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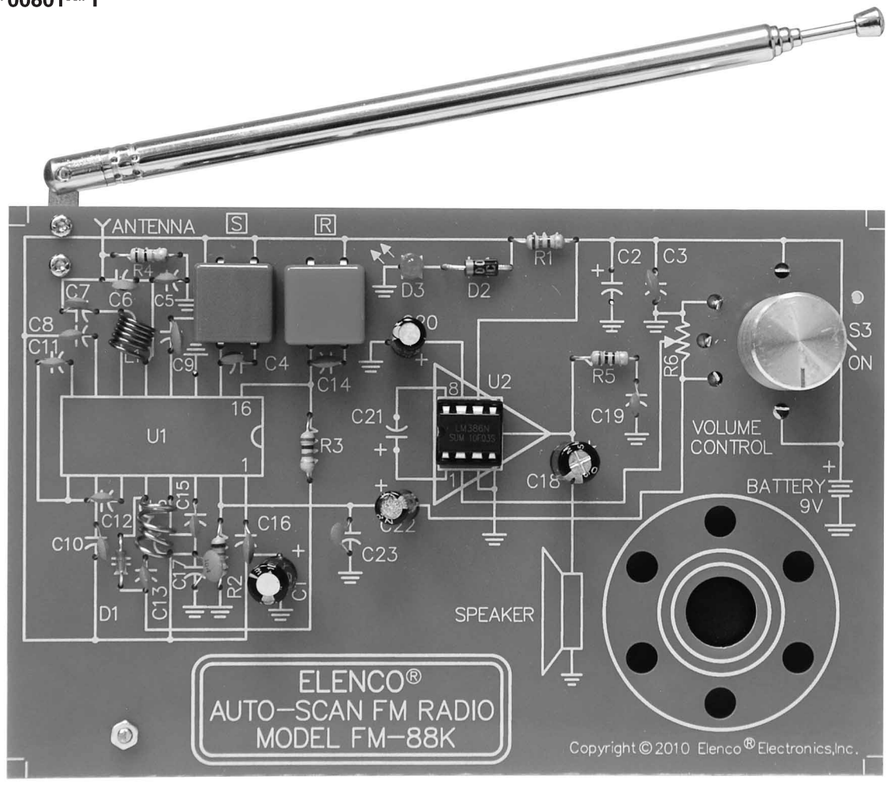
AUTO-SCAN FM RADIO KIT

MODEL FM-88K



Assembly and Instruction Manual

ELENCO®

753050

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® (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	10Ω 5% 1/4W	brown-black-black-gold	121000
❒ 1	R1	680Ω 5% 1/4W	blue-gray-brown-gold	136800
❒ 1	R3	5.6kΩ 5% 1/4W	green-blue-red-gold	145600
❒ 1	R4	10kΩ 5% 1/4W	brown-black-orange-gold	151000
❒ 1	R2	18kΩ 5% 1/4W	brown-gray-orange-gold	151800
❒ 1	R6/S3	Potentiometer 50kΩ & switch w/ nut & washer		192522

CAPACITORS

Qty.	Symbol	Value	Description	Part #
❒ 1	C6	33pF	Discap (33)	213317
❒ 1	C7	82pF	Discap (82)	218210
❒ 1	C10	180pF	Discap (181 or 180)	221810
❒ 1	C5	220pF	Discap (221 or 220)	222210
❒ 1	C8	330pF	Discap (331 or 330)	223317
❒ 1	C4	470pF	Discap (471 or 470)	224717
❒ 1	C13	680pF	Discap (681 or 680)	226880
❒ 1	C23	1500pF	Discap (152)	231516
❒ 2	C11, C12	3300pF	Discap (332)	233310
❒ 1	C15	0.033µF	Discap (333)	243318
❒ 1	C19	0.047µF	Discap (473)	244780
❒ 6	C3, C9, C14, C16, C17, C*	0.1µF	Discap (104)	251010
❒ 2	C21, C22	10µF	Electrolytic radial	271044
❒ 1	C20	22µF	Electrolytic radial	272244
❒ 1	C1	100µF	Electrolytic radial	281044
❒ 2	C2, C18	220µF	Electrolytic radial	282244

COILS

Qty.	Symbol	Value	Description	Part #
❒ 1	L2		Coil 4-turn	430150
❒ 1	L1		Coil 6-turn	430160

SEMICONDUCTORS

Qty.	Symbol	Value	Description	Part #
❒ 1	D1	BB909/BB910	Varactor	310909
❒ 1	D2	1N4001	Semiconductor silicon diode	314001
❒ 1	D3		Red LED 3mm	350003
❒ 1	U2	LM-386 or identical	Low voltage audio power amplifier	330386
❒ 1	U1	TDA7088T or identical	FM receiver SM installed on PC board	

MISCELLANEOUS

Qty.	Description	Part #	Qty.	Description	Part #
❒ 1	Antenna FM	484005	❒ 1	Screw M1.8 x 7.5mm	641100
❒ 1	PC board w/ installed U1 (TDA7088T)	517038	❒ 2	Antenna screw M2 x 5mm	643148
❒ 2	Push button switch 12mm	540005	❒ 1	Nut M1.8	644210
❒ 1	Battery holder	590096	❒ 1	Socket IC 8-pin	664008
❒ 1	Speaker 8Ω	590102	❒ 1	Speaker pad	780128
❒ 1	Cap push button switch yellow	622001	❒ 3”	Wire 22 ga. solid	834012
❒ 1	Cap push button switch red	622007	❒ 1	Solder Lead-free	9LF99
❒ 1	Knob pot / switch	622050			

GLOSSARY (Continued)

RF Radio Frequency.

Sensitivity The ability of a receiver to pick up low-amplitude signals.

Speaker An electronic device that turn electric impulses into sound.

Surface-mount Technology A method of using special components that are soldered to the PC board’s surface.

Trimmer An adjustable fine-tuning resistor, capacitor, or inductor of small values.

Transistor A semiconductor component that can be used to amplify signals, or as electronic switches.

Varactor A diode optimized to vary its internal capacitance with a change in its reverse bias voltage.

Voltage Electrical potential difference measured in volts.

Voltage Regulator A circuit that holds the DC voltage.

QUIZ

INSTRUCTIONS: Complete the following examination, check your answers carefully.

1. The number of cycles produced per second by a source of sound is called the . . .
   - ❒ A) amplitude.
   - ❒ B) vibration.
   - ❒ C) sound wave.
   - ❒ D) frequency.
2. The frequency of the modulating signal determines the . . .
   - ❒ A) number of times the frequency of the carrier changes per second.
   - ❒ B) maximum deviation of the FM carrier.
   - ❒ C) maximum frequency swing of the FM carrier.
   - ❒ D) amount of amplitude change of the FM carrier.
3. The FM broadcast band is . . .
   - ❒ A) 550 – 1,600kHz.
   - ❒ B) 10.7MHz.
   - ❒ C) 88 – 108MHz.
   - ❒ D) 98.7 – 118.7MHz.
4. The AFC circuit is used to . . .
   - ❒ A) automatically hold the local oscillator on frequency.
   - ❒ B) maintain constant gain in the receiver to prevent such things as fading.
   - ❒ C) prevent amplitude variations of the FM carrier.
   - ❒ D) automatically control the audio frequencies in the receiver.
5. The device most often used for changing the local oscillator frequency with the AFC voltage is a . . .
   - ❒ A) feedthrough capacitor.
   - ❒ B) variable inductor.
   - ❒ C) varactor.
   - ❒ D) trimmer capacitor.
6. The capacitance of the varactor is determined by . . .
   - ❒ A) the voltage level.
   - ❒ B) the amount of current in the circuit.
   - ❒ C) the signal strength of the RF carrier.
   - ❒ D) the amount of resistance in the circuit.
7. The ability to select a specific band of frequencies, while rejecting others, is called . . .
   - ❒ A) selectivity.
   - ❒ B) sensitivity.
   - ❒ C) demodulation.
   - ❒ D) none of the above.
8. The process of mixing two signals to produce a third signal is called . . .
   - ❒ A) filtering.
   - ❒ B) detecting.
   - ❒ C) rectification.
   - ❒ D) heterodyning.
9. The circuit designed to supply substantial power output into low impedance load is called . . .
   - ❒ A) power supply.
   - ❒ B) pre-amplifier.
   - ❒ C) power amplifier.
   - ❒ D) detector.
10. The gain of the LM-386 amplifier can be set in range from . . .
    - ❒ A) 1 to 20.
    - ❒ B) 20 to 200.
    - ❒ C) 0 to 200.
    - ❒ D) 50 to 100.

Answers: 1. D, 2. A, 3. C, 4. A, 5. C, 6. A, 7. C, 8. D, 9. C, 10. B

TROUBLESHOOTING

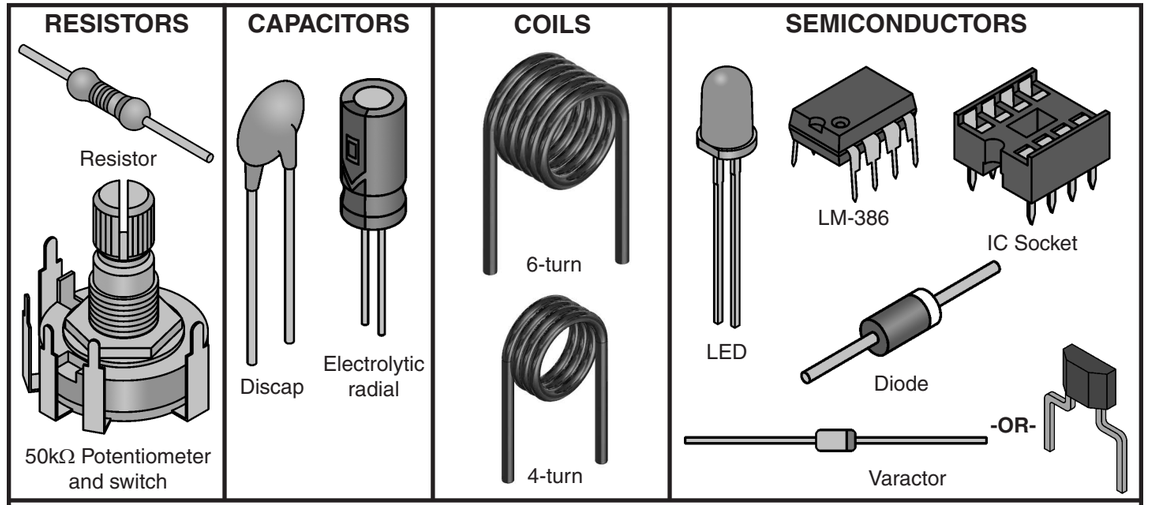
Contact ELENCO® if you have any problems. **DO NOT** contact your place of purchase as they will not be able to help you.

1. One of the most frequently occurring problems is poor solder connections.
   - ❒ a) Tug slightly on all parts to make sure that they are indeed soldered.
   - ❒ b) All solder connections should be shiny. Resolder any that are not.
   - ❒ c) Solder should flow into a smooth puddle rather than a round ball. Resolder any connection that has formed into a ball.
   - ❒ d) 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 soldering iron.
2. Use a fresh 9V battery.
3. Make sure that all of the parts are placed in their correct positions. Check if the IC, diode and lytic orientations are correct.

GLOSSARY

AGC	Automatic Gain Control.
AF	Audio Frequency
AM	Amplitude Modulation
Amplifier	Converts input signal to output.
Anode	The positive terminal of a diode.
Antenna	Any device that either radiates a signal or pulls in a signal.
Baffle	Used to ensure positive airflow.
Bandwidth	The amount of frequency spectrum, in hertz, utilized by a filter or channel.
Bypass Capacitor	A capacitor used to shunt AC around a component.
Capacitor	An electronic component that has ability to store a charge and block DC current.
Cathode	The negative terminal of a diode.
Coil	A component with inductive reactance.
Current	Transport of electrons throughout a conductor and measured in amps.
Detector Circuit	Receiver circuit that recovers the modulated portion of the signal impressed on the RF carrier wave.
Diode	An electronic component that changes alternating current to direct current.
FM	Frequency Modulation.
Frequency	Wave or pulse repetition rate.
Gain	Signal multiplication.
IC	Integrated Circuit.
LED	Light Emitting Diode. A semiconductor device that emits light when voltage and current are passed through it.
PC Board	Printed Circuit Board.
Potentiometer	Three-terminal variable resistor, volume control.
Power Supply	An electronic circuit that produces the necessary power for another circuit.
Resistor	An electronic component that obstructs (resists) the flow of electricity.

PARTS IDENTIFICATION



You Will Need:

- 9V Battery
- 25 or 30 watt Soldering Iron
- Small Phillips and Slotted Screwdrivers
- Long Nose Plier
- Side Cutters

IDENTIFYING RESISTOR VALUES

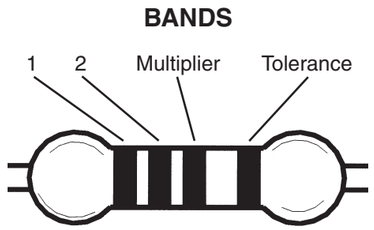
Use the following information as a guide in properly identifying the value of resistors.

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	±0.5%
Blue	±0.25%
Violet	±0.1%



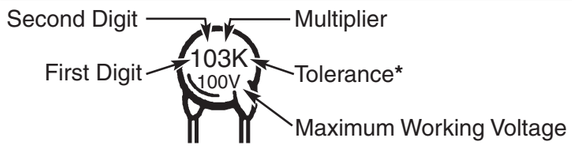
IDENTIFYING CAPACITOR VALUES

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 maximum operating voltage may also be printed on the capacitor.

Electrolytic capacitors have a positive and a negative electrode. The negative lead is indicated on the packaging by a stripe with minus signs and possibly arrowheads.

Warning:
If the capacitor is connected with incorrect polarity, it may heat up and either leak, or cause the capacitor to explode.

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



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%

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

METRIC UNITS AND CONVERSIONS

Abbreviation	Means	Multiply Unit By	Or
p	Pico	.000000000001	10^{-12}
n	nano	.000000001	10^{-9}
μ	micro	.000001	10^{-6}
m	milli	.001	10^{-3}
–	unit	1	10^{0}
k	kilo	1,000	10^{3}
M	mega	1,000,000	10^{6}

1. 1,000 pico units	= 1 nano unit
2. 1,000 nano units	= 1 micro unit
3. 1,000 micro units	= 1 milli unit
4. 1,000 milli units	= 1 unit
5. 1,000 units	= 1 kilo unit
6. 1,000 kilo units	= 1 mega unit

TESTING - SECTION 2

Voltage reference chart for U1 TDA 7088T (turn radio on and press reset).

Test

Verify that FM signals are present in your location by listening to another FM radio placed near the FM-88K.

1. Install fresh 9V battery into holder.
2. Bend the antenna to vertical position and adjust for maximum length.
3. Turn ON power switch (rotate clockwise until a "click" is heard). RED LED should light. Turn the VOLUME CONTROL potentiometer to middle position (comfortable level).
4. Press and release "RESET" (R) button.

Press and release the "SCAN" (S) button once or a couple of times; a station should be heard. Press and release "SCAN" button again; the radio should be automatically searching for other broadcast station. When you press the "SCAN" button in several times, there should be other broadcast stations coming before the HIGH-END frequency (FM106-108MHz).

If test fails;

Make sure that all of the parts are placed in their correct position. Check if the orientation of D1 is correct.

Short pins 2 and 14 of U1 several times using a wire. If you don't hear tapping from the speaker, check U1, capacitors C22 and C23, resistor R2, and potentiometer R6.

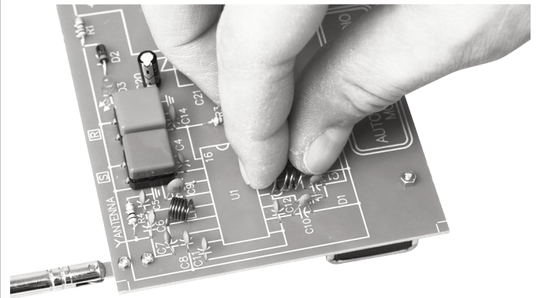
Pin #	Voltage	Pin #	Voltage
1	2.4	9	1.9
2	1.3	10	1.9
3	2.2	11	0.9
4	2.6	12	0.9
5	2.6	13	1.8
6	2.0	14	0
7	1.9	15	1.7
8	1.2	16	2.1

Alignment

The first time "SCAN" button is pressed, the radio should start at the bottom end of the FM band (88-90 MHz). You may need to press the SCAN button a couple of times. If it doesn't tune to the low end, you will need to adjust the coil.

If the radio is receiving station frequencies higher than 90MHz after pressing the "RESET" button, you will need to adjust coil L2 to a higher value (by making the gap between the coils smaller as shown in Figure L). Carefully press the coils of L2 together.

Figure L



If the radio is receiving station frequencies smaller than 87MHz after pressing the "RESET" button (to receive regular FM stations you need to press the "SCAN" button several times), then you will need to adjust the L2 coil to a smaller value (carefully slide a small screwdriver between coils to get the spacing shown in Figure M).

If sound is not clear;

Install capacitor C* onto the copper side of the PC board as shown in Figure N.

If you need more gain (up to 200), install capacitor C21 (10μF) as shown in Figure D.

Figure M

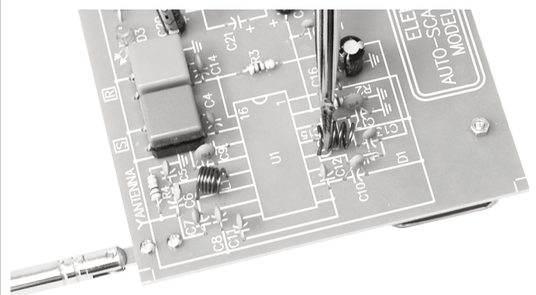


Figure N

SECTION 2

ASSEMBLE COMPONENTS TO THE PC BOARD

Place a check mark ☑in the box provided next to each step to indicate that the step is completed.

☐ C5 - 220pF Discap (221 or 220)

☐ R4 - 10kΩ 5% 1/4W Res. (brown-black-orange-gold)

☐ C6 - 33pF Discap (33)

☐ C7 - 82pF Discap (82)

☐ C8 - 330pF Discap (331 or 330)

☐ C11 - 3300pF Discap (332)

☐ L1 - Coil 6-turn (see Figure K)

☐ C9 - 0.1µF Discap (104)

☐ C4 - 470pF Discap (471 or 470)

☐ C16 - 0.1µF Discap (104)

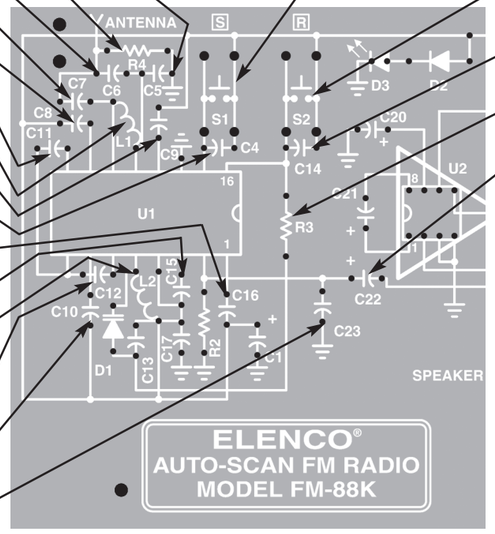
☐ C15 - 0.033µF Discap (333)

☐ L2 - Coil, 4-turn (see Figure I)

☐ C12 - 3300pF Discap (332)

☐ C10 - 180pF Discap (181 or 180)

☐ C23 - 1500pF Discap (152)



☐ S1 - Push button switch
☐ S1 - Cap yellow (see Figure J)

☐ S2 - Push button switch
☐ S2 - Cap red (see Figure J)

☐ C14 - 0.1µF Discap (104)

☐ R3 - 5.6kΩ 5% 1/4W Res. (green-blue-red-gold)

☐ C22 - 10µF Electrolytic (see Figure D)

Note: Capacitors C21 and C* are not used.

❒ Install FM antenna

Mount the antenna to the PC board using two M2 x 5mm screws as shown.

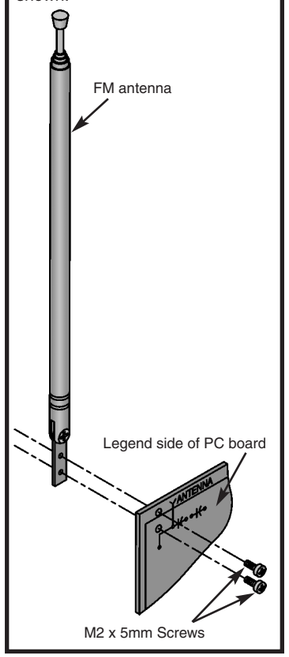


Figure I

Using a spacer, create three 1/16" gaps in the 4-turn coil as shown. Mount the coil to the PC board as shown. Solder and cut off excess leads.

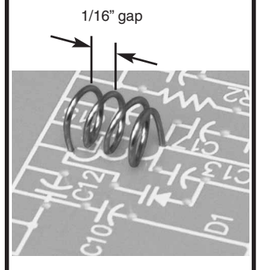


Figure J

Mount the push button switch flush to the PC board and solder into place. Attach the plastic button cap to the switch by snapping it into place.

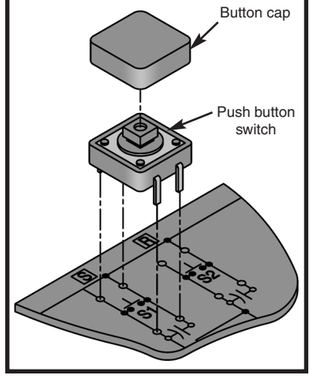
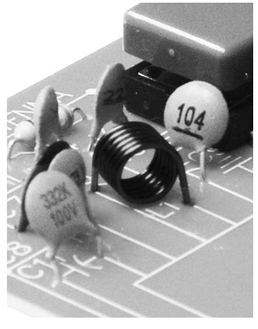


Figure K

Mount the 6-turn coil to the PC board as shown. Solder and cut off excess leads.



DESCRIPTION AND FEATURES

The ELENCO® FM-88K Kit is a monophonic, two-IC, FM (frequency modulation) receiver designed to receive FM signals in the frequency range (88-108MHz). It uses electronic auto-scan to search for FM stations. This scan system is done with two button switches - one switch scans up, the other resets to the start of the tuning position.

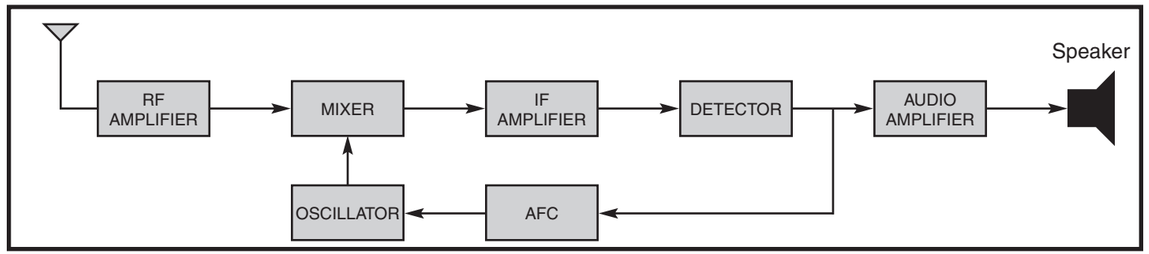
The unique design of this radio kit allows you to place the parts over the corresponding symbols in the schematic drawing on the surface of the printed circuit board. This technique maximizes the learning process, while keeping the chance of assembly error at a minimum.

To simplify troubleshooting the FM radio, it is constructed in two sections (Audio and RF). There are two IC's, one for the audio section, the other for the RF. The RF IC is surface mounted (SM-IC), pre-installed on the high quality printed circuit board.

- Electronic auto-scan FM RADIO FM-88K is a receiver for searching FM stations
- Operated by two push button switches
- Frequency range: (88 – 108) MHz
- High sensitivity
- Volume control of 8Ω speaker
- Telescopic antenna
- LED power ON indicator
- Power source 9V battery with ON/OFF power switch

INTRODUCTION

The FM (Frequency Modulation) band covers 88 – 108 MHz. There are signals from many radio transmitters in the band inducing signal voltages in the area. Below is a block diagram of a basic SUPERHETERODYNE FM radio:



FM RF AMPLIFIER, MIXER, OSCILLATOR

The RF amplifier selects and amplifies a desired station from many. It is adjustable so that the selection frequency can be altered, also known as tuning. The selected frequency and the output of an Oscillator are applied to the mixer, forming a frequency changer circuit. The RF amplifier and the oscillator are the only two resonant circuits that change when the radio is tuned for different stations. Since a radio station may exist 10.7MHz above the oscillator frequency, it is important that the RF stage rejects this station and selects only the station 10.7MHz below the oscillator frequency.

The frequency of the undesired station 10.7MHz above the oscillator is called the Image Frequency. Since the FM receiver has an RF amplifier, the image frequency is reduced significantly. The output from the mixer is the Intermediate Frequency (IF), a fixed frequency of 10.7MHz. The IF signal is fed into the IF amplifier. The advantage of the IF amplifier is that its frequency and bandwidth are fixed, no matter what the frequency of the signals. The IF amplifier increases the amplitude, while also providing selectivity. Selectivity is the ability to "pick out" one station while rejecting all others.

FM DETECTOR

The amplified IF signal is fed to the detector. This circuit recovers the audio signal and discards the IF carrier. Some of the audio is fed back to the oscillator as an Automatic Frequency Control (AFC) voltage. This ensures that the oscillator frequency is stable in spite of temperature, voltage, and other effects changes. If this occurs, the center frequency of 10.7MHz will not be maintained. AFC is used to maintain the 10.7MHz center frequency. When the local oscillator drifts, the radio detector will produce a DC (direct current) "correction" voltage. This signal is fed to a filter network that removes the audio so that pure DC voltage is produced and changes the frequency of oscillation of the local oscillator.

AUDIO AMPLIFIER

The audio amplifier increases the audio power to a level sufficient to drive an 8Ω speaker. To do this, DC from the battery is converted by the amplifier to AC (alternating current) in the speaker. The ratio of the power delivered to the speaker and the power taken from the battery is the efficiency of the amplifier. In a class A amplifier (transistor on over entire cycle), the maximum Theoretical efficiency is 0.5 or 50%. In

a class B amplifier (transistor on for ½ cycle), the maximum theoretical efficiency is 0.785 or 78.5%. Since transistor characteristics are not ideal in a pure class B amplifier, the transistors will introduce crossover distortion. This is due to the non-linear transfer curve near zero current or cutoff. This type distortion is shown in Figure 1. In order to illuminate crossover distortion and maximize efficiency, the output transistors of the audio amplifier are biased on for slightly more than ½ of the cycle, known as class AB. In other words, the transistors are working as class A amplifiers for very small levels of power to the speaker, but they side toward class B operation at lager power levels.

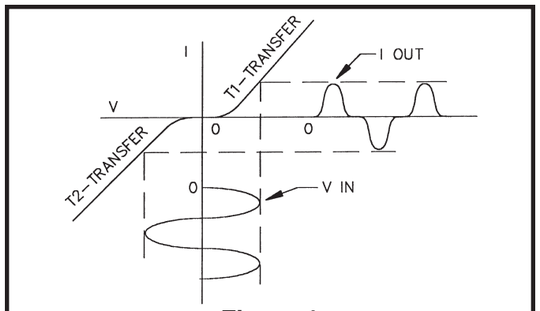


Figure 1

CIRCUIT DESCRIPTION

The model FM-88K is a monophonic FM receiver made on base TDA7088T IC, as shown in the schematic diagram (Figure 2). The circuit contains two ICs, speaker, two coils, and a few other components. The IC TDA7088T (U1) (depending on the manufacturer, may be type SC1088, SA1088, CD9088, D7088, or YD9088) is a surface mount, bipolar integrated circuit of a proper FM "superheterodyne" receiver. The IC contains a frequency-locked-loop (FLL). The station signals led from the telescopic antenna to the input circuit consists of L1, C5, C6 and C7. It is a parallel oscillatory circuit damper with resistor R4. Inside IC signals are led into the mixer, where they are given a new carrier intermediate frequency. The IF amplifier then follows, amplifying only one of those signals - the one whose frequency is equal to the IC - followed by the limiter, the demodulator, mute control circuit, and pre-audio amplifier. The FM-88K is an auto-scan radio containing two switches, scan "S" and reset "R". Tuning is done by using a varactor diode (D1) instead of a tuning gang found in most radios. The varactor's capacitance is changed by varying the DC voltage supplied to its anode over resistor R3.

This is how the tuning is performed:

When switch S1 "S" (Scan) is pressed and released, a positive voltage is applied to the input of the Tuning Search circuit pin 16. Capacitor C14 starts charging and the voltage on pin 16 increases. This voltage is

SCHEMATIC DIAGRAM FM-88K

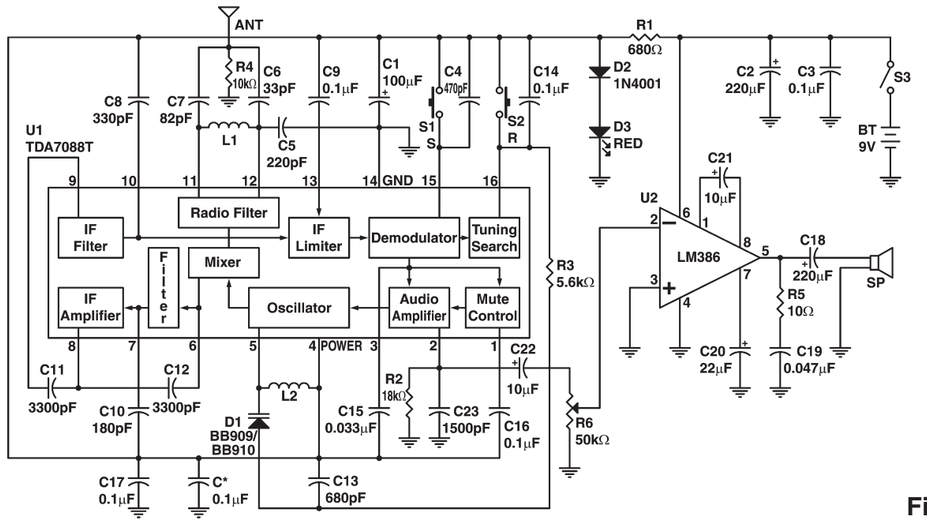


Figure 2

TESTING - SECTION 1

In this test, you will produce a clicking sound by shorting the bottom volume control pin to ground using your finger.

❒ 1. Install a new 9V battery into the battery holder. Turn the power switch on and turn the knob fully clockwise. The LED should light.

If LED does not light;

Make sure the diode D2 and LED D3, capacitor C2, and U2 are mounted in the correct position as marked on the PC board.

Check that resistor R1 is the correct value.

Check if the battery is properly installed in the battery holder and that the power switch is operational.

Check capacitors C3 and C17.

❒ 2. Touch the bottom and mounting pins with one finger as shown in Figure H. You may need to wet your finger.

Figure H

You should hear a clicking sound every time the pins are shorted. If you hear no sound then;

❒ Check that U2 and C18 are installed in the correct position as marked on the PC board.

❒ Check the potentiometer R6 and the speaker. Make sure the speaker's wires are soldered correctly and not shorting together.

Voltage reference chart for U2 LM386

Pin #	Voltage	Pin #	Voltage
1	1.3	5	4.5
2	0	6	9.0
3	0	7	4.5
4	0	8	1.3

Voltage Regulator Circuit
Check the following voltages.

❒ 1. Voltage across D2 and D3 should be 2.6V

❒ 2. Voltage across the LED D3 should be 1.9V.

Turn the power switch off and remove the battery from the holder.

FM RADIO HIGHLIGHTS

1. The FM broadcast band covers the frequency range from 88MHz to 108MHz.
2. FM signals are usually limited to line a sight.
3. Audio signals up to 15kHz are transmitted on the FM carrier.
4. The amount that the RF carrier changes frequency is determined by the amplitude of the modulating signal.
5. The number of times the carrier frequency changes in a period of time is exactly equal to the audio frequency.
6. The bandwidth assigned for FM is 200kHz.

ASSEMBLE COMPONENTS TO THE PC BOARD

Place a check mark ☑in the box provided next to each step to indicate that the step is completed.

☐ C1 - 100µF, Electrolytic (see Figure D)

☐ R2 - 18kΩ 5% 1/4W Res. (brown-gray-orange-gold)

☐ C13 - 680pF Discap (681 or 680)

☐ D1 - BB909/BB910 Varactor (see Figure G)

☐ C17 - 0.1µF Discap (104)

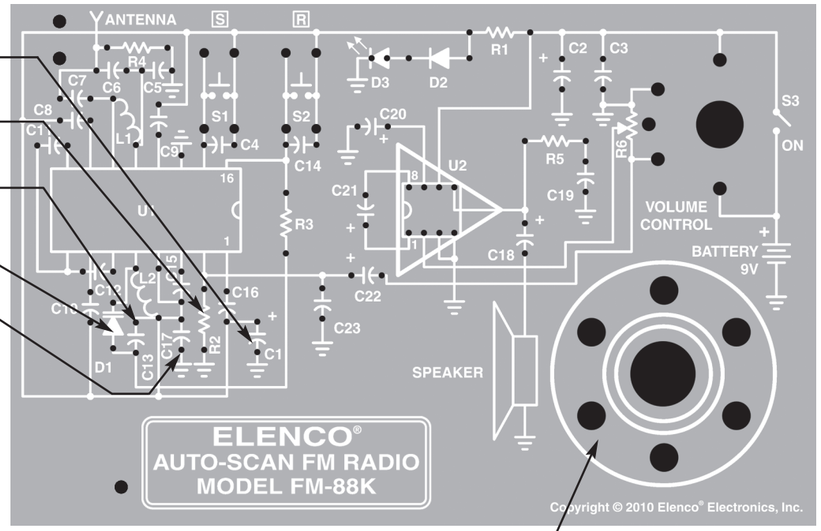
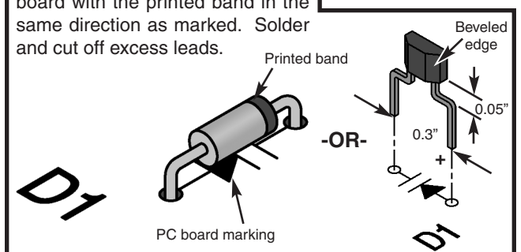


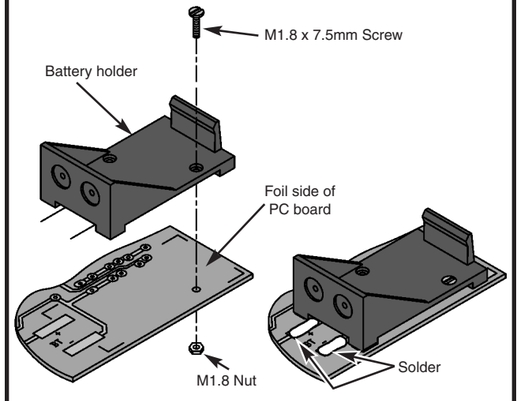
Figure G

Your kit contains one of two types of varactor. Use the figure that corresponds to your varactor style for mounting instructions.
Mount the varactor flush to the PC board with the printed band in the same direction as marked. Solder and cut off excess leads.

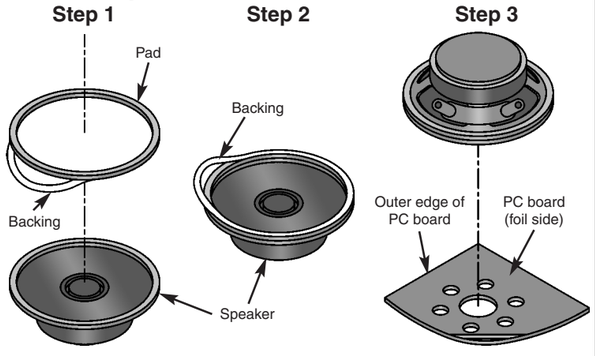


❒ Install battery holder

Bend the leads of the battery holder as shown. Fasten the battery holder to the PC board with a M1.8 x 7.5mm screw and M1.8 nut. Solder the leads to the PC board pads as shown.



❒ Install speaker



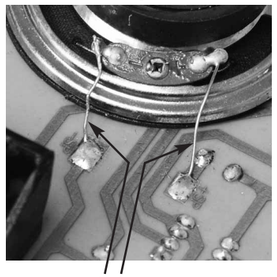
Step 1: If the speaker pad has center and outside pieces, then remove them. Peel the backing off of one side of the speaker pad and stick the pad onto the speaker.

Step 2: Remove the other backing from the speaker pad.

Step 3: Stick the speaker onto the solder side of the PC board.

Step 4: Solder two 1½" wires from the speaker to the pads +SP and –SP.

Step 4



transferred through resistor R3 to the anode of the varactor diode D1 (BB910), causing its capacitance to decrease. Decreasing the capacitance of D1 increases the frequency of the local Oscillator (VCO).

The Oscillator voltage and signals of all the other FM stations (Fs) from pin 11 are inputted into the Mixer. The output of the mixer is only FM signals whose frequencies are equal to the differences of the oscillator and the original station frequency.

Only a signal whose carrier frequency is equal to IF can reach the "Demodulator". Selectivity (ability to "pick out" one station while rejecting all others) is accomplished by two active filters made from the capacitors connected to pins 6, 7, 8, 9 and 10). The oscillator frequency increases until the condition $F_O - F_S = 70kHz$ is accomplished. When this happens, the charging of the capacitor is halted by the command that is sent into the "Tuning Search" circuit by two detectors (diode-blocks) located in the "Mute Control" circuit.

In order to hold the frequency, the voltage on pin 16 must not change until the "Scan" switch is pushed again. That is the function of the AFC (Automatic Frequency Control) circuit; controlling the voltage on pin 16.

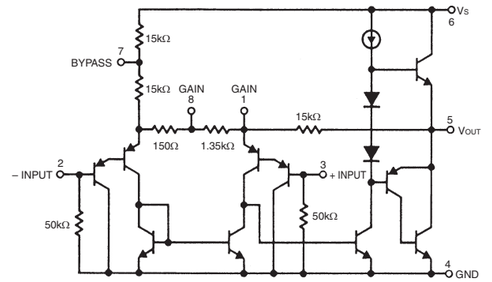
When the switch S2 "R" (Reset) is pushed, the capacitor C14 is discharged, the voltage on pin 16 drops down to zero, and the receiver is set to the low end of the reception bandwidth 88MHz.

Capacitor C23 and resistor R2 filter out the radio frequency component of the signal, leaving a clean audio signal. Capacitor C22 couples the audio signal to the input of the power amplifier. Since the maximum operating DC voltage of the U1 is 5V, the battery voltage must be regulated down. Components D2, D3, R1, C1, C17 and C* make up that circuit.

Our kit uses the standard design for the audio amplifier on base of the integrated circuit (U2) LM-386, or identical. In Figure 3, you can see equivalent schematic and connection diagrams. To make the LM-386 a more versatile amplifier, two pins (1 and 8) are provided for gain control. With pins 1 and 8 open, the 1.35kΩ resistor sets the gain at 20 (see Figure 4a). The gain will go up to 200 (see Figure 4b) if a capacitor (capacitor C21) is placed between pins 1 and 8. The gain can be set to any value from 20 to 200 if resistor is placed in series with the capacitor. The amplifier with a gain of 150 is shown in Figure 4c. The amount of gain control is varied by potentiometer R6, which also varies the audio level and, consequently, the volume.

Capacitor C20 is a bypass and necessary for an amplifier with a high gain IC. Capacitor C18 blocks the DC to the speaker while allowing the AC to pass.

Equivalent Schematic and Connection Diagrams



Dual-In-Line and Small Outline Packages

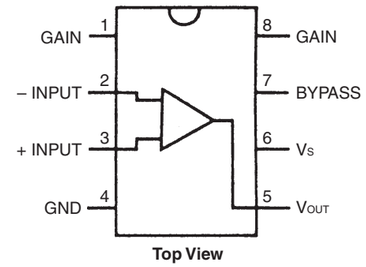


Figure 3

Typical Applications

Amplifier with Gain = 20
Minimum Parts

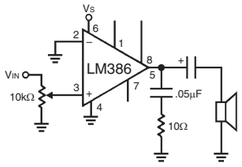


Figure 4a

Amplifier with Gain = 200

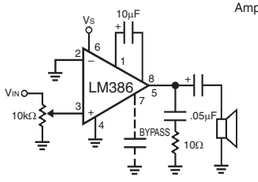


Figure 4b

Amplifier with Gain = 150

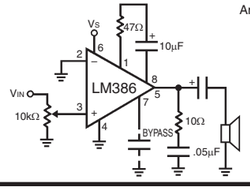


Figure 4c

CONSTRUCTION

Introduction

The most important factor in assembling your FM-88K Auto-scan FM Radio 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

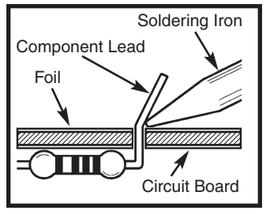
In all of the following assembly steps, the components must be installed on the top side of the PC board unless otherwise indicated. The top legend shows where each component goes. The leads pass through the corresponding holes in the board and are soldered on the foil side.
Use only rosin core solder.

DO NOT USE ACID CORE SOLDER!

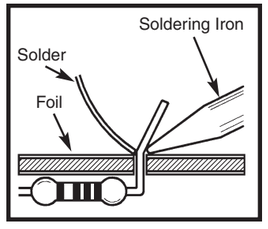
What Good Soldering Looks Like

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

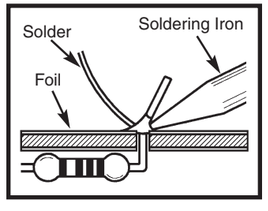
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.



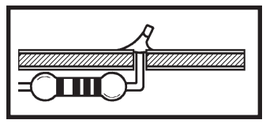
2. Apply a small amount of solder to the iron tip. This allows the heat to leave the iron and onto the foil. Immediately apply solder to the opposite side of the connection, away from the iron. Allow the heated component and the circuit foil to melt the solder.



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.

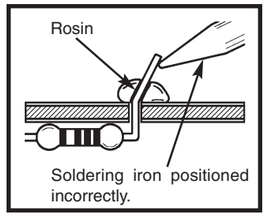


4. Here is what a good solder connection looks like.

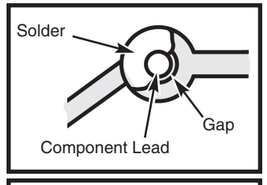


Types of Poor Soldering Connections

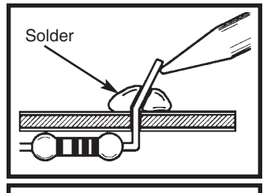
1. **Insufficient heat** - the solder will not flow onto the lead as shown.



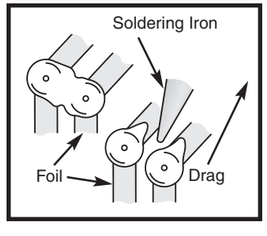
2. **Insufficient solder** - let the solder flow over the connection until it is covered.
Use just enough solder to cover the connection.



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.



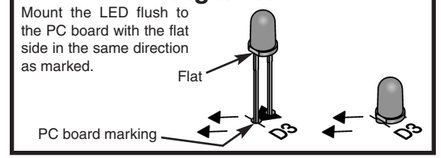
SECTION 1

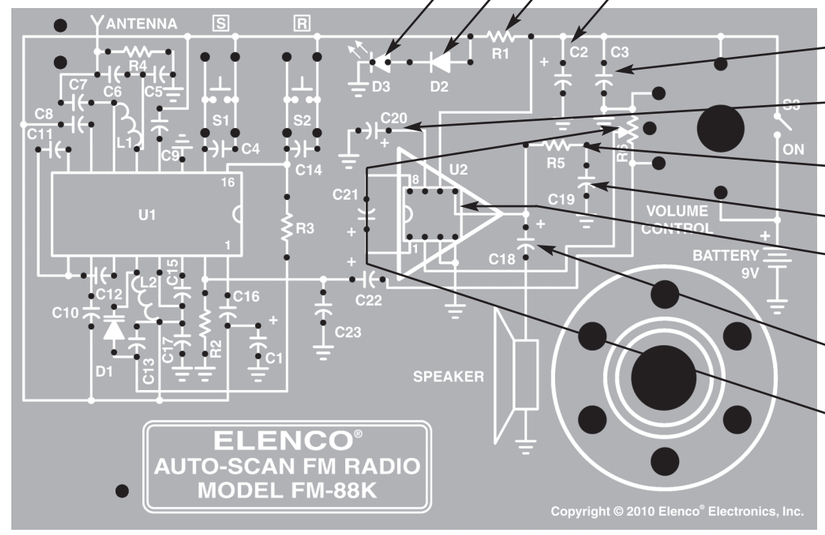
ASSEMBLE COMPONENTS TO THE PC BOARD

Place a check mark ☑ in the box provided next to each step to indicate that the step is completed.

Figure A

Mount the LED flush to the PC board with the flat side in the same direction as marked.





- ☐ D3 - Red LED (see Figure A)
- ☐ D2 - 1N4001 Diode (see Figure B)
- ☐ R1 - 680Ω 5% 1/4W Res. (blue-gray-brown-gold)
- ☐ C2 - 220µF, Electrolytic (see Figure C)
- ☐ C3 - 0.1µF Discap (104)
- ☐ C20 - 22µF, Electrolytic (see Figure D)
- ☐ R5 - 10Ω 5% 1/4W Res. (brown-black-black-gold)
- ☐ C19 - 0.047µF Discap (473)
- ☐ U2 - 8-pin IC Socket
- ☐ U2 - LM-386 IC (see Figure E)
- ☐ C18 - 220µF, Electrolytic (see Figure D)
- ☐ R6/S3 - Potentiometer
- ☐ Nut & Washer
- ☐ Knob (see Figure F)

Figure B

Mount the diode flush to the PC board with the printed band in the same direction as marked.

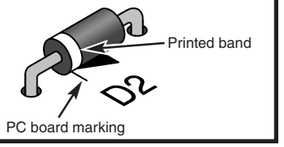


Figure C

Mount capacitor C2 on the back of the PC board in the location shown. Make sure the lead with the polarity marking is in the correct hole as shown.

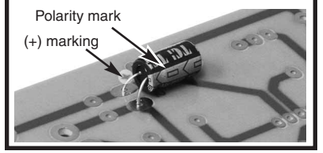
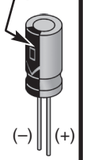


Figure D

Electrolytics have a polarity marking indicating the (–) lead. The PC board is marked to show the lead position.



Warning:

If the capacitor is connected with incorrect polarity, or if it is subjected to voltage exceeding its working voltage, it may heat up and either leak or cause the capacitor to explode.

Figure E

Insert the IC socket into the PC board with the notch in the direction shown on the top legend. Solder the IC socket into place. Insert the IC into the socket with the notch in the same direction as the notch on the socket.

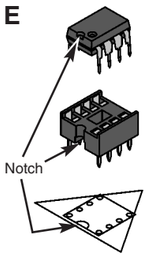


Figure F

Cut the tab off of the potentiometer as shown. Insert the potentiometer into the PC board holes, from the foil side, as shown. Place the washer over the shaft and tighten the nut. Solder the potentiometer into place and then insert the knob onto the shaft.