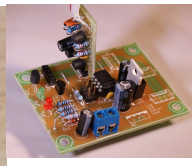
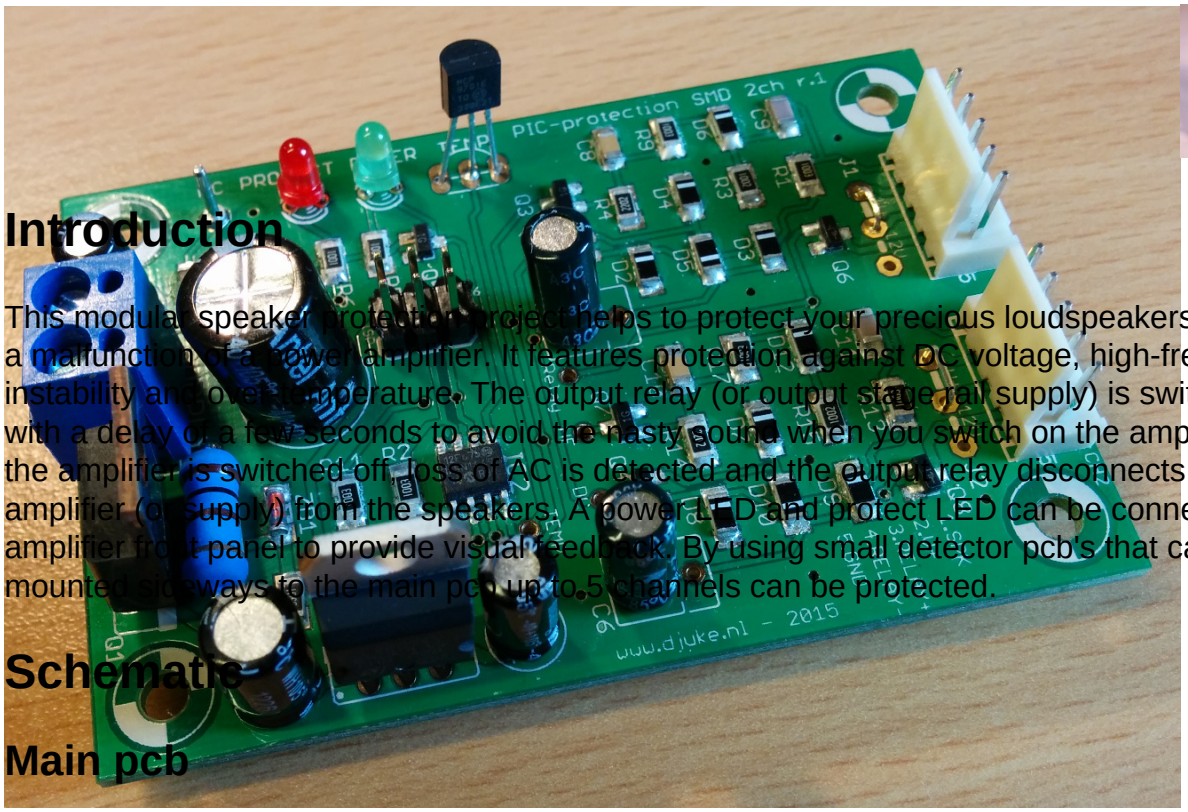
Products related to this project are for sale on this page.





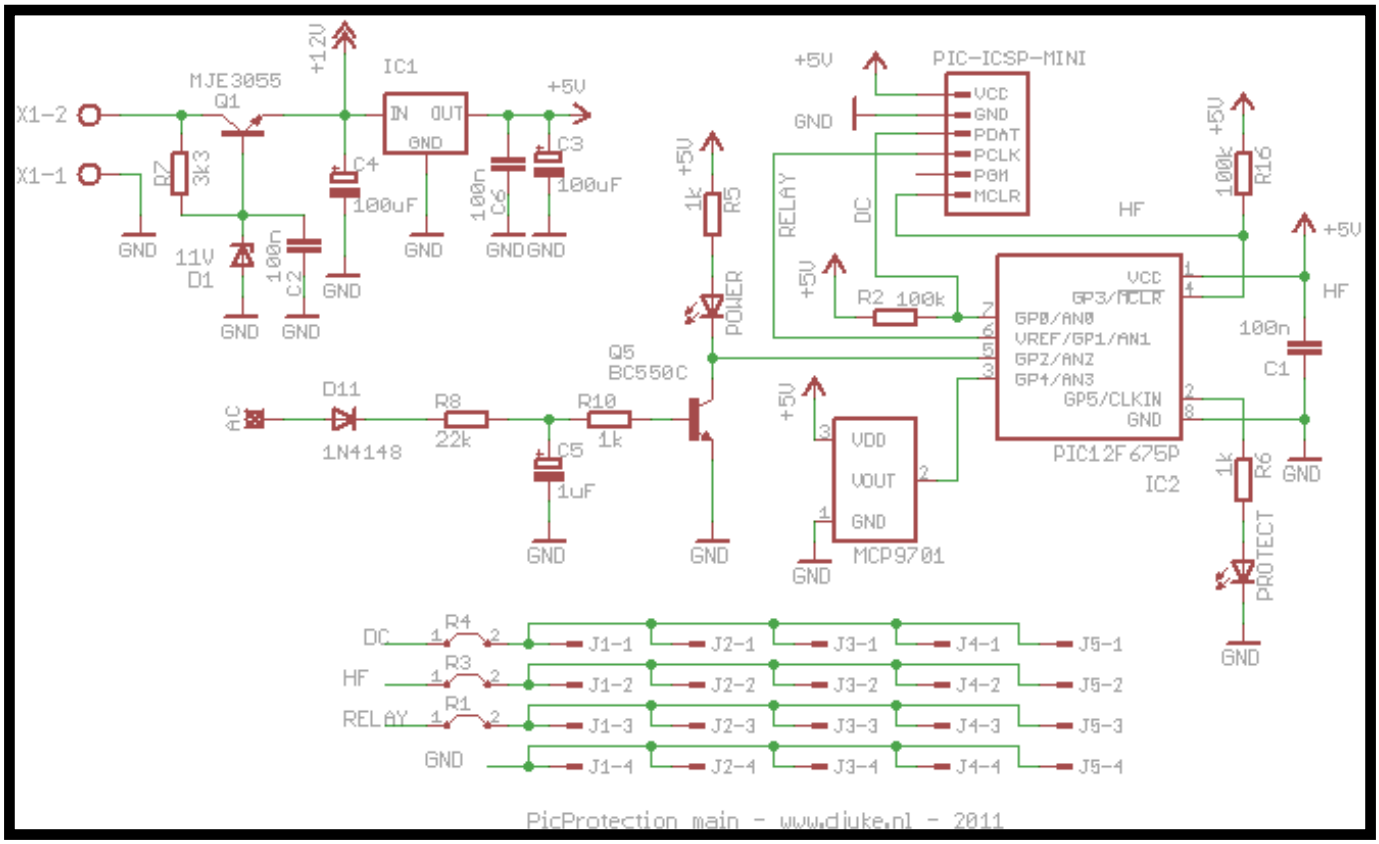
Introduction

This modular speaker protection project helps to protect your precious loudspeakers in case of a malfunction of a power amplifier. It features protection against DC voltage, high-frequency instability and overtemperature. The output relay (or output stage rail supply) is switched on with a delay of a few seconds to avoid the nasty sound when you switch on the amplifier. When the amplifier is switched off, loss of AC is detected and the output relay disconnects the amplifier (or supply) from the speakers. A power LED and protect LED can be connected to the amplifier front panel to provide visual feedback. By using small detector pcb's that can be mounted sideways to the main pcb up to 5 channels can be protected.

Schematic

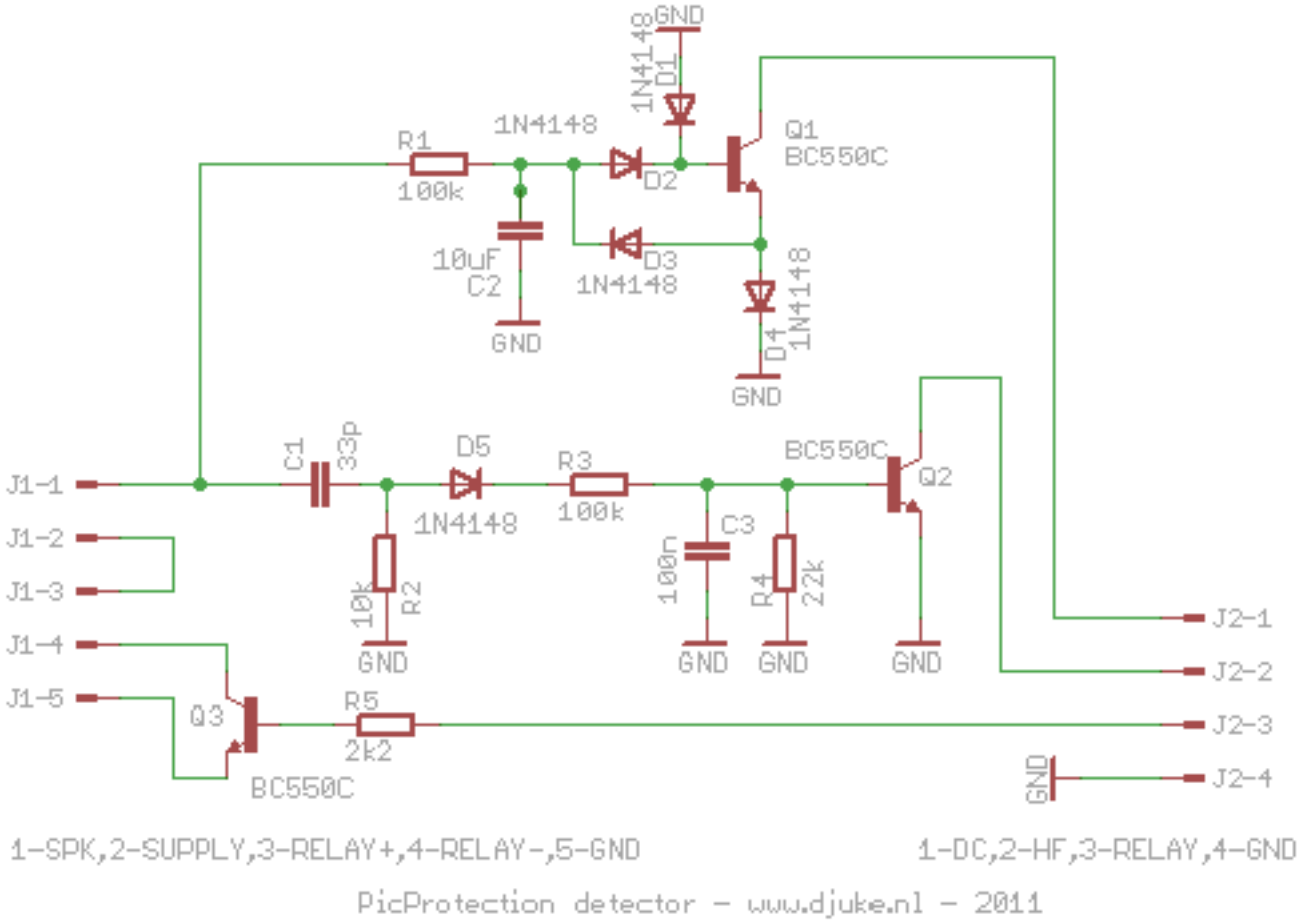
Main pcb

The heart of this PCB is a PIC12F675 microcontroller with the functionality implemented in a small piece of software. The top left part delivers a 5V supply for the microcontroller, and can be fed directly from the positive rail supply (max 60VDC for the MJE3055). In that case R7, D1, C2 and Q1 form a cascode to reduce the voltage to about 12V. If a lower voltage supply (e.g. 15V) is available, these components can be omitted and the connection for Q1 bridged. The AC detection circuit of D11, R8, C5, R10 and Q5 is used to directly switch the output LED using R5, which is connected to GP2 (digital input). The protect LED is connected to output GP5 using R6. An optional MCP9701 temperature sensor measures the temperature inside the amplifier and is connected to GP4 (analog input). The DC and HF detection circuits on the detector pcb's pull GP0 and GP3 low respectively (both digital input). Finally, the output relay is switched from GP1 (digital output).



Detector pcb

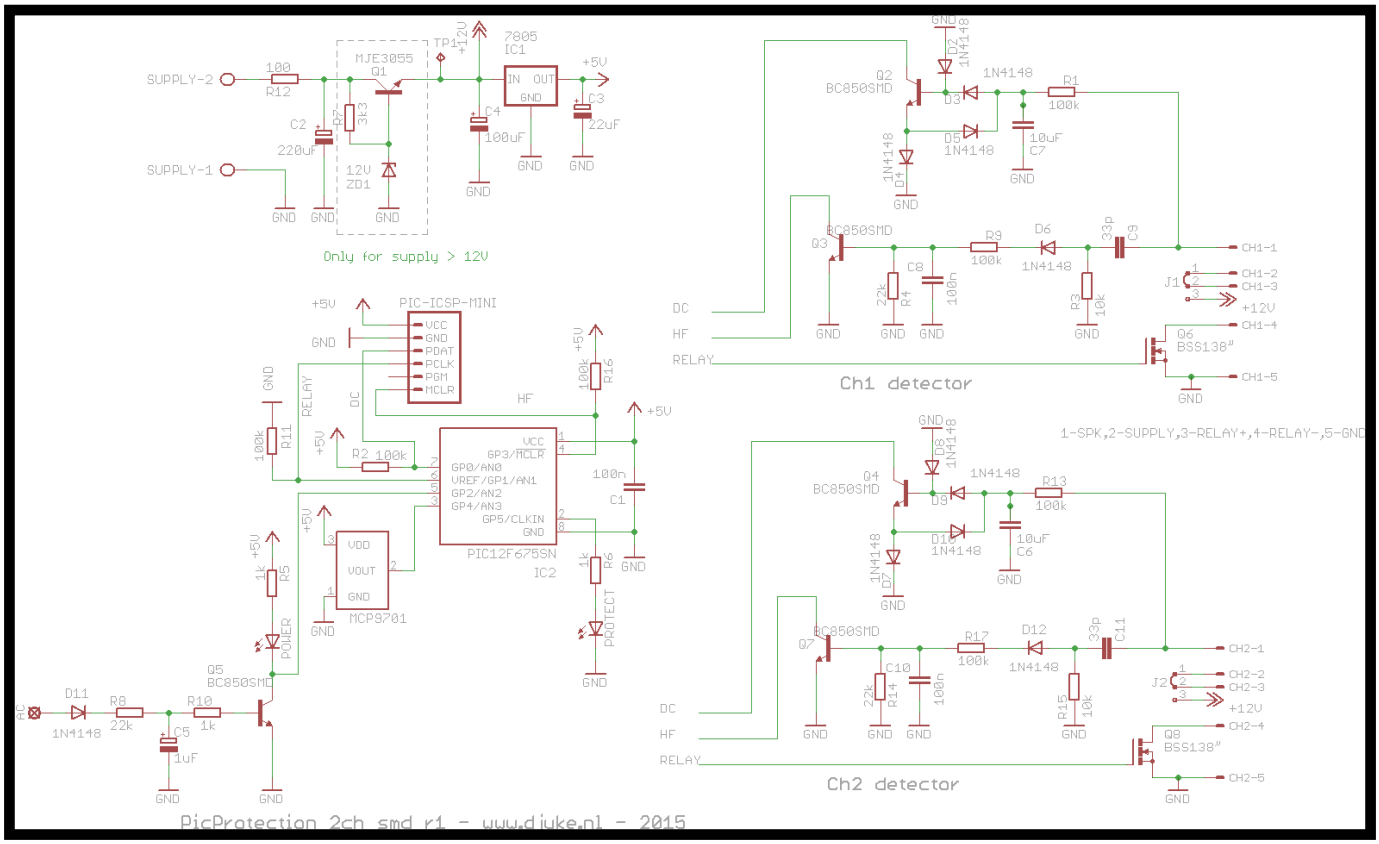
The actual DC and HF detection is done on the detector boards, so separately for each power amplifier. Connector J2 connects to the main pcb, which can be easily done with an angled pinheader. The amplifier output (before the output relay) must be connected to J1-1. DC detection is done with a quite conventional circuit (R1, C2, D1-D4, Q1), current component values are fine for a Full range amplifier, but C2 can be decreased to protect e.g. a tweeter amplifier. HF detection is done with components C1, R2, D5, R3, C3, R4 and Q1. With the currently used component values, a 50V/50kHz sine signal will not trigger the circuit, but a 20V/500kHz sine signal will trigger it. This will prevent the HF detection from triggering with normal musical content but will hopefully protect your speakers and/or output zobel network in the power amplifier in the case of a (speaker induced) instability occurs.



The relay can be mounted on or after the power amplifier board, or 2 relays can be used to switch the positive and negative supply of the output stage. One side of the relay inductor is connected to the positive rail supply, which is the connection between J1-2 and J1-3 (I normally use 48V relays, but you can adapt this to your own need). The other side of the relay is connected to J1-4 and trough Q3 and J1-5 to the power amplifier ground. Transistor Q3 is switched by the microcontroller control voltage on J2-3. The use of BC550 limits the max relay supply voltage to 50VDC, if a higher voltage is needed, Q3 can be replaced with e.g. BC546.

Update: Combined SMD version for 2 channel protection

As it turns out, most people only need 2 channel protection for the left and right channel of a power amplifier. To make the circuit more compact and faster to build, I made a redesign with SMD components, which combines 2 channel protection on one pcb:



The functionality of the circuit is very similar to the modular version with through-hole components. As an additional feature, an onboard 12V supply is generated from the input voltage, which can be used to switch a 12V relay. Instead of a BJT, a FET is now used to switch the output relay. With the BSS138, max positive relay voltage is 50V (can be increased to 60V by replacing BSS138 with MMBF170).

Software functionality

Most of the functionality of this project is implemented in software:

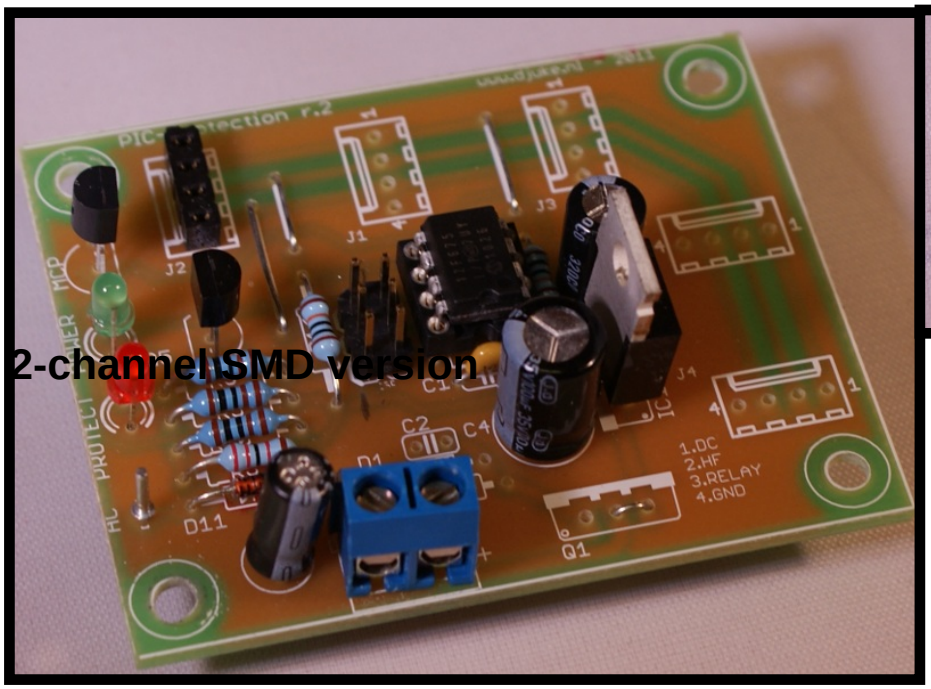
- If DC is detected (GP0 becomes 0), switch on protect LED, switch off output relay
- If HF is detected (GP3 becomes 0), blink protect LED at 4Hz, switch off output relay
- If temperature becomes more than 50 deg C (warning temp), blink protect LED at 1Hz, output relay stays on
- If temperature becomes more than 70 deg C (error temp), blink protect LED at 2Hz, switch off output relay
- If AC is first detected (GP2 becomes 1), switch on output relay after 3s, if above conditions are all ok. During delay, protect LED blinks at 0.5Hz.
- If AC is lost, immediately switch off output relay.
- Automatic recovery from a protect situation is only allowed for overtemperature. In the case of DC or HF protection, user interaction is needed, e.g. by switching the amplifier off and on.

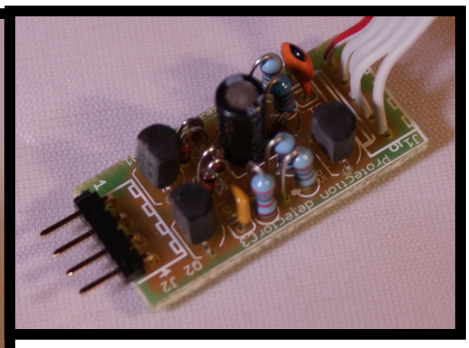
Software for this project is written using SDCC, I am not willing to give it away, but a programmed microcontroller is available.

Prototypes

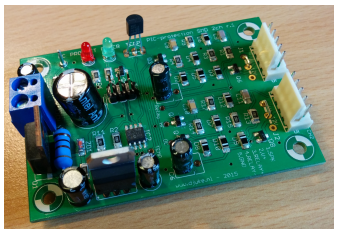
Modular through-hole version

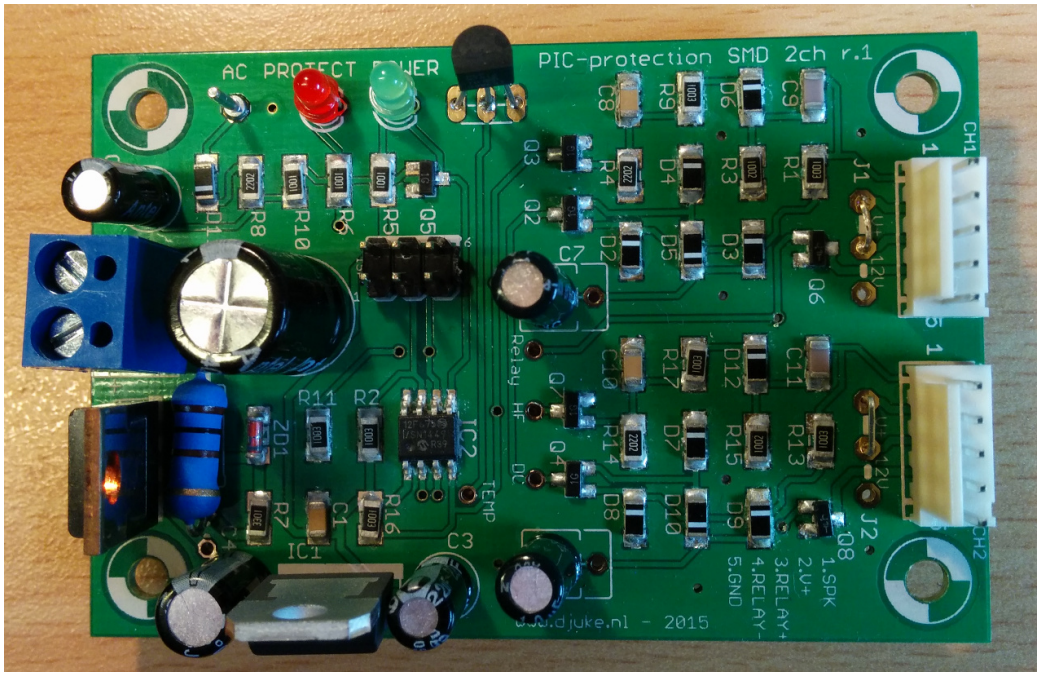
A prototype with one detector has been built, photo's are shown below. Note how you can easily stack the detector pcb on the main pcb using a female pinheader. The detector pcb can be stacked straight if you only need one or two channels, or sideways if you want to use all five channels.





2-channel SMD version




PIC-protection SMD 2ch r.1
CH1
CH2
J1
J2
12V
Relay HF DC
TEMP
IC1
IC2
1.SPK
2.V+
3.RELAY+
4.RELAY-
5.GND
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