

GTDT – a small desktop amp

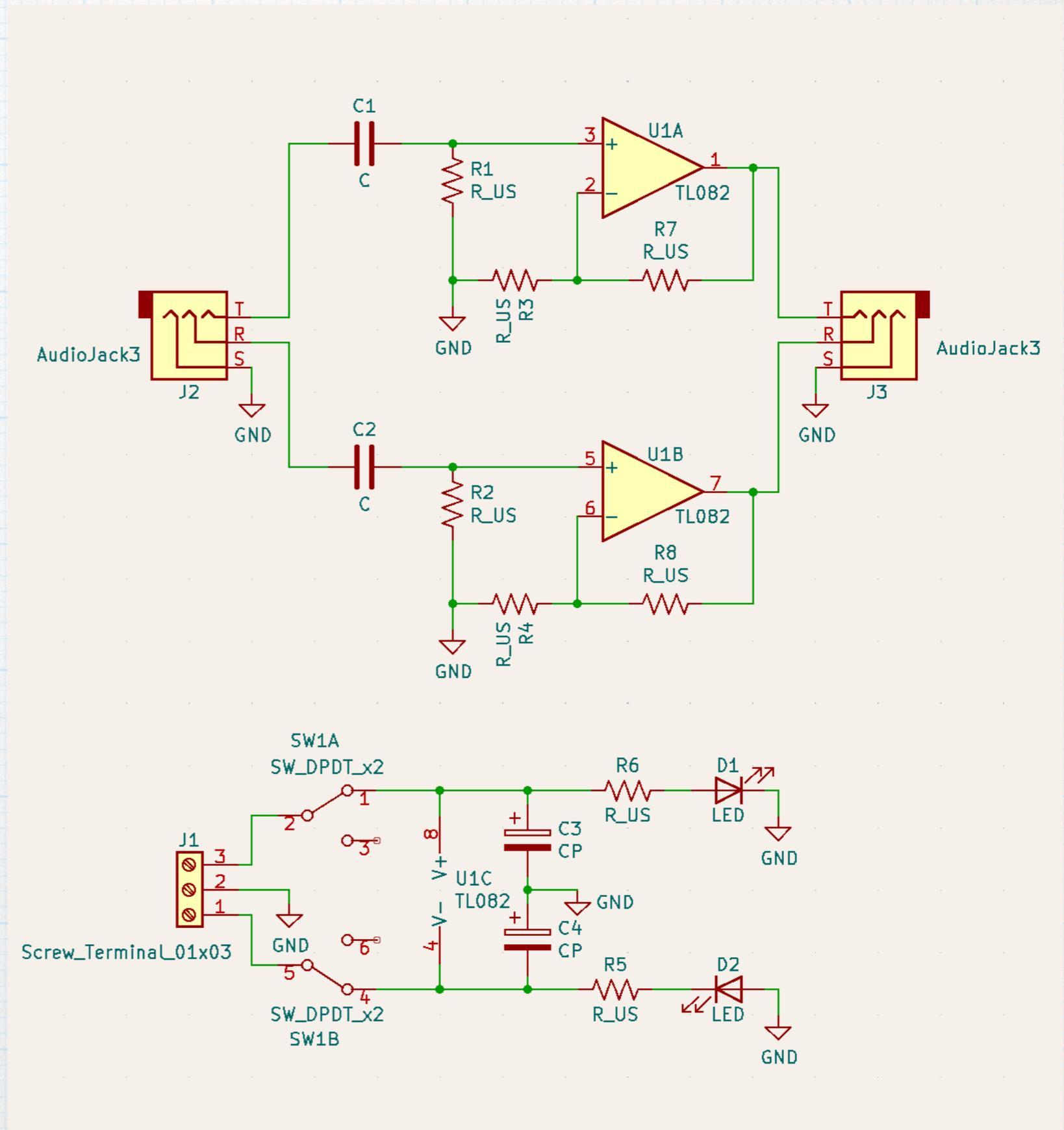


Altoids amp

- simple, clean design
- easy to understand
- easy to build
- dual batteries make an easy power config.
- works well for headphones

However:

- Cannot drive larger speakers. (op-current limited to few 10s of milliamps).
- Dual supplies can be tricky with larger amps.



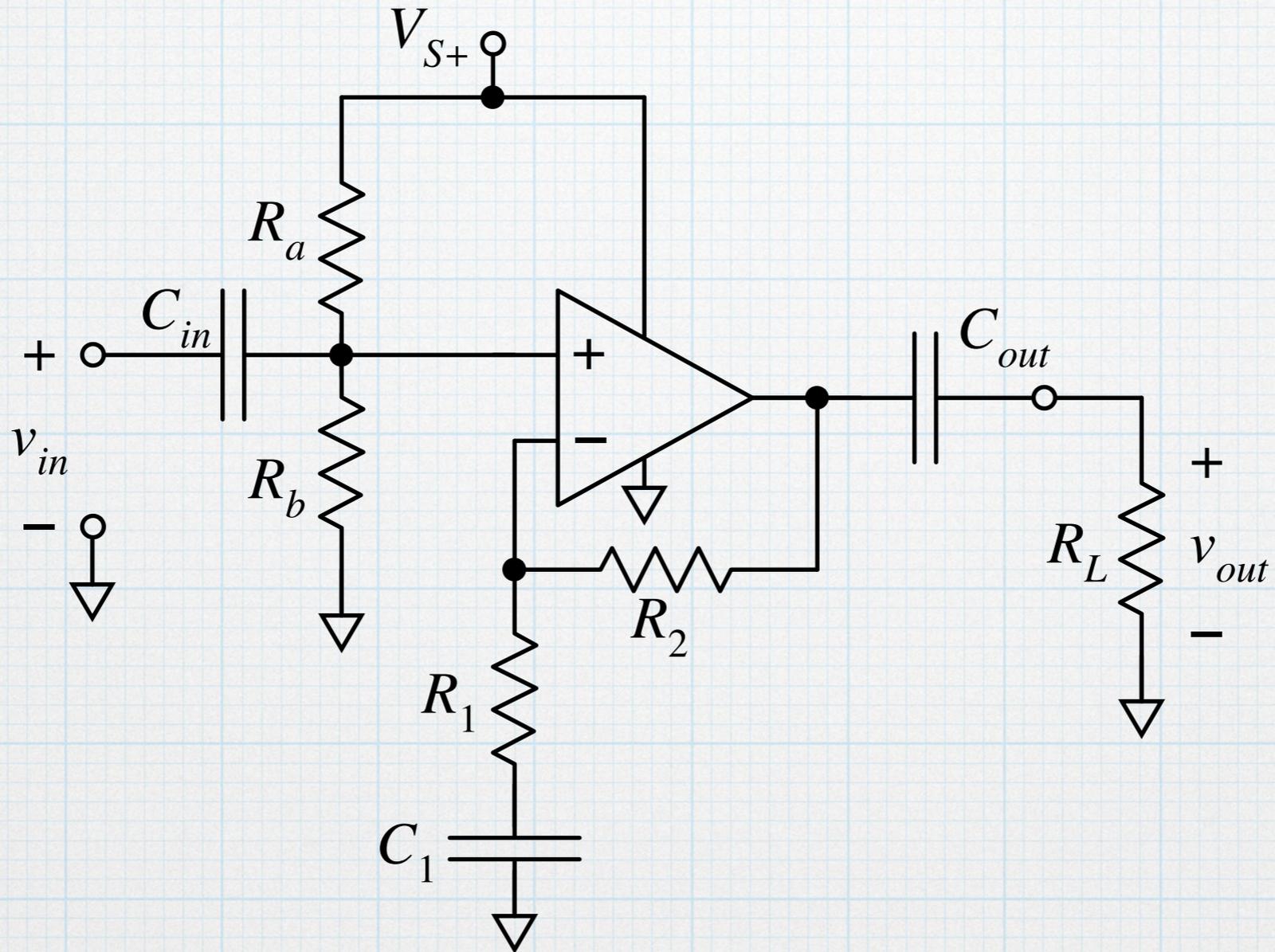
Goals for a larger amp

- Stay with simple analog design, with Altoids as a starting point
- Provide more current for driving a small set of speakers.
- Move to single power supply. (Avoid using a center-tapped transformer.) Single supply is simpler, safer, and cheaper.
- Make it easy to build.
- Provide some flexibility to keep cost low.
- Not high performance, but “good enough” as a first project.

Design considerations

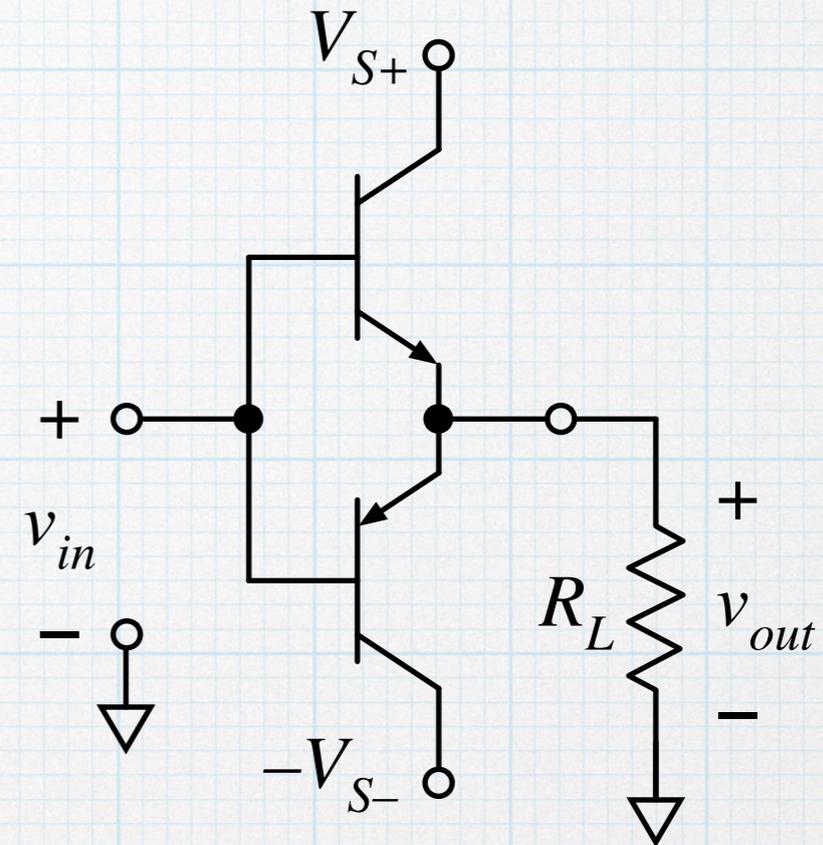
- Stereo amp — two channels, so everything in the audio path is duplicated.
- Should be able to drive speakers with 4- Ω voice coils.
- Basic non-inverting amp configuration with fixed gain of 16.
- Use a single 15-V supply. Requires DC level-shifting and by-passing to work with audio input and output that can go positive *and* negative.
- Use LM7815 voltage regulator to set 15-V system supply.
- Maximum possible peak amplitude would be 7.5-V. Maximum power would be $\frac{(7.5 \text{ V})^2}{2(4 \Omega)} \approx 7.5 \text{ W}$. Actual results will certainly be less than this.
- Power from a 12-V RMS AC wall-plug transformer (17-V peak) or 18-V DC wall-plug converter. Or even two 9-V batteries in series.
- Use traditional class-B push-pull BJT output stage. (Old school!)
- Rely on feedback to minimize cross-over distortion.

Single-supply non-inverting amp



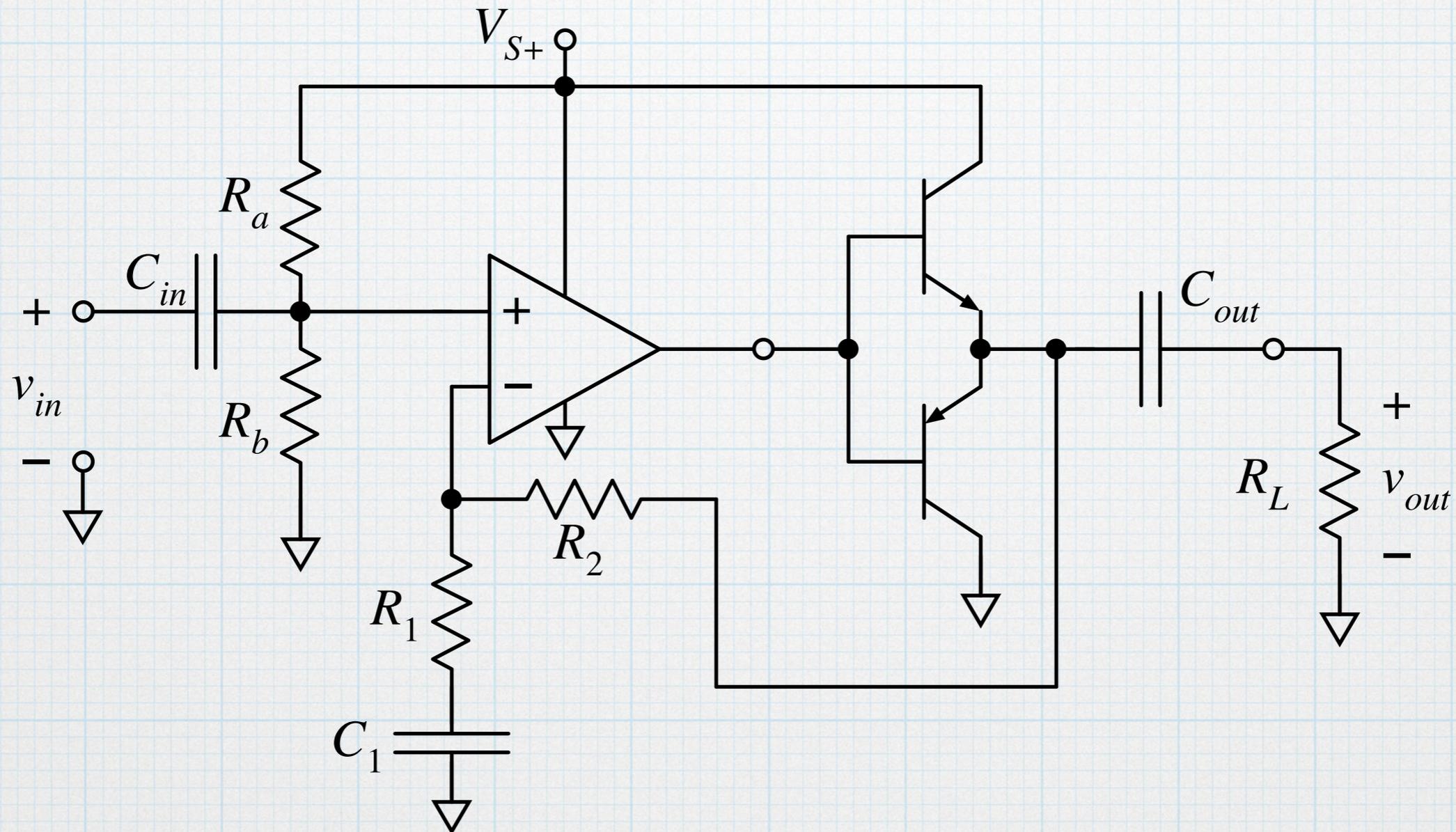
Push-pull class B output

- $v_{in} > 0.7 \text{ V}$:
npn turns on (pnp stays off)
 $v_{out} = v_{in} - 0.7 \text{ V}$ and $i_{out} = \beta \cdot i_{in}$.
Output “follows” input but current is much bigger.
- $v_{in} < -0.7 \text{ V}$:
pnp turns on (npn stays off)
 $v_{out} = v_{in} + 0.7 \text{ V}$ and $i_{out} = \beta \cdot i_{in}$.
Output “follows” input but current is much bigger.
- $-0.7 \text{ V} < v_{in} < 0.7 \text{ V}$:
neither transistor is on.
 $v_{out} = 0$ and $i_{out} = 0$.
“Dead band”, leading to “cross-over distortion”. Problem.

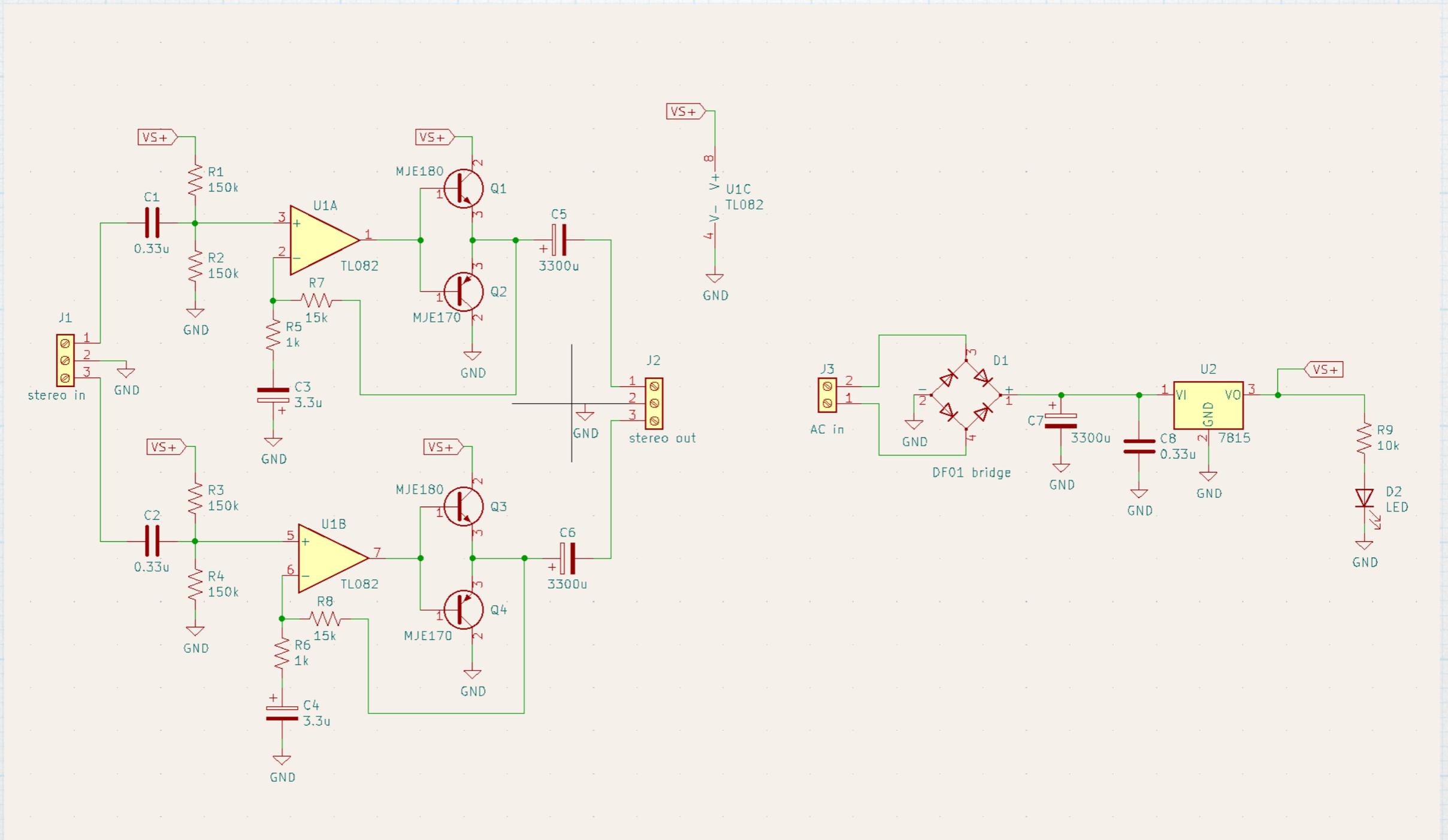


Put it all together

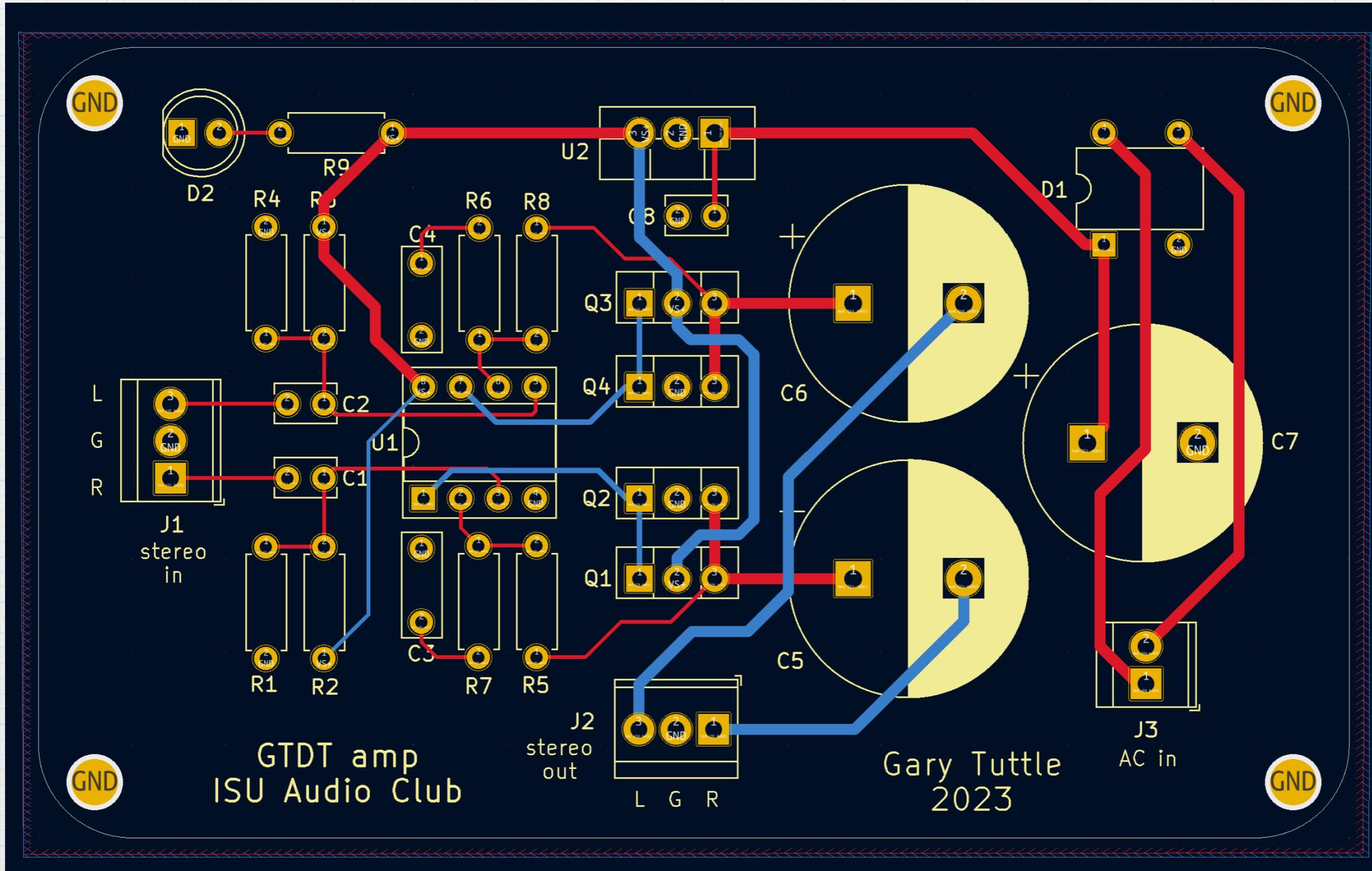
Use feedback to correct the cross-over distortion.



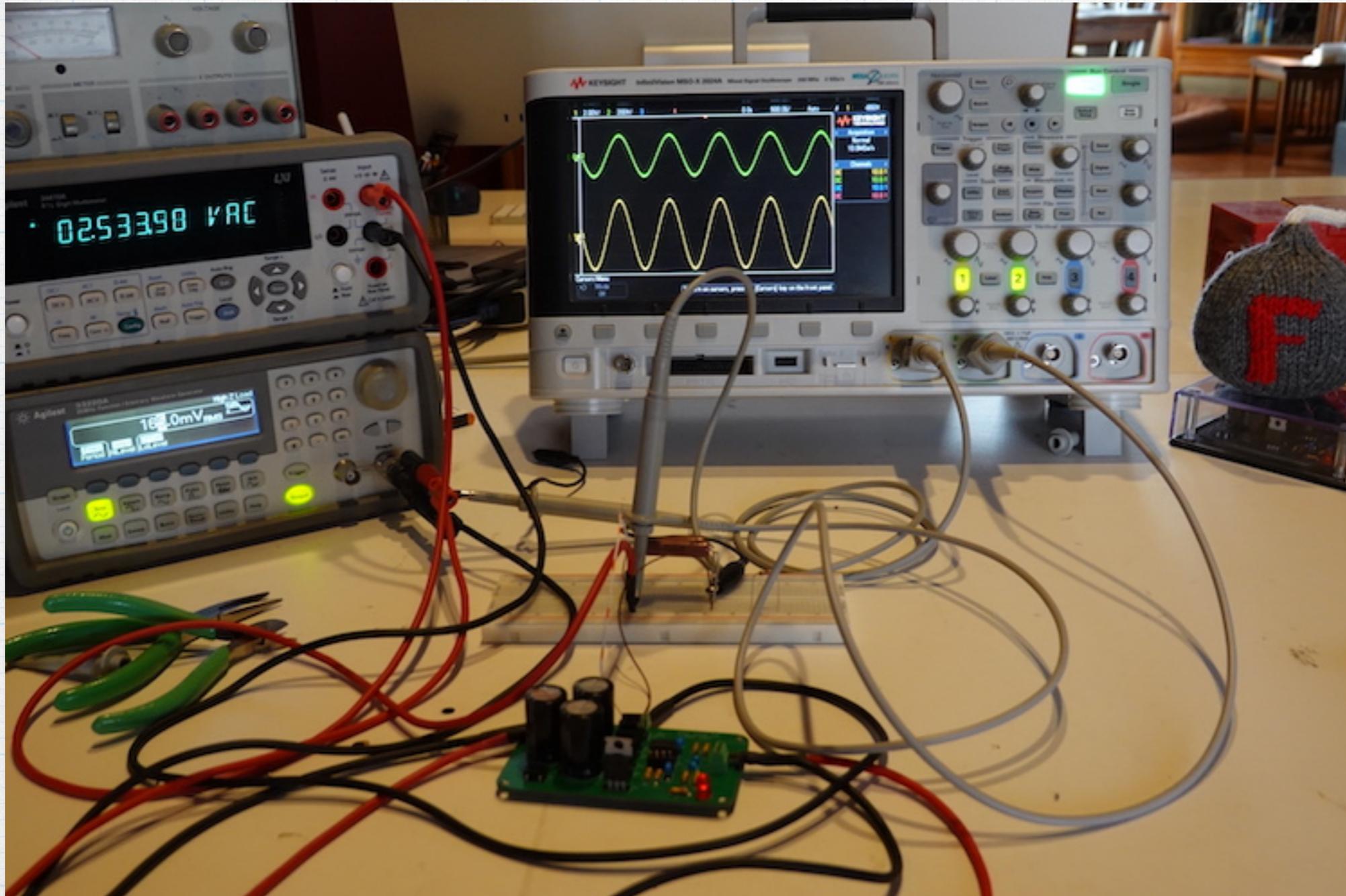
Schematic for PCB design



PCB



Results



4- Ω resistor
load

- Gain = $v_o/v_i = (2.53 \text{ V})/(0.265 \text{ V}) = 15.3$ (close)
- Output: v_o (max) = 2.5 V RMS and P_o (max) = 1.6 W
- Not much cross-over distortion — feedback works pretty well.

PCB electronics — Oct 2023

| item | manufacturer's number | DigiKey number | quantity | item cost | total |
|-------------------------|---------------------------|-----------------------|----------|-----------|-------|
| socket | Assmann AR 08 HZL-TT | 123-AR08-HZL-TT-ND | 1 | 0.50 | 0.50 |
| TL082 | Texas Instruments TL082CP | 296-1780-5-ND | 1 | 0.69 | 0.69 |
| 330-nF cap | TDK FG14X7R1H334KNT06 | 445-173139-1-ND | 3 | 0.34 | 1.02 |
| 3.3- μ F cap | TDK FG26X7R1H335KRT06 | 445-173440-1-ND | 2 | 0.73 | 1.46 |
| 3300- μ F cap | Nichicon UVZ1E332MHD | 493-1307-ND | 3 | 1.04 | 3.12 |
| 150-k Ω resistor | Stackpole CF14JT150K | CF14JT150KCT-ND | 6 | 0.10 | 0.60 |
| 10-k Ω resistor | Stackpole CF14JT10K0 | CF14JT10K0CT-ND | 3 | 0.10 | 0.30 |
| MJE182 npn | onsemi MJE182G | MJE182GOS-ND | 2 | 0.64 | 1.28 |
| MJE172 pnp | onsemi MJE172G | MJE172GOS-ND | 2 | 0.65 | 1.30 |
| red LED | Cree C5SMF-RJF-CT0W0BB1 | C5SMF-RJF-CT0W0BB1-ND | 1 | 0.17 | 0.17 |
| 7815 regulator | STMicro L7815CV | 497-1454-5-ND | 1 | 0.68 | 0.68 |
| DF01 bridge | Diodes Inc DF01M | DF01MDI-ND | 1 | 0.46 | 0.46 |
| screw term - 3 | On Shore OSTVN03A150 | ED10562-ND | 2 | 1.23 | 2.46 |
| screw term - 2 | On Shore OSTVN02A150 | ED10561-ND | 1 | 1.08 | 1.08 |
| PCB | | Available from IEEE. | 1 | 2.50 | 2.50 |
| | | | | | 17.62 |

Enclosure, connectors, power supply — Oct 2023

| item | manufacturer number | vendor number | quantity | item cost | total |
|------------------|-------------------------|---------------------|----------|-----------|-------|
| box | Serpac 032C,BK | DigiKey SR032-CB-ND | 1 | 11.74 | 11.74 |
| 1/8" audio jack | CUI SJ1-3515 | DigiKey CP1-3515-ND | 1 | 1.82 | 1.82 |
| barrel jack | MPD EJ501A | Digikey EJ501A-ND | 1 | 2.02 | 2.02 |
| speaker conn. | GC Electronics 33-1404 | Jameco 2123469 | 1 | 1.65 | 1.65 |
| 12-V transformer | Reliapro ADU120150E1012 | Jameco 16751 | 1 | 12.95 | 12.95 |
| Total | | | | | 30.18 |
| Alternate trans | Triad WAU12-1500 | Digikey 237-1879-ND | | 17.42 | |