MMIC Research and Development at Austrian Universities

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1. Introduction

Over the past decades, microwave circuit technology has shifted from the conventional waveguide and coaxial line components and systems to the use of planar circuits, so-called MICs or microwave integrated circuits. In the hybrid form active and passive discrete components (in packaged and chip form) are connected to each other by wire or band bonds which suffer from uncontrolled parasitics yielding low reproducibility. These drawbacks have been eliminated by using monolithic microwave integrated circuits or MMICs, wherein all components are fabricated using deposition and etching processes allowing small size, low weight and low-cost mass production which are indispensable for commercial applications.

MIC engineering was characterized by tuning the circuit by the use of metal and dielectric disks, by adjusting bond wire lengths or by the substitution of one FET for another, all while observing the microwave response on a network analyzer. For MMICs, a complete reappraisal of design and technological methods is necessary. Successful realization of MMICs requires process tolerant circuit design and simulation of overall MMIC behavior.

It is obvious that MMIC design and MMIC fabrication must be coordinated as closely as possible. Since MMIC fabrication is very cost-intensive only a few process technologies have been developed successfully in the past, and they are today available at "foundries". They are either silicon-based or gallium-arsenide-based. For both advanced versions have been developed by introducing heterostructure layers (Si/Ge and AlInGaAs) thereby pushing up the frequency limit into the 100 GHz range and beyond.

A very promising alternative approach to MMIC technology is the Flip-Chip technology allowing the combination of MMIC and hybrid technology.

Due to the very broad spectrum of MMIC development small research groups frequently seek cooperation with partners as it is the case for the two examples described below.

2. MMIC R&D at the Technical University of Vienna

2.1 High-Efficiency Harmonic-Control Amplifier[1]

B. Ingruber, W. Pritzl, D. Smely, M. Wachutka and G. Magerl,
Institute of Electrical Measurements

A two-stage half-sinusoidally driven class-A harmonic-control amplifier (hHCA) has been realized in hybrid MIC technology using GaAs MESFETs which delivers 27,9 dBm output power at 1.62 GHz with 22,4 dB gain and 71% overall efficiency. Third and fifth order intermodulation distortion were –29dBc and –21dBc, respectively [1].

An MMIC version of the two-stage hHCA using AlGaAs HEMT technology is presently developed in cooperation with the Fraunhofer-Institute for Applied Physics, Freiburg, where the fabrication of the MMIC will be carried out.

3. MMIC R&D at Johannes Kepler University, Linz

3.1 CAD center

Richard Hagelauer,
Research Institute for Integrated Circuits

Design of front-end chip-sets and bipolar power amplifiers for cellular applications and for microwave sensing, RF CMOS design, single chip radar module, etc., all in silicon technology (Siemens foundry processes like B6HF and others) [2], [3].

3.2 Clean room

Hartwig Thim,
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Fabrication of simple Ga(In)As MMICs in 0,5µm MESFET technology compatible with standard foundry processes, hybrid MIC (interconnection) technologies, etc. [4], [5]. MMICs with smaller dimensions (< 0,5 µm) have been developed in cooperation with foundries, for example, a 40 GHz frequency divider has been supplied by IAF Freiburg.

3.3 Microwave equipment

Robert Weigel,
Institute for Communications and Information Engineering

Network Analyzer + Wafer Prober up to 75GHz, etc., etc.

References

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