Millimeter Chips

Best RF, Microwave, & Millimeter wave ICs

Case Study of Direct Coupled Amplifiers

MMICs

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Millimeter Chips Pvt. Ltd

Millimeter Chips Pvt. Ltd is a fabless RF Design House focused primarily on wireless Solutions, with Headquarters in SanJose, USA and a design centre in India. We design highly integrated system on chip (SOC) and system on a package (SOP); custom ICs, IP cores using state-of-the-art GaAs, InGaP/GaAs, InP, CMOS and SiGe Semiconductor processes utilizing MESFET, pHEMT and HBT devices. Expertise includes LNA, PA, Switch, complete transceivers/ Millimeter Chips & RF Modules for any wireless system, including WLAN, WiMAX, PCS and Cellular applications.

Millimeter Chips Pvt. Ltd is a Total solution provider for RF & Microwave. Our Business model encompasses Design IPs, Design services, PCB Design services, Layout services, Foundry services, & Supply of complete RF chips.

The Client:

The client was a South Korean-based organization that designs innovative solutions and is dedicated to RF technology and products for the wireless industry. They provide next-generation products and are manufacturers of innovative RF components, including gain blocks, local drivers, IF ICs, power amplifiers, discrete devices, and RF integrated circuits Millimeter Chips Pvt. Ltd

Introduction:

A **Direct Coupled Amplifier (DCA)** is a type of amplifier in which the output of one stage is directly connected to the input of the next stage without using capacitors or transformers. This type of coupling allows the amplifier to amplify low-frequency and DC signals, making it suitable for applications requiring high stability and accurate signal transmission over a wide frequency range.

DCAs can suffer from **thermal drift**, where temperature variations affect transistor characteristics, leading to unwanted signal changes. To minimize this, proper biasing and compensation techniques are us

Design Challenges:

The client's main objective was to create a high-performance Direct Coupled Amplifier for use in their advanced wireless communication systems. The amplifier had to exhibit the following key characteristics:

- Low noise figure (NF) to ensure minimal signal degradation.
- High linearity for robust performance across varying input power levels.
- Wide frequency range to support 5G, Wi-Fi, and other modern communication systems.
- Temperature stability to ensure consistent performance across diverse operating environments
- Low power consumption, enabling cost-effective and energy-efficient designs.

Additionally, the project timeline was tight, requiring the amplifier to be designed, fabricated and tested within six months. The challenge was to achieve outstanding linearity and noise figure performance while maintaining stability across various process, temperature, and supply voltage variations.

Millimeter Chips Pvt. Ltd was approached to develop the Direct Coupled Amplifier design. Their track record of delivering high-quality RF designs and their cost-effective model, supported by an experienced design team in India, made them the ideal choice for this high-priority project.

Our Solution:

Millimeter Chips Pvt. Ltd leveraged its robust design process and state-of-the-art RF design capabilities to address the client's specific requirements. The key elements of the solution included:

Millimeter Chips Pvt. Ltd used GaAs (Gallium Arsenide), a semiconductor process known for its excellent performance in RF applications, particularly for low-noise and high-linearity requirements. The design incorporated pHEMT (Pseudo-HEMT) transistors to achieve low noise and high linearity across the specified frequency range.

The Direct Coupled Amplifier was designed with a focus on broadband performance, spanning DC to 20 GHz. The design was highly tuned to meet the low-noise figure (NF) and high OIP3 (output third-order intercept point) for cellular and PCS applications.

The designs were optimized for temperature compensation and voltage variation tolerance. This ensured that the Direct Coupled Amplifier maintained consistent performance under real-world operating conditions, with minimal deviation in performance.

Millimeter Chips Pvt. Ltd utilized its design IPs (Intellectual Property cores), which significantly reduced development time and cost. By integrating these IPs into the amplifier design, the project was able to leverage proven and efficient solutions, reducing the risk of development delays.

Once the initial design was finalized, Millimeter Chips Pvt. Ltd utilized its expertise in layout design and GDSII tape-out processes to ensure a smooth transition to IC fabrication. The layout was optimized for minimal coupling and parasitic effects, ensuring superior performance in terms of noise and linearity.

To reduce the cost of assembly, the Direct Coupled Amplifier design was optimized to use only coupling and bypass capacitors as off-chip components. This simplified the overall design and reduced production complexity.

Upon successful fabrication, Millimeter Chips Pvt. Ltd assisted the client in testing the amplifier's performance across the required frequency band and under varying temperature and voltage conditions. This phase included delivering test plans, data sheets, and assembly guidelines to help the client validate the final product.

Benefits for Client:

The client received a highly efficient and cost-effective solution that addressed their exact requirements for a high-performance Direct Coupled Amplifier. The key benefits for the client included:

- Outstanding Noise Performance: The Direct Coupled Amplifier achieved 0.5 dB better noise figure than competitors' designs, providing superior signal quality.
- Superior Linearity: The design exhibited high linearity, ensuring excellent performance even in high-power conditions.
- Reduced Costs: Millimeter Chips Pvt. Ltd design services led to a 40% reduction in development costs, thanks to the efficient use of design IPs and the India-based design center.
- Faster Time-to-Market: The client was able to launch their new Direct Coupled Amplifier chips within six months, meeting their aggressive timeline.
- Improved Engineering Efficiency: The client was able to reallocate their internal resources to focus on other strategic initiatives, improving overall team efficiency.
- Minimal On-chip Components: The designs utilized minimal off-chip components, reducing board assembly costs and simplifying the manufacturing process.
- Reliable Performance: The Direct Coupled Amplifiers performed well across various conditions, including temperature variations and voltage fluctuations, ensuring long-term reliability.