

DESIGN AND SIMULATION OF A CAPACITIVE SENSOR INTERFACE USING A CHARGE AMPLIFIER IN ESIM

Problem Statement:

Capacitive sensors are widely used in applications such as pressure sensing, humidity measurement, displacement detection, and touch-based systems due to their high sensitivity and low power consumption. However, interfacing capacitive sensors with electronic circuits is challenging because the sensor output is a change in capacitance rather than voltage.

In conventional sensor interface circuits, voltage-based measurement techniques suffer from reduced sensitivity, noise susceptibility, and nonlinearity when measuring small changes in capacitance. Research studies on capacitive sensing indicate that charge amplifier-based interfaces provide improved sensitivity and linearity by converting capacitance variations directly into measurable voltage changes.

Despite their importance in sensor systems, the circuit-level implementation and simulation of capacitive sensor interfaces using charge amplifiers are not commonly explored in basic electronic design workflows, especially within open-source EDA platforms.

Proposed Solution:

To address the limitations of conventional capacitive sensing interfaces, this project proposes the **design and simulation of a capacitive sensor interface using a charge amplifier** in eSim.

The proposed approach focuses on:

- 1. Capacitance-to-Voltage Conversion:**
A charge amplifier converts small variations in sensor capacitance into proportional voltage changes, enabling accurate measurement of capacitive signals.
- 2. Improved Sensitivity and Linearity:**
The charge amplifier architecture ensures high sensitivity and stable operation, making it suitable for precision sensor applications.
- 3. Circuit-Level Implementation Using eSim:**
The complete interface circuit, including the capacitive sensor model, operational amplifier, feedback capacitor, and signal conditioning components, will be designed and simulated using eSim.
- 4. Performance Verification:**
Simulation results will be analyzed by varying the sensor capacitance to verify the correct input-to-output relationship and system behavior.

The proposed design demonstrates an effective and reliable capacitive sensor interface suitable for research and educational applications using eSim.

Reference:

S. Franco, *Design with Operational Amplifiers and Analog Integrated Circuits*, McGraw-Hill Education