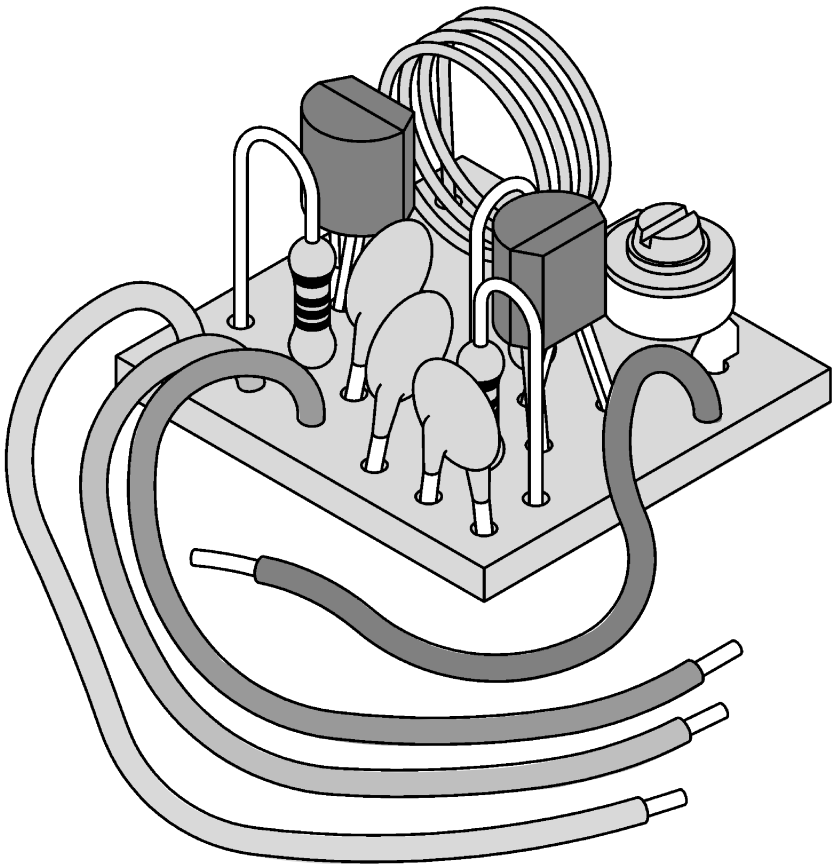
TELEPHONE BUG KIT

MODEL K-35



Assembly and Instruction Manual

Elenco® Electronics, Inc.

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PARTS LIST

If you are a student, and any parts are missing or damaged, please see instructor or bookstore.
If you purchased this kit from a distributor, catalog, etc., please contact Elenco® Electronics (address/phone/e-mail is at the back of this manual) for additional assistance, if needed. **DO NOT** contact your place of purchase as they will not be able to help you.

RESISTORS

Qty.	Symbol	Description	Color Code	Part #
❒ 1	R1	Resistor 47Ω 5% 1/4W	yellow-violet-black-gold	124700
❒ 1	R3	Resistor 680Ω 5% 1/4W	blue-gray-brown-gold	136800
❒ 1	R2	Resistor 270kΩ 5% 1/4W	red-violet-yellow-gold	162700

CAPACITORS

Qty.	Symbol	Description	Part #
❒ 1	C2	Trimmer Cap 5-40pF	201088
❒ 1	C3	Capacitor 47pF (47)	214710
❒ 1	C1	Capacitor 100pF (101 or 100)	221017
❒ 1	C4	Capacitor 470pF (471 or 470)	224717

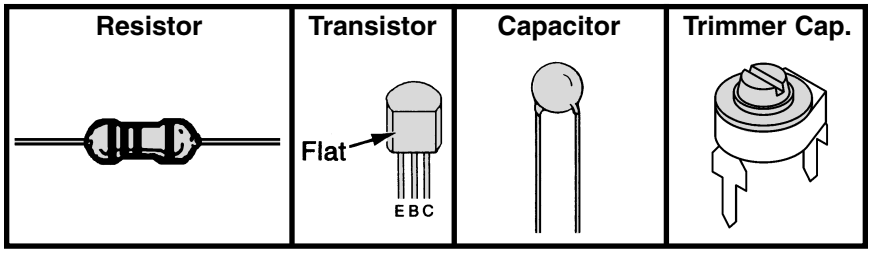
SEMICONDUCTORS

Qty.	Symbol	Description	Part #
❒ 1	Q1	Transistor 2N3904	323904
❒ 1	Q2	Transistor MPSA56	320056

MISCELLANEOUS

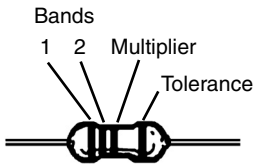
Qty.	Description	Part #
❒ 1	PC Board	517001
❒ 6”	Wire black 22ga Solid	814120
❒ 6”	Wire red 22ga Solid	814220
❒ 6”	Wire green 22ga Solid	814520
❒ 6”	Wire gray 22ga Solid	814820
❒ 6”	Wire enamel 28ga	857220

PARTS IDENTIFICATION



IDENTIFYING RESISTOR VALUES

Use the following information as a guide in properly identifying the value of resistors.



BAND 1 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

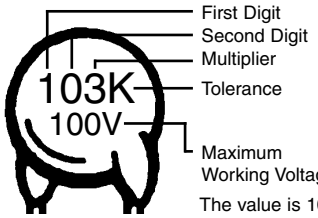
BAND 2 2nd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Multiplier	
Color	Multiplier
Black	1
Brown	10
Red	100
Orange	1,000
Yellow	10,000
Green	100,000
Blue	1,000,000
Silver	0.01
Gold	0.1

Resistance Tolerance	
Color	Tolerance
Silver	±10%
Gold	±5%
Brown	±1%
Red	±2%
Orange	±3%
Green	±.5%
Blue	±.25%
Violet	±.1%

IDENTIFYING CAPACITOR VALUES

Capacitors will be identified by their capacitance value in pF (picofarads), nF (nanofarads), or μF (microfarads). Most capacitors will have their actual value printed on them. Some capacitors may have their value printed in the following manner.



The value is 10 x 1,000 = 10,000pF or .01μF 100V

Multiplier	For the No.	0	1	2	3	4	5	8	9
	Multiply By	1	10	100	1k	10k	100k	.01	0.1

The letter M indicates a tolerance of ±20%
The letter K indicates a tolerance of ±10%
The letter J indicates a tolerance of ±5%

Note: *The letter "R" may be used at times to signify a decimal point; as in 3R3 = 3.3*

IMPORTANT NOTICE

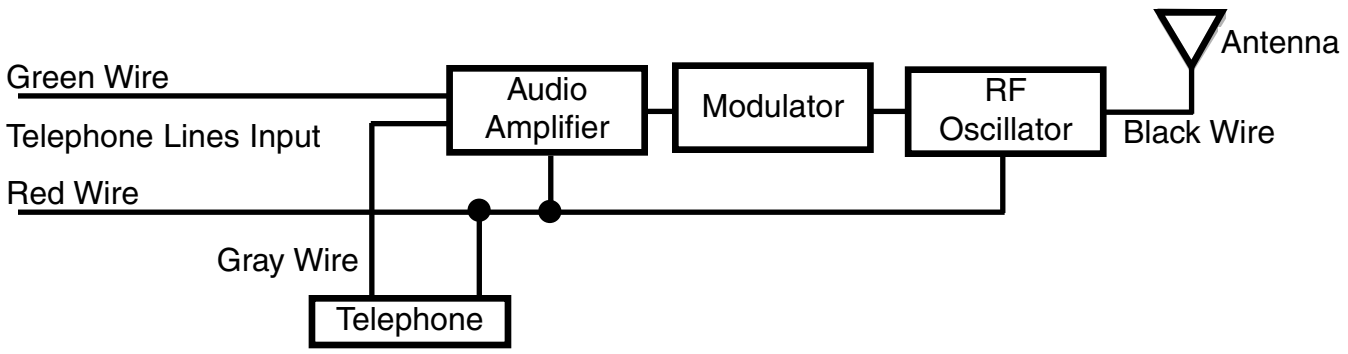
It is illegal to listen to a telephone conversation without the person's consent. This kit is designed for educational purposes only. It is meant to teach students and hobbyists the transmitting principle for a cordless telephone. The manufacturer of this kit cannot be held responsible for any illegal use.

INTRODUCTION

The Telephone Bug is really a miniature FM radio transmitter broadcasting within the 88 to 108MHz (megahertz) band. It is designed to be wired inside a telephone or the wires leading to the telephone. The voice frequencies carried by the telephone wires modulate the FM transmitter allowing both sides of the telephone conversation to be heard on any standard FM radio. Because of the unique circuitry , no battery is needed to operate the unit. The power is taken from the telephone line.

CIRCUIT OPERATION

Figure 1 is a block diagram of how the Telephone Bug works. It consists of an audio amplifier, modulator, an RF oscillator and an antenna. We shall look at these basic circuits and examine how they function.



THE RF OSCILLATOR

Figure 2 shows a simplified version of the oscillator circuit. The heart of the circuit is transistor Q1. It is biased into conduction by resistor R2. In the collector of the transistor is a tuned circuit consisting of inductor coil L1 and capacitors C2, C3 and C4. A tuned circuit resonates at a natural resonant frequency. In our case, the resonant frequency is in the FM radio band, between 88 and 108 megahertz (MHz). Capacitor C2 is a variable capacitor. By adjusting C2, you can change the frequency of oscillation.

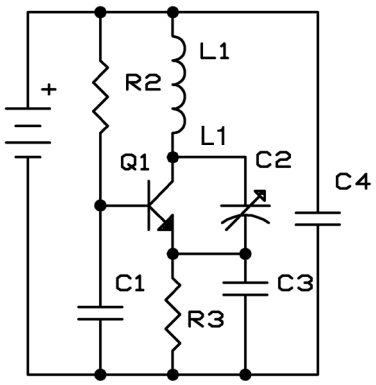


Figure 2

To get an oscillator to work, you need positive feedback with a voltage gain greater than one. Transistor Q1 provides the gain and capacitor C2 gives the positive feedback. Under these conditions, transistor Q1 will oscillate at the natural frequency of the tuned circuit. Capacitor C1 bypasses the base of the transistor, and capacitor C4 blocks the DC voltage from the tuned circuit.

THE VOICE AMPLIFIER

Figure 3 shows the basic circuit of the voice amplifier. It consists of transistor Q2 and resistor R1. The output load for this amplifier is the oscillator circuit. This is a unique arrangement and we shall explain why in the next section.

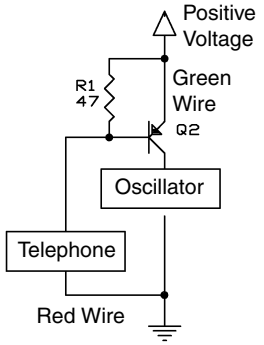


Figure 3

The positive voltage for the amplifier is supplied by the telephone line. When the telephone receiver is off the hook, 6-8 volts appear across the green and red telephone wires. This causes a current flow through resistor R1, which turns on transistor Q2. Any voice frequencies on the telephone line will be amplified at the output of the collector of Q2.

THE MODULATOR

Thus far we have discussed the RF oscillator and the voice amplifier. These two signals by themselves cannot be heard on an FM receiver. They must be mixed together or modulated so that the RF signals will carry the voice signals. To do this, we must understand the basic principle of FM radio.

The letters FM mean “frequency modulation”. If you send a 100MHz RF signal into an FM radio and tune the radio to the 100 spot on the dial, you will only hear silence. No noise or hissing sounds. That is because the RF carrier will capture the frequency dial and produce only a DC voltage. If you take this 100,000,000 cycle (100MHz) carrier and some how move it between 99,900,000 and 101,000,000 cycles ($\pm$100,000 cycles) at the rate of 1,000 times per second, you will be modulating the RF carrier with a 1,000 cycle tone. Your FM receiver will now put out a 1,000Hz tone which you will hear from the speaker. Thus, the RF carrier is modulated with a 1,000Hz voice type signal. Note that the rate you change the RF carrier produces the audible signals and how far away from the original RF carrier produces the loudness of the tone. Thus, if we move the RF carrier only $\pm$10,000, the tone will be 1/10 the loudness.

How do we get the Telephone Bug to modulate the RF signal? Refer to Figure 2 and tune capacitor C2 to produce 100MHz, using a 6 volt battery for power. Now replace the 6V with a 3V and you will find that the RF carrier will drop in frequency. This is because the collector in transistor Q1 will change in capacitance, with DC voltage change. A change in capacitance will change the resonance frequency of the LC tuned circuit, thus the RF frequency will change.

In the Voice Amplifier section, we learned that the output load of transistor Q2 amplifier was the oscillator circuit. Therefore the oscillator circuit gets its DC voltage from the voice amplifier. Thus, the oscillator’s voltage depends on the voice signal, or the voice frequency will modulate the RF signal.

THE ANTENNA

To radiate the RF signal into space, we need an antenna. The antenna in the telephone bug is only a short length of wire. This wire is connected to the emitter of transistor Q1. The longer the antenna, the further the RF will be transmitted.

CONSTRUCTION

Introduction

The most important factor in assembling your K-35 Telephone Bug Kit is good soldering techniques. Using the proper soldering iron is of prime importance. A small pencil type soldering iron of 25 - 40 watts is recommended. **The tip of the iron must be kept clean at all times and well-tinned.**

Solder

For many years leaded solder was the most common type of solder used by the electronics industry, but it is now being replaced by lead-free solder for health reasons. This kit contains lead-free solder, which contains 99.3% tin, 0.7% copper, and has a rosin-flux core.

Lead-free solder is different from lead solder: It has a higher melting point than lead solder, so you need higher temperature for the solder to flow properly. Recommended tip temperature is approximately 700°F; higher temperatures improve solder flow but accelerate tip decay. An increase in soldering time may be required to achieve good results. Soldering iron tips wear out faster since lead-free solders are more corrosive and the higher soldering temperatures accelerate corrosion, so proper tip care is important. The solder joint finish will look slightly duller with lead-free solders.

Use these procedures to increase the life of your soldering iron tip when using lead-free solder:

- Keep the iron tinned at all times.
- Use the correct tip size for best heat transfer. The conical tip is the most commonly used.
- Turn off iron when not in use or reduce temperature setting when using a soldering station.
- Tips should be cleaned frequently to remove oxidation before it becomes impossible to remove. Use Dry Tip Cleaner (Elenco® #SH-1025) or Tip Cleaner (Elenco® #TTC1). If you use a sponge to clean your tip, then use distilled water (tap water has impurities that accelerate corrosion).

Safety Procedures

- **Always wear safety glasses or safety goggles to protect your eyes when working with tools or soldering iron, and during all phases of testing.**
- Be sure there is **adequate ventilation** when soldering.
- Locate soldering iron in an area where you do not have to go around it or reach over it. Keep it in a safe area away from the reach of children.
- **Do not hold solder in your mouth.** Solder is a toxic substance. Wash hands thoroughly after handling solder.

Assemble Components

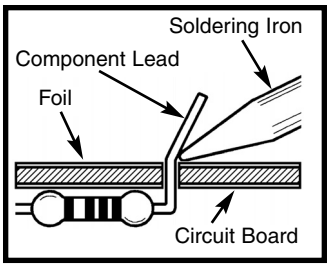
In all of the following assembly steps, the components must be installed on the top side of the PC board unless otherwise indicated. The top legend shows where each component goes. The leads pass through the corresponding holes in the board and are soldered on the foil side.
Use only rosin core solder.

DO NOT USE ACID CORE SOLDER!

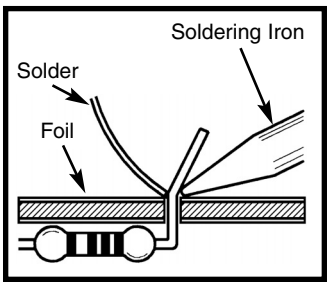
What Good Soldering Looks Like

A good solder connection should be bright, shiny, smooth, and uniformly flowed over all surfaces.

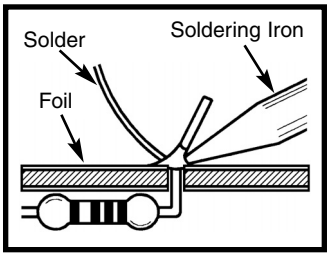
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.



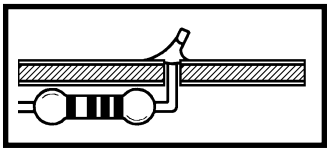
2. Apply a small amount of solder to the iron tip. This allows the heat to leave the iron and onto the foil. Immediately apply solder to the opposite side of the connection, away from the iron. Allow the heated component and the circuit foil to melt the solder.



3. Allow the solder to flow around the connection. Then, remove the solder and the iron and let the connection cool. The solder should have flowed smoothly and not lump around the wire lead.

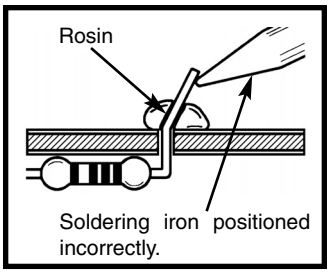


4. Here is what a good solder connection looks like.

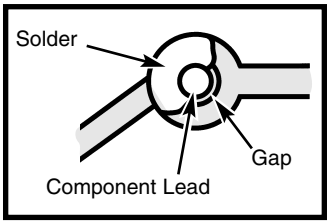


Types of Poor Soldering Connections

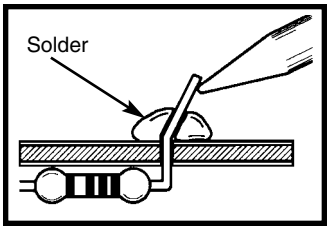
1. **Insufficient heat** - the solder will not flow onto the lead as shown.



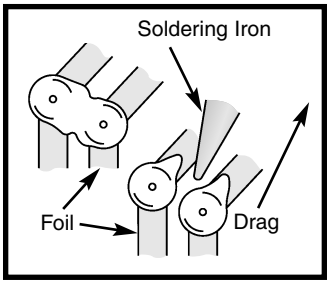
2. **Insufficient solder** - let the solder flow over the connection until it is covered.
Use just enough solder to cover the connection.



3. **Excessive solder** - could make connections that you did not intend to between adjacent foil areas or terminals.



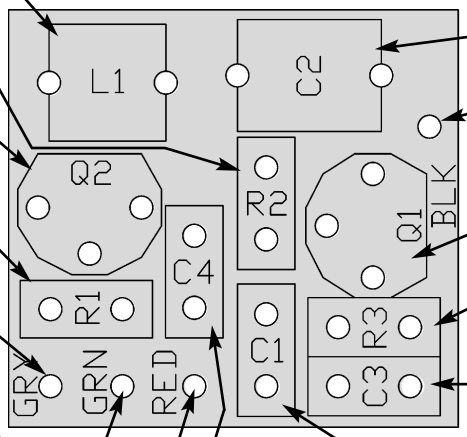
4. **Solder bridges** - occur when solder runs between circuit paths and creates a short circuit. This is usually caused by using too much solder.
To correct this, simply drag your soldering iron across the solder bridge as shown.



ASSEMBLE COMPONENTS TO THE PC BOARD

- ☐ L1 - Coil (see Figure A)
- ☐ R2 - 270kΩ 5% 1/4W Resistor (red-violet-yellow-gold) (see Figure B)
- ☐ Q2 - MPSA56 Transistor (see Figure C)
- ☐ R1 - 47Ω 5% 1/4W Resistor (yellow-violet-black-gold) (see Figure B)
- ☐ GRY - Gray Wire (Strip 1/4" of insulation off of both ends.)
- ☐ GRN - Green Wire (Strip 1/4" of insulation off of both ends.)
- ☐ RED - Red Wire (Strip 1/4" of insulation off of both ends.)
- ☐ C4 - 470pF (471) Capacitor (see Figure D)

PC board shown at three times the actual size.



- ☐ C2 - 5-40pF Trimmer Cap
- ☐ BLK - Black Wire (Strip 1/4" of insulation off of one end.)
- ☐ Q1 - 2N3904 Transistor (see Figure C)
- ☐ R3 - 680Ω 5% 1/4W Resistor (blue-gray-brown-gold) (see Figure B)
- ☐ C3 - 47pF (47) Capacitor (see Figure D)
- ☐ C1 - 100pF (101) Capacitor (see Figure D)

Figure A

Scrape off 1/8" of enamel off of both ends of the 6" enamel wire. This will allow the wire to be soldered to the PC board pads. Wind the enamel wire around a pencil. Be sure to leave some straight wire at the ends of the coil so that it can be mounted. Carefully slide the coil off of the pencil and mount it in the place shown on the top legend. Solder in place.

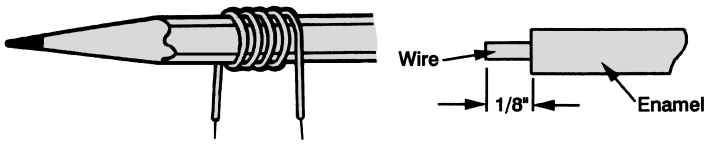


Figure B

Mount the resistors vertically to the PC board in the places shown on the top legend. Solder and cut off excess leads.

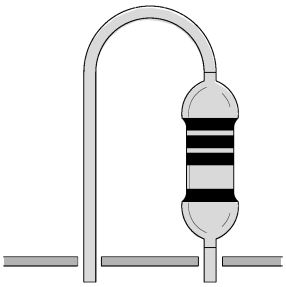


Figure C

Mount the transistors with the flat side in the same direction as shown on the PC board. Solder and cut off the excess leads.

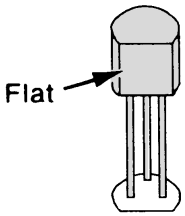
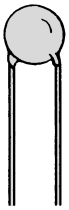


Figure D

Mount the capacitor onto the PC board as marked on the PC board. Solder and cut off the excess leads.



INSTALLATION

The Telephone Bug can be installed inside the telephone, the line leading to the telephone, or anywhere on the telephone line. If it is installed at the point where the telephone line enters the house, then any telephone will activate the Telephone Bug.

The active wires of a telephone line are red and green. Check that the polarity of the line is correct by measuring the voltage across the red and green line while listening to a dial tone. It should be about 6 volts with the green being positive. Install the unit as shown in Figure 4. You may have to cut the green wire and connect the K-35 green wire to the incoming line and connect the K-35 gray wire to the other cut green wire. If the connection is made properly, the telephone will operate normally.

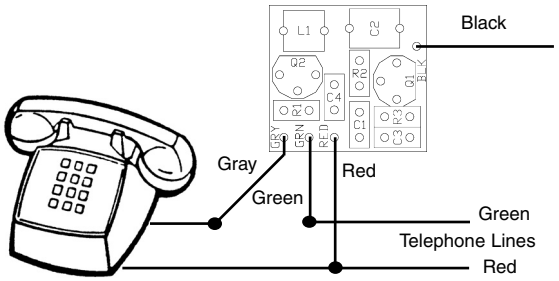


Figure 4

After installation, you'll need an FM radio to tune in the signal. Tune the radio to a quiet spot, usually around the low end of the dial. Lift the telephone receiver off the hook. Carefully turn the adjustable capacitor C2 with a small screwdriver (insulated type preferred), until the dial tone is heard on the FM radio. You must turn very slowly because it is easy to pass the station. Once the dial tone is heard, you have achieved the alignment.

TROUBLESHOOTING

The most frequently occurring problems result from poor solder connections.

1. Tug slightly on all parts to make sure that they are indeed soldered.
2. All solder connections should be shiny.
3. Solder should flow into a smooth puddle rather than a round ball. Resolder any connection that has formed into a ball.
4. Have any solder bridges formed? A solder bridge may occur if you accidentally touch an adjacent foil by using too much solder or by dragging the soldering iron across adjacent foils. Break the bridge with your iron.

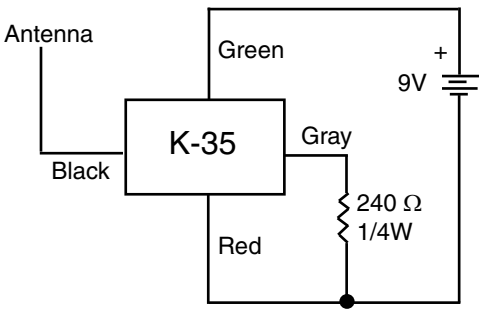
COMPONENT CHECK

1. Be sure that all of the components have been mounted in their correct positions.
2. The most likely problem to occur is getting the FM radio tuned to the Telephone Bug frequency. Follow the alignment procedure carefully. If you cannot tune, then change the coil by pinching the loops closer or spreading the loops slightly. This will change the inductance of the coil. Also, try the high side of the radio dial.
3. If still no luck, check the wiring to be sure that there are no mistakes.

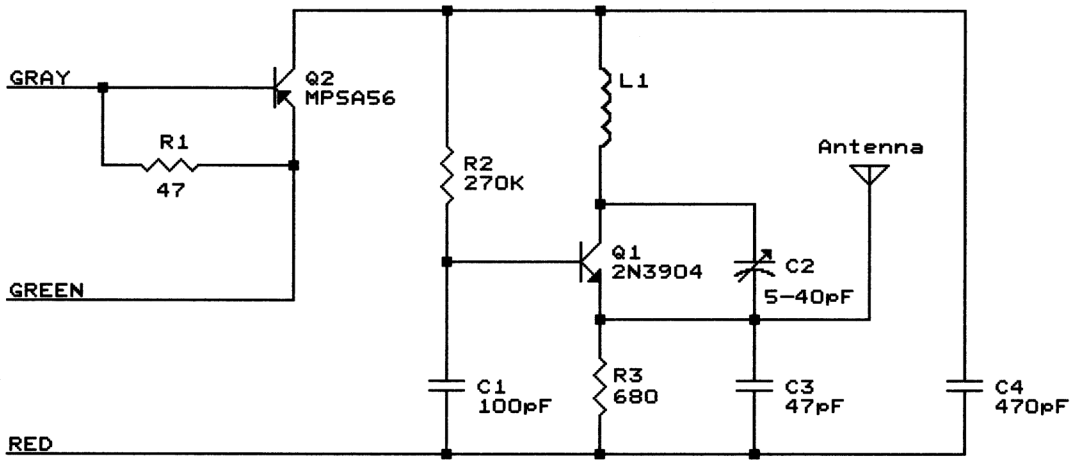
TEST CIRCUIT

To test the unit without using a phone line, follow the steps below.

1. Connect the K-35 as shown in the test circuit.
2. Tune the radio to a spot where no stations are present (only static is heard).
3. Carefully turn the adjustable capacitor C2 with a small screwdriver (insulated type preferred), until the static is not heard on the radio. You must turn very slowly because it is easy to pass the station.



SCHEMATIC DIAGRAM



QUIZ

1) The Telephone Bug is a small FM radio _____.

2) The main components of the Bug are the modulator, _____ oscillator, _____ amplifier, and antenna.

3) The RF oscillator frequencies for FM radio are between 88MHz and _____MHz.

4) An _____ circuit consisted of a coil and a capacitor connected together.

5) The Bug gets its power from the _____ line.

6) Current through resistor _____ turns on transistor Q2.

7) Transistor Q2 amplifies the _____ frequencies on the telephone line.

8) The modulation adds the _____ signal to the RF carrier.

9) The further the FM carrier is pulled from its center frequency, the _____ will be the voice signal heard in the radio speaker.

10) The antenna will _____ the signal into space.

Answers: 1. transmitter; 2. RF, voice; 3. 108; 4. oscillator; 5. phone; 6. R1; 7. voice; 8. voice; 9. louder; 10. radiate

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