Title: Original Xbox HDMI Board Project

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Version: 1.0

Date: 09/07/2024

1. Introduction

- **Project Overview**:
    - I chose to make an HDMI board that will replace the AV port on the original XBOX. It will take the digital signals from the XBOX's GPU using cables and then it will be passed through the circuit board giving clean HDMI output at the end.
- **Motivation**:
    - I chose this project because it requires me to use all possible tools and ways of designing the most optimal design. I need to make a schematic, design the proper PCB and because I am a huge fan of old consoles, and I love to repair and bring them up to date. The original XBOX was extremely flexible in terms of modding and therefore this is possible. And I want a good HDMI output solution.

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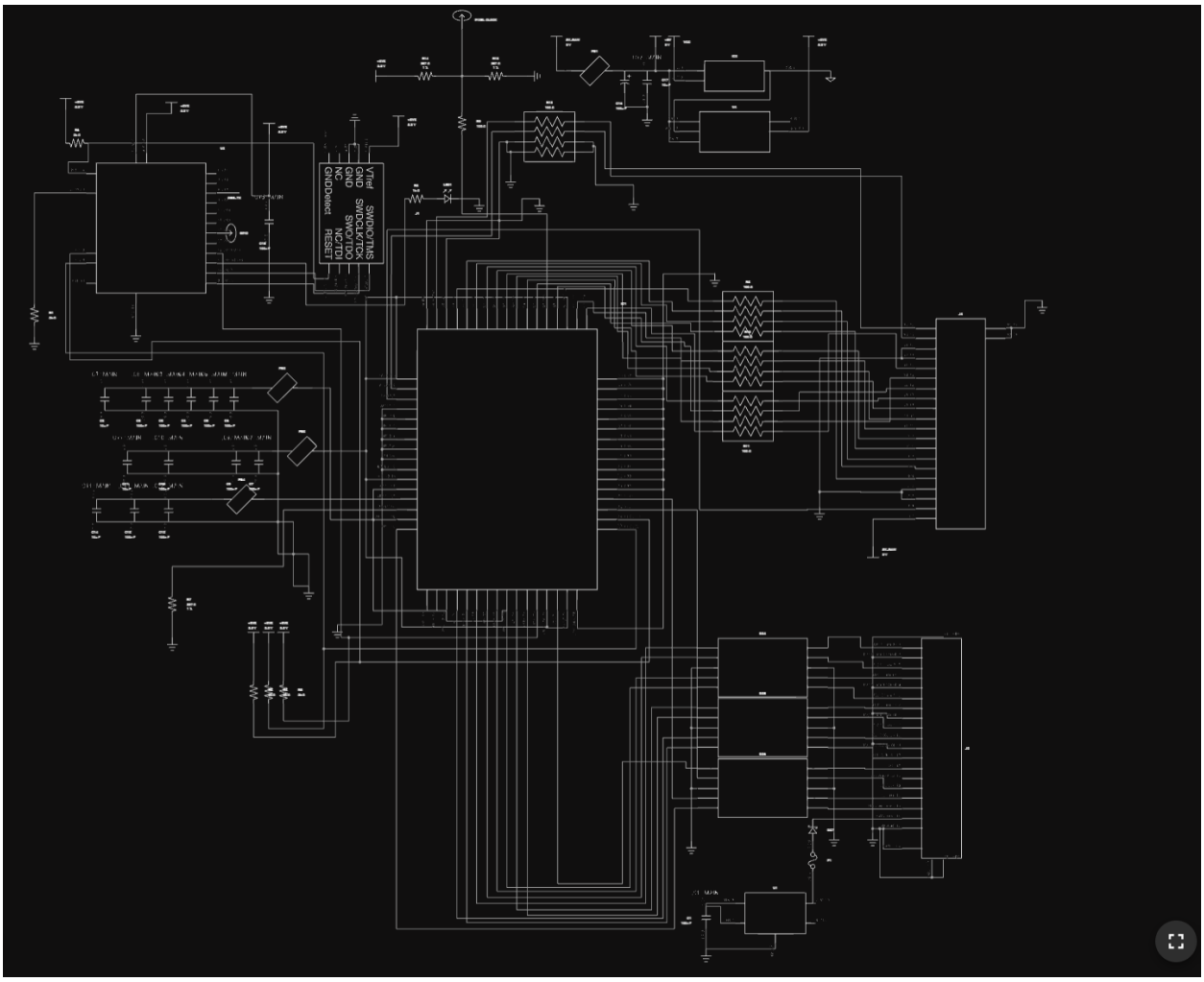
2. Design Process

2.1 Schematic Design

- **Tools Used**:
    - I used Flux.ai to design the schematic and PCB. Flux.ai has amazing resources and documentation as well which I used to quickly fill in any knowledge gaps that I may have had. In the PCB viewer, it is amazing that it allows a 3D view and a 2D view for maximum configuration.
    - ChatGPT4 was another tool that I used extensively to make sure that my design was sound electrically and logically. I have taken some electronics classes in the past as well, so I know what to look for, but ChatGPT is very good at helping me brainstorm.
    - KiCAD I used briefly to check out some custom parts that I may need such as the HDMI transmitter or a specific inductor that I could not find.

- **Schematic Overview**:



  - A screenshot of my schematic has been provided; it is quite large, so it is hard to capture it in its entirety. Some of the main components I used and needed were the HDMI transmitter in the center, I needed the HDMI receptacle connector on the right, diodes were needed to clean the signal from the transmitter to the receptacle, The power circuity is on the top right with two voltage regulators one for 3.3V and the other for 5V. On the left is the micro controller, I also added a place for the ribbon cable to connect to on the middle right which is where the ribbon cable will connect to the original XBOX's GPU. Other components present are resistor arrays, I have inductors, regular resistors, capacitors for decoupling and much more.

2.2 PCB Layout

- **Layer Utilization**:
    - I decided to go with a multilayer approach with my circuit board because I know that I would need the extra space allocated to me by the extra trace room but also because I am working with signals which are very sensitive and require special attention.
    - The multilayer design is used to make a cleaner design but as I mentioned before also needed to ensure the form factor is small enough to fit in the Original XBOX or at least not too big.
    - The top layer was used extensively for signals because it would be the strongest for this, while the bottom layer I rarely used unless I really needed it for a ground or something else. The internal layers were also used extensively to route the different components to the HDMI transmitter which had the most pins.
- **Routing Techniques**:
    - I had a massive issue with four differential pairs of HDMI signals that I had to carefully manage and do each trace individually so that they would have a close distance to the diodes. I resolved the issue by isolating each pair and at the end making sure they would stick together.
- **Design Optimization**:
    - At the beginning of the project, the board was very big, and I had to reduce the size significantly. Eventually I reached an adequate size that could house all the components, but I still believe I needed it to be smaller if I am to make it fit in the original XBOX without major modifications to the housing.
    - Signal integrity was improved massively by using diodes that were responsible for cleaning the signal and many different decoupling capacitors.

2.3 Custom and Imported Parts

- **Custom Parts**:
    - I only had to rely on a specific inductor part that was not on Flux, but I eventually cross-referenced it to a data specification, and I managed to narrow it down to an alternative piece on Flux that would serve a similar purpose to the part I was seeking.

3. Technical Details

- **Key Components**:
    - There were many key components but the most important is the HDMI transmitter (ADV7513BSWZ). This transmitter has all the required pins and logic that come with it to ensure I transmit a good and clean signal to the HDMI receptacle. The HDMI transmitter works in tandem with the HDMI controller which is a simple ARM Cortex microcontroller that has all the required pinouts. The big voltage regulator used to supply 5V directly to the HDMI connector is also a critical part in the design, the name for it was MIC29152WT. Admittedly, it was a bit too big for this design, but it was the best I could do at the time.
    - The HDMI receptacle or J2, is what the user will plug their HDMI cable into, and the other end will plug into their HD television directly bypassing the need for any sort of composite or component cables and disregarding the AV port. Another connector necessary was the 20 position FFC which is needed to connect a ribbon cable that will be installed on the signals from the XBOX original GPU. It basically captures the signals generated from the GPU and passes it through into a resistor array to clean the signals and prevent any impedance loss and then they are passed into the HDMI transmitter which will parse them and move them out into the decoupling capacitors.
- **Power Supply Design**:
    - The power supply approach was interesting because the plan is to use the power or at least siphon the power directly from the original XBOX motherboard. And so, I needed 5V to power the two regulators which are linked together, and they are connected to a 100uF capacitor and a 220R inductor at 100MHz. The two regulators ensure I can get a regulation of 5V to 3.3V which the large one takes care of while the smaller one does 5V to 1.8V. There was a 100uf capacitor and a filtering capacitor of 10uf.
- **Signal Integrity**:
    - For high-speed signals, I put the components closer together to ensure less travel, but I also added decoupling capacitors of 100nF, and a special inductor of 220R at 100Mhz. I also used a diode to clean the signal by running it through it and cutting off any AC interference to provide a clean signal to the HDMI receptacle.

4. Future Improvements:

- Some future improvements I will certainly work on are reducing the size of some of the components and of the board to fit better into the original XBOX and eventually just make it fit into where the AV port used to fit.
- I also want to make a bios on board a possibly make it serve as a modchip as well, so an HDMI solution and modchip combo.

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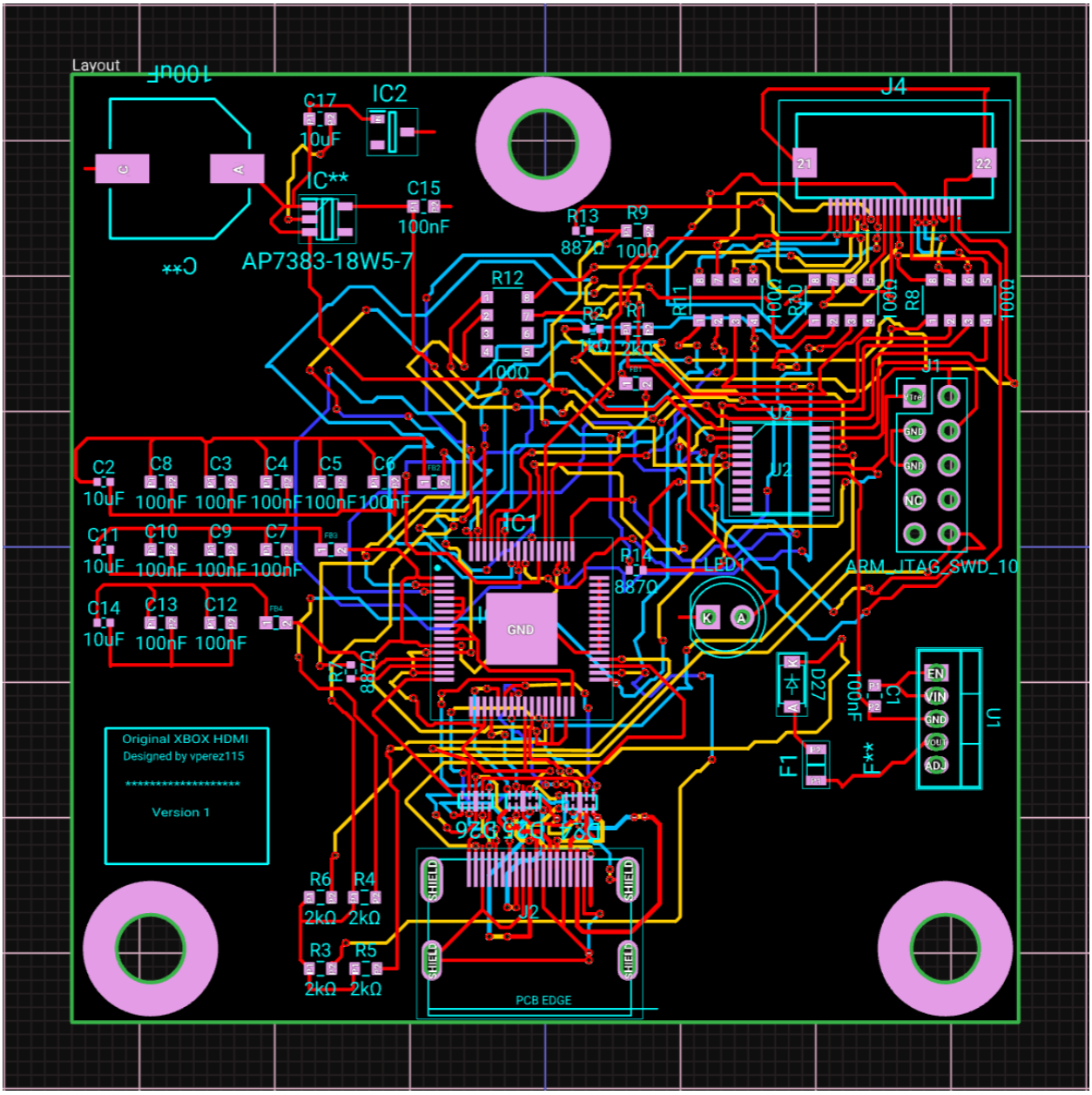
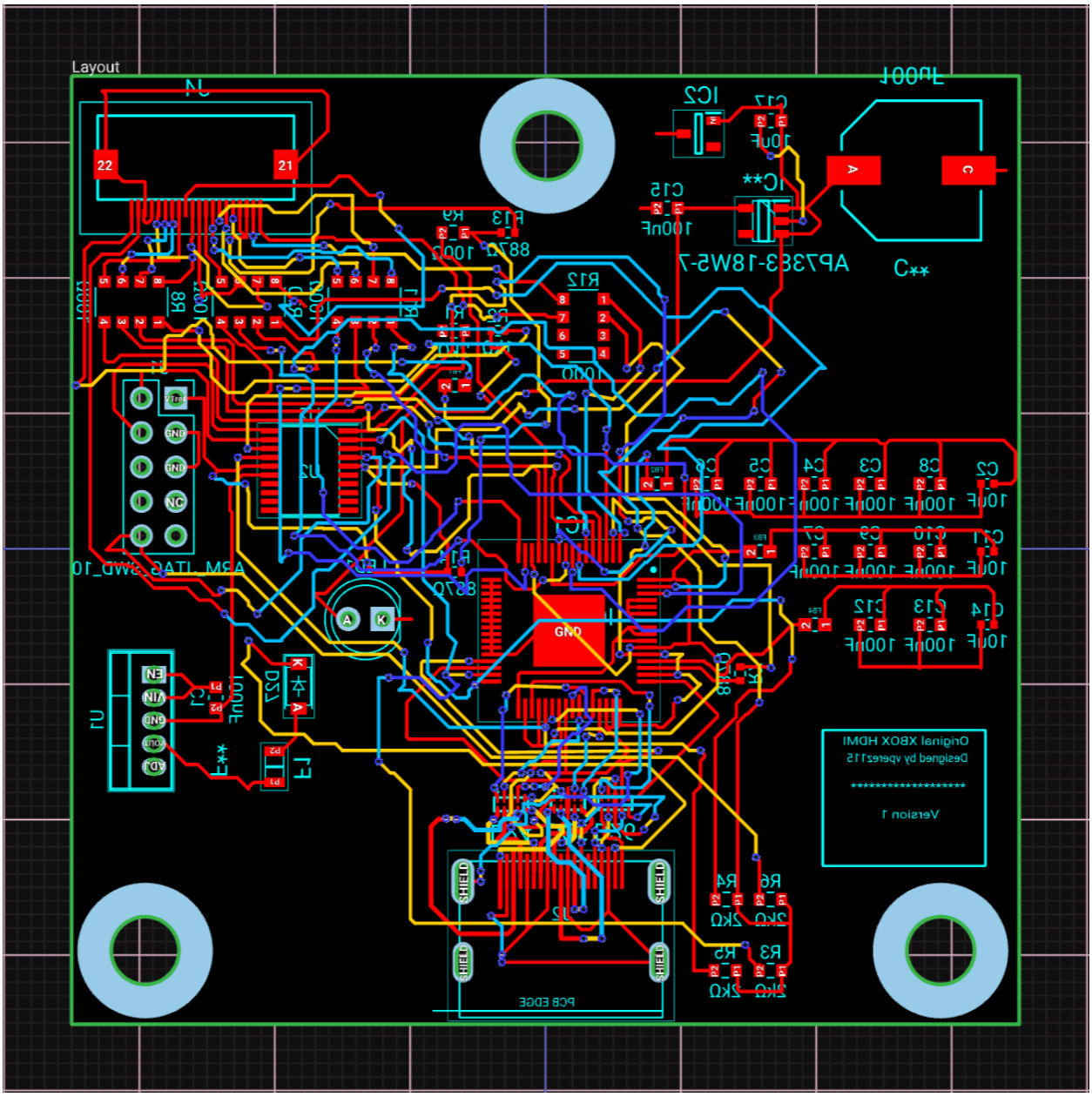
5. Conclusion

- **Summary**:
  - In conclusion, this project was very fun, and I had a great time learning and putting everything together. Although the HDMI board I built may not have the best signal integrity or the most form-fitted form factor, it is and will always be one of the best projects I have worked on. I do believe it met my expectations and I hope to continue working on it.
- **Project Link**:
  - https://www.flux.ai/techengineered/original-xbox-hdmi-board-v1?editor=schematic
- **Feedback Request**:
  - Please let me know what you think of my project! I know that it may look a mess and have some major flaws and inefficiencies, but I am very proud of it since it is the hardest and most technically involved project, I have ever done. I hope to continue improving it and maybe one day, I will build it and install it on my original XBOX to test it for real.

Appendix

- **Additional Schematics**:
    - 2D view of board, top and bottom:




Layout
Original XBOX HDMI
Designed by vperez115
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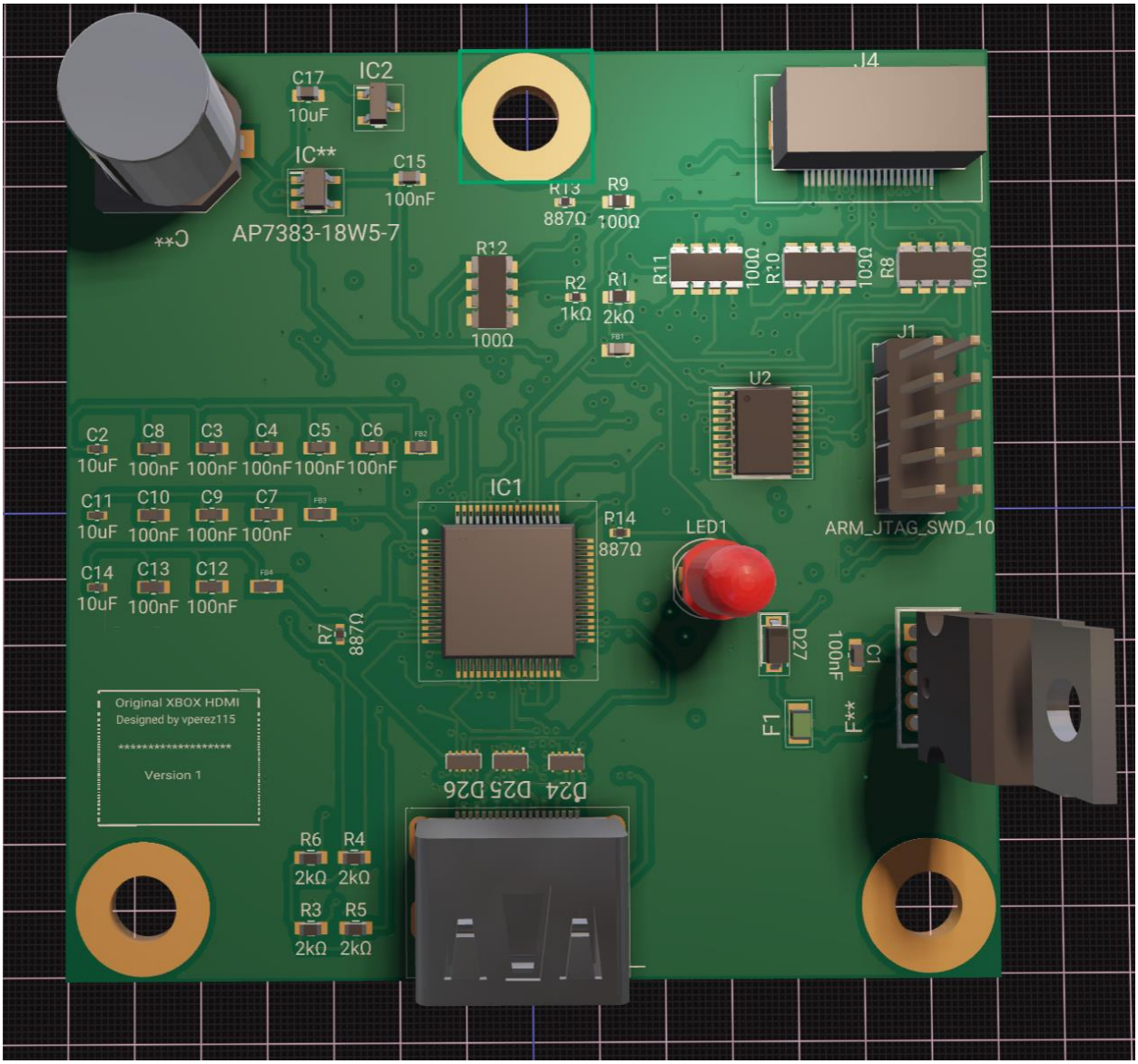
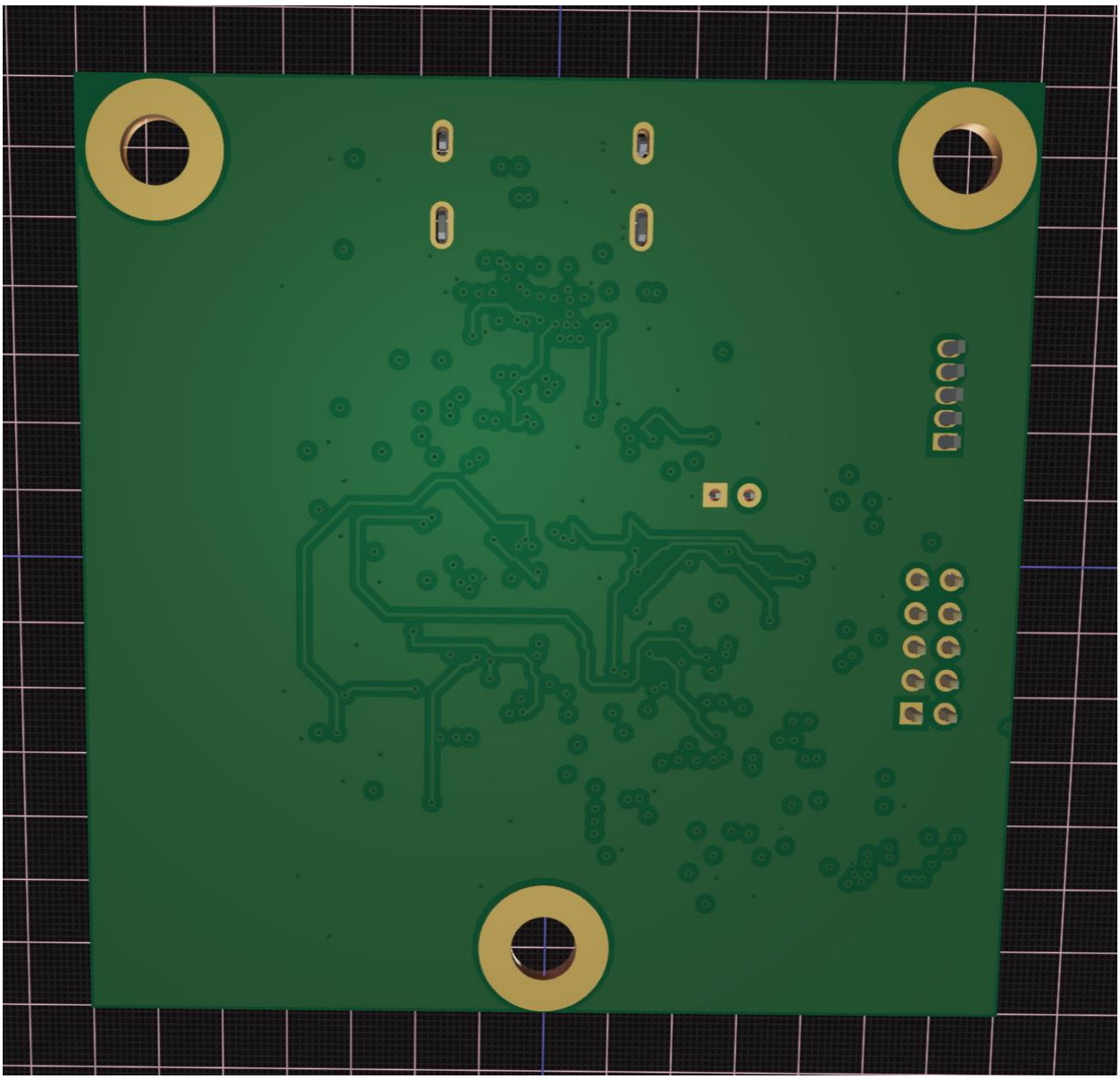
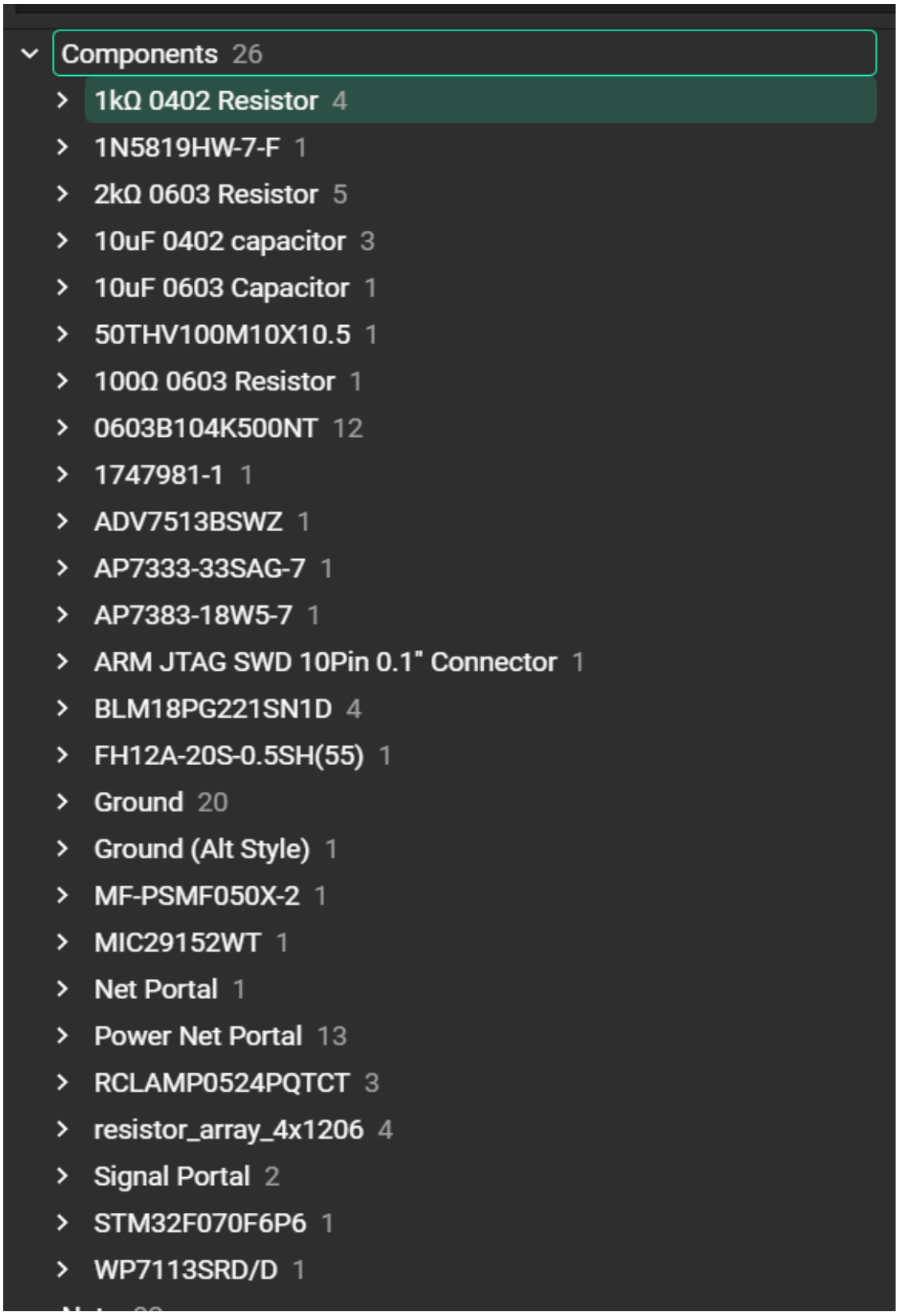
Version 1
PCB EDGE
GND
SHIELD
AP7383-18WS-7

- **PCB Layout Screenshots**:
    - High quality screenshots of 3D board render top and bottom:





- **Bill of Materials (BOM)**:
  - 

- **DRC Check Results**:
    - I attached an image of the DRC check section which shows no air wires or any outstanding issues or problems.