformer is modest — around 3 VA is more than enough — it would be feasible to use quite a small transformer to allow the protection circuit to be fitted within the speaker being protected.

You will note that the 555 is powered between the centre zero rail (which is its positive rail) and the −12 V rail.

Choosing a low-current LED for D8 will let you save a few tens of milliamps, at least when the diode is lit. In this case, the value of R10 will increase from 680 Ω to 4.7k so as to reduce the current to 2 mA instead of 15 mA!

When testing, bear in mind that when the protection circuit input is open-circuit, the two opamps receive no bias voltage. So to test their operation, you'll need to apply a DC voltage source.

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