Generation, Obtention, Assessment and Treatment of Signal Corporation.

[Audio amplifier quality control]

Project Plan

REVISION HISTORY AND APPROVAL RECORD

Revision	**Date**	**Purpose**
0	11/3/2025	Document creation
1	23/3/2025	Document revision

DOCUMENT DISTRIBUTION LIST

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0. CONTENTS

1. DOCUMENT SCOPE

The goal of this document is to outline the key aspects of the project. It serves as a comprehensive guide to ensure alignment among the client and the effective execution of project tasks.

First of all we are going to talk about the main goals of the project, we will also talk about its scope and the team members' roles in this project.

Then we will present the phases of our project, where we can find the deliverables to the client, our work packages with all the tasks needed to succeed in our project, a gantt diagram with our scheduling for every task and our communication plan to accomplish all the work.

And last but not least, the cost analysis. Here we are going to review the cost of design, prototypes and patents or other legal regulations.

2. PROJECT GOALS

The goal of this project is to develop a MATLAB-based program that has three main functionalities:

1. A Virtual Instrumentation set, capable of performing essential measurements to evaluate the key characteristics of an audio amplifier, including output power, frequency response, and distortion among others.

2. A Simulator of a Class D audio power amplifier

3. An Equalizer. Designed to be used as a pre-equalizer, enhancing the amplifier's output by adjusting the input signal.

The client is a pro audio company needing advanced tools for amplifier testing, simulation, and optimization. This software helps reduce prototyping costs compared to the similar products in the market, and enhance the device compatibility, because it only needs a device capable of running MATLAB.

3. PROJECT SCOPE

Our project involves developing software to analyze and enhance an audio signal by amplifying it. As experts in audio, we will concentrate on characterizing and optimizing its performance.

This project includes:

Design of a Class D Audio Power Amplifier Simulation – The amplifier will be modeled and programmed using MATLAB.

Development of Analysis Software – A software tool will be created to evaluate key performance metrics, including power output, frequency response, distortion, and signal-to-noise ratio (SNR) among others.

Pre-Equalizer Design – A pre-equalization system will be developed to refine the amplifier's output by adjusting the input signal.

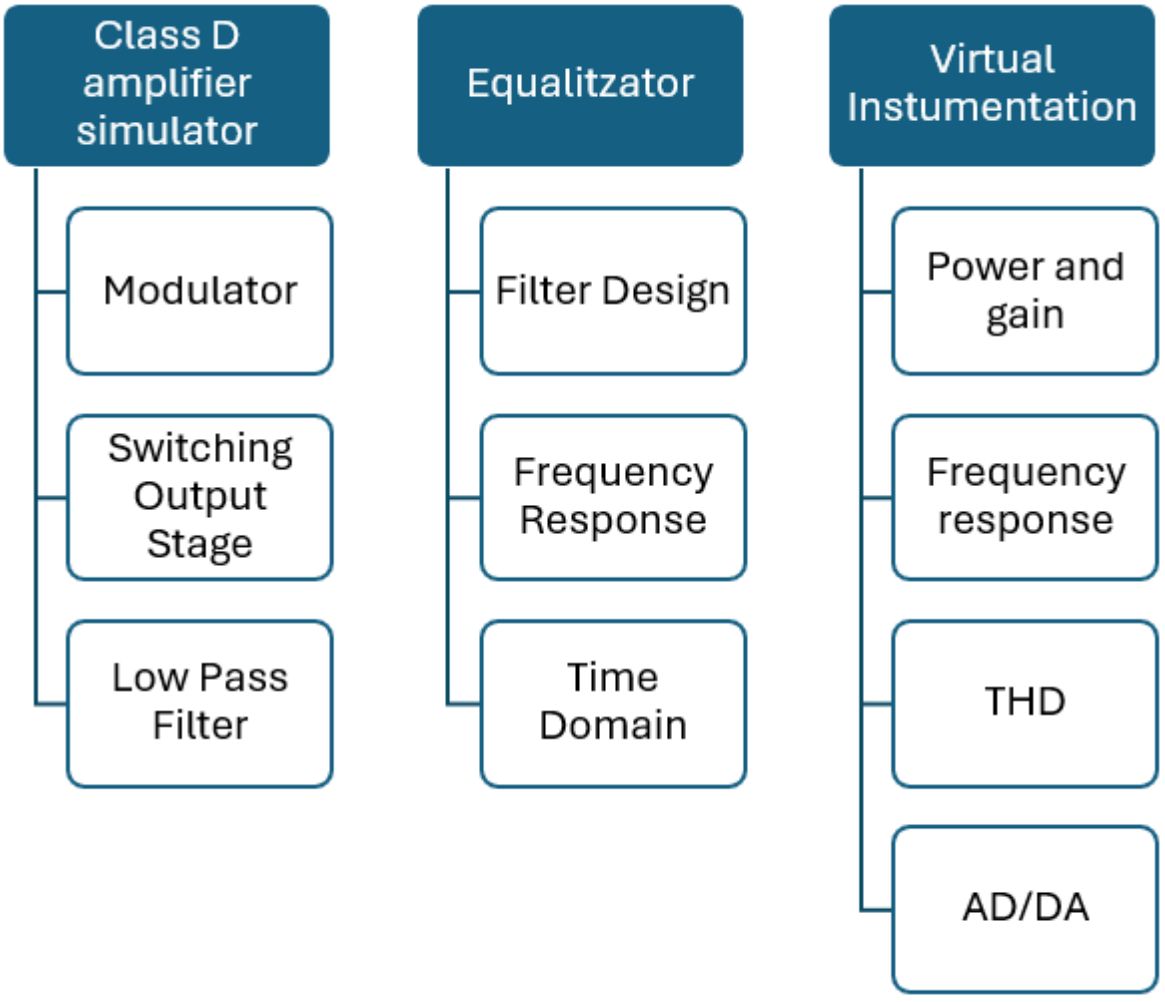
User Guide Creation & Programmers Manual – A comprehensive manual will be provided, allowing clients to operate the software independently.

This project will focus solely on audio-related aspects and will not include:

Hardware Development - The physical design and construction of a Class D audio power amplifier.

Conversion Hardware - Any hardware required for A/D and D/A conversion.

A structured breakdown of project tasks will guide the development process.



4. PROJECT TEAM

Name	Initials	Role	E-mail
Pol Calvo	PC	Project Leader & Lead Developer	pol.calvo@estudiantat.upc.edu
Yeyu Chen	YC	Tester & Compliance	yeyu.chen@estudiantat.upc.edu
Aitor Pitarch	AP	R+D & Designer	aitor.pitarch@estudiantat.upc.edu
Pere Sanchez	PS	Secretary & Project Documenter	pere.sanchez@estudiantat.upc.edu

Although each team member has a unique role in the project, everyone shares responsibility for programming, testing, documenting, and designing the entire system. Roles are assigned based on each member's expertise, with one person leading each area to ensure its successful execution.

Project Leader & Lead Developer

- Oversees the project, ensuring deadlines and goals are met.
- Makes key decisions and assigns tasks to the team.
- The Lead Developer takes on this role due to their expertise in MATLAB, guiding the team in technical decisions and implementation.

Tester & Compliance

- Executes test cases to identify bugs and ensure functionality.
- Reports defects and collaborates with developers to resolve issues.
- Ensures the project follows regulations and specifications.
- Verifies that the software aligns with the project plan and technical requirements.

R+D (Research & Development) & Designer

- Conducts research to find the best technologies, frameworks, or approaches.
- Designs the UI/UX of the software, making it user-friendly and visually appealing.
- Develops innovative solutions for technical challenges.

Secretary & Project Documenter

- Keeps records of meetings, decisions, and progress updates.
- Documents the development process, including technical details and user guides.
- Ensures clear communication among team members and clients.

5. PLAN FOR THE PROJECT PHASES

5.1. Project phases and deliverables to the client

- ➔ Before starting the project
  - ◆ Requirements&Specification
  - ◆ Project Plan
- ➔ During the project
  - ◆ Weekly status reports (SR)
  - ◆ Preliminary Design Review (PDR)
  - ◆ Critical Design Review (CDR)
  - ◆ Final Demonstration
- ➔ After the Project
  - ◆ Final report (Project documentation)
  - ◆ Regulation issues

5.2. Work Packages, Tasks and internal deliverables

Work Packages organization:

<table>
<tr><td colspan="2">Workpackage: Design of the measurement system</td><td colspan="2">WP ref: WP1</td></tr>
<tr><td colspan="2">Major constituent: Virtual Instrumentation</td><td colspan="2">Sheet 1 of 5</td></tr>
<tr><td colspan="2" rowspan="2">Short description:

Design the Matlab code to measure all the system parameters and its interfaces.</td><td colspan="2">Planned start date: 25/03
Planned end date: 15/04</td></tr>
<tr><td colspan="2">Start event:
End event:</td></tr>
<tr><td>WP manager (initials): PC</td><td colspan="3">WP participants (initials): PC, YC, AP, PS</td></tr>
<tr><td colspan="2">● Internal task T1:
Design a Matlab code able to measure and compute the A/D and D/A conversion.

● Internal task T2:
Do a Matlab code that measures Power Output and Gain and an interface for the Power and Gain measurer.

● Internal task T3:
Do a Matlab code that measures Frequency Response and an interface for the Frequency Response measurer.

● Internal task T4:
Do a Matlab code that measures SNR and an interface for the SNR measurer.

● Internal task T5:
Do a Matlab code that measures THD and an interface for the THD measurer.

● Internal task T6:
Test of the work package 1.</td><td>Deliverables:</td><td></td></tr>
</table>

Workpackage: **Class D Amplifier Simulation**		WP ref: **WP2**	
Major constituent: Amplifier		Sheet 2 of 5	
Short description: Design the Matlab code to simulate a class d amplifier.		Planned start date: 8/04 Planned end date: 29/04	
		Start event: End event:	
WP manager (initials): PS	WP participants (initials): PC, YC, AP, PS		
● Internal task T1: Design the modulator with matlab. ● Internal task T2: Design the switching output stage with matlab. ● Internal task T3: Design the low pass filter with matlab. ● Internal task T4: Test of the work package 2.		Deliverables:	

Workpackage: **Equalization Simulation**		WP ref: **WP3**	
Major constituent: Equalizer		Sheet 3 of 5	
Short description: Design the Matlab code to simulate an equalizer.		Planned start date: 22/04 Planned end date: 11/05	
		Start event: End event:	
WP manager (initials): AP	WP participants (initials): PC, YC, AP, PS		
● Internal task T1: Design the equalizer. ● Internal task T2: Design the multiple filters with matlab. ● Internal task T3: Design the equalization interface. ● Internal task T4: Test of the work package 3.		Deliverables:	

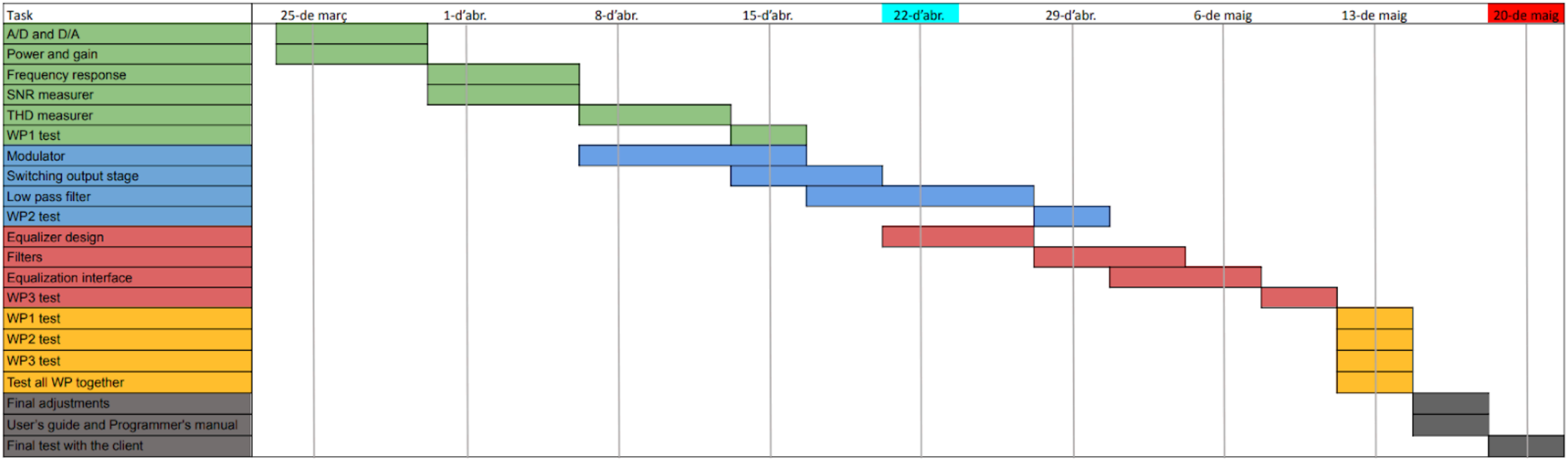
Workpackage: **Testing**		WP ref: **WP4**	
Major constituent:		Sheet 4 of 5	
Short description: Test again all the work packages individually and together.		Planned start date: 13/05 Planned end date: 13/05	
		Start event: End event:	
WP manager (initials): YC	WP participants (initials): PC, YC, AP, PS		
● Internal task T1: Test again the work package 1. ● Internal task T2: Test again the work package 2. ● Internal task T3: Test again the work package 3. ● Internal T4: Test all work packages together.		Deliverables:	

Workpackage: **Final adjustments**		WP ref: **WP4**	
Major constituent:		Sheet 5 of 5	
Short description: Do all the final adjustments once the project is finished and elaborate the documents for the users and programmers.		Planned start date: 15/05 Planned end date: 20/05	
		Start event: End event:	
WP manager (initials): PS	WP participants (initials): PC, YC, AP, PS		
● Internal task T1: Do the final adjustments according to the client's feedback. ● Internal task T2: Do the documents: User's guide and Programmer's manual. ● Internal task T3: Final test with the client.		Deliverables:	

Work Packages and tasks summary:

WP#	Task#	Short title	Responsible	Deliverable	Date (week)
1	1	A/D and D/A	AP,PS		1
	2	Power and gain	PC,YC		1
	3	Frequency response	AP,PC		2
	4	SNR measurer	PS,YC		2
	5	THD measurer	PS,AP		3
	6	WP1 test	AP		4
2	1	Modulator	PC,PS		3-4
	2	Switching output stage	AP,YC		4
	3	Low pass filter	YC,PC		4-5
	4	WP2 test	PS		6
3	1	Equalizer design	AP,PS		5
	2	Filters	PC,YC		6
	3	Equalization interface	PC,AP		6-7
	4	WP3 test	PC		7
4	1	WP1 test	YC		8
	2	WP2 test	PC		8
	3	WP3 test	AP		8
	4	Test all WP together	PS		8
5	1	Final adjustments	PC,YC		8
	2	User's guide and Programmer's manual	PS,AP		8
	3	Final test with the client	PC,PS		9

5.3. Time Plan (Gantt diagram)



5.4. Meeting and communication plan

Effective communication is essential for the success of our project. To ensure smooth collaboration, we will primarily use WhatsApp for quick updates and discussions, while email and Google drive will be reserved for formal updates and document sharing. Project progress and task management will be tracked through Google drive as well. For in-depth discussions, we will hold video meetings via Google Meet if it's necessary, but we will give priority to face to face meetings.

Regular meetings will be scheduled to keep the team aligned. A kick-off meeting will take place at the start of the project to define objectives, roles, and timelines. Weekly check-ins will allow us to discuss progress, address challenges, and adapt depending on the progress of the project. Before submission, a final review meeting will be conducted to assess deliverables and finalize details.

Each meeting will have a designated facilitator responsible for guiding the discussion and a note-taker to document key points and action items. Team members are expected to respond to messages within 24 hours and to notify any delay as soon as possible. Attendance at meetings is required unless a valid reason is communicated in advance. In case of disagreements, the team will aim to resolve issues through discussion or voting if it's necessary.

By maintaining clear and structured communication, we will ensure a well-coordinated and productive collaboration throughout the project.

6. COST ANALYSIS

This section is about the cost that will be incurred during the development of the project. It includes the costs associated with design, prototyping, regulations and patents.

6.1. Design

The design of the product will take 2 weeks. Each member of our team will dedicate 7 hours per week. The salary of each member will be 15 €/hour. So the total of salary will be 840€ (4 members x 7 hours x 2 weeks x 15€)
During this stage, our team will be working from home and using our own computer and online communication. The cost of working space will be counted as 0. Then other costs like electricity will be less than 20€. Finally the total design cost will be

salary	15€ x 4 members x 7 hours x 2 weeks
other	20€
total of design	860€

6.2. Prototyping

The prototyping of the product will take 8 weeks. During this stage, our team will rent an audio laboratory which will include all the necessary instruments in this project (PC, sound card, speaker, oscilloscope, spectrum analyzer). The rent of the laboratory will be 2.500€/month. Furthermore, our team will work in pairs and each PC will be used by two members. Then we need the license of MatLab for 2 PCs. The standard version will cost 2.345€/perpetual. The salary of each member in this stage will be 20€/hour. The working hours per week will be the same as the previous stage. Additionally, Other cost such as electricity, resistance, audio amplifier for testing will be included in a Budget of 100€

Laboratory	2.500€ x 2 months
MatLab licence	2.345€ x 2 PCs
Salary	20€ x 4 members x 7 hour x 8 weeks
other	100€
total of prototyping	14.270€

6.3. Regulations and Patent

To ensure that products meet industry standards, The product will need to pass the AES17 standard by Audio Engineering Society. AES17 is a standard of methods for digital audio engineering and measurement of digital audio equipment. The official standard document will cost 100€. Then our product will be tested in a third-party laboratory to get the certification of AES17 which will cost 2000€. This test will demonstrate to customers the accuracy of the data obtained through our products.

The product will be patented through the European Patent Office, and each member of the team will hold 25% of the patent. In the application stage,It will cost approximately 4000€. Then in order to maintain the patent, a certain amount of fees will be incurred each year. These fees will increase as the patent ages:

- **Year 1**: No fee for the application.
- **Year 2**: Approximately **€470**.
- **Year 3**: Approximately **€590**.
- **Year 4**: Approximately **€730**.
- **Year 5**: Approximately **€880**.
- These fees continue to increase annually, reaching approximately **€1,780** by year 10.

AES Standard document	100€
AES Standard test	2.000€
Application of patent	4.000€
Maintenance of patent of first 5 years	2.670€
Total of regulations and patent in first 5 years	8.770€

Summary			
Development (15.130€)	Design (860€)	Salary	840€
		Other	20€
	Prototyping (14.270€)	Laboratory	5.000€
		MatLab licence	4.690€
		Salary	4.480€
		other	100€
Regulations and Patent (8.770€)		AES Standard document	100€
		AES Standard test	2000€
		application of patent	4000€
		maintenance of patent of first 5 years	2670€
Total		23,900€	