DIGITAL BIRD KIT

MODEL K-19

Assembly and Instruction Manual

ELENCO®

 Revised 2012 REV-H 753219

PARTS LIST

If you are a student, and any parts are missing or damaged, please see instructor or bookstore. If you purchased this Digital Bird 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	Description	Color Code	Part #
❒ 1	R5	39Ω 5% 1/2W	orange-white-black-gold	123901
❒ 1	R4	4.7kΩ 5% 1/4W	yellow-violet-red-gold	144700
❒ 3	R1, R2, R3	500Ω Potentiometer		191351

CAPACITORS

Qty.	Symbol	Value	Description	Part #
❒ 1	C5	10pF (10)	Discap	211011
❒ 2	C3, C4	1μF	Electrolytic	261047
❒ 2	C1, C2	1000μF	Electrolytic	291044

SEMICONDUCTORS

Qty.	Symbol	Value	Description	Part #
❒ 1	Q1	2N3904	Transistor	323904
❒ 1	IC1	4011	Integrated circuit (IC)	334011

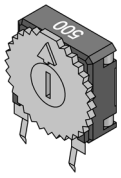
MISCELLANEOUS

Qty.	Symbol	Description	Part #
❒ 1		PC board	518019
❒ 1	S1	Switch push button	540001
❒ 1	B1	Battery snap 9V	590098
❒ 1	SPK1	Speaker 8Ω	590102
❒ 1		IC socket 14-pin	664014
❒ 2		Wire 4” blue	814620

PARTS IDENTIFICATION

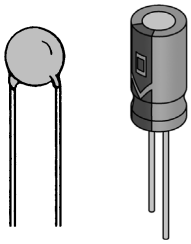
Resistors

Carbon film



500Ω Potentiometer

Capacitors

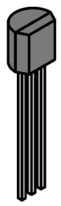


Discap

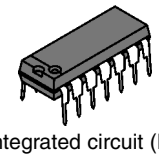
Electrolytic (radial)

Wire

Semiconductors

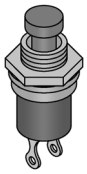


Transistor

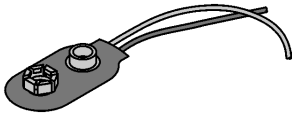


Integrated circuit (IC)

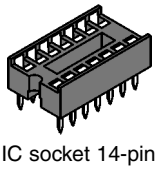
Miscellaneous



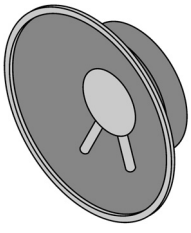
Push button switch with 1/4” nut and washer



Battery snap 9V



IC socket 14-pin



Speaker 8Ω

Batteries:

- **Do not short circuit the battery terminals.**
- **Never throw the battery in a fire or attempt to open its outer casing.**
- **Use only 9V alkaline battery (not included).**
- **Insert battery with correct polarity.**
- **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.

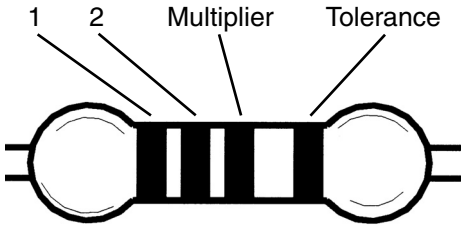
BAND 1 1st Digit	
Color	**Digit**
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

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	±0.5%
Blue	±0.25%
Violet	±0.1%

BANDS



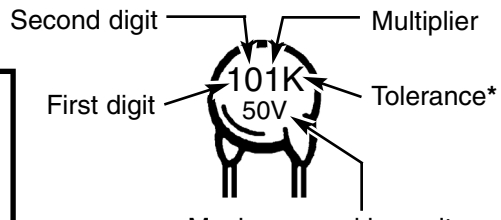
IDENTIFYING CAPACITOR VALUES

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.

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.

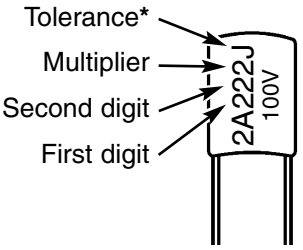
Multiplier	For the No.	0	1	2	3	4	5	8	9
	Multiply By	1	10	100	1k	10k	100k	.01	0.1

CERAMIC DISC



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

MYLAR



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

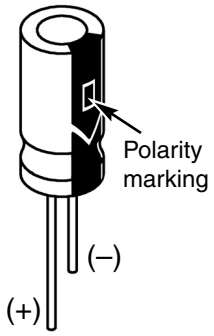
* The letter M indicates a tolerance of ±20%
The letter K indicates a tolerance of ±10%
The letter J indicates a tolerance of ±5%

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

CIRCUIT OPERATION

The Digital Bird uses four digital NAND gates to produce the birdy sounds. It consists of four individual circuits: two oscillators, an audio amplifier and an R/C network as shown in the block diagram in Figure 1. The first oscillator produces a square wave signal whose frequency can be varied by adjusting a variable resistor. The output of the first oscillator is modified by passing it through a high pass R/C network. The resulting sound is fed to an audio amplifier which drives a speaker.

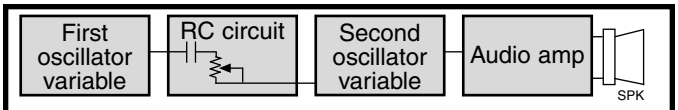


Figure 1

What makes the Digital Bird so exciting is the fact that three circuits have variable controls. Thus, the sound output can be adjusted over a wide range to give an unusually large variety of audio sounds in the "birdy frequency" spectrum.

Oscillator Circuit

The circuit of the first oscillator is shown in Figure 2. Two NAND gates are wired as inverters. This means that when the input is high, the output goes low. To make a circuit oscillate, we need positive feedback. This is achieved by adding capacitor C1. The output of inverter G1 is fed back to the input of G2 in the same phase to build-up the oscillations. Capacitor C1 and resistor R1 form an R/C network, and this network determines the frequency of oscillation. Since resistor R1 can be varied, the frequency of oscillation can be varied. The resulting output produces a square wave whose frequency is varied by adjusting resistor R1. The operation of the second oscillator is the same as the first oscillator except that the value of capacitor C1 is 1,000 times smaller. This produces a frequency much higher than the first oscillator. The input of the second oscillator is modulated with the output of the first oscillator to produce the weird sounds of the Digital Bird.

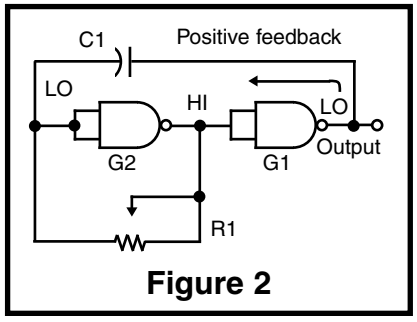


Figure 2

Audio Amplifier

Figure 3 shows the circuit of the audio amplifier used in the Digital Bird. This transistor circuit is known as an emitter follower. The output of the second oscillator is fed to the input base of the amplifier via capacitor C4. In a transistor, the base-emitter current is amplified in the collector-emitter circuit, usually about 100 times. Therefore, the speaker will produce a much amplified sound. The emitter of transistor Q1 supplies the power to the speaker. Resistor R5 is added to protect the transistor from excessive current. Resistor R4 is added to bias the transistor on.

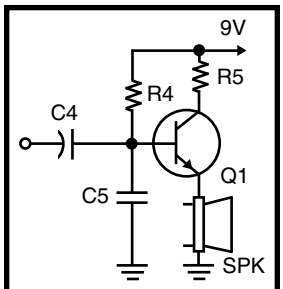


Figure 3

The R/C Circuit

There is an R/C network in both of the oscillators in the Digital Bird. These R/C circuits control the frequency of oscillation. The output of the first oscillator is a low frequency square wave. This square wave is fed to a third R/C network which drives the second oscillator. Resistor R2 and capacitor C2 make up this R/C network. Its function is to alter the square wave before it is mixed with the second oscillator. The resulting special effects voltages are fed to the audio amplifier stage through coupling capacitor C4. The function is to block the DC output of G3 while passing the desired AC pulse.

Note that the waveform of each of the three circuits, the two oscillators and the connecting R/C circuit, can be altered by varying potentiometer R1, R2, and R3. The results are the interesting special effect sounds which provide hours of entertainment.

CONSTRUCTION

Introduction

The most important factor in assembling your K-19 Digital Bird 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

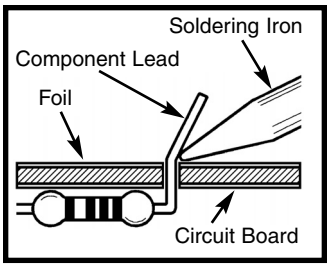
In all of the following assembly steps, the components must be installed on the top side of the PC board unless otherwise indicated. The top legend shows where each component goes. The leads pass through the corresponding holes in the board and are soldered on the foil side.
Use only rosin core solder.

DO NOT USE ACID CORE SOLDER!

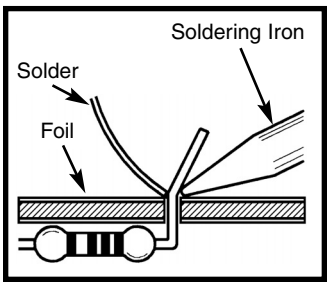
What Good Soldering Looks Like

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

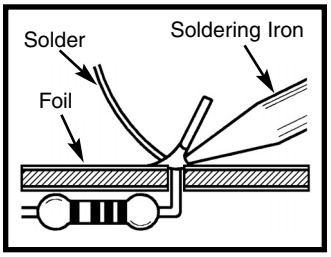
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.



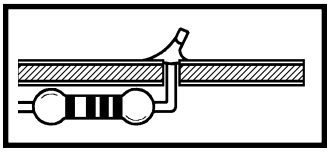
2. Apply a small amount of solder to the iron tip. This allows the heat to leave the iron and onto the foil. Immediately apply solder to the opposite side of the connection, away from the iron. Allow the heated component and the circuit foil to melt the solder.



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.

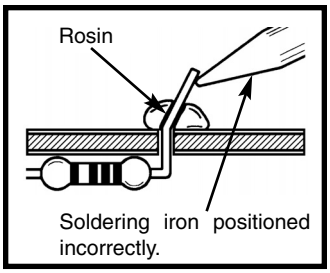


4. Here is what a good solder connection looks like.

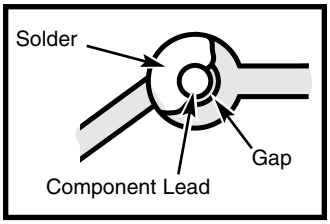


Types of Poor Soldering Connections

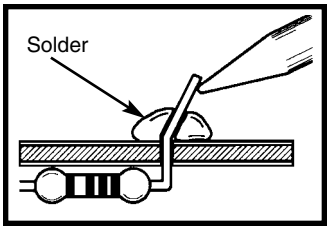
1. **Insufficient heat** - the solder will not flow onto the lead as shown.



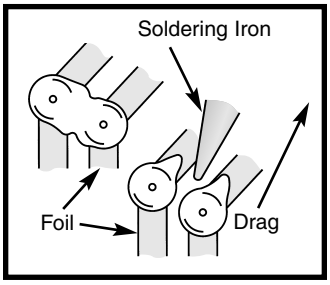
2. **Insufficient solder** - let the solder flow over the connection until it is covered.
Use just enough solder to cover the connection.



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

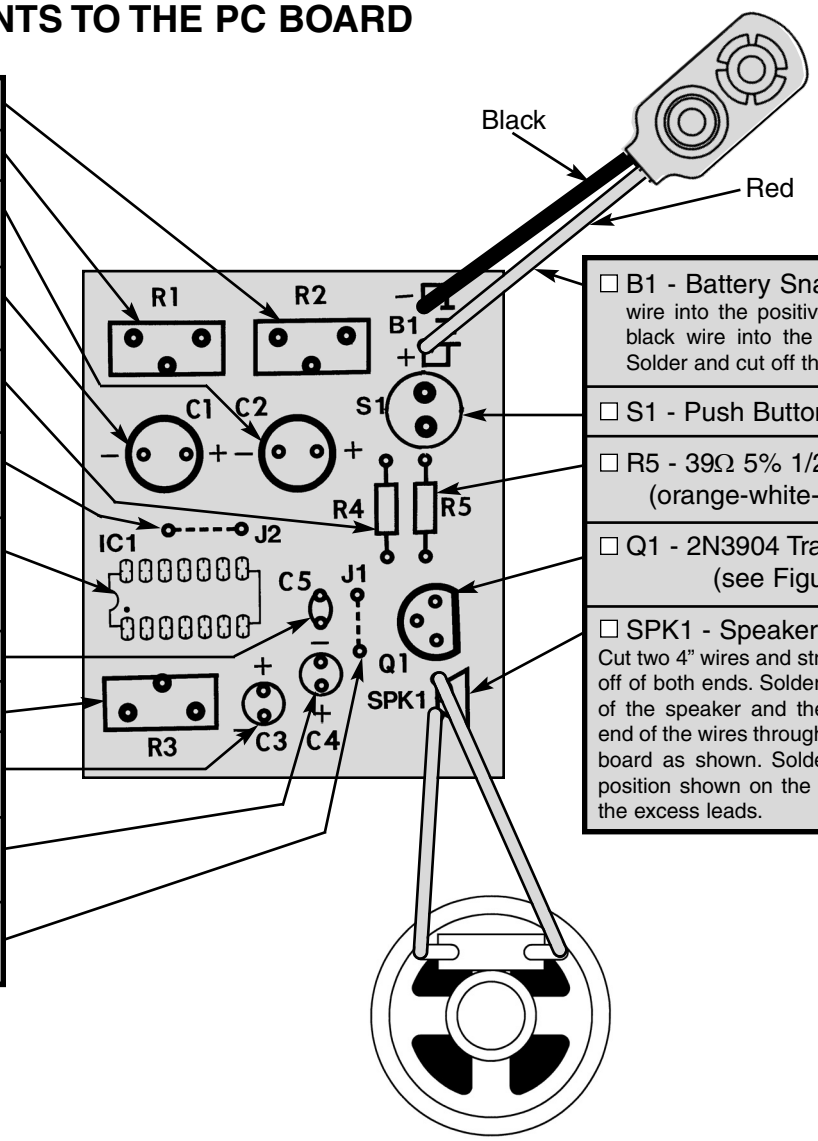


4. **Solder bridges** - occur when solder runs between circuit paths and creates a short circuit. This is usually caused by using too much solder.
To correct this, simply drag your soldering iron across the solder bridge as shown.



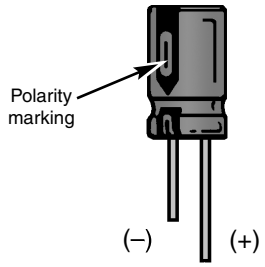
ASSEMBLE COMPONENTS TO THE PC BOARD

- ☐ R2 - 500Ω Potentiometer
- ☐ R1 - 500Ω Potentiometer
- ☐ C2 - 1000µF Electrolytic Cap. (see Figure A)
- ☐ C1 - 1000µF Electrolytic Cap. (see Figure A)
- ☐ R4 - 4.7kΩ 5% 1/4W Resistor (yellow-violet-red-gold)
- ☐ J2 - Jumper Wire (see Figure B)
- ☐ IC1 - 14-pin IC Socket
  IC1 - 4011 Integrated Circuit (see Figure C)
- ☐ C5 - 10pF Discap
- ☐ R3 - 500Ω Potentiometer
- ☐ C3 - 1µF Electrolytic Capacitor (see Figure A)
- ☐ C4 - 1µF Electrolytic Capacitor (see Figure A)
- ☐ J1 - Jumper Wire (see Figure B)



- ☐ B1 - Battery Snap - Install the red wire into the positive (+) hole and the black wire into the negative (–) hole. Solder and cut off the excess leads.
- ☐ S1 - Push Button Switch
- ☐ R5 - 39Ω 5% 1/2W Resistor (orange-white-black-gold)
- ☐ Q1 - 2N3904 Transistor (see Figure D)
- ☐ SPK1 - Speaker
  Cut two 4" wires and strip 1/8" of insulation off of both ends. Solder a wire to each lug of the speaker and then insert the other end of the wires through the hole in the PC board as shown. Solder the wires in the position shown on the top legend. Cut off the excess leads.

Figure A



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.

Figure B

Use an excess lead to form a jumper wire. Bend the wire to the correct length and mount it to the PC board.

Figure C

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.

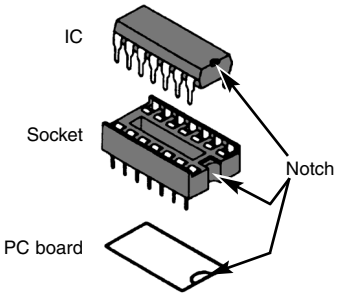
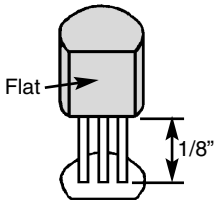


Figure D

Mount the transistors with the flat side in the same direction as marked on the PC board. Solder and cut off the excess leads.



OPERATION

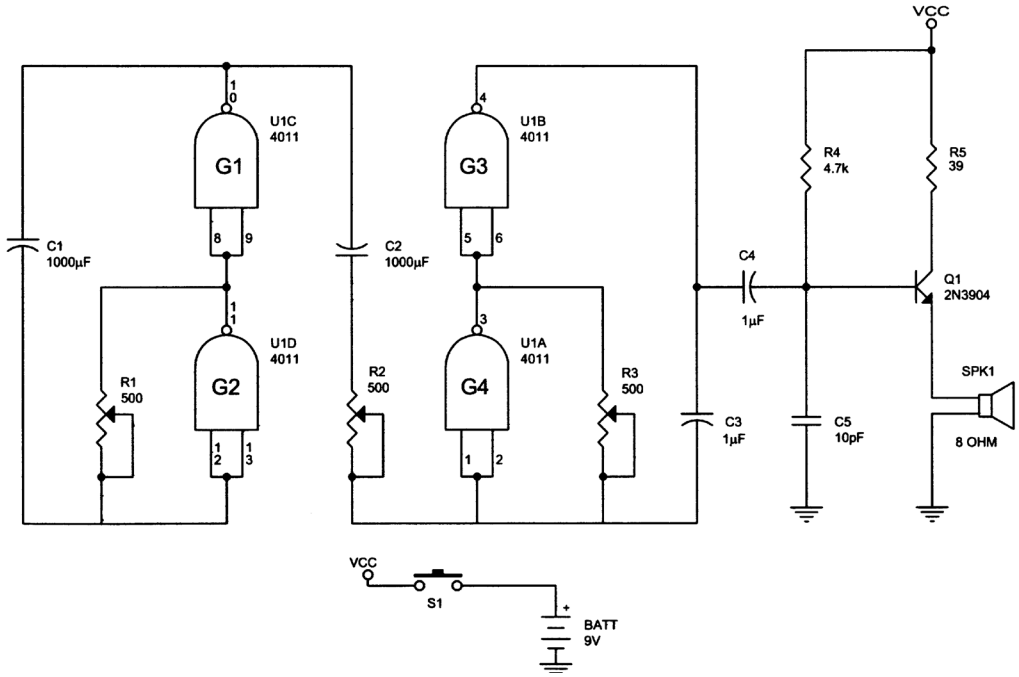
Install a 9-volt battery to the battery snap (B1). Adjust the potentiometer R1 so that the arrow is turned all of the way counter-clockwise. Adjust the potentiometers R2 and R3 so that the arrow is turned all of the way clockwise. Hold down the push button switch and the bird will sing. For varied sounds, adjust the potentiometers. Be creative, a variety of sounds can be created!

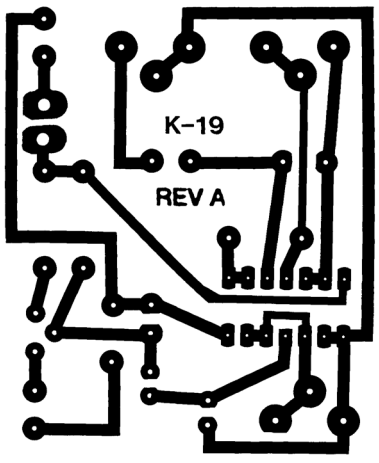
TROUBLESHOOTING

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) Make sure that C1-C4, the electrolytic capacitors, are mounted correctly. The negative lead should be in the hole as shown on the top legend.
   b) Make sure that U1 has been installed correctly. The notch of the IC is in the same direction as the notch on the socket.
   c) Pay close attention to the red and black wires of the battery snap. The red wire should be installed in the positive (+) hole and the black wire in the negative (–) hole. Snap in a fresh 9-volt battery.

SCHEMATIC DIAGRAM





Foil Side of PC Board

QUIZ

1. The Digital Bird uses four _____ to produce the birdy sounds.
2. There are _____ oscillators used in the Digital Bird.
3. The frequency of the oscillators are controlled by _____ circuits.
4. The frequency of the first oscillator is lower because the capacitor is _____ than the value used in the second oscillator.
5. The NAND gates are wired as _____.
6. An IC inverter, if the input is high, then the output will be _____.
7. To vary the frequency of the second oscillator, you must vary resistor _____.
8. The main component of the audio amplifier is the _____.
9. The speaker gets its power from the _____ of transistor Q1.
10. There are _____ variable resistor(s) in the Digital Bird.

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Answers: 1. NAND gates; 2. two; 3. R/C; 4. larger; 5. inverters; 6. low; 7. R2; 8. transistor; 9. emitter; 10. three