Millimeter Chips

Best RF, Microwave, & Millimeter wave ICs

Case Study of Design of Differential 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 design center in India. We design highly integrated system on chip (SOC) and system on a package (SOP); custom ICs, IP cores using state-of-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 Korea based organization that designs innovative solutions, and is dedicated to RF technology and products for wireless industry. They provide next generation products and are manufacturer of innovative RF components including gain blocks, local drivers, IF ICs, power amplifiers, discrete devices, and RF integrated circuits Millimeter Chips.

Introduction:

An **RF Differential Amplifier** is a specialized amplifier designed to amplify the difference between two input signals while rejecting common-mode noise and interference. It operates at radio frequencies (RF)**,** making it essential in wireless communication, radar, and signal processing applications. RF differential amplifiers are commonly implemented using **field-effect transistors (FETs)** and often include techniques like **current mirror biasing** to ensure stability.

An RF Differential Amplifier is a critical component in high-frequency electronics, specifically designed to amplify the difference between two input signals while rejecting unwanted noise, interference, and common-mode signals. It plays a key role in modern wireless communication, radar, and high-speed data transmission systems, where signal integrity and noise immunity are essential. The RF differential amplifier operates using two symmetrical transistors. configured to process differential signals. The amplifier produces an output proportional to the voltage difference between the two inputs while suppressing any common-mode noise. This makes it highly effective in environments with electromagnetic interference (EMI).

Design Challenges:

The client aimed to enhance its market leadership and drive revenue growth by developing low-noise, high-linearity differential amplifier designs. The project focused on designing a high-performance differential amplifier with low noise and excellent linearity. **The client sought a cost-effective, quick solution that could be tuned to achieve optimal noise figure (NF), gain, and output third-order intercept point (OIP3) performance for cellular, PCS, and WCDMA applications.** The requirement was for a broadband differential amplifier covering a wide frequency range with exceptional performance across various conditions, including temperature and supply voltage variations.

Millimeter Chips Pvt. Ltd. was chosen for this project to deliver the differential amplifier designs on a GaAs process, focusing on stability and maintaining low noise and high linearity across temperature, process, and supply voltage variations. The project had a strict timeline of six months, including IC fabrication and testing.

Our Solution:

Millimeter Chips Pvt. Ltd. was selected due to its innovative design service model, which utilizes a combination of existing design IPs and an efficient project execution process. The company presented a detailed project plan that maximized engineering resources and minimized time to delivery. Additionally, Millimeter Chips Pvt. Ltd. cost-effective pricing model, leveraging its India-based design center, allowed for high-quality Millimeter Chips Pvt. Ltd. design services at a lower cost.

Millimeter Chips Pvt. Ltd. completed the four differential amplifier designs within the agreed-upon timeframe, achieving all specifications over process, temperature, and supply voltage variations, with designs ready for tape-out. The differential amplifiers were designed to be highly stable, ensuring consistent performance across different conditions. These designs only required coupling and bypass capacitors as off-chip components, significantly reducing the cost of board assembly.

Millimeter Chips Pvt. Ltd. provided comprehensive support throughout the GDSII tape-out process, offering layout design expertise and ensuring that the designs could be tuned with minimal mask changes through a process known as "mask sharing." The engineers at Millimeter Chips Pvt. Ltd. maintained constant communication with the client's team, ensuring that any specification changes were handled efficiently and effectively. The design changes were carefully tracked and implemented to the client's satisfaction, which helped improve the overall design process.

Once the designs were fabricated, Millimeter Chips Pvt. Ltd. assisted the client in testing the differential amplifiers, providing test plans, component data, and assembly diagrams. The designs were successfully tested, and the differential amplifiers met the required specifications, including an OIP3 as high and noise figure as low. Although the broadband differential amplifiers showed some deviations from the desired specifications (DC-12 dB), tuning was performed to achieve close to the desired performance across the 40MHz to 12 GHz frequency band.

Benefits for Client:

Millimeter Chips Pvt. Ltd. provided the client with a cost-effective solution that met their high-performance requirements. As a result, the client was able to launch new high-performance differential amplifier chips into the market within seven months of project initiation. The key benefits to the client included:

- Achieved 0.5 to 1dB better noise figure performance compared to competitors.
- The differential amplifiers exhibited superior linearity performance.
- Millimeter Chips Pvt. Ltd. design service helped reduce overall costs by 40%.
- The client was able to utilize its engineering resources more effectively and efficiently.
- Product launch within scheduled time.