Science Fair®

Cat. No. 28-253

5-Transistor AM Radio Kit

Your Five Transistor AM Radio Kit combines the excitement of working in electronics with the pleasure of building various radios that you will treasure. This manual contains easy-to-follow, step-by-step instructions and plenty of drawings to help make the instructions clear.

If you read and follow the instructions carefully, checking off each step as you complete it, you will soon be proud of the result – a radio kit that's a lot of fun.

REQUIRED TOOLS

You will only need a few simple tools to build your kit.

- Small Phillips screwdriver
- A pair of needle-nose pliers
- Wire cutters
- A ruler (with inches and milimeters marking)

You will also need one 9-volt battery. We recommend Radio Shack's 23-464 or 23-583. (Figure 1.)

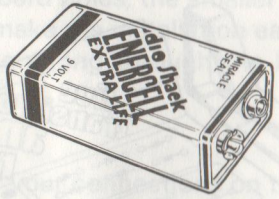


FIGURE 1

GETTING STARTED

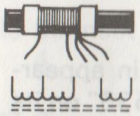
The first thing any good kit builder does with a new project is to make sure all the necessary parts are included in the kit.
To do this, check the contents of your kit against the parts list.

The parts list is separated into two sections – electrical contents (resistors, transistors and so forth) and mechanical parts (nuts, screws, wires, etc.). As you check off the parts, put them in a safe place so they will not get lost or damaged. Keeping them in the lid of the kit box is a good idea.

Each electronic part has its picture and "schematic symbol" next to the description in the parts list. The schematic symbol will help you locate the correct position for the parts on the kit's cardboard panel.

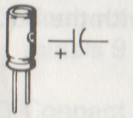
PARTS LIST

Electrical Components



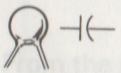
☐ Bar Antenna (1) – This is a ferrite bar with the antenna coil around it.

☐ Capacitors (6) – There are two kinds of capacitors in your kit: electrolytic and ceramic. The electrolytic capacitors look like tiny tin cans. You should have two of these.

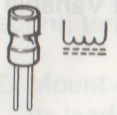


☐ 1 small – marked 1 μF, 50 V
☐ 1 larger – marked 100 μF, 10 V

☐ The ceramic capacitors are small and circular. Each is marked with its value.



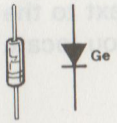
☐ 2 – marked "100" or "101"
☐ 1 – marked "0.047" or "473"
☐ 1 – marked "0.0047" or "472"



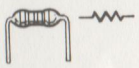
☐ Choke Coil (1) – this is a tan and spotted. In your kit, it will be used to classify high frequency and low frequency.

☐ Diodes (3) – There are two kinds of diodes in your kit. Larger one with a red band around it and two smaller with a white (or yellow) band.

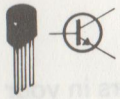
☐ Two small diodes are silicon type and with white (or yellow) band.



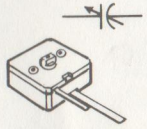
☐ The larger diode is germanium type and with red band.



☐ Resistors (6) – These are the small, tan tubular objects with colored stripes. The stripes will help you identify them later.



☐ Transistors (2) – Both transistors are similar in appearance, but they are different. One is marked "C535" on its flat side and the other is marked "C945", "C828", or "C1684".



☐ Variable Capacitor (1) – This is a special capacitor that will be used to catch the frequency you need with the Bar Antenna.

Mechanical Parts

☐ ⓐ Antenna Holder for Bar Antenna mounting, polypropylene

☐ ⓑ Battery Snap for 9-volt Battery (1)

☐ ⓒ Cardboard Panel with Printed Circuit Board, Speaker, and Variable Resistor

☐ ⓓ Frames, plastic

☐ ⓔ Holder for 9-Volt Battery, plastic (1)

☐ Nuts:
for long Phillips-head Screws (2)

☐ Screws:
long Phillips-head (2)
short Phillips-head (3)

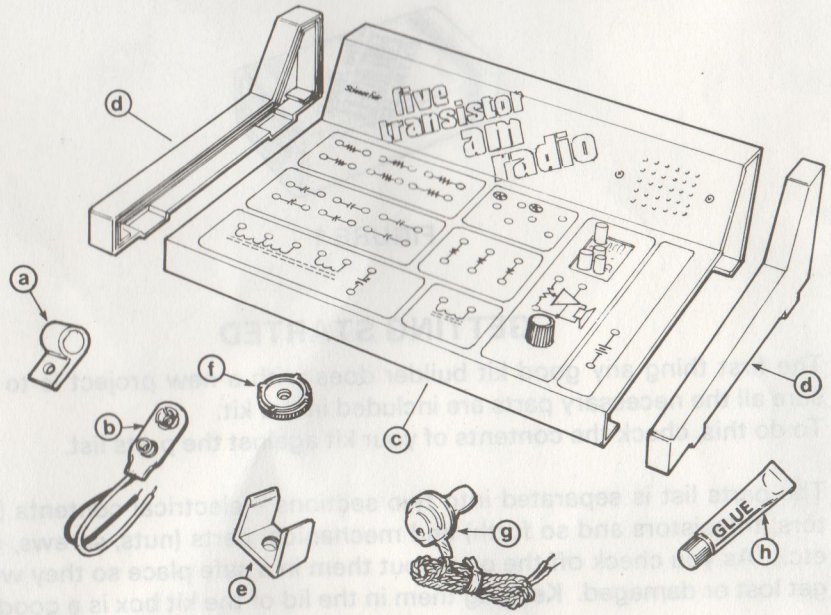
☐ Spring Terminals (50)

☐ ⓕ Tuning Knob (1)

☐ Wires:
Blue, 25 cm, 9.8" (2)
Red, 15 cm, 5.9" (12)
White, 7.5 cm, 2.9" (18)
Green, 3 m, 10" (1)

☐ ⓖ Earphone, Crystal (1)

☐ ⓗ Glue, Small Tube (1)



ASSEMBLY

Cardboard Panel and Frames

Make a hole in the tip of the tube of glue. Apply a bead of glue to the grooves on the inside of each plastic frame. (See Figure 2.)

Carefully bend the cardboard panel and insert the edges into the grooves of the plastic frames. (See Figure 2.)

Important: Allow the glue to dry for 1 to 2 hours before continuing.

Spring Terminals

The spring terminals provide an easy way to make electrical connections without the use of solder.

☐ From the top side of the cardboard panel, install 50 spring terminals into the 50 large, numberd holes; the smaller end of the spring should be at the bottom. To make the installation easier, use the pointed end of a pencil to push the spring through the holes and twist slightly. (See Figure 3.)

You will make many of your connections on the back side of the cardboard panel. As you install each spring, mark the number of each terminal.

Resistors

You will mount the 100 ohm resistor first. It is banded with colored stripes (brown, black, brown, gold).

☐ Mount the resistor by bending its leads and inserting them, from the top of the cardboard panel, through the holes next to schematic symbol (See Figure 4.).

☐ Now turn over the panel and connect each lead to 1 and 2. Simply bend the spring to one side with the needle-nose pliers or your finger and insert the wire between the coils of the spring. The first connections are always the hardest, but you will soon learn to do this easily.

Remember, you will identify the resistors by their colored bands.

☐ Connect the 2.2 k ohm resistor (red, red, red, gold) to terminals 3 and 4.

☐ Connect the 3.9 k ohm resistor (orange, white, red, gold) to terminals 5 and 6.

☐ Connect the 47 k ohm resistor (yellow, violet, orange, gold) to terminals 7 and 8.

☐ Connect the 390 k ohm resistor (orange, white, yellow, gold) to terminals 9 and 10.

☐ Connect the 680 k ohm resistor (blue, gray, yellow, gold) to terminals 11 and 12.

Capacitors

From the top of the cardboard panel, insert the two leads of each capacitor through the holes next to its schematic symbol. (See Figure 5.). Then, on the back side of the panel, connect the leads to the designated spring terminals.

☐ Mount one of the 100 pF capacitors (marked 100 or 101) and connect its leads to 13 and 14.

☐ Mount the other 100 pF capacitor and connect its leads to 15 and 16.

☐ Mount the 0.0047 μF capacitor (marked 0.0047 or 472) and connect its leads to 17 and 18.

☐ Mount the 0.047 μF capacitor (marked 0.047 or 473) and connect its leads to 19 and 20.

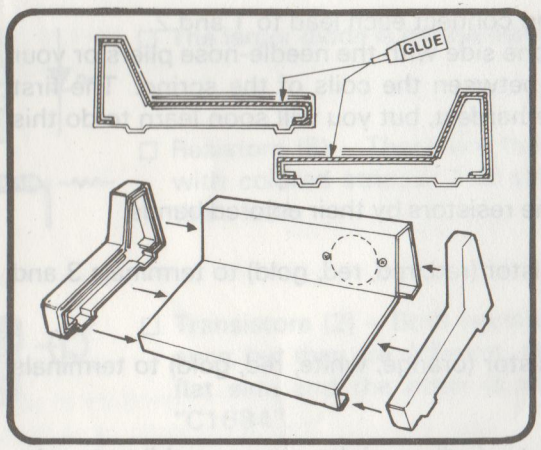


FIGURE 2

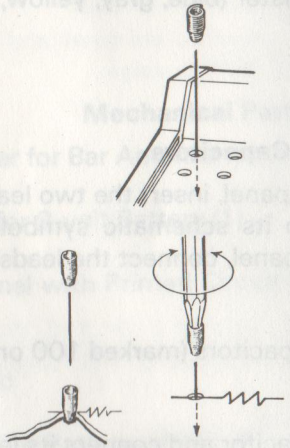


FIGURE 3

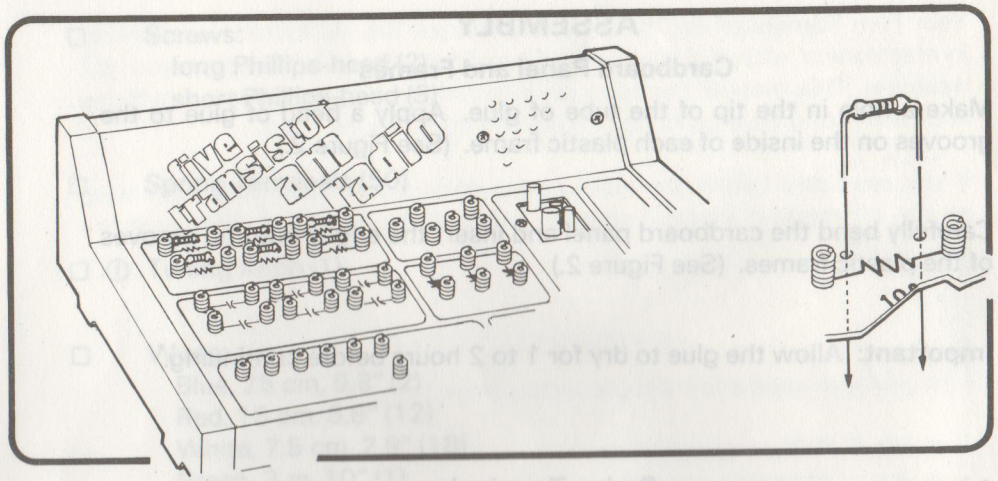


FIGURE 4

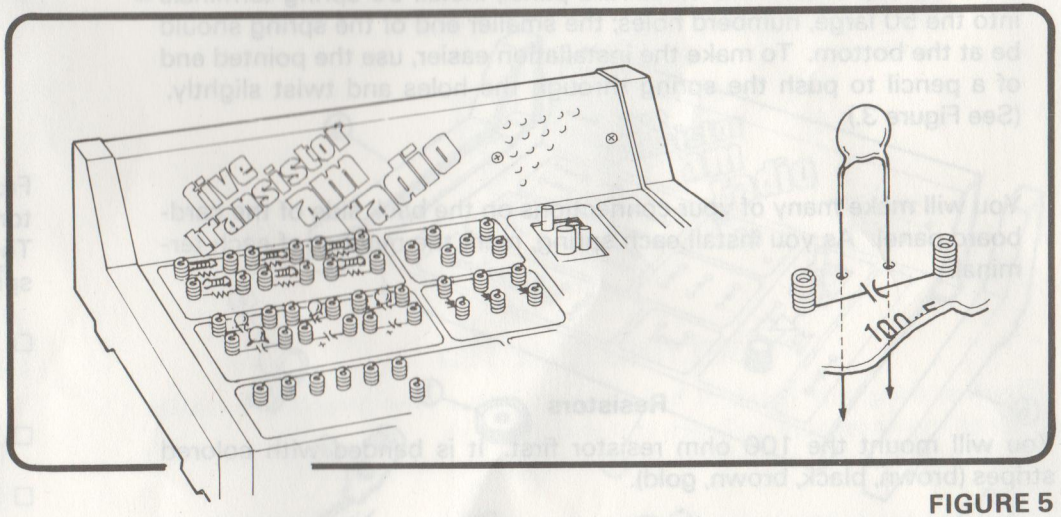


FIGURE 5

The remaining two capacitors are electrolytic; this means they must be connected with the proper polarity (+ and –).
The side of the capacitor with the (–) lead is marked with a vertical stripe and minus signs. Of course, the other side is (+). (See Figure 6.)

☐ Connect the 1 μF capacitor (small) to terminals 21 (+) and 22 (–).

☐ Connect the 100 μF capacitor (large) to terminals 23 (+) and 24 (–).

Transistors

☐ The first transistor you will mount is marked with the number "C535" on its flat side (Q1).

☐ Make sure the transistor's three leads (wires) are not tangled, then insert them through the hole surrounded by spring terminals 25, 26 and 27 (on the top of the cardboard panel); the flat side of the transistor must face terminal 26.

☐ Now turn the panel over and connect the transistor's center lead (collector) to spring terminal 26. (See Figure 7.)

☐ Connect the other two leads (emitter and base) of the transistor to terminals 27 and 25, as shown in Figure 7. (Connect each lead to the nearer spring terminal.)

☐ The second transistor you will mount is marked on its flat side with the number "C945," "C828" or "C1684" (Q2). Mount it in the hole surrounded by terminals 28, 29 and 30 and the flat side facing terminal 29.

☐ On the back side of the cardboard panel, connect the center lead (collector) to terminal 29. Then connect the other two leads to terminals 30 (emitter) and 28 (base), (Connect each lead to the nearer spring terminal.)

Diodes

The diodes must be mounted one way only. The first one you mount will be the germanium (red-banded) one.

☐ From the top of the cardboard panel, insert the two leads of the diode through the holes next to the schematic symbol. Banded end to terminal 32. (See Figure 8.)

☐ Connect the leads, on the bottom side of the board, to terminals 31 and 32.

Connect the 2 smaller diodes – the silicon (white or yellow banded.)

☐ Connect one of the silicon diodes to terminals 33 and 34. Banded end to terminal 34.

☐ Connect the other silicon diode to terminals 35 and 36. Banded end to terminal 36.

Bar Antenna

☐ Insert the Bar Antenna into the Antenna Holder keeping the white wire of the antenna coil to your left. Then, adjust the Bar Antenna. (See Figure 9.) So the left end is barely outside the coil.

☐ From the top of the cardboard panel, insert the five wires of the coil through the rectangular hole next to the schematic symbol.

☐ Position the Antenna Holder in place on the top side of the panel. Then insert the long Phillips-head screw through the hole in the cardboard panel and secure the holder with a nut. Use a screwdriver to tighten the screw. (See Figure 9.)

On the back side of the cardboard panel, connect each wire to terminals as follows: (See Figure 9.)

☐ Connect white wire to terminal 37.

☐ Connect black wire to terminal 38.

☐ Connect yellow wire to terminal 39.

☐ Connect red wire to terminal 40.

☐ Connect green wire to terminal 41.

Variable Capacitor

☐ On the bottom side of the cardboard panel, position the Variable Capacitor getting its two terminals facing terminals 42 and 43. Then connect the wire of its shorter terminal to terminal 42, and the other wire to terminal 43. (See Figure 10.)

☐ Turn the panel over and insert two short Phillips-head screws through the holes in the cardboard panel. Then fasten the screws with the screwdriver. (See Figure 10.)

☐ Mount the Turning Knob onto the shaft of the Variable Capacitor. Insert the short, Phillips-head screw and fasten it with the screwdriver as shown in Figure 10.

Choke Coil

☐ From the top of the cardboard panel, insert the two leads of the Choke Coil through the holes next to its schematic symbol. (See Figure 11.) Then on the bottom side of the panel, connect the leads to terminals 44 and 45.

Wiring in Amplifier Module

On the bottom side of the cardboard panel, connect four wires to terminals 46, 47 and 48 as follows. (See Figure 12.)

☐ Connect the orange wire of the right terminal of the Variable Resistor to terminal 46.

☐ Connect the gray wire of the left terminal of the Variable Resistor to terminal 48.

☐ Connect the violet wire of the Printed Circuit Board to terminal 47.

☐ Connect the brown wire of the Printed Circuit Board to terminal 48.

Battery Holder and Snap

☐ On the top side of the panel, position the Battery Holder over the proper hole. Then insert the long Phillips-head screw and secure the holder with a nut. Use a screwdriver to tighten the screw. (See Figure 13.)

☐ From the top side of the panel, insert the wires of the Battery Snap through the hole next to terminal 49. Then turn the panel over; tie a knot in the wire (See Figure 13.). The knob will keep the wire from coming out of the hole.

☐ Connect the red wire of the Battery Snap to terminal 49 on the back of the panel.

☐ Connect the black wire of the Battery Snap to terminal 50.

OPERATION

The power for the Five Transistor AM Radio Kit will be supplied by a 9-volt battery.

☐ After connecting the Battery Snap to the terminals of your battery, place the battery in the Battery Holder.

Important: There is no on/off switch for your kit. You must disconnect the red battery wire when the kit is not being used. If you do not, the battery will run down in a few hours.

Now let's proceed to the exciting world of electronics – with your own AM radios!

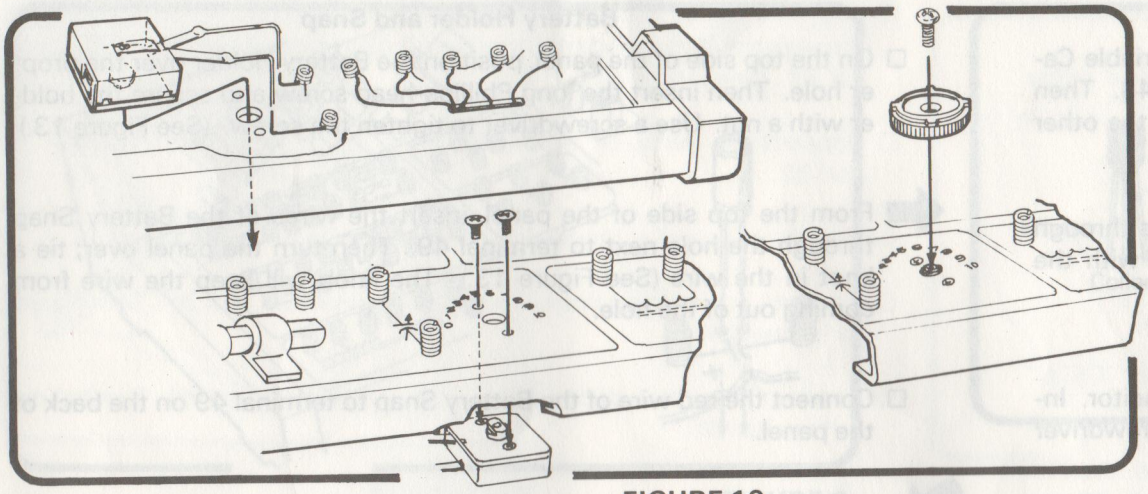


FIGURE 10

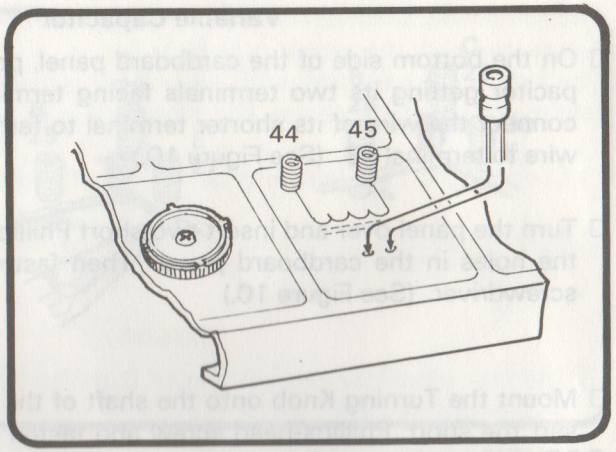


FIGURE 11

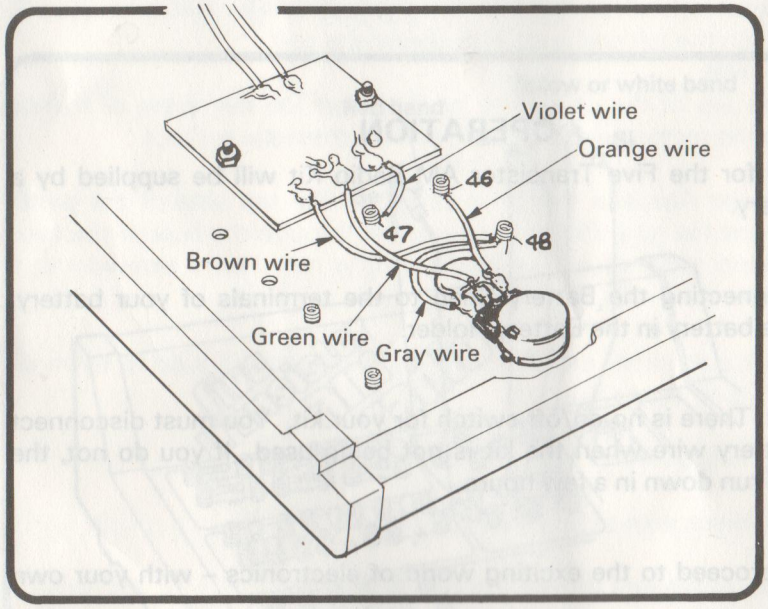


FIGURE 12

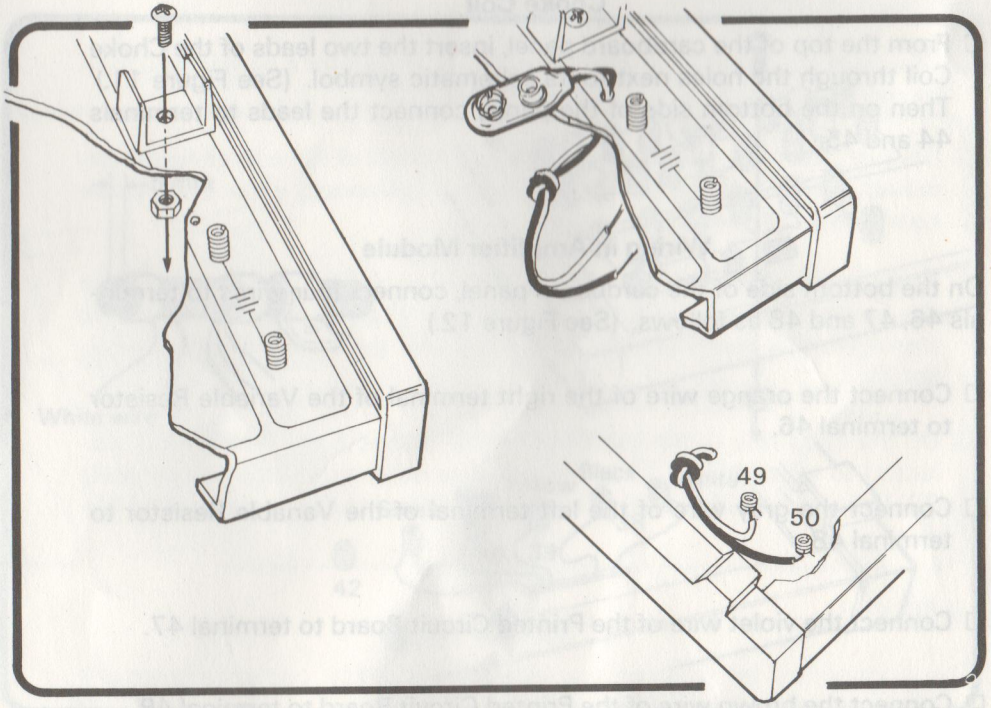


FIGURE 13

1. Crystal Radio

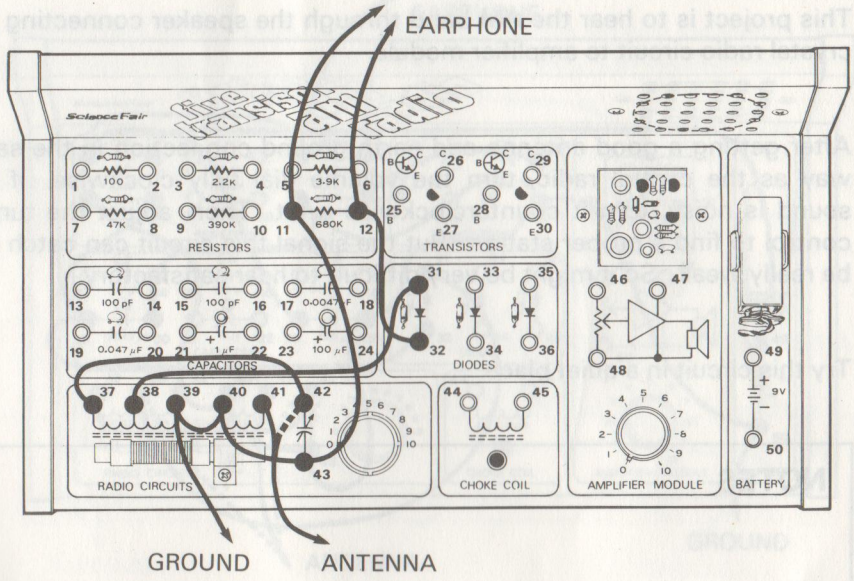
Back in the early days of radio, crystal sets were widely used (your grandparents might remember them). This project is more up-to-date version of the classic crystal set.

A good antenna and earth ground connection are required to receive distant stations. A long piece of wire (like the green wire in your kit) will probably make an adequate antenna in most cases. Earth ground means just that; you connect the wire to the ground. One easy way to do this is to connect a wire to a metal, cold water pipe. If this is not possible, you will need to drive a metal stake into the ground and connect the wire to that.

When radio waves strike the outdoor antenna, they set up small electric current in the antenna. The lead-in wire carries these currents to the antenna coil. These currents are AC and are at different frequencies. The tuning control selects one set of frequencies and passes the current on the diode. The diode rectifies AC into DC. You hear the results of all this in the earphone.

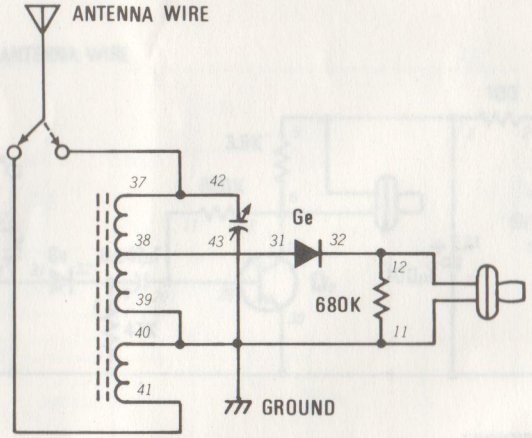
This Project will let you tune stations on the AM broadcasting band. Adjust the tuning control to find the station you want to hear. Don't be too surprised if all you can hear is one loud local station with this circuit. And if you live several miles from the nearest AM station, you may not be able to hear any stations. Be sure to use the kit outdoor for best results.

NOTES



WIRING SEQUENCE:

31-38, 32-12-EARPHONE, EARPHONE-11-43-40-39-GROUND, 37-42, 41-ANTENNA (or 42-ANTENNA)



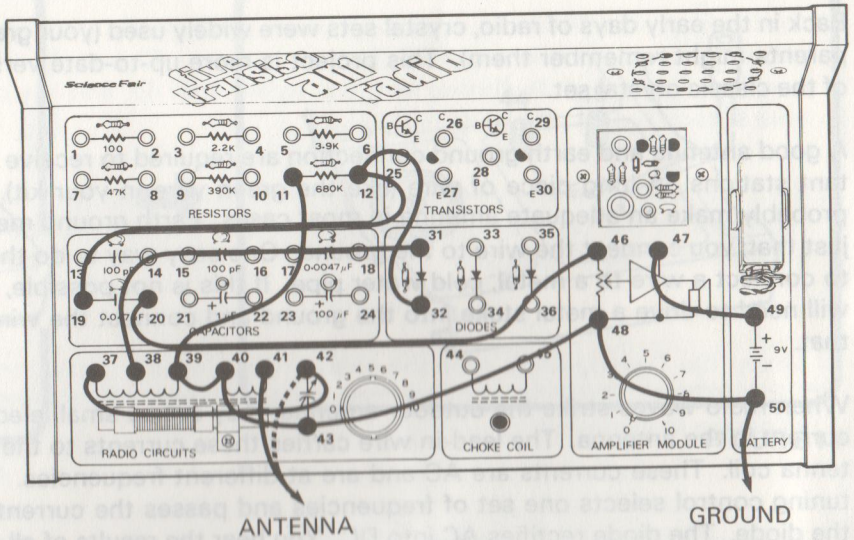
2. Crystal Radio With Amplifier

This project is to hear the AM band through the speaker connecting the crystal radio circuit to amplifier module.

After getting a good antenna and earth ground connection in the same way as the crystal radio, turn the volume dial fully clockwise. If the sound is noisy, turn it counterclockwise a bit. Then, adjust the tuning control to find a proper station. But the signal this circuit can catch will be really weak. So it might be very difficult to hear satisfactory.

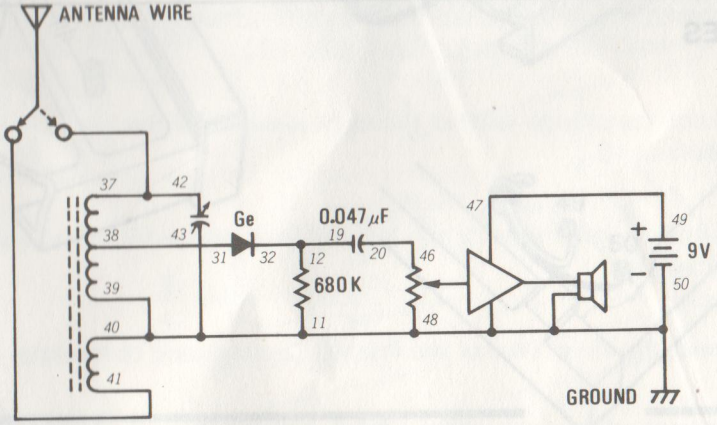
Try this circuit in a quiet place.

NOTES



WIRING SEQUENCE:

11-39-40-43-48-50-GROUND, 19-12-32, 20-46, 31-38, 37-42, 47-49, 41-ANTENNA (or 42-ANTENNA)



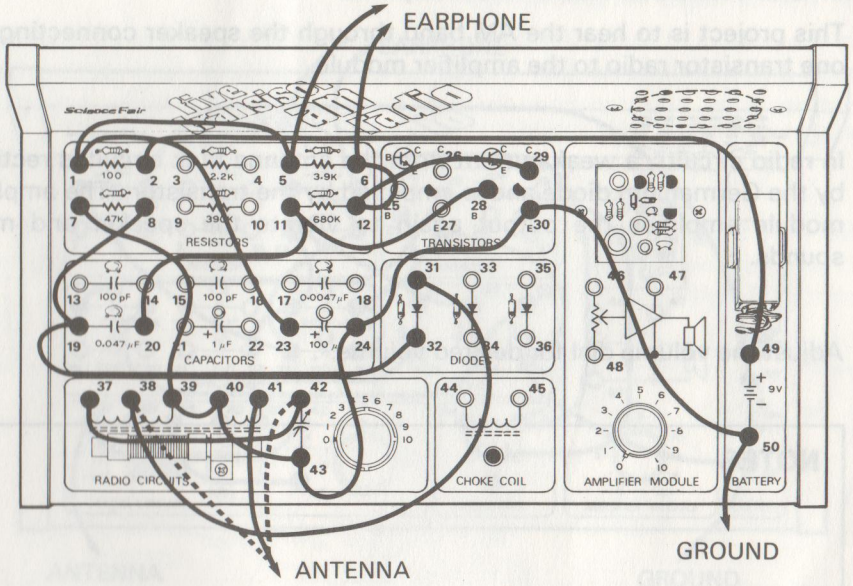
3. One Transistor Radio

This project is to grade up crystal radio adding one transistor amplifier.

Electric waves from the broadcast station are caught by the antenna. These waves are selected into one wave by the tuning circuit. The wave is rectified from AC to DC by the germanium diode. No, difference, so far, from crystal radio, but after this, there are other steps the wave should go through. The rectified weak current flows into the base of the transistor. In the collector, there flows a strong current by the amplification effect of the transistor. Finally, in both sides of 3.9 k resistor, much stronger currents are generated and the ceramic earphone sounds.

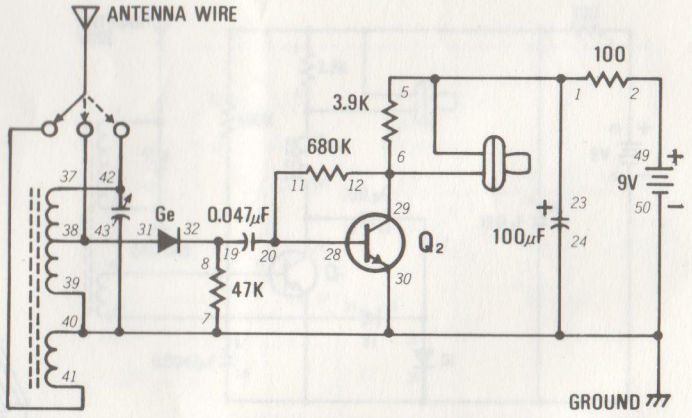
Through these steps, you can hear louder sound than from crystal radio.

NOTES



WIRING SEQUENCE:

2-49, 7-39-40-43-24-30-50-GROUND, 8-19-32, 20-11-28, 23-1-5-EARPHONE, EARPHONE-6-12-29, 31-38, 37-42, 41-ANTENNA (or 42-ANTENNA)



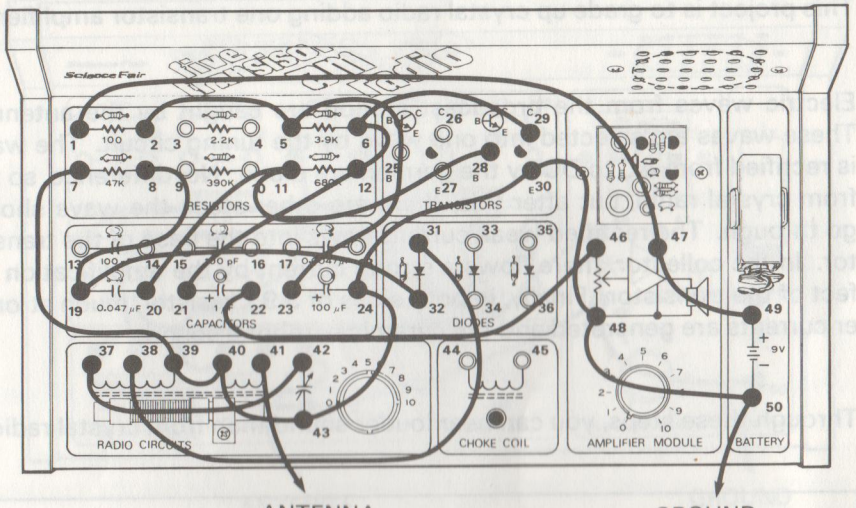
4. One Transistor Radio With Amplifier

This project is to hear the AM band through the speaker connecting the one transistor radio to the amplifier module.

In radio circuits, a weak current from the antenna tank circuit is rectified by the Germanium diode and is amplified by the transistor. The amplifier module amplifies the output again to vibrate the speaker and make sounds.

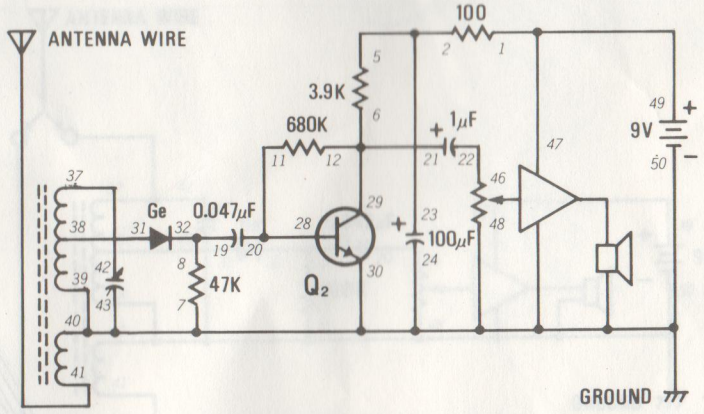
Adjust the volume dial for desired volume.

NOTES



WIRING SEQUENCE:

1-47-49, 2-5-23, 7-39-40-43-24-30-48-50-GROUND, 8-19-32, 20-11-28, 21-12-6-29, 22-46, 31-38, 37-42, 41-ANTENNA



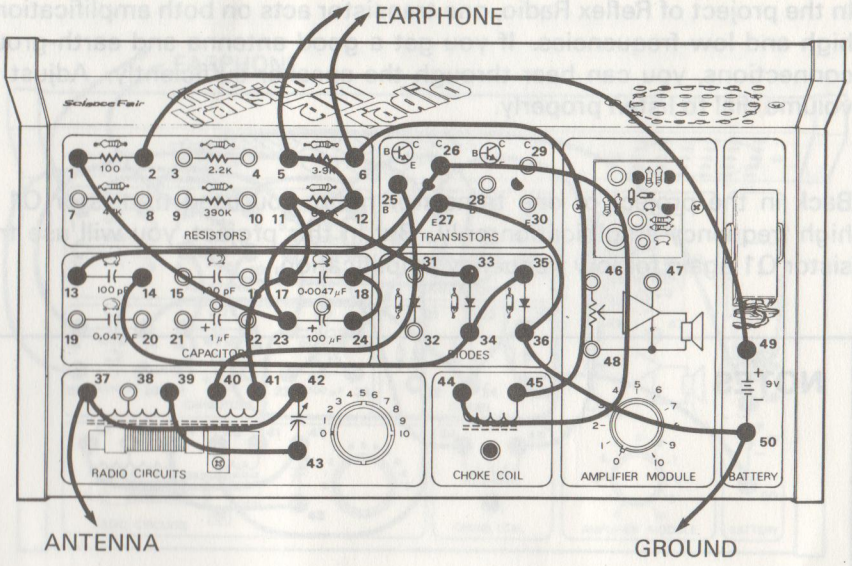
5. Reflex Radio

This project also belongs to the one transistor radio. But the sensitivity is better than that of the one transistor radio. Because its transistor acts on amplification of both high and low frequencies.

The selected weak current in the antenna-tank circuit flows through the second coil of the antenna bar into the base of the transistor. There, the frequency of the current is amplified and then flows into the collector with the load of the choke coil. The current flows into the Silicon diode and through the 100 pF capacitor where it is rectified. Having its high frequency cut in 0.0047 μF Capacitor, the current changes to low frequency only. Then the current re-enters into the base to be amplified. Finally, the current generates voltage in both sides of the 39 k ohm resistor and sounds the ceramic earphone.

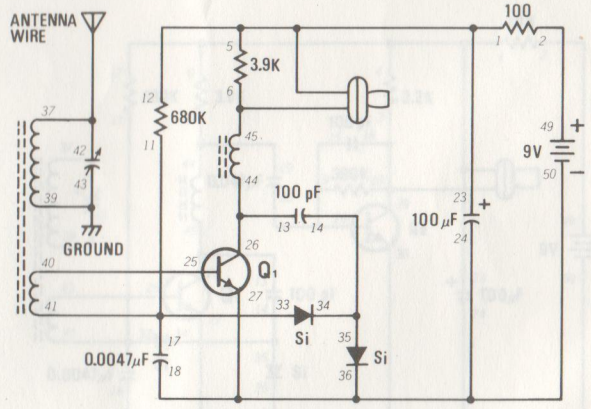
Important: Do not let the wire connected between terminal 14 and 34 be close to the wire 37 and 42. This is to protect the self-oscillation that occurs because of reflex energy from the output of Q1 feeding back to the antenna tank circuit.

NOTES



WIRING SEQUENCE:

1-23-12-5-EARPHONE, EARPHONE-6-45, 2-49, 13-26-44, 14-34-35, 24-18-27-36-50-GROUND, 25-40, 33-11-17-41, 37-42, 39-43, 37-ANTENNA

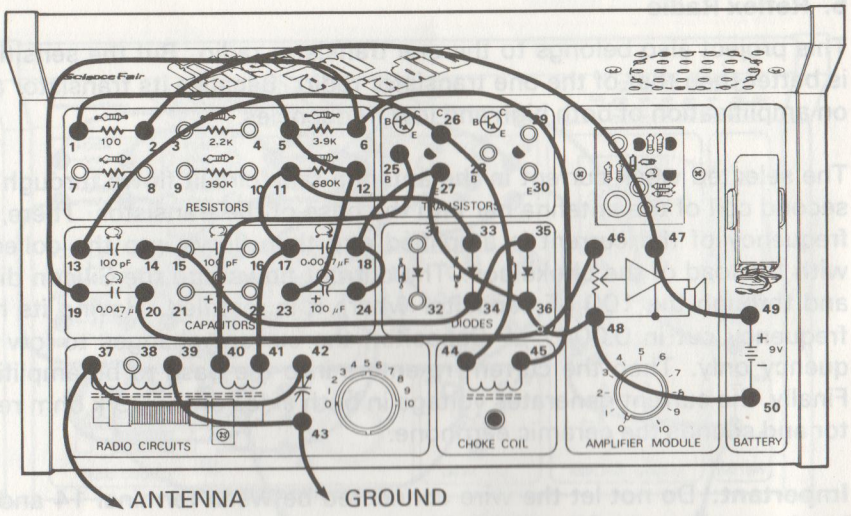


6. Reflex Radio With Amplifier

In the project of Reflex Radio, one transistor acts on both amplification of high and low frequencies. If you get a good antenna and earth-ground connections, you can hear through the speaker sufficiently. Adjust the volume dial to listen properly.

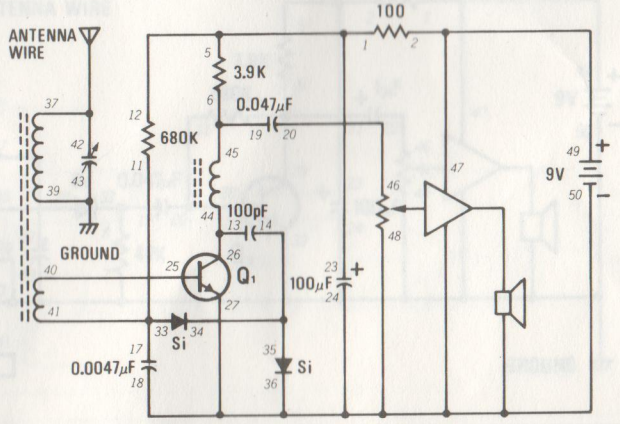
Back in the project of one transistor radio, you used transistor Q1 for high frequency amplification only. But in this project, you will use transistor Q1 again for low frequency amplification.

NOTES



WIRING SEQUENCE:

1-5-12-23, 2-47-49, 13-26-44, 14-34-35, 19-6-45, 20-46, 24-18-27-36-48-50, 25-40, 33-11-17-41, 39-43-GROUND, 42-37-ANTENNA



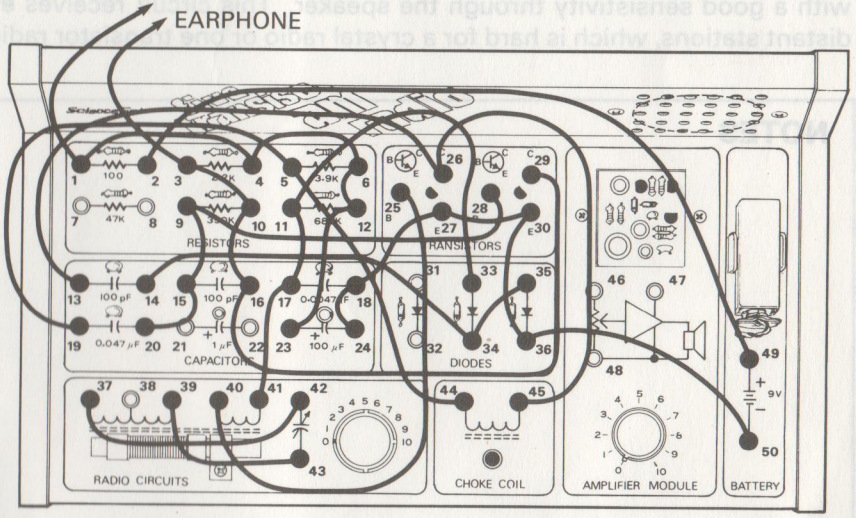
7. Two Transistor Reflex Radio

This project is to get the highest sensistivity possible in this kit. You will be able to listen in a sufficient volume even with no antenna or ground. (If you can not listen well, connect the Antenna wire to terminal 37.)

After amplifying twice by Q1 in this circuit, another transistor Q2 is used for low frequency amplification.

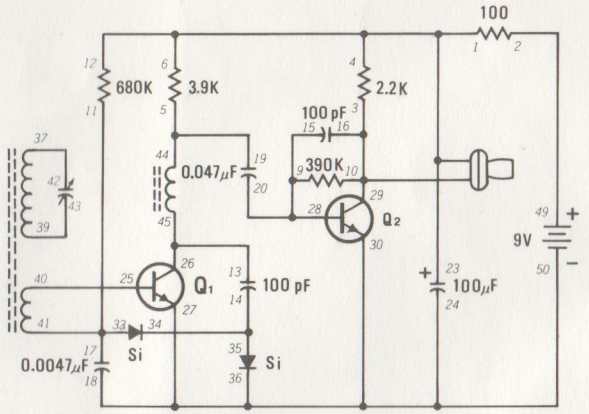
Since this project is equiped with three time amplification, you are able to hear rather loud sound in the earphone.

NOTES



WIRING SEQUENCE:

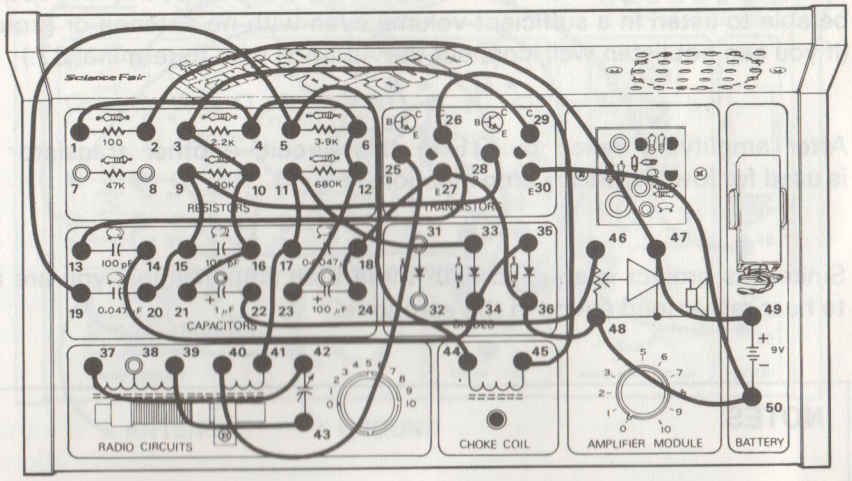
2-49, 13-26-45, 14-34-35, 19-5-44, 20-15-9-28, 23-12-6-4-1-EARPHONE, EARPHONE-3-10-16-29, 24-18-27-30-36-50, 25-40, 33-11-17-41, 37-42, 39-43



8. Two Transistor Reflex Radio With Amplifier

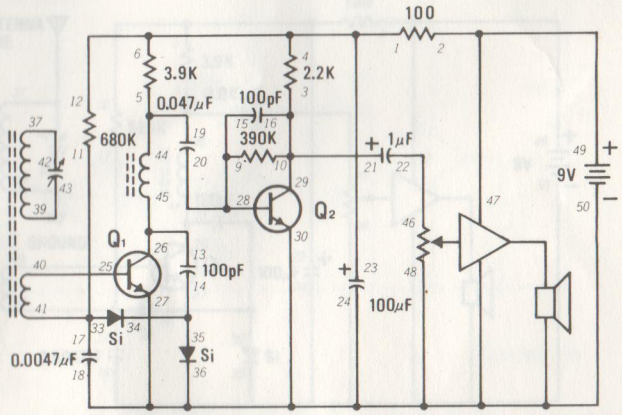
Finally, you will challenge the last project in this kit – the highest grade with a good sensistivity through the speaker. This circuit receives even distant stations, which is hard for a crystal radio or one transistor radio.

NOTES



WIRING SEQUENCE:

✓1-4-6-12-23, ✓13-26-45, ✓14-34-35, ✓19-5-44, ✓20-15-9-28, ✓21-16-10-3-29, ✓22-46, ✓24-18-27-36-48-50-30, ✓25-40, ✓33-11-17-41, ✓37-42, ✓39-43, ✓2-47-49.



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