



VEX VRC - 2022 Reverse Engineering Online Challenge

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Introduction

There are 7 members in our robotics team. We are mostly high schoolers. All of us have a lot of extracurriculars, but we find time and commit to VEX robotics.

We decided to analyze an air purifier, because Taiwan's urban air quality has been quite poor in the past few years. Almost every household has at least one air purifier. Air purifiers have become a norm in Taiwanese living, and we thought it might be interesting to see how it works.



Figure 1: Group photo of all 7 members



Figure 2: The air purifier we will be analyzing

Disassembly

We decided to use a typical air purifier found in Taiwan. The model is a 3M Filtrete CHIMSPD-02UCLC Air Purifier. Manual:

https://www.costco.com.tw/medias/sys_master/images/h8b/h3e/11205105451038.pdf


Disassembly tools:

- Safety Goggles
- Safety Gloves
- Screwdrivers
- Wrench



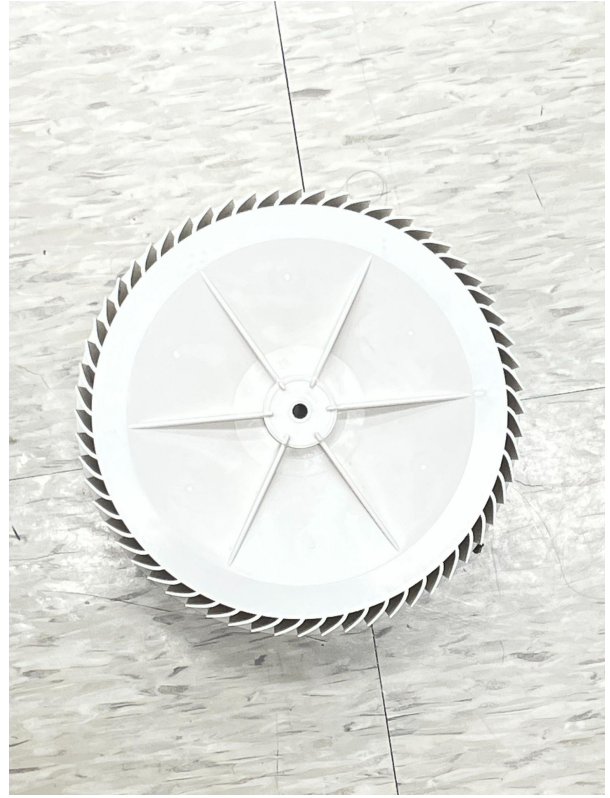
Figure 3: Tools we used to disassemble

Device Non-electrical Components

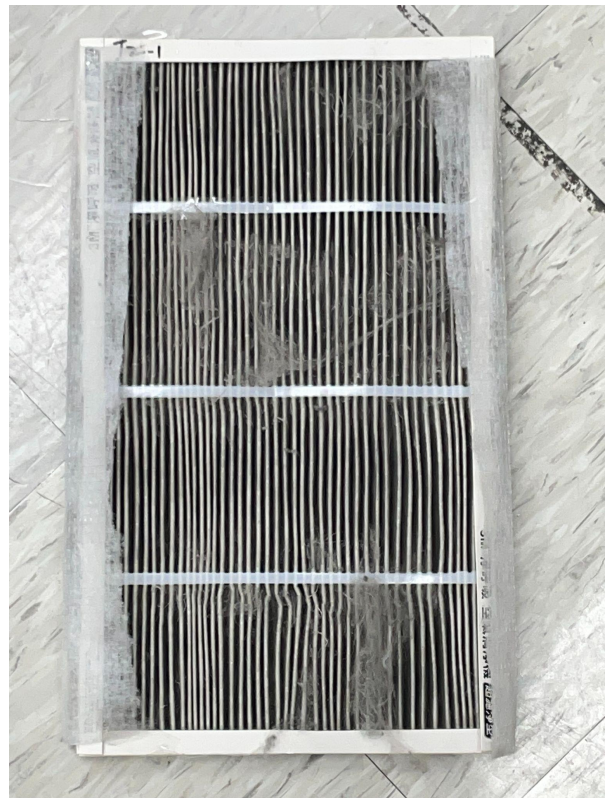
Name and Description	Photo(s)
Outer body of the air purifier	 The photograph shows two white plastic components of an air purifier. The top component is the outer shell, which is open, revealing a circular fan with a white grille and a central hub. To the right of the fan, there is a small red and black electrical wire connected to a terminal. The bottom component is the inner shell, which is also open, showing a smooth white interior surface with a recessed area on the right side. Both components are placed on a light-colored wooden floor.

Fan

Pushes air into the air filter to be cleaned.

**Air filter**

Separate dust from air by passing through the filter.



Bearings

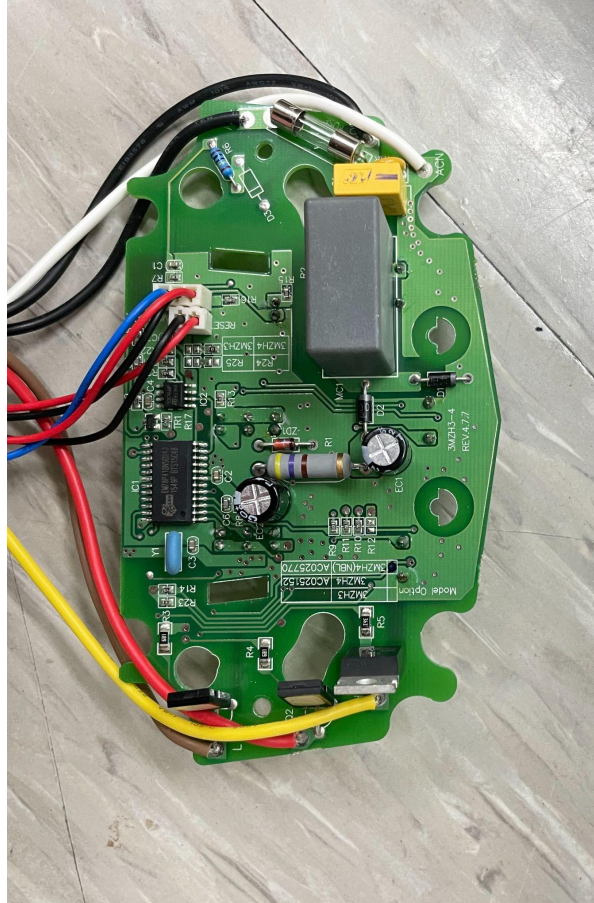
Rotates the fan. Axis is connected to the motor and the fan.

**Display**

Allows the user to function the fan using buttons.



Device Electrical Components


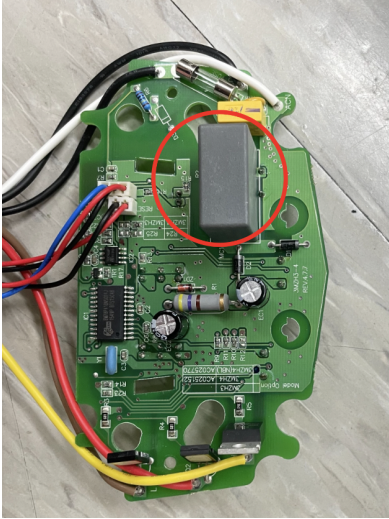
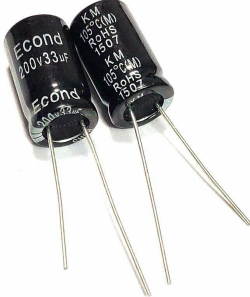
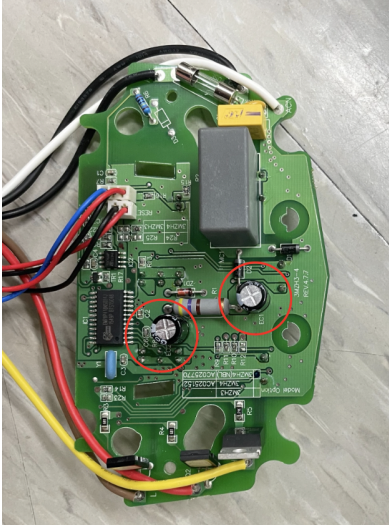
Name and Description	Photo(s)
<p>Circuit Board Sends signals and receives signals. Functions similarly to the motherboard of a computer.</p>	

Motor (AC120V 60hz)

Spins the bearings, rotating the fan. This motor requires a minimum of 120 volts of AC electricity in order to function. Its current alternates at 60/s. Different amounts of electricity are passed through the copper coils to change the speed of the fan.



Circuit Board Components

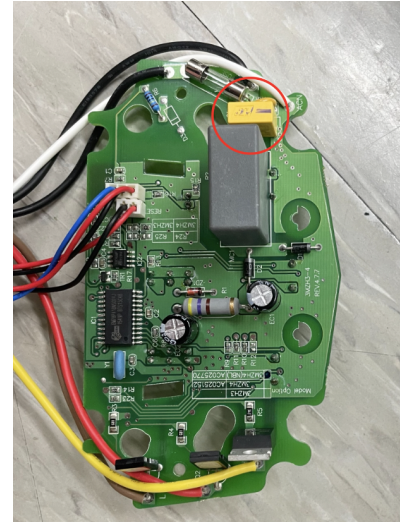
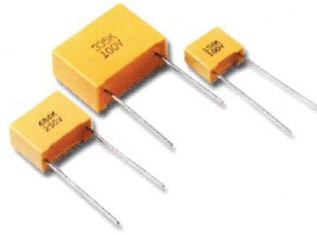
Name and Description	Photo	Location on circuit board
<p>GS-L X2 AC Capacitor Stores and sends a small initial voltage to get a kickstart on the motor that spins the fan to get it running. Uses AC.</p> <p>Data Sheet: https://www.mouser.com/catalog/specsheets/1778275.pdf</p>		
<p>KM105C Electrolytic Capacitor Small batteries that hold charges and are used as timers and smooth out the flow of electricity on the circuit board.</p> <p>Data Sheet: http://www.capxongroup.com/files/KM_Series.pdf</p>		

CBB21 Film Capacitor

Stores and distributes electricity for the lighting on the display screen.

Data Sheet:

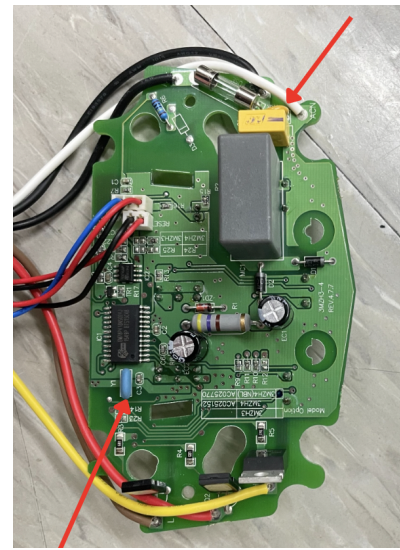
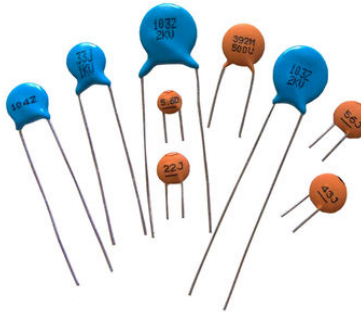
<https://datasheetspdf.com/pdf/816942/ETC/CBB21/1>

**Ceramic Capacitor**

Capacitor used for higher voltages. It can take up to 100 volts.

Data Sheet:

<https://www.mouser.com/c/ds/passive-components/capacitors/ceramic-capacitors/>

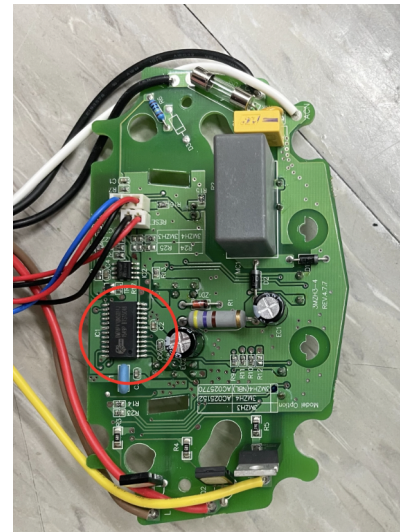
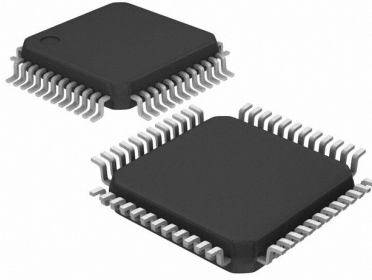


EM78P418NSO24J Semiconductor

Acts like the CPU of a computer. Makes calculations and controls the circuit board.

Data Sheet:

<https://www.datasheets360.com/part/detail/em78p418nso24j/3729768487294850282/>

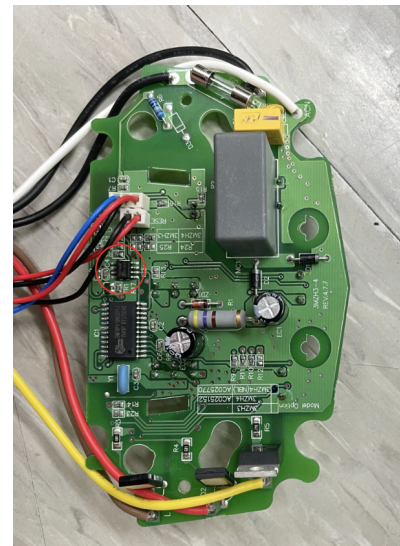
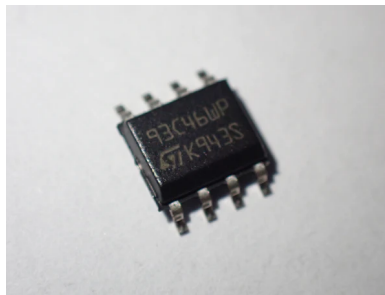


93C46WP EEPROM

Stores small amounts of data up to several hundred bytes. It is also able to delete data that is no longer necessary.

Data Sheet:

<http://www.datasheetcafe.com/93c46wp-pdf-31483/>

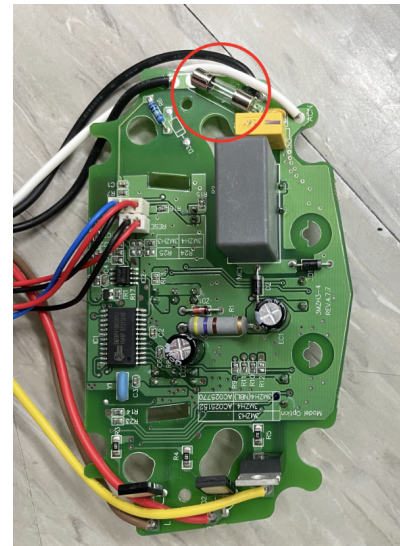


3A250V Fuse

Protects more important electrical components when overheating. When too much electrical current is passed through the fuse, it breaks, breaking the flow of electricity to prevent further damage.

Data Sheet:

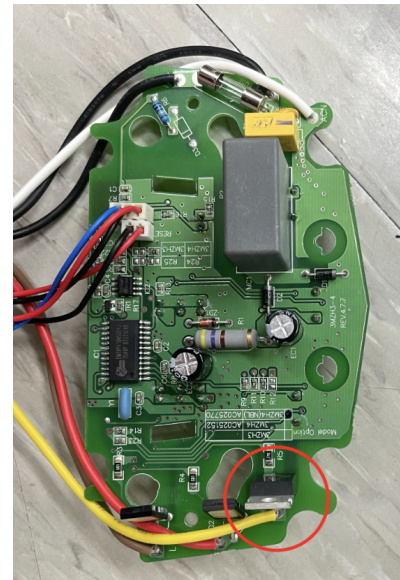
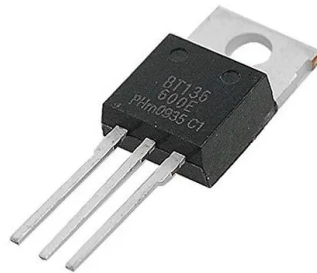
<https://datasheet.octopart.com/30243-Vicor-datasheet-13065911.pdf>

**BT136 TRIAC**

Directs electrical flow. Opens and closes gates according to the direction of which electricity is going.

Data Sheet:

<https://www.mouser.com/datasheet/2/302/BT136-600E-352978.pdf>

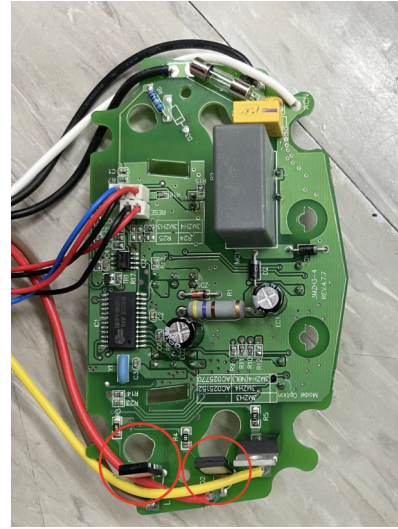
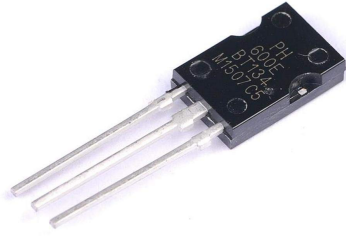


BT134 TRIAC Transistor

Directs electricity flow and also amplifies the current.

Data Sheet:

https://www.mouser.com/datasheet/2/302/BT134_SERIES_1-79951.pdf



Resistors

Controls electrical flow. Delivers special voltages to supply transistors.

Data Sheet:

<https://www.mouser.com/c/ds/passive-components/resistors/>



Everywhere!

Flow Chart

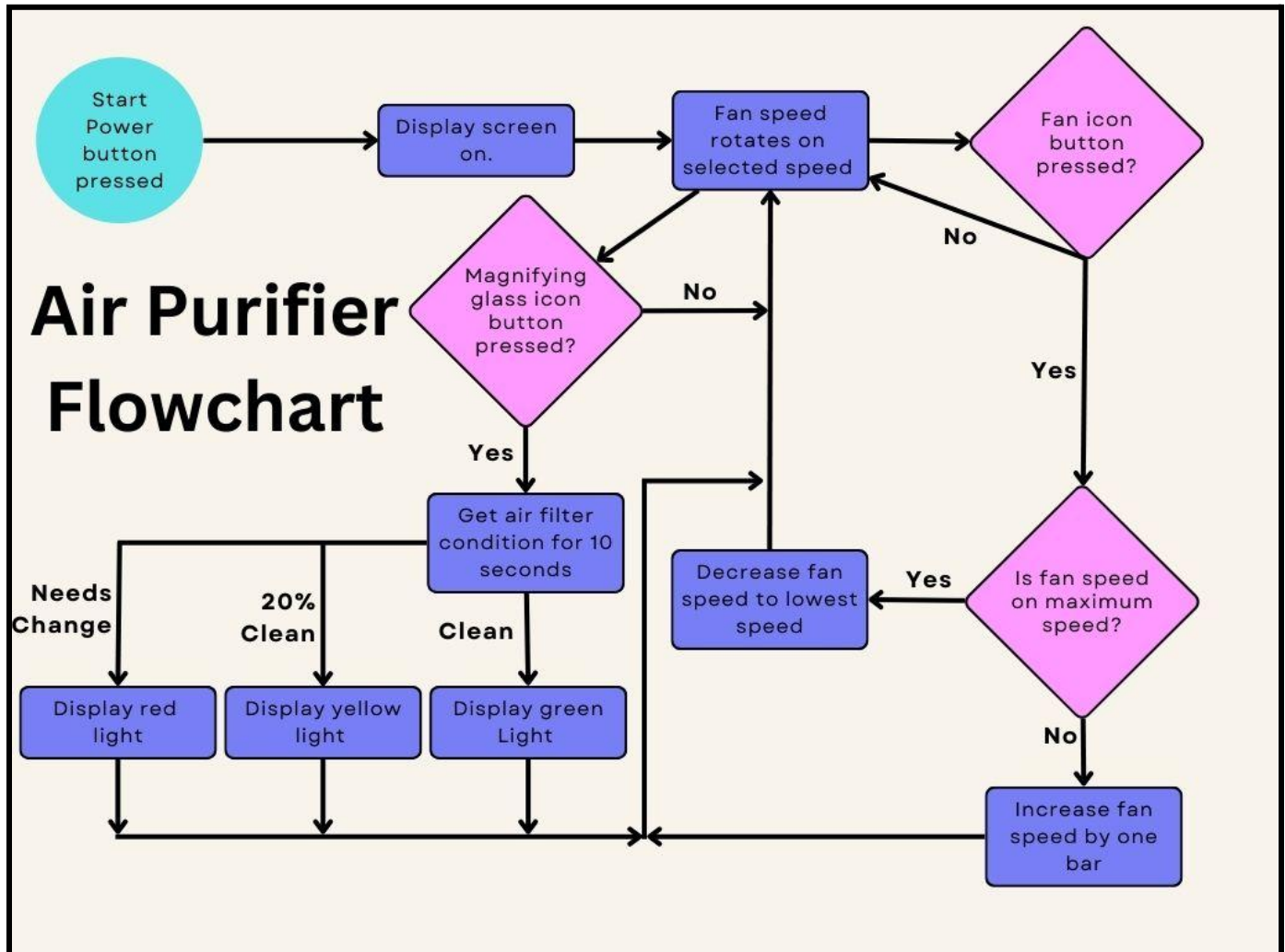


Figure 3: Flowchart of how the air purifier works

Conclusion

A lot of research had been done into the electrical components. We found out how all the different electrical components and non-electrical components worked together. For some of us, it was the first time seeing inside a motor, and we were also surprised to find out how complicated the circuit board of an air purifier machine could be. We also learned the main differences between AC and DC electrical currents. We also gained a basic understanding of electrical components, such as capacitors, resistors, transistors, and fuses.

Works Cited

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<https://www.electricalvolt.com/2022/03/introduction-to-electrical-components/>. Accessed 4 January 2023.

Sheikh, Mahnoor. “How to Make a Flowchart: Beginner's Guide (& Free

Templates).” *Visme*, 22 July 2021,

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