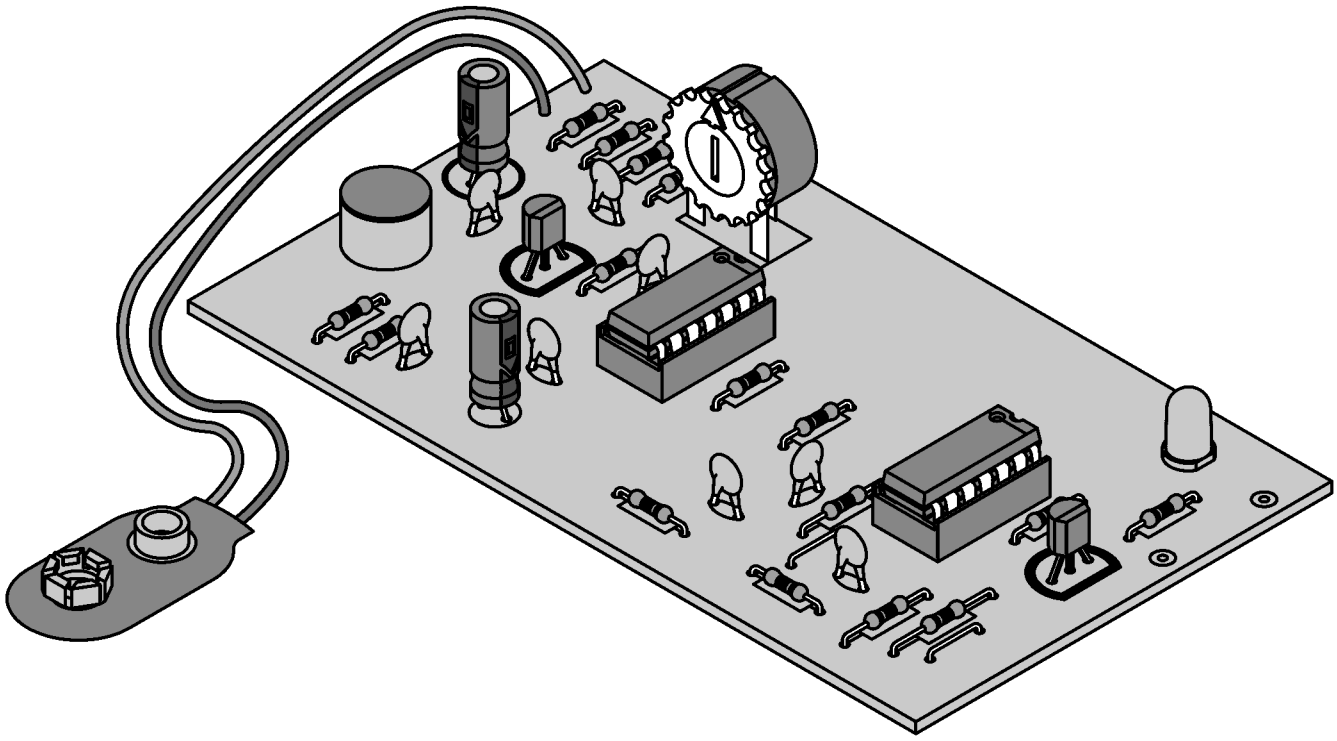
SOUND ACTIVATED SWITCH KIT

MODEL K-36



Assembly and Instruction Manual

ELENCO®

 Revised 2012 REV-L 753236

PARTS LIST

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

RESISTORS

Qty.	Symbol	Value	Color Code	Part #
❒ 1	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

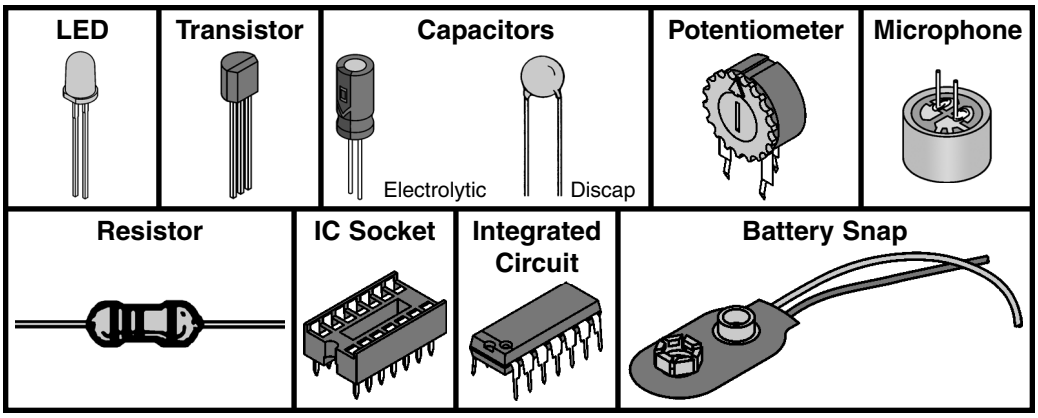
SEMICONDUCTORS

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	MIC	Microphone	568000
❒ 1		Battery Snap 9V	590098
❒ 2		IC Socket 14-pin	664014

PARTS IDENTIFICATION

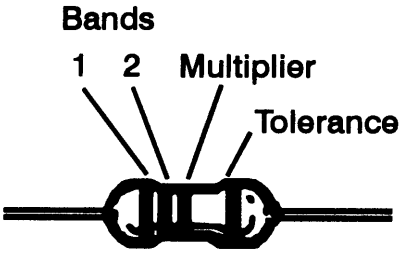


Batteries:

- **Do not short circuit the battery terminals.**
- **Never throw batteries in a fire or attempt to open its outer casing.**
- **Use only 9V type alkaline battery (not included).**
- **Insert battery with correct polarity.**
- **Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.**
- **Non-rechargeable batteries should not be recharged. Rechargeable batteries should only be charged under adult supervision, and should not be recharged while in the product.**
- **Remove battery when it is used up.**
- **Batteries are harmful if swallowed, so keep away from small children.**

IDENTIFYING RESISTOR VALUES

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



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

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

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

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

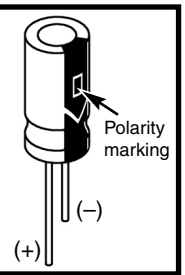
IDENTIFYING CAPACITOR VALUES

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

Electrolytic capacitors have a positive and a negative electrode. The negative lead is indicated on the packaging by a stripe with minus signs and possibly arrowheads. Also, the negative lead of a radial electrolytic is shorter than the positive one.

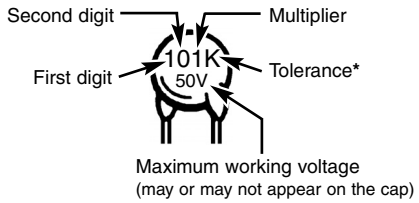
Warning:

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



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

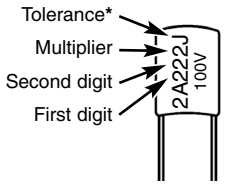
CERAMIC DISC



The value is 10 x 10 = 100pF, ±10%, 50V

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

MYLAR



The value is 22 x 100 = 2,200pF or .0022μF, ±5%, 100V

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

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.

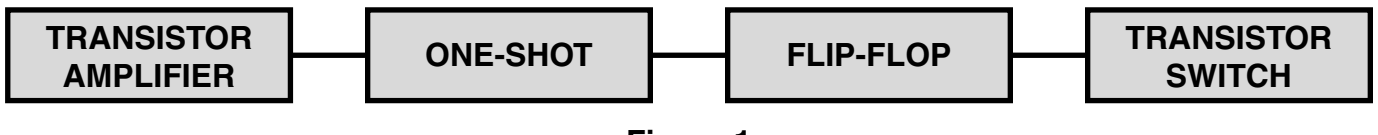


Figure 1

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 K-36 Sound Activated Switch Kit is good soldering techniques. Using the proper soldering iron is of prime importance. A small pencil type soldering iron of 25 - 40 watts is recommended. **The tip of the iron must be kept clean at all times and well-tinned.**

Solder

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

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

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

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

Safety Procedures

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

Assemble Components

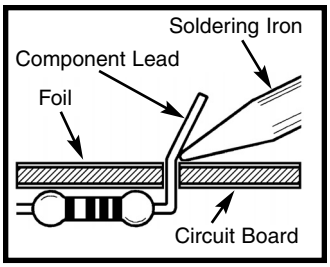
In all of the following assembly steps, the components must be installed on the top side of the PC board unless otherwise indicated. The top legend shows where each component goes. The leads pass through the corresponding holes in the board and are soldered on the foil side.
Use only rosin core solder.

DO NOT USE ACID CORE SOLDER!

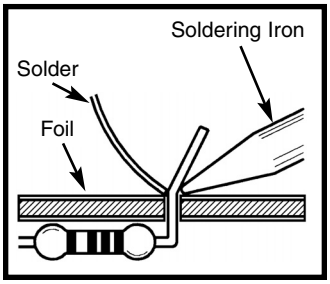
What Good Soldering Looks Like

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

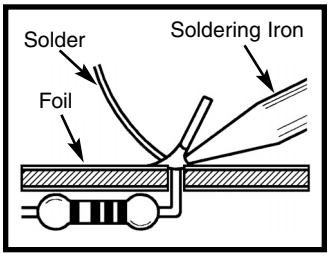
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.



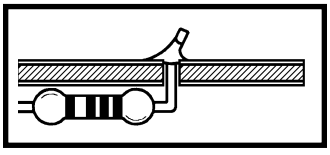
2. Apply a small amount of solder to the iron tip. This allows the heat to leave the iron and onto the foil. Immediately apply solder to the opposite side of the connection, away from the iron. Allow the heated component and the circuit foil to melt the solder.



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

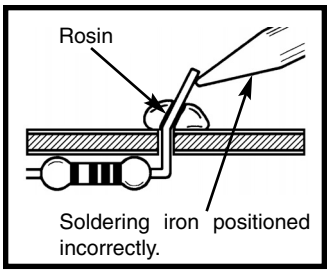


4. Here is what a good solder connection looks like.

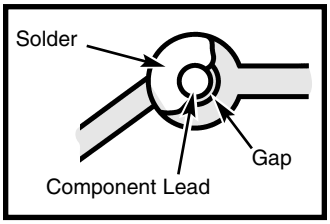


Types of Poor Soldering Connections

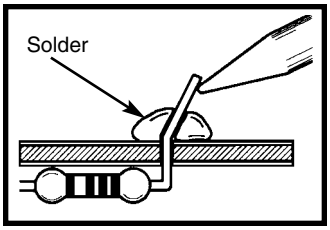
1. **Insufficient heat** - the solder will not flow onto the lead as shown.



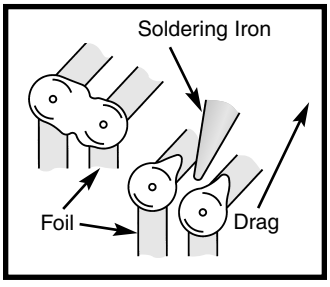
2. **Insufficient solder** - let the solder flow over the connection until it is covered.
Use just enough solder to cover the connection.



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



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



ASSEMBLE COMPONENTS TO THE PC BOARD

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

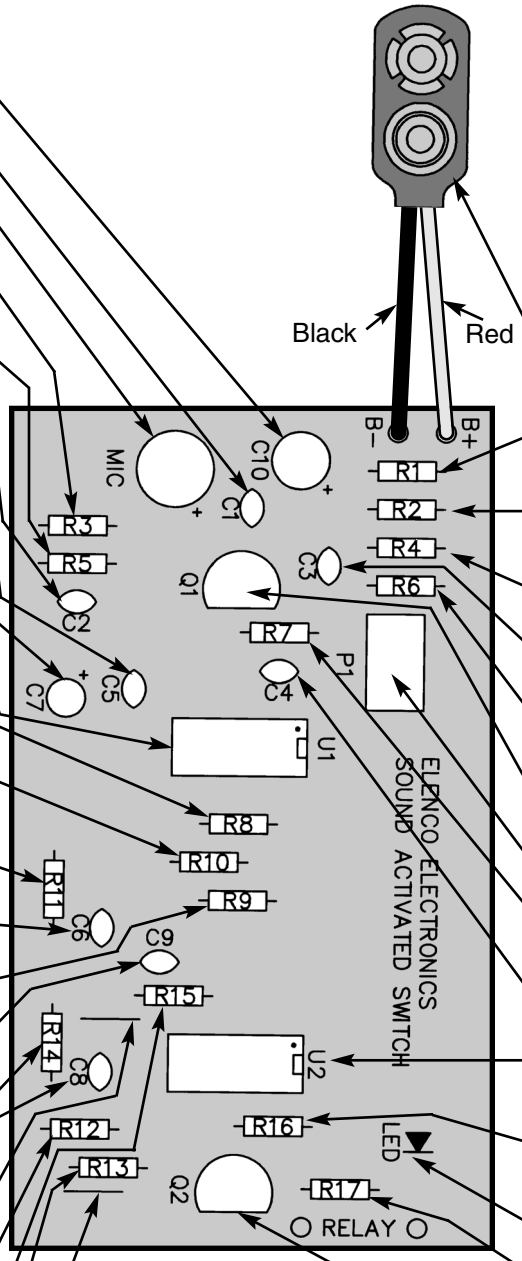
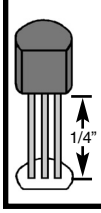


Figure A

Jumper Wire - Use a discarded resistor lead.

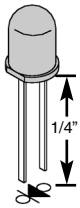
- ☐ Battery Snap
- ☐ R1 - 10kΩ 5% 1/4W Resistor (brown-black-orange-gold)
- ☐ R2 - 220kΩ 5% 1/4W Resistor (red-red-yellow-gold)
- ☐ R4 - 100kΩ 5% 1/4W Resistor (brown-black-yellow-gold)
- ☐ C3 - .01µF Discap (103)
- ☐ R6 - 220kΩ 5% 1/4W Resistor (red-red-yellow-gold)
- ☐ Q1 - 2N3904 Transistor (see Figure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

Figure B



Be sure that the flat of the transistor is in the same direction as the marking on the PC board.

Figure C



Be sure that the flat of the LED is facing the line marked on the PC board as shown.

Figure D

If the mic has no leads, bend and solder a cut off resistor lead to the (+) pad and another wire to the (–) pad (the negative pad is always connected to the case. Mount the mic assembly to the board with the (+) lead in the (+) hole.

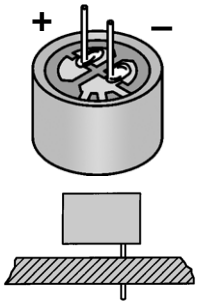


Figure E

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

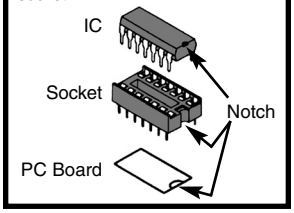
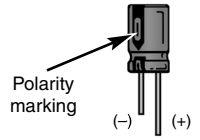


Figure F



Electrolytic capacitors have polarity. Be sure to mount them with the short negative (–) lead (marked on side) in the correct hole. The PC board is marked to show the lead positioning.

Warning:

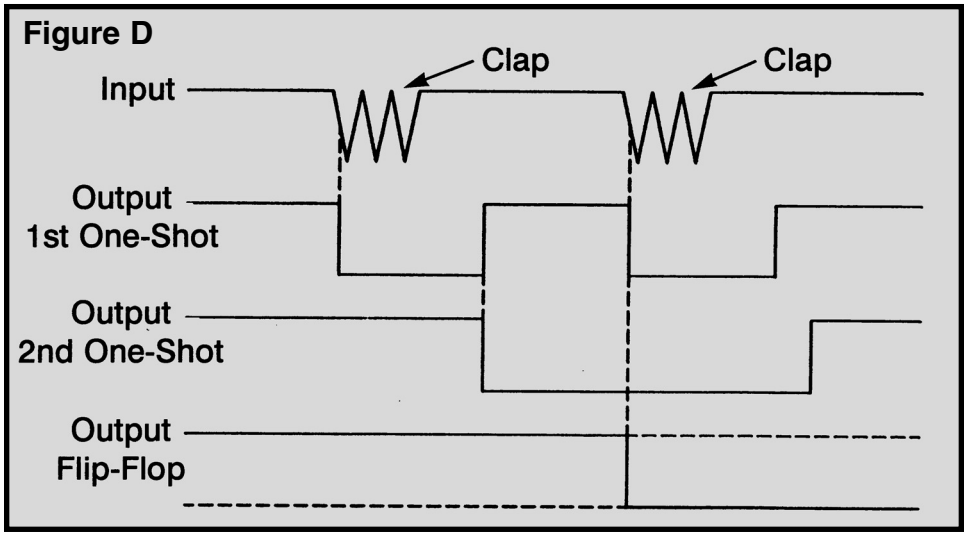
If the capacitor is connected with incorrect polarity, it may heat up and either leak, or cause the capacitor to explode.

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.

Figure D



TROUBLESHOOTING

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

1. One of the most frequently occurring problems is poor solder connections.

   a) Tug slightly on all parts to make sure that they are indeed soldered.

   b) All solder connections should be shiny. Resolder any that are not.

   c) Solder should flow into a smooth puddle rather than a round ball. Resolder any connection that has formed into a ball.

   d) Have any solder bridges formed? A solder bridge may occur if you accidentally touch an adjacent foil by using too much solder or by dragging the soldering iron across adjacent foils. Break the bridge with your soldering iron.

2. 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.

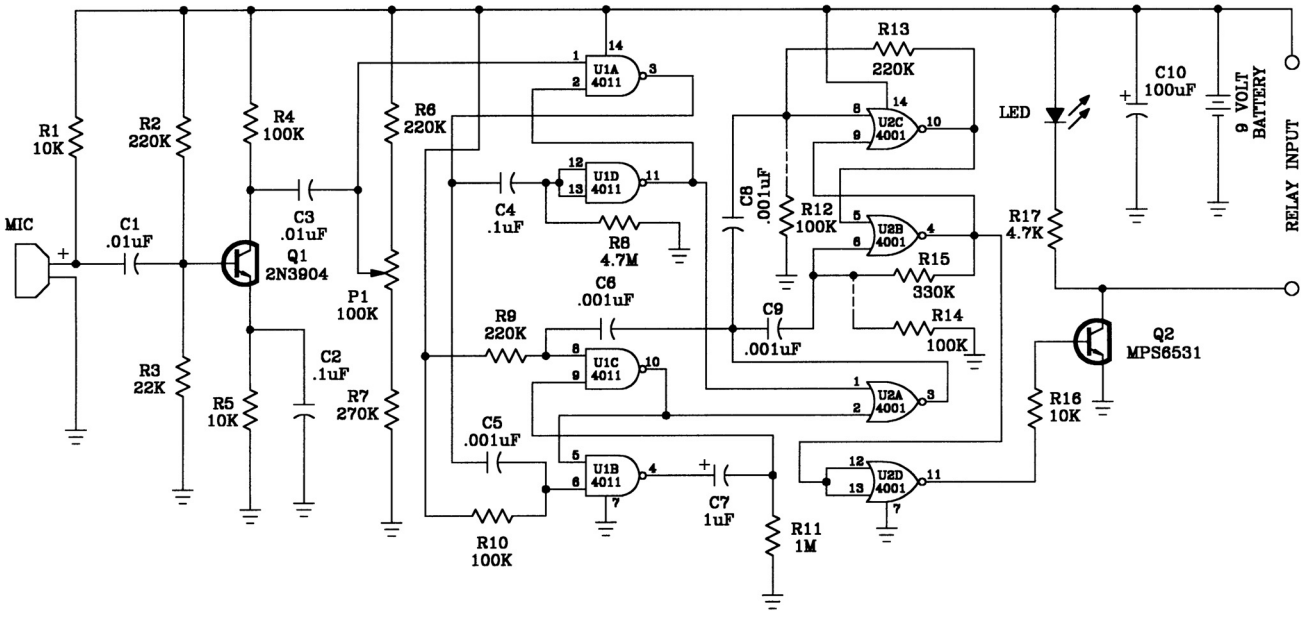
   b) Are capacitors C7 and C10 installed correctly? These capacitors have polarity, be sure that the positive lead is in the correct hole.

   c) Be sure that the ICs are installed correctly.

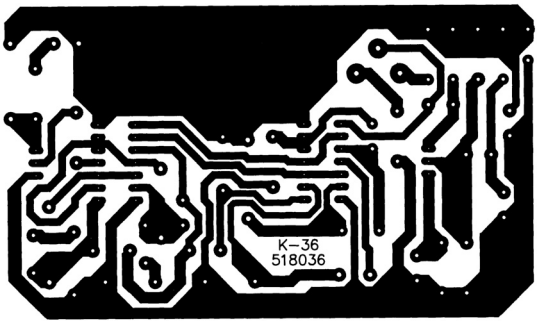
   d) Be sure that transistors Q1 and Q2 have been installed correctly. The flat side should be in the same direction as shown on the top legend.

   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

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