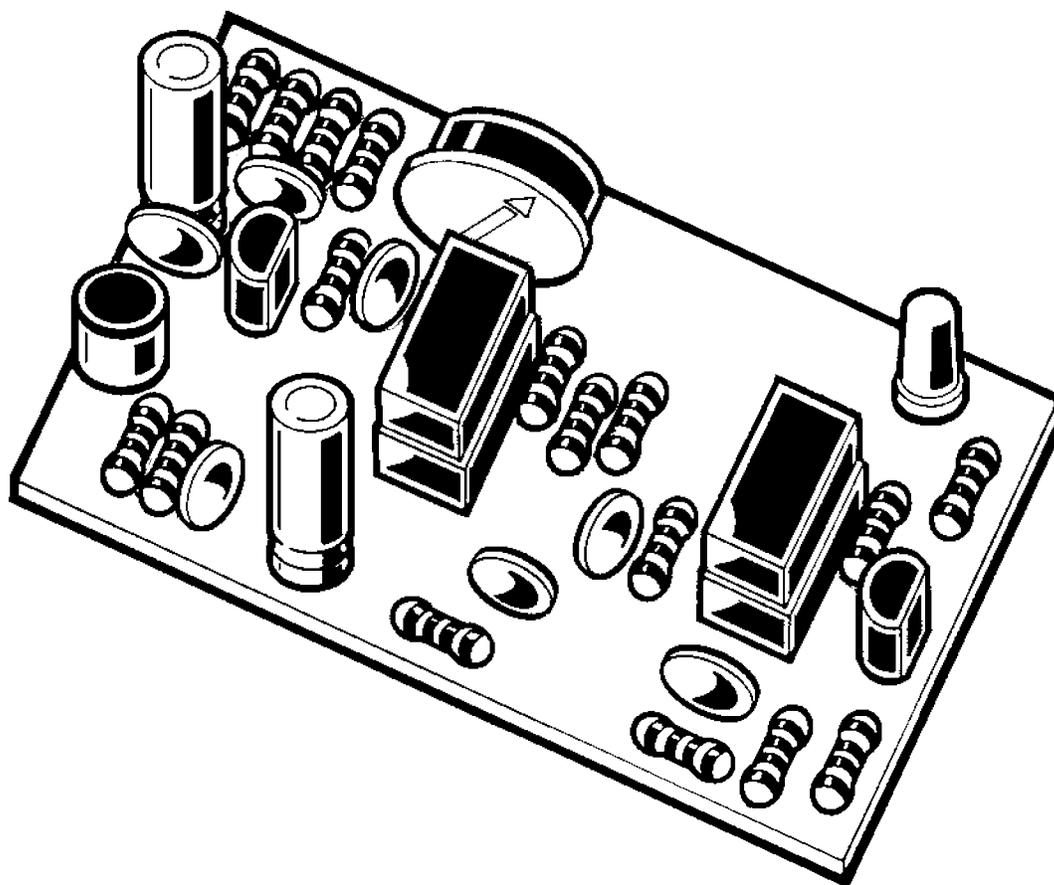


# SOUND ACTIVATED SWITCH KIT

MODEL K-36



7 56619 00028 2



Assembly and Instruction Manual

## PARTS LIST

If any parts are missing or damaged, see instructor or bookstore. **DO NOT** contact your place of purchase as they will not be able to help you.

Contact Elenco Electronics (address/phone/e-mail is at the back of this manual) for additional assistance, if needed.

### RESISTORS

Qty.	Symbol	Value	Color Code	Part #
□ 1	R17	4.7kΩ 5% 1/4W	yellow-violet-red-gold	144700
□ 3	R1, R5, R16	10kΩ 5% 1/4W	brown-black-orange-gold	151000
□ 1	R3	22kΩ 5% 1/4W	red-red-orange-gold	152200
□ 4	R4, R10, R12, R14	100kΩ 5% 1/4W	brown-black-yellow-gold	161000
□ 4	R2, R6, R9, R13	220kΩ 5% 1/4W	red-red-yellow-gold	162200
□ 1	R7	270kΩ 5% 1/4W	red-violet-yellow-gold	162700
□ 1	R15	330kΩ 5% 1/4W	orange-orange-yellow-gold	163300
□ 1	R11	1MΩ 5% 1/4W	brown-black-green-gold	171000
□ 1	R8	4.7MΩ 5% 1/4W	yellow-violet-green-gold	174700
□ 1	P1	100kΩ Trim Pot		191611

### CAPACITORS

Qty.	Symbol	Value	Description	Part #
□ 4	C5, C6, C8, C9	.001μF (102)	Discap	231036
□ 2	C1, C3	.01μF (103)	Discap	241031
□ 2	C2, C4	.1μF (104)	Discap	251010
□ 1	C7	1μF	Electrolytic (Lytic)	261047
□ 1	C10	100μF	Electrolytic (Lytic)	281044

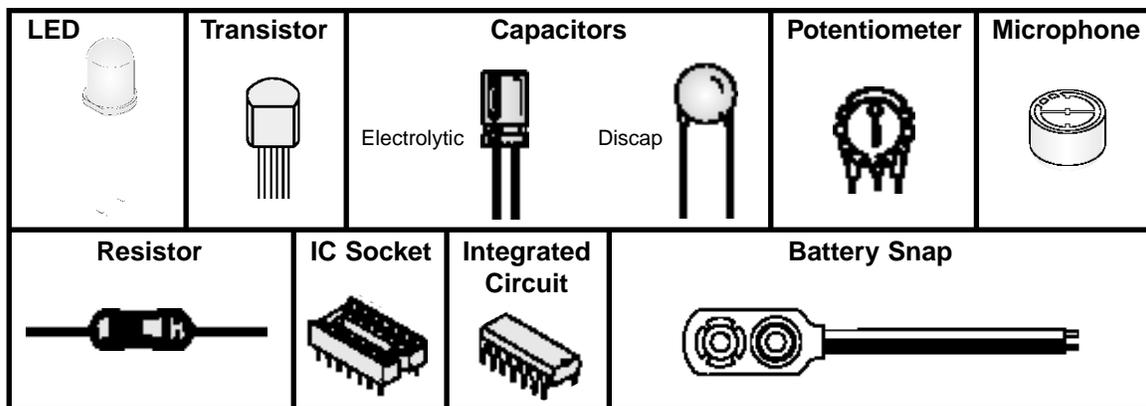
### SEMICONDUCTORS

Qty.	Symbol	Value	Description	Part #
□ 1	Q1	2N3904	Transistor	323904
□ 1	Q2	MPS6531	Transistor	326531
□ 1	U2	4001	Integrated Circuit	334001
□ 1	U1	4011	Integrated Circuit	334011
□ 1	LED		LED Red	350002

### MISCELLANEOUS

Qty.	Symbol	Description	Part #
□ 1		PC Board	518036
□ 1		Solder	551124
□ 1	MIC	Microphone	568000
□ 1		Battery Snap 9V	590098
□ 2		IC Socket 14-pin	664014

## PARTS IDENTIFICATION



## IDENTIFYING RESISTOR VALUES

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



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

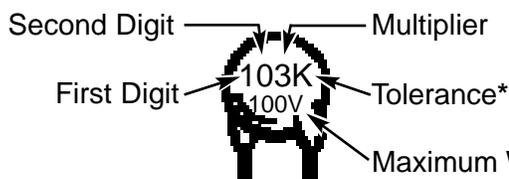
BAND 2 2nd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

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

Resistance Tolerance	
Color	Tolerance
Silver	+10%
Gold	+5%
Brown	+1%
Red	+2%
Orange	+3%
Green	+5%
Blue	+20%
Violet	±1%

## IDENTIFYING CAPACITOR VALUES

Capacitors will be identified by their capacitance value in pF (picofarads), nF (nanofarads), or  $\mu$ 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.



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

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



**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  $\pm 20\%$   
 The letter K indicates a tolerance of  $\pm 10\%$   
 The letter J indicates a tolerance of  $\pm 5\%$

## INTRODUCTION

Just clap your hands together twice and watch the Sound Activated Switch turn on the light emitting diode (LED). Clap twice more and watch the LED turn off.

## THEORY OF OPERATION

Figure 1 shows the block diagram of the Sound Activated Switch. It consists of a transistor amplifier, a transistor switch and two types of digital circuits, a one-shot and a flip-flop.

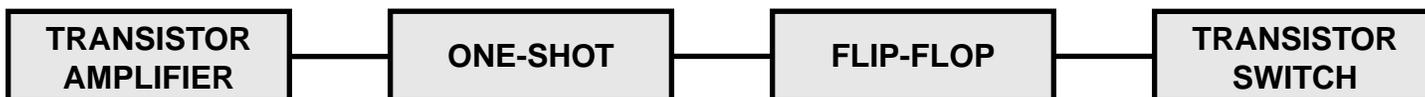


Figure 1

## THE TRANSISTOR AMPLIFIER

A waveform is created when hands are clapped together. The MIC senses this waveform and couples it to the base of Q1 by capacitor C1 (refer to schematic diagram). The transistor is configured as a common emitter amplifier since the AC signal is bypassed to ground by capacitor C2. The transistor amplifier is set for a gain of 50, so the waveform is amplified 50 times. Capacitor C3 couples the amplified waveform to the input of the first digital circuit.

## SENSITIVITY

The potentiometer, P1, adjusts the sensitivity of the Sound Activated Switch. Varying the resistance of P1 will vary the DC voltage at the input of the first one-shot. Rotating P1 counter-clockwise causes the voltage at the input of the first one-shot to increase. This means that a louder clap is required to activate the first one-shot, making the Sound Activated Switch less sensitive to sound. Likewise, rotating P1 clockwise causes the voltage at the input of the first one-shot to decrease, making the Sound Activated Switch more sensitive to sound.

## THE ONE-SHOT

A one-shot, or monostable multivibrator, is a circuit that, once triggered, will switch its output logic level. The output will remain at this new logic level for a predetermined period of time, after which the output will switch back to its previous logic state.

The 4011 IC is a quad 2 input CMOS NAND gate. There are two separate one shots, each using 2 NAND gates. Both one-shots are configured in such a way that the normal steady state output is equal to a high voltage, or logic 1.

When the first one-shot is idle, waiting to be triggered, the capacitor C4 is completely discharged. When the input at pin 1 goes low, due to the waveform from C3, the capacitor C4 begins to charge. The output of the one-shot changes from a high voltage, logic 1, to a low voltage, logic 0. The output will remain at a logic 0 until the capacitor C4 charges through resistor R8. The time the first one-shot remains at a logic 0 is approximately .25 seconds. After the capacitor C4 charges, the output of the one-shot switches back to a logic 1.

When the first one-shot's output switches back to a logic 1, the second one-shot is triggered, causing capacitor C7 to charge. The second one-shot will remain at a logic 0 for approximately .7 seconds. Now, if the first one-shot is triggered again by another clap within .7 seconds, both one-shot outputs will be at logic 0. The outputs of both one-shots are connected to the input pins of a NOR gate. When both inputs of NOR gate U2A are at a logic 0, the output will be at a logic 1. This output pulse is then coupled to the input of the flip-flop.

## THE FLIP-FLOP

A flip-flop, or a bistable multivibrator, is a circuit whose output logic level changes when a pulse is applied to the input. The output will remain at its logic state until the next pulse is applied. The only two possible output states for a flip-flop are a logic 1 and a logic 0.

The 4001 IC is a quad 2 input CMOS NOR gate. The first NOR gate is used as its primary purpose, a NOR gate. The next two NOR gates are configured as a flip-flop.

When pin 4 is at logic 1, or 9 volts, pin 10 will be at a logic 0. The voltage divider of R15 and R14 sets pin 6 at approximately 2 volts. The voltage needed at the input of the NOR gates to switch the outputs from one state to the other is between 4.5 and 5.5 volts. It can be seen that the voltage at pin 6, when pin 4 is at logic 1, is biased at less than the trigger voltage. Capacitor C9 couples the output pulse from the first NOR gate to the input of pin 6. The pulse is now "riding" on the DC level at pin 6. The peak of the pulse is now high enough in amplitude to reach the trigger level of the flip-flop. The flip-flop will now trigger causing its output logic state to change.

When pin 4 is at a logic 0, pin 10 will be at a logic 1. The trigger pulse is then coupled into pin 8 through capacitor C8 to change the output state of the flip-flop.

The last NOR gate is used as an inverting buffer to separate the input of the transistor switch from the output of the flip-flop.

## THE TRANSISTOR SWITCH

When a transistor is biased on by a high base current, its collector to emitter saturation voltage is very low making the transistor look like a closed switch. When a transistor is off, no base current, the collector to emitter current is very low making the transistor look like an open switch.

Resistor R16 sets the current through the base of Q2 at about 1 milliamp when pin 11 of the 4001 is at a logic 1. This base current turns on Q2 causing current to flow through the LED and R17. When current flows through an LED, it will emit light. R17 is used to limit the current flow through the LED so that the LED is not damaged.

Although not included in the kit, a relay can be connected to the two points indicated on the PC board. When the LED is turned on, the relay will pick. The relay could then be used to power up other electronic circuits. If using a relay, we recommend using a 7 to 9 volt with a coil resistance of 500 ohms or greater.

# CONSTRUCTION

## Introduction

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

## Safety Procedures

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

## Assemble Components

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

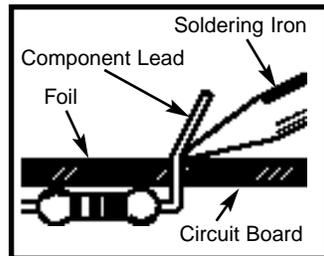
**Use only rosin core solder of 63/37 alloy.**

**DO NOT USE ACID CORE SOLDER!**

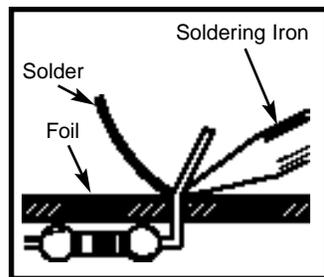
## What Good Soldering Looks Like

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

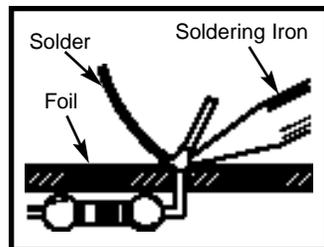
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.



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



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

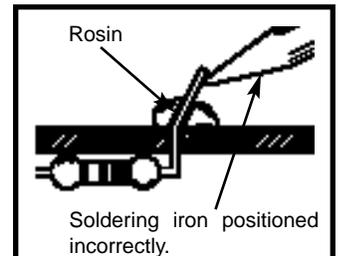


4. Here is what a good solder connection looks like.

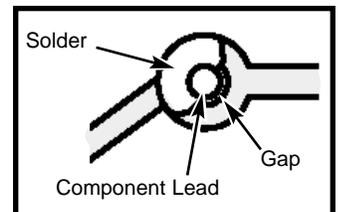


## Types of Poor Soldering Connections

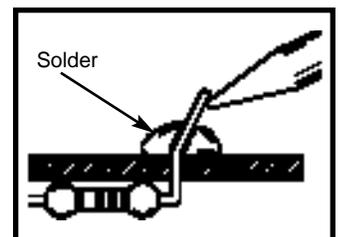
1. **Insufficient heat** - the solder will not flow onto the lead as shown.



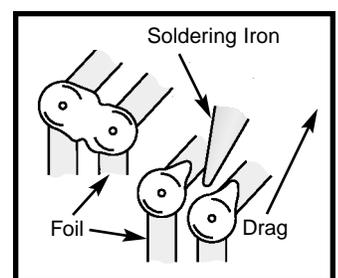
2. **Insufficient solder** - let the solder flow over the connection until it is covered. Use just enough solder to cover the connection.



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

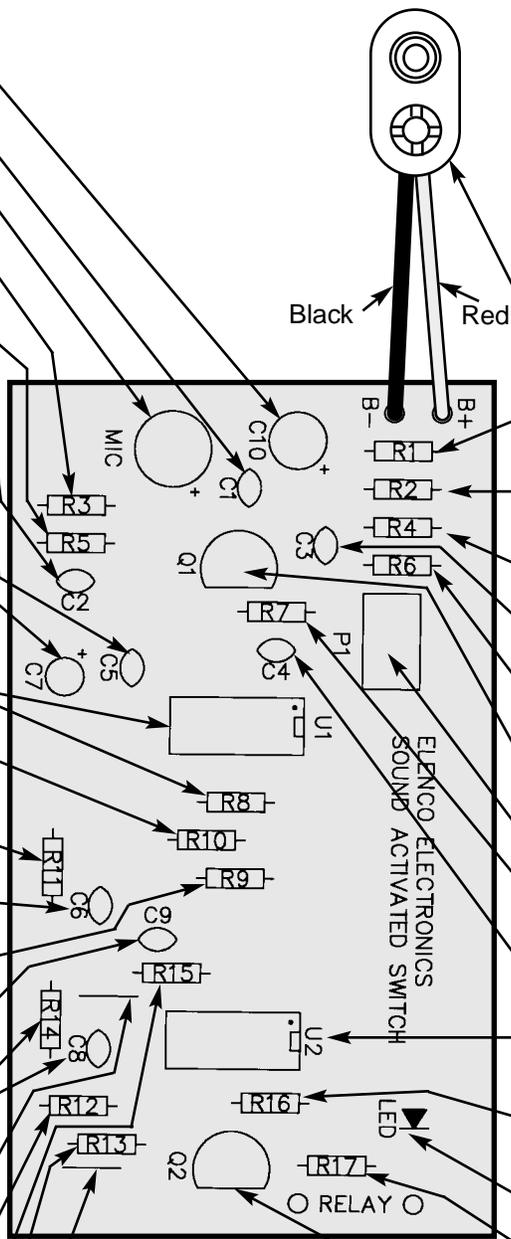
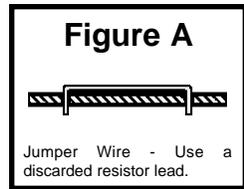


4. **Solder bridges** - occur when solder runs between circuit paths and creates a short circuit. This is usually caused by using too much solder. To correct this, simply drag your soldering iron across the solder bridge as shown.

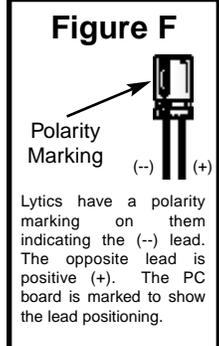
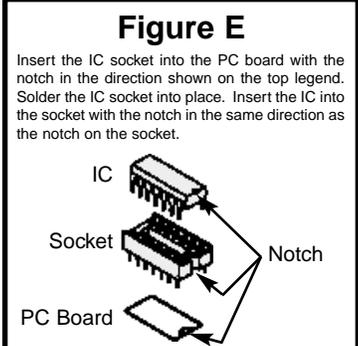
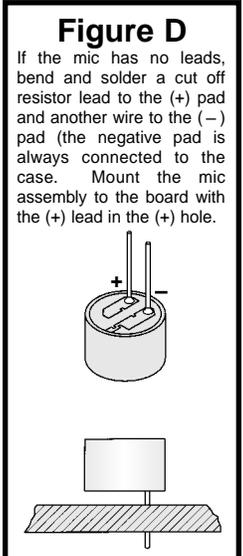
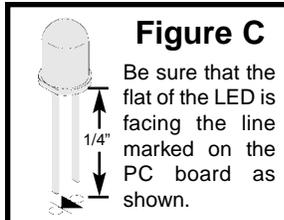
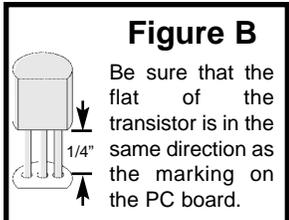


# ASSEMBLE COMPONENTS TO THE PC BOARD

- C10 - 100 $\mu$ F Electrolytic Cap. (see Figure F)
- C1 - .01 $\mu$ F Discap (103)
- MIC - Microphone (Figure D)
- R3 - 22k $\Omega$  5% 1/4W Resistor (red-red-orange-gold)
- R5 - 10k $\Omega$  5% 1/4W Resistor (brown-black-orange-gold)
- C2 - .1 $\mu$ F Discap (104)
- C5 - .001 $\mu$ F Discap (102)
- C7 - 1 $\mu$ F Electrolytic Capacitor (see Figure F)
- U1 - 14-pin IC Socket
- U1 - 4011 IC (see Figure E)
- R8 - 4.7M $\Omega$  5% 1/4W Resistor (yellow-violet-green-gold)
- R10 - 100k $\Omega$  5% 1/4W Resistor (brown-black-yellow-gold)
- R11 - 1M $\Omega$  5% 1/4W Resistor (brown-black-green-gold)
- C6 - .001 $\mu$ F Discap (102)
- R9 - 220k $\Omega$  5% 1/4W Resistor (red-red-yellow-gold)
- C9 - .001 $\mu$ F Discap (102)
- R14 - 100k $\Omega$  5% 1/4W Resistor (brown-black-yellow-gold)
- C8 - .001 $\mu$ F Discap (102)
- Jumper Wire (see Figure A)
- R12 - 100k $\Omega$  5% 1/4W Resistor (brown-black-yellow-gold)
- R15 - 330k $\Omega$  5% 1/4W Resistor (orange-orange-yellow-gold)
- R13 - 220k $\Omega$  5% 1/4W Resistor (red-red-yellow-gold)
- Jumper Wire (see Figure A)



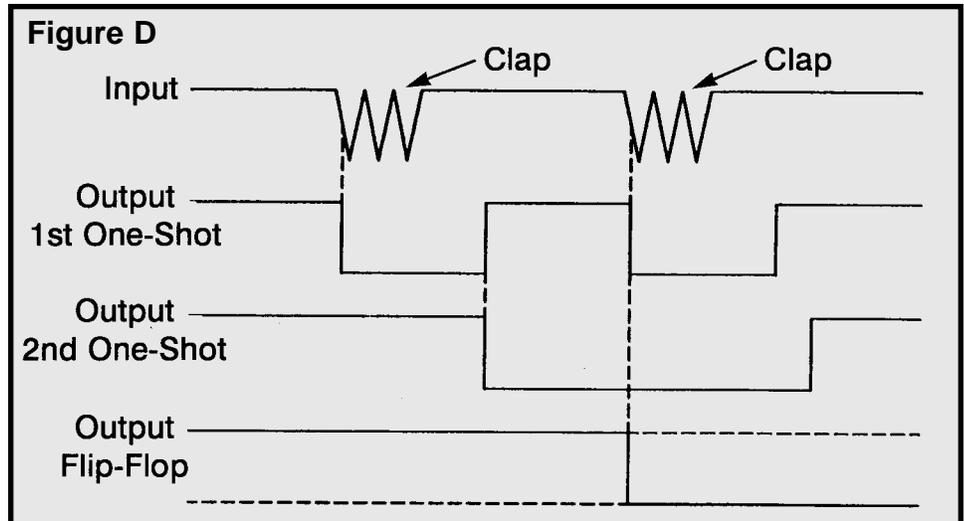
- Battery Snap
- R1 - 10k $\Omega$  5% 1/4W Resistor (brown-black-orange-gold)
- R2 - 220k $\Omega$  5% 1/4W Resistor (red-red-yellow-gold)
- R4 - 100k $\Omega$  5% 1/4W Resistor (brown-black-yellow-gold)
- C3 - .01 $\mu$ F Discap (103)
- R6 - 220k $\Omega$  5% 1/4W Resistor (red-red-yellow-gold)
- Q1 - 2N3904 Transistor (see Figure B)
- P1 - 100k $\Omega$  Trim Pot
- R7 - 270k $\Omega$  5% 1/4W Resistor (red-violet-yellow-gold)
- C4 - .1 $\mu$ F Discap (104)
- U2 - 14-Pin IC Socket
- U2 - 4001 IC (see Figure E)
- R16 - 10k $\Omega$  5% 1/4W Resistor (brown-black-orange-gold)
- LED - Red LED (see Figure C)
- R17 - 4.7k $\Omega$  5% 1/4W Resistor (yellow-violet-red-gold)
- Q2 - MPS6531 Transistor (see Figure B)



## OPERATING PROCEDURE

Figure D shows the output waveforms most important to the operation of the Sound Activated Switch. When a waveform is created by a clap, it causes the first one-shot to trigger, causing its output to switch to a logic 0. When the first one-shot's output switches back to a logic 1, the second one-shot triggers, causing its output to change to a logic 0. When another waveform is created due to another clap, the one-shot will trigger again causing its output to go low once more. When the first one-shot switches to a logic 0 the second time, the flip-flop is activated, causing its output logic level to change.

Rotate P1 fully counter-clockwise and connect a 9 volt battery. Stand about 10 to 20 feet away from the Sound Activated Switch. Clap twice with a short pause between the two claps. The LED should turn on, or it should turn off if it was already on. If the LED did not change, rotate P1 clockwise a small amount and repeat the same steps as above. Repeat this procedure until the Sound Activated Switch is operating properly.

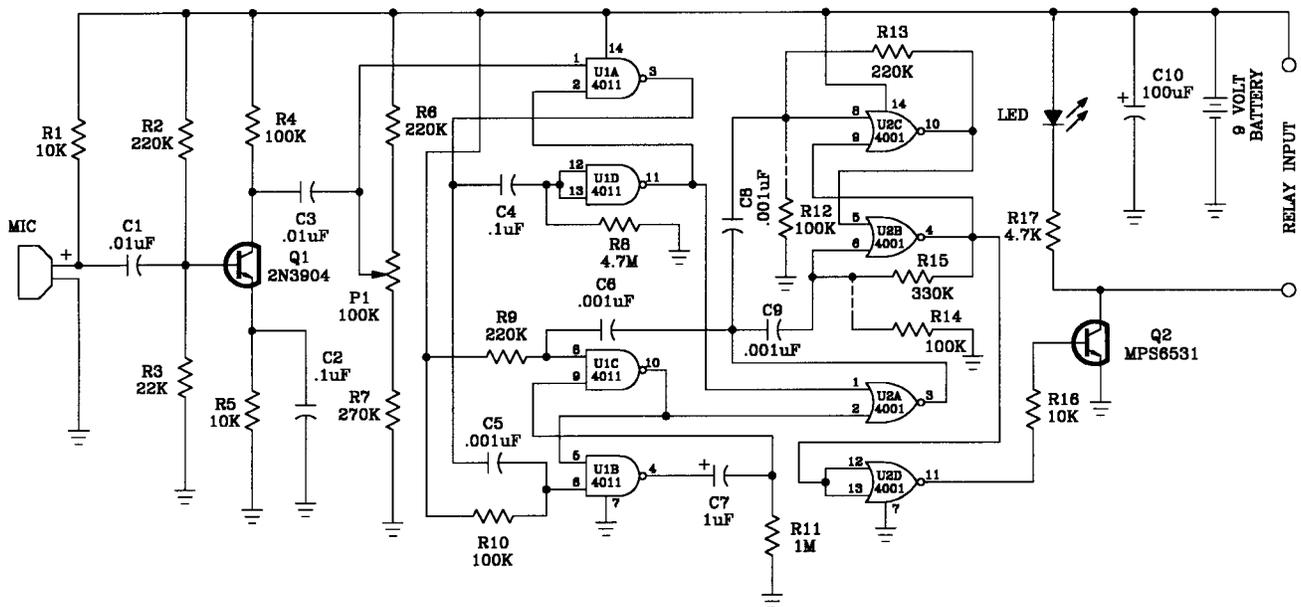


## TROUBLESHOOTING

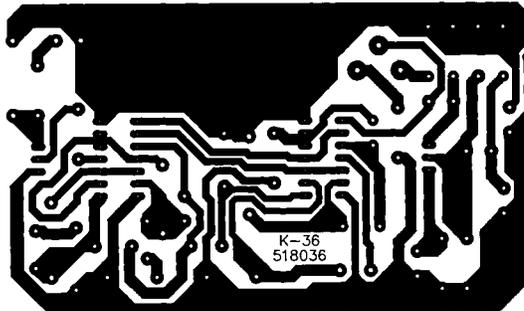
Consult your instructor or contact Elenco Electronics if you have any problems. **DO NOT** contact your place of purchase as they will not be able to help you.

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. Be sure that all components have been mounted in their correct places.
  - a) The LED will not light if it has not been installed correctly. The flat side of the LED should be in the same direction as shown in the top legend.
  - b) Are capacitors C7 and C10 installed correctly? These capacitors have polarity, be sure that the positive lead is in the correct hole.
  - c) Be sure that the ICs are installed correctly.
  - d) Be sure that transistors Q1 and Q2 have been installed correctly. The flat side should be in the same direction as shown on the top legend.
  - e) Microphones have polarity. The negative lead is always from the pad and shorted to the case. The PC board is marked to show the lead positioning.

## SCHEMATIC DIAGRAM



## FOIL SIDE OF PC BOARD



## QUIZ

1. The Sound Activated Switch consists of a transistor amplifier, a transistor switch and \_\_\_\_\_ types of digital circuits.
2. A \_\_\_\_\_ is created when hands are clapped together.
3. A one-shot is also called a \_\_\_\_\_ multivibrator.
4. When triggered, the first one-shot will remain at a logic 0 for \_\_\_\_\_ second(s).
5. When both inputs of NOR gate U2A are at a logic 0, the output will be at a logic \_\_\_\_\_.
6. A flip-flop is also called a \_\_\_\_\_ multivibrator.
7. A flip-flop is a circuit whose output \_\_\_\_\_ changes when a pulse is applied to the input.
8. The voltage needed at the input of the NOR gates to switch the outputs from one state to the other is between \_\_\_\_\_ and \_\_\_\_\_ volts.
9. When current flows through an LED, it will emit \_\_\_\_\_.
10. The transistor amplifier is a \_\_\_\_\_ emitter amplifier set at a gain of \_\_\_\_\_.

**Answers:** 1. two; 2. waveform; 3. monostable; 4. 0.25; 5. 1; 6. bistable; 7. logic level; 8. 4.5, 5.5; 9. light; 10. common, 50