Hifisonix
Speaker Protection Board

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July 2021

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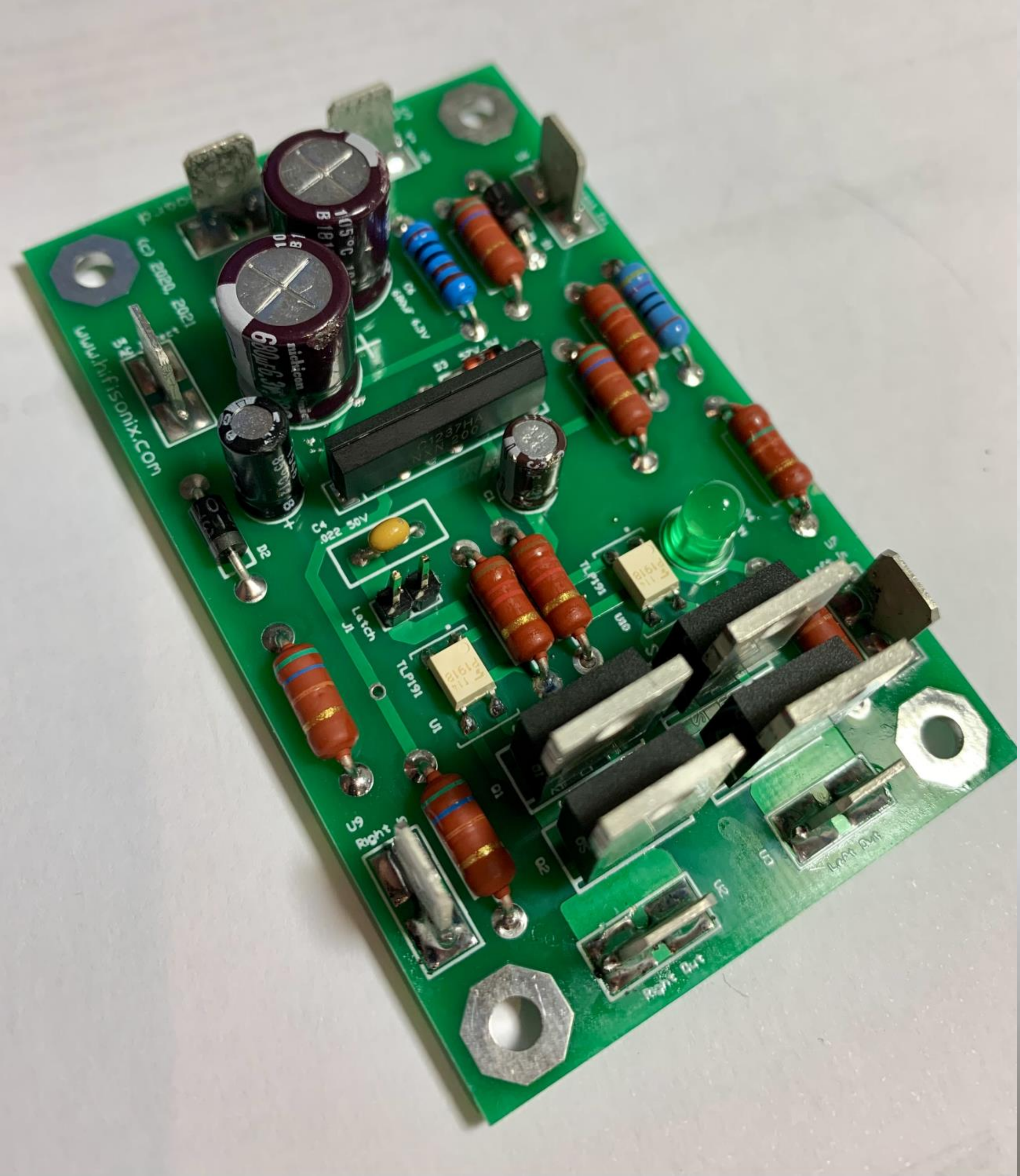
Click here for Double sided, silk screened PCB's for the speaker Protection Board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(c) 2020, 2021
C4
.022 50V
Latch
TLP191
Right Out


Speaker Protection Board
(c) 2020, 2021
37V 1W
UPC1237

Specifications – Hifisonix Speaker Protection board

Protection IC: Unisonic UPC1237

Protection functions: Switch on mute, switch off mute, DC offset protection; overcurrent trip input facility

DC Offset detect speaker disengage time: 20ms for Vdc = 50V; 100ms for Vdc = 10V; 3 seconds for Vdc = 2V

Current Overload disengage time: ~5ms

Usable Supply Voltage: 25 to 75V (requires resistor changes for the opto drivers – see details further on)

Options: latching/non-latching operation by means of link

Speaker Relay: TO-220 high power mosfets configured as bi-directional solid state relay

ON resistance: dependent upon mosfets used (see Table 1) but typically <20 milli-Ohms and as low as 3 milli-Ohms

PCB Dimensions: 80mm x 50mm

Brief Description

This speaker protection board uses the popular UPC1237 IC to provide DC offset protection, AC power detection, DC detection and overcurrent protection (see notes later in this document), facilitating comprehensive speaker protection with just a few extra components

The original µPC1237 was created by NEC Japan, but discontinued many years ago. Taiwanese semiconductor company Unisonic now supply a pin for pin replacement, the UPC1237 available from numerous suppliers in the US and Europe (UK builders can get them from Cricklewood Electronics in London via their website).

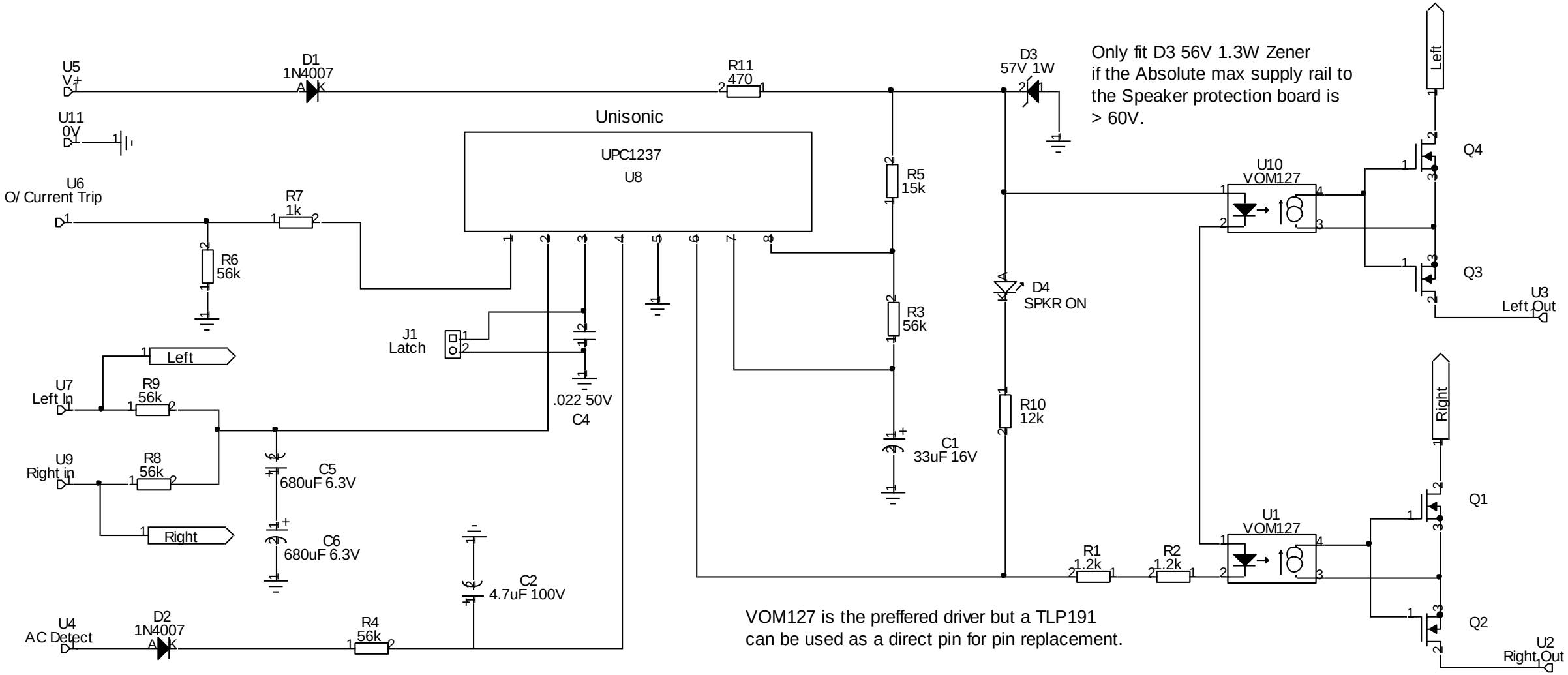
There are a lot of low cost speaker protection boards based on the UPC1237 available on eBay and AliExpress. Most use cheap relays to connect the amplifier to the speakers and will fail if there is a catastrophic DC offset, as is the case if one of the output devices on the amplifier go short – see this thread on diyAudio for example. The relays used by the complainant in this case were industrial grade Tyco 16A devices in which the contacts welded short, putting 75V DC onto the B&W 703 bass loudspeakers, cooking them in about 3 seconds. The repair bill was close to US$400.

Relays are not a good solution when dealing with high voltage, high current switching, or with inductive loads.

Instead of using relays between the amplifier output and the speaker, the hifisonix speaker protection board uses power mosfets. These offer lower on resistances than relays, easily switch 10x the currents a good quality relay can, suffer no contact degradation over time, handle inductive loads, switch DC just as well as AC and can interrupt the amplifier<>speaker connection in under 10ms in this specific design.

The standard UPC1237 device will work to 60V. On the hifisonix board, a simple zener voltage limiter extends the maximum operating voltage allowing use with high power amplifiers with supply voltages of up to +-75V (using suitable mosfets of course – see table later in this document)

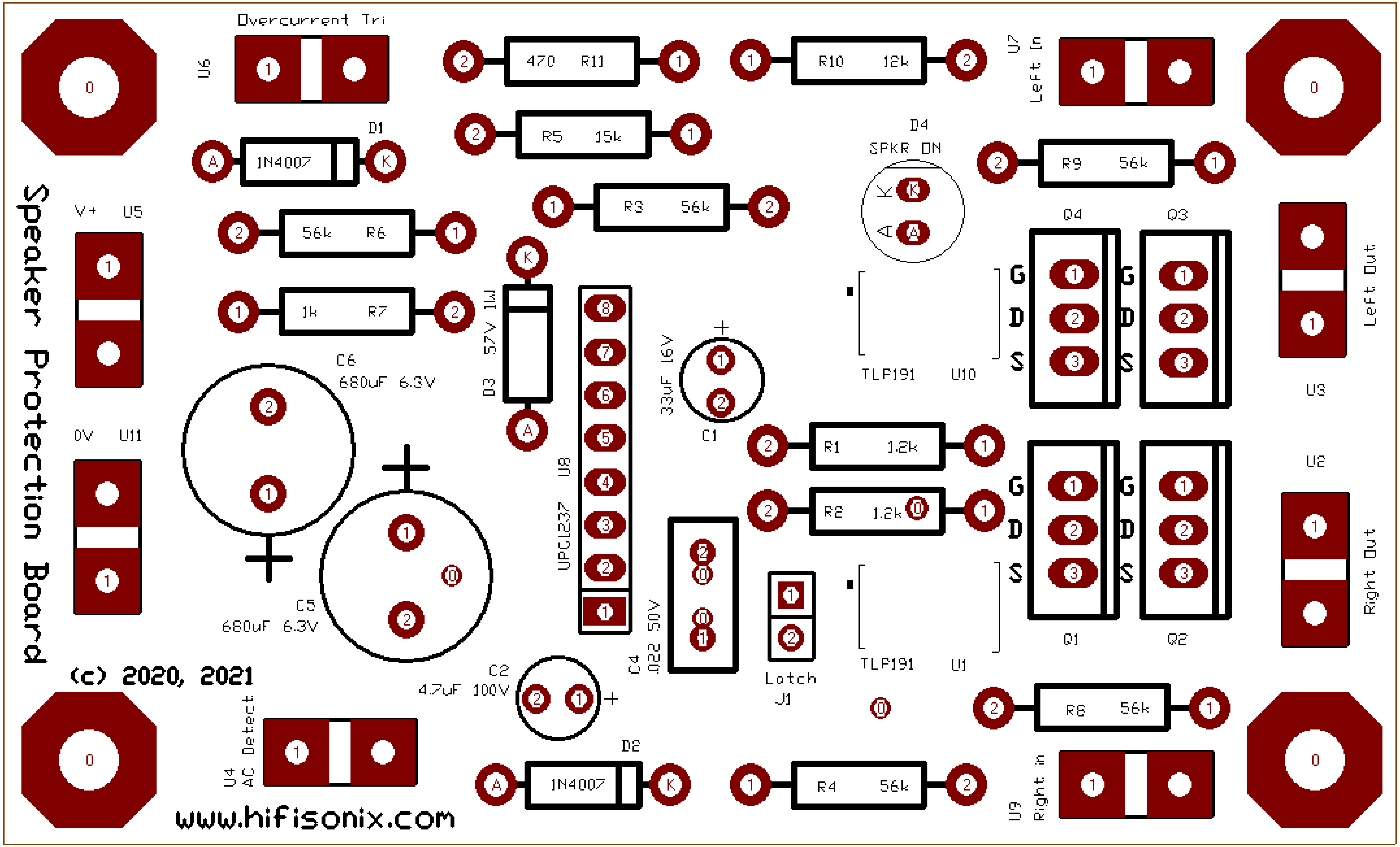
Hifisonix Speaker Protection Board Schematic



Link J1 for auto reset. Leave open for latching operation
(recommended where the overcurrent trip input is used)

VOM127 is the preffered driver but a TLP191
can be used as a direct pin for pin replacement.

See write up for details for choice of Q1 through Q4


Speaker Protection Board
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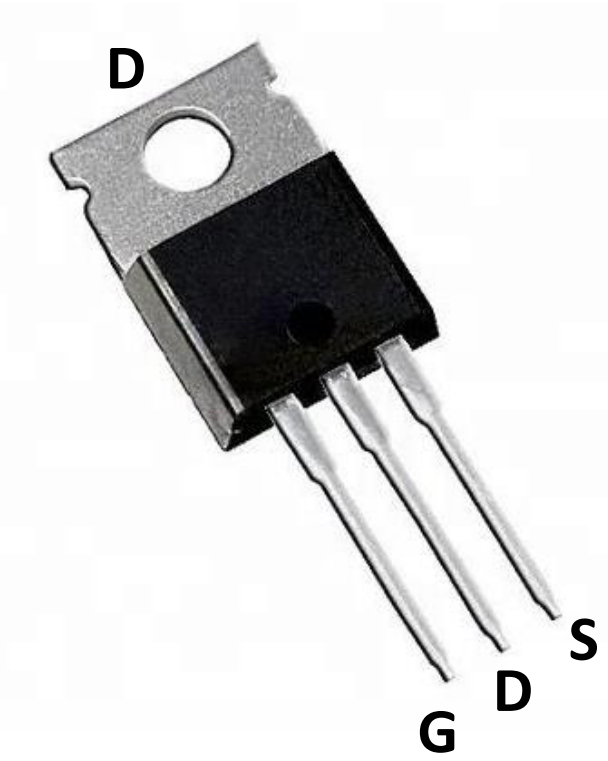
Overcurrent Tri
U6
470 R11
R10 12k
U7 Left In
D1
1N4007
R5 15k
D4
SPKR ON
R9 56k
V+ U5
56k R6
R3 56k
Q4
Q3
1k R7
D3 57V 1W
C6
680uF 6.3V
33uF 16V
C1
TLP191 U10
U3
Left Out
0V U11
U8
UPC1237
R1 1.2k
R2 1.2k
U2
Right Out
C5
680uF 6.3V
C4 .022 50V
Latch
J1
TLP191 U1
Q1
Q2
C2
4.7uF 100V
R8 56k
U4 AC Detect
D2
1N4007
R4 56k
U9 Right In

Table 1 – Mosfet Selection. Note: All mosfet types are TO-220.

Amplifier Absolute Max Supply Voltage	Suggested Mosfets
<= +-30V	IRLB8748PBF, IPP042N03L G, PSMN2R7-30PL,127, IRLB8743PBF, STP200N3LL
+-40V	PSMN2R1-40PL, PSMN1R9-40PL, IRF40B207, TK3R1A04PL,S4X, IPA041N04NGXKSA1, PSMN8R0-40PS,127, IPP80N04S404AKSA1, PSMN4R5-40PS,127
+-50V ~ +-60V	BUK954R8-60EL, PSMN2R5-60PL, PSMN2R5-60PL, PSMN3R3-60PL, PSMN4R2-60PL, IXTP120N075T2, STP220N6F7
>+-60V ~ +-75V	PSMN3R5-80PS, PSMN4R4-80PS, PSMN4R3-80PS, FDP4D5N10C, TK5R3E08QM,S1X, FDP053N08B-F102, IRF1407PBF, DMTH10H005LCT, SQP120N10-09_GE3, PSMN3R3-80PS,127

Device Pinout



The table above is a list of indicative power mosfets that can be used with the speaker protection board. In general, logic level types with low gate charge ('Qdg') are preferred.

Notes about using mosfets for loudspeaker solid state relays

- Power mosfets come in 3 gate voltage thresholds: Logic, Intermediate (from some manufacturers) and standard level. Logic level devices are fully ON with c. 3.5-4 volts applied to the gate wrt the source, and Standard level devices requite 8-10 Volts to be fully on.
- Logic level is preferable in all cases, but at higher drain-source voltage ratings, logic level devices are not readily available because the device gate oxide thickness (an important determinant of gate threshold voltage) has to be thicker to withstand the higher drain voltage, hence standard level devices only are available.
- Therefore, for amplifier voltages above 60V where logic level devices become scarce, you must use a standard level device but it must be low Rds(on) – say <5 milli-Ohms.
- This will ensure that with the 5-8 V supplied by the VOM127 or TLP191 gate drivers, the Rds(on) of the individual mosfets will be below 10 milli-Ohms, which is still 20% to 50% lower than a good high powered relay when new. Electro-mechanical relay contact resistance degrades over time, and especially so when switching a load. This is not the case with mosfet SSR.
- The peak drain current should be rated for the worst case expected short circuit current. For most amplifiers, this will be in the region of 1 Ohm
- Never use a mosfet beyond its absolute maximum ratings – if for example the amplifier supply voltage is likely to occasionally be as high as 65V, use the next available voltage group which will be 75V

How to select the value of R1 and R2 to set up the correct opto coupler drive current

Use the following formula to select the correct resistor values

$$R = \frac{[(v_S - 3.1) \times 50] - 470}{2}$$

Where Vs is the supply voltage on connector U5

Make R1 and R2 each equal to the value you compute above.

See the next slide for suggested values

R1, R2 and R10 for selected supply voltages

Vs is the supply voltage at U5

Vs	R1	R2	R10
25	330	330	4700
30	390	390	5600
35	560	560	6800
40	680	680	6800
45	820	820	8200
50	1k	1k	10k
55	1k	1k	10k
60	1.2k	1.2k	12k
65	1.2k	1.2k	12k
70	1.5k	1.5k	12k
75	1.5k	1.5k	15k

Using the Current Overload Detection Input (terminal U6) – Some Ideas