

1. Introduction

This project, titled 'Analog Computer', aims to explore and demonstrate the functionality of op-amp circuits in performing fundamental analog computations – addition, subtraction, and multiplication. The utilization of these analog operations holds immense potential in the field of analog signal processing. The project will dive into the design and implementation of analog adder, subtractor, and multiplier circuits, analysing their underlying principles and practical applications. By successfully executing this project, we will not only grasp the intricacies of analog electronics but also underscore their relevance in contemporary signal manipulation techniques.

2. Technical Specifications

1. Required Operations:

1.1 Addition

1.2 Subtraction

1.3 Multiplication

2. **Analog Computing Principles:** Utilize operational amplifier (op-amp) circuits for implementing the desired operations. Design dedicated circuits for each operation, considering appropriate signal conditioning and biasing.
3. **Frequency Range:** The device should be able to perform computations on waveforms within the frequency range of 1 Hz to 10 kHz.
4. **Addition and Subtraction:** Create separate analog adder and subtractor circuits. The circuits must handle both positive and negative input voltages and produce accurate results within the specified frequency range.
5. **Multiplication:** Design an analog multiplier circuit capable of accurately multiplying two input waveforms. The multiplier should have a controllable gain and be operational within the specified frequency range.

6. **Input and Output:** Provide dual-channel input interfaces for each operation. The input interfaces should accept waveforms within the specified frequency range and ensure proper impedance matching. Output interfaces must deliver computed results with minimal distortion.
7. **Control Interface:** Implement control mechanisms for adjusting gain, biasing, and operation mode (addition, subtraction, multiplication). Consider using potentiometers or digital control for user-friendly manipulation.
8. **Accuracy and Precision:** Aim for high accuracy and precision in the computed results. Minimize signal distortion, noise, and non-linearities to achieve reliable analog computation.
9. **Power Supply:** Design a stable and clean power supply system to ensure consistent operation of the op-amp circuits. Include appropriate filtering and regulation to minimize interference.

3. Additional Notes

- All the circuits must be simulated using software (Ex- LT Spice, Multisim, PLECS etc.) before the implementation.
- All circuits should be tested on the breadboard and reviewed by the assigned supervisor before moving further.
- Circuits must be designed using professional EDA software (Altium Designer, OrCAD)
- Schematics should be verified and evaluated by the assigned supervisor.
- Design for manufacturability should be considered when designing the PCB Complete set of design and manufacturing documents Schematics, Layout, 3D file Gerber files, Assembly files BoM must be generated and properly documented.
- Students are encouraged to procure components from international component distributors (Mouser, DigiKey, Arrow Electronics, LCSC).
- Students are encouraged to get the PCBs manufactured from international PCB manufacturers (JLCPCB, PCBway).
- Main functionality of the project must be achieved with basic electronic components such as resistors, capacitors, inductors, diodes, transistors and other analog integrated circuits.
- Using any other pre-built programmable ICs are prohibited.
- Microcontrollers can be only used for user interface operation.
- Enclosure design must be done using a professional software (Solidworks).
- Enclosure and 3D model of the circuit must be assembled and inspected before manufacturing. 3D printing, Laser cutting, and Sheet metal bending can be used to manufacture the enclosure.
- Student are encouraged to consider the 3D model and PCB co-design (design in parallel by taking their integration into consideration) when designing.
- Final implementation of the project needs to done in a PCB.
- Follow provided “General guidelines”.