A Mm-wave Front-end Receiver Design Using 0.15μm GaAs pHEMT Technology

R1 – RF, Microwaves and Millimeter-wave Systems
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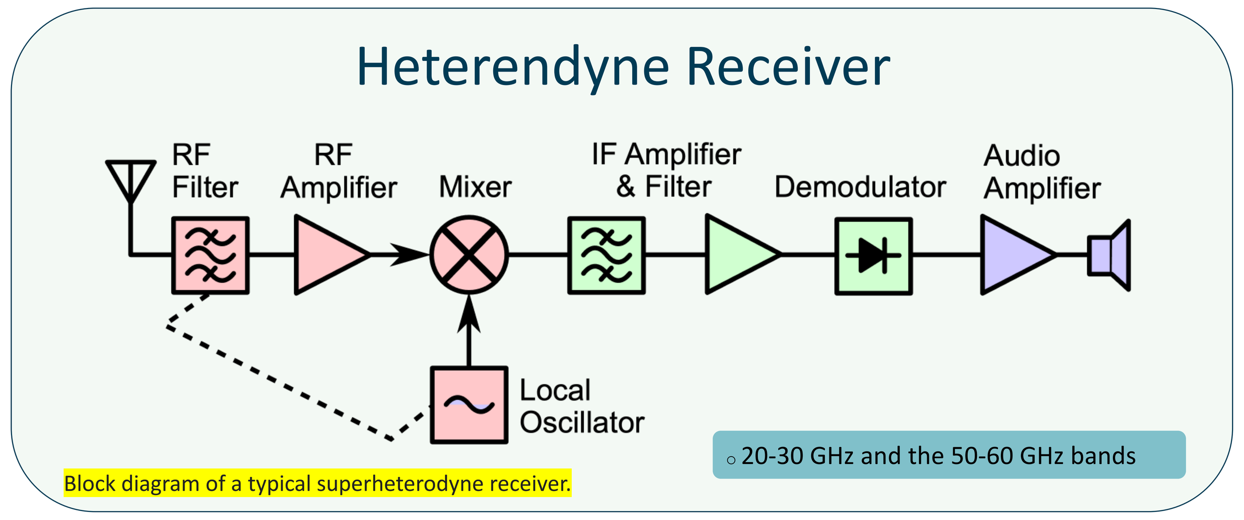
Abstract

This project consists in the development of a millimeter-wave receiver front-end, characterized by its Size, Weight, and Power plus Cost (SWaP-C) requirements. The front-end encompasses a low-noise amplifier and a self-oscillating mixer that will be seamlessly integrated with the antenna system. For the receiver design, a MMIC PH15 process based on a 0.15 microns gate Pseudomorphic High Electron Mobility Transistors (0.15 microns P-HEMT) technology from UMS has been selected. For the design of the LNA and Mixer the impact of the gate width and number of fingers on the pHEMT performance was investigate [1]. The cascode topology was selected for the LNA, which makes it unconditional stable, and the Mixer was designed using a double balance topolya. These advanced receiver systems are specifically tailored for employment within distributed spectrum monitoring systems, as well as integrated arrays designed for the purpose of interference mitigation.

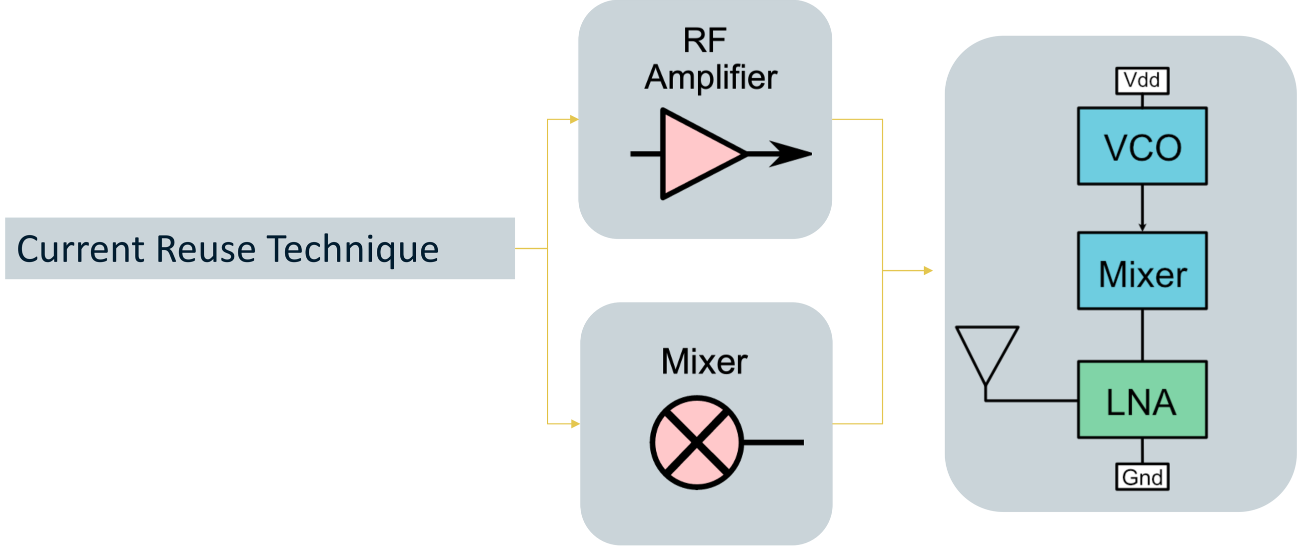
Objectives

The key contribution of this work is the design of front-end receiver system with an integrated antenna to target the main challenges generated by high power consumption in high-frequency receiver designs [2]. The designed front-end will be capable for the integration in a spectrum monitoring platform.



Block diagram of a typical superheterodyne receiver.

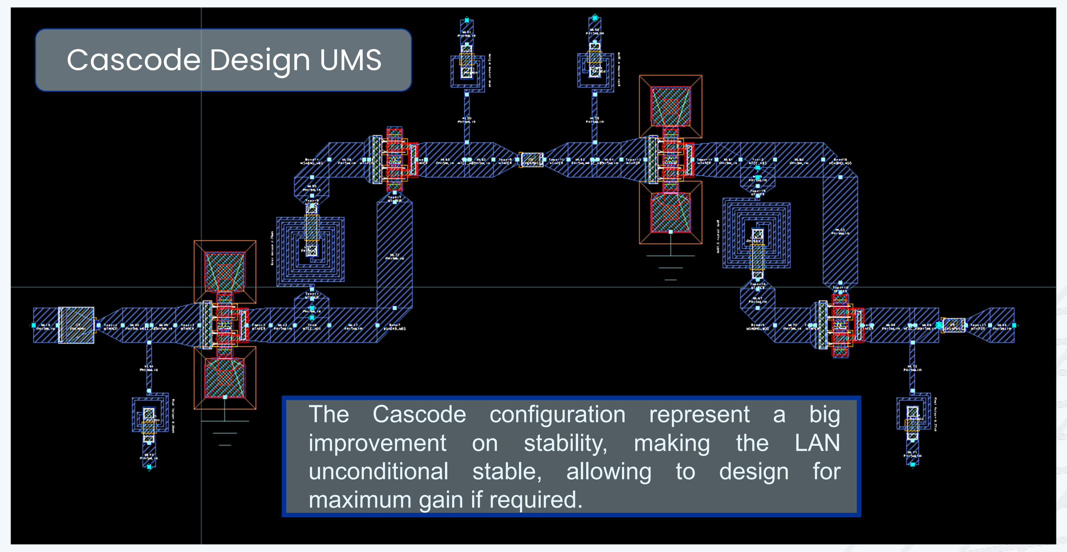
Methodology



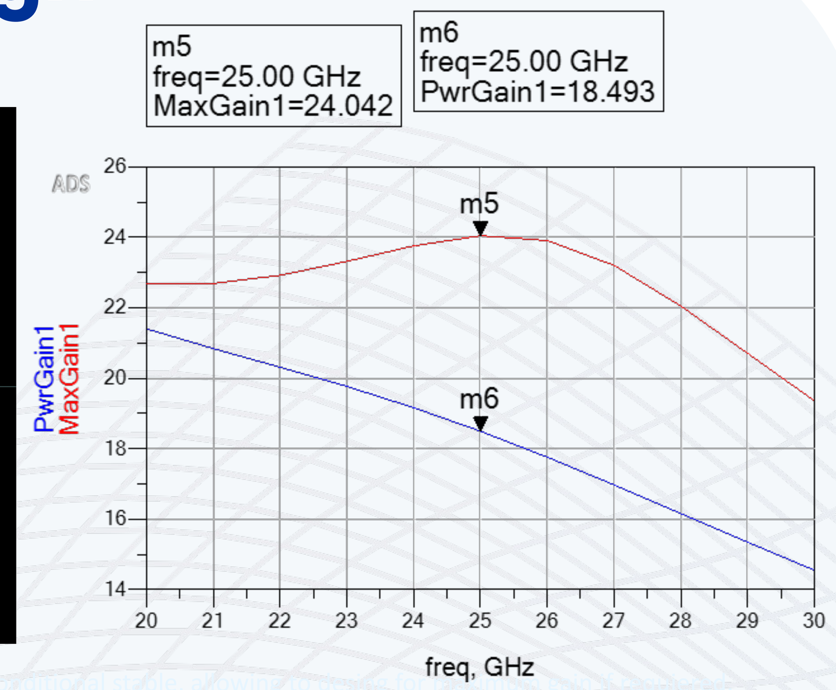
A significant advantage of the current reuse topology is that the same bias current is shared across multiple amplifier stages [3]. This leads to lower overall power consumption, crucial in millimeter-wave (mm-wave) designs with power constraints.

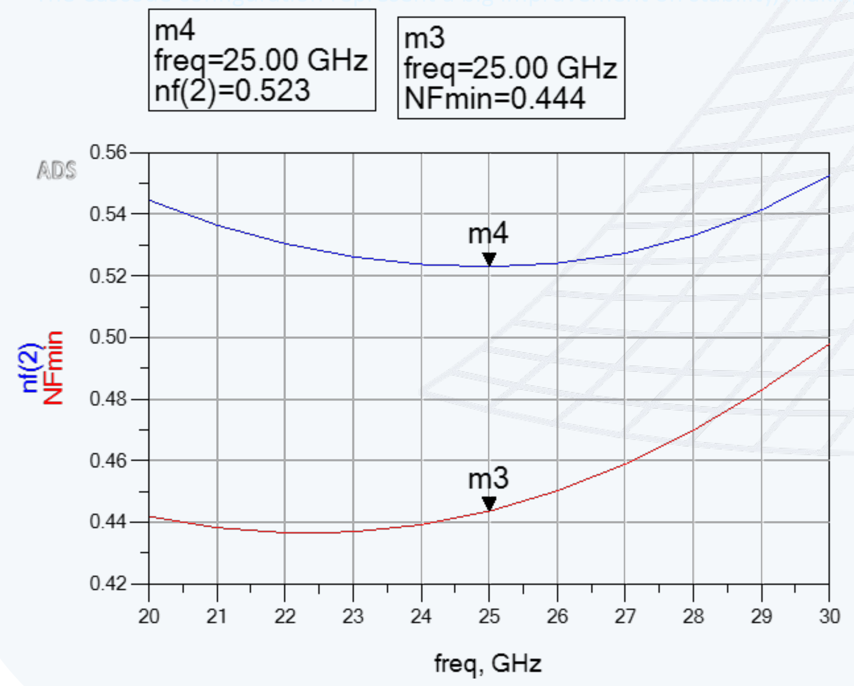
Results

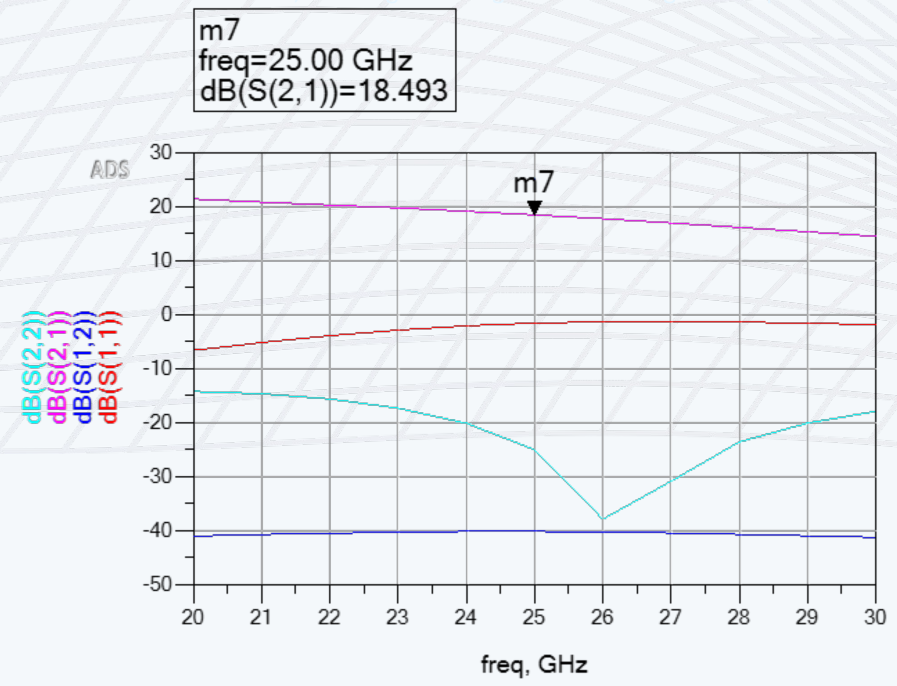
LNA Design



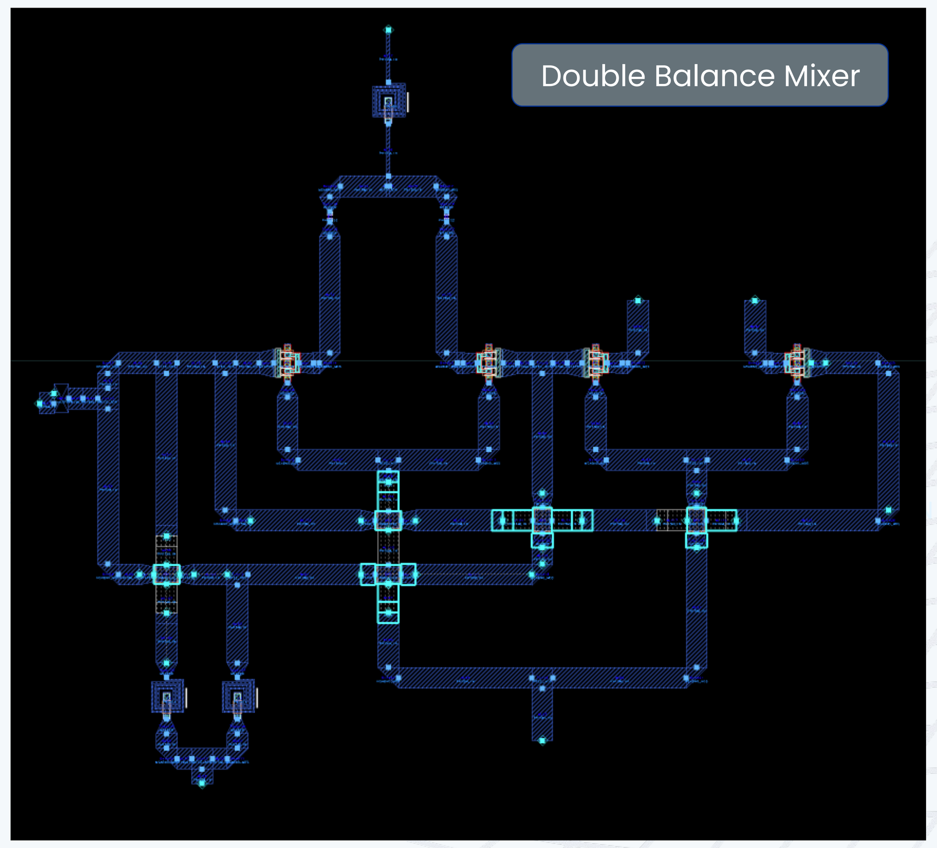
The Cascode configuration represent a big improvement on stability, making the LAN unconditional stable, allowing to design for maximum gain if required.

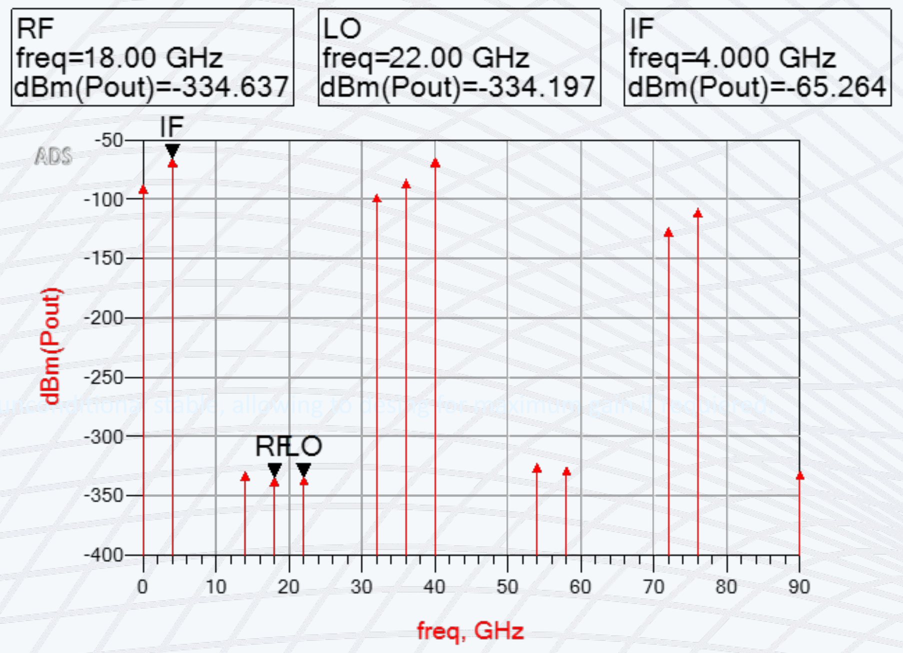






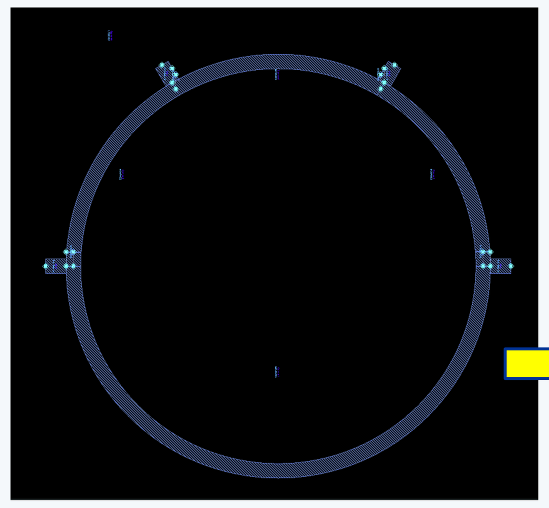
Mixer Design

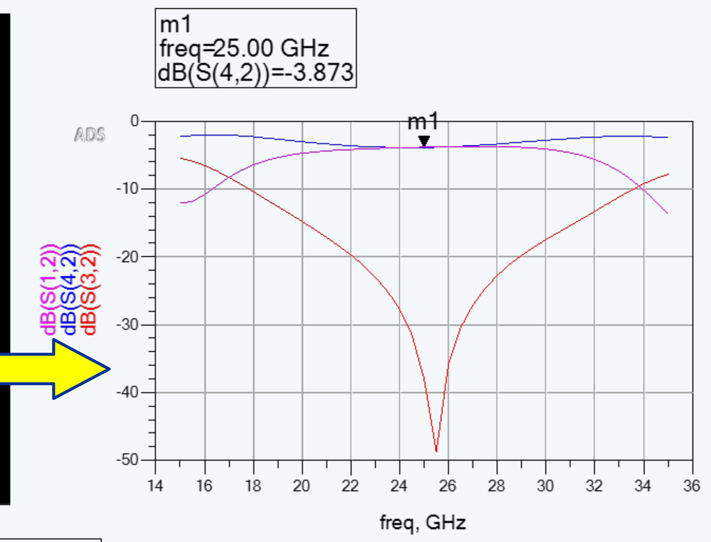


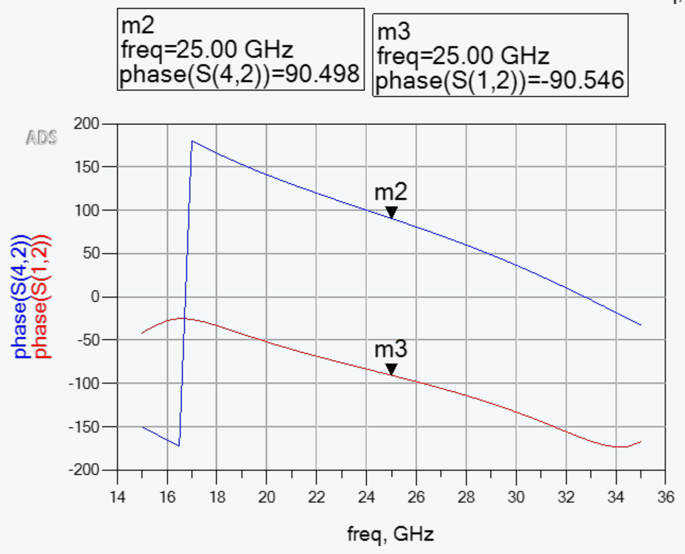


Double-balanced mixer is a vital component in RF and microwave systems used for frequency conversion. It multiplies two input signals. This topology reduced crosstalk between input ports whichs improves system performance and has excellent suppression of RF and LO signals leads to cleaner output with fewer unwanted frequencies.

Rat Race 180 Hybrid Coupler







Conclusions

This work presents a design of front-end receiver using GaAs PHEMT-based technology. The LNA MMIC was designed to operate from 20 to 30 GHz for RFI applications. Simulation results demonstrate the superiority of the cascode topology[4], the 2-stages cascode LNA demonstrates exceptional performance with a 21 dB gain at 20 GHz and a noise figure of 0.55 dB. A mixer was designed for IF at 2GHz and a Rat Race 180 Hybrid for couple the single end of the LNA with the diferential input of the Mixer.

References

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