



RECF Reverse Engineering Online Challenge

“The Workings of a Framework Laptop”

425 Words

(excluding image descriptions, works cited, table of contents, headers, page numbers, and table descriptions)

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1. Introduction

Hello!

We are team 59735A CobraTRONIX from Cabarrus Early College of Technology in Concord, NC!

Our team includes six members (five Sophomores and a Senior), all with varying degrees of engineering experience. To better help us in future competition seasons, we decided to challenge ourselves to take apart a laptop (something we use every day) and better understand how it works.

The purpose of this challenge to us is to build team collaboration, learn engineering methods, and learn about the inside workings of things we use every day!



Figure 1: Team Picture

(from left to right: Anthony, William, Cooper, Shubh, Kat, and Lucas)



2. Electronic Device Chosen

We decided to pick an electronic device that is easy to access and something we use every day, like a laptop!

Framework is a startup laptop company whose goal is to create laptops that are user-serviceable and environmentally friendly.

We chose the Framework Laptop 13 as we believe it provides a great window into laptop design and the different fundamental components that go into a laptop.

In addition, it should be relatively easy to take apart due to the simple repairability of Framework as a company.



Figure 2.1: Framework: "Mainboard Kit (AMD Ryzen™ 7040 Series)"



Figure 2.2: Anthony's laptop that we are taking apart



3. Goals

To successfully complete this challenge, we have developed three objectives:

- ❑ Successfully dismantle the device
- ❑ Accurately identify and catalog the components of the device
- ❑ Draw conclusions from identified components

Once we have successfully done these three tasks, then we will know that we successfully succeeded in doing this challenge



4. Method

This is our plan to take apart the laptop:

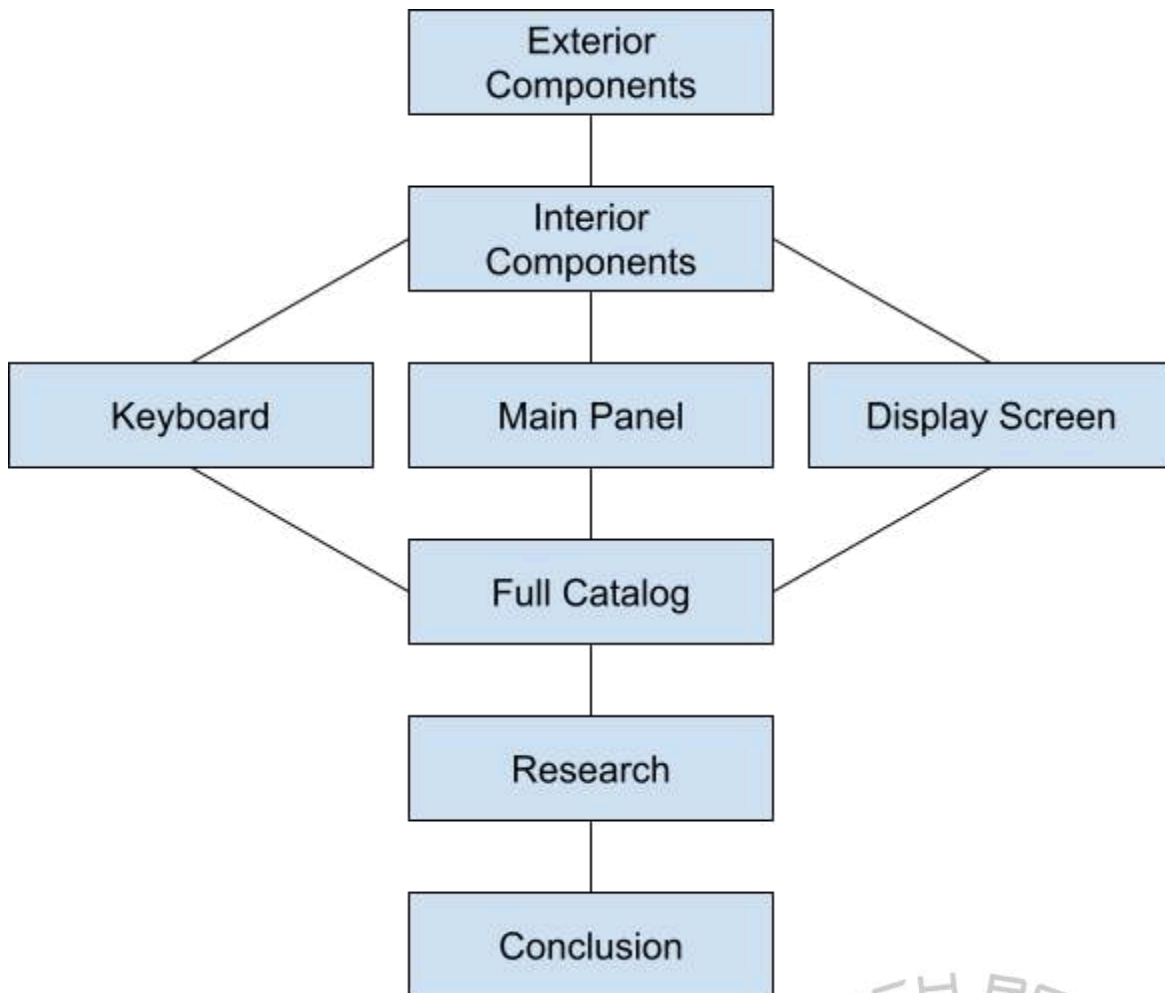
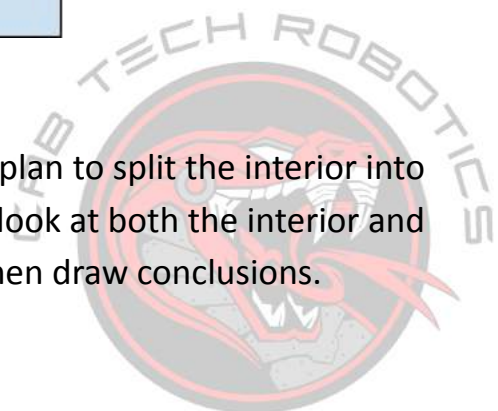


Figure 3: Dismantle Method

After looking at the exterior of the computer, we plan to split the interior into three sections for further investigation. Once we look at both the interior and exterior, we will do a full catalog, research, and then draw conclusions.



5. Materials Required

Safety Glasses



Figure 5.1: "VEX Safety Glasses" VEX Robotics

We need safety glasses to protect our face in case of flying objects from the laptop. Even though it is unlikely, better to be safe than in a hospital with a screw lodged in your cornea.

Screwdriver



Figure 5.2: "Framework Screwdriver" Framework

We also need a screwdriver to take off the bottom plate screws and to take out and components that are screwed in.



6. Disassembly

6.1 Exterior

The exterior of the computer really has only two components, the computer shell and the I/O ports





Figure 6.1.1: The Shell of the Laptop



Figure 6.1.2: I/O Ports



6.2 Exterior Catalog

Component	Image	Electrical or Non-Electrical	Usage	Resource
Outer Shell		Non-Electrical	<p>The outer shell is also known as the laptop's chassis. It secures the inner components and protects the laptop itself from external damage.</p> <p>This laptop is specifically made out of aluminum.</p>	<p>https://www.lenovo.com/us/en/glossary/chassis/?orgRef=https%253A%252F%252Fwww.google.com%252F</p>
I/O Ports		Electrical	<p>I/O ports are used to connect different types of cables to the laptop.</p> <p>These laptops are interchangeable with USB, HDMI, and USB.</p>	<p>https://www.pcmag.com/encyclopedia/terms/io-port#:~:text=(1)%20(Input%2FOutput,network%20via%20a%20network%20interface.</p>



7. Interior Disassembly

7.1 Interior Components

In order to make this process easier on us and easier to document, we decided to split up the interior of the computer into three components: Keyboard, Main Panel, and Display Screen



Figure 7.1.1: Back of the Keyboard



Figure 7.1.2: The Main Panel



Figure 7.1.3: The Display Screen



7.2 Input Panel

7.2.1 Behind the Input Panel

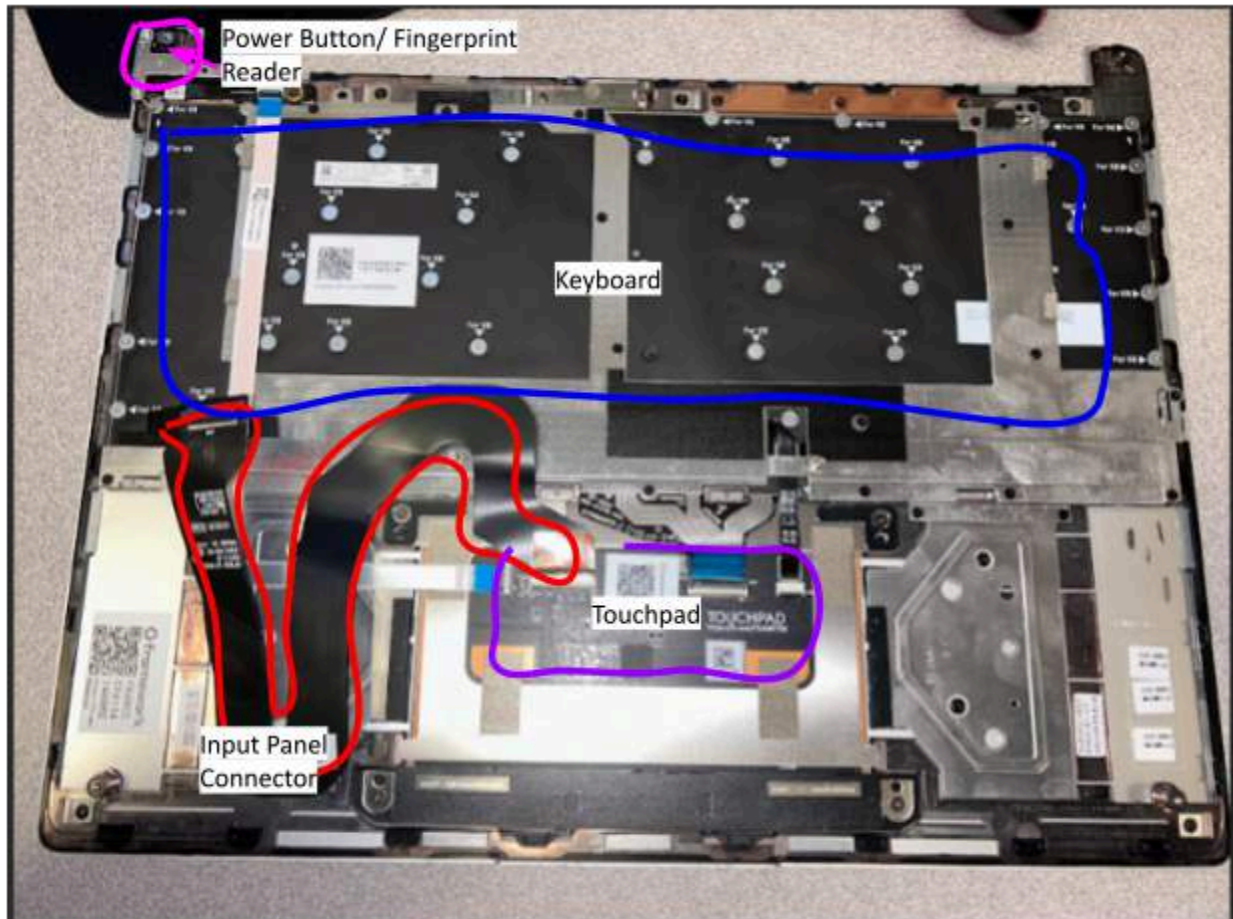




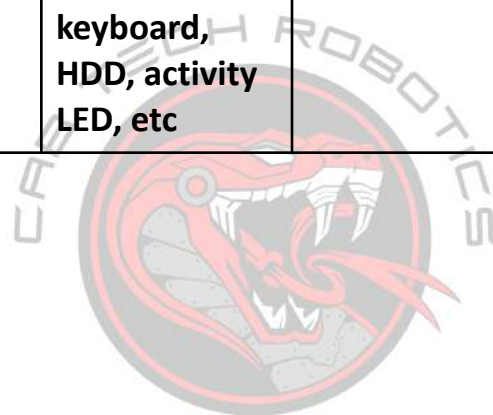
Figure 7.2.1.1: Keyboard Diagram



From what we can tell with the QR codes and just the look of the keyboard itself, we can identify 4 distinct components (highlighted areas.) These are the touchpad, power button/fingerprint reader, input panel connector, and the keyboard.



7.2.2 Input Panel Catalog

Component	Image	Electrical or Non-Electrical	Usage	Resource
Power Button/Fingerprint Reader		Electrical	<p>Power Button: The power button on a laptop is used to turn the laptop on or off.</p> <p>Fingerprint Reader: The fingerprint reader on a laptop allows the laptop to identify the user and unlock the laptop (or keep it locked.)</p>	<p>https://answers.microsoft.com/en-us/windows/forum/all/what-the-power-button-does/be12fff8-4a6c-46bf-bac8-1f8792fe5eb8</p> <p>https://www.pcmag.com/encyclopedia/term/fingerprint-reader</p>
Input Panel Connector		Electrical	<p>Serves as a connector between the motherboard and “front panel elements” such as keyboard, HDD, activity LED, etc</p>	<p>https://www.lenovo.com/us/en/glossary/system-panel-connector/</p>



Touchpad		Electrical	The touchpad of a laptop allows the user to move graphics on the screen using their fingers.	https://www.lenovo.com/us/en/faqs/laptop-faqs/what-is-a-trackpad?orgRef=https%253A%252F%252Fwww.google.com%252F
Keyboard		Electrical	The keyboard on a laptop allows the user to input numbers, letters, and characters, into the laptop.	https://www.easYTECHJUNKIE.COM/what-is-a-laptop-keyboard.htm



7.2.3 Input Panel Schematics

****Note:** These are the schematics that were available to us, not every part has a schematic listed, this applies to this section and further sections**

Fingerprint Reader Pin Specifics

Pinout

The Fingerprint Reader resides on the Input Cover and connects through the Touchpad. All of its signals are directly passed to the Input Cover Interface described in the Mainboard documentation. The connector used is Kyocera 046809610110846+.

Pin	Signal	Notes
1	VBUS	5V
2	USB_P	USB data
3	USB_N	USB data
4	GND	
5	FPR_CTRL	Output (mask switch events)
6	SWITCH	Open collector output
7	FPR_LED_W	
8	FPR_LED_G	
9	FPR_LED_R	
10	FPR_LED_COM	5V

Figure 7.2.3.1: "Fingerprint Reader READ.ME.md" Framework



Touchpad ZIF Pin Specifics

Keyboard Connector
This is the ZIF connector for the keyboard, using a Jyocera 04800001010640+ part.

Pin	Signal	Notes
1	K00	
2	K01	
3	K02	
4	K03	
5	K04	
6	K05	
7	K06	
8	K07	
9	K08	
10	K09	
11	K10	
12	K11	
13	K12	
14	K13	
15	K14	
16	K15	
17	K16	
18	K17	
19	K18	
20	K19	
21	K20	
22	K21	
23	K22	
24	K23	
25	CAPL_P	5V
26	CAPL_N	

Figure 7.2.3.2: "Touchpad READ.ME.md" Framework

Keyboard Backlight Connector
The ZIF connector for the keyboard backlight, using a ACS 51001-0045M-001 part.

Pin	Signal	Notes
1	KBL_N	
2	KBL_N	
3	KBL_P	5V
4	KBL_P	5V

Fingerprint Reader Connector
The ZIF connector for the Fingerprint Reader, using a Jyocera 048000010110640+ part.

Pin	Signal	Notes	Voltage
1	VBUS	Power	5V
2	USB_DM	USB Data	
3	USB_DP	USB Data	
4	GND	Power	
5	EC_CONTROL	Output - multi switch events	
6	SWITCH	Open collector output	
7	LED_W		
8	LED_B		
9	LED_R		
10	LED_CDM		5V

Figure 7.2.3.3: "Touchpad READ.ME.md" Framework

Mainboard Connector
The ZIF connector for the PCB going to the Mainboard, using a ACS 51000-00100-001 part.

Pin	Signal	Notes	Voltage
1	GND		
2	GND		
3	K07		
4	K05		
5	K03		
6	K04		
7	K05		
8	K06		
9	K07		
10	K08		
11	K09		
12	K10		
13	K11		
14	K12		
15	K13		
16	K14		
17	K15		
18	K16		
19	K17		
20	K18		
21	K19		
22	K20		
23	K21		
24	K22		
25	K23		
26	GND		
27	CAPL_P	5V Supply	

Figure 7.2.3.4: "Touchpad READ.ME.md" Framework

28	CAPL_N		
29	KBL_N		
30	KBL_P	5V supply (PWR)	
31	KBL_N		
32	KBL_P	5V supply (PWR)	
33	GND		
34	TR_SCL		
35	TR_INT		
36	TR_SDA		
37	GND		
38	BOARD_ID		
39	Reserved	Not connected	
40	SVS		5V
41	SWAGW	Always on supply	5V
42	USB_DM		
43	GND		
44	USB_DP		
45	EC_CONTROL		
46	SWITCH		
47	LED_R		
48	LED_G		
49	LED_B		
50	LED_CDM		5V
51	Reserved	Not connected	

Figure 7.2.3.5: "Touchpad READ.ME.md" Framework



7.3 Main Panel

7.3.1 Main Panel Diagram

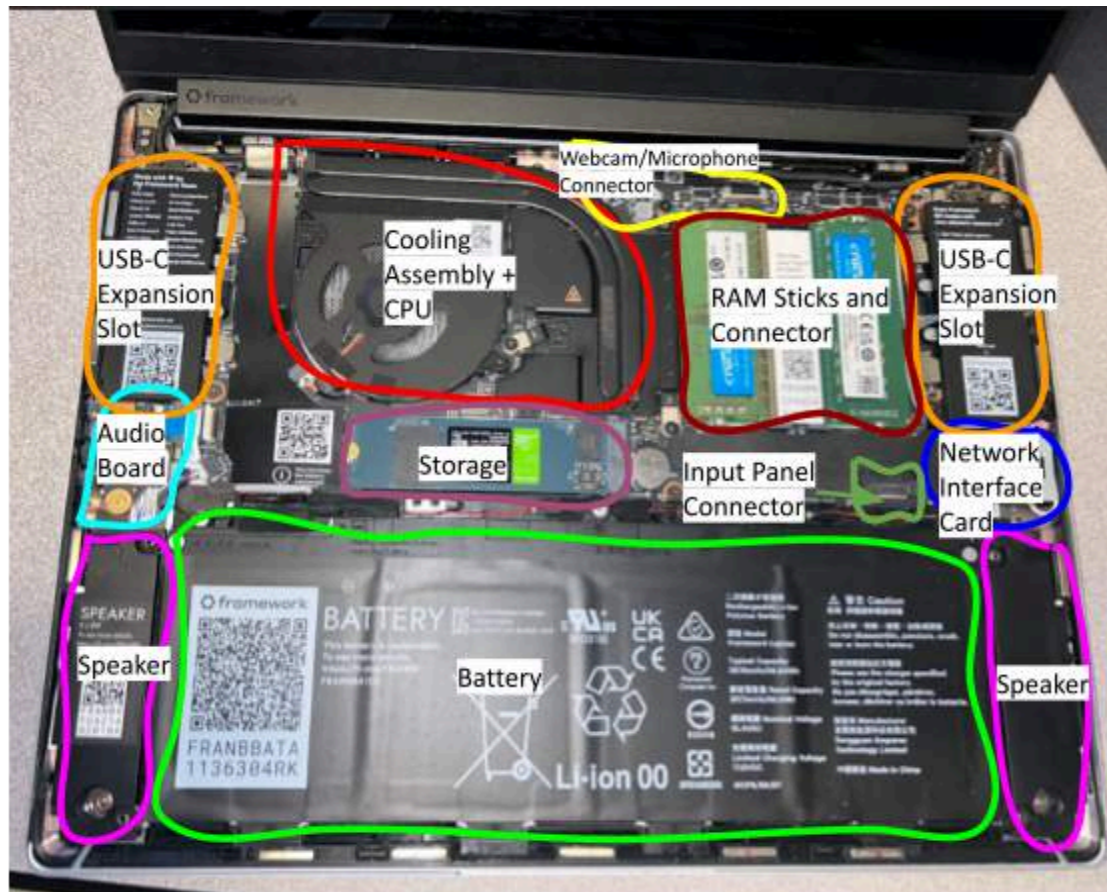







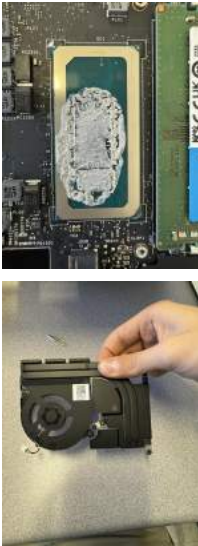

Figure 7.3.1.1: Main Panel Diagram



Again, just by looking at the QR codes and having general computer knowledge, we can identify 10 distinct components (highlighted areas.) These are the USB-C expansion slots, audio board, battery, storage, webcam/microphone connector, cooling assembly + CPU, RAM sticks, network interface card, speakers, and the input panel connector.



7.3.2 Main Panel Catalog

Component	Image	Electrical or Non-Electrical	Usage	Resource
USB-C Expansion Slots		Electrical	This is an extension for a USB-C, it allows the USB-C it is plugged into to be longer.	https://hackaday.com/2023/01/26/all-about-usb-c-framework-laptop/#:~:text=The%20simplest%20one%2C%20USB%2DC,the%20properties%20of%20the%20ports.
Audio Board		Electrical	An audio board in a laptop is used to organize and connect audio output and input devices.	https://www.arylic.com/blogs/news/audio-board-guide-audio-port-basics
Battery		Electrical	The battery in a laptop is the main source of power to the laptop itself, it can be rechargeable if needed.	https://www.lenovo.com/us/en/glossary/laptop-battery/?orgRef=https%253A%252F%252Fwww.google.com%252F
Storage		Electrical	The storage in a laptop is used to primarily store all of the laptop's data. This includes system files, applications, etc.	https://www.hp.com/us-en/shop/tech-takes/computer-memory-vs-storage#:~:text=Storage%20is%20where%20data%20is,potos%2C%20music%2C%20and%20videos.

<p>Webcam/Microphone Connector</p>		<p>Electrical</p>	<p>Webcam: Video taking capabilities</p> <p>Microphone: connects to sound systems for input</p>	<p>https://www.syncaudio.com/blogs/news/everything-about-camera-microphone</p>
<p>Cooling Assembly + CPU</p>		<p>Electrical</p>	<p>CPU: the Central Processing Unit acts as the brain of a computer, instructing how to manage and process data.</p> <p>Cooling Assembly: Heat is a large issue for the efficacy of pc's. Having effective heatsinks and fans is very helpful for managing the longevity of components</p>	<p>https://www.khanacademy.org/computing/computers-and-internet/xcae6f4a7ff015e7d:computers/xcae6f4a7ff015e7d:computer-components/a/central-processing-unit-cpu#:~:text=Central%20Processing%20Unit%20(CPU),and%20how%20to%20process%20it.</p>
<p>RAM Sticks</p>		<p>Electrical</p>	<p>Random Access Memory - the short-term memory that is actively needed by the computer for the proper</p>	<p>https://www.intel.com/content/www/us/en/tech-tips-and-tricks/computer-ram.html#:~:text=RA</p>

			functioning of the computer.	M%20provide s%20the%20s horter%2Dterm,experience %20when%20 using%20your %20device.
Network Interface Card		Electrical	A network interface card (NIC) is able to provide a laptop with full-time connection to a network.	https://www.techtarget.com/searchnetworking/definition/network-interface-card#:~:text=A%20NIC%20provides%20a%20computer,of%20data%20on%20the%20network.
Speakers		Electrical	Output sound systems based at the bottom of the “front panel”. Used for sound demonstrations and media usage.	https://www.kentfaith.com/blog/article-do-laptops-have-built-in-speakers_1567#:~:text=The%20primary%20function%20of%20laptop,use%20headphones%20or%20external%20speakers.

Input Panel Connector		Electrical	Serves as a connector between the motherboard and “front panel elements” such as keyboard, HDD, activity LED, etc	https://www.lenovo.com/us/en/glossary/system-panel-connector/
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7.3.3 Main Panel Schematics

Battery

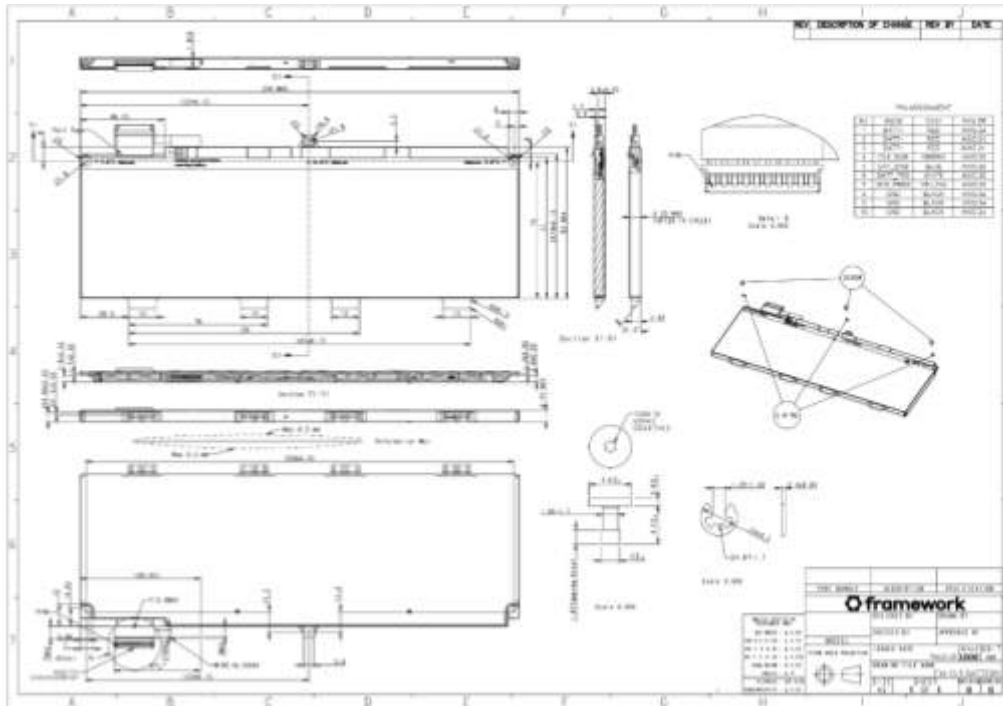


Figure 7.3.3.1: "fw_13_Sinch_battery.pdf" Framework



Mainboard

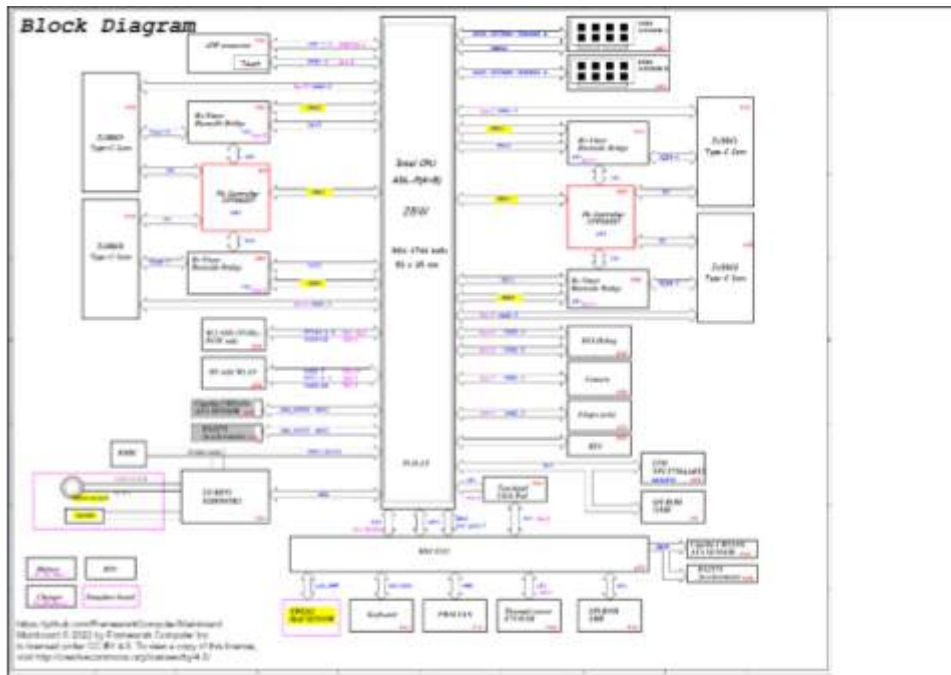


Figure 7.3.3.3: "Mainboard_interfaces_Schematic_12th_Gen.pdf" Framework

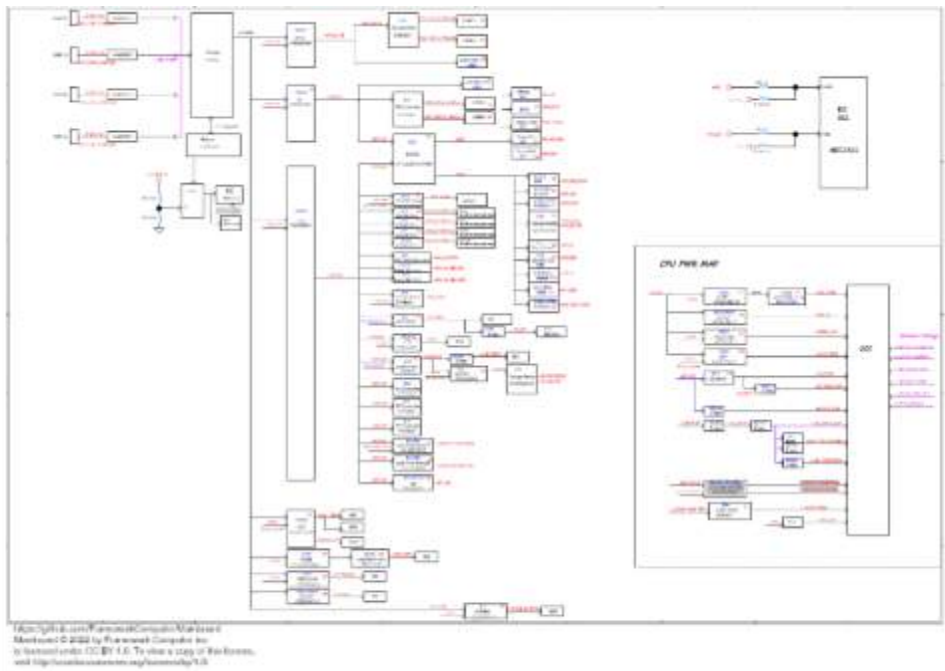


Figure 7.3.3.4: "Mainboard_interfaces_Schematic_12th_Gen.pdf" Framework



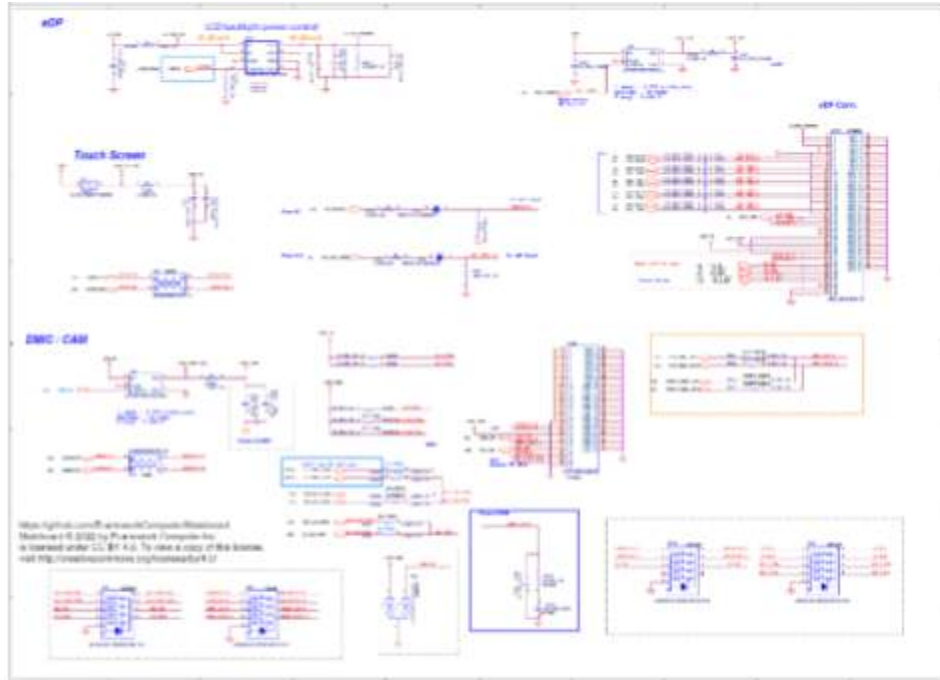


Figure 7.3.3.5: "Mainboard_Interfaces_Schematic_12th_Gen.pdf" Framework

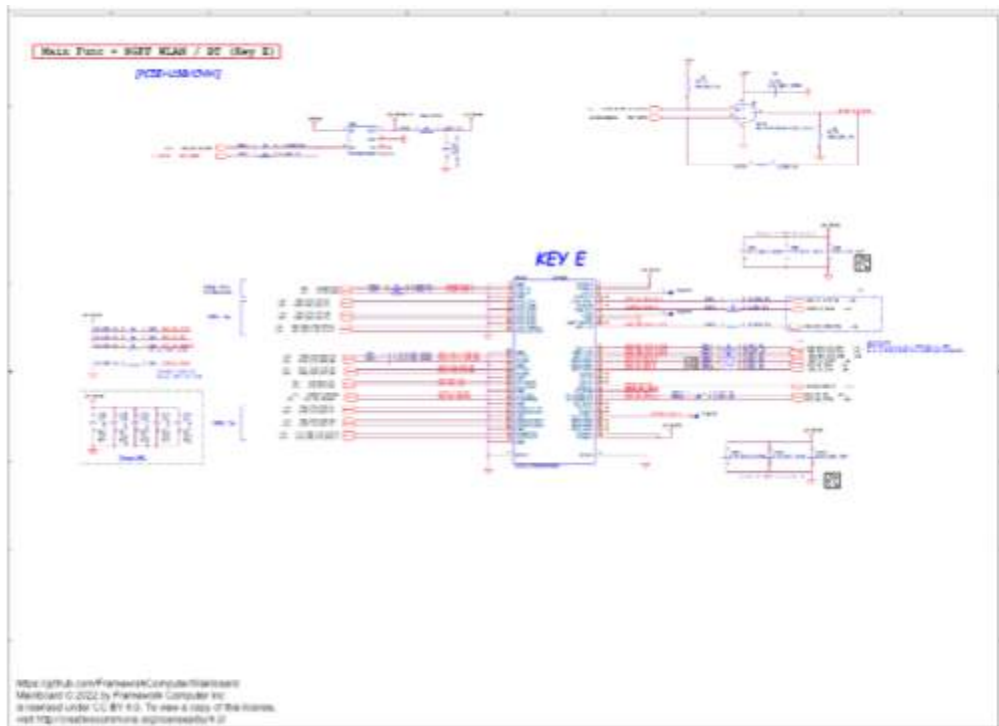
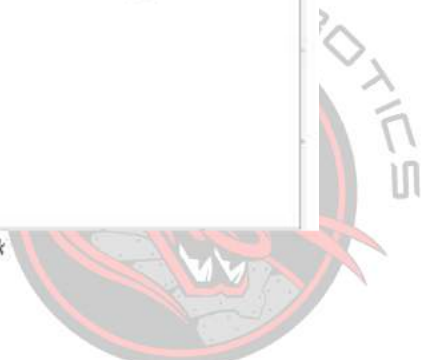


Figure 7.3.3.6: "Mainboard_Interfaces_Schematic_12th_Gen.pdf" Framework



7.4 Display Assembly

7.4.1 Display Assembly Diagram



Figure 7.4.1.1: Display Screen with Bezel

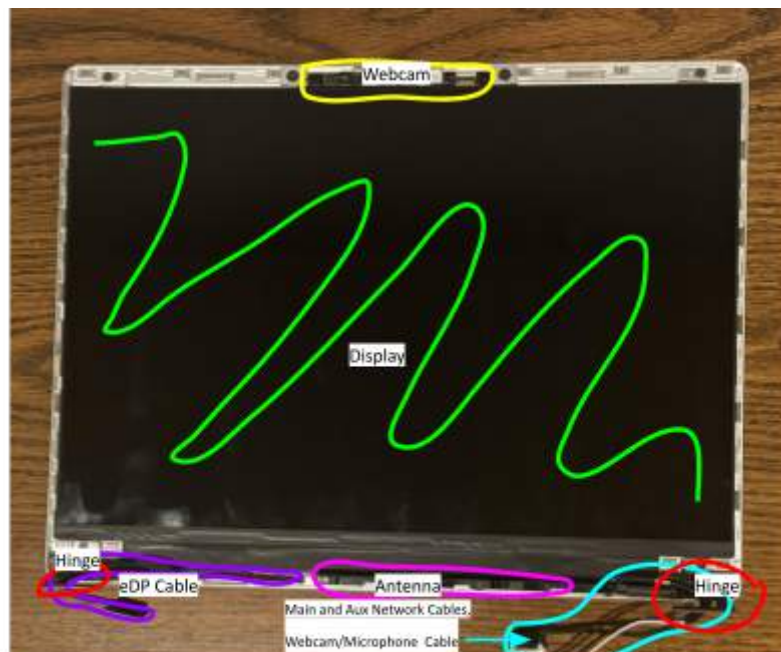








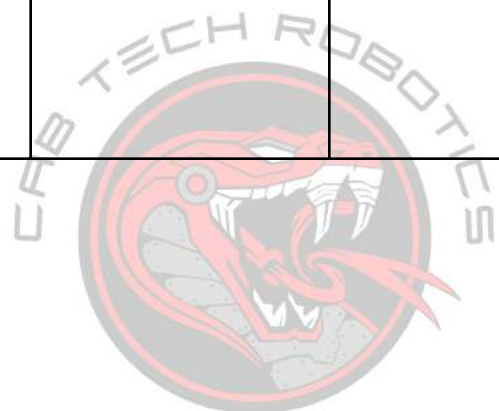
Figure 7.4.1.2: Display Screen without Bezel


One again, through basic knowledge and observation skills, we can identify 7 distinct components in the Display Screen. These are the bezel, webcam, display, antenna, main, aux, webcam, and microphone cables, hinges, and the eDP cable.

7.4.2 Display Assembly Catalog

Component	Image	Electrical or Non-Electrical	Usage	Resource
Display		Non-Electrical	A display is a device on a laptop that displays the graphics from the laptop. It is made up of tiny pixels that show these graphic elements.	https://www.techtarget.com/whatis/definition/display#:~:text=In%20computing%2C%20a%20display%20is,distinguishes%20text%20and%20graphic%20elements
Bezel		Non-Electrical	A laptop bezel is a supportive frame that lies between the display and the inside of the laptop screen.	https://www.techtarget.com/whatis/definition/bezel#:~:text=A%20bezel%20is%20the%20border,glass%20of%20an%20LCD%20screen.
eDP Cable		Electrical	Also known as an embedded display port, it allows graphics to be displayed in 4k graphics.	https://www.quadrangleproducts.com/guide-to-edp-embedded-display-port-cables/#:~:text=Embedded%20DisplayPort%20commonly%20referred%20to,display%20in%204k%20and%20beyond.
Main and Aux Network Cables, Webcam/Microphone Cable		Electrical	These cables help to give wifi/bluetooth to the rest of the laptop. The white and	https://www.dell.com/community/en/conversations/networking-internet-bluetooth/what-is-the-difference-if-any-between-aux-an

			black cables attach to a wifi adapter card	d-main-antennas-on-the-truemobile-cards-in-systems-with-2-antennas/647e411cf4ccf8a8deb39f1c
Webcam/Microphone		Electrical	Connect to the input for audio and visual components of the panel.	https://support.microsoft.com/en-us/windows/windows-camera-microphone-and-privacy-a83257bc-e990-d54a-d212-b5e41beba857#:~:text=In%20Windows%2C%20having%20a%20camera,use%20your%20camera%20or%20microphone
Antenna		Electrical	Built-in connection component to connect to nearby wifi and Bluetooth. Primarily radio-wave signals, which it transmits and receives at the speed of light.	https://superuser.com/questions/1382438/what-is-this-part-in-my-laptop-screen



<p>Hinges</p>		<p>Non-Electrical</p>	<p>Screen hinges hold the monitor of a laptop static, ensuring a proper viewing angle.</p>	<p>https://www.linkedin.com/advice/0/what-best-practices-replacing-laptop</p>
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7.4.3 Display Assembly Schematics

Hinges

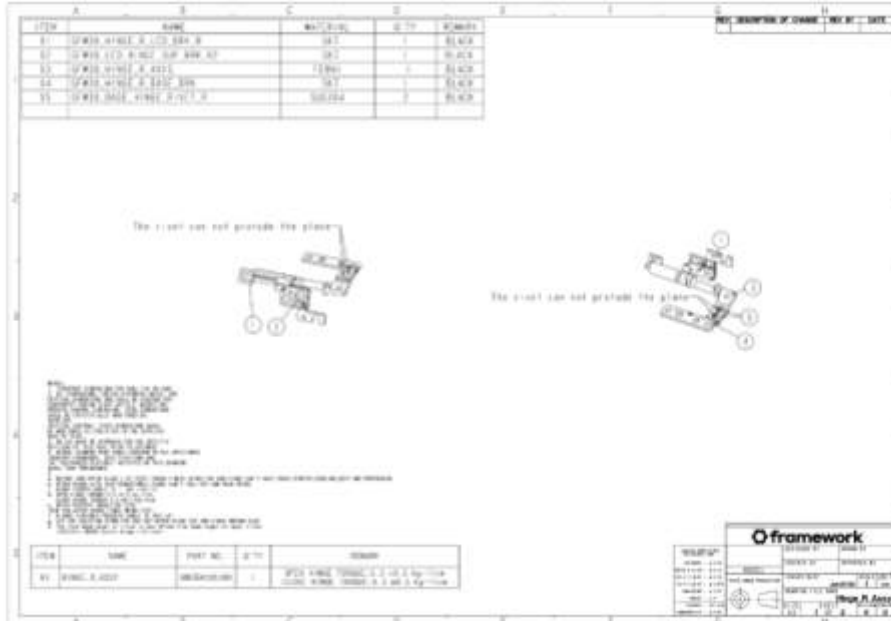


Figure 7.4.3.1: "13_5_hinge_R_assy_00.pdf" Framework

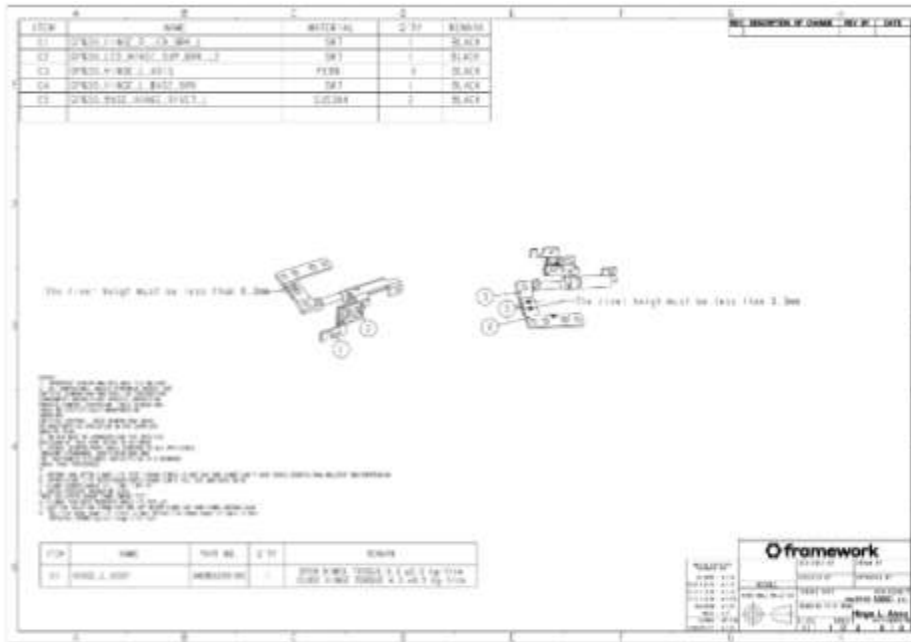


Figure 7.4.3.2: "13_5_hinge_L_assy_00.pdf" Framework



Webcam Pin Specifics

Pinout

This is the ZIF connector that is on the Webcam Module itself. The connector is Kyocera 046809612110846+. The ALS is CM32183A3OP. The Mics are SPK06411HT4H.

Pin	Signal	Type	Voltage	Notes
1	GND			
2	USB_DP	Input/Output	3v3	USB 2.0
3	USB_DM	Input/Output	3v3	USB 2.0
4	3V3			
5	CAM_SW	Output	3v3	State of camera privacy switch
6	MIC_CLK	Input	1v8	Microphone PDM clock
7	MIC_DAT	Output	1v8	Microphone PDM data (2 channel L/R)
8	MIC_SW	Output	3v3	State of microphone privacy switch
9	INT_ALS	Output	3v3	Interrupt from ALS
10	SCL_ALS	Input	3v3	
11	SDA_ALS	Input/Output	3v3	
12	GND			

Figure 7.4.3.2: "Webcam README.md" Framework



8. Full Catalog

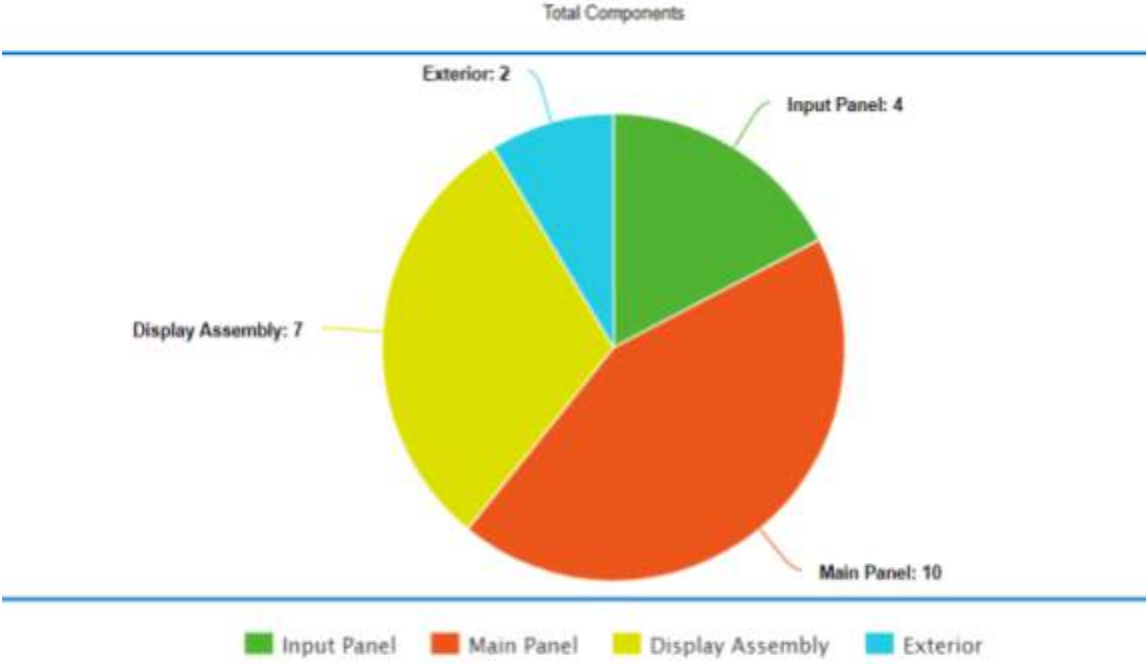


Figure 8.1: Electrical vs. Non-Electrical Components Pie Chart

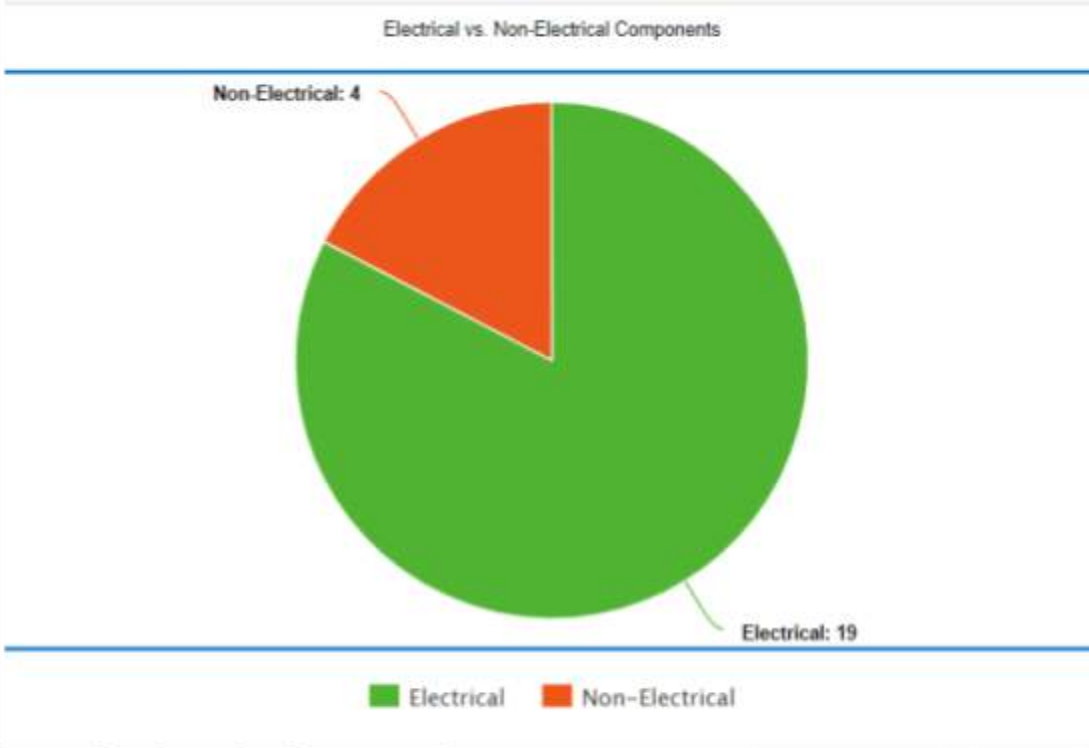
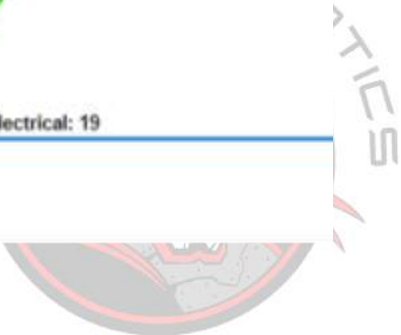


Figure 8.2: Electrical vs. Non-Electrical Components Pie Chart



9. Conclusion

So... what did we learn from this?

Through this challenge, we learned a lot more about how laptops and other types of computers work. We looked at many different types of component schematics to see how they specifically work and how they are built and connected through pins.

We can use that knowledge of detailed schematics in our team's engineering notebook to make our designs more understandable and professional.

We also gained more knowledge on how to carefully take things apart and how to reconstruct them. We carefully categorized which screws came from where when taking components out so we could put the laptop back together when we finished (which we did, and it works!)

Most importantly, this challenge brought together our team cooperation skills. We learned how to work together better, share team tasks, and split up roles accordingly. This challenge brought our team closer together and it helped us become better teammates.



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