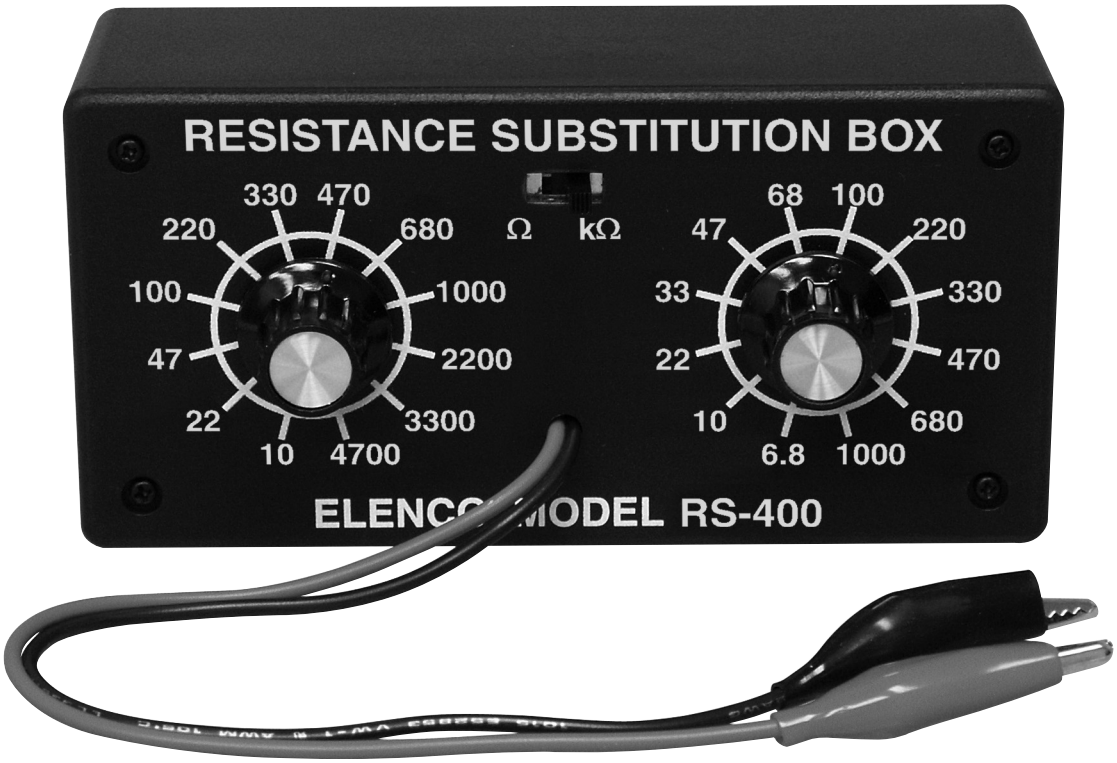
RESISTANCE SUBSTITUTION BOX

MODEL K-37



Assembly and Instruction Manual

Elenco® Electronics, Inc.

 Revised 2009 REV-A 753400

The Resistance Substitution Box is a convenient instrument in determining the desired resistance values in circuits under design or test. The values selected for your resistance substitution box were determined to be the most commonly used in modern solid-state circuits. The values are from 10Ω to 1,000kΩ (1 meg) in 24 steps. All resistors are 5% tolerance 1/2 watt.

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® Electronics (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

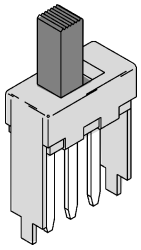
Qty.	Symbol	Description	Color Code	Part #
❒ 1	R1	10Ω 5% 1/2W	brown-black-black-gold	121001
❒ 1	R2	22Ω 5% 1/2W	red-red-black-gold	122201
❒ 1	R3	47Ω 5% 1/2W	yellow-violet-black-gold	124701
❒ 1	R4	100Ω 5% 1/2W	brown-black-brown-gold	131001
❒ 1	R5	220Ω 5% 1/2W	red-red-brown-gold	132201
❒ 1	R6	330Ω 5% 1/2W	orange-orange-brown-gold	133301
❒ 1	R7	470Ω 5% 1/2W	yellow-violet-brown-gold	134701
❒ 1	R8	680Ω 5% 1/2W	blue-gray-brown-gold	136801
❒ 1	R9	1kΩ 5% 1/2W	brown-black-red-gold	141001
❒ 1	R10	2.2kΩ 5% 1/2W	red-red-red-gold	142201
❒ 1	R11	3.3kΩ 5% 1/2W	orange-orange-red-gold	143301
❒ 1	R12	4.7kΩ 5% 1/2W	yellow-violet-red-gold	144701
❒ 1	R13	6.8kΩ 5% 1/2W	blue-gray-red-gold	146801
❒ 1	R14	10kΩ 5% 1/2W	brown-black-orange-gold	151001
❒ 1	R15	22kΩ 5% 1/2W	red-red-orange-gold	152201
❒ 1	R16	33kΩ 5% 1/2W	orange-orange-orange-gold	153301
❒ 1	R17	47kΩ 5% 1/2W	yellow-violet-orange-gold	154701
❒ 1	R18	68kΩ 5% 1/2W	blue-gray-orange-gold	156801
❒ 1	R19	100kΩ 5% 1/2W	brown-black-yellow-gold	161001
❒ 1	R20	220kΩ 5% 1/2W	red-red-yellow-gold	162201
❒ 1	R21	330kΩ 5% 1/2W	orange-orange-yellow-gold	163301
❒ 1	R22	470kΩ 5% 1/2W	yellow-violet-yellow-gold	164701
❒ 1	R23	680kΩ 5% 1/2W	blue-gray-yellow-gold	166801
❒ 1	R24	1MΩ 5% 1/2W	brown-black-green-gold	171001

MISCELLANEOUS

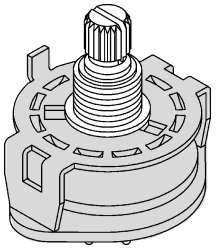
Qty.	Description	Part #
❒ 1	PC Board	517007
❒ 1	Switch SPDT PC Mount	541103
❒ 2	Switch 12 Position	542013
❒ 2	Knob	622009
❒ 1	Case with Cover	62RS400
❒ 4	Screw 4 x 1/2” Phil A	642465
❒ 2	Nut 9mm	644102
❒ 2	Washer 9mm x 15mm	645103
❒ 1	Alligator Clip Black	680001
❒ 1	Alligator Clip Red	680002
❒ 1	Wire Black Stranded 12”	814210
❒ 1	Wire Red Stranded 12”	814215
❒ 1	Solder Lead-free	LF99

PARTS IDENTIFICATION

Switch PC Mount



Switch 12 Position

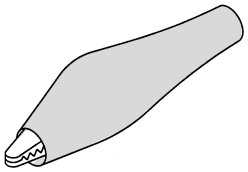


9mm Nut

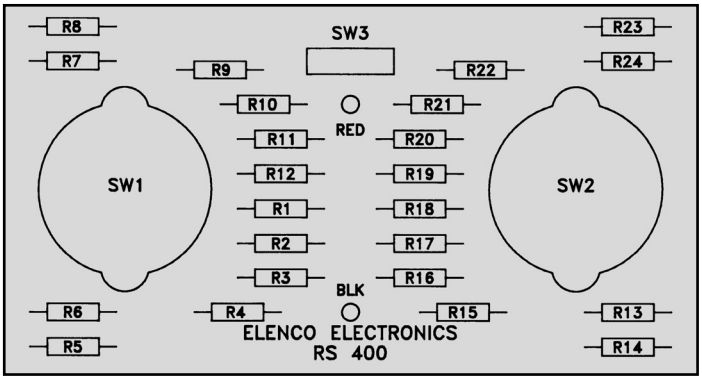
Washer

Resistor

Alligator Clip



PC Board



IDENTIFYING RESISTOR VALUES

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

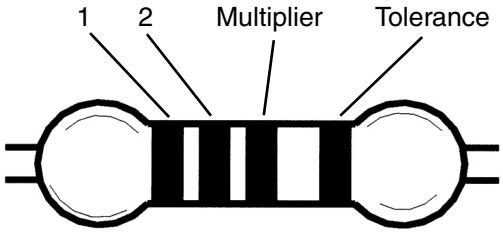
BAND 1 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

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



CONSTRUCTION

Introduction

The most important factor in assembling your K-37 Resistance Substitution Box 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

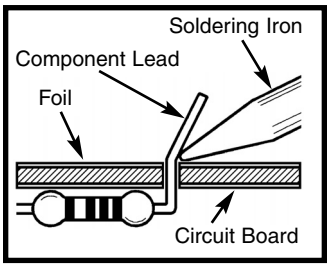
In all of the following assembly steps, the components must be installed on the top side of the PC board unless otherwise indicated. The top legend shows where each component goes. The leads pass through the corresponding holes in the board and are soldered on the foil side.
Use only rosin core solder.

DO NOT USE ACID CORE SOLDER!

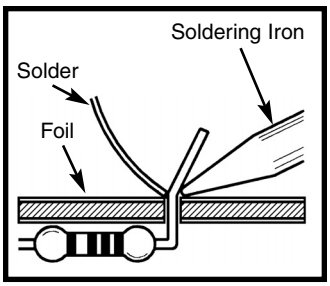
What Good Soldering Looks Like

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

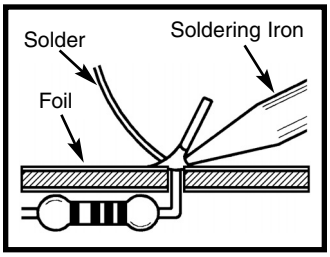
1. Solder all components from the copper foil side only. Push the soldering iron tip against both the lead and the circuit board foil.



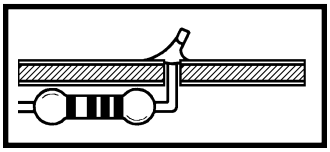
2. Apply a small amount of solder to the iron tip. This allows the heat to leave the iron and onto the foil. Immediately apply solder to the opposite side of the connection, away from the iron. Allow the heated component and the circuit foil to melt the solder.



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.

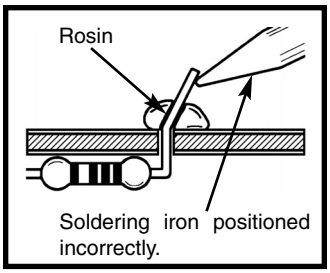


4. Here is what a good solder connection looks like.

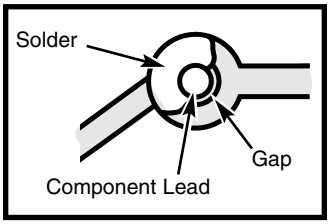


Types of Poor Soldering Connections

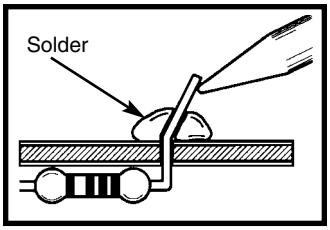
1. **Insufficient heat** - the solder will not flow onto the lead as shown.



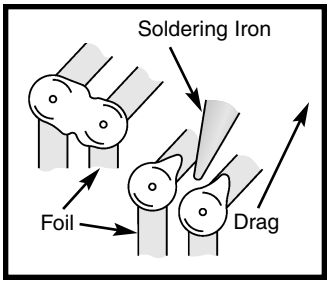
2. **Insufficient solder** - let the solder flow over the connection until it is covered.
Use just enough solder to cover the connection.



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.



ASSEMBLY INSTRUCTIONS

Begin the PC board assembly with resistor R12. Be sure to identify the correct value by reading the color code. Place the resistor into the PC board with the leads coming out on the copper foil side. Solder in place and clip off the excess leads, close to the connection.

☐ R12 - 4.7kΩ 5% 1/2W Resistor (yellow-violet-red-gold)

☐ R11 - 3.3kΩ 5% 1/2W Resistor (orange-orange-red-gold)

☐ R10 - 2.2kΩ 5% 1/2W Resistor (red-red-red-gold)

☐ R8 - 680Ω 5% 1/2W Resistor (blue-gray-brown-gold)

☐ R7 - 470Ω 5% 1/2W Resistor (yellow-violet-brown-gold)

☐ R9 - 1kΩ 5% 1/2W Resistor (brown-black-red-gold)

☐ R1 - 10Ω 5% 1/2W Resistor (brown-black-black-gold)

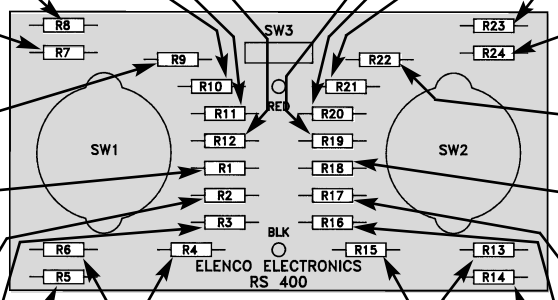
☐ R2 - 22Ω 5% 1/2W Resistor (red-red-black-gold)

☐ R3 - 47Ω 5% 1/2W Resistor (yellow-violet-black-gold)

☐ R5 - 220Ω 5% 1/2W Resistor (red-red-brown-gold)

☐ R6 - 330Ω 5% 1/2W Resistor (orange-orange-brown-gold)

☐ R4 - 100Ω 5% 1/2W Resistor (brown-black-brown-gold)



☐ R19 - 100kΩ 5% 1/2W Resistor (brown-black-yellow-gold)

☐ R20 - 220kΩ 5% 1/2W Resistor (red-red-yellow-gold)

☐ R21 - 330kΩ 5% 1/2W Resistor (orange-orange-yellow-gold)

☐ R23 - 680kΩ 5% 1/2W Resistor (blue-gray-yellow-gold)

☐ R24 - 1MΩ 5% 1/2W Resistor (brown-black-green-gold)

☐ R22 - 470kΩ 5% 1/2W Resistor (yellow-violet-yellow-gold)

☐ R18 - 68kΩ 5% 1/2W Resistor (blue-gray-orange-gold)

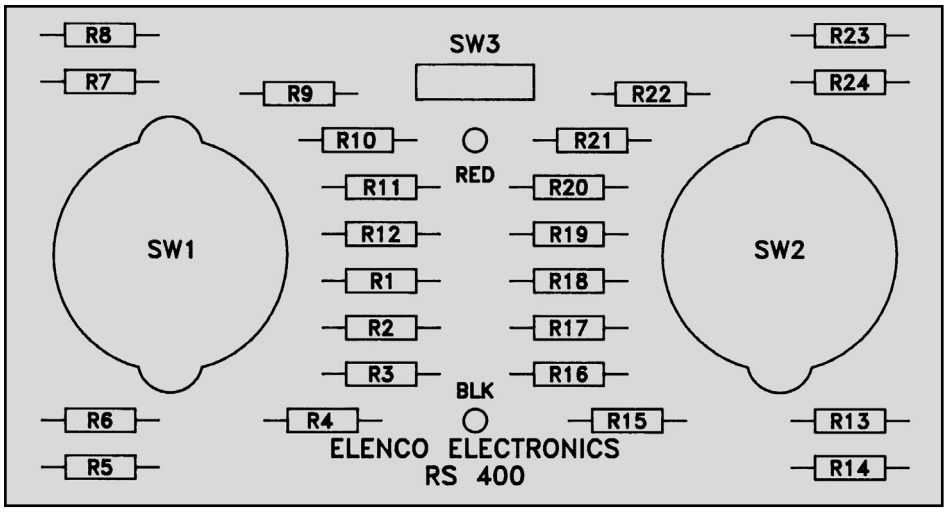
☐ R17 - 47kΩ 5% 1/2W Resistor (yellow-violet-orange-gold)

☐ R16 - 33kΩ 5% 1/2W Resistor (orange-orange-orange-gold)

☐ R14 - 10kΩ 5% 1/2W Resistor (brown-black-orange-gold)

☐ R13 - 6.8kΩ 5% 1/2W Resistor (blue-gray-red-gold)

☐ R15 - 22kΩ 5% 1/2W Resistor (red-red-orange-gold)



❒ SW3 - PC Mount Switch

Mount SW3 in the place shown on the PC board. Solder into place.

❒ Red Test Lead

❒ Black Test Lead

Cut off 1 1/2” of wire off of both the red and black wires (SAVE them for later use). Strip 1/4” of insulation off both ends of the 10 1/2” red and black wires and insert them into the holes as marked on the PC board. Solder into place. Tie a knot with both wires 1 1/2” from the surface of the PC board as shown in Figure 1. Pull the wires through the hole in the cover. Slide the alligator boots onto the wires. Solder the wires to the alligator clips. Then, slide the boots onto the clips.

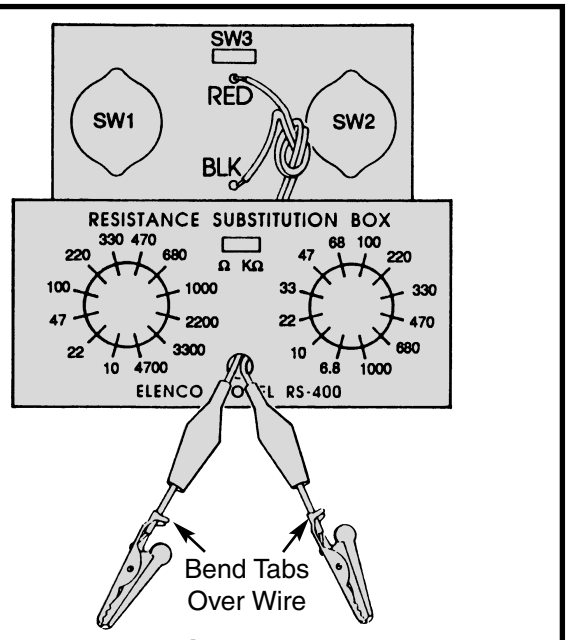


Figure 1

❒ SW1

❒ SW2

Bend the tab on the switches down (see Figure 2). Attach the two switches loosely to the front panel with the 9mm nuts and washers. Line up the holes of the PC board with the switch lugs, as shown in Figure 3. Be sure that the board lays flat, then solder the lugs into place. Tighten down the 9mm nuts.

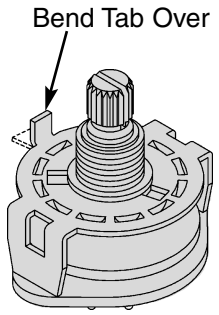


Figure 2

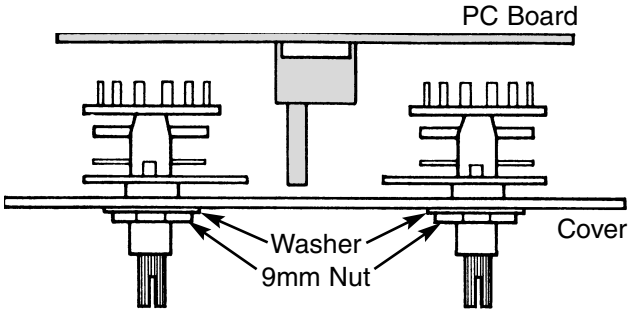


Figure 3

❒ Jumper wire from SW1

❒ Jumper wire from SW2

Strip 1/4” of insulation off of both ends of the 1 1/2” red and black wires. Solder one end of the wire to the wiper pin on the 12 position switches and the other to the pad without a hole, as shown in Figure 4.

❒ Installation of Knobs if an Ohmmeter is Available

Place the knobs loosely on the switch posts. Push the slide switch to the “Ω” position. Connect an ohmmeter to the output. Line up the pointer of the knob with the value shown on your meter, then push the knob onto the shaft. Push the slide switch to the “KΩ” position and repeat the same procedure.

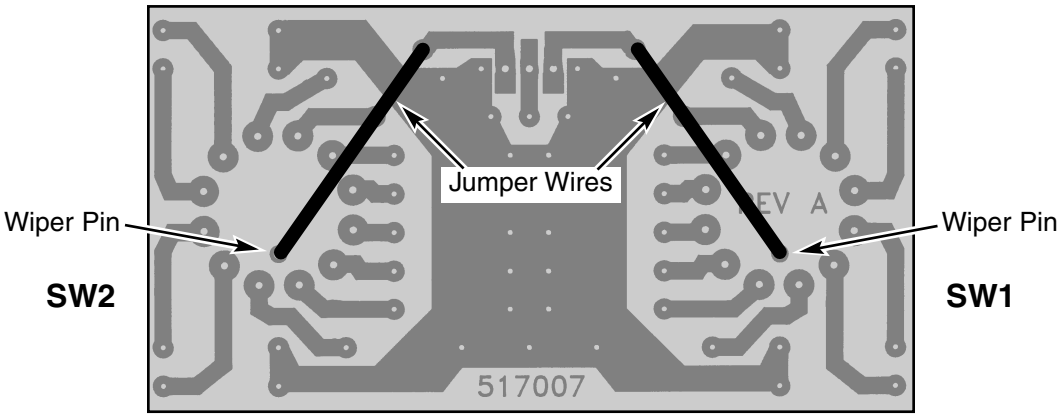


Figure 4

❒ Installation of Knobs without an Ohmmeter

If an ohmmeter is not available, turn both switches so that the wiper contact is in the position shown in Figure 5. Start with switch SW1, follow the copper run on the PC board from the lug in contact with the wiper to the 470Ω (R7) resistor, to be sure that the switch is set in the proper position. Align the knob on the SW1 (Ω) switch to the 470 position, push the knob onto the shaft. Follow the same procedure for switch SW2 (KΩ), except follow the copper run to the 6.8KΩ (R13) resistor. Align the knob on the SW2 (KΩ) switch to the 6.8 position.

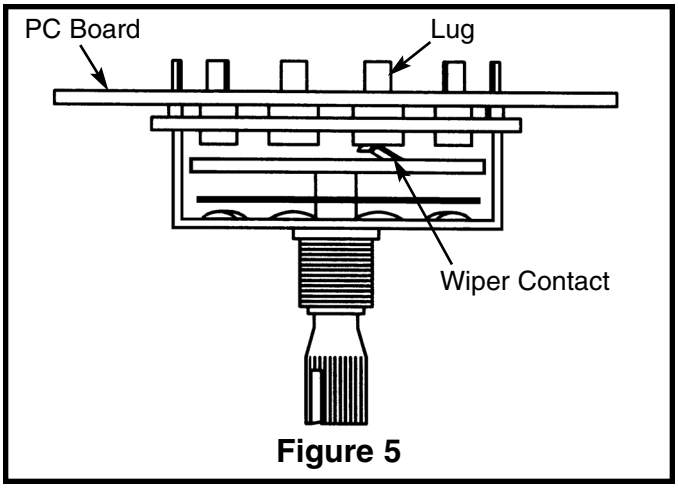


Figure 5

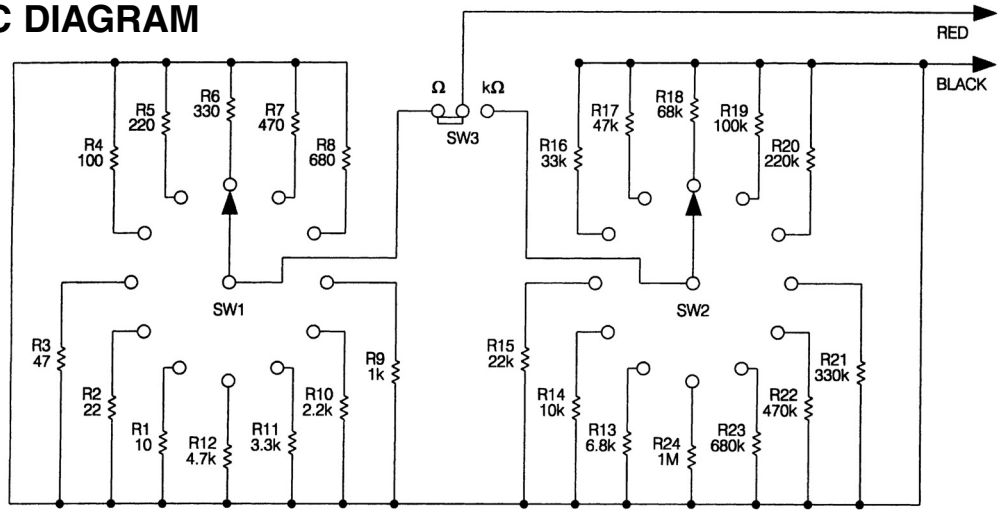
TESTING THE CIRCUIT

The following test is to be made with your meter to determine that the resistors are in their correct circuit positions. The resistors used in your circuit are gold banded with a tolerance of ±5%. That means that a 10kΩ resistor could measure between 9,500Ω and 10,500Ω and be correct. Each of the 24 resistance value positions will be tested and recorded in the chart below.

SW1 Ω POSITION	
Value Position	Meter Reading
10Ω	
22Ω	
47Ω	
100Ω	
220Ω	
330Ω	
470Ω	
680Ω	
1000Ω	
2200Ω	
3300Ω	
4700Ω	

SW2 KΩ POSITION	
Value Position	Meter Reading
6.8KΩ	
10KΩ	
22KΩ	
33KΩ	
47KΩ	
68KΩ	
100KΩ	
220KΩ	
330KΩ	
470KΩ	
680KΩ	
1MΩ	

SCHEMATIC DIAGRAM



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