# Reverse Engineering Challenge 2024

**Understanding Laptops:**

Reverse Engineering the Surface Laptop Go and Dell Latitude D830

# Team 614A - Aquarius


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**Word Count: 499 (Excluding Title Page, Teardown, Parts List (Component Analysis), Image Captions, Diagrams, and Research)**

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# What Did We Choose and Why?

- For this year's Reverse Engineering Challenge, we chose a topic that doesn't come up too much: two devices. To be more specific, two laptops. We chose these items to study the evolution of laptops between the early 2000s and early 2020s. This was one of the most important points of evolution in modern technology.
- Laptops are used so widely today that this choice was almost obvious to us. They are one of the most complex devices on earth, and we wanted to learn even more about them by taking them apart and researching the parts. The two devices we chose were
- 1. The Surface Laptop Go (2020)
- 2. Dell Latitude D830 (2007)
- Both laptops are mid–range laptops from two different technological eras, making them very easy to compare. Additionally, both are very repairable, unlike many other computers. The Surface Laptop Go, particularly, has set a new standard for repairability in a modern laptop.
- With no further ado, **614A PRESENTS REVERSE ENGINEERING 2024!**

Figure 1 – Front view of Surface Laptop Go


Figure 2 – Front view of Dell Latitude D830

# Summary Report

In 1981, a magical little thing… well, more of a magical huge thing, called the Osborne 1 emerged. The world's first laptop, weighing 24 pounds and resembling a suitcase with a built-in keyboard and screen. But that suitcase changed the world as we know it. From the Osborne 1 came hundreds of different brands, hundreds of different models, and most importantly, millions of different ideas. And out of those millions of ideas came two laptops which happened to fall into the hands of 614A.

Laptops, in general, use the same architecture methods to work. The process starts with the battery providing power to the motherboard, starting the CPU (central processing unit) and its four-step cycle of Fetch, Decode, Execute, Repeat. The CPU **fetches** instruction from the memory, **decodes** the instruction, **executes** the instruction, then **repeats** everything. While **executing,** the CPU "contacts" different parts of the laptop. If the function to execute requires something to be printed on the screen, the GPU is "contacted" and processes the binary data, converting it to an image. Obviously, the process is a little more complicated than that, but that is the base of how laptops work.

Through taking apart the laptops, we learned how a little chip can make a huge difference – how every component contributes to the final result, and this is very similar to how our team works. Everybody contributes to the final robot, whether it be through programming, building, doing the engineering notebook, driving, etc. This is the spirit of teamwork, and we were delighted to find this same spirit being used by laptops.

The two laptops we took apart taught us how technology got to where it is today, and how it may improve in the future. Knowing and learning about technology from two different 'eras' could help us develop new technologies if we pursue that field. The challenge also taught us to keep on going and persevere – we would often find ICs that did not match any datasheets, but we had to keep on researching until we found something.

Overall, the online challenge was a wonderful experience. The amount of knowledge we gained from this and the love and passion for the devices is hard to describe, but we'll try. We learned about different electronic components and tried to understand how they work. We researched the history of each and made some predictions for the future. We looked at the design and physical components of the laptop, and we started to understand the sheer amount of work that goes into even the smallest part of the device. Every time we even press a key on a computer, we will know and understand what happens to print that key on the screen. And learning everything was just… fun. That ecstatic feeling we got when we finally identified an IC – the feeling when something just clicked and we understood how a component worked when we couldn't before. And that knowledge and understanding is simply amazing. Thank you, VEX IQ.

**Word Count: 499 (Excluding Title Page, Teardown, Parts List (Component Analysis), Image Captions, Diagrams, and Research)**

# Basic Information

## DELL Latitude D830

**Task 1 - Learn the Laptop, Inspect, and Research**

After some research, the basic specs of the DELL Latitude D830 are below:

- CPU - Latitude D830, Intel Core 2 Duo T7250, 1.80GHz - 2.00GHz, 2M L2 Cache, Dual Core
- GPU - Intel Integrated Graphics Media Accelerator X3100 Latitude D830
- RAM - 2.0GB, DDR2-667 SDRAM, 2 DIMM for Dell Latitude Notebooks
- SSD – 80GB
- Screen - 15.4 inch Wide Screen WXGA LCD for Latitude D830
- Battery - 6-Cell/56 WHr Primary Battery Latitude D830

**Learnings after Laptop Inspection**

-The battery is easily removable without unscrewing anything.

-Screws are a very common size, 10X M3x3MM M3X3L PM3X3.0 Screw.

-Square panel on the bottom that covers the first stick of RAM.

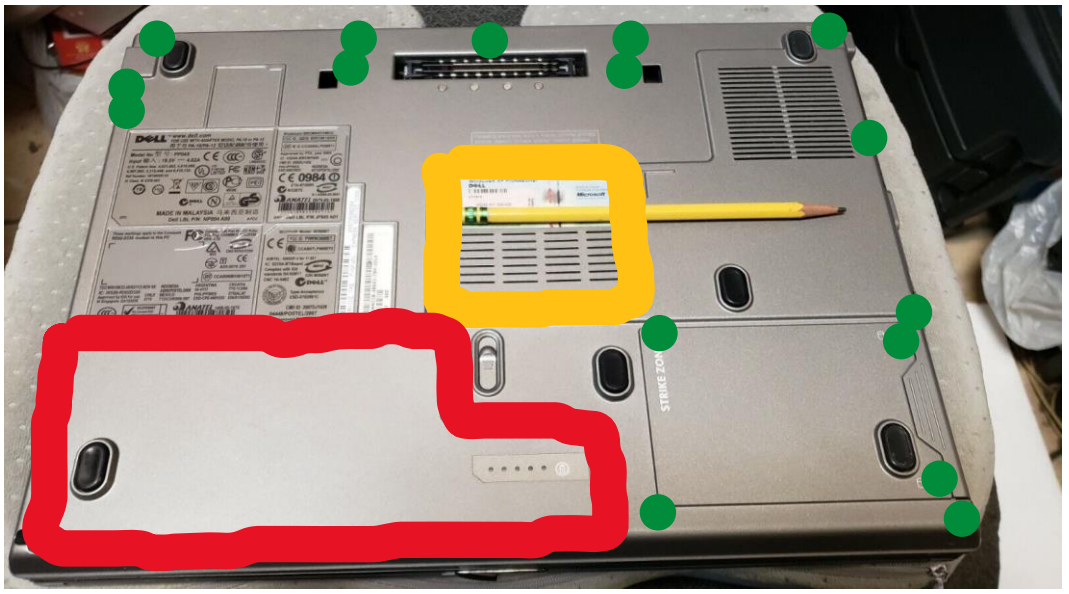


*Figure 3 – Bottom of DELL Latitude D830*

Removable Battery (VERY Helpful)

Removable Panel, exposing one removable stick of RAM and CMOS (**(complementary metal oxide semiconductor)** battery

Screws

# External Anatomy*

## DELL Latitude D830

*Figure 4 – DELL Latitude D830 Front*

*Figure 5 – DELL Latitude D830 Bottom*

*Figure 6 – DELL Latitude D830 Back*

*Most of the earliest pictures of the project were located on one of our old phones, which were wiped when the team member transferred phones (They had forgotten that the pictures were located on the phone). To find pictures for this external anatomy page, we had to use online resources, which we refer to in Sources

# Architecture Diagram

## DELL Latitude D830

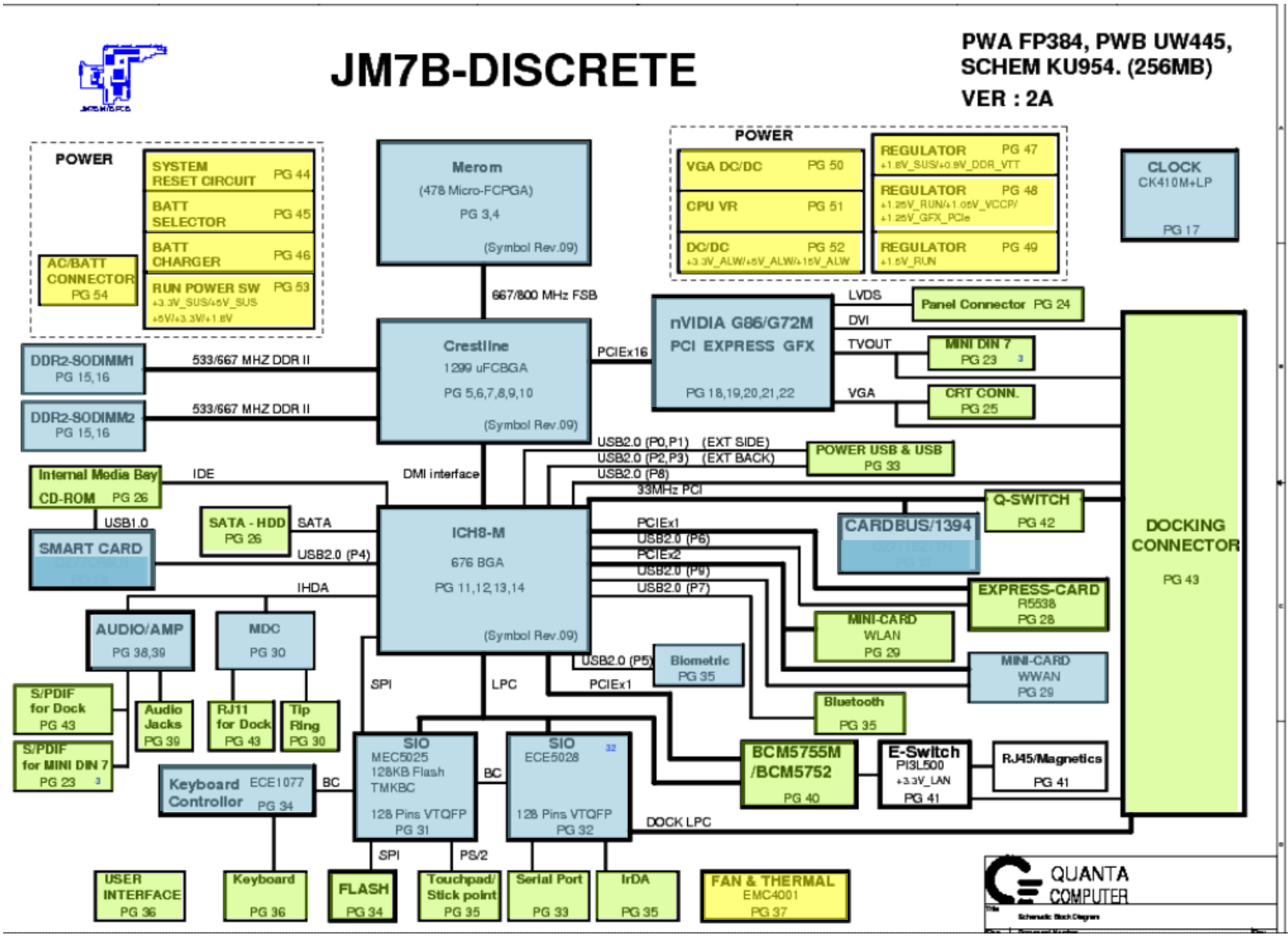



*Figure 7 – DELL Latitude D830 Architecture Diagram*

# LEGEND

An architecture diagram is used to show how components in the system interact with each other. We found it incredibly helpful to see how each component interacted and what communication protocol they used. This helped us when disassembling the devices, and identifying components, because we understood the basic use of each component.

- Processing/Memory-Related Components
- Peripheral/Communication-Related Components
- Power-Related Components

# ‘Dissection’ Process

## DELL Latitude D830

### Task 2 – Unscrew and Open

⚠ Before unscrewing or opening the laptop, we made sure to disconnect the battery, and understand exactly how the laptop was built.

**STEP 1 – We started by removing the battery and unscrewing the laptop on the bottom, sides, and top (outlined in red)**

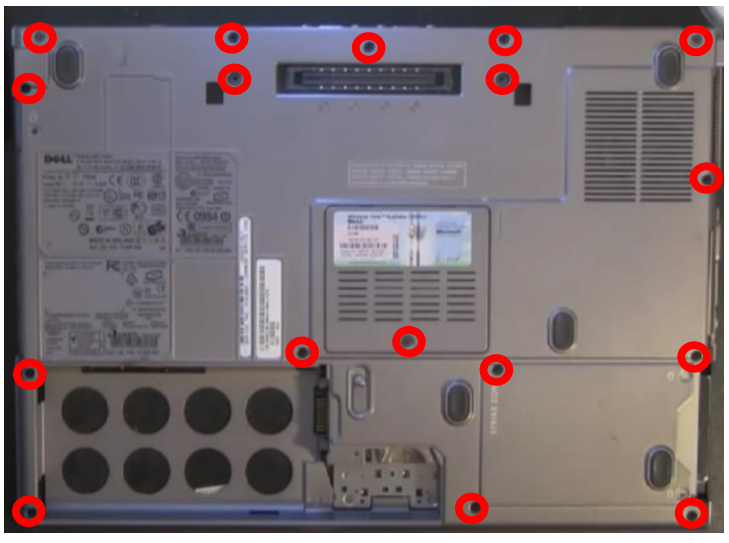


*Figure 8 – DELL Latitude D830 bottom with battery removed*

**STEP 2: We removed the Floppy Disk and the removable panel on the bottom of the laptop (refer to Figure 3). This revealed the CMOS battery (complementary metal oxide semiconductor) and the first stick of RAM, 1GB and removable.**

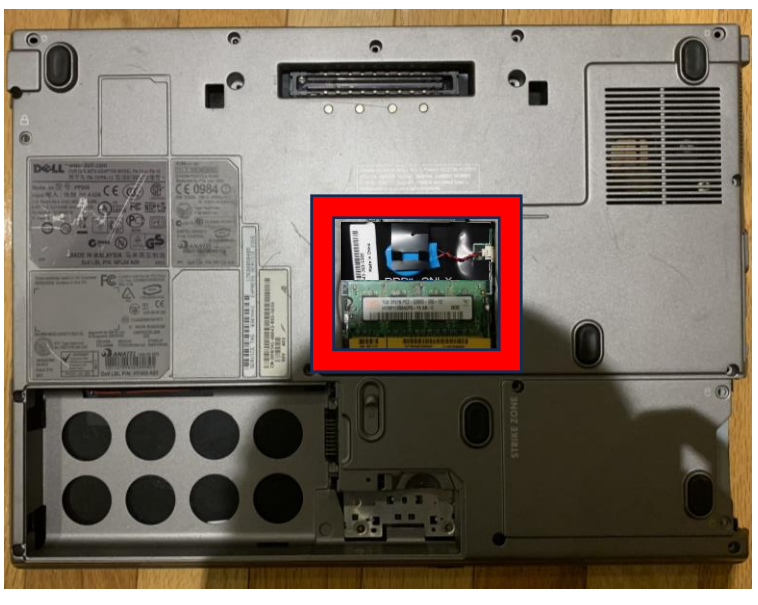


*Figure 9 – DELL Latitude D830 with back panel removed*

**Step 3: Turning over the laptop, we removed the keyboard. This allowed us to remove the screen, the second stick of RAM, and the trackpad and surrounding frame. This revealed the full motherboard, and we removed the DVD Drive, AKA an optical disk drive (ODD)**

*Figure 10 – Dell Latitude with button strip above keyboard removed*

*Figure 11 – Dell Latitude D830 with keyboard removed*

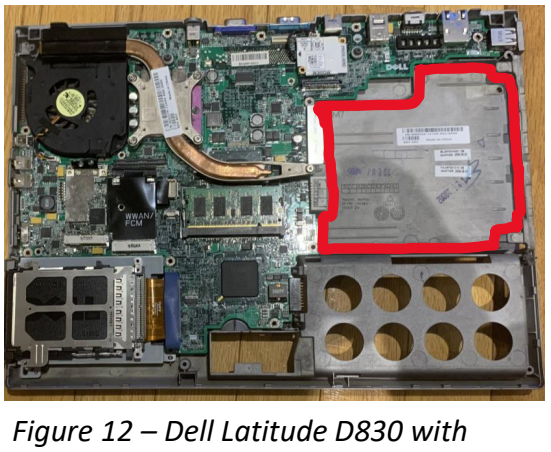


*Figure 12 – Dell Latitude D830 with trackpad shell removed and ODD removed*

# ‘Dissection’ Process

## DELL Latitude D830

### Task 3 – Remove Components from Motherboard

**STEP 1 – We started by removing the modem card (outlined in red) and PC Card (outlined in yellow)**

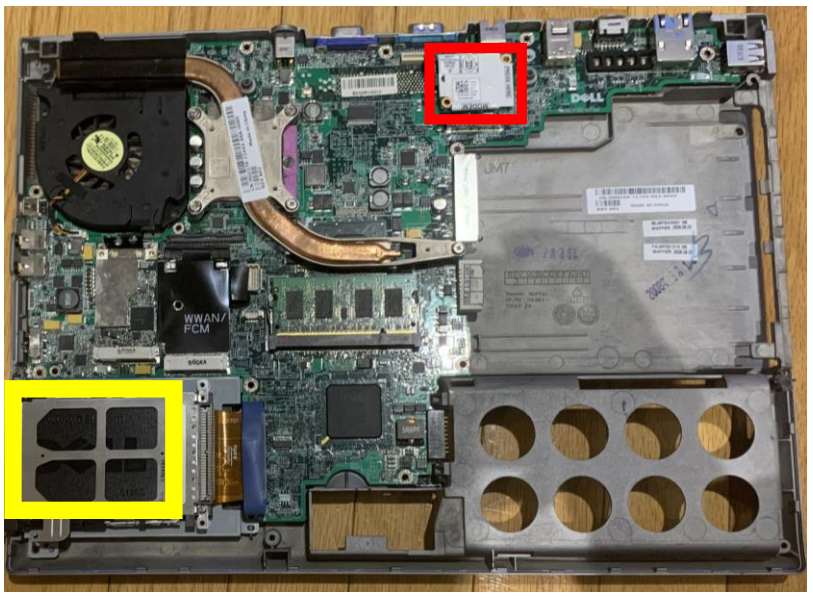



*Figure 13 – Dell Latitude D830 with modem (red) and PC Card/Slot (yellow)*


*Figure 14 – Dell Latitude D830 with modem and PC Card removed*

**STEP 2: We removed the heatsink (outlined in red) and the PC Card Slot (outlined in blue)**

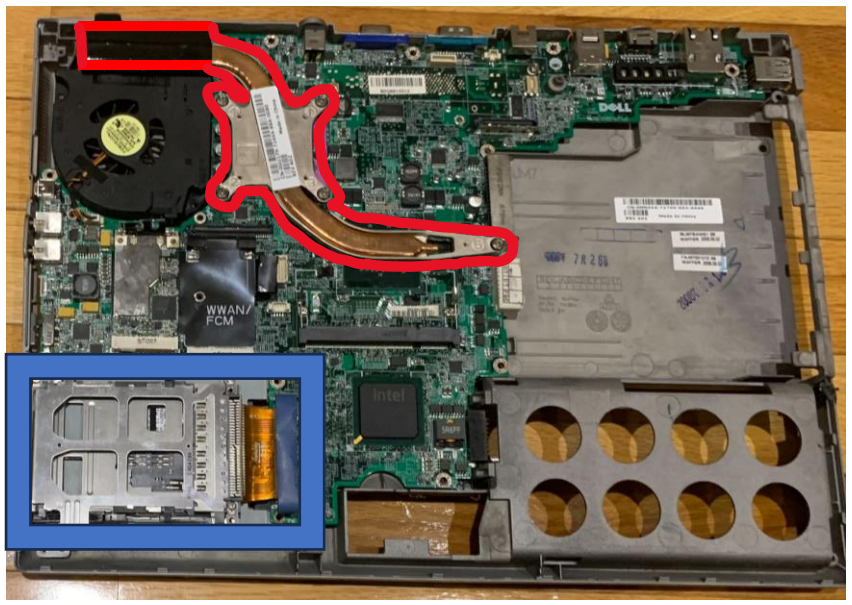



*Figure 15 – Dell Latitude D830 with heatsink (red) and PC Card Slot (blue) outlined*


*Figure 16 – Dell Latitude D830 with heatsink and PC Card Slot removed*

# ‘Dissection’ Process

## DELL Latitude D830

### Task 3 – Remove Components from Motherboard

**Step 3: We removed the CPU (outlined in blue) and the fan (outlined in red)**

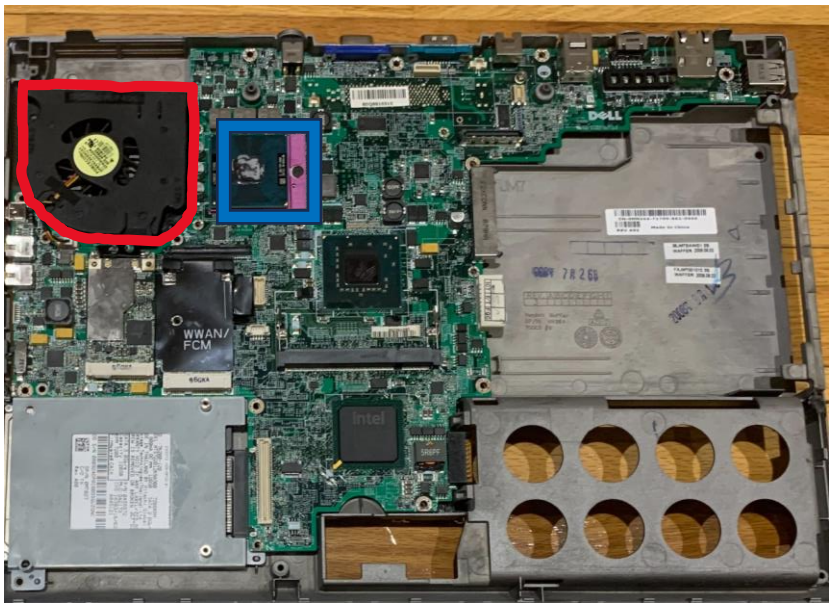



*Figure 17 – Dell Latitude D830 with fan(red) and CPU (blue) outlined*

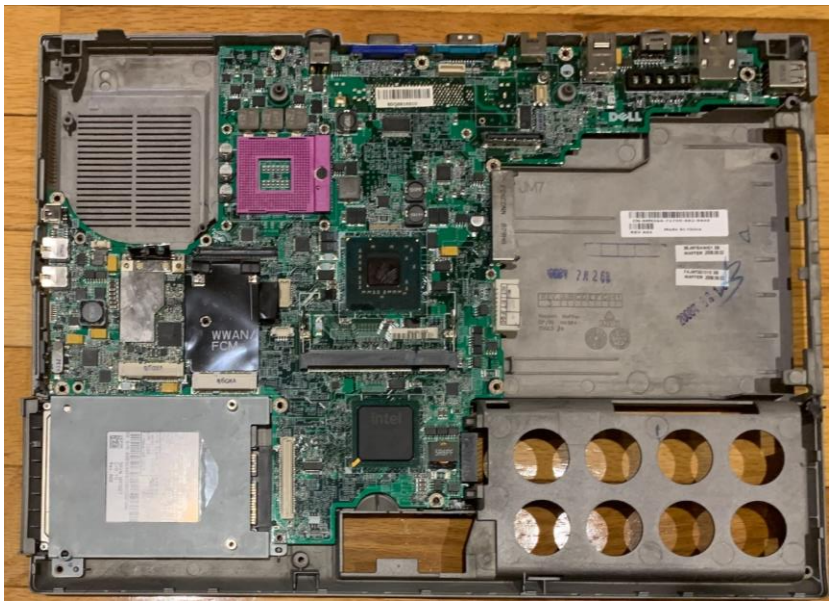



*Figure 18 – Dell Latitude D830 with fan and CPU removed*

**Step 4: We removed the HDD (outlined in blue) and the Wi-Fi Card (outlined in red)**

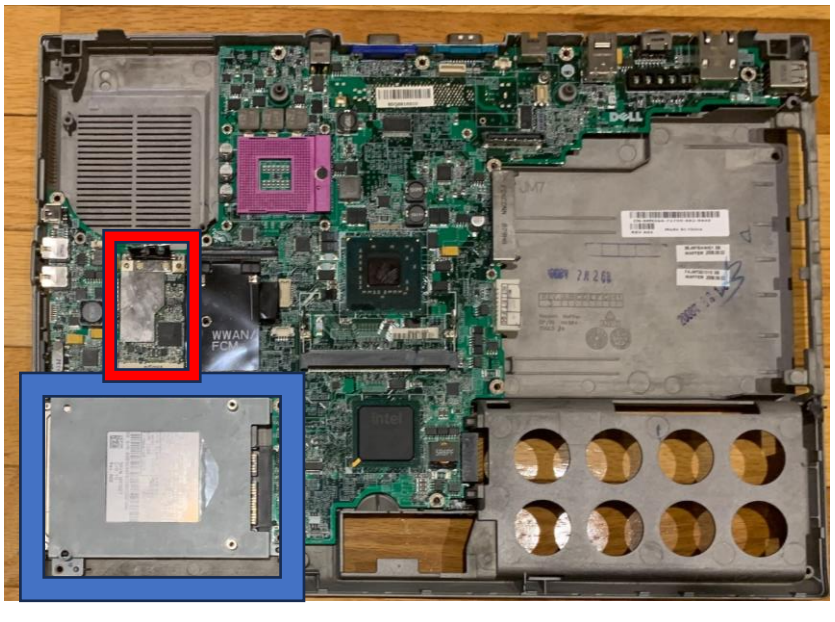



*Figure 19 – Dell Latitude D830 with Wi-Fi card (red) and HDD (blue) outlined*

*Figure 20 – Dell Latitude D830 with Wi-Fi card and HDD removed*

# ‘Dissection’ Process

## DELL Latitude D830

### Task 4 – Open Screen

This LCD’s backlight uses CCFL lighting, which contains small traces of mercury. We made sure to be incredibly gentle with the screen and wear gloves during the process to be safe.

**STEP 1 – We started by removing the plastic bezels around the screen, by removing the screws securing it (outlined in red).**


*Figure 21 – Dell Latitude D830 Screen with screws on bezels outlined in red*

*Figure 22 – Dell Latitude D830 Screen with bezel removed*

**STEP 2: We removed the screws securing the screen to its shell (outlined in red).**

*Figure 23 – Dell Latitude D830 Screen with screws attaching screen to shell outlined in red*

**Step 3: We removed the screen from the shell and turned it over, revealing the LCD cable’s connections – one attaching to the LCD Controller Board (outlined in red), and one connecting to the inverter (outlined in yellow).**

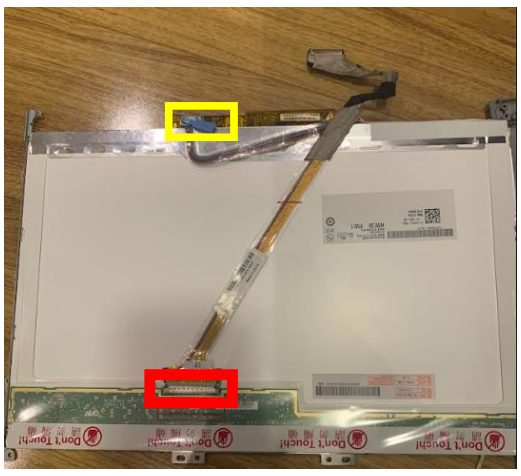


*Figure 24 – Dell Latitude D830 Screen with connections to inverter and LCD controller board outlined in yellow and red, respectively*

**Step 4: We unplugged the connection at the top and bottom.**


*Figure 25 – Dell Latitude D830 Screen with connection to LCD Controller Board unplugged*

*Figure 26 – Dell Latitude D830 Screen with connection to inverter unplugged*

# ‘Dissection’ Process

## DELL Latitude D830

### Task 4 Continued – Open Screen

**Step 5 – We un-taped and removed the bottom circuit board (outlined in red).**


*Figure 27 – Dell Latitude D830 Screen with inverter removed and outlined in red*

**Step 6 – We removed the screens on both sides of the screen (screws outlined in red) (image 1), which revealed another layer beneath that (image 2). We removed those two screws (outlined in red)**

*Figure 28 – Dell Latitude D830 Screen with side screws outlined in red*

**Step 7 – We removed the screws at the bottom of the screen (Image 1 - outlined in red), which removed the metal component securing the Liquid Crystal to the backlight, allowing us to open the screen (Image 2 – Liquid Crystal on left, backlight and polarizing layers on right).**

*Figure 29 – Dell Latitude D830 Screen with bottom screws outlined in red*

*Figure 30 – Dell Latitude D830 Screen opened*

# ‘Dissection’ Process

## DELL Latitude D830

**Task 4 Continued – Open Screen**

Step 8 - We removed the four layers between the backlight and the liquid crystal, shown below. (Layer 4 is closest to the backlight, and layer 1 is the farthest from the backlight.

Layer 1 - Transparent

*Figure 31 – First layer, transparent*

Layer 2 and 3 are very similar; transparent from one angle, reflective from the other angle.

*Figure 32 – Second/third layer, transparent from one angle*

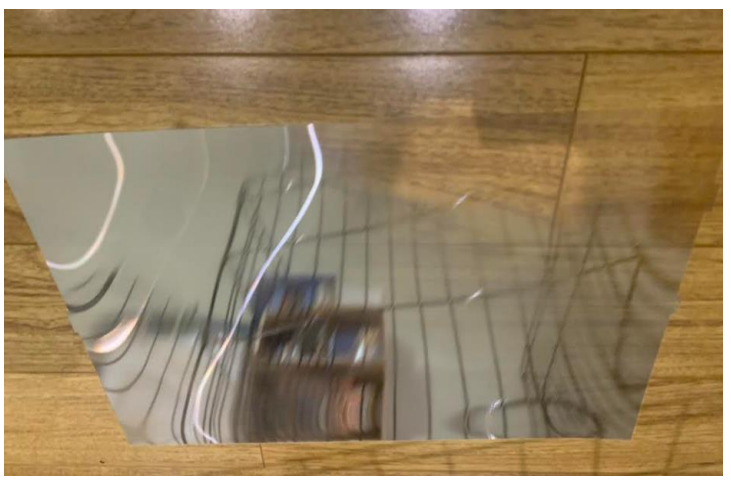


*Figure 33 – Second/third layer, reflective from the other angle*

Layer 4 is translucent – it allows light to pass through but not all of it.

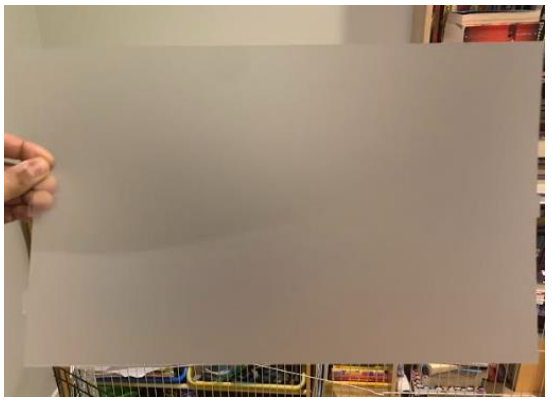


*Figure 34 – Fourth layer, translucent*

# Labelled Motherboard (Front)*

## DELL Latitude D830

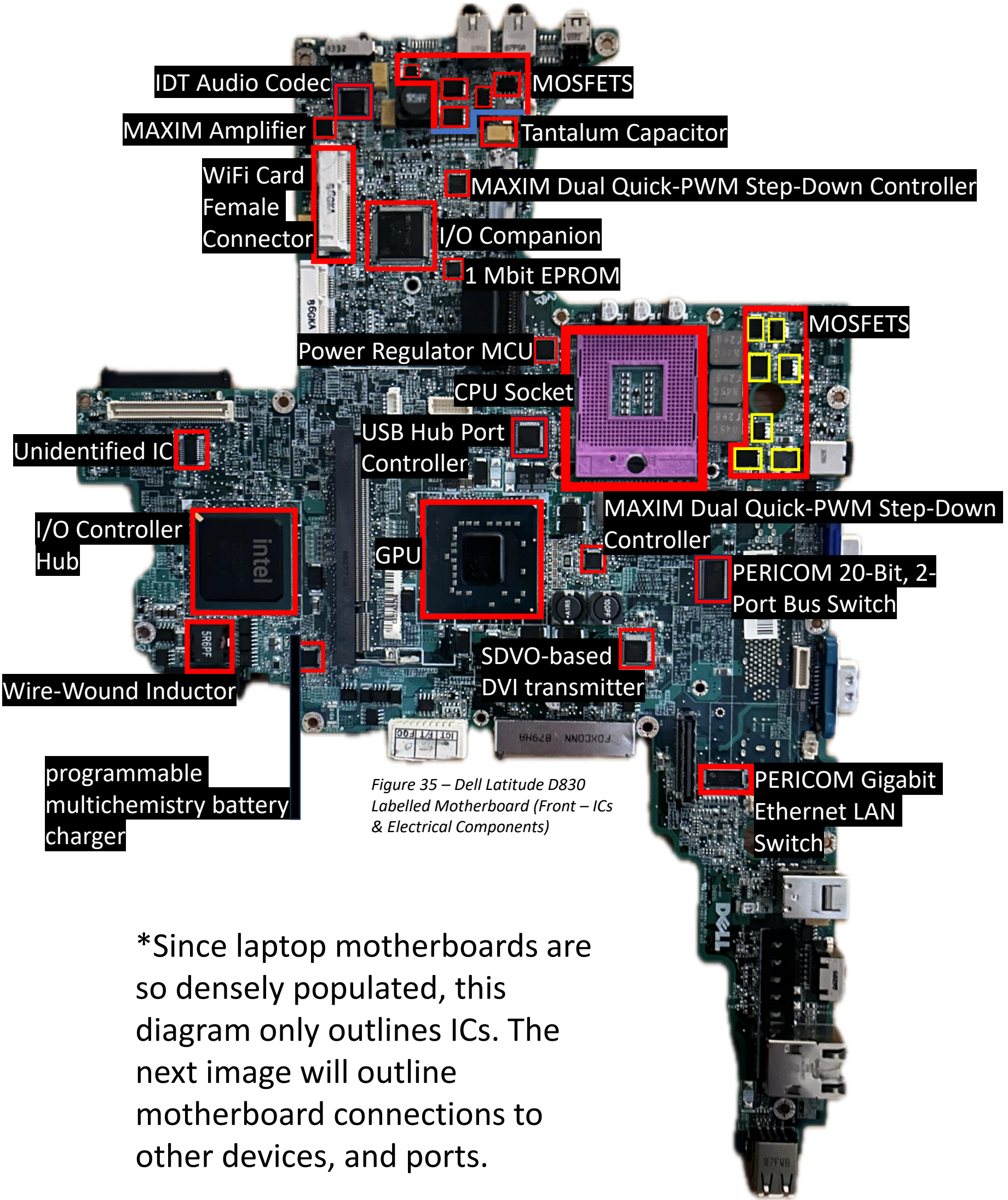



*Figure 35 – Dell Latitude D830 Labelled Motherboard (Front – ICs & Electrical Components)*

*Since laptop motherboards are so densely populated, this diagram only outlines ICs. The next image will outline motherboard connections to other devices, and ports.

# Labelled Motherboard (Front)*

## DELL Latitude D830

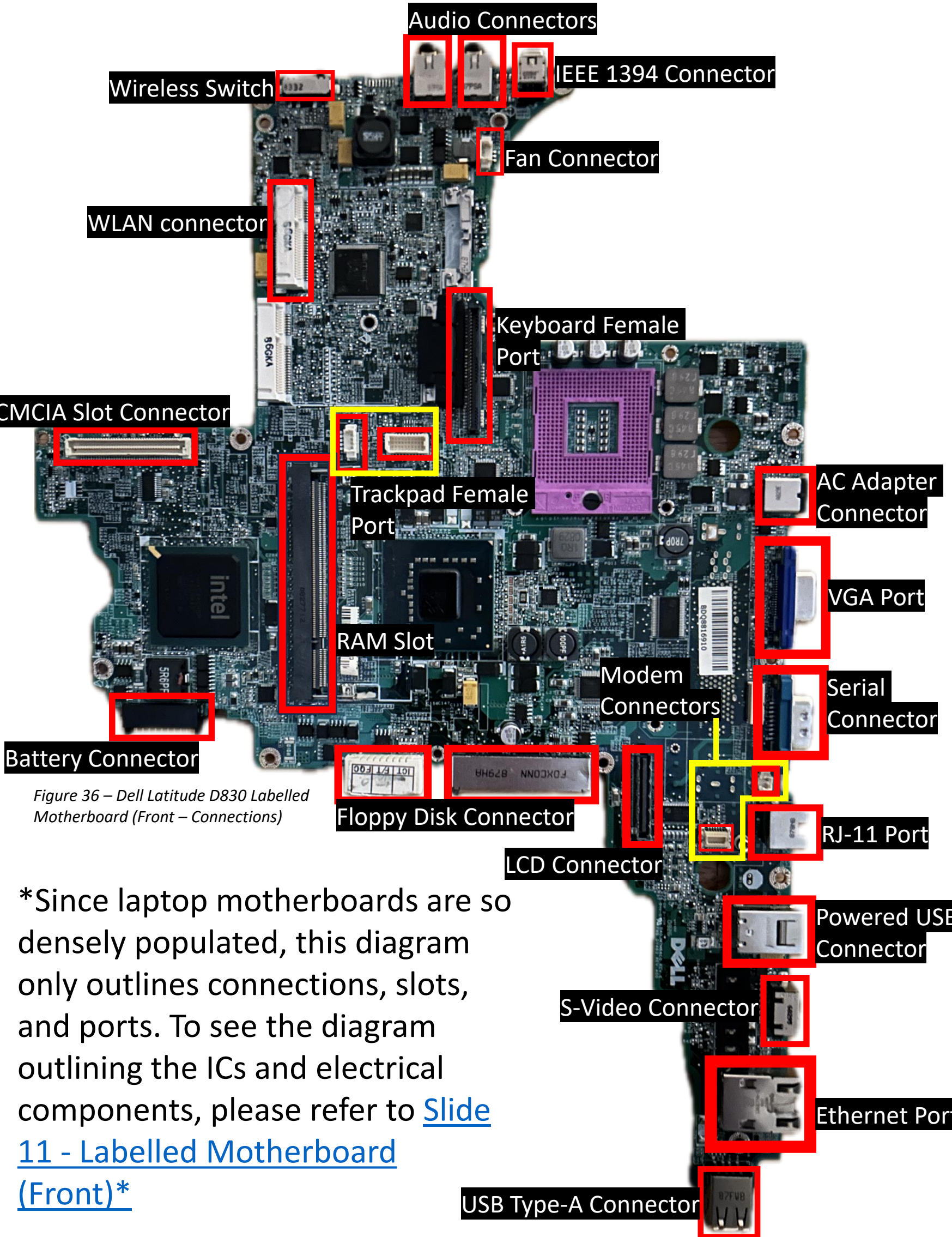



*Figure 36 – Dell Latitude D830 Labelled Motherboard (Front – Connections)*

*Since laptop motherboards are so densely populated, this diagram only outlines connections, slots, and ports. To see the diagram outlining the ICs and electrical components, please refer to Slide 11 - Labelled Motherboard (Front)*

# Labelled Motherboard (Back)

## DELL Latitude D830

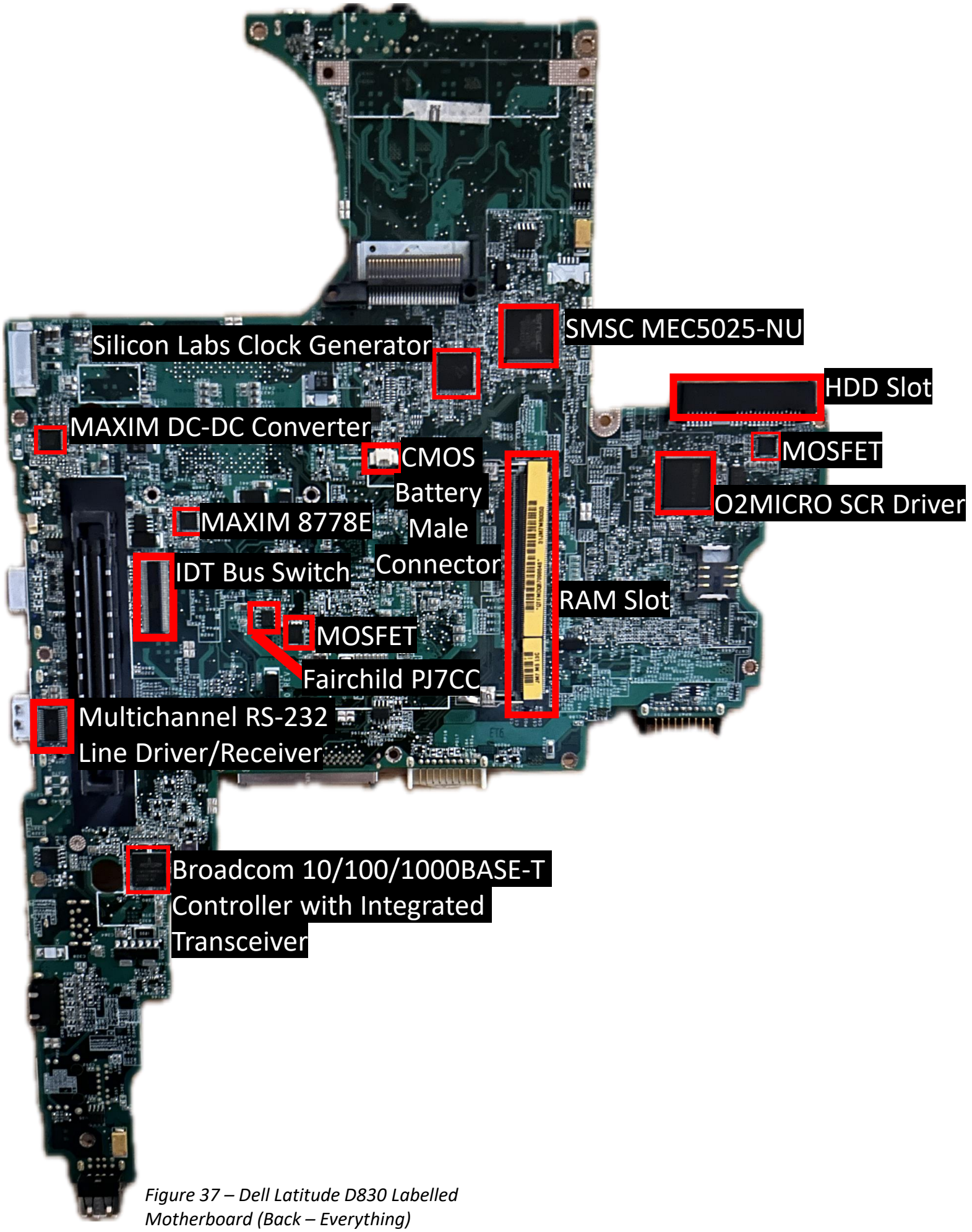



*Figure 37 – Dell Latitude D830 Labelled Motherboard (Back – Everything)*

# Motherboard Diagram (Graphs)*

## DELL Latitude D830

| Compone | Quantity | Size | Percent |
|---|---|---|---|
| ICs | 45 | *0.8 | 12.16% |
| Inductors | 20 | *1 | 6.76% |
| Capacitor: | 900 | *0.1 | 30.41% |
| Resistors | 900 | *0.1 | 30.41% |
| Transistor | 300 | *0.2 | 20.27% |

*Figure 38 – Dell Latitude D830 Motherboard Component Chart*

*These numbers are estimations based on fact

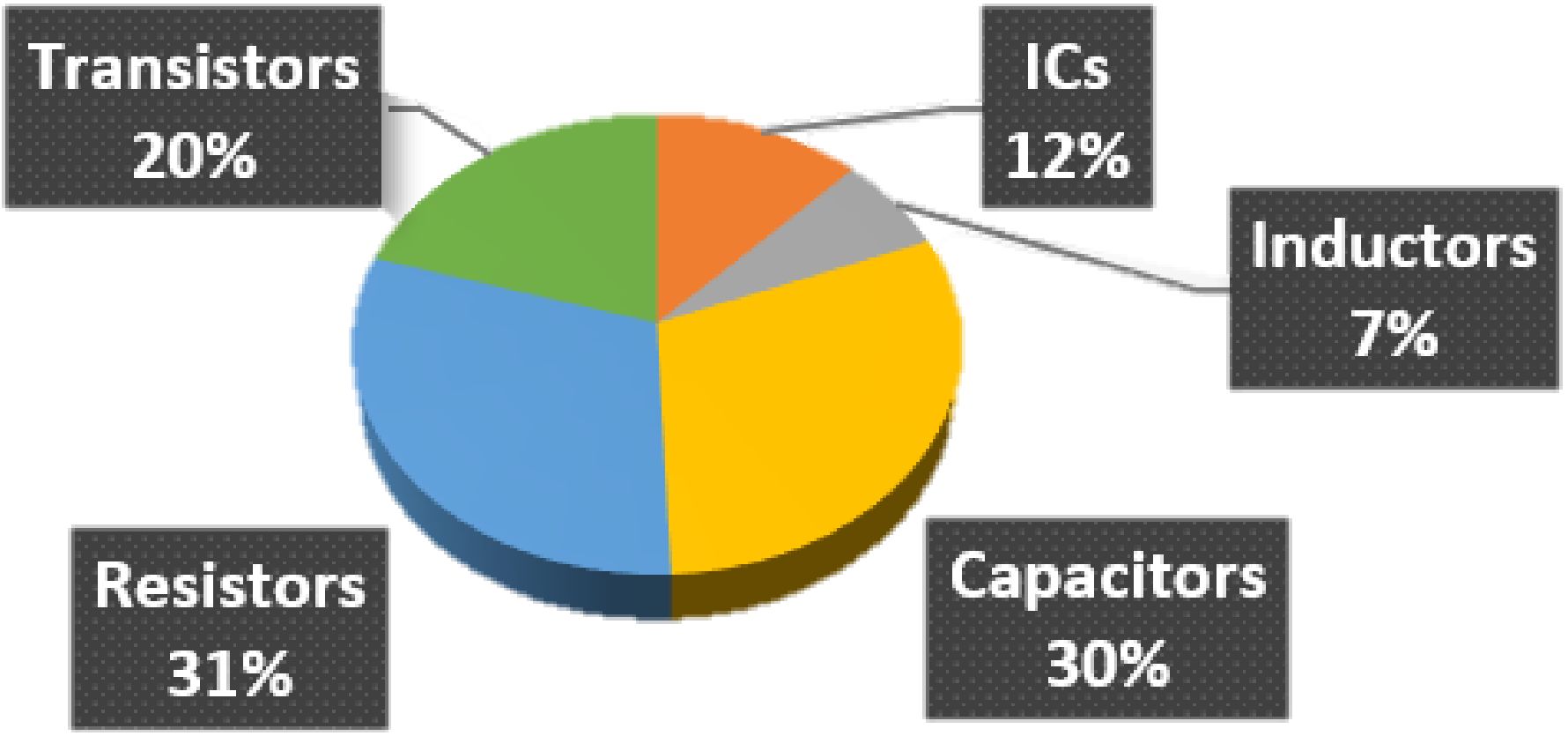
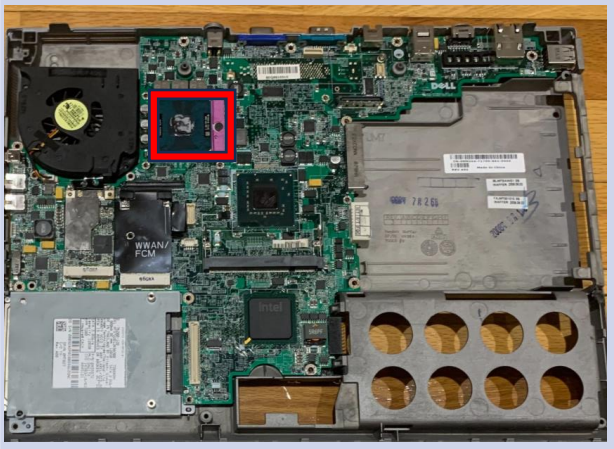
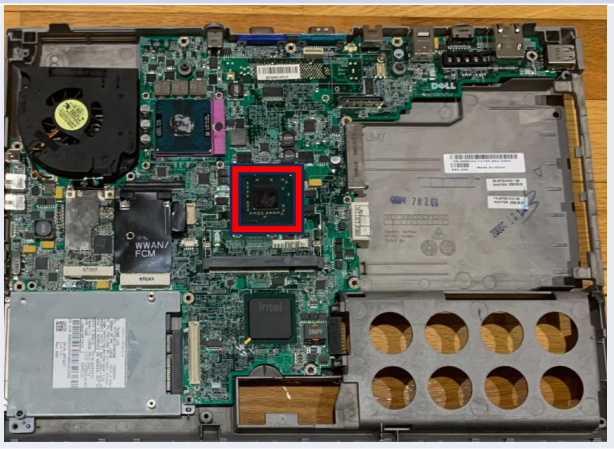
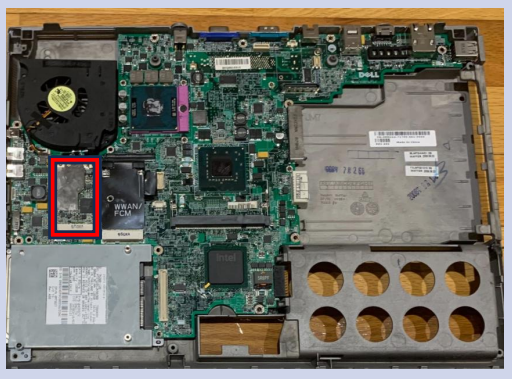
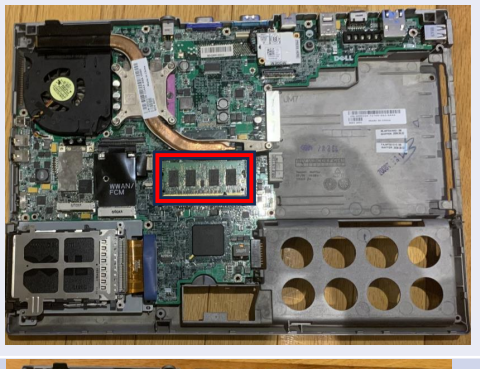
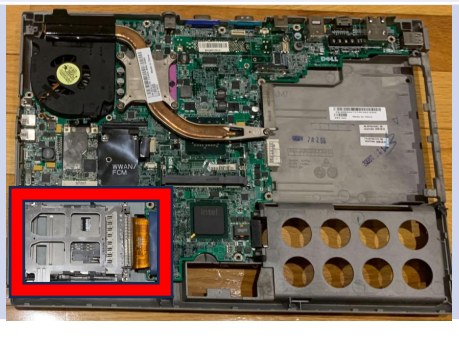



*Figure 39 – Dell Latitude D830 Motherboard Component Pie Graph*

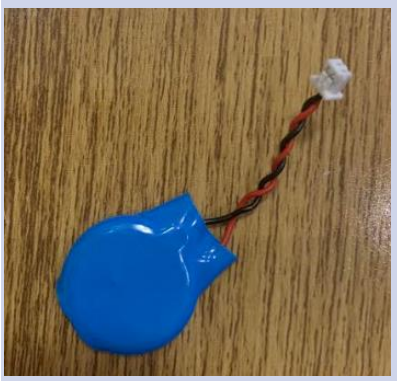
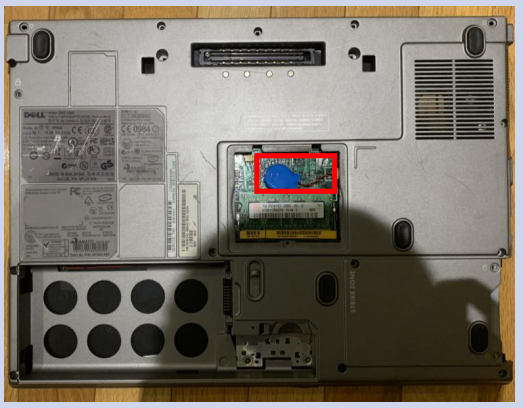
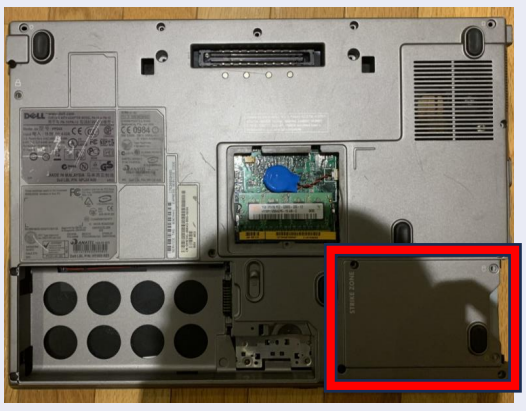
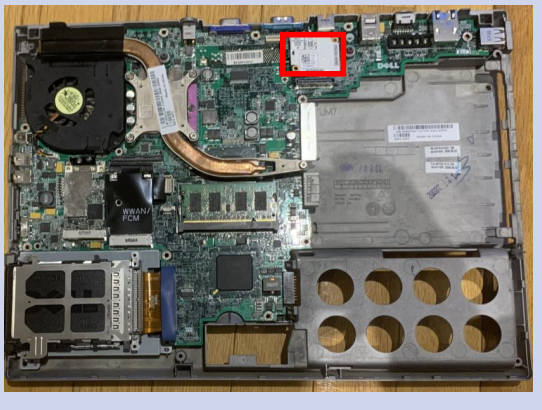
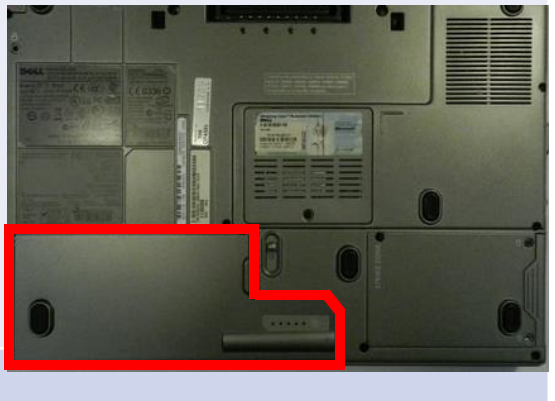
# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| CPU - Latitude D830, Intel Core 2 Duo T7250, 1.80GHz - 2.00GHz, 2M L2 Cache, Dual Core<br><br>T7250 | The CPU of a laptop is short for the Central Processing unit and is the 'brain' of the laptop. It has a four step process called, Fetch, Decode, Execute, Repeat. The CPU **fetches** instruction from the memory, **decodes** the instruction, **executes** the instruction, then **repeats** everything. The CPU also performs different operations, like basic arithmetic, logic, and input and output operations. |  |  |
| GPU - Intel Integrated Graphics Media Accelerator Latitude D830<br><br>X3100 | The GPU of a laptop is short for the Graphics Processing Unit, and is like a CPU, but for graphics. It uses parallel processing, allowing it to work efficiently by handling multiple tasks at the same time. Using mathematical operations, the GPU can process graphics and load the data to the display. |  |  |
| Wireless WiFi Card - 1395 802.11 b/g Wireless WiFi Card - WLAN Mini-PCI Express<br><br>WX781 | The WiFi Card of a laptop enables the device to connect to a wireless network, which allows the laptop to be used for so much more (e.g exchanging data with other devices). |  |  |
| RAM –DDR2 2GB 667Mhz Sodimm Laptop RAM Memory Stick<br><br>PC5300 | RAM, short for Random Access Memory, is for temporary storage, and allows applications to run, and store/access data. The RAM gives instructions to the CPU (the Fetch part of the cycle), through the memory bus. |  |  |
| PC Card Slot - Dell OEM Latitude D820 D830 / Precision M65 PCMCIA Slot | A PCMCIA slot, short for Personal Computer Memory Card International Association, is an expansion slot in older computers allowing for the easy addition of many different things, including memory. |  |  |

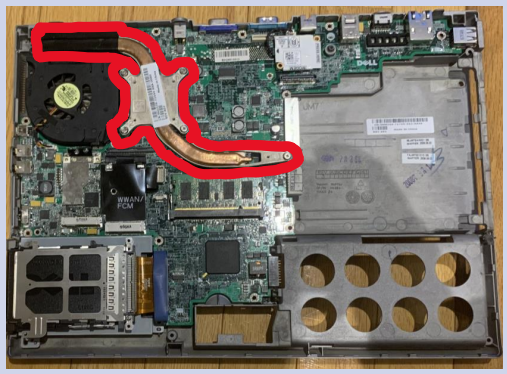
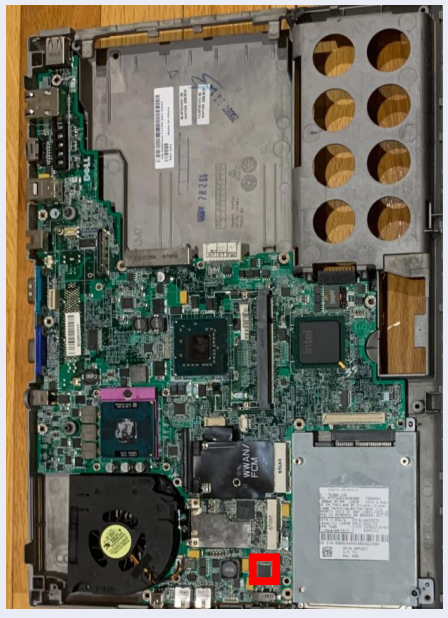
# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| CMOS Battery - CR2032<br>3V - 220 mAh | The CMOS (Complementary Metal-Oxide Semiconductor) battery is one of the most important items on a laptop, although it often goes unnoticed. It provides power to the CMOS chip on the motherboard even when the computer is off, so the chip can retain the date and time, BIOS settings, and configurations. |  |  |
| HDD - 80.0GB fast SATA hard disk drive (HDD) 5400 rpm | The HDD is a non-volatile storage device, meaning it can store data even when the computer is off. It is used to store things like OS, files, and applications (the code and settings for the application – the RAM stores the application instructions while the application is on, sending instructions to the CPU). |  |  |
| Modem - Dell Latitude D830 OEM Internal 56k Mini Modem Card | A modem, standing for Modulator-Demodulator, allows a device to connect to the internet. Although it sounds incredibly similar to a Wi-Fi card, and it is, it differs in its ways to connect to the internet. It converts digital signals to analog signals to transmit them across networks (through a router), and converts analog signals to digital signals when it receives data. |  |  |
| Battery - 6-Cell/56 WHr Primary Battery Latitude D830 | A battery stores chemical energy, then, through a conversion process, transforms that energy into electrical energy which powers the circuits in the laptop. After the energy in the battery runs out, it must be charged. |  |  |
| | | | |

# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Dell OEM Latitude D830 CPU Heatsink for Integrated Intel Graphics –<br><br>UMA - GU179 | A heatsink is a part used in computers to prevent overheating in components like the CPU and GPU. Often, computer parts doing strenuous tasks (the CPU and GPU) overheat, and this could cause them to break. This is why a solution was engineered – a heatsink. The heatsink helps to spread and release the heat generated by the CPU and GPU. The fins on the heatsink allow the heat to escape into the air, causing it to dissipate. Usually, a fan propels air into the heatsink, which moves the fins, which allows the heat to dissipate quicker. |  |  |
| IDT Audio Codec 4-CHANNEL HD AUDIO CODEC WITH QUAD DIGITAL MICROPHONE INTERFACE<br><br>STAC9205X5 | A lot of times, files are very big and hard for a computer to handle. Therefore, people had to find a way to reduce the size of the files so they could be easily downloaded or sent, while still maintaining the quality of the file. This was an especially big problem in terms of audio, so an audio codec (a mix of the words coder and decoder) was created. By compressing and decompressing audio files by encoding analog audio into digital signals (compressing) and decoding the digital signals back into analog audio (decompressing). This allowed audio files to easily be downloaded and sent, and not take up too much space in the computer, while still maintaining the quality. |  |  |
| | | | |

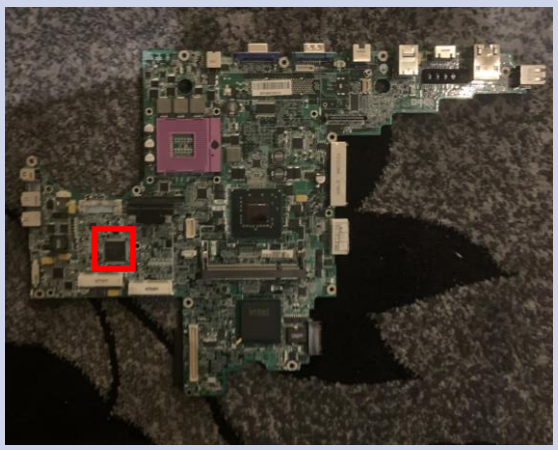
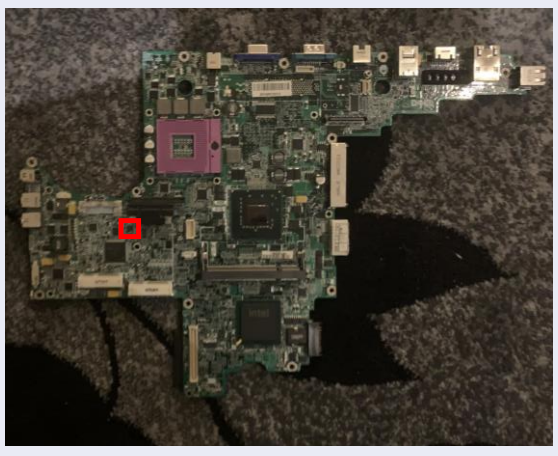
# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| MAXIM Amplifier IC 2-Channel (Stereo) with Stereo Headphones Class AB 32-TQFN (5x5)<br><br>9789AE | Audio amplifiers are used to control and amplify the strength of the audio. |  |  |
| NXP N-channel TrenchMOS-TM logic level FET<br><br>12NQ03L | This is a MOSFET, a metal-oxide semiconductor field-effect transistor, a type of field-effect transistors, that has the capability of DC-DC conversion. A normal transistor is a component in electronics used to amplify electronics signals, as well as acting like a switch – opening and closing an electronic gate. An FET is usually used for amplifying wireless signals, by using an electric field to control the flow of the current. This particular FET is an N-channel one, which means it has a channel consisting of an N-type semiconductor. |  |  |
| MAXIM Dual Quick-PWM Step-Down Controller with Low-Power LDO, RTC Regulator<br><br>8778E | This IC uses PWM (pulse-width-modulation) to control and regulate voltage. This specific PWM controller can handle two channels/outputs. Using power regulation, it works with the RTC (Real-Time-Clock) and regulates its power supply to provide accurate timekeeping while being efficient with energy. |  |  |

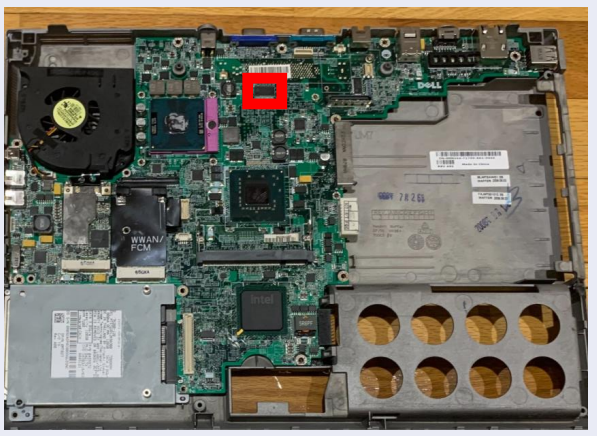
# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| MICROCHIP Advanced I/O BC-LinkTM Companion<br><br>SMSC ECE5028-NU | This is an I/O (Input- Output) companion with an LPC (Low-Pin-Count) interface, used as a communication bridge in a system. The I/O companion is used for input and output functions in a system, while an LPC interface provides communication capabilities for the components on a circuit board. |  |  |
| MICRO 1 Mbit EPROM<br><br>27C10LN | This IC is an EPROM (Erasable Programmable Read-Only Memory). It is a type of non-volatile memory (meaning whatever it holds is stored even when there is no power), and is usually used to store things like firmware or BIOS (Basic Input/Output System), as well as other things that need to be stored even when the device has no power. An important feature of an EPROM, separating it from other types of non-volatile memory, is the fact that they are erasable and reprogrammable. This is very convenient for users and saves a lot of space. This specific IC has 1 Mbit of storage. |  |  |

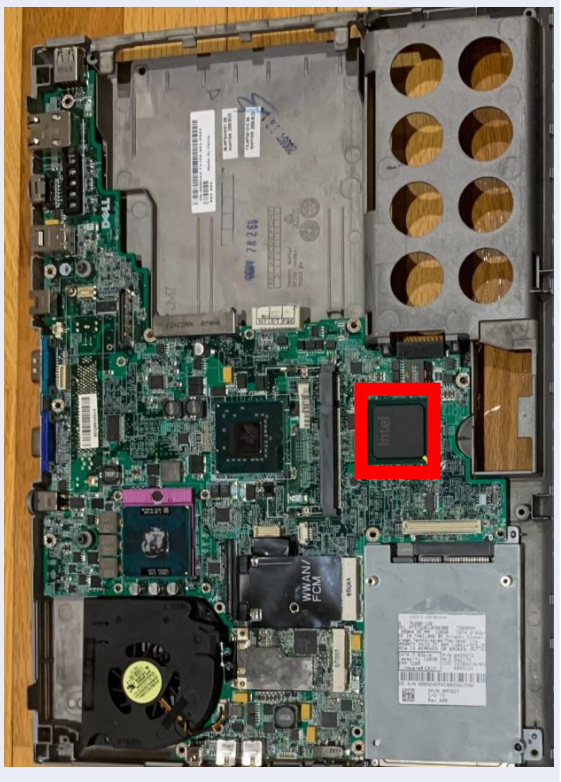
# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| SMSC USB 2.0 High Speed 4-Port Hub Controller<br><br>EMC4001-HZH | Many times, users may want to connect external devices to their computer, be it a stick of memory, a mouse, a keyboard, a camera, etc. Computer manufacturers can't put everything that users want in the computer, so they have something called a USB (Universal Serial Bus) port. This allows users to connect external devices and exchange data between the computer and the external device, as well as other functions. But now there's a problem – the computer needs something to manage the communication between the USB device and the computer. This IC is the 'brain' of the USB hub. It handles the communication between the two devices. |  |  |
| PERICOM 20-Bit, 2-Port Bus Switch<br><br>PI5C162861AE | In electronics, a bus is a communication pathway used to transfer data between two components on a circuit board. A bus switch is a device that can turn on/off the connection to a bus. This IC can switch between two buses. |  |  |
| ON Semiconductor P-Channel PowerTrench ® MOSFET<br><br>FDS6679AZ | This IC is similar to the N-channel MOSFET mentioned a couple rows above. It is used for amplifying and switching signals, and is a P-Channel FET, which means it has a channel consisting of a P-type semiconductor. |  |  |

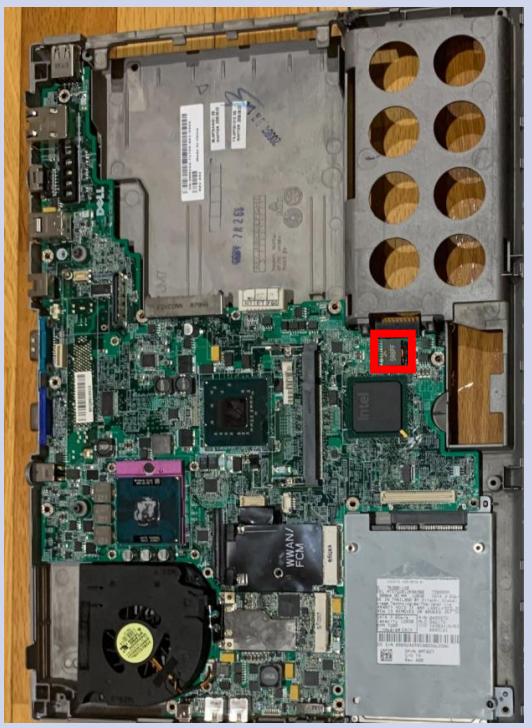
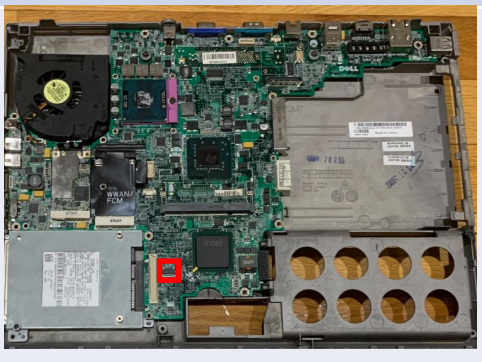
# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Silicon Image PanelLink Transmitters<br><br>SIL1362ACLU | This IC is an SDVO-based DVI transmitter. SDVO (Serial Digital Video Output) is a video interface standard created by Intel. It is among other interfaces like HDMI, VGA, DisplayPort, etc. A DVI (Digital Visual Interface) is another type of video interface. This particular IC uses the DVI interface to encode video signals from the GPU, but the IC was engineered to be compatible with both platforms, and transmits the video to the display using SDVO technology. |  |  |
| Intel I/O Controller Hub<br><br>NH82801HBM | An I/O (Input/Output) controller hub is a hub with input/output functions that acts as a ‘middleman’ between the CPU and peripheral devices like USB devices, hard drives, audio drives, etc. |  |  |
| | | | |

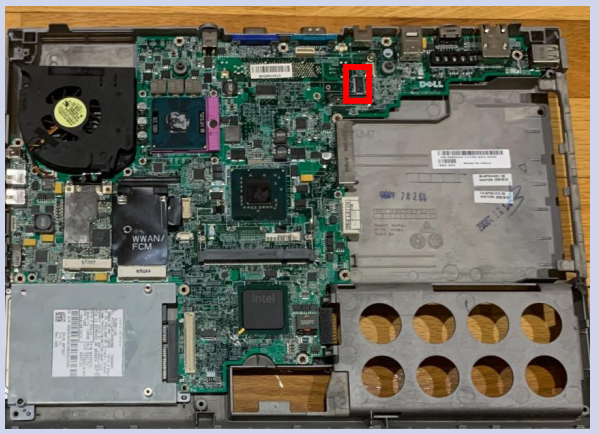
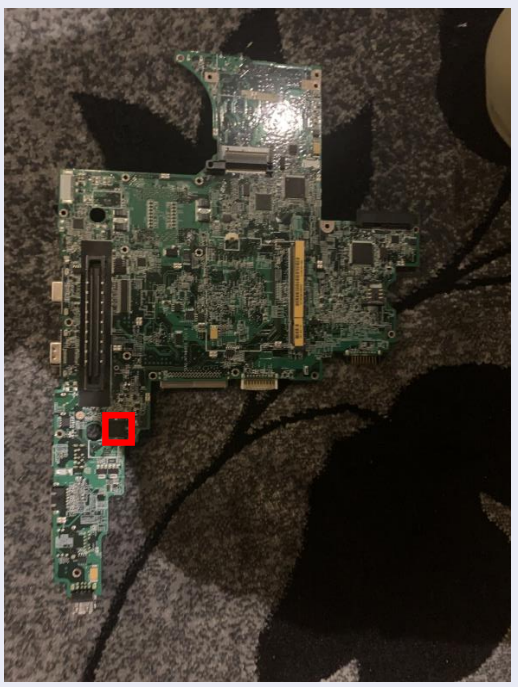
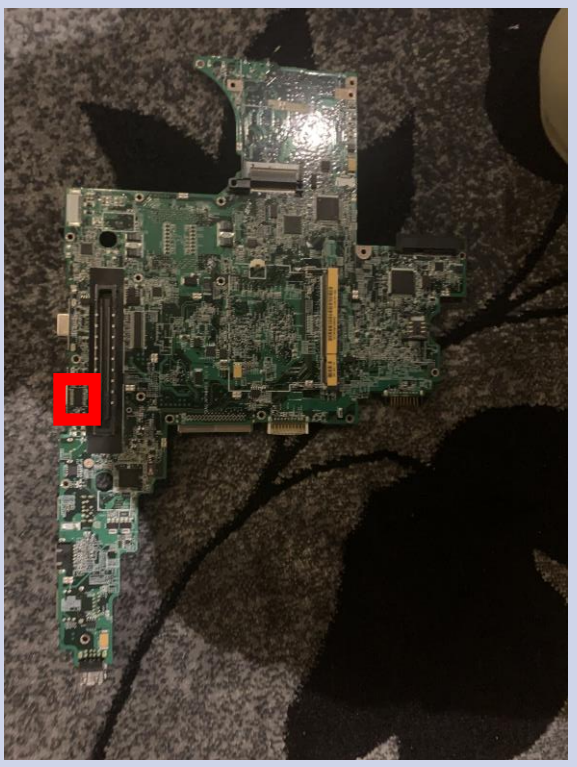
# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Wire Wound SMD Inductor<br><br>5R6PF | An inductor is an electrical component that stores energy when a current flows through it, and releases that energy when there is no current. It uses a magnetic field to do this. A wire-wound inductor is a type of inductor where a wire is wound into a coil shape. The wire creates a magnetic field when electrical current flows through the inductor. A wire wound inductor is one of the most common types of inductors. When the power to the circuit is lost for a split second, it would usually cause the whole circuit to shut down, but inductors release their stored energy and keep everything running until the circuit's power is back up. |  |  |
| OZ2532SN | Unfortunately, we could not find any information on this IC, other than images. The only thing we could find is the fact that it was a specialized IC. |  |  |
| Solid State Devices Fast Recovery High Voltage Rectifier<br><br>SDH3LL | A rectifier is a component used in electronics to convert AC (alternating current) to DC (direct current). This is useful when a device may need DC to function, but the incoming current is AC. This specific IC is a high-voltage rectifier, meaning it can handle high-voltage levels and easily convert them. |  |  |

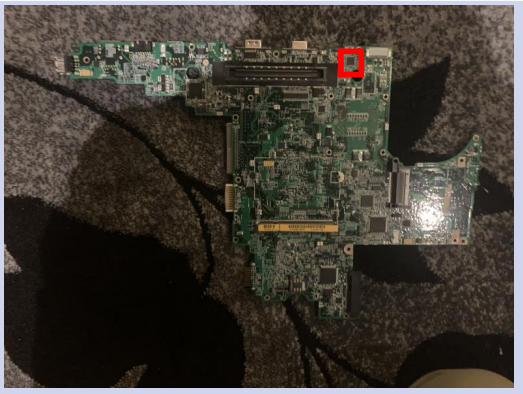
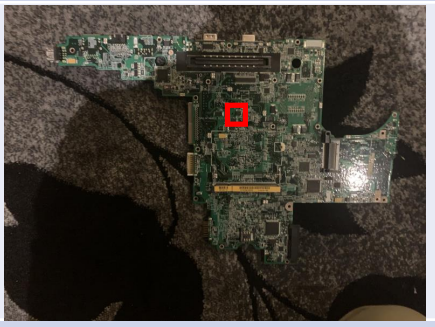
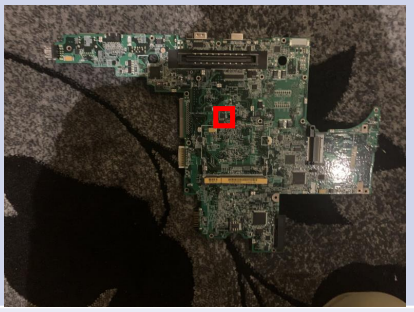
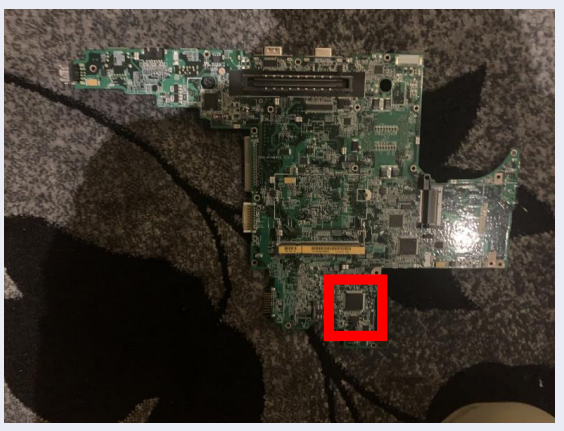
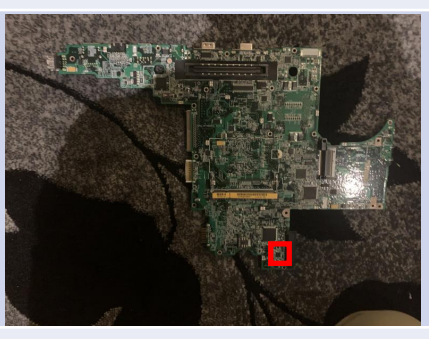
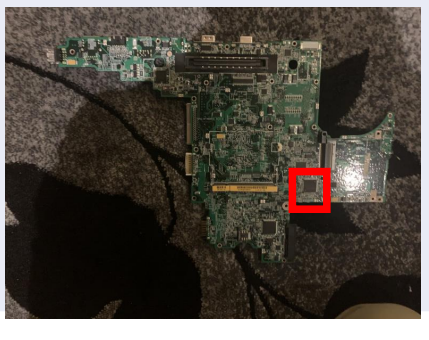
# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| PERICOM Gigabit Ethernet LAN Switch<br><br>PI3L500-AZFE | A LAN (Local Area Network) switch is a device used to connect the devices in the same network. It can also switch between devices, allowing two devices to connect only to each other and transfer data only between each other. In a laptop, it is used to connect the laptop to other devices on the network directly and exchange data/communicate. |  |  |
| Broadcom 10/100/1000BASE-T Controller with Integrated Transceiver<br><br>BCM5755 | This IC is a chip used for communication and data transfer over Ethernet. This specific IC can support multiple Ethernet standards, including 10/100/1000BASE-T. There are 2 main components to the chip. The integrated transceiver is the one that handles transmission and reception of data over Ethernet. The Network Controller manages connection and communication between the device and Ethernet network. |  |  |
| Texas Instruments 3-V to 5.5-V Multichannel RS-232 Line Driver/Receiver With ±15-kV IEC ESD Protection<br><br>MAX3243E (MP243EC) | This IC is a chip used for communication between devices. RS-232 (Recommended Standard 232) is a serial communication standard that many devices use. This chip controls the signals between the devices, boosts them, and receives and transmits signals from and to devices. This specific IC can handle multichannel communication and can organize communication between many different devices and channels. |  |  |

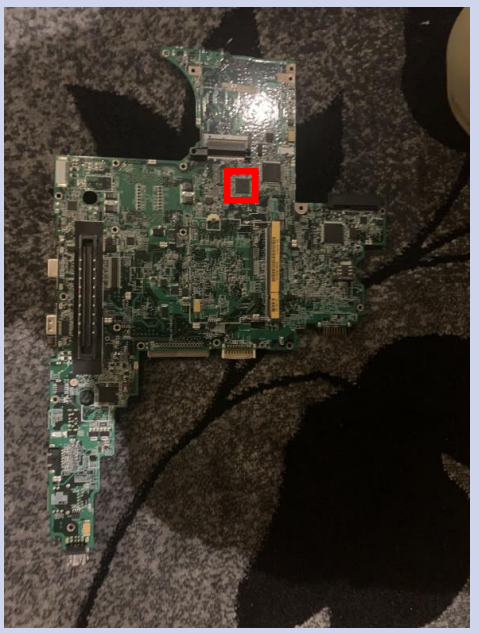
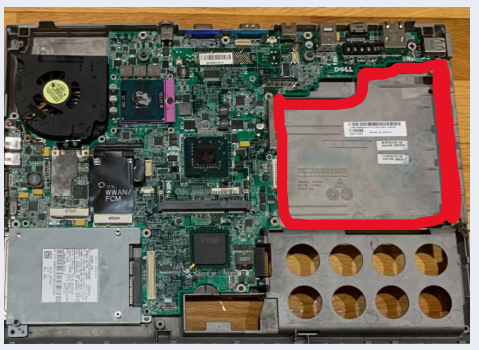
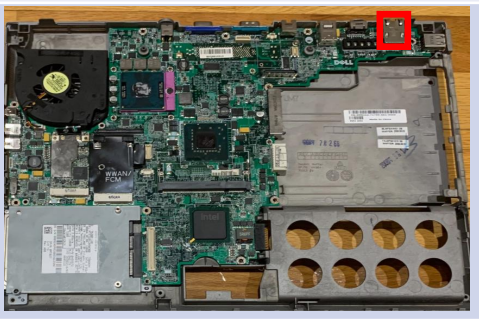
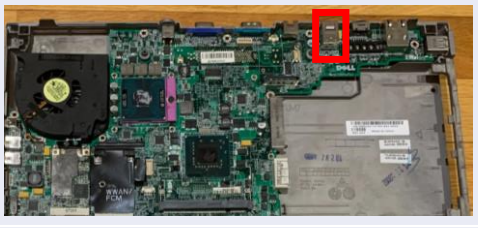
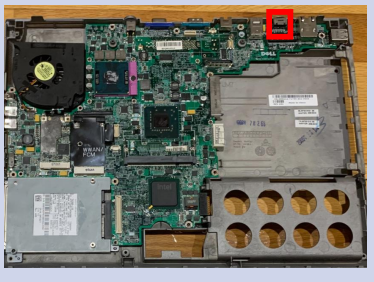
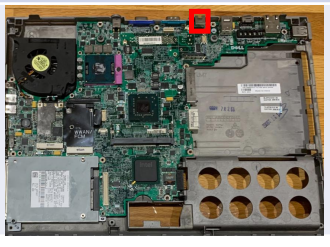
# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| MAXIM 5V/3.3V/3V/Adjustable-Output, Step-Up/Step-Down DC-DC Converters<br><br>MAX878E | This IC is a DC-DC converter that can control and boost voltage to match the requirements of the system. |  |  |
| Fairchild PJ7CC | Unfortunately, we could not find any information on this IC, other than the manufacturer name. |  |  |
| ON Semiconductor Power MOSFET<br><br>NTMFS4835N | A MOSFET (Metal-Oxide Semiconductor Field-Effect Transistor) is a type of transistor used for controlling the flow of current in a circuit. |  |  |
| O2MICRO SCR Driver<br><br>OZ711 | An SCR (Silicon Controlled Rectifier) is an electrical component used to only allow current to flow in a specific manner. It is used in situations where precise power control is needed. An SCR driver is the device that controls the SCR, switching it on and off at specific times. |  |  |
| O2MICRO MOSFET<br><br>OZ77CR6LN | A MOSFET (Metal-Oxide Semiconductor Field-Effect Transistor) is a type of transistor used for controlling the flow of current in a circuit. |  |  |
| SMSC MEC5025-NU | Unfortunately, we could not find any information on this IC. |  |  |

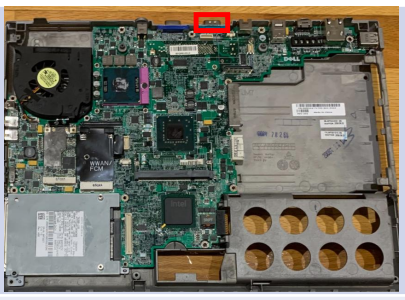
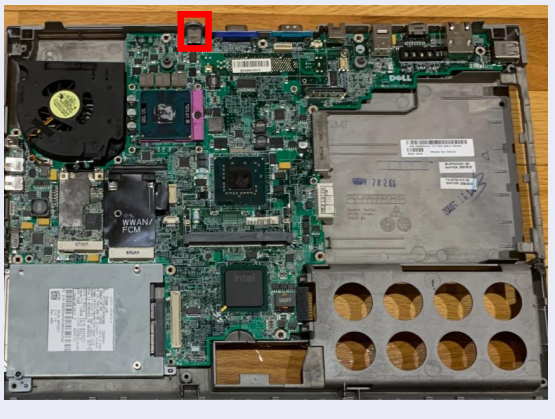
# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Silicon Labs Clock Generator for Intel®CK410M/CK505<br><br>CY28547 | A clock generator is a device that creates rhythmic electrical signals to a specific time. These are used as a reference to the speed of different components and used to coordinate the different electronics based on that. Have you ever thought about how Task Manager can accurately return the CPU's speed? Well, using this clock generator and its periodic signals, the system can measure and synchronize the speed of the CPU. |  |  |
| Optical Disk Drive (ODD) | An ODD is a device used to store data and transfer data. Whereas an HDD uses magnetic techniques to read/write data, an ODD uses laser light to read or write data on the disk drive. |  |  |
| USB Type-A Port | A USB Type-A Port is a Universal Serial Bus port used to connect an external device to the main laptop and can be used for power delivery, communication, and data transfer. |  |  |
| Ethernet Port | An ethernet port is a port used to connect a device to a router, allowing it to communicate over the internet and access the internet. |  |  |
| S-Video Port | An S-Video (separate-video) port connects to an s-video cable, which is used to transmit analog video signals. |  |  |
| RJ-11 Port | An RJ-11 Port (Registered-Jack 11) is used to connect a laptop to a dial-up modem, which connects the laptop to internet by using a telephone line. |  |  |

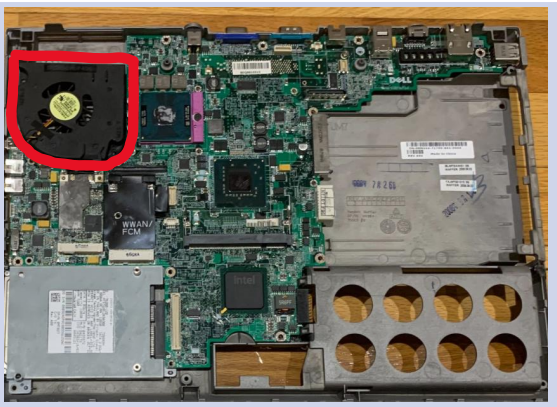
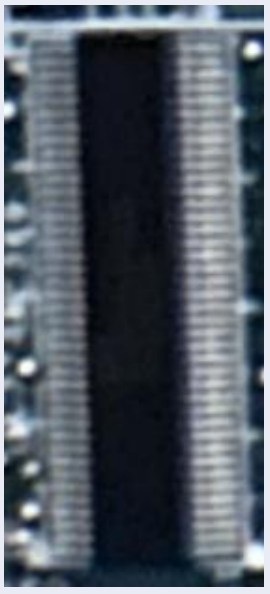
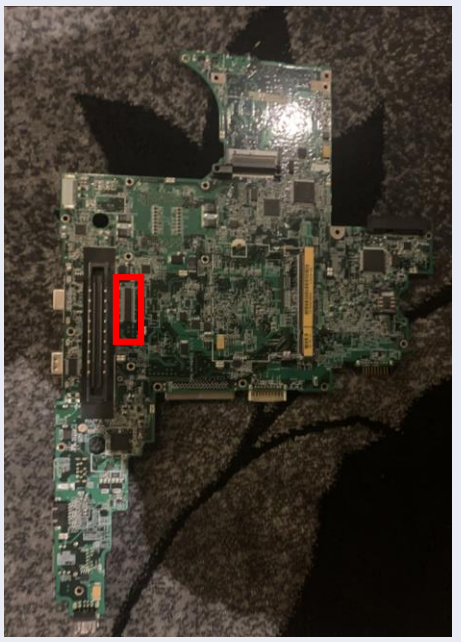
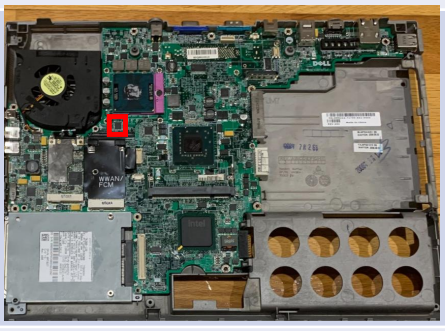
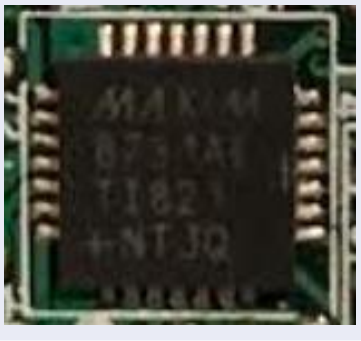
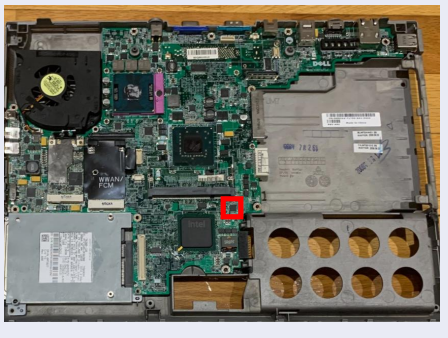
# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| DE-9 or RS-232 Port | This port was commonly used for serial data transmission and was used to connect many peripheral devices, like modems, keyboards, mice, external storage, etc. |  |  |
| VGA (Video Graphics Array) Port | A VGA port is used to transmit video signals to an external monitor. |  |  |
| Audio Ports | An audio port is used to transmit audio signals to an external device. |  |  |
| Wireless Switch | A wireless switch is used to enable/disable a laptop's wireless features (Wi-Fi & Bluetooth) physically. |  |  |
| IEEE 1394 Connector | An IEEE 1394 connector is a connector using the IEEE 1394 standard, a fast serial bus standard that is used to connect external devices to the computer, like cameras, hard-drives, and audio equipment. |  |  |
| AC Adapter Connector | The AC Adapter connector connects the laptop to an electrical power source with alternating current. This charges the laptop's battery and therefore, supplies power to the motherboard. The adapter part of it controls the power supplied, and prevents short-circuiting/exploding/ burning up. |  |  |

# Motherboard Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Fan | A fan in a laptop is usually used with the heatsink. The heatsink itself is a passive component, meaning it cannot move. The fan allows the heatsink's fins to move, which allows the heat produced by the CPU and GPU to dissipate quicker. |  |  |
| IDT Bus Switch<br><br>QS34X2245Q3G | A bus switch is an electronic component used to control and regulate the "traffic" between all the buses. Essentially, buses are used for communication between different components on the circuit board, and sometimes, there is a lot of communication and 'traffic' builds up. The bus switch can be used to isolate signals, reroute them, or enable and disable buses. All of these functions allow the bus switch to control and regulate the 'traffic' between buses. |  |  |
| SMSC Power Regulator MCU<br><br>ECE1077-FZG | This is a micro-controller unit (MCU) used for power regulation. It is essentially a mini-CPU with different functions and uses its capabilities to manage power. |  |  |
| MAXIM SMBus™ programmable multichemistry battery charger<br><br>8731AE | This IC is used to manage and regulate the charging of the laptop battery. It can be programmed to specific battery capacities, and can support chemically different types of battery, such as lithium-ion, or lithium-polymer. |  |  |

# Screen Diagram (2D)

## DELL Latitude D830

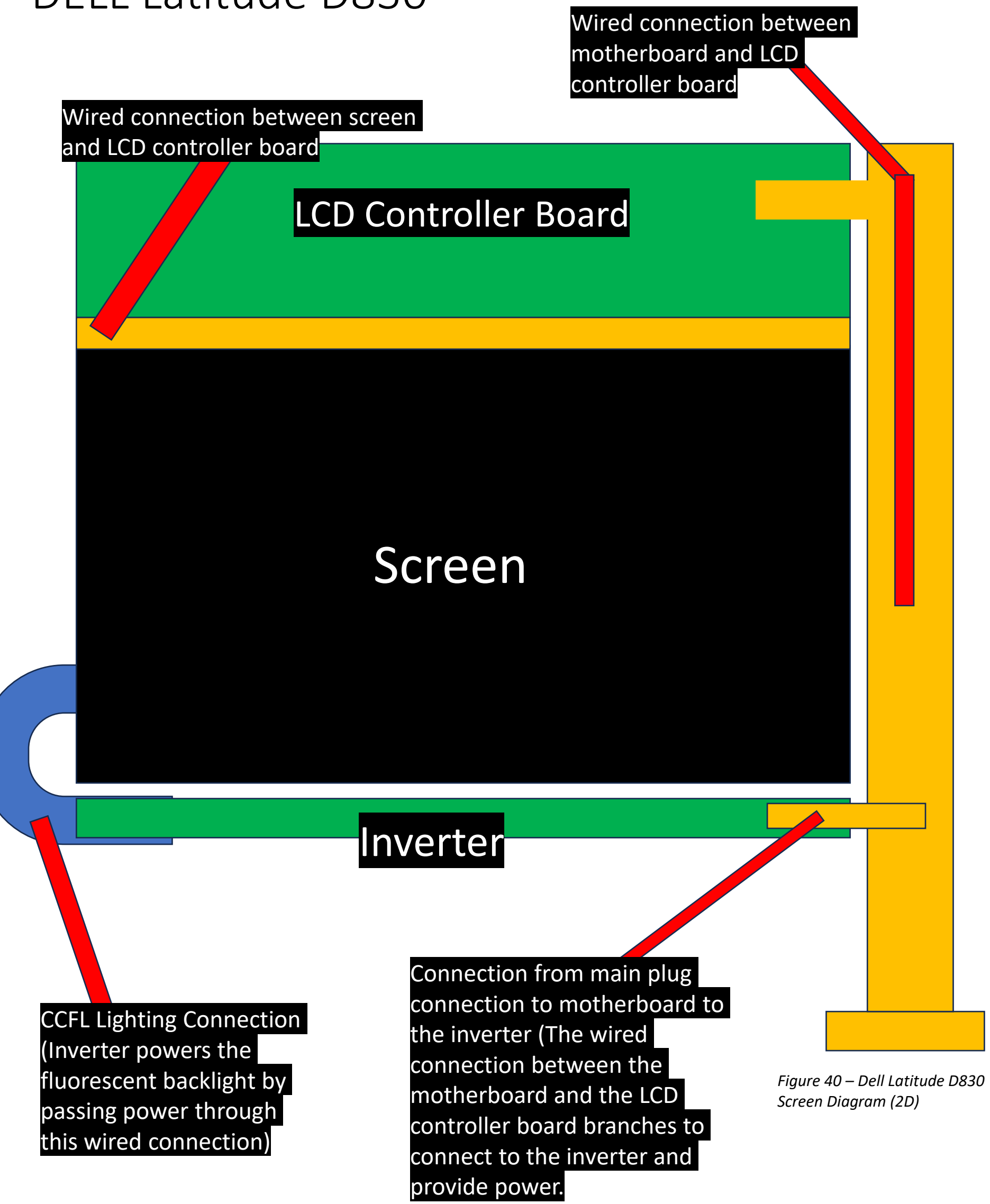



*Figure 40 – Dell Latitude D830 Screen Diagram (2D)*

# LCD Diagram (3D)

## DELL Latitude D830

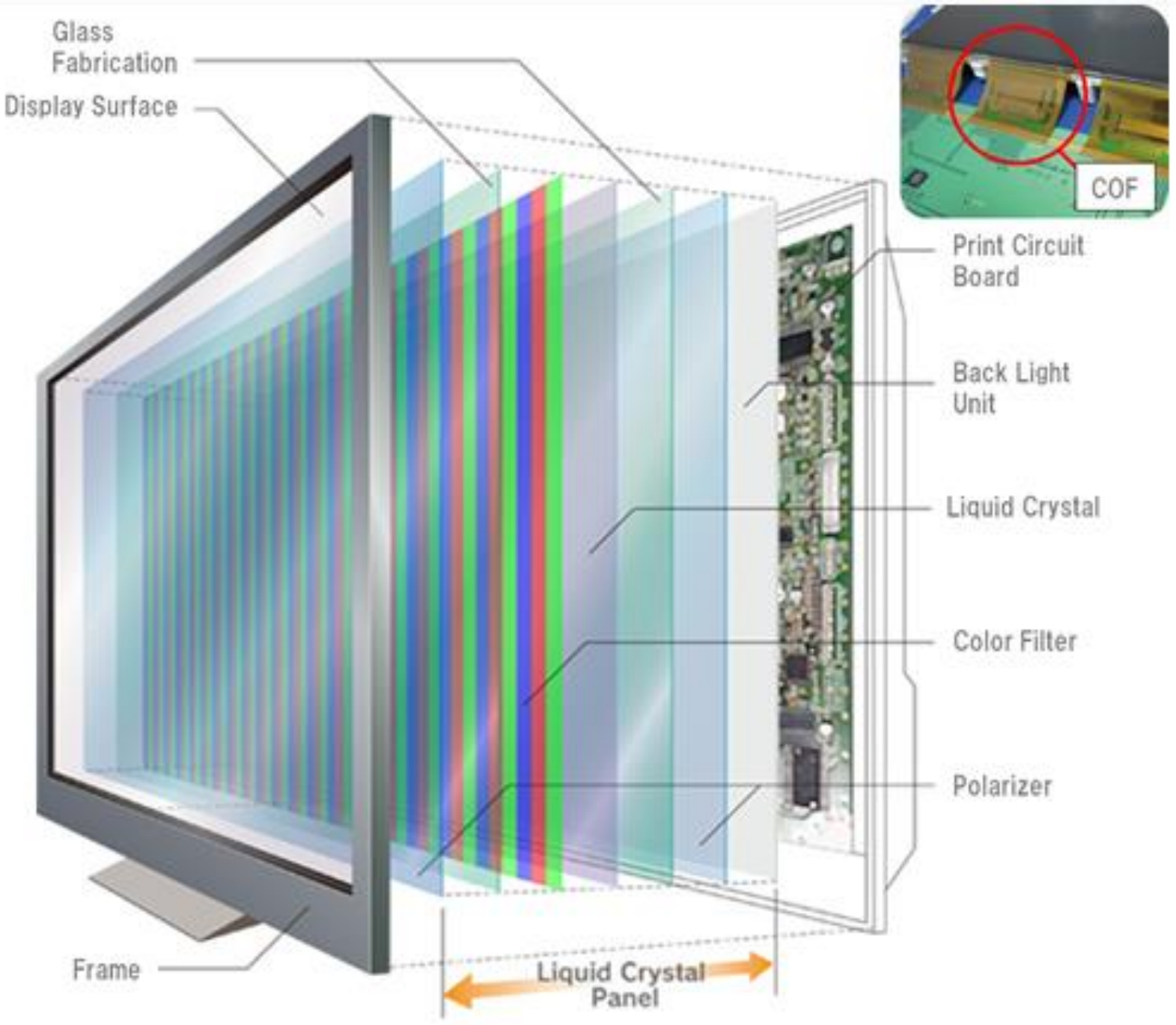



*Figure 41 – LCD Diagram (3D)*

*This is a general LCD diagram and does not represent the Dell Latitude D830's LCD to the most accurate degree. Instead, this is for a basic understanding of an LCD.

# Labelled LCD Inverter (Front)*

## DELL Latitude D830

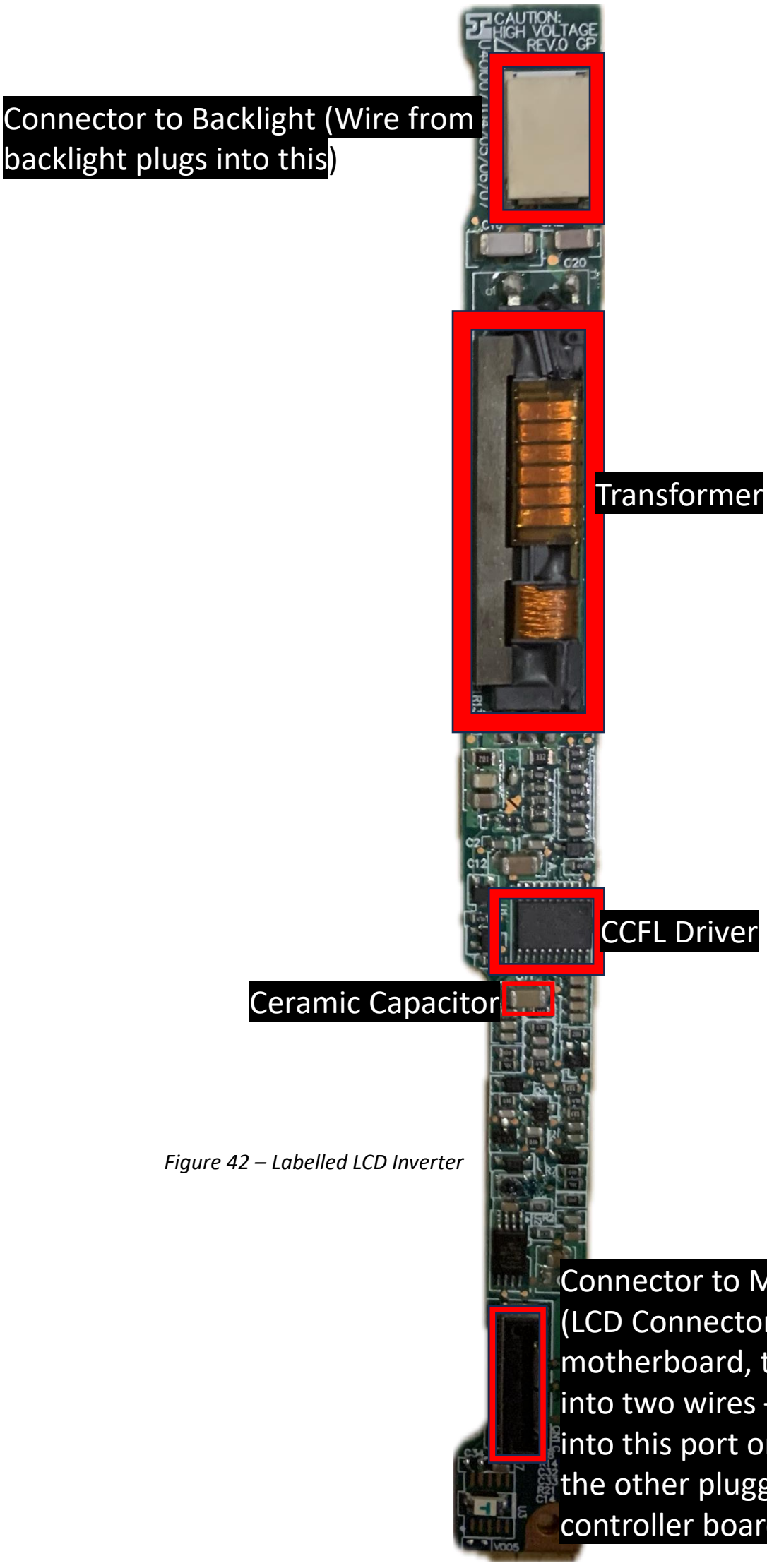



*Figure 42 – Labelled LCD Inverter*

# Labelled LCD Controller Board (Front)*

## DELL Latitude D830

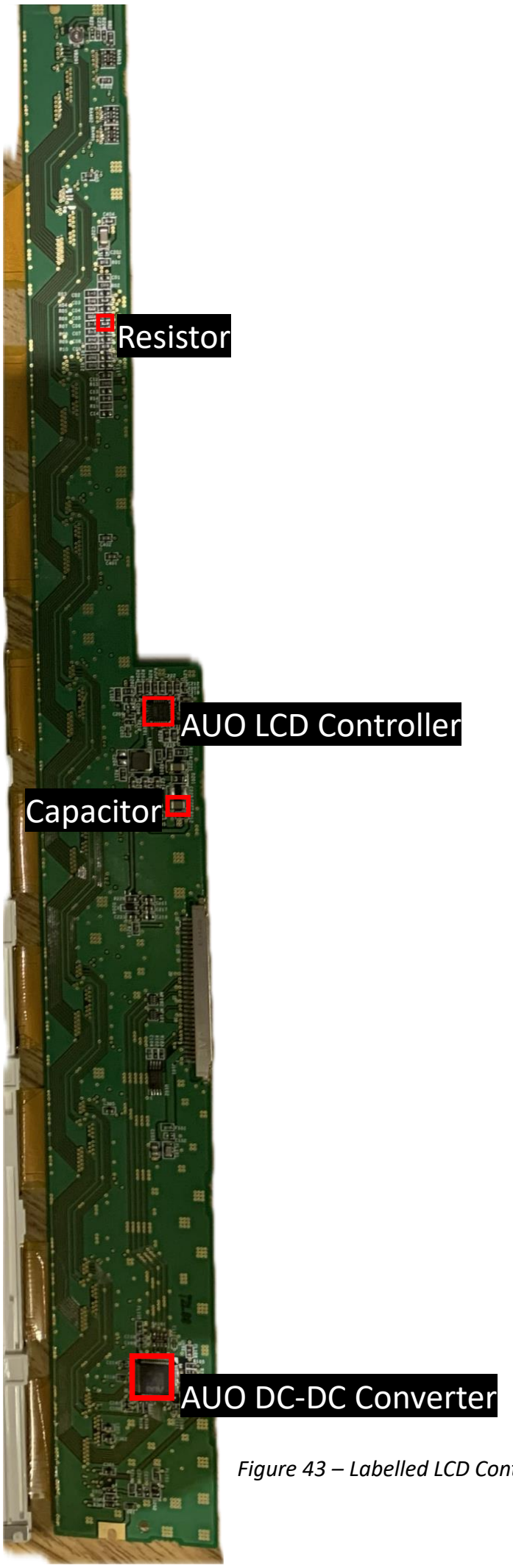
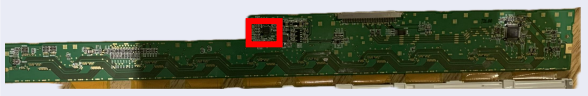
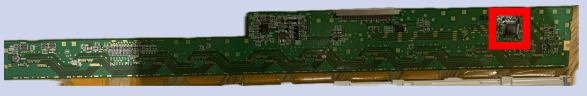



*Figure 43 – Labelled LCD Controller Board*

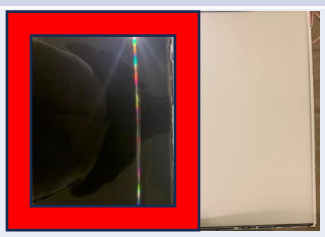
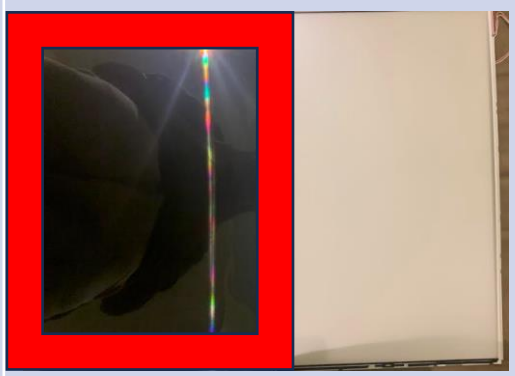
# Screen Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Monolithic Power Systems CCFL Driver<br><br>MP1026EF | A CCFL (cold cathode fluorescent lamp) driver is a device used to power and control the CCFL tubes in the backlight of an LCD. The driver regulates the power and provides the necessary current and voltage to power the CCFL tube. CCFL tubes themselves are a type of lighting that uses a cold cathode to stimulate phosphor, producing light. They used to be very common, but have been replaced with LEDs because of their energy efficiency (see the evolution section for more details on LEDs). |  |  |
| AUO LCD Controller<br><br>0823-ER | This IC is an LCD controller. It is used for controlling the LCD display, particularly handling data communication between the LCD and main motherboard. It decodes the signals sent to it and displays them on the LCD. |  |  |
| AUO DC-DC Converter<br><br>014-MQHSK-4V101-0821-B0 | A DC-DC converter on the LCD controller board is used to regulate the voltage level for the LCD, making sure it doesn't have too much or too little, and can function properly. |  |  |

# Screen Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Transformer for LCD Inverter<br><br>4608C | A transformer in a circuit board is used for voltage regulation (changing the voltage to suit the requirements of the device) and is also used for isolation (to keep the different parts of a circuit separate, reducing interference). The inverter is used to power and regulate the backlight, so this transformer is likely used for both of the above purposes |  |  |
| Polarizing Layers | A polarizing layer in an LCD display is used to filter light based on its orientation (polarization). This, used in conjunction with liquid crystal and color filters, is used to control and regulate the amount of light and characteristic of light reaching each pixel. |  |  |
| Backlight | A backlight is, as the name suggests, a back-light. It is the last layer of the LCD, at the very back, and is a panel that can light up, usually using CCFL (cold cathode fluorescent lighting) or LEDs (light-emitting diodes). The backlight's light passes through the multiple layers to end up creating an image. |  |  |
| Color Filter | A color filter is a filter that is used to only allow specific wavelengths of light through, changing the color of each pixel to either red, green, or blue. |  |  |
| Liquid Crystal | A liquid crystal is a substance between liquid and solid, depending on the voltage applied to it. It has crystalline shapes. When voltage is applied to specific pixels, it determines the crystals' orientation, which controls the amount of light passing through the color filter, and what color will be produced, as well as the brightness of the pixel. |  |  |

# Labelled Trackpad Shell/PCB (Back)*

## DELL Latitude D830

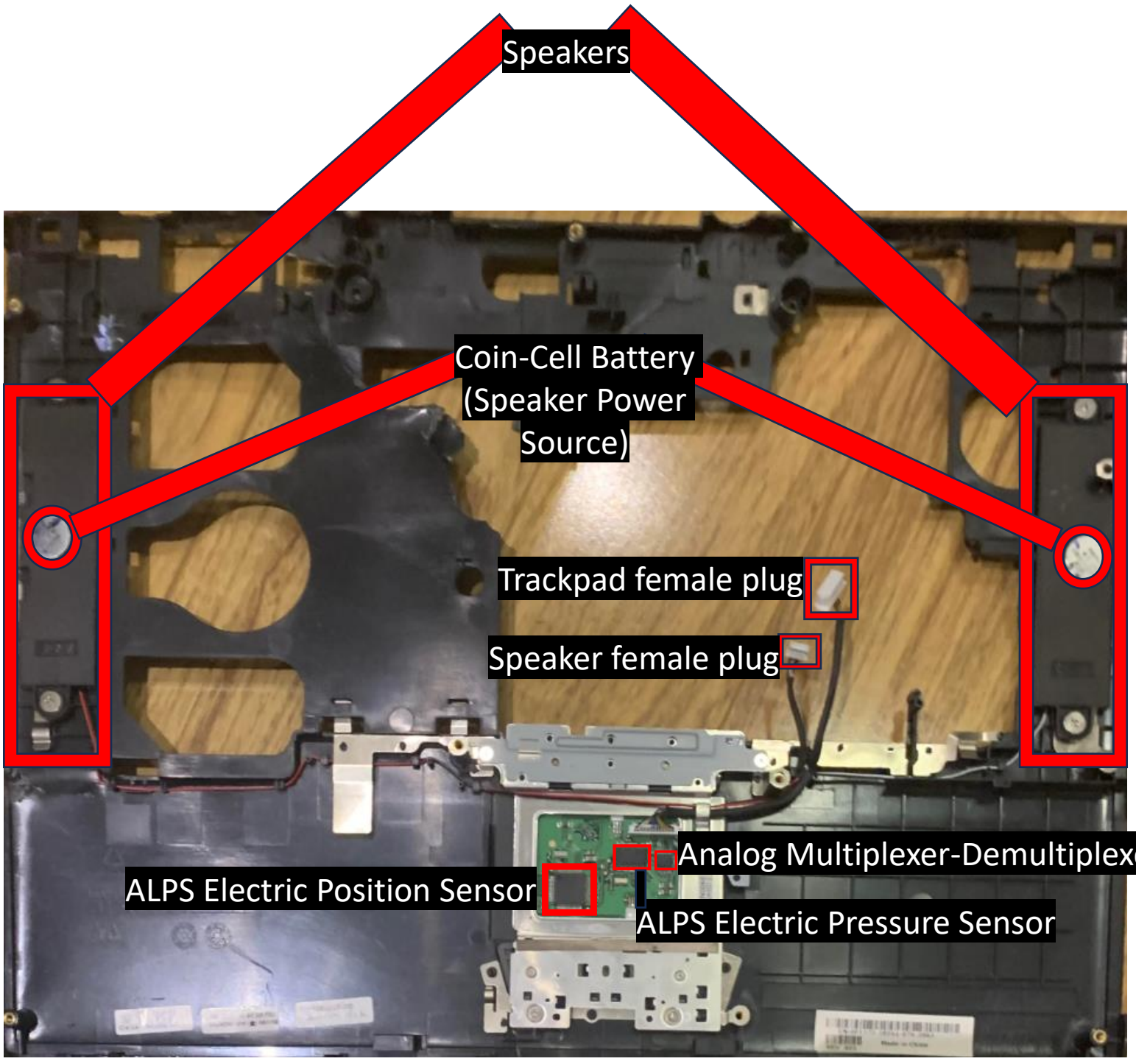
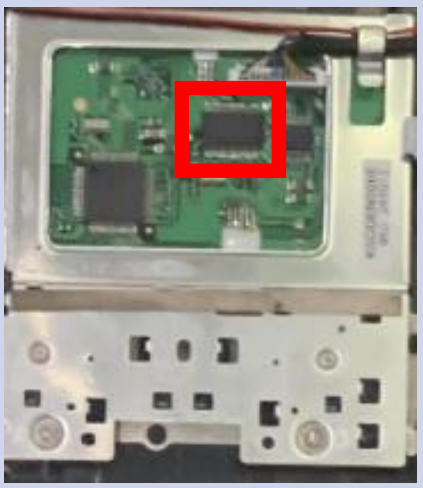
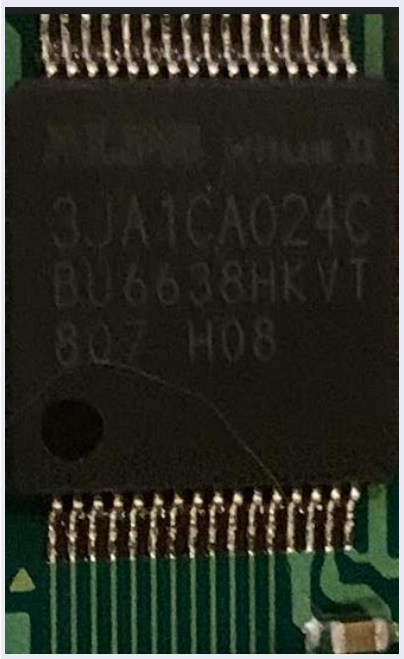
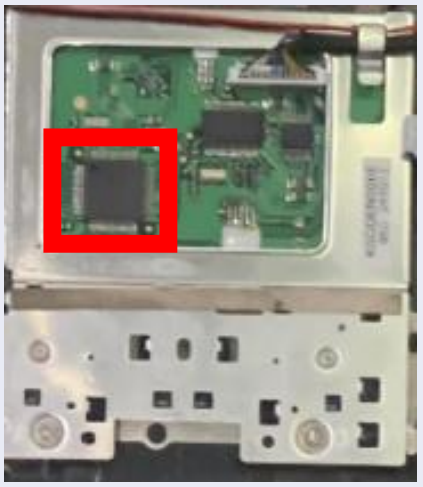
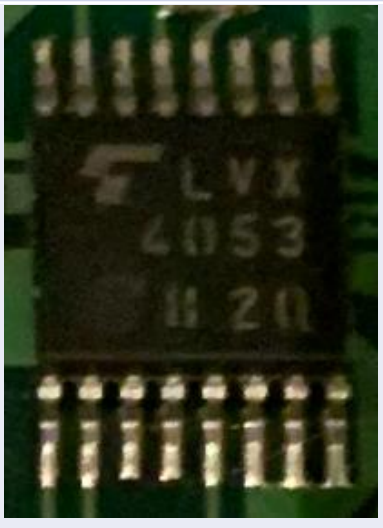
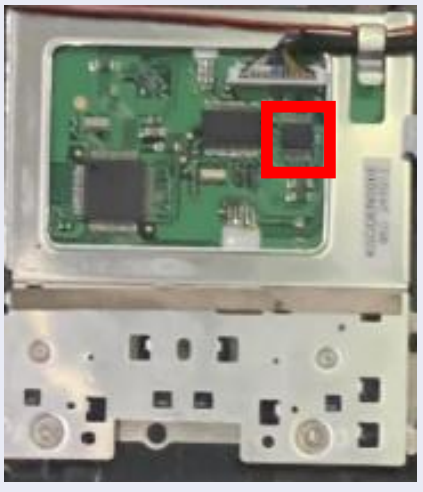



*Figure 44 – Labelled Trackpad Diagram*

*Due to the fact that all the components are located in the back of the trackpad shell, this is the only diagram required for the trackpad.

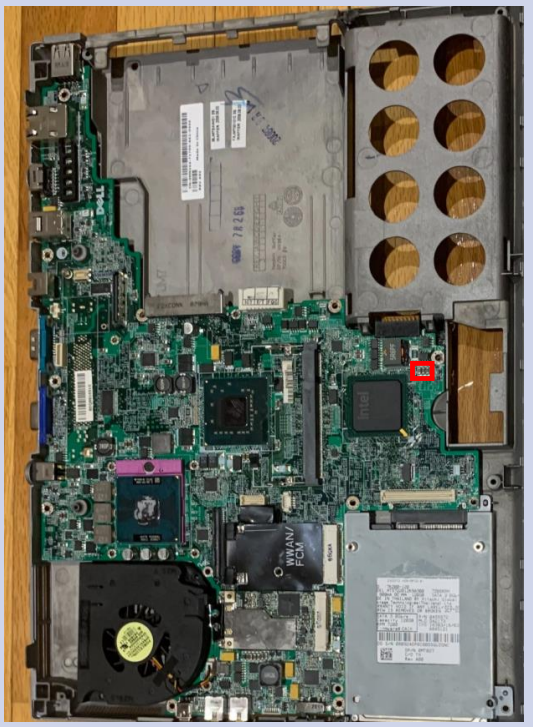
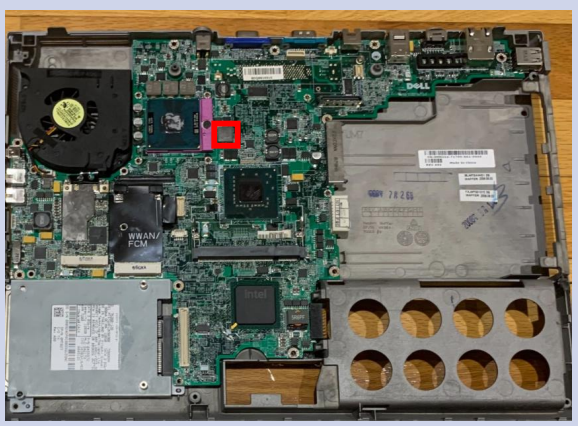
# Keyboard/Trackpad Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| ALPS Electric Pressure Sensor<br><br>3DA3DT356C | This IC is a pressure sensor, which means it can detect the pressure put on the touchpad and the system can respond to that. This works by using a resistive system, where pressure alters the resistance of a material. Another system measures that changed resistance and deduces the pressure applied. All of these systems are located in the IC. |  |  |
| ALPS Electric Position Sensor<br><br>3JA1CA024C | This IC is a position sensor, but as for how it detects position, we have to go back to the touchpad itself. Essentially, there is a grid of electrodes underneath the touchpad. These electrodes can sense changes in capacitance (an object's ability to store an electric charge). When a finger (a conductive object) touches the trackpad, the capacitance is changed. The position sensor takes that data and processes it to determine where the finger is on the touchpad. |  |  |
| Physical Switch for each Key | When a key is pressed, this switch is triggered. Each key's switch sends its own signal to the motherboard, which is then processed and recognized as a specific key. |  |  |
| Analog Multiplexer-Demultiplexer<br><br>LVX4053 | A multiplexer-demultiplexer is an IC that can combine multiple signals together (multiplexer), then separate those signals (demultiplexer). In a trackpad, the multiplexer-demultiplexer is used to handle the transfer of the immense amounts of data (all the points being touched on the trackpad, constantly checking which points are touched or not, etc.) |  |  |

# Electrical Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Capacitor | A capacitor is another electrical component that is similar to an inductor in that they both store and release energy, but are essentially opposites in every other way. While inductors store current in a magnetic field, capacitors store voltage in an electrical field. Capacitors release energy very fast, while inductors tend to take more time. However, the fact that they are opposites is really useful to circuits and allow for a range of different capabilities in circuits. There are different types of capacitors that use different materials, like ceramic capacitors (top image), tantalum capacitors (middle image), and polycarbonate capacitors (bottom image). |  |  |
| Resistor | A resistor is an electrical component that limits the flow of electric current in a circuit. For example, if 5V travelled through the resistor, it may get stripped to 3V. Although the resistor limits current, that affects voltage, according to Ohm's Law (V = I x R). R is resistance, I is current, and V is voltage. If the current is 5 and the resistance is 0.5, the voltage is 2.5V. Resistors are measured in what are called Ohms. |  |  |
| Inductor | An inductor is an electrical component that uses a magnetic field to store energy when current flows through it, then releases it. |  |  |

# Electrical Component Analysis

## DELL Latitude D830

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Transistor | A transistor is an electrical component that can act as an amplifier or a digital gate. There are different types of transistors, and it can be used in power regulation/control, as well as base logic-level programming. CPUs use transistors to work, and often contain billions. In binary code, there are two values: 0 and 1. A transistor acts as a digital gate or switch. If the gate is open, it is high voltage (1). If the gate is closed, it is low voltage (0). By opening and closing the transistor's digital gate, we can create binary code, which can then be used for many logical operations, and is why the CPU can perform basic arithmetic. It is really interesting how something that can only perform two functions can do basic arithmetic and can be used for programming. |  |  |

# Design Analysis

## DELL Latitude D830

While the technological components of laptops are very important to how they work, the design of laptops and why they are built the way they are built is constantly underappreciated, even though it is a vital part of the laptop. This section will cover observations we made on the laptop and how it was built, referencing the technological period it was built in and the potential choices behind its design.

**Repairability** - The Dell Latitude D830 seems to focus on easy repairability, with a removable battery, common screw size, easily removable components of the motherboard, and a manual published by the company explaining how to replace parts in the laptop.

After lots of research, we came to a general conclusion that older laptops were ‘pioneering’ the way for new technology, and as such, companies were more focused with technological advancements, rather than money.

Additionally, laptops were bulkier, which meant companies could design repairable laptops without worrying about if it would make it heavier. As time went on, companies tried to cut costs, which meant less effort designing the laptops, which meant no more removable batteries, etc.

They also started to make laptops lighter and thinner, which meant compact designs, which meant that companies started to use things like glue to keep computers together.

Companies like Apple started to see the money benefits of making less repairable laptops (instead of fixing their devices themselves, people would buy new computers!). However, in recent years, organizations like the EU and iFixit have been advocating for accessible, repairable devices.

This is why the Surface Laptop Go was marketed as a repairable laptop, and marked the partnership between Microsoft and iFixit. With things like repairability scores, iFixit has been trying to encourage companies to make repairable laptops. The EU (European Union), has made Apple switch to USB-C, and is now putting laws in place for phones to have removable batteries. Overall, repairability has been an interesting concept over the past twenty years, but devices may start to become more repairable in the next few years.

# Design Analysis

## DELL Latitude D830

**Material** – The Dell Latitude D830 uses a Magnesium alloy chassis, which allows a rather lightweight laptop (in comparison to other 2007 laptops), and a generally durable design. This fulfills the need for a laptop to be lightweight, while not compromising the structure of the device.

**DVD Space** – We noticed that the DVD took up a lot of space in the device, showing the priority that was put on storage devices and also how large the technology was. However, lots of space for the DVD did make sense, thinking about the time period and how most people used the DVD for media.

**What was the D830 made to do?** – In 2007, there were three main models of Dell Laptops – OptiPlex, Precision, and Latitude. The OptiPlex models were intended for home-use, and therefore prioritized media greatly. The Precision models, on the opposite end of the spectrum, were created for high-end businesses and professionals who NEEDED power and really good specs. And finally, the Latitudes were made for standard business use. This is why they still had DVDs for media and decent specs for the time. As such, the D830 was Dell's fourth model of Latitude laptops. They were created for the average business user and therefore many specs were lowered for a good cost. Overall, the business plan of Dell was very smart, and led them to the crown in their earlier years.

**USB Ports & Connectivity** – In the early years of laptops, many ports were used because of the different communication standards. In recent years, more and more of these ports have been abandoned for either

A) The ports were too big and the laptop needed to be thinner
Or
B) The ports were no longer really needed

In the D830, many ports are used and have to be coordinated around the laptop for the best and most convenient experience for the user.

# Basic Information

## Surface Laptop Go

**Task 1 - Learn the Laptop, Inspect, and Research**

After some research, the basic specs of the Surface Laptop Go are below:

- Display: 12.45 inches, 1536 x 1024 (148 ppi) touchscreen, 3:2 aspect ratio
- Processor: Intel Core i5-1035G1
- RAM: 8GB LPDDR4x
- Storage: 128GB SSD
- Wireless: Wi-Fi 6: 802.11ax, Bluetooth 5.0
- Ports: 1 USB-C, 1 USB-A, 1 3.5mm headphone jack, 1 Surface Connect (Surflink) port

**Learnings after Laptop Inspection**

**-**The two rubber feet at the bottom of the laptop reveal multiple screws, and unscrewing those screws allow the keyboard/trackpad layer to be taken off the laptop, revealing the motherboard.

**-**Battery can only be taken off once the keyboard has been removed.

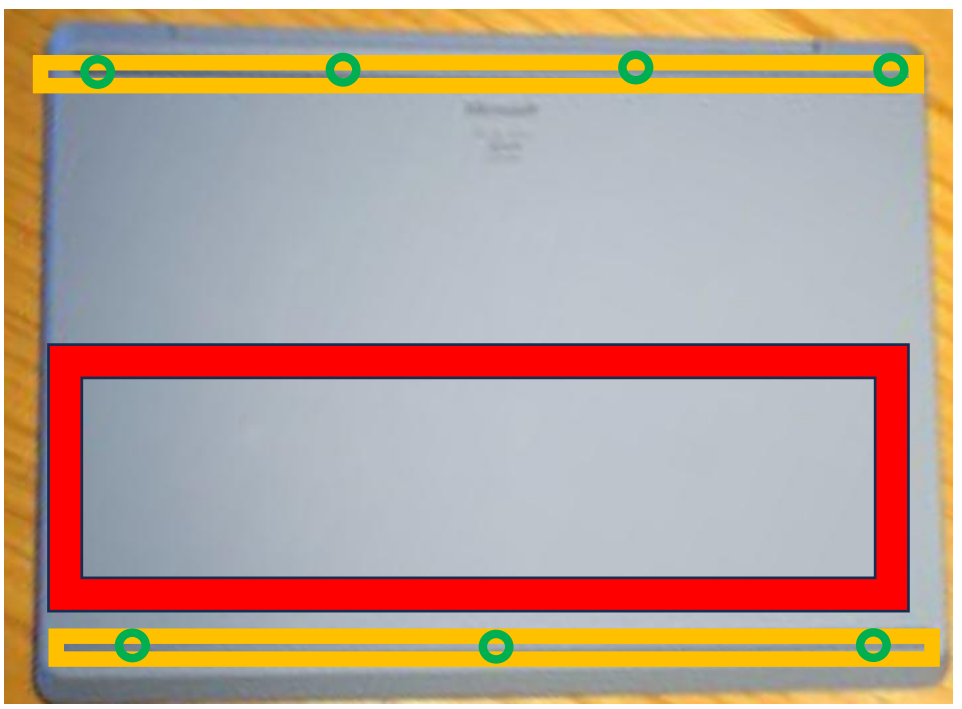


*Figure 45 – Surface Laptop Go labelled bottom*

Rough outline of battery

Removable rubber feet, exposing screws

Screws

# External Anatomy*

## Surface Laptop Go

*Figure 46 – Surface Laptop Go Bottom View*

*Figure 47 – Surface Laptop Go Side View*

*Figure 48 – Surface Laptop Go Top View*

*Figure 49 – Surface Laptop Go Front View*

*Most of the earliest pictures of the project were located on one of our old phones, which were accidentally wiped when the team member transferred phones (They had forgotten that the pictures were located on the phone). To find pictures for this external anatomy page, we had to use online resources, which we refer to in Sources

# Architecture Diagram

## Surface Laptop Go

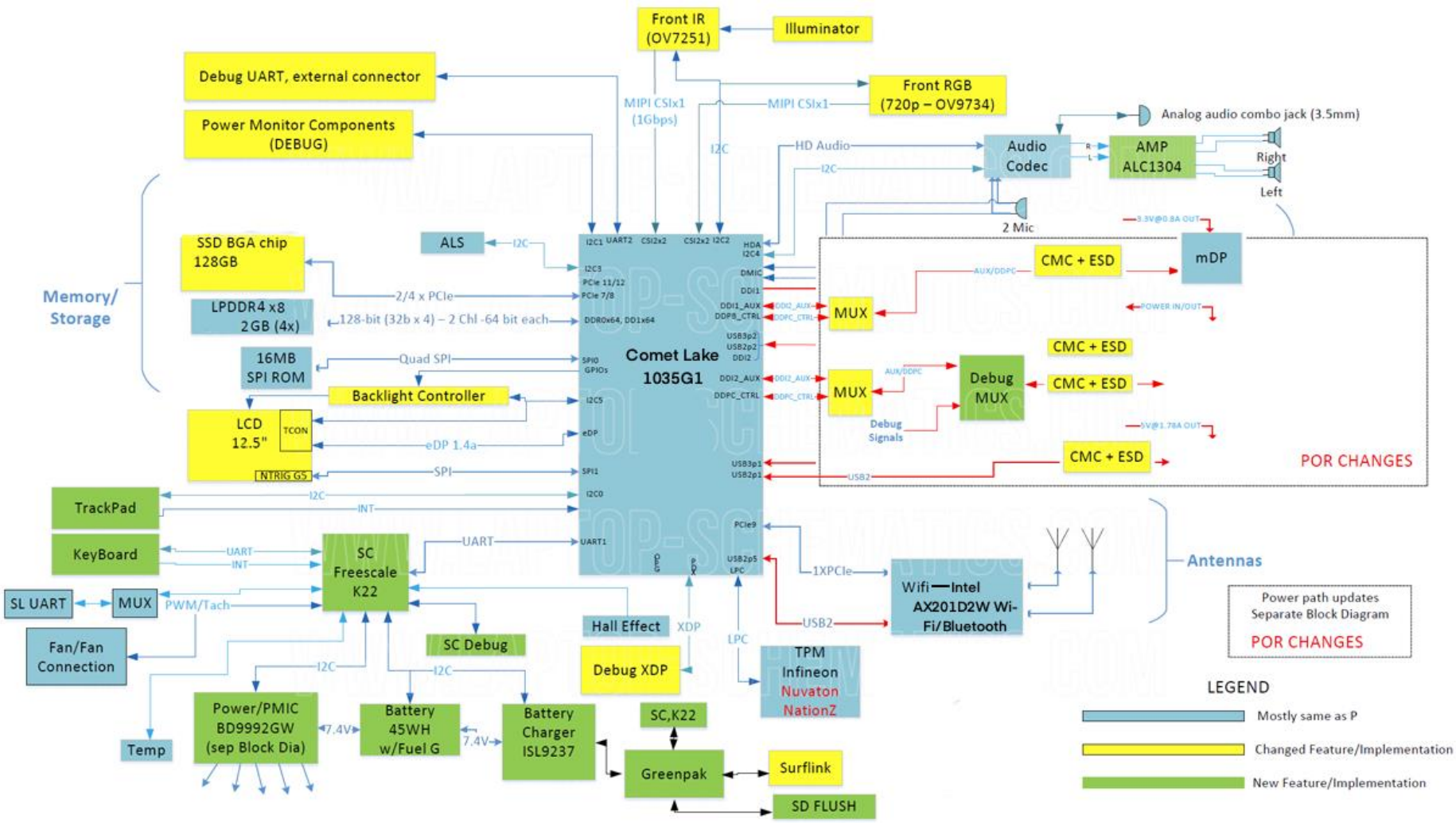



*Figure 50 – Surface Laptop Go Architecture Diagram*

An architecture diagram is used to show how components in the system interact with each other. We found it incredibly helpful to see how each component interacted and what communication protocol they used. This helped us when disassembling the devices, and identifying components, because we understood the basic use of each component.

# ‘Dissection’ Process

## Surface Laptop Go

**Task 2 – Unscrew, Open, Remove**

⚠ Before unscrewing or opening the laptop, we made sure to understand exactly how the laptop was built and how to disconnect the battery once we had opened it up

**STEP 1 – We started by removing the rubber feet and unscrewing all the screws at the bottom (outlined in red)**

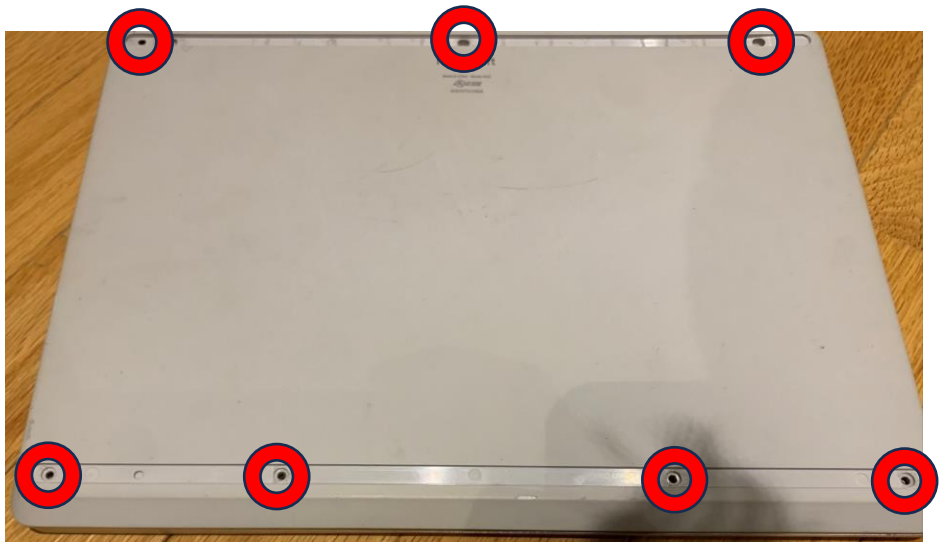


*Figure 51 – Surface Laptop Go bottom with screws outlined in red*

**STEP 2: We removed the keyboard, revealing the motherboard. We then unplugged all connections (outlined in red), and unscrewed all screws.**

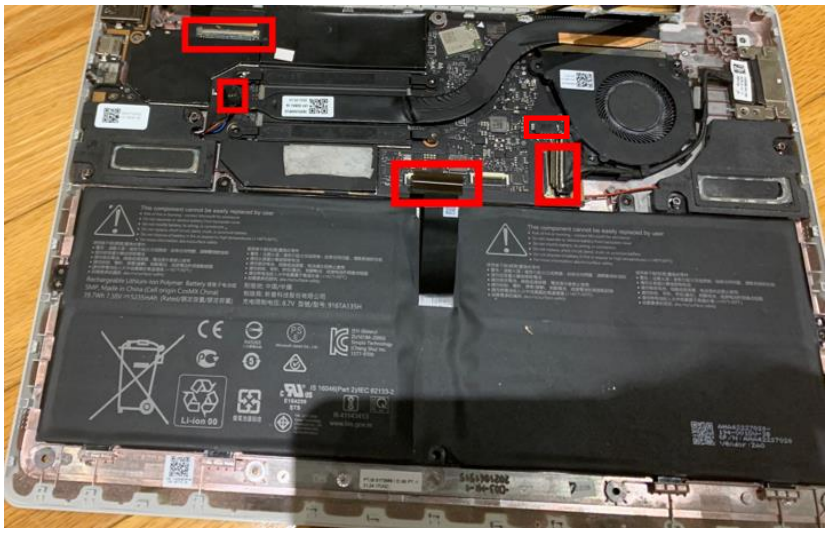


*Figure 52 – Surface Laptop Go with keyboard removed and components visible, as well as connections outlined in red and screws unscrewed*

**Step 3: We removed the battery**

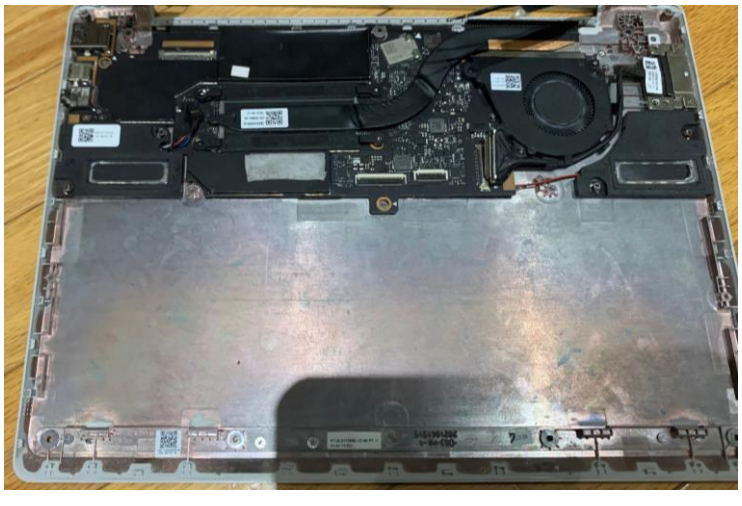


*Figure 53 – Surface Laptop Go with battery removed*

**Step 4: We removed the heatsink and cleaned off the old thermal paste with isopropyl alcohol and a paper towel.**

*Figure 54 – Surface Laptop Go with heatsink and thermal paste removed*

# ‘Dissection’ Process

## Surface Laptop Go

**Task 2 Continued – Unscrew, Open, Remove**

**Step 5 – We removed the fan and Surflink port (a specially built charging port built by Microsoft for the Surface**

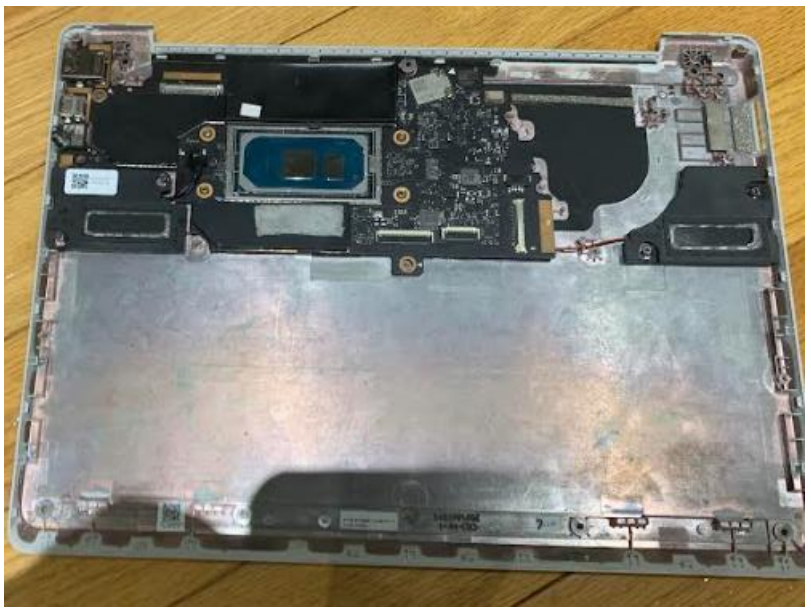


*Figure 55 – Surface Laptop Go with Surface Connect (or Surflink) port removed*

**Step 6: We removed the three plastic shieldings on the motherboard, which revealed the removable SSD in one, thermal putty in the other, as well as 2 1R5 inductors, and 3 R15 inductors. The other shielding covered a USB controller (an IC used to manage data transfer through the USB ports.**

*Figure 56 – Surface Laptop Go with plastic shieldings removed*

**Step 3: We removed the motherboard and speakers**

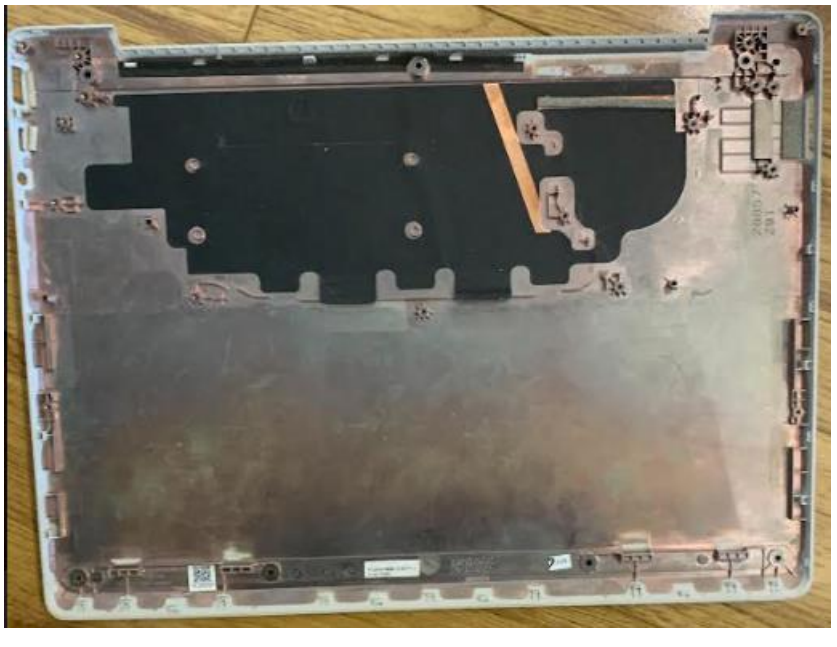


*Figure 57 – Surface Laptop Go with motherboard and speakers removed*

# ‘Dissection’ Process

## Surface Laptop Go

### Task 3 – Open the Screen

Step 1: Remove the Wi-Fi antenna source shielding.

*Figure 58 – Surface Laptop Go screen with Wi-Fi antenna source shielding outlined*

*Figure 59 – Surface Laptop Go screen with Wi-Fi antenna source shielding removed*

Step 2: Unscrew and remove the Wi-Fi antenna source.

*Figure 60 – Surface Laptop Go screen with Wi-Fi antenna source removed (location outlined in red)*

Step 3: We took a plastic triangle and started to slide it around the screen to pry the screen off. On the back of the screen, we observed the LCD plug travelling to two areas: one at the top of the screen (the webcam), and one to the bottom, taped off (the LCD controller board).

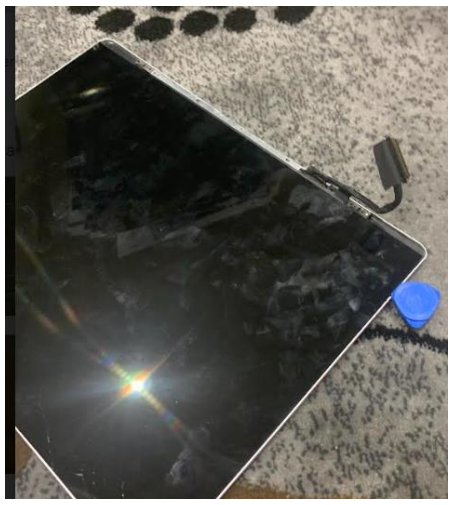


*Figure 61 – Surface Laptop Go screen with plastic triangle removing the screen from its shell*

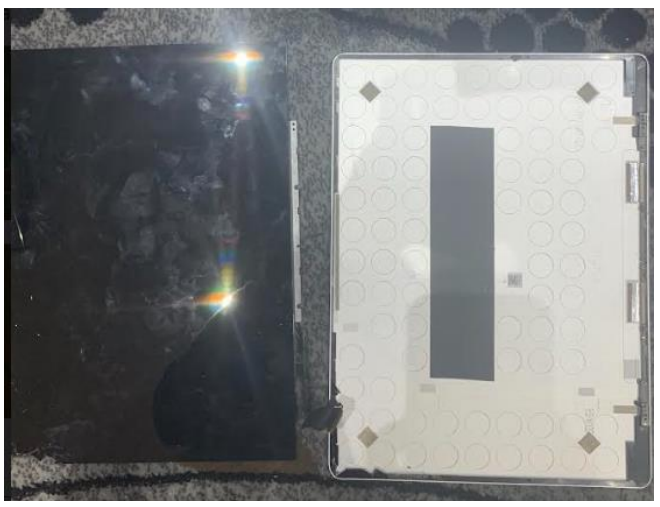


*Figure 62 – Surface Laptop Go screen (left) separated from its shell (right)*

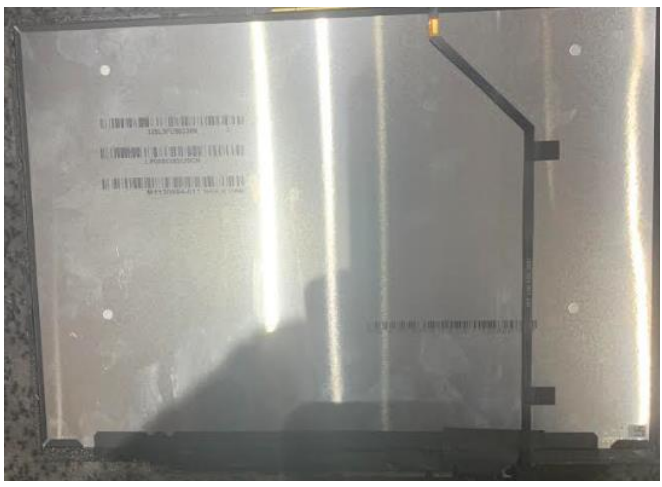


*Figure 63 – Surface Laptop Go screen (back view)*

Step 4: We took off the tape at the top, revealing a PCB (outlined in yellow) with four ICs (Integrated Circuits – outlined in red) on it.

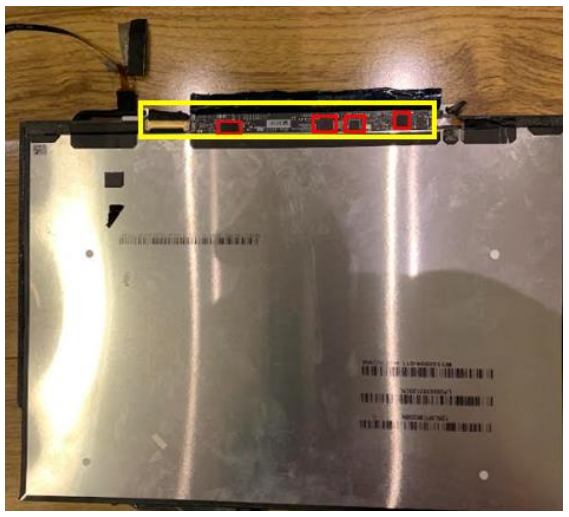


*Figure 64 – Surface Laptop Go screen (back view) with LCD Controller Board outlined*

Step 5: We removed the webcam module (outlined in yellow)

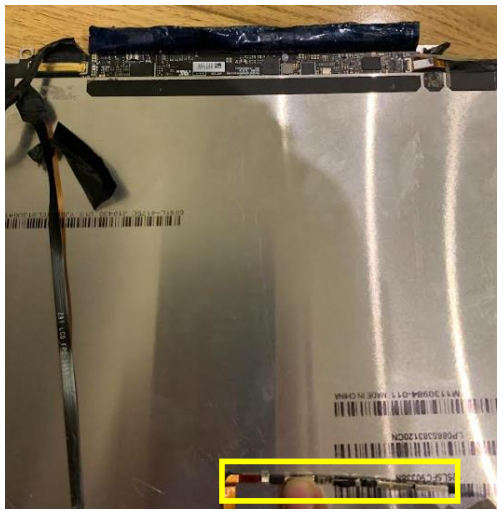


*Figure 65 – Surface Laptop Go screen (back view) with webcam module outlined*

# ‘Dissection’ Process

## Surface Laptop Go

### Task 3 – Open the Screen Continued

Step 5: We separated the backlight (left) and the LCD layers of the display (right). This revealed a connection that seemed to be used for the touch screen (outlined in yellow).

*Figure 66 – Surface Laptop Go screen (opened)*

Step 6: We removed the three layers on top of the backlight, which seemed to be one mirror layer and two polarizing layers.

The first, transparent, layer

*Figure 67 – Transparent layer found between backlight and Liquid Crystal*

The last two layers were reflective from one angle, and transparent from another. They seemed to be polarizing layers.

*Figure 68 – Polarizing layers found between backlight and Liquid Crystal*

# ‘Dissection’ Process

## Surface Laptop Go

### Task 4 – Open the Keyboard

Step 1 – We unscrewed all the screws securing the metal plate to the frame (outlined in red), as well as the wired connection to the motherboard (blue) and the wired connection to the fingerprint scanner (red)

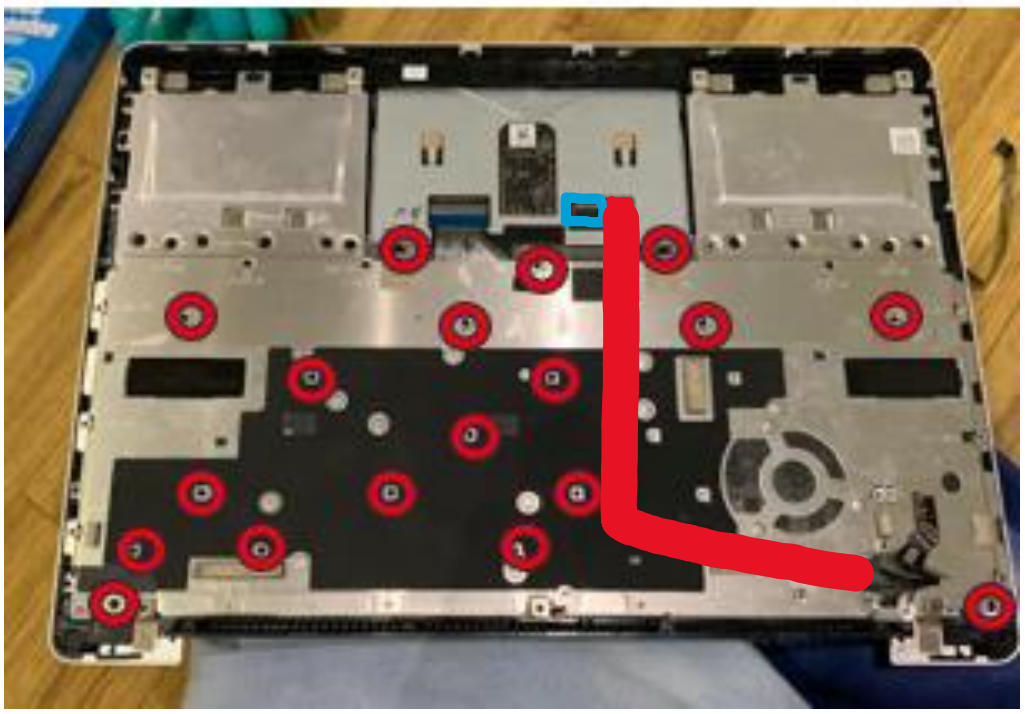


*Figure 69 – Back of keyboard/trackpad shell with all screws outlined in red, and two connections outlined in red and blue*

Step 2 – We removed the metal plate holding the keyboard in place (see keyboard diagram), that held the power button, also a fingerprint scanner.

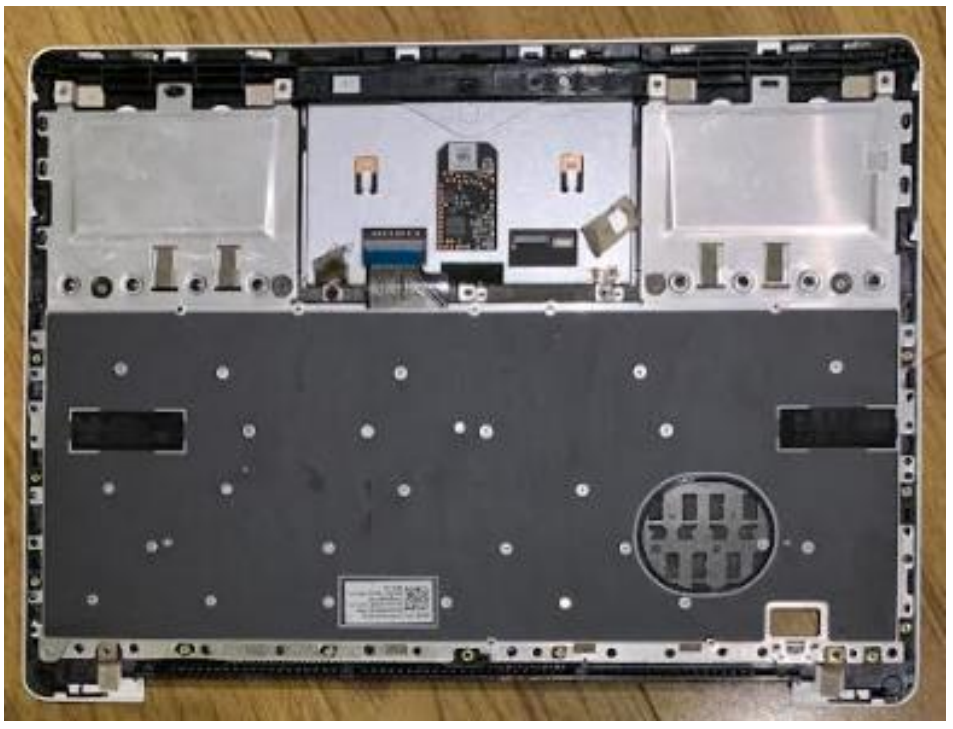


*Figure 70 – Back of keyboard/trackpad shell with metal base and fingerprint scanner removed*

# ‘Dissection’ Process

## Surface Laptop Go

**Task 4 Continued – Open the Keyboard**

Step 3 – We unplugged and removed the keyboard.

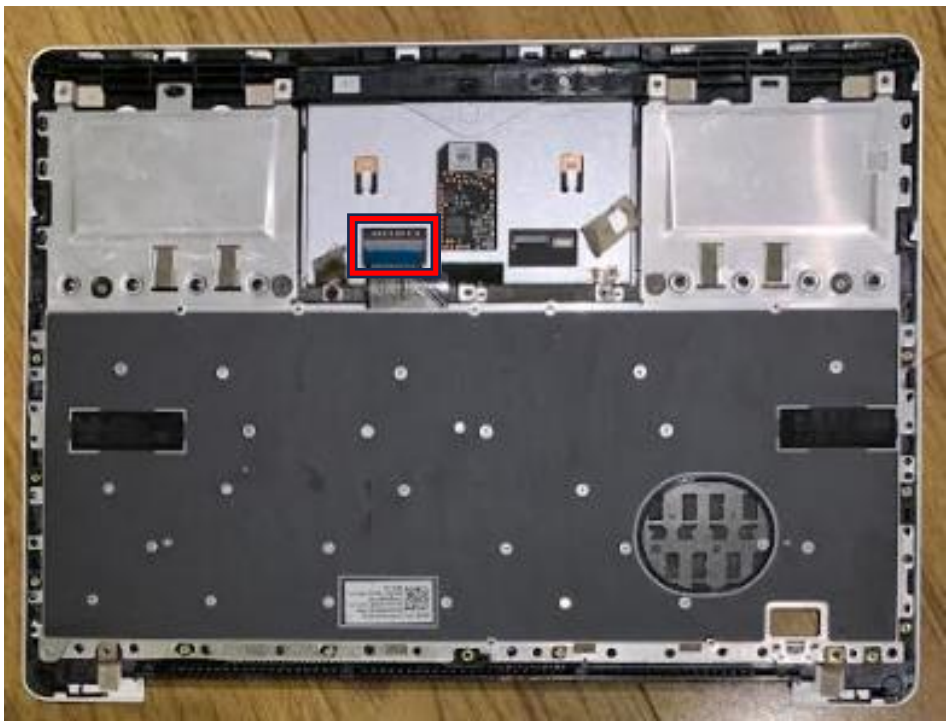


*Figure 71 – Back of keyboard/trackpad shell with keyboard wired connection outlined in red*

*Figure 72 – Back of keyboard/trackpad shell with keyboard removed*

Step 4 – We unscrewed the screws (outlined in red) securing the trackpad to the frame.

*Figure 73 – Back of keyboard/trackpad shell with trackpad screws outlined in red*

*Figure 74 – Front of keyboard/trackpad shell with trackpad and keyboard removed*

# Labelled Motherboard (Front)

## Surface Laptop Go

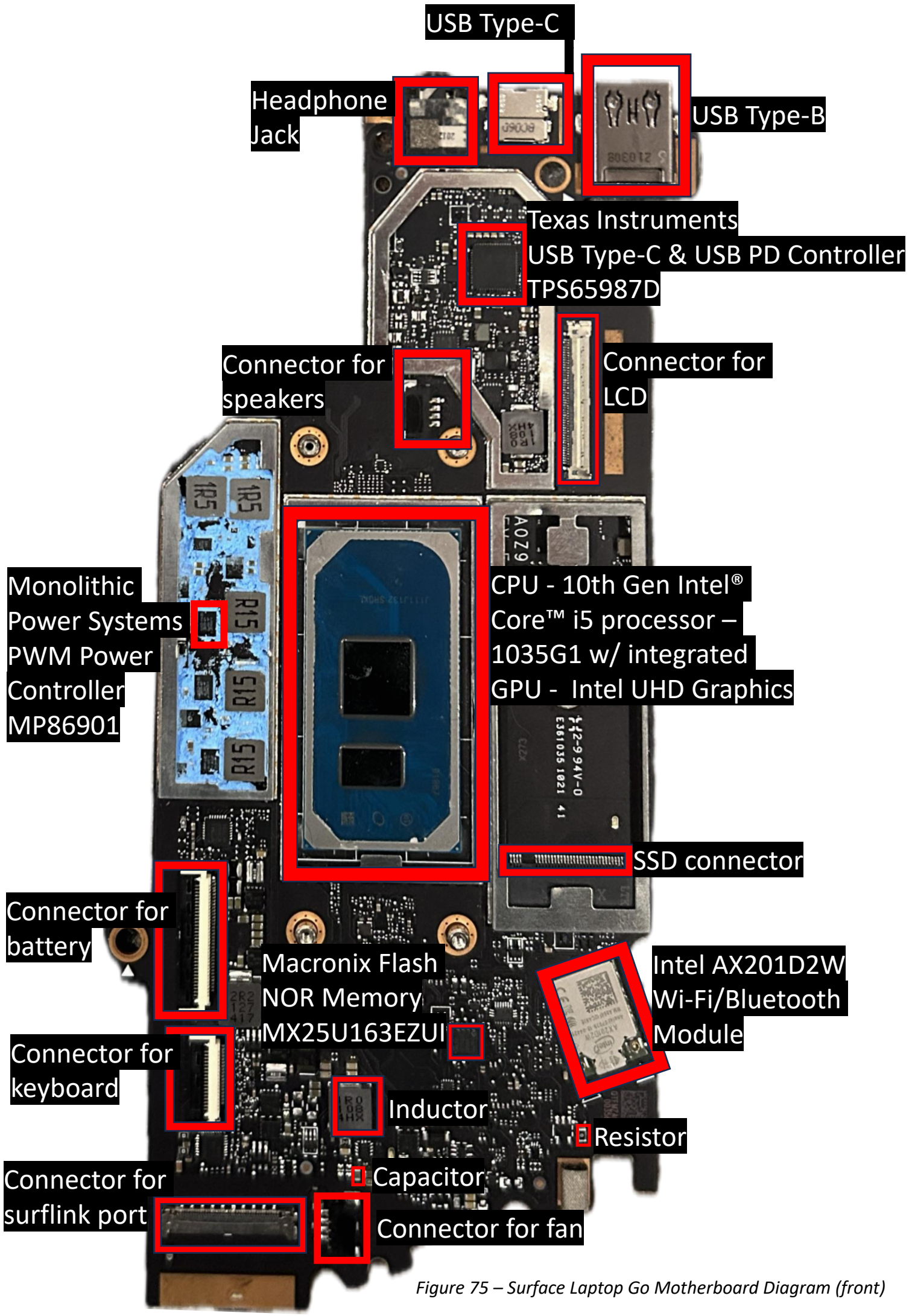



*Figure 75 – Surface Laptop Go Motherboard Diagram (front)*

# Labelled Motherboard (Back)

## Surface Laptop Go

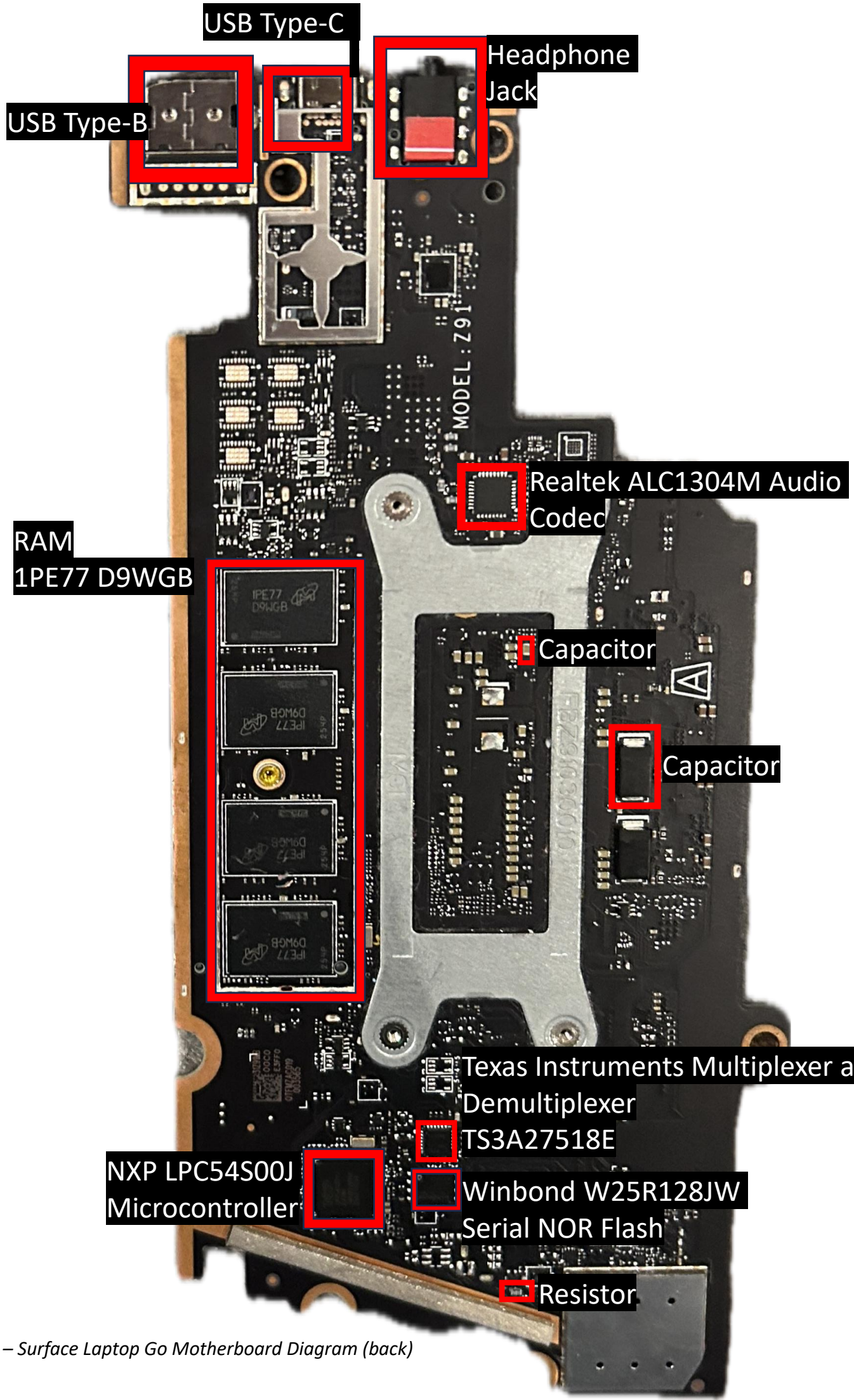



*Figure 76 – Surface Laptop Go Motherboard Diagram (back)*

# Motherboard Diagram (Graphs)*

## Surface Laptop Go

| Componer | Quantity | Size | Percent |
|---|---|---|---|
| ICs | 30 | *0.8 | 27.59% |
| Inductors | 8 | *1 | 9.20% |
| Capacitors | 240 | *0.1 | 27.59% |
| Resistors | 200 | *0.1 | 22.99% |
| Transistors | 55 | *0.2 | 12.64% |

*Figure 77 – Surface Laptop Go Motherboard Component Chart*

*These numbers are estimations based on fact

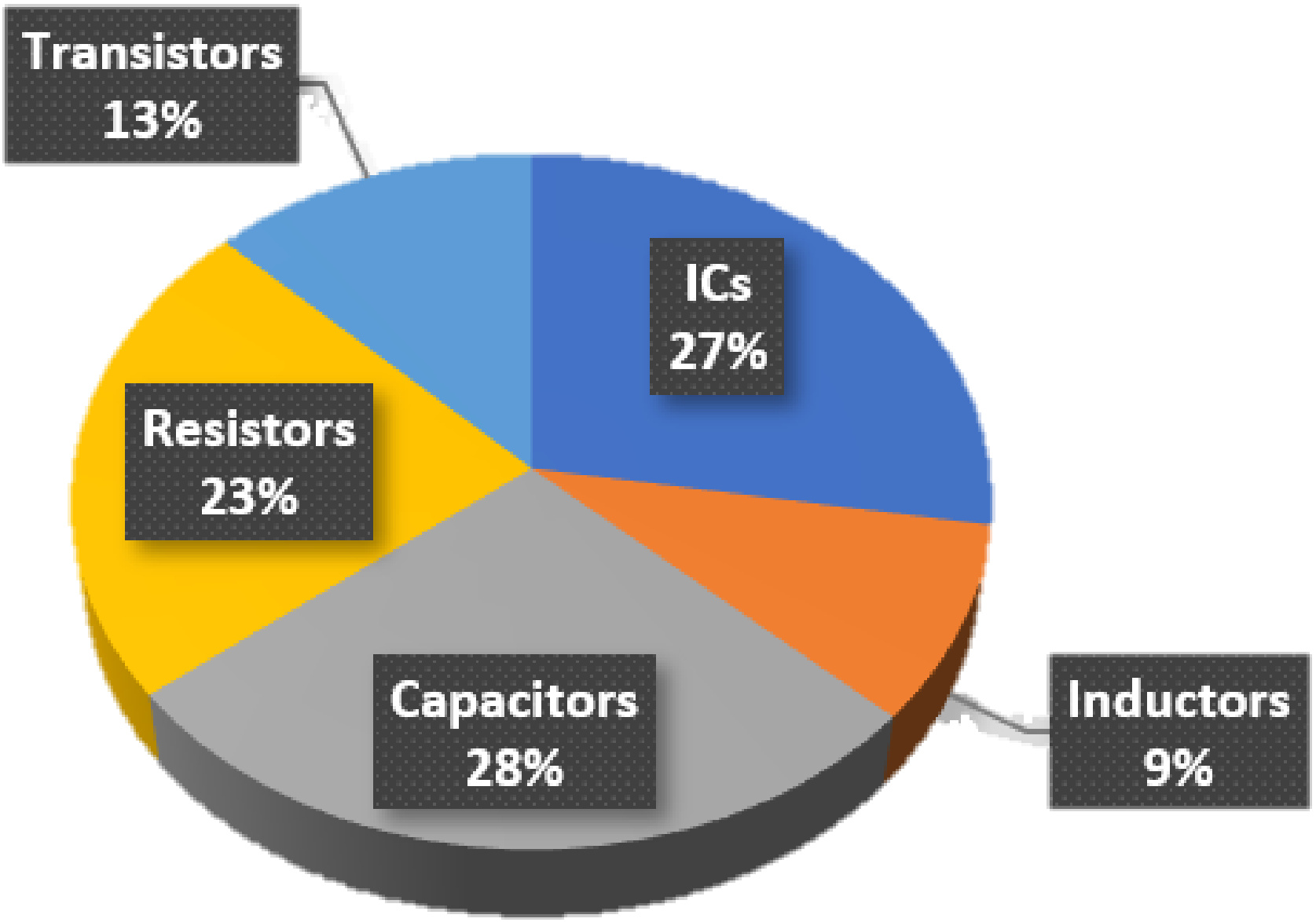
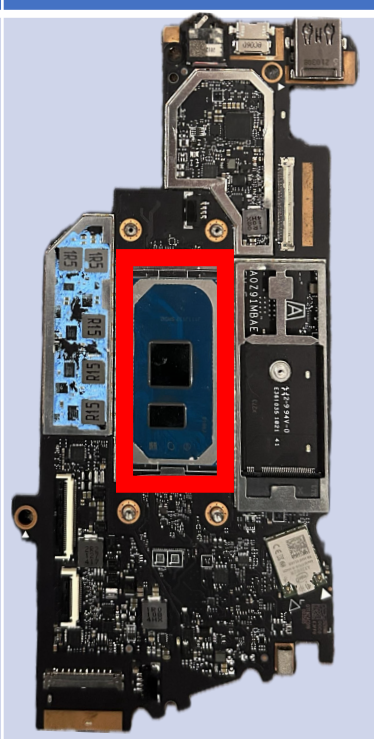
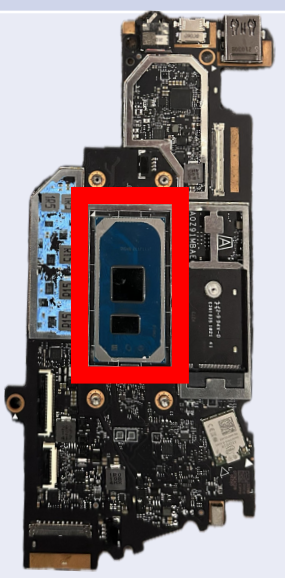



*Figure 78 – Surface Laptop Go Motherboard Component Pie Graph*

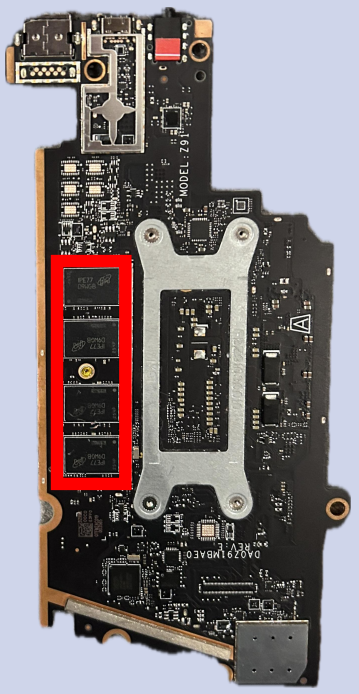
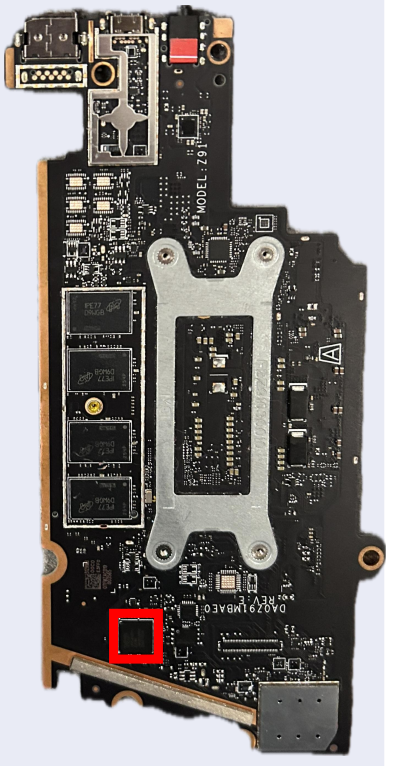
# Motherboard Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| 10th Gen Intel® Core™ i5 processor<br><br>1035G1 | The CPU of a laptop is short for the Central Processing unit and is the 'brain' of the laptop. It has a four step process called, Fetch, Decode, Execute, Repeat. The CPU **fetches** instruction from the memory, **decodes** the instruction, **executes** the instruction, then **repeats** everything. The CPU also performs different operations, like basic arithmetic, logic, and input and output operations. |  |  |
| Intel® UHD Graphics (Integrated into CPU)<br><br>1035G1 | The GPU of a laptop is short for the Graphics Processing Unit, and is like a CPU, but for graphics. It uses parallel processing, allowing it to work efficiently by handling multiple tasks at the same time. Using mathematical operations, the GPU can process graphics and load the data to the display. |  |  |
| Intel Wi-Fi/Bluetooth Module<br><br>AX201D2W | The Wi-Fi module of a laptop enables the device to connect to a wireless network, which allows the laptop to be used for so much more (e.g exchanging data with other devices). A Bluetooth module allows the device to wirelessly communicate with other Bluetooth devices. |  |  |

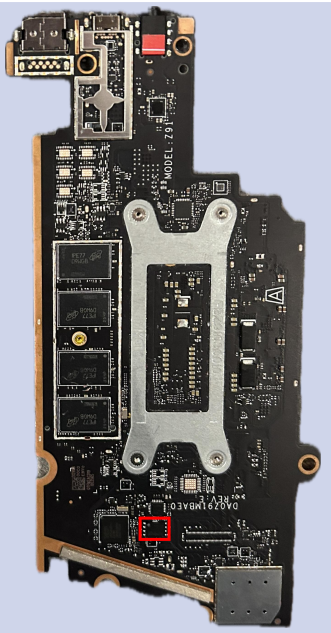
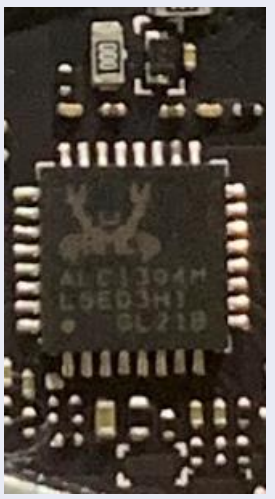
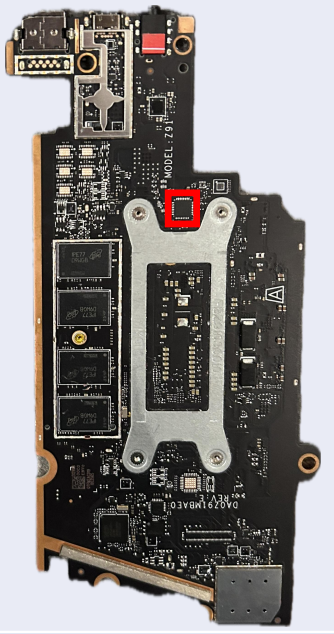
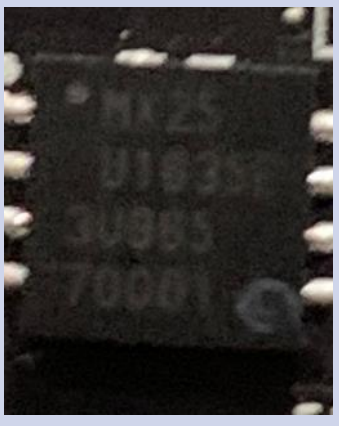
# Motherboard Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| 8GB Soldered RAM<br><br>IPE77 D9WGB | RAM, short for Random Access Memory, is for temporary storage, and allows applications to run, and store/access data. The RAM gives instructions to the CPU (the Fetch part of the cycle), through the memory bus. |  |  |
| NXP Microcontroller<br><br>LPC54S00J | This IC is something known as a microcontroller. There are millions of different operations going on inside a computer per second. The CPU can't handle it all, so it 'delegates' tasks. On a motherboard, there are different subsystems. These could be, regulating USB connection, WiFi connection, LCD connection, power regulators, etc. The CPU can't handle it all, so for each subsystem, there is usually something controlling it, that 'reports' to the CPU. The thing controlling a subsystem is a microcontroller – a mini-CPU that has less power and memory, but can do some simple tasks. This particular MCU (Microcontroller Unit) has many different uses, but in this situation, this microcontroller is used for RTC (Real-Time Clock) capabilities in the motherboard. |  |  |

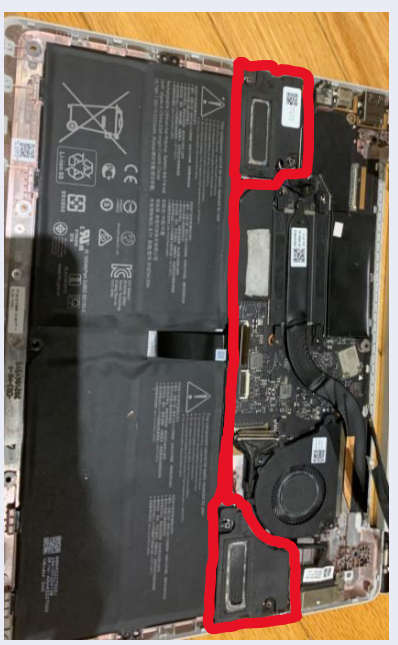
# Motherboard Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Winbond Serial NOR Flash<br><br>W25R128JW | This IC is a type of non-volatile memory component (the data stored on them is stored even when no power is provided to the computer). They are usually used to hold things like BIOS updates, firmware, and other data that needs to be kept even when the power is off. |  |  |
| Realtek Audio Codec<br><br>ALC1304M | An audio codec (mix of the words coder and decoder) is used to compress and decompress audio files while still maintaining their quality. It compresses the files by converting them to digital signals and decompresses them in the opposite way (digital to analog). |  |  |
| Macronix Flash NOR Memory<br><br>MX25U163EZUI | This IC is a type of non-volatile memory component (the data stored on them is stored even when no power is provided to the computer). They are usually used to hold things like BIOS updates, firmware, and other data that needs to be kept even when the power is off. |  |  |

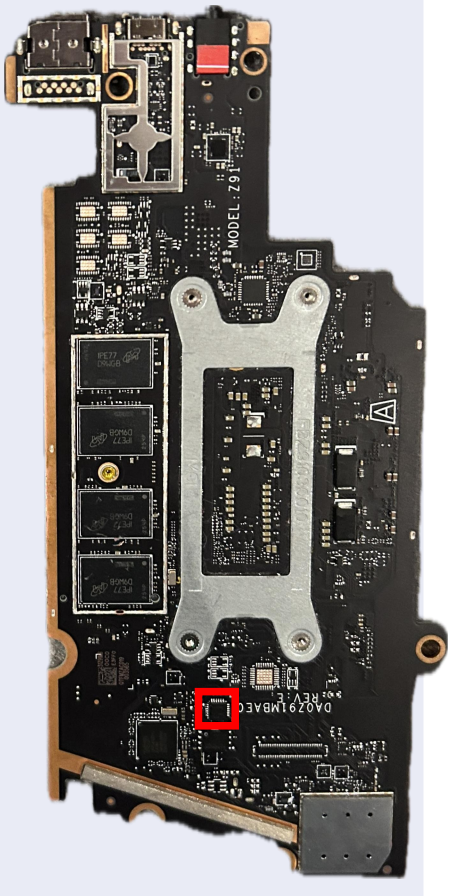
# Motherboard Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| 5235 mAh Battery<br><br>916TA135H | A battery stores chemical energy, then, through a conversion process, transforms that energy into electrical energy which powers the circuits in the laptop. After the energy in the battery runs out, it must be charged. |  |  |
| Speakers<br><br>DN191016000 | Speakers, although many take them for granted, are some of the most complex parts of devices, including a lot of different components that work to create audio. The main process in the speakers involves converting electrical signals into mechanical vibrations, creating soundwaves. |  |  |
| Surflink Charging Port<br><br>DDOZ91MU300 | The charging port is a convenient port that plugs directly into the motherboard and directly powers it. It takes less time to charge since it is a specialized port and is very useful to charging the battery and proving power to the laptop. |  |  |

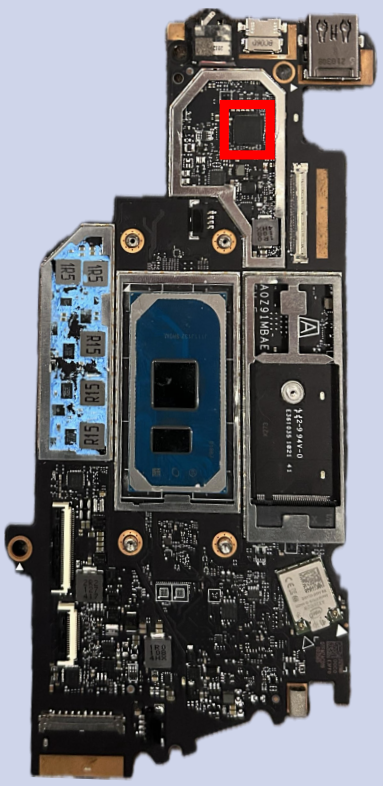
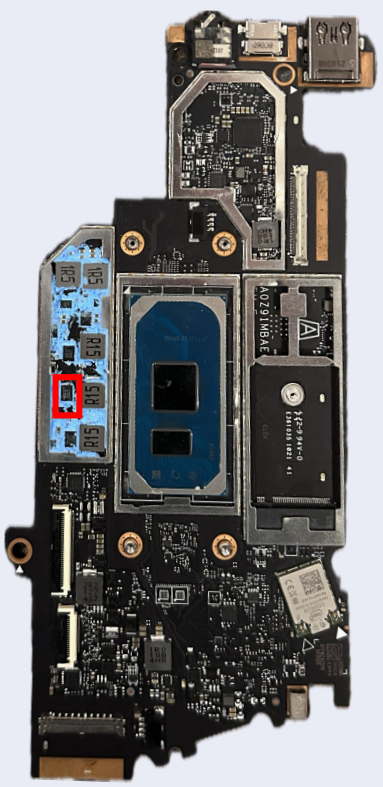
# Motherboard Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Heatsink<br><br>38Z91HSMFOO | A heatsink is a part used in computers to prevent overheating in components like the CPU and GPU. Often, computer parts doing strenuous tasks (the CPU and GPU) overheat, and this could cause them to break. This is why a solution was engineered – a heatsink. The heatsink helps to spread and release the heat generated by the CPU and GPU. The fins on the heatsink allow the heat to escape into the air, causing it to dissipate. Usually, a fan propels air into the heatsink, which moves the fins, which allows the heat to dissipate quicker. |  |  |
| Texas Instruments Multiplexer and Demultiplexer<br><br>TS3A27518E | Many times, signals are transmitted over channels, but sometimes, there are too many signals for not too many channels. This is where this IC helps. A multiplexer, in communication systems, is used to combine multiple signals into one channel, which is very efficient and optimizes bandwidth. A demultiplexer then takes that combined signal and separates it, sending each to their respective address (where they have to go). This allows the signals to stay the same while taking up less space when they are travelling. |  |  |

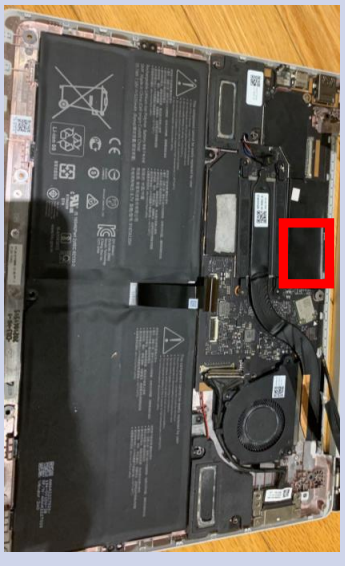
# Motherboard Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Texas Instruments USB Type-C & USB PD Controller<br><br>TPS65987D | In a laptop, they often have ports that can plug into other devices with a wire, for power exchange, data exchange, and communication. Therefore, there must be something to control all these exchanges. This IC is a USB (Universal Serial Bus) Type-C and USB PD (power delivery) controller. The controller manages the different components of USB. It 'negotiates' power exchange and regulates the current and voltage between the two devices. It also handles communication between the devices and data exchange. Without it, USB connections would be impossible. |  |  |
| Monolithic Power Systems PWM Power Controller<br><br>MP86901 | A PWM (Pulse-Width-Modulation) controller is a device that uses PWM signals to regulate power. PWM is a modulation technique that changes the width of pulses to either convey information or control power. It uses something called a duty cycle to determine the average power delivered. A high duty cycle is more power, and a low duty cycle is less power. A PWM power controller controls the duty cycle to control the voltage supplied to a device, and is very useful for power efficiency. |  |  |

# Motherboard Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| USB Type-C Port | A USB Type-C Port is a Universal Serial Bus port used to connect an external device to the main laptop and can be used for power delivery, communication, and data transfer. |  |  |
| Headphone Jack | A headphone jack is a port used to connect an external audio or recording device to the main laptop. It can act as a bridge for audio input (microphones) or output (headphones). |  |  |
| USB Type-A Port | A USB Type-A Port is a Universal Serial Bus port used to connect an external device to the main laptop and can be used for power delivery, communication, and data transfer. |  |  |
| Fan | The fan propels air into the heatsink, and allows the heatsink to dissipate the heat generated by the CPU and GPU. |  |  |
| SSD | The SSD is the main non-volatile storage on the laptop, and is used to store the operating system, files, and applications. It uses floating gate transistors (which hold a charge even when no power is supplied) to store data electronically. With billions of transistors, it can store a lot of data while being physically small. |  |  |

# Screen Diagram (2D)

## Surface Laptop Go

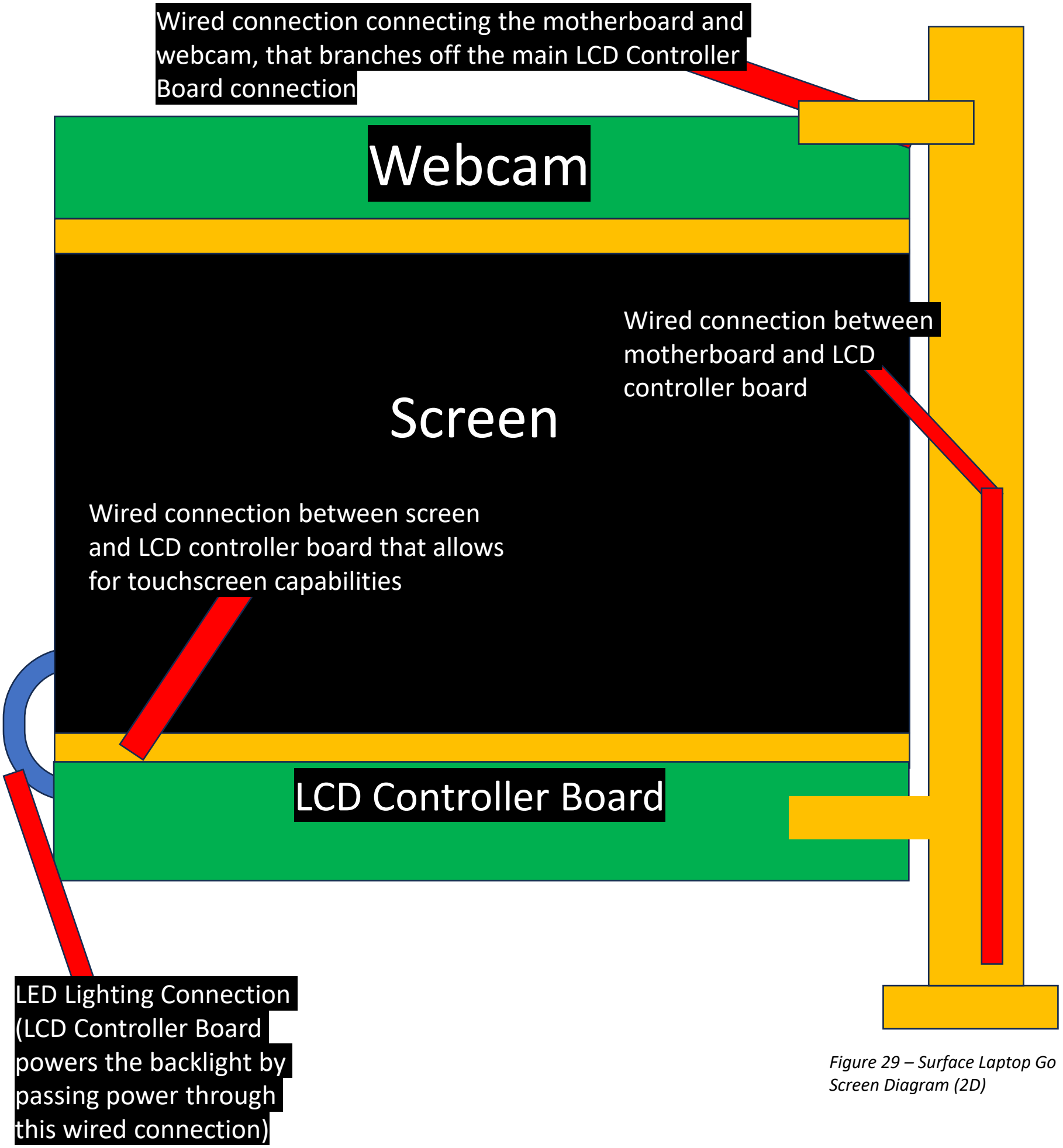



*Figure 29 – Surface Laptop Go Screen Diagram (2D)*

# Labelled LCD Controller Board (Front)

## Surface Laptop Go

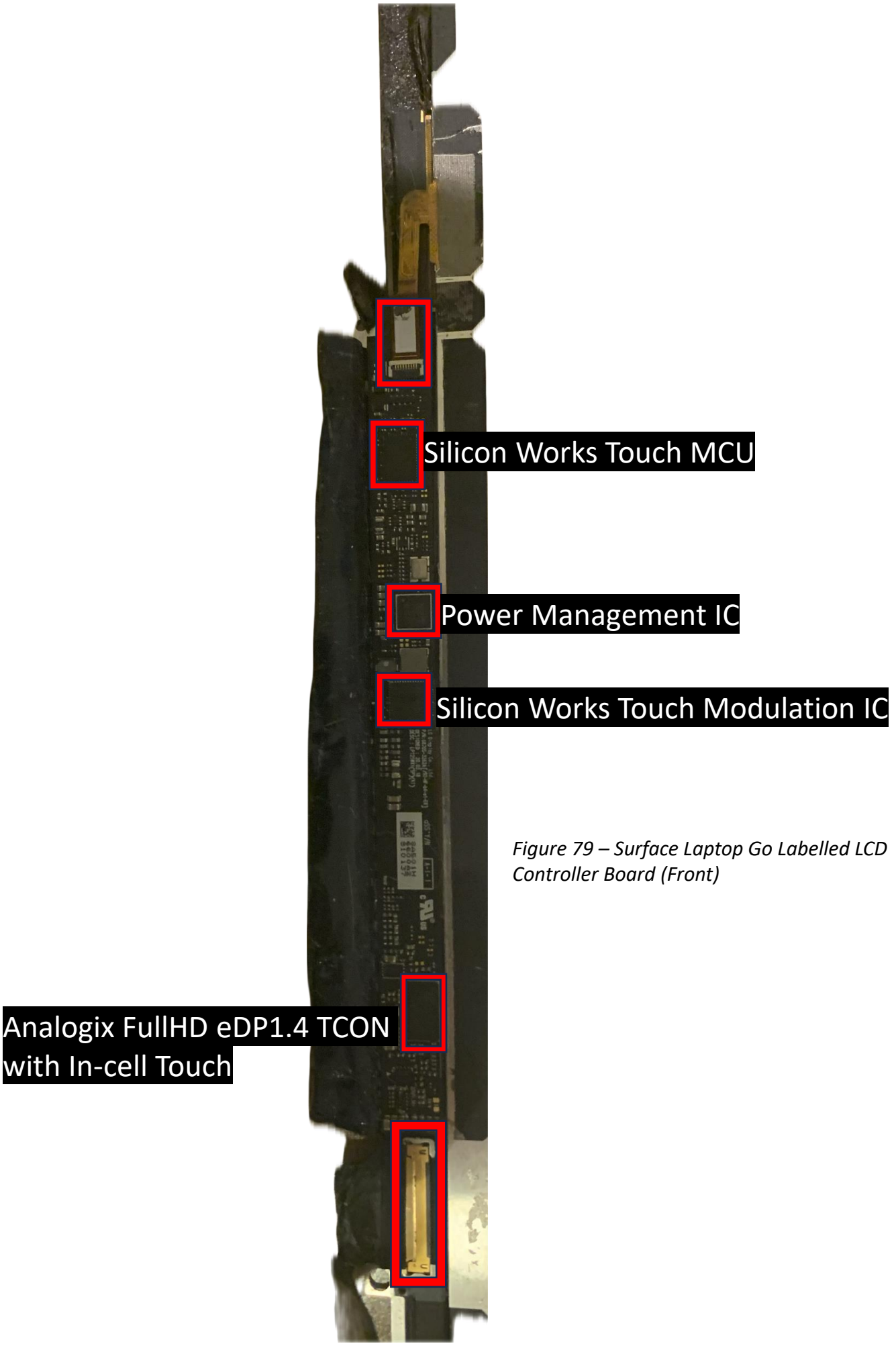



*Figure 79 – Surface Laptop Go Labelled LCD Controller Board (Front)*

# LCD Diagram (3D)

## Surface Laptop Go

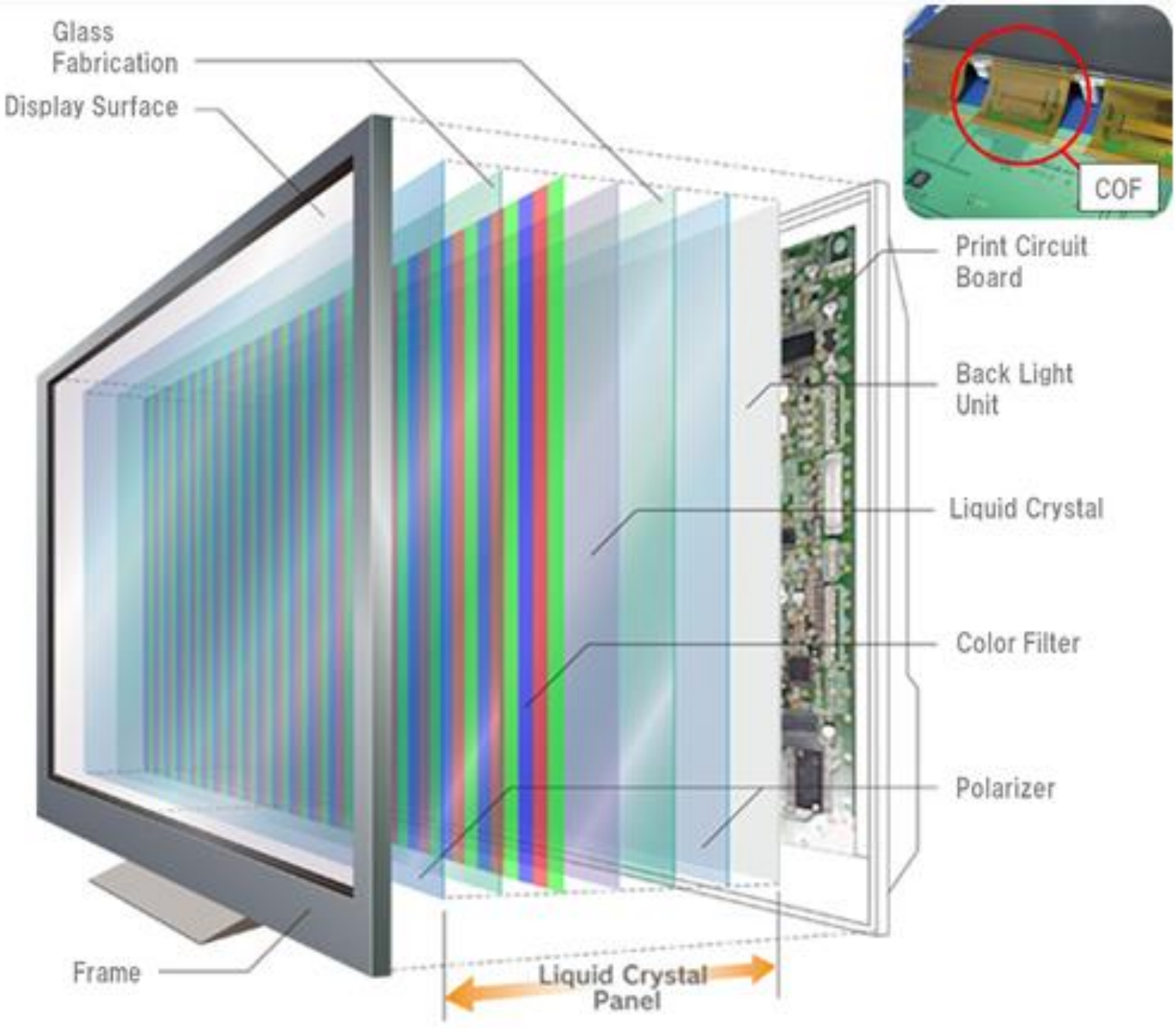
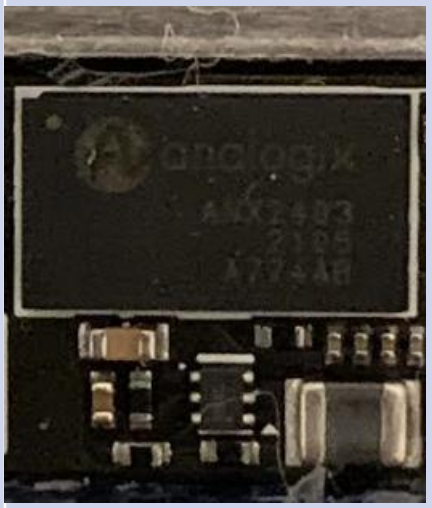



*Figure 80 – LCD Diagram (3D)*

*This is a general LCD diagram and does not represent the Surface Laptop Go's LCD to the most accurate degree. Instead, this is for a basic understanding of an LCD.

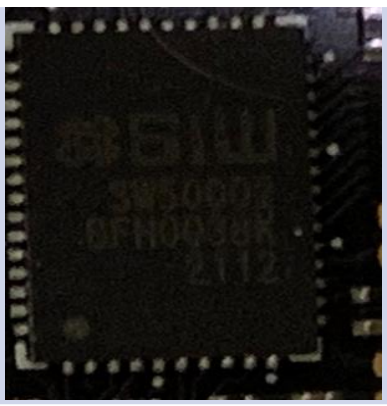
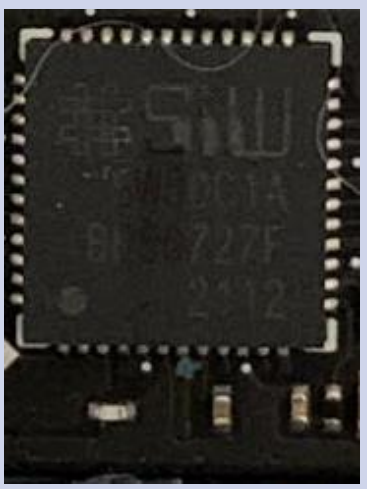
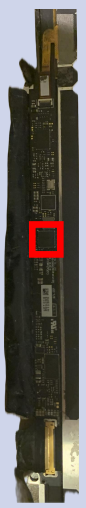
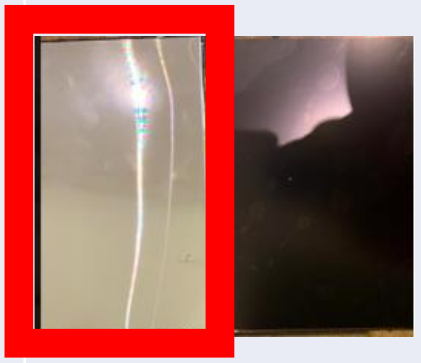
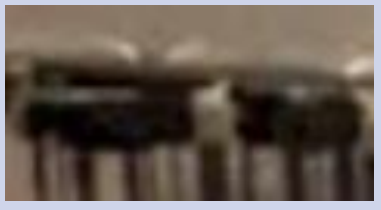
# Screen Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Analogix FullHD eDP1.4 TCON with In-cell Touch<br><br>ANX2403 | A TCON (Timing Controller) in an LCD is one of the most important components. It first decodes the video signal into timing signals and uses those to power specific pixels on the screen. It determines when each pixel should be lit up, and refreshes the display. It also organizes the pixels and coordinates their activation by controlling the voltage applied to each pixel, which changes their brightness and color. This TCON supports finger touch functions, which means that it also can work with a touch input device, decoding the signals sent from touch, and controlling the pixels accordingly. The TCON definitely does a LOT* for the LCD.<br><br>*Although the TCON does do a lot for the LCD, many of its functions are helped by other ICs – e.g another IC processes the touch input and sends it to the TCON, and the TCON determines the voltage to change, but the power regulators on the LCD controller board actually do it. |  |  |

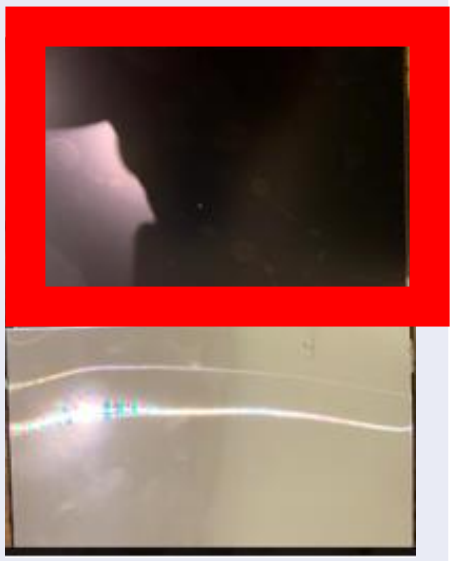
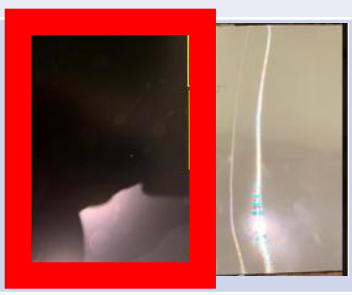
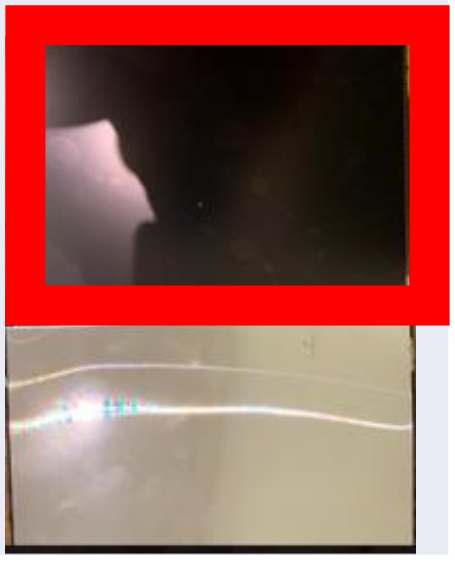
# Screen Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Silicon Works Touch MCU<br><br>SW50007 | A touch MCU (microcontroller unit) is an IC used to manage the touch capabilities of the LCD. It handles the data from the touch and processes and transmits it to the main motherboard. |  |  |
| Power Management IC<br><br>MFSD8 | A power management IC in the LCD controller board is used to manage the power given to the backlight and the power given to the ICs on the LCD controller board. Without it, the LCD and LCD controller board will suffer electrical issues. |  |  |
| Silicon Works Touch Modulation IC<br><br>SW50G1A | A touch modulation IC takes the touch signal as an input, and modifies the voltage applied to the electrodes in the touch panel based on the touch signal. This allows the touch panel to be more responsive to the touch signals, and more accurate, as well as reducing interference. |  |  |
| Polarizing Layers | A polarizing layer in an LCD display is used to filter light based on its orientation (polarization). This, used in conjunction with liquid crystal and color filters, is used to regulate the amount of light and characteristic of light reaching each pixel. |  |  |
| Webcam | A webcam is a small camera usually found in the front of a laptop, that is used for virtual meetings and pictures. |  |  |

# Screen Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Backlight | A backlight is, as the name suggests, a back-light. It is the last layer of the LCD, at the very back, and is a panel that can light up, usually using CCFL (cold cathode fluorescent lighting) or LEDs (light-emitting diodes). (This backlight uses LEDs)The backlight's light passes through the multiple layers to end up creating an image. |  |  |
| Electrodes used for Touch Capabilities | We have covered the ICs used for processing touch data, but the way that the screen actually detects that data is interesting. The electrodes in the screen have a capacitance (an object's ability to store electrical charge). Once you put a finger in there (which is a conductor), there is a change in capacitance. This change, as well as the points where the capacitance changed, is measured by the ICs and then processed. |  |  |
| Color Filter | A color filter is a filter that is used to only allow specific wavelengths of light through, changing the color of each pixel, with a mix of red, green, or blue. |  |  |
| Liquid Crystal | A liquid crystal is a substance between liquid and solid, depending on the voltage applied to it. It has crystalline shapes. When voltage is applied to specific pixels, it determines the crystals' orientation, which controls the amount of light passing through the color filter, and what color will be produced, as well as the brightness of the pixel. |  |  |

# Keyboard/Trackpad Diagram (2D)

## Surface Laptop Go

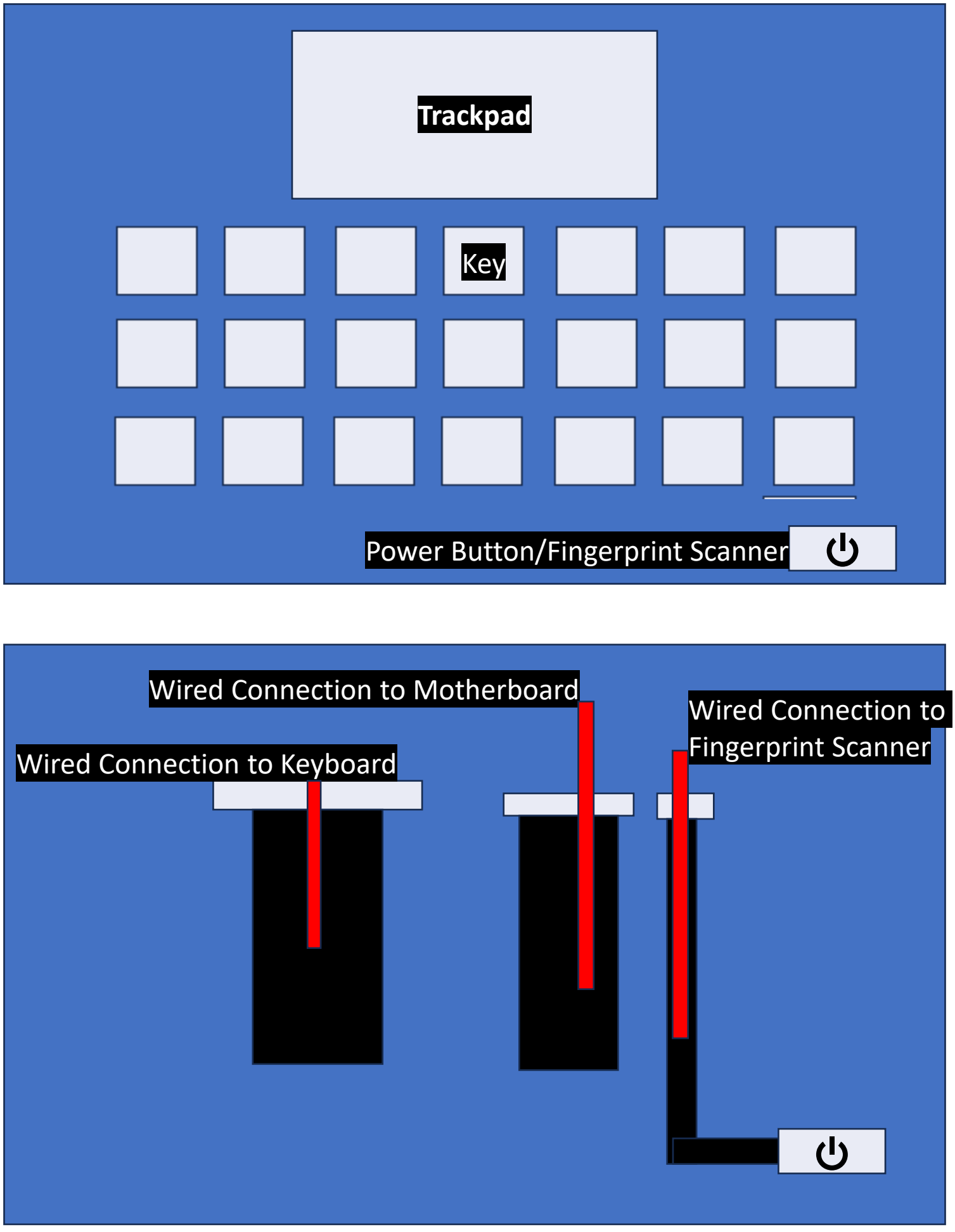



*Figure 81 – Surface Laptop Go Trackpad/Keyboard 2D Diagram*

# Labelled Trackpad PCB

## Surface Laptop Go

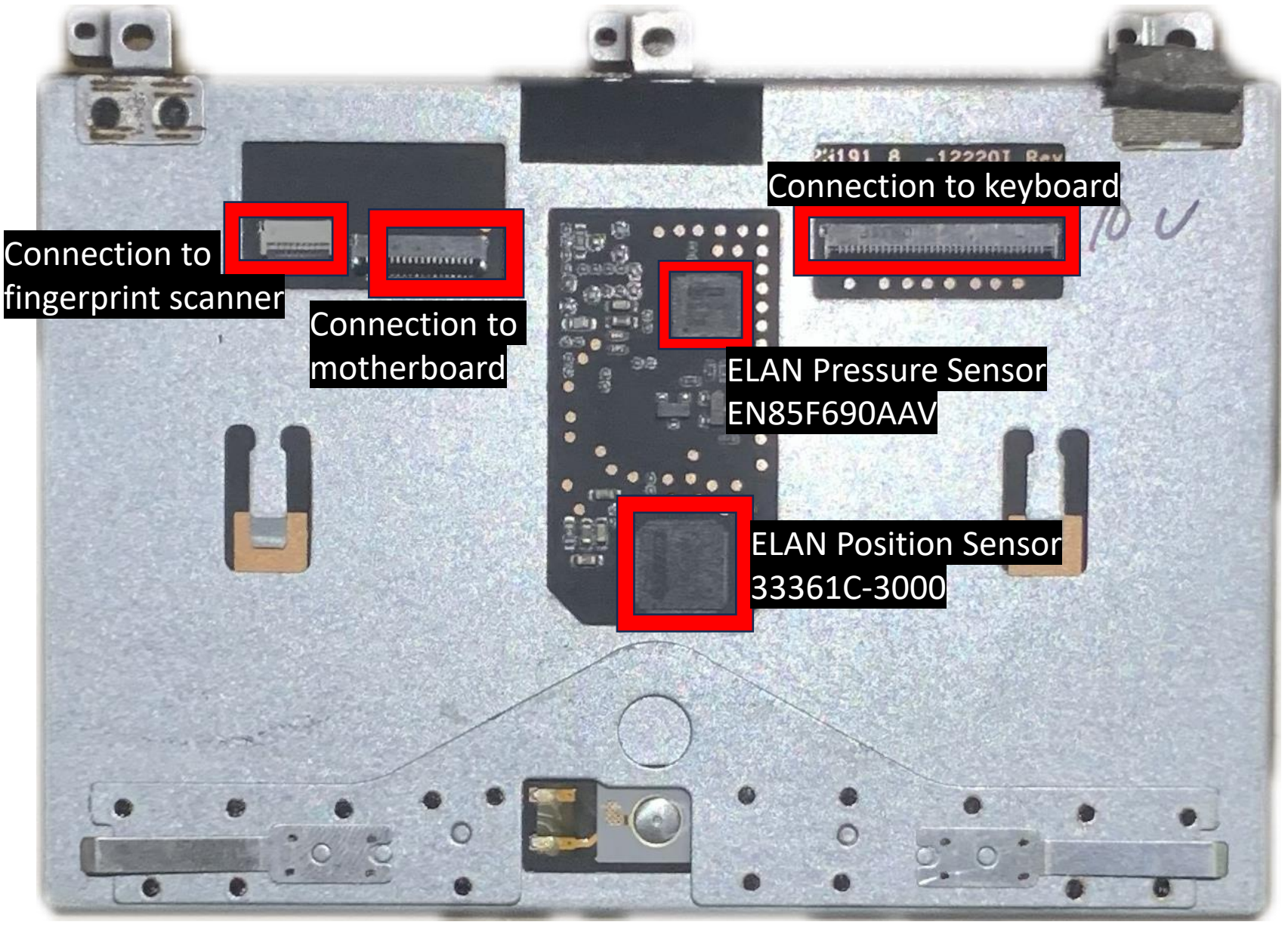
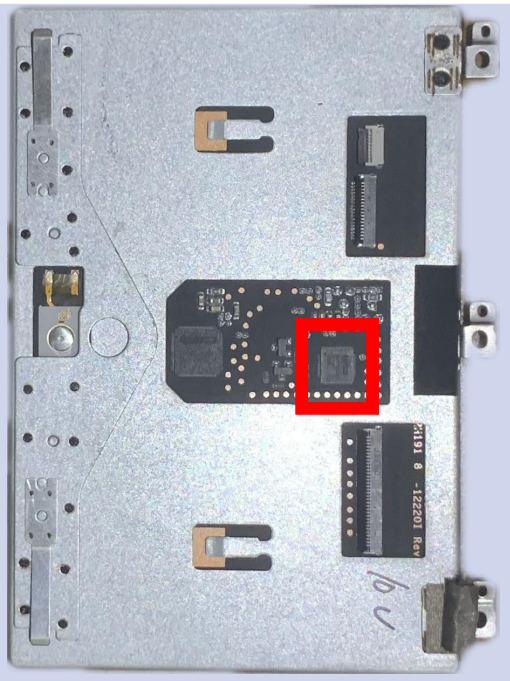
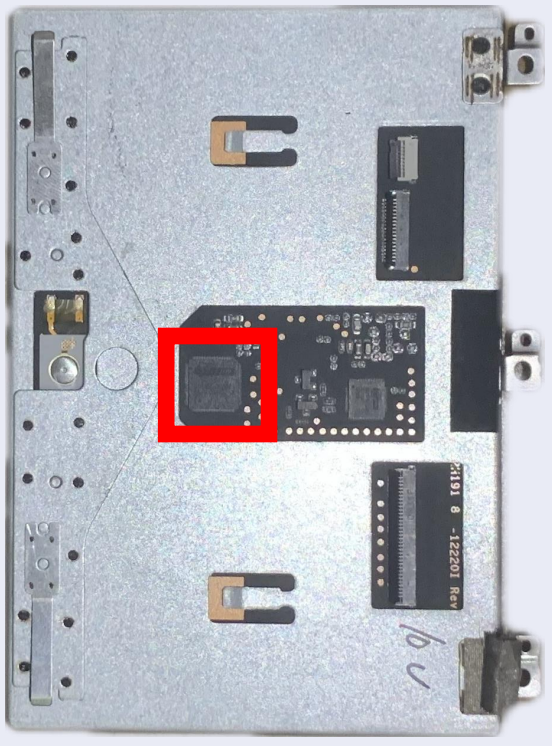
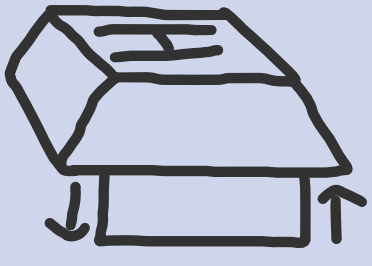



*Figure 82 – Surface Laptop Go Trackpad PCB Diagram*

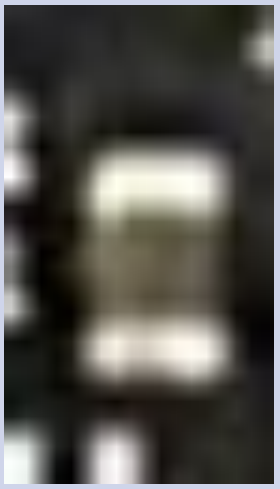
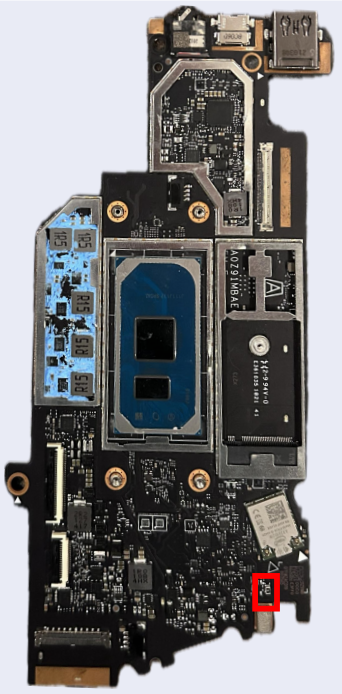
# Keyboard/Trackpad Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| ELAN Pressure Sensor<br><br>EN85F690AAV | This IC is a pressure sensor, which means it can detect the pressure put on the touchpad and the system can respond to that. This works by using a resistive system, where pressure alters the resistance of a material. Another system measures that changed resistance and deduces the pressure applied. All of these systems are located in the IC. |  |  |
| ELAN Position Sensor<br><br>33361C-3000 | This IC is a position sensor, but as for how it detects position, we have to go back to the touchpad itself. Essentially, there is a grid of electrodes underneath the touchpad. These electrodes can sense changes in capacitance (an object's ability to store an electric charge). When a finger (a conductive object) touches the trackpad, the capacitance is changed. The position sensor takes that data and processes it to determine where the finger is on the touchpad. |  |  |
| Physical Switch for each Key | When a key is pressed, this switch is triggered. Each key's switch sends its own signal to the motherboard, which is then processed and recognized as a specific key. |  <br>*This diagram is easier to understand than the actual image | |

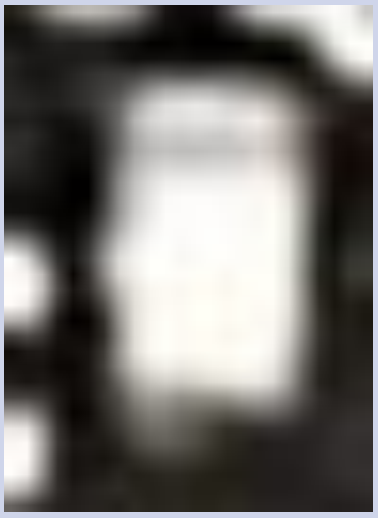
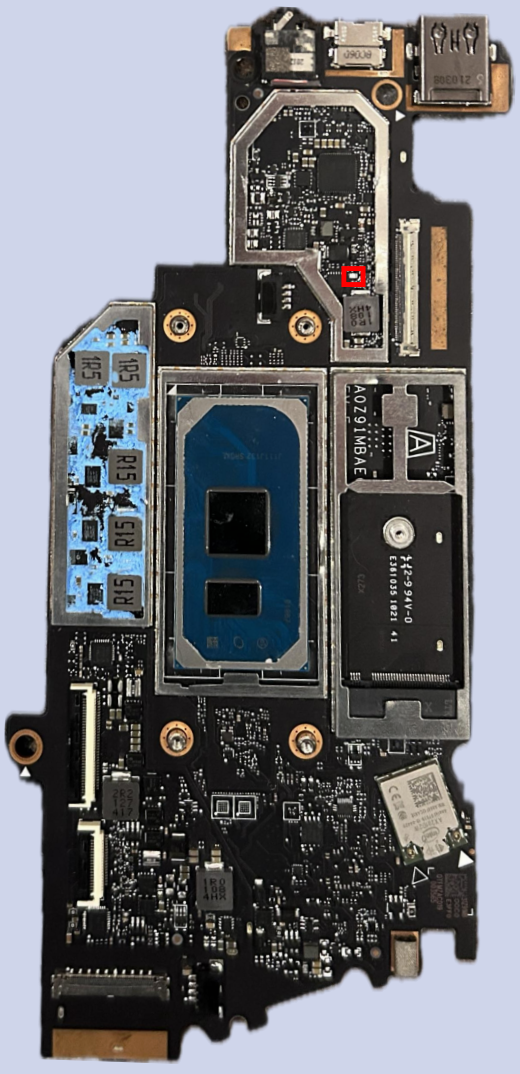
# Electrical Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Capacitor | A capacitor is another electrical component that is similar to an inductor in that they both store and release energy, but are essentially opposites in every other way. While inductors store current in a magnetic field, capacitors store voltage in an electrical field. Capacitors release energy very fast, while inductors tend to take more time. However, the fact that they are opposites is really useful to circuits and allow for a range of different capabilities in circuits. |  |  |
| Resistor | A resistor is an electrical component that limits the flow of electric current in a circuit. For example, if 5V travelled through the resistor, it may get stripped to 3V. Although the resistor limits current, that affects voltage, according to Ohm's Law (V = I x R). R is resistance, I is current, and V is voltage. If the current is 5 and the resistance is 0.5, the voltage is 2.5V. Resistors are measured in what are called Ohms. |  |  |
| Inductor | An inductor is an electrical component that uses a magnetic field to store energy when current flows through it, |  |  |

# Electrical Component Analysis

## Surface Laptop Go

| Part | Description/Role in System | Image | Location |
|---|---|---|---|
| Transistor | A transistor is an electrical component that can act as an amplifier or a digital gate. There are different types of transistors, and it can be used in power regulation/control, as well as base logic-level programming. CPUs use transistors to work, and often contain billions. In binary code, there are two values: 0 and 1. A transistor acts as a digital gate or switch. If the gate is open, it is high voltage (1). If the gate is closed, it is low voltage (0). By opening and closing the transistor's digital gate, we can create binary code, which can then be used for many logical operations, and is why the CPU can perform basic arithmetic. It is really interesting how something that can only perform two functions can do basic arithmetic and can be used for programming. |  |  |

# Design Analysis

## Surface Laptop Go

While the technological components of laptops are very important to how they work, the design of laptops and why they are built the way they are built is constantly underappreciated, even though it is a vital part of the laptop. This section will cover observations I made on the laptop and how it was built, referencing the technological period it was built in and the potential choices behind its design.

**Battery** - The battery takes up half the space in the laptop shell, and the motherboard takes up another almost-half of the space. This shows how much priority battery life is in the modern day world, that companies are willing to sacrifice a bigger motherboard for more battery. It also shows that sacrifices have to be made when the laptop has a pretty small shell and has to remain thin, and has to have a low price.

**Thin and Small** – The surface laptop go is clearly designed to be thinner and smaller than its Surface Laptop counterparts. The Surface Laptop Go has an aluminum top and keyboard cover, but a **"polycarbonate composite resin system with glass fiber and 30% post-consumer recycled content"** base. The plastic base is cheaper but works to keep the laptop light and cheap.

**Keep it Cheap** – The Surface Laptop Go is designed to be cheap everyday laptop. Its top configuration ($900 – 8GB RAM, 256GB SSD), is a decent configuration that surprisingly works very well and smoothly. Although its hardware isn't the best, because Microsoft is the manufacturer of both the software and laptop, they can customize the software and specialize it to make it just work smoother. The little things help a lot. Additionally, small cuts in different things allow Microsoft to bump down the price significantly.

**Simple Structure** – A very simple structure for the main shell of the laptop allows consumers to replace the parts themselves, which is cheaper, and allows the laptop to be structurally stable without having to design a complex structure. The easily removable keyboard and strong metal hinges both contribute significantly to the structure of the laptop.

# History/Evolution

This is the reason why we chose to take apart two laptops – to observe the evolution from two drastically different technological periods (although there is less than 20 years between them). We also covered the evolution from the very beginning as well, to give a broader outlook on how we got where we are.

| What Evolved? | DELL Latitude D830 - 2007 | Surface Laptop Go - 2020 | Research |
|---|---|---|---|
| PCB (Printed Circuit Board)Printing | The PCBs in the Dell Latitude D830 and many other laptops from the early 2000s are surprisingly pretty thin, measuring 1mm in width. | The PCBs in the Surface Laptop Go and other laptops from the 2020s are thinner than laptops from the early 2000s, but not by too much, measuring 0.5mm in width. Although the difference is not much, cutting the width in half is still impressive. | The early 2000s and 2020s didn't have any revolutionary change in PCB Printing, but in this research section, we do want to focus on the evolution even outside of the two laptops we have. In the early days of circuits, every component had to be connected with wires, which was messy, time-consuming, took up lots of space, and unreliable – circuits would often break because of how easily the wires could come out. The concept of PCBs was created at the beginning of the 20$^{th}$ century, but the technology was too far behind. In 1948, after testing, the PCB was released commercially. However, because it was still being created by hand, mass production was incredibly hard. In the 1980s, the production started to become automated, advancing over the next 20 years. From the 2000s to 2020s, PCBs have continued to evolve in the design process (with applications to help streamline the process) and the manufacturing process (more advances in the technology used to create PCBs). There are many opportunities for PCBs in the future, including the potential of 3D-printing PCBs. |

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| What Evolved? | DELL Latitude D830 - 2007 | Surface Laptop Go - 2020 | Research |
|---|---|---|---|
| ICs (Integrated Circuits) | The biggest IC on the motherboard (not including the CPU or GPU) measures 625mm squared – the I/O Controller Hub. | The largest IC on this motherboard (not including the CPU or GPU or RAM) measures 240 mm squared – the WiFi module. | As you can see from the comparison, ICs have shrunk a lot since the early 2000s, and even more if we go all the way back. The birth of ICs was actually directly correlated with the birth of the transistor. In the 1940s, the invention of the transistor was one of the most revolutionary moments in technology. It set new standards for power regulation and control, but more importantly, new standards in processing. The fact that the transistor could create basic binary code and do logic level programming in such a small package was an amazing thing. Manufacturers quickly started to find ways to integrate these transistors into circuits, and in the 1950s, a patent was filed for a chip with multiple transistors on it – the first integrated circuit. At the time, they were known as SSI circuits ( small-scale integration circuits). However, these circuits could barely do any processing. The 1960s introduced MSI circuits (medium-scale-integration circuits), with hundreds of transistors on one chip. Although the power was greatly improved, it was still hard to do logic level processing. The 1970s introduced LSI circuits (large-scale integration circuits), with thousands of transistors on one chip.. |

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| ICs (Integrated Circuits) | The biggest IC on the motherboard (not including the CPU or GPU) measures 625mm squared – the I/O Controller Hub. | The largest IC on this motherboard (not including the CPU or GPU or RAM) measures 240 mm squared – the WiFi module. | This was the creation of the first microprocessors, with the Intel 4004 releasing in 1971. This was a huge step for microprocessors and ICs in general. From there, the technology had finally caught up to ICs and transistors. The 1980s and 90s introduced VLSI circuits (very large scale integration circuits), and ULSI circuits (ultra large scale integration circuits), respectively. These could hold millions (VLSI) and billions (ULSI) of transistors, leading to very powerful processors and ICs. The reason of this huge jump was the evolution of nanoscale integration - a way to reduce the size of electronics to as little as possible. Over the 90s to the 2000s, transistors have shrunk a lot. The shrinking of transistors has allowed ICs to become smaller yet more powerful, allowing motherboards to do the same. Technological evolutions regarding transistors and ICs are still happening in 2023. Apple introduced 3nm transistors to their devices, allowing them to pack 19 billion transistors on their processor. New technologies are allowing us to shrink ICs even more, but as we are approaching our limit with silicon-based ICs, researchers are experimenting with new materials. The future evolution of ICs holds a lot for us, particularly in newer things like quantum computing. This is really exciting. |

# History/Evolution

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| What Evolved? | DELL Latitude D830 - 2007 | Surface Laptop Go - 2020 | Research |
|---|---|---|---|
| Memory | The RAM on the D830 is 2GB of DDR2, which is incredibly slow by today's standards, but worked for the laptop to deliver a good performance. The D830 uses a optical disk drive (ODD) and a hard disk drive (HDD), both of which are older technologies. The HDD measures 7 x 10 cm (70 cm2), and the ODD measures 13 x 13 cm (269 cm2). | The Surface Laptop Go has 8GB of DDR4 RAM, which is the average amount for mid-range laptops, and works for most. The Surface uses a solid state drive (SDD), the newest non-volatile storage solution for large amounts of data. It measures 2.3cm x 3.1cm (7.13 cm2). | This will cover the evolution of RAM and non-volatile memory.<br><br>RAM – RAM was one of the most changed components in electronics. In the early 1930s, the first iteration of RAM was created (although it was technically designed as a non-volatile memory solution, at that time, there wasn't much of a point for two types of memory). This was called Drum memory, and it worked by an electromagnetic pulse adjusting the orientation of a magnetic particle, which stored the data as binary code. The next iteration was called vacuum tube memory, and worked by sending an electron beam, and reflecting it onto a phosphor surface to create a grid pattern, which is then read. However, there was a major flaw regarding the fact that the machine was very sensitive to electrical fields. Despite that, vacuum tube memory was implemented in the Manchester Baby computer in 1948, allowing it to run programs. The next iteration was magnetic core memory, which altered the direction of magnetization to store data. Obviously, it is a bit more complex, but that is the basic idea. The next iteration of RAM, which is still here today, is the use of transistors and capacitors to create a single memory cell, which can hold a single bit of data (1 or 0). |

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# History/Evolution

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| Display Technology | The Dell Latitude D830 has a 1280x800 WXGA LCD screen. | The Surface Laptop Go has a 1536 x 1024 LCD screen. | As you can see from the comparison, both screens use LCD technology to function, and really, the only difference is the pixel count and the size of the screen (the Dell measures in at 15.4 inches, while the Surface is 12.4 inches). Display technology started in 1897, with the invention of the CRT (cathode ray tube). Essentially, the screen is filled with phosphor dots that glow either red, green or blue when exposed to an electron beam. When the electron beam is shone on the screen, the different pixels light up in different colors to create an image. |

# History/Evolution

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|---|---|---|---|
| Display Technology | The Dell Latitude D830 has a 1280x800 WXGA LCD screen. | The Surface Laptop Go has a 1536 x 1024 LCD screen. | In 1907, the discovery of electroluminescence (light that doesn't produce heat* - a natural phenomena). This was the base of LEDs (light-emitting diodes), which were invented in 1961. They were limited in capacity, but were a huge revolution when it came to light production. Over the next 4 decades, LEDs continued to evolve. We'll come back to that later, but for now, let's focus on the most common display technology right now, LCDs (liquid-crystal displays). A liquid crystal is a very interesting material. It is between a solid and liquid, and has a crystalline formation. Thus, it was dubbed 'Liquid Crystal'. Researchers experimented with the liquid crystal, and noticed it could block out light or let it pass through. In a liquid crystal display, voltage changes how the liquid crystal is formed, and depending on the way the liquid crystal is, it only lets specific light through. This is called polarization. For more details, here. This happens on every pixel in the LCD, allowing the LCD to control which pixels are lit, not lit, and in which way. That light then passes through a color filter, which turns into red, green or blue, allowing images to be created. Liquid crystals themselves are passive components, which means that they don't really do anything until stimulated. |

# History/Evolution

| What Evolved? | DELL Latitude D830 - 2007 | Surface Laptop Go - 2020 | Research |
|---|---|---|---|
| Display Technology | The Dell Latitude D830 has a 1280x800 WXGA LCD screen. | The Surface Laptop Go has a 1536 x 1024 LCD screen. | In an LCD, a backlight is shone through the LCD, and voltage is used to affect what light can pass through. LCDs are still widely used today, after years of evolution, making them lighter and thinner, adding more pixels. The two biggest evolutions that we can notice between the Dell Latitude and Surface Laptop Go, is the addition of more pixels to the screen (allowing for a brighter, sharper image), and the change in backlight technology – while 2007 laptops commonly used CCFL (Cold-Cathode Fluorescent Lighting) for the backlight, modern LCDs use LED backlighting. LEDs allow for better power efficiency and a brighter result. Additionally, they also allow for a longer lasting backlight, and a less dangerous one (CCFL lighting uses small traces of mercury, which could seriously hurt someone if the screen was broken – granted, a cracked screen wouldn't do it, you'd have to absolutely demolish the screen for the slight amount of mercury in the screen to leak). Nevertheless, LEDs are much better than CCFL lighting. The next step of display technologies is one that is still being perfected, which is LEDs. Over the decades, LEDs evolved, and in 1987, OLED (organic light-emitting diode) was created. OLEDs were incredibly small and a huge step in electroluminescence. They were arguably better than LCDs display-wise, but still had their flaws, in that they were incredibly expensive to manufacture and had a shorter lifespan than LCDs. However, over the years, most of these issues were fixed, and OLED has become more of a "luxury" standard than anything. However, the future of display technologies relies on types of LED displays. The next and final iteration of display technology, and very recently introduced, is QLED (quantum light-emitting diode), which is a really interesting concept. The idea of using QLED was created in the 1990s, but was not put into use as a display technology until 2017. In fact, in October 2023, three scientists won the Nobel Prize in chemistry for their work on quantum dots. |

# History/Evolution

| What Evolved? | DELL Latitude D830 - 2007 | Surface Laptop Go - 2020 | Research |
|---|---|---|---|
| Display Technology | The Dell Latitude D830 has a 1280x800 WXGA LCD screen. | The Surface Laptop Go has a 1536 x 1024 LCD screen. | Quantum dots are nanoparticles, that when modified, change their properties, including their color. They are incredibly small and are being used for a lot of things, one being their use in display technology. However, they are still relatively new, and are pretty expensive, but are definitely the future of display technology. Display technology is really interesting because it's not so much of an electrical process, but more of a chemical process, which is super cool and super fun to research. The evolution of displays has spanned for a while, and we are curious to what will happen next.<br><br>*obviously, any type of light energy will produce heat as a byproduct. Electroluminescence just reduces that heat and is much more efficient when it comes to power. |
| Internet/Wireless Communication | | | Internet and wireless communication is used very widely today, and modern technology couldn't exist without it. The birth of wireless communication can be traced to early wired communication, in the form of telegraphy and morse code. In the late 1800s, radio waves were discovered, and were eventually used in 1906 to create the first radio broadcast. |

# History/Evolution

| What Evolved? | DELL Latitude D830 - 2007 | Surface Laptop Go - 2020 | Research |
|---|---|---|---|
| Internet/Wireless Communication | The DELL Latitude D830 uses the 802.11b/g WiFi standard. | The Surface Laptop Go uses the 802.11ax WiFi standard (WiFi 6). | The discovery of radio waves and their uses revolutionized wireless communication, and in the 1920s-1930s, the introduction of AM (amplitude modulation) and FM (frequency modulation) allowed for better audio transmission and further broadcasting. In the 1940s, the concept of a cellular network was created, which separated geographical areas into 'cells', each cell having a base station and antennas for signal transmission. By the 1980s, 1G mobile networks were created and marked a major step in wireless communication. The introduction of digital transmission in wireless communication allowed data to be easily encrypted and compressed, as well as travelling faster while taking up less space. 2G networks used digital transmission and introduced text messaging, a huge step for wireless communication. 3G networks came next, in the early 2000s, and 4G and 5G followed. Each had their own new features and allowed for faster data transmission, more areas where you could access a cellular network, etc. In 1997, WiFi (what laptops use even today) was created using similar digital transmission technology. However, WiFi (wireless fidelity) is different in that it taps into an already established network through a router. You must be close to that router to use the WiFi. |

# History/Evolution

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|---|---|---|---|
| Internet/Wireless Communication | The DELL Latitude D830 uses the 802.11b/g WiFi standard. | The Surface Laptop Go uses the 802.11ax WiFi standard (WiFi 6). | The birth of WiFi can be traced to 1983. Ethernet was essentially the wired form of WiFi, the device having an ethernet port and cable that would directly plug into the router. This allowed for fast data transfer, but was an inconvenience for many people, because to access a network, they always had to have their device plugged into the router. Many people renovated their homes to allow ethernet cables to travel through the house, allowing devices to be connected from each room. However, always being plugged in was still an inconvenience. Ethernet is still around today, in use by people that absolutely need a high-speed internet connection (gamers, etc.). As it is wired, the most recent ethernet technology will always be faster than the most recent WiFi technology, no matter what, but WiFi is coming rather close. Throughout the years, there have been many different WiFi standards including (in chronological order), 802.11 (1997), 802.11b(1999), 802.11a (1999), 802.11g (2003), 802.11n (WiFi 4, 2009), 802.11ac (WiFi 5, 2013), 802.11ax (WiFi 6 & 6E, 2019 & 2020). Each one allowed for faster data transfer rates, more accessibility for frequency, and more options for bandwidth. Overall, WiFi and wireless communication has evolved greatly over the years, but we may be reaching the cap of wireless communication as we know it. Research and experiments with brain chips shows that that may be the next, futuristic form of communication, but that poses more ethical questions. The future of wireless communication has a lot in store for us, and we are excited to find out. |

# Sources

## How do things work?

How does an SSD work?

How do LCDs work?

What is a Wi-Fi module?

How do IC USB Controllers work?

How does a touchscreen work?

How does a CPU work?

How does a heatsink work?

How does a GPU work?

How does a touchpad work?

How does RAM work?

How does an inductor work?

How does a transistor work?

How does a capacitor work?.

How does an ODD work?

How does a resistor work?

How does an HDD work?

How do audio codecs work?

## Datasheets

STAC9205X5
9789AE
12NQ03L
8778E
SMSC ECE5028-NU
27C10LN
SMSC EMC4001-HZH
PI5C162861AE
FDS6679AZ
SIL1362ACLU
NH82801HBM
NXP LPC54S00J
W25R128JW
ALC1304M
MX25U163EZUI
916TA135H
TPS65987D
MP1026EF
QS34X2245Q3G
ANX2403
MP86901

## Figures & Diagrams

Fig. 1 – Surface Laptop Go Front View
Fig. 2 – Dell Latitude D830 Front View
Fig. 4- Dell Latitude Front View (2)
Fig. 5- Dell Latitude D830 Bottom
Fig. 6- Dell Latitude D830 Side/Back - Displaying ports
Fig. 7 - Dell Latitude D830 Architecture Diagram (Edited by 614A)
Fig. 41 & 80 - LCD Diagram (3D)
Fig. 47- Surface Laptop Go Side View
Fig. 48- Surface Laptop Go Top View
Fig. 49 - Surface Laptop Go Front View
Fig. 50 – Surface Laptop Go Architecture Diagram (Edited by 614A)

## Evolution

Evolution of PCBs

Evolution of Wi-Fi (1)

Evolution of Wi-Fi (2)

Evolution of ICs

Evolution of RAM

Evolution of Non-Volatile Memory

Evolution of Display Technology

# THANKS FOR READING!