R3500D ARDF Receiver
Assembly Manual

by

CR KITS

by
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for
Youth On The Air
YOTA Region 2 Camp
June 21-26, 2020

Introduction

This assembly manual is written with the goal that it will help you to properly build the receiver. We hope you will follow our suggestions for construction as you read through this manual. We encourage you to read the manual through completely before starting to build the R3500D receiver (the “kit”).

Parts Inspection

The kit comes packaged in its own case, as shown in Figure 1. The magnetic rod, the PC board, and

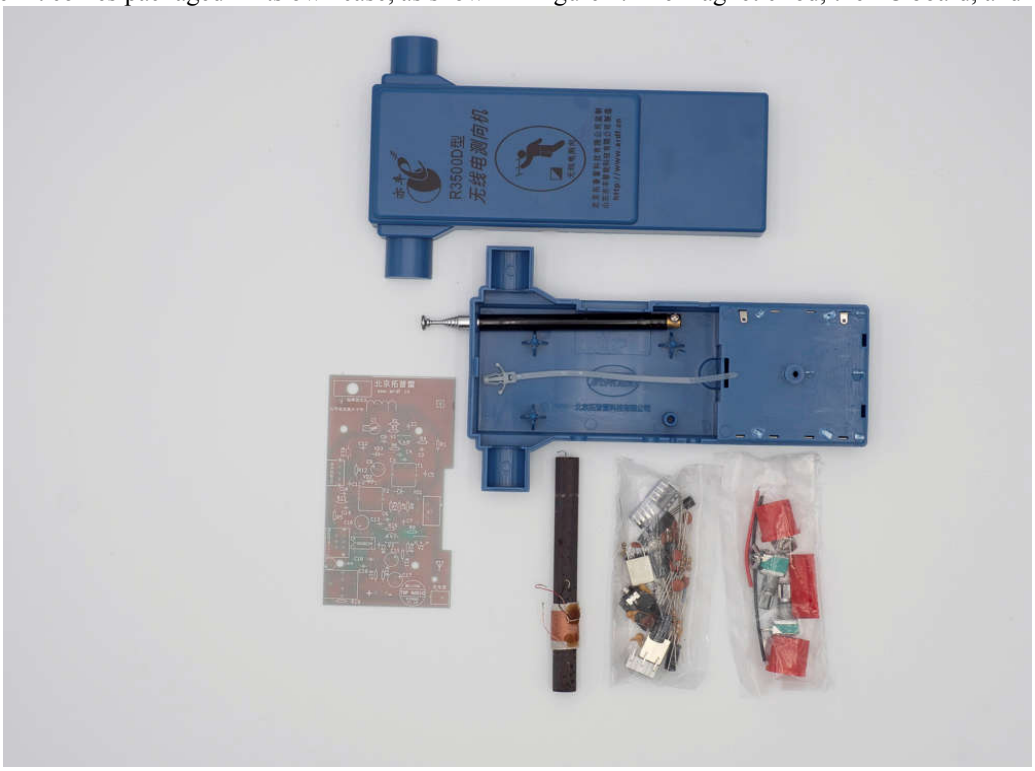

Figure 1. The packaged parts removed from their case.

two bags of parts are all contained within the blue plastic case [CRKits: The case color is randomly shipped from orange, blue, green and black]. Opening the two bags and arranging all of the components for the kit is shown in Figure 2. The actual parts count is relatively small, so we can call this a beginners-to-intermediate builder's kit. The reason we increased it out of the beginners category is because the instructions range from non-existent to horrible [CRKits: The English manual serves as the translation of the attached Chinese manual]. The kit did come with instructions, Unfortunately, my Mandarin is a little rusty, hence this manual.

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Figure 2 was taken after all of the kit's components are spread out for display. The Printed Circuit Board (PCB) is of good quality and its top has the part numbers silk screened on it, which makes parts placement fairly easy. The kit uses three transistors (all the same), one IC, two variable potentiometers,

various capacitors and resistors, and additional hardware.

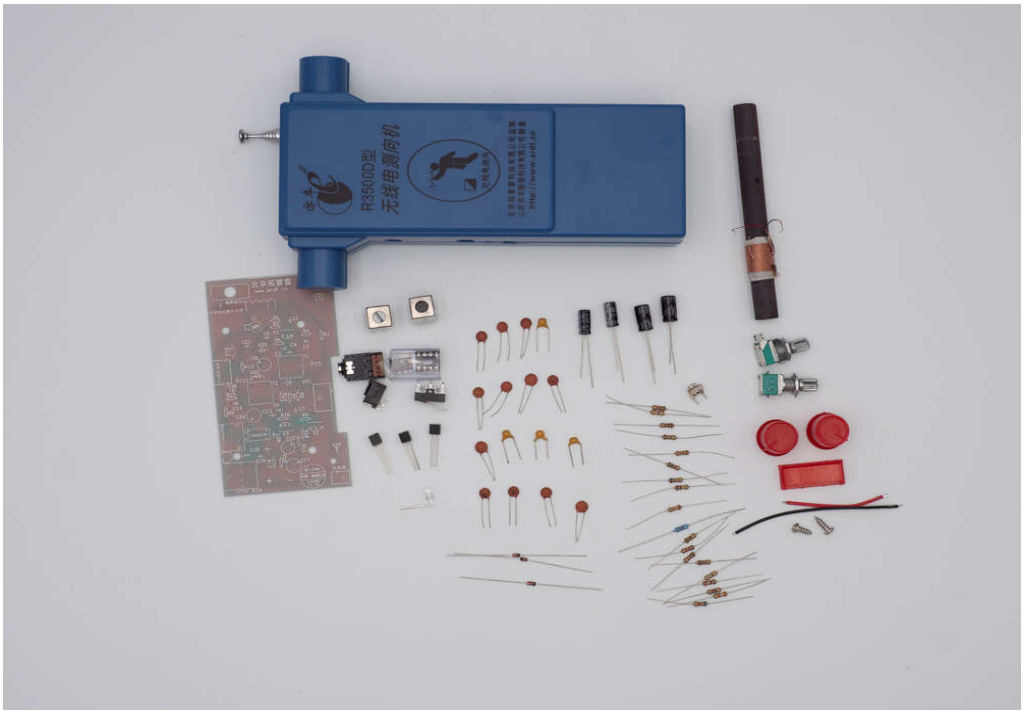

Figure 2. All of the components laid out for viewing.

Parts Identification

If you are new to electronic kit building, great! We think you will find it enjoyable. Figure 3 shows you some of the basic circuit components you will be using. Each transistor has a “flat” side to it and the

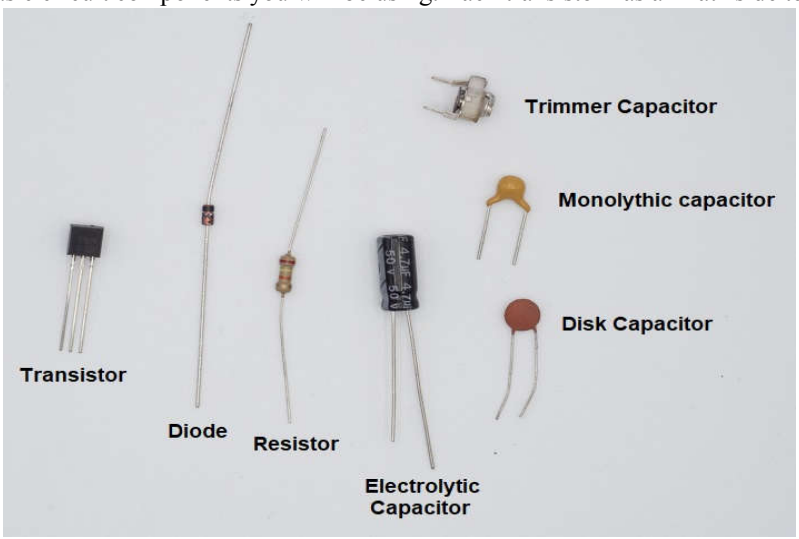

Figure 3. Component types.

silk screen on the PCB uses that flat side of the transistor to make sure you place it on the board with the correct orientation. If you get the base, collector, and emitter (B, C, E silk screened on the PCB) leads wrong, the circuit won't work properly, so pay close attention when you place the transistor leads into the PCB holes.

There are three diodes in the kit and they look very similar. All three have a glass body with a black band around one end, but they are all different parts. One of them is a Zener diode which behave differently, too. The black band is used to identify the cathode end of the diode and is the "vertical bar"

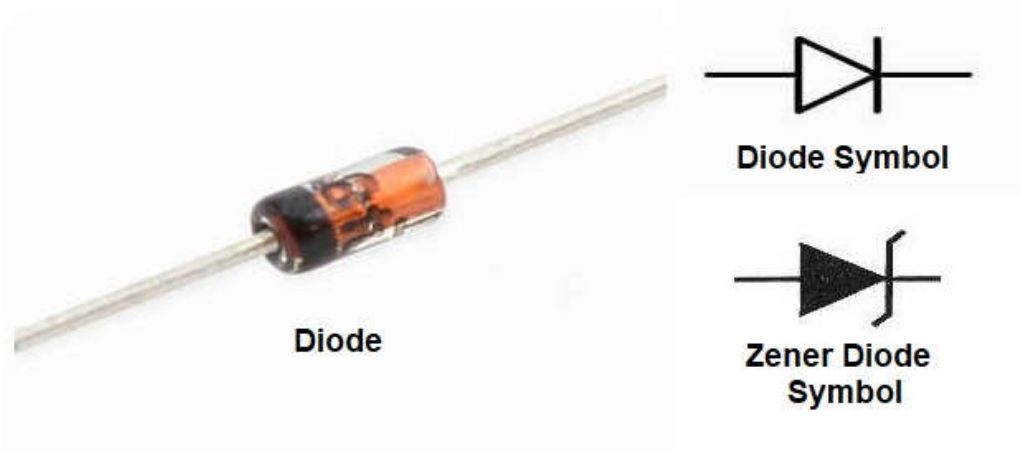

Figure 4. Diodes and their circuit symbols.

end of the diode symbol. The band can be seen in diode image on the left side of Figure 4. A zener diode looks the same, but its cathode symbol uses a "broken" bar in its symbol. The type of diode is written on the diode body, but can be difficult to read. Ask the instructors for help if you are not absolutely sure of a diode's identifying part number.

The remaining component types look sufficiently different that they probably do not need clarification.

Kit Assembly

We have arranged for the assembly steps to be performed in a specific order. There are a number of reasons for following the assembly sequence used in this manual. First, it places the "easiest" parts on the board first. We mean "easiest" in the sense there is plenty of room to place the parts without other parts getting in the way. Second, the component placement begins with the resistors and capacitors, and those are easy to identify. And finally, some parts cannot be placed into position until some other part is its proper position first (e.g., the Press To Talk (PTT) switch and the PTT button).

Resistors

As you can see in Figure 3, the resistors are like small cylinders with painted bands on them. The color of each band corresponds to a number. Table 1 shows the part number, its resistance value, and its associated color code. Notice that R1 and R13 have asterisks after them. The reason is because those resistors may have values that vary in the kit. We suggest that you place those two resistors on the PCB

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last, as it will make it easy to determine which of the two remaining resistors are the correct ones for R1 and R13. So far, their color codes appear to agree with Table 1.
Although you may not be able to tell it, look closely at the resistors in Figure 5. From this viewpoint,

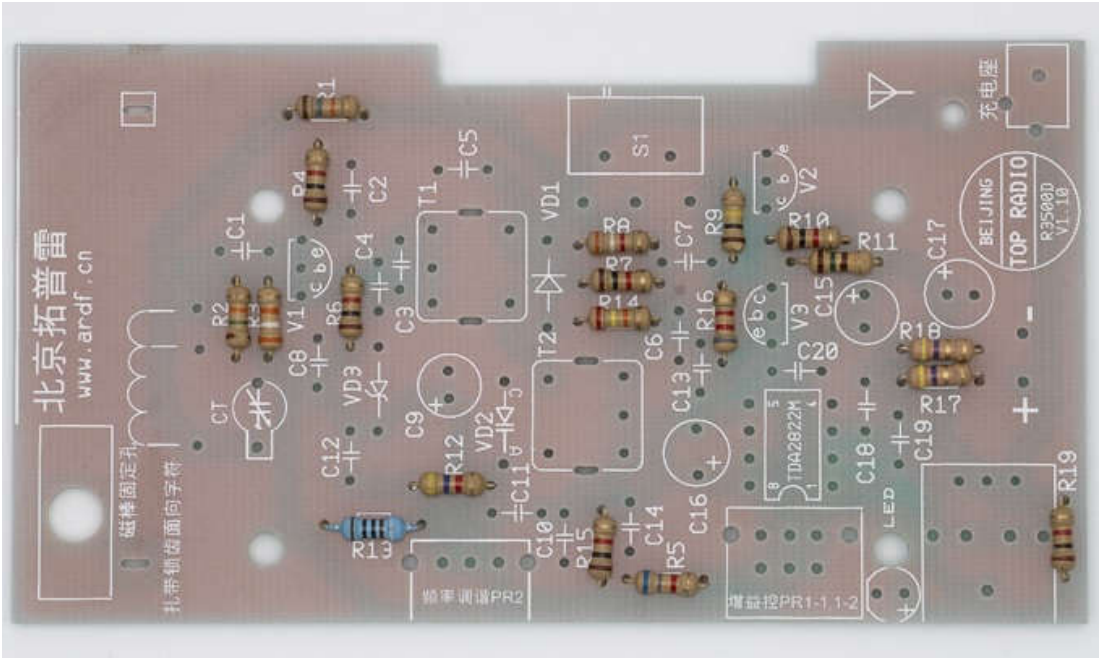

Figure 5. Resistor placement. Note that R13 is the only blue resistor on the board.

note how all of the color bands read from left to right for all of the horizontal resistors. If you stand the board on its right edge, those resistors that appear as vertical resistors in Figure 5 are now horizontal and also read the color bands from left to right. Given that resistors are symmetrical (i.e., both leads are identical in a circuit), why bother? Three reasons: 1) it makes it easier to read values should the need arise, 2) it looks neater, and 3) because I can. It's just a way of showing that you care about what you're doing.

Placing Resistors on the PCB

There is a seven-step process we want you to use when placing a resistor on the PCB.

Table 1. Resistors

PCB Part Number	Resistance Value	Color Codes
R1*	18k, 5~20k	BRN-GRY-ORG-GLD
R2	15k	BRN-GRN-ORG-GLD
R3	39k	ORG-WHT-ORG-GLD
R4	1k	BRN-BLK-RED-GLD
R5	6.8k	BLU-GRY-RED-GLD
R6	1k	BRN-BLK-RED-GLD

R7	1k	BRN-BLK-RED-GLD
R8	3.9k	ORG-WHT-RED-GLD
R9	100k	BRN-BLK-YEL-GLD
R10	1k	BRN-BLK-RED-GLD
R11	150 ohm	BRN-GRN-BRN-GLD
R12	4.7k	YEL-VIO-RED-GLD
R13*	910 ohm, 300~1.5k	WHT-BRN-BRN-GLD
R14	24k	RED-YEL-ORG-GLD
R15	1k	BRN-BLK-RED-GLD
R16	8.2k	GRY-RED-RED-GLD
R17	4.7 ohm	YEL-VIO-GLD-GLD
R18	4.7 ohm	YEL-VIO-GLD-GLD
R19	1k	BRN-BLK-RED-GLD
RP1	10k	two gang pot
RP2	10k	single gang pot

Step 1. Using the color code listed in Table 1, locate the resistor to place on the board (i.e., your first resistor will be R2, color code Brown, Green, Orange, Gold).

Step 2. Use the VOM to measure the resistors value and compare what you read to the values shown in Column 2 of Table 1. It should be within +/- 10% of the value in the table. If not, have one of the instructors check the value for possible replacement.

Step 3. Take the resistor and gently bend both leads so they form 90° angles to the resistor body. This will make it easier to mount the resistor on the PCB.

Step 4. Locate the silk screen part number (e.g., R2) on the PCB that corresponds to the resistor you are about to mount on the PCB. The part number should be centered on the two holes for the resistor leads.

Step 5. Guide the two resistor leads into the two mounting holes allocated for the resistor. Push the resistor all the way down to the PCB so it sits flat on the PCB.

Step 6. Flip the board over and bends the two leads of the resistor you just mounted towards the board. This will help keep the resistor tight to the PCB as you mount the remaining resistors.

批注: I find it best to solder each component as it is placed. Tha tway you won't miss solder one compared to doing then all at once.,
Al

Step 7. Go back and repeat the steps until you have mounted all of the resistors EXCEPT resistors R1 and R13. Eventually, you will be left with only two resistors left. It should be clear from their color bands which is R1 and which is R13. If that is not clear, ask for help from one of the instructors.

Resistor R13

Resistor R13 is a little different from the rest of the resistors because of the role it plays in aligning the receiver. To make alignment a little easier, we want you to mount that resistor as shown below in Figure 6. For all other resistors, we want you to snug the resistor down so it touches the PCB. However,

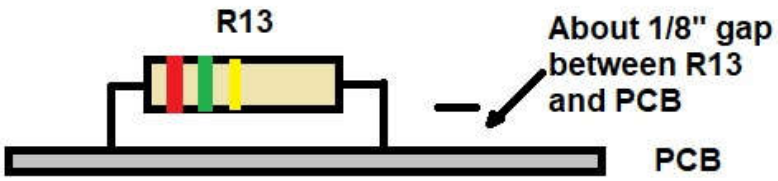

Figure 6. The placement of R13 on the PCB.

for R13, we want you to leave about 1/8” between the body of R13 and the PCB. The reason is because, during the alignment process, we may need to either remove R13 and replace it with a different resistor, or we may have to tack-solder a second resistor in parallel with R13 to get the correct alignment. Mounting R13 with the gaps shown makes this process easier.

When you have completed all of the steps above, you should not have any resistors left except RP1 and RP2. You will place those on the board later.

The 3-1-3 Soldering Method

Now, flip the board over and solder the resistors in place. We use the 3-1-3 Method for soldering components to a PCB. That is, place the soldering iron tip on the PCB pad to be soldered and also touching the wire coming through the board so the soldering iron tip touches both the pad and the lead for about 3 seconds. That should be enough heat to melt the solder. Now touch the solder to the spot where the wire and the pad come together, but *not* touching the soldering iron tip. It should take about 1 second for the solder to melt into the connection. Next, remove the remaining solder, but continue to hold the soldering iron tip where it is for 3 more seconds. This keeps the connection hot enough for the solder to wick-up towards the top side of the PCB. This is more important for multilayered PCB boards, but it doesn't hurt to practice here.

批注: I do not ti”time the process, but rather heat both parts while touching the silder to the joint when the solder melts you are finished. The solder will wick through in the process and you run less risk of over-heating the part,
Al

Now, visually inspect the solder connection. The solder should be shiny, silver, color and not granular or sand-like on the surface.

After the connection is soldered and has cooled, take your thumbnail and “pluck” the end of the lead. It should have an almost musical note. If you hear a “thunk” instead, touch the soldering iron tip to the connection again to reheat it. Let it cool again, and then pluck it again to see if it's a good connection. Al doesn't like the “pluck check” that Jack's been using for four decades of kit building. He prefers that you check the joint to make sure the solder coats both the lead and the pad and that its appearance is a shinny and silver in color with no grainy appearance. Doing both checks pretty much assures the solder connection it good.

After all of the connections are soldered, plucked, and inspected, use wire trimmers to remove the excess lead length. Dispose of the clipped leads now, as they are a short circuit waiting to happen.

Capacitors

Arrange all of the capacitors at the top of your work area. Capacitors CT, C9, C15, C16, and C17 are placed on the board last. When you place the capacitors, insert them into the PCB so that you can easily

Table 2. Capacitors

PCB Part Number	Capacitance Value	Capacitor Codes
CT	5-20p	Trimmer capacitor
C1	0.01µ	103
C2	4700p	472
C3	47-68p	50
C4	4700p	472
C5	0.01µ	103
C6	0.01µ	103
C7	0.1µ	104
C8	0.01µ	103
C9	470µ	electrolytic
C10	100p	101, monolithic
C11	200p	201, monolithic
C12	1000p	102
C13	1000p	102, monolithic
C14	2200p	222, monolithic
C15	4.7µ	electrolytic
C16	10µ	electrolytic
C17	470µ	electrolytic
C18	0.1µ	104
C19	0.1µ	104
C20	0.01µ	103

see their value markings and that those marking are not obscured by some larger component. Use the following sequence for placing the part.

NOTE: The larger electrolytic capacitors (C9, C15, C16,and C17) must be placed on the boards according to the polarity of their leads. The negative lead is the shorter of the two leads and it usually marked on the case, too, as a grey-colored stripe with a minus sign ('-') on it.

Step 1. Using the capacitor codes listed in Table 2, locate a capacitor to place on the board (i.e., your first capacitor is C1, not CT).

Step 2. If you cannot read the part number (they are pretty small), ask one of the instructors to help

you. We do have a capacitance meter that can be used to check its value.

Step 3. Locate the silk screen part number (e.g., C1) on the PCB that corresponds to the capacitor you are about to mount on the PCB. The part number should be silk screened near the two holes for the capacitor leads. If it is an electrolytic capacitor, pay close attention to its polarity when placing it on the PCB.

Step 4. Guide the two capacitor leads into the two mounting holes allocated for the capacitor. Push the capacitor as far as you can until you feel some resistance. Pushing the capacitor any further runs the risk of fracturing the capacitor.

Step 5. Flip the board over and bends the two leads of the capacitor you just mounted towards the board. This will help keep the capacitor tight to the PCB while you mount the remaining capacitors.

Step 7. Go back and repeat the steps until you have mounted all of the capacitors EXCEPT resistors CT and C9, C15, C16, and C17 . Eventually, you will be left with only those five capacitors left. Now mount those capacitors in their proper place.

When you are finished, your board should look similar to Figure 7. Now flip the board over to the backside and solder, pluck, trim, and dispose the capacitor leads.

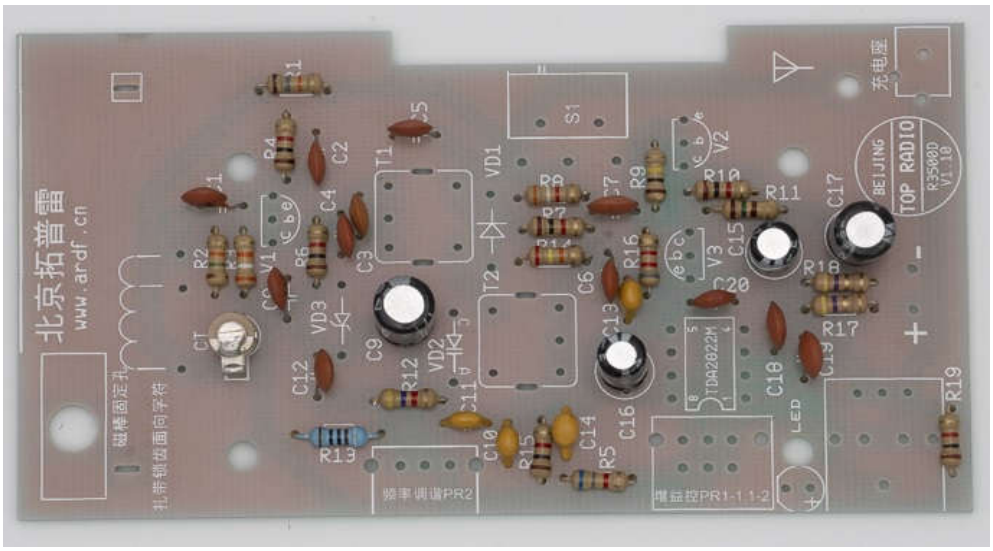

Figure 7. Capacitor placement.

Diodes, Tranformers, IC socket, and Transistor Placement

Diodes

First, locate the three diodes (see Figure 4) and determine their identities. Their parts numbers are:

VD1	1N60
VD2	FV1043
VD3	3.5-4.4V Zener diode

If you have trouble reading their part numbers, ask an instructor for help.

Note that the cathode end with the black band on it corresponds to the vertical bar in the diode symbol printed on the PCB. If you look near the middle of Figure 7, you can see the diode symbol for VD1. The symbol tells you that the black band should be near the top of Figure 7 after placing it on the board. Fan out the diode leads on the back side of the PCB just like you did for the resistors and capacitors. Again, you want the diodes close to the PCB.

Some care is needed when soldering diodes as they are a little more fragile than resistors or capacitors. Too much heat can destroy them. Al likes to mount the diodes a little above the PCB (1/16") to promote air flow and also transfer less contact heat to the diode. For that reason, we suggest you solder one diode lead, move to the second diode and solder one lead, and then move to the last diode lead and solder one lead. Now go back and solder the remaining unsoldered leads. This sequence gives the diode body a chance to cool down a bit before the opposite lead is soldered.

批注: Good pratice for beginners is to use a small heat sink on the diode lead and to raise the diode just a bit off the board, maybr 1/16". The heat sink could be a pair of tweezers with a rubber band. Same goes for transistors, although theare less fragile, as you point out.
Al

Transistors

The three transistors are all the same, so just pick the transistor components as depicted in Figure 3. Their location on the PCB is silk screened using a "half circle" shape. Match the flat side of the transistor with the flat side of the half circle silk screened on the PCB and gently push the three leads through the appropriate holes. Because the mounting holes are spaced further apart than the leans on the transistor, do NOT try to force the transistor body to be flush with the PCB. The spacing difference means the transistor will be about 1/4" above the PCB surface. Once all three leads are in place, flip over and gently fan the leads enough that the transistor won't fall out of its holes.

Once again, transistors are less fragile than diodes, but more so that resistors. We use the one-lead-at-a-time sequence for transistors just like we did for the diodes. Probably overkill, but it only takes a few seconds more. Strum the leads and listen for a musical note-like sound. Reheat if necessary and then trim the leads. You did throw the leads away, right?

IC Socket

Now locate the IC socket, which looks similar to Figure 8. Notice how the right edge of the socket

Figure 8. The IC socket.

has a notch in it. Now look in Figure 7 and locate the location where the socket is to be solder in place (i.e., towards the lower-right area of the PCB). Note that the silk screen also has a notch. Align the IC socket so the notches match up and push the socket pins through their mounting holes. While holding the socket in place with a finger, flip the board over and with your thumbnail, bend one of the corner socket pins over towards the surface of the PCB. Now do the same to the pin on the opposite corner of the socket. This will hold the socket in place while you solder the pins.

Transformers

There are two transformers in the kit that look like small rectangular metal boxes. You can see the tops of the transformers in Figure 9. One of them has a dark adjustment screw in the middle of the box while the other has a white adjustment screw. Locate the two transformers and mount them on the PCB. Pay attention to the color of the adjustment screw as you mount them on the board.

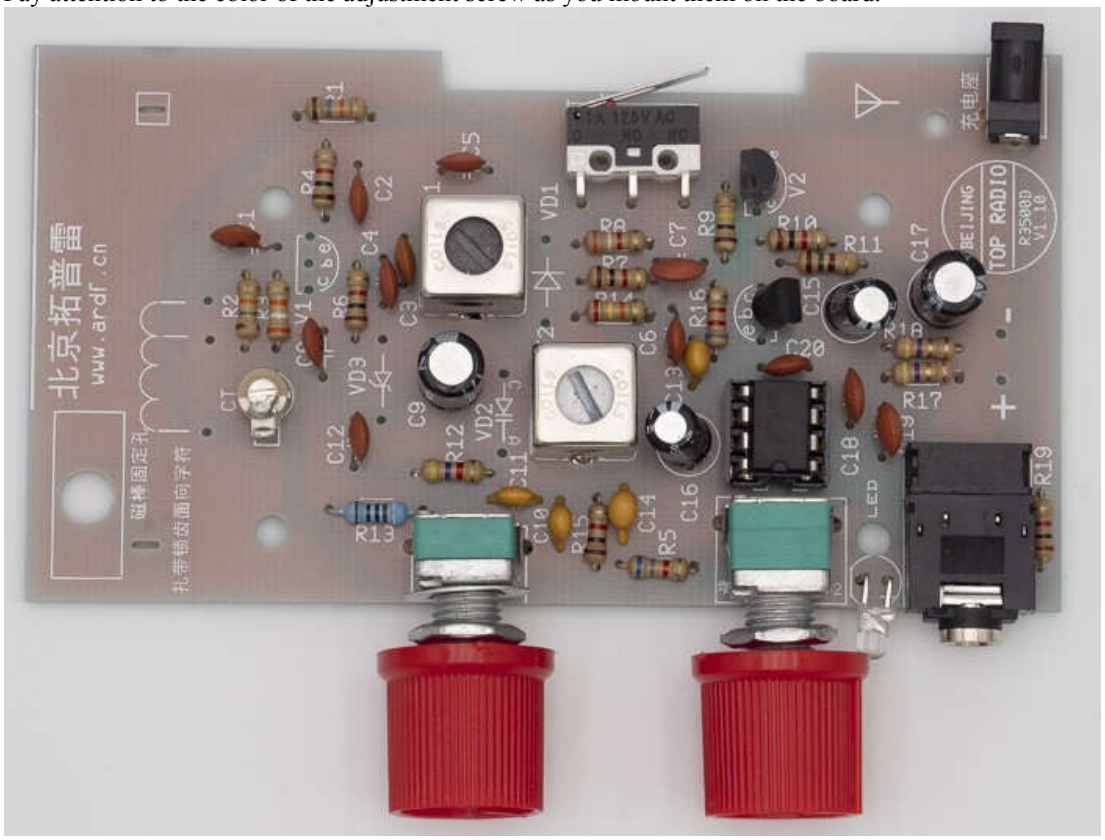

Figure 9. The board with the transistors and hardware in place.

There is only one orientation that allows all of the pins to protrude through to the back of the PCB. If the transformer doesn't seem to cooperate, check to make sure all of the pins are straight and try again. After both transformers are mounted in place, flip the PCB over and solder the pins that are sticking out from the back side of the PCB.

Remaining Hardware

Now mount the micro switch (near the cutout at the top of Figure 9), the power connector (top-right of Figure 9), the two potentiometers and knobs (bottom edge), the ear bud jack (lower right of Figure 9), and the LED indicator (between the two-ganged pot and the ear bud jack).

Locate the short red and black pieces of wire. Place the red wire in the + hole on the PCB and the black wire in the – hole on the PCB. (The holes are marked on the right edge of the PCB. See Figure 10.) Hold the two wires in place while you flip the board over and place it on your work table. The tension in the wires should hold them in place while you solder them.

When you mount the LED, place it so it faces outwards from the PCB and mount it with about an 1/8" clearance between the bottom of the LED and the PCB. (LED's require paying attention to polarity. However, facing the LED outward will have the correct polarity provided you have its flat side mounted as shown on the PCB's silk screen.) This position aligns better with the hole that lets the LED shine through the case. Solder and trim the leads that protrude through the PCB.

Magnetic Rod

The magnetic rod is the black rod you can see towards the left side of Figure 11. On the rod is a sleeve of coiled wire with 3 leads coming from it. Looking at Figure 11, a white-ish wire is coming from the bottom of the sleeve coil, a black wire from the middle of the coil, and a red wire from the top of the coil. Loosely place the rod towards the left edge of the PCB. Now look for the holes on the PCB for the 3 wires. They are near the left edge of the PCB and look like Figure 10. We have also labeled Figure 10 where each of the 3 wires are to be attached to the PCB.

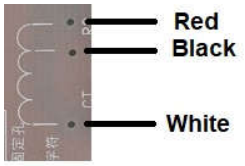

Figure 10. Magnetic Rod coil wires.

Thread the three wires through the appropriate holes, carefully turn the board over. Only pull enough

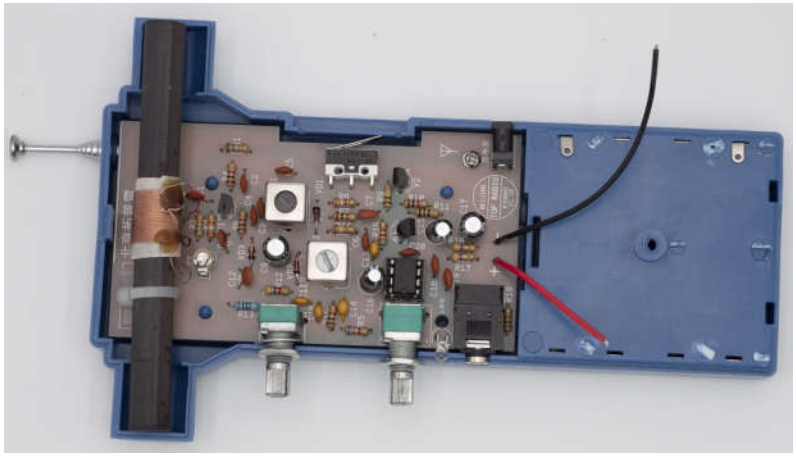

Figure 11. PCB in position within the case.

of the wire lead through to allow you to solder the ends of the wires to the pads. You will need some slack in the wires after they are soldered to mount the rod to the plastic case. Now solder the ends of the wires to their respective pads.

There is a special type of twist-tie in the kit that is used to secure the magnetic rod to the PCB. Inspect the twist-tie carefully, as there is only one way to feed the tie into the latch that allows the strap to remain tight. The twist-tie has a special fitting on it that feeds a plug through a hole in the PCB and snaps to lock it in place. (You can see the large mounting hole for the locking plug in the lower-left corner of Figure 9. You can see the twist-tie strap in place on the magnetic rod in Figure 11.) Push the mounting plug on the twist-tie into the hole in the PCB until it snaps into place. Take the loose end of the twist tie strap and push it partway into the twist-tie lock. Leave it loose enough that you can slide the rod into the loop.

Now slide the coil sleeve to approximately the middle of the rod and thread the rod into the twist-tie loop that is formed by the strap. Once you have the assembly centered similar to that shown in Figure 11, pull the twist tie snug around the rod. Snip off the excess part of the twist tie.

Antenna Whip

As you can see at the top of Figure 12, there is a collapsible whip antenna protruding out of the left side of the case. Inside the case, that whip antenna has a small screw and lock washer attached to the end of it. (If you look closely at Figure 1, you can see the screw at the right end of the whip antenna.) Carefully remove the screw and lock washer.

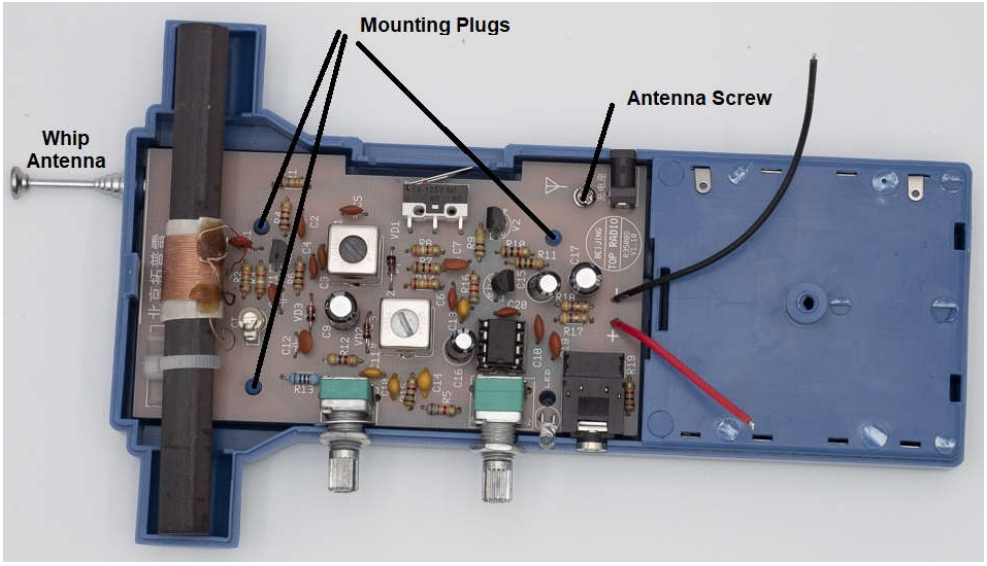

Figure 12. Completed Parts Placement

Now tilt the PCB and its case up on its side enough that you can move the antenna whip inside the case. You need to align the hole in the bottom of the whip with the mounting hole for the antenna screw in the PCB so you can re-insert the screw through the PCB and back into the antenna whip. Make sure you thread the lock washer back onto the screw before securing it to the PCB and the antenna whip.

Once the antenna screw is secure, find the plastic mounting plugs that are molded into the case and place the PCB so it aligns with the mounting plugs. Gently push the PCB so it seats tightly on the mounting plugs. If you've done this correctly, all of the external components will align perfectly with their mounting holes that are molded into the plastic case.

Batteries

The kit provides a compartment designed to hold 4 AA batteries to power the radio. If you look at the top-right in Figure 13, you can see two solder tabs. The long black wire is soldered to the right-most

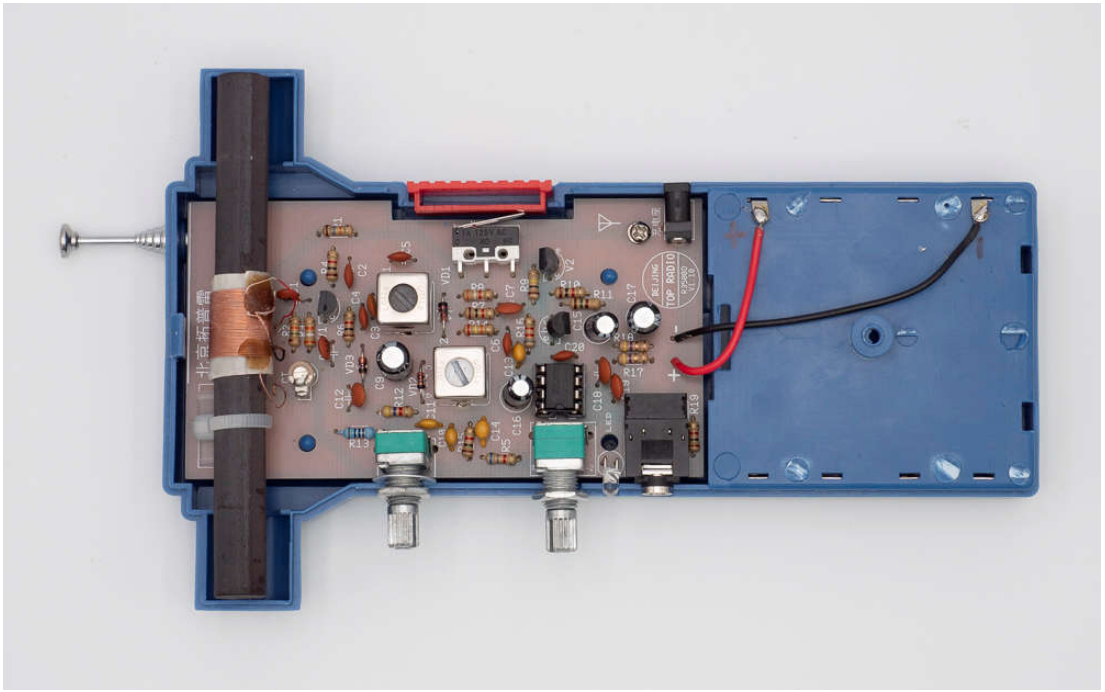

Figure 13. Connecting red and black power wires to battery tabs.

tab and the shorter red wire is soldered to the remaining tab. This provides about 6V to the receiver.

Radio Power Switch

So where's the power switch to turn the battery power on and off? Well, it's sort of hidden. The kit comes with a set of ear buds wired to a headphone connector that plugs into the headphone jack. (The headphone jack is the black square object just below the red wire in Figure 12.) When you plug the ear buds into the jack, it completes a circuit to the battery pack, resulting in voltage being applied to the receiver. Unplug the ear buds and the radio is powered down. As a result of the circuit arrangement, you need to have the ear buds plugged in if you want the receiver activated. This also means you need to unplug the ear buds when the radio is not in use to avoid draining the batteries.

The battery compartment is accessed by removing the battery pack cover, which is a small plastic door on backside of case as seen in Figure 14. Place your fingernail into the “half-moon” cutout and gently

push the door towards the opposite edge while pulling the door upward. Place the batteries into the battery pack compartment, paying attention to the polarity of the batteries as molded into the bottom of the battery compartment.

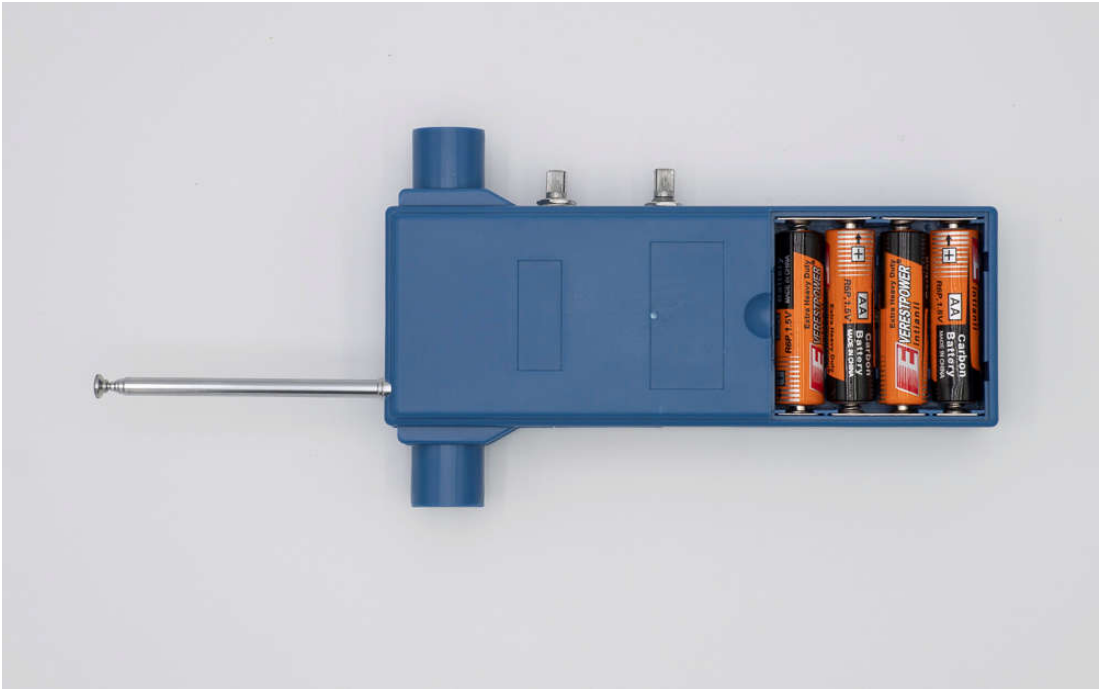

Figure 14. Battery compartment.

There is a small hole in the middle of the battery compartment. A machine screw eventually is used to secure the two plastic halves of the case together. However, that is not done until the very last step of the assembly process.

Alignment

The instructors need to perform the radio's alignment. The instructors have a signal generator that is used to align the receiver. Essentially, this requires coupling the output from the signal generator to a simple wire loop wrapped around the magnetic rod. We tune the signal generator to about 3.5 - 3.6 MHz. (The actual transmitter will be on 3.579 MHz .) A tone should be heard in the ear buds.

Now set the signal generator to 3.55 MHz and adjust T2 (using the white screw on its top) until the tone is heard again. The tuning is very sensitive, so make the adjustments slowly. Also, your body capacitance can affect the circuit, so use a non-conductive (plastic) tool to make the adjustments. Once T2 is set, you should be able to set the signal generator to a frequency between 3.5 MHz and 3.6 MHz and, by adjusting the RP2 potentiometer, you should be able to hear the new signal generator tone.

If adjusting RP2 does not find the new tone, the value of R13 (discussed earlier) needs to be adjusted. Once the proper value of R13 is determined, the instructors will fine tune the radio using the trimmer capacitor CT.

Finally, T1 is adjusted to peak the tone heard in the ear buds.

Final Assembly

You can now attach the two halves of the receiver case together. You need to remove the batteries first. Now place the plastic switch plate (look for the piece of red plastic near the top of Figure 13) into position using the two slots cut into the case. Position the interior edge of the switch plate between the arm of the switch and the plastic case. How carefully fit the other half of the plastic case in place. The external power connector and LED may need some coaxing to get the two halves to fit together. You may also need to remove the lock washers and nuts from the two potentiometers.

Once the two case halves are in the proper position, put the small metal tapping screw into the hole in the middle of the battery compartment and tighten to hold the case together. Don't over-tighten as you don't want to strip the plastic holding the screw. Now replace the batteries and snap the battery compartment cover in place.

Your receiver is now ready to use.

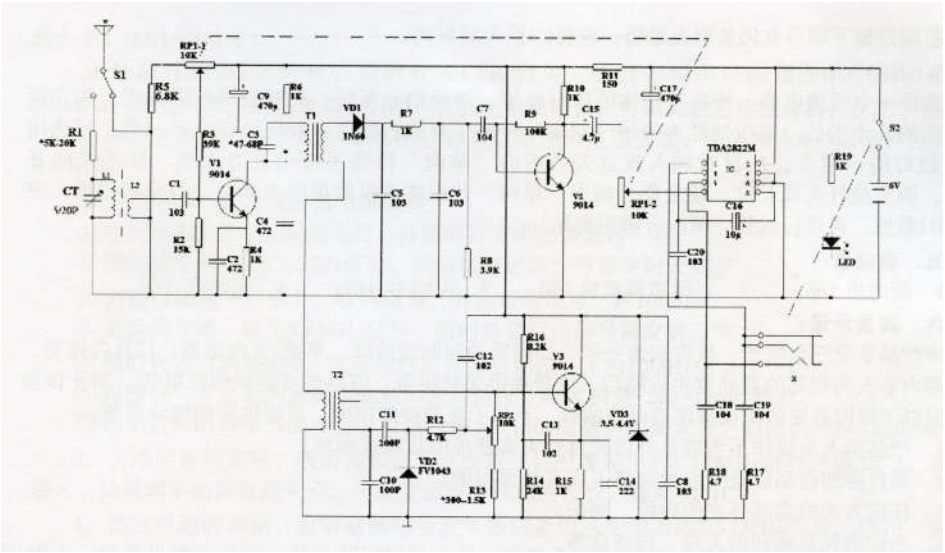

Figure 15. Schematic