FM WIRELESS MICROPHONE KIT

MODEL K-30/AK-710

Assembly and Instruction Manual

Elenco™ Electronics, Inc.

Revised 2004 REV-I 753016

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	Value	Color Code	Part #
☐ 1	R5	150Ω 5% 1/4W	brown-green-brown-gold	131500
☐ 2	R8, R10	1kΩ 5% 1/4W	brown-black-red-gold	141000
☐ 1	R7	1.5kΩ 5% 1/4W	brown-green-red-gold	141500
☐ 1	R3	4.7kΩ 5% 1/4W	yellow-violet-red-gold	144700
☐ 1	R1	8.2kΩ 5% 1/4W	gray-red-red-gold	148200
☐ 1	R6	10kΩ 5% 1/4W	brown-black-orange-gold	151000
☐ 1	R2	27kΩ 5% 1/4W	red-violet-orange-gold	152700
☐ 2	R4, R9	47kΩ 5% 1/4W	yellow-violet-orange-gold	154700

CAPACITORS

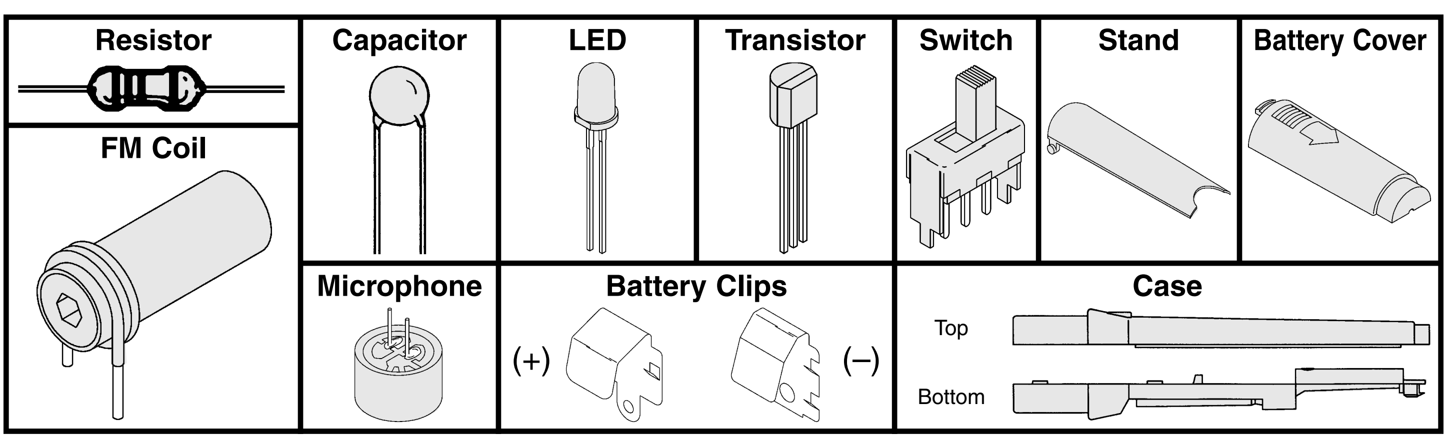
Qty.	Symbol	Value	Description	Part #
☐ 1	C4	10pF (10)	Discap	211011
☐ 1	C5	12pF (12)	Discap	211210
☐ 1	C6	33pF (33)	Discap	213317
☐ 2	C3, C7	.001μF (102)	Discap	231035
☐ 2	C1, C2	.1μF (104)	Discap	251010

SEMICONDUCTORS

Qty.	Symbol	Value	Description	Part #
☐ 3	Q1 - Q3	2N3904	Transistor	323904
☐ 1	LED		Light Emitting Diode (LED)	350001
☐ 1			Coil FM Mic	468751

Qty.	Description	Part #	Qty.	Description	Part #
☐ 1	PC Board	517710	☐ 1	Battery Cover	627002
☐ 1	Switch (S1)	541024	☐ 1	Alignment Tool	629011
☐ 1	Mic	568000	☐ 1	Screw 2.5mm x 4mm	641310
☐ 1	Battery Clip (+)	590091	☐ 3	Screw 2.6 x 8mm	642109
☐ 1	Battery Clip (–)	590093	☐ 12”	Wire 22ga. Gray	814810
☐ 1	Foam Cover	620002	☐ 6”	Wire 26ga. Black	816210
☐ 1	Top Case	623105	☐ 10.5”	Wire 26ga. Red	816220
☐ 1	Bottom Case	623205	☐ 1	Solder Tube	9ST4
☐ 1	Stand	626010			

PARTS IDENTIFICATION



IDENTIFYING RESISTOR VALUES

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

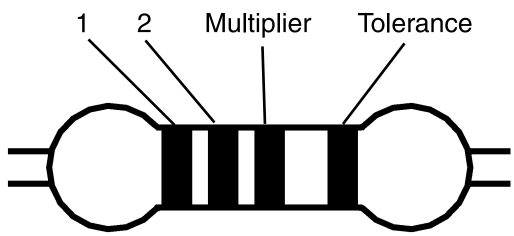
BAND 1 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

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%

BANDS



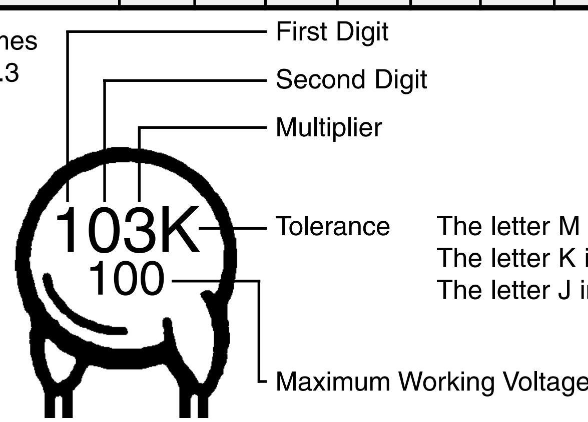
IDENTIFYING CAPACITOR VALUES

Capacitors will be identified by their capacitance value in pF (picofarads) 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 maximum operating voltage may also be printed on the capacitor.

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

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

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



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

FM MICROPHONE KIT

Your FM Microphone is really a miniature frequency modulated transmitter operating in the standard FM broadcast band. The range of frequencies for the FM broadcast band is 90MHz (MHz = Megahertz or 90 million cycles per second). Because the FM microphone has a variable tuned circuit, it can be tuned to a quiet spot on your local FM broadcast band for the best reception. When the small microphone element is struck by sound, it converts the audio to a change in current through resistor R1 (see schematic diagram). This electrical change is amplified and eventually frequency modulates the transmitter. The transmission range of the FM microphone is approximately 100 feet, depending on the efficiency of the antenna (properly tuned or not) and the quality of the FM radio receiver.

BASIC MODULATION THEORY

There are many different methods for modulating information onto a radio wave. The two most popular methods are Amplitude Modulation (AM) and Frequency Modulation (FM). Figure 1 shows the basic difference between these two methods. In an amplitude modulated radio wave, the audio information (voice) varies the amplitude of the RF carrier. To recover this information, all that is needed is a peak detector that follows the carrier peaks. This is fairly easy to understand. In a frequency modulated radio wave, the information changes the frequency of the carrier as shown in Figure 1.

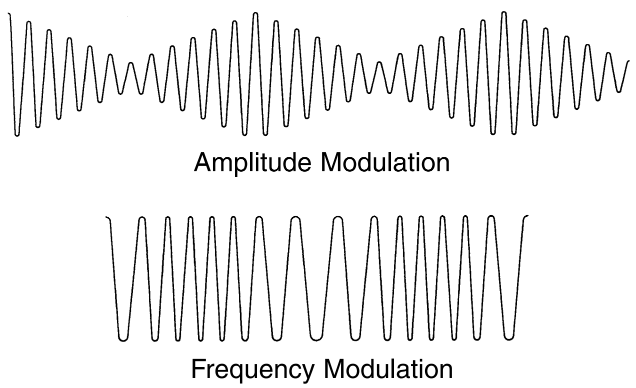


Figure 1

The amplitude of the radio frequency carrier wave remains constant. The loudness of the audio determines how far the frequency is moved from the unmodulated carrier frequency. In a normal FM radio broadcast, the maximum deviation from center frequency is set at ±150kHz for the loudest sound. A soft sound may move the carrier only +10kHz. The number of times the carrier deviates from the center frequency, each second depends on the frequency of the audio. For example, if the carrier is moved to +75kHz, then –75kHz 1,000 times each second, the carrier is 50% modulated for loudness with a 1,000 cycle audio tone.

One advantage of FM modulation over AM modulation is the carrier amplitude is not important since the information is carried by the frequency. This means that any amplitude noise added to the signal after transmission (such as lightning, spark or ignition noise in cars, etc.) can be reduced by allowing the amplifiers before detection to limit or saturate. This principle is shown in Figure 2.

The standard broadcast band for FM was also designed to have an audio range up to 25,000 Hertz (Hertz = cycles per second). The standard AM broadcast band has only 7,000 Hertz band width (Figure 3). The FM band is therefore considered to be “High Fidelity” compared to the older AM band.

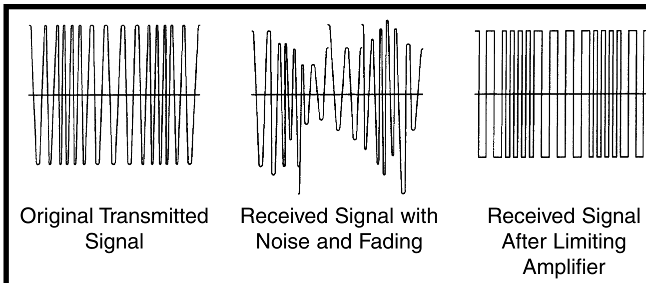


Figure 2

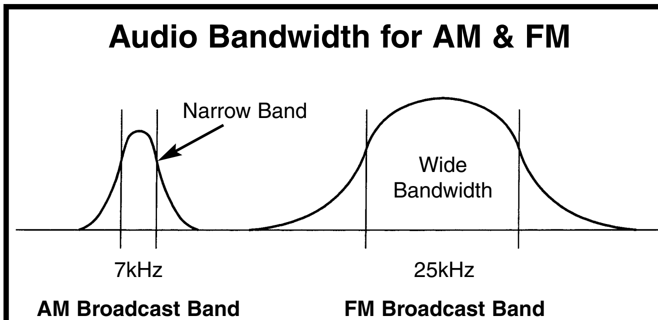


Figure 3

Another big advantage that FM has over AM is the “Capture” effect in FM broadcast. If two different broadcasts are very close in frequency or on the same frequency in AM, they will produce an audio tweet or beat. In FM, the receiver will “Capture” the strongest signal and ignore the weaker one. In other words, if a local transmitter and another distant transmitter are on the same frequency, the FM receiver will lock in on the strong local station and reject the weak one. In an AM radio, if the same conditions exist, you will hear a beat (a whistle) between the two stations, which is very annoying.

Capture works because the receiver “sees” radio waves as the sum of each frequency present. Since FM only looks at frequency, the weaker signal can be eliminated by the limiter as shown in Figure 4. The detector “sees” only the strong signal after the limiting amplifier has stripped the weak one away.

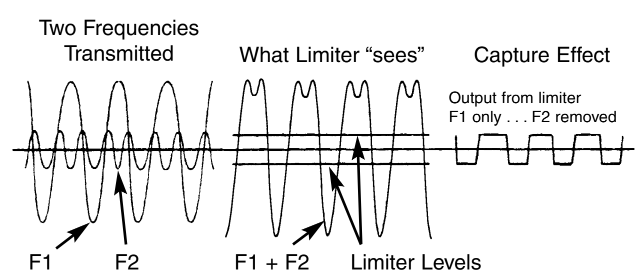


Figure 4

CIRCUIT OPERATION

Figure 5 shows a block diagram of the FM wireless microphone circuit. The microphone element in Block 1 acts like a resistor that changes when exposed to sound waves. The change in resistance causes current through the microphone element to change when sound waves apply pressure to its surface. This action is similar to squeezing a garden hose and watching the water through it decrease. When the hose is released, the water through it will increase. When sound waves hit the microphone element, the electrical current through the element will increase and decrease according to the pressure (loudness) of the sound.

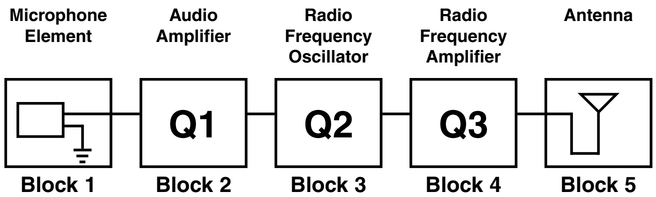


Figure 5

Block 2 is a transistor (Q1) used as an audio amplifier. The signal from the micro-phone element is increased in amplitude by a factor of 3. In electronics, this action is described as transistor Q1 having an audio gain of 3.

Block 3 is a transistor (Q2) used as an oscillator. An oscillator is an electronic circuit similar to the pendulum in a grandfather clock. Once the pendulum is started in motion, it will use only a small amount of energy from the main spring to keep it swinging at the exact same frequency. It is this stable frequency rate that sets the time accurately. If the weight is moved down the stick on the pendulum, the swing takes longer if the frequency is lower. If the weight is moved up the stick, the frequency increases. This is called tuning the frequency of the pendulum. In electronics, an oscillator circuit also has tunable elements. The inductor in a tuned circuit is equivalent to the length of the pendulum (see Figure 6).

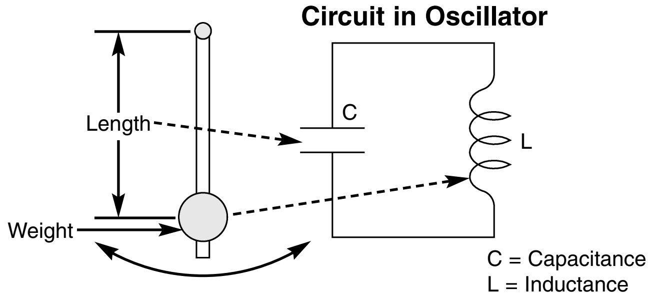


Figure 6

By changing the position of the iron core in the inductor, the inductance can be changed to tune the oscillator to a desired radio frequency, just like changing the weight of the pendulum would change its frequency. When sound strikes the microphone element, it is converted to an electrical signal, amplified and used to change the capacitance (length of the pendulum) of the electronic oscillator's tuned circuit. This causes the frequency of the oscillator to make slight changes at the same rate as the sound striking the microphone. This effect is known as frequency modulation.

Block 4 is a transistor used as a radio frequency amplifier. This block amplifies the modulated signal from the oscillator and acts as a buffer stage between the antenna and the oscilator. If the antenna were tied directly to the oscillator without the buffer, any capacitance added to the antenna (touching it with your finger for example) would produce a large change in the frequency of oscillation. The receiver would not be able to follow this large change in frequency and would lose the transmission.

Block 5 is the antenna. The antenna is also a tuned element since the length of the antenna determines how well it will radiate the modulated signal. An antenna acts much like a piece of string tied to a wall and stretched tight. If you tap the string, a wave will travel to the wall and part of the energy will go into the wall and part will be reflected back (see Figure 7A). If the length of the string is adjusted to match the rate of tapping as shown in Figure 7B, the wall receives all of the energy because it is at a node or proper multiple of the wavelength. In electronics, the wall is similar to the space around the antenna. By properly tuning the antenna, all of the available power in the antenna will be radiated into the space around the antenna. None will reflect back. A term used in electronics to describe the amount of power reflected back as a ratio of the amount of power radiated is called "The Standing Wave Ratio".

Figure 7A

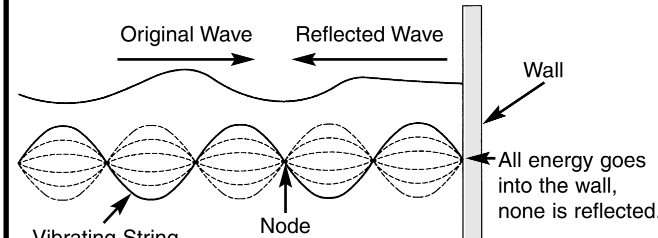


Figure 7B

CONSTRUCTION

Introduction

The most important factor in assembling your FM Wireless Microphone 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.**

Safety Procedures

- Wear eye protection when soldering.
- Locate soldering iron in an area where you do not have to go around it or reach over it.
- **Do not hold solder in your mouth.** Solder contains lead and is a toxic substance. Wash your hands thoroughly after handling solder.
- Be sure that there is adequate ventilation present.

Assemble Components

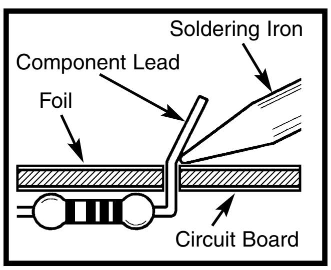
In all of the following assembly steps, the components must be installed on the top side of the PC board unless otherwise indicated. The top legend shows where each component goes. The leads pass through the corresponding holes in the board and are soldered on the foil side.
Use only rosin core solder of 63/37 alloy.

DO NOT USE ACID CORE SOLDER!

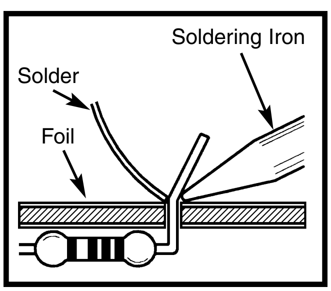
What Good Soldering Looks Like

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

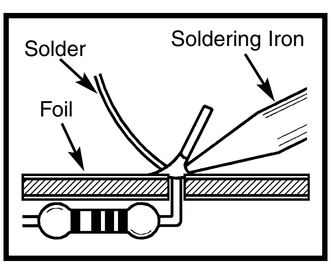
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.



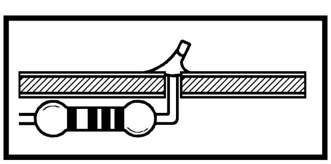
2. Apply a small amount of solder to the iron tip. This allows the heat to leave the iron and onto the foil. Immediately apply solder to the opposite side of the connection, away from the iron. Allow the heated component and the circuit foil to melt the solder.



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.

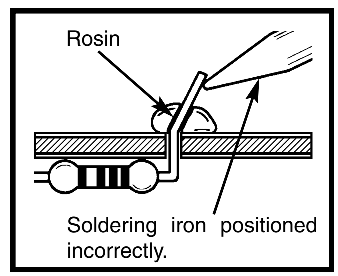


4. Here is what a good solder connection looks like.

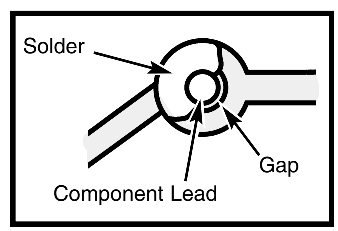


Types of Poor Soldering Connections

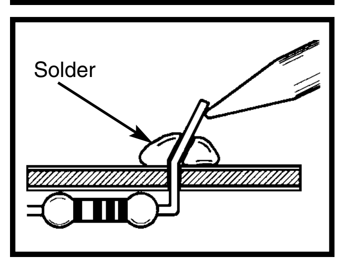
1. **Insufficient heat** - the solder will not flow onto the lead as shown.



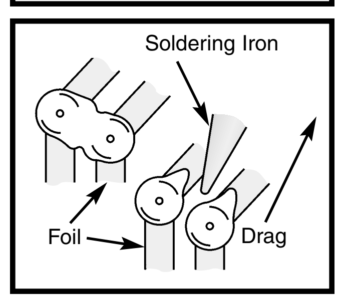
2. **Insufficient solder** - let the solder flow over the connection until it is covered. Use just enough solder to cover the connection.



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



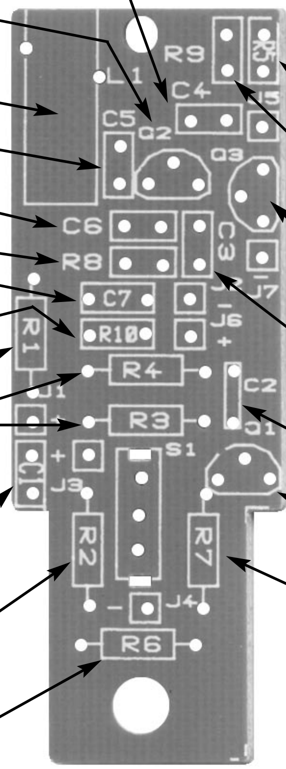
4. **Solder bridges** - occur when solder runs between circuit paths and creates a short circuit. This is usually caused by using too much solder. To correct this, simply drag your soldering iron across the solder bridge as shown.



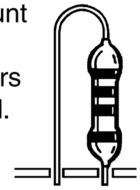
ASSEMBLE COMPONENTS TO THE PC BOARD

- ☐ C4 - 10pF Discap (10)
- ☐ Q2 - 2N3904 Transistor (see Figure A)
- ☐ L1 - Coil
- ☐ C5 - 12pF Discap (12)
- ☐ C6 - 33pF Discap (33)
- ☐ R8 - 1kΩ 5% 1/4W Res.* (brown-black-red-gold)
- ☐ C7 - .001μF Discap (102)
- ☐ R10 - 1kΩ 5% 1/4W Res.* (brown-black-red-gold)
- ☐ R1 - 8.2kΩ 5% 1/4W Res. (gray-red-red-gold)
- ☐ R4 - 47kΩ 5% 1/4W Res. (yellow-violet-orange-gold)
- ☐ R3 - 4.7kΩ 5% 1/4W Res. (yellow-violet-red-gold)
- ☐ C1 - .1μF Discap (104)
- ☐ R2 - 27kΩ 5% 1/4W Res. (red-violet-orange-gold)
- ☐ R6 - 10kΩ 5% 1/4W Res. (brown-black-orange-gold)

Top Legend of PC Board



* Mount these resistors on end.



Mount the transistor with the flat side as shown on the top legend.

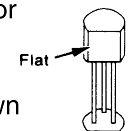


Figure A

- ☐ R5 - 150Ω 5% 1/4W Res.* (brown-green-brown-gold)
- ☐ R9 - 47kΩ 5% 1/4W Res.* (yellow-violet-orange-gold)
- ☐ Q3 - 2N3904 Transistor (see Figure A)
- ☐ C3 - .001μF Discap (102)
- ☐ C2 - .1μF Discap (104)
- ☐ Q1 - 2N3904 Transistor (see Figure A)
- ☐ R7 - 1.5kΩ 5% 1/4W Res. (brown-green-red-gold)

☐ Strip the insulation off of one end of the 12" gray wire to expose 1/8" of bare wire. Mount and solder the wire to the foil side of the PC board in hole J5.

☐ Cut a 1 1/2" red wire and 1 1/2" black wire. Strip the insulation off of both ends to expose 1/8" of bare wire. Mount and solder the red wire to the foil side of the PC board in hold J6 (+) and the black wire to hole J7 (–).

☐ Cut the leads of the LED so that they are 1/4" long, then spread them slightly apart (see Figure B).

☐ Solder the free end of the black wire to the flat side lead of the LED. Solder the free end of the red wire to the other lead of the LED.

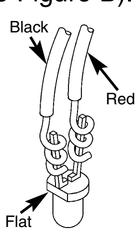
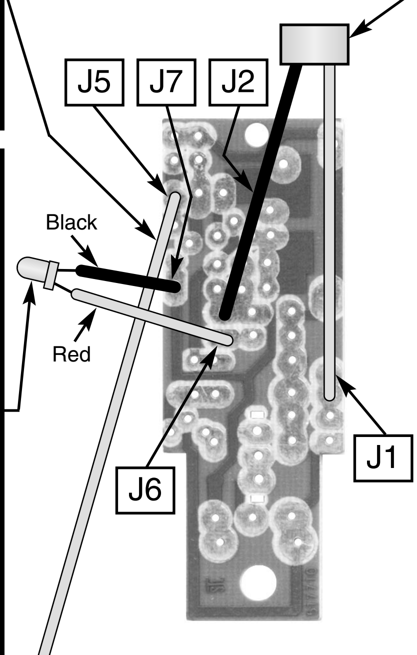


Figure B

Foil Side of PC Board



☐ If your microphone has leads attached to it, cut them off flush with the pads on the microphone. Cut a 2" piece of red wire and a 2" piece of black wire. Strip the insulation off of both ends to expose 1/8" of bare wire. Solder the red wire to the foil side of the PC board in hole J1 (+) and the black wire to hole J2 (–).

☐ Solder the free end of the red wire to the (+) pad on the mic and the black wire to the (–) pad on the mic as shown in Figure C.

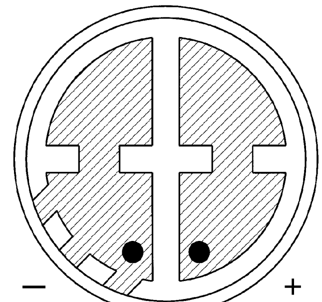
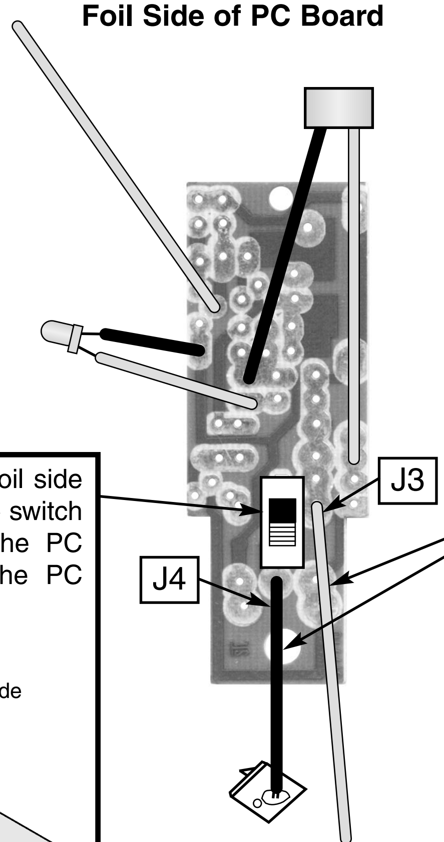


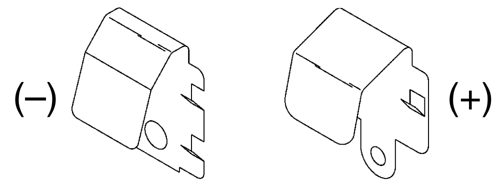
Figure C

Foil Side of PC Board

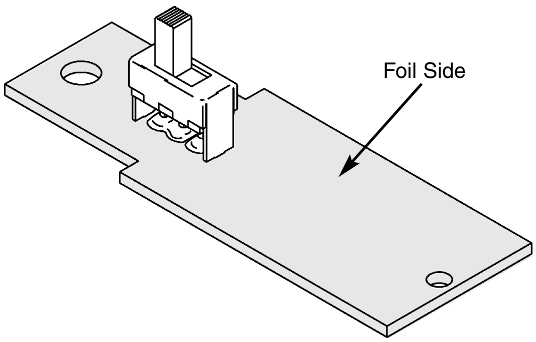


- ☐ Strip the insulation off of both ends on the remaining 2 1/2” of black wire and the 7” of red wire to expose 1/8” of bare wire. Mount and solder the black wire to the foil side of the PC board in hole J4 (–) and the red wire in hole J3 (+).

- ☐ Solder the free end of the black wire to the back side fo the negative (–) clip.



- ☐ Mount the slide switch onto the foil side of the PC board. The tabs on the switch must go through the slots of the PC board. Solder the switch to the PC board.



- ☐ Insert the free end of the red wire through the slot in the bottom case and solder to the positive (+) clip (see Figure D).

Pull the wire back through the slot and insert the clip into the case as shown in Figure E.

Figure D

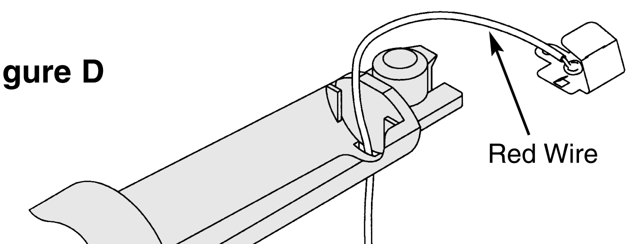
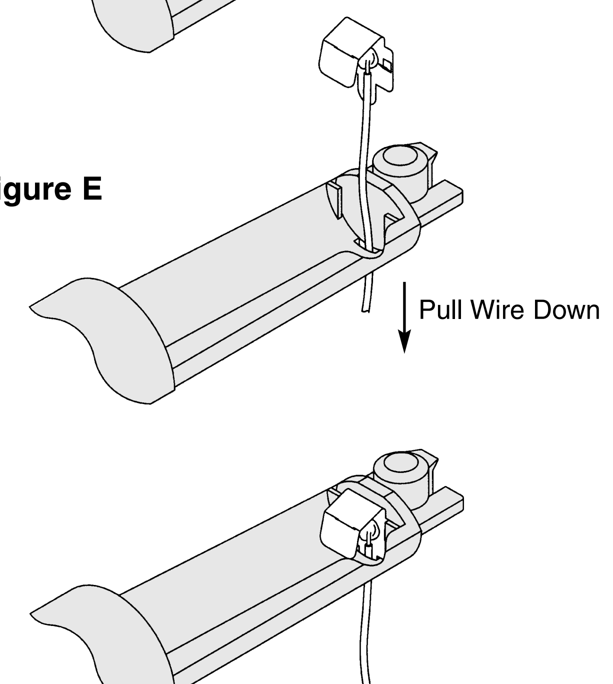


Figure E



FINAL ASSEMBLY

- ☐ Insert the mic into the slot as shown in Figure F.
- ☐ Insert the LED into the hole as shown in Figure F. Place a piece of tape over the LED to hold it in place.
- ☐ Insert the PC board into the top case, as shown in Figure G.
- ☐ Insert the negative (–) battery clip into the bottom case as shown in Figure G.
- ☐ Press the gray antenna wire and the 7” piece of red wire through the slots in the top case as shown in Figure G.
- ☐ Place the bottom case onto the top case. Hold the two halves together with three 2.6 x 8mm screws and one 2.5mm x 4mm screw, as shown in Figure H.
- ☐ Insert the stand in the case as shown in Figure H.
- ☐ Push the foam cover onto the case as shown in Figure H.
- ☐ Insert two “AA” batteries into the case with the positive (+) side toward the back end of the case (see the inscription on the inside of the case). Insert the battery cover onto the case as shown in Figure H.

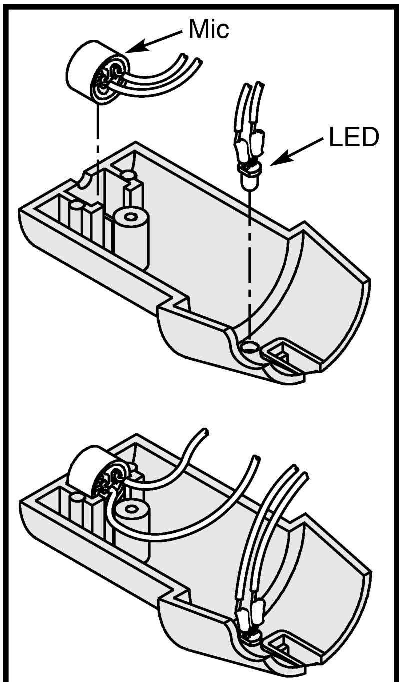


Figure F

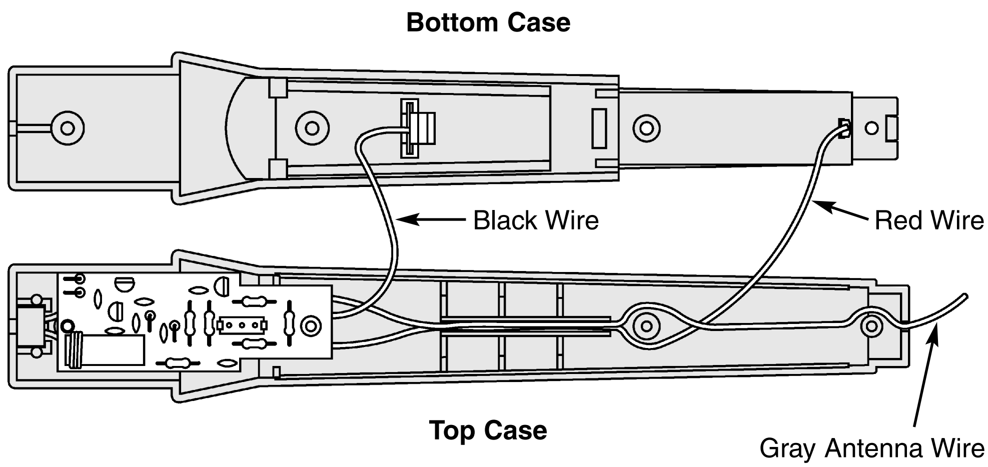


Figure G

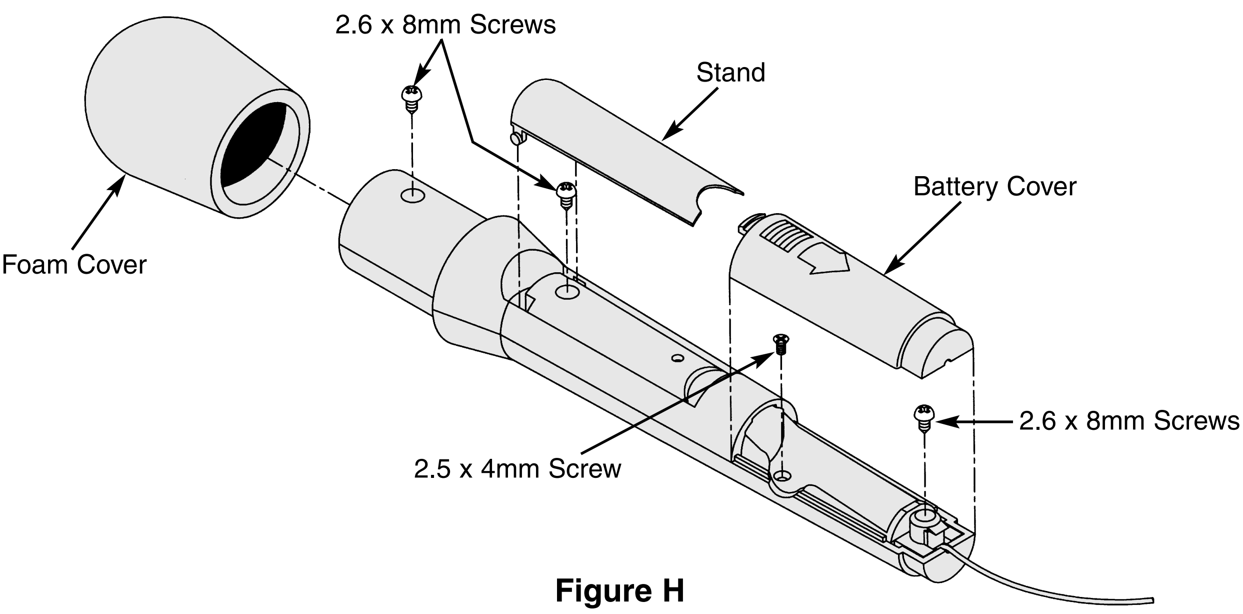


Figure H

OPERATING THE FM MIC

After assembling the kit, it will be necessary to tune in the transmitter. First, be sure that all of the parts are in correctly and that you have good solder connections without any solder shorts.

Get an FM radio and tune it away from any FM stations. You should hear only noise and no programs. Place the unit about 2 feet from the radio with the microphone facing the radio speaker. Remove the foam cover and tune the RF coil with the tuning stick and listen for a howl in the radio. This indicates that you have tuned the transmitter to the FM radio frequency. Place the transmitter away from the radio until the howl disappears. Talk into the microphone and you should hear your voice on the radio. If your voice comes through the radio distorted, speak softer (you are over-modulating). Push the foam cover onto the case when tuned.

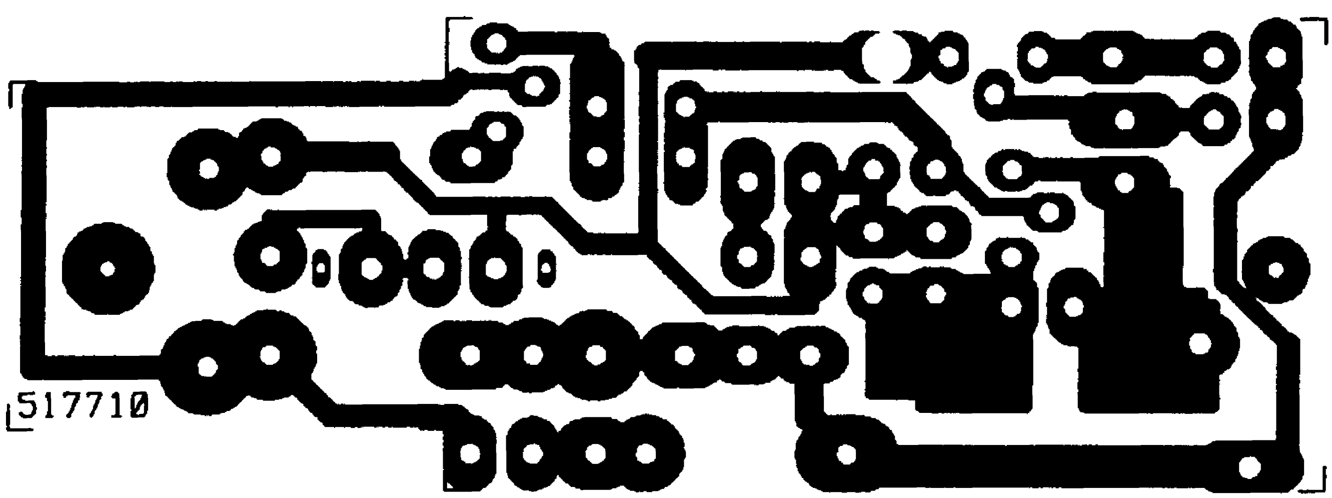
Have a friend listen to the radio and move the transmitter about 100 feet away. Your voice should still be heard over the radio. To obtain further distance, add a longer antenna.

TO CONSERVE BATTERIES, TURN THE POWER SWITCH OFF WHEN NOT ACTUALLY TALKING.

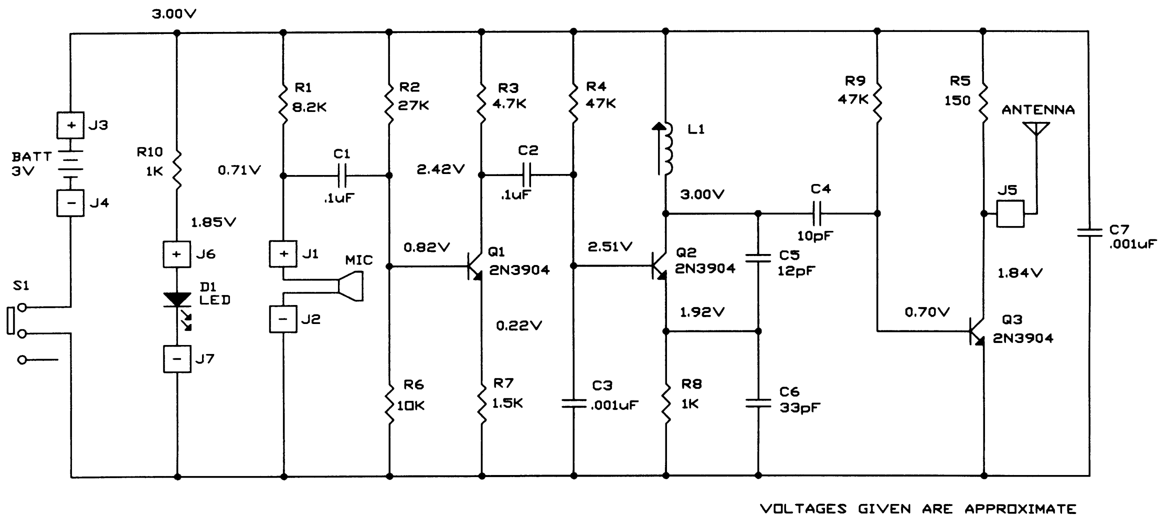
TROUBLESHOOTING

- ☐ Tug slightly on all parts to make sure that they are indeed soldered.
- ☐ A solder bridge may occur if you accidently touch an adjacent foil by using too much solder or by dragging the soldering iron across adjacent foils. Break the bridge with your iron.
- ☐ Make sure that all of the parts are placed in their correct position. Check if the transistors' orientations are correct.
- ☐ Make sure that the polarity of the LED and microphone are placed in the correct position.

FOIL SIDE OF PC BOARD



SCHEMATIC DIAGRAM



GLOSSARY

Amplitude Modulation To modify the amplitude of the carrier wave in accordance with the desired signal, often abbreviated as AM.

Amplify To enlarge; increase in scope or volume.

Antenna A device by which radio waves are released or received.

Audio Sounds that are capable of being heard by the human ear.

Buffer Stage A circuit used to insulate signals from other circuits.

Capacitor A device that is capable of holding an electric charge.

Capture The capacity of an FM receiver to pick only the strongest signal and thus reduce co-channel interference.

Carrier Wave The unmodulated wave radiated by a broadcast station.

Deviation The change in frequency away from the carrier wave due to FM modulation.

Efficiency The ratio of energy expended to power produced.

Frequency Modulation To modify the frequency of the carrier wave in accordance with the desired signal, often abbreviated as FM.

FM Broadcast Band The range of frequency where commercial frequency modulation is allowed by the Federal Communications Commission (FCC).

FM Transmitter The sending apparatus of a radio wave in which the message is contained in the frequency of the carrier wave.

Hertz A term used to indicate the number of cycles per second.

High Fidelity A term used to indicate total coverage of the hearing system.

Inductor A device capable of storing electrical energy in the form of a magnetic field.

MHz or Megahertz A million cycles per second.

Microphone A device used for producing an electrical current corresponding in its variations in air pressure of sound.

Modulate To modify a characteristic of a carrier wave in accordance with the characteristics of a desired signal.

Noise In electronics, noise is usually the random electrical signal produced by the thermal agitation of atoms or static discharges.

Oscillator A device that continually swings back and forth between two fixed points.

Peak Detector A device used to recover the modulated signal from an amplitude modulated wave.

Pendulum A body suspended from a fixed point so that it may swing freely.

Resistor An electric device used to restrict the flow of electrical current.

RF Carrier The radio frequency wave used to "carry" the desired signal.

Saturate Completely charged or at its limit of operation.

Standing Wave Ratio A term used in electronics to describe the amount of power reflected back as a ratio of the amount of power radiated.

Tuned Circuit A collection of components used to select a single or small group of frequencies.

QUIZ

1. The letters FM stand for ____________ ____________.
2. In AM transmissions, the audio information varies the ______________ of the radio frequency carrier wave.
3. In FM transmissions, the audio information varies the ______________ of the radio frequency carrier wave.
4. In a standard FM radio broadcast moving the carrier ±75kHz from the center frequency would represent ______________% modulation.
5. The effect of rejecting the weaker station and accepting only the strong station is called ______________.
6. When the microphone is exposed to sound waves, it acts like a changing ______________.
7. An oscillator circuit is similar to the ________________ in a clock.
8. Sound striking the microphone is converted to an electrical signal, amplified, and used to change the ______________ of the electronics oscillators tuned circuit.
9. Using an element to change the frequency of an oscillator at the same rate as the data to be transmitted is called _____________ _____________.
10. The antenna is also a ______________ element.

Answers: 1. frequency modulation; 2. amplitude; 3. frequency; 4. 50%; 5. capture; 6. resistor; 7. pendulum; 8. capacitance; 9. frequency modulation; 10. tuned