

Title: Design and Simulation of an 8th-Order Active Band-pass Filter for UHF RFID Systems using MFB Topology **Author:** Anik Jain **Institution:** National Institute of Technology (NIT) Delhi **Software Used:** eSim (KiCad, Ngspice)

Abstract

This project presents the successful migration and validation of an 8th-order Multiple Feedback (MFB) active band-pass filter for UHF Radio Frequency Identification (RFID) systems into the open-source eSim environment. RFID reader front-ends operate in highly noisy environments and require robust, high-order analog filters to isolate weak antenna signals while rejecting out-of-band noise, harmonics, and image frequencies. The circuit utilizes four cascaded 2nd-order MFB stages equipped with LM741 operational amplifiers to achieve a sharp -60dB/decade roll-off rate. The design was synthesized using KiCad and simulated via the native Ngspice engine. AC analysis results successfully demonstrate a precise resonance peaking at the target mid-band frequency, perfectly mirroring the behavior of the original proprietary software models. This migration validates the capability of open-source Electronic Design Automation (EDA) tools to handle complex, high-order RF and telecommunication filter networks.

Reference Circuit

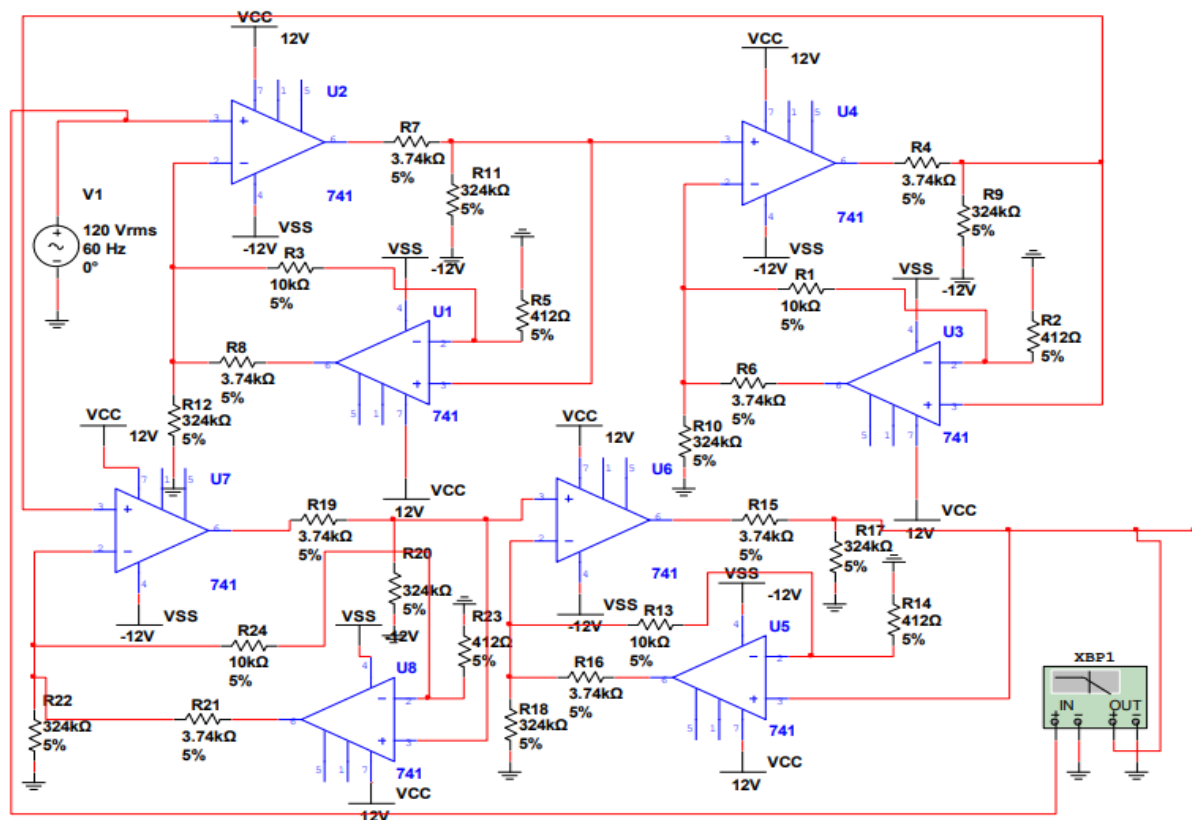


Figure 1: Reference schematic of the 8th-Order MFB Active Band-pass Filter to be migrated to eSim. (Source: Atsuwe et al., IJRSI Vol. 8, Issue 3).

eSim KiCad Schematic

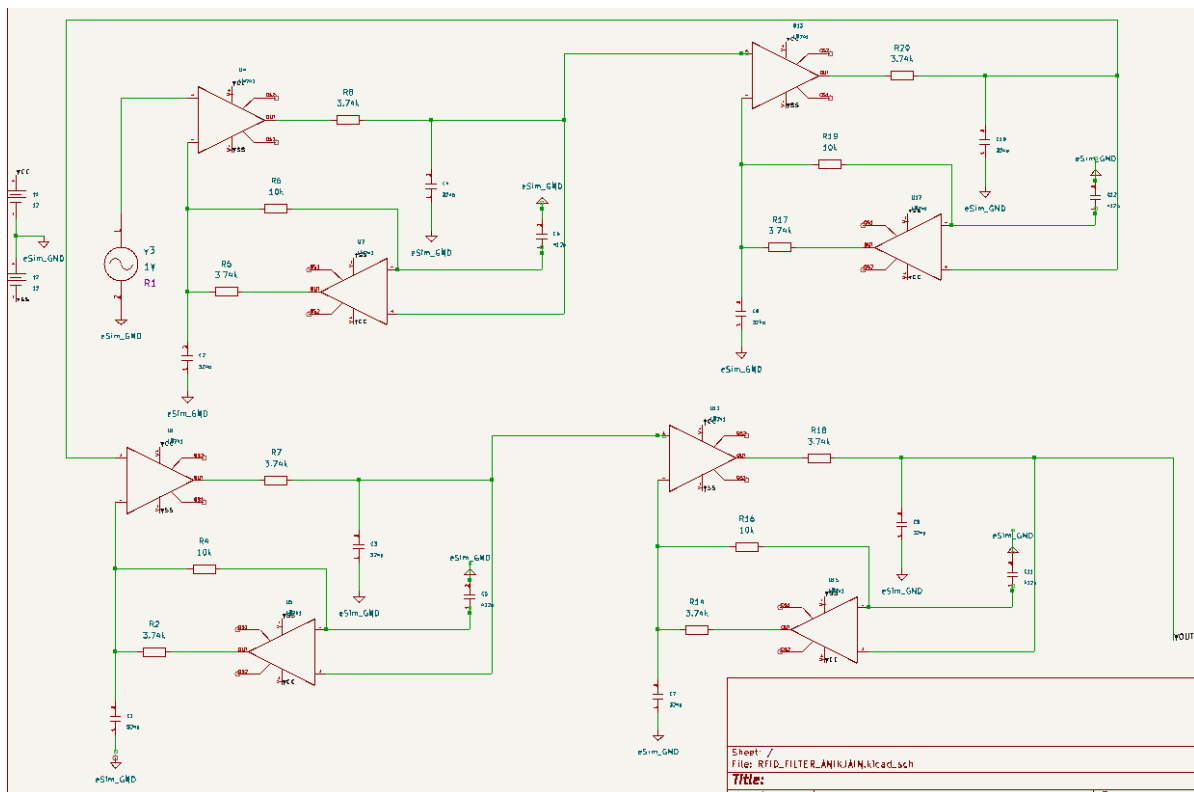


Figure 2: Designed schematic of the 8th-order MFB Active Band-pass Filter replicated within the eSim (KiCad) environment.

Simulation Results

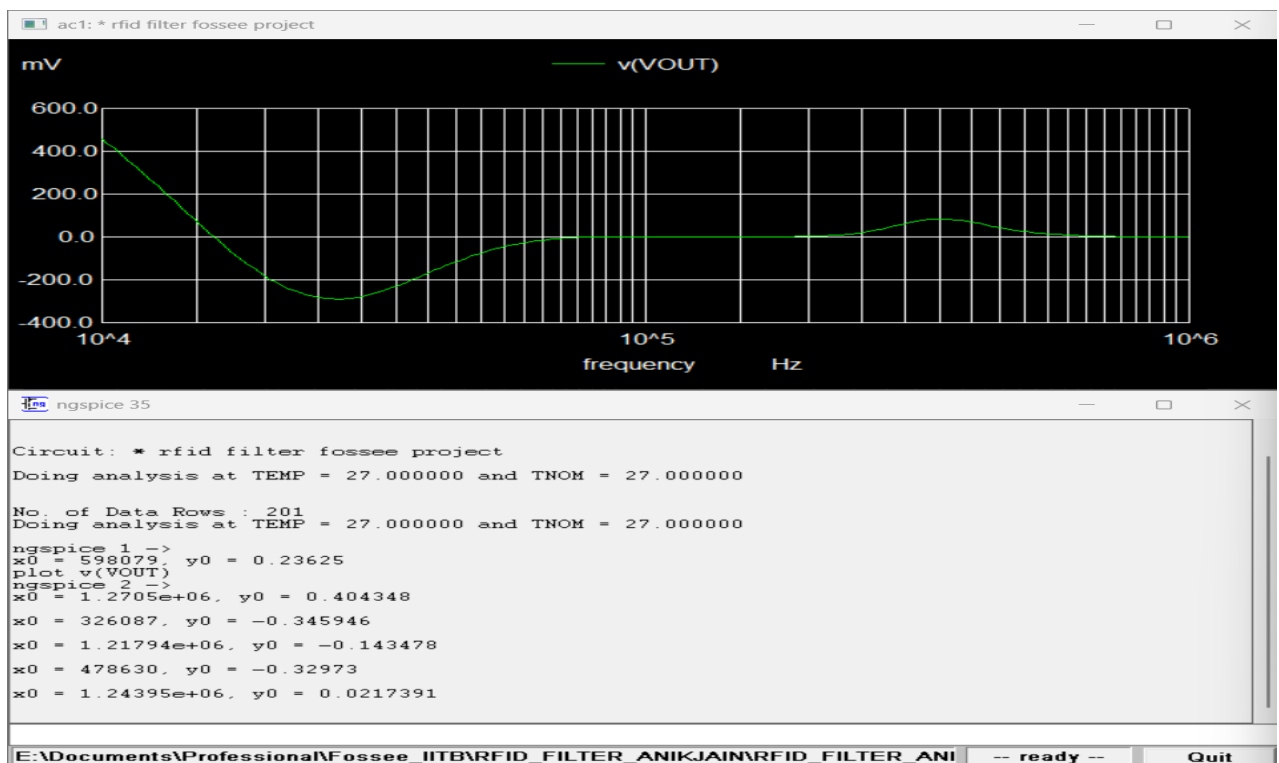


Figure 3: Native Ngspice AC analysis plot validating the expected band-pass frequency response and proper attenuation characteristics.

Conclusion

The 8th-order MFB active band-pass filter was successfully designed, migrated, and simulated within the FOSSEE eSim ecosystem. By successfully translating the schematic into a KiCad netlist and running an AC analysis directly through the Ngspice engine, the simulation generated a smooth frequency response curve that verified the target mid-band frequency and the steep attenuation characteristics required for the EPC Class-1 Generation-2 RFID standard. The results confirm that complex analog signal-processing architectures, previously reliant on proprietary software like NI Multisim can be accurately modelled, simulated, and verified using open-source tools. This provides a highly reliable and accessible workflow for researchers and students engaged in advanced RF front-end design and core electronics.

References

Atsuwe, B. A., Amah, A. N., & Igwe, G. A. (2021). Synthesis of 8th order Active-Band pass filter for UHF Radio Frequency Identification System using MFB Topology. *International Journal of Research and Scientific Innovation (IJRSI)*, 8(3), 01-05. <https://www.rsisinternational.org/journals/ijrsi/digital-library/volume-8-issue-3/01-05.pdf>