

PULSE/TONE TELEPHONE KIT

MODEL AK-700/PT-323K



7 56619 00213 2



Assembly and Instruction Manual

Elenco® Electronics, Inc.

SECTION 4 - 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.

* BAG 1 *

Resistors (For identifying values, refer to page 8).

QTY.	SYMBOL	DESCRIPTION	COLOR CODE	PART #
<input type="checkbox"/> 1	R18	10 Ω 5% 1/4W	brown-black-black-gold	121000
<input type="checkbox"/> 1	R19	120 Ω 5% 1/4W	brown-red-brown-gold	131200
<input type="checkbox"/> 1	R7	2.2k Ω 5% 1/4W	red-red-red-gold	142200
<input type="checkbox"/> 4	R12, R13, R15, R20	3.3k Ω 5% 1/4W	orange-orange-red-gold	143300
<input type="checkbox"/> 2	R5, R23	10k Ω 5% 1/4W	brown-black-orange-gold	151000
<input type="checkbox"/> 3	R16, R17, R22	15k Ω 5% 1/4W	brown-green-orange-gold	151500
<input type="checkbox"/> 4	R1 - R4	47k Ω 5% 1/4W	yellow-violet-orange-gold	154700
<input type="checkbox"/> 4	R6, R9, R11, R21	100k Ω 5% 1/4W	brown-black-yellow-gold	161000
<input type="checkbox"/> 2	R10, R14	150k Ω 5% 1/4W	brown-green-yellow-gold	161500
<input type="checkbox"/> 1	R8	1M Ω 5% 1/4W	brown-black-green-gold	171000

Diodes

QTY.	SYMBOL	VALUE	DESCRIPTION	PART #
<input type="checkbox"/> 4	D1 - D4	1N4004 or 1N4007	Diode	314004
<input type="checkbox"/> 2	D5, D6	1N4148	Diode	314148
<input type="checkbox"/> 1	D8	55C2V7/1N5223 2.7V	Zener Diode	315223
<input type="checkbox"/> 1	D7	55C4V7/1N5230 4.7V	Zener Diode	315230

* BAG 2 *

Capacitors (For identifying values, refer to page 8).

QTY.	SYMBOL	VALUE	DESCRIPTION	PART #
<input type="checkbox"/> 2	C10, C11	30pF	Discap (30)	213010
<input type="checkbox"/> 1	C5	300pF	Discap (300 or 301)	223017
<input type="checkbox"/> 1	C2	.01 μ F	Discap (.01 or 103)	241031
<input type="checkbox"/> 1	C8	.02 μ F	Discap (.02 or 203)	242010
<input type="checkbox"/> 1	C7	.04 μ F	Discap (.04 or 403)	240417
<input type="checkbox"/> 1	C1	.47 μ F	Mylar (474/470N)	254710
<input type="checkbox"/> 1	C6	1 μ F 50V	Electrolytic (Lytic)	261047
<input type="checkbox"/> 3	C3, C4, C9	47 μ F 10V	Electrolytic (Lytic)	274742

* BAG 3 *

QTY.	SYMBOL	VALUE	DESCRIPTION	PART #
<input type="checkbox"/> 1	Q2	2N5401	Transistor PNP	325401
<input type="checkbox"/> 1	Q3	2N5551	Transistor NPN	325551
<input type="checkbox"/> 1	Q4	9013H	Transistor NPN	329013
<input type="checkbox"/> 2	Q1, Q5	9014C	Transistor NPN	329014
<input type="checkbox"/> 1	IC1	HM9102	Integrated Circuit (IC)	339102
<input type="checkbox"/> 1	X		Resonator 3.58MHz	560358
<input type="checkbox"/> 4	LP1 - LP4		Neon Bulb	585021
<input type="checkbox"/> 1	IC1		IC Socket 18-pin	664018

*** BAG 4 ***

QTY.	DESCRIPTION	PART #
<input type="checkbox"/> 1	Switch SPDT (Hook) (S2)	541108
<input type="checkbox"/> 2	Switch SPDT (S1, S3)	541109
<input type="checkbox"/> 2	Screw 1/4" (Keyboard)	642237
<input type="checkbox"/> 2	Screw 5/8" (Case)	642477

*** BAG 5 ***

QTY.	DESCRIPTION	PART #
<input type="checkbox"/> 1	Microphone (MIC) (without leads)	568001
<input type="checkbox"/> 1	Buzzer (B)	595223
<input type="checkbox"/> 1	Modular Jack	621019
<input type="checkbox"/> 1	Label Telephone # (2 parts)	721006
<input type="checkbox"/> 1	Microphone Pad	780126
<input type="checkbox"/> 1	Buzzer Pad	780125

*** BAG 6 ***

QTY.	DESCRIPTION	PART #
<input type="checkbox"/> 1	Battery Snap 9V	590098
<input type="checkbox"/> 1	Wire 26AWG Stranded Red 2"	834520
<input type="checkbox"/> 1	Wire 26AWG Stranded Red 4"	834521
<input type="checkbox"/> 4	Wire 26AWG Stranded Gray 3"	834530
<input type="checkbox"/> 1	Wire 26AWG Stranded Orange 2"	834523
<input type="checkbox"/> 1	Ribbon Cable 1" (9 wires)	879009
<input type="checkbox"/> 1	Solder Lead-Free	9LF99

*** BAG 7 ***

QTY.	DESCRIPTION	PART #
<input type="checkbox"/> 1	PC Board Keypad	517028
<input type="checkbox"/> 1	Push Button Set (12)	540103
<input type="checkbox"/> 1	Contact Pad Keypad	789032

*** MAIN BAG ***

QTY.	DESCRIPTION	PART #
<input type="checkbox"/> 1	PC Board Main	517027
<input type="checkbox"/> 1	Speaker (SP)	590102
<input type="checkbox"/> 1	Case Top Clear	623300
<input type="checkbox"/> 1	Case Bottom Clear	623400
<input type="checkbox"/> 1	Cradle Clear	626001
<input type="checkbox"/> 1	Hook Button Clear	626040
<input type="checkbox"/> 1	Label Dial	721027
<input type="checkbox"/> 1	Speaker Pad	780127
<input type="checkbox"/> 1	Telephone Cord	860900

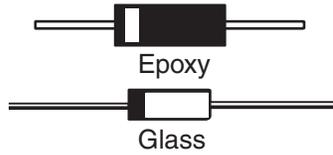
PARTS IDENTIFICATION

BAG 1

Resistor



Diodes

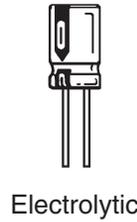


Epoxy

Glass

BAG 2

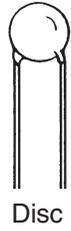
Capacitors



Electrolytic



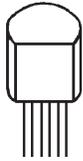
Mylar



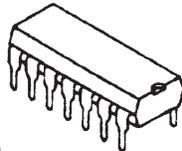
Disc

BAG 3

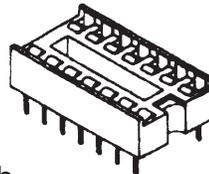
Transistor



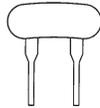
Integrated Circuit (IC)



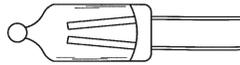
IC Socket



Resonator

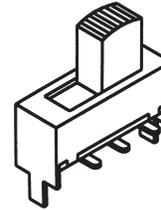


Neon Bulb



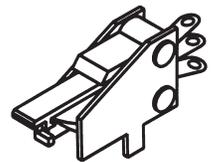
BAG 4

Switch SPDT (S1, S3)



5/8" Screw

Switch SPDT (Hook) (S2)



1/4" Screw

BAG 5

Microphone



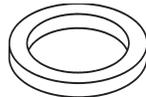
Microphone Pads



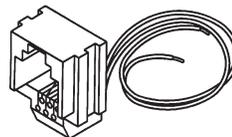
Buzzer



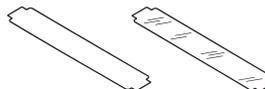
Buzzer Pad



Modular Jack

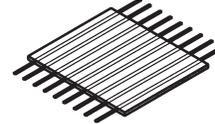


Label & Cover



BAG 6

Ribbon Cable



Solder

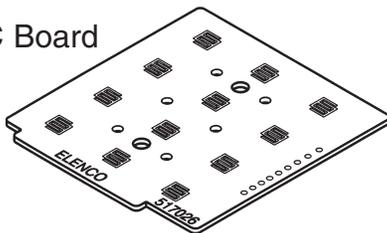


Battery Snap

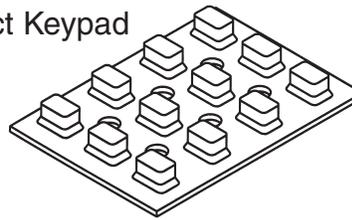


BAG 7

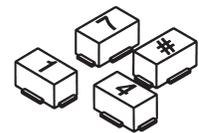
Keypad PC Board



Contact Keypad

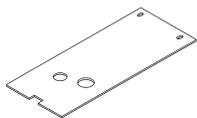


Push Button Set (12)

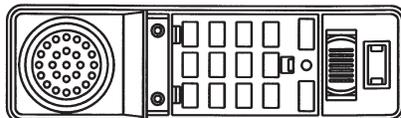


MAIN BAG

Main PC Board



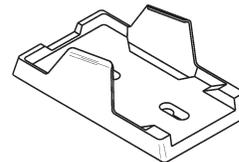
Clear Top Case



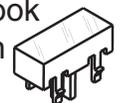
Speaker Pad



Clear Cradle



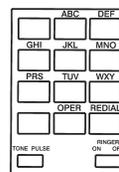
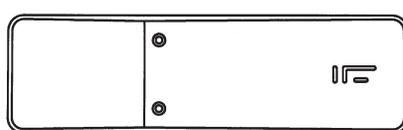
Clear Hook Button



Speaker (SP)

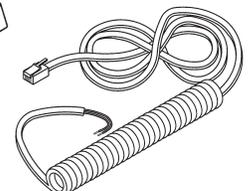


Clear Bottom Case



Label Dial

Telephone Cord

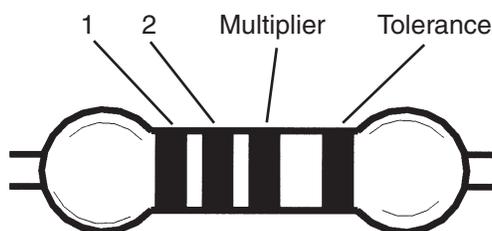


IDENTIFYING RESISTOR VALUES

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

BAND 1 1st Digit		BAND 2 2nd Digit		Multiplier		Resistance Tolerance	
Color	Digit	Color	Digit	Color	Multiplier	Color	Tolerance
Black	0	Black	0	Black	1	Silver	±10%
Brown	1	Brown	1	Brown	10	Gold	±5%
Red	2	Red	2	Red	100	Brown	±1%
Orange	3	Orange	3	Orange	1,000	Red	±2%
Yellow	4	Yellow	4	Yellow	10,000	Orange	±3%
Green	5	Green	5	Green	100,000	Green	±0.5%
Blue	6	Blue	6	Blue	1,000,000	Blue	±0.25%
Violet	7	Violet	7	Silver	0.01	Violet	±0.1%
Gray	8	Gray	8	Gold	0.1		
White	9	White	9				

BANDS



IDENTIFYING CAPACITOR VALUES

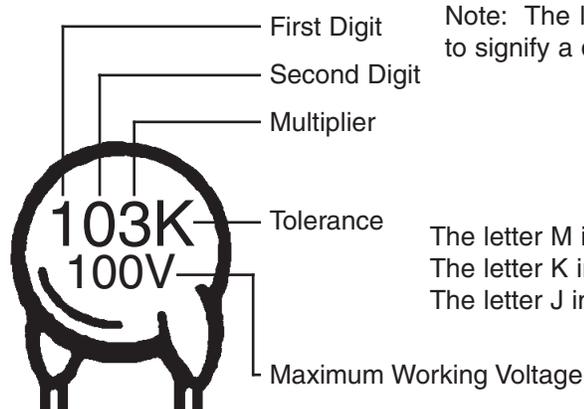
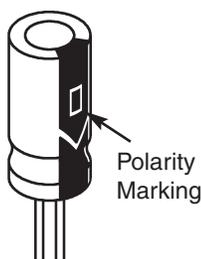
Capacitors will be identified by their capacitance value in pF (picofarads), nF (nanofarads), or μ F (microfarads). Most capacitors will have their actual value printed on them. Some capacitors may have their value printed in the following manner. The maximum operating voltage may also be printed on the capacitor.

Multiplier	For the No.	0	1	2	3	4	5	8	9
	Multiply By		1	10	100	1k	10k	100k	0.01

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.



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

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

The value is $10 \times 1,000 = 10,000\text{pF}$ or $.01\mu\text{F}$ 100V

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

- 1,000 pico units = 1 nano unit
- 1,000 nano units = 1 micro unit
- 1,000 micro units = 1 milli unit
- 1,000 milli units = 1 unit
- 1,000 units = 1 kilo unit
- 1,000 kilo units = 1 mega unit

SECTION 1 - INTRODUCTION

The Model AK-700 / PT-323K is a push button electronic telephone kit. Your telephone is equipped with the following features: A) a tone/pulse switch, B) automatic redial (for pulse dialer) of up to 32 digits, C) a ringer turn off switch, and D) four neon bulbs to give a visual indication that the telephone is ringing. The kit is built up in three sections: 1) Ringer, 2) Transmit-Receive, and 3) Dialer. As each section is added, its function is explained and tests are run to demonstrate its operation.

FCC regulations do not allow the Model AK-700 / PT-323K Telephone to be connected to the telephone network unless it has been either assembled under the supervision of an instructor or been tested by Elenco®.

SECTION 2 - FCC REQUIREMENTS

For the last several years, the Federal Communications Commission (FCC) has provided the standards for the protection of the telephone network from harm caused by the connection of terminal equipment. The rules established require that all terminal equipment, such as your telephone, be registered with the FCC. The FCC registration number of your telephone is GXA3PP-19545-TE-E.

If trouble is experienced, the telephone must be removed from the telephone network to determine if it is malfunctioning. If it is malfunctioning, the telephone must not be reconnected to the telephone network until repairs are made. Repairs should be made by Elenco®. To arrange for repairs, contact Elenco® at the address given on the back of this manual.

SECTION 3 - GENERAL DESCRIPTION

The primary purpose of the telephone is to transmit and receive voice signals allowing two people with telephones to communicate with each other. To be of practical value, the telephone must be connected to a switching network capable of connecting each telephone to many other telephones. To accomplish this switching, each subscriber telephone is connected to the telephone company's Central Office by two wires referred to as the "Local Loop". A simplified diagram of this connection is shown in Figure 3-1. The Tip and Ring designation of the + and - leads come from the days of the manual switchboard. The tip of the plug the operator used to connect telephones carried the (+) lead and the ring immediately behind the tip carried the (-) lead.

When a subscriber wishes to place a call, they merely pick up the telephone and a small current flows in the local loop. This current picks a relay in the Central Office indicating that service is being requested. When the Central Office is ready to accept the number being called, a dial tone is sent to the calling telephone. The dial pulses, or tones, then signal to the Central Office the number of the telephone being called. A path is then established to that telephone. This path may be a simple wire connection to a telephone connected to the same Central Office or it may go via wire, microwave link, or satellite to a telephone connected to a distant Central Office. To signal the incoming call, a ringing signal is placed on the local loop of the called telephone. The ringing signal is a 90 VAC 20Hz signal superimposed on the 48VDC present on the local loop. A ringing tone is also sent to the calling telephone. When the called party picks up the telephone, voice communication is established.

The Rotary Dial Telephone

A simplified schematic diagram of the traditional rotary dial telephone is shown in Figure 3-2. The major parts of this telephone are explained below. Your kit is a newer electronic type telephone. When you build your telephone in Section 6, you will notice several differences between the traditional and electronic type telephones.

Hook Switch

When the hook switch is open (on hook) no current flows in the local loop. The 48VDC from the battery in the Central Office appears on the tip and ring input to the telephone set. When the receiver is lifted, the hook switch closes and a current of about 20 to 120mA flows in the local loop. The resistance of the local loop drops the voltage at the telephone to about 6 volts. The current picks a relay in the Central Office which tells other equipment there that service is being requested. When the Central Office is ready to accept the number being called, a dial tone is sent to the calling telephone. The dial tone stops when the first digit is dialed.

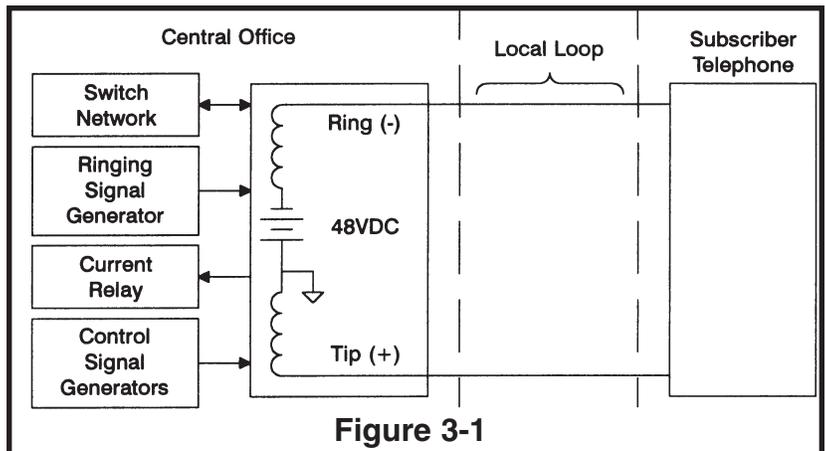


Figure 3-1

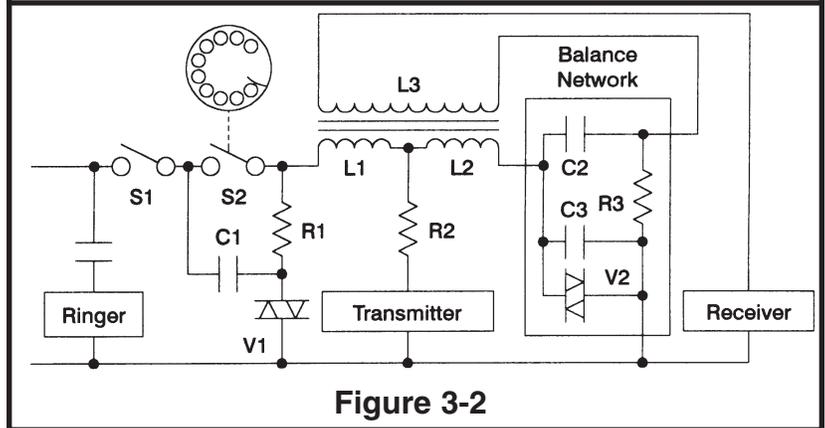


Figure 3-2

Dialer

There are two types of dialers, pulse and tone.

Pulse Dialer

Pulse dialing is accomplished by the familiar rotary dial shown in Figure 3-2. The dial is rotated to the stop and then released. A spring in the dialer returns the dial to its null position. As the dial returns, the dial switch (S2) opens and closes at a fixed rate. This switch is in series with the hook switch. Opening the switch interrupts the current in the local loop. A series of current pulses is thus sent out on the local loop as shown in Figure 3-3. The number of pulses sent corresponds to the digit dialed. Dialing "0" sends ten pulses. The dial pulses are sent at a rate of 10 pulses per second (100 ms. between pulses). Each pulse consists of a mark interval (loop current) and a space interval (no loop current). In America, the mark interval is 40 ms. and the space interval is 60 ms. giving a mark/space ratio of 40/60. In Europe, the mark space ratio is usually 33/67.

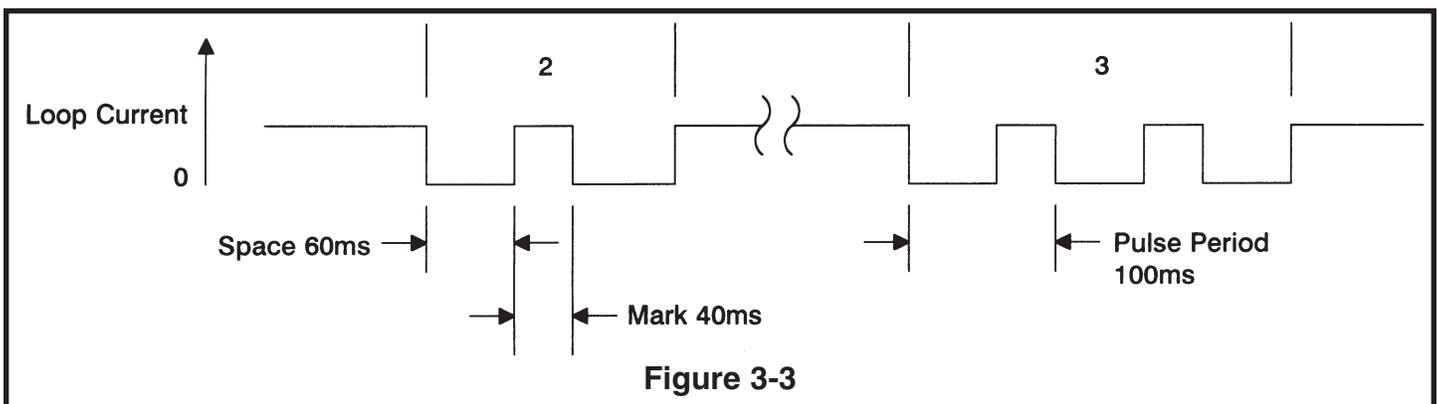
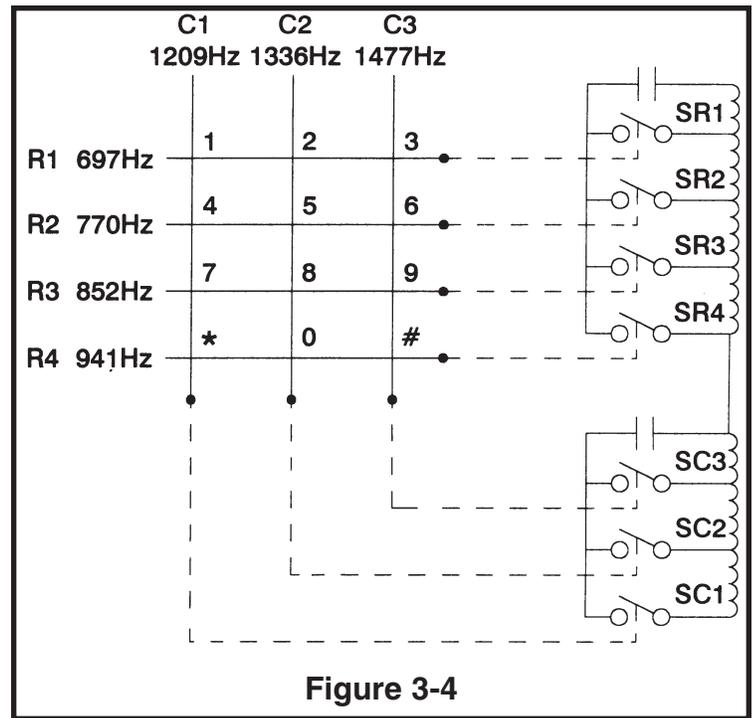


Figure 3-3

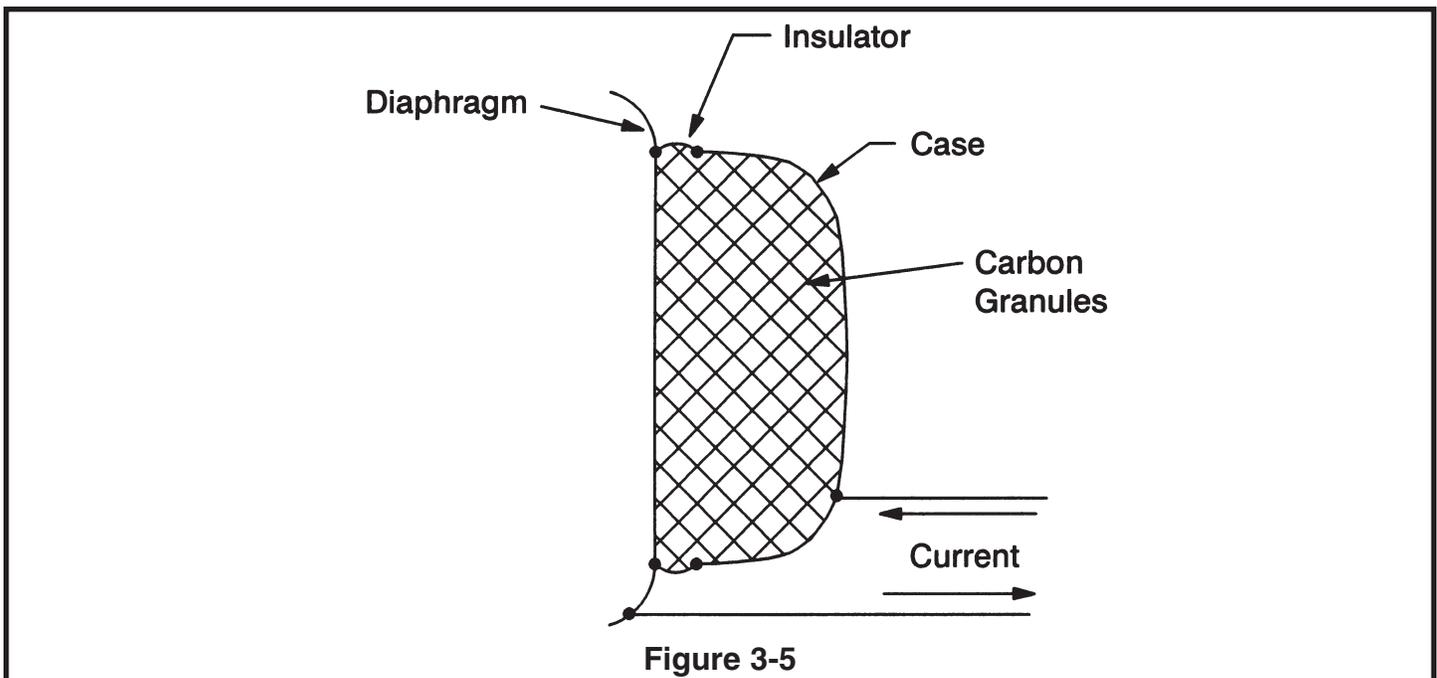
Tone Dialer

Tone dialing is accomplished with a keyboard of 12 keys arranged in 4 rows and 3 columns. As seen in Figure 3-4, low frequencies of 697, 770, 852 and 941 are associated with rows R1 through R4 and high frequencies of 1209, 1336 and 1477Hz are associated with columns C1 through C3. To send each digit, two frequencies are sent to the Central Office simultaneously. For this reason, this method of dialing is referred to as Dual Tone Multifrequency (DTMF). The different frequencies are generated by connecting a capacitor to different taps of a transformer to establish a resonant circuit of the correct frequency. Each of the 3 keys of row 1 are mechanically connected to switch SR1. Similarly, each of the other rows and columns are connected to their corresponding switch. Thus, pressing any key closes two switches and generates two frequencies. Pressing a 6 for example, closes switches SR2 and SC3 and generates 770 and 1477Hz.



Transmitter

The Transmitter consists of a metal diaphragm and a metal case insulated from each other as shown in Figure 3-5. The case is filled with carbon granules. When you speak into the transmitter, the sound waves of your voice strike the diaphragm and causes it to vibrate. This causes the carbon granules to compress and expand. When compressed, the resistance of the carbon granules is less than when expanded. The change of resistance causes a corresponding change in the current. The current thus varies in step with the sound waves of your voice.



Receiver

There are several different types of receivers. In principle, they work the same as the speakers in your radio and TV. The speaker consists of a small coil attached to a diaphragm. The coil is mounted over a permanent magnet as shown in Figure 3-6. Coil current in one direction causes the coil and diaphragm to be repelled from the permanent magnet. Coil current in the other direction causes the coil and diaphragm to be attracted to the permanent magnet. If a current of audio frequency is sent through the coil, the diaphragm vibrates and generates sound waves in step with the current. Thus, if the current from the transmitter is sent through the coil, the sound produced will duplicate the sound striking the transmitter.

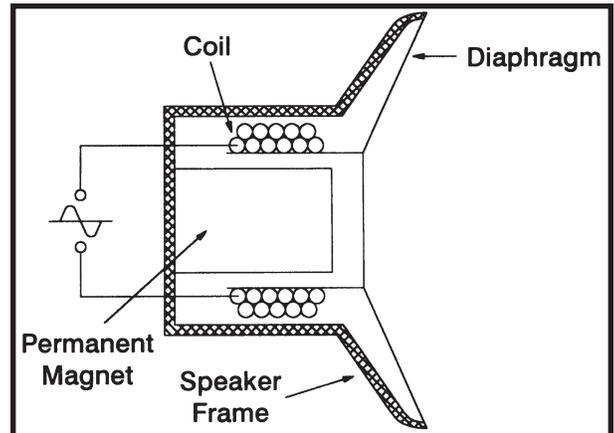


Figure 3-6

Ringer

As shown in Figure 3-2, the ringer is connected across the tip and ring inputs in series with a capacitor to block the 48VDC. The ringer consists of a permanent magnet attached to an armature as shown in Figure 3-7. When an alternating current of 20Hz is passed through the coils, the armature is alternately attracted to one coil and then the other. The hammer attached to the armature thus strikes one bell and then the other to produce the ringing sound.

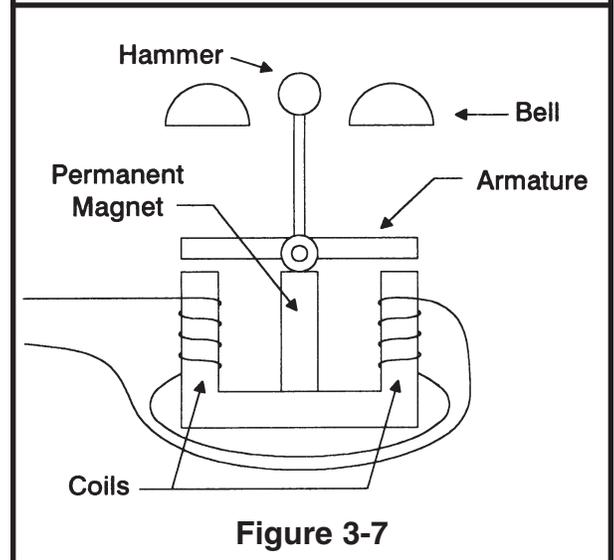


Figure 3-7

Induction Coil / Balance Network

When transmitting and receiving is done over the same two wires, the problem arises that current from the transmitter flows through the receiver. The speaker then hears their own voice from the receiver. This is called sidetone. Too much sidetone may be objectionable to the speaker and cause them to speak too softly. A small amount of sidetone is desirable to keep the telephone from sounding dead.

The induction coil and balance network limit the sidetone. The impedance of the balance network shown in Figure 3-2 approximately matches the impedance of the local loop. Thus, about half of the current from the transmitter flows through L1 and the local loop and the other half flows through L2 and the balance network. The currents in L1 and L2 induce voltages in L3 of opposite polarity which limits the voltage across the receiver to an acceptable level. When receiving a signal from the local loop, the currents in L1 and L2 induce voltages in L3 of the same polarity. These voltages combine to drive the receiver.

CONSTRUCTION

Introduction

The most important factor in assembling your AK-700/PT-323K Pulse/Tone Telephone 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.**

Safety Procedures

- Wear eye protection when soldering and during all phases of construction.
- 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.** 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.

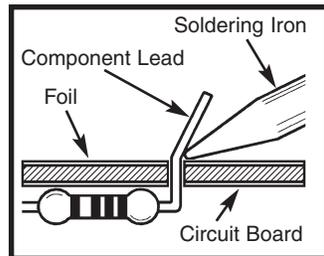
Use only rosin core solder.

DO NOT USE ACID CORE SOLDER!

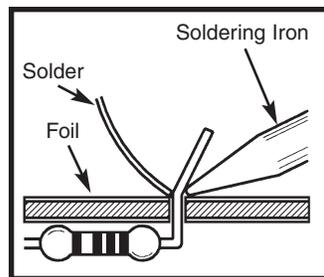
What Good Soldering Looks Like

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

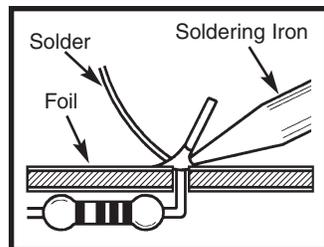
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.



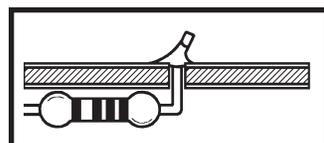
2. Apply a small amount of solder to the iron tip. This allows the heat to leave the iron and onto the foil. Immediately apply solder to the opposite side of the connection, away from the iron. Allow the heated component and the circuit foil to melt the solder.



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.

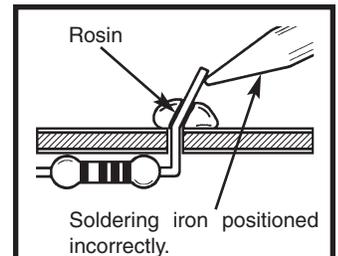


4. Here is what a good solder connection looks like.

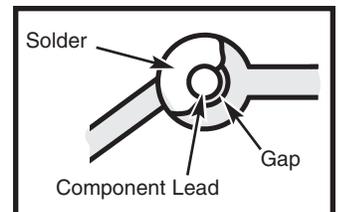


Types of Poor Soldering Connections

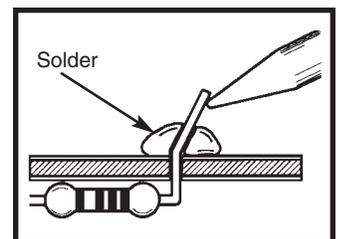
1. **Insufficient heat** - the solder will not flow onto the lead as shown.



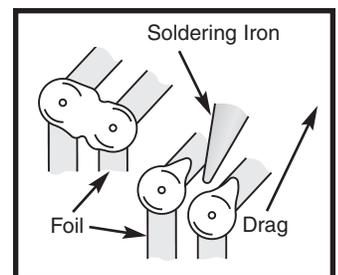
2. **Insufficient solder** - let the solder flow over the connection until it is covered. Use just enough solder to cover the connection.



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

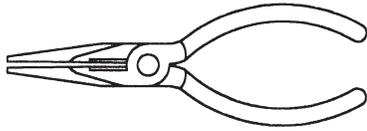


4. **Solder bridges** - occur when solder runs between circuit paths and creates a short circuit. This is usually caused by using too much solder. To correct this, simply drag your soldering iron across the solder bridge as shown.

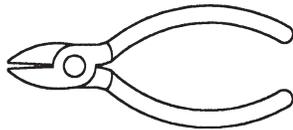


SECTION 5 - EQUIPMENT NEEDED

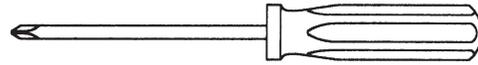
Tools Needed (not provided)



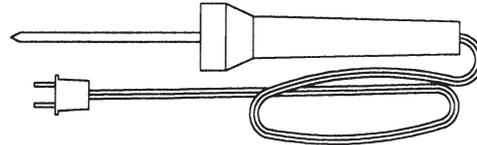
Long Nose Pliers



Diagonal Cutters



Phillips Screwdriver (small point size)



**Small Pencil Type Soldering Iron
of 25 - 40 Watts**

Note: The following equipment is not included unless indicated.

Testing Equipment Needed:

The test procedures are written for using AC and DC power supplies (only for final ringer test) or a 9V battery. If you don't have a power supply for the ringer, transmit-receive and dialer tests, you can use a 9V battery.

Using a 9 Volt Battery

- 9 volt battery
- Battery Snap (Included)

Using Power Supplies

- 9 - 48VDC Power Supply
- Resistor 1k Ω 5W
- Voltmeters 48VDC and 50VAC
- Oscilloscope
- Variac
- Isolation Transformer

SECTION 6 - ASSEMBLY INSTRUCTIONS

RINGER

Circuit Description - The ringer circuit is connected directly across the Tip and Ring inputs (see Schematic Diagram). The capacitor C1 blocks the 48VDC that is present on the inputs when the phone is on the hook. To signal an incoming call, the Central Office places a 90VAC 20Hz signal on top of the 48VDC. If the ringer switch (S1) is closed, transistor Q1 conducts during the 1/2 cycle that the Ring terminal is positive. The collector to emitter voltage is applied to the buzzer causing it to change dimensions. The feedback lead is connected to the base of transistor Q1 through resistor R7 causing the circuit to oscillate at about 3kHz. There is no oscillation during the negative portion of the 20Hz signal. The buzzing sound is thus produced by the buzzer changing dimensions at 3kHz during the positive portion of the 20Hz ringing signal.

The four neon bulbs LP1 through LP4 and resistors R1, R2, R3 and R4 are also connected across the Tip and Ring inputs. When the ringing signal causes the voltage across the bulbs to exceed about 100 volts, the bulbs conduct, giving a visual indication of the incoming call.

PC BOARD ASSEMBLY

Identify and install the following parts as shown in Figure 6-1. After soldering each part, place a check in the box provided.

- R3 - 47kΩ Resistor
(yellow-violet-orange-gold)
- R4 - 47kΩ Resistor
(yellow-violet-orange-gold)
- LP4 - Neon Bulb
- LP3 - Neon Bulb
(see Figure A)

- R5 - 10kΩ Resistor
(brown-black-orange-gold)
- C1 - .47μF Mylar Cap. (474)
(see Figure B)
- R6 - 100kΩ Resistor
(brown-black-yellow-gold)
- Q1 - 9014C Transistor
(see Figure C)
- R7 - 2.2kΩ Resistor
(red-red-red-gold)
- R14 - 150kΩ Resistor
(brown-green-yellow-gold)
- LP1 - Neon Bulb
(see Figure A)
- R1 - 47kΩ Resistor
(yellow-violet-orange-gold)
- T - Jumper Wire
- R - Jumper Wire
(see Figure D)
- R2 - 47kΩ Resistor
(yellow-violet-orange-gold)
- LP2 - Neon Bulb
(see Figure A)

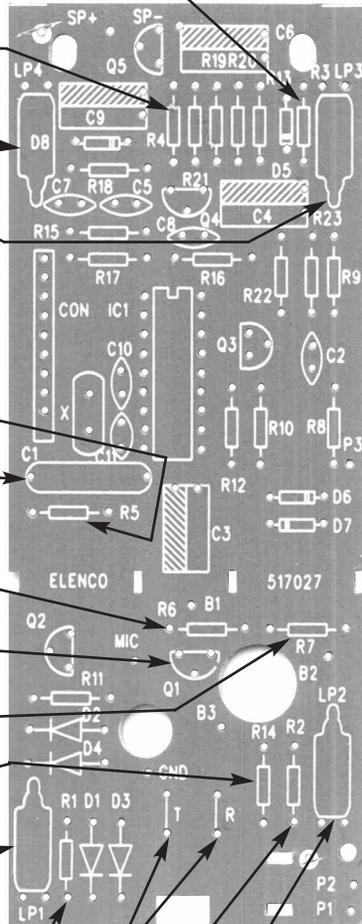


Figure 6-1

Figure A

Mount the neon bulb as shown with the bulb in the same direction as marked on the PC board. Give about a 1/8" space between the bulb and the holes in the PC board.

Figure B

Mount the mylar capacitor flat against the PC board as shown. Leave about 1/4" space between the capacitor and the PC board holes as shown. Solder and twist the leads together. **DO NOT CUT THE LEADS.**

Note: Make sure that these leads do not touch.

Twist the leads.

Figure C

Mount the transistor with the flat side in the same direction as marked on the PC board.

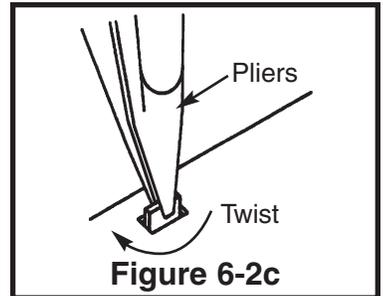
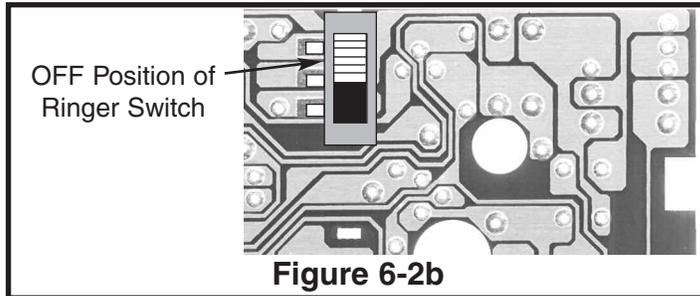
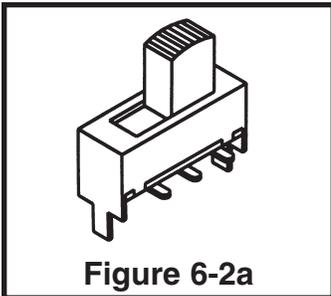
Figure D

Use a discarded resistor lead for a jumper wire. Leave about a 1/16" space between the jumper and the PC board.

Install the following parts. After soldering, place a check in the box provided.

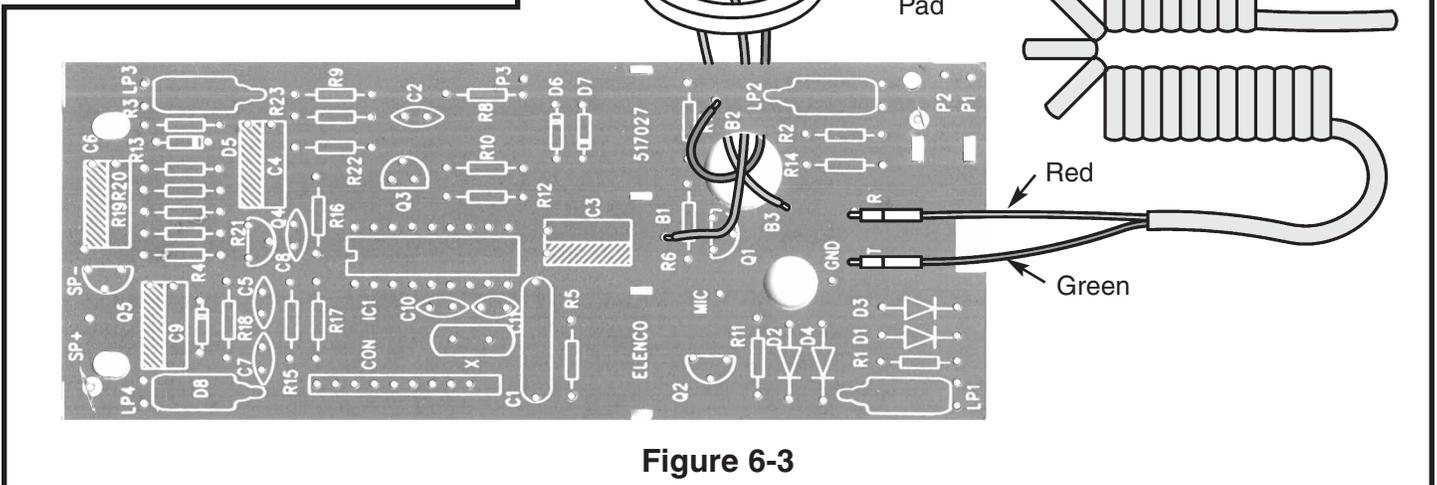
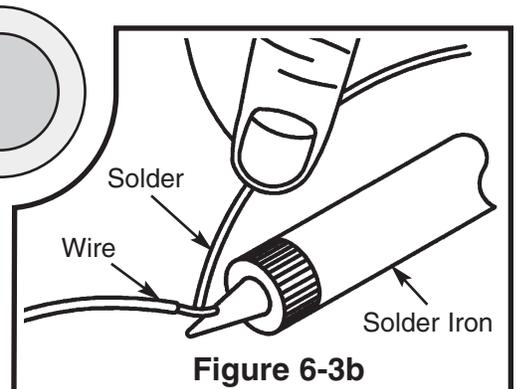
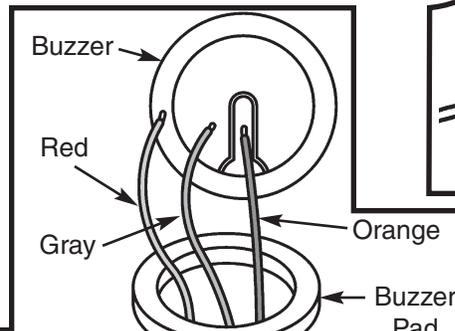
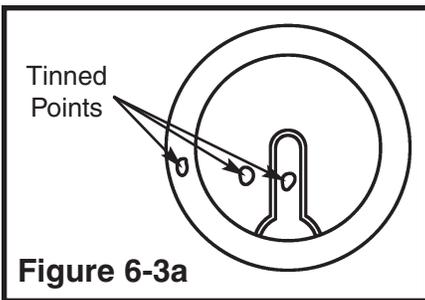
- Identify the ringer switch as shown in Figure 6-2a. The ringer switch is mounted on the copper side of the PC board. Insert the switch tabs into the holes provided and solder the three terminals as shown in Figure 6-2b. Be sure that the switch is perpendicular to the PC board.

To anchor the switch in place, grasp the switch tabs with your pliers and give a 1/8 turn as shown in Figure 6-2c.



- Identify the telephone cord. Solder the red wire to the ring jumper and the green wire to the tip jumper as shown in Figure 6-3.
- Identify the buzzer and buzzer pad. Use three 2" wires of different color (red, orange, and gray) to connect the buzzer to the PC board. Identify the red and orange wire and cut a 2" piece of wire off of the 3" gray wire. If needed, strip 1/8" of insulation off of each end.
- Tin the buzzer with solder in the locations shown in Figure 6-3a.
- Tin both ends of the three 2" wires as shown in Figure 6-3b.
- Carefully solder the three 2" wires onto the buzzer as shown in Figure 6-3.
- Thread the three wires through the buzzer pad and then through the hole from the solder side of the PC board as shown in Figure 6-3.
- Solder the three wires to the PC board as shown in the Figure 6-3. The gray wire goes to B1, the orange wire goes to B2 and the red wire goes to B3.

Note: If the buzzer pad has a center piece, then remove it.



If you have a 9VDC power supply, skip to the Ringer Test on page 14.

RINGER TEST (Using a 9 Volt Battery)

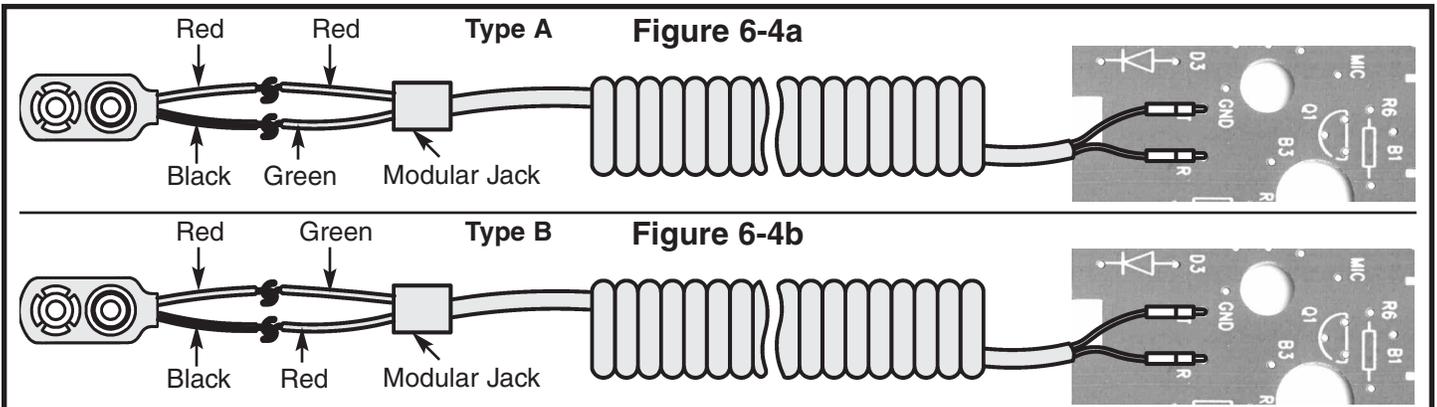
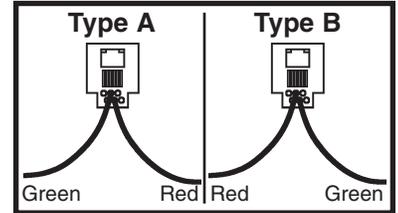
Test Equipment Needed

- 9 volt battery (not provided). Use a fresh alkaline battery.
- 9 volt battery snap.

Testing is done with a 9 volt battery. To conserve the battery, it should be connected for only short periods of time and disconnected whenever tests are not actually being performed.

Since capacitor C1 blocks the DC voltage, it is shorted for this test (Figure B on page 11).

1. Set the ringer switch to the OFF position (refer to Figure 6-2b).
2. Check to see which modular jack, type A or B, has been included in your kit. If you have type A, then use Figure 6-4a for testing. If you have type B, then use Figure 6-4b for testing.
3. Solder the red and black wires from the 9 volt battery snap to the wires of the modular jack as shown in Figure 6-4a or Figure 6-4b.
4. Put the 9V battery into the battery snap. Be sure that the telephone cord is plugged into your modular jack. Set the ringer switch to ON (toward the center of the PC board). You should hear a 3kHz tone from the buzzer. If no tone is heard, unplug the telephone cord from the modular jack and:
 - a) Check that the battery snap is connected with the right polarity as shown in Figure 6-4a or Figure 6-4b.
 - b) Check that the buzzer is wired as shown in Figure 6-3. Check that the telephone cord wires are soldered correctly.
 - c) Check that transistor Q1 is a 9014C and is mounted with the emitter, base and collector leads as shown in the assembly instructions.
 - d) Check that R5, R6 and R7 are the correct values.
 - e) Check for bad solder joints and solder bridges.
5. Put the ringer switch to OFF (toward the edge of the PC board). The 3kHz tone should stop. Put the ringer switch back to ON.
6. Unplug the telephone cord from the modular jack. Cut the leads from C1 (see Figure B on page 11). This removes the short from capacitor C1.
7. With the ringer switch ON, reconnect the telephone cord to the modular jack. Since the capacitor now blocks the DC, no tone is heard from capacitor C1.
8. Unplug the telephone cord from the modular jack.
9. Peel the backing off of the buzzer side of the buzzer pad and place it on the buzzer as shown in Figure 6-6a. The pad goes directly on top of the three buzzer wires. Peel the second backing off of the buzzer mounting pad and stick the pad onto the solder side of the PC board as shown in Figure 6-6b. **Note:** When mounting, be sure that you allow room for the Pulse/Tone Switch and Hook Switch.
10. Continue to the Transmit-Receive Section on page 15.



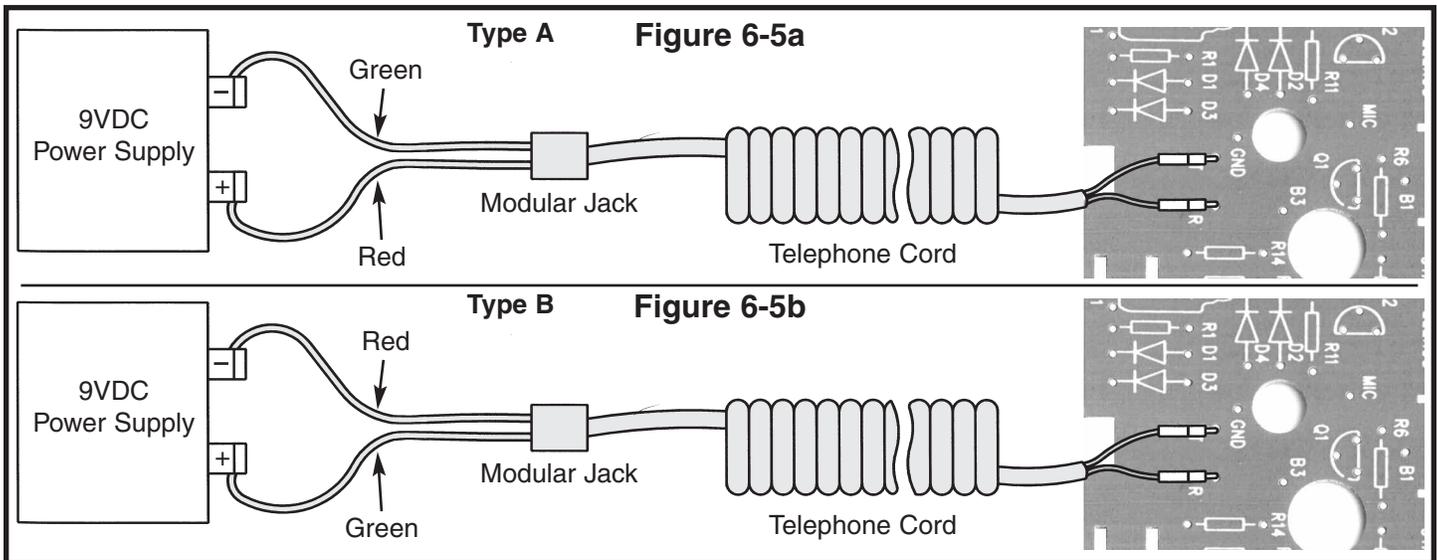
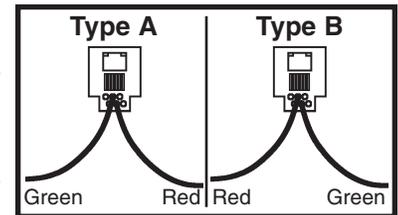
RINGER TEST (Using a Power Supply)

Test Equipment Needed (not provided)

- 9VDC power supply.

Since capacitor C1 blocks the DC voltage, it is shorted for this test (Figure B on page 11).

1. Set the ringer switch to the OFF position (refer to Figure 6-2b).
2. Check to see which modular jack, type A or B, has been included in your kit. If you have type A, then use Figure 6-5a for testing. If you have type B, then use Figure 6-5b for testing.
3. Connect the modular jack wires to the terminals on the power supply (as shown in Figure 6-5a or Figure 6-5b).



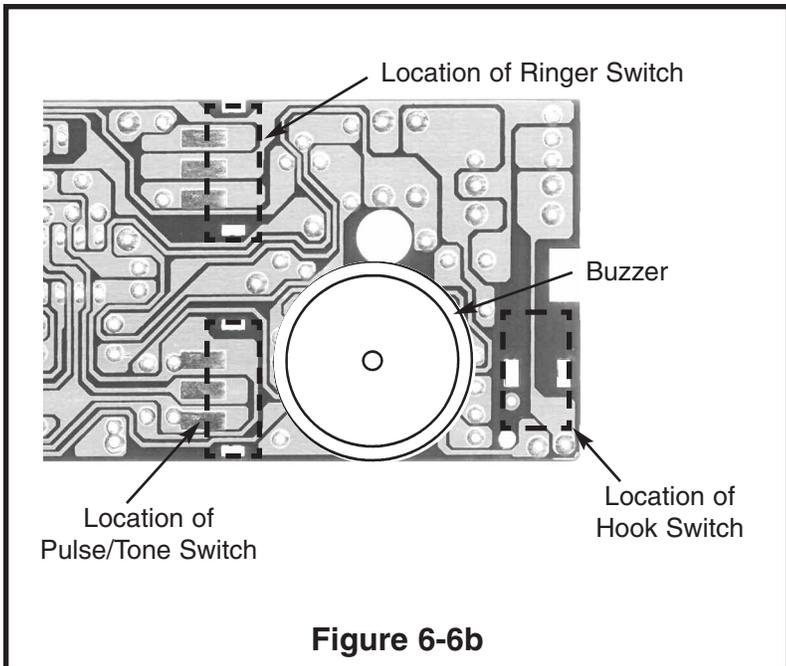
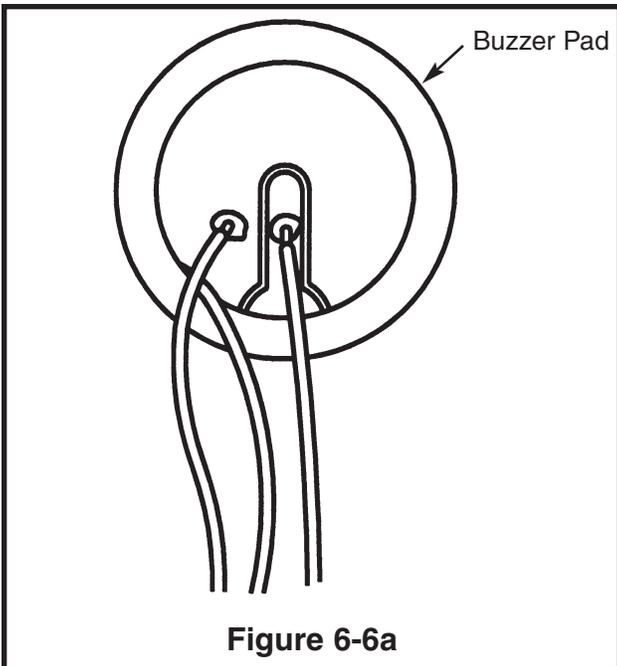
Perform the following Ringer tests:

4. Turn on the power supply. Set the ringer switch to ON (toward the center of the PC board). You should hear a 3kHz tone from the buzzer. If no tone is heard, unplug the telephone cord from the modular jack and:
 - a) Check that the power supply is connected with the right polarity as shown in Figure 6-5a or Figure 6-5b.
 - b) Check that the buzzer is wired as shown in Figure 6-3. Check that the telephone cord wires are soldered correctly.
 - c) Check that transistor Q1 is a 9014 and is mounted with the emitter, base and collector leads as shown in the assembly instructions.
 - d) Check that R5, R6 and R7 are the correct values.
 - e) Check for bad solder joints and solder bridges.
5. Put the ringer switch to OFF (toward the edge of the PC board). The 3kHz tone should stop. Put the ringer switch back to ON.
6. Turn the power supply OFF. Reconnect the power supply with the wire to the positive terminal and the wire to the negative terminal reversed. This simulates the negative portion of the ringing signal. Turn the power supply ON. No tone should be heard from the buzzer.
7. Have your instructor inspect the ringer circuitry and verify test performed.

Instructor's Approval: _____

8. Unplug the telephone cord from the modular jack. Cut the leads from C1 (Figure B on page 11). This removes the short from capacitor C1.
9. With the ringer switch ON, reconnect the circuit as shown in Figure 6-5a or Figure 6-5b and plug the telephone cord to the modular jack. Since the capacitor now blocks the DC, no tone is heard from capacitor C1.
10. Turn the power supply OFF and disconnect the power supply from the modular jack wires.

11. Unplug the telephone cord from the modular jack.
12. Peel the backing off of the buzzer side of the buzzer pad and place it on the buzzer as shown in Figure 6-6a. The pad goes directly on top of the three buzzer wires. Peel the second backing off of the buzzer mounting pad and stick the pad onto the solder side of the PC board as shown in Figure 6-6b. **Note:** When mounting, be sure that you allow room for the Pulse/Tone Switch and Hook Switch.
13. Continue to the Transmit-Receive Section.



TRANSMIT-RECEIVE

Circuit Description - The Tip and Ring inputs are fed to a diode bridge made up of diodes D1 through D4 (see schematic diagram). The bridge insures that a positive voltage is fed to the telephone circuit regardless of the polarity of the input. This is done to protect the integrated circuit and other components that may be damaged by a reversal of polarity.

When the hook switch is not depressed, the telephone is ready to transmit and receive. The incoming signal from the Central Office is sent via R20 and C6 to the speaker amplifier made up of transistor Q5. This amplifier drives the speaker.

Transmission begins when you speak into the microphone. The microphone used is an electret type. This type of microphone is made up of a capacitor with a dielectric material which holds a permanent electric charge. Sound waves striking a plate of this capacitor cause the plate to vibrate and thus generate a small voltage across the capacitor. This voltage is amplified by a Field Effect Transistor (FET) mounted inside the microphone. The signal from the microphone is then amplified and sent to the Central Office via the local loop. A portion of the signal is also sent to the speaker amplifier to provide the desired sidetone.

PC BOARD ASSEMBLY

Identify and install the following parts as shown in Figure 6-7. After soldering each part, place a check in the box provided.

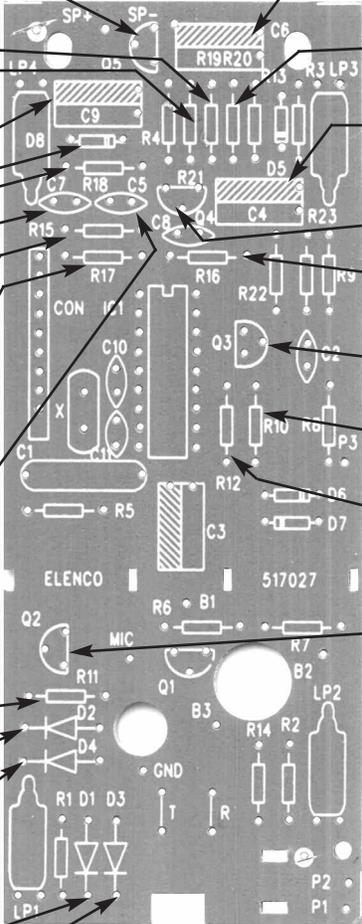
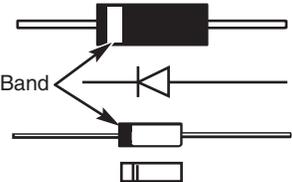
<input type="checkbox"/> Q5 - 9014 Transistor (see Figure C)	 <p>A detailed diagram of a PC board with various components labeled. Arrows point from the parts list to their respective locations on the board. Components include resistors (R1-R23), capacitors (C1-C10), diodes (D1-D5), transistors (Q1-Q5), and integrated circuits (IC1, IC2). The board also features a microphone (MIC), a speaker (SP), and various connectors (CON, P1, P2, P3, LP1, LP2, LP3).</p>	<input type="checkbox"/> C6 - 1 μ F Lytic Capacitor (see Figure F)
<input type="checkbox"/> R19 - 120 Ω Resistor (brown-red-brown-gold)		<input type="checkbox"/> R20 - 3.3k Ω Resistor (orange-orange-red-gold)
<input type="checkbox"/> R21 - 100k Ω Resistor (brown-black-yellow-gold)		<input type="checkbox"/> C4 - 47 μ F Lytic Capacitor (see Figure F)
<input type="checkbox"/> C9 - 47 μ F Lytic Capacitor (see Figure F)		<input type="checkbox"/> Q4 - 9013 Transistor (see Figure C)
<input type="checkbox"/> D8 - 2.7V Zener Diode (see Figure E)		<input type="checkbox"/> R16 - 15k Ω Resistor (brown-green-orange-gold)
<input type="checkbox"/> R18 - 10 Ω Resistor (brown-black-black-gold)		<input type="checkbox"/> Q3 - 2N5551 Transistor (see Figure C)
<input type="checkbox"/> C7 - .04 μ F Discap (.04 or 403)		<input type="checkbox"/> R10 - 150k Ω Resistor (brown-green-yellow-gold)
<input type="checkbox"/> R15 - 3.3k Ω Resistor (orange-orange-red-gold)		<input type="checkbox"/> R12 - 3.3k Ω Resistor (orange-orange-red-gold)
<input type="checkbox"/> R17 - 15k Ω Resistor (brown-green-orange-gold)		<input type="checkbox"/> Q2 - 2N5401 Transistor (see Figure C)
<input type="checkbox"/> C5 - 300pF Discap (300)		
<input type="checkbox"/> R11 - 100k Ω Resistor (brown-black-yellow-gold)		
<input type="checkbox"/> D2 - 1N4004 Diode (see Figure E)		
<input type="checkbox"/> D4 - 1N4004 Diode (see Figure E)		
<input type="checkbox"/> D1 - 1N4004 Diode (see Figure E)		
<input type="checkbox"/> D3 - 1N4004 Diode (see Figure E)		

Figure 6-7

Figure E

Mount the diodes with the band marked on them in the same direction marked on the PC board.

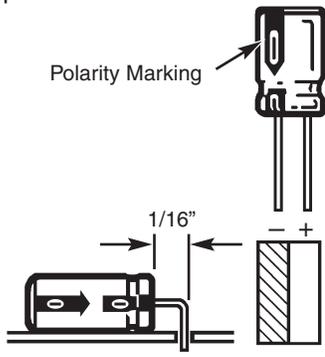


The diagram shows a diode with a white band on its body. Below it, a schematic symbol for a diode is shown with an arrow pointing to the band. A second diode is shown below the schematic, also with the band pointing in the same direction. A small rectangular component is shown at the bottom.

Figure F

Electrolytics have a polarity marking indicating the (-) lead. The PC board is marked to show the lead position. Mount the capacitor laying down on the PC board as shown.

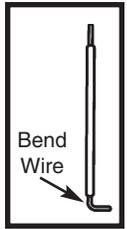
Warning: If the capacitor is connected with incorrect polarity, it may heat up and either leak or cause the capacitor to explode.



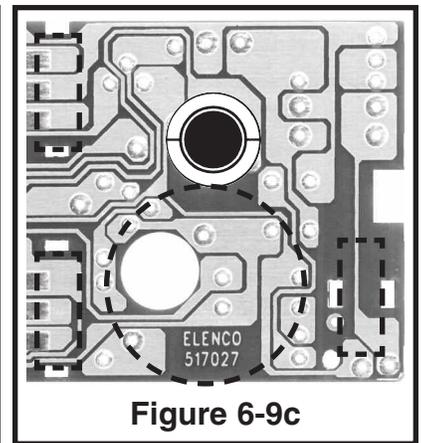
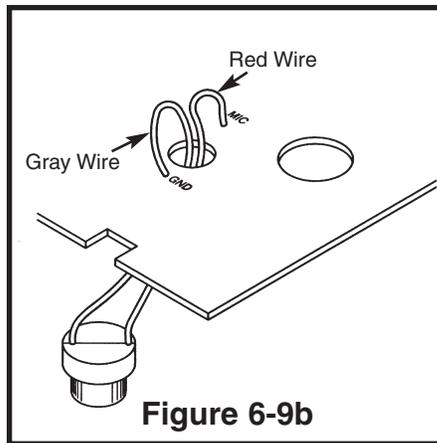
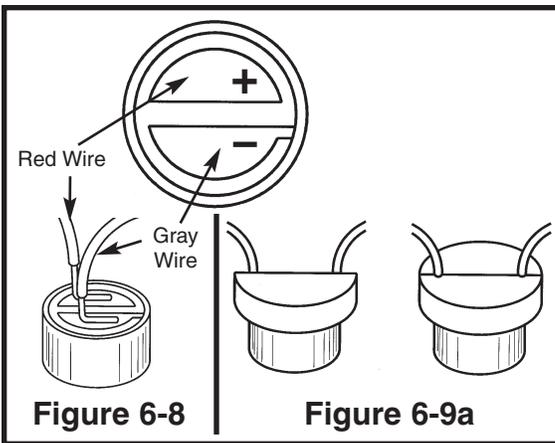
The diagram shows a cylindrical electrolytic capacitor being inserted into a hole on a PC board. The capacitor has a polarity marking on its top surface, indicated by a minus sign (-) and a plus sign (+). The board has a corresponding marking. A dimension line indicates a distance of 1/16" from the edge of the board to the center of the capacitor.

Install the following parts. After each step is completed, place a check mark in the box.

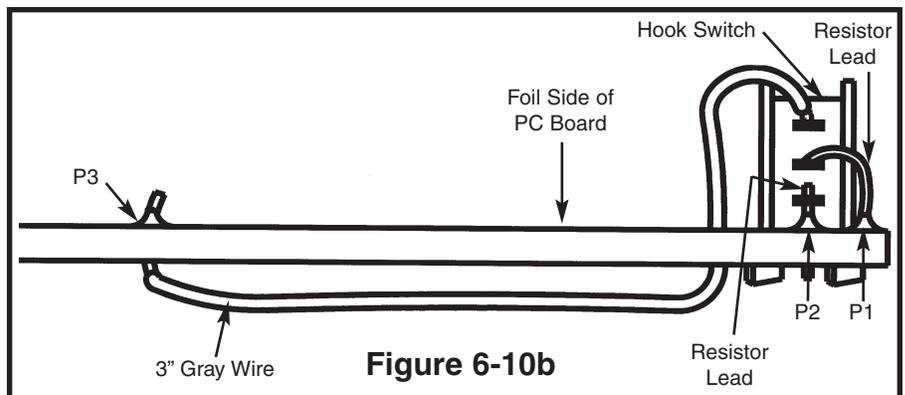
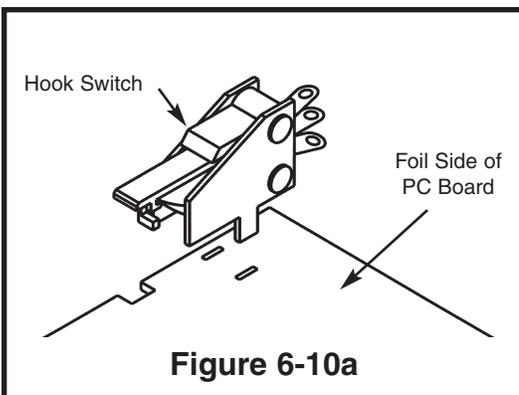
- Identify two wires (4" red and 3" gray), microphone and microphone pad. Cut the 4" red wire down to 2" and the 3" gray wire to 2". Use the 2" red and 2" gray stranded wires and strip 1/8" of insulation off of each end. Identify the microphone. Bend the wires and very carefully solder the wires to the microphone as shown in Figure 6-8.



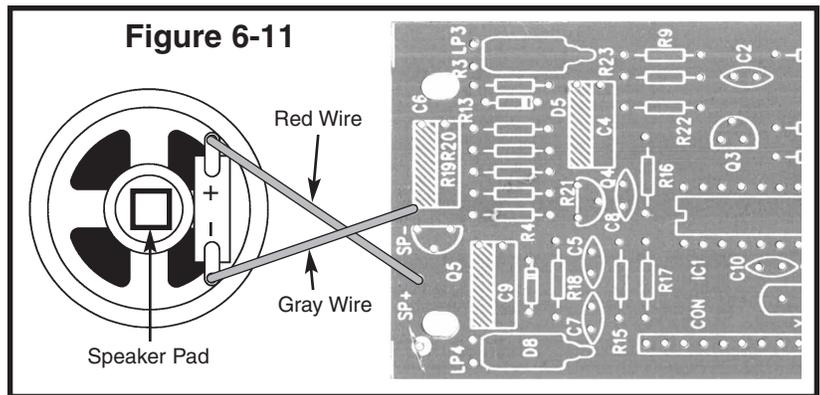
- Peel the backing off of one side of the microphone pads and place them onto the microphone as shown in Figure 6-9a.
- Peel the second backing off of the microphone pads and thread the wires through the hole in the PC board from the solder side as shown in Figure 6-9b. Solder the red wire to the hole marked MIC on the PC board and the gray wire to the hole marked GND on the PC board. Place the microphone on the PC board on the solder side as shown in Figure 6-9c. DO NOT contact the microphone with the buzzer.



- Identify the hook switch. The hook switch mounts to the copper side of the PC board. Insert the switch tabs into the mounting holes (see Figure 6-10a) and twist the tabs 1/8 of a turn as was done with the ringer switch. Solder the switch's contacts to the PC board using two pieces of discarded resistor leads and a 3" gray stranded wire as shown in Figure 6-10b.



- Identify the speaker with pad, 3" gray wire, and the second half of the 4" red wire (the first half was used for the microphone). Cut a 2" piece from the 3" gray wire and strip 1/8" of insulation off of both ends. Solder the red wire to the speaker + and the gray wire to the speaker - as shown in Figure 6-11. Solder the red wire to SP+ on the PC board and the gray wire to SP-.



If you have a 48VDC power supply, skip to the Transmit/Receive Test on page 19.

TRANSMIT - RECEIVE TESTS (Using a 9 volt battery)

Before completing the assembly, we will want to power up and test the Transmit-Receive Section.

1. Connect the telephone cord to the modular jack with the battery snap as shown in Figure 6-4a or 6-4b.
2. Put your ear to the receiver and depress and release the hook switch. You should hear a click when the switch is depressed. If you do not hear the click, then unplug the telephone cord from the modular jack and:
 - a) Check that the speaker wires are connected as shown in Figure 6-11.
 - b) Check diodes D1 through D4 and D8. Be sure that they are installed according to the polarity markings on the PC board.
 - c) Check transistors Q2, Q3, Q4 and Q5. Be sure that they are the proper type and that the emitter, base and collector leads are mounted as shown in the assembly instructions.
 - d) Check that the resistors just installed are the correct values as shown in the assembly instructions.
 - e) Check the hook switch and the wires to the PC board.
 - f) Check the components just installed for bad solder joints and solder bridges.
3. Put the receiver to your ear and gently tap or scratch the microphone. You should hear tapping from the receiver. Unplug the telephone cord from the modular jack. If you do not hear the tapping, then:
 - a) Check that the speaker wires are connected as shown in Figure 6-11.
 - b) Check that the microphone is connected as shown in Figure 6-9.
 - c) Check that transistors Q2 through Q5 are the proper type and are mounted as shown in the assembly instructions.
 - d) Check the components just installed for bad solder joints and solder bridges.
4. Reverse the battery snap leads to the wires of the modular jack, plug the telephone cord to the modular jack and repeat steps 2 and 3.
5. Unplug the telephone cord from the modular jack.
6. To avoid breaking the speaker wires, unsolder them from the PC board (see Figure 6-11). Leave the wires connected to the speaker. They will be reconnected later.
7. Continue to the Dialer Section on page 21.

TRANSMIT - RECEIVE TESTS (Using a power supply)

Before completing the assembly, we will want to power up and test the Transmit-Receive Section. See Figure 6-12 for these tests.

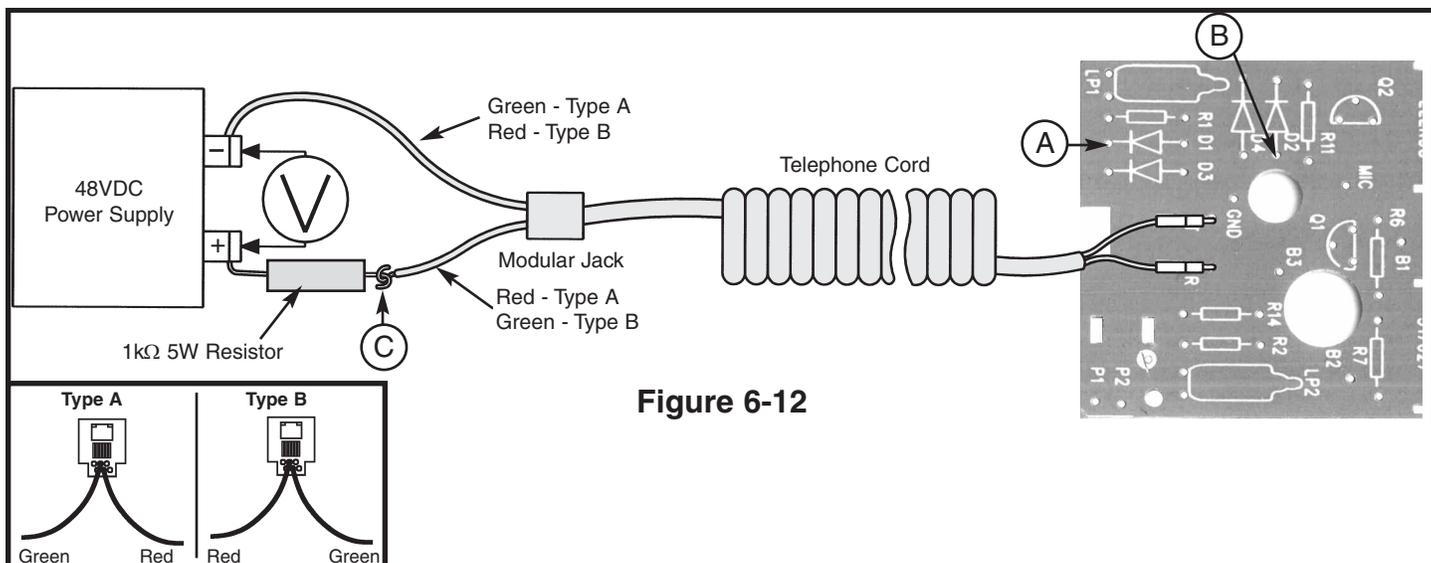


Figure 6-12

CAUTION: This test and succeeding tests involve 48VDC. This voltage is potentially hazardous. Use great care when working with these voltages. Always turn the power supply OFF before touching any wires on the power supply, PC board or modular jack.

Test Equipment Needed (not provided)

- 48VDC power supply
- 1k Ω 5W resistor
- 48VDC voltmeter

1. Turn the power supply OFF.
2. Solder one side of the 1k Ω 5W resistor to the wire from the modular jack as shown in figure 6-12
3. Connect the other side of the resistor and the other wire from the modular jack to the 48VDC power supply as shown in Figure 6-12.
4. Plug the telephone cord into the modular jack.
5. Set the voltmeter to read 48VDC and connect as shown in the Figure 6-12. Position the PC board so that the telephone is off the hook (hook switch not depressed). Turn the power supply ON and adjust it for 48VDC on the meter.
6. To measure the input voltage to the diode bridge, connect the negative voltmeter lead to the negative power supply terminal and the positive voltmeter lead to point "C". Record the Input Voltage: _____
7. To obtain the voltage across the diode bridge, connect the positive voltmeter lead to the cathode of D1 (point A in Figure 6-12) and the negative voltmeter lead to the anode of D2 (point B in the figure). Record the Output Voltage: _____
8. To obtain the voltage across the diode bridge, subtract the Output Voltage (step 7) from the Input Voltage (step 6). The difference should be between 1.3 and 1.9VDC. If the voltage difference is not within these limits, then unplug the telephone cord from the modular jack and:
 - a) Be sure that the telephone is off the hook (hook switch not depressed).
 - b) Check diodes D1 through D4. Be sure that they are installed according to the polarity markings on the PC board.

- c) Check transistors Q2, Q3, Q4 and Q5. Be sure that they are the proper type and that the emitter, base and collector leads are in the correct holes as shown in the assembly instructions.
 - d) Check that the resistors just installed are the correct values as shown in the assembly instructions.
 - e) Check the components just installed for bad solder joints and solder bridges.
 - f) Check the hook switch and wires to the PC board.
9. Turn the power supply OFF. Disconnect the voltmeter. Disconnect the $1k\Omega$ resistor and the red wire from the power supply terminals.
 10. To reverse the voltage polarity to the diode bridge, connect the free end of the $1k\Omega$ resistor to the negative power supply terminal and the red wire from the modular jack to the positive power supply terminal.
 11. To set the power supply voltage, connect the positive voltmeter lead to the positive terminal of the power supply and the negative voltmeter lead to the negative terminal of the power supply. Turn the power supply ON and adjust it to 48VDC on the voltmeter.
 12. To again measure the input voltage to the diode bridge, connect the positive voltmeter lead to the positive power supply terminal and the negative voltmeter lead to point "C". Record the Input Voltage: _____
 13. To measure the output voltage of the diode bridge, connect the positive voltmeter lead to the cathode of D1 (point A in Figure 6-12) and the negative voltmeter lead to the anode of D2 (point B in Figure 6-12). Record the Output Voltage: _____
 14. To obtain the voltage across the diode bridge, subtract the Output Voltage (step 13) from the input voltage (step 12). The difference should be between 1.3 and 1.9VDC. If the voltage difference is not within these limits, then unplug the telephone cord from the modular jack and:
 - a) Be sure that the telephone is off the hook (hook switch not depressed).
 - b) Check diodes D1 through D4. Be sure that they are installed according to the polarity markings on the PC board.
 15. Put the receiver to your ear and gently tap the microphone. You should hear the tapping from the receiver. If you do not hear the tapping, then unplug the telephone cord from the modular jack and:
 - a) Check that the speaker wires are connected as shown in Figure 6-11.
 - b) Check that the microphone is connected as shown in Figure 6-9.
 - c) Check that transistors Q2 through Q5 are the proper type and that the emitter, base and collector leads are in the correct holes as shown in the assembly instructions.
 - d) Check the components just installed for bad solder joints and solder bridges.
 16. Have your instructor inspect the transmit-receive circuitry and verify the tests performed.
Instructor's Approval: _____
 17. Turn the power supply OFF. Disconnect the power supply and unplug the telephone cord from the modular jack. Leave the resistor. It will be used again for the dialer tests.
 18. To avoid breaking the speaker wires, unsolder them from the PC board (see Figure 6-11). Leave the wires connected to the speaker. They will be reconnected later.

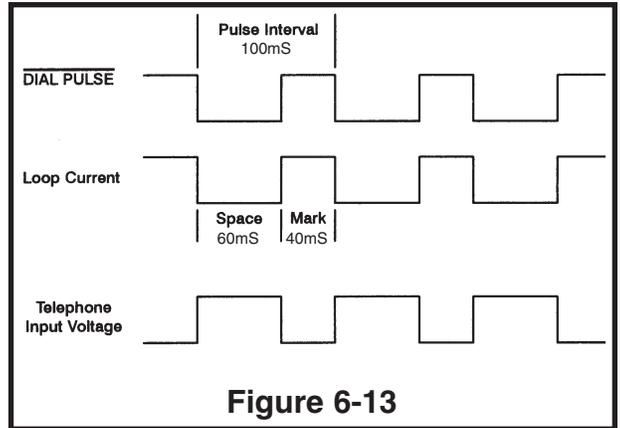
DIALER

Circuit Description - The main elements of the Dialer Section are the keyboard and the dialer IC HM9102. These two components perform all of the functions of the rotary dial found in older telephones.

The HM9102 is the tone/pulse switchable dialer with last number redial which is fabricated with CMOS technology. It has a wide operating voltage for both tone and pulse modes, and consumes very low memory retention current in the on-hook state.

As the schematic diagram shows, the keyboard is laid out as a 3 column by 4 row matrix. Each of the 12 keyboard buttons is located at the intersection of a row and column line. Pressing the button connects the row to the column line. Thus, pressing button 4 connects column 1 to row 2. **NOTE:** For this design of telephone, the keyboard assignment is as follows:

- a) Button "*" - In Tone Mode: Execute "*"
 - In Pulse Mode: Execute Pause
- b) Button "#" - In Tone Mode: Execute "#"
 - In Pulse Mode: Execute Redial



When the "#" button is pushed (only for pulse mode), the last number dialed is automatically redialed.

The functions of the dialer IC are as follows:

Power - The DC voltage at the Tip and Ring inputs is fed to the dialer IC via the diode bridge, the hook switch, resistor R14 and diode D5. Since excessive voltage may damage the IC, zener diode D7 limits the voltage to less than 4.7 volts. When the phone goes on hook, the charge on capacitor C3 provides the small current needed for the IC memory circuits to retain the last number dialed.

Dialing - The Central Office responds to two types of dialing signals, Pulse and Tone. In your phone, the IC turns transistor Q3 on or off to generate dial pulses. When the switch (S3) is in the Tone position - potential pin mode - GND and Dial will be for tone signals. When the switch (S3) in the the Pulse position - potential pin mode - VDD (4.7V) and Dial will be used for pulse signals.

Oscillator - The IC HM9102 has a built-in oscillator (clock) which is used for tone generation and other timing functions. Because the frequency of dialing tones must be precise for the Central Office to recognize them, a ceramic resonator (X) used to accurately control the frequency of the IC's oscillator. This oscillator's frequency is 3.58MHz, and it is divided down to lower frequencies inside the IC.

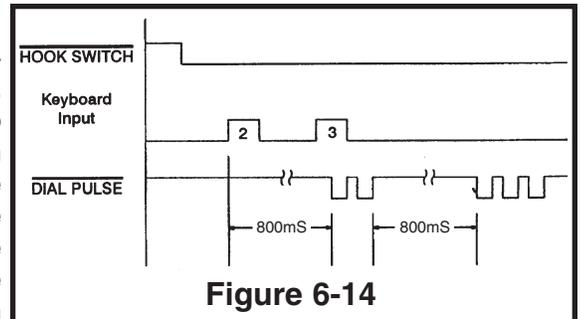
Hook Switch (HKS) - When the phone is off the hook, the HKS input of the IC is grounded through resistor R9. This enables the keyboard inputs, when the phone is on the hook, a small current flows through resistors R8 and R9, this biases the HKS input to about 2V which disables the keyboard inputs.

Mark/Space Select - This input selects the Mark to Space ratio. In this kit, the line is tied to ground, giving a Mark to Space ratio of 40% to 60%.

Keyboard Inputs - Keyboard inputs C1 through C3 and R1 through R4 accept the column and row inputs from the keyboard (see Figure 3-4). When a row and a column line are connected, the digit corresponding to that row and column stored in the IC memory. The dial pulses start when the first button is pushed. In a conventional rotary dial, the pulses are sent as the rotor returns to its null position. This may take about one second if a zero is dialed. The next digit is entered only when the preceding digit is transmitted. With the HM9102 dialer IC, scanning of the keyboard continues while the dial pulses are being transmitted as shown in Figure 6-14. When the number is dialed, a memory section in the IC is loaded with each digit as it is dialed. Later, if the redial button (#) is pressed, the IC automatically dials the digits you previously entered (for Pulse Mode). For Tone Mode, button (#) - execute "#".

The button "*" for Pulse Mode - execute pause (pause time 3.6s), for Tone Mode - execute "*".

Dialing Rate Select - For the IC HM9102, the Dialing Rate Select line is tied to ground, giving a dialing rate of 10 pulses per second or 20pps for pulse mode and tone for tone mode.



PC BOARD ASSEMBLY

Identify and install the following parts as shown in Figure 6-15. After soldering each part, place a check in the box provided.

<input type="checkbox"/> C8 - .02 μ F Discap (.02 or 203)
<input type="checkbox"/> C10 - 30pF Discap (30)
<input type="checkbox"/> X - Resonator 3.58MHz
<input type="checkbox"/> C11 - 30pF Discap (30)
<input type="checkbox"/> C3 - 47 μ F Lytic Capacitor (see Figure F)

<input type="checkbox"/> R13 - 3.3k Ω Resistor (orange-orange-red-gold)
<input type="checkbox"/> D5 - 1N4148 (see Figure E)
<input type="checkbox"/> R23 - 10k Ω Resistor (brown-black-orange-gold)
<input type="checkbox"/> R9 - 100k Ω Resistor (brown-black-yellow-gold)
<input type="checkbox"/> R22 - 15k Ω Resistor (brown-green-orange-gold)
<input type="checkbox"/> IC1 - IC Socket <input type="checkbox"/> IC1 - HM9102 IC (see Figure G)
<input type="checkbox"/> C2 - .01 μ F Discap (.01 or 103)
<input type="checkbox"/> R8 - 1M Ω Resistor (brown-black-green-gold)
<input type="checkbox"/> D6 - 1N4148 Diode (see Figure E)
<input type="checkbox"/> D7 - 4.7V Zener Diode (see Figure E)

Figure 6-15

Figure G

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.

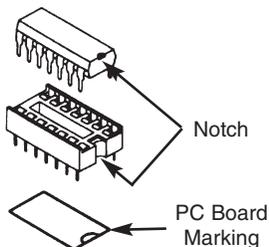


Figure H

Identify the pulse/tone switch as shown in Figure Ha. The pulse/tone switch is mounted on the copper side of the PC board. Insert the switch tabs into the holes provided and solder the three terminals as shown in Figure Hb. Be sure that the switch is perpendicular to the PC board.

To anchor the switch in place, grasp the switch tabs with your pliers and give a 1/8 turn as shown in Figure Hc.

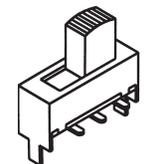


Figure Ha

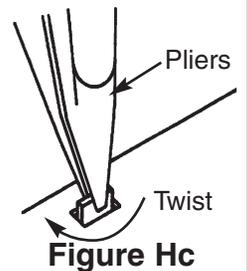


Figure Hc

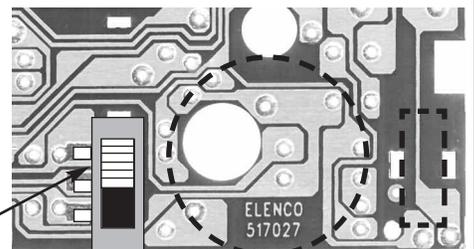


Figure Hb

KEYBOARD ASSEMBLY

- Insert the ribbon cable through the holes in the main PC board and solder as shown in Figure 6-16.
- Insert the ribbon cable through the holes in the keyboard PC board. Solder the ribbon cable to the keyboard's PC board as shown in Figure 6-16.
- Carefully inspect the ribbon cable solder joints. If there are many solder bridges between adjacent pads, remove them with your soldering iron.
- If not already in place, snap the dial buttons onto the contact pad as shown in Figure 6-17.

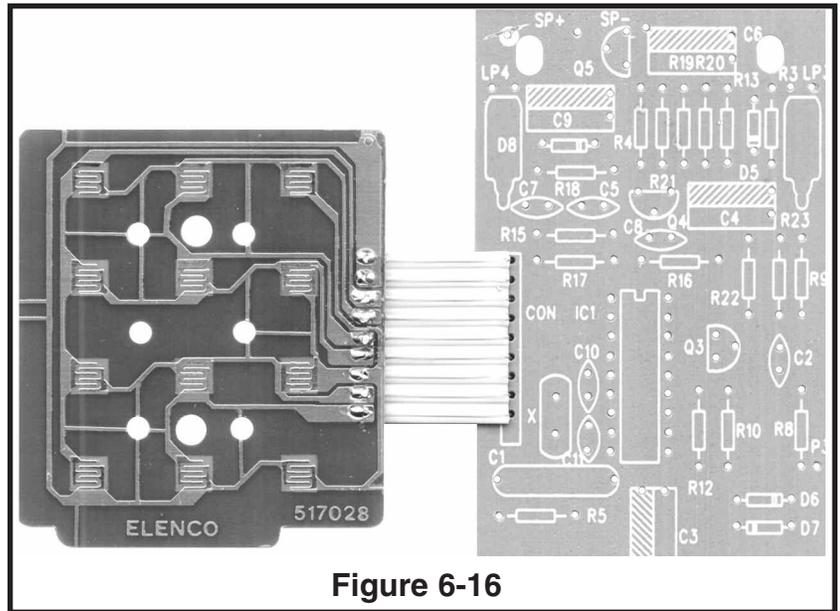


Figure 6-16

- Peel the backing off of the dial label and place it on the top case (make sure that the holes line up).
- Insert the buttons through the holes in the front plate (see Figure 6-18). BE SURE THAT THE "2" BUTTON IS IN THE HOLE MARKED "ABC".
- With the contact pad laying flat on the front side, insert the keyboard's PC board under the two upper restraining tabs. Push the lower restraining tab back and snap the PC board in place as shown in Figure 6-18. Fasten the PC board in place with the two 1/4 inch screws as shown in the Figure 6-18.

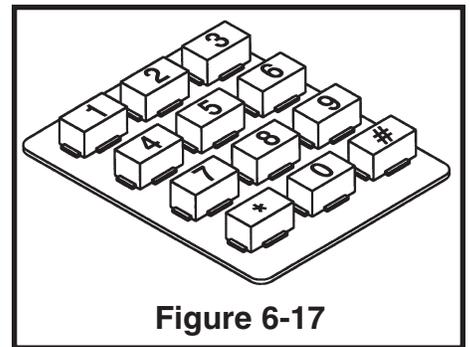


Figure 6-17

- Reconnect the speaker wires as shown in Figure 6-11.
- If your kit contains extra wires, please disregard them.
- Insert the hook button into the top case as shown below. **Note:** Check that there are no burrs on the sides of the button. It must move freely once installed.
- Cut the excess plastic off of the case as shown below. Make sure that the top of the middle post is level to or below the two outside posts.

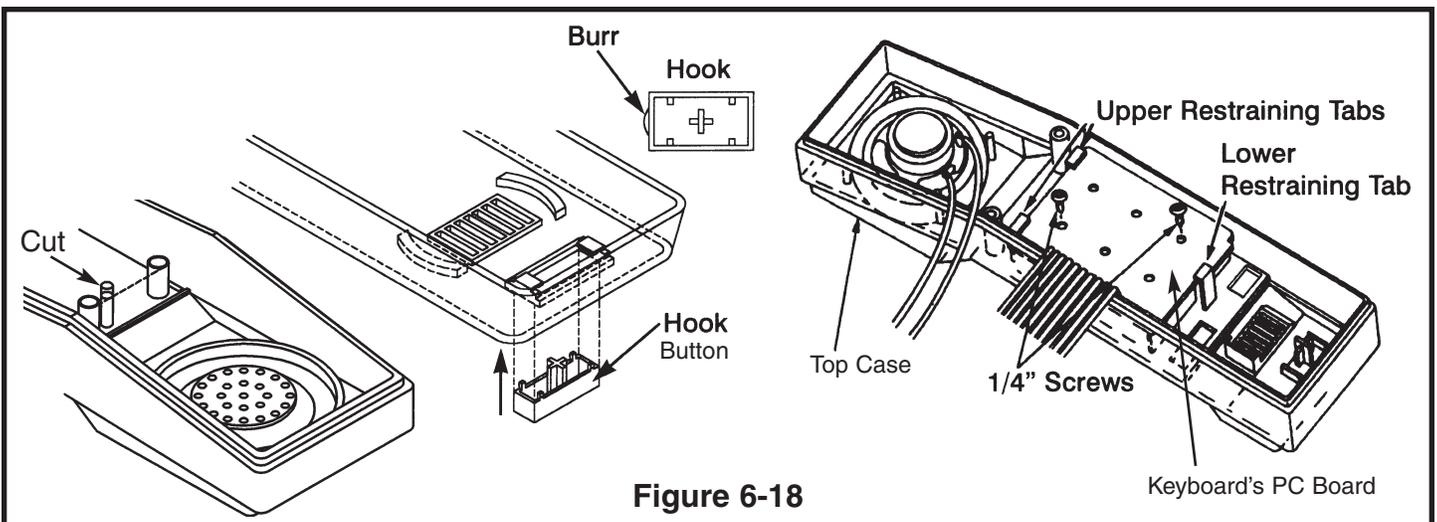


Figure 6-18

If you have a 48VDC power supply, skip to the Dialer Test on page 25.

DIALER TEST (Using a 9 volt battery)

1. Be sure that the telephone cord is connected to your modular jack. Be sure that the telephone is off the hook (hook switch not depressed).
2. Switch tone/pulse switch to the tone position.
3. Put the receiver to your ear and push the “1” button. You should hear a click. This is the result of the loop current being turned off and then back on.
4. Push the “2” button. You should hear a click.
5. Press each of the remaining numbered buttons including the “*” and “#” buttons to verify that each is operational.

If any of the above tests fail, then unplug the telephone cord from the modular jack and:

- a) Check that the keyboard buttons are seated properly on the contact pad.
 - b) Check the HM9102 IC. Be sure that it is installed with the alignment notch as shown in the assembly instructions.
 - c) Check that diodes D5, D6 and D7 are installed with the polarity markings as shown in the assembly instructions.
 - d) Check the ribbon cable for broken wires, check switch S3.
 - e) Check for bad solder connections and solder bridges. Look closely at the IC and the ribbon cable. The pads on these components are very close.
6. Switch the tone/pulse to the pulse position.
 7. Put the receiver to your ear and push the “1” button, you should hear a click. Push the “2” button, you should hear two clicks. Press each of the remaining numbered buttons (from “3” to “0”) to verify that each is operational.
 8. If any of the above tests fail, unplug the telephone cord and check switch S3 and the IC.
 9. Unplug the telephone cord from the modular jack and move on to the Final Assembly on page 26.

The automatic redial function doesn't work for test using 9 volt battery.

DIALER TEST (Using a power supply)

1. With the power supply OFF, reconnect the test circuit as shown in Figure 6-12. Position the PC board so that the hook switch is not depressed (off hook).
2. Set the voltmeter to read 48VDC. Turn the power supply ON and adjust it for 48VDC on the meter.
3. Switch tone/pulse switch to the tone position.
4. Put the receiver to your ear and push the "1" button. You should hear a click. This is the result of the loop current being turned off and then back on.
5. Push the "2" button. You should hear a click.
6. Press each of the remaining numbered buttons including the "*" and "#" buttons to verify that each is operational.

The automatic redial function doesn't work for the tone position of tone/pulse switch.

If any of the above tests fail, then unplug the telephone cord from the modular jack and:

- a) Check that the keyboard buttons are seated properly on the contact pad.
 - b) Check the HM9102 IC. Be sure that it is installed with the alignment notch as shown in the assembly instructions.
 - c) Check that diodes D5, D6 and D7 are installed with the polarity markings as shown in the assembly instructions.
 - d) Check the ribbon cable for broken wires, check switch S3.
 - e) Check for bad solder connections and solder bridges. Look closely at the IC and the ribbon cable. The pads on these components are very close.
7. Switch the tone/pulse switch to the pulse position.
 8. Put the receiver to your ear and push the "1" button, you should hear a click.
 9. Push the "2" button, you should hear two clicks.
 10. Press each of the remaining numbered buttons (from "3" to "0") to verify that each is operational.
 11. Press the redial button. You should hear nothing. The phone must go on hook before the number will be redialed.
 12. Press and release the hook switch. Now press the redial button. You should hear the numbers you pressed in steps 8, 9 and 10 being dialed.

If any of the above tests fail, unplug the telephone cord and check switch S3 and the IC.

13. Have your instructor inspect the dialer circuitry and verify tests performed.

Instructor's approval: _____

14. Turn the power supply OFF. Disconnect the power supply and unplug the telephone cord from the modular jack. Leave the resistor. It will be used again for the final tests.

FINAL ASSEMBLY

- ❑ See Figure 6-19. Place the PC board on the top case so that the ringer switch is in the ringer switch hole, the tone/pulse switch is in the tone/pulse hole and the two mounting holes on the PC board line up with the mounting posts on the top case. If the PC board does not stay lined up with the two mounting posts, insert one or both of the 5/8" screws to keep it in place. Check the following:
 - a) Be sure that the speaker wires do not lay between the speaker and the telephone top case.
 - b) Be sure that the keyboard ribbon cable is in the notch in the side of the PC board and does not extend out over the edge of the top case.
 - c) **Make sure that no leads from the PC board touch the 1/4" screws mounting the keypad.**
 - d) Be sure that the keyboard PC board does not hit the buzzer.
- ❑ Loop the telephone cord through the strain relief tabs on the bottom case as shown in the Figure 6-19.
- ❑ Place the bottom case over the top case. Be sure that the telephone cord is in the notch at the base of the bottom case. Snap the bottom case in place and secure it with two 5/8" screws as shown in Figure 6-19.
- ❑ The telephone number label with its cover mounts over the two 5/8" screws. Insert the tabs at each end of the label into the slots along side the screws.

If you are doing the testing with a 9V battery, skip to Section 7 now.

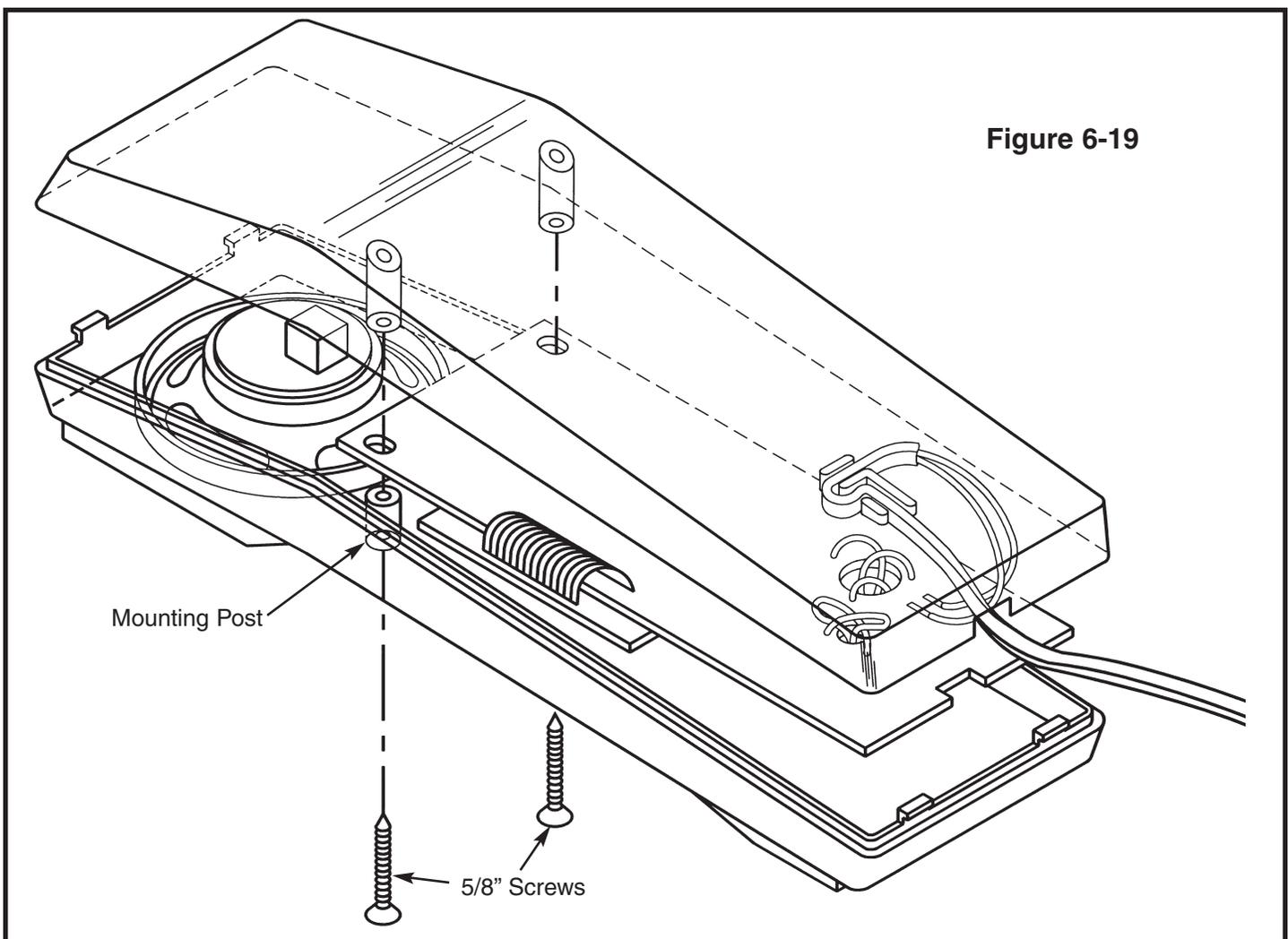


Figure 6-19

FINAL TESTS (Using a 48VDC power supply)

Test Equipment Needed (not provided):

- 48VDC power supply
- Variac (only for ringer test)
- 1k Ω 5W resistor
- Isolation transformer (only for ringer test)
- 48VDC voltmeter
- Oscilloscope (only for voice test)
- 50VAC voltmeter (only for the ringer test)

Perform the following tests and record the readings obtained in the space provided.

DC TEST - Refer to Figure 6-20 for the DC test configuration. The oscilloscope is not used for the DC test.

1. Turn the power supply OFF. Connect the 48VDC power supply, 1k Ω resistor, modular jack, and the telephone as shown in Figure 6-20.
2. Set the ringer switch to ON and position the telephone so that it is off hook (hook switch not depressed).
3. Set the voltmeter to read 48VDC and connect it as shown in Figure 6-20.
4. Turn the power supply ON and adjust it for a reading of 48VDC on the voltmeter.

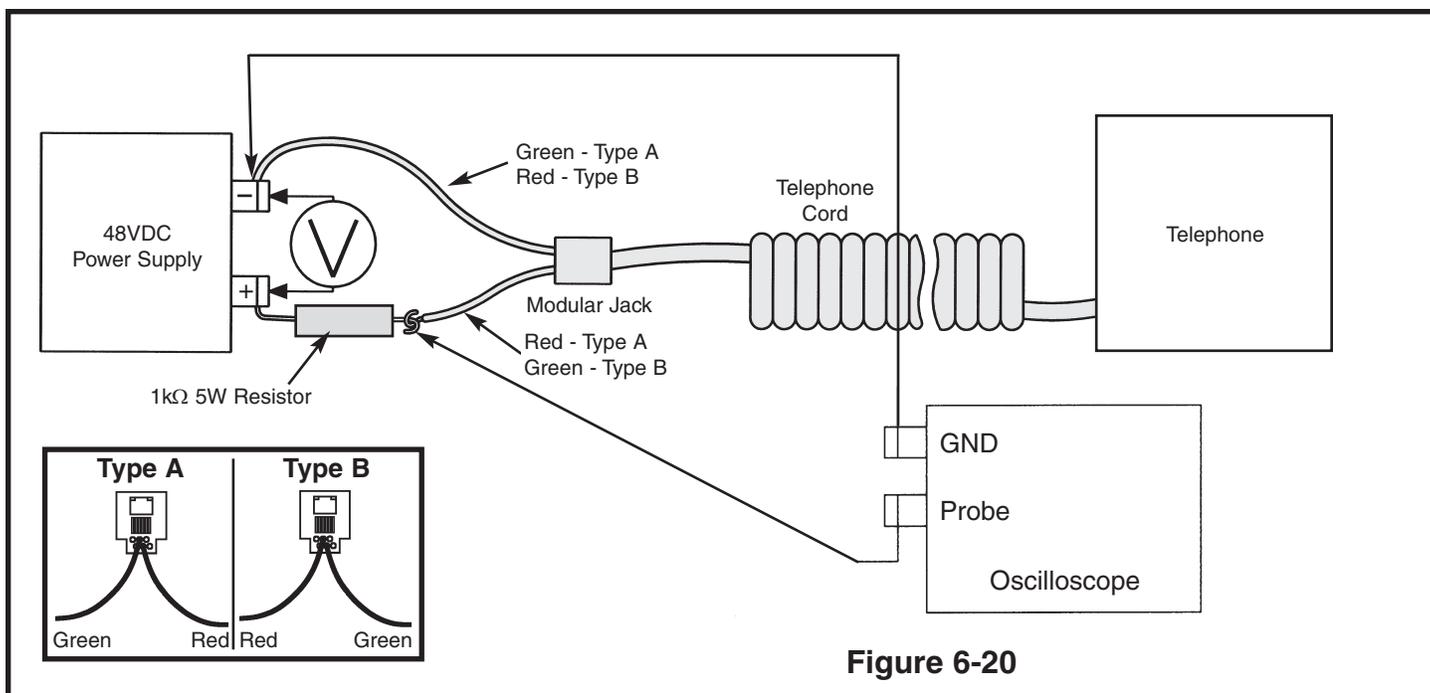


Figure 6-20

5. To measure the input voltage to the telephone, connect the negative voltmeter lead to the negative (-) power supply terminal and the positive voltmeter lead to point "C". The voltage should be between 5 and 12.5VDC. Input Voltage: _____
6. To measure the input current to the telephone, measure the voltage across the 1k Ω resistor. Connect the negative voltmeter lead to point "C" and the positive voltmeter lead to the positive (+) power supply terminal. The voltage should be between 35 and 45VDC. This indicates that the current drawn by the telephone is between 35 and 45mA. Resistor voltage: _____
7. Turn the power supply OFF. Disconnect the voltmeter. Disconnect the 1k Ω resistor and the red wire from the power supply terminals.
8. To reverse the voltage polarity to the telephone, connect the free end of the 1k Ω resistor to the negative power supply terminal and the red wire from the modular jack to the positive power supply terminal.
9. To set the power supply voltage, connect the positive voltmeter lead to the positive power supply terminal and the negative voltmeter lead to the negative power supply terminal. Turn the power supply ON and adjust it for 48VDC on the voltmeter.

10. To measure the input voltage to the telephone, connect the positive voltmeter lead to the negative terminal of the power supply and the negative voltmeter lead to point C. The voltage reading should be between 5 and 12.5VDC. Input Voltage: _____
11. To measure the input current to the telephone, measure the current in the 1kΩ resistor. Connect the positive voltmeter lead to point “C” and the negative voltmeter lead to the negative power supply terminal. The voltage reading should be between 35 and 45VDC. Resistor voltage: _____
12. Have your instructor verify the DC tests just performed.

Instructor's Approval: _____

VOICE TEST - Refer to Figure 6-20 for the voice test configuration.

1. Turn the power supply OFF. Connect the components, including the oscilloscope, as shown in the Figure 6-20.
2. Set the Ringer switch to ON and position the telephone so that it is off hook (hook switch not depressed). Set the tone/pulse switch to the pulse position.
3. Set the voltmeter to read 48VDC. Turn the power supply ON and adjust it for a reading of 48VDC on the voltmeter.
4. Set the oscilloscope as follows:

Coupling	AC
Sweep	10mS / Division
Sensitivity	0.1V / Division
6. Speak into the microphone in a normal voice. The peak-to-peak amplitude of the voice signal on the oscilloscope should be between .2 and .5V. Voice signal amplitude: _____
7. Set the oscilloscope as follows:

Coupling	DC
Sweep	50mS / Division
Sensitivity	10V / Division
8. Press the 8 button and sync the oscilloscope on the positive transition of the input signal. You should see the telephone input voltage waveform shown in Figure 6-14. The peak-to-peak amplitude should be 35V minimum. Input voltage amplitude: _____
9. Have your instructor verify the Voice Tests just performed.

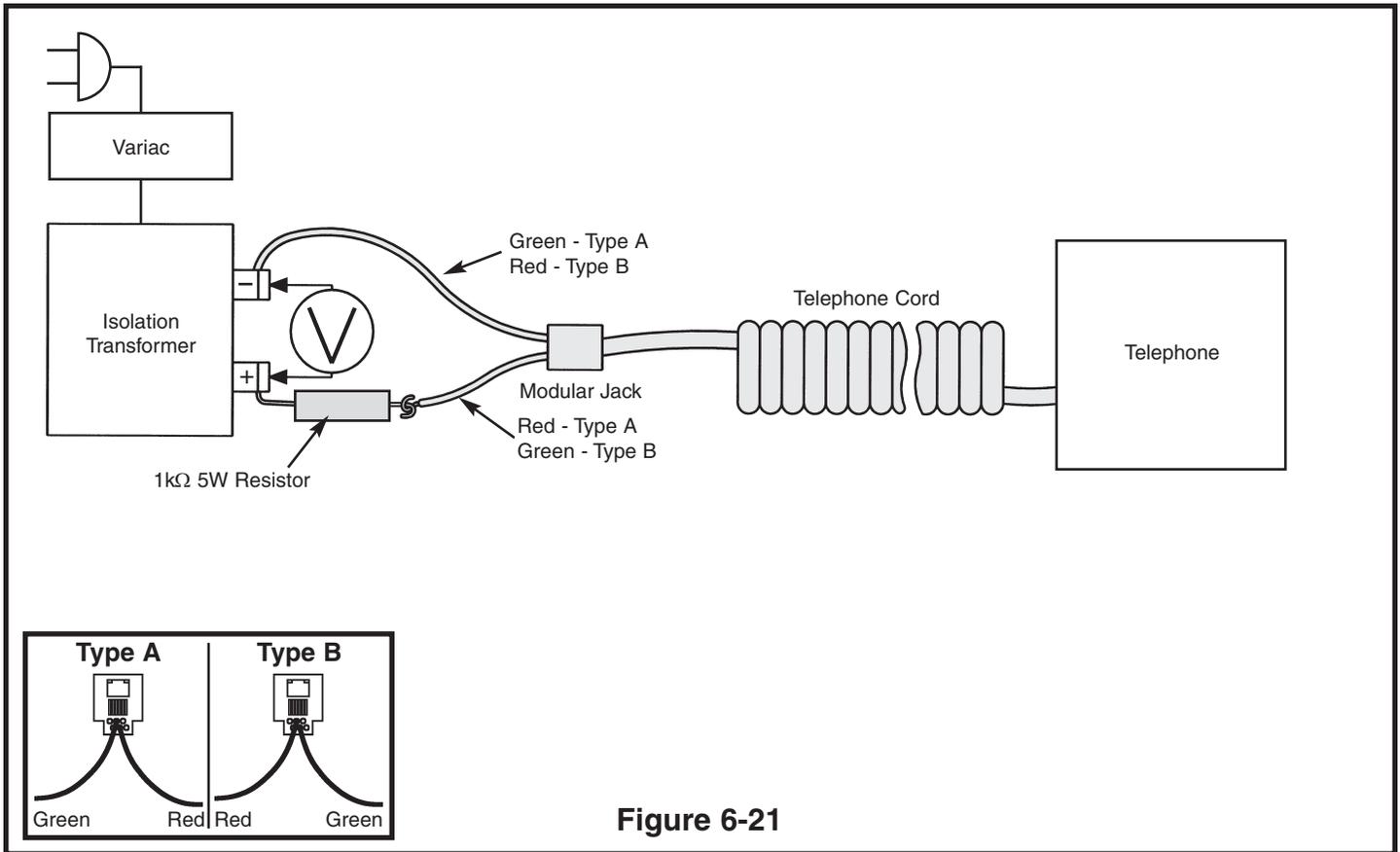
Instructor's Approval: _____

10. Turn the power supply OFF.

RINGER TEST - Refer to Figure 6-21 for the ringer test configuration.

1. Set the variac to 0 and connect the variac, isolation transformer, 1kΩ resistor, modular jack, and voltmeter as shown in the Figure 6-21. Do not connect the telephone cord.

- Set the voltmeter to read 50VAC. Put the variac ON and adjust it to obtain 50VAC on the voltmeter.
- Put the ringer switch ON. Plug in the telephone cord and position the telephone so that it is on hook (hook switch depressed). You should hear a steady ringing from the telephone.



- Take the variac OFF.
- To measure the AC voltage across the $1k\Omega$ resistor, move the voltmeter lead from the red wire of the modular jack to point "C". Put the variac ON. The voltage should be between 2 and 5VAC. This indicates that the AC current drawn by the telephone is between 2 and 5mA. AC resistor voltage: _____
- Take the variac OFF.
- Have your instructor verify the ringer test just performed.

Instructor's approval: _____

If any of the above tests should fail:

- Check for broken wires on the keyboard, speaker, buzzer, hook switch, and telephone cord.
- Check that the hook switch is seated properly against the switch button and that it operates freely.
- Recheck the PC board for bad solder joints and solder bridges.
- Recheck the PC board components. Be sure that all resistor and capacitor values are correct according to the assembly instructions. Be sure that each transistor is the proper type and is installed properly.

Disconnect the test setup.

SECTION 7 - INSTALLING THE TELEPHONE

Mounting the Cradle

- Select a convenient place for your phone. Place the telephone cradle against the wall and mark the center of the upper lobes of the two mounting holes as shown in Figure 7-1.
- Screw in the two mounting screws (not provided) to about 1/4" of the mounting surface. Slide the cradle over the two screws and then tighten the screws. The phone and cradle are very light. However, if you are mounting the cradle on drywall, you should use drywall screws. Drywall screws are available at most hardware stores.

Connecting the Telephone

The procedure for connecting the telephone to the telephone service line depends on the present termination of your line. If your line terminates in a modular jack, you need to only plug in the telephone cord and the installation is complete. Modular jacks may be recognized by the distinctive shape of the outlet as shown in Figure 7-2.

Connecting to a Hard Wired Jack

If your telephone service wiring terminates in an old type hard wired jack, you may either 1) replace it with a modular jack if your telephone is to be installed in the same place, or 2) install a modular jack in a new location and connect it to the hard wired jack with a length of 4 conductor telephone wire. Modular jacks are available in most stores where telephones are sold.

To replace the old type jack:

- Loosen the screw from the green wire and remove the wire.
- Loosen each of the remaining screws and remove the wires.
- Unscrew the mounting screws and remove the base of the old jack.

Refer to Figure 7-3 to install the modular jack. Your jack may look somewhat different, but it should have the red, green, yellow and black wires and the four marked screws. The cover may snap or screw onto the base.

- Screw the modular jack to the wall. As with the cradle, if you are mounting on drywall, use drywall screws.
- If the telephone service wires are not already stripped and bent, strip 1/2" of insulation off of each wire and bend the stripped portion into a "U".
- Loop the green wire around the "G" screw between the washer and the head of the screw. The loop should be in a clockwise direction. Insert the spade lug of the green wire from the modular connector under the washer and tighten the screw.
- Connect the red wire to the "R" screw in the same way.

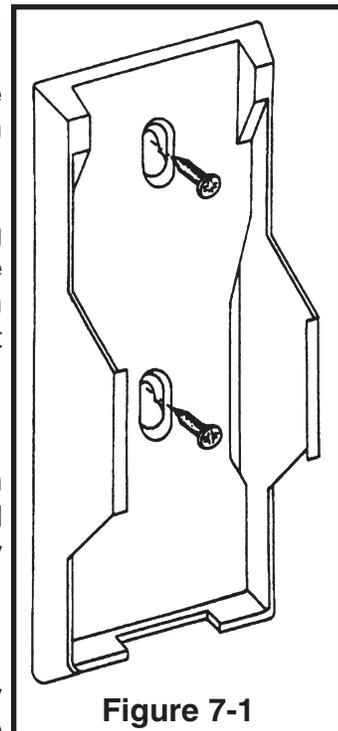


Figure 7-1

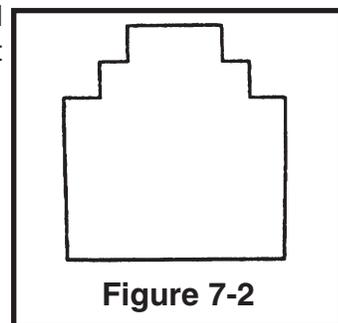


Figure 7-2

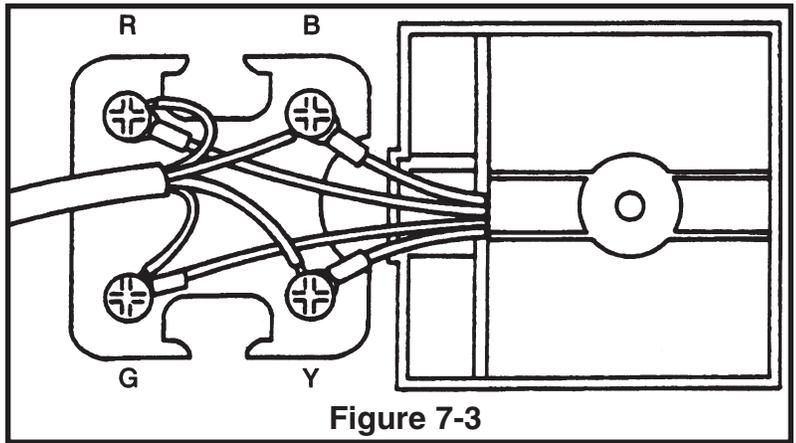
- If present, connect the black and yellow wires in the same way. If these are missing, merely connect the black and yellow spade lugs to the “B” and “Y” screws. This will keep them from shorting to the other wires.

- Place the modular jack cover on the base.

- Plug in the telephone line cord.

To locate the modular jack in the new location:

- Obtain the proper length of 4 wire telephone cable.



- Install the modular jack as shown in Figure 7-3 using the 4 wire telephone cable in place of the telephone service wires.

- Run the 4 wire telephone cable to the old type hard wired jack.

- Strip 1/2” of insulation off of the green telephone cable wire and bend the stripped portion into a “U”.

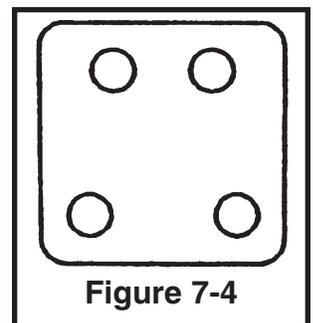
- Loosen the screw holding the green telephone service wire. Connect the two green wires and tighten the screw.

- Fasten the red telephone service wire to the red telephone cable wire in the same way.

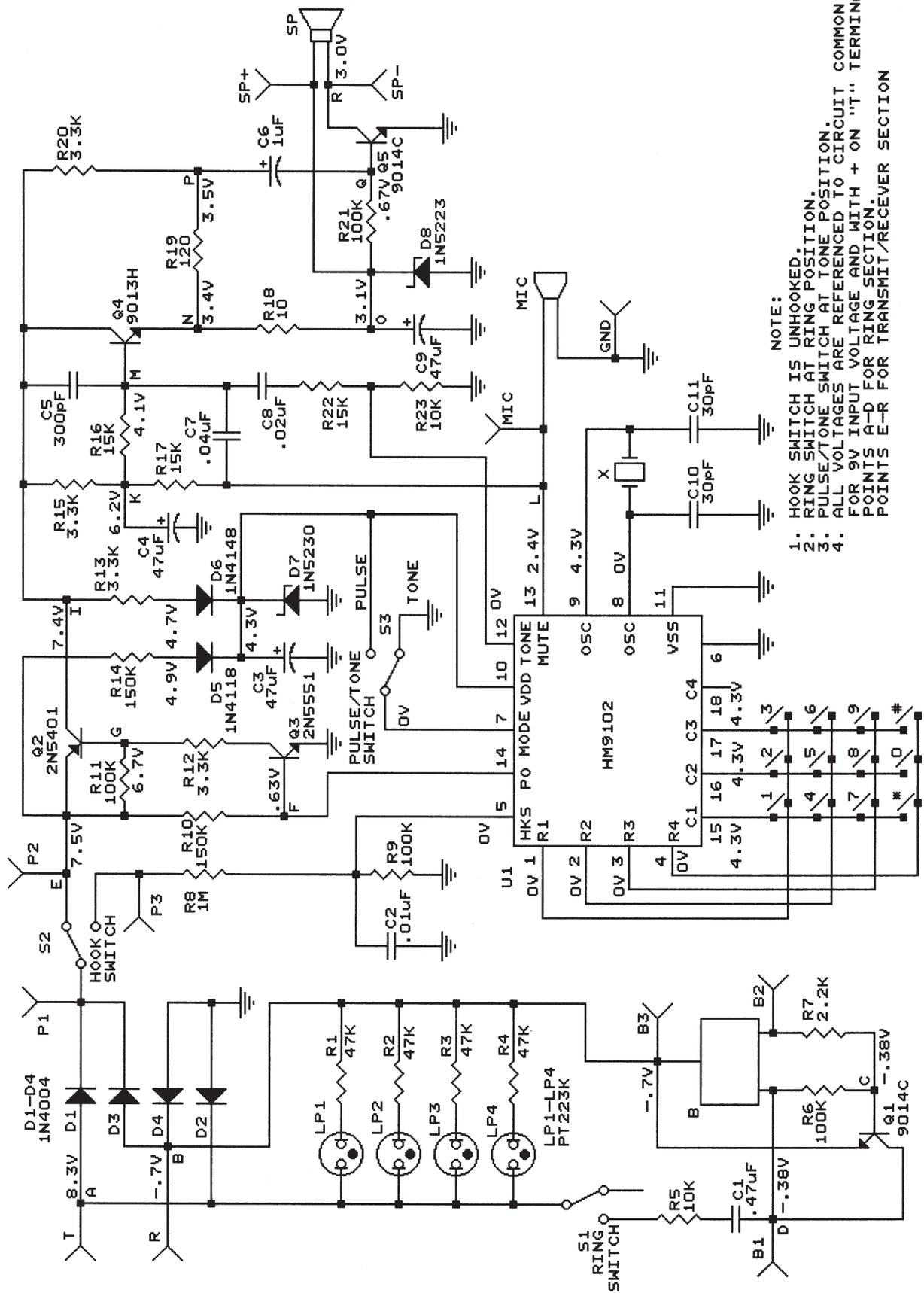
- Fasten the remaining wires in the same way. If the black or yellow telephone service wires are missing, fasten the telephone cable wire to the empty screw to keep it from shorting to the other wires.

Connecting to Old Four Connector Jacks

If your telephone service wiring terminates in a four connector jack as shown in Figure 7-4, you may replace this jack in a manner similar to replacing the hard wired jack. Be sure that the green telephone service wire is connected to the red modular jack wire and the red telephone service wire to the green modular jack wire. You may instead purchase an adapter which converts the old four connector jack to a modular jack. The USOC (Universal Service Order Code) for this adapter is RJA1X.



SCHEMATIC DIAGRAM



NOTE:
 1. HOOK SWITCH IS UNHOOKED.
 2. RING SWITCH AT RING POSITION.
 3. PULSE/TONE SWITCH AT TONE POSITION.
 4. ALL VOLTAGES ARE REFERENCED TO CIRCUIT COMMON.
 FOR 9V INPUT VOLTAGE AND WITH + ON "T" TERMINAL.
 POINTS A-D FOR RING SECTION.
 POINTS E-R FOR TRANSMIT/RECEIVER SECTION

QUIZ

Mark the box next to the letter with the correct answer. Answers on next page.

- 1) The ringer in the traditional rotary dial telephone utilizes . . .
 - A. a speaker and microphone.
 - B. a permanent magnet and armature.
 - C. a liquid crystal display.
 - D. a piezoelectric buzzer.
- 2) The ringer circuits are connected . . .
 - A. directly to the dialer IC.
 - B. between the tip and ring outputs.
 - C. to the speaker input.
 - D. between the microphone and ground.
- 3) When the ringer switch is off, . . .
 - A. the 20Hz ringing signal is converted to DC.
 - B. the 20Hz ringing signal is converted to 3kHz.
 - C. the buzzer is disabled.
 - D. none of the above.
- 4) In the traditional rotary dial telephone, the transmitter consists of . . .
 - A. a speaker similar to those found in your radio and TV.
 - B. a piezoelectric buzzer.
 - C. a case filled with carbon granules.
 - D. an electret microphone.
- 5) In the traditional rotary dial telephone, the receiver consists of . . .
 - A. a speaker similar to those found in your radio and TV.
 - B. an integrated circuit.
 - C. an FET amplifier.
 - D. an electret microphone.
- 6) Sidetone is . . .
 - A. the frequency band on either side of the voice signal.
 - B. the tone a caller hears when the number called does not exist.
 - C. the tone a caller hears when the number called is ringing.
 - D. the tone a speaker hears from the receiver when he speaks into the transmitter.
- 7) The bridge rectifier D1 through D4 . . .
 - A. rectifies the 3kHz buzzer signal.
 - B. reverses the polarity of the 48VDC input.
 - C. insures that a positive voltage is fed to the telephone circuit regardless of the input polarity.
 - D. none of the above.
- 8) In a tone dialer . . .
 - A. the number of tones sent correspond to the digit being dialed.
 - B. each digit corresponds to a different frequency tone.
 - C. the amplitude of the tone corresponds to the digit being dialed.
 - D. none of the above.
- 9) Pressing the “*” button . . .
 - A. executes pause (pulse mode).
 - B. redials the last number dialed.
 - C. resets the dialer IC.
 - D. disables the ringer.
- 10) Pressing the “#” button . . .
 - A. disables the microphone.
 - B. redials the last number dialed (pulse mode).
 - C. resets the dialer IC.
 - D. disables the ringer.

GLOSSARY

DTMF	Dual Tone Multifrequency.
Electret Microphone	A microphone made up of a capacitor with a dielectric that holds a permanent electric charge.
FET	Field Effect Transistor.
Hook Switch	A switch inside the telephone which closes when the receiver is lifted.
IC	Integrated Circuit.
FCC	Federal Communications Commission.
Local Loop	The pair of wires between a telephone set and the telephone company Central Office.
Mark Interval	The portion of a dial pulse during which loop current is flowing.
Pulse Dialing	A dialing system in which the number of pulses on the local loop represents the number dialed.
Ring Wire	The red (negative) wire of the local loop.
Sidetone	The sound heard from the telephone receiver due to the speaker's own voice.
Space Interval	The portion of the dial pulse during which current is not flowing.
Tip Wire	The green (positive) wire of the local loop.
Tone Dialing	A dialing system in which a combination of two frequencies on the local loop represent the number dialed.
USOC	Universal Service Order Code.
Zener Diode	A diode that has nearly constant voltage drop over a wide range of reverse current.

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

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