

Disassembly Of a PS2 - Reverse Engineering Online Challenge
2022-2023



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1.0

Summary Report

The PS2 was released on 4th March 2000, nearly 23 years ago but it is still the most-sold gaming console of all time. An estimated 159 million units were sold and 3,874 games were released for it. This was a surprise to us so we chose to disassemble the PS2 to see what made it so popular. We chose the theme of a gaming console because video games are a passion of many teenagers and consoles are very interesting pieces of technology. With just electricity, video game consoles can transport gamers into a new world and provide hours of entertainment.

Our journey starts at the AC port where electricity first enters the PS2. This electricity is then distributed throughout the PS2. The I/O system reads the inputs of the controllers and hard drives, connects to the internet and the bios ROM, reads the DVDs, and sends sound out of the PS2 into our ears. The I/O System is connected to a system interface that links the inputs, ethernet ports, and the audio system to the rest of the PS2.

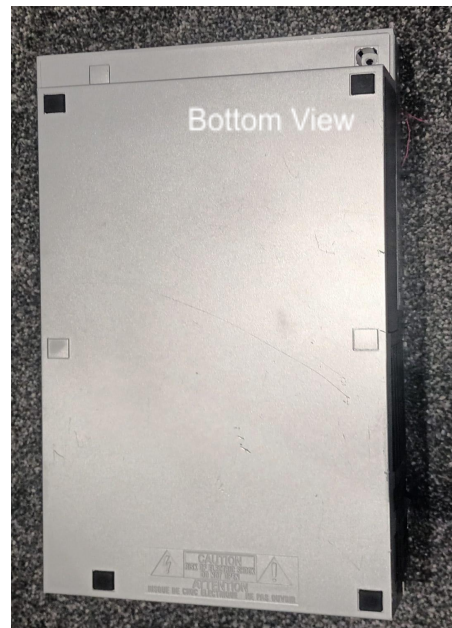
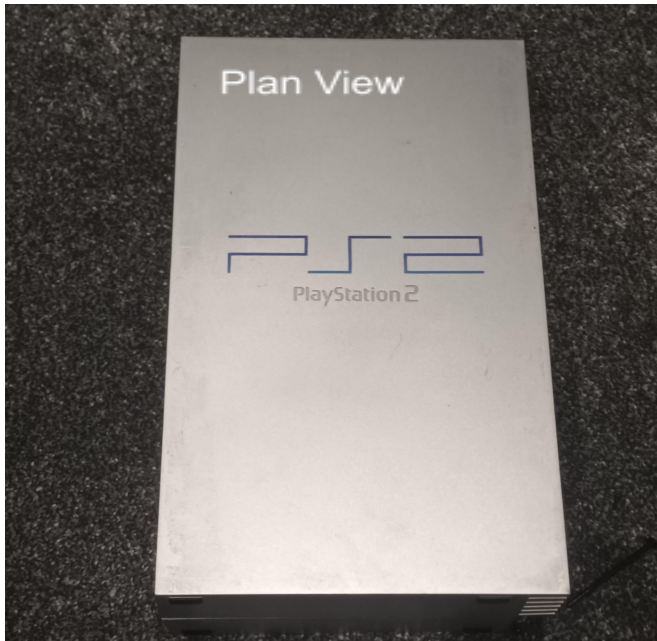
The CPU is directly connected to the RAM and the storage, the FPU, which does all the maths and the graphical processing system, which sends instructions to the pixels of the TV screen. This enables consumers to play games.

Disassembling the PS2 was a very interesting and valuable experience. We learnt and improved many vital skills. The PS2 has a number of thin wires so during the disassembly process we had to be cautious and precise.

The PS2 we disassembled was a model "39001" however, the one in the guide we were following was a model "50003". As a result of this, we had a problem once we lifted the case as we could no longer follow the guide. Both of the PS2 models had different motherboards so they were built differently. While this was a challenge, we are very grateful for it as we were able to disassemble the PS2 freely, rather than following a set of instructions. This is very beneficial for both VEX and our future careers because as Herman Melvill once said, "It is better to fail in originality than to succeed in imitation." In VEX, we design our robot by being imaginative and not following a set of instructions so this experience was beneficial in that aspect.

This experience also increased our knowledge about the world of consumer electronics. We learnt how global-level technology looks and works, and gained a lot of valuable experience. For example, we were able to see how professional soldering is done, we learnt how important resistors are, how a DVD reader works, and much, much more.
(445 words)

The Casing of the PS2



3.0

Guide on how to disassemble a PS2

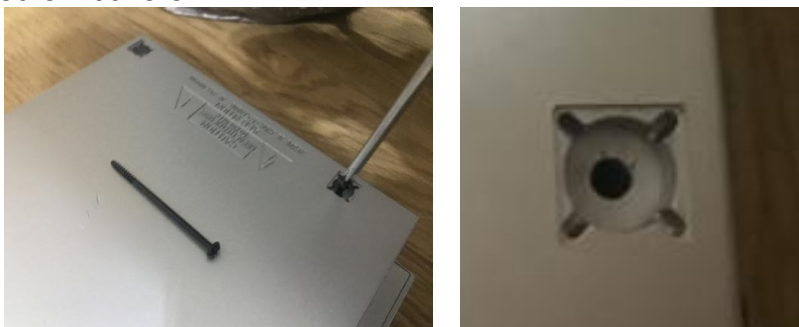
- 1) Wear a pair of safety goggles. Make sure the PS2 has no power running through and all cables are unplugged.
- 2) Remove the plastic cover which is covering the hard drive expansion bay.



- 3) Using your fingers or a flathead screwdriver to remove the rubber feet and the plastic screw covers on the bottom of the PS2.



- 4) Unscrew the screws which were underneath the rubber legs and the plastic screw covers.



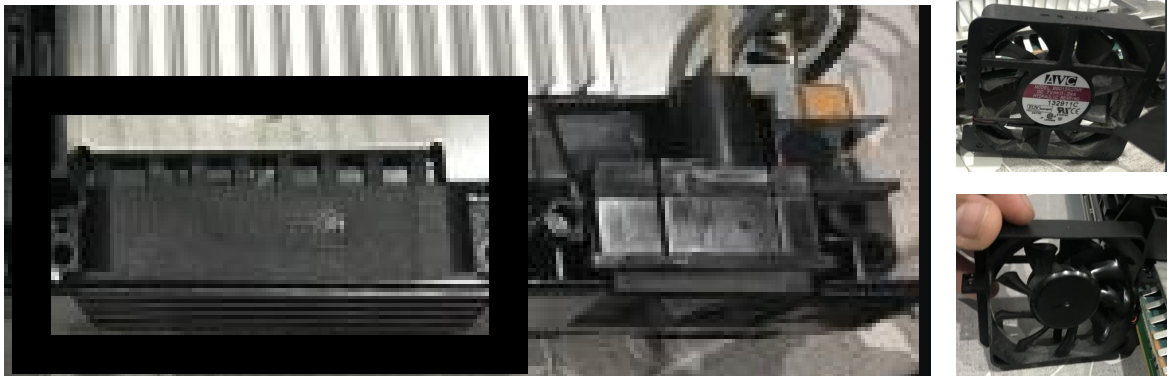
5) Once all eight screws are removed, lift the top cover.



6) Then remove the bottom cover of the PS2.



7) Unscrew the fan and AC port bracket and remove the fan by sliding it up.



8) Then remove the AC port and switch from the bracket by pushing it up.

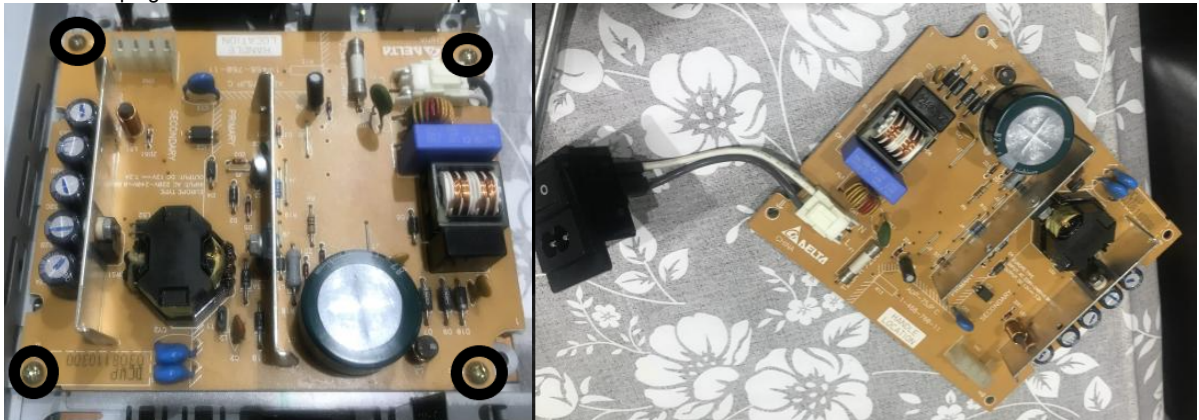


9) Using a screwdriver, unscrew and remove the top of the DVD reader.

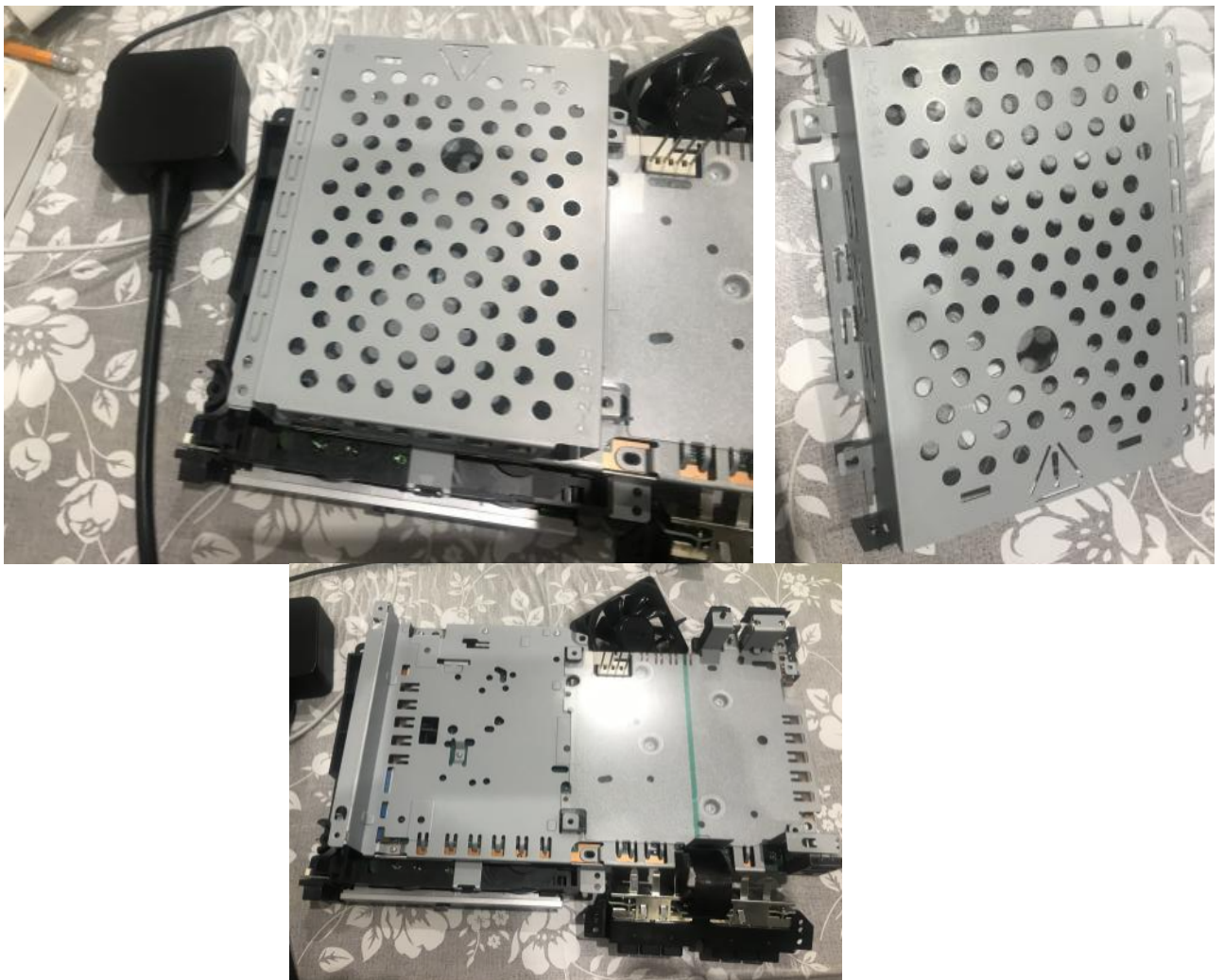


10) Unscrew the four screws highlighted below and lift the powerboard off the motherboard.

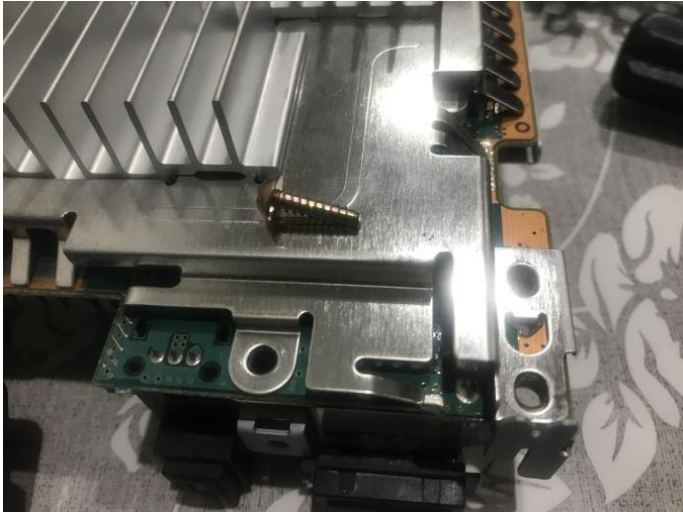
Note: The AC port is connected to the powerboard so when lifting the powerboard off the motherboard it is better to unplug the cable connected to the AC port.



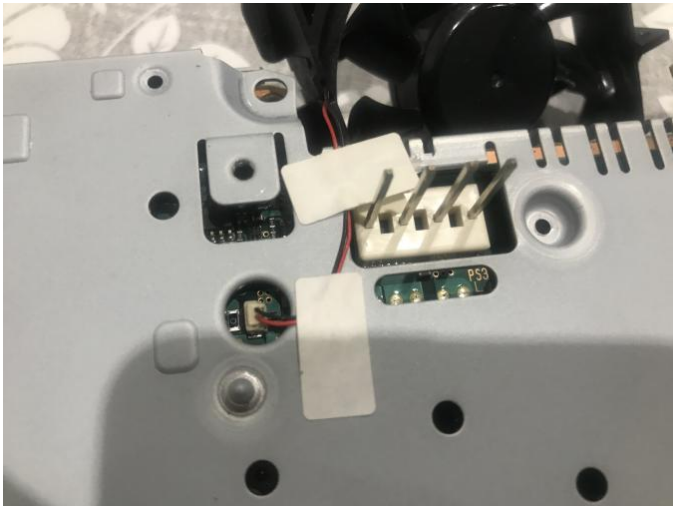
11) Remove the metal grate carefully as it is sharp so it may cause injury.



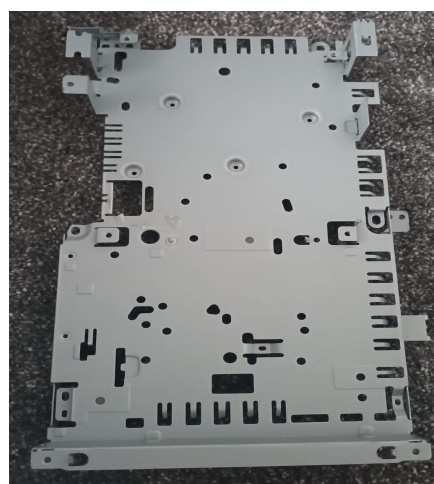
12) Remove the screws and the plate with the heatsink from the motherboard.



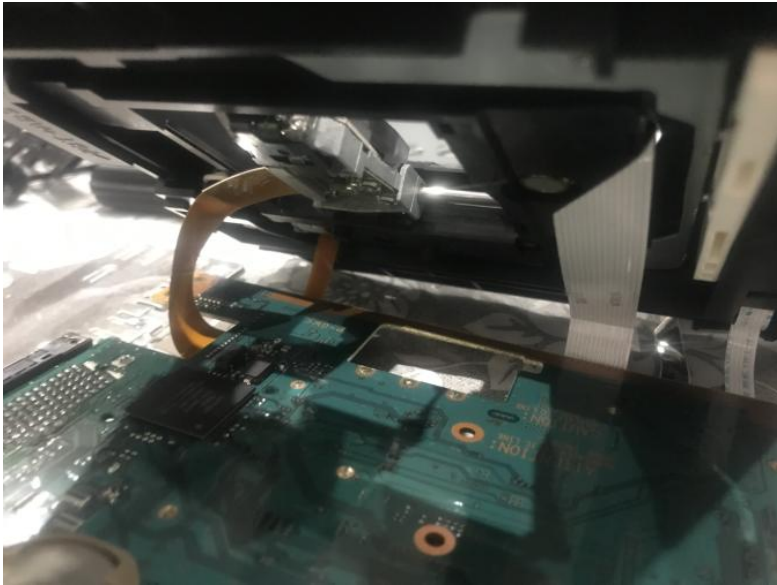
13) Remove the tape and unplug the fan.



14) Remove the screws and the plate on top of the motherboard.



15)Unplug all of the thin cables connecting the DVD reader to the motherboard

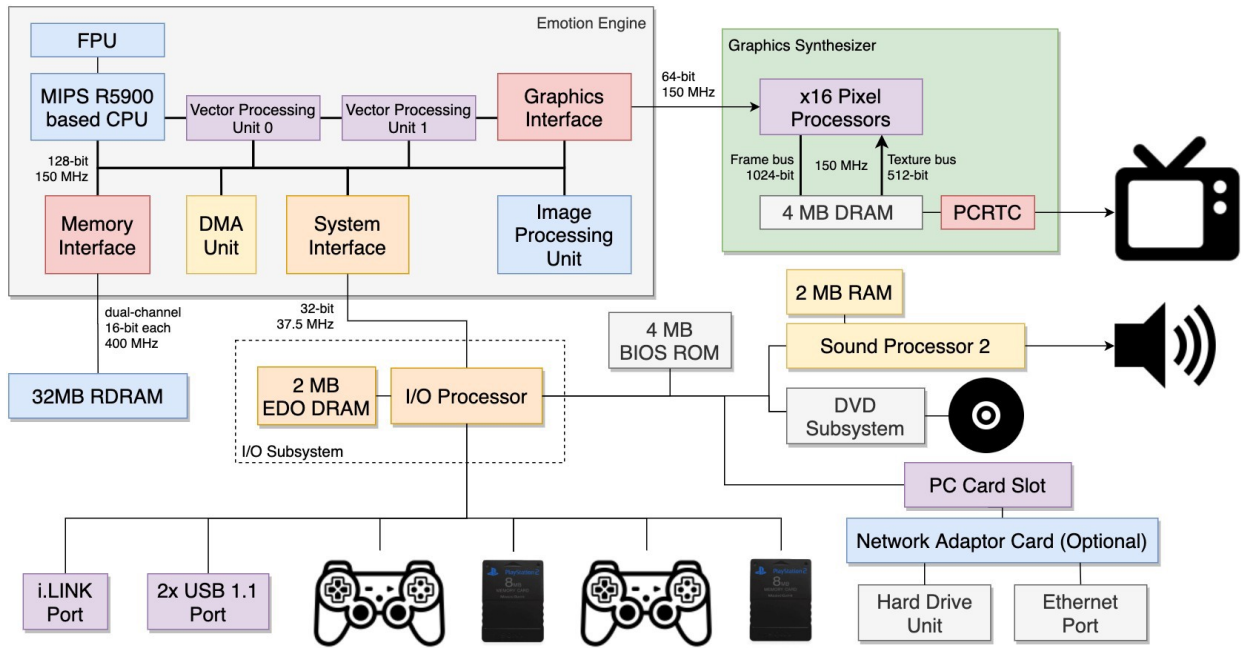


16)Unplug the memory card reader by lifting the brown flap which covers the cable.



4.0

Circuit Diagram

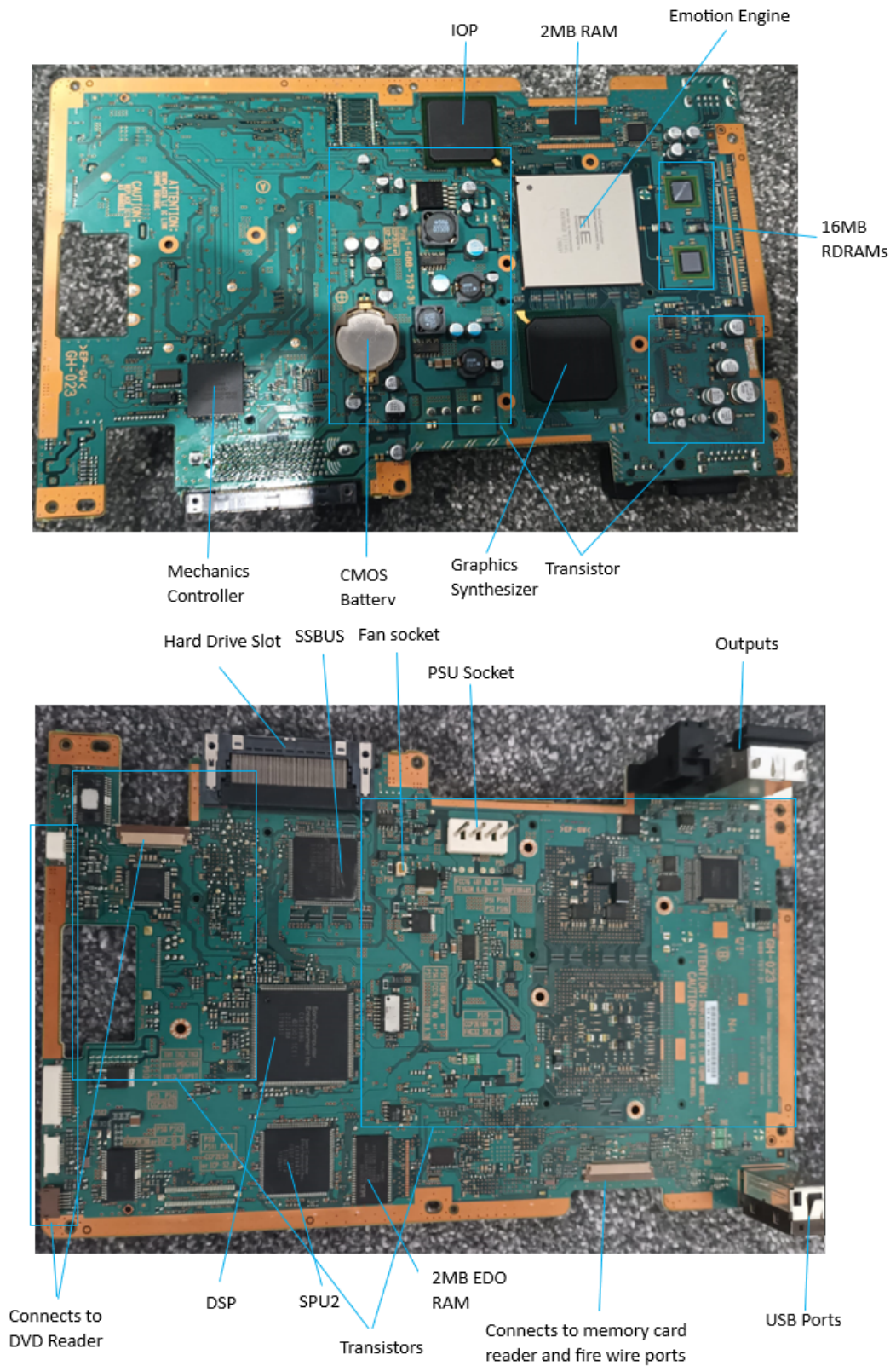


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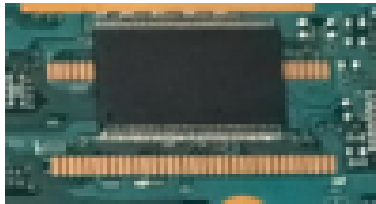

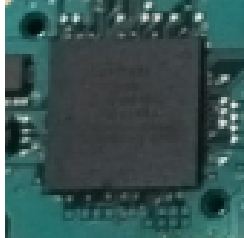

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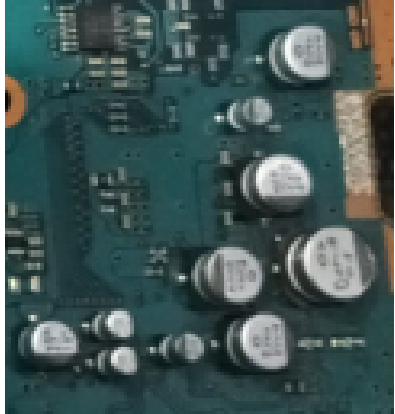
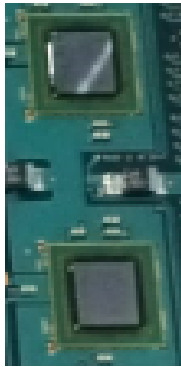


Analysing the Motherboard



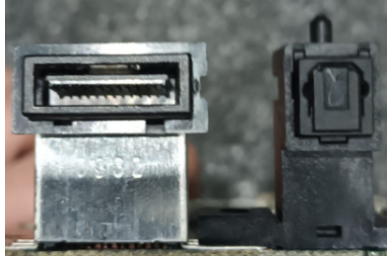


5.1 Labelled Diagram of the Motherboard

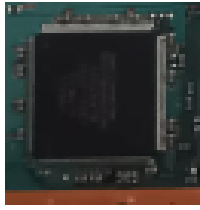






5.2 In-depth look at the motherboard

Name	Picture	Description
I/O		<p>The IOP also known as the I/O (input-output) processor is made up of a few bits of data and is in charge of input and output data transfers. It is a part of the I/O subsystem.</p>
2MB RAM		<p>RAM stands for Random Access Memory. It temporarily holds 2MB of data so that the IOP is able to work faster as RAM is able to send data to a CPU faster than a hard drive to a CPU.</p>
Emotion Engine		<p>The emotion engine is a game engine and is the biggest CPU on the motherboard. A game engine can do a variety of things; it can simulate physics in a sports game, it can react to a player's movements, and can render graphics.</p>
Mechanics Controller		<p>The mechanics controller's job is to read and scan the inserted DVD. The PS2 can't download files from the internet so most malware would have been from the inserted DVD. As a result of this, Sony tasked the mechanics controller with being the CPU responsible for security.</p>
CMOS Battery		<p>A CMOS battery is generally a lithium coin cell. It has an estimated life span of 3 years. It is used to power the CMOS memory that holds system configuration information and firmware data. The CMOS battery also powers the RTC (real-time clock) - the RTC maintains the date and time inside the console.</p>

Graphic Synthesizer		<p>The Graphic Synthesizer is the equivalent of a GPU in a PC. It turns all of the information from the PS2 into an image. That image is then sent to the monitor or TV and into the user's eyes. The technical term for this process is rendering.</p>
Capacitor		<p>A capacitor is similar to a battery, however, a battery can create and store electrons while a capacitor can only store electrons. It has two ports, one is used for receiving electrons that need to be stored, and one for sending out electrons that need to be used. Capacitors are placed near fans and CPUs because they need a constant flow of electricity and capacitors can hold excess electricity or temporarily provide parts of the PS2 with electricity when there isn't enough. When a PS2 shuts down all the electricity from the capacitors needs to be used up so the PS2 takes time to fully shut down.</p>
16MB RDRAMs		<p>The 16MB of RDRAM is used to store Data from the USBs, Memory cards, and DVDs which are connected to their own sub-systems on the other side of the motherboard. The RDRAM temporarily keeps data until the data is pulled by the different systems. There are two RDRAMs as 8MB isn't enough storage capacity so Sony added two pieces of 8MB RDRAMs.</p>
Hard Drive expansion slot		<p>The PS2 has the option to extend its storage. The Hard Drive can be slotted into the hard drive expansion bay and a cable could be plugged into the port shown in the image.</p>
SSBUS		<p>The SSBUS reads and distributes the Data on the hard drive to other systems which require that data. In some later models, it is called a hard drive disk controller.</p>

Fan Socket		<p>The fan socket connects the Motherboard to the fan so that the fan can receive power. It has two pins inside, one to send electricity and one to receive electricity.</p>
PSU Socket		<p>The PSU socket consists of 4 large pins soldered onto the motherboard with a white baseplate. It takes electricity from the powerboard and then distributes it around the motherboard to all of the sub-systems.</p>
Outputs		<p>There are two outputs: a “digital audio port” and an “av multi out”. The digital audio port has a flap for protection but is moved when the cable is inserted. The digital audio port is audio only but sends a digital signal while the av multi out sends video and audio but is analogue. The av multi out stands for audio visual multi out and is the port which sends information to the TV or monitor.</p>
Connects to DVD Reader		<p>The DVD player has five thin cables coming out of it. The order of these cables (going up and then right) are the motor which ejects the hard DVD holder, the buttons to reset and eject the DVD, The DVD spinner, the motor which moves the DVD reader and then the DVD Reader. The port which connects to the DVD reader has a brown flap. This flap needed to be lifted before we were able to remove the cable.</p>
DSP		<p>The DSP sends commands to the DVD reader. It tells the spinner to spin, the scanner to scan and the motor to pull and push the scanner so that it is able to read the whole DVD.</p>

SPU2		<p>The SPU2 receives information from the 2MB of Edo RAM. It takes the information and turns it into usable information which gets sent out of the PS2 through the av multiport or the digital audio port.</p>
Transistors		<p>Transistors can be used as a switch or electrical signal amplifier. They contain 3 terminals (emitter, base, and collector). The emitter is where the current enters the transistor, the base acts like a switch or amplifier, controlling the circuit, and the collector is where the current leaves the transistor.</p>
2MB EDO RAM		<p>This RAM is connected to the SPU2 and it receives information from the DVD reader, start-up code, OS, hard drive, and memory card reader. It temporarily stores this information so that the audio is able to be sent out quickly.</p>
USB Ports		<p>The USB ports exist as a way for inputs to be connected to the PS2. The controllers used firewire ports but some games required a keyboard and mouse with some requiring a steering wheel.</p>
Memory Card Reader and Firewire ports		<p>The memory card reader is able to transport data from the inserted memory card. The firewire ports connected the controllers to the PS2</p>

5.3 Transistors:

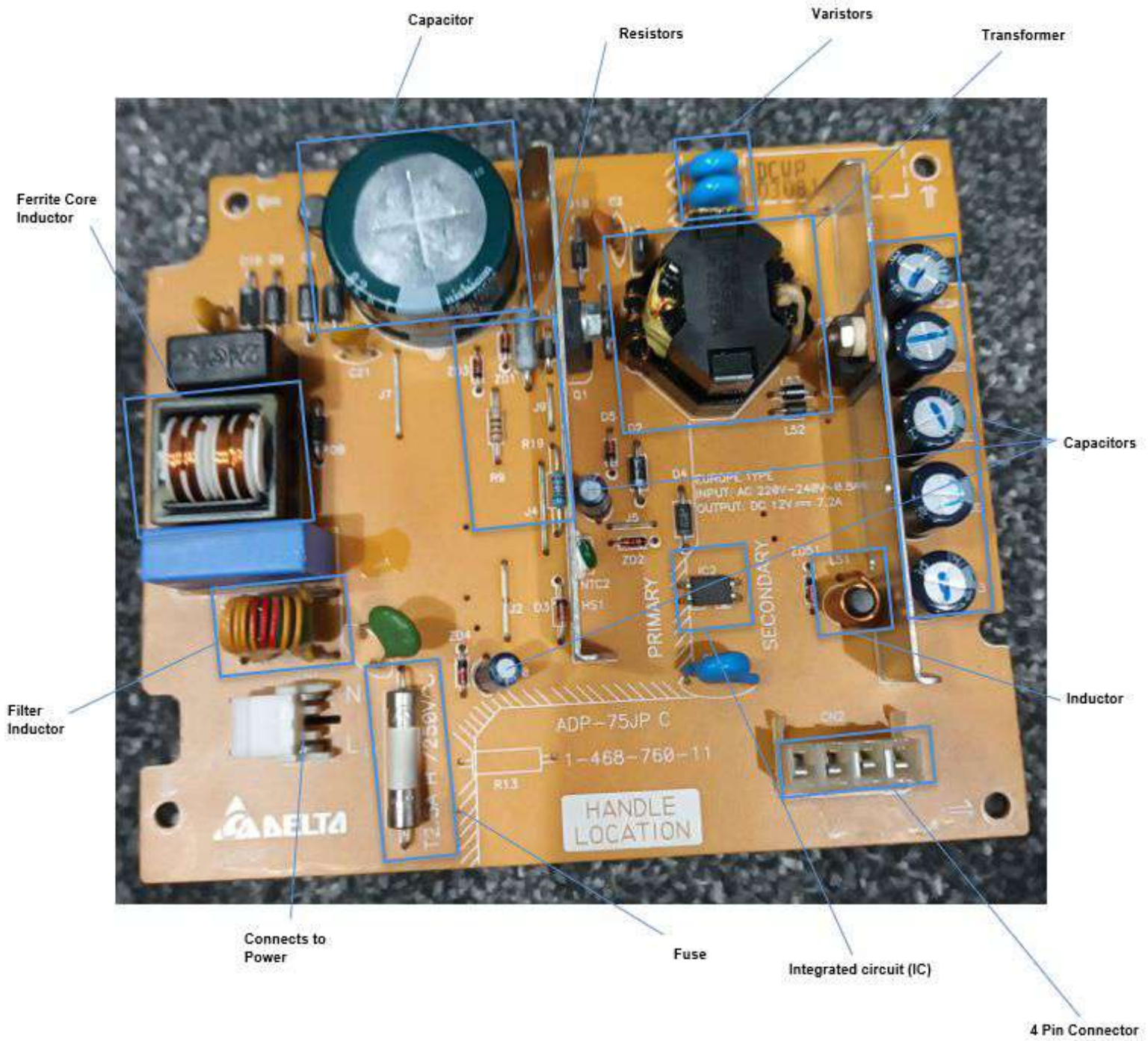
A transistor contains three terminals. These are called the emitter, the base, and the collector. The emitter is where the electrical current is inputted into the transistor. However, the current is blocked once passed through the emitter due to the semiconductive material insulating the current. The base of the transistor acts like a switch. The base of a transistor is connected to a doped silicon material (which is semiconductive). The semi-conductive material remains an insulator until a current is passed through the material making it conductive. Therefore, when current is passed through the base of a transistor, the current passed through the emitter can carry on, making the transistor act like a switch. The collector is where the current from the emitter flows to and then, it can carry on through the rest of the circuit.

Transistors can also act as an amplifier of electrical signals. It does this as doped silicon (which is connected to the base terminal of the transistor) becomes a lot more conductive as the electrical input in the base is slightly increased. Therefore, a slight increase in the electrical input in the base pin can lead to a much larger electrical output as the silicon becomes more conductive. Hence, a larger voltage (which is inputted through the emitter) is controlled by a much smaller voltage (which is inputted through the base terminal).

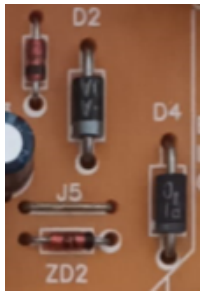


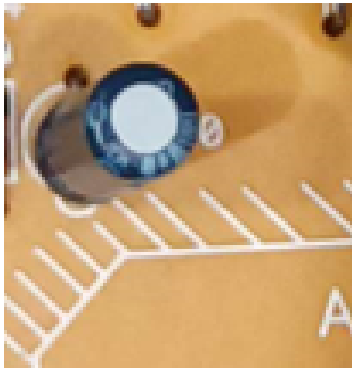
Overall, transistors can be used as a switch or as an amplifier of electrical currents. However, when used in large numbers, they can also act as logic gates. Logic gates compare electrical currents to provide an output based on the inputs. An example is, for a circuit that relies on two buttons being pressed at the same time, two transistors could be used to only let the current flow when both buttons are pressed, sending an electrical current to the base terminal. Only when both buttons are pressed, the current will flow in the circuit and an electrical current will pass through other components in the circuit.





6.0 Analysing the Powerboard


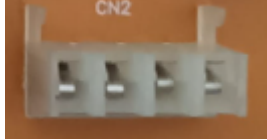

6.1 Labelled Diagram of the Powerboard



6.2 In-depth look at the Powerboard

Resistors		Resistors are designed to resist electrical current. They do this to prevent damaging sensitive components like LEDs and transistors as they will not be able to handle high currents. Variable resistors help configure components such as a speaker's volume. By increasing the resistance, the speaker gets quieter.
Varistors		A varistor is able to suppress electrical charge. If a large voltage passes through the system it is able to dissipate the energy.
Transformer		A transformer keeps the frequency of the current the same but it can decrease or increase ac voltage between two circuits. It is able to do this by the application of Faraday's law of induction. The law states that electromotive force can be produced when a magnetic field interacts with an electrical circuit.
Capacitor		A capacitor is similar to a battery, however, a battery can create and store electrons while a capacitor can only store electrons. It has two ports, one is used for receiving electrons that need to be stored, and one for sending out electrons that need to be used. Capacitors are placed near fans and CPUs because they need a constant flow of electricity and capacitors can hold excess electricity or temporarily provide parts of the PS2 with electricity when there isn't enough. When a PS2 shuts down all the electricity from the capacitors needs to be used up so the PS2 takes time to shut down fully.

<p>Ferrite Core Inductor</p>		<p>A ferrite core inductor is an electromagnet and it has two parts, the ferrite core and the coil. The ferrite core inductor was made to block low frequency and absorb high frequency noise. This blocks electromagnetic emissions which in turn stops electromagnetic interference.</p>
<p>Filter Inductor</p>		<p>A filter inductor is an electrical component which allows direct current to pass through but doesn't let the alternating current pass through easily at high frequencies.</p>
<p>Connects to Power</p>		<p>This plug connects to the AC port which receives electricity from the socket. It has two pins and is the entry point for electricity.</p>
<p>Fuse</p>		<p>A fuse is similar to a varistor however, there are a few differences. A fuse protects the motherboard from high voltage. If high voltage passes through the circuit from lightning or any other accident which results in high voltage, then the fuse burns out and stops the electricity from reaching the parts of the circuit which can't easily be fixed, unlike a fuse which is cheap and can be easily replaced.</p>

IC		<p>An IC has thousands or millions of tiny resistors, transistors, diodes and capacitors and it can act as an amplifier, oscillator, timer, counter, logic gate, computer memory, microcontroller or microprocessor.</p>
4 Pin Connector		<p>The 4 pin connector connects the powerboard to the motherboard and it is the pathway that electricity goes through to reach the motherboard. It is encased in white plastic to protect it as if it is damaged electricity can't pass.</p>
Inductor		<p>An inductor deals with high frequency noises, it stores and transfers energy in power converters. It has two parts: an inner core material and a coil.</p>

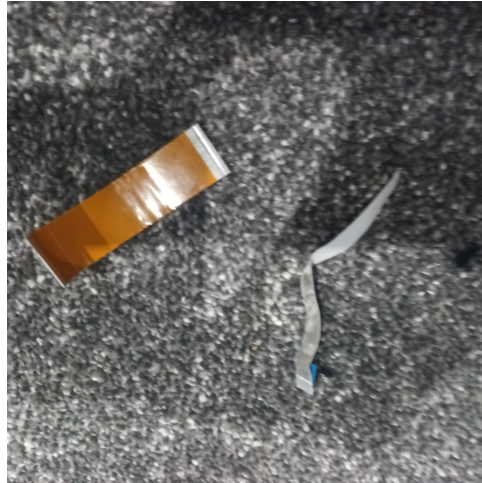
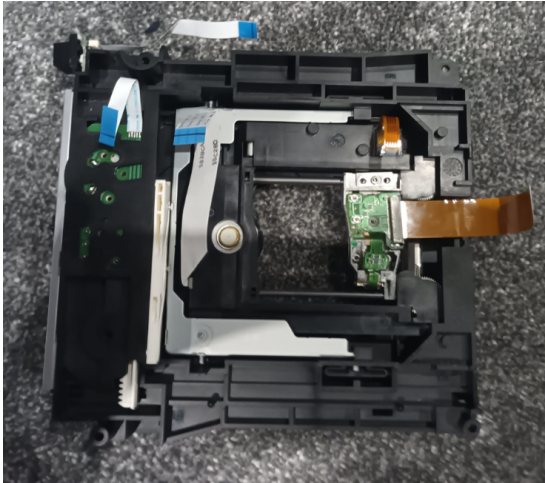
6.3 Resistors:

A resistor is an electrical component that creates resistance in the flow of current. Most modern resistors are made out of carbon, metal, or metal oxide film which is wrapped in a helix within the resistor. They are commonly used to limit current or divide voltages. Resistors can be very useful in circuits. For example, for a circuit with a high voltage which contains a component that cannot withstand large electrical currents, we can use Ohm's law and resistors to protect the component. Ohm's law is a formula involving voltage(V), resistance(R), and current(I). The formula is $V=IR$. This formula can then be rearranged to give $I=V/R$. Through this formula, we can see that by increasing the resistance, we can reduce the current. This protects sensitive components in the circuits such as LEDs and transistors. There is also another type of resistor called a variable resistor. Variable resistors can change their resistance within a circuit. They do this by sliding a contact(conductive material or wire) over a resistive element (carbon or cermet). Variable resistors can be used to adjust many things within a circuit, such as adjusting the volume of a device by controlling the current that passes through the component. Variable resistors are used in the DVD reader of the PS2.

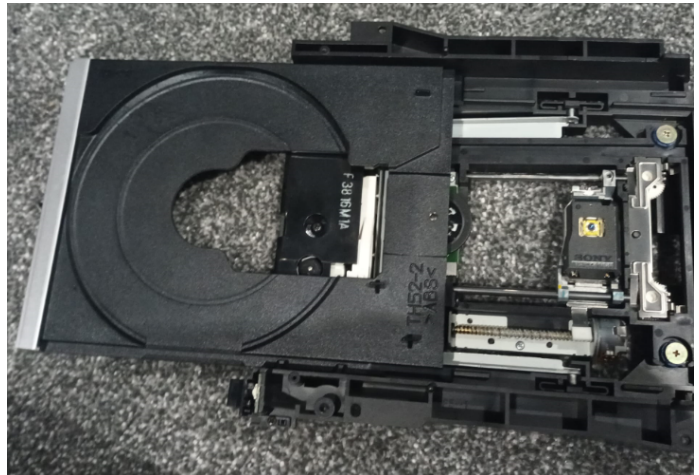
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Guide on how to disassemble the DVD drive

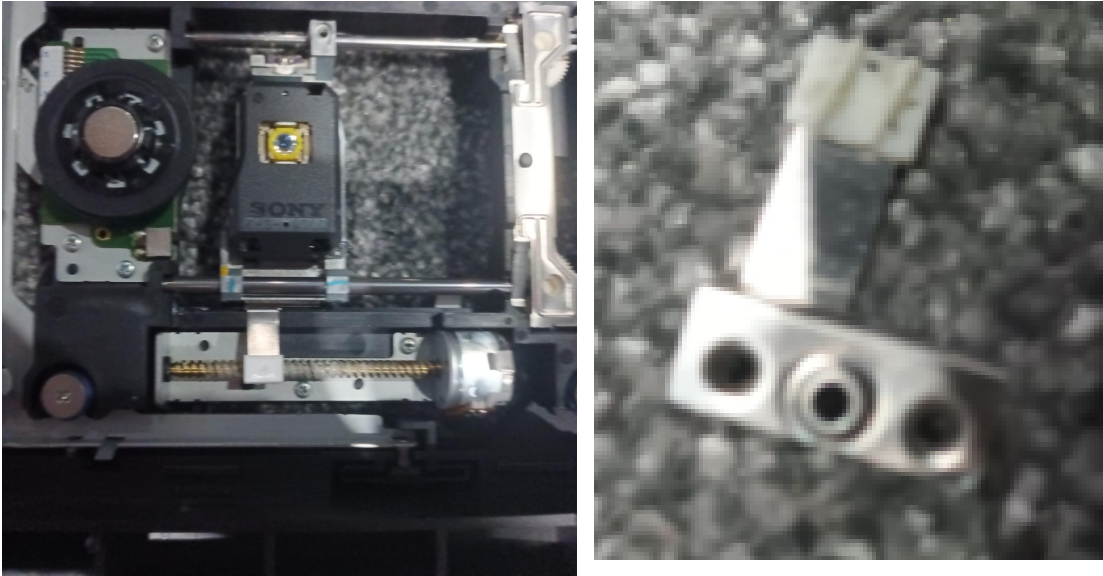
- 1) Follow the safety rules from section 3.0 .
- 2) Unplug the cables from the buttons and the DVD scanner to make the disassembly process easier.



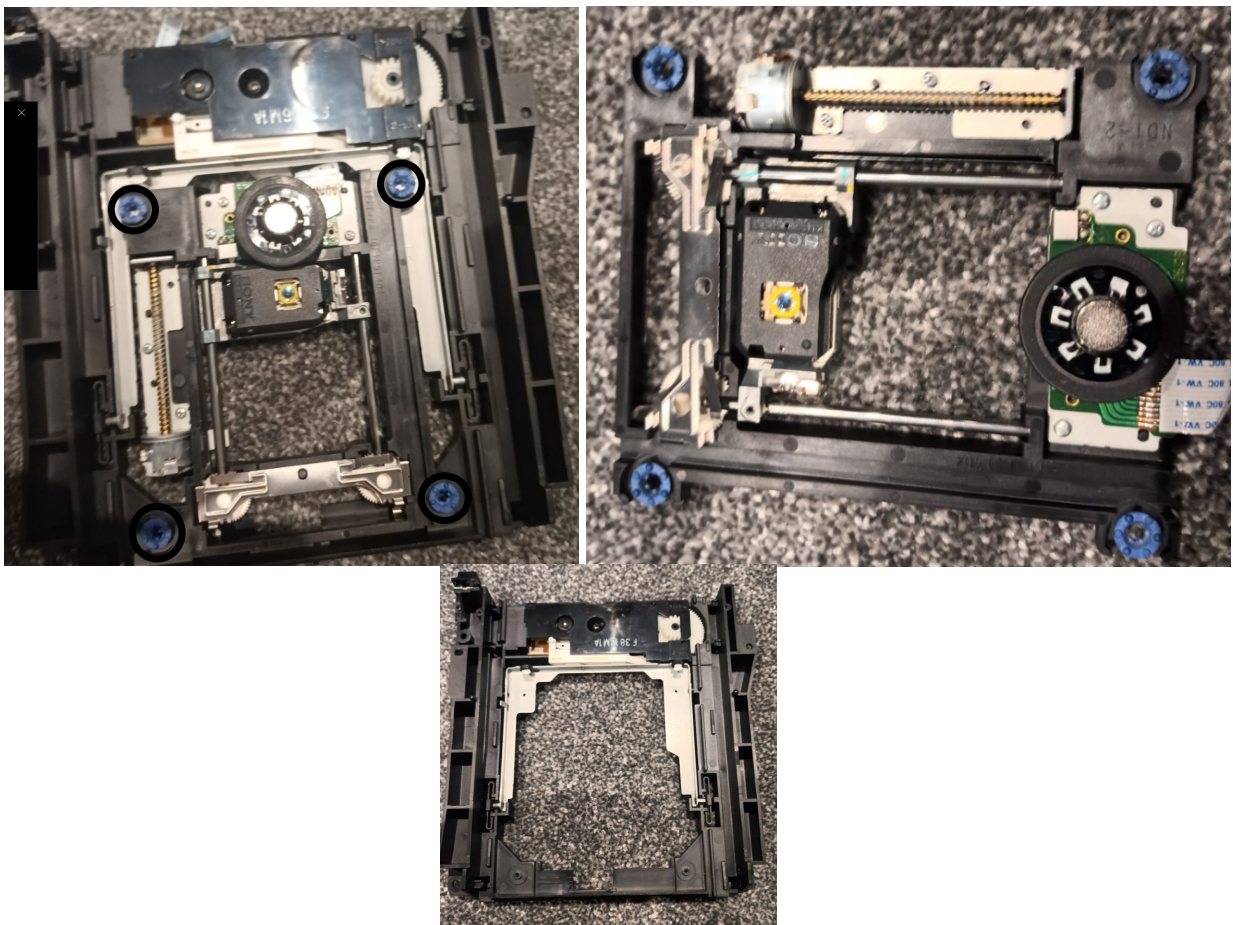
- 3) Move the white slider across to eject the DVD holder and pull it out using your hand.



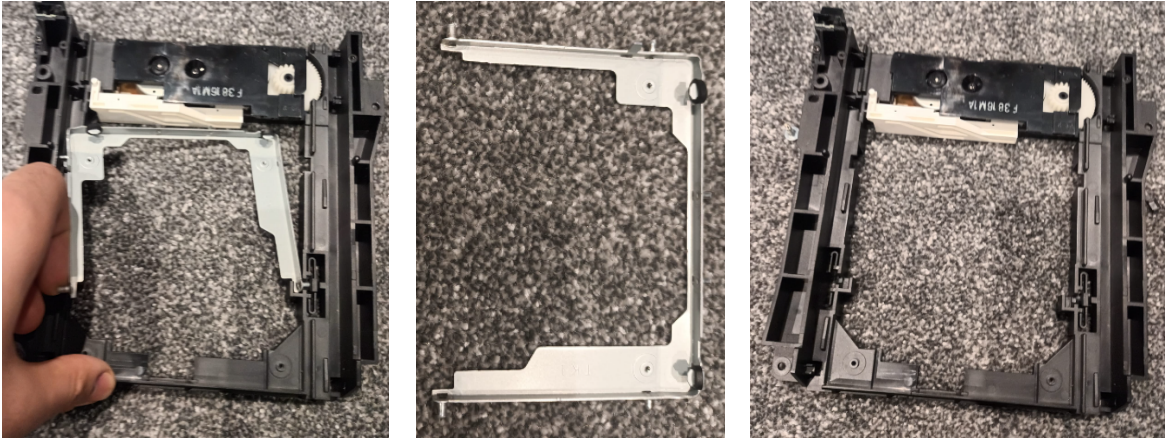
4) Remove the piece that connects the motor to the DVD reader.



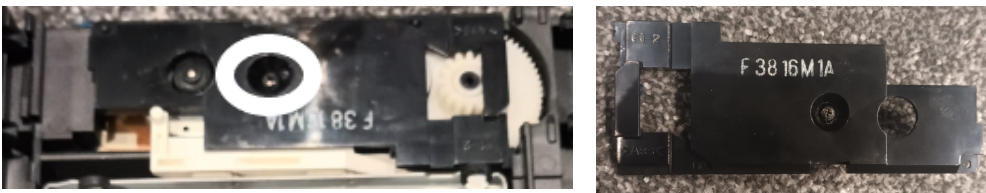
5) Unscrew the 4 highlighted screws and remove the centre frame from the exterior one.



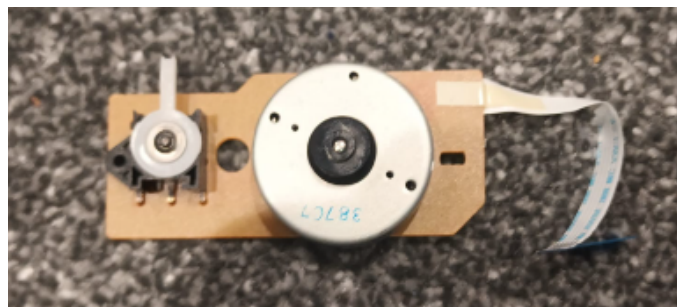
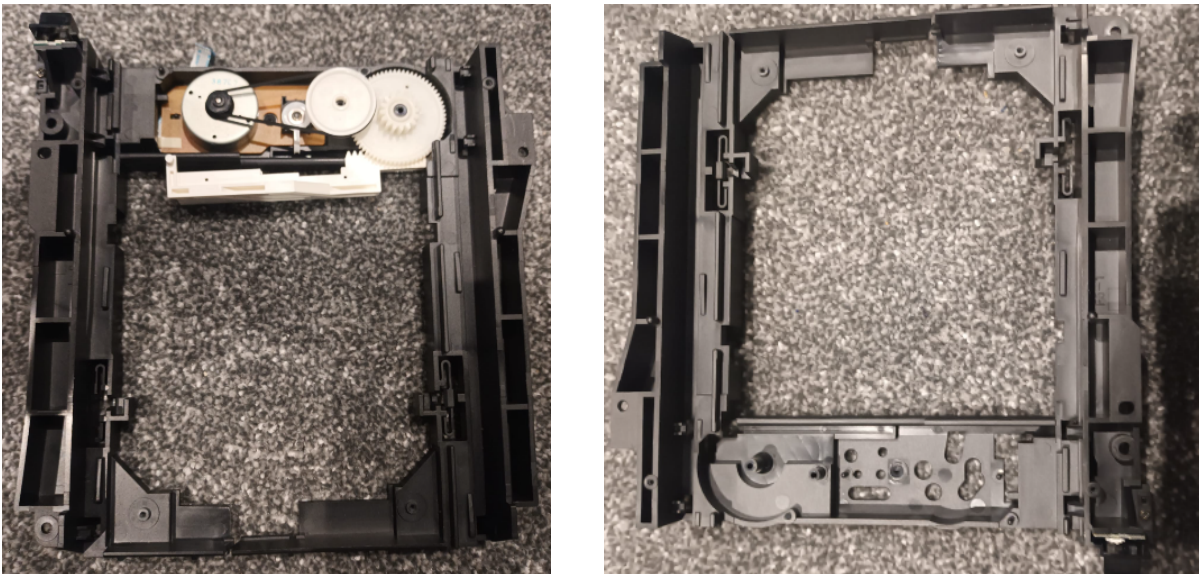
6) Then carefully remove the metal piece from the exterior casing.



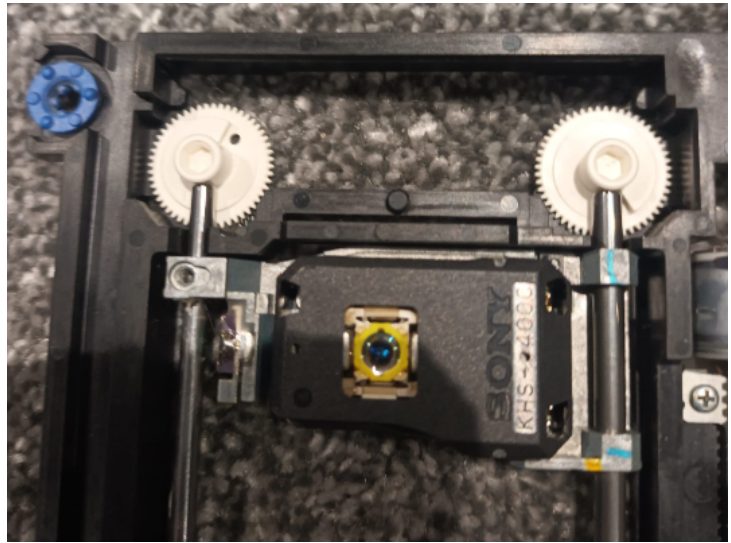
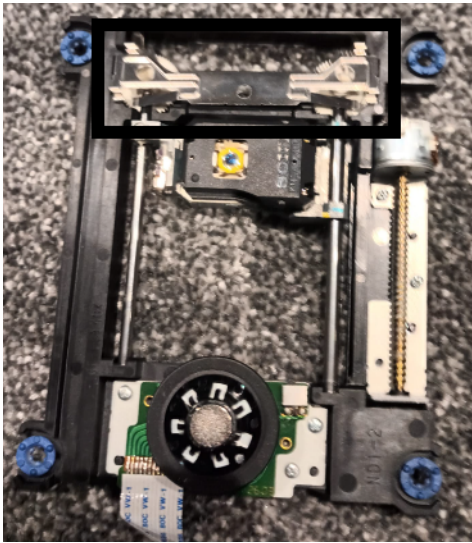
7) Unscrew the highlighted screw and remove the plastic cover



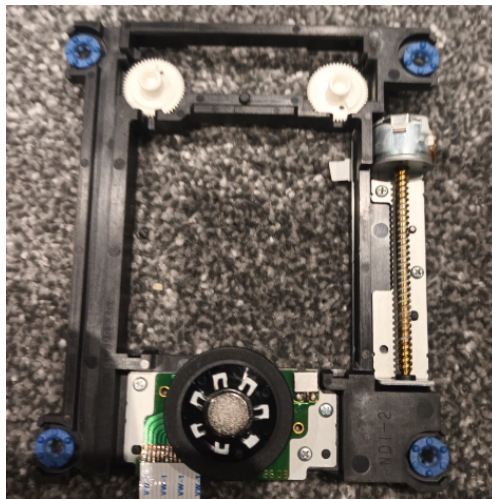
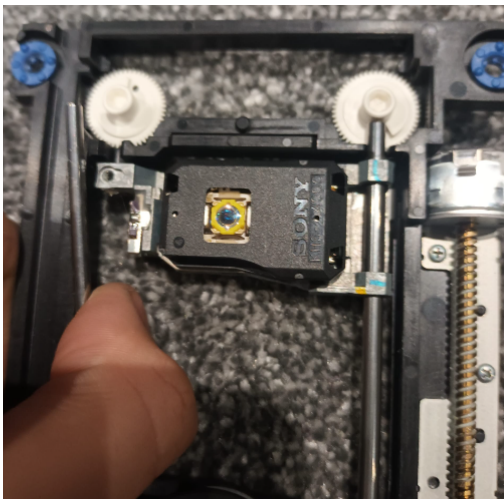
8) Then remove all of the gears, the rubber band and the motor underneath



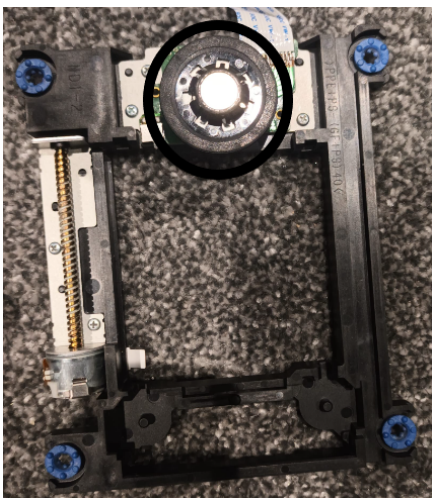
9) Remove the metal plate covering the gears on the inside frame.



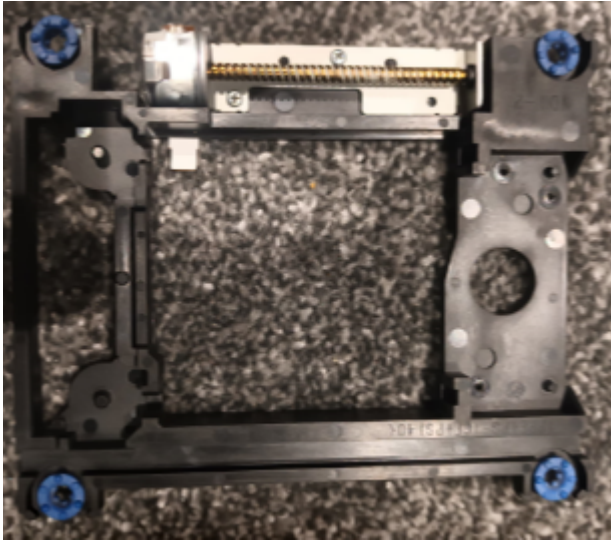
10) Remove the two metal rods.



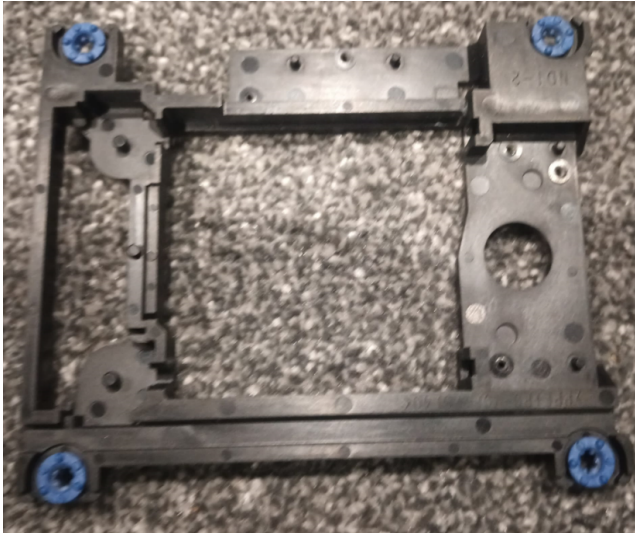
11) Unscrew the DVD spinner.



12) Unscrew the motor which moves the DVD reader.

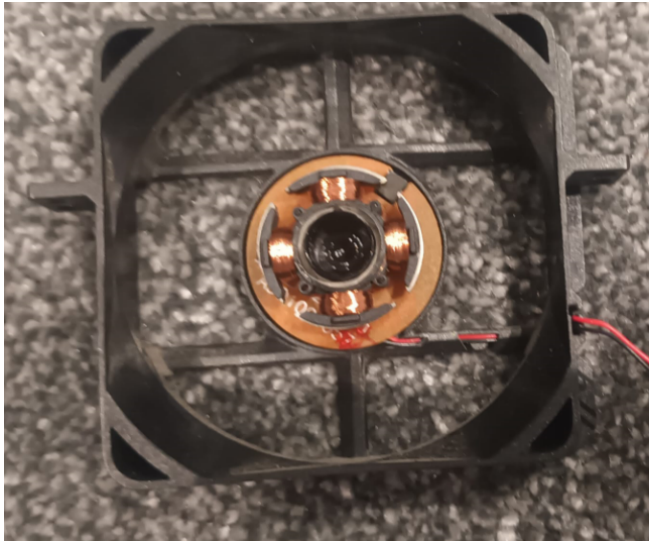


13) Remove the four blue rubber rings.

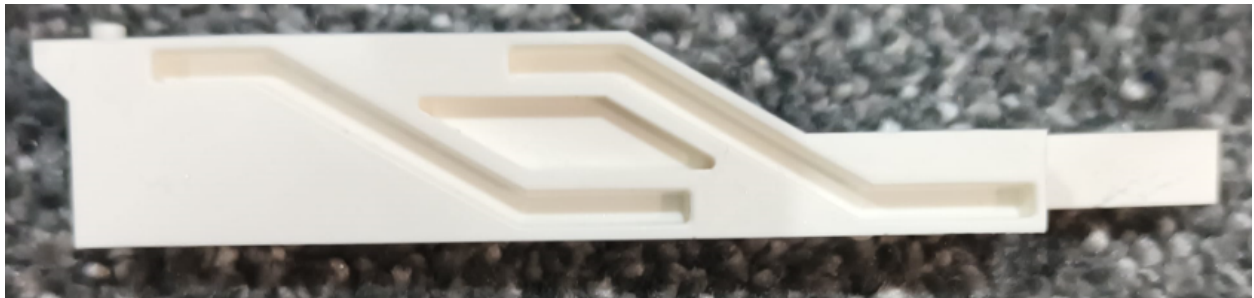


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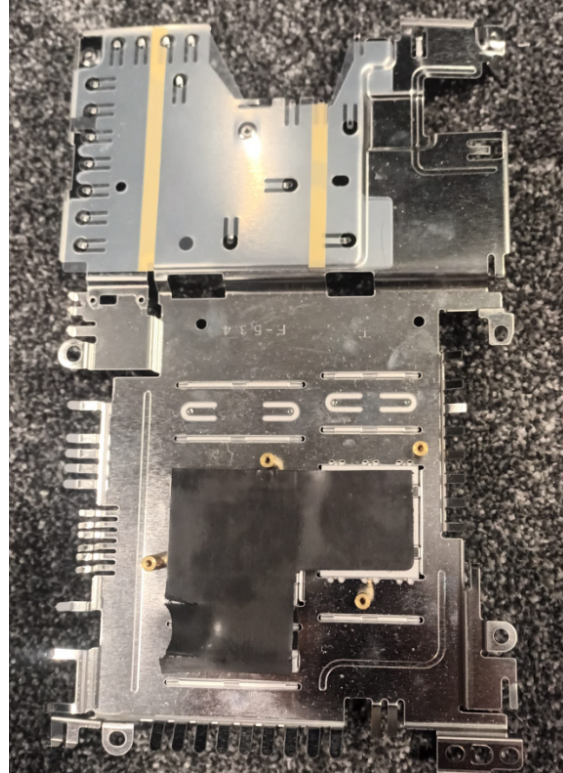
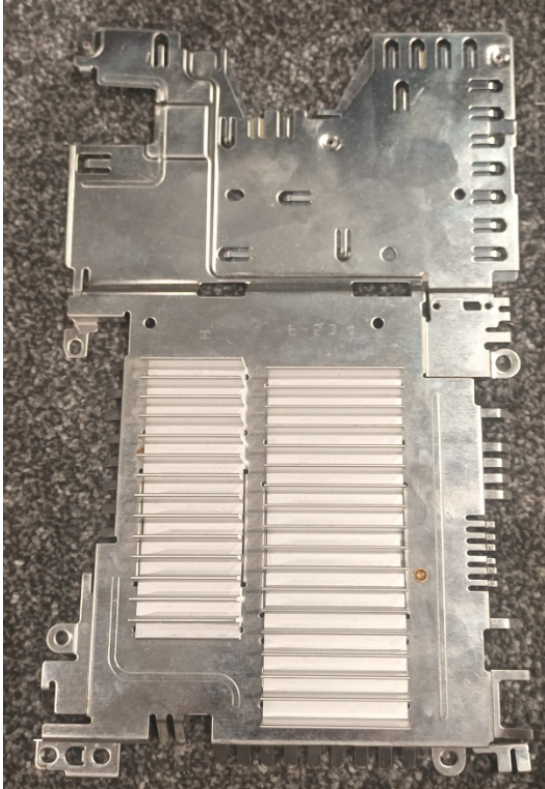
Electrical and mechanical features of the PS2



An electromagnet spins a metal cylinder connected to the blade so that the fan is able to direct air into the PS2. The air from outside the PS2 is colder than the air inside the PS2 so once the cold air enters, the heat from the CPU is taken by the cold air through the process of convection. The now warm air then exits the PS2 so that new cold air is able to enter. At the bottom of the fan is a lubricant which removes friction. As there is little friction, the fan's blade is able to spin very quickly which increases air circulation.



This piece is responsible for moving the DVD spinner up and down. While this may seem useless, it is actually crucial. When the DVD holder is trying to eject, if the DVD spinner isn't lowered then the holder can't pass as it is obstructed by the spinner. If the spinner was lower then it would not be able to reach the DVD and therefore it would not be able to spin the DVD. This piece moves when the gears spin as it has teeth.



The black element on the metal is called a thermal pad. It absorbs heat from the graphics synthesiser, emotion engine and IOP. If they are too hot then they can burn out and not work. The fins on the metal piece take heat from the thermal pad and take the heat away from the CPUs. These fins are called a heatsink and are used in many electrical devices.

➤ The PS2 in general:

- <https://www.ifixit.com/Teardown/PlayStation+2+Teardown/1253>
- <https://www.ps2-home.com/forum/app.php/page/fmcb-compatible-ps2-models-chart>
- [https://consolemods.org/wiki/PS2:PS2_Model_Differences#%E2%80%9CSCPH-50001%E2%80%9D_\(2003-2004\)](https://consolemods.org/wiki/PS2:PS2_Model_Differences#%E2%80%9CSCPH-50001%E2%80%9D_(2003-2004))
- https://en.wikipedia.org/wiki/PlayStation_2#:~:text=It%20is%20the%20best%2Dselling,over%20155%20million%20units%20worldwide.&text=Announced%20in%201999%2C%20Sony%20began,as%20well%20as%20its%20games.
- <https://www.thefactsite.com/sony-playstation-2-facts/>

➤ Motherboard:

- <https://www.copetti.org/writings/consoles/playstation-2/>
- <https://playstationdev.wiki/ps2devwiki/index.php/IOP/Deckard>
- <https://playstationdev.wiki/ps2devwiki/index.php/MechaCon>
- <https://playstationdev.wiki/ps2devwiki/index.php/DSP>
- https://playstationdev.wiki/ps2devwiki/index.php/SSBUS_controller
- <https://playstationdev.wiki/ps2devwiki/index.php/SPU2>
- https://en.wikipedia.org/wiki/PlayStation_2_technical_specifications

- <https://electronics.stackexchange.com/questions/471317/identify-components-on-computer-motherboard-cylindrical-and-cube-shapes>
- <https://electronics.howstuffworks.com/ps21.htm#:~:text=The%20PlayStation%20has%20two%20USB%20ports%20and%20a%20FireWire%20port.>
- <https://www.arm.com/glossary/gaming-engines#:~:text=A%20gaming%20engine%20may%20include,effects%2C%20an%20animation%20engine%2C%20and>

- https://en.wikipedia.org/wiki/Game_engine
- https://playstationdev.wiki/ps2devwiki/index.php/Emotion_Engine
- <https://www.geeksforgeeks.org/introduction-of-input-output-processor/>
- <https://playstationdev.wiki/ps2devwiki/index.php/Motherboards>
- <https://electronics.howstuffworks.com/capacitor.htm>
- [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi_pOj8vbj8AhXzSkEAHYyWAAYQFnoECCYQAw&url=https%3A%2F%2Fwww.techopedia.com%2Fdefinition%2F18897%2Fhard-disk-controller-hdc%23%3A~%3Atext%3DDisk%2520Controller%2520\(HDC\)-%2CWhat%2520Does%2520Hard%2520Disk%2520Controller%2520\(HDC\)%2520Mean%253F%2Cto%2520control%2520the%2520hard%2520disk.&usg=AOvVaw0WucUsk0LA2V-BW86y-UAz](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwi_pOj8vbj8AhXzSkEAHYyWAAYQFnoECCYQAw&url=https%3A%2F%2Fwww.techopedia.com%2Fdefinition%2F18897%2Fhard-disk-controller-hdc%23%3A~%3Atext%3DDisk%2520Controller%2520(HDC)-%2CWhat%2520Does%2520Hard%2520Disk%2520Controller%2520(HDC)%2520Mean%253F%2Cto%2520control%2520the%2520hard%2520disk.&usg=AOvVaw0WucUsk0LA2V-BW86y-UAz)
- <https://www.techtarget.com/whatis/definition/transistor#:~:text=A%20transistor%20is%20a%20miniature,which%20can%20carry%20a%20current.>
- <https://www.pcmag.com/encyclopedia/term/transistor#:~:text=In%20the%20digital%20world%2C%20a,See%20CPU%20and%20SoC>
- https://www.youtube.com/watch?v=J4oO7PT_nzQ&ab_channel=TheEngineeringMindset

➤ **Powerboard**

- https://product.tdk.com/en/techlibrary/applicationnote/howto_disk-varistor.html
- <https://www.laird.com/products/inductive-components-emc-components-and-ferrite-cores/ferrite-cable-cores>
- <https://www.fierceelectronics.com/electronics/what-a-transformer#:~:text=It%20is%20designed%20to%20either,connection%20between%20the%20two%20circuits.>
- <https://www.techtarget.com/whatis/definition/integrated-circuit-IC#:~:text=An%20IC%20can%20function%20as,of%20all%20modern%20electronic%20devices.>