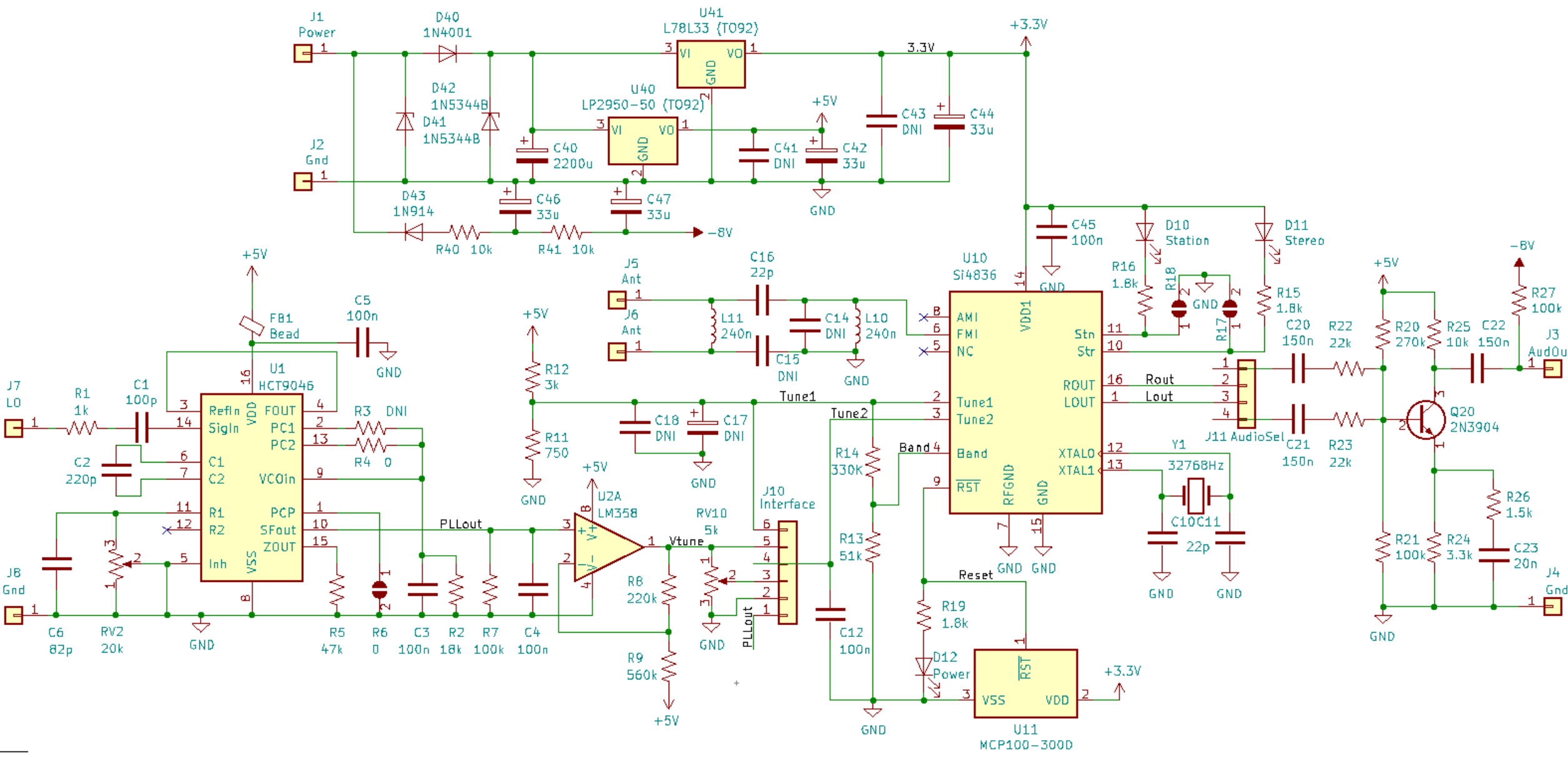


# Assembling the FM Converter Circuit Board

March 2026

Added resistor in parallel with C3 to improve PLL performance. Page 32.



Power Supply

Level Shifter

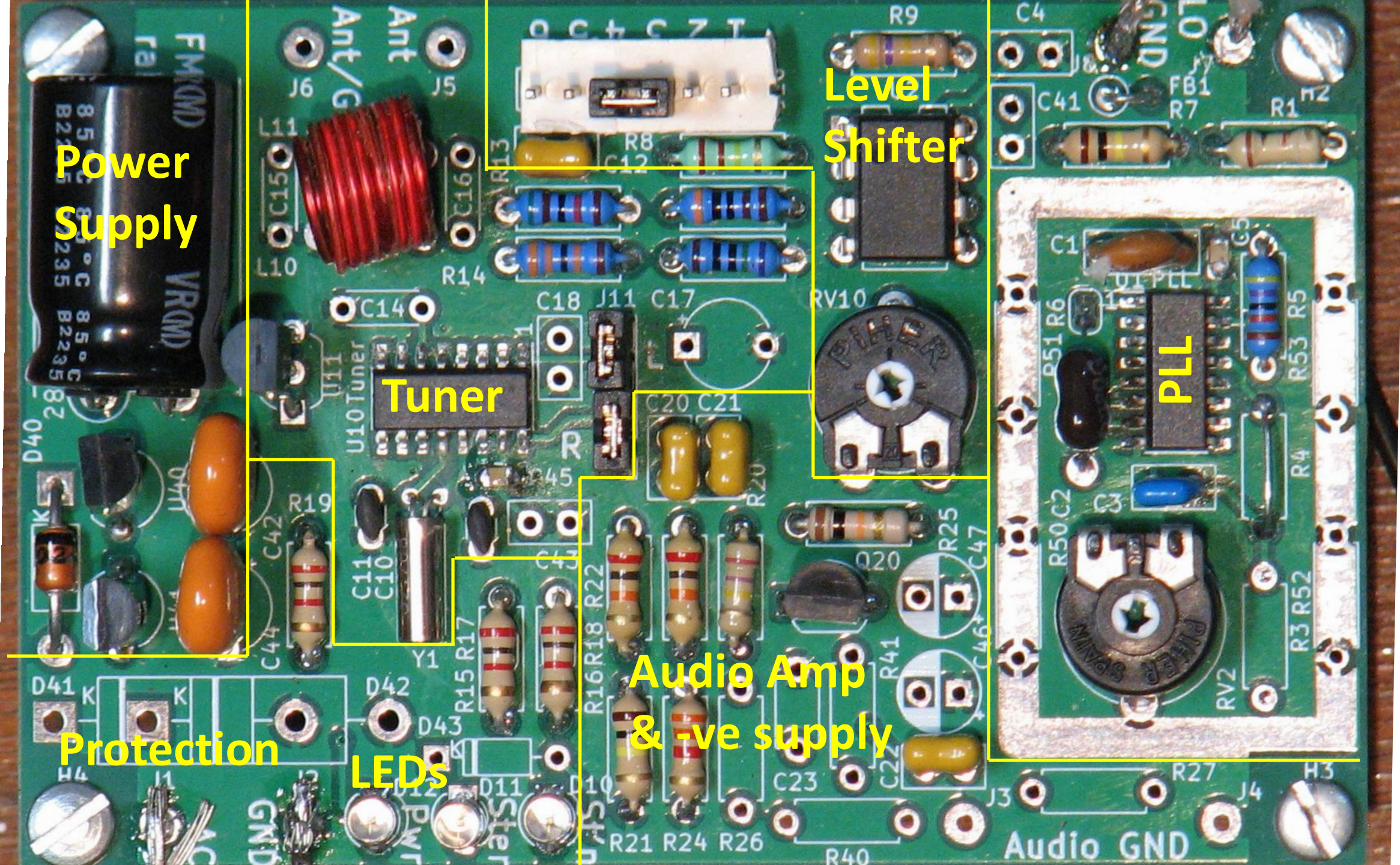
Tuner

PLL

Audio Amp & -ve supply

Protection

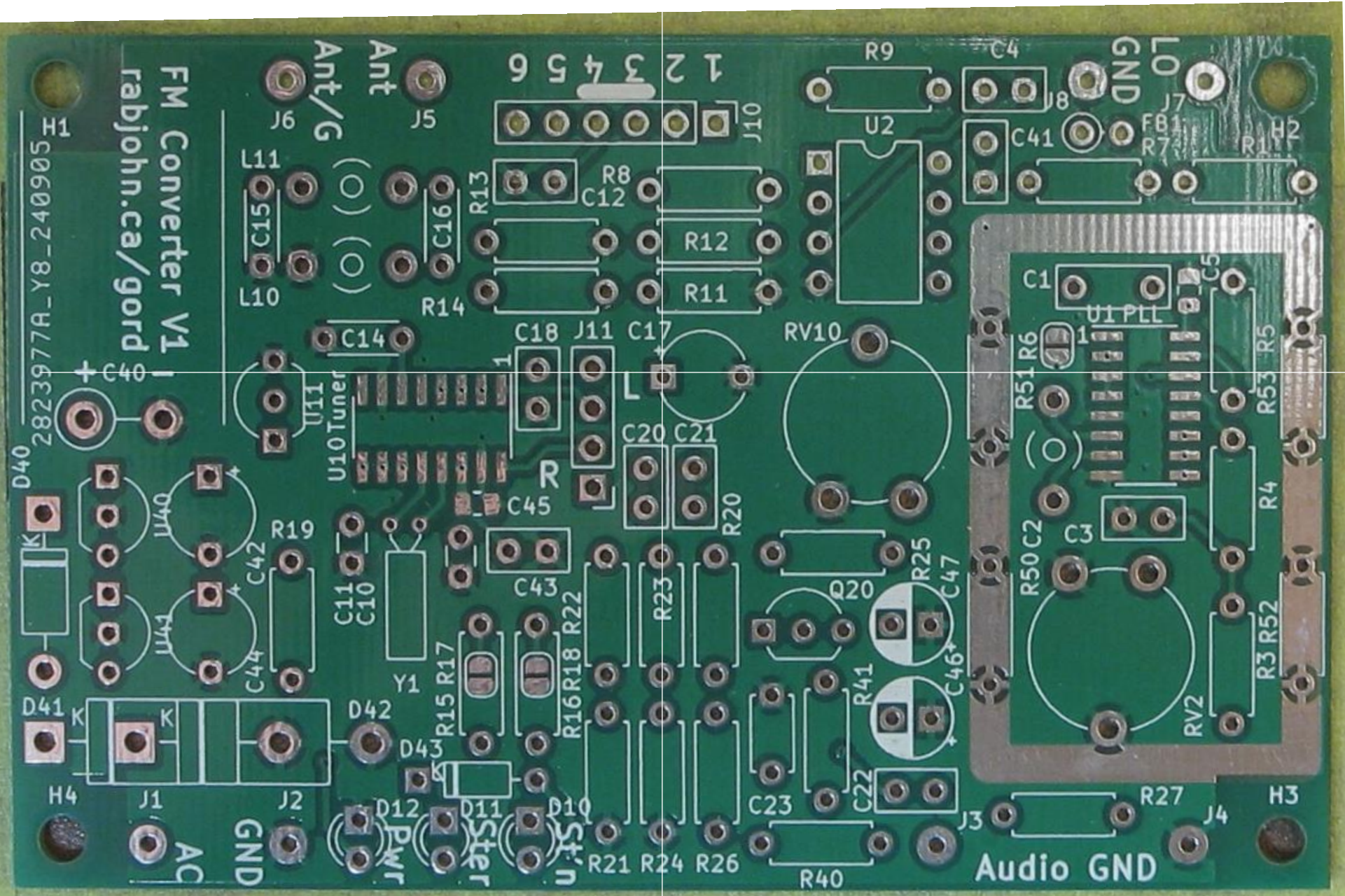
LEDs



# Choices

- Tuner chip: Use a Si4825 or a Si4836. Si4836 is stereo, and has indicator LEDs, but Si4825 is cheaper and works as well.
- Antenna coupling: Transformer coupling for a balanced twinlead antenna (like a folded dipole) or single ended coupling for a single wire antenna.
- PLL chip: A 74HCT9046 is highly recommended. A 74HC4046 will do in a pinch but needs temperature compensation (discussed in main document).
- Higher voltage electrolytic caps needed if operated from 12VAC.
- Schottky rectifier and 5V LDO required if operated from 6VDC.
- Protection, negative DC supply: depends on application.

Assembly Instructions. 0. Bare Board



# Soldering the SMT components

- I recommend using lead-tin solder paste. (lead-free is more difficult to work with) (this is not flux! this is solder in a paste form)
- Place paste on the solder pads for the two ICs and the two caps. You'll need a microscope unless you are very experienced.
- Reflow the solder paste using either:
  - Hot plate (my preferred technique) at about 220C
  - Hot air gun (use low air flow so you do not dislodge the components)
  - Oven (makes rework more difficult). Toaster oven may be OK.
- OR Use a hot plate to get the board up to ~150C, then use an iron for local heating. ← this is my preferred approach... You can melt the solder paste on a single pin to secure the IC in place, then solder the rest of the pins one at a time. Easy to touch-up.
- There are those who can do this all with just a fine soldering iron. Not me!
- Clean with flux remover.

# Electrostatic Discharge Precautions

- Semiconductors (especially the integrated circuits) can be damaged by electrostatic discharge (ESD)
- Familiarize yourself with proper handling procedures.
- Days with low humidity are the worst.
- Use a wrist strap to leak charge off of your body.
- Make sure the soldering iron tip has a path to ground.
- Keep parts in their ESD safe bags until they are needed.

## Assembly Instructions. 1. SMD

**U10: Si4825 or Si4836**

Note orientation: the bevel should be on the top (towards C14)

Pin 1

**C5, C45: 0.1uF 0805  
Capacitors.**

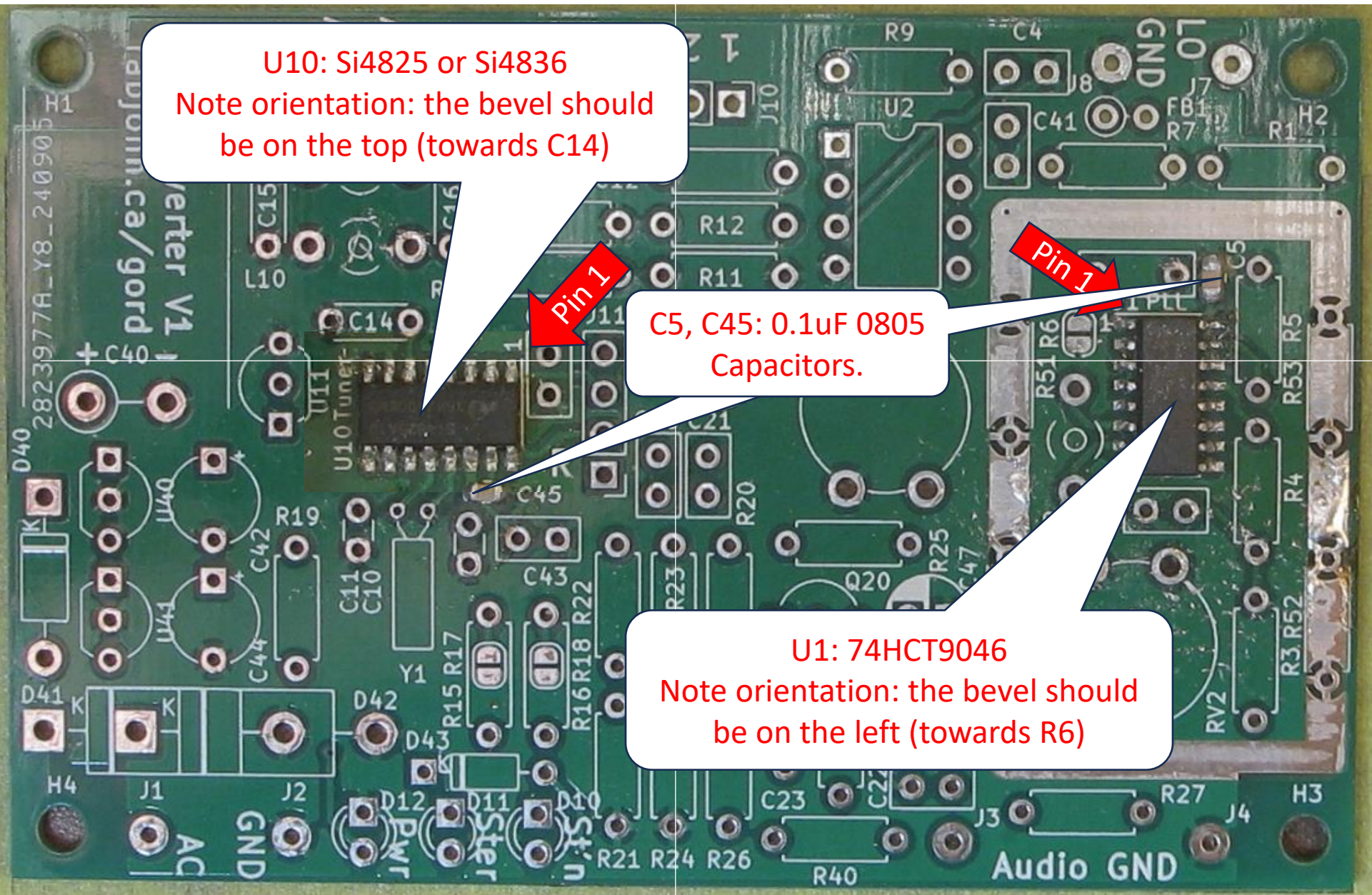
Pin 1

**U1: 74HCT9046**

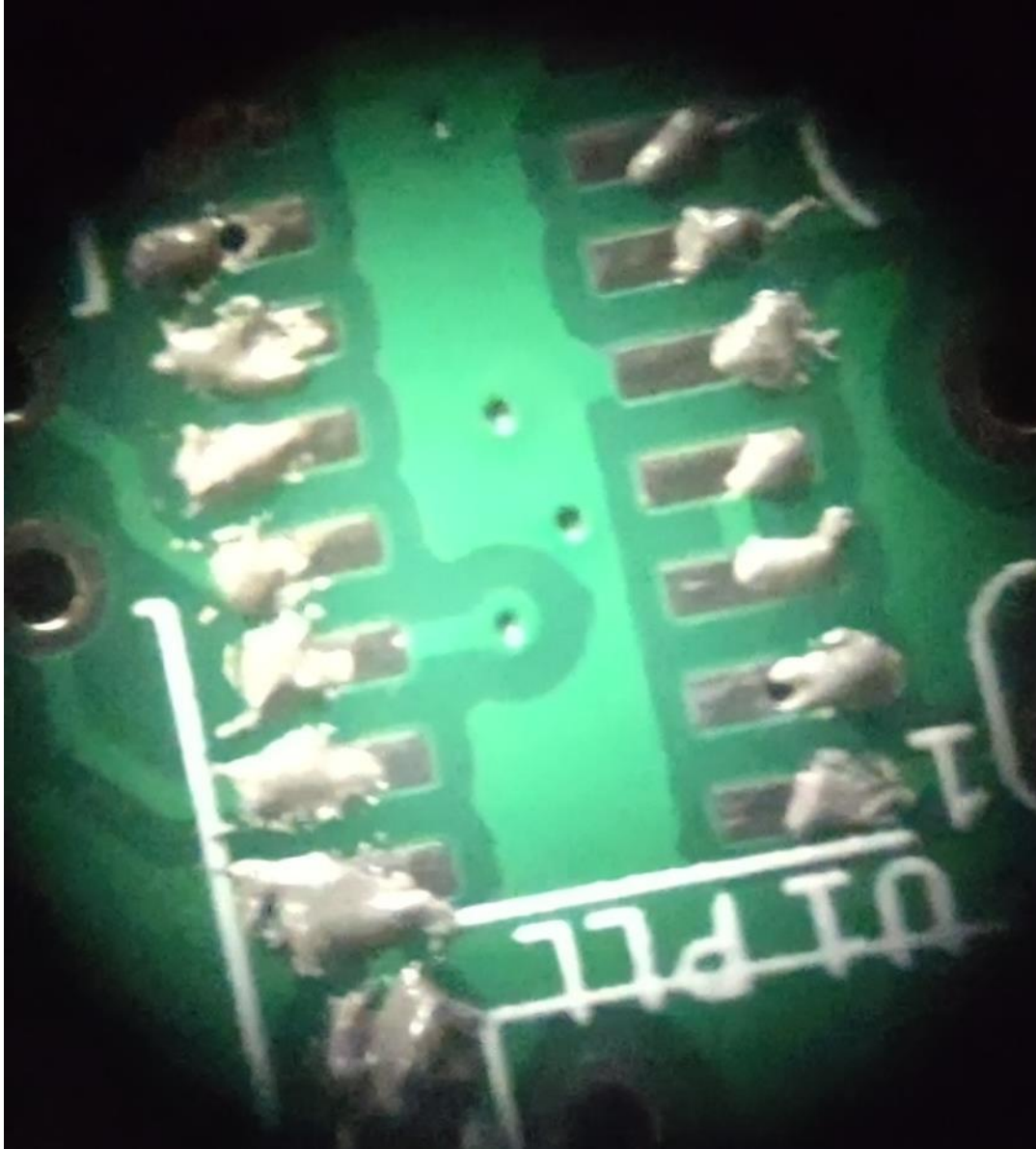
Note orientation: the bevel should be on the left (towards R6)

Although this board can accommodate a 74HC4046 PLL, it is not recommended, as it is less temperature stable.

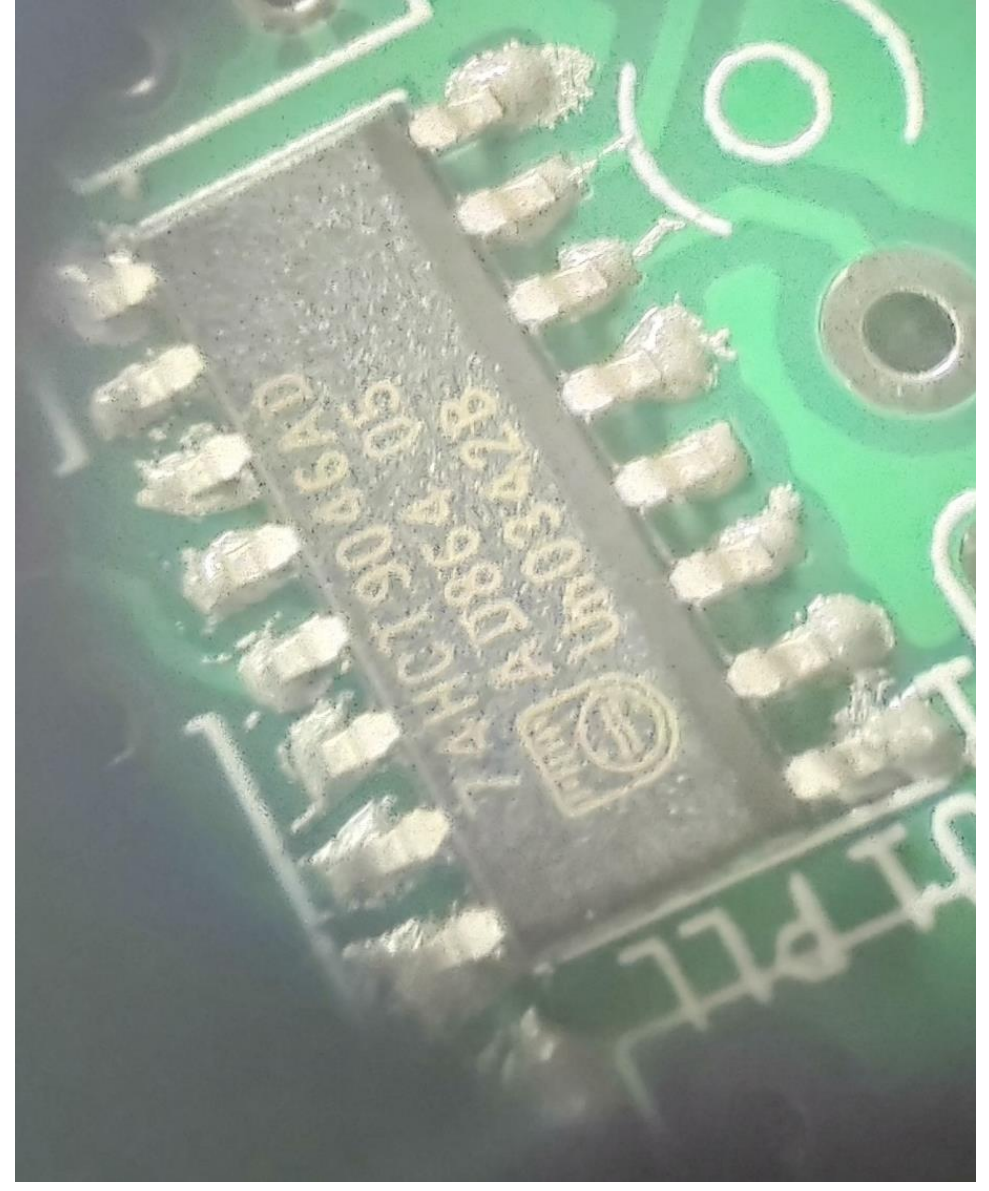
If you must use it, be prepared to add temperature compensation.



Assembly Instructions. 1. SMD  
Blobs of solder paste on each pad



Drop the IC into the paste



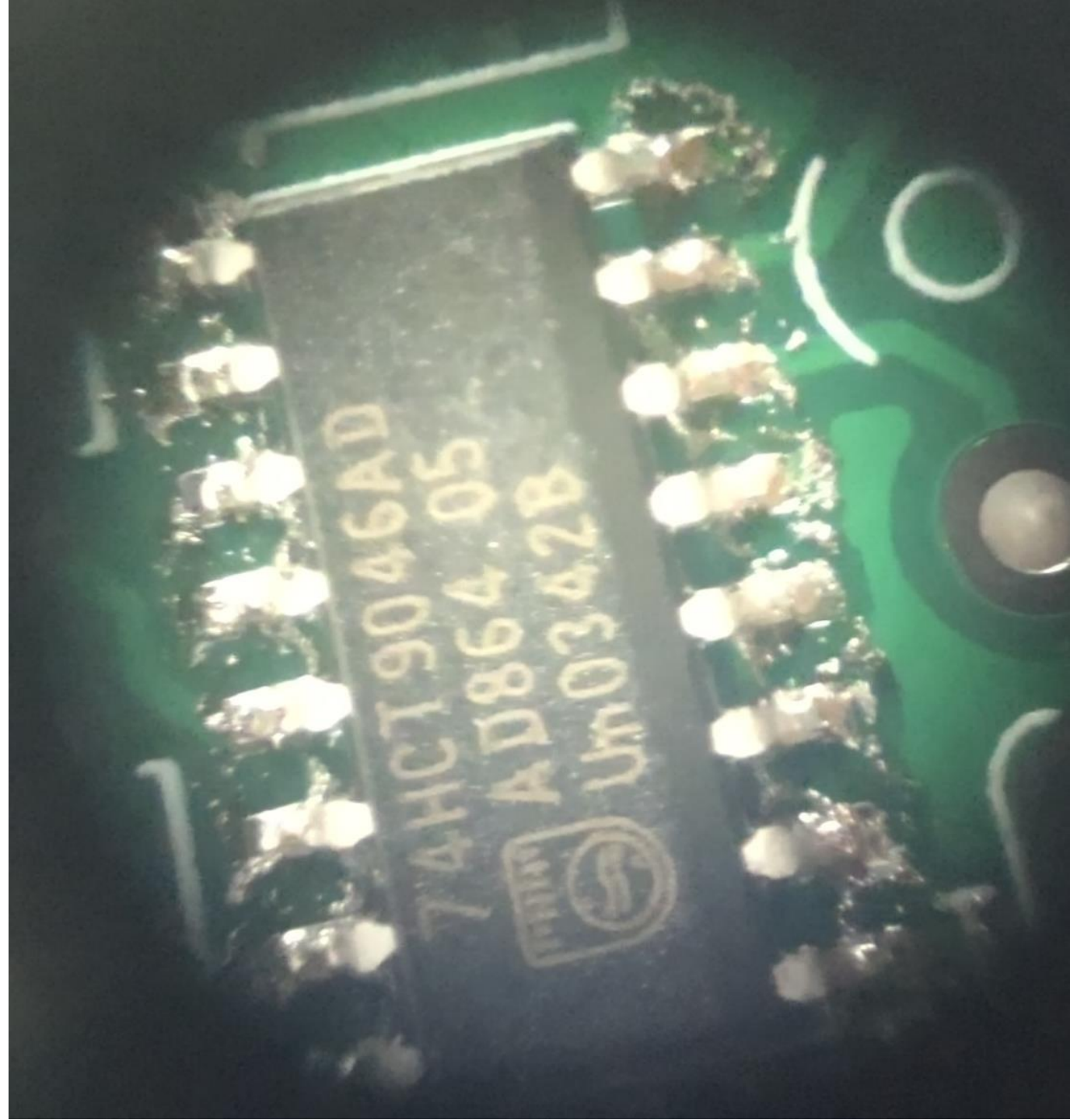
## Assembly Instructions. 1. SMD

Heat the board to ~100-150 C.

Reflow one pin with a fine-tip iron to get the IC in the right location.

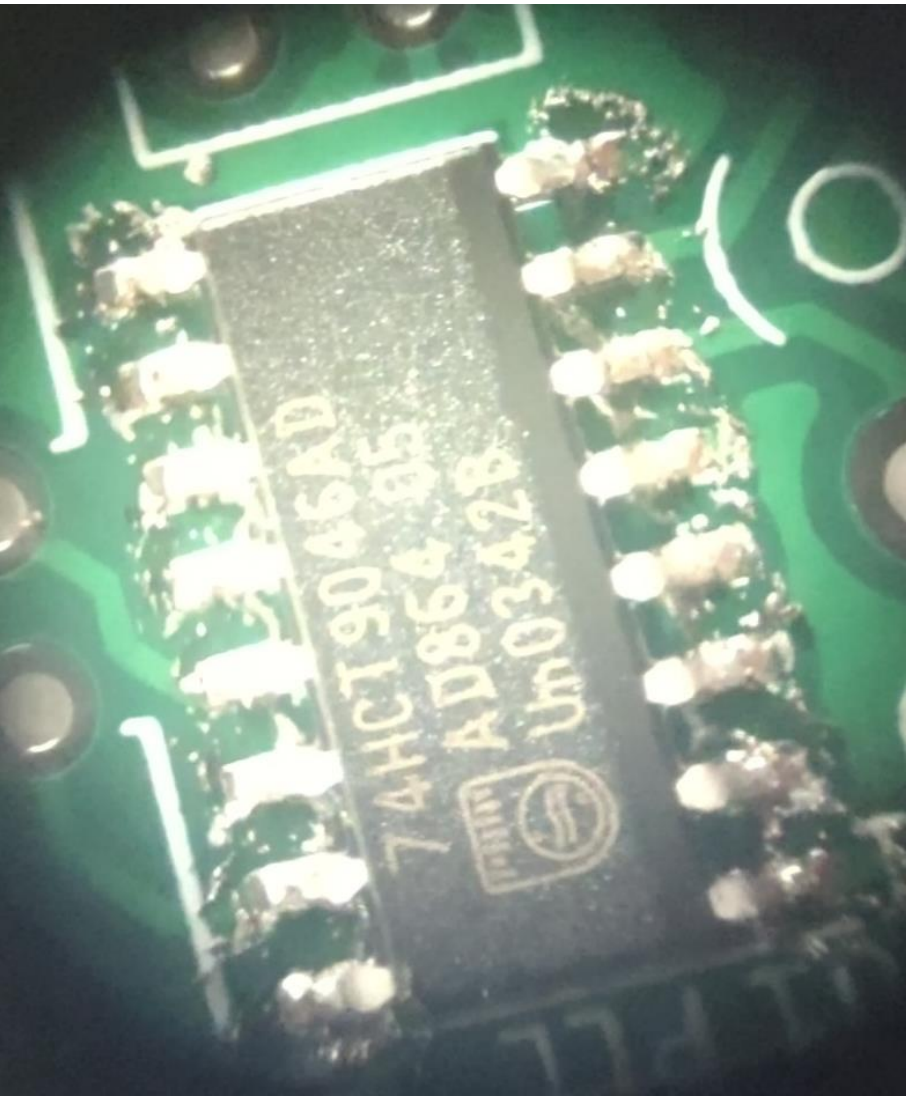
Reflow each pin..

Solder-wick can remove excess solder if necessary.

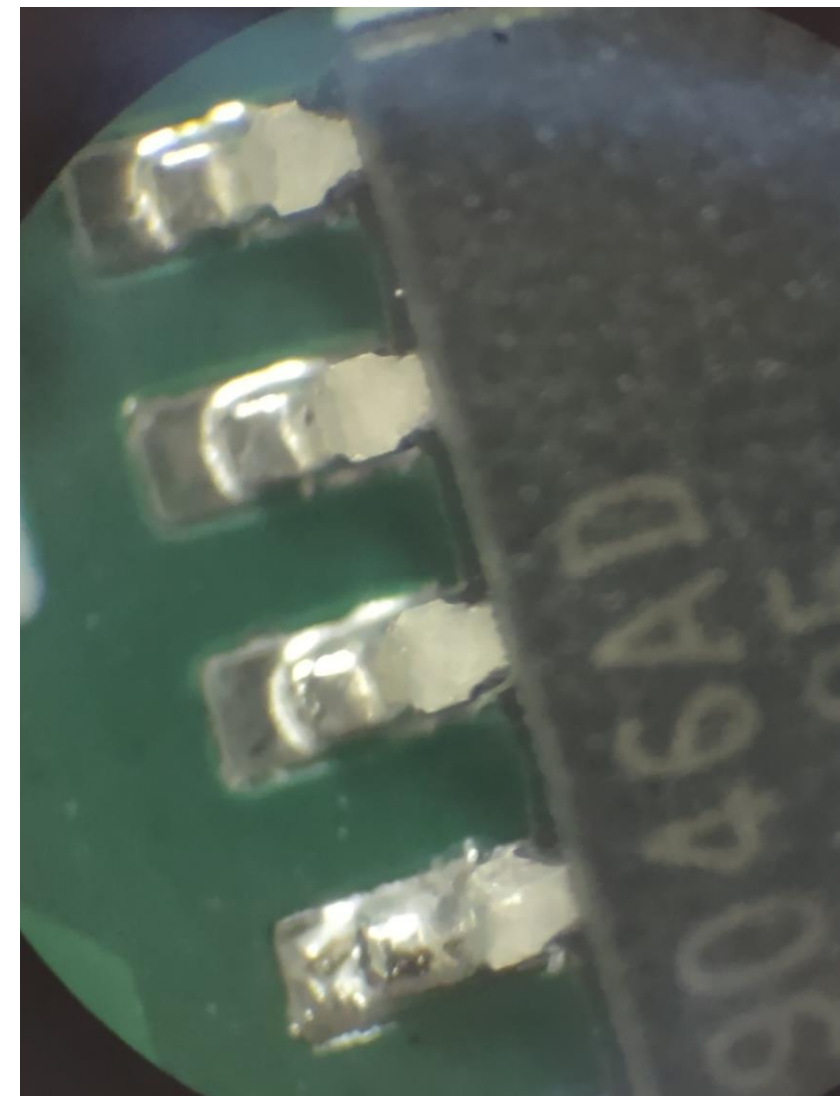
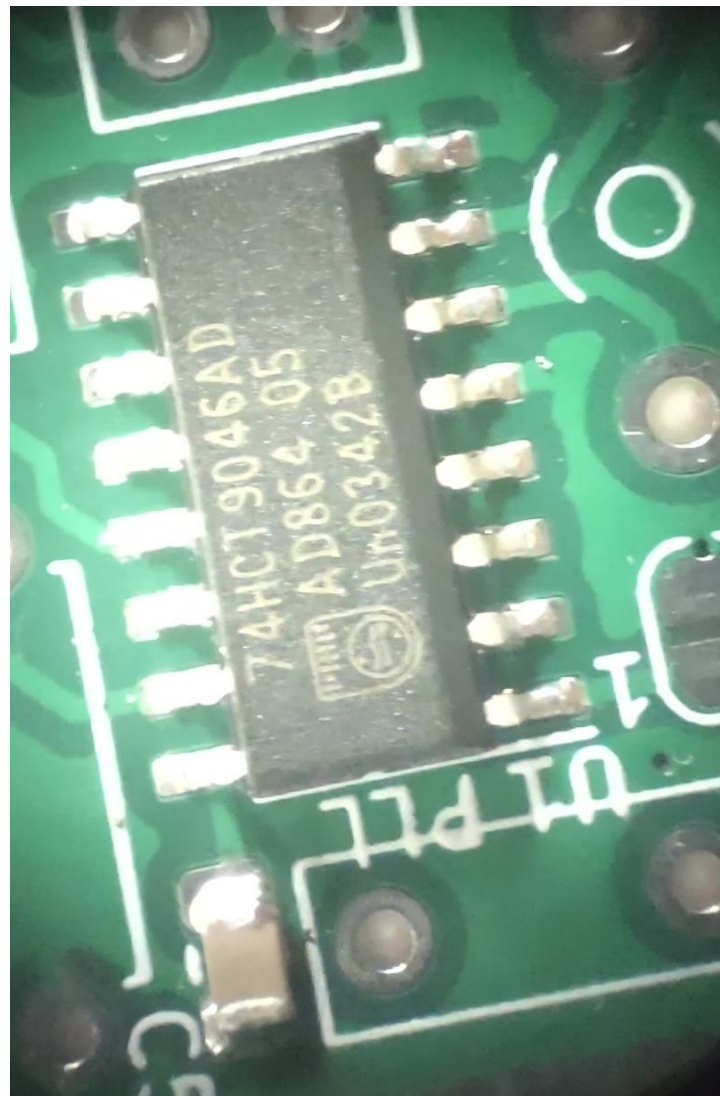


Assembly Instructions. 1. SMD  
Clean the board up with flux remover. Inspect each pin.

Before Flux Cleaning

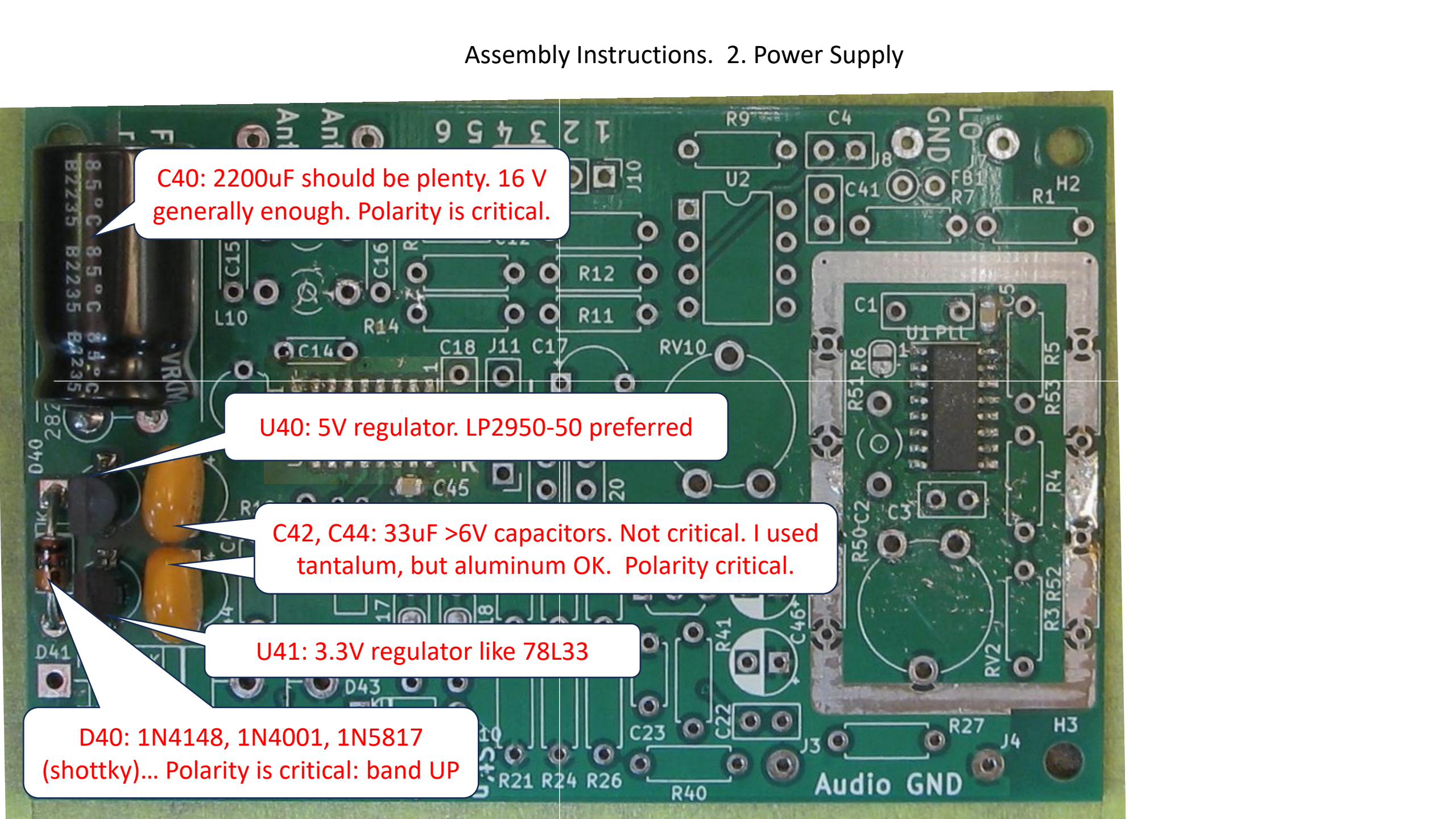


After Flux Cleaning





## Assembly Instructions. 2. Power Supply



C40: 2200uF should be plenty. 16 V generally enough. Polarity is critical.

U40: 5V regulator. LP2950-50 preferred

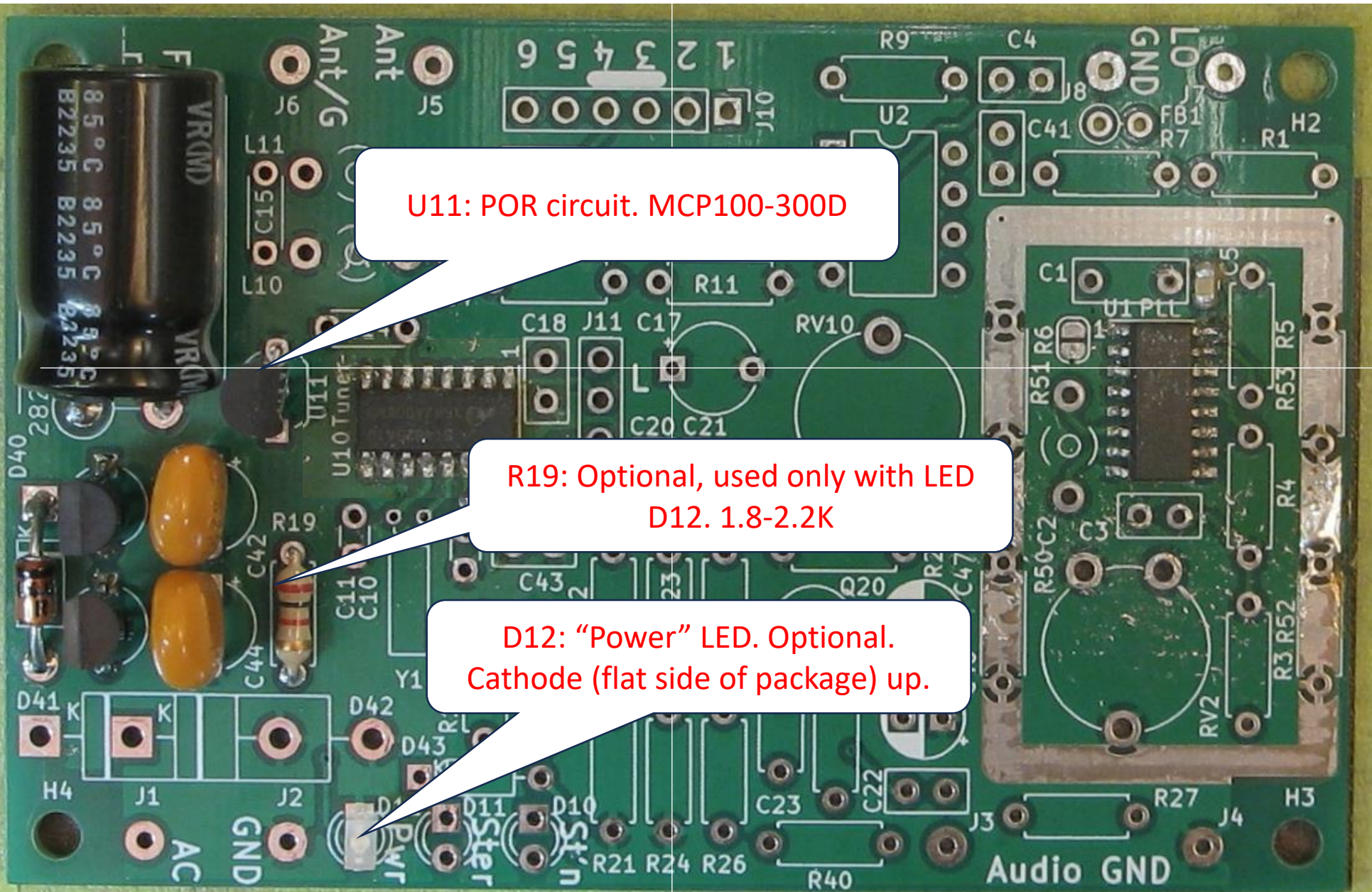
C42, C44: 33uF >6V capacitors. Not critical. I used tantalum, but aluminum OK. Polarity critical.

U41: 3.3V regulator like 78L33

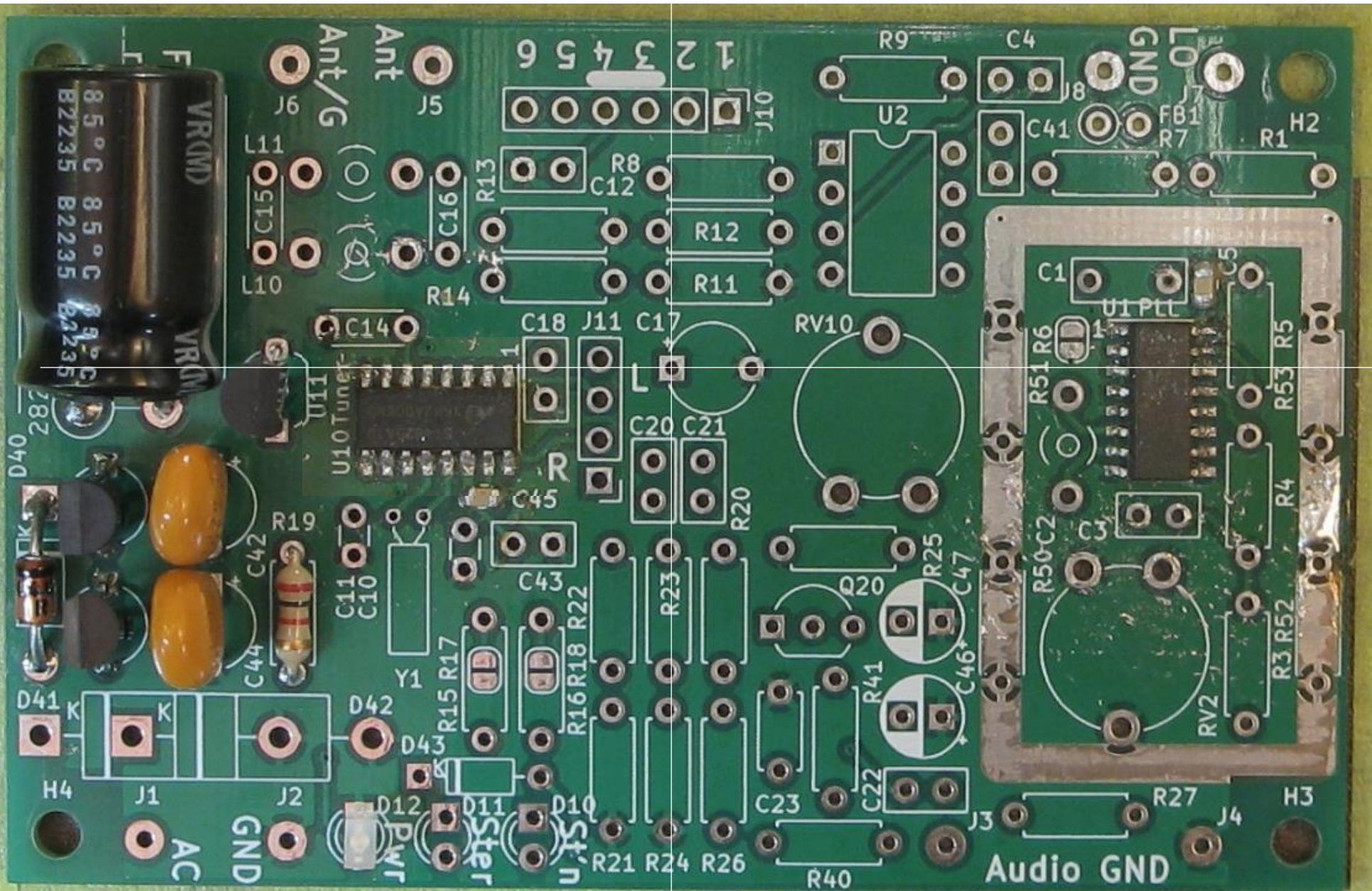
D40: 1N4148, 1N4001, 1N5817 (shottky)... Polarity is critical: band UP



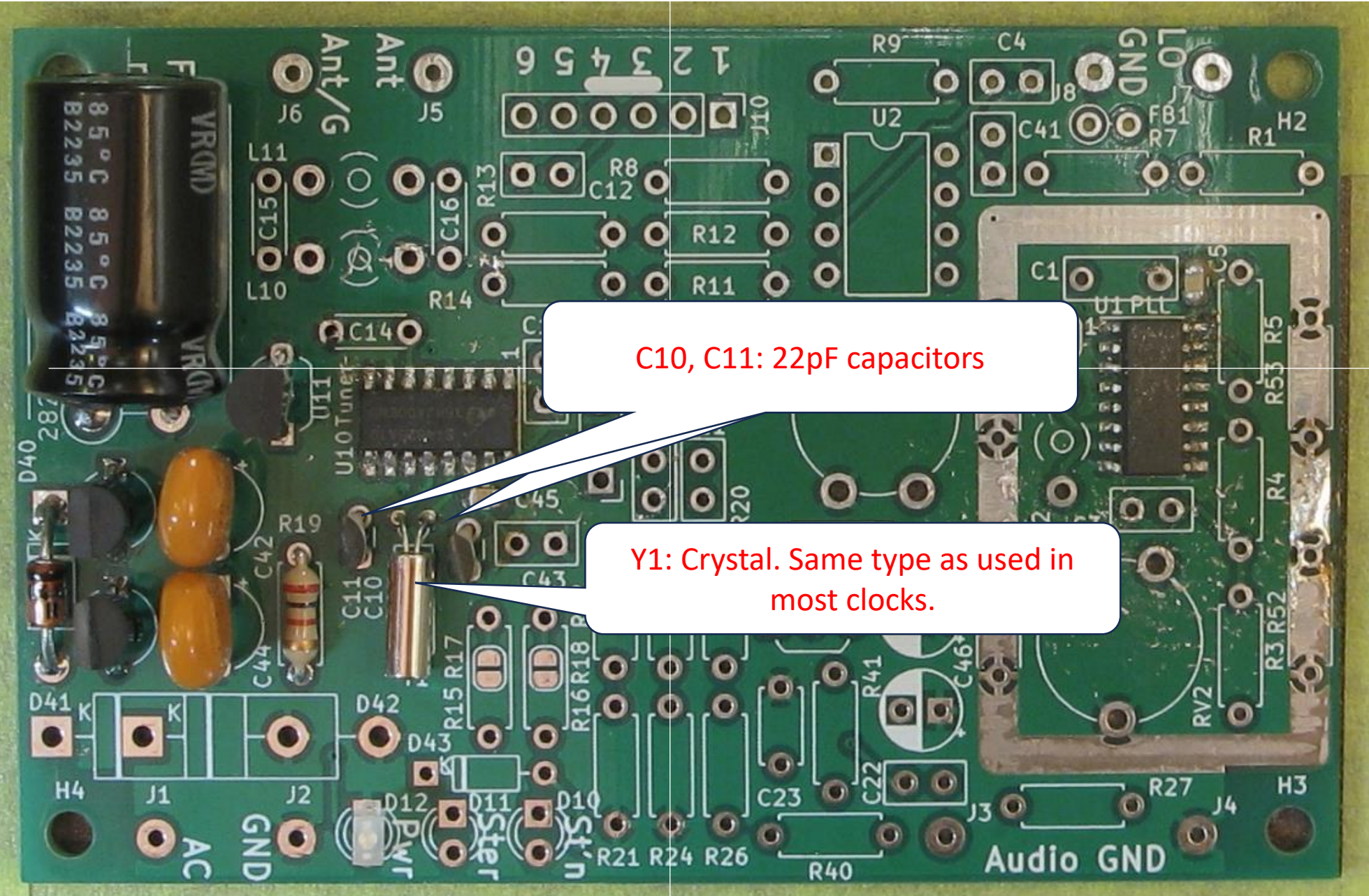
### Assembly Instructions. 3. Parts surrounding FM tuner



### Assembly Instructions. 3. Parts surrounding FM tuner



# Assembly Instructions. 4. Parts surrounding FM tuner



C10, C11: 22pF capacitors

Y1: Crystal. Same type as used in most clocks.



Assembly Instructions. 5a. Parts surrounding FM tuner

C12: Filter 0.1uF not critical

J10: 6-pin header

R13: 51K 1% Band select.

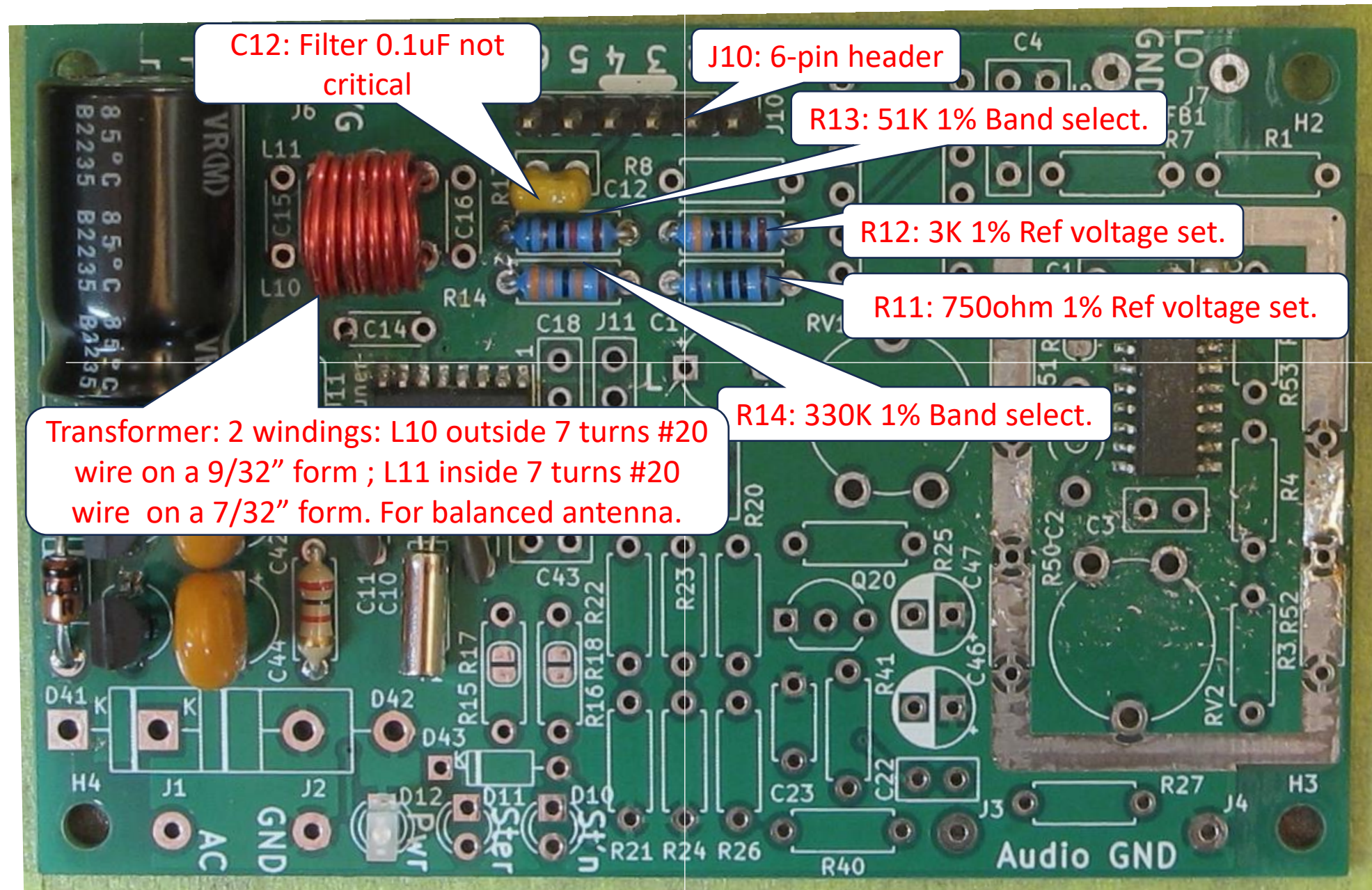
R12: 3K 1% Ref voltage set.

R11: 750ohm 1% Ref voltage set.

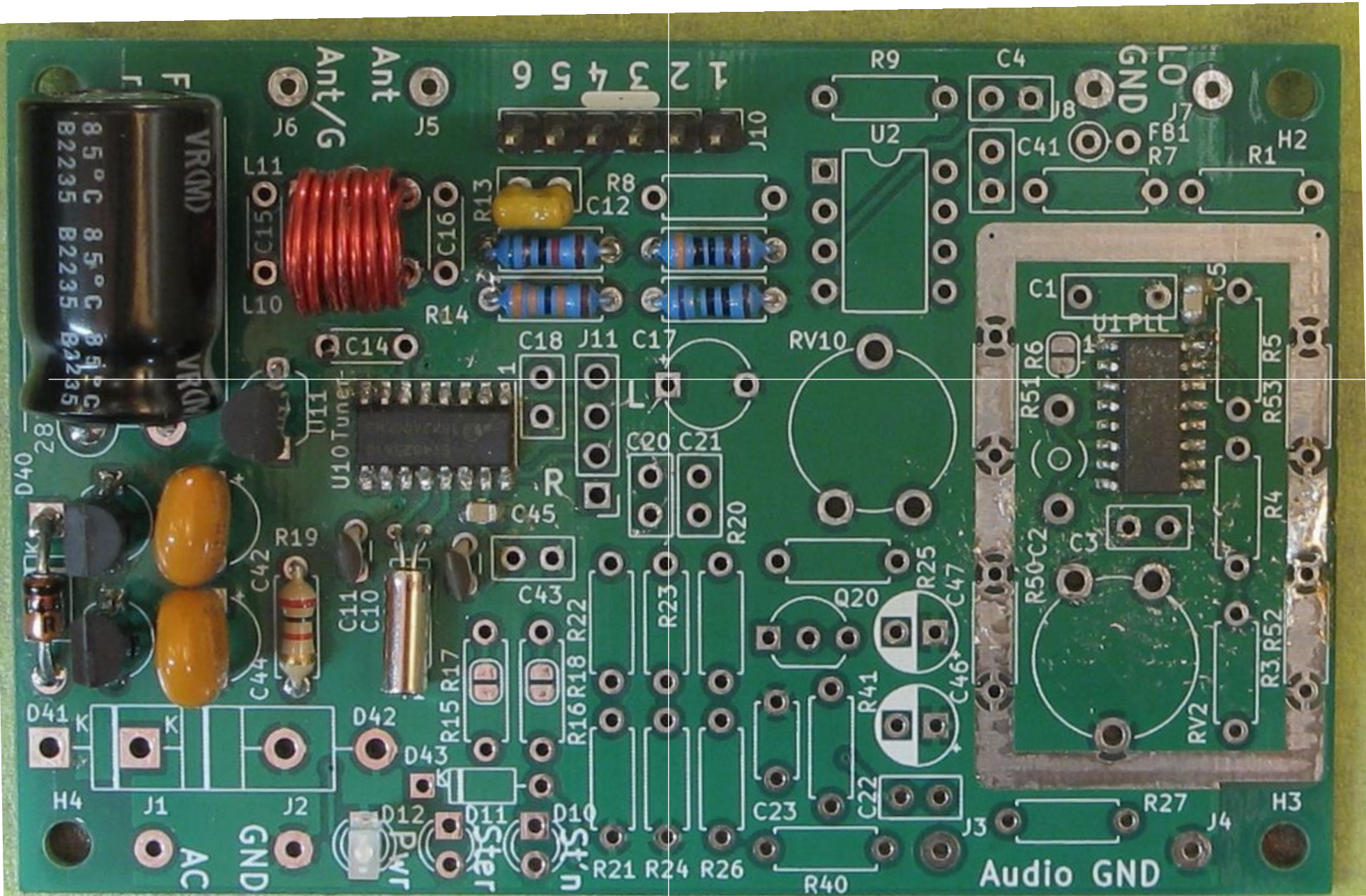
R14: 330K 1% Band select.

Transformer: 2 windings: L10 outside 7 turns #20 wire on a 9/32" form ; L11 inside 7 turns #20 wire on a 7/32" form. For balanced antenna.

R13, R14 select the band of operation, and deemphasis options. See Si4825/4836 data sheet and application data for other band options.



Assembly Instructions. 5a. Parts surrounding FM tuner



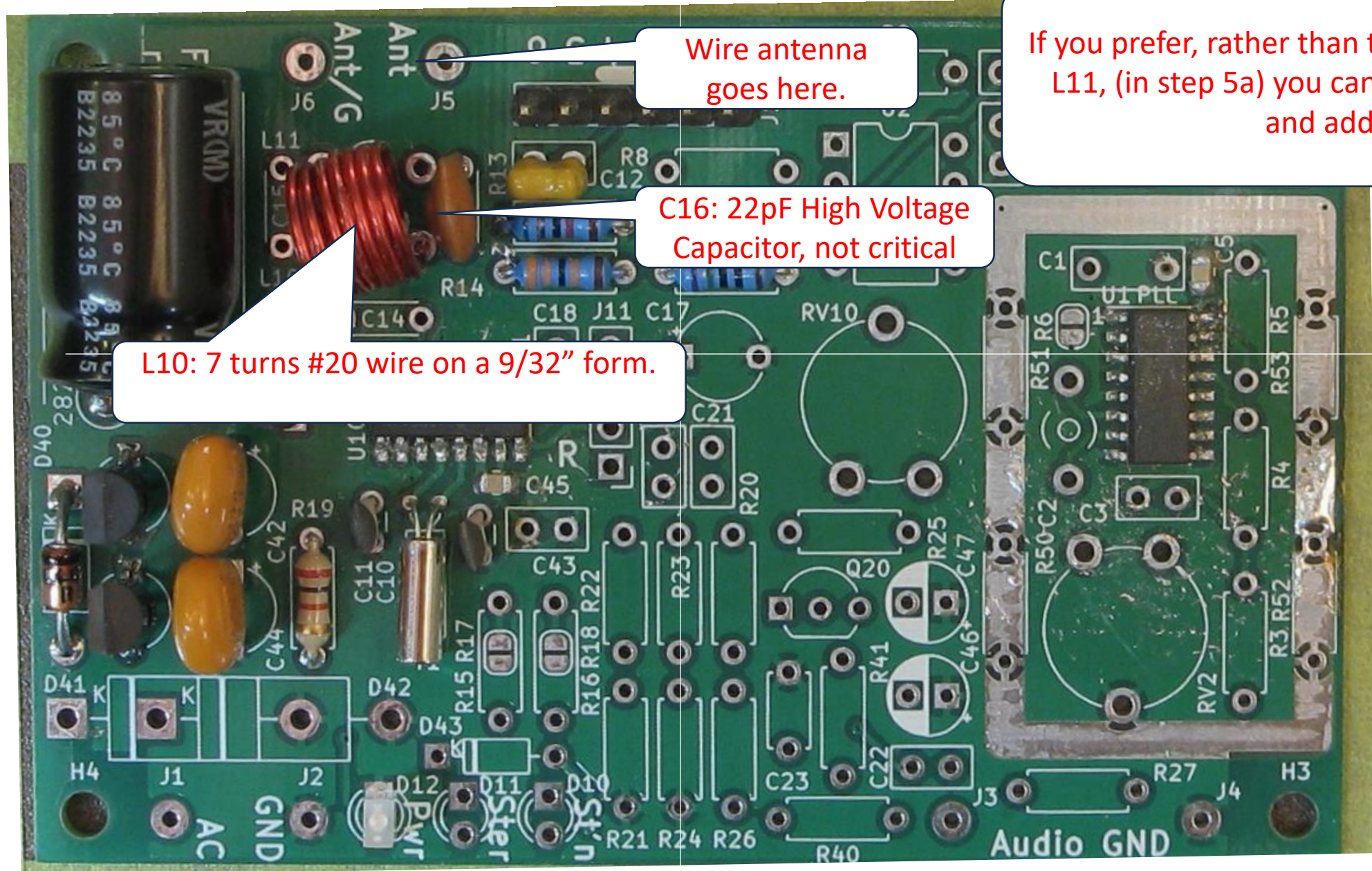
## Assembly Instructions. 5b. Alternative Antenna Circuit

Wire antenna goes here.

C16: 22pF High Voltage Capacitor, not critical

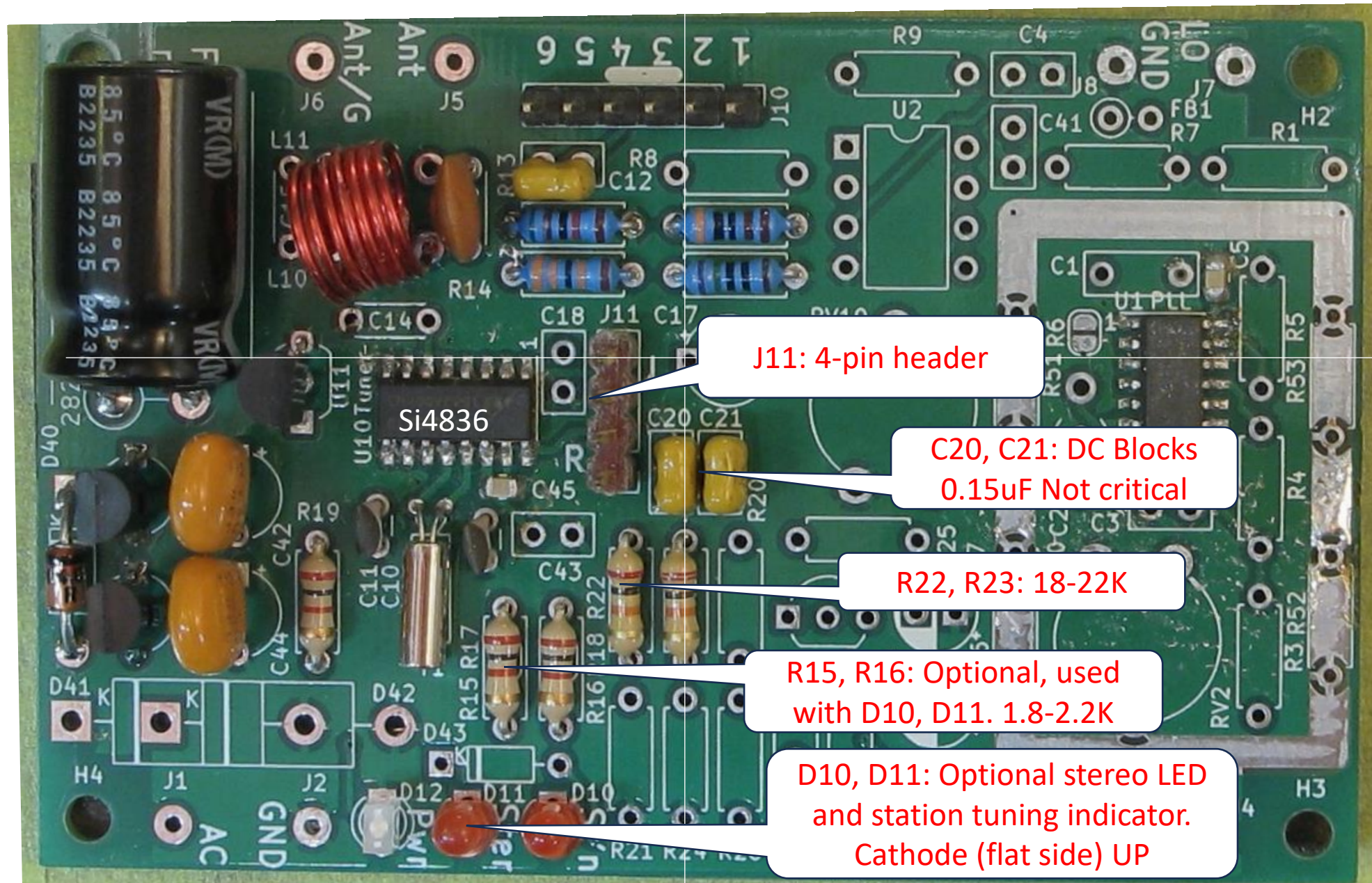
L10: 7 turns #20 wire on a 9/32" form.

If you prefer, rather than the transformer at L10, L11, (in step 5a) you can just use a coil at L10 and add C16.





# Assembly Instructions. 6a. Audio Circuitry for Si4836



J11: 4-pin header

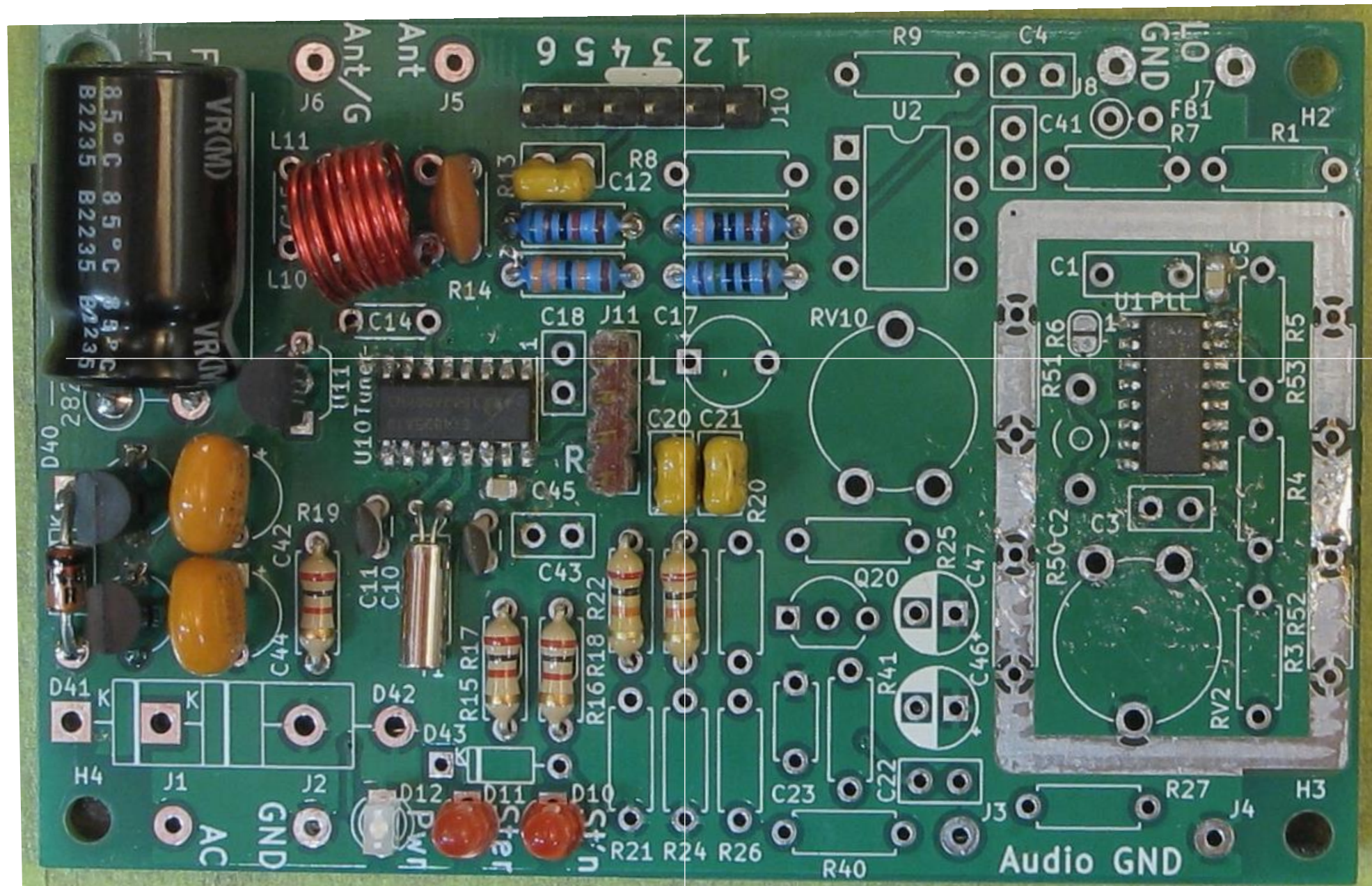
C20, C21: DC Blocks  
0.15uF Not critical

R22, R23: 18-22K

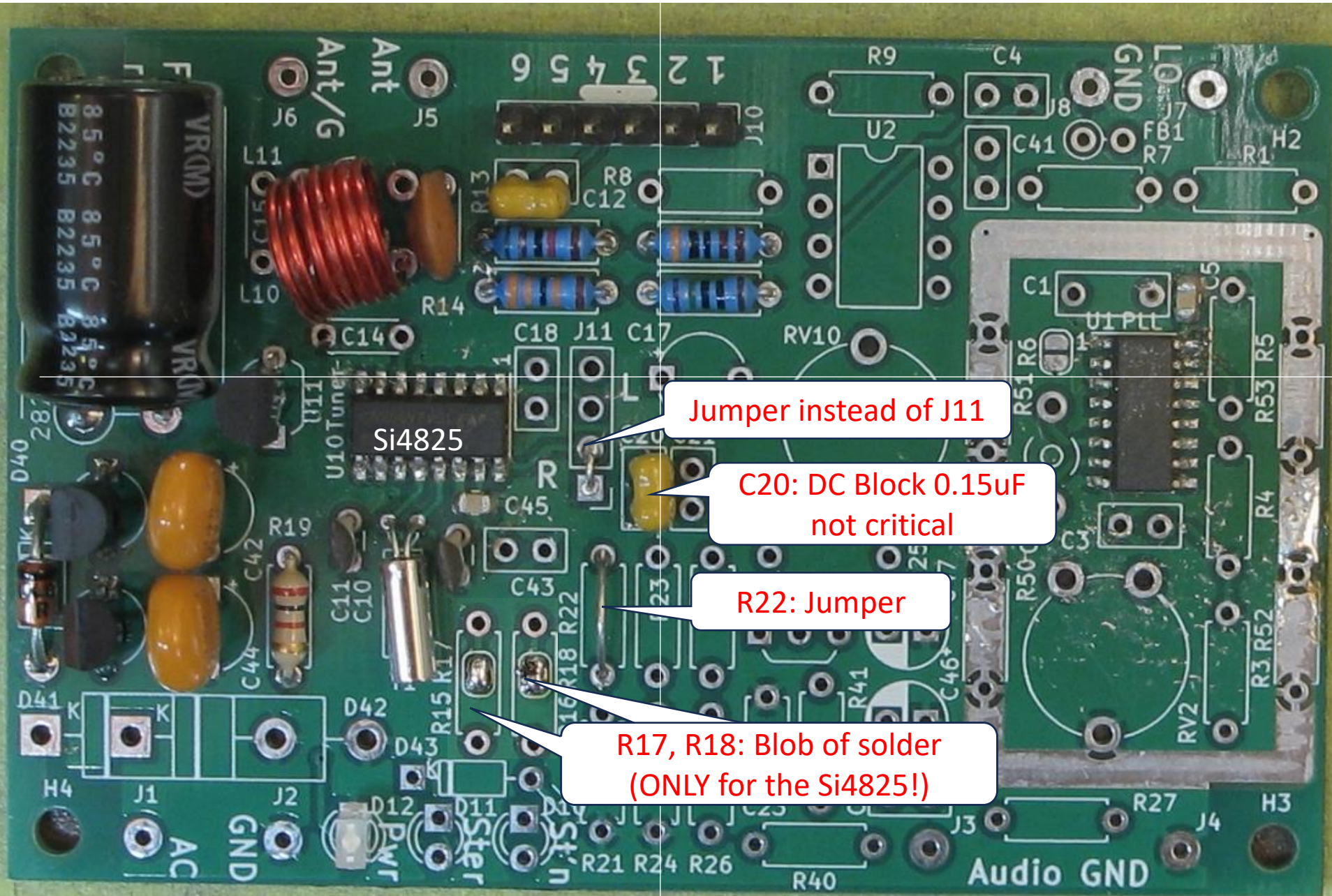
R15, R16: Optional, used  
with D10, D11. 1.8-2.2K

D10, D11: Optional stereo LED  
and station tuning indicator.  
Cathode (flat side) UP

# Assembly Instructions. 6a. Audio Circuitry for Si4836



# Assembly Instructions. 6b. Audio Circuitry for Si4825



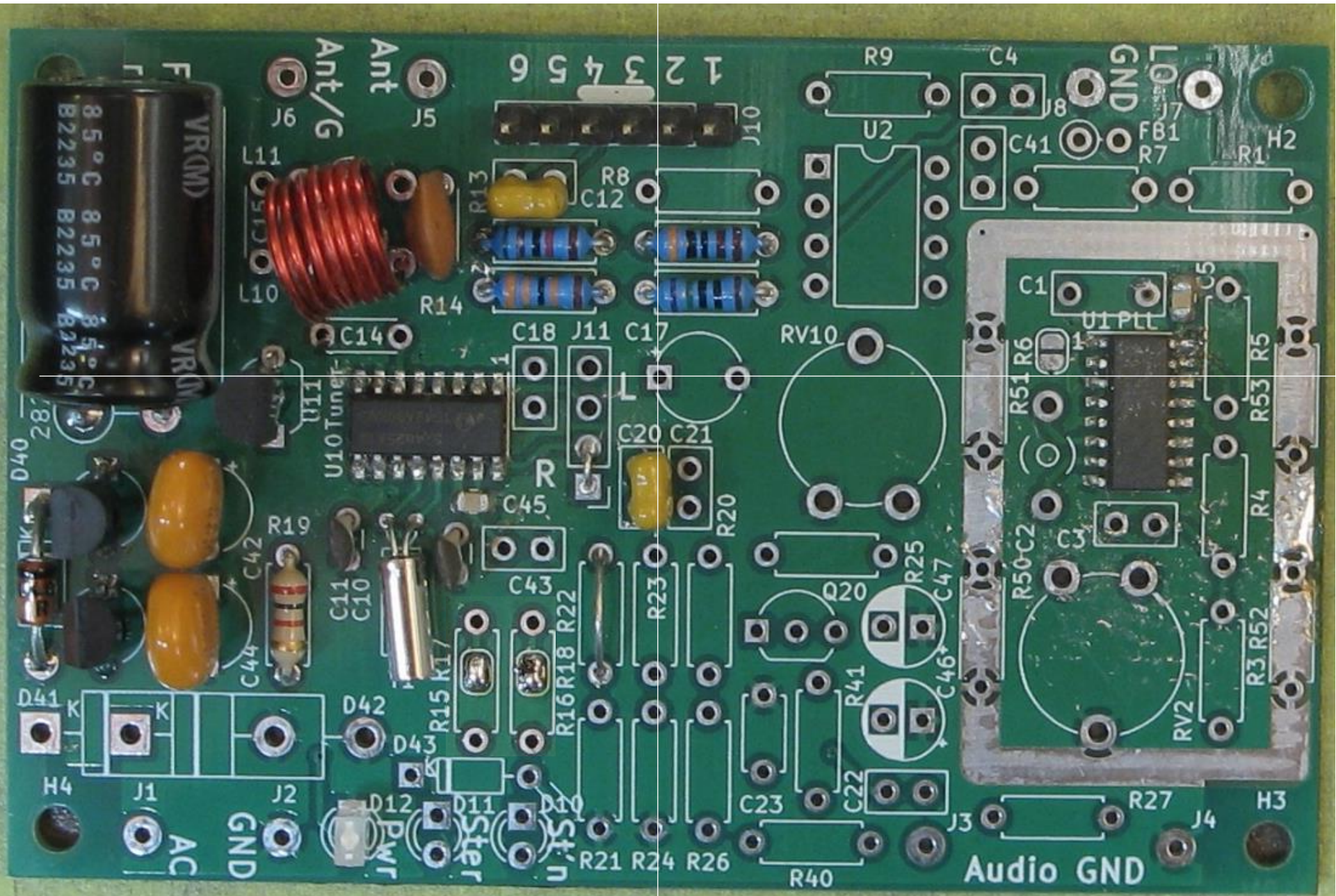
Jumper instead of J11

C20: DC Block 0.15uF  
not critical

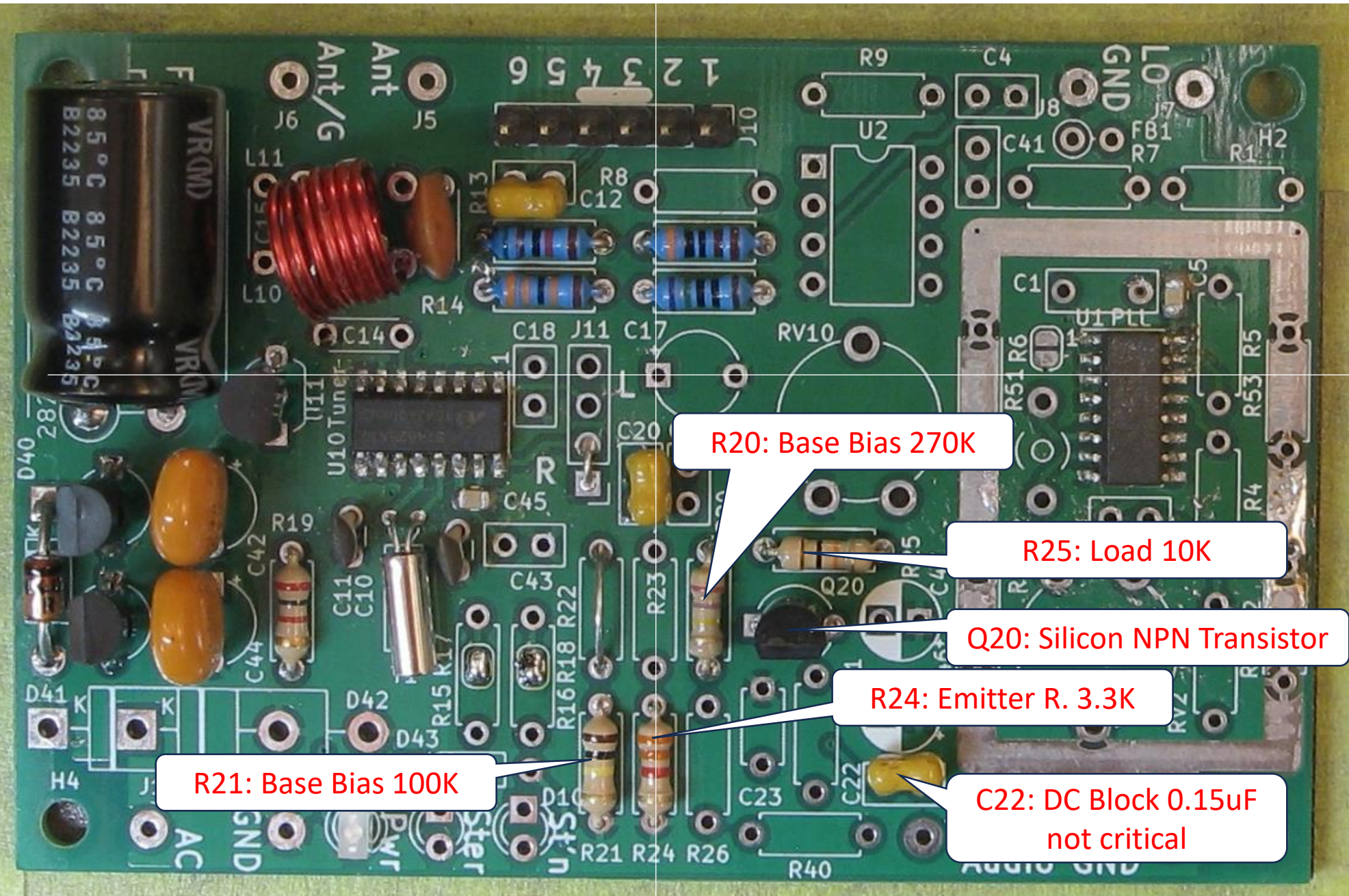
R22: Jumper

R17, R18: Blob of solder  
(ONLY for the Si4825!)

# Assembly Instructions. 6b. Audio Circuitry for Si4825



# Assembly Instructions. 7. Audio Amplifier



R20: Base Bias 270K

R25: Load 10K

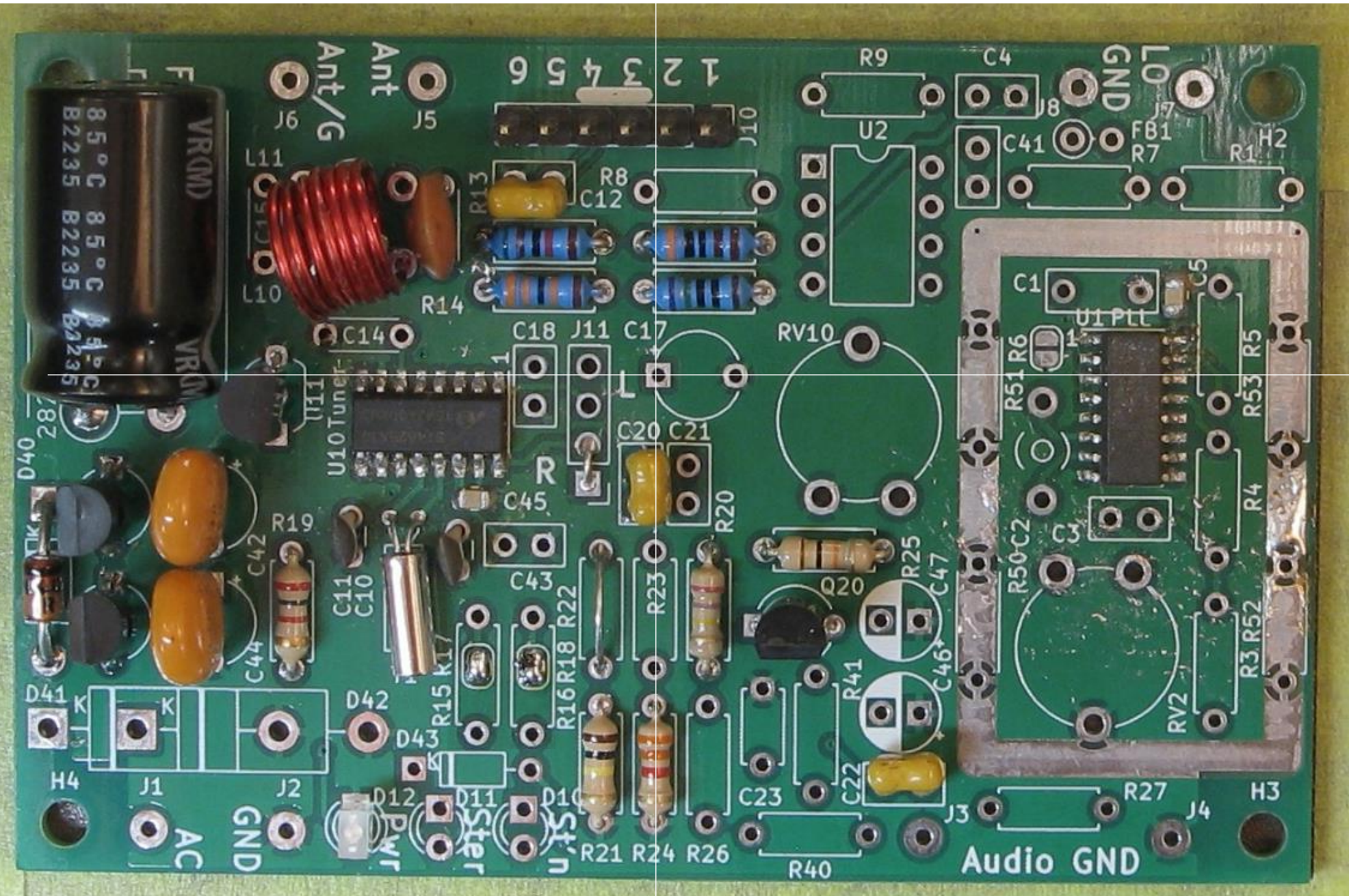
Q20: Silicon NPN Transistor

R24: Emitter R. 3.3K

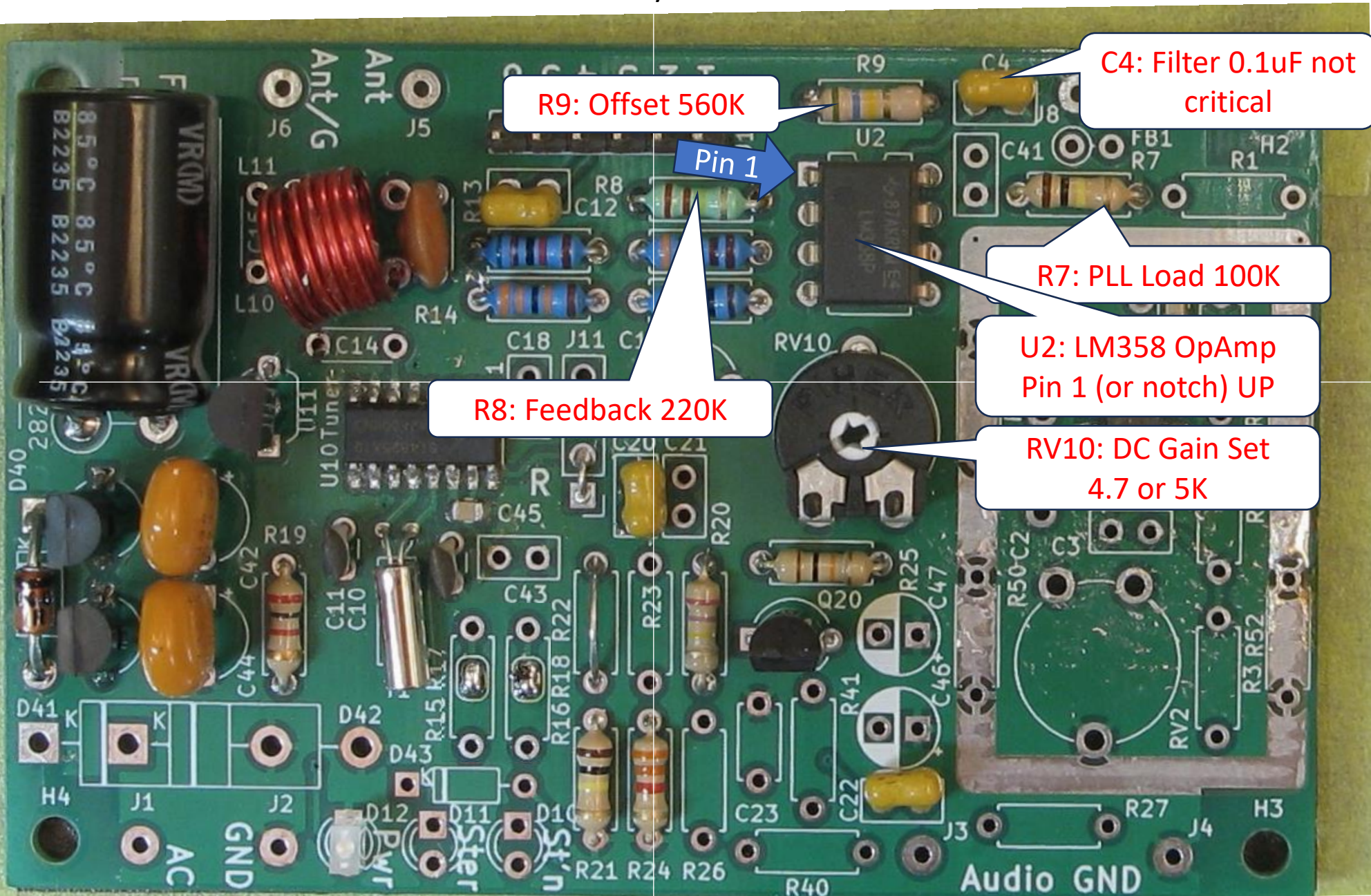
R21: Base Bias 100K

C22: DC Block 0.15uF  
not critical

# Assembly Instructions. 7. Audio Amplifier



# Assembly Instructions. 8. Level Shifter



R9: Offset 560K

C4: Filter 0.1uF not critical

Pin 1

R7: PLL Load 100K

R8: Feedback 220K

U2: LM358 OpAmp  
Pin 1 (or notch) UP

RV10: DC Gain Set  
4.7 or 5K

Audio GND



# Assembly Instructions. 9. PLL

Jumper from 3 to 4

R1: Input 1k

FB1: Jumper

C1: LO Coupling 100pF  
not critical

R6: Solder blob

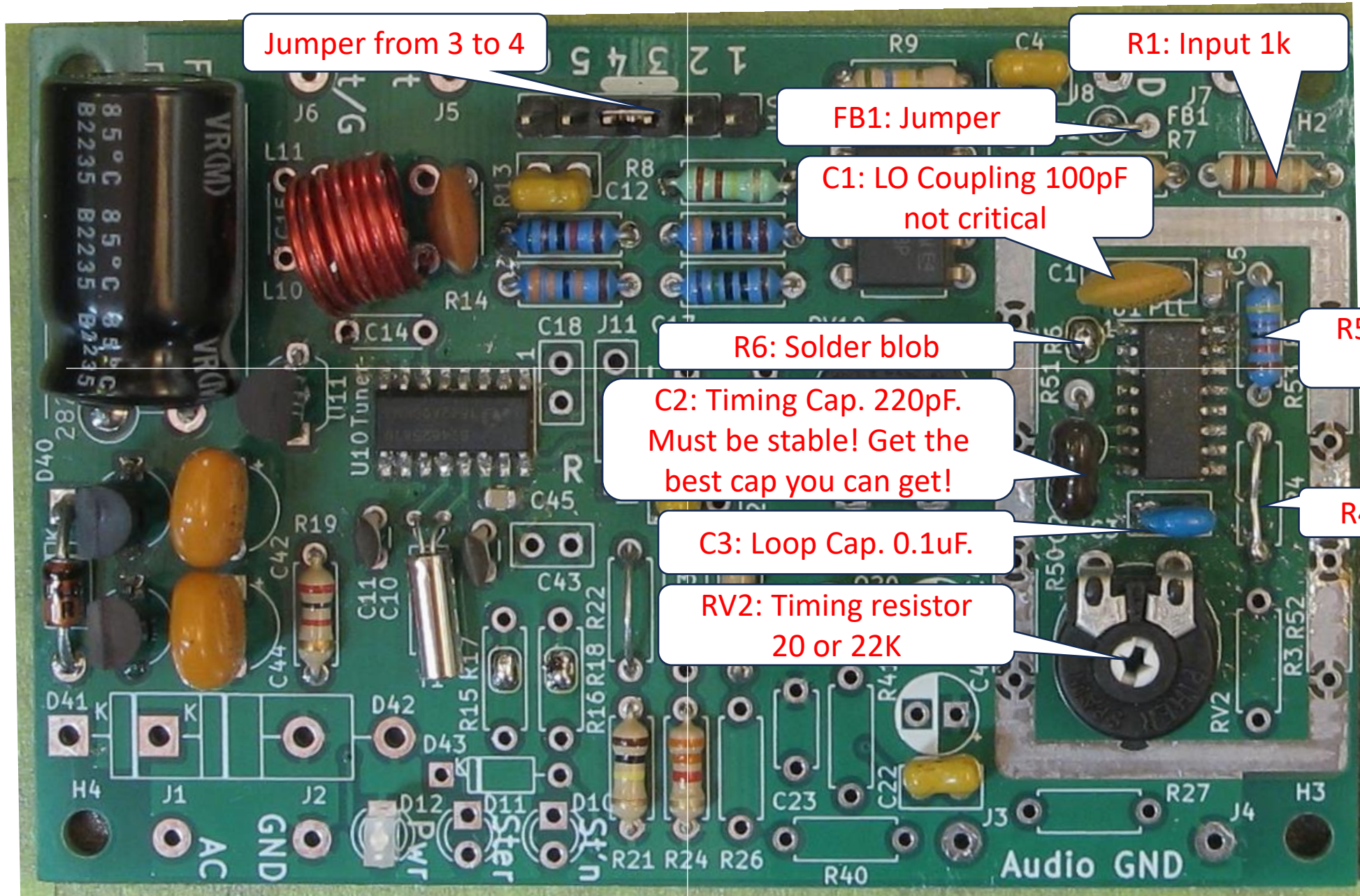
R5: Charge Pump  
47K

C2: Timing Cap. 220pF.  
Must be stable! Get the  
best cap you can get!

R4: Jumper

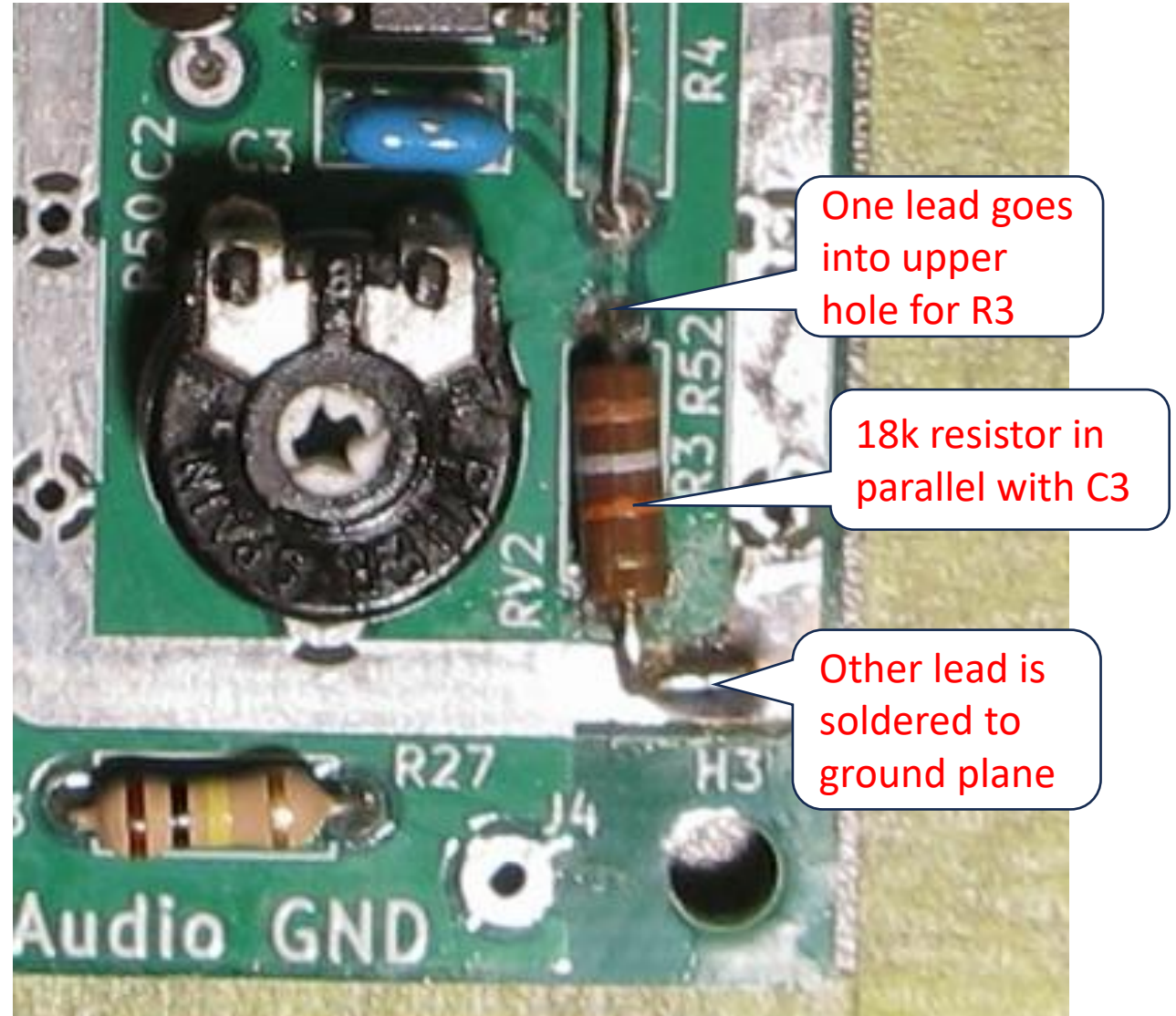
C3: Loop Cap. 0.1uF.

RV2: Timing resistor  
20 or 22K

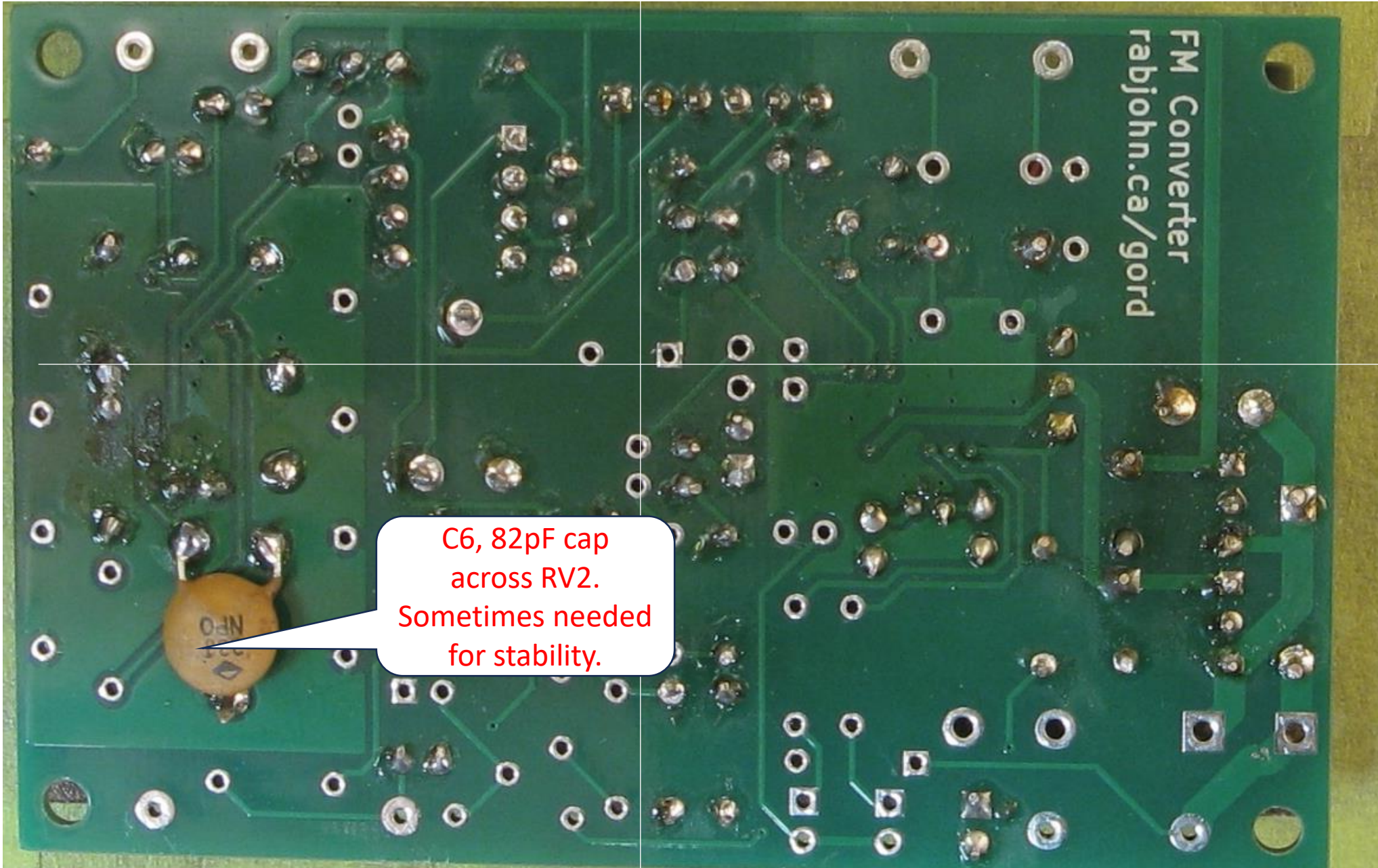


## Assembly Instructions. 9\_added resistor at PLL

- An added resistor and capacitor is recommended for improved PLL performance (sensitivity, stability) .  
C6: 82pF on back of board  
R2: 18k on front of board
- See documentation for an explanation.
- There is no footprint for these on the PCB, but they can be neatly added.
- I did not redo this entire presentation, so the resistor does not appear in subsequent photos.



Assembly Instructions. 9back. PLL



C6, 82pF cap  
across RV2.  
Sometimes needed  
for stability.



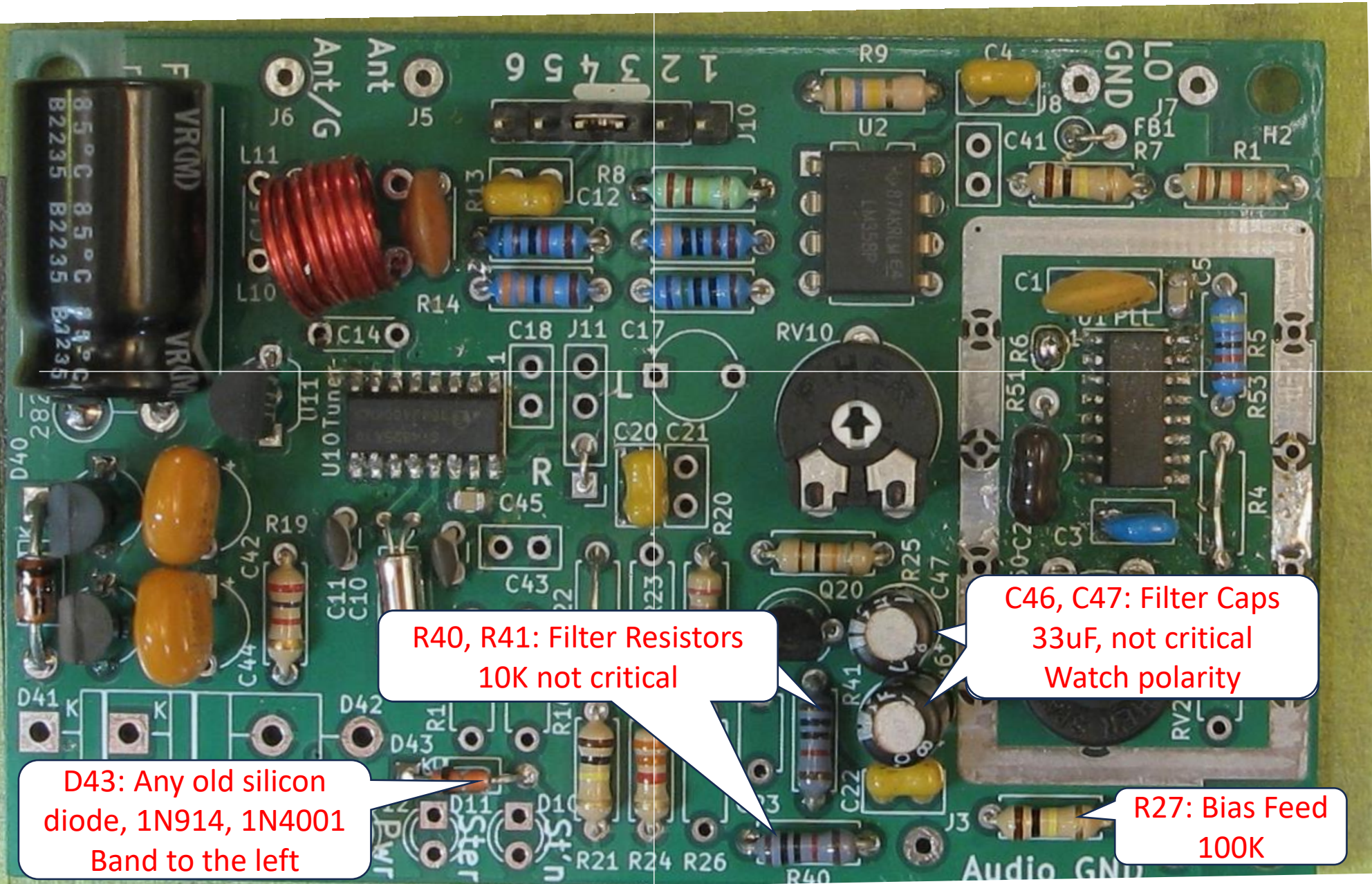
# Options

- Protection Zener diodes: D41 is absolutely necessary for series-string operation.
- Negative voltage supply:
  - This reverse-biases the detector (deactivating it). If the detector is not deactivated (either by disconnecting it or reverse biasing it), it can cause distortion.
  - It also reduces the gain on the IF amplifier (eliminating it as a potential source of noise)
  - If the detector diode is disconnected, the reverse supply is not necessary.
  - In parallel filament radios, the IF amplifier tube can be removed.
  - In radios powered by DC (eg. car radios), the negative voltage generator does not work.
  - In series radios (using the 8.2V Zener diode), it will not work unless 2 back-to-back Zener diodes are used.

# Protection Diodes

- In series heater radios, where the converter is powered in series with the heaters, an 8.2V Zener diode is used at D41. This carries the 150mA (typical) heater current, and limits the voltage into the converter to 8.2V.
- In series heater radios, where the converter is powered in parallel with one of the heaters (recommended only with 300mA series string), a Zener diode (10V -20V, high enough that it is not on) is used at D42. This diode is usually off, but if the heater opens, it prevents the converter from getting damaged by excess voltage.
- In parallel heater radios, no protection diode is required.

# Assembly Instructions. 10. Negative Supply



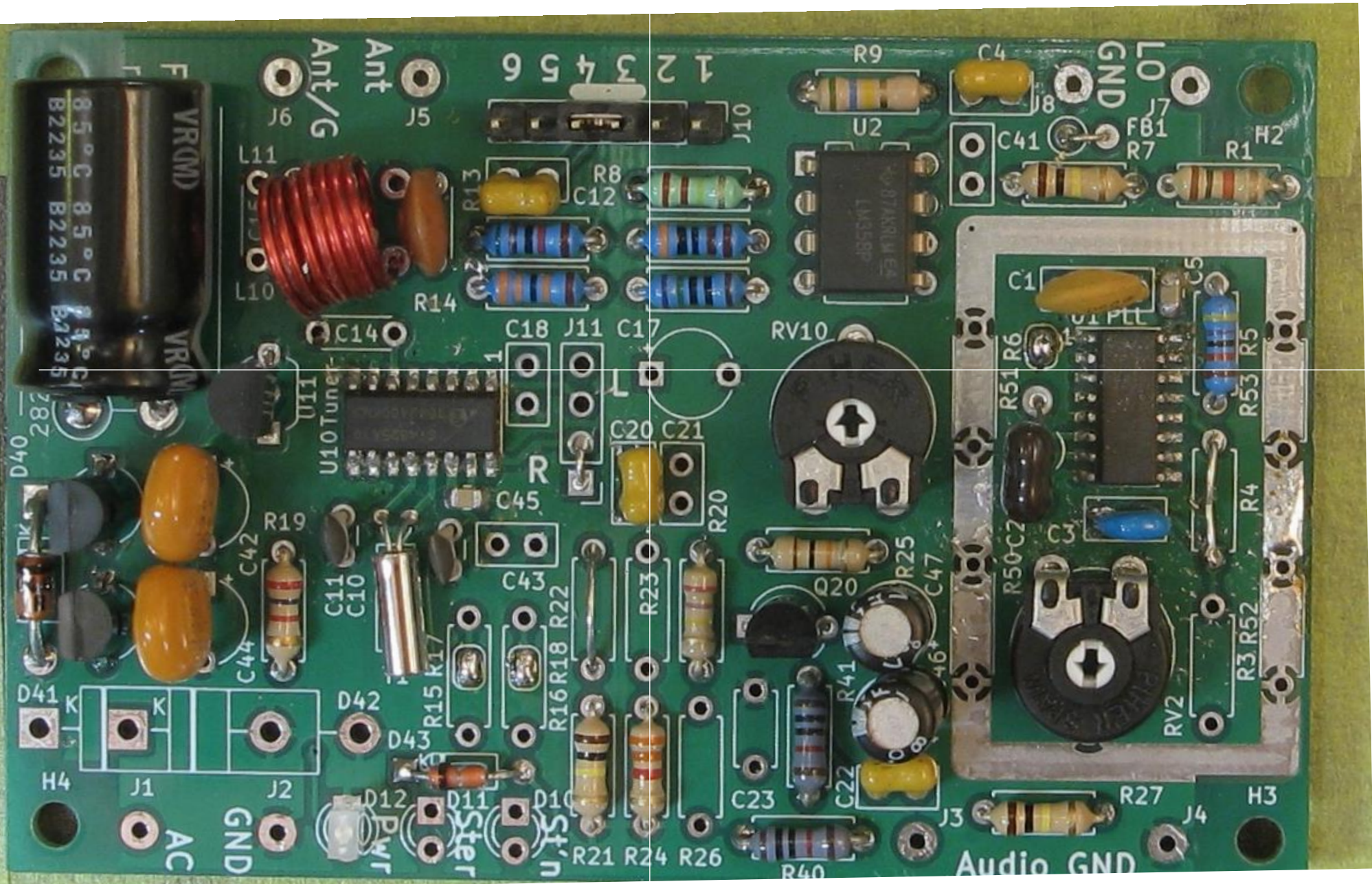
R40, R41: Filter Resistors  
10K not critical

C46, C47: Filter Caps  
33uF, not critical  
Watch polarity

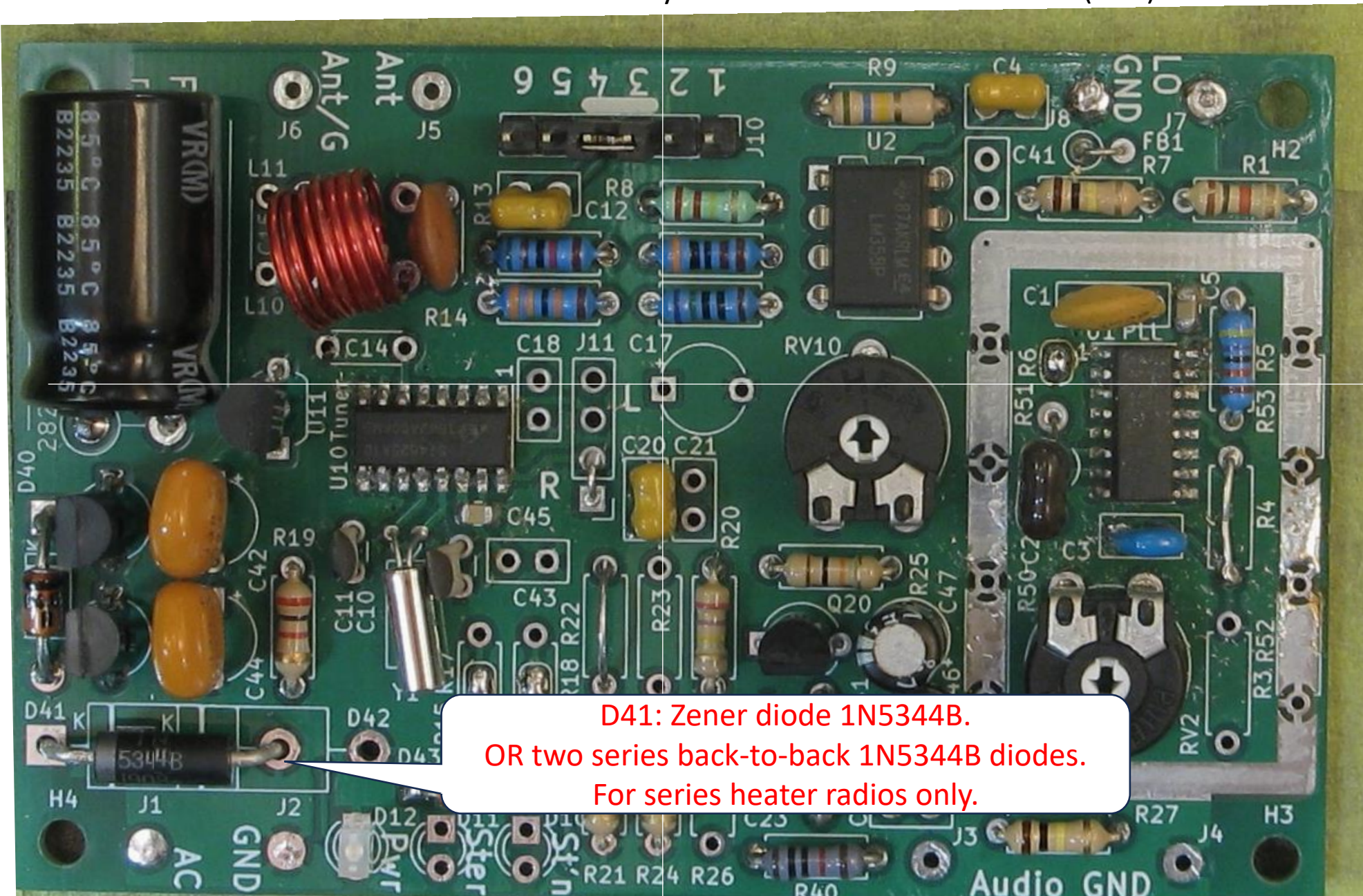
D43: Any old silicon  
diode, 1N914, 1N4001  
Band to the left

R27: Bias Feed  
100K

# Assembly Instructions. 10. Negative Supply

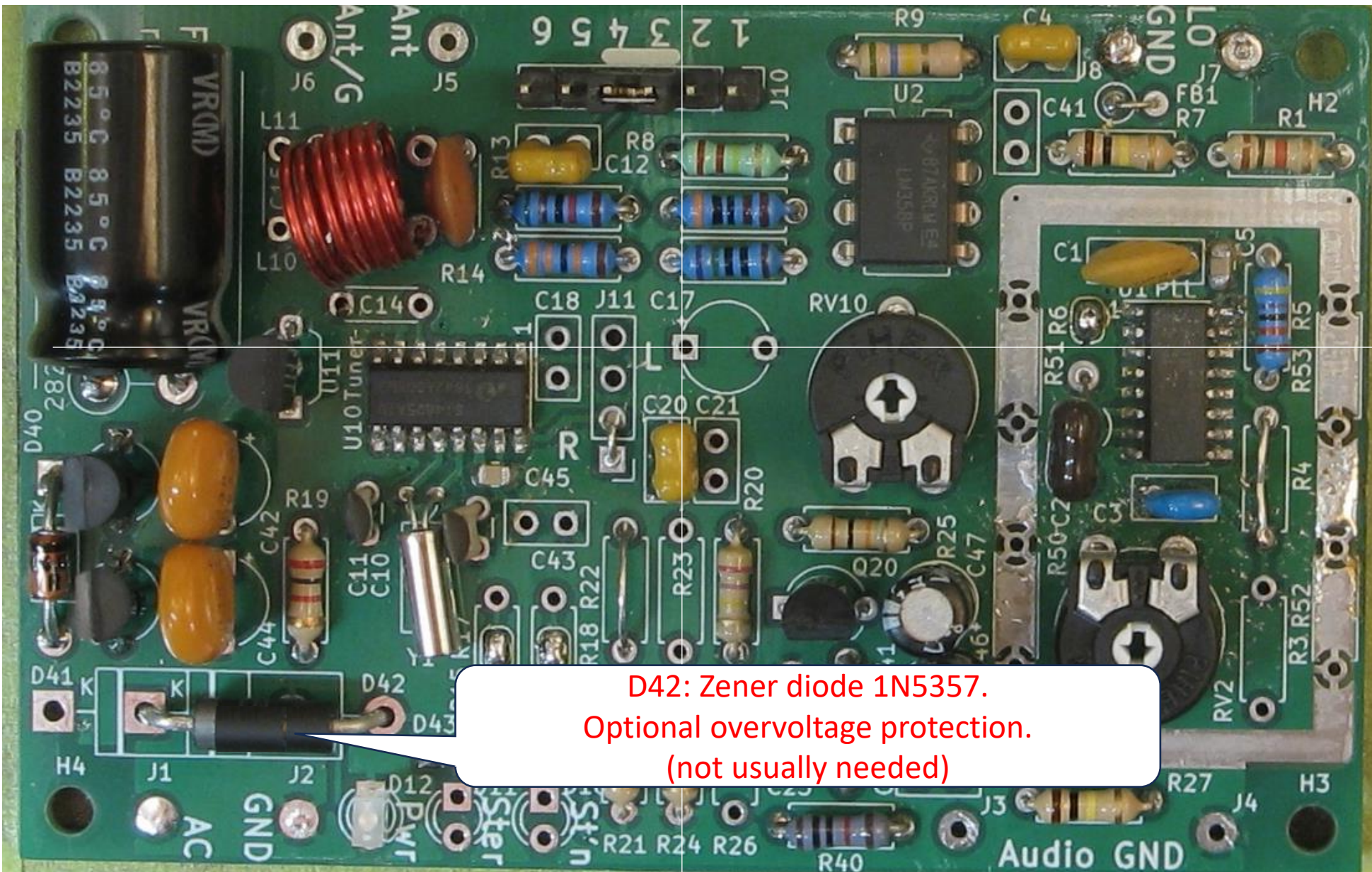


# Assembly Instructions. 11A. Protection (D41)



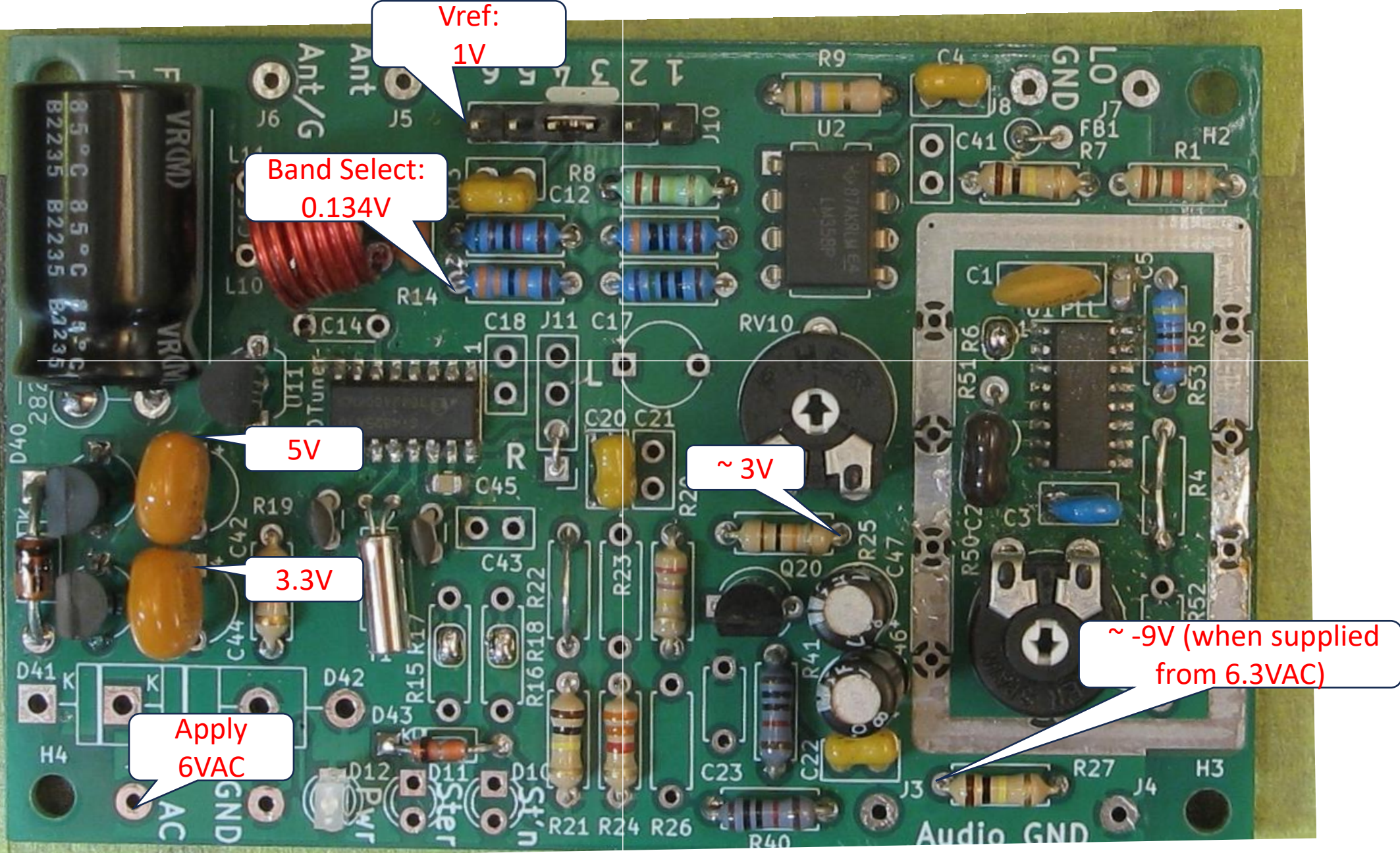
D41: Zener diode 1N5344B.  
OR two series back-to-back 1N5344B diodes.  
For series heater radios only.

## Assembly Instructions. 11B. Protection (D42)



Tests

# DC Tests



Vref:  
1V

Band Select:  
0.134V

5V

3.3V

Apply  
6VAC

~ 3V

~ -9V (when supplied  
from 6.3VAC)

# Tuner Tests

1 metre antenna wire

50K pot to pins 2, 4, 6

Remove jumper

For Si4836, jumper here

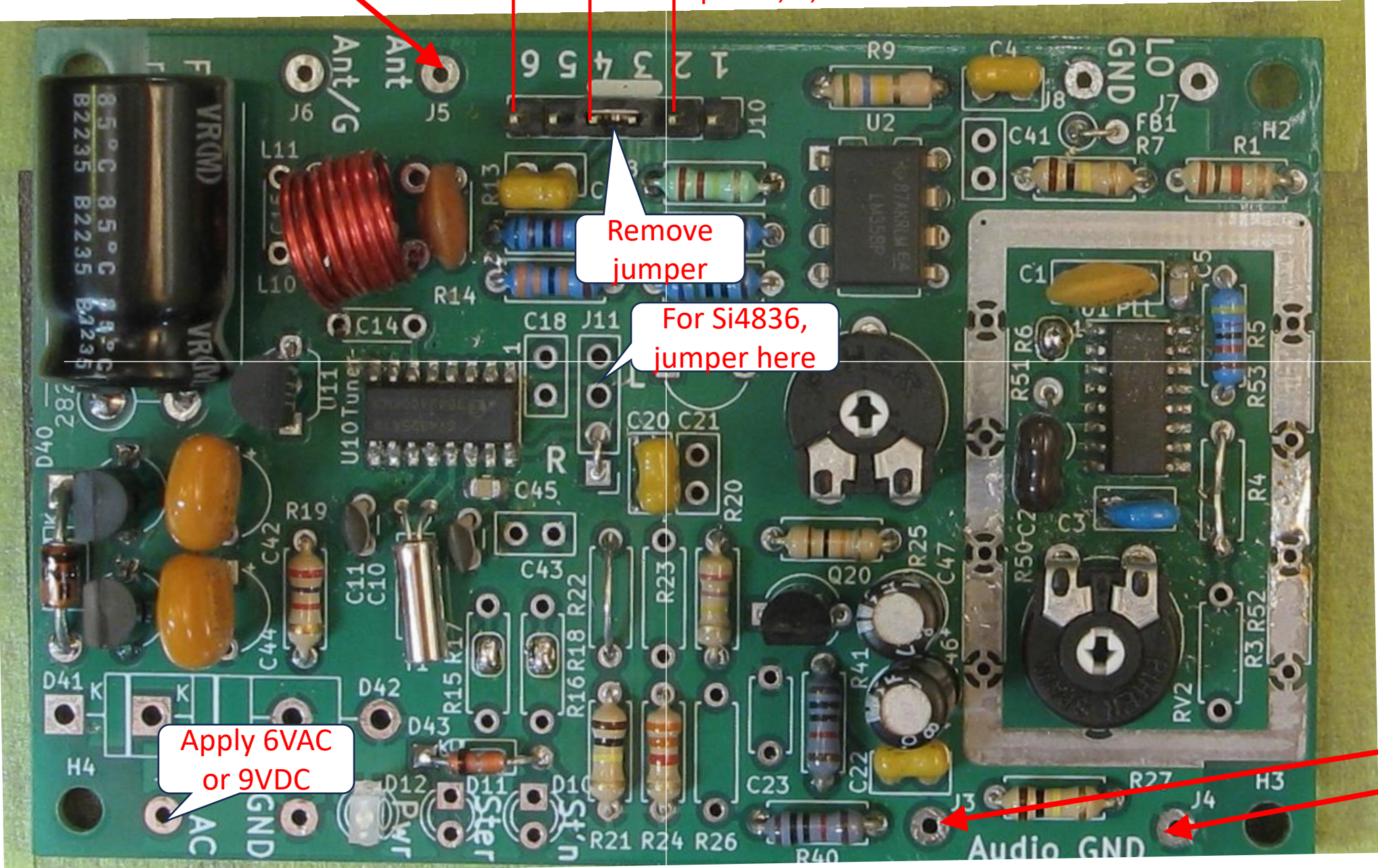
Apply 6VAC or 9VDC

To an audio amplifier

Connect an audio amplifier, antenna, power source (9V battery works), and a 50K pot.

If you use a Si4836 chip, jumper pins 1 to 2 and 3 to 4 on J11

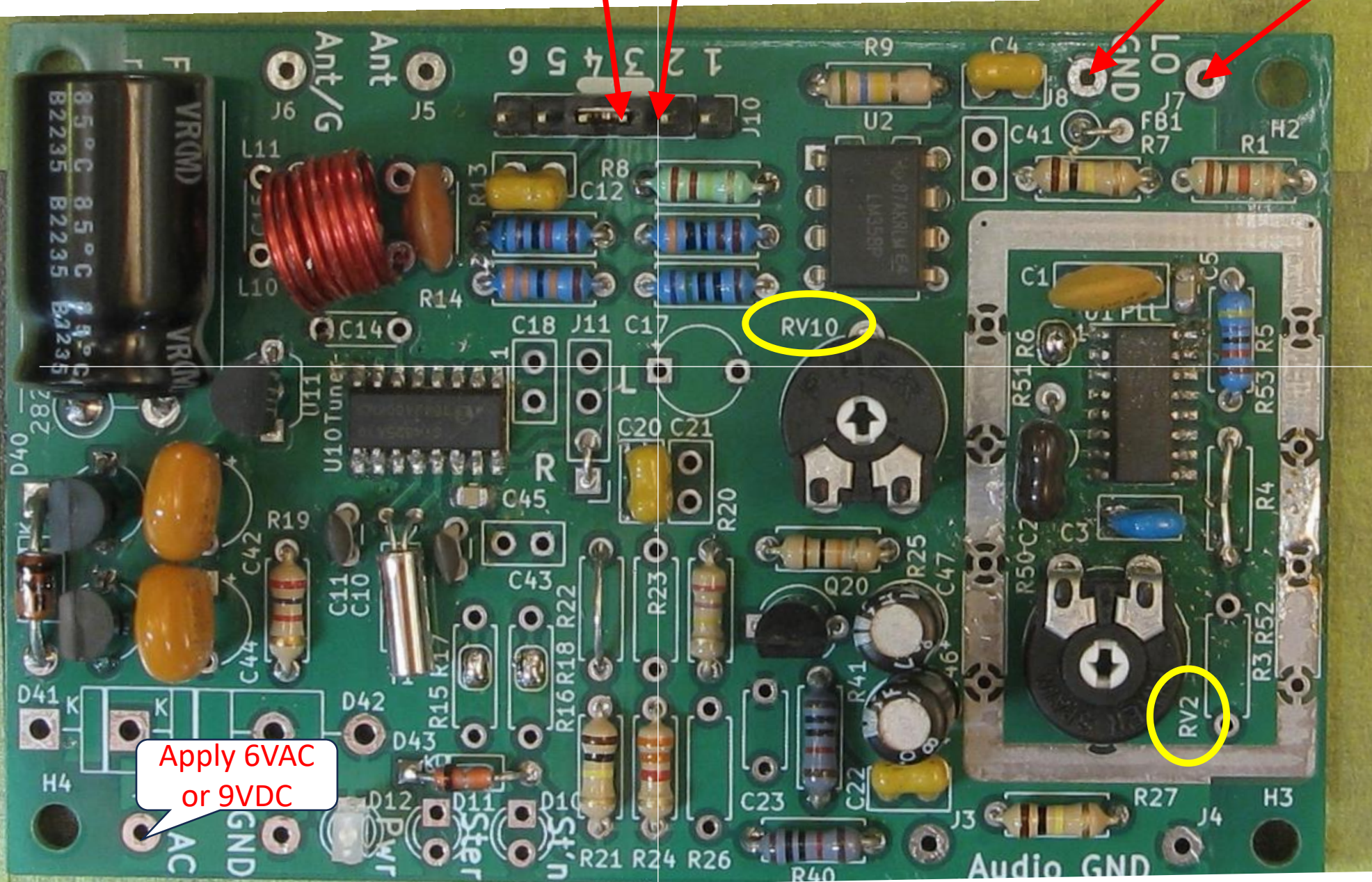
As you rotate the pot, you should receive stations across the entire FM band with good fidelity.



# PLL Adjustments and test

To Voltmeter  
(3 to 2=ground)

To an adjustable, stable RF  
source, 1MHz to 2MHz



Connect an RF source, power source (9V battery works), and a voltmeter.

Rotate RV10 fully clockwise, RV2 fully counterclockwise.

Set source to 1MHz. Rotate RV2 until the voltage rises (50mV max)

Set source to 2MHz. Adjust RV10 for 1V on voltmeter.

As the source is varied from 1MHz to 2MHz, the voltage should vary smoothly from under 0.05V to 1V

Full Test (after PLL adjustment) 1m antenna wire

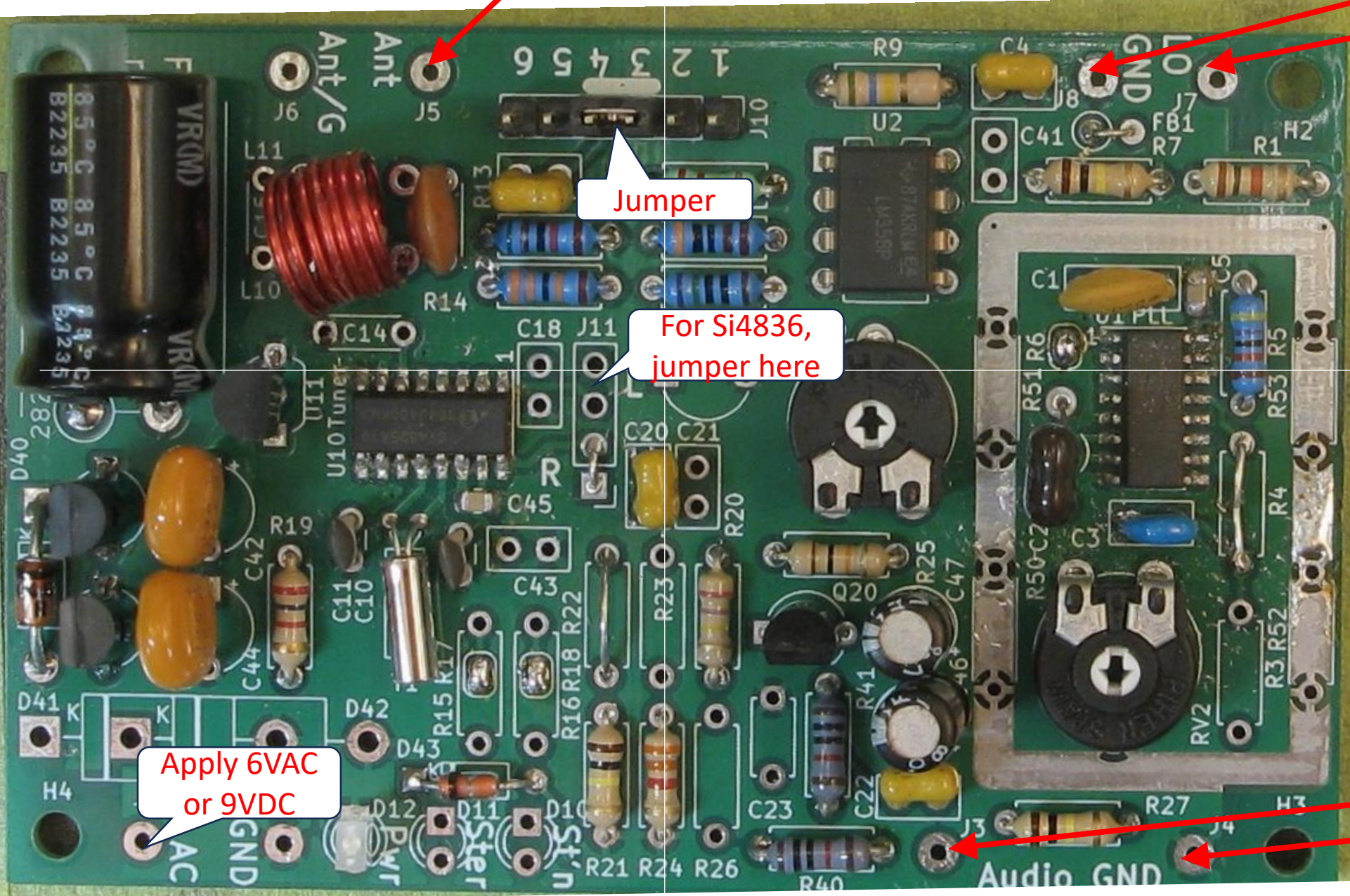
To an adjustable, stable RF source 1MHz to 2MHz

Connect the RF source, audio amp, antenna, power supply (or a 9V battery works).

Jumper J10 from pin 3 to 4. If you use a Si4836 chip, jumper pins 1 to 2 and 3 to 4 on J11

As the RF source is adjusted from 1MHz to 2MHz, stations across the full FM band should be heard.

To an audio amplifier



Jumper

For Si4836, jumper here

Apply 6VAC or 9VDC

# Alignment

- Jumper J10 pin 3 to 4. If you use a Si4836, jumper J11 pins 1 to 2 and 3 to 4
- Connect board to radio as described in the FM\_conversion\_ACset or FM\_conversion\_AA5 or FM\_conversion\_car radio
- Connect a DC voltmeter from J10 pin 4 to pin 2 (ground).
- You might need an antenna, a metre of wire.
- Turn on radio and let it warm up. Rotate RV10 fully clockwise, RV2 fully counterclockwise.
- Tune the radio to where you want the low end of the FM band to be (probably around 550kHz).
- The voltage should be quite low, 10-20mV or so, Rotate RV2 CW until the voltage just starts to rise, no more than 50mV.
- Tune the radio to where you want the high end of the FM band to be (probably around 1600kHz).
- Adjust RV10 until the voltage 1.0V.
- You're done. As you tune the radio across the band, you should hear all your local FM stations!