TOPIC:- Down-Conversion Mixer Design

Title

Design and Simulation of Down-Conversion Mixer using Transistor-based Circuit in e-Sim.

Introduction

A mixer is an essential block in communication systems, used to translate signals from one frequency to another. In this project, we focus on designing a **Down-Conversion Mixer**, which converts a high-frequency RF signal into a lower Intermediate Frequency (IF) using a Local Oscillator (LO). The design will be implemented and simulated in **e-Sim software** without the use of specialized ICs, instead using transistors and basic components.

Objectives

1. To design a down-conversion mixer using transistors in e-Sim.
2. To verify the working principle of frequency translation (RF → IF).
3. To analyze the mixed output using transient and Fourier analysis.

Methodology

1. Generate RF signal (example: 100 kHz sine).
2. Generate LO signal (example: 90 kHz sine).
3. Build transistor-based mixer circuit (Gilbert Cell / Differential pair).
4. Take output at the collector nodes.
5. Perform simulation in e-Sim to observe IF = (RF – LO).

Expected Outcome

1. The mixer output will contain both **sum (RF + LO)** and **difference (RF – LO)** frequencies.
2. By filtering, a clean IF signal (difference frequency) will be obtained.

Applications

1. Superheterodyne Receivers
2. Wireless Communication
3. Radar Systems
4. Signal Processing Front-Ends

Conclusion

This project demonstrates the design and working of a **Down-Conversion Mixer** using transistors in e-Sim software. The simulation validates the principle of frequency translation and its importance in modern communication systems.