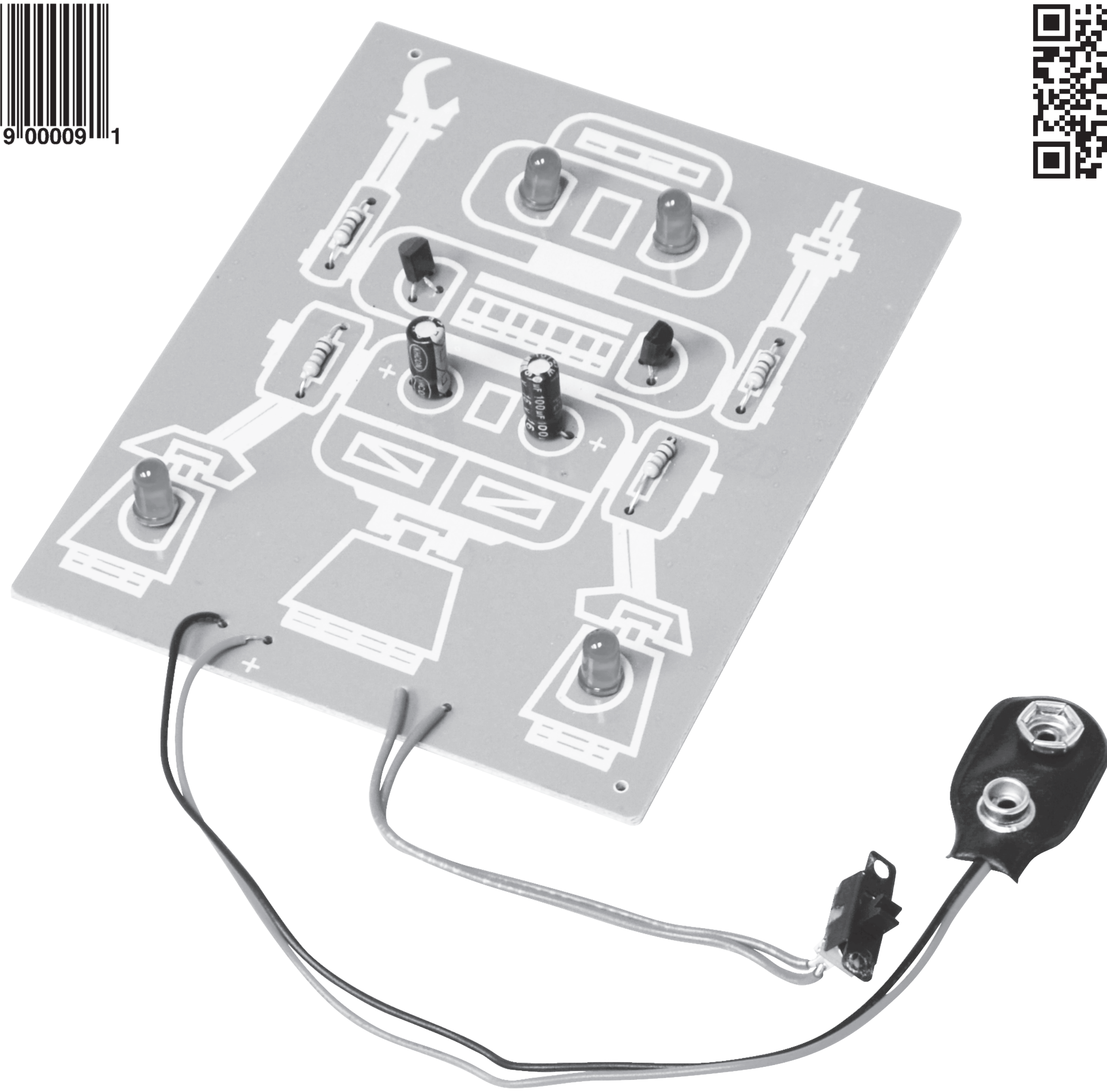
LED ROBOT BLINKER KIT

MODEL K-17



Assembly and Instruction Manual

ELENCO®

Revised 2013 REV-P 753217

PARTS LIST

If you are a student, and any parts are missing or damaged, please see instructor or bookstore.

If you purchased this LED robot blinker 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 #
❒ 2	R2, R3	330Ω 5% 1/4W	orange-orange-brown-gold	133300
❒ 2	R1, R4	10kΩ 5% 1/4W	brown-black-orange-gold	151000

CAPACITORS

Qty.	Symbol	Value	Description	Part #
❒ 2	C1, C2	100μF	Electrolytic	281044

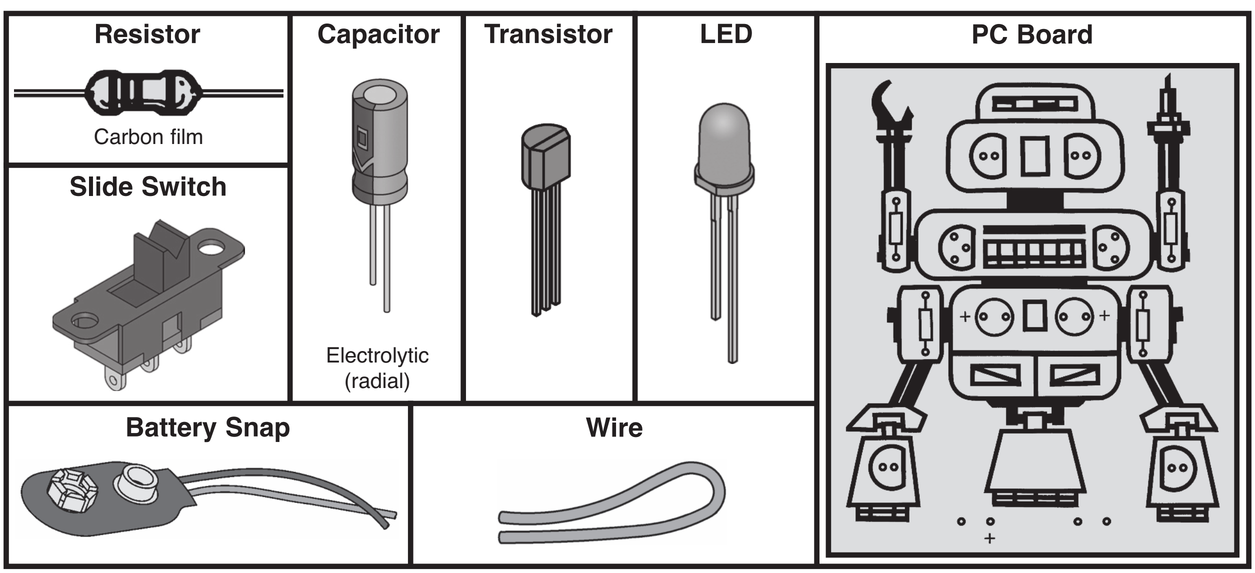
SEMICONDUCTORS

Qty.	Symbol	Value	Description	Part #
❒ 2	Q1, Q2	2N3904	Transistor NPN	323904
❒ 4	D1 - D4		Light emitting diode (LED) red	350002

MISCELLANEOUS

Qty.	Symbol	Description	Part #
❒ 1		PC board	518017
❒ 1	S1	Slide switch	541102
❒ 1	B1	Battery snap	590098
❒ 2		4” Wire	814620

PARTS IDENTIFICATION



IDENTIFYING RESISTOR VALUES

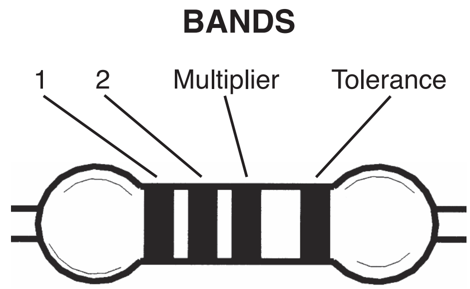
Use the following information as a guide in properly identifying the value of resistors.

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	±0.5%
Blue	±0.25%
Violet	±0.1%



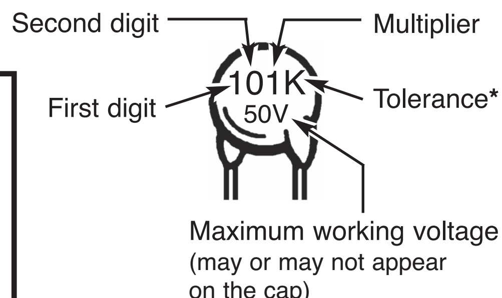
IDENTIFYING CAPACITOR VALUES

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

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

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

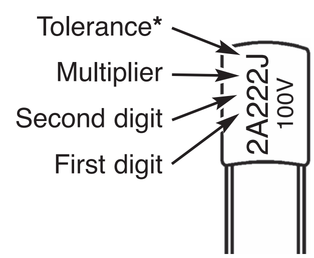
CERAMIC DISC



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

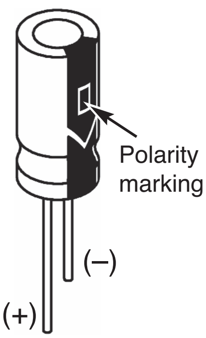


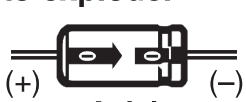
The value is 22 x 100 = 2,200pF or .0022μF, ±5%, 100V

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

Warning:

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





Axial **Radial**

METRIC UNITS AND CONVERSIONS

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

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

INTRODUCTION

The Robot Blinker alternately flashes a pair of LEDs (light emitting diode) on at about two blinks per second. The circuit is basically an astable multivibrator or free-running oscillator. In analyzing how it works, we will look at the start-up stage and then at the continuous cycle stage where the LEDs flash at a continuous two cycles per second.

COMPONENT OPERATION

Let's first review the operation of critical components. A light emitting diode (LED) is a device that emits light whenever a current passes through it. The more the current, the brighter the light. See Figure 1, resistor R2 is placed in series with the LED to limit the current to the desired amount.

An NPN transistor is a device that amplifies and controls the current. It consists of three elements: Base, Emitter, and Collector. The emitter is connected to a negative voltage and the collector to a positive voltage. The base controls the collector-emitter, the collector will conduct current to the emitter when the voltage across the base-emitter junction is 0.7V. This current is many times the base emitter current and therefore the transistor is said to be amplifying the current. A capacitor is a device that stores current and a resistor is a device that limits current.

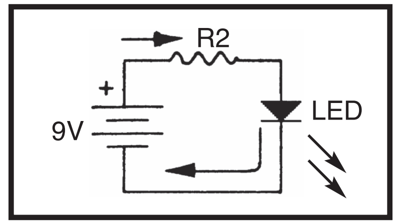


Figure 1

START-UP STAGE

Looking at the schematic diagram (on page 6) shows that the circuit is essentially symmetrical. There are two transistors, capacitors, LEDs and resistors. These components are wired exactly the same. If all of the components were exactly the same, then this circuit could not work. In reality, the components' tolerances are different. When the power is turned ON, one branch will conduct faster than the other. This causes the slower branch to turn OFF. Let's assume transistor Q1 conducts first and therefore LEDs D1 and D3 turn ON as shown in Figure 2. The collector voltage of Q1 immediately goes slightly above the emitter voltage, therefore charging capacitor C2 through resistor R4. The time it takes to charge capacitor C2 determines the frequency or "blink rate" of the Robot Blinker. In our case, it takes about 1/4 of a second. As long as C2 is charging, the current through resistor R4 will produce a negative voltage at the base of transistor Q2, keeping this transistor turned OFF.

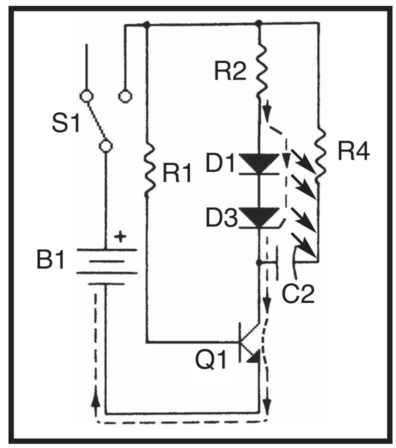


Figure 2

CONTINUOUS CYCLE STAGE

We've learned that as long as C2 is charging, the current through R4 will keep transistor Q2 OFF. When C2 is near full charge, the current through R4 will reduce, causing the voltage at the base of Q2 to rise to 0.7V above its emitter. This begins to turn transistor Q2 ON. At this moment, the collector voltage of Q2 drops and capacitor C1 begins to charge. The current through R1 produces a negative voltage at the base of Q1, causing a rapid shutdown of Q1 and a rapid turn ON of Q2.

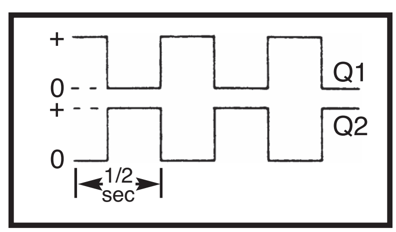


Figure 3

The process now repeats itself with Q2 conducting until capacitor C1 nears full charge and begins to turn transistor Q1 ON. Effectively the two transistors will alternately turn ON and OFF every 1/2 second. The voltage on the collector will form a square wave as shown in Figure 3. Whenever the voltage goes negative, a current will flow in the two associated LEDs and light will be emitted.

CONSTRUCTION

Introduction

The most important factor in assembling your K-17 LED Robot Blinker Kit is good soldering techniques. Using the proper soldering iron is of prime importance. A small pencil type soldering iron of 25 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

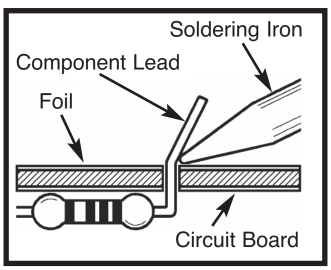
In all of the following assembly steps, the components must be installed on the top side of the PC board unless otherwise indicated. The top legend shows where each component goes. The leads pass through the corresponding holes in the board and are soldered on the foil side.
Use only rosin core solder.

DO NOT USE ACID CORE SOLDER!

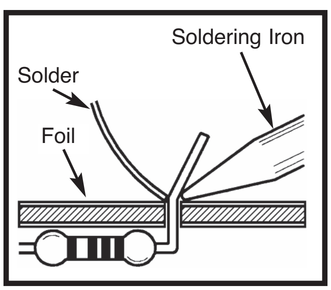
What Good Soldering Looks Like

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

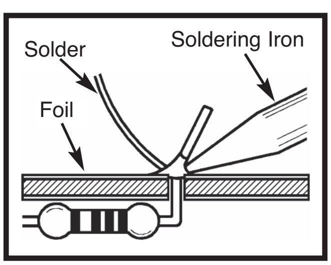
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.



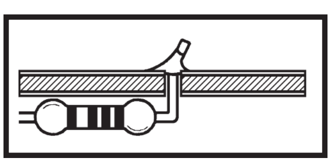
2. Apply a small amount of solder to the iron tip. This allows the heat to leave the iron and onto the foil. Immediately apply solder to the opposite side of the connection, away from the iron. Allow the heated component and the circuit foil to melt the solder.



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.

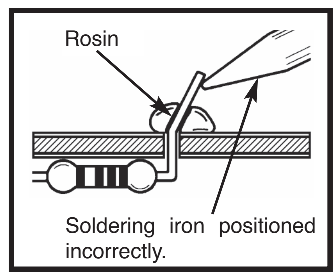


4. Here is what a good solder connection looks like.

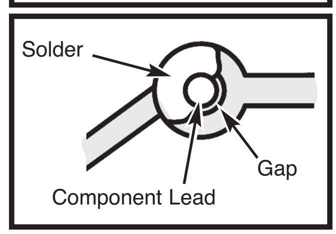


Types of Poor Soldering Connections

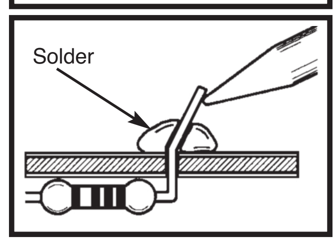
1. **Insufficient heat** - the solder will not flow onto the lead as shown.



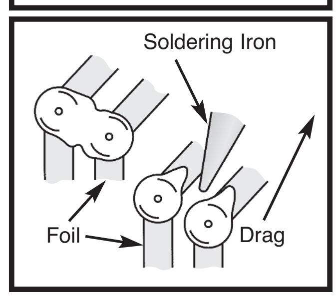
2. **Insufficient solder** - let the solder flow over the connection until it is covered.
   Use just enough solder to cover the connection.



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.

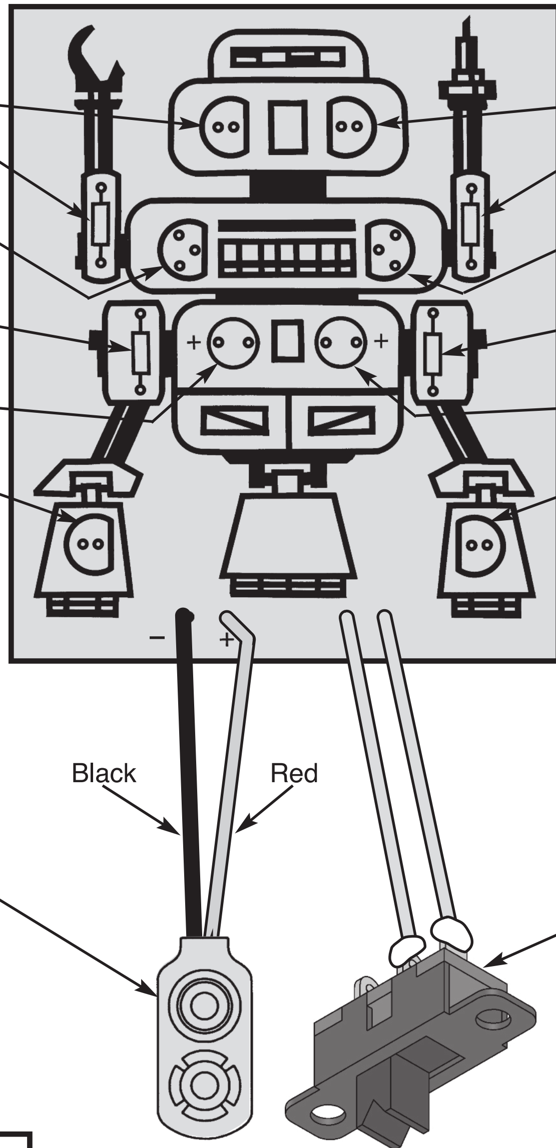


ASSEMBLE COMPONENTS TO THE PC BOARD

Wear safety goggles when assembling.

- ☐ D2 - LED (see Figure A)
- ☐ R3 - 330Ω 5% 1/4W Resistor (orange-orange-brown-gold)
- ☐ Q1 - 2N3904 Transistor (see Figure B)
- ☐ R1 - 10kΩ 5% 1/4W Resistor (brown-black-orange-gold)
- ☐ C2 - 100μF Electrolytic Cap. (see Figure C)
- ☐ D3 - LED (see Figure A)

- ☐ D1 - LED (see Figure A)
- ☐ R2 - 330Ω 5% 1/4W Resistor (orange-orange-brown-gold)
- ☐ Q2 - 2N3904 Transistor (see Figure B)
- ☐ R4 - 10kΩ 5% 1/4W Resistor (brown-black-orange-gold)
- ☐ C1 - 100μF Electrolytic Cap. (see Figure C)
- ☐ D4 - LED (see Figure A)



☐ B1 - Battery Snap - Install the red wire into the positive (+) hole and the black wire into the negative (–) hole as shown. Bend the leads to hold the battery snap in place. Solder and cut off the excess leads.

☐ S1 - Slide Switch - Cut two 4" wires and strip 1/2" of insulation off of both ends of the wires. Solder a wire to the middle lug and the other wire to one of the other lugs. Insert the other ends into the PC board. Solder and cut off the excess leads.

Figure A

Mount the LED onto the PC board with the flat side of the LED in the same direction as marked on the PC board. Be sure to mount the LED flush with the PC board as shown below.

Solder and cut off the excess leads.

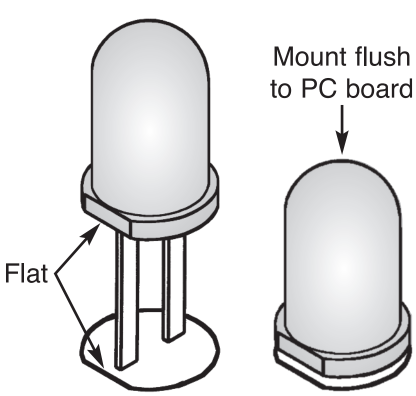


Figure B

Mount the transistor on the position shown. Make sure that the flat side of the transistor agrees with the flat side of the marking on the PC board.

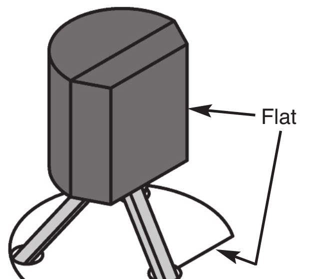
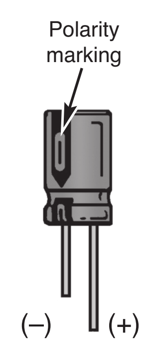


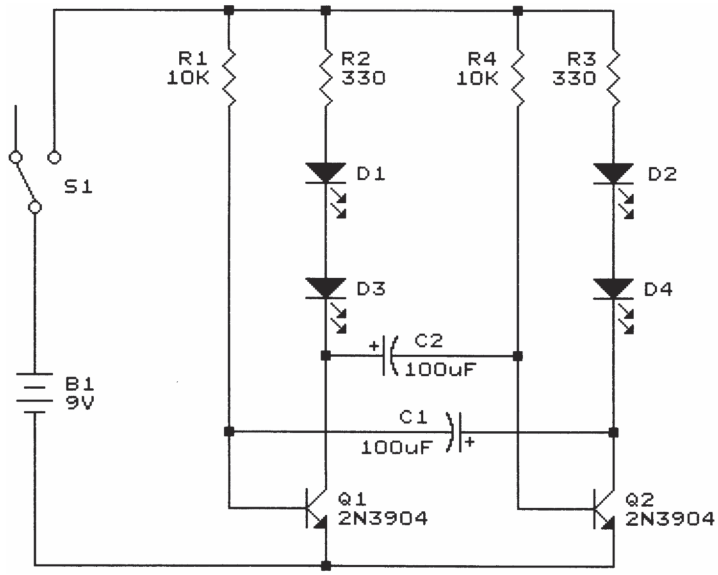
Figure C

Electrolytic capacitors have polarity. Be sure to mount them with the negative (–) lead (marked on side) in the correct hole.

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



SCHEMATIC DIAGRAM



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.

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.

The LEDs will not light

1. Use a fresh 9 volt battery.
2. Check to see that the battery snap is correctly mounted to the PC board.
3. Check to see that the LEDs are mounted correctly. Short the cathode of LED D1 to the negative (–) battery lead. The LED should light. If not, it is then in backwards or defective. Do the same with LED D3. Both LEDs should light up. Repeat with LEDs D2 and D4.
4. If the LEDs still don't light, check the battery snap wiring. The wires must be as shown in the assembly diagram. Be sure that resistors R2 and R3 are the correct values (330Ω).
5. Check transistors Q1 and Q2. Be sure that they are in correctly. The flat side should be in the direction as shown in the pictorial diagram.
6. Check the switch S1. Short the lugs of S1 with the two wires. If the LEDs light, the switch is not good.

The LEDs will not blink

1. If only one pair of LEDs light, then check the transistor whose LEDs are not lit. Replace if necessary.
2. If all four LEDs are lit, then check to see if capacitors C1 & C2 and resistors R1 & R4 have been installed correctly.

QUIZ

1. The Robot Blinker circuit is essentially _________________.
2. The LED emits light when ____________ passes through it.
3. The transistor has three elements, name them: _____________, ____________, ____________.
4. The collector voltage must be ________ in respect to the emitter voltage.
5. For the transistor to conduct, the base must be about _____ volts above the emitter.
6. When transistor Q1 is conducting capacitor C2 will be ____________.
7. When transistor Q2 is conducting LEDs D__ and D__ will be on.
8. The frequency of the Robot Blinker is ___ cycles per second.
9. When transistor Q2 is ON, transistor Q1 is _____.
10. Resistors R2 and R3 are used to ________ the current in the LEDs.

7 56619 00009 1

GLOSSARY

Astable Multivibrator A type of transistor configuration in which only one transistor is on at a time.

Base The controlling input of an NPN bipolar junction transistor.

Battery A device which uses a chemical reaction to create an electric charge across a material.

Capacitance The ability to store electric charge.

Capacitor An electrical component that can store electrical pressure (voltage) for periods of time.

Collector The controlled input of an NPN bipolar junction transistor.

Color Code A method for marking resistors using colored bands.

Current A measure of how fast electrons are flowing in a wire or how fast water is flowing in a pipe.

Disc Capacitor A type of capacitor that has low capacitance and is used mostly in high frequency circuits.

Electricity A flow of electrons between atoms due to an electrical charge across the material.

Electrolytic Capacitor A type of capacitor that has high capacitance and is used mostly in low frequency circuits. It has polarity markings.

Emitter The output of an NPN bipolar junction transistor.

Farad, (F) The unit of measure for capacitance.

Ground A common term for the 0V or "–" side of a battery or generator.

Integrated Circuit A type of circuit in which transistors, diodes, resistors, and capacitors are all constructed on a semiconductor base.

Kilo- (k) A prefix used in the metric system. It means a thousand of something.

LED Common abbreviation for light emitting diode.

Light Emitting Diode A diode made from gallium arsenide that has a turn-on energy so high that light is generated when current flows through it.

Micro- (μ) A prefix used in the metric system. It means a millionth (0.000001) of something.

NPN Negative-Positive-Negative, a type of transistor construction.

Ohm, (Ω) The unit of measure for resistance.

Printed Circuit Board A board used for mounting electrical components. Components are connected using metal traces "printed" on the board instead of wires.

Resistance The electrical friction between an electric current and the material it is flowing through; the loss of energy from electrons as they move between atoms of the material.

Resistor Components used to control the flow of electricity in a circuit. They are made of carbon.

Schematic A drawing of an electrical circuit that uses symbols for all the components.

Semiconductor A material that has more resistance than conductors but less than insulators. It is used to construct diodes, transistors, and integrated circuits.

Series When electrical components are connected one after the other.

Short Circuit When wires from different parts of a circuit (or different circuits) connect accidentally.

Solder A tin-lead metal that becomes a liquid when heated to above 360 degrees. In addition to having low resistance like other metals, solder also provides a strong mounting that can withstand shocks.

Transistor An electronic device that uses a small amount of current to control a large amount of current.

Voltage A measure of how strong an electric charge across a material is.

Volts (V) The unit of measure for voltage.

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Website: www.elenco.com ● e-mail: elenco@elenco.com

Answers: 1. oscillator; 2. current; 3. base, emitter, collector; 4. high; 5. 0.7; 6. charging; 7. 2,4; 8. two; 9. off; 10. limit