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Exploring the versatality of BiCMOS Technology

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ABSTRACT:

The state-of-the-art method for fabricating semiconductors called BiCMOS technology combines the benefits of MOSFETs (metal-oxidide-semiconductor field-effect transistors) with bipolar junction transistors (BJTs). BiCMOS stands for bipolar complementary metal-oxidide-semiconductor. The goal of this lecture is to explore the basic ideas, design processes, and real-world uses of BiCMOS technology.BiCMOS circuits, such as power management, noise reduction, and layout techniques.

Keywords: BiCMOS, BJT, MOSFET, microelectronics, substrate, oxide layer, impurities, epitaxy layer, gate terminals, doped, IOT, AI, ML, Quantum, Radar, Metal oxide,Thinox

INTRODUCTION

The search is always on in the field of semiconductor technology for quicker, more capable, and more adaptable electronic gadgets. In this race, BiCMOS technology stands out as a strong competitor, providing a special fusion of the advantages of both Bipolar Junction semiconductor field-effect transistors (MOSFETs) and bipolar junction transistors (BJTs). Because of this fusion, high-speed, low-power, and highly integrated circuits may be produced, which is why BiCMOS technology is essential to contemporary microelectronics.

Fundamentally, bipolar and CMOS semiconductor production techniques are combined to form BiCMOS technology. BiCMOS technology overcomes the constraints of traditional methods by fusing the low-power properties of CMOS devices with the current-handling capabilities of bipolar transistors. This opens the door for the creation of innovative electronic systems for a wide range of applications.

Applications of BiCMOS in the real world that highlight how it can revolutionize the field of semiconductor engineering today. The exploration of BiCMOS technology, from its conception to its practical applications, is expected to be both educational and inspirational, providing insightful information about the direction of technological design and progress.

The main goal of creating complementary MOSFET (CMOS) technology was to provide low-power, high-speed logic gates for digital circuitry. CMOS technology enables the creation of a wide range of powerful analog and digital circuit designs. Comparable to BJT logic devices, CMOS devices are switched by voltage instead of current since their gates are not open to current flow.

In the 1970s, CMOS technology was limited to specific consumer markets, such as electronic watches. However, because of benefits including low power consumption, large noise margin, a wider operating temperature and voltage range, overall circuit simplification, ease of layout, dependability, and electro migration, VLSI technology shifted toward CMOS in the 1980s. Millions of transistors on a single chip were the result of the development of VLSI in the 1980s. The most common technology used in VLSI digital and mixed-signal designs at the moment is CMOS. Comparing CMOS to TTL, TTL is slower, less power-hungry, and less suited to work at low supply voltages.

LITERATURE SURVEY

A circuit model based on physical interpretation of CMOS coplanar structures.
AUTHORS : K. Datta and H. Hashemi
PUBLISHED ON : 17 Jan 2021.
DESCRIPTION : This paper gives an overall picture from BiCMOS technologies up to THz systems integration, which were developed in the European Research project TARANTO. The European high performance BiCMOS technology platforms are presented, which have special

advantages for addressing applications in the sub millimeter-wave and THz range. The status of the technology process is reviewed and the integration challenges are examined.

Output power D-band power source with 5 dB conversion gain in BiCMOS.
AUTHORS : A. Mukherjee and M. Schroter
PUBLISHED ON : 25 Jan 2022.
DESCRIPTION : This paper provides a comprehensive review of high performance BiCMOS technology platforms providing HBTs with fMAX up to 500GHz and beyond are presented. It is shown that these technology platforms are key enablers for high speed & high data rate communication systems, which require high integration level.

On-chip interconnect for mm-wave applications using an all-copper technology and wavelength reduction.
AUTHORS : E. piston and D. Gloria
PUBLISHED ON : 20 Nov 2022.
DESCRIPTION: This survey paper provides an overview of BiCMOS-enabled systems and applications with focus on future wireless communication systems and high-speed optical transmission systems up to resulting net data rates of 1.55 Tbit/s demonstrate the superior potential of BiCMOS technology platforms.

Noise and linearity of high-speed SiGe HBT cells in CE and CB configuration.
AUTHORS: D. Gloria and A.L. Franc
PUBLISHED ON :15 May 2023
DESCRIPTION : This paper reviews BiCMOS technologies which support integrated CMOS based on- chip signal processing offer a promising solution. The dual stream repeater (in the center supports two orthogonal polarizations ('H' and 'V'). The underlying RFICs are realized in IHP's SiGe- BICMOS SG13S and Infineon's B11HFC and B12HFC.

The Noise of high-speed SiGe HBT in BiCMOS Technology
AUTHORS: W. Liang and P. Sakalas
PUBLISHED ON : 8 Jun 2023.
DESCRIPTION : This paper reviews the access network is the last-stage link towards the users. This part of the network is typically flexible and functionally diverse to support user mobility and multiple applications and services. The evolution of different mobile-communication generations was driven by the increasing demands on data rate, mobility, reliability, latency and power efficiency.

WORKING PRINCIPLE

CMOS Technology: It is an adjunct to MOS technology, which was first developed by the Commodore Semiconductor Group (CSG), to manufacture electronic calculators. After then, integrated circuits like this are developed using CMOS technology, which is a complement to MOS technology. Digital logic circuits in addition to microprocessors and microcontrollers. With a high packing density, CMOS technology offers the advantages of reduced power dissipation and low noise margin.

Bipolar Technology: Bipolar transistors are integrated circuit components whose operation depends on both kinds of charge carriers—holes and electrons—or on two different types of semiconductor material. PNP and NPN are the two general classifications for these, which are based on the doping of their three the polarity of the terminals. It offers fast input/output speed and excellent noise performance in addition to high switching.

TECHNOLOGY

Step1: P-Substrate is taken to fabricate BiCMOS chip.
Step2: The p-substrate is covered with the oxide layer.
Step3: A small opening is made on the oxide layer.
Step4: N-type impurities are heavily doped through the opening.
Step5: The P – Epitaxy layer is grown on the entire surface.
Step6: Again, entire layer is covered with the oxide layer and two openings are made through this oxide layer.
Step7: From the openings made through oxide layer n-type impurities are diffused to form nWells.
Step8: Three openings are made through the oxide layer to form three active devices.
Step9: The gate terminals of NMOS and PMOS are formed by covering and patterning the entire surface with Thinox and Polysilicon.
Step10: The P-impurities are added to form the base terminal of BJT and similar, N-type impurities are heavily doped to form emitter terminal of BJT, source and drain of NMOS and for contact purpose N-type impurities are doped into the N-well collector.

Step11: To form source and drain regions of PMOS and to make contact in P-base region the Ptype impurities are heavily doped.
Step12: Then the entire surface is covered with the thick oxide layer.
Step13: Through the thick oxide layer the cuts are patterned to form the metal contacts.
Step14: The metal contacts are made through the cuts made on oxide layer and the terminals.

ADVANTAGES

1. High Speed
2. Low Power Consumption
3. Mixed-Signal Integration
4. Robustness
5. Design Flexibility
6. Compatibility
7. Cost-Effectiveness

APPLICATIONS

1. High-Speed Data Networking
2. Mixed-Signal ICs
3. Automotive Electronics
4. Aerospace and Defense
5. Medical Electronics
6. Consumer Electronics
7. Industrial Automation

CONCLUSION

Chip makers must charge more for BICMOS products due to the additional production complexity. The business is still in its infancy, but the potential of BiCMOS to interconnect huge mixed systems offers a significant cost advantage. BiCMOS is an additional to bipolar and pure CMOS technology in significant areas of system application. SiGe BiCMOS technology covers a wide range of market niches. Modern technology offers a range of functions while preserving the advantages of producing silicon-based products.

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