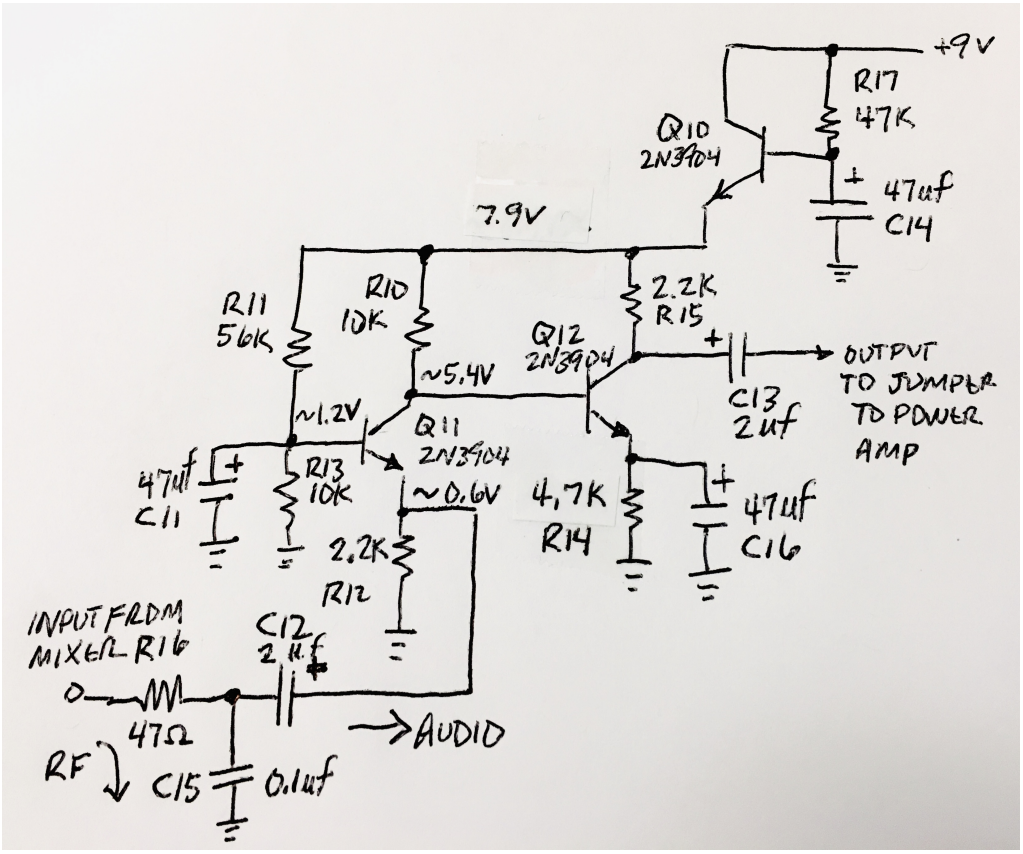
CORNERSTONE HAM RADIO FLEX CLUB
SOLDERING PART FOUR -- AUDIO PREAMPLIFIER

SECTIONS TO BE SOLDERED / CONSTRUCTED

No.	Section
1	9VDC Power Supply
2	5VDC Power Supply
3	Audio Power Amplifier
4	Test Microphone
5	**Audio Preamplifier**
6	Wind trifilar transformers
7	Balanced (de)modulator
8	Arduino computer controlled variable frequency oscillator / display / controls

PREAMP CIRCUIT SCHEMATIC:



SCHEMATIC NOTES:

- It is traditional to put the power supply lines at the top of a schematic.
- It is traditional to have the INPUT be somewhat to the left of a schematic
- It is traditional to put the OUTPUT somewhat to the right of a schematic.
- It is traditional to have the "ground" or "chassis" be "lower" at each point in the schematic.

Audio Preamplifier Explanation. The audio preamplifier takes the tiny audio (hence, alternating current) signal from the **double-balanced mixer** and adds tremendous amplification to the audio signal, while providing an important 50 ohm termination impedance for radio frequencies, which is very important to the proper operation of the double balanced mixer. It also avoids accidental backwards sending of any signal backwards into the mixer through the use of a common-based input amplifier stage (transistor Q11). With that BASE of the transistor grounded by AC signals by C11, there is very little reverse transmission of signal from the collector back to the emitter.

The audio preamplifier is made using three high gain inexpensive bipolar junction transistors (usually just called "transistors") denoted 2N3904. This transistor is VERY widely used in audio circuits, because of its high current gain (>100 times). A small change in current created in the BASE will be amplified 100 times at audio frequencies, when measured in the emitter or collector circuits.

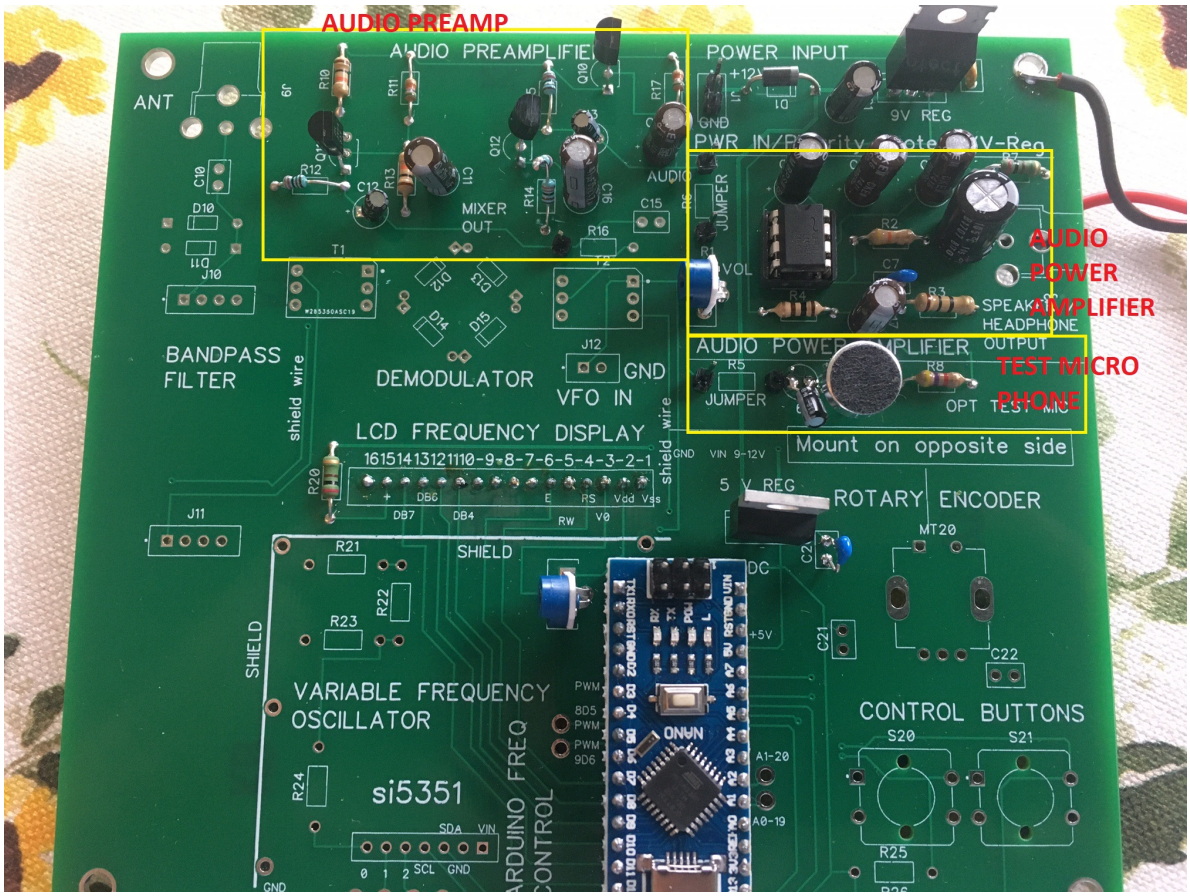
Transistor Q10 acts like a miniature **steady power supply** for the audio preamplifier -- important to avoid internal feedback in this *very high gain amplifier* to avoid squeals and howls in the speaker. It's collector and base terminals gets their power from the already-regulated 9V power line. Its base however has a huge amount of FILTERING applied with R17 and C14. This creates a VERY steady voltage at the base, and the high current gain of the transistor makes the emitter of the transistor able to supply power to the remainder of the preamplifier at about 7.9 volts DC with very little AC ripple or audio frequency signals from anywhere. This kind of a transistor circuit is called an "emitter follower" because the emitter output voltage "follows" the base voltage, only just about 0.6V below it. This kind of a circuit is widely used in many "linear" power supplies.

Transistor Q11 is a common-base amplifier with a gain of approximately 5 times. Thats not much gain, but its primary role is to protect the mixer from any backwards signal, and to provide a stable audio impedance for the balanced mixer to "see" and set the bias voltages to run the high gain audio amplifier stage Q12.

Capacitor C11 effectively "grounds" the base terminal of this transistor for audio frequencies, which is why it is called a "common base" amplifier. The input signal is applied at the emitter of Q11, and the output signal is developed at the collector. The input impedance of the Q11 audio stage is set at 2200 ohms by its input resistor R12. Radio frequency signals from the mixer are effectively sent to "ground" through a stable near-50 ohm termination by way of R16 (47 ohms) and C15 (0.1 uF). This makes the mixer have higher quality.

Resistors R11 and R13 act like a "voltage divider" to divide the 7.9 volt supply voltage from Q10 down to about 1.2volts and set the operating current of Q11.

The amplified signal from the collector of Q11 is sent onwards to Q12. Transistor Q12 is operated as a very high gain small signal audio amplifier, because it has relatively little negative feedback to reduce its gain. Capacitor C16 effectively grounds the emitter of Q12 at audio frequencies, so this is called a "common emitter" amplifier. The output signal is developed at the collector and is coupled out of the amplifier by capacitor C13 which strips out the DC portion and only passes the AC audio signals to a jumper pin at "R5" where the audio can be sent over to the power audio amplifier.



CONSTRUCTION STEPS

❑ Solder in 2N3904 transistors at Q10, Q11 and Q12. Note which side the "flat" on the transistor faces -- this is important. Don't spend too much time heating their leads -- just enough to solder properly. Try to have the transistors NOT be "flush" to board but maybe 2-3 mm off the board -- this gives their leads a little more length to protect the transistor from the heat of the soldering iron. (This circuit works at audio frequency, so the tiny amount of added inductance in those leads doesn't matter.)

❑ Solder in a single "pin" at the left side of resistor R16 spot. Longer end up. Then solder a 47 or 50 ohm resistor in that spot, wrapping a single turn around the pin on the left side, as close to the board as possible so you can still get a connector on the remaining amount of the pin for testing later.

❑ Solder a 0.1 uF capacitor at C15. This capacitor bypasses RF to ground at the input of the audio preamplifier.

❑ Solder in a 2 uF capacitor at C12. Pay attention to the polarity -- plus side goes toward the transistor.

❑ Solder in a 2200 ohm resistor at R12. This is in the emitter of Q11 and sets the input impedance of the amplifier stage.

❑ Solder in a 10K (10,000 ohm) resistor at R10. This is the collector resistor for that stage where the output voltage is developed.

❑ Resistors R11 and R13 form a "voltage divider" that sets the DC voltage applied to Q11 and thus the biasing of the stage. It has to be adjusted to match the supply voltage. We want Q11 not to be fully turned ON ("saturated") nor fully turned off. Ideally, the resting collector voltage of Q11 will be in the range of 5-6 volts. To obtain that, solder in a 56K resistor for R11 and a 10K ohm resistor for R13.

❑ Solder in a 47uF electrolytic capacitor for C11. This capacitor establishes an "AC GROUND" at the base of the common base amplifier Q11.

❑ Solder in a 4700 (4.7K) ohm resistor at R14.

❑ Solder in a 47 uf electrolytic capacitor for C16. Pay attention to polarity. This capacitor establishes an AC ground at the emitter of common emitter amplifier Q12, operated at maximum gain with no negative feedback.

❑ Solder in a 2 uF capacitor at C13, with the positive side toward Q12. This capacitor strips off the DC component of the output amplified voltage and only passes the AC (audio) to the audio amplifier stage.

❑ Solder in a 2200 ohm resistor at R15. This is the collector resistor that helps develop the voltage gain of the stage.

❑ Solder in a 47K resistor at R17. Along with C14, this provides a very stable power supply voltage for the entire preamplifier stage and reduces unwanted FEEDBACK through the power supply

❑ Solder in a 47 uF capacitor at C14. This is part of the anti-feedback system as discussed above.

TESTING

❑ By connecting the output of the board microphone to the input of the preamplifier we can verify that it works and sounds correct.

❑ To connect the output of the preamp to the amplifier, use a jumper lead with dupont sockets to connect the two pins at "R6 JUMPER" together.

❑ Using another jumper lead, connect the right side of jumper R5 (next to capacitor C9) to the single pin you soldered at the left side of R16.

❑ With a speaker connected to the output of the audio amplifier, the gain of the system may be so high that you have immediate loud feedback squeal. You will likely have to adjust the audio gain potentiometer R1 way clockwise to reduce the total gain. Position the speaker a few feet away and you should be able to have a nice little public address amplifier with reasonable sounding audio.

❑ If there is excessive distortion, check the collector voltage of Q11 versus ground and discuss with your instructor the biasing of Q11.