Ali Express AM Transmitter Kit

This kit is a revision of a kit sold earlier on AliExpress with a few more added components to address the issues with harmonics and noise in the power section. The instructions included with the kit are written in both Chinese and English. The description of the circuit is good and it resembles that of an Armstrong Regenerative receiver thrown into permanent oscillation. Although the kit can be purchased in the US and Canada, IT IS NOT A PART 15 TRANSMITTER as designed or built. The included documentation states the transmitter output power at 400 mW, four times the maximum allowed power of 100 mW under FCC Part 15 rules. In order (attempt) to meet Part 15 requirements, it is suggested that the operating voltage be reduced to 6 volts and keep the total length of the antenna less than 4 feet. The kit will tune to approximately 1845 Khz by adjusting the padding capacitor on CV (tuning capacitor) and the tuning slug on B1 (tuning inductor). On 160 meters it can be operated as QRPP (extreme low power operation). The kit can be operated with a voltage up to 12 volts on the 160m band for increased output. To do so, two electrolytic capacitors and a resistor will need to be replaced. See text for details.

Before you fire up the soldering iron, you need to inventory all of the items that came with the kit.

Parts List

Resistors 1/8 Watt Unless Specified:

R1,R6	33 Ohm (Orange Orange Black Gold)
R2, R3	470 Ohm (Yellow, Purple Brown Gold)
R4,R9,R13,R14	2K Ohm (Red Black Red Gold)
R5,R8	10K Ohm (Brown Black Orange Gold)
R7	5.1 K Ohm (Green Brown Red Gold) PC Board shows 5K1 Schematic shows 8K2
R10	100 Ohm (Brown Black Brown Gold)
R12	10 Ohm (Brown Black Black Gold) PC Board shows 10 Schematic shows 100
R11,RX	75K Ohm (Purple Green Orange Gold)
R15	2.2 Ohm 1 Watt (Red Red Gold Gold)
SW1	50K Ohm potentiometer With Switch for power
SW2	200 Ohm mini potentiometer Marked 201
SW3	20K Ohm mini potentiometer Marked 203
SW4	50K Ohm potentiometer Marked B503

Capacitors

C1,C6,C7,C13	470 µF 16V Electrolytic
C2,C4	100 nF (0.1µF) Cermic Disc Marked 104
C25,C28	0.1 µF Orange Film
C3, C5	10 nF (.01 µF) Ceramic Disc Marked 103
C8,C17,C22,C23	220 µF 16v Electrolytic (Replace C22 and C23 with 16V types) Do not use 10V type.
C9	4.7 µF 50V Electrolytic
C10	1500 pF (1.5nF) Green Marked 152
C11,C12	100 µF 16V Electrolytic (your kit may be supplied with 10V capacitors Replace with 16V ones)
C20	470 pF Ceramic Disc Marked 471
C14,C15,C16	
C18,C19,C21	
C24	20000 pf (20 nF, .02 µF) Ceramic Disc Marked 203
C26	2700 pF (2.7 nF, .00027 µF) Ceramic Disc Marked 272
C27	1500 pF (1.5 nF, .00015 µF) Ceramic Disc Marked 152
CV	300 pF variable

Semi Conductors

IC1	TA7638P Audio IC
Q1,Q2	9018 NPN Transistor (2N3904 or 2N2222 equivalent)
Q3,Q4	D882 NPN Power Transistor

D1	LED (Light Emitting Diode)
D2	1N448 Diode

Inductors

B1	Toko Type canned inductor (Black slug – Usually 455 Khz Oscillator Coil)
L1	50 Turn Slug Tuned Inductor (Pre-Tuned to 0.04 mH) Large black coil
L2,L3	26 Turn Slug Tuned Inductor – Small Brown Coil – See Text for adjustment
T1	10 Turn : 10 Turn Large Toroid inductor (10 turns on each side)
T2	10T : 10T Small Toroid Inductor (10 turns wound together – Bifilar winding)

Misc Parts

J1	2.3mm Barrel power jack
J2	3.5mm Stereo audio jack
J3,J4	M4 screw terminal for Antenna and ground leads
	Two screws to mount tuning capacitor
	Heat sink for Q3 with screw and nut
	Printed circuit board
	3.5mm to 3.5mm audio cable. One meter in length (39 inches)

Optional Parts

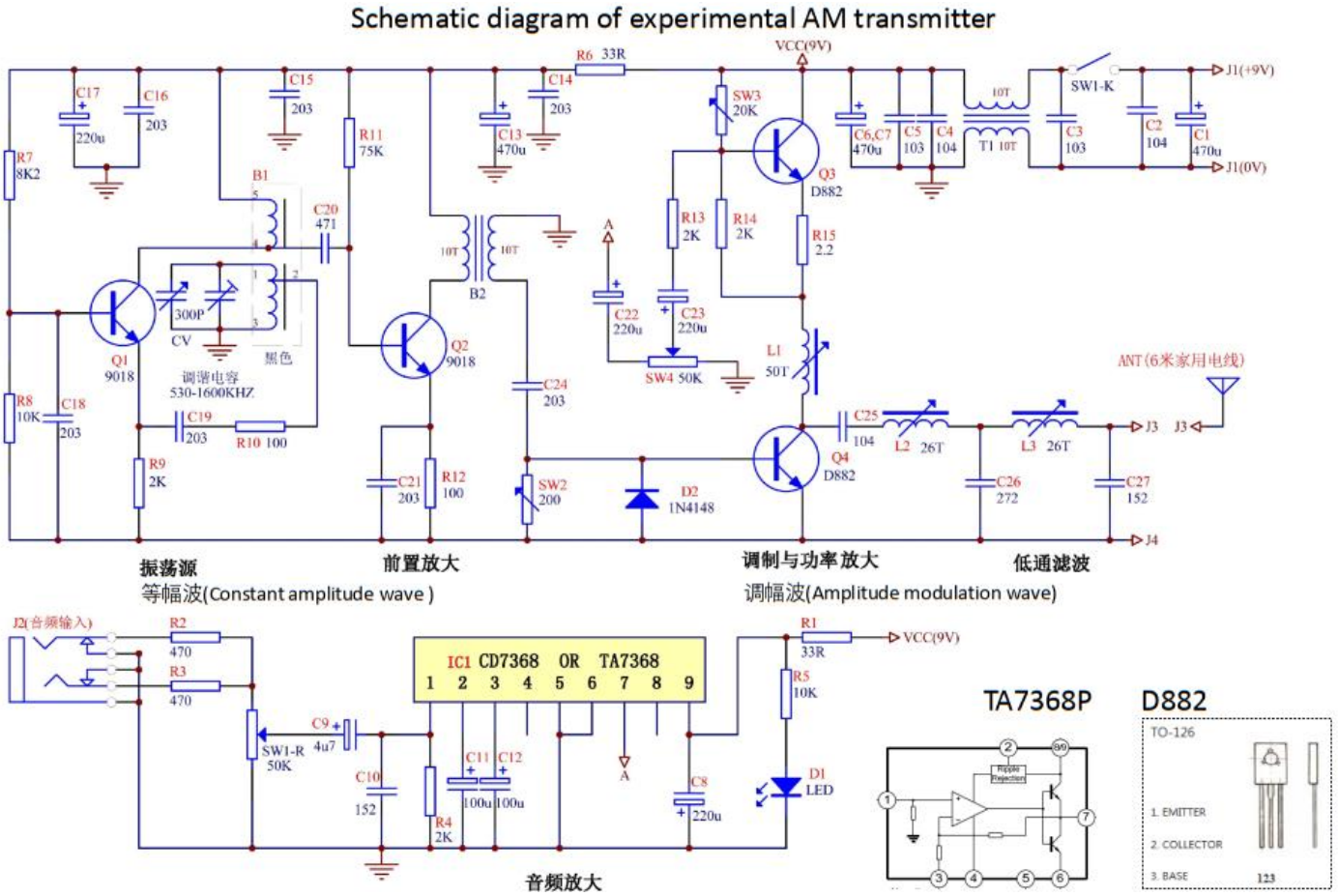
Aluminum Heatsink for Q1 and IC1. See Text for details
68 or 100 Ohm 1/8 watt resistor to replace R1 if operated with VCC at 12 or 13.6 V
Two 220 µF 16v electrolytic Capacitors to replace C22 and C23 See text
Four 12mm (1/2 inch) circuit board stand offs
Knob and M2 screw for SW1 Input volume potentiometer
Knob and M3 screw for CV Tuning Capacitor

Tools required or recommended to build this kit:

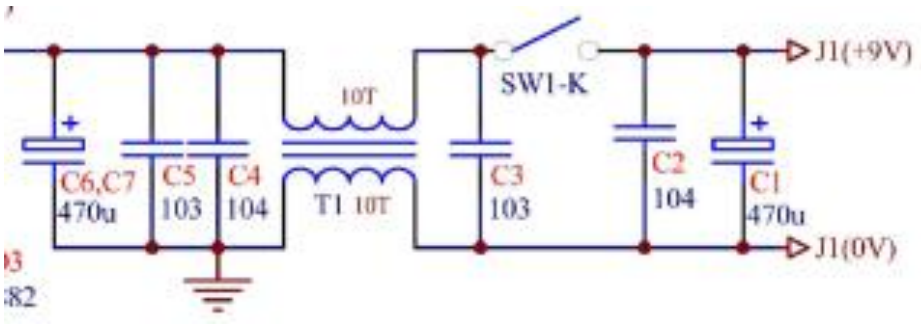
You will need, at minimum, a 25-40 Watt pencil soldering iron, 0.8mm (1/32 inch) 60/40 solder, small Phillips and Flat blade screw drivers, needle nose pliers and wire cutters. An analog or digital multimeter is recommended for checking voltages as well as an Arduino Component checker for identifying those tiny resistors. Both are available online for less than $20US. A beginners oscilloscope (online for less than $150US) will be handy to look at the waveforms.

Organize your parts layout

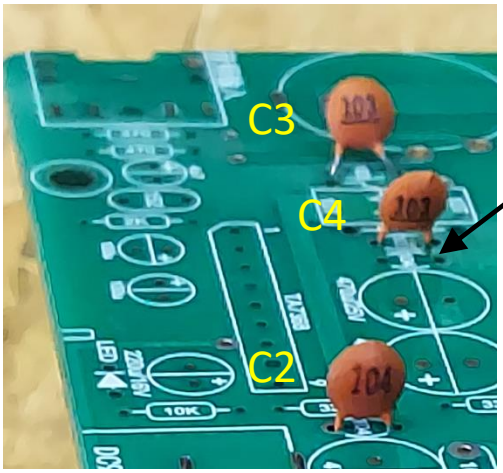
Get a small block of foam. Organize and stick all of the parts into the foam for easy access. Label the resistors on the block by their value. The resistors are color coded and extremely small. Unless you have magnifying eyeballs and have the color code memorized, it is best to measure each resistor with a meter or component tester before sticking them into the foam or placing them into the printed circuit board.



Building the Power supply section



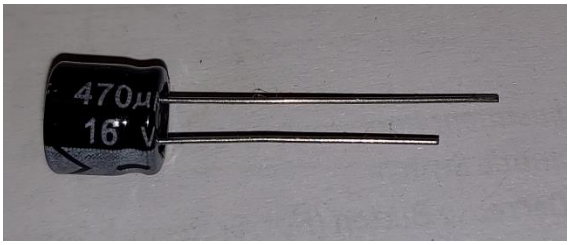
Start by inserting and soldering in place C2, C3, C4 and C5. The PCB is labeled with the correct values.

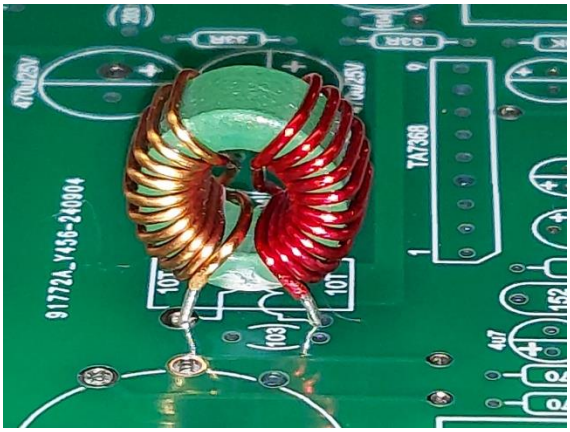


The bottom disc capacitor is C2. The top one pictured is C3 and the middle one is C4. C5, not pictured, goes directly in front of C4 and is marked 104.

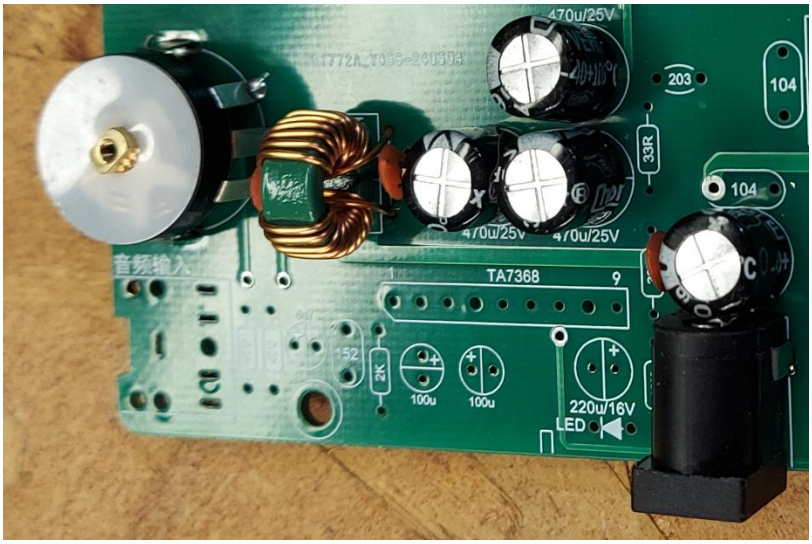
Next install C1, C6, C7 and C13. These are 470 µF 16V Electrolytic capacitors. The PCB shows them as 25V but 16V capacitors are the correct ones. Make SURE you install these correctly. LOOK at the picture below. The Negative side is ALWAYS marked with a white stripe and a minus sign. The negative lead is ALWAYS shorter than the positive lead.

The picture shown here has the capacitors in the CORRECT position.





Install and solder in place T1. This is the toroid transformer with two windings on opposite sides. Your transformer may have the same color of wire on both sides. Install it just the way you see it in the picture at left.



The final components of the power supply section are SW1, the volume potentiometer and switch combo and J1 the power jack.

Check your work.

Are the electrolytic capacitors installed correctly? Are all four disc capacitors installed at the correct locations? Is T1 the correct toroid inductor and is it installed as shown? Are all solder joints clean and shiny?

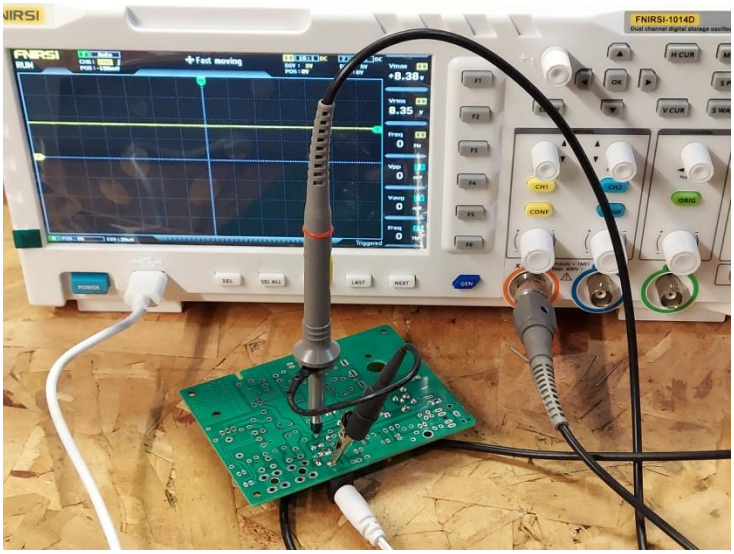
Time to check voltages. Find a suitable 9 volt power supply (6 volts if you plan on using this under Part 15 rules).

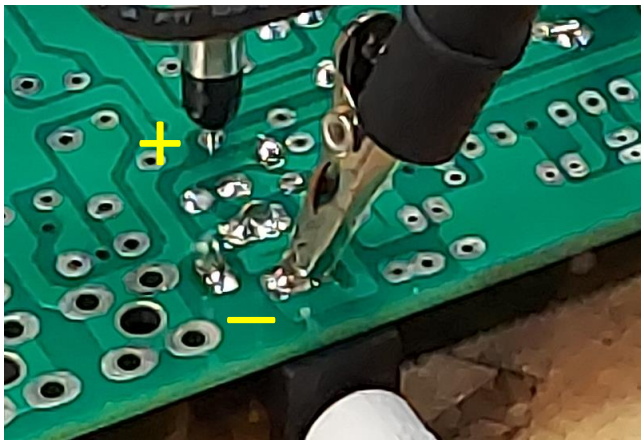
You may use either a linear (pictured at left) or a switching (pictured at right) supply. The differenc e is that a switching supply is physically smaller and weighs less than the linear supply. A switching supply's output voltage is constant. It measures the same with or without a load (plugged in or not plugged in to the transmitter). Linear "Wall Wart" type supplies typically do NOT have voltage regulators built in to them. With no load (not plugged in) on a 9 Volt Linear supply the voltage will measure somewhere about 14.5 Volts. Under load (plugged in) it will measure about 13.5 volts.

If you plan on using a linear supply, you should consider modifying and substituting parts later on in this project build.

Both switching and linear supplies will have some kind of noise on the voltage output. The switching supply will have high frequency noise like a whistle or rushing sound at low volume in the AM signal. The linear supply will have some AC ripple (50 or 60 Hz depending on the country you live in) and will sound like a low hum. The parts you just soldered on the PCB is a filter to lessen or eliminate this noise and deliver a clean DC voltage to the transmitter.

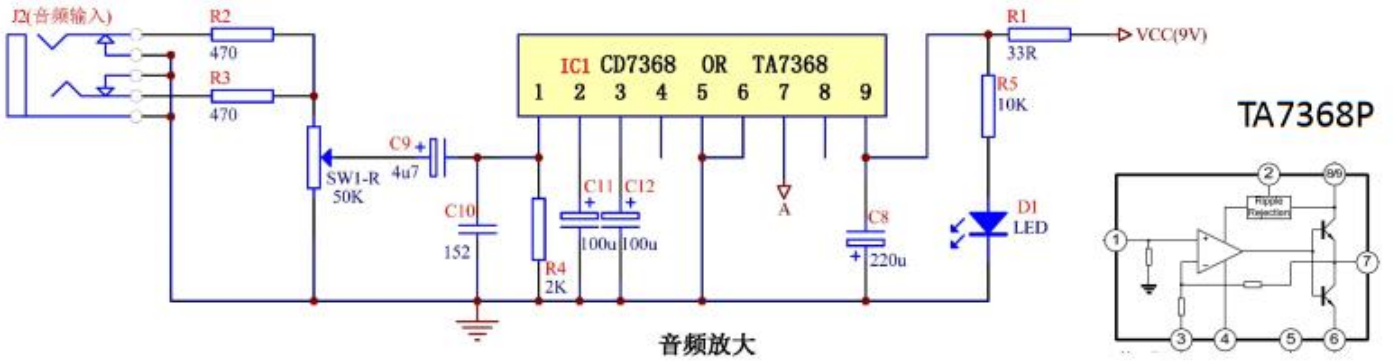
Measuring the supply voltage





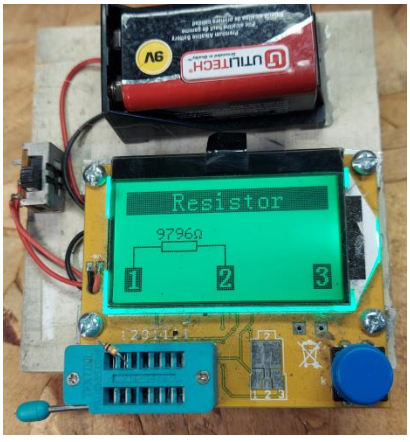
With an oscilloscope or multimeter, measure the voltage at the points shown above. With an 8 volt switching supply, the voltage should read about 8.35 volts. If you get no voltage, check to see if SW1 is switched ON. Check your work again. Make sure all solder joints are clean and all parts are installed correctly.

Building The Audio Amplifier Section

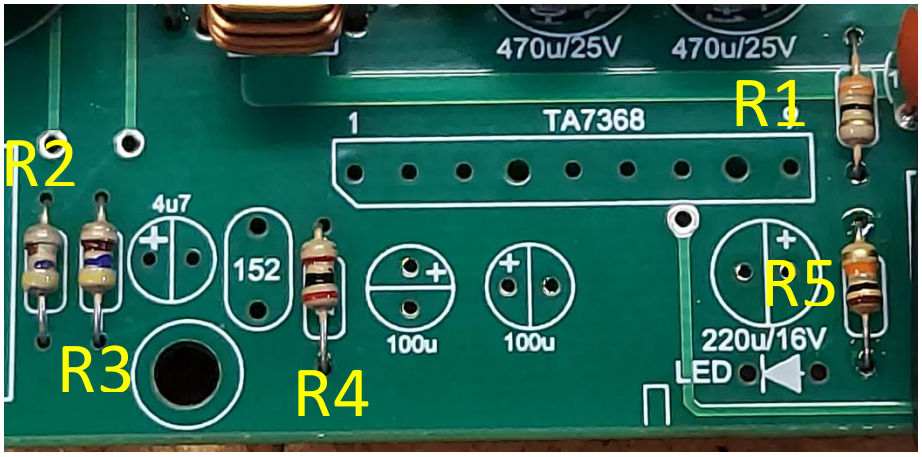


The designer(s) of this transmitter chose to use a TA7368P amplifier IC over the more common LM386 for a couple of reasons. The TA7368 only requires four external parts (not including the volume control and speaker). This kit adds three more for input noise and fidelity filtering. The LM386, while being a slightly cheaper amplifier IC, often goes into oscillation (howling and squealing) at moderate volume levels. It requires far more parts and the circuit layout and component placement is critical to prevent random oscillations. The TA7368P does not exhibit the problems associated with the LM386. The circuit layout is not critical and is limited to a maximum operating voltage (VCC) to 14 Volts. At that voltage it will deliver just over 1 Watt of power but will need a heat sink fashioned for it if operated over 12 Volts VCC. A capacitor is REQUIRED on pin 7 if you want to test it with a speaker. Without the capacitor the speaker presents a short circuit on pin 7. No output will be heard and the IC will begin overheating.

Begin construction of the audio amp by inserting and soldering R1 33 Ohm (Orange Orange Black Gold), R2 and R3 470 Ohm (Yellow, Purple Brown Gold), R4 2K Ohm (Red Black Red Gold) and R5 10K Ohm (Brown Black Orange Gold). Use a multimeter or component checker to verify EACH resistor BEFORE you insert and solder them in place.

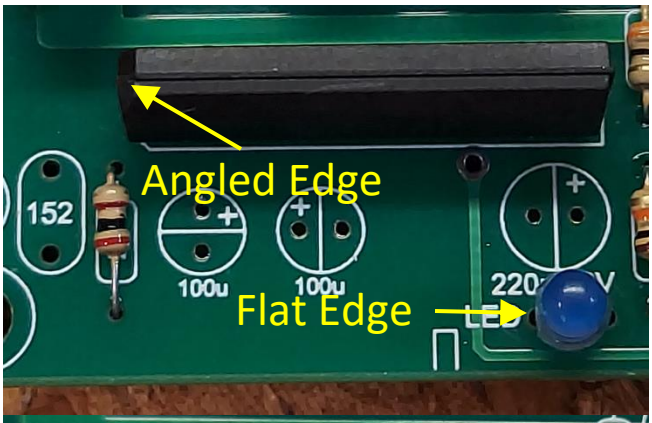


The resistors are VERY SMALL. You will need a magnifying glass to see the color bands on them. The component checker shown at left is an excellent tool to verify resistors.

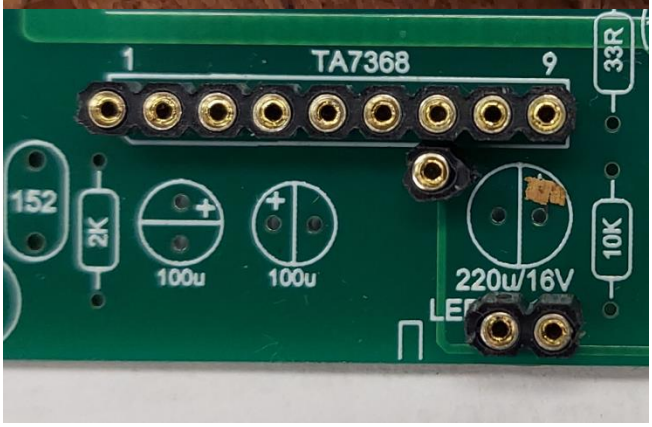


If you plan on operating this on the 160 meter Ham band at 12 volts VCC, replace R1 (33 Ohm) with at least a 68 Ohm resistor. This will insure that the input VCC voltage to the IC is less than or slightly less than 12 Volts when powered by a linear supply.

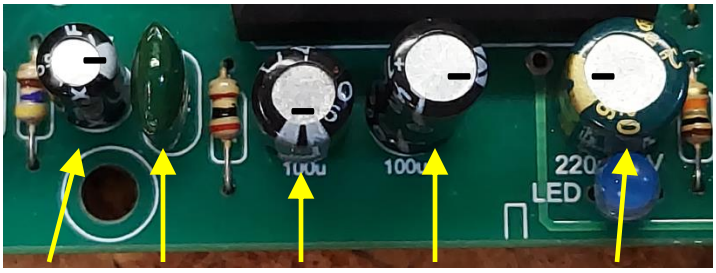
Next insert and solder in place IC1 and D1 (LED).



The angled edge on the IC is pin 1. The flat edge on the LED is the Cathode side. The Cathode side is also the shorter lead. If you get these inserted wrong the IC will heat up considerably and may damage it. The LED won't be damaged. It simply will not light up if inserted backward.

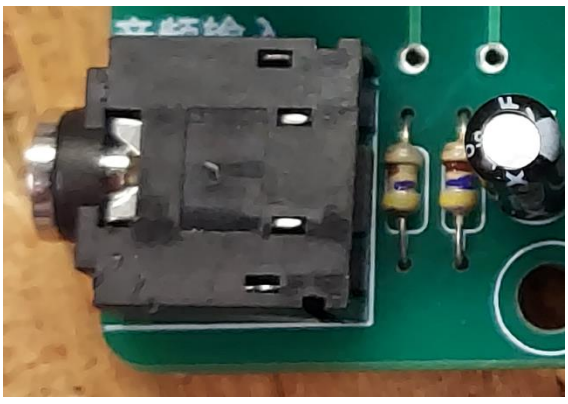


As an alternative option, you can purchase Single Inline Sockets and solder them in place as shown at left. If the IC is inserted backwards, you can easily remove it and insert a new one. The socket for the LED is for mounting the LED in a case of your choice. You will need two leads to plug it in. Just remember to observe the correct polarity or it will not light up. The single socket at pin 7 is for testing the amp with a capacitor and speaker.



Insert and solder in place C9 - 4.7 µF, C10 - 1500 pF (green body marked 2A152J), C11 and C12 - 100 µF, and C8 - 220 µF. C8,9,11 and 12 are electrolytic capacitors. The picture shown here has them inserted correctly. C10 has no polarity.

If your kit is supplied with 10V electrolytic capacitors for C11 and C12, replace them with 16V capacitors.



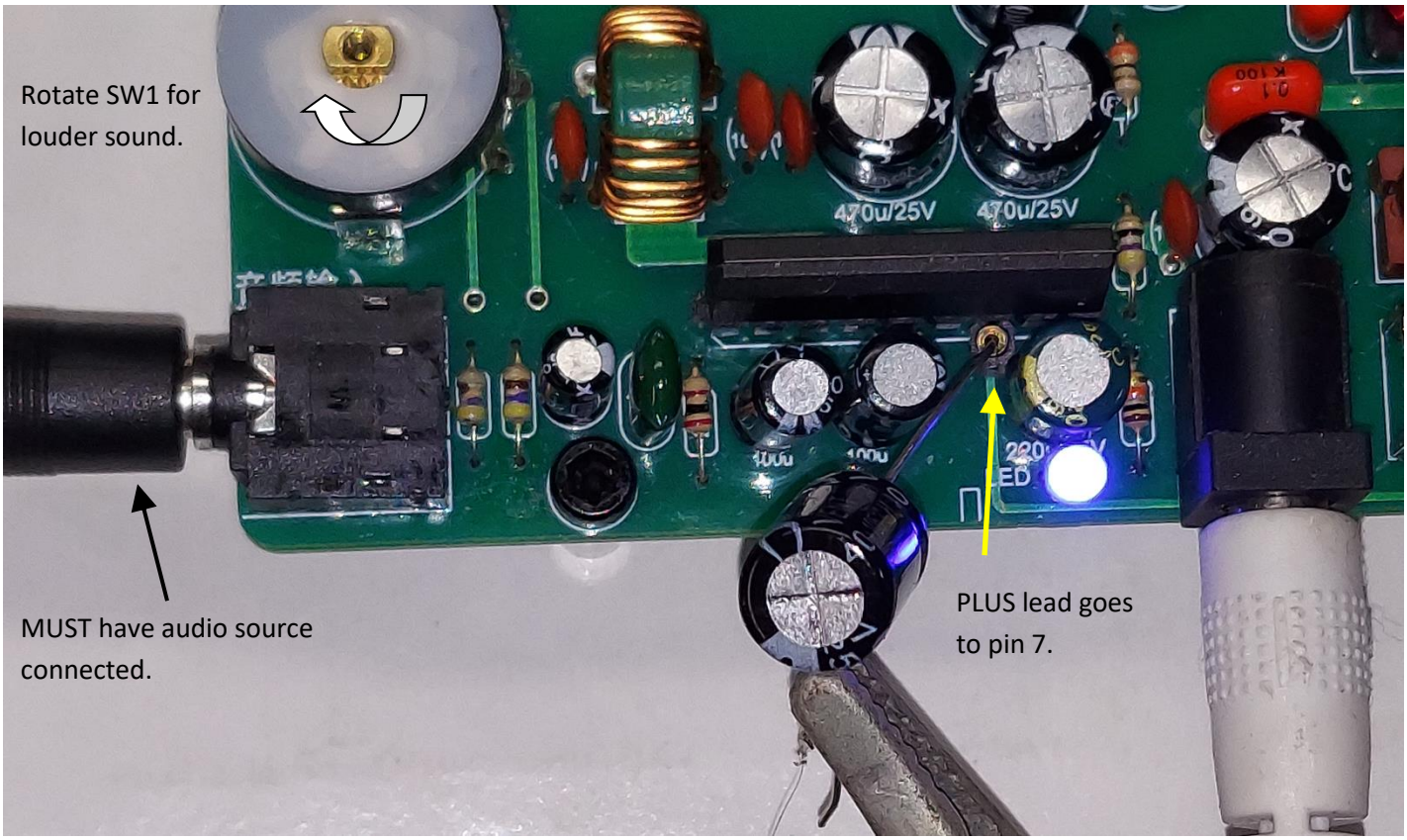
Insert and solder in place J2, the 3.5mm audio jack.

Check your work.

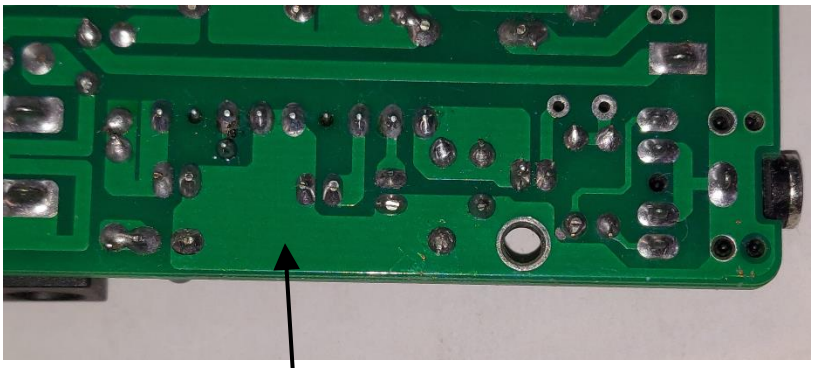
Is the IC installed correctly with the angled edge at pin 1 on the board? Is the flat on the LED facing the word LED on the board? Are the capacitors installed correctly? Are the resistors installed with the correct values?

If all looks good, proceed to checking the audio amp.

Testing the Audio Amp



Connect an audio source (MP3 player, your phone or a radio) to the 3.5mm input jack. Temporarily install a 220 µF capacitor with the POSITIVE lead to the hole at pin 7. Connect a speaker to the NEGATIVE lead of the capacitor and a ground point on the other side of the PC board.

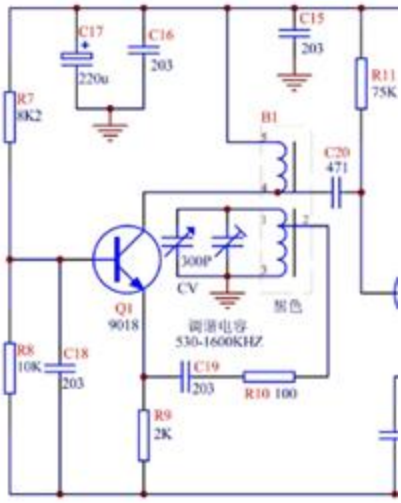


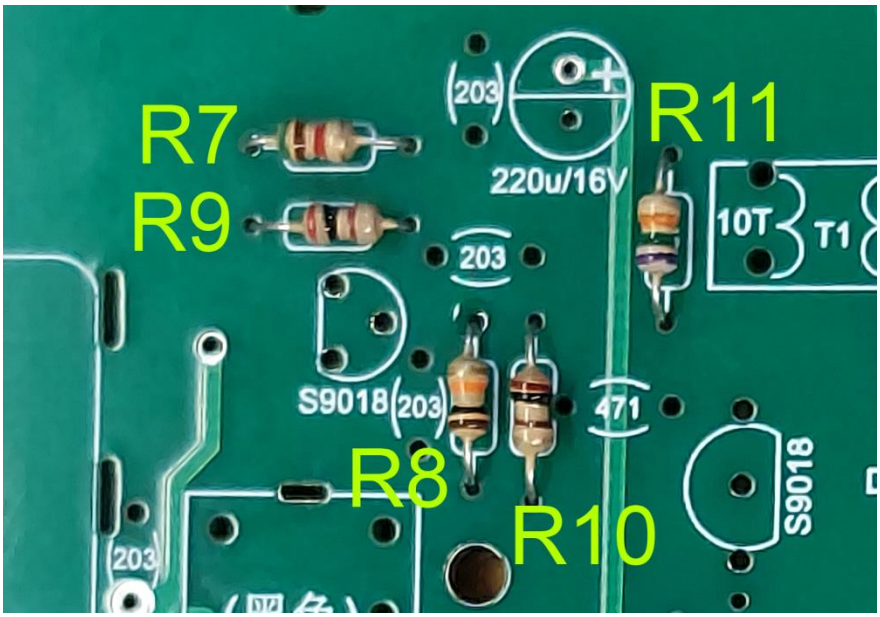
Any solder joint on this area is CIRCUIT GROUND.

Connect 9 volts to the power jack and turn on your audio source. Rotate SW1 enough to hear sound from the speaker. You MUST insert a plug into the audio input jack. Without an audio source plugged in, the input to the IC is grounded and NO SOUND will be heard from the speaker. Even if you touch pin 1 with your finger no sound or hum will be heard until you plug in a source for audio. Do not connect the speaker directly to pin 7. You MUST use the capacitor or the speaker will short pin 7 to ground. No sound will be heard and the IC could be damaged and quickly heat up.

If you hear sound from the speaker, the test is successful. Unplug the power and audio source. Remove the capacitor from pin 7.

Building the Feedback Oscillator





Install and solder in place:

R7 5.1K (Green Brown Red Gold) Resistor

R8 10K (Brown Black Orange Gold)

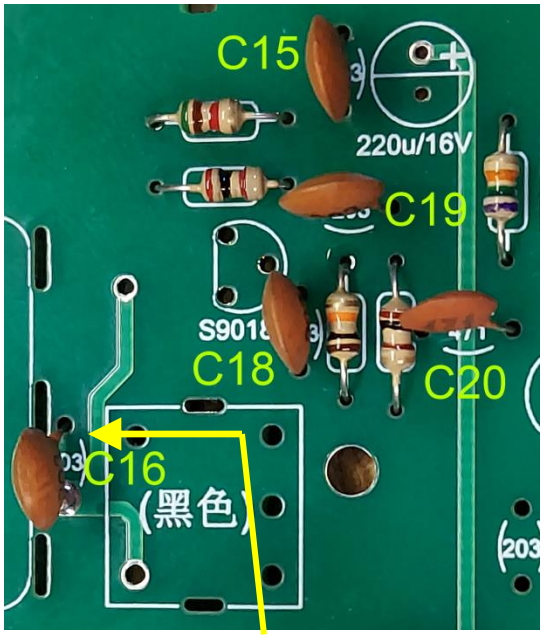
R9 2K (Red Black Red Gold)

R10 100 (Brown Black Brown Gold)

R11 75K (Purple Green Orange Gold)

Remember to check the values with a component checker or multimeter BEFORE you install them.

Don’t forget to install and solder in R6 33 Ohm (Orange Orange Black Gold) resistor. If you forget this resistor, there will be no voltage or power present at Q1 or Q2.



Install and solder in place:

C15 20 nF or .02 µF Ceramic Disc Capacitor (Marked 203)

C16 20 nF or .02 µF Ceramic Disc Capacitor (Marked 203)

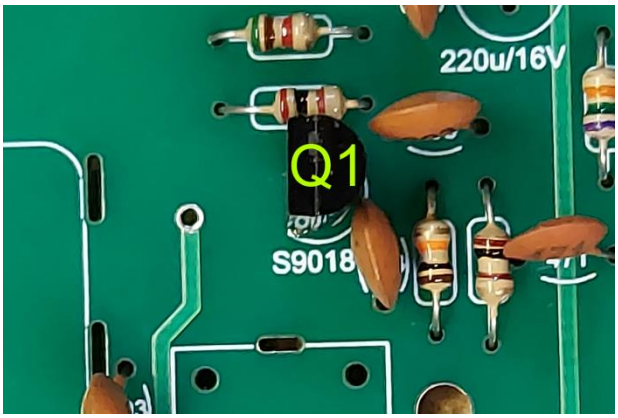
C18 20 nF or .02 µF Ceramic Disc Capacitor (Marked 203)

C19 20 nF or .02 µF Ceramic Disc Capacitor (Marked 203)

C20 470 pF Ceramic Disc Marked 471

DO NOT SOLDER THIS LEAD IN PLACE.
Wait until you install CV, the tuning capacitor.

Also Install and solder in place C14 20 nF or .02 µF Ceramic Disc Capacitor (Marked 203)



Install and solder in place

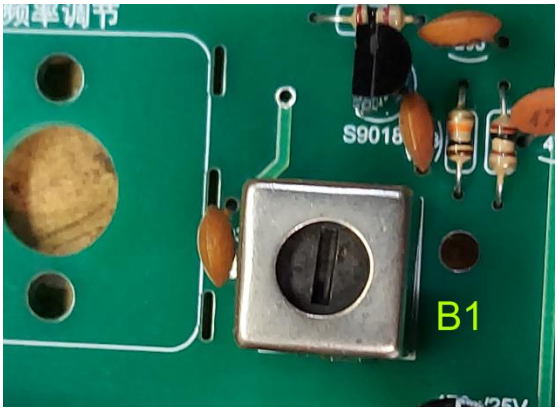
Q1 9018 NPN Transistor

Bend the middle lead slightly AWAY from the flat and insert it in place. The flat on the transistor MUST face left as shown in the picture.

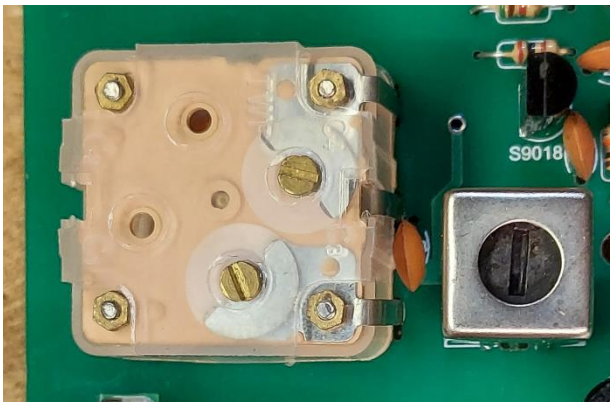
Install and solder in place:

C17 220 µF 16v Electrolytic Capacitor.

This is a POLARIZED capacitor. The NEGATVE lead has the stripe with the minus sign on it and points to the center of the PC Board. The picture at left shows the capacitor installed correctly.



Install and solder in place B1, the metal can inductor. It only fits in ONE WAY. Make sure it sits flat against the PC board when soldering it in.



Install and solder in place CV the tuning capacitor. If you made the mistake of completely soldering both leads of C16 (the ceramic disc capacitor next to it), you will need to UNSOLDER the lead on C16 next to the slot hole to get the middle lead of CV to pass through the hole.

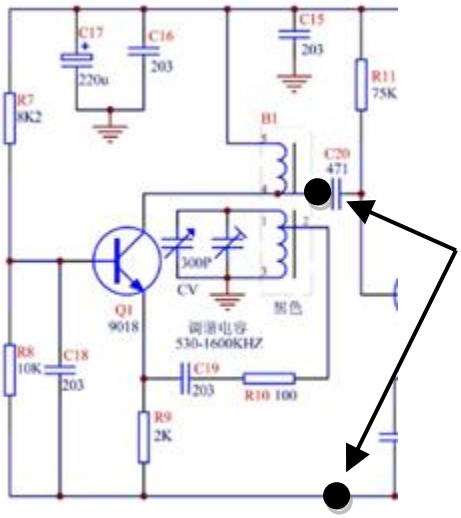
Check your work.

Are ALL resistors soldered in lace with the correct values (check the color codes on them).

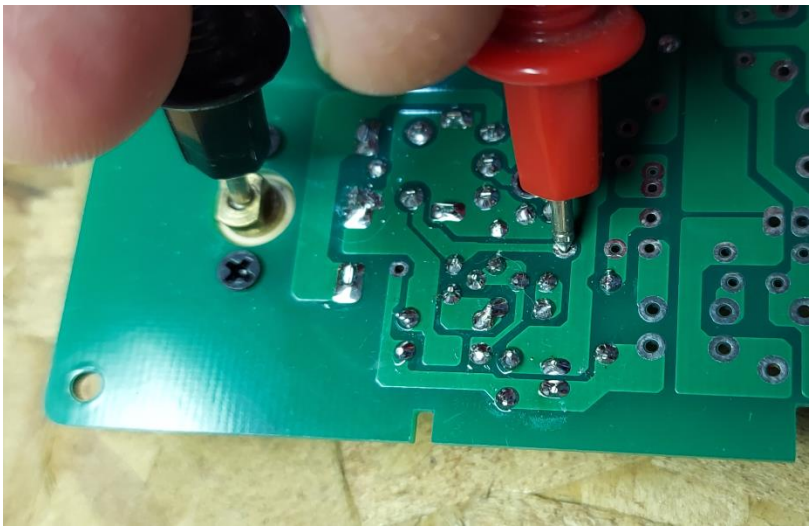
Are all disc capacitors the correct value? Did you solder the electrolytic capacitor in with the correct polarity?

Is the transistor soldered in place correctly? Are the solder joints clean and shiny?

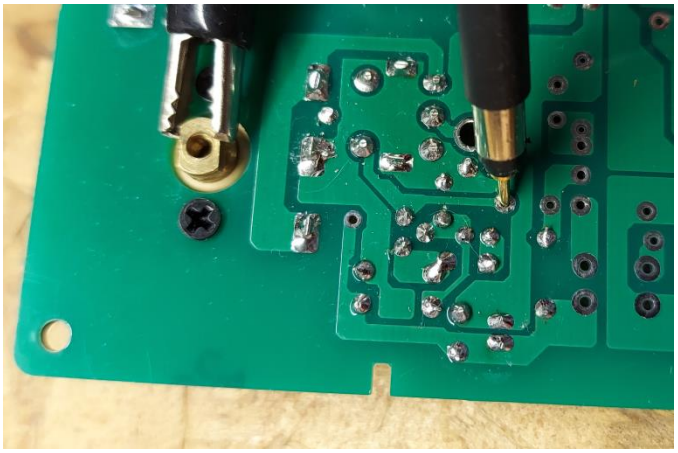
Checking the voltage levels and waveform



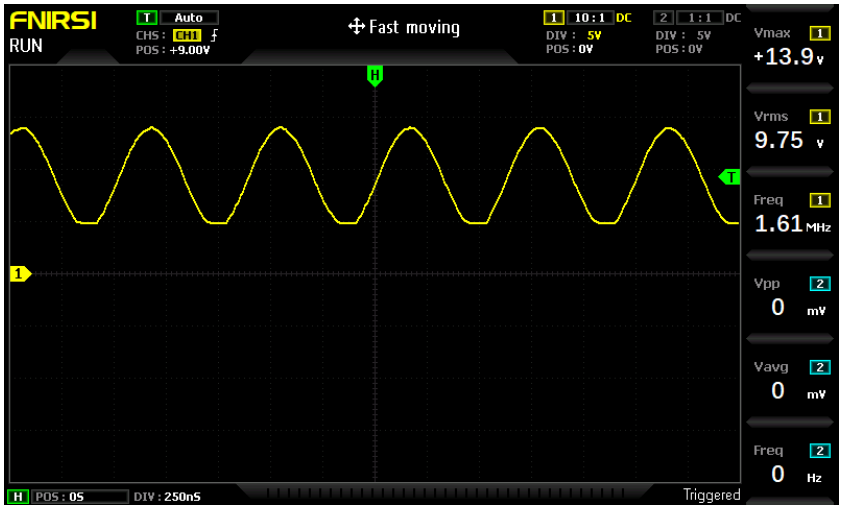
Connect your multimeter at the two areas indicated on the schematic. The positive lead (red) goes to the collector of the transistor. The negative lead (black) goes to ground. Plug in your 9V power source and check the voltage. You should be reading somewhere between 9.0 and 9.3 Volts



Turn the knob shaft on CV all the way to the right (clockwise). Bring a small portable AM radio close to the transmitter. You should hear a strong carrier signal on or about 1610 KHz

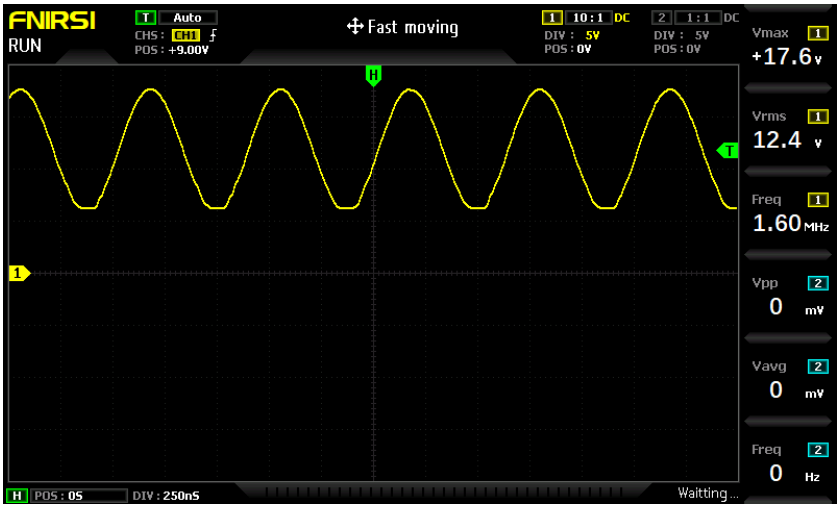


If you have an oscilloscope handy, connect it to the board as shown at left.



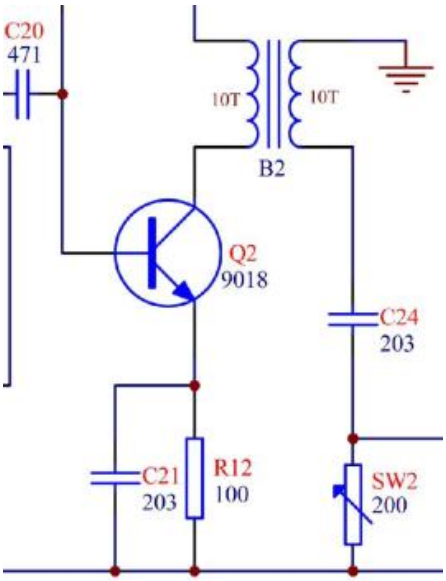
Here an oscilloscope shows the average wavewforem voltage is 9.75 volts (Vrms). The maximum voltage (Vmax) is 13.9 Volts. This is why you MUST replace all 10 Volt electrolytic capacitors with 16 Volt types.

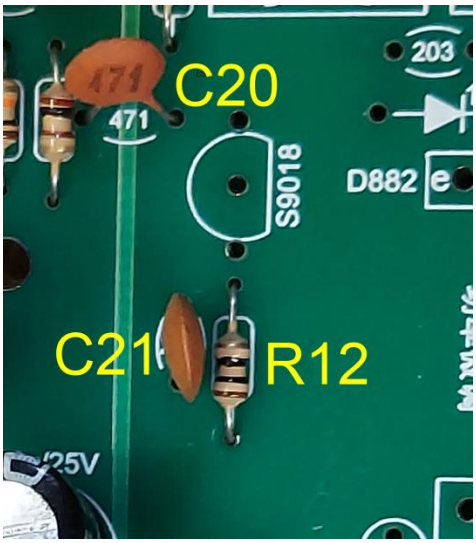
The Vendor/supplier of this kit is **not responsible for damages** caused by the operation of this kit with voltages higher than 9 Volts.



At 12 Volts input, the average voltage is now 12.4 volts (Vrms) and Vmax is 17.6 Volts. Long term operation at 12 volts input will eventually cause C13 and C17 to fail. The MAXIMUM safe input voltage is 10.5 Volts (Vmax=15.9 Volts).

Building the Buffer Amp

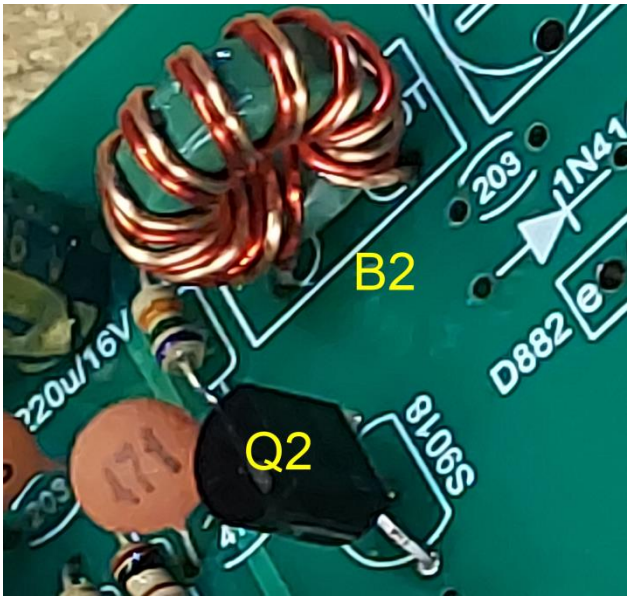




Install and solder in place:

C21 20 nF or .02 µF Ceramic Disc Capacitor (Marked 203)

R12 100 Ohm (Brown Black Brown Gold)



Next install and solder in place:

Q2 9018 NPN Transistor

T2 Toroid Inductor (10 turns wound together – Bifilar winding)

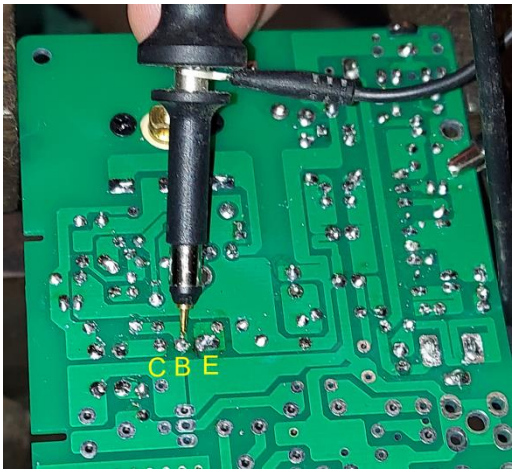
On the board it is marked T1. The schematic shows it as B2

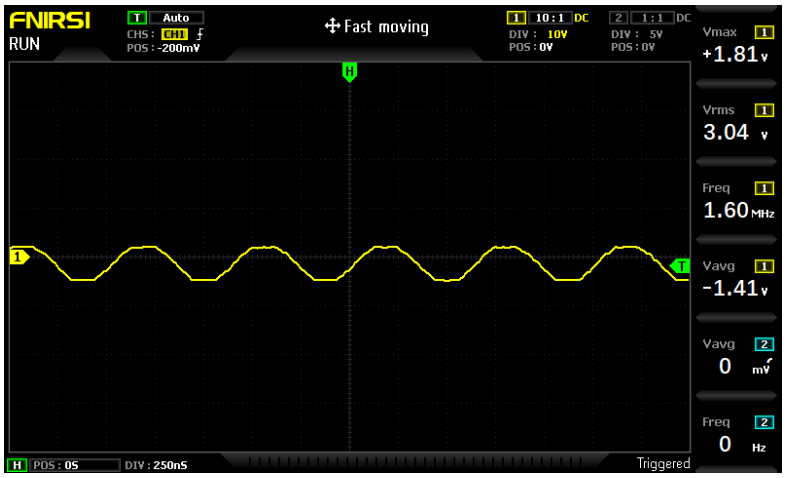
Check your work.

Is C21 and R12 the CORRECT values? Is Q1 and B2 soldered in place correctly as shown? Are all solder joints clean and shiny?

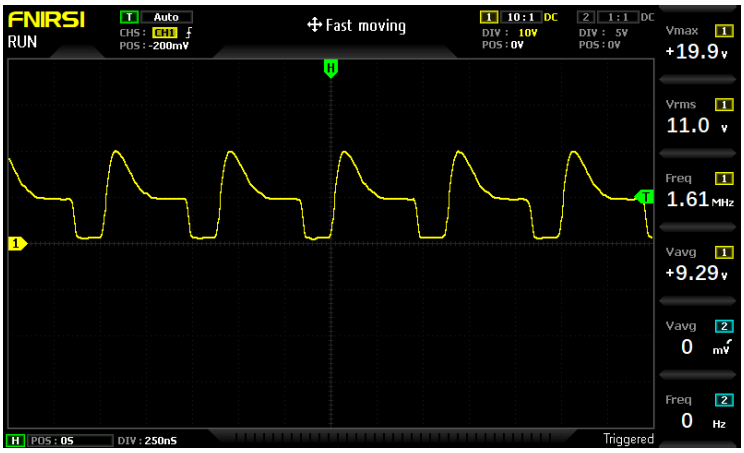
Checking Voltages and Waveforms

With a multimeter check the voltage at the base of Q2 (point B shown at left). It should read about -1.5 volts. If you have an oscilloscope, you should see the waveform at right with Vavg = -1.4 volts.

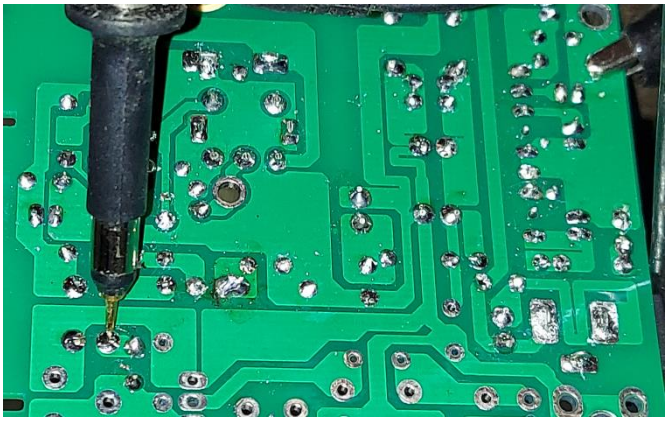


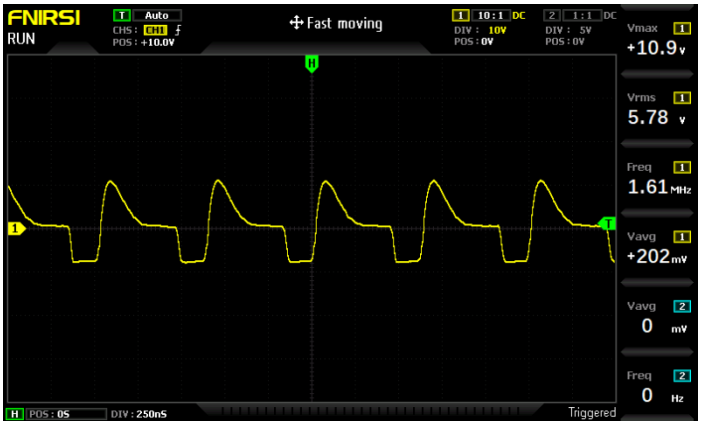


Now check the voltage at the collector of Q2 (point C shown at left). The oscilloscope no longer shows a pure sine wave. This is normal. The waveform will be filtered and reshaped to a sine wave in later stages.

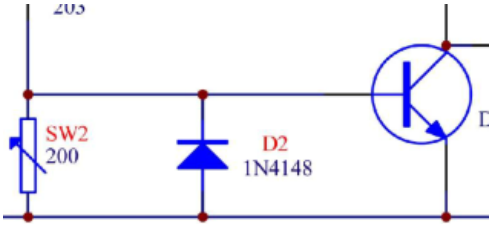


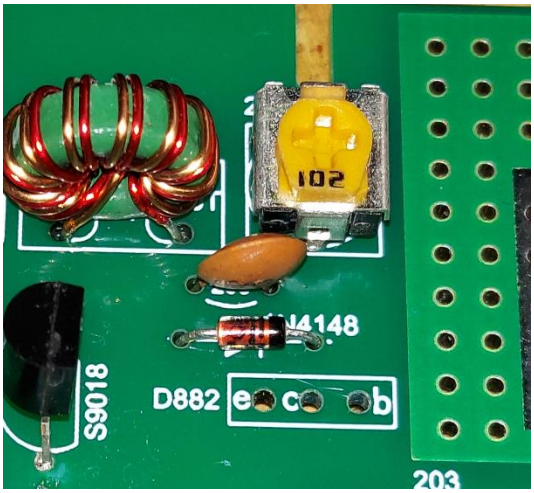
Finally check the voltage at the output of B2 shown at left. The multimeter will show a voltage between -0.5 and +0.5 volts. The oscilloscope shows the same waveform but shifted down.





Build the Power Amp





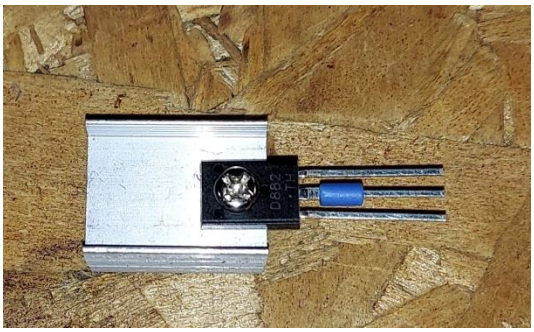
Install and solder in place:

C24 20 nF or .02 µF Ceramic Disc Capacitor (Marked 203)

SW2 200 Ohm mini potentiometer Marked 201

D2 1N448 Diode

Make SURE the black band of the diode is to the RIGHT, pointing towards the 4148 lettering. The picture at left shows the diode installed correctly.



Before you install Q4 (D882 transistor), you MUST purchase and attach a heat sink to the back metal exposed side. Without a heat sink, Q4 WILL get HOT, even with VCC at 6 Volts. With VCC at 10 Volts, Q4 will get hot enough to burn your fingers. An aluminum finned heat sink designed for a TO-220 type transistor should be attached as shown at left. You can get 10 of these heat sinks online for less than $10US.

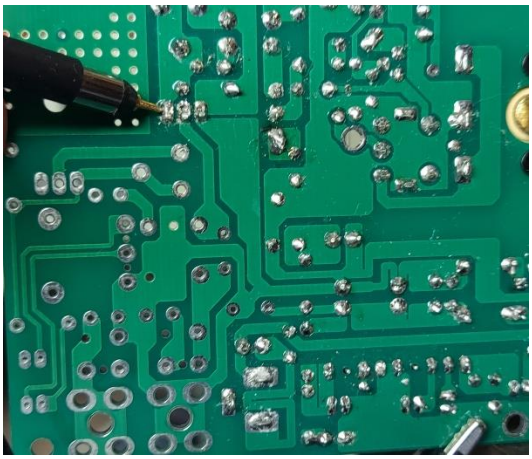
In order to keep the heat sink from touching the toroid windings or the metal case of SW2, strip off about 5mm (1/8 Inch) of insulation from a length of 20 gauge hook up wire. Place that on the middle leg of the transistor. Then insert that into the PC board and solder it in place with the fins toward the potentiometer SW2.

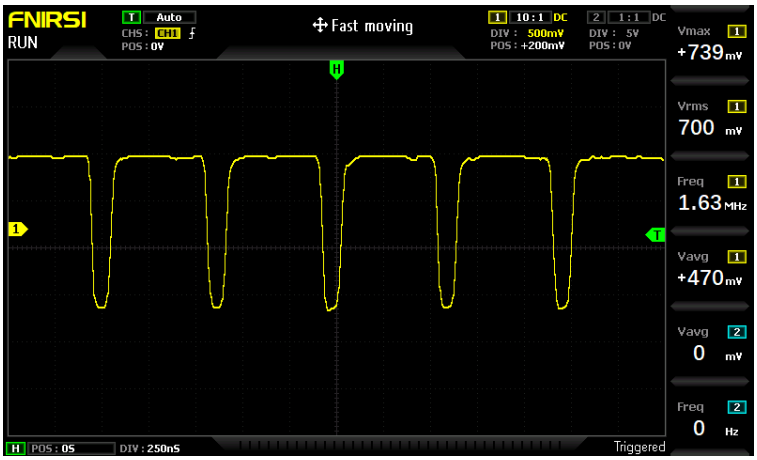
The picture at left shows Q4 soldered correctly in place.

Check your work.

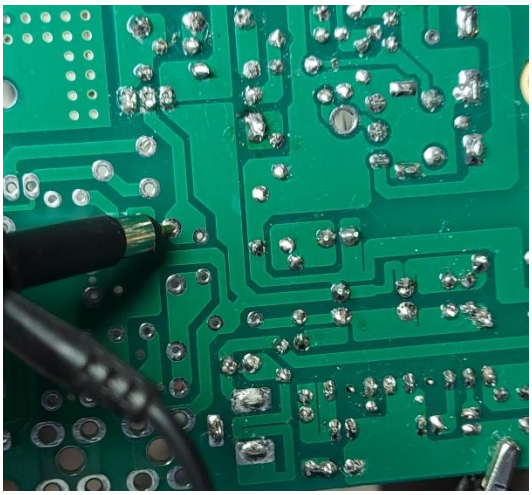
Did you install the correct capacitor value? Is the band on the diode installed to the right as shown in the picture? Did you attach a heat sink on Q4 and install it correctly?

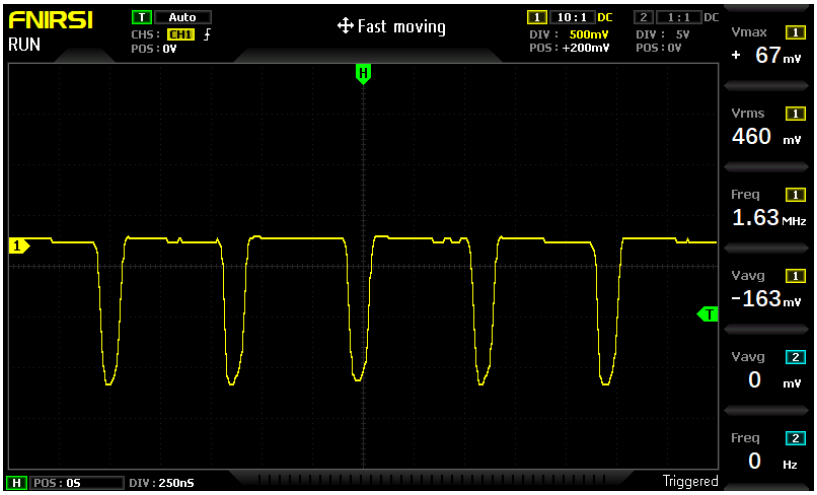
Checking the Waveform





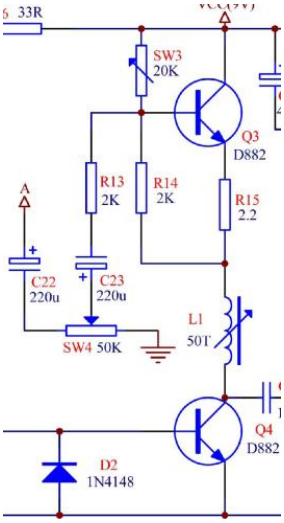
Check the voltage at the base of Q4. A multimeter will show an average voltage of about 500 mV. The oscilloscope shows an almost square wave pattern.





On the collector of Q4 the voltage drops to -160 mV. The oscilloscope confirms the pattern drop.

Building the Modulator and Final Output.

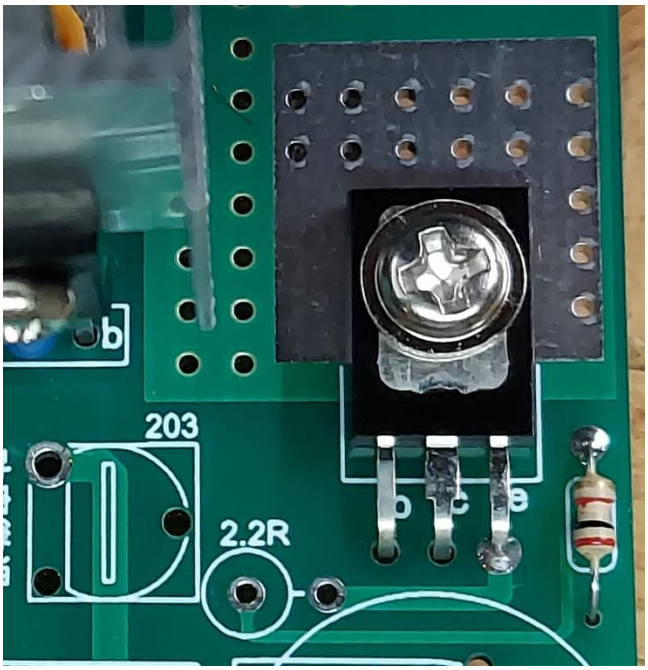


Install and solder in place the following components:

C25 and C28 0.1 µF Orange Film Capacitor. The board is marked 104 with an oval shape. The capacitors are marked 0.1. Note that C28 is NOT shown on schematic but is listed on the vendor's included parts inventory.

C26 2700 pF (2.7 nF, .00027 µF) Ceramic Disc Marked 272
C27 1500 pF (1.5 nF, .00015 µF) Ceramic Disc Marked 152

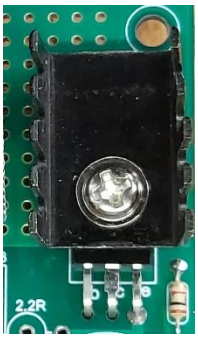
R13 and R14 2K Ohm (Red Black Red Gold) resistors

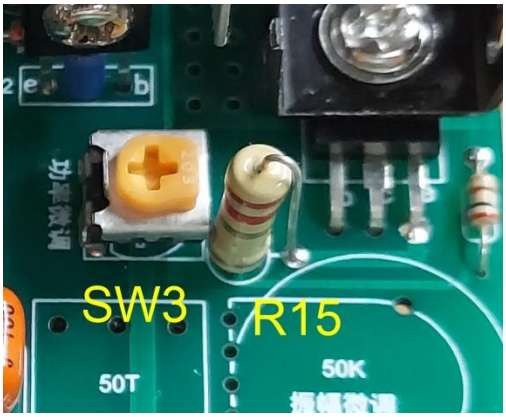


Next install and solder in place Q3, the D882 transistor. Bend the leads of the transistor and use the supplied screw and nut to temporarily secure the transistor to the board. Then solder the leads in place. After soldering and cutting the leads short, remove the screw and nut. Place a small amount of silicon grease on top of the transistor and then mount the black heat sink on TOP with the screw and nut.

This installation method is different than what is shown on the vendor's instructions. If you only plan on operating this as a Part 15 device at 5 or 6 volts VCC, you may install the heat sink under the transistor as shown on the vendor's instructions. At that voltage and power level the transistor won't experience a great amount of heat and the heat sink will safely absorb the heat.

If you plan on operating this transmitter at full power (VCC=10.5 or 12 Volts), it is better to install the transistor FIRST, followed by the silicon grease and then the heat sink on TOP. The metal part of the transistor actually heats up faster and HOTTER than the case. Installing the heat sink on TOP insures maximum efficiency of heat transfer on to the heat sink.

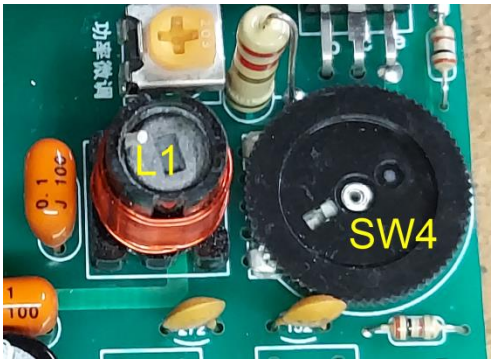




Install and solder on place:

SW3 20K Ohm mini potentiometer Marked 203

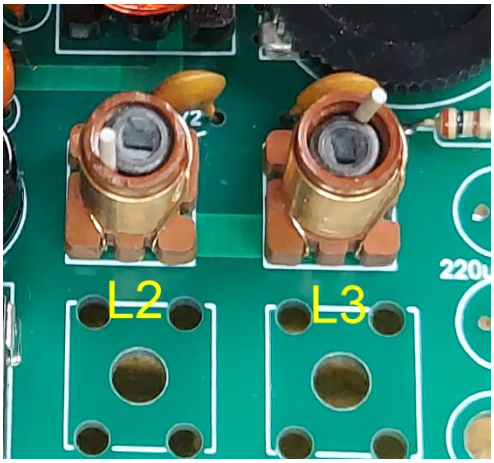
R15 2.2 Ohm 1 Watt (Red Red Gold Gold) resistor



Install and solder in place:

L1 50 Turn Slug Tuned Inductor (Pre-Tuned to 0.04 mH) Large black coil

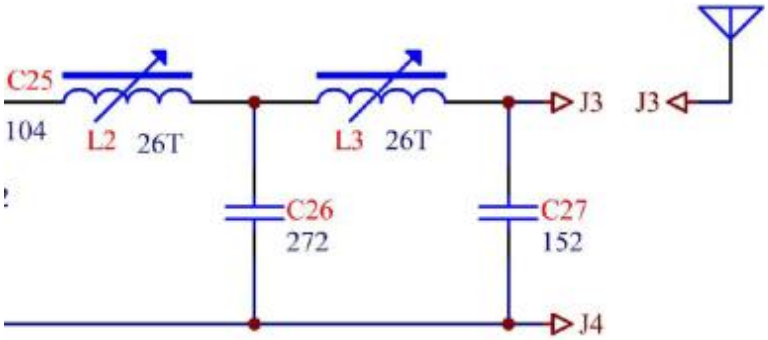
SW4 50K Ohm potentiometer Marked B503



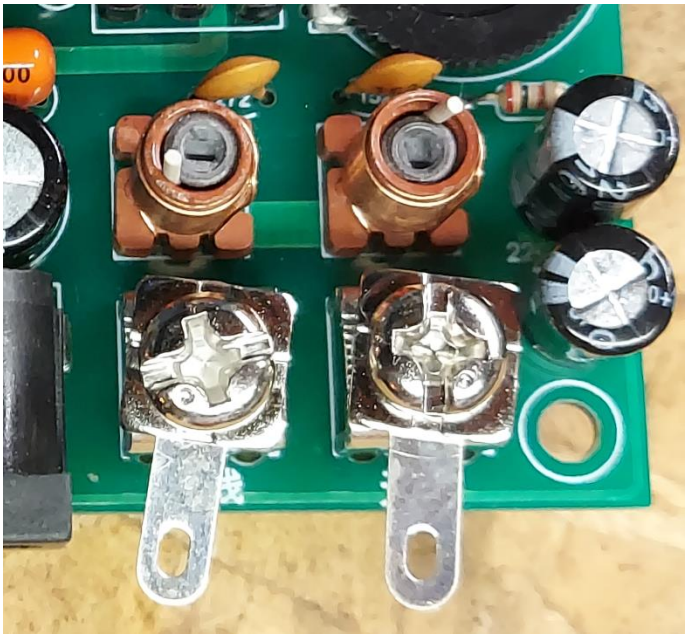
Install and solder in place:

L2 and L3 26 Turn Slug Tuned Inductor – Small Brown Coil

The vendor's instructions say to adjust L2 upwards but it does not say how much. Unfortunately, an inexpensive Arduino based component checker is unlikely to resolve inductances in the micro Henry range. If you have an accurate LC meter you can pre-adjust them to the values in the instructions or to that shown on the PC board. Or you can estimate it by adjusting the slug on L1 flush to slightly higher than the top of the coil form.



These two coils along with C26 and C27 form a low pass filter to reduce harmonic interference in the shortwave (HF) bands. With a spectrum analyzer and a sweep generator you can adjust the low pass cut off to a frequency of your choice. You may have to replace C26 and C27 with different values for a cut off frequency in the 160 meter amateur band. This kit is sold as an “experimenters kit” and you are free to make changes.



The final components to be installed and soldered in place are the two screw terminals for the antenna and ground and C232 and C23.

C22 and C23 are 220 µF 16v Electrolytic capacitors. The kit is supplied with 10V types. DO NOT USE THE 10 VOLT ELECTROLYTIC CAPACITORS. Replace them with 16 volt types.

The kit is now completed. However…. Before you power this up….

Check your work

Are all resistors installed with the correct values? Are the capacitors installed with the correct values in the correct places on the board? Did you accidently install 10 volt electrolytic capacitors instead of the 16 Volt types? Did you observe the correct polarity? The picture above shows them installed correctly. These kits are usually supplied with EXTRA parts. Make sure you have the correct parts installed.

Testing this now only requires a power source, and audio source and a MW (AM) radio. Connect an audio source (MP3 player, phone, etc) to J2 with the supplied audio cable. Connect a power source (6 volts for part 15 operation) to J1. Then bring your MW (am) radio close to the transmitter. Adjust all four potentiometers to mid range. You should be hearing the audio from the radio, most likely at a low volume.

For Part 15 operation, use no more than 6 volts at J1 (VCC). Adjust SW2 (to the rear of Q4 and right of the toroid B2 to the spot where the carrier disappears on the radio. Then adjust it back slightly until it re-appears. Then adjust SW1, SW3 and SW4 to a level similar to what to regular commercial stations sound like.

Getting More Range From Your Transmitter

The vendor's instruction manual suggests using a 6 meter (20 foot) antenna. For Part 15 operation you are limited to 3 meters, including the feedline and ground lead, if used. Just connecting a wire of either length will not result in a range of more than a meter or two. Operating the transmitter at full power WILL NOT increase the range. Please do not go to the vendor and give them a low rating just because you cannot get the range you expect. The problem is not the transmitter, nor how it is designed or built. The problem is the antenna is not properly designed, tuned and built for operation on the MW band.

The builder (you) is encouraged to research the web on Part 15 antennas. A good place to start is on Robert Weaver's Electron Bunker site. Check this page out on that site:

https://electronbunker.ca/eb/AntennaMatch.html

On that page Robert explains why your transmitter antenna is not working like you expect. The page has quite a bit of advanced math but he explains it well enough that even someone with limited math skill can understand.

When you are finished reading that, go to Part15.org. On the Forums pages are users that have built antennas for use on MW. You might even find a design from someone there that you can build.

73 de Sam Anderson N8VES

N8ves@yahoo.com