

R1, R2, R4, R5 form a voltage divider that senses B+/B- level. If either falls too low, Q2 will turn off. Compute the divider ratios so that B is 0.65V and E is 0V at the low voltage detection threshold. Displayed values are computed for B+=26V B-=23V (undervoltage thresholds)

V+ must equal the relay coil voltage. Range 8-30V (LM78L05 limitation)

Connect B+/B- to the amp power rails. If the amp is single rail, omit R4/R5 and connect Q2 E to GND.

R20 is used to detect J7 position and can be omitted if the code is compiled with a fixed CC or CA config.

R15 sets the output current limit. Change only after consulting Q7 SOA table. Q7 must be heatsinked. R13+R14 provide base current to Q7. If substituting Q7, compute so that $I_b > (I_{out(max)} / h_{FE(min)})$
 $R = U/I = (V(B+) - V_{out}) / I_b$
 $I_b \cdot V_{out} < U^3 P_d(max)$

Preregulator (place on separate PCB)

Select D1 (zener) so that $V_z + V_{AA} < Q3 V_{ce0} / V_{cbo}$. For 12V relay and BC546:
 $V_z(D1) < (65V - 12V - \text{safety margin})$
 $V_z(D1) < 53V - \text{safety margin}$
 (higher V_z will give faster relay turn-off)

R6, C2 (R12, C4) form a lowpass filter from the power amp output. Compute the filter so that its attenuation will guarantee a filter output voltage <0.5V at maximum amp output voltage and lowest design (-3dB) output frequency. For an amp with +/-40V rails and -3dB freq. 20Hz:
 $0.5V/40V = 1/80 = -40dB$
 1st order = 6dB/octave
 $40dB/(6dB/octave) = 6.6 \text{ octaves (round up to 7 octaves)}$
 7 octaves below 20Hz = $20/(2^7) = 0.156Hz$
 $1/(2 \cdot \pi \cdot R \cdot C) = 1/(2 \cdot \pi \cdot 100k \cdot 10\mu F) = 0.159Hz$
 Since C2 will never see more than +/-0.7V (VBE) it can be a low-voltage ceramic type (the voltage-dependent nonlinearity ceramics otherwise exhibit are not important in this application)

Disconnect the speaker + from the amp output, connect the amp to AMP+, speaker to SPEAKER+. Connect "SPEAKER-" directly to the speaker output jack. If the amp is not BTL (SPEAKER- connects to POWER GND), omit Q5, Q6, C4, R12.

Use a sealed relay to prevent contact tarnishing which will give erratic or distorted amp output. If more parallel relays are needed and the transistor current exceeds 100mA, substitute Q3 and recompute R3 for the new hFE.

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