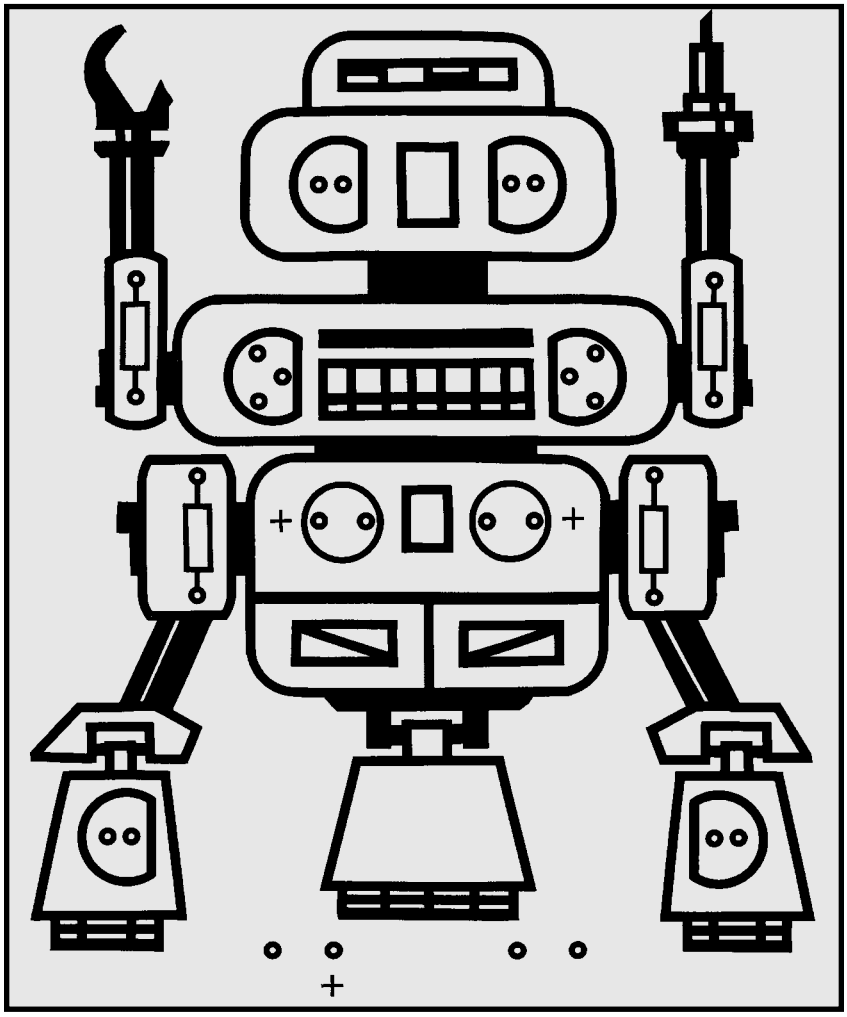
LED ROBOT BLINKER KIT

MODEL K-17



Assembly and Instruction Manual

Elenco Electronics, Inc.

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 #
☐ 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

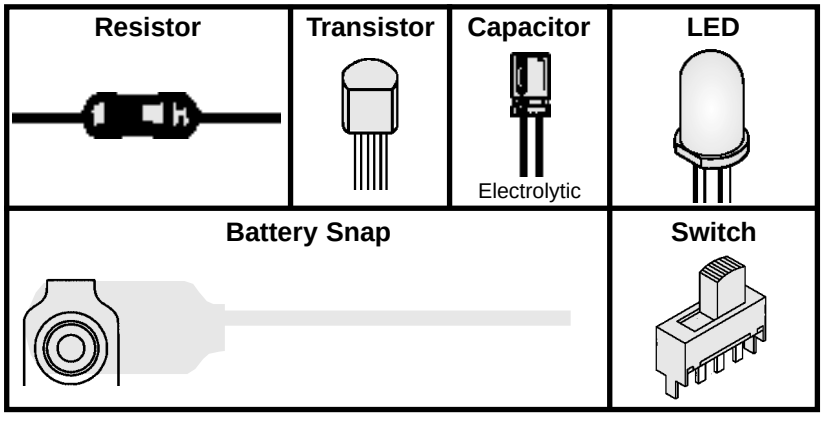
SEMICONDUCTORS

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		24” Solder Roll	551124
☐ 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.

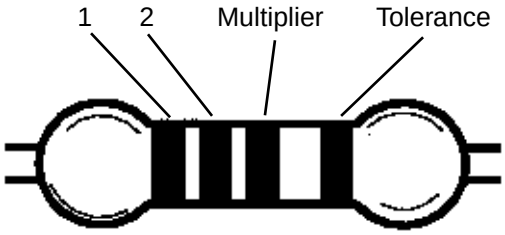
BAND 1 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

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	±.5%
Blue	±.25%
Violet	±.1%

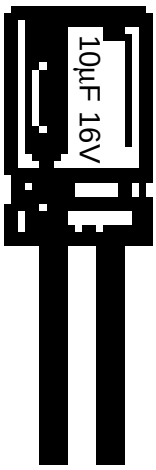
BANDS

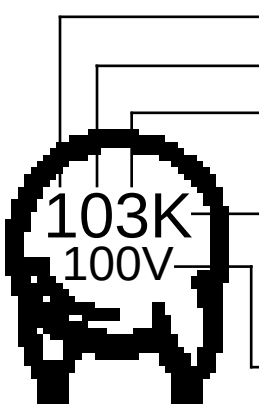


IDENTIFYING CAPACITOR VALUES

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.

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





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 x 1,000 = 10,000pF or .01µF 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 kilo 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 .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.

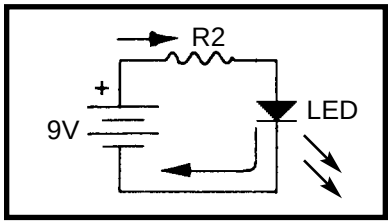


Figure 1

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.

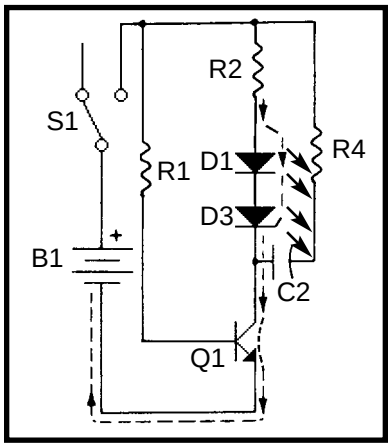


Figure 2

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 .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 fo Q1 and a rapid turn ON of Q2.

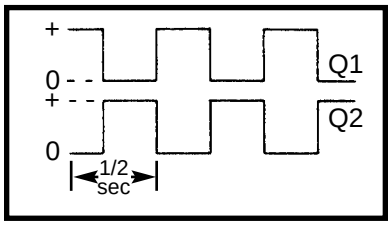


Figure 3

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 Robot Blinker 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.
- 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

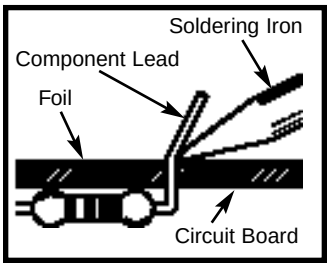
In all of the following assembly steps, the components must be installed on the top side of the PC board unless otherwise indicated. The top legend shows where each component goes. The leads pass through the corresponding holes in the board and are soldered on the foil side.
Use only rosin core solder of 63/37 alloy.

DO NOT USE ACID CORE SOLDER!

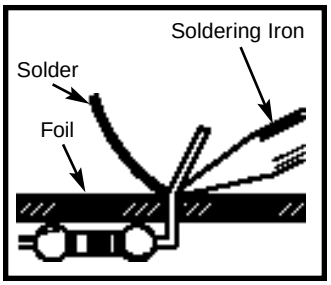
What Good Soldering Looks Like

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

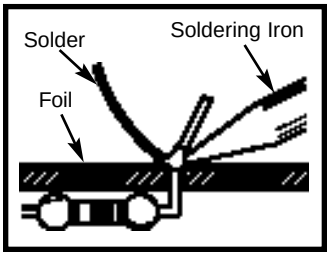
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.



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.



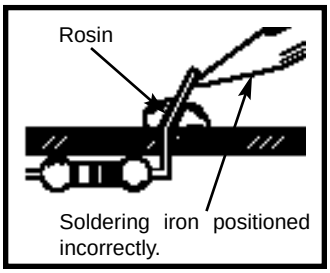
3. Allow the solder to flow around the connection. Then, remove the solder and the iron and let the connection cool. The solder should have flowed smoothly and not lump around the wire lead.



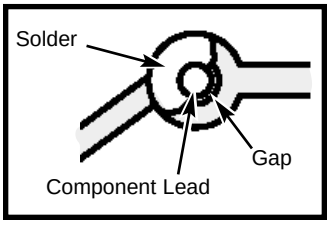
4. Here is what a good solder connection looks like.

Types of Poor Soldering Connections

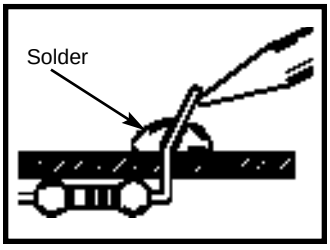
1. **Insufficient heat** - the solder will not flow onto the lead as shown.



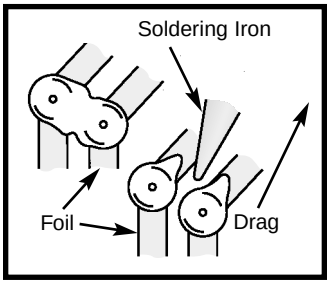
2. **Insufficient solder** - let the solder flow over the connection until it is covered. Use just enough solder to cover the connection.



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

☐ D2 - LED (see Figure A)

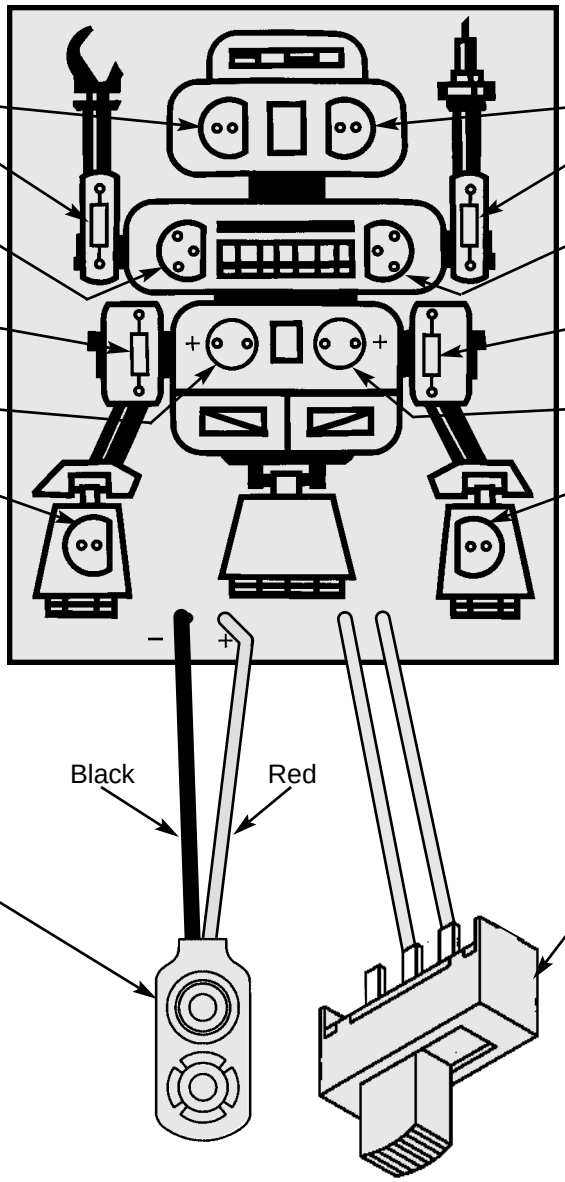
☐ R3 - 330Ω 5% 1/4W Resistor (orange-orange-brown-gold)

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

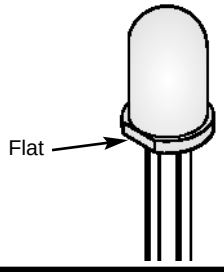


Figure B

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.

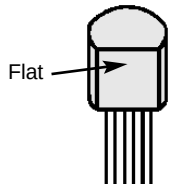
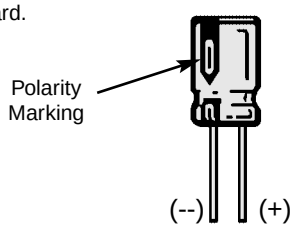
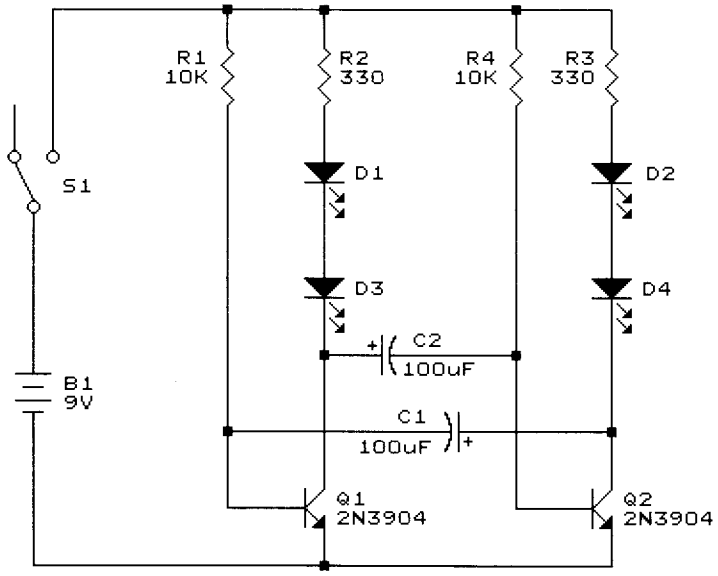


Figure C

Electrolytic capacitors have polarity. Mount the capacitor with the positive lead in the hole marked (+) on the PC board.



SCHEMATIC DIAGRAM



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.

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.

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