

2024 Electric Kit Assembly

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**“We Bring
Engineering
to Life”**

Electric Kit Objectives

- Learn to read and follow an electric schematic
- Identify electronic circuit components
- Function of circuit components (Electric Guide IV)
- How to solder correctly
- Electric activity to assist with promoting the program
- Promote Science and Technology

2024 Electric Kit

- Temperature Warning Kit
- Counties interested in obtaining the kits will need a volunteer, Agent or PA to assemble the kit for eligibility
- Promote Science and Technology

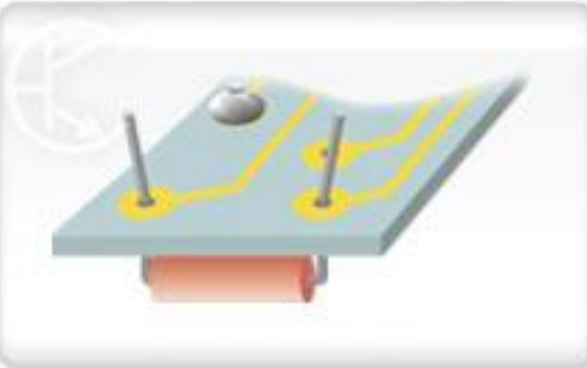
Safety First: How to use a soldering iron

- Soldering joins metals to make electrical and mechanical connections.
- Solder is an alloy of metals which can include tin, copper, silver, and lead.
- Soldering irons are used to melt solder and can reach temperatures of 600-700 degrees Fahrenheit.
- Irons should always be positioned in the stand when not in use.
- Always wash your hands once the activity is completed.

HOW TO: Basic Soldering Techniques for Kit Building



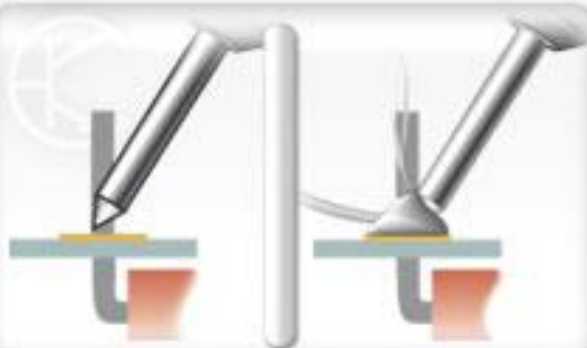
1. Assemble the proper tools.



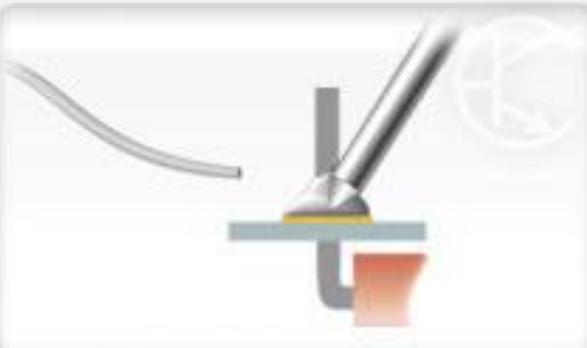
2. Mount component by bending leads out slightly.



3. Heat iron. Clean tip with damp sponge.



4. Apply heat. Apply solder.



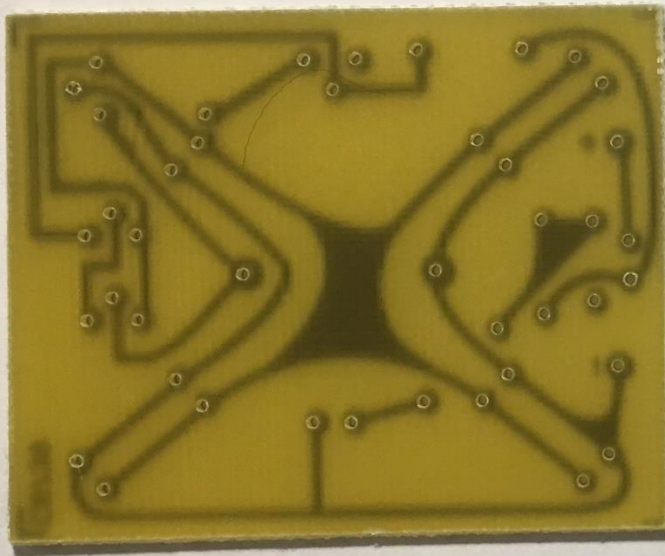
5. Remove solder. Remove iron.



6. Inspect solder. Cut lead.

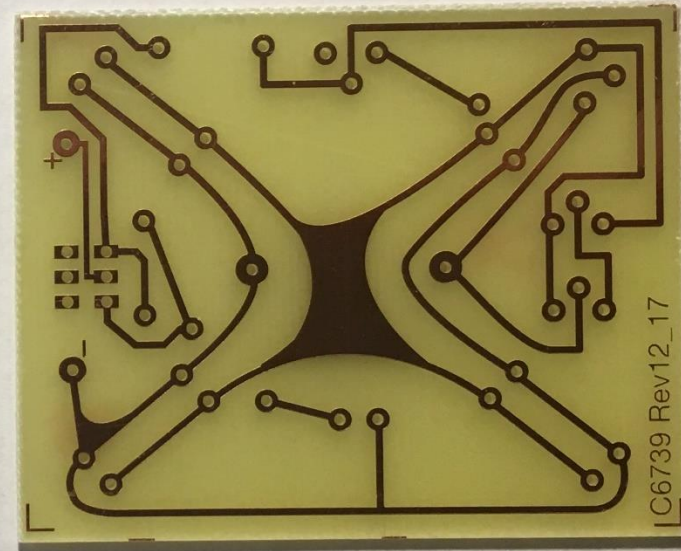
Typical PC (Printed Circuit) Board Orientation

Front Side



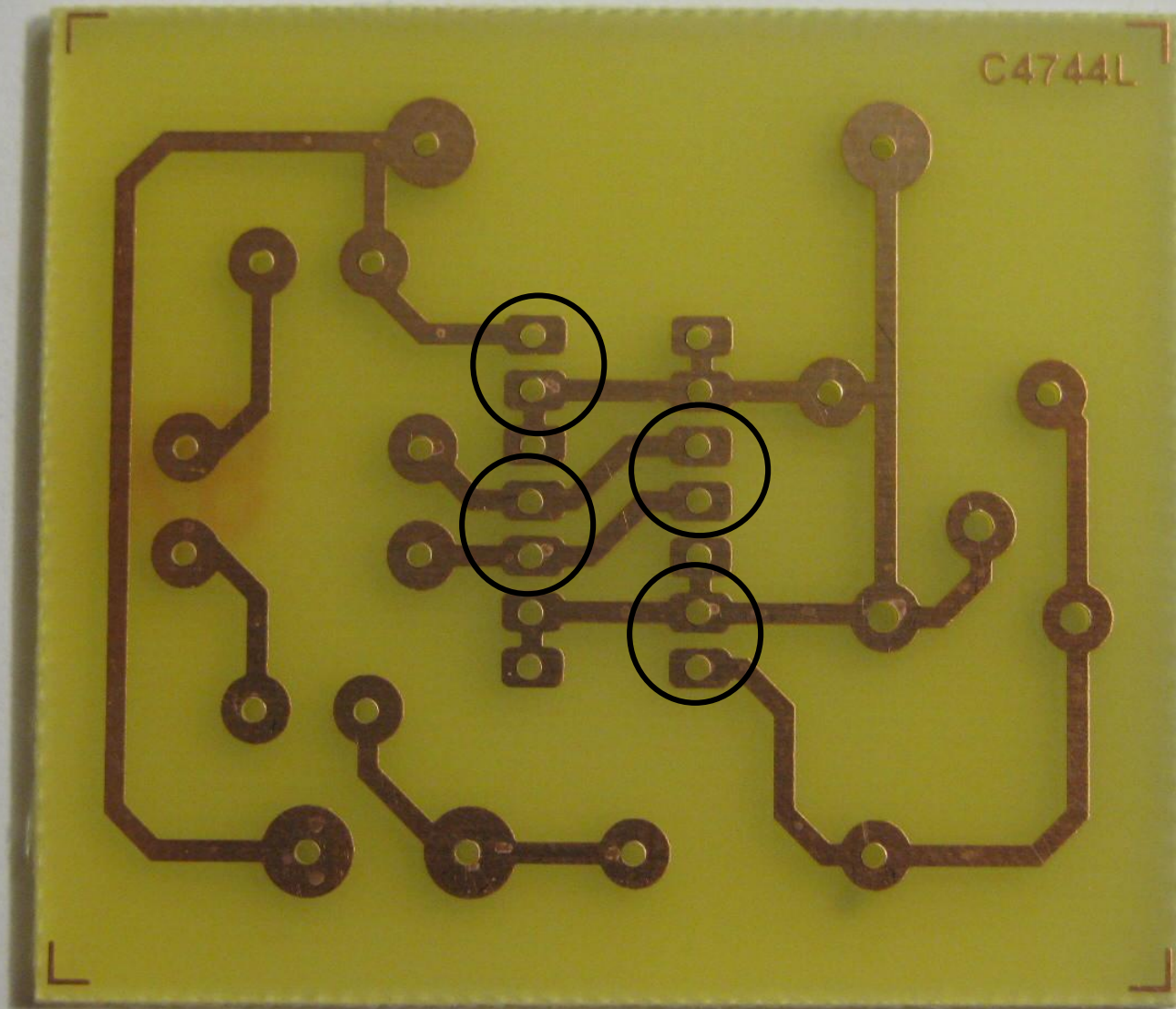
Components positioned
on the board *Front side*.

Back Side



Components soldered
on the board *Back side*.

Note the holes circled are not connected by the copper foil to the adjacent hole above and/or below. Be careful to avoid solder bridges at these locations.



Correct Solder Joints

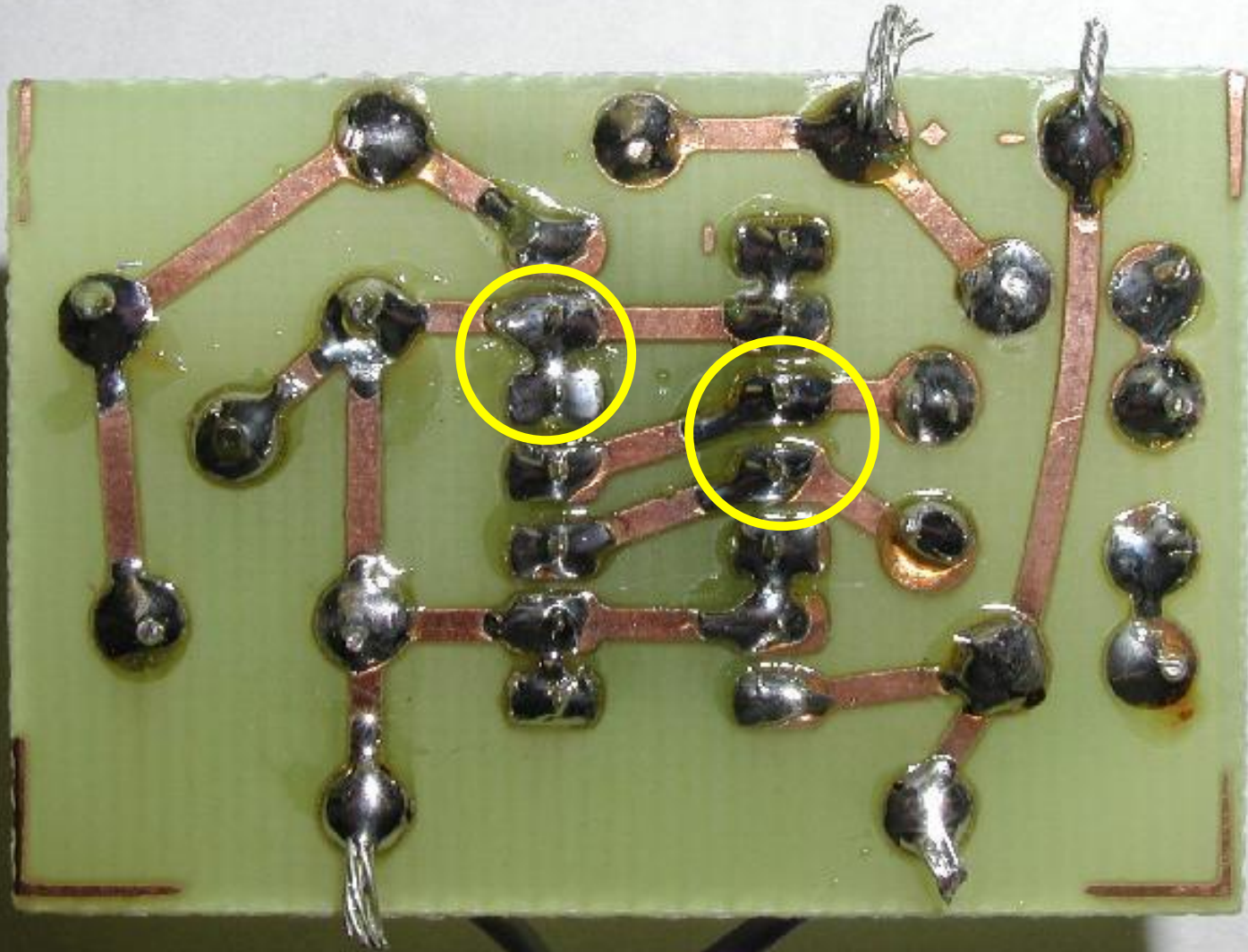
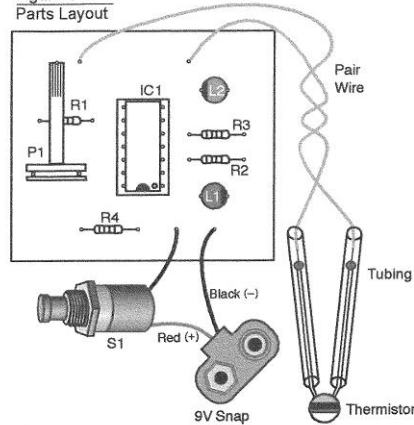
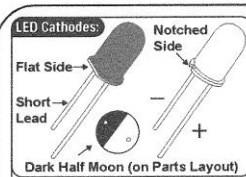


Figure 1
Parts Layout



PARTS LIST

- IC1 _____ 4001 or 14001 CMOS IC
- L1 _____ Red Jumbo LED
- L2 _____ Green Jumbo LED
- P1 _____ 50K Ω Vertical Trimmer Resistor
- R1 _____ 470K Ω Resistor
- R2, R3 _____ 200 Ω Resistor
- R4 _____ 100 Ω Resistor
- S1 _____ N.O. Push-button Switch
- T1 _____ Thermistor
- Misc. _____ 9V Snap, 14 Pin IC Socket,
Wire, Pair Wire, PC Board,
Heat Shrink



There are three main ways to determine the cathode side of the LED. The Parts Layout will indicate the cathode side of the LED by a dark half moon shape. On the physical part, usually, the cathode can be identified by one of three ways:

- 1) The lens of the LED has a flat side when viewed from the top (sometimes difficult to see).
- 2) The shorter lead of the LED.
- 3) If there is no flat side on the LED, there will be a notch in the lens of the LED.

Please Note: Some LEDs may have both a flat side and a notched side. With these LEDs, always use the flat side to locate the cathode of the LED.

Figure 2
LED (cathode) information

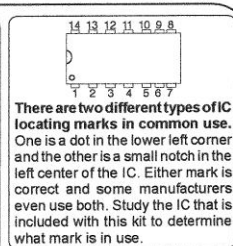


Figure 3
IC Locating Marks

RESISTOR COLOR CODE

BAND COLOR	1st DIGIT	2nd DIGIT	MULTIPLIER
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000 Ω
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000 (M)
VIOLET	7	7	10,000,000
GREY	8	8	100,000,000
WHITE	9	9	1,000,000,000

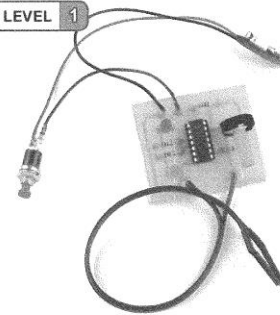
*TOLERANCE: NO COLOR 20%; SILVER 10%; GOLD 5%

Figure 4
Resistor Color Code



C6908 - TEMPERATURE WARNING KIT

SKILL LEVEL 1



SOLDERING PRECAUTIONS

Electronic components in this kit are solder plated. Solder contains lead and therefore, do not put components in your mouth. Always wash your hands after working with components. Students under the age of 13 should not build this kit. Soldering requires adult supervision.

Assembly Instructions

C6908 TEMPERATURE WARNING KIT

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Tools Needed for Assembly:

- Small Pencil type soldering iron (40 watts rating or less)
- Pair of wire cutters, a screwdriver & needle nose pliers
- Pair of safety goggles or safety eyeglasses
- Damp sponge
- Fresh Rosin or Resin Core Tin/Lead solder

ASSEMBLY INSTRUCTIONS

1. Assemble per Parts Layout (Figure 1), Parts List and Schematic (Figure 6) using rosin or resin core solder only. Make sure to wear your safety eyeglasses or goggles before you start assembly.
2. Install IC socket. Observe locating mark on IC (see Figure 3 for IC locating marks info) and cathode side on LEDs when installing these components. Refer to Figure 2 if you need help locating the cathode of the LEDs. Install resistors per Resistor Color Code. Install P1, S1 and battery snap.
3. Cut heat shrink tubing in half. Slip one piece over each lead of pair wire (Figure 7). Solder one thermistor leg to one lead of pair wire then solder the other leg to the other pair wire lead. Finally slip heat shrink tubing over solder joints and flush with thermistor body, then heat with the hot tip of a soldering iron. Now install other end of pair wire onto PC board as shown.
4. To operate, place thermistor body (not entire kit) into the freezer section of the refrigerator, wait 5 minutes, press push-button and rotate control P1 until red LED just comes on. Release push-button and remove from freezer. After a few minutes press button, the Green LED will come on indicating that temperature is above freezing. Now without changing the control setting, place thermistor back into freezer for 5 minutes. Do NOT touch control P1 but press button on switch S1. The Red LED should come on indicating a freezing temperature. The kit can be used to warn of freezing temperatures impacting outside garden plants and trees. Just run a long enough cable to mount the thermistor outside. Now, if you press the button anytime day or night and the Red LED comes on, it will indicate a temperature of 32° or less outside. If the Green LED comes on it's above 32°. The kit can also be used to indicate a variance in a desired room temperature. Set kit in a room, let the thermistor sit for 5 minutes undisturbed. Now press button on S1 and adjust control P1 until Green LED just goes out and Red LED now comes on. Without adjusting control P1 press button and the Red LED will light up. Now while holding the push-button down with one hand grasp the end of the thermistor with your fingers from your other hand. Within several seconds you will see the Red LED go out and the Green LED will come on. This indicates a rise in temperature (of course it was caused by your body heat), however once calibrated, the kit will indicate a room that is normal (Red LED on) or hotter than calibration temperature (Green LED on).

THEORY OF OPERATION

The C6908 Temperature Warning Kit uses a quad 2 input NOR gate IC and a thermistor to test the temperature. This thermistor is a negative coefficient type which means its resistance drops as it is heated. Assume that the control trimmer resistor P1 has been adjusted to calibrate for a known temperature. If we now turn on push-button switch S1 one of two events will occur:

1. The temperature will be lower. This causes the resistance of the thermistor to be higher than what the unit was calibrated for, causing the first NOR gate output to go "high", therefore lighting red LED L1, causing the second NOR gate output to go "low", which causes green LED L2 to turn off.
2. If the temperature is higher than what the kit was calibrated, the thermistor resistance will be low enough to keep the first NOR gate turned "off", which causes the second NOR gate output to stay high turning green LED L2 on.

Each LED is made of a PN junction of special semiconductor material that has the ability to convert electrons directly into photons (visible light). Since LEDs have PN junctions, they have a polarity that must be observed (marked by a flat side, cathode-negative) and the current flowing through them must be limited (this is the purpose of resistors R2 and R3).

TROUBLESHOOTING HINTS

1. First of all, make sure that the solder used to build the kit was rosin or rosin core. If acid core solder was used, the kit will be conducting high voltage to various points where it should not and the kit will be **DESTROYED**. **PLEASE NOTE:** We cannot repair any kit that was assembled using acid core solder!
2. Recheck all resistors against Resistor Color Code (Figure 4) and Parts Layout (Figure 1).
3. Look for solder bridges by comparing actual foil on PC board to Foil Pattern (Figure 5).
4. Check for cold solder joints and reheat, adding solder to any suspect connections.
5. Make sure that the battery snap has been installed with polarity as shown (Figure 1). Is your battery good?
6. Check to make sure that the IC has been installed with locating mark(s) in direction shown (Figure 1).
7. Recheck all LEDs to make sure that the cathode sides are facing direction shown on Parts Layout (Figure 1).
8. If your kit still does not operate, recheck all assembly instructions. If everything is correct, return your kit per our repair policy.

Assembly Instructions

C6908 TEMPERATURE WARNING KIT

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Figure 5
Foil Pattern of PC board

FOIL PATTERN OF PC BOARD

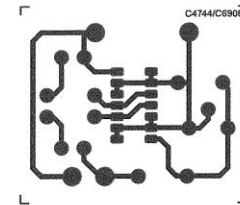


Figure 6
Schematic

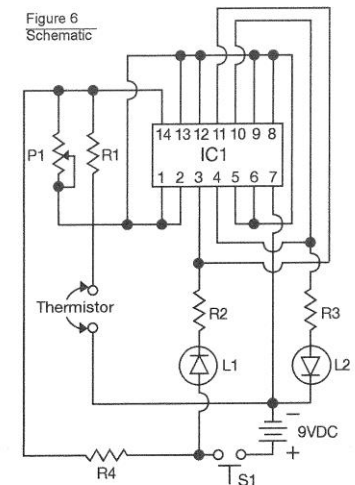
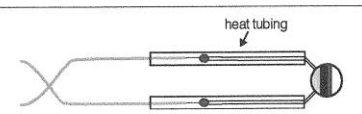
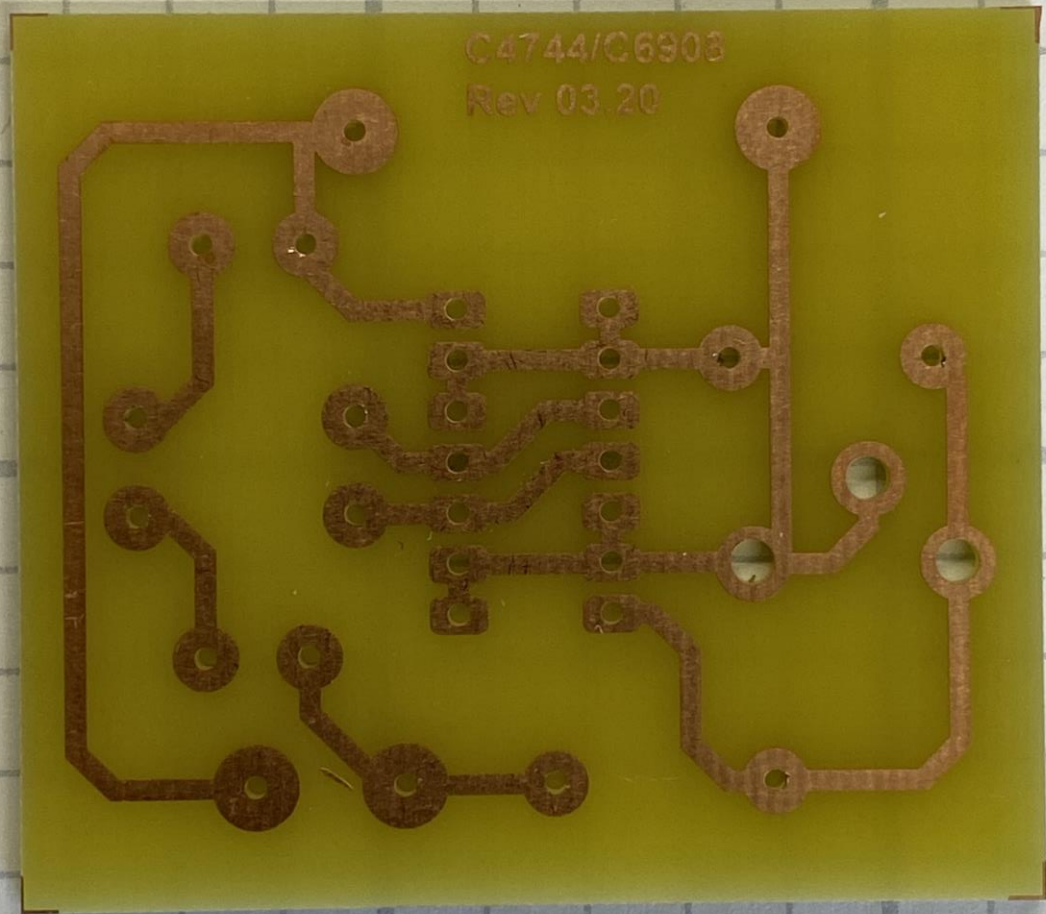


Figure 7
Placing heat shrink
over pair wire

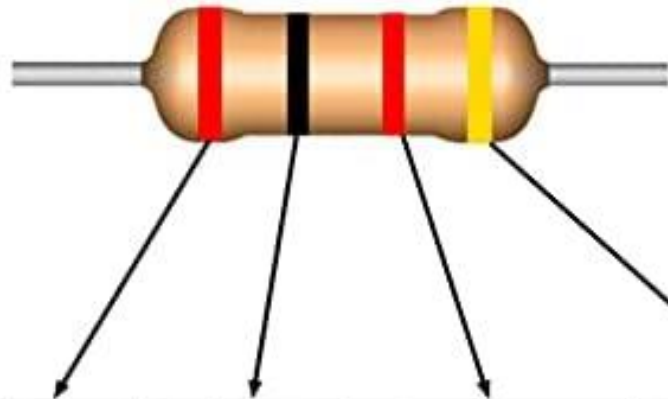


Figure 8
Heating tubing over
solder points





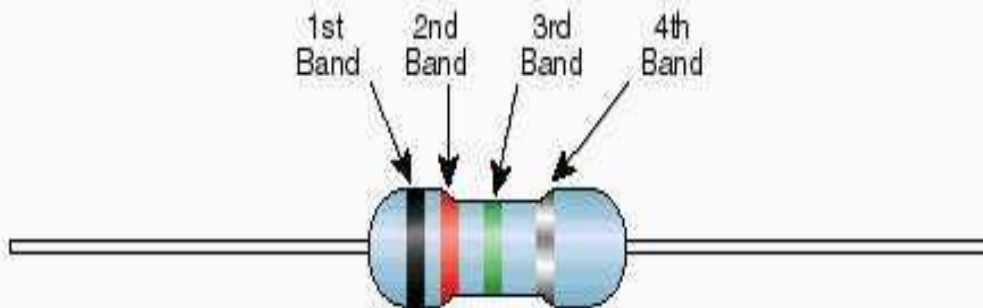
C4744/C6908
Rev 03.20



COLOR	1 st DIGIT	2 nd DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	0	1Ω	
BROWN	1	1	10Ω	± 1% (F)
RED	2	2	100Ω	± 2% (G)
ORANGE	3	3	1kΩ	± 3%
YELLOW	4	4	10kΩ	± 4%
GREEN	5	5	100kΩ	± 0.5% (D)
BLUE	6	6	1MΩ	± 0.25% (C)
VIOLET	7	7	10MΩ	± 0.10% (B)
GREY	8	8	100MΩ	± 0.05% (A)
WHITE	9	9	1GΩ	
GOLD			0.1Ω	± 5% (J)
SILVER			0.01Ω	± 10% (K)

Resistors

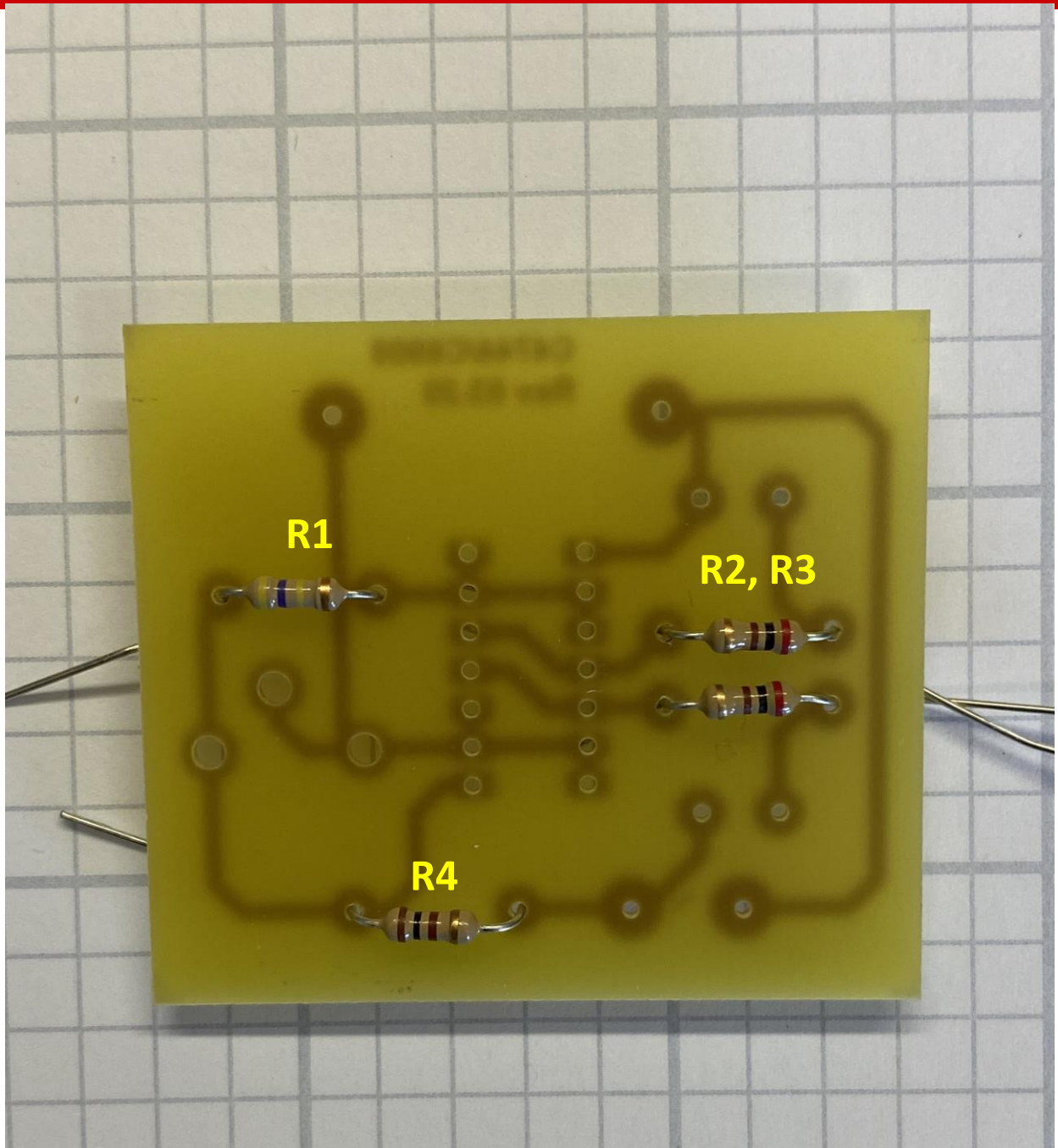
Standard EIA Color Code Table 4 Band: $\pm 2\%$, $\pm 5\%$, and $\pm 10\%$



Color	1st Band (1st figure)	2nd Band (2nd figure)	3rd Band (multiplier)	4th Band (tolerance)
Black	0	0	10^0	
Brown	1	1	10^1	
Red	2	2	10^2	$\pm 2\%$
Orange	3	3	10^3	
Yellow	4	4	10^4	
Green	5	5	10^5	
Blue	6	6	10^6	
Violet	7	7	10^7	
Gray	8	8	10^8	
White	9	9	10^9	
Gold			10^{-1}	$\pm 5\%$
Silver			10^{-2}	$\pm 10\%$

Resistors are electrical components that impede the flow of electrons. The measurement unit for resistance is an *Ohm* (Ω).

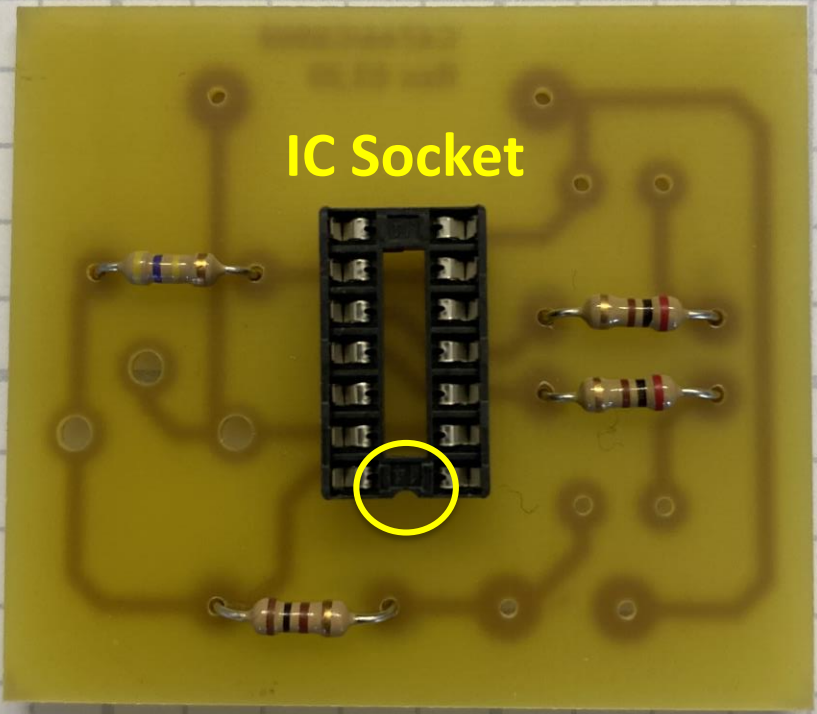
$$1\text{k}\Omega = 1,000 \Omega$$



R1

R2, R3

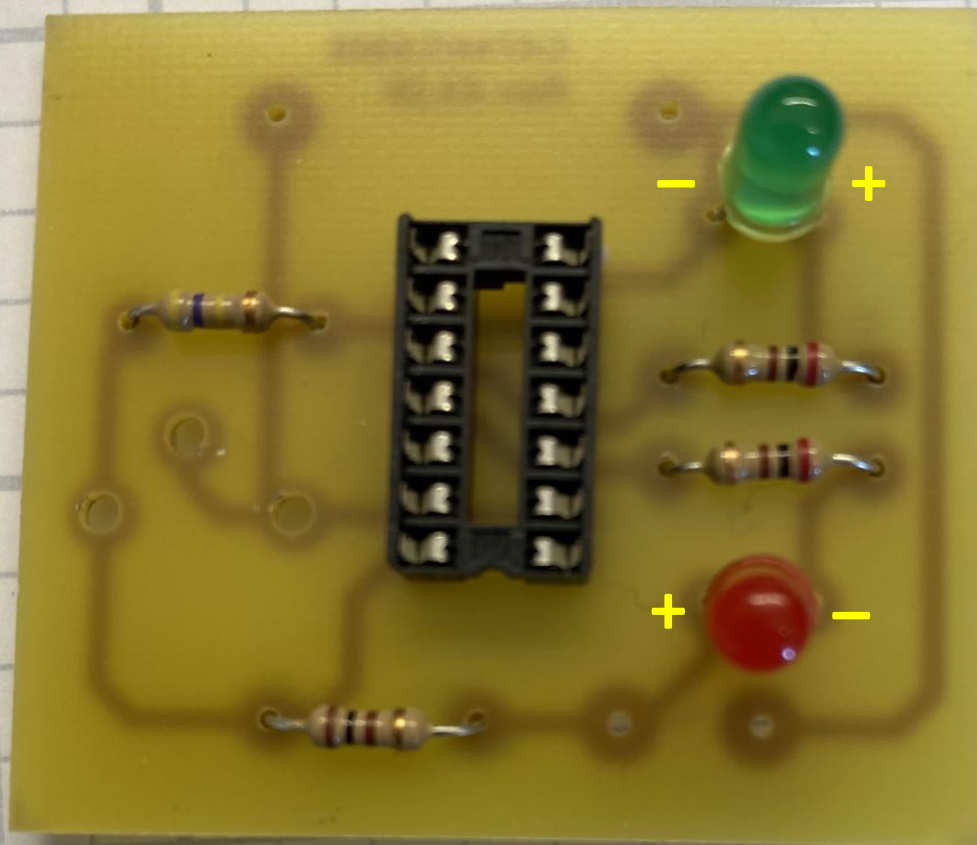
R4



IC Socket



LEDs (short leg is “-”)



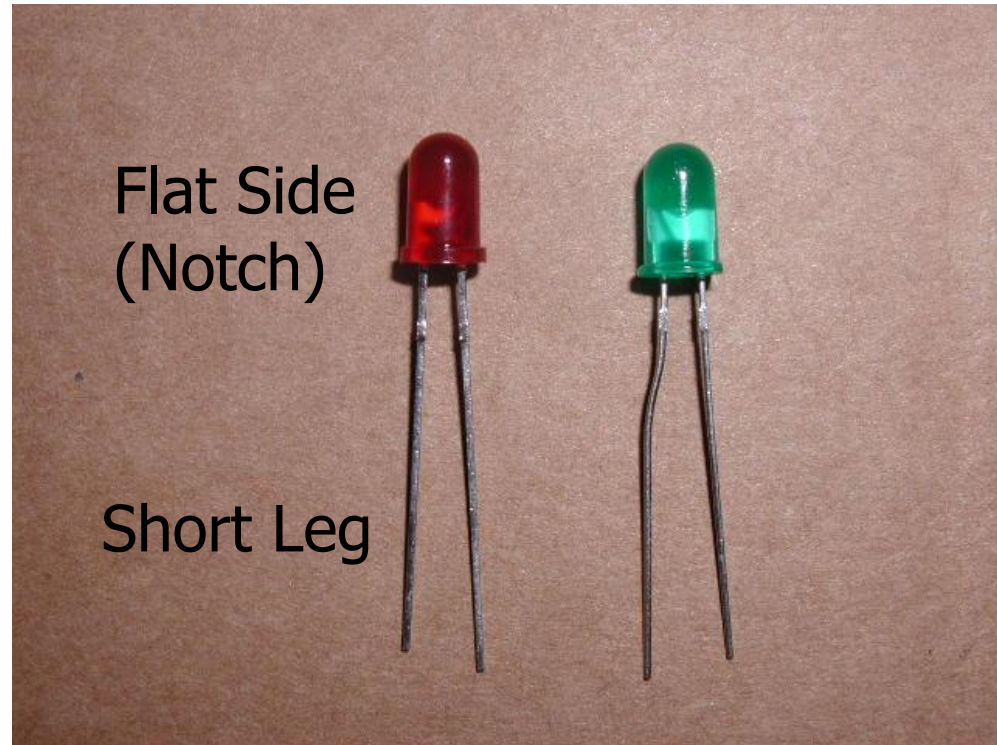
LED (Light Emitting Diode)

Polarity sensitive:

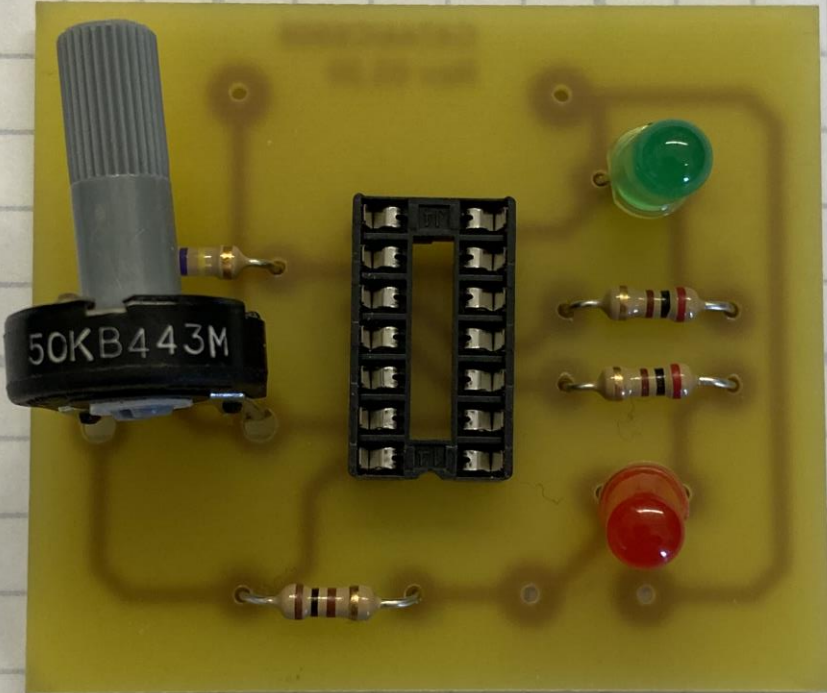
Anode (+)

Cathode (-) short leg or bulb base with flat side

= dark half moon on schematic

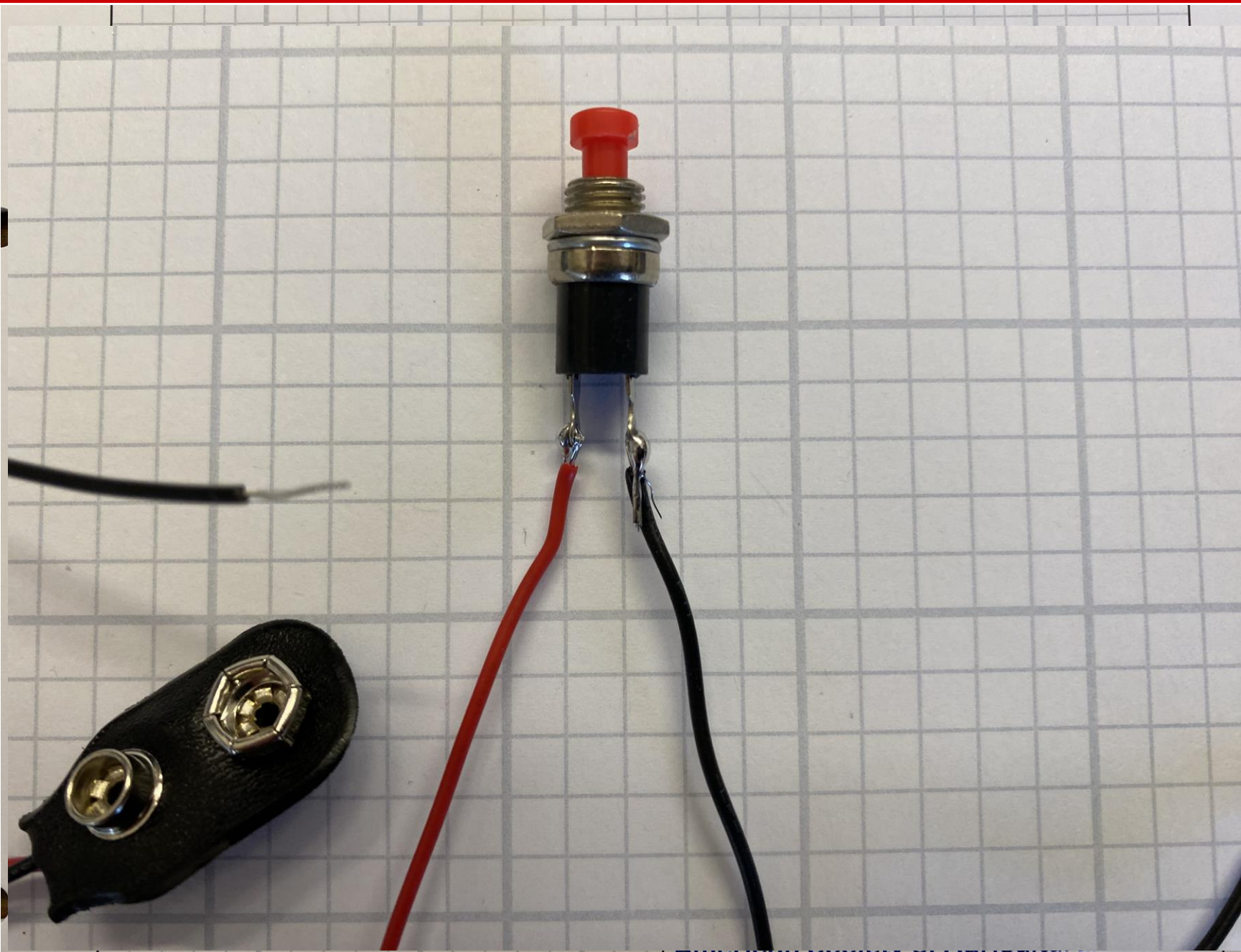


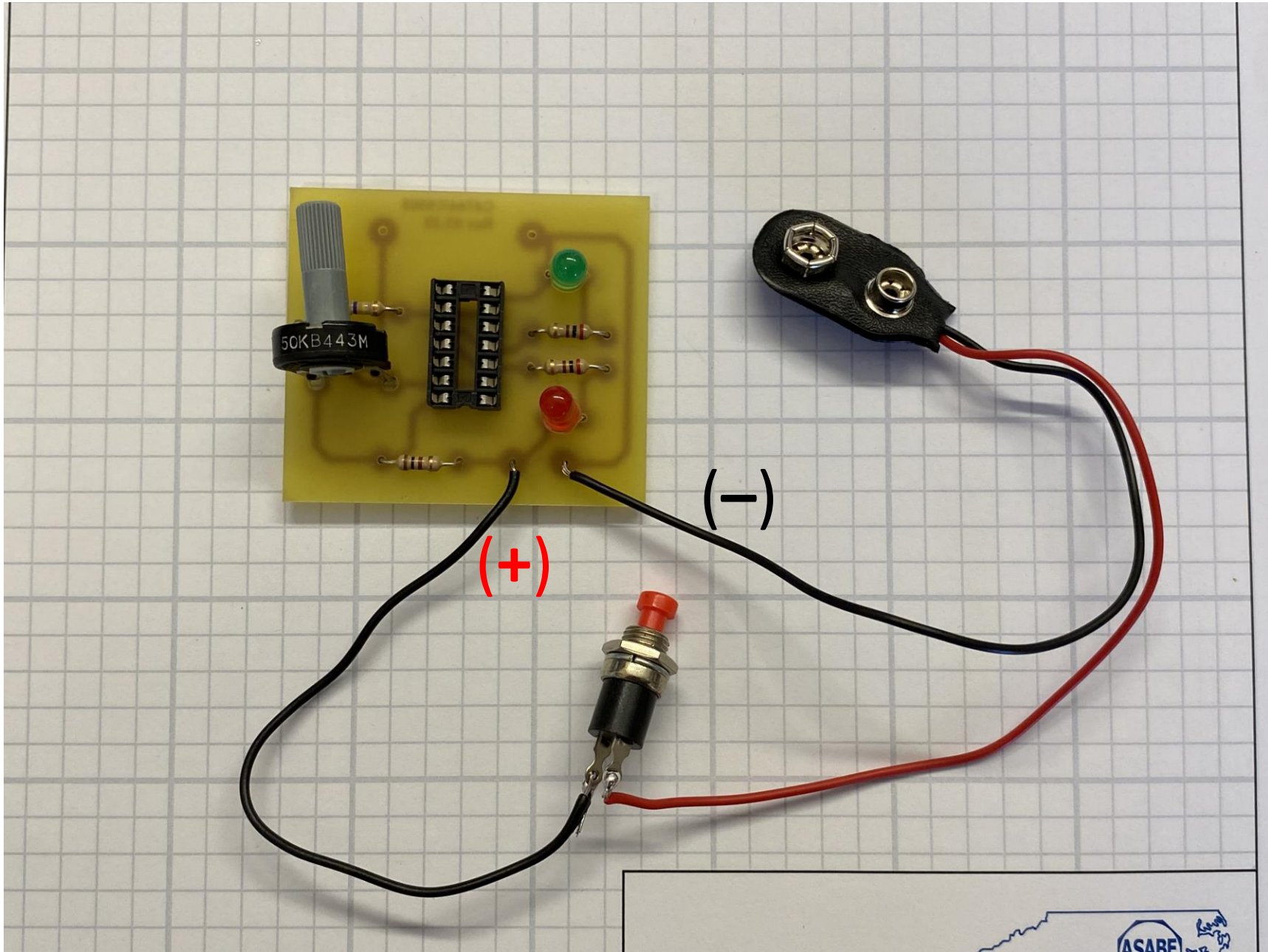
P1 Variable Resistor



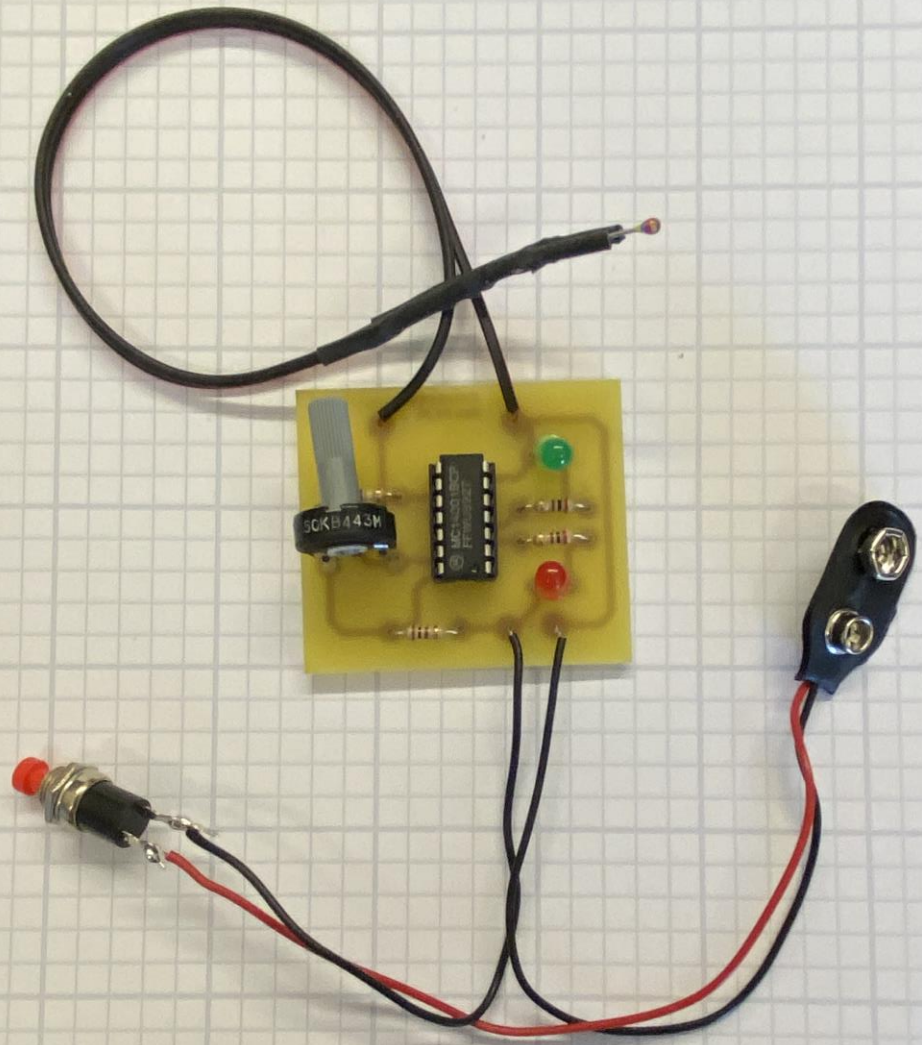
T1 Thermistor, Wire, Heat Shrink







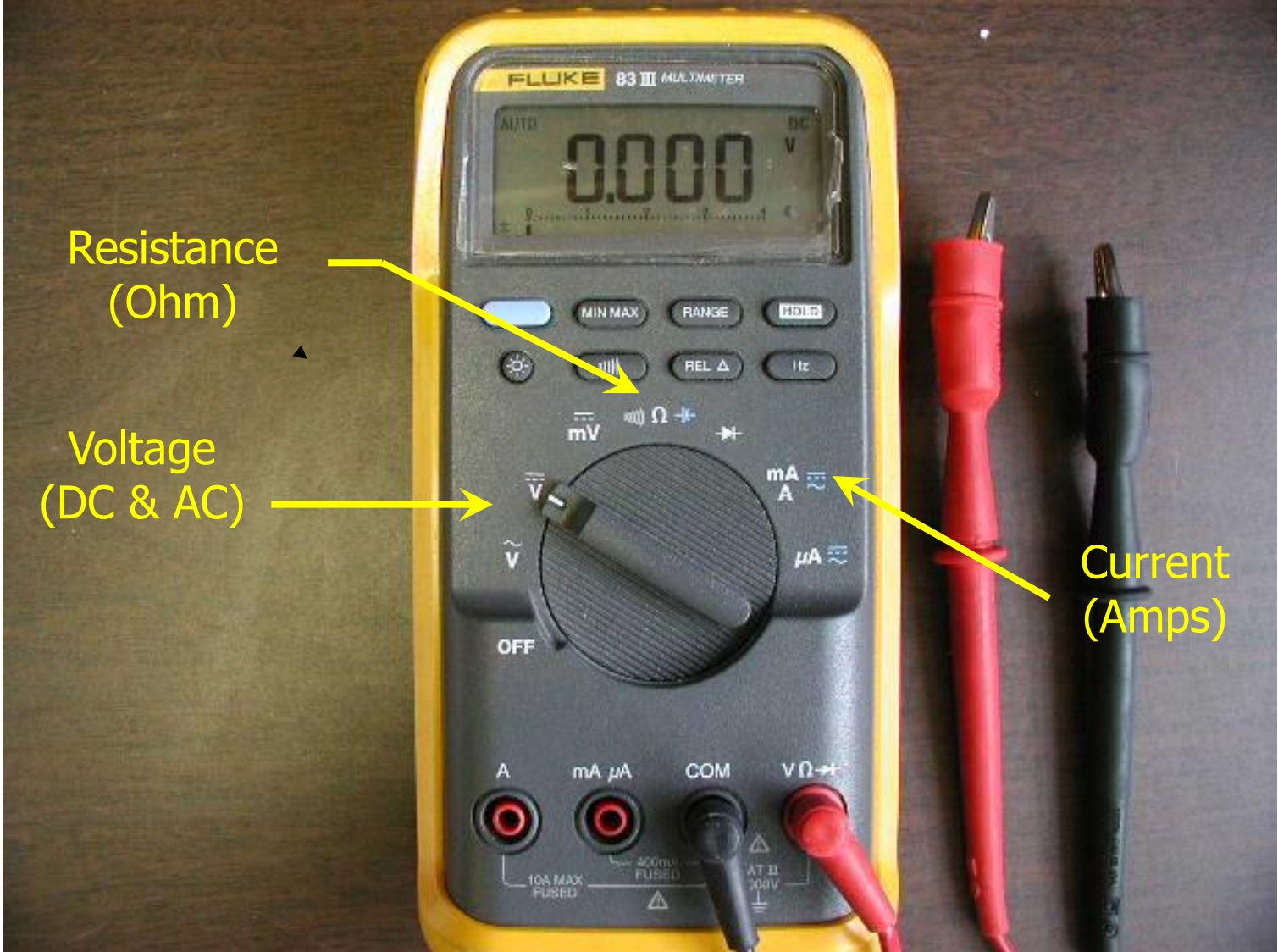
Assembled Kit



Troubleshooting Hints

- Check all resistors are in the correct location. Remember resistors have no polarity and as a result can be oriented in any direction.
- Check LEDs have the short leg or notched side facing the shaded direction
- Check transistor location, orientation and type. Typically have a flat or beveled side.
- Check polarity (+/-) on capacitors, if applicable.
- Check the battery snap wire locations for correct polarity (+/-).
- Check all solder joints. Add additional solder if they are not solid or have a hole.
- Inspect closely for solder bridges, especially around IC sockets.
- Only solder the IC socket to the board, **not the chip!**

Multimeter (Volt-Ohm Meter)



Resistance
(Ohm)

Voltage
(DC & AC)

Current
(Amps)