



EE DEPARTMENT, IIT BOMBAY

23RD MAR 2025

TUE - 08
MILESTONE - 3

STRUCTURAL HEALTH MONITORING SYSTEM
USING DSPIC33A

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MILESTONE-2

FEEDBACK

MILESTONE - 2 FEEDBACK

Instead of using Power Amplifier Module MP111, use external Power Amplifier box.

- Action: We tested MP111 but we did not get suitable amplification, so we decided to have a power select switch on our PCB through which we can choose to either bypass the external Power Amplifier or use it.

Need to speed up testing of components and trying to test complete circuit on breadboard.

- Action: We speeded up component testing and completed testing of UART Communication, Damage Index Algorithm, DAC, ADC (using DMM), Electronic Switch, MUX, INA and Clipper Circuit.

MILESTONE - 2 FEEDBACK

COMSOL simulation results were not there and it was delaying our testing process, so either finish it or leave it and move forward.

- Action: We finished COMSOL simulation and obtained required results.

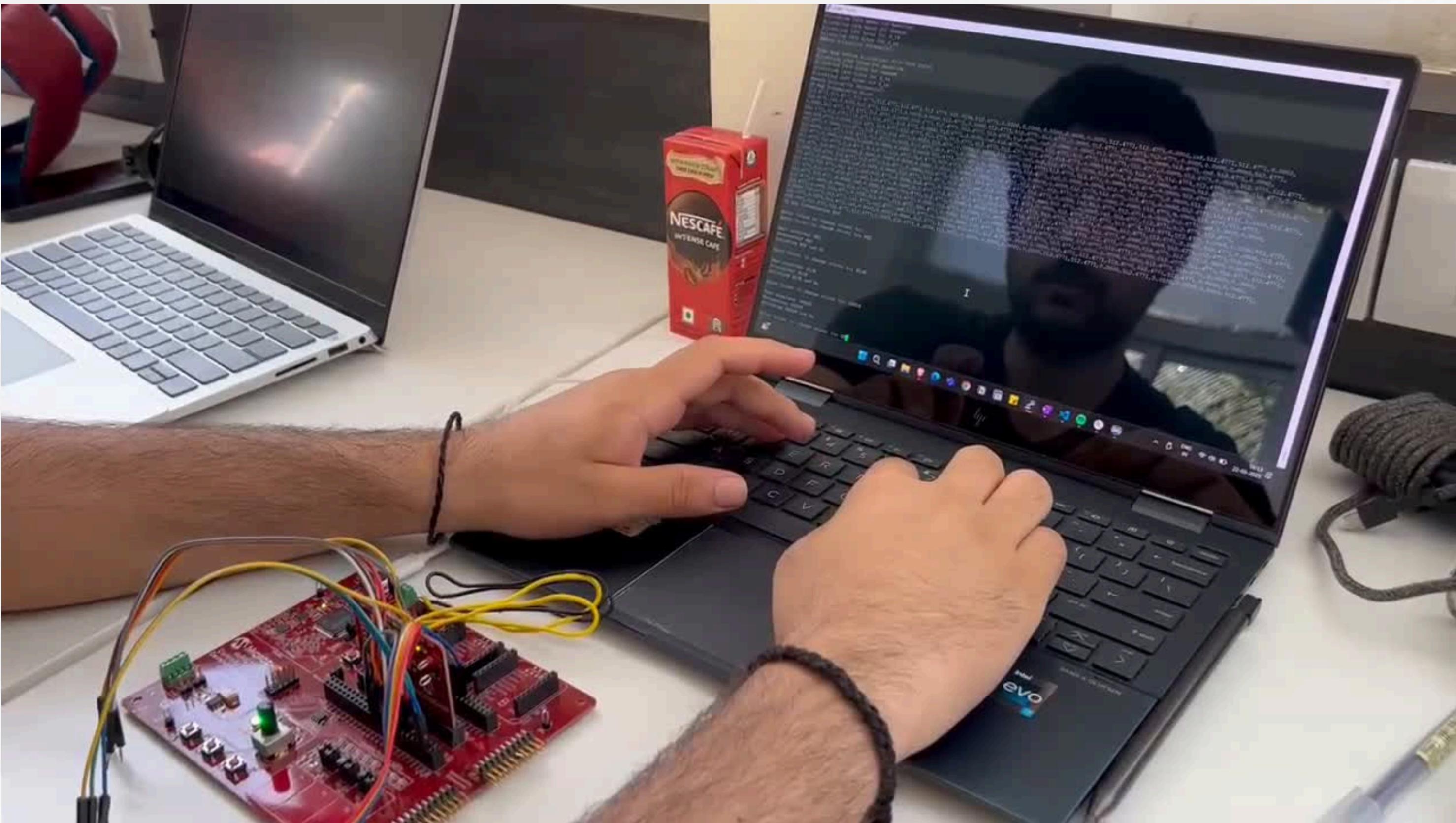
While most of the members gave time in testing the components and circuit, one of the member can parallelly start the PCB layout.

- Action: We parallelly started PCB Layout with component testing, and finished the placement of components.

PROOF OF CONCEPT

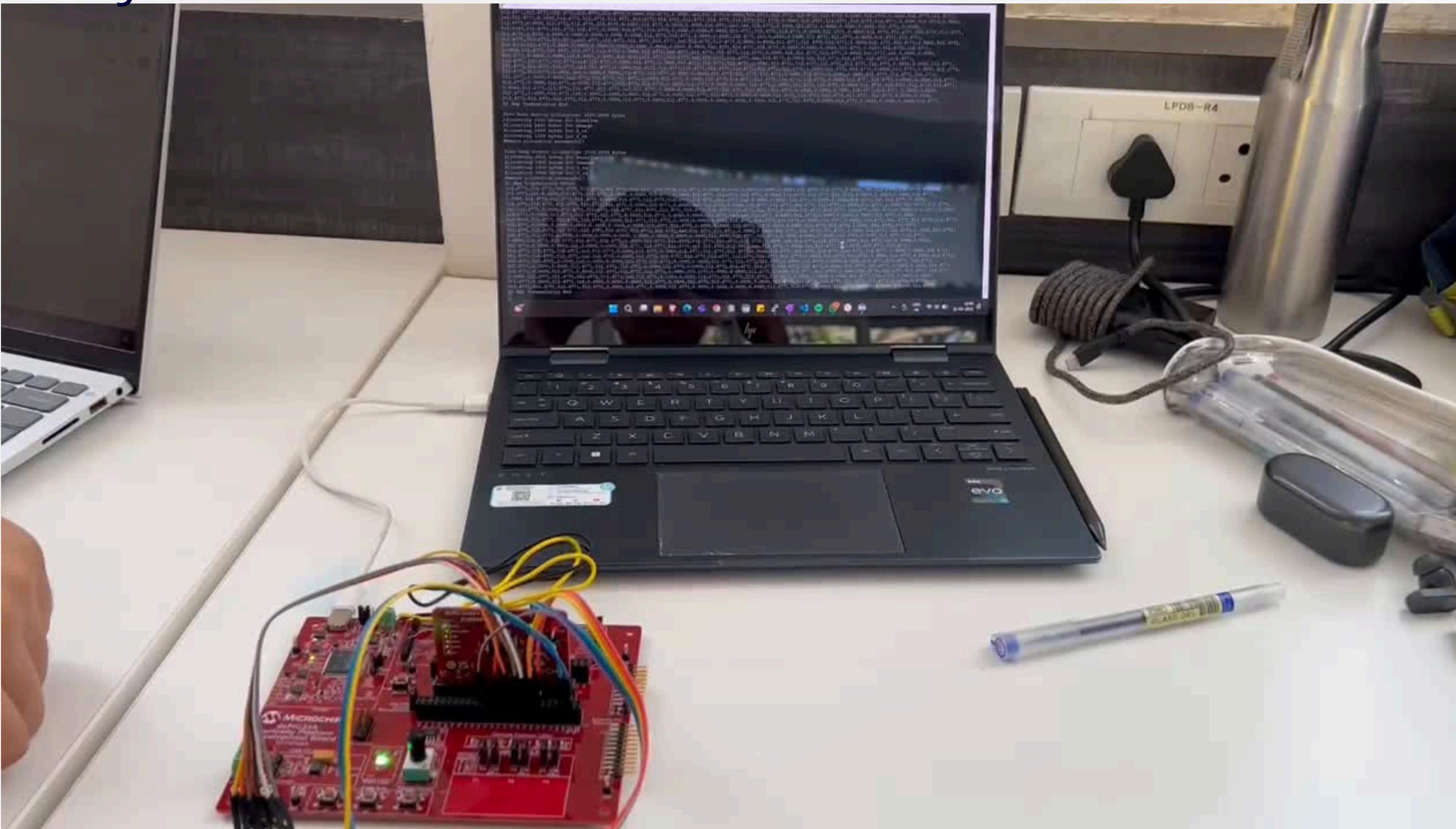
PROOF OF CONCEPT

UART COMMUNICATION SETUP



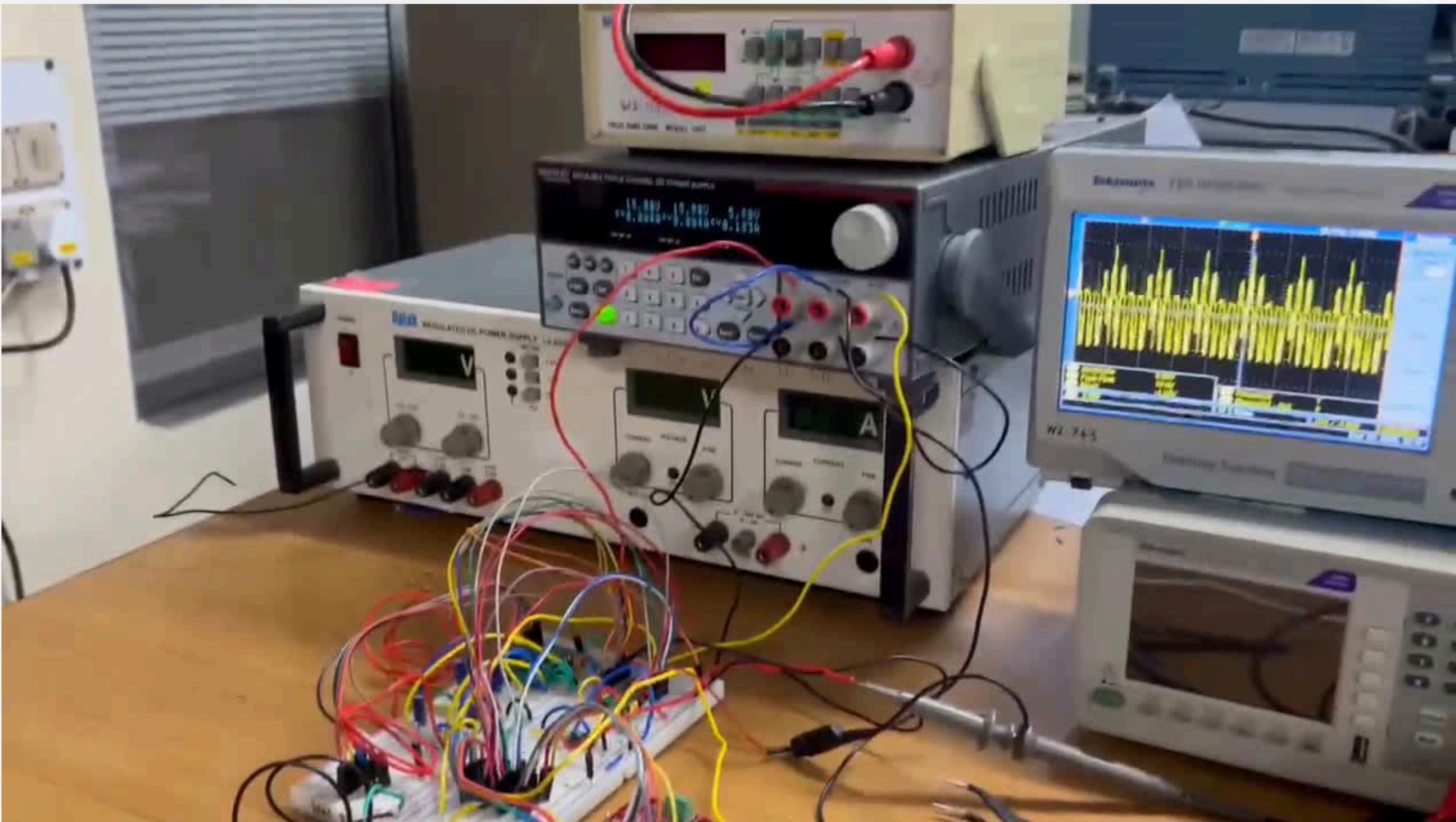
PROOF OF CONCEPT

Damage Index ALGORITHM OUTPUT



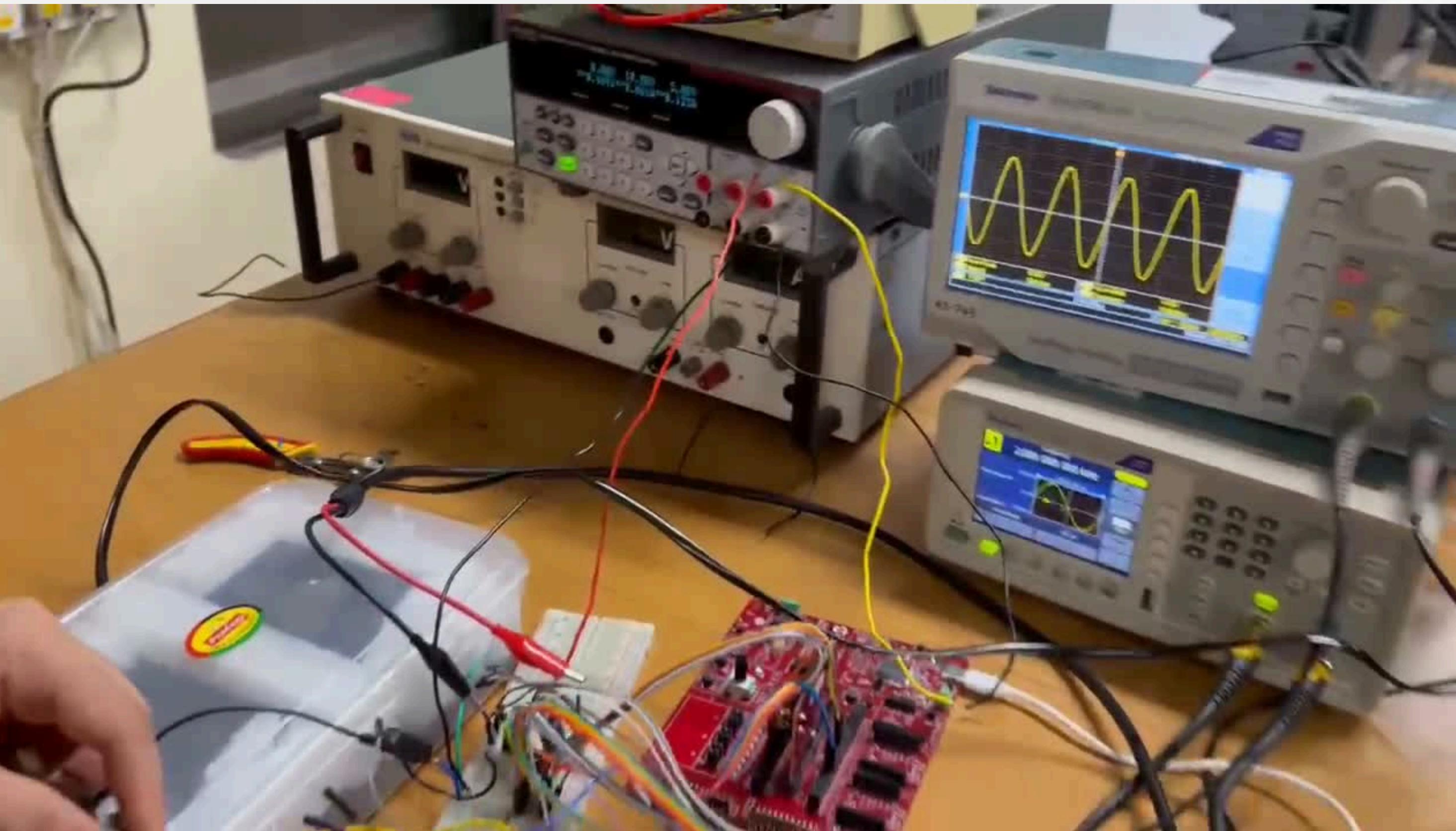
PROOF OF CONCEPT

DAC



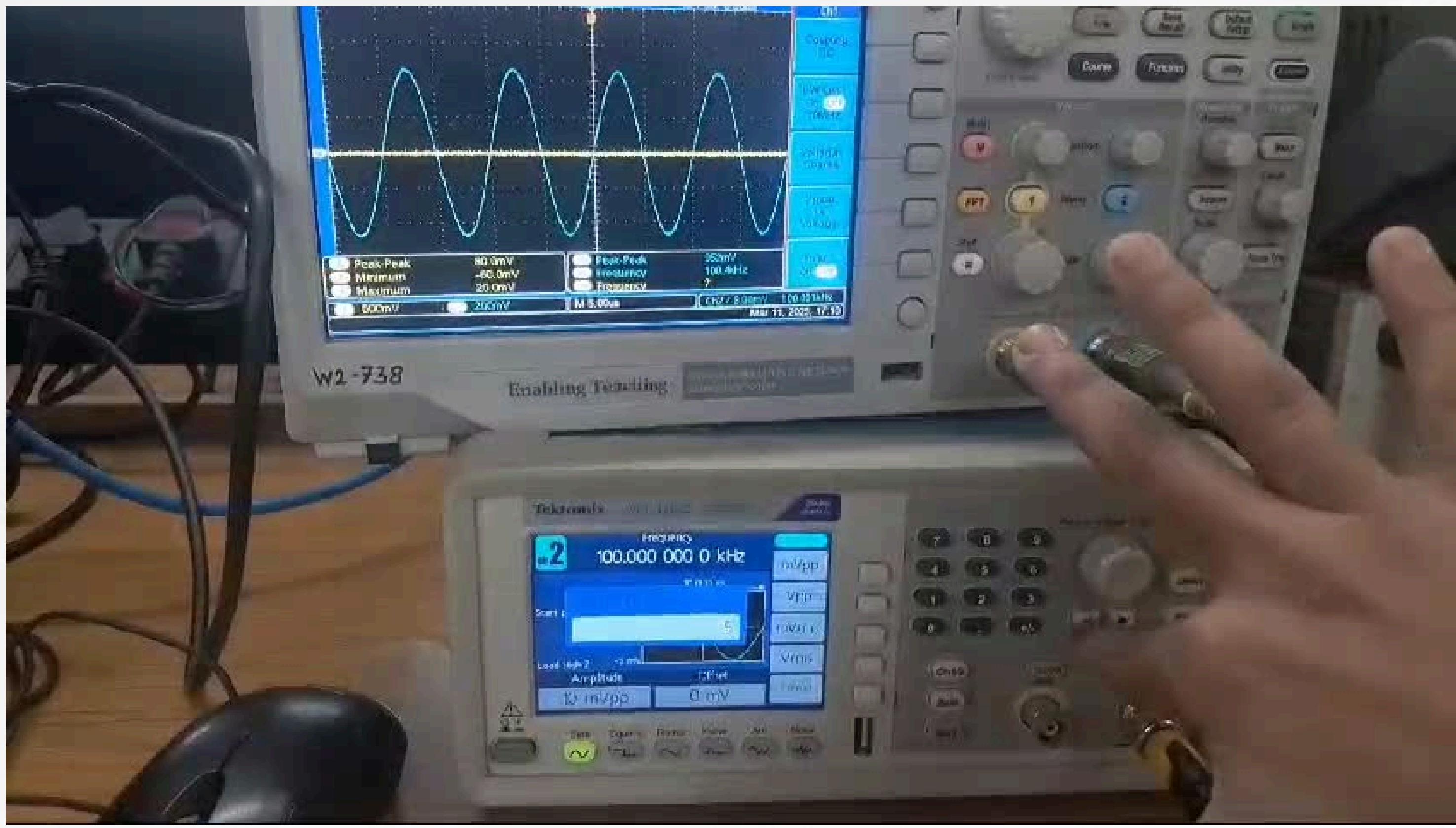
PROOF OF CONCEPT

Electronic Switch



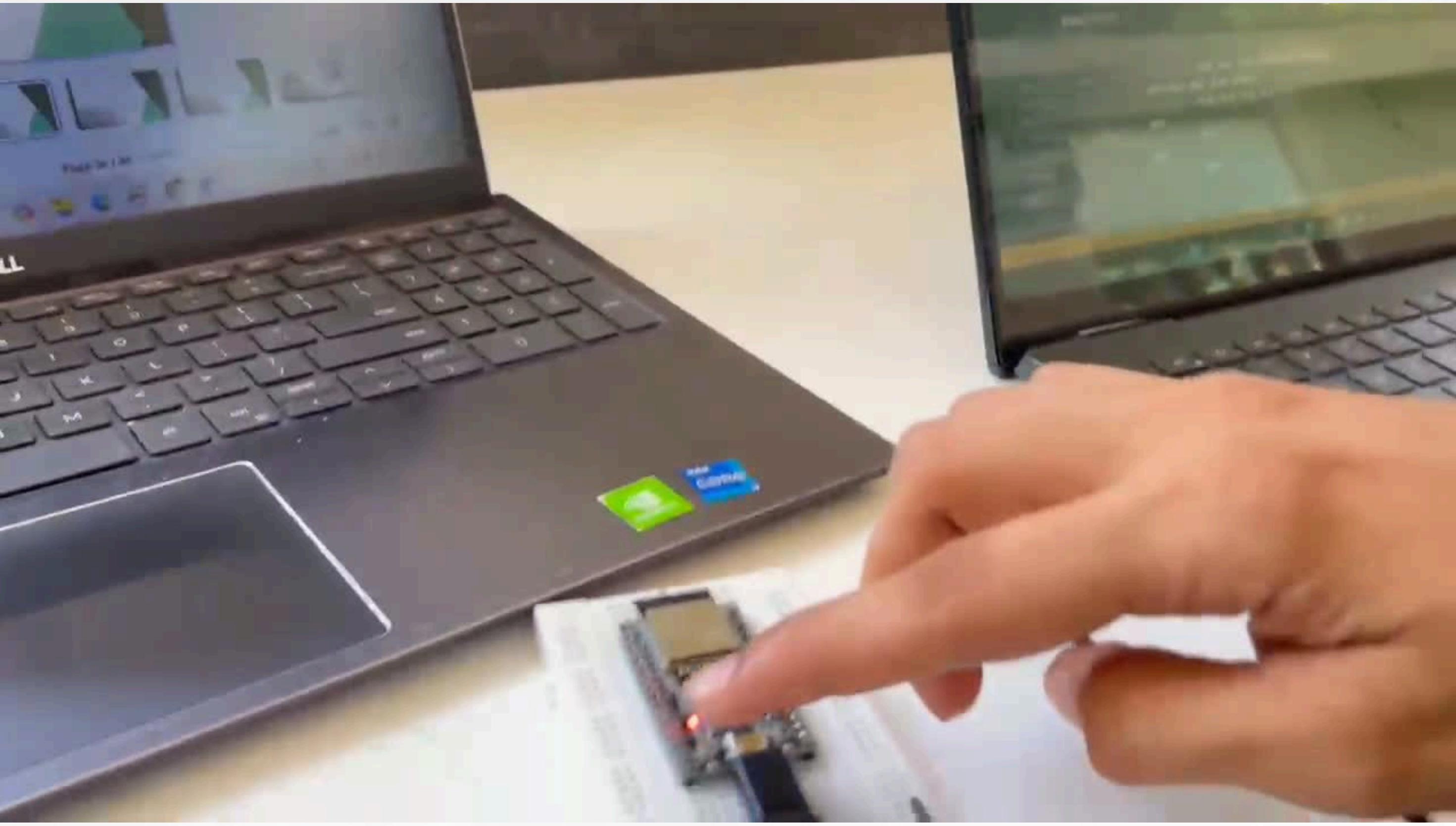
PROOF OF CONCEPT

INA + CLIPPER



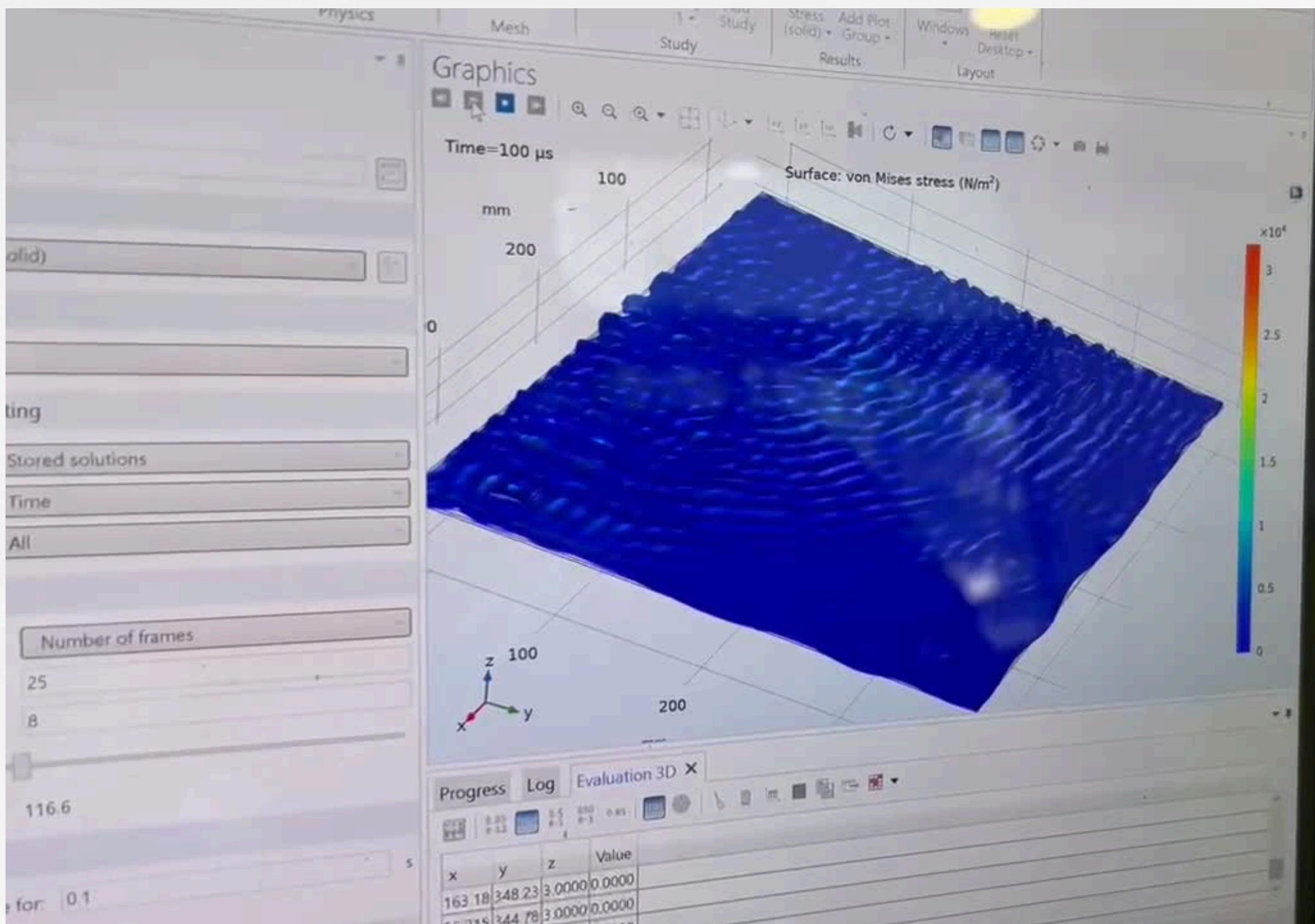
PROOF OF CONCEPT

WIFI MODULE



PROOF OF CONCEPT

COMSOL Simulations



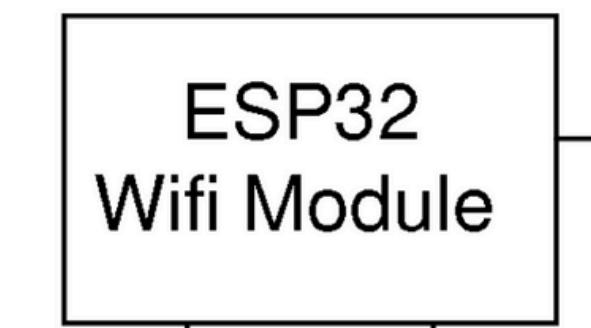
PROJECT STATUS AND ISSUES





BLOCK DIAGRAM

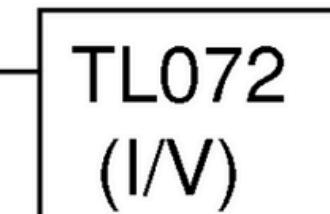
Used to wirelessly receive base model from PC and receive data values from microcontroller via UART.
 $V_{in} = 3.3V$



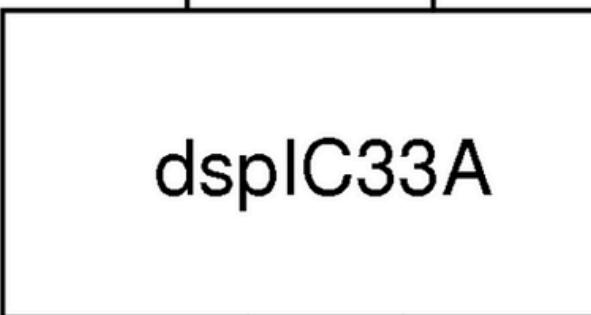
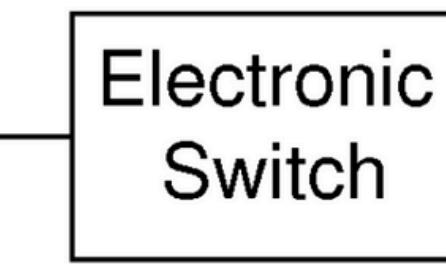
Digital Hanning Pulse to Analog Waveform
 $V_{dd} = 5V$,



Amplification of 4 for high voltage and high frequency signal
 $+V_s = +48V, -V_s = -48V, I_{out} = 15A$



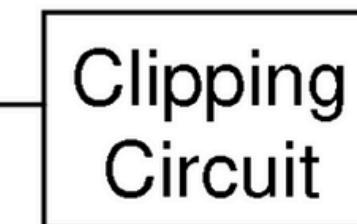
High voltage switching for selecting the PZT for transmitting
 $I = 3A, V_{dd} = 5V, V_{pp} = -48V, V_{nn} = 48V, Clk = 5MHz$



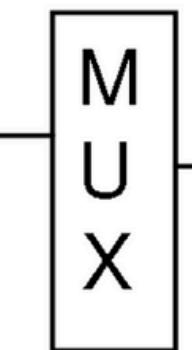
Used to store data
 $V_{in} = 2.2V \text{ to } 5.5V$



Amplify voltage from mV to 1V
 $V_{ss+} = 15V, V_{ss-} = -15V$
 $V_{in} = (\text{in mV}), V_{out} = 1V$



Clip out the of higher amplitude to bring down in suitable range
 $V_{in} \text{ range} = 0 \text{ to } 70V$
 $V_{out} = 0 \text{ to } 0.7V$



8 out 1 of one PZT is multiplexed
 $V_s = +48V$
 $-V_s = -48V,$



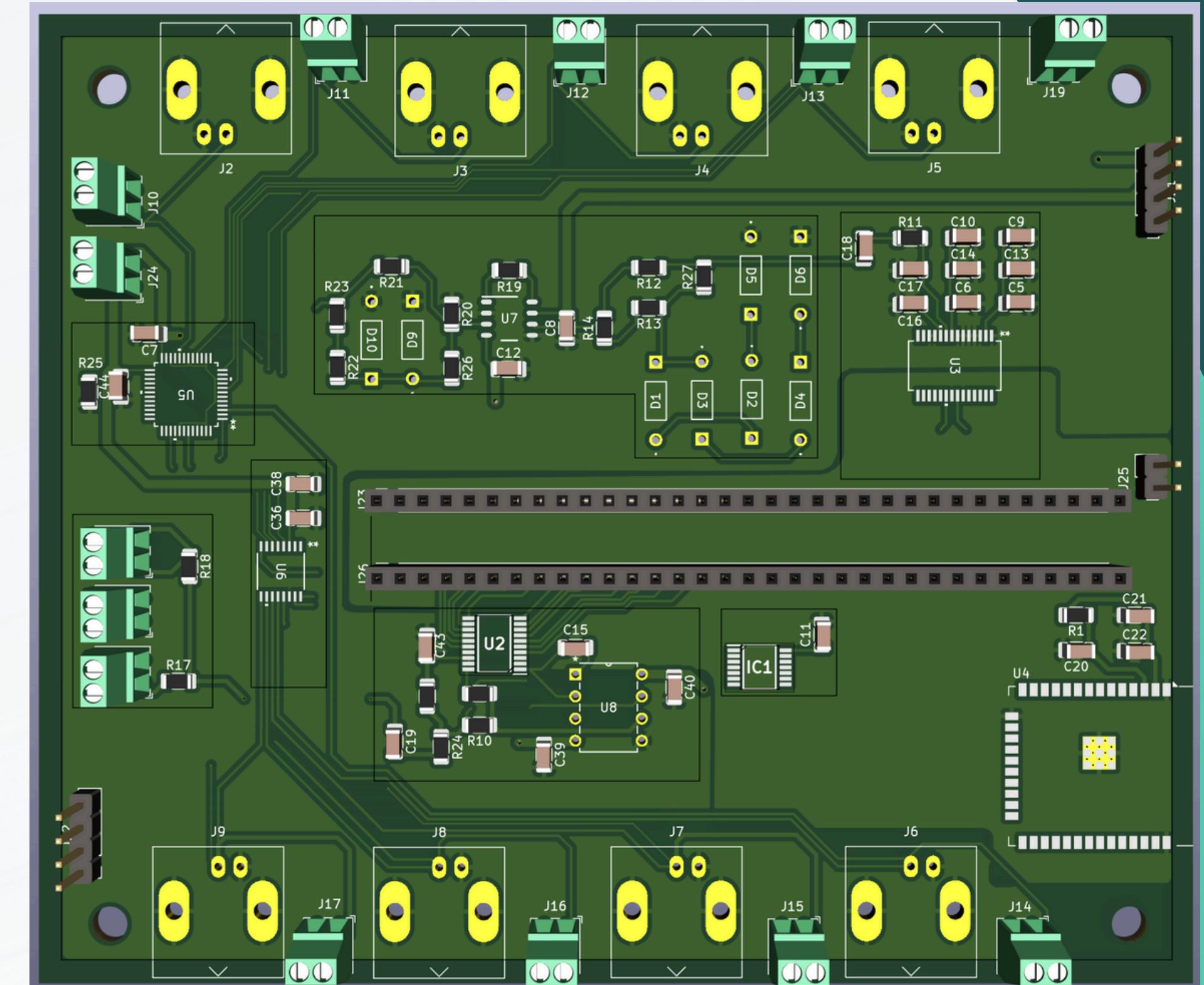
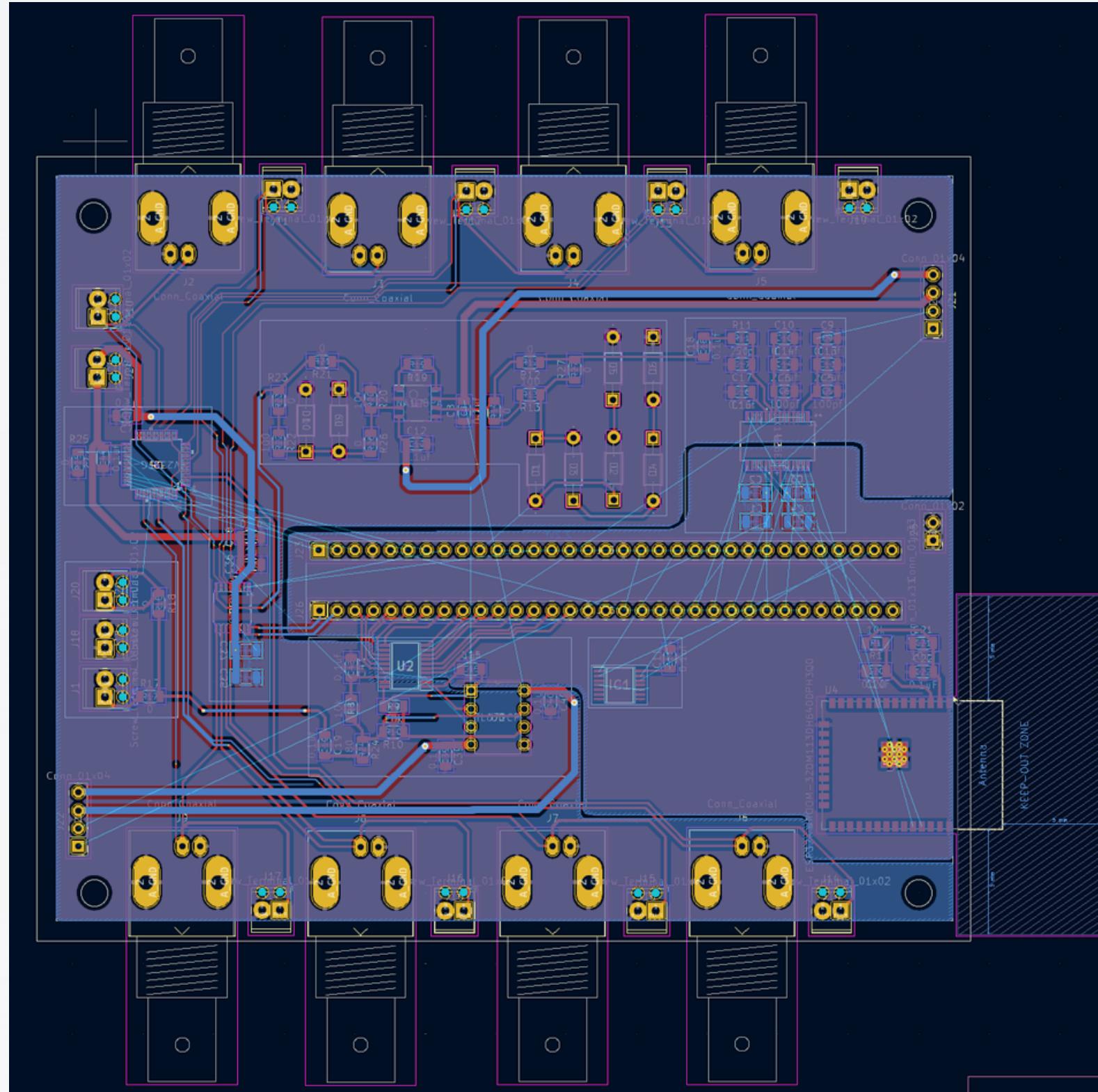
PROJECT STATUS AND ISSUES

PCB - Readiness

- Layout footprint and floorplan reviewed
- Currently in routing stage.
- Key Learnings:
 - Isolation of Analog Ground and Digital Ground is important so that noise in each side is not propagated to other. And connecting them using Ferrite Bead.
 - Spacing of components should be maintained (at least 1.5mm) so that soldering is easy.
 - Decoupling capacitors should be placed near to the power supply pin and the connection must be taken through the capacitor and not directly from the pin so that noise is minimised.
 - Transmission and Reception path must be isolated so that noise in one does not affect other.

PROJECT STATUS AND ISSUES

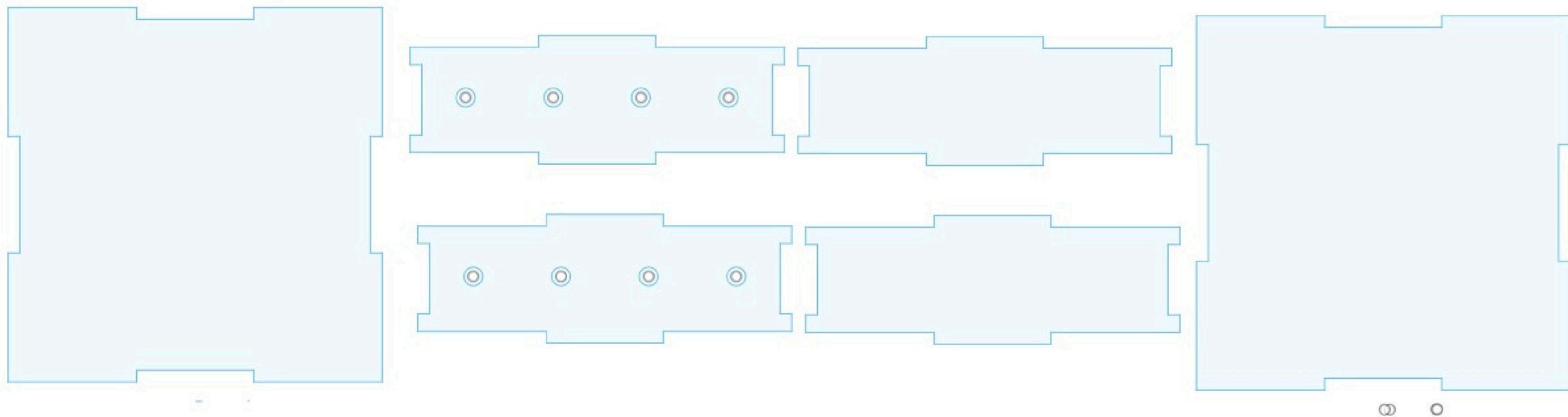
PCB layout and 3D view, until now



PROJECT STATUS AND ISSUES

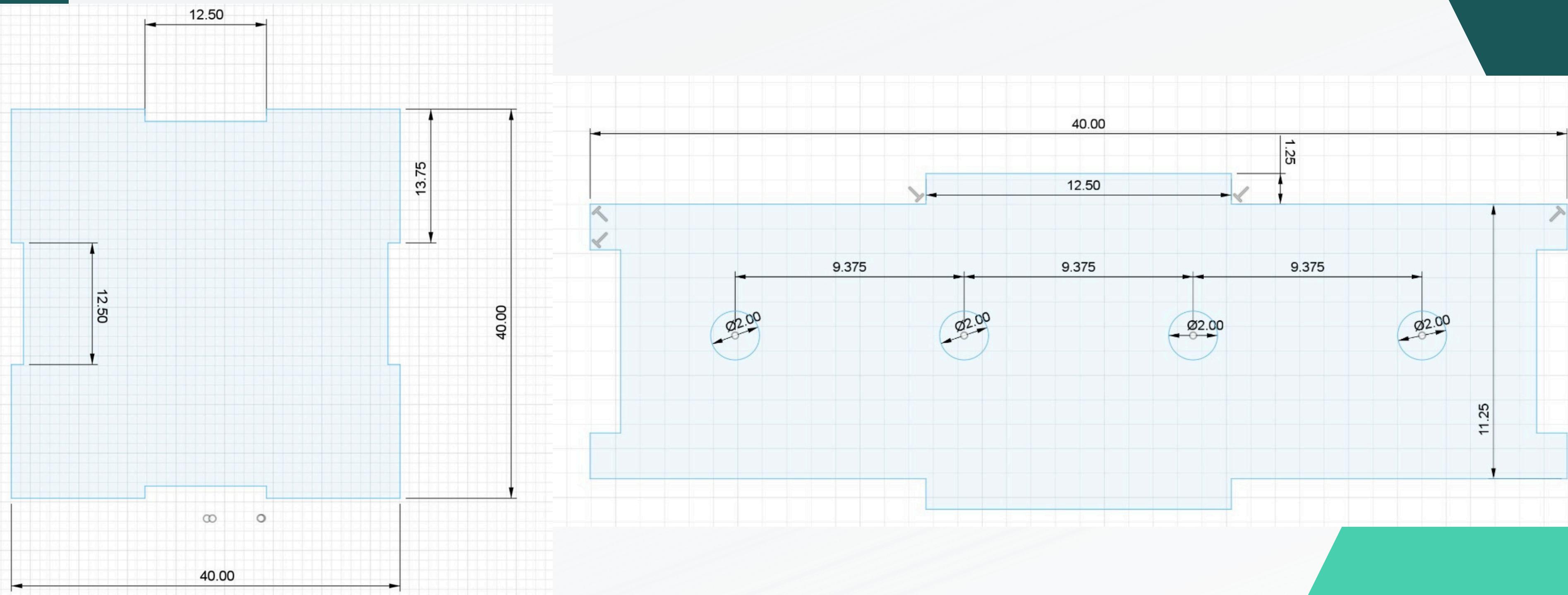
CAD - readiness

- Our CAD Model is just an enclosure of PCB, Microcontroller Development board and SMPS. Thus, we have designed a simple box with openings for heat flow and designated places for above.
- We are using simple acrylic sheets for enclosure.



PROJECT STATUS AND ISSUES

Individual parts with dimensions



PROJECT STATUS AND ISSUES

Completed Tasks -

Established UART communication between the microcontroller and the laptop.

Enter Colour to change colour to:
Enter Colour to change colour to: RED

Text received: RED
Processing: RED
Swtiching RED Led On

Enter Colour to change colour to: BLUE

Text received: BLUE
Processing: BLUE
Swtiching BLUE Led On

Enter Colour to change colour to: GREEN

Text received: GREEN
Processing: GREEN
Swtiching GREEN Led On

Enter Colour to change colour to: GREEN

Text received: GREEN
Processing: GREEN
Swtiching GREEN Led On

Enter Colour to change colour to: BLUE

Text received: BLUE
Processing: BLUE
Swtiching BLUE Led On

Enter Colour to change colour to: RED

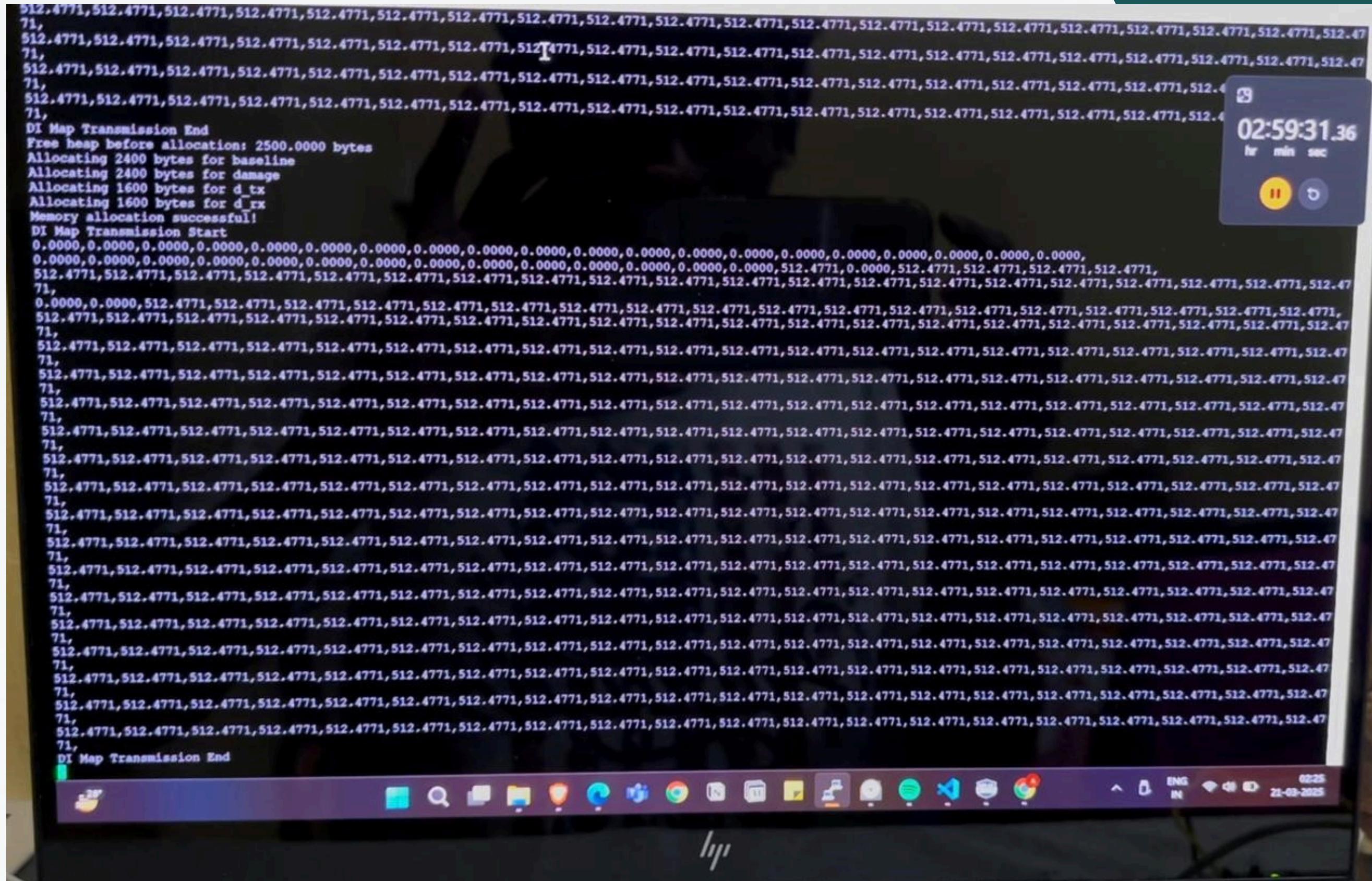
Text received: RED
Processing: RED
Swtiching RED Led On

Enter Colour to change colour to:
Enter Colour to change colour to: █

PROJECT STATUS AND ISSUES

Completed Tasks

Implemented DI Map
Algorithm on the
microcontroller and
successfully transmitted
results via UART.



PROJECT STATUS AND ISSUES

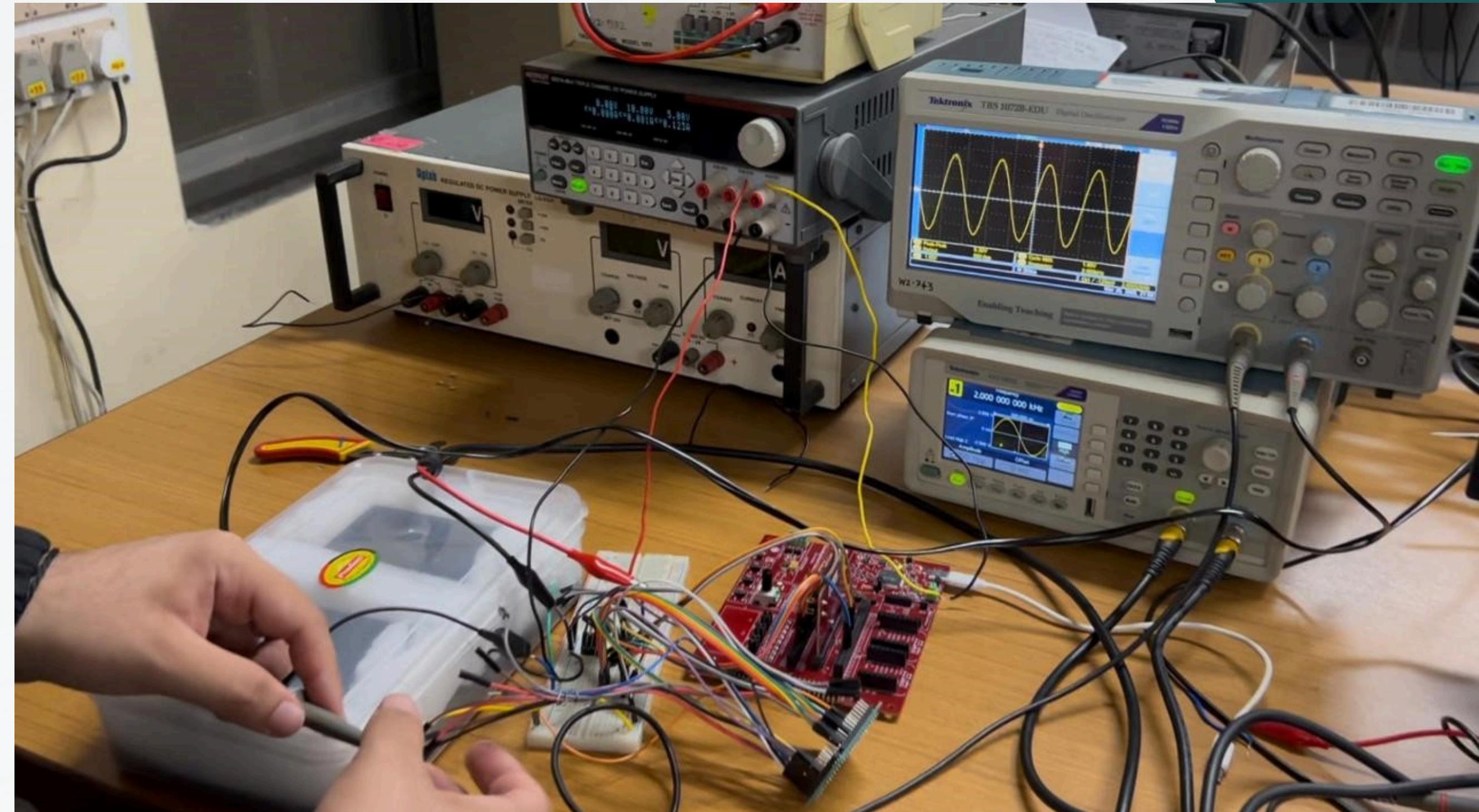
Completed Tasks -
Completed DAC
interfacing.



PROJECT STATUS AND ISSUES

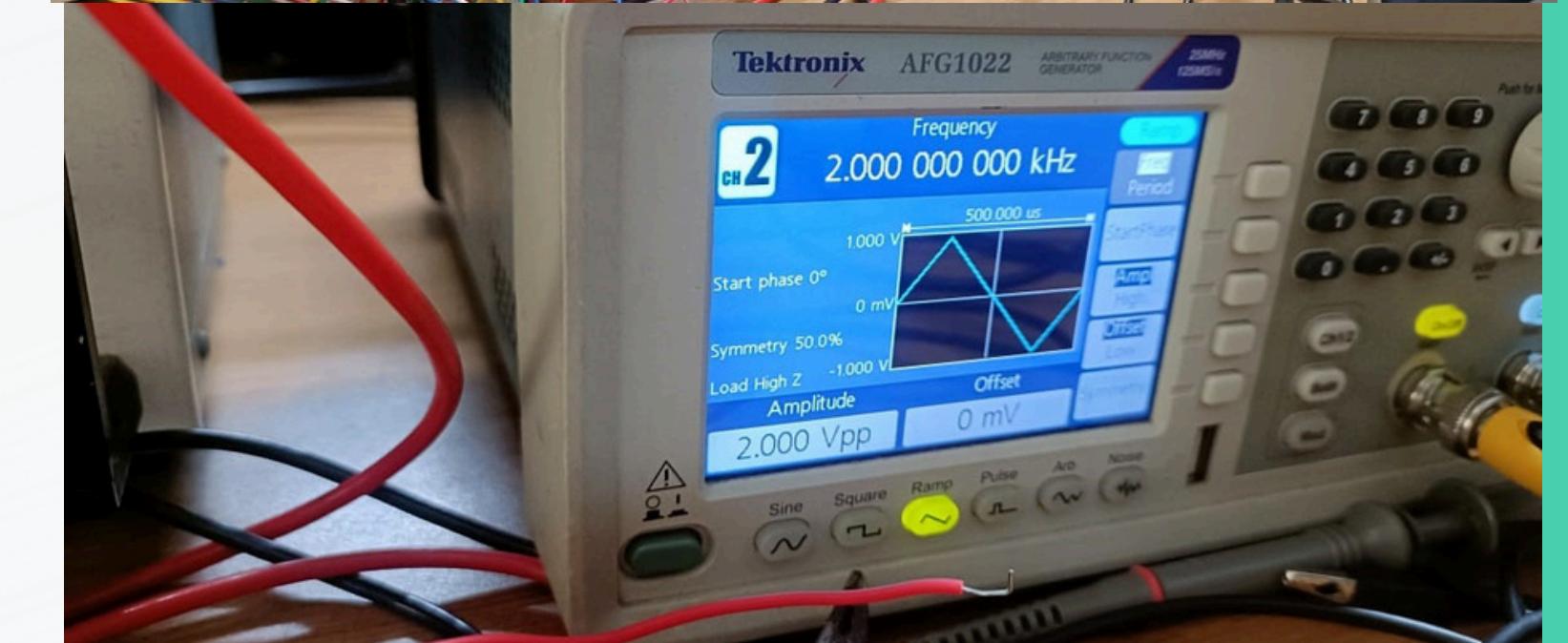
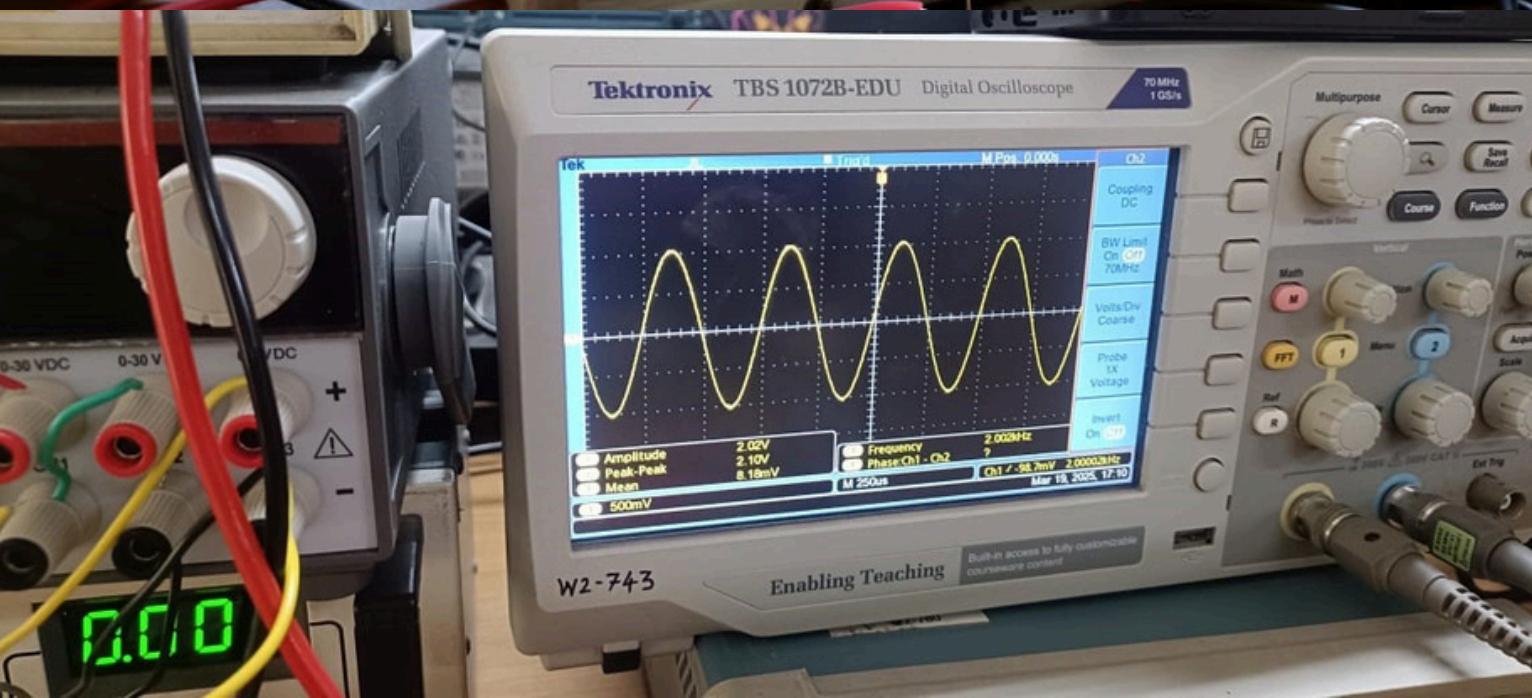
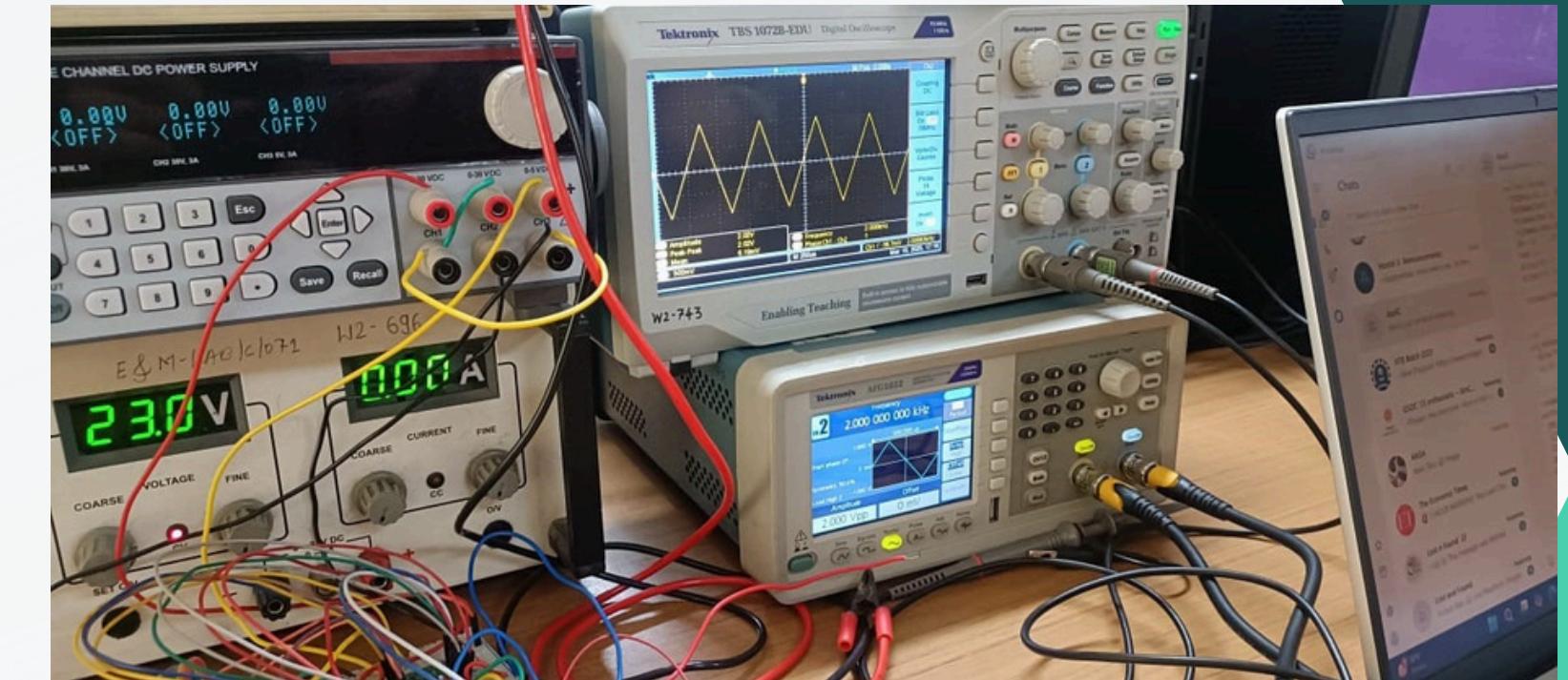
Completed Tasks -

Completed testing of the electronic switch.



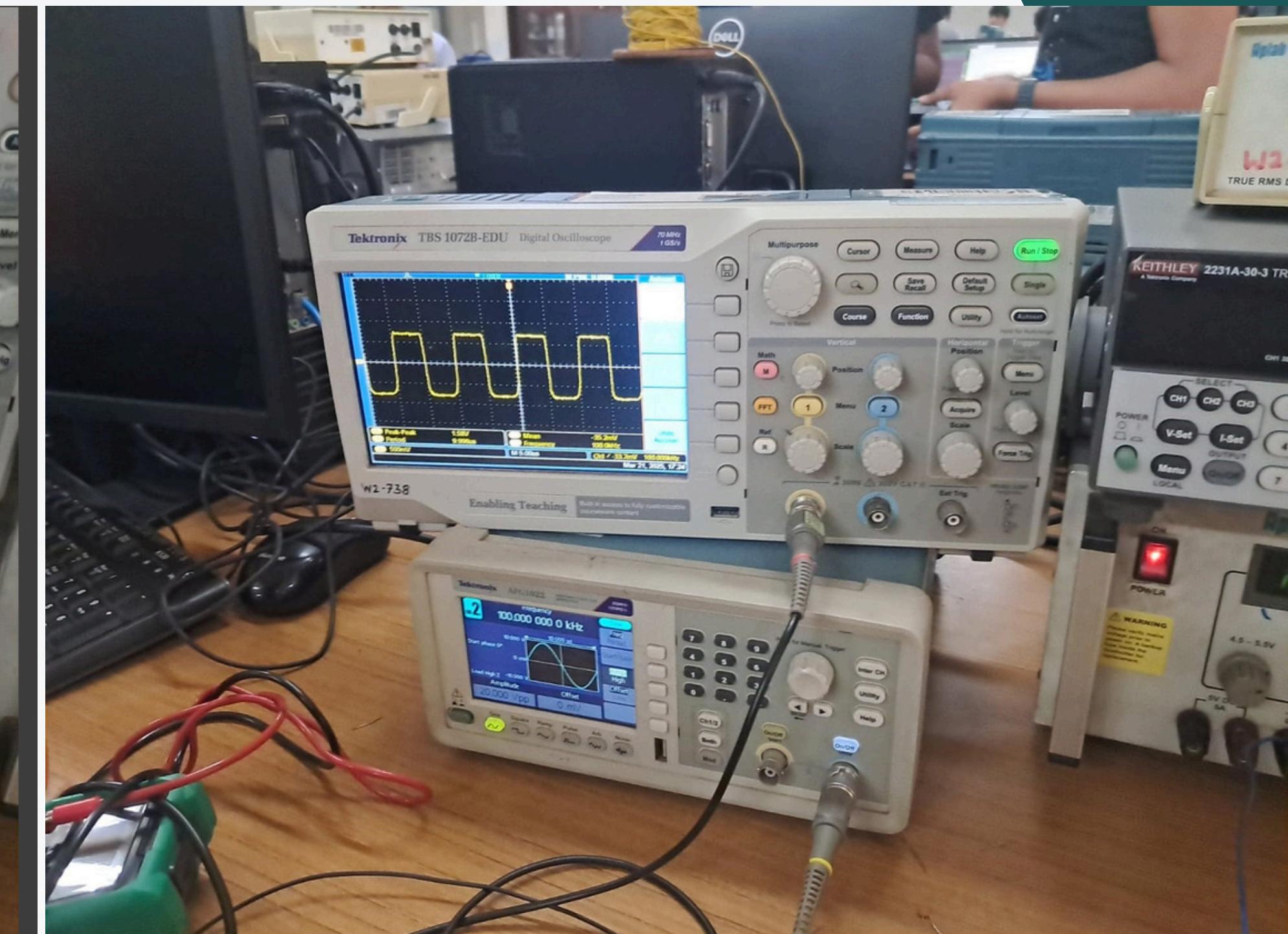
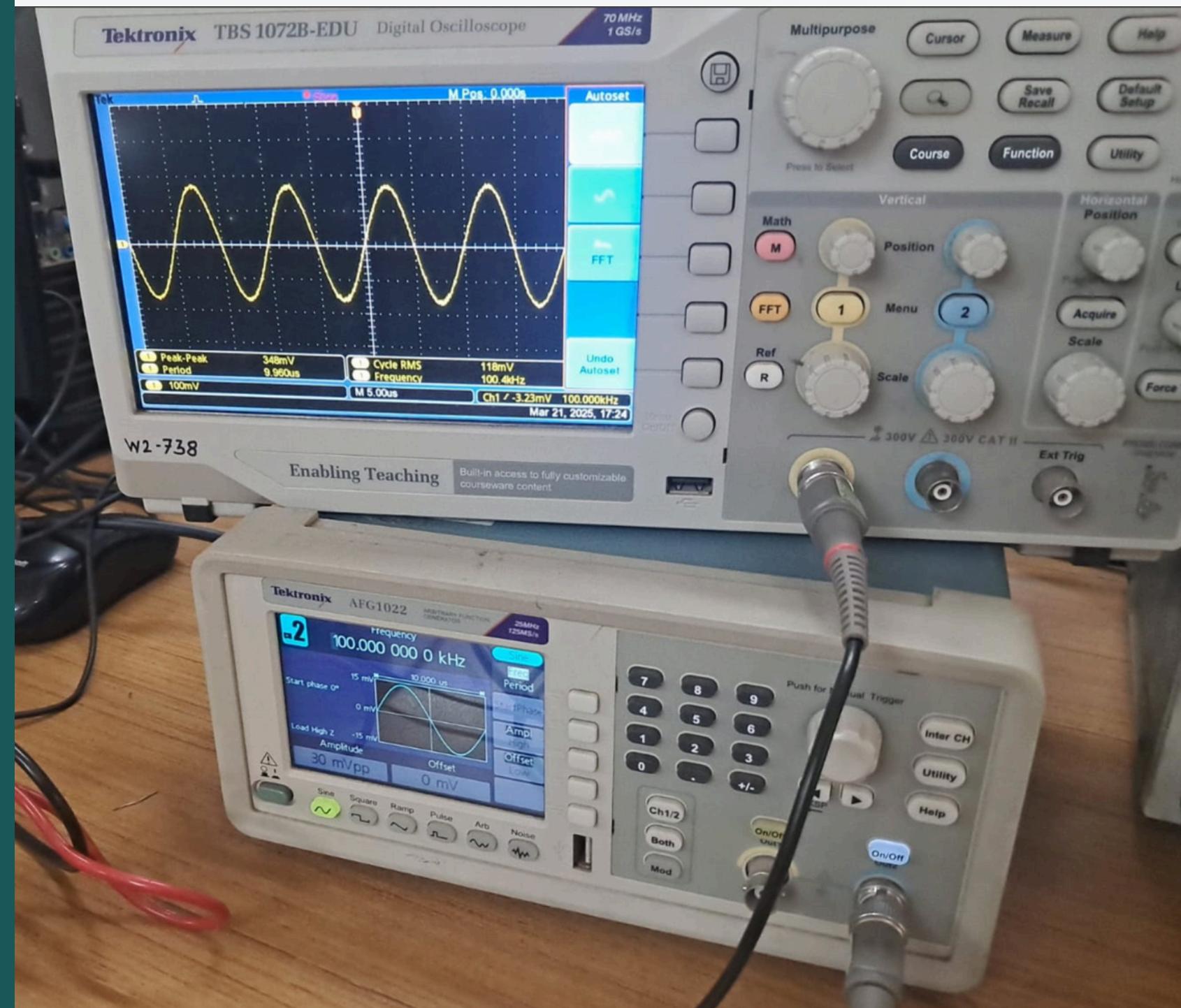
PROJECT STATUS AND ISSUES

Completed Tasks - Completed MUX testing.



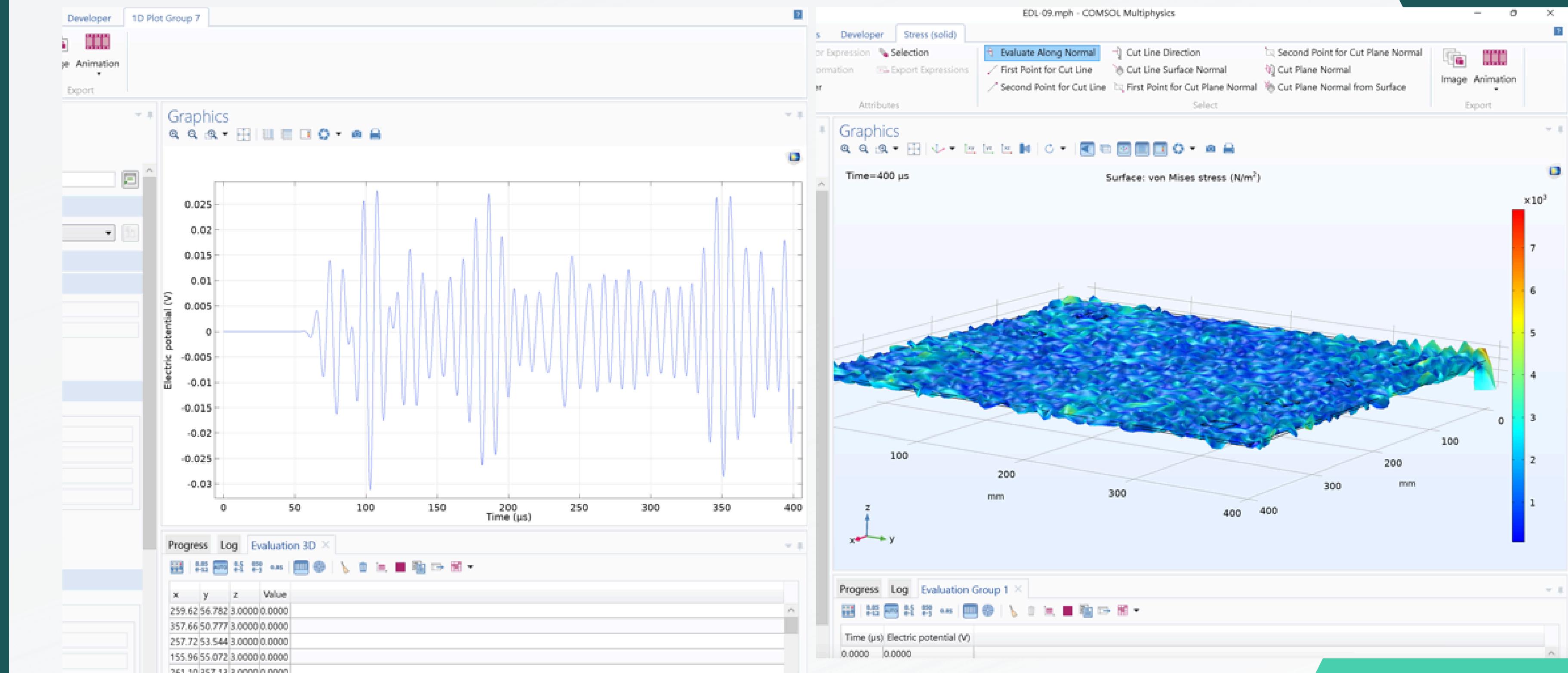
PROJECT STATUS AND ISSUES

Completed Tasks - Successfully tested INA and voltage clipping circuits. .



PROJECT STATUS AND ISSUES

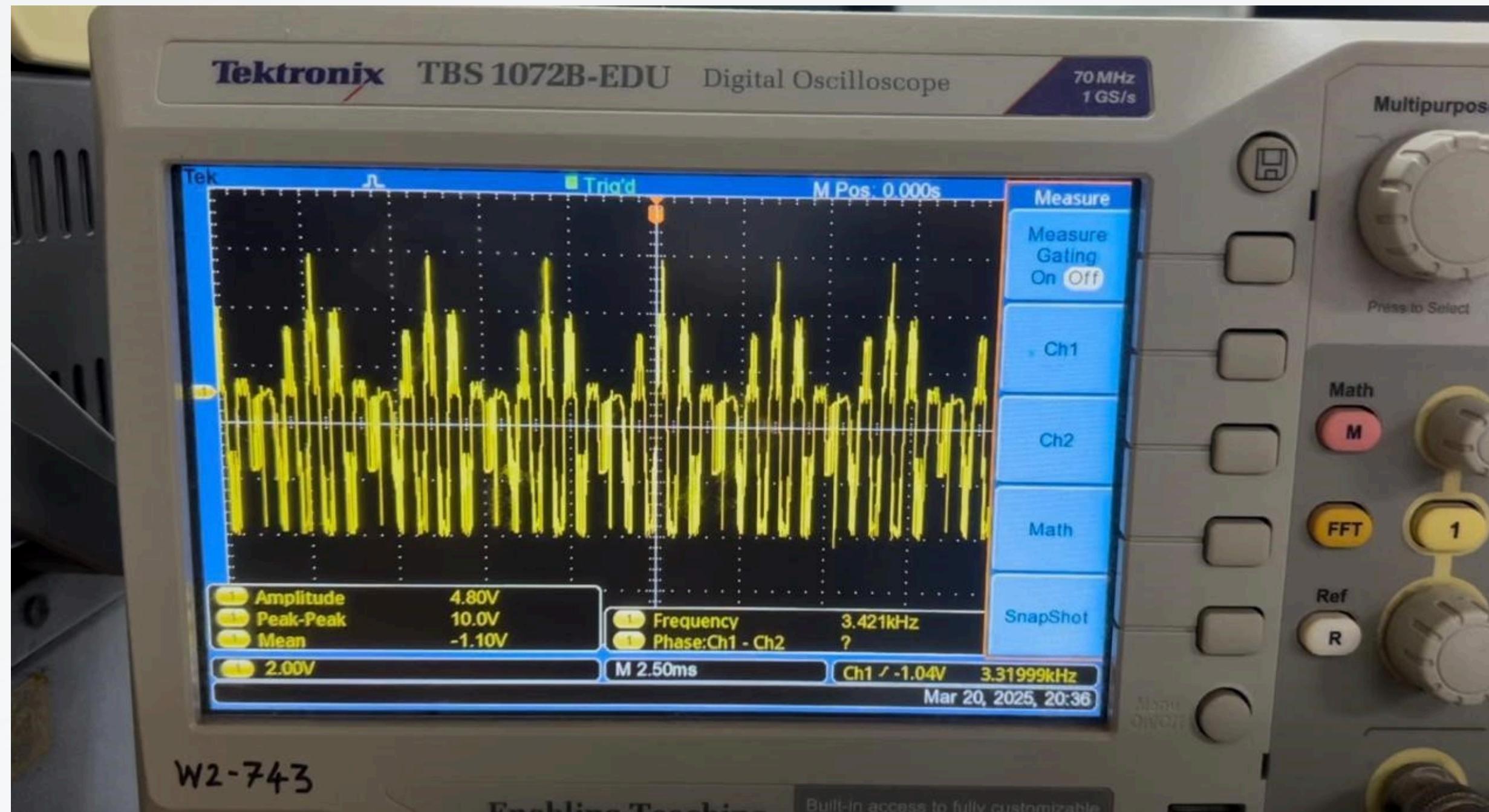
Completed Tasks - Successfully completed COMSOL simulations



PROJECT STATUS AND ISSUES

Ongoing Tasks (Near Completion) -

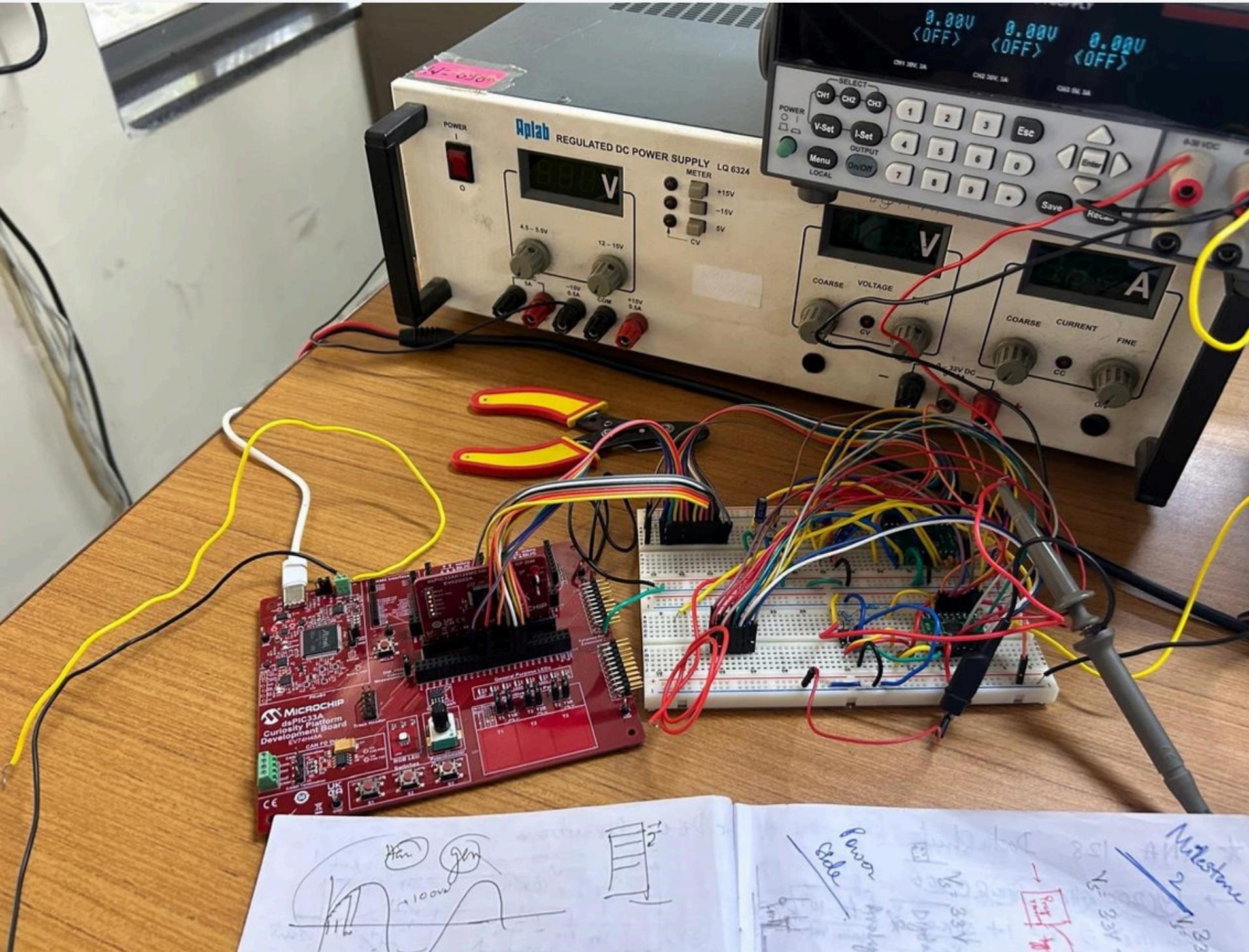
DAC: The Hanning waveform currently appears as a piecewise constant (staircase-like) waveform due to the internal clock being set at the default 8 MHz. Efforts are underway to increase the frequency for a smoother output.



PROJECT STATUS AND ISSUES

Ongoing Tasks (Near Completion) -

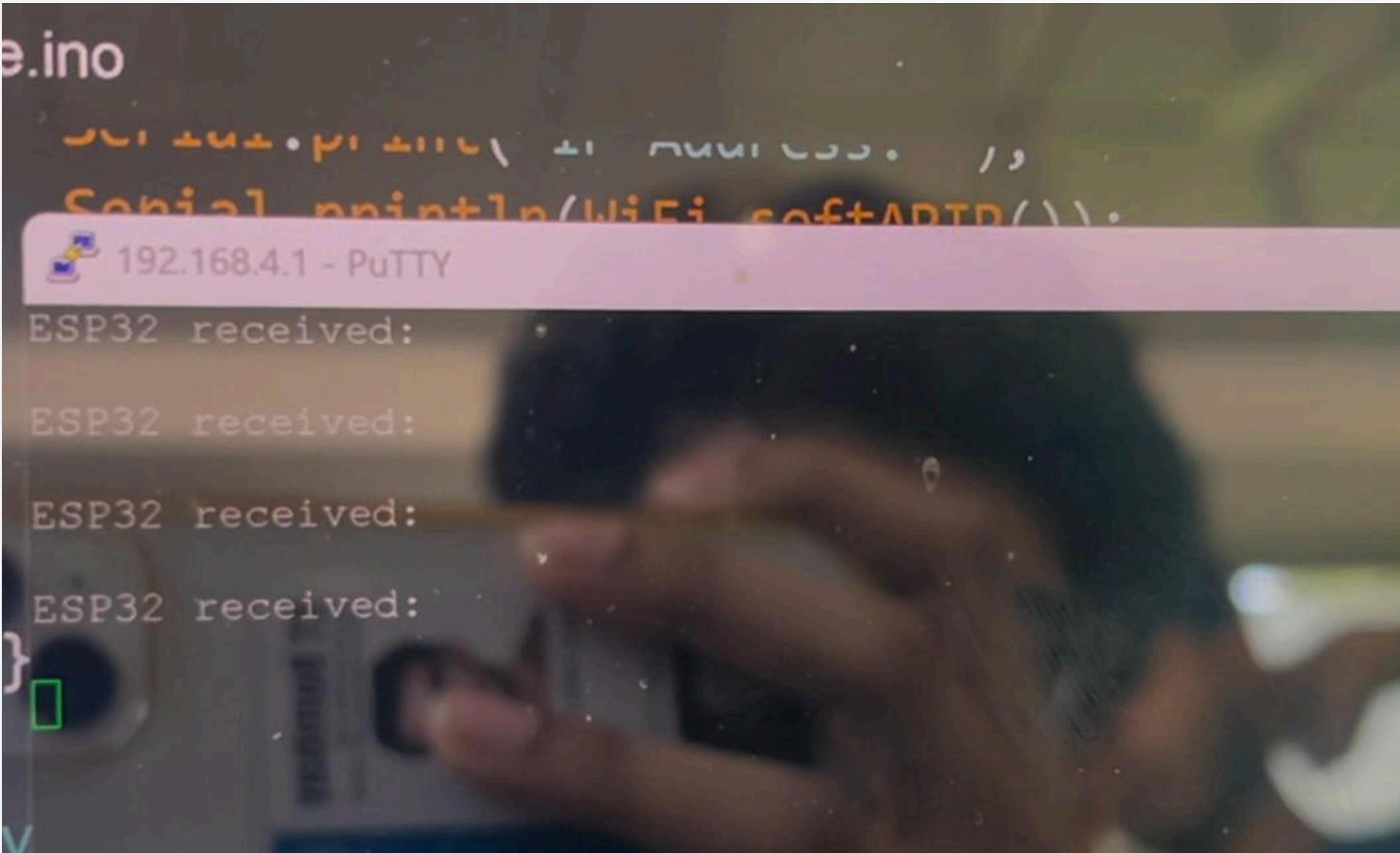
ADC: Digital bits are toggling using DMM but verification via UART communication is yet to be performed.



PROJECT STATUS AND ISSUES

Ongoing Tasks (Near Completion) -

Wifi-Module: ESP-32 interfaced wirelessly with Laptop. Interfacing dsPIC33A with ESP-32 still pending.



PROJECT STATUS AND ISSUES

Pending tasks -

- **SRAM:** Work in progress.
- **Wi-Fi Module:** Work in progress.
- **Integrated Circuit Testing:** Full system integration and testing pending.
- **Piezoelectric Transducer Transmission:** Transmission through PZT transducers is yet to be tested.
- **Microcontroller VQFN Package Programming:** Yet to be completed using PICkit3 programming tool.
- **Graphical User Interface:** Interface for operating the system
- **Buck Converter Testing**

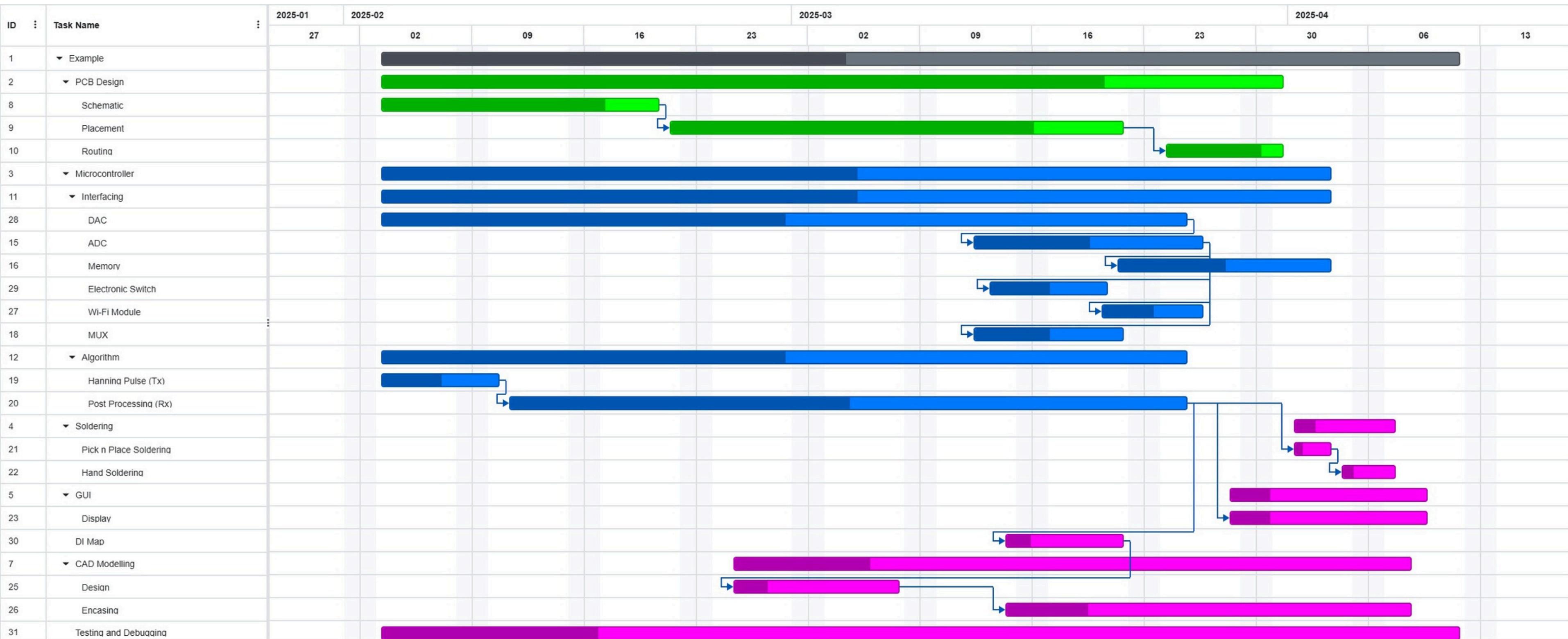
PROJECT STATUS AND ISSUES

Key Risks and Challenges -

- **Signal Noise & Debugging:** If received signals are noisy, debugging will be challenging, especially after PCB fabrication, as modifications may be difficult.
- **Hanning Waveform Transmission:** The attenuation of the waveform upon transmission via piezoelectric transducers isn't tested.
- **Thermal Management:** Potential heating issues need to be addressed.

GANTT CHART





DEVIATIONS FROM PRIOR GANTT CHART

- **SRAM and Wifi Module:** These parts still need to be interfaced.
- **ADC:** UART communication is pending but DMM testing is done.
- **DAC:** Piecewise constant waveform achieved but for a smoother waveform setting, a higher clock rate is yet to be found out.

WORK DISTRIBUTION



WORK DISTRIBUTION UNTIL THE FINAL DEMO

- Amol Pagare
 - ADC & DAC Integrated Testing
 - Microcontroller Integration
 - DI Map Algorithm Implementation
 - UART Command Protocol Development
 - CAD Modelling
- Angad Singh
 - Electronic Switch Integrated Testing
 - GUI development
 - Microcontroller Integration
 - Piezoelectric Transducer Transmission & Reception

WORK DISTRIBUTION UNTIL THE FINAL DEMO

- Anuj Gautam
 - MUX Integrated Testing
 - PCB Placement, Layout, Routing, and Silkscreen Design
- Anuj Yadav
 - INA & Voltage Clipper Circuit
 - SRAM Implementation and Integrated Testing
 - PCB Placement, Layout, Routing, and Silkscreen Design
 - Soldering Components onto PCB
- Shubhanshu Choudhary
 - Wi-Fi Module and Microcontroller Communication via UART
 - Power Supply (Buck Converter)

PLAN FOR FINAL

DEMO

PLAN FOR FINAL DEMO

- Create an end-to-end integrated system that monitors the structural health of various metal structures
- We plan to have a Graphical user Interface(GUI) that will interface with microcontroller.
- In GUI, we'll have options to set the mode of operation i.e. Pulse-Echo and Pitch-Catch, and the frequency of Hanning waveform.
- This will be interpreted by the microcontroller, by the Command Protocol developed.
- Then as per the user inputs, microcontroller will transmit and receive the guided waves and a Damage Index will be calculated, that will be transmitted to the Laptop.
- GUI will process and create a Damage Index Map, that will be displayed in the Laptop.

THANK YOU!

