VEX ROBOTICS COMPETITION

OVER UNDER

VEX VRC – 2023 / 2024
Reverse Engineering Online Challenge

PIONEER VSX 1123

Overdrive Robotics - 1696Z
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Word Count: 496/500

(excluding intro and image descriptions)*(only including core content)*

0. Introduction - Why We Chose The Pioneer Receiver

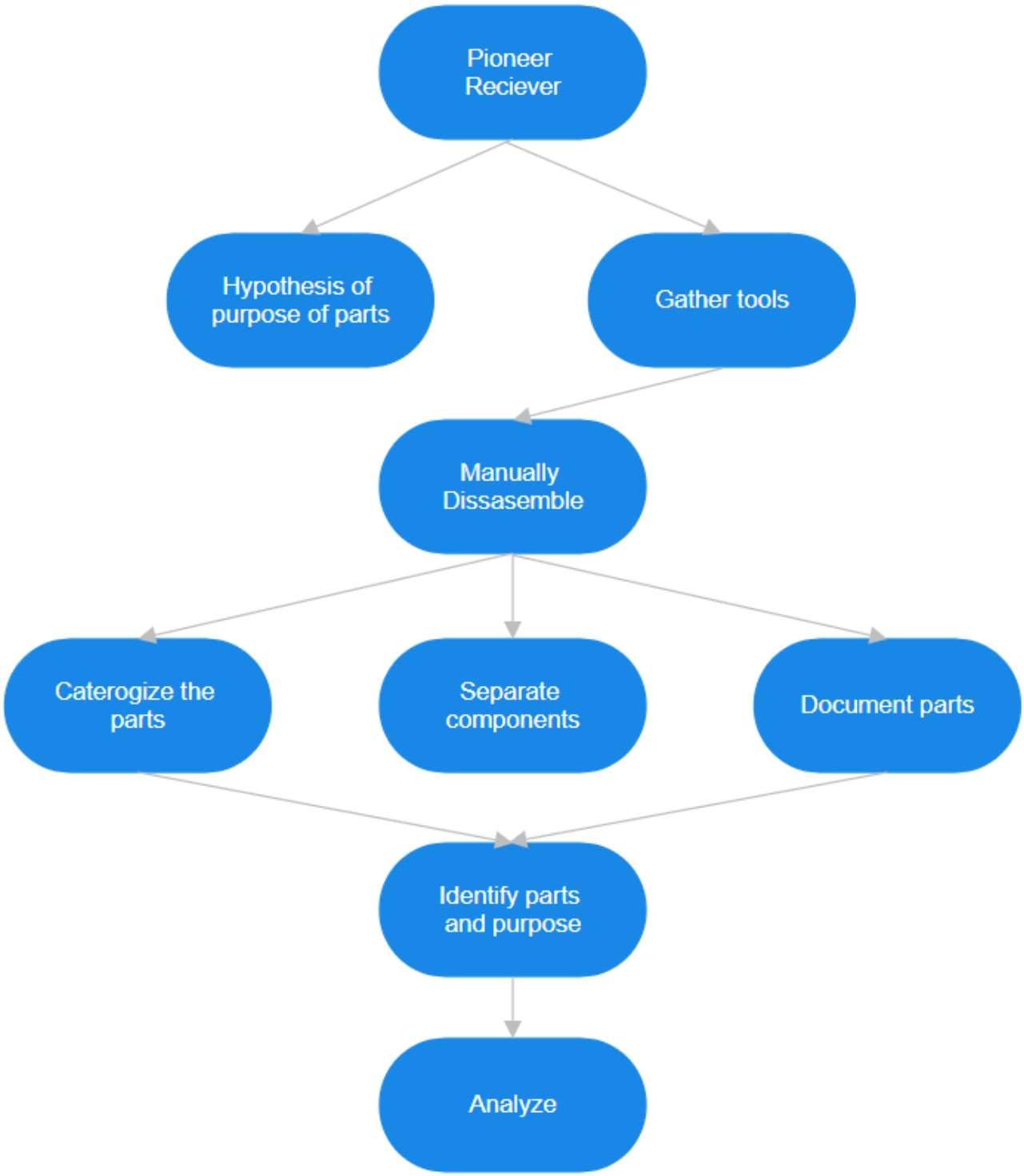
About Us

We are Team Overdrive 1696Z, a group of passionate robotics enthusiasts. Many of us have honed our skills by assembling computers, gaining a foundational knowledge of motherboards and various electrical components. We have also taken apart the VEX VRC motors and brain in the past in order to further our knowledge of electrical components. Eager to deepen our expertise, we have chosen to undertake the reverse engineering challenge this year, focusing on the Pioneer VSX 1123 receiver.

Why We Chose the Pioneer VSX 1123 Receiver

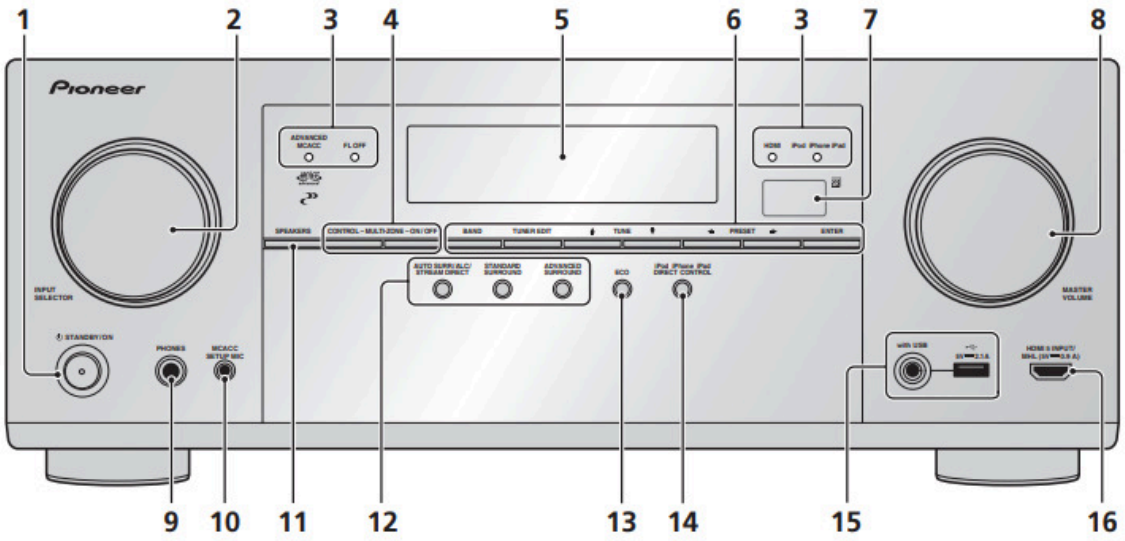
To maximize our exploration of intricate electrical components, we chose to deconstruct a device surpassing the simplicity of a phone or computer, the Pioneer VSX-1123 AV receiver. This device was particularly intriguing to us due to its intricate array of complex motherboards and wiring configurations, which go beyond what is typically encountered in standard computers. Along with the technical knowledge available, we thought reverse engineering this device would also broaden our mechanical skills as there are a lot of internal connections across the multiple motherboards which isn't seen in most electronic devices that run on 1-2 electrical boards. This challenge presents a unique opportunity for us to broaden our technical skills in a hands-on, engaging manner.

1. Plan of Action



2. Disassembly Plan

Front panel



Rear panel

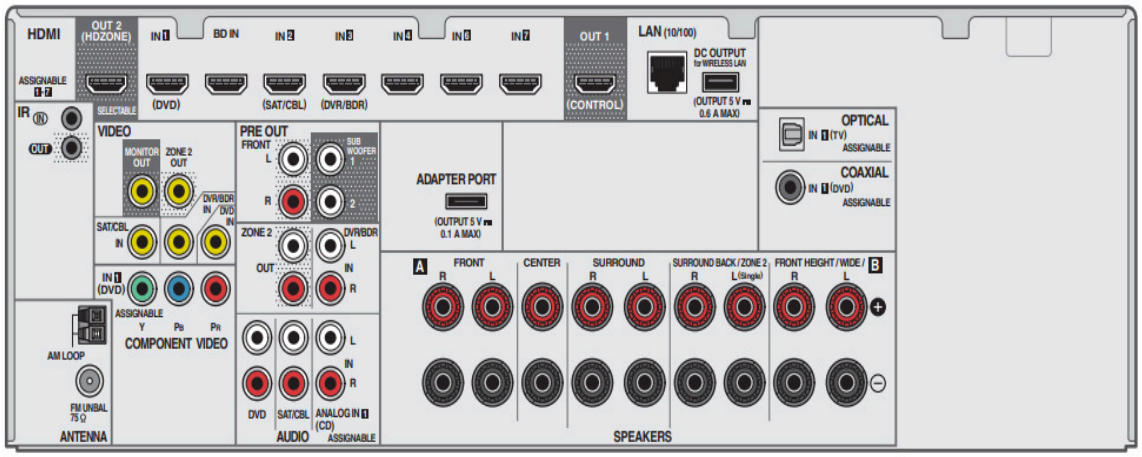


Fig 1. All of the motherboard wiring from the transformer stems to the rear panel

First, to access the insides, we removed screws on the front and back panels, as well as on the middle frame connection.

Second, for safety, we cleaned all of the thermal paste and transformer grease chemicals off of the components using isopropyl alcohol.

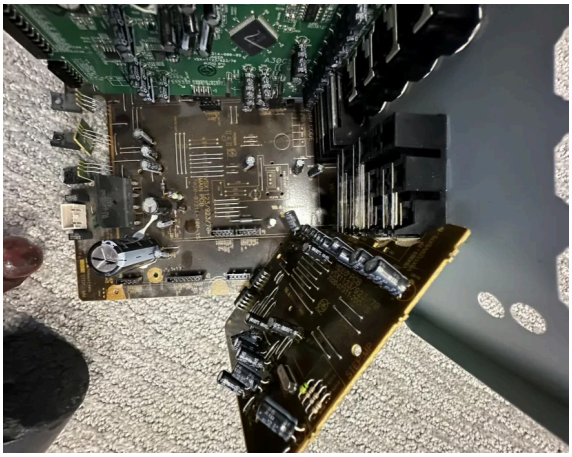
Next, to separate the multiple motherboards, we first unplugged all of the wires, and then separated the pin connections by hand.

Lastly, we sorted the non-electronic and electronic components separately.

3. Disassembly Process

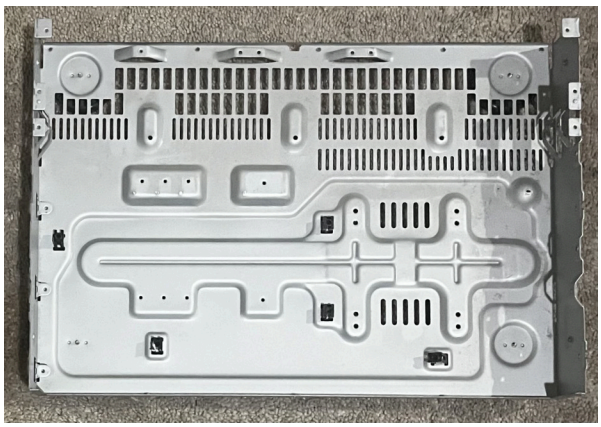
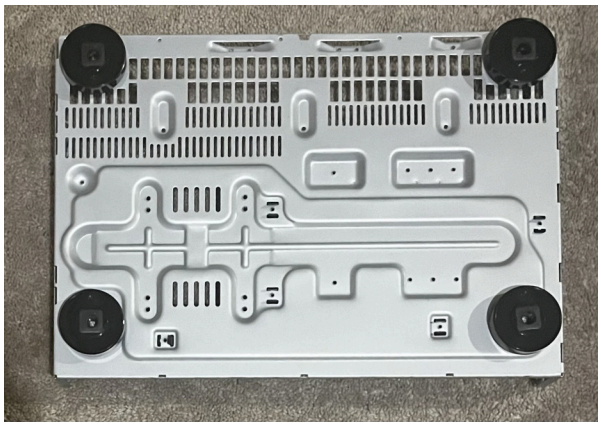
STEP 1: Examine Receiver

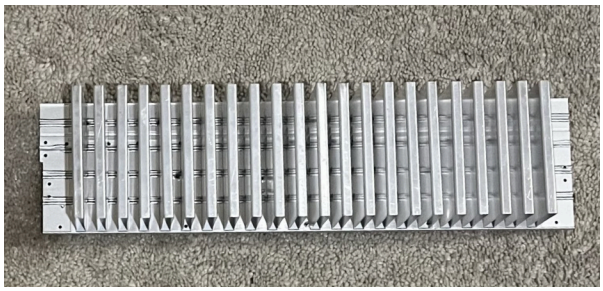
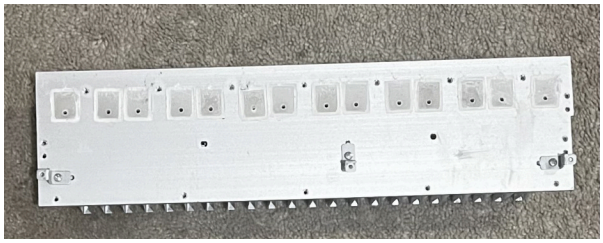
STEP 2: Removal of Panel Frames



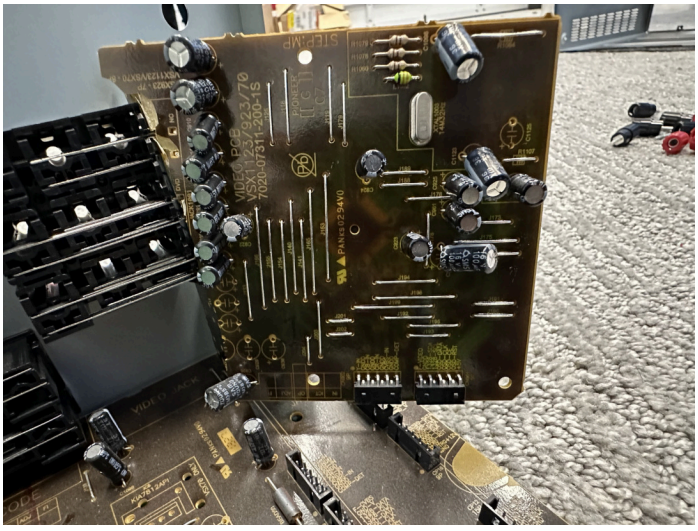
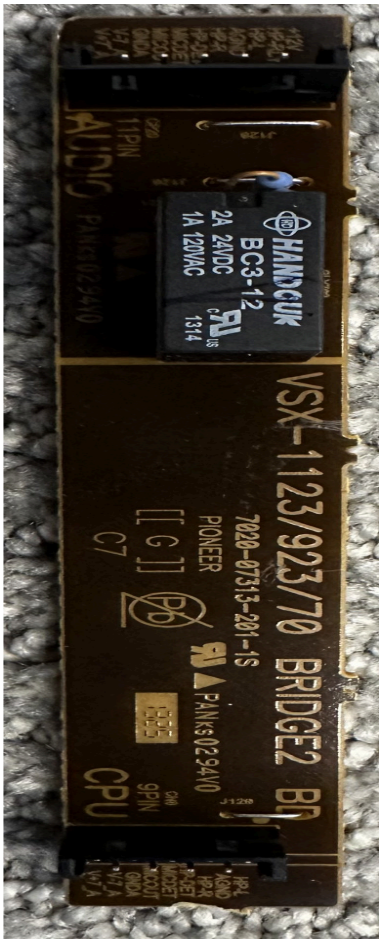
STEP 3: Separation of Motherboard Wiring and Pins

4. Non-Electronic Component Explanation

Description	Photo
Metallic Motherboard Frames: The two metal frames shown on the right are protective frames for the inner motherboards. The outer plastic coating is not enough protection for the motherboards as dust can degrade on it. There are holes placed appropriately lining up with the capacitors and the motherboard ports to allow for effective air flow and to prevent overheating.	 
Radiator Frame: This frame goes over the heat sink. The long zig-zag shaped metal block is a heat sink with thermal paste attached, which needs to stay cool through effective air flow. This is why this radiator frame shown on the right is aligned with the heat sink, with the maximum amount of holes to allow for the most efficient air flow while preventing the entrance of big dust particles.	

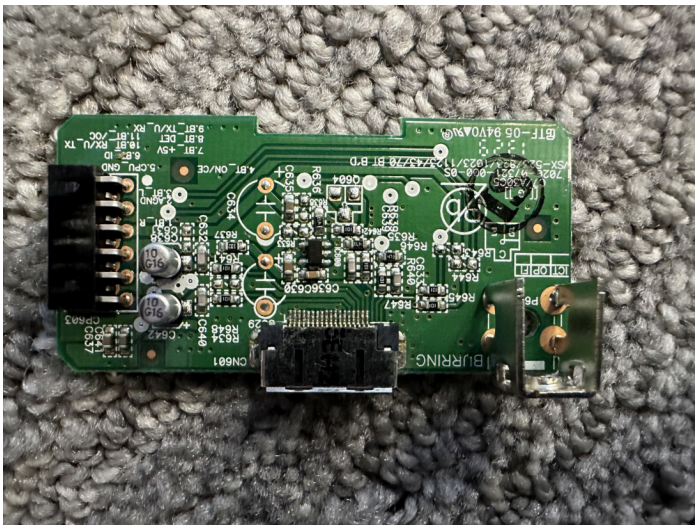
Heat Sink: The Heat sink is a component designed to dissipate the heat from the electronics overtime without the use of fans. The metal is bent into a shape with increased surface area to increase the contact of the heated metal with the cooler air. The processors of the main control board are placed directly onto this board with thermal paste in between them to increase conductivity. This maintains the system at a lower temperature and prevents overheating.	 
Front Control Panel: The front panel of the system contains the various audio controls and the basic functionality buttons like power and streaming device switch.	
Front Control Knob: The front panel of the system contains the various audio controls and the basic functionality buttons like power and streaming device switch. This knob works using a rotary pulse generator to change the volume and channels.	

5. Electronic Component Explanation

Description	Photo
Video PCB: This circuit board is dedicated to processing video signals received from the front panel. It allows the receiver to switch between video sources like Blu-ray, consoles, and cable boxes. This board plays a crucial role in video distribution as it manages the HDMI signals for control of other devices.	
Audio Bridge Board: A bridge board can route signals from any section of an AV receiver, but in this case, it routes audio signals processed by the CPU. The audio bridge board transfers processing from the CPU containing audio signals to the video board. This allows for more effective signal flow rather than every single CPU signal stemming from the CPU power board. The bridge is a physical board, as there is a 4 pin CPU cable on the right side, and a 5 pin AUDIO cable that plugs into the video board.	

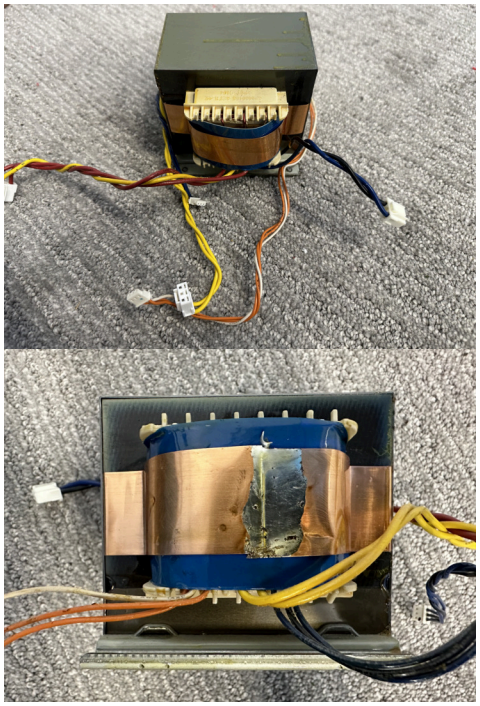
Connector Piece:

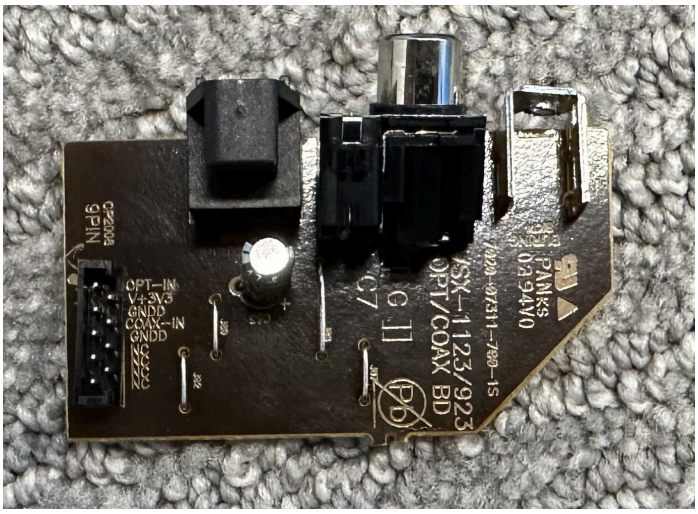
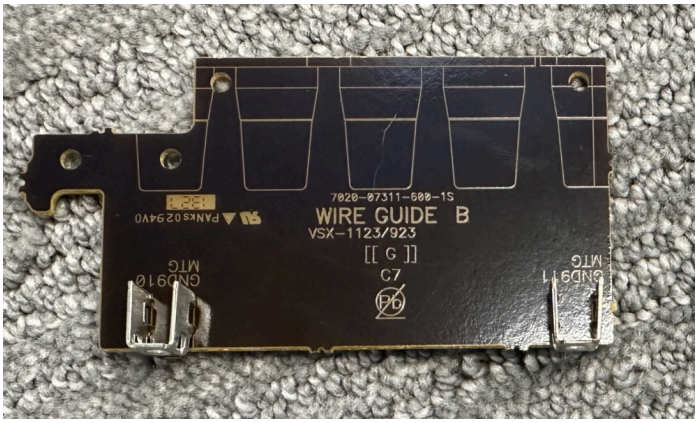
The connector piece does not have a serial label imprinted on the circuit board because it just serves as a power connector from one circuit board to another. The groove on the top and the metal protrusion on the bottom right corner are designed purely for fitting into the flat sides of the receiver panels. It allows for two of the boards, the audio amplification board as well as the audio bridge board, to be oriented vertically at 90 degrees in order to save space inside the receiver. Connectors like these allow for maximal air flow in the receiver.

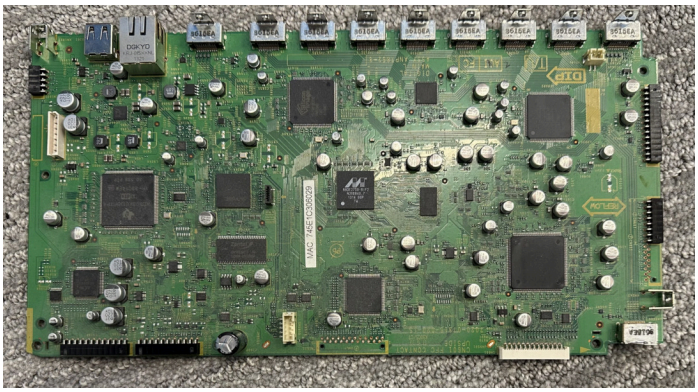


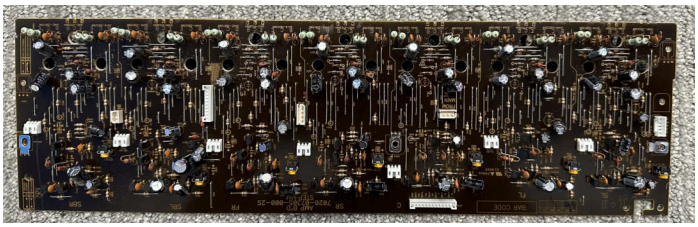
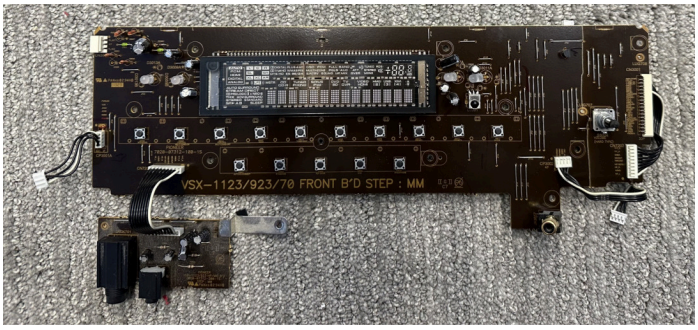
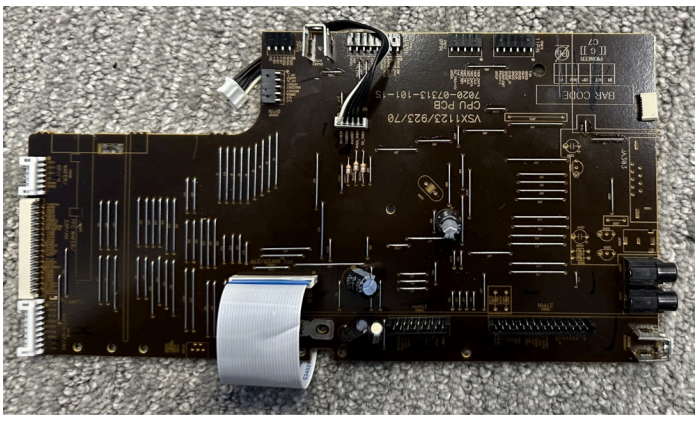
Transformer:

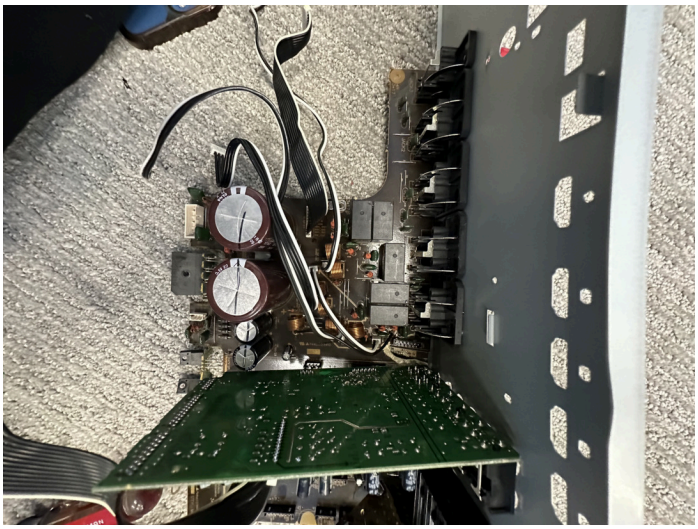
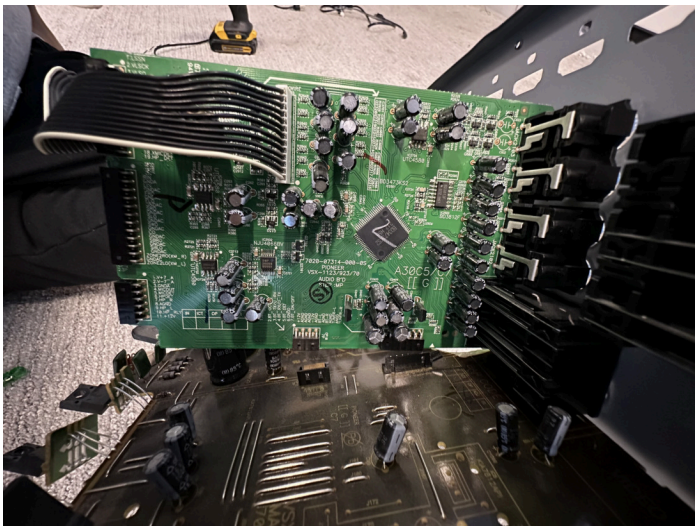
The transformer is the largest and heaviest component of the receiver. The purpose of the transformer is to allow the receiver to continue electrical transmission at higher voltages, while preventing loss due to heating of wires. The reason the transformer is heavy is due to the large copper coil on the inner section. The power is then transferred to other circuits, hence the 4 power wires stemming from the transformer.



<u>COAX Board:</u> This board is the main operating device and regulator for the coaxial cable. The coaxial cable is the thick copper wire bunch covered in wire coating that is the main connector between audio and video signals. The 9 pin connector on the COAX board allows for regulation of the coaxial cable's current and signal functionality.	
<u>Wire Guide:</u> The wire guide is considered an electrical component because it is a direct attachment to the motherboard, however, there are no actual electronics in this device. It acts as a 90 degree angle connector between the CPU PCB and the back panel frame to allow for structure. Certain wires are wired through the four holes located at the top side of the board.	

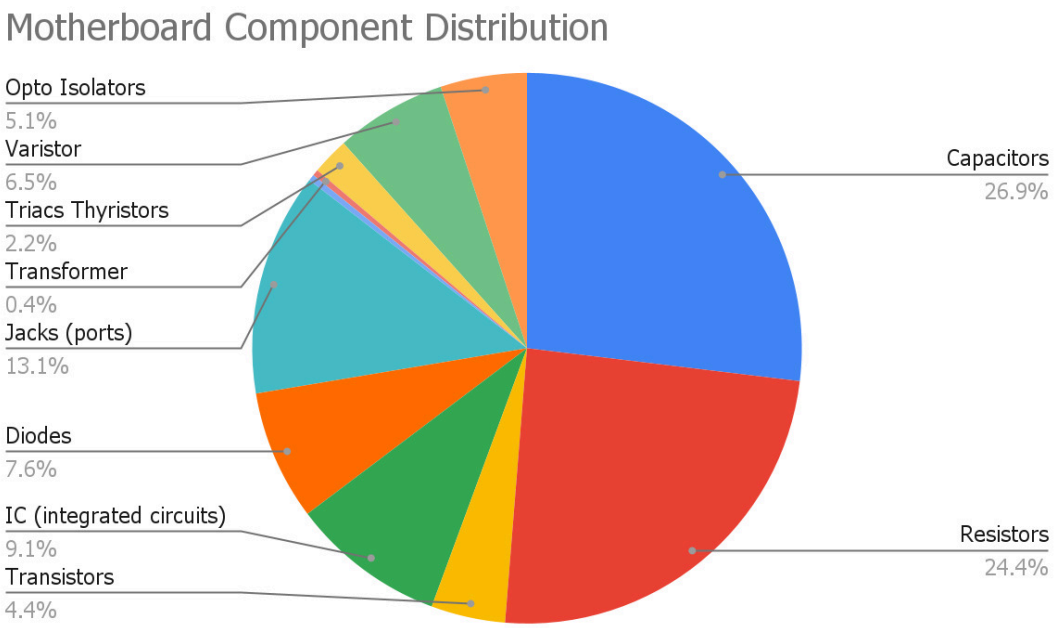
<u>Main Audio Board:</u> The main audio board is used to process all of the audio signals inputted by the user and the speakers connected to the receiver. The processor is the square piece rotated diagonally towards the right side of the board. The reason there are so many longer capacitors on the main audio board is because audio amplification happens and sometimes more power than ideal is inputted. The capacitors are the cylindrical tubes vertically stemming from the board.	
<u>Back Side of CPU PCB:</u> The CPU PCB back side displays the computer motherboard-like functionality. At the top, the power club ports are visible just like in a computer. However, multiple mini processors are included because different types of information processing is required, for audio, video, as well as platform functionality.	
<u>VSX Bridge Board 1:</u> The VSX bridge board is the biggest bridge board in this receiver as it has a 23 pin and a 21 pin connection stemming from the main CPU power board. All of the CPU audio and video signals have to stem to this bridge board to complete processing and then be sent back to the front panel board.	

Amplifier Board: The AMP board is responsible for amplifying audio signals so that they can drive speakers at a higher power level that is not always necessary. This ensures that power is effectively used. The amplification pattern can be seen as repetitive lines across the horizontal section of the board, with each set of lines coupled with capacitors at the top of the board.	
VSX Front Board: The VSX front board is the panel directly underneath the front controls side. It contains the display component which shows the current status of the receiver, including volume levels, input source, and sound mode. The main purpose is to process the user's input and send signals to the main CPU via a cable to the internal microcontroller. This cable is present on the bottom left corner of the board.	
CPU PCB: In the AV receiver, the CPU (central processing unit) PCB (printed circuit board) serves as the central controller for the device. It's responsible for running the receiver's firmware, controlling input/output (sound processing), as well as general signal decoding and processing.	

Power Supply Board: The power supply board is responsible for converting alternating current (AC) from the wall outlet into direct current (DC) used by the different receiver components. The two large capacitors (cylindrically shaped) smooth out the output from the rectifier to deliver a more stable DC current while also temporarily storing current in case of minor ripples in current.	
VSX Audio Board: The audio board decodes digital audio signals from various formats such as Dolby Digital, DTS, and PCM. The audio board contains DACs that convert digital audio signals into analog signals that can be input into speakers. This board also is responsible for all the signal processing for audio enhancements, equalization, and room correction algorithms.	
Back Control Panel: The back control panel contains all of the ports for the HDMI cables, display in and out cables, DVD cables, as well as knobs for controlling each zone's sound/sensitivity. Some of the electrical cables are connected directly to the back control panel as a structural means.	

6. Motherboard Component analysis (Across 8+ circuit boards)

Component	Quantity
Capacitors	74
Resistors	67
Transistors	12
IC (integrated circuits)	25
Diodes	21
Jacks (ports)	36
Heat Sink	1
Transformer	1
Triacs Thyristors	6
Varistor	18
Opto Isolators	14

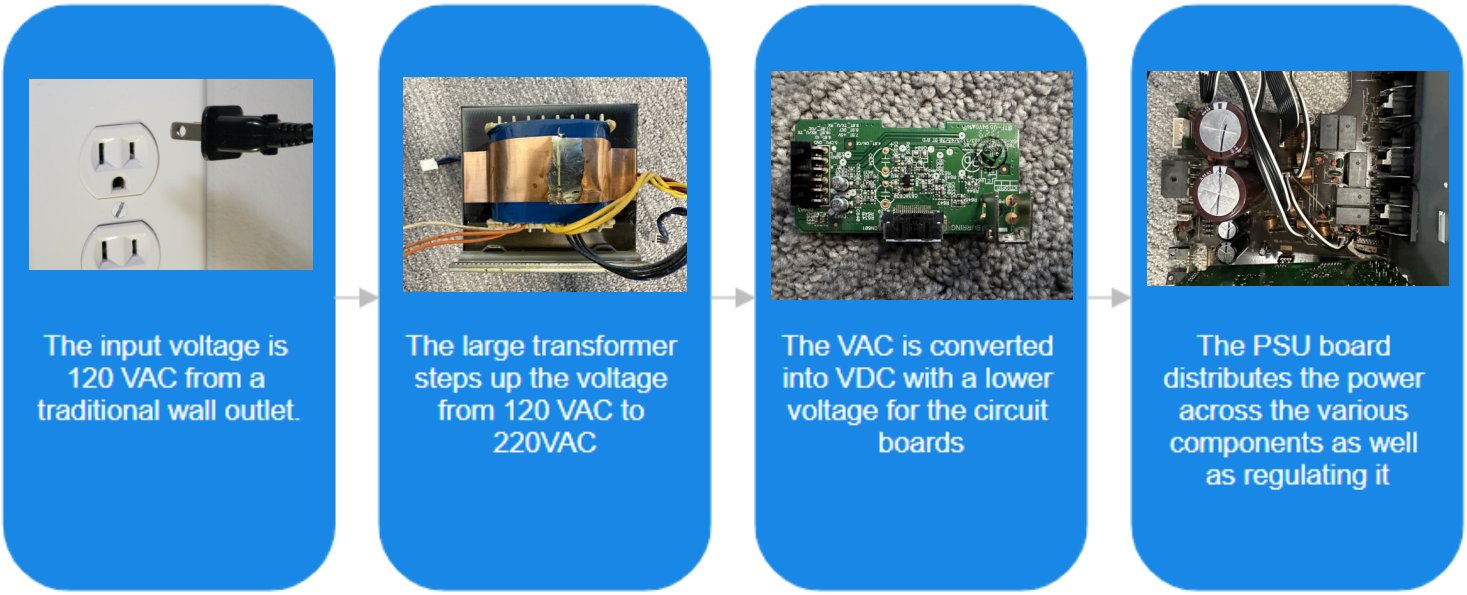


7. Findings

After analyzing the parts using the names of the products inscribed on each piece of PCB we were able to determine the model number and purpose of each of the parts. Through this we saw the flow of commands, power as well as how signals were taken in from the Television and relayed it to the speakers.

Power Flow:

The power going into the receiver is the AC current from a traditional outlet. This power must be converted into a DC current for the circuit boards and display. The Input voltage is 220 V and on average in use it consumes 550W and .01W on standby.



Radio Signals:

The Radio signals and the commands flow from the TV to an HDMI cable connected to the back panel of the receiver. This is then transmitted to the CPU board and signal amplifier which then either through using radio signals or other cables connect to the speakers in order to provide them with the commands to play the proper sound at a certain volume.

Control Flow:

1. **Choose Input**: Pick where your audio is coming from (like a DVD player, game console, or radio).
2. **Select Mode**: Decide if you want regular stereo or surround sound.
3. **Adjust Volume**: Make it louder or quieter to your liking.
4. **Fine-Tune Sound**: If needed, adjust the bass, treble, or other sound settings.
5. **Setup Surround Sound**: If you have multiple speakers, set them up for the best sound experience.
6. **Switch Between Inputs**: Easily switch between different devices connected to your receiver.
7. **Control Network Features**: If your receiver can connect to the internet, control streaming services or play music from your phone.
8. **Change System Settings**: Customize settings like display brightness or network settings.
9. **Manage Power**: Turn the receiver on or off, or set it to standby mode to save energy when not in use.

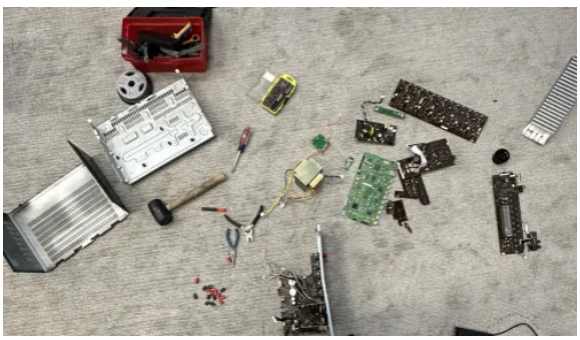
8. Conclusion

In conclusion, our exploration into the reverse engineering of the Pioneer VSX 1123 receiver as Team Overdrive 1696Z has been an enlightening experience. Throughout this challenge, we have gained invaluable insights into the field of audio engineering, an area marked different from our prior endeavors in assembling computers. By dissecting the complex layers of this receiver, we have familiarized ourselves with advanced audio processing circuits and the roles of specialized components like DACs, amplifiers, and custom processors.

This intricate network of wiring and multi-channel output systems in the receiver has broadened our knowledge far beyond the simpler single processor configurations in standard computers. This experience increased our technical expertise but also our problem-solving skills as it was not simple to disassemble the multiple inner motherboard components.

Furthermore it provided us with key understanding of certain components which are common in most pieces of electronics such as transformers, resistors and capacitors. This knowledge could potentially allow us to see defects and faults in pieces of technology and provide skills of repairing and analyzing different technology.

Overall, the insights and skills gained from this challenge are similar to those involved in our VRC robotics, and ignite our creativity that will be required throughout our lives.



9. Resources and Sources:

- https://www.google.com/search?q=pioneer+vsx+1123&oq=pion&gs_lcrp=EgZjaHJvbWUqDggAEEUYJxg7GIAEGIoFMg4IABBFGCcYOxiABBiKBTIbCAEQLhhDGIMBGMcBGLEDGMkDGNEDGIAEGIoFMgwIAhAjGCcYgAQYigUyBggDEEUYOTINCAQQABiDARixAxiABDIHCAUQABiABDIGCAYQRRg9MgYIBxBFGD3SAQgyMDIyajBqN6gCALACAA&sourceid=chrome&ie=UTF-8

- https://www.manualslib.com/products/Pioneer-Vsx-1123-K-3257234.html

- https://www.manua.ls/pioneer/vsx-1123-k/manual

- https://www.avsforum.com/threads/expanding-speaker-capacity-on-my-pioneer-vsx-1123-k.3252466/?post_id=61925873&nested_view=1&sortby=oldest#post-61925873

- https://www.manualslib.com/manual/471240/Pioneer-Vsx-1123-K.html

- https://elektrotanya.com/pioneer_vsx-70_1028-k_1123-k_1128-k_av_receiver_rrv4420_sm.pdf/download.html

- https://towardsdatascience.com/transformers-explained-visually-not-just-how-but-why-they-work-so-well-d840bd61a9d3

- https://gearspace.com/board/geekzone/1143344-amek-big-44-master-section-cpu-board-psu-issues.html