

# DC Protection and Switch-On Delay for Power Amps

Easy to build, simple electrical circuit that protects a loudspeaker from unwanted DC, and also provides a switch-on delay function.

By Jenoe Keceli

The idea came as I was repairing a prefabricated transistor high-powered amplifier that did not have any kind of protective circuit. When switched on, these kinds of power amplifiers produce unpleasant static. In this case, or due to an amplifier failure, DC can get to the output, which poses a great danger to the loudspeaker.

The standard solutions for this problem all seemed too complicated and required many components, so I tried to find a simple solution, and I arrived at the idea of the opto-coupler as the sensor element. The application of the opto-coupler significantly simplifies the circuit solution. The protective circuit consists of a DC sensor and a timer that controls the switch-on-delay (*Photo 1*).

The relay carries out the actual loudspeaker switch-on/off. All this happens in stereo, with separate earth-conductors, so that you can also use this solution for amplifiers with balanced output.

## FUNCTIONAL DESCRIPTION

*Figure 1* shows the schematic of the protective circuit. When you switch on the amplifier, the C3 capacitor slowly charges from the power-supply voltage through the R4 resistor. If the amplifier function well, the transistor opens and the relay switches on the loudspeakers with a slight delay. In the first

operating point of the amplifier has been settled. The delay-time depends on the values of the R4-C3 components.

The signal from the output of the amplifier reaches the opto-coupler input that is functioning as a sensor through an RC filter. The task of the R1-C1 and R2-C2 components is to eliminate the

second the loudspeakers are protected and the relay switches on only after the

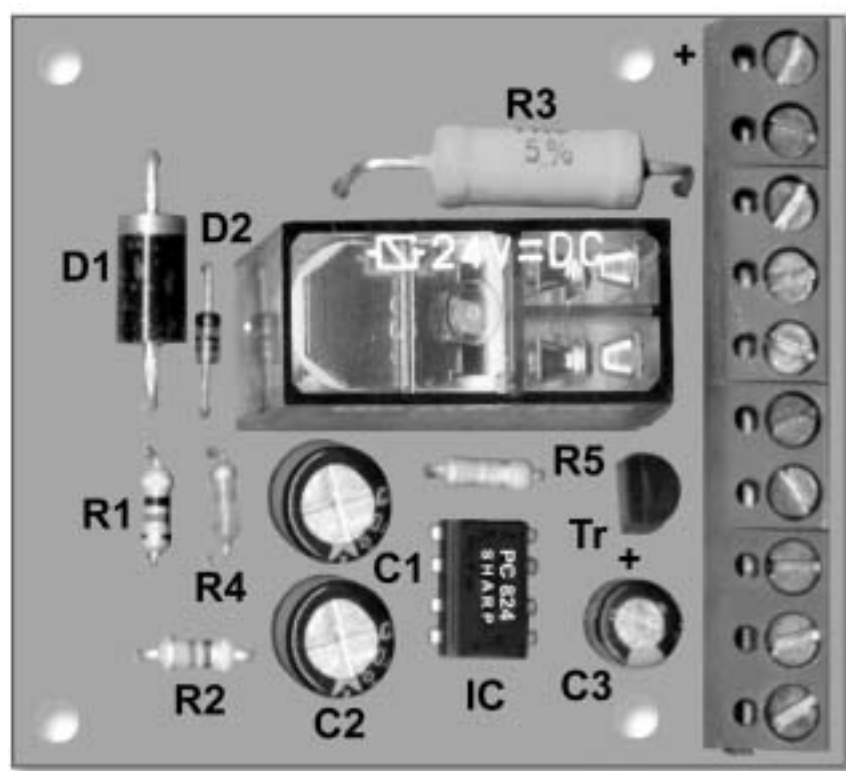


PHOTO 1: The DC protection and switch-on delay circuit.

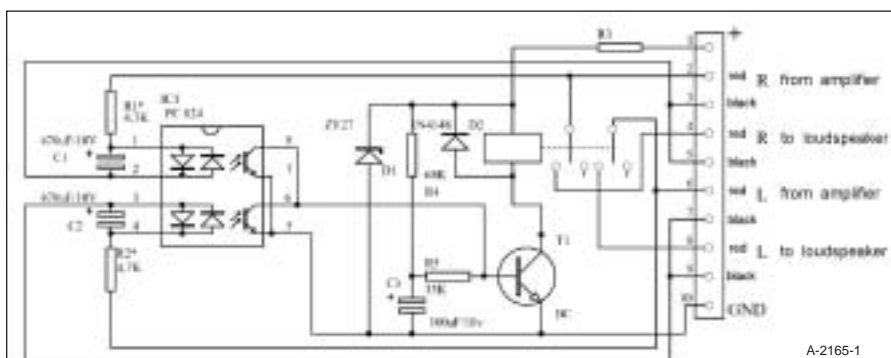


FIGURE 1: The full circuit diagram of the protective circuit. The values of the R1, R2, R3 resistors can vary according to the application. See detailed description.

## ABOUT THE AUTHOR

Jenoe Keceli is a long-time electronics enthusiast with 40 years of experience. His main fields of interest are designing and building tube and transistor power amplifiers. He has much experience with sound and disco equipment. He has been publishing his articles in electrotechnical journals. He now runs his own firm, where he builds, repairs, and gives advice.

loud frequency AC. Supposing that the amplifier functions well, there is no DC on the output, so no sign gets to the sensors. The transistor of the opto-coupler does not conduct, hence the relay switches on. In case the amplifier fails, DC will appear on its output; the C1 or C2 capacitors do not hinder the change of the voltage.

The actual diode of the opto-coupler opens its transistor, which bypasses the T1 transistor's base current. As a result, the T1 transistor closes and the relay switches off the loudspeakers. The relays will stay switched off as long as the failure persists.

What is interesting about the opto-coupler is that it exhibits a rectifier behavior on the anti-parallel diodes. The opto-coupler is activated regardless of the polarity of the applied signal on the diodes' inputs. The AC signal that

results from normal functioning of the amplifier is filtered out by the C1 and C2 capacitors. It is well known that the electrolytic capacitors are sensitive to correct DC polarity. However, as the diodes

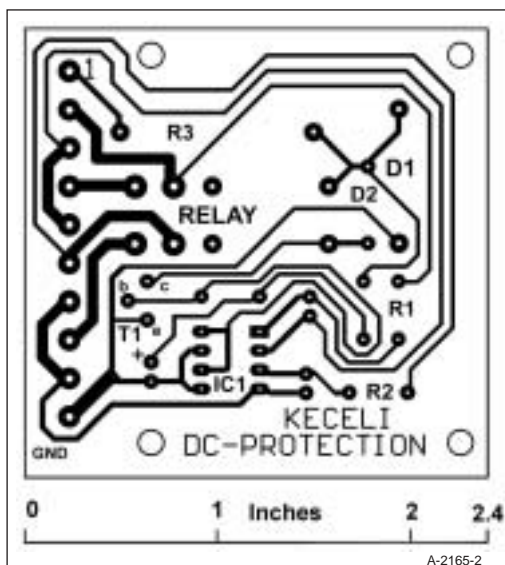


FIGURE 2: Printed circuit board, soldering side.

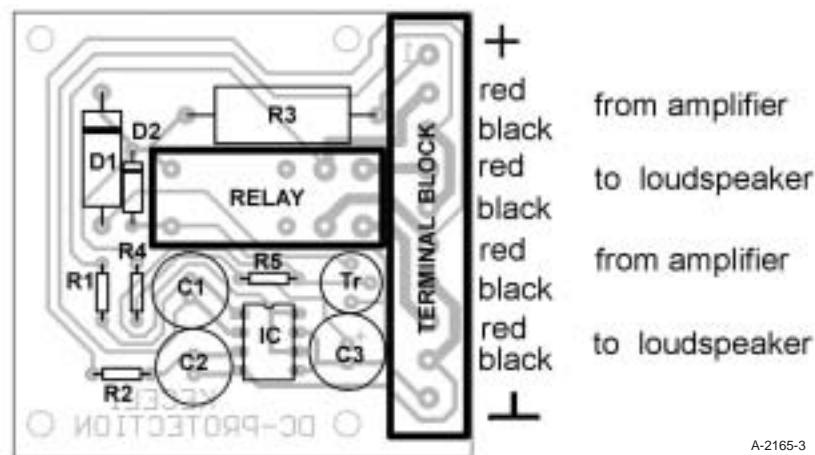


FIGURE 3: The soldering of the components on the printed circuit board. Component side.

TABLE 1  
PARTS LIST

R1, R2	Resistor, ¼W 4.7k for a 300W amplifier. For other powers refer to the article.
R3	Resistor 2.2k 4W, for a 72V, 22mA relay. The value of the R3 resistor depends on the power-supply voltage and the relay's coil current rating.
R4	Resistor 68k ¼W
R5	Resistor 33k ¼W
C1, C2	Aluminum electrolytic capacitor, radial 470µF 16V
C3	Aluminum electrolytic capacitor, radial 100µF 16V
IC1	Opto-coupler PC824, LTV824, or equivalent
D1	Zener diode ZY27 (27V 2W)
D2	Diode 1N4148
T1	Universal, low signal NPN transistor, e.g., BC547, BC546, BC548, or equivalent
Re	Relay 24V, 22mA, two contact sets 10–15A, e.g., RP 420024 (Siemens, Schrack), or Finder—Type 4052, or equivalent
Ko	Terminal block—PCB 10 way (0.1")
PCB	Single-sided PCB

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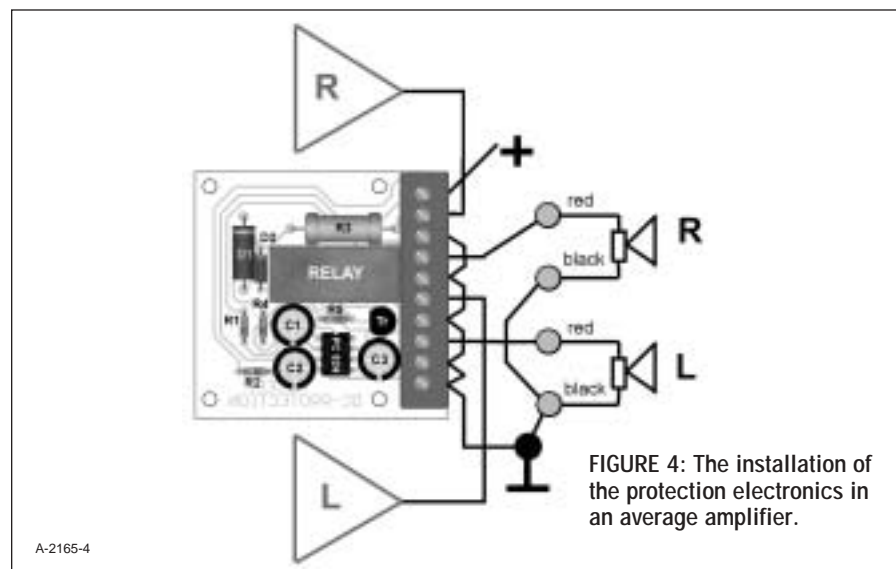
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restrict the voltage to low level (remember, DC appears only in case of amplifier failure), there is no risk of damaging the capacitor in this application.

The (lower) cut-off frequency, which is determined by the R1-C1 and R2-C2 constants and which influences the sensitivity of the protective circuit, does not play a significant role in the operation of the protective circuit. Therefore, you can freely choose the values for C1 and C2 capacitors. I advise you to choose the values of R1 and R2 according to the amplifier's output power rating. The suggested

value of 4k7Ω is for 300W amplifiers.

You should experiment with selecting the optimum resistor value of R1 and R2 using the actual amplifier. You should begin with smaller-value resistors in normal operation of the amplifier at maximum volume. If the relay does not hold, try to use higher-value resistors. You should increase the value of R1 and R2 as long as the relay becomes stable and the circuit functions well at the full amplifier power. The unstable holding of the relay appears when the value of R1 and R2 resistors is too low because the capacitor still



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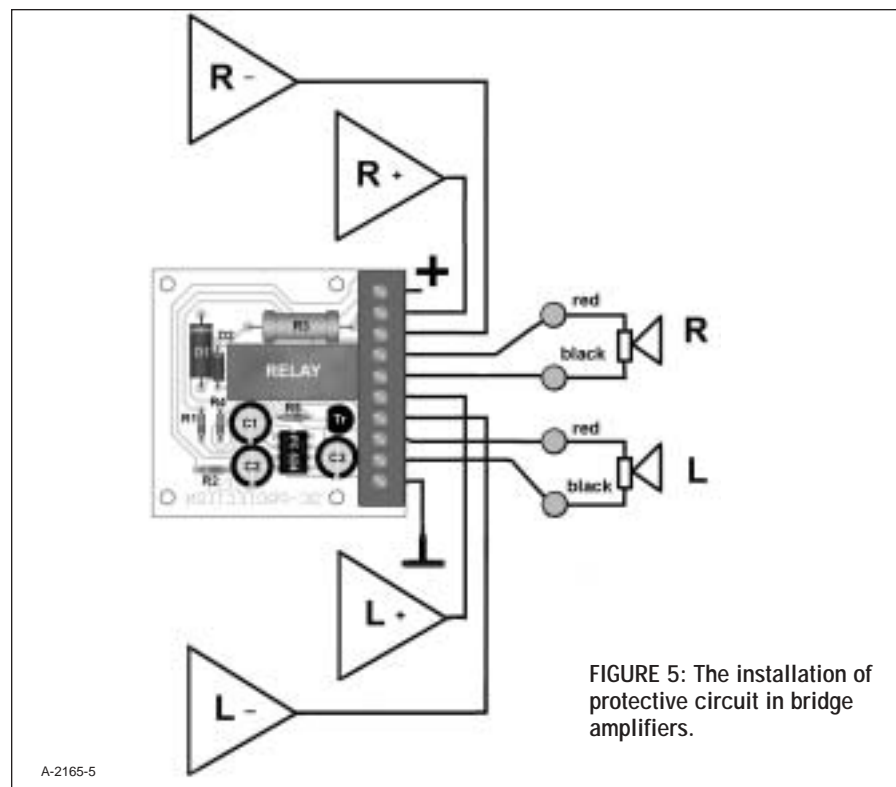
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lets through a small amount of low-frequency signals and the anti-parallel diodes sense this as DC.

Warning: Never choose the R1 and R2 resistors to be less than 500Ω, not even as a test, because it could lead to destruction of the opto-coupler. (Such a low value can only work with low-power amplifiers.)

## SELECTION OF COMPONENTS

There are various types of opto-couplers. If you choose a different type, do not forget that it is better to select those with better sensitivity. The T1 transistor can be a universal, NPN low-power device. You should choose the relay contacts between 10–15A, depending on the amplifier; its coil should be 24V. The power-supply voltage of the prototype circuit was 24V.

In this case, application of the D1 zener diode is unnecessary. Instead of the R3 resistor, it is sufficient to use a short wire bridge. As the power-supply voltage is fed from the amplifier, in many cases it would be more than 24V, so it is limited by the D1 zener diode and the R3 resistor to 24V. When the relay drops, the D1 diode takes over the load of the relay-coil, which is why I chose a 2W type resistor for R3.

The value of the R3 resistor is defined by the following simple calculation:

$$R3 = \frac{U - 24}{I}$$

where U stands for power-supply voltage in V, and I is the normal current of the relay coil in A. The formula applies to a 24V relay. Assume that the power-supply voltage from the amplifier is 72V. In this case the value of R3 will be:

$$R3 = \frac{72 - 24}{0.022} = 2181 \approx 2200\Omega$$

Its power rating should be 2–4W. For higher power-supply voltage, besides a higher ohmical value, a higher power rating is required.

## CIRCUIT ASSEMBLY

Figure 2 shows the printed circuit board, and Fig. 3 shows the arrangement of the components.

The printed circuit board should be conventional—single-sided with four

mounting holes and a PCB mounting terminal block. Because the thickness of the copper foil did not prove to be thick enough at higher currents, you should strengthen the already broader tracks using soldered wire between the contacts of the relay and the terminal block. Since the R3 resistor might develop excessive heat, I suggest you solder it with longer legs to place it further away from the printed circuit board and to prevent the board from burning.

## INSTALLATION

With average stereo amplifiers, where you need to deal with two separate amplifiers, one pole of the loudspeaker is on earth potential, so you can earth one of the poles of the input. Disconnect the red loudspeaker wire and patch through the protective circuit and connect the circuit to the ground. Figure 4 shows the installation details.

Reduce (with the help of R3) the power-supply voltage of the power amplifier to the supply voltage of the protective circuit. Do not forget about the proper selection of the R1, R2, R3 resistors as described earlier. Occasionally, you can still find bridge amplifiers, especially among the higher-power amplifiers, or in car hi-fi equipment.

In these stereo-channel cases, you have two pairs of amplifiers that are biased in opposite phase. Both wires of the loudspeaker receive an active sign, and there is no earth potential, so bind in the protective circuit according to this circumstance. Free the inputs from the earth potential and connect them to the active signal (Fig. 5). You can even install two protective circuits in bridge amplifiers so that both amplifiers get their own protection.

After the installation you can forget about the few components you have used to make the protective circuit. In case of eventual failure of the amplifier, the loudspeakers will be turned off and saved from destruction. Saved, just like you from a financial catastrophe! ♦

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