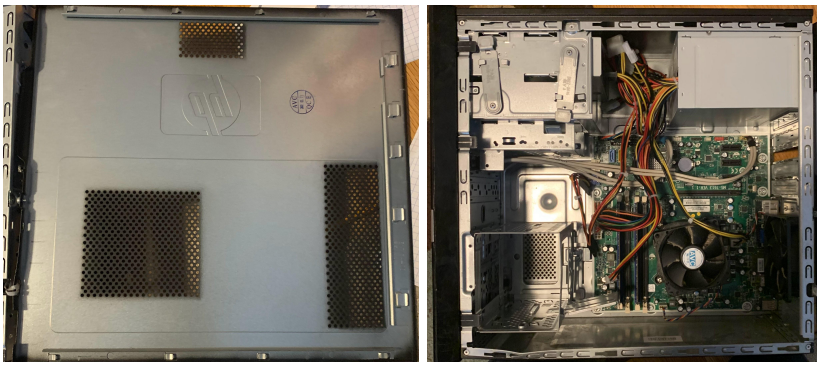

Reverse Engineering an HP Pro 3130 Minitower PC

By team 1715X (vorteX)
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All images and diagrams are original from team 1715X

1.0 Summary

PC's, or personal computers, are (by definition) computing devices for use by an individual, rather than requiring a team of engineers to operate. However if you look past the dictionary, PC's hold another meaning. The catalyst for the tech revolution. A public display of what technical developments like the internet, micro-transistors, compact data storage solutions, and dozens more could become. Computers have sparked innovation, skyrocketed sales and the global economy, modernized long distance communication, transformed education, and so much more. So let's take one apart.

The 2011 HP Pro 3130 Minitower PC is a fairly standard desktop, even today. This computer shipped with a hard disk drive, however it was previously stripped. The motherboard is the heart of the computer. It's what connects peripherals like the RAM, video card, hard drive, and more. The CPU, which performs many of the main functions of the PC is nested in the motherboard for quick access to data. The motherboard's main access point to other components are the PCI slots. PCI stands for Peripheral Component Interconnect and is the gateway to customize and future-proof the machine. In the power supply, many components such as transformers and voltage regulators help to make sure that components don't overheat. In the optical drive, the spindle, rail, and axle help the disk reader to perform its function. PCs are chock full of capabilities, which are discovered in this document.

Our team is always looking for a challenge. PC's contain a wide range of complex components. From the video card to the smallest resistor, each component plays a vital role in this system. This computer works just like our team, each component working together to do a different job, just as different teammates on our team work together to solve a problem.

Word Count: 294

2.0 Exterior Components and Architecture Diagram

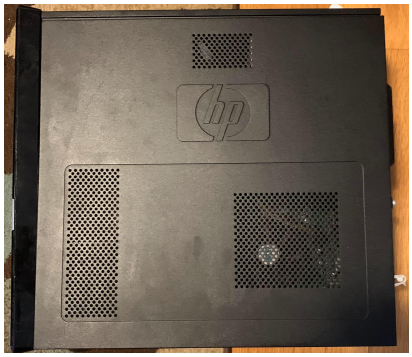


Figure 2.1 PC Lid

Figure 2.2 Front I/O Panel

Figure 2.3 Back Panel

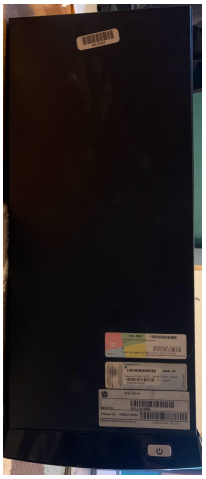


Figure 2.4 Side Panel

Figure 2.5 Side Panel

Figure 2.6 Quality Control Stamp

Figure 2.7 Power Supply Panel

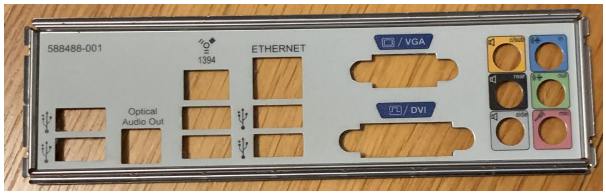


Figure 2.8 Back I/O Panel

Figure 2.9 Power Supply Warranty Stamp

Figure 2.10 Disk Drive Chassis

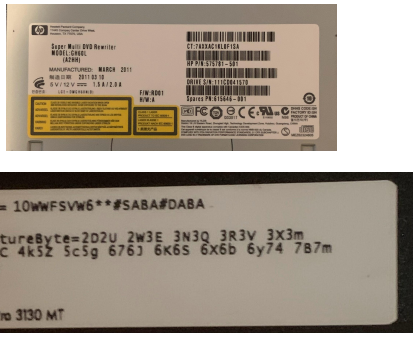


Figure 2.11 Optical Drive Serial Number

The diagram below represents how components are connected to each other.[1] Refer to Figure 2.13 for the locations of these components.

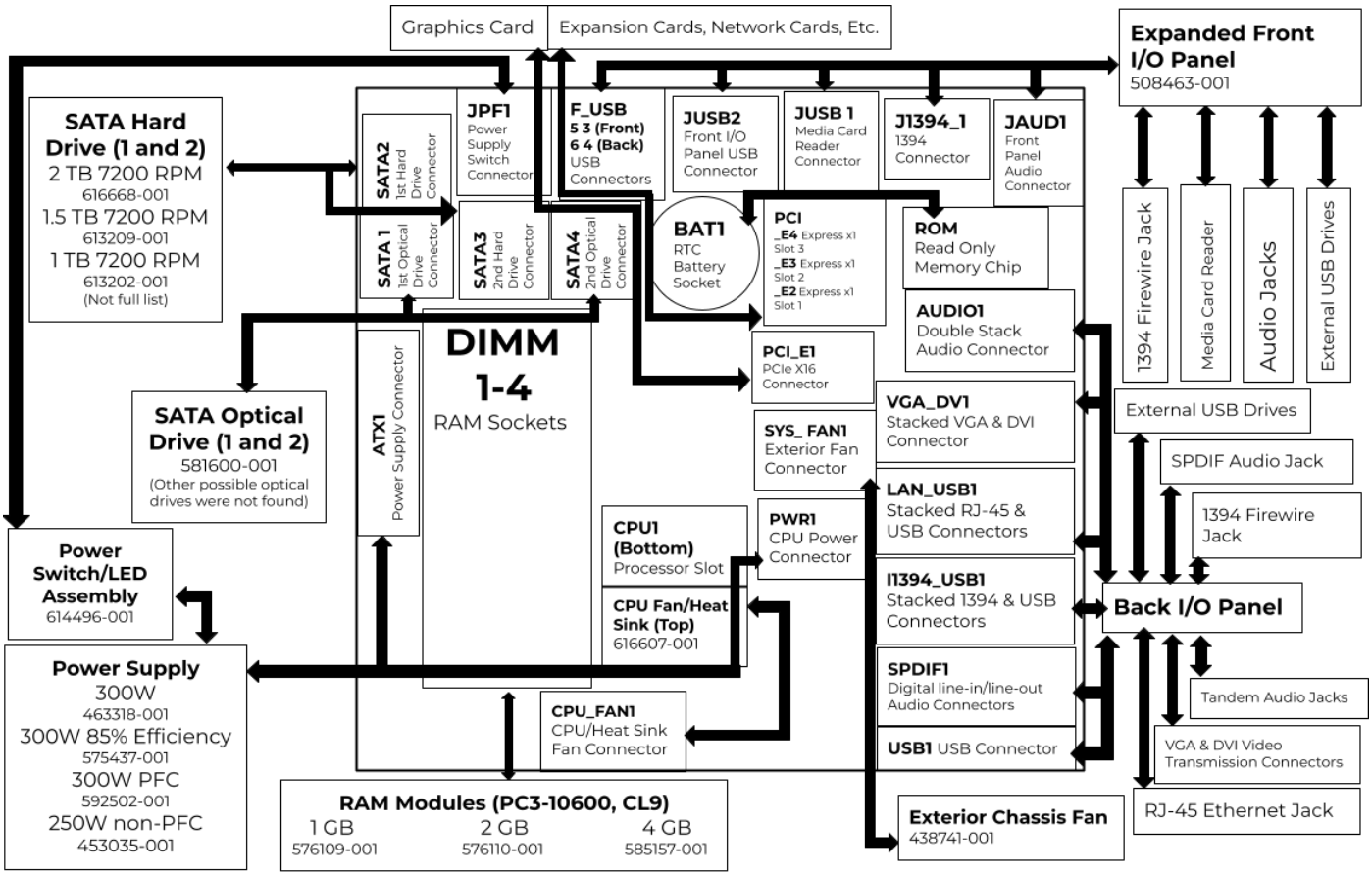


Figure 2.12 Architecture Flow Chart

This diagram shows the location of each port connection on the motherboard. Figure 2.12 (above) gives the description of each of these ports.

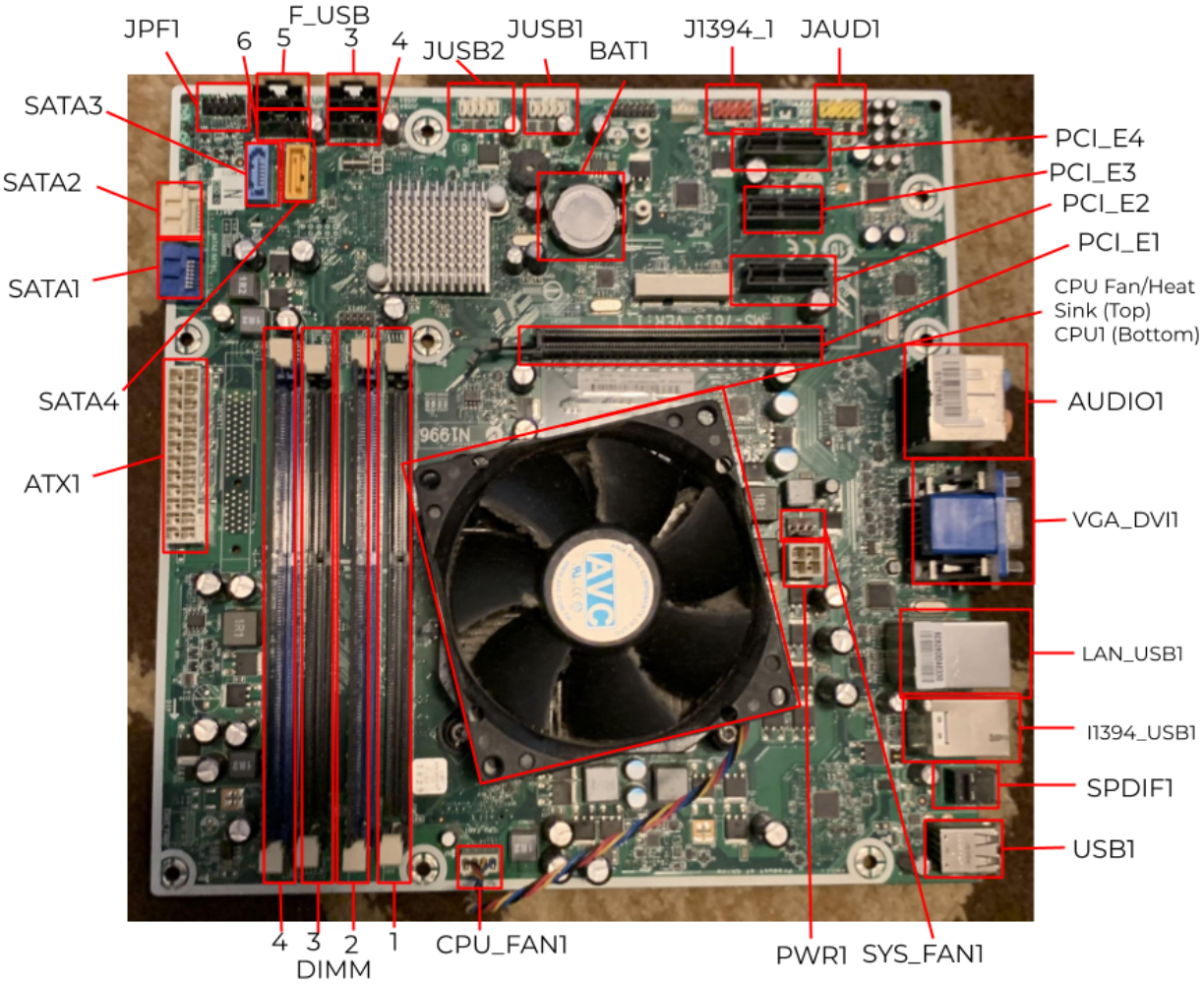


Figure 2.13 Port Locations

3.0 Decomposition Steps

3.1 Removing Components from the Frame

Note: While removing any screws, we used the Jakemy 43 Piece Screwdriver Kit

Step 1: Cut the zip tie attaching the lid to the PC, and slide off the lid

Step 2: Disconnect all wires connecting the power supply to the motherboard

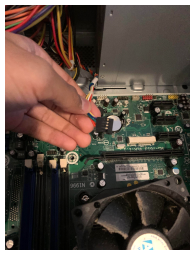


Figure 3.1.1 Detaching wires from power supply

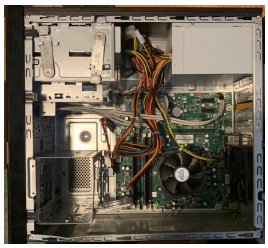


Figure 3.1.2 Opened up PC

Step 3: Using a T2 hex head screwdriver bit, unscrew the screws attaching the motherboard to the frame, and remove the motherboard.

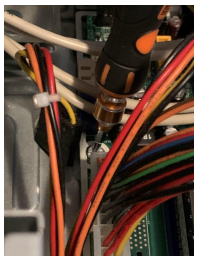


Figure 3.1.3 Unscrewing Screws Connecting the Motherboard

Step 4: Using a 2.5 standard bit, remove the screws attaching the power supply to the frame.

Figure 3.1.4 Detaching Screws Connecting Power Supply

Step 5: Push down on the lever connecting the power supply to the bottom of the frame. Slide out the power supply.

Figure 3.1.5 Lever Attaching Power Supply to Frame

Step 6: Detach the clips connecting the front cover to the frame, and take off the front cover.

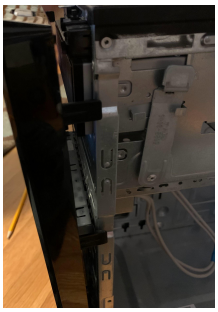


Figure 3.1.6 Clips Attaching Cover

Step 7: Lift and turn the levers connecting the optical drive to the frame. Slide the optical drive out.

Figure 3.1.7 Levers Attaching Optical Drive

Figure 3.1.8 Sliding out the Optical Drive

Step 8: Using a 2.5 standard bit, remove the screws attaching the front I/O panel to the frame, and remove the panel.

Figure 3.1.9 Removing the I/O Panel

Step 9: Using a 2.5 standard bit, remove the screws att1aching the exterior fan, and take out the fan.

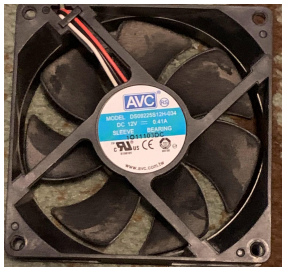


Figure 3.1.10 Exterior Fan

Figure 3.1.11 Empty Frame

3.2 Decomposition of Individual Sections

3.2.1 Motherboard Decomposition

Step 1: Using a T2 screw bit, remove the screws attaching the CPU fan and heat sink, and remove the fan and heat sink.

Figure 3.2.1.1 Removed Motherboard

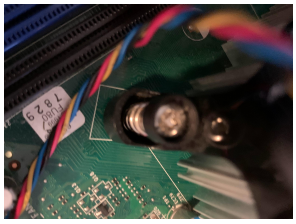


Figure 3.2.1.2 Removing Fan & Heat Sink

Step 2: Detach the clips attaching the CPU fan to the heat sink, and remove the fan.

Step 3: Using a ⬡3 screw bit, remove the screws attaching the CPU frame to the motherboard. Remove the CPU frame, rear frame, and CPU.

Figure 3.2.1.3 CPU Frame

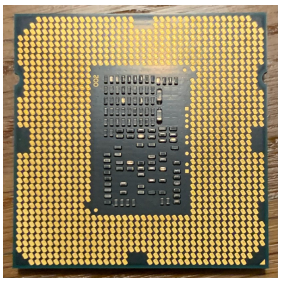


Figure 3.2.1.4 CPU

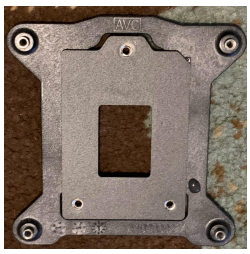


Figure 3.2.1.4 Rear CPU Frame

Step 4: Unclip the RAM from the DIMM slots.

Figure 3.2.1.6 RAM Slot Clips

3.2.2 Power Supply Decomposition

Step 1: Using a 2.5 standard screw bit, remove the screws forming the power supply frame.

Figure 3.2.2.1 Removing Power Supply Screws

Step 2: Using a 2.5 standard screw bit, remove the screws connecting the power supply fan to the power supply frame.

Step 3: Using a 2.5 standard screw bit, remove the screws attaching the heat sinks to the power supply circuit.

Note: On the middle screw of the 2nd heat sink, use pliers to hold the nut connecting the screw. This took some effort, but thanks to Edwin it was taken out.

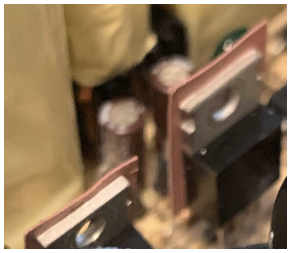


Figure 3.2.2.2 Heat Sink Screw Holes

3.2.3 Optical Drive Decomposition

Step 1: Using a 2.5 standard screw bit, remove the screws connecting the optical drive frame.

Step 2: Disconnect all wires connecting the circuits inside the drive.

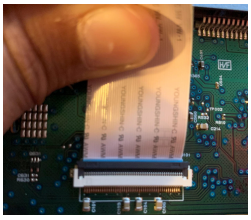


Figure 3.2.3.1 Disconnection of Optical Drive Wires

Step 3: Using a 2.5 standard screw bit, remove the screws attaching the spindle to the frame.

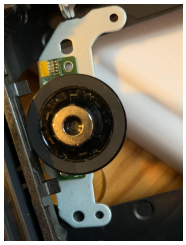


Figure 3.2.3.2 Removing Spindle

Step 5: Using a 2.5 standard screw bit, remove the screws attaching the rail to the frame. Then, remove the axle and disc reader.

Figure 3.2.3.3 Removing Rail

Step 6: Detach the silicon connectors attaching the drive interior frame to the exterior frame. Then, using a 2.5 standard bit, remove the screws attaching the metal piece on the interior frame and remove it.

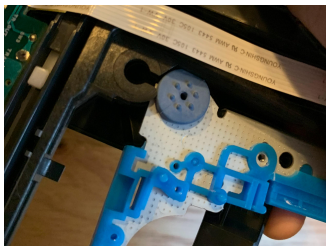


Figure 3.2.3.4 Detaching Silicon Connectors

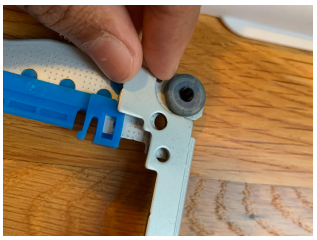


Figure 3.2.3.5 Removing Metal Piece

Step 7: Detach the connectors attaching the front frame to the exterior frame, and slide it outward.

Step 8: Remove the gear that is controlling the drive opening motion.

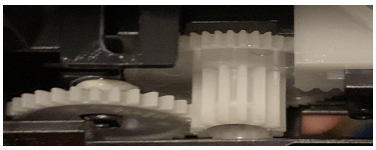


Figure 3.2.3.6 Optical Drive Gears

4.0 Analysis of the Components

Identifying components is a key part of reverse engineering. Through some research, we learned that circuit components are numbered with 2 numbering systems: block numbering and unit numbering.[2]

On a circuit board, many components are labeled with 1-2 letters next to it, and a number. We learned that the letters are called reference designators, which define what the component is and its location.[3] This is used with both block and unit numbering systems.

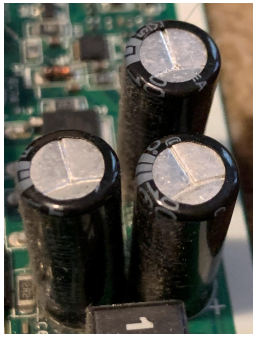
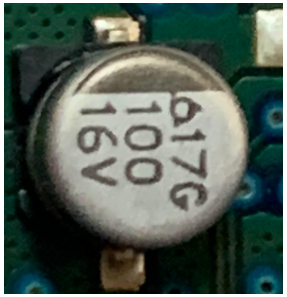
While comparing circuits, we were able to define that the numbers mean either 1 of 2 things depending on the manufacturer's system choice:

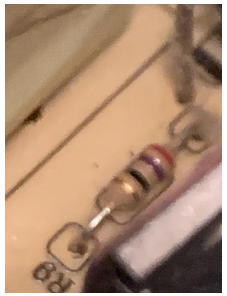
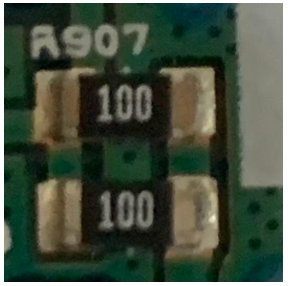
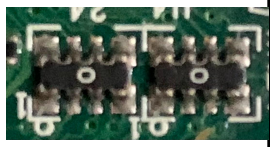
- **Block Numbering:** Components of each type are numbered consecutively, determining how many of that type of component there are
  Example: Transistors (Q) are labeled from Q1-Q78
- **Unit Numbering:** The total number of components in a specific region of function are numbered with the region's number as its first digit
  Example: Region 3 has components labeled with 3 as their first digit (R301, C302, C303, etc)

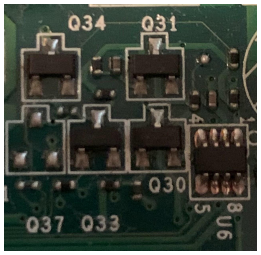
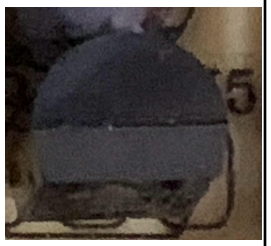
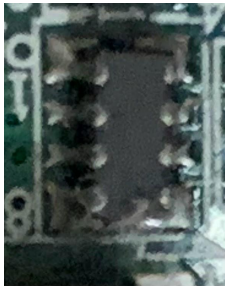
4.1 Shared Components

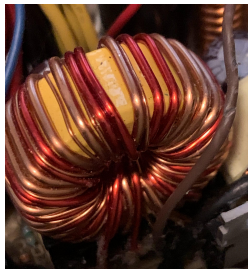
This section will cover components that are common among multiple of the circuit boards. Most of these components are commonly found on most types of circuits.

Note: All of these components have multiple types that are not listed in the images section.

Name of Component & Quantity from Each Circuit	Motherboard Component	Power Supply Component	Optical Drive Component	Description
Capacitors Motherboard: 60 Power Supply: 38 Optical Drive: 68				The main purpose of a capacitor is to store energy. On one side of the capacitor, positive energy is stored, while on the other, negative energy is stored. The two sides of stored energy form an energy field, which allows the energy to pass from one side of the capacitor to the other when

				the circuit is on.
Resistors[9] Motherboard: 20 Power Source: 76 Optical Drive: 47				Resistors are used to restrict the electrical current. They stop the current from producing too much heat, which would overheat the rest of the circuit board. Resistors are color coded based on their tolerance, or how much heat they can handle.
RC Networks[9] Motherboard: 22 Optical Drive: 5		N/A		RC networks, also known as resistor or capacitor networks, divide voltages provided resistors into smaller amounts. Then, they distribute the voltage throughout the circuit.

Transistors Motherboard: 78 Power Source: 3 Optical Drive: 2				Transistors amplify the strength of the current. They also can turn the electric current on and off. They do this by shorting the circuit.
Inductors[7] Motherboard: 11 Power Supply: 9			N/A	Inductors are electromagnets, as they transform electrical energy into magnetic energy. Using a coiled conductor, the electrical energy that is passing through generates a magnetic field.
Diodes Motherboard: 35 Power Supply: 24 Optical Drive: N/A			N/A	Diodes restrict the direction of the current, allowing it to only flow in one direction. When the current is flowing forward, it is forward-biased, while when it is reverse, it is reverse-biased.

Choke Inductors[7] Motherboard: 12 Power Sup ply: 2			N/A	Choke inductors, often referred to as chokes, cut off high frequency currents, while allowing direct currents to pass through. They also protect the circuit's insulators from steep rises in currents by breaking down voltage.

4.2 Motherboard Components (Block Numbered)

4.2.1 Motherboard Diagram

Note: This diagram doesn't show all component listings, due to space limitations. For a full list of location descriptions, see section 4.2.3.

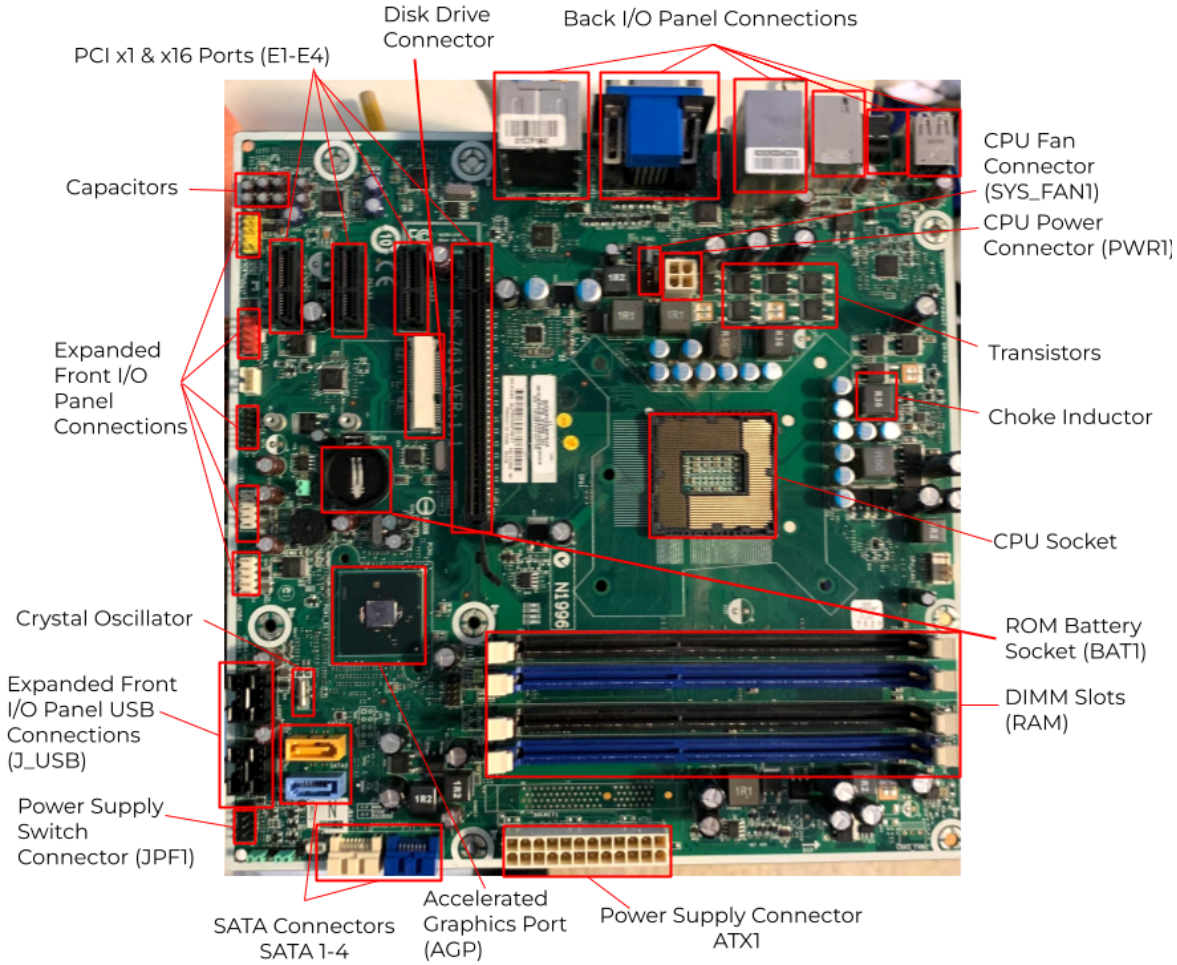


Figure 4.2.1.1 Motherboard Diagram

4.2.2 Percentage of Components on Motherboard

Note: The quantities of components are not perfectly accurate

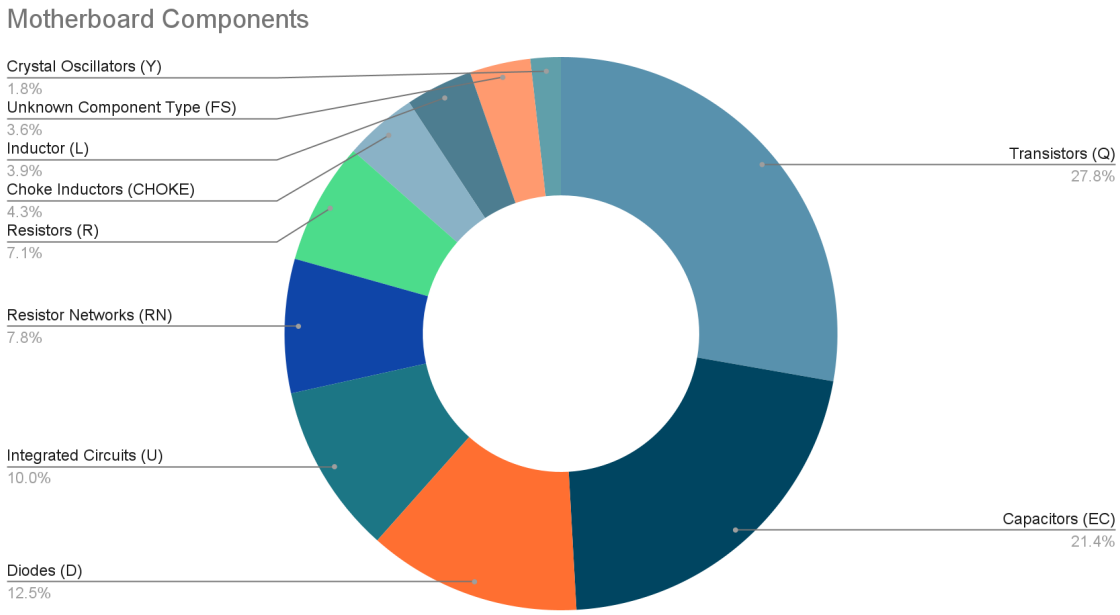
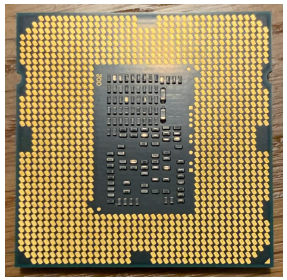
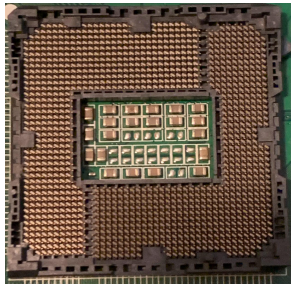
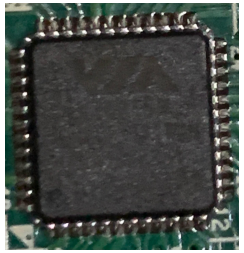
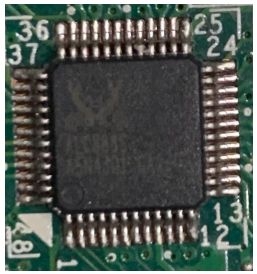
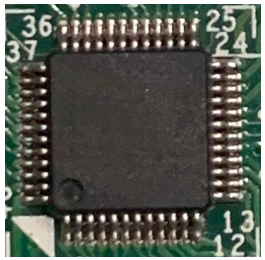


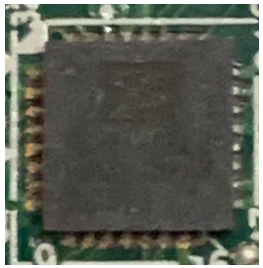
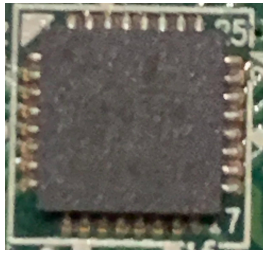
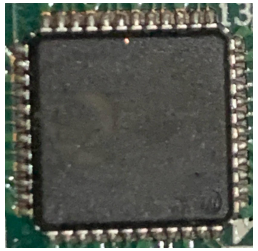
Figure 4.2.2.1 Motherboard Component Percentages Diagram

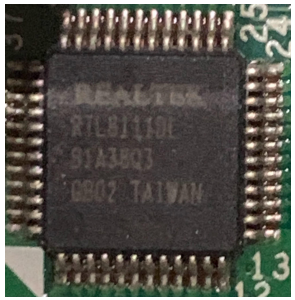
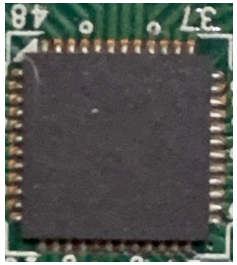
4.2.3 Description of Motherboard Components

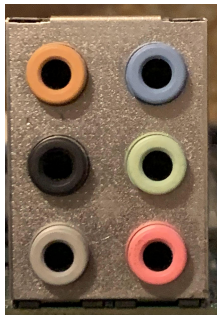
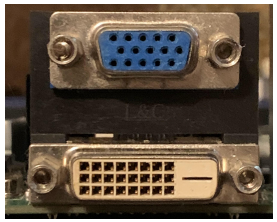
Name of Component	*Image*	*Description*
CPU (Central Processing Unit)[4]		The CPU performs all the instructions that are in a computer program. CPUs have many principal components, including the ALU, which performs arithmetic and logic functions, and CPU cores, which read and execute commands. The specific CPU model in the PC has an integrated GPU, or graphics processing unit. GPUs are used in Graphics, Video Rendering and many other applications.
CPU Socket[5]		CPU sockets connect the CPU to the motherboard without soldering it directly through a series of pins. The pins are the small brown dots in the image to the left.

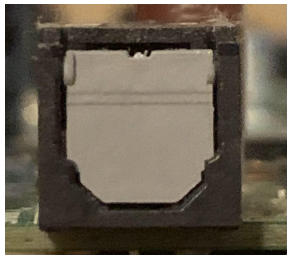
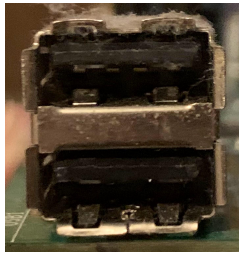
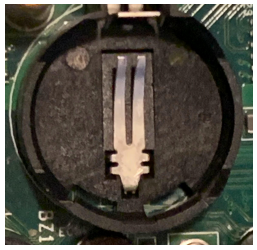
AGP (Accelerated Graphics Processing)[6] BOB2H5SLGZLJ8 39C269		AGP is an integrated graphics card. There are two types of graphics cards: ones that can be connected to PCI x16 slots, and AGP. While PCI slots don't just host graphics cards, AGP is dedicated only to graphics. This also means that it has faster speeds than a PCI slot graphics card.
Crystal Oscillators[8] Quantity: 5		Crystal Oscillators are small wafers or slices of cut quartz. Electricity is passed through them, causing the piezo-electric effect, warping the quartz. The piezo-electric effect is when electrical energy converts into mechanical energy, vice versa.
VIA 1394 Connector Control Microchip[10] VT6315N		This microchip controls the processing of data that is transferred by the 1394 connector, allowing for higher speeds.

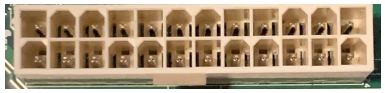
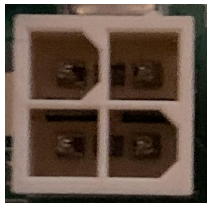
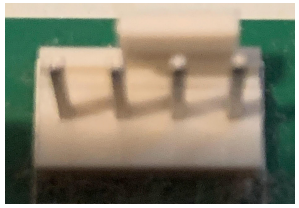
Realtek SPDIF Connector Control Microchip[11] ALC888S		This microchip controls the process of converting audio from the SPDIF. It allows for the consumer to be able to listen to the audio as well.
Fintek Keyboard & Mouse Control Microchip[12] F71858DG		This microchip allows the consumer to connect and use a keyboard or mouse through one of the USB ports.

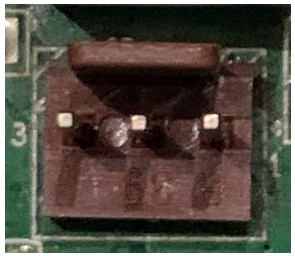
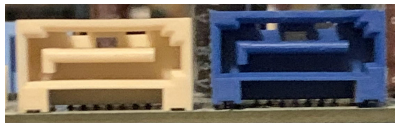
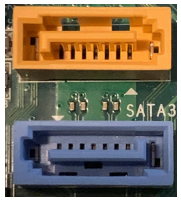
Silicon Laboratories Clock Control Microchip[13] SL28748		This microchip controls the real time built in digital clock, which tracks the passage of time.
Renesas Voltage Management Microchip[14] ISL6314		This microchip controls voltage regulation among other microprocessors. It also provides voltage sensing of other microprocessors.
Pericom HDMI Control Microchip[15] P13VDP		This microchip allows consumers to be able to connect an HDMI monitor to the PC.

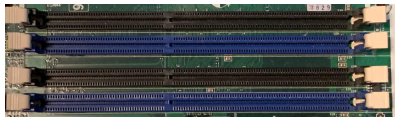
Realtek Ethernet Control Connector Microchip[16] RTL8111DL		This microchip allows for ethernet cables to be able to transmit data swiftly through the machine.
Renesas Voltage Regulation Microchip[17] ISL6333		This microchip has a similar function to ISL6314, which regulates the voltage of other microprocessors. The difference is this one has an integrated MOSFET system, which is able to amplify the voltage.

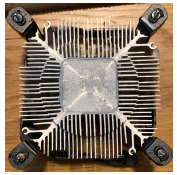
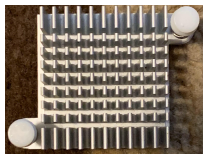
Audio Connector (AUDIO1)[18]		Each colored port represents which system they support: - Blue is for inputting audio into the PC - Green is for headphones, or any device you can listen to audio through - Pink is for microphones - Orange is for subwoofers, or center speakers - Black is for rear speakers - Gray is for side speakers
VGA/DVI Connector (VGA_DVI1)[19]		VGA (video graphics array) connectors transmit red, blue, and green lengths through each row of the connector to display visuals on a screen. While VGA can only transmit analog signals, DVI (digital visual interface) can transmit both analog and digital signals.
LAN and I1394 Connectors (LAN_USB1 & I1394_USB1)		LAN (Local Area Networks) connect ethernet cables, which can connect to other devices connected to the internet. I1394 ports connect firewires, which connect other devices that transmit data, like hard drives.

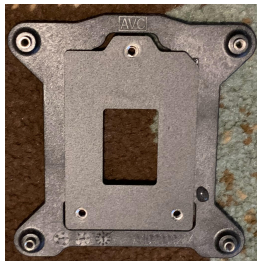
SPDIF Connector (SPDIF1)[20]		SPDIF (Sony Philips Digital Interface) connectors transmit audio over short distances. It can also connect blu-ray, DVD players, or other computers through a TOSLINK connector.
USB Connectors (USB1)		USB (Universal Serial Bus) connectors can connect any device that has a USB-A connector. These ports are normally taken up by mice and keyboards.
ROM Battery Socket (BAT1)		This battery socket fits a CR 2032 battery. It is used to power the ROM, or Read-Only Memory chip. ROM is used to store data, and holds firmware updates for when the PC needs them.

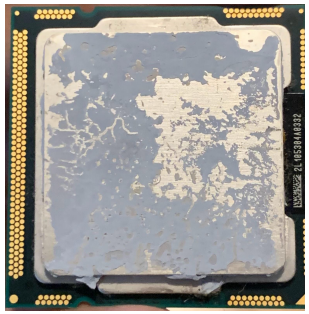
Power Supply Connector (ATX1)		This connects the power supply to the motherboard. Power is connected through the wires and is transferred here.
CPU Power Connector (PWR1)		This connector brings additional power to the CPU.
CPU Fan Connector (CPU_FAN1)		This connector brings power to the CPU fan.

Exterior Fan Connector (SYS_FAN1)		This connector brings power to the exterior fan (the exterior fan is only connected to the motherboard through this connector).
SATA Connectors (SATA 1-4)	 	SATA connectors connect hard drives and optical drives. SATAs 2 and 3 connect hard drives, and SATAs 1 and 4 connect optical drives.
Power Supply Switch Connector (JPF1)		This connector connects the power supply on/off switch to the motherboard.

Expanded Front I/O Panel Connections	See Figure 2.13 for these images	Each front I/O panel push pin connector has a different purpose: F_USB 1-4: USB connectors J_USB2: Connects the front I/O panel to the motherboard JUSB1: Connects a media card reader to the PC J1394_1: Connects a 1394 firewire connector JAUD1: Connects an audio connector
RAM Slots (DIMM 1-4)[21]		This is where RAM is connected to the motherboard. Motherboards have from 1 to 8 slots, but most mainstream motherboards have 4 slots.
PCI Slots (PCI_E1-4)		PCI slots are able to host exterior cards, including sound cards, data extensions, and cards that are able to host more PCI slots. Graphics cards can also be connected, but only in x1 and x16 slots. PCI slots come in different sizes ranging from x1-x16.
Disk Drive Connector		This connector connects the hard drive to the motherboard. While SATA connectors transmit data, disk drive connectors bring power to the hard drive.

RAM (Random Access Memory)[22]		RAM memory stores data before it is processed. It is made of multiple RAM memory chips. If the PC is shut down, all the data that is stored here will be erased.
Hynix RAM Memory Chip[23] H5TQ2G83BFA		This memory chip performs all the main functions of the RAM. It can store a large amount of data, and has a high bandwidth.
Heat Sinks[24]	 	Heat sinks keep components from overheating. They allow heat that is created by the component of cooling flow through the fins. The CPU heat sink (left image) also has a fan on top to blow the heat away. The AGP heat sink (right image) is just fins.

CPU Frame		This frame sits under the CPU heat sink. It holds the CPU in place, so it doesn't come out of the CPU socket.
CPU Rear Frame		The CPU rear frame connects the CPU front frame to the back of the motherboard.

Thermal Paste		Thermal paste is an added cooling component before hardware, like heat sinks, are connected. It also helps transfer heat from the component to its cooling hardware mechanism. Without thermal paste, the PC will overheat and fail.

4.3 Power Supply Components (Block Numbered)

4.3.1 Power Supply Diagram

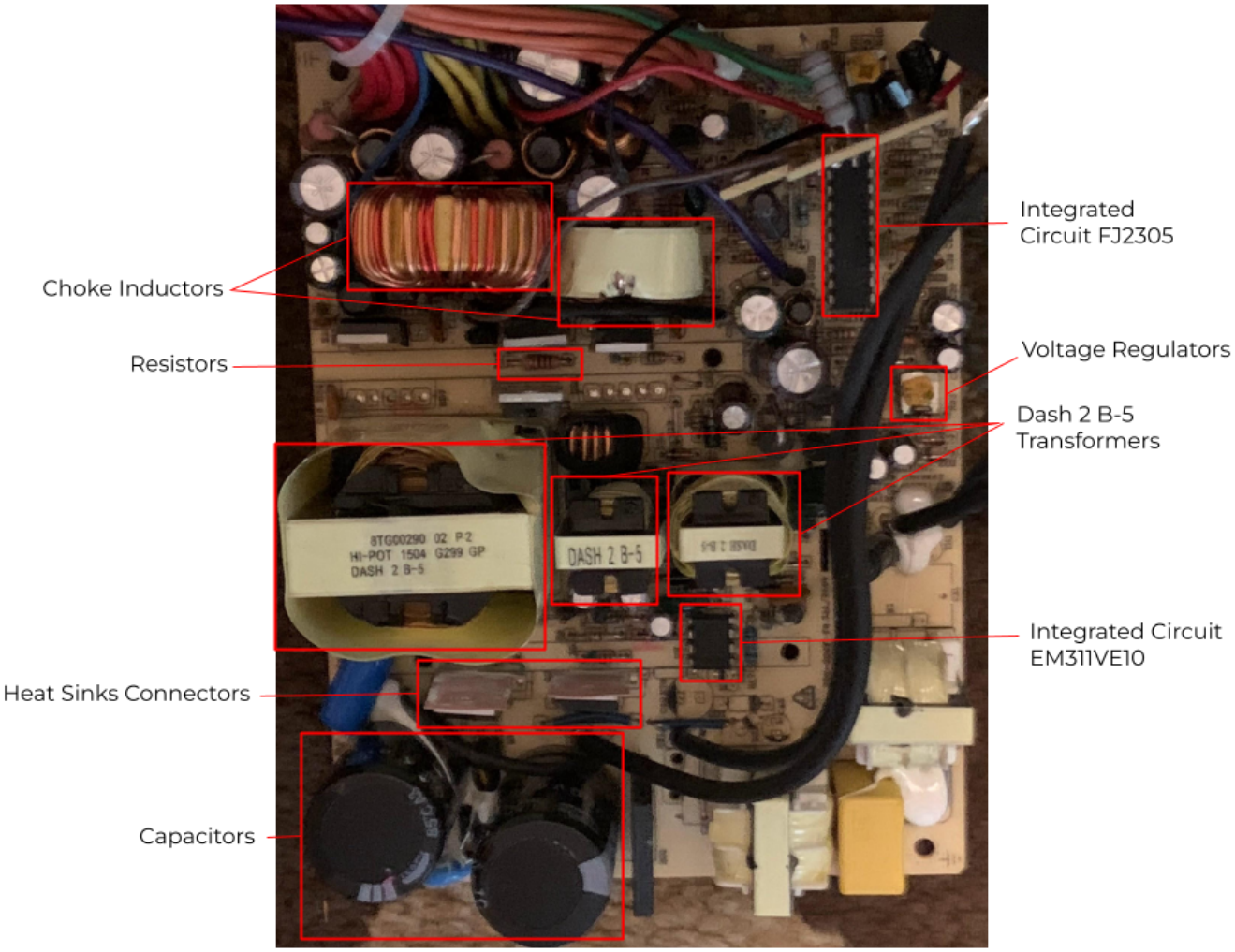


Figure 4.3.1.1 Power Supply Diagram

4.3.2 Percentages of Components on Power Supply Circuit

Note: The quantities of components are not perfectly accurate

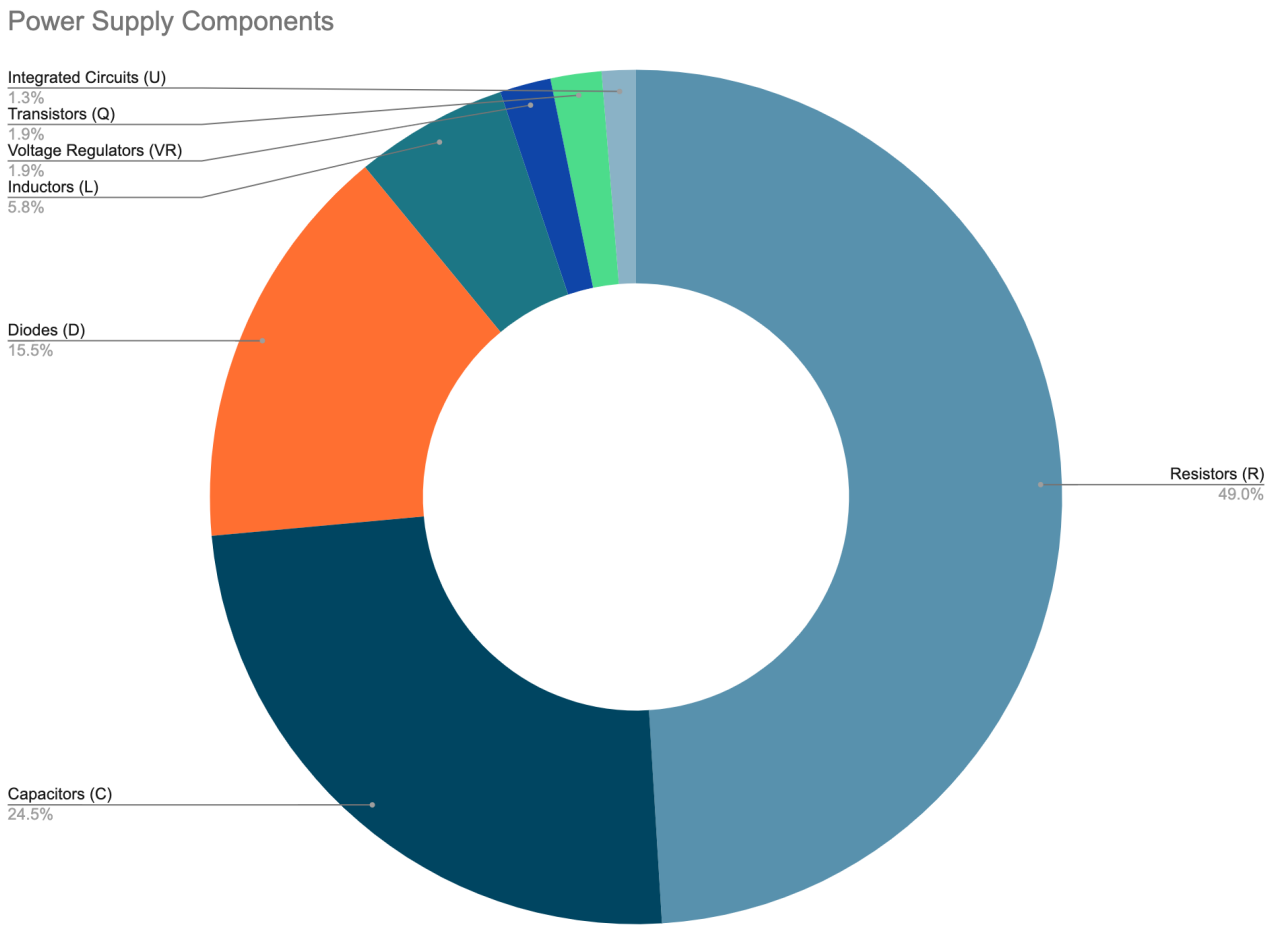
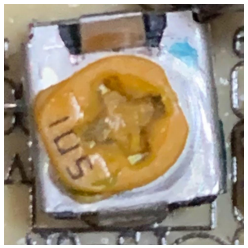
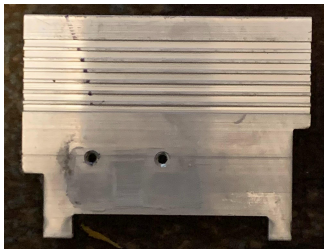


Figure 4.3.2.1 Power Supply Component Percentages Diagram

4.3.3 Description of Power Supply Components

Name of Component	*Image*	*Description*
Dash 2 B-5 Transformers[25] Quantity: 3	 	Transformers are used to increase voltage, when supplying power over long distances, and to decrease power in low voltage devices.
Voltage Regulators[26] Quantity: 3		Voltage regulators control the flow of the current. Higher input voltage is converted into lower output voltage, so other components in the power supply don't receive overt amounts of electricity. They also protect components from power surges.

Heat Sinks[24] Quantity: 2		See description in Heat Sinks, Section 4.2.3
Heat Sink Connectors Quantity: 6		These connectors connect the heat sinks that protect the transformers to the circuit.
Power Supply Switch		This switch cuts electricity being provided to the power supply. It is powered through JPF1.

4.4 Optical Drive Components (Unit Numbered)

4.4.1 Optical Drive Diagram

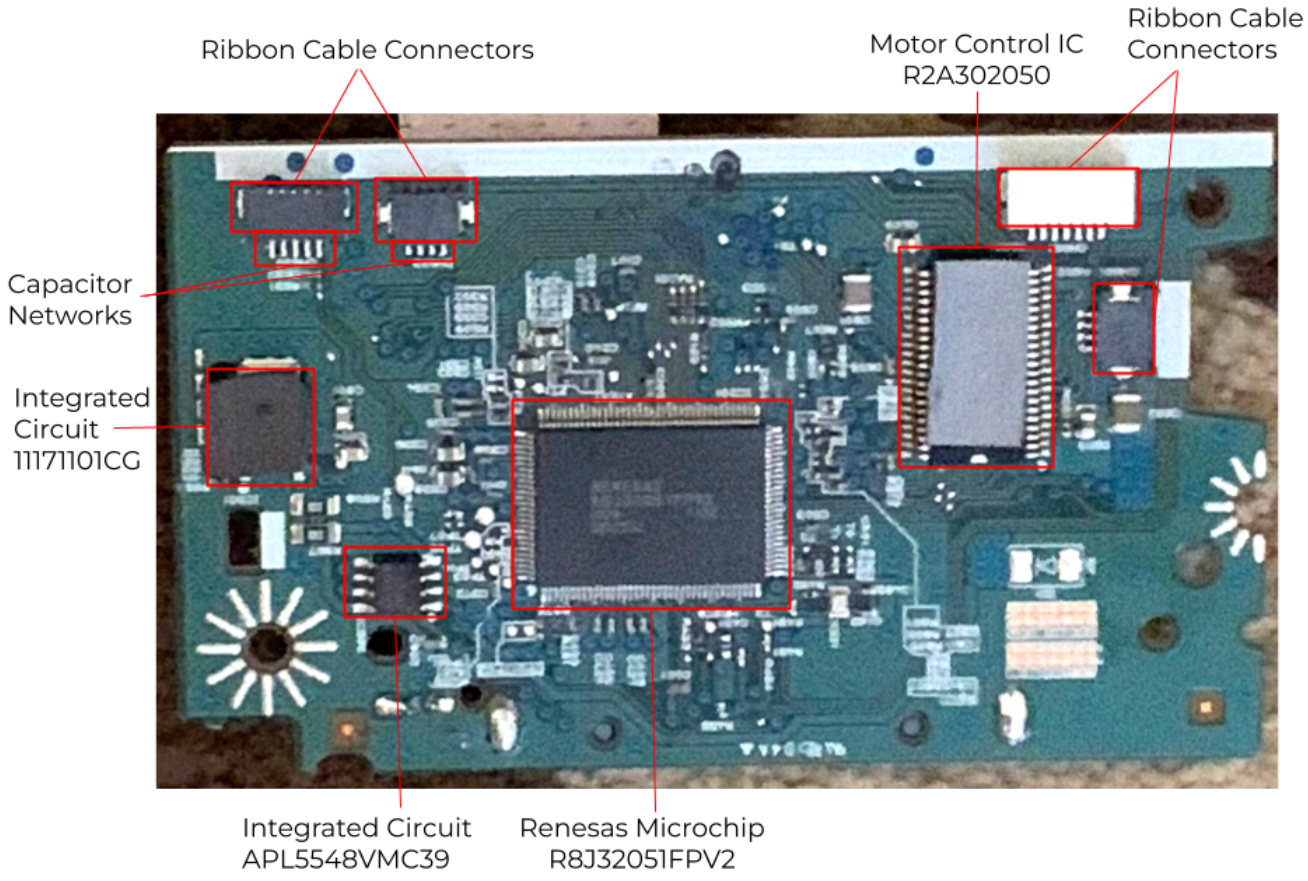


Figure 4.4.1.1 Front Side of Optical Drive Circuit

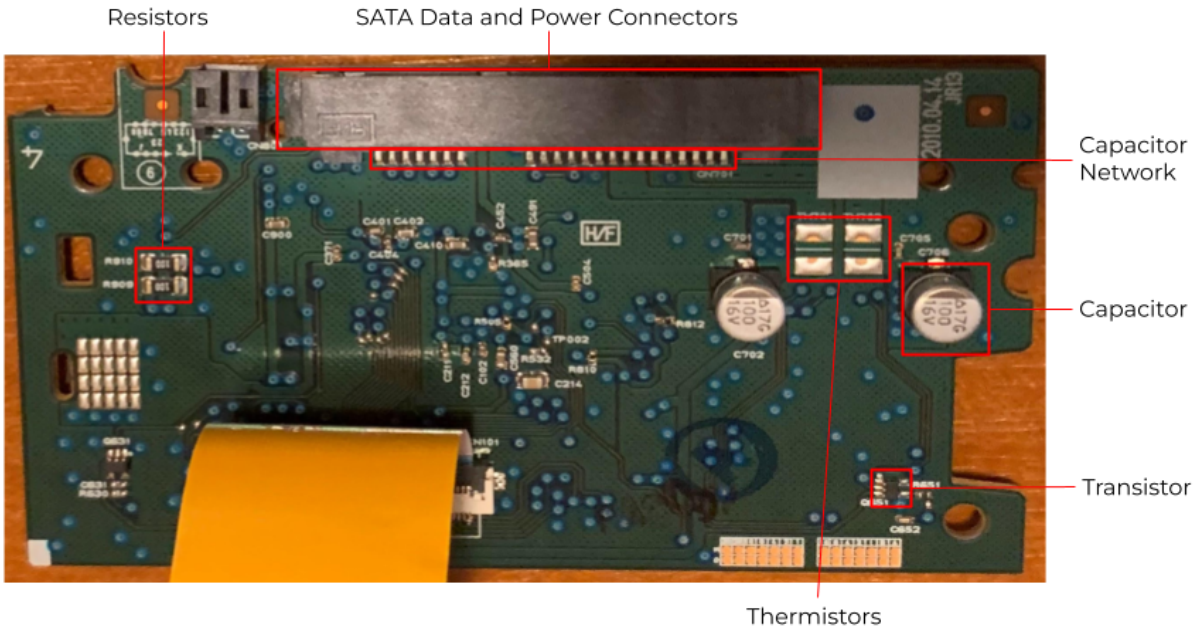


Figure 4.4.1.2 Back Side of Optical Drive Circuit

4.4.2 Percentages of Components on Optical Drive Circuits

Note: The quantities of components are not perfectly accurate

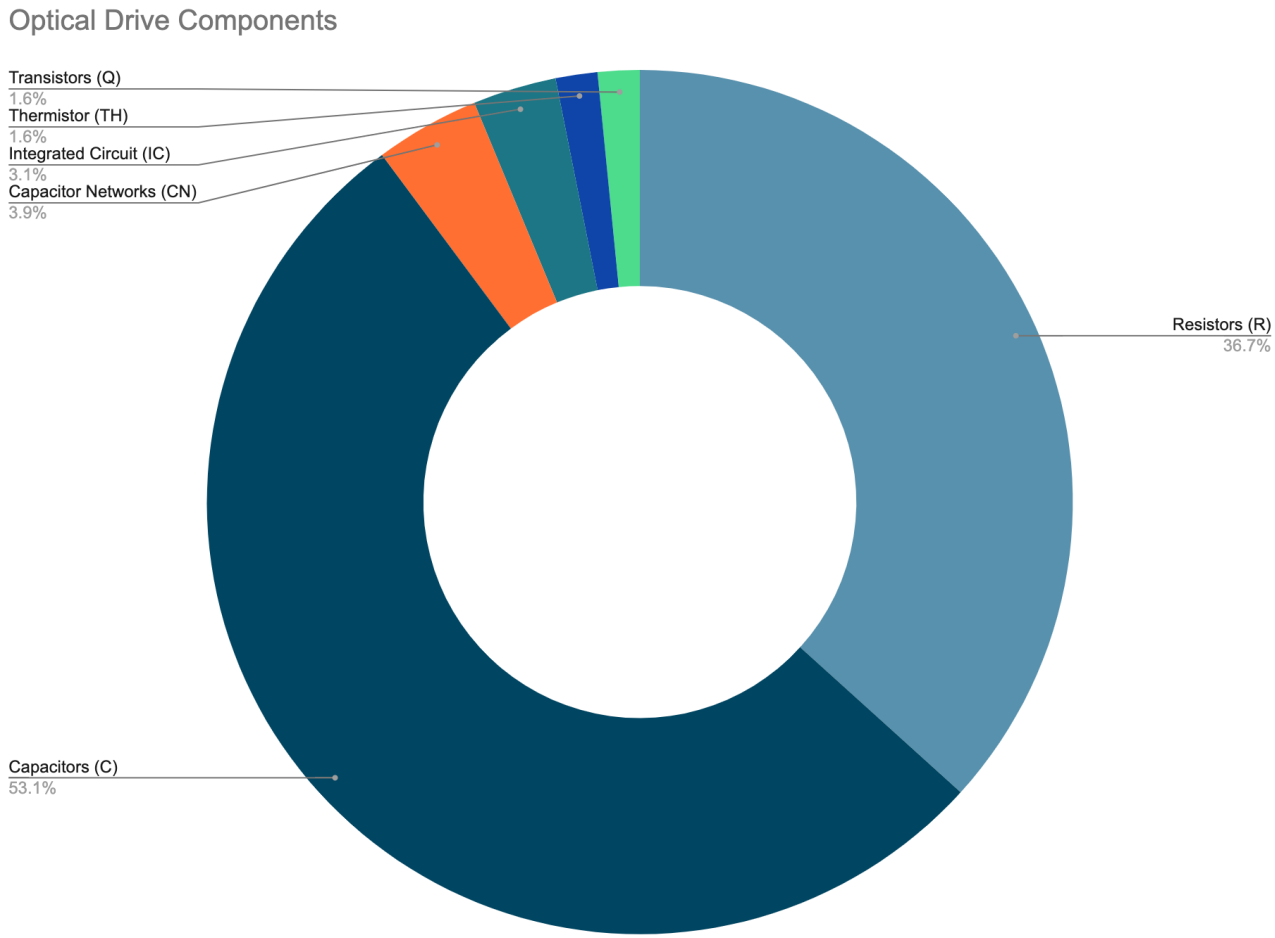
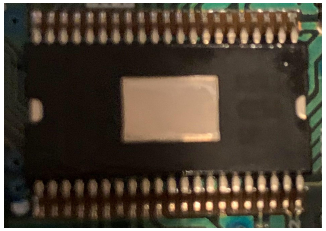
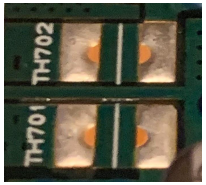
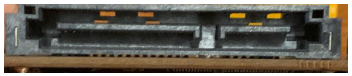
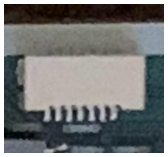
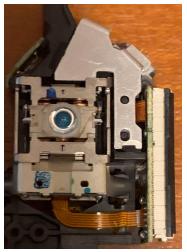
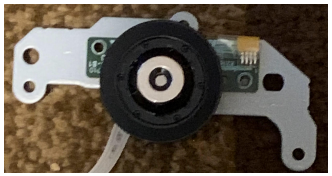
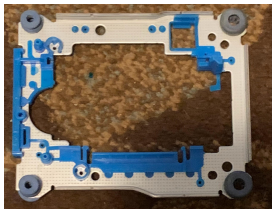
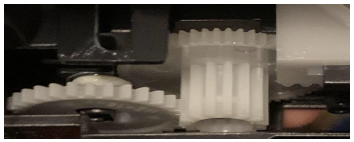


Figure 4.4.2.1 Optical Drive Component Percentages Diagram

4.4.3 Description of Optical Drive Components

Name of Component	*Image*	*Description*
Renesas Drive Control Microchip R8J32051FPV2		This microchip performs the main functions of the optical drive.
Motor Control IC[27] R2A302050		Motor control controls motors on a circuit, including their speed and direction. In the case of this optical drive, the motor control controls the motor for the rail.
Thermistors[28] Quantity: 2		Thermistors measure the temperature of the circuit. They also measure the temperature of the environment.

SATA Power and Data Connectors		This connector connects SATA connectors. The larger one on the left provides power from the power supply, while the right one connects to an external hard drive.
Ribbon Cable Connectors		Ribbon cable connectors provide a pin connection to connect ribbon cables to.
Ribbon Cables[29]		Ribbon cables are flexible wires that are often used in computers. They are used often when space is limited, and when fast processing is required. They sometimes are color coded to define what each individual wire in the ribbon connects to.
Disk Reader[30]		The disk reader is what reads a CD or DVD. The circle in the center of the reader is the plastic housing for the laser lens. Two copper coils are located next to the laser, which creates a magnetic field, stopping the laser before it burns through the CD or DVD.

Spindle		The spindle rotates the disk, so the disk reader can read the entire disk. A ribbon cable connects to the main circuit, which provides power.
Rail		The rail is what helps the disk reader to move back and forth. It is connected to a motor, the small metal part on the end of it (left side of image).
Axle		The axle is what the disk reader moves back and forth on.
Optical Drive Interior Frame		The interior frame provides a base for all of the main components, including the spindle and rail, to sit on top of.
Gears		Gears in the drive control the opening and closing of the DVD compartment.

4.5 Miscellaneous Parts Descriptions

Name of Component	*Image*	*Description*
Front I/O Panel		The front I/O Panel is connected to the front faceplate, and allows for audio connectors, and USB connectors.
Fan Quantity: 3		Fans cool the systems down, so components don't overheat. 3 are located in the computer, one in the power supply, one on the motherboard (CPU fan) and one on the frame.
Optical Drive Lever		These levers allow the optical drive to be taken out. When both levers are moved to the right, the optical drive can be removed.

5.0 Conclusion

Learning is an important part of being an engineer. People must be innovative, but to do this, we must take inspiration from existing devices to continue to create more advanced devices. For example we can use reference designators (see section 4.0) to label circuits. We can improve the system in the future, but we first had to have this label system idea.

Another thing that can be learned is that these devices use many voltage reducing components. In the future, engineers can come up with a solution to use less of these components, so there is more space on the circuit for other components. Some of these innovations have already been made, but it can be advanced even further.

The most important thing we learned is that learning is the basis on which we will advance forward in our careers, and that engineering is a path that may be our future.

Word Count: 146

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