

# 2024 REVERSE ENGINEERING ONLINE CHALLENGE

## 70478S

### GEORGETOWN TEXAS



**DISASSEMBLY AND ANALYSIS OF A TOAST MAKER TWO  
SLICE TOASTER**

**BY: SAM  
DURGARAMAN**

**TANISH  
MURALIDHAR**

**KRISHNA  
PERLA**

**SAI  
VEERAPANENI**

**NAREN  
MAYILSAMY**

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# Introduction

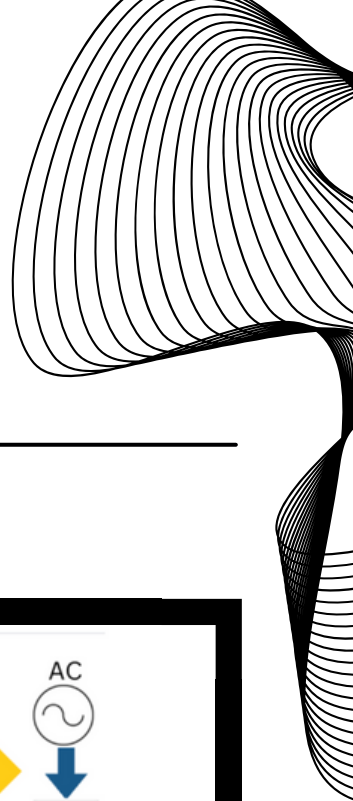
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During team meetings, we snack up on sandwiches to keep us energized. One day, our toaster started burning our toast regardless of the toaster's heat setting. We wanted to troubleshoot this issue so we could enjoy our sandwiches again.

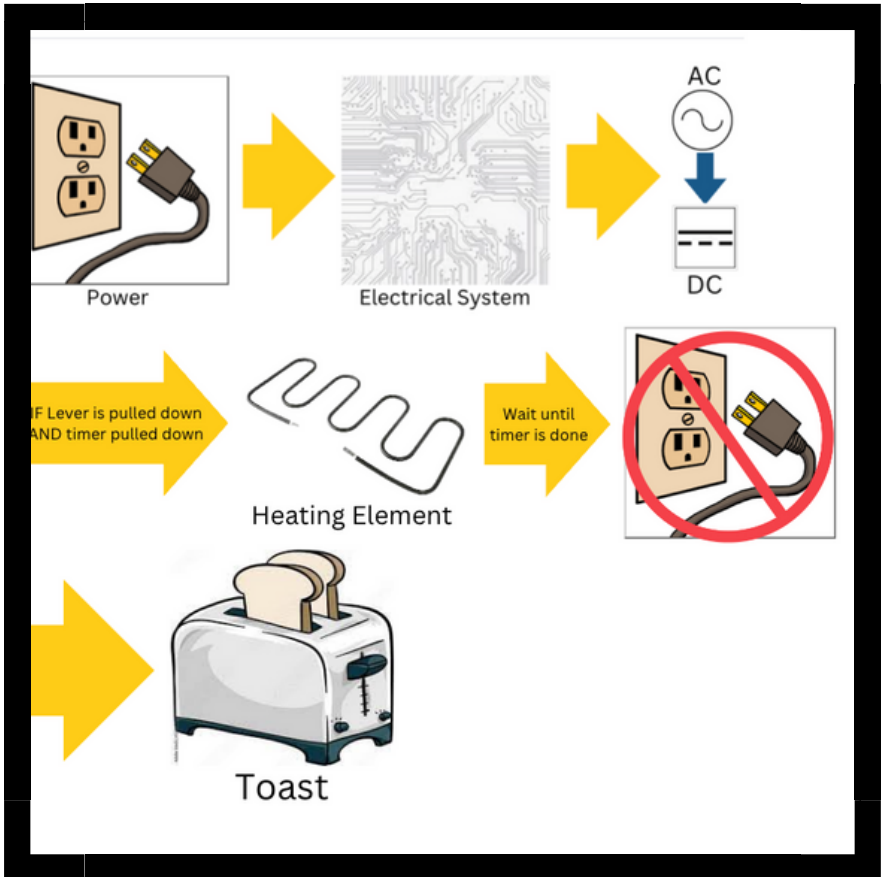
During this time, our Coach told us about VEX Online Challenges. We researched into potential challenges we could do and found the reverse engineering challenge. This challenge was a perfect opportunity for us to discover the toaster's underlying electrical system & components, and potentially fix the burning issue.



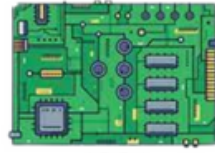
# Proposed Mechanisms of Action



Before deconstructing, we hypothesized the toasters function:



# Researching Parts



J321



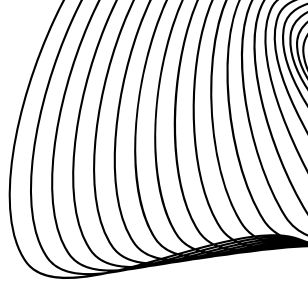
# Disassembly Process



Safety



# Main Components



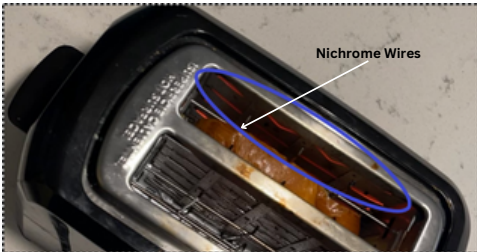
Outer Shell



Metal Clamping System



Nichrome Wires

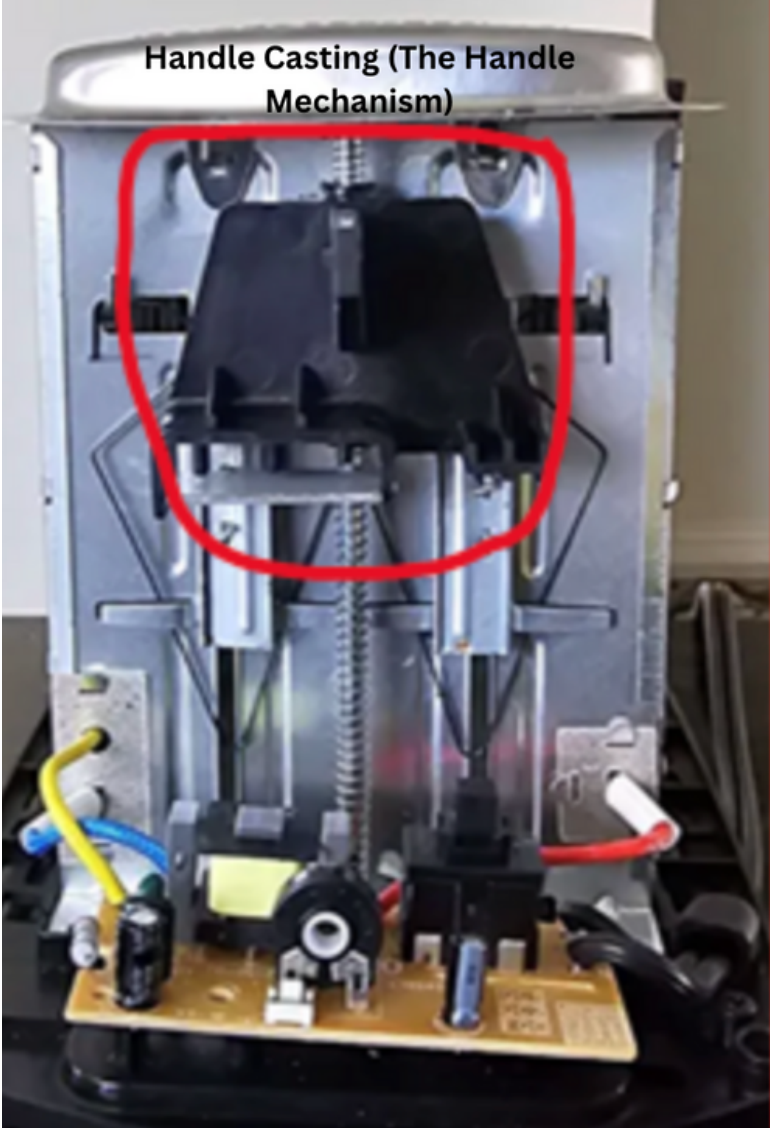


Handle Casting (The Handle Mechanism)



# Main Components

Handle Casting (The Handle Mechanism)

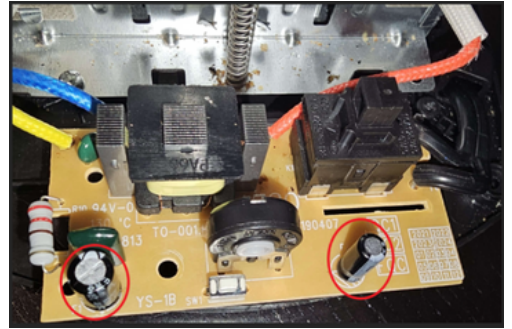
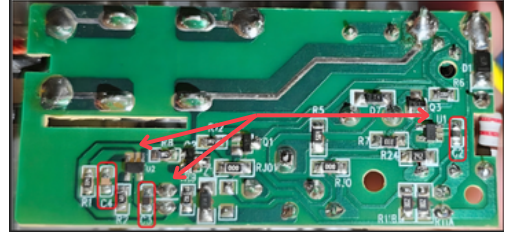




# Electrical Components

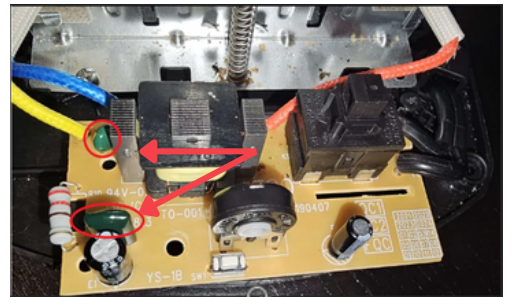
## ELECTROLYTIC CAPACITOR

The purpose of the electrolytic capacitor is to store energy and divert stored energy to the Polyester Film Capacitor (PCF) when needed. Power goes into the electrolytic capacitor first and then to PCF. Electrolytic capacitor have polarity so it has +/- ends. We found 100 micro-farad 16-volt and 100 micro-farad 50-volt capacitors.



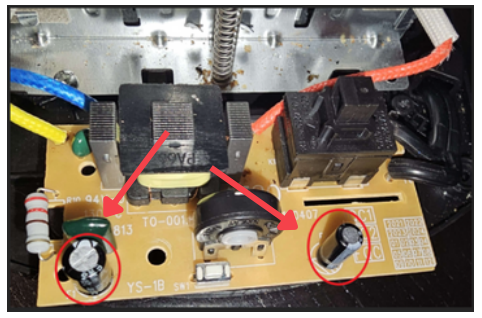
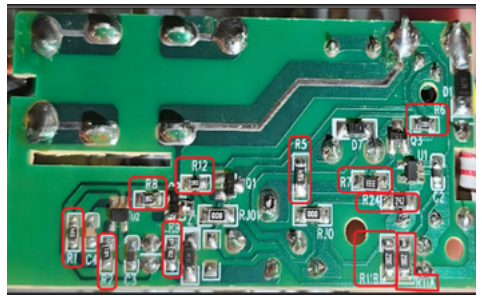
## POLYESTER FILM CAPACITOR (GREEN)

Polyester Film Capacitor has non-polarity doesn't need +/- ends. Used to prevent electrical energy from transferring across the circuit & protects electrical "noise" in the circuit.



# RESISTOR

The purpose of the resistor is to regulate the current and power in the circuit. We calculated the resistance of our resistor using the color codes: ( $220 \Omega \pm 5\%$  tolerance)

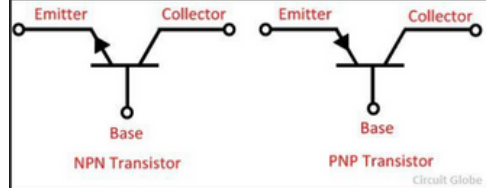
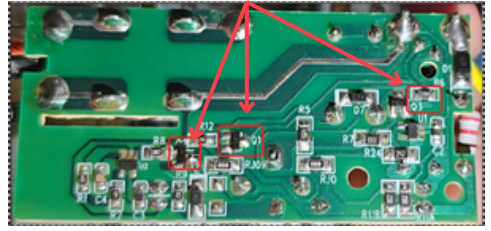


	1 <sup>st</sup> Digit	2 <sup>nd</sup> Digit	Multiplier	Tolerance
Black	0	0	x 1	
Brown	1	1	x10	±1%
Red	2	2	x10 <sup>2</sup>	±2%
Orange	3	3	x10 <sup>3</sup>	±3%
Yellow	4	4	x10 <sup>4</sup>	±4%
Green	5	5	x10 <sup>5</sup>	±0.5%
Blue	6	6	x10 <sup>6</sup>	±0.25%
Violet	7	7	x10 <sup>7</sup>	±0.1%
Grey	8	8	x10 <sup>8</sup>	±0.05%
White	9	9	x10 <sup>9</sup>	
Gold			x10 <sup>-1</sup>	±5%
Silver			x10 <sup>-2</sup>	±10%

Resistor

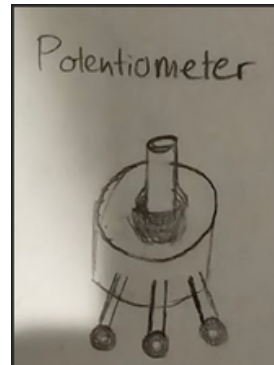
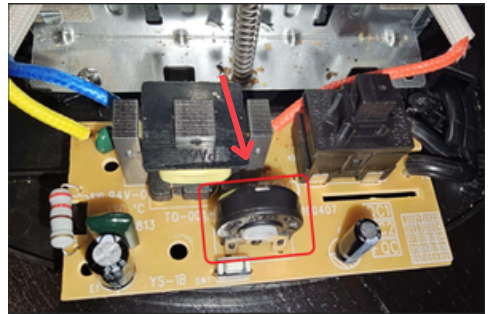
## TRANSISTOR

Transistors amplify the electric-power of the current. Bipolar transistors have 3-pins (base, collector, emitter), & are classified as NPN or PNP transistors.



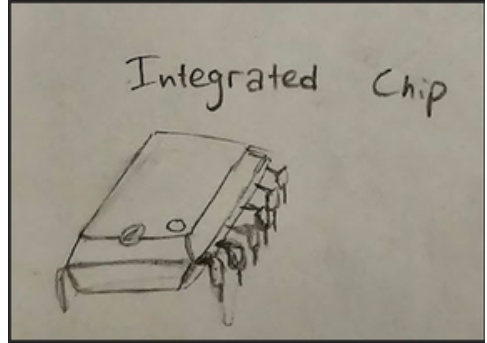
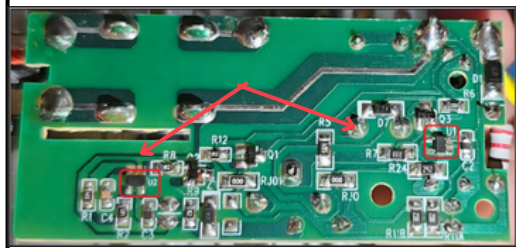
## POTENTIOMETERS

Potentiometer controls the amount of resistance between 2 of 3 terminals, adjusting the voltage/current to the dial, measured through a position-sensor.



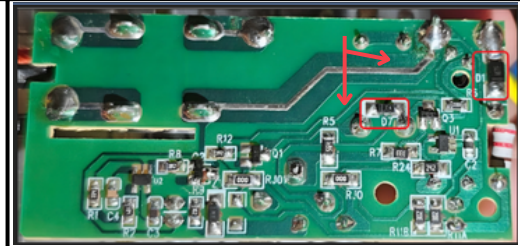
### INTEGRATED CHIP

The integrated chip acts as the brains of the toaster & oversees operations like turning on/off the circuit.



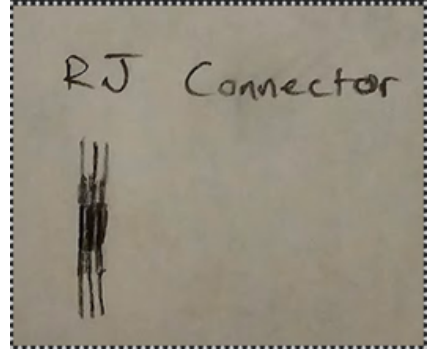
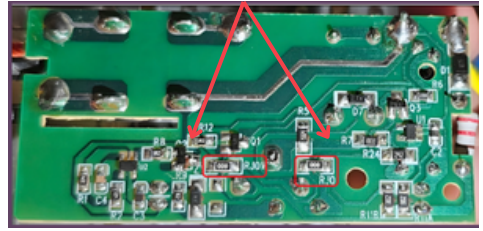
### DIODE

Diode allows current to flow in one direction only (cathode(+) to anode(-)).



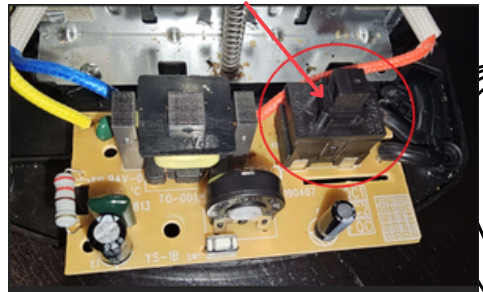
### RJ CONNECTER

RJ connectors are devices connecting resistors.



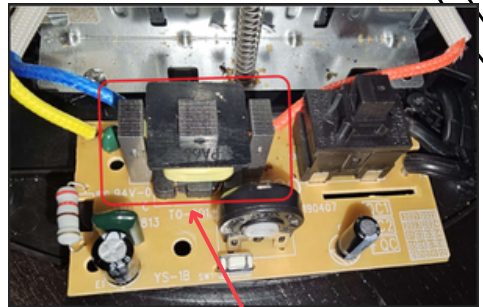
### HEAT SWITCH

When the switch is pressed, current flows.



### ELECTROMAGNET

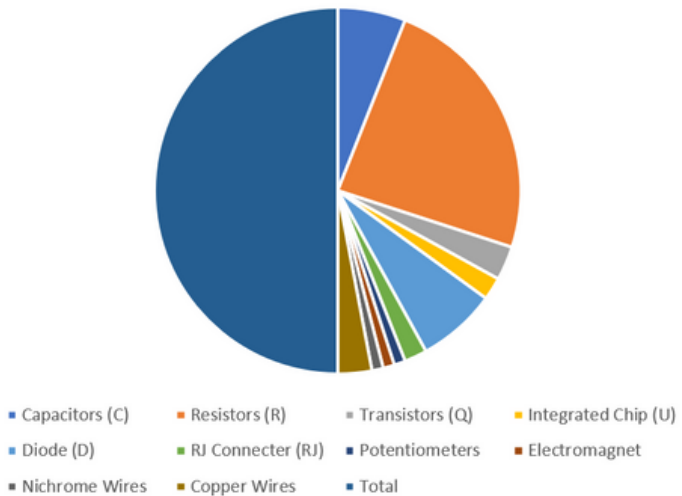
The electromagnet magnetizes the metal on top with current.



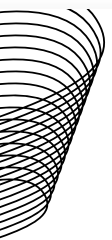
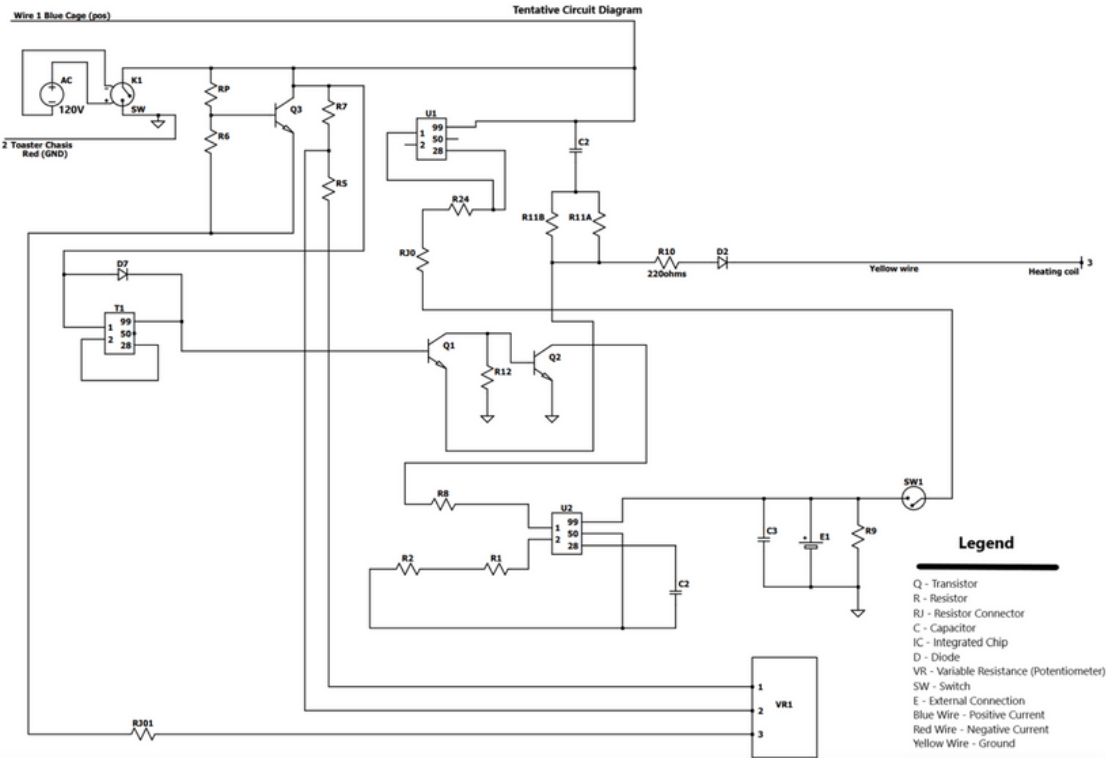
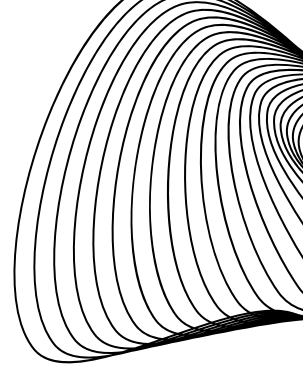
# Electrical Component Breakdown

Components	Count	Percentage
Capacitors (C)	6	12%
Resistors (R)	24	48%
Transistors (Q)	3	6%
Integrated Chip (U)	2	4%
Diode (D)	7	14%
RJ Connector (RJ)	2	4%
Potentiometers	1	2%
Electromagnet	1	2%
Nichrome Wires	1	2%
Copper Wires	3	6%
Total	50	100%

Electrical Component Breakdown

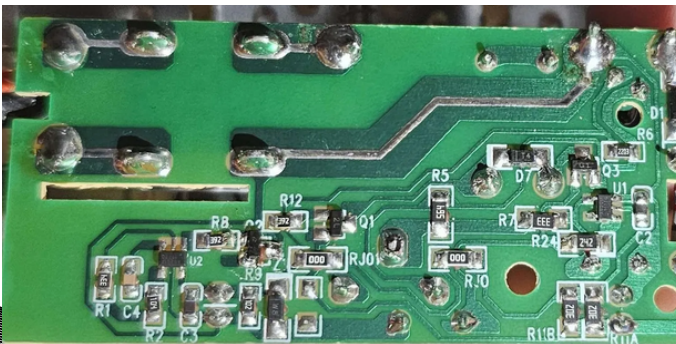
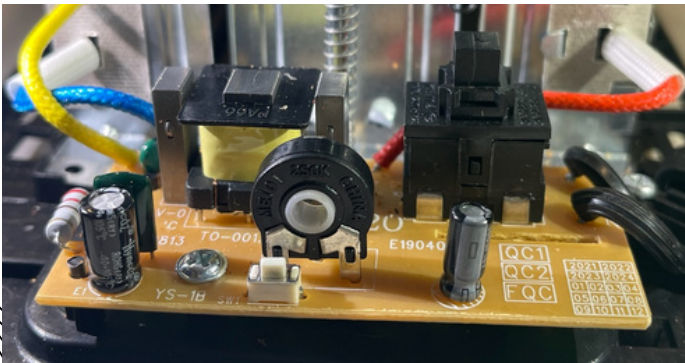


# Tentative Circuit Diagram



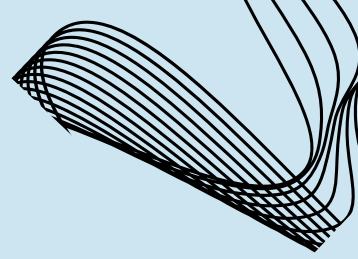
# Surface Mount Device (SMD) & Through-Hole Devices (THD)

The backside of the PCB uses SMD components which are installed in the same direction & require less space. THD requires more space.

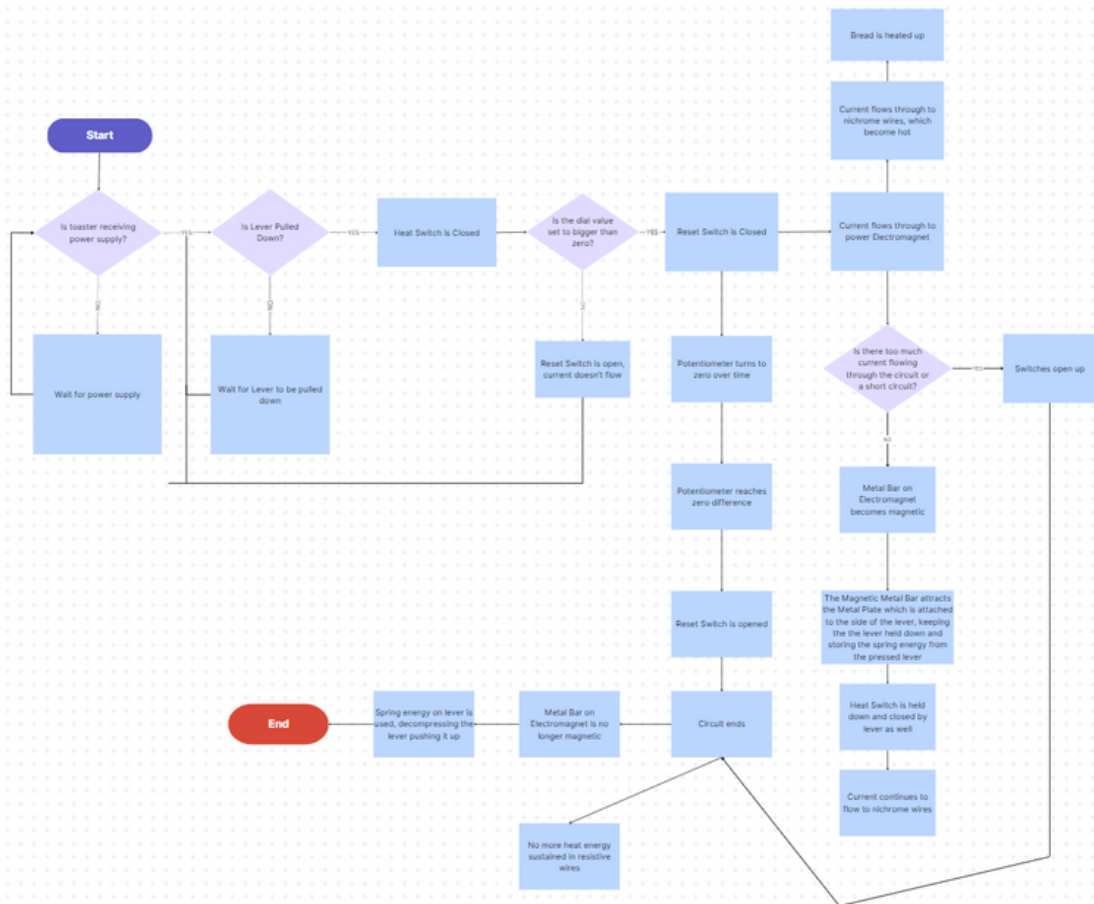




# Conclusions & Findings



In summary, the toaster uses electrical and mechanical housing components to function. We learned how the toaster's components work together. Below is the control flow chart which shows how all the toaster components function to heat up the toast.



# GEN



#### Works Cited

- <https://resources.altium.com/p/which-type-capacitor-should-you-use>
- <https://home.howstuffworks.com/toaster4.htm>
- <https://www.protoexpress.com/kb/basic-components-overview/#:-:text=Some%20of%20the%20most%20commonly,switches%2C%20ICs%2C%20and%20connectors.>