GaAs DEVICES FOR NEW MOBILE COMMUNICATION SYSTEMS APPLICATION

Invited Paper

E.Pettenpaul und K.J.Schöpf

Siemens Semiconductor Group
D-8000 Munich FRG

1. ABSTRACT

A set of GaAs SMD devices has been developed for use in the new european mobile communication equipment, i.e. for DECT and PCN at 1900 and 1800 MHz, respectively. These devices cover the rf part of mobile communication terminals. The devices considered are a GaAs LNC chip for the receiver part, an upconversion mixer MMIC, a prescaler and GaAs power MESFETs as end-stages for the transmitter. The complete DECT, PCN block circuit including GaAs and Si devices will be described.

Keywords: Mobile Terminals, DECT, PCN, GaAs Devices

1. INTRODUCTION

Among those applications of GaAs components considered as volume markets, i.e. DBS, phased array radar and mobile communication, the latter one seems to be the by for largest one. Although the frequency ranges are relatively low, we see clear market chances for GaAs rf components due to some performance advantages combined with very low power consumption. Besides, the GaAs wafer technology has achieved a sufficient level of maturity that in combination with an approved surface mount packaging technique the base of a large-volume low-cost product line is available. In the following we describe some new GaAs components for the use in DECT-PCN systems.

2. SYSTEM DESCRIPTION AND MARKET

The second generation of mobile communication services are characterised by the change from exclusively national to a mass European-wide service which needs new digital transmission techniques to handle the high amount of communication. In the following a short description of the systems is given.

The GSM (Group Special Mobile) telephone system is a full featured telephone network which allows communication (receiving and calling) with automatic allocation of all users. The system can be accessed with various types of user equipment: from lightweight microportables up to high power mobile transceivers. The system will automatically transfer users from one base station to another if the mobile is moving

3. COMPONENTS FOR MOBILE COMMUNICATION SYSTEMS

In Fig. 1 a schematic block diagram of the complete receiver-transmitter unit is shown, which represents the areas of the circuit in which GaAs components can be used. The unit consists of an RF part, a signal processor, a multifunction interface, a microprocessor, and a frequency synthesiser. The RF part, containing a LNA, a LNA/Mixer, a VCO, a frequency divider and power driver and output stages can be fabricated in GaAs technology.

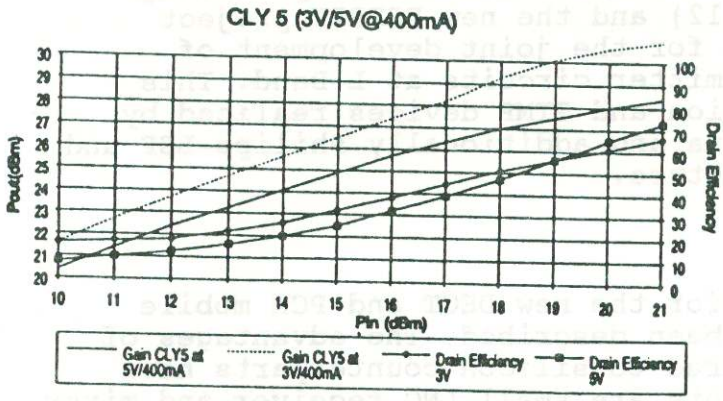
The specifications of the systems are such that many features are best fulfilled by GaAs components giving the following benefits: low current consumption, low battery voltage requirement, high linearity, low noise figure (receiver), high power added efficiency (transmitter). Si technology is highly competing with GaAs in terms of price and maturity but especially at 1.8 GHz operation frequency clear performance advantages with comparable price levels can be offered by GaAs devices.

A component set proposed by Siemens for the RF part of PCN-DECT terminals is shown in Fig. 2. It represents a mixture of GaAs and Si parts in costeffective SMD technology. A main feature is that it needs only 3-5 V supply voltage and low current which is of enormous importance for hand-helds.

In the receiver part, the main requirements are low noise operation combined with sufficient isolatioon and linearity. The proposed GaAs MMIC CMY 90 is a 3-stage LNC chip consisting of a preamplifier, mixer and postamplifier. A schematic circuit diagram is shown in Fig. 3. The core of this circuit is a FET switch mixer with gate at pinch-off, i.e. the on-off state is realized by the LO signal. The device is assembled in a 7-pin plastic SMD package called MW 7 (modified SOT 223). Typical performance achieved is a conversion gain of 15 dB, SSB-NF of below 4.5 dB, 3rd order intermodulation of 7 dBm at output and LO-RF isolation of 25 dB. The results are measured at 1.8 GHz with 120 MHz IF, 2.5 mA / 3 V, and 0 dBm LO level.

For the VCO we currently recommend a Si bipolar transistor (BFT 92) and Si varactor diode (BBY 52) together with a Si prescaler (PMB 2312) and Si PLL-IC (TBB 206). For further improvements in performance and power consumption, a GaAs 64/65 prescaler is in development using DCFL circuit topology. A first design showed potential up to 2 GHz with only 5 mA operating current and 1-2 V supply voltage.

For the upconversion the GaAs MMIC CF 750 is a good choice. The schematic diagram of Fig. 4 shows the simple but very effective circuit topology. It is a DG FET mixer with source LO allowing the desired low current - low LO level operation. The circuit is also attractive since only 4 pins are necessary which allows the use of a standard SOT 143 SMD package.



Type	CLY 5	CLY 10
• Endstage for	DECT	PCN
• Operating voltage	3 V	3 V
• Output power	500 mW	1200 mW
• Frequency	1900 MHz	1800 MHz
• Drain efficiency	≥ 60 %	≥ 50 %
• Total gate width	4 mm	8 mm

Fig. 5,6: Summary of GaAs P MESFETs CLY 5, 10

4. STATE OF THE ART

To our knowledge the present paper is the first describing a complete set of devices for the new 1.8 - 1.9 GHz mobile communication systems PCN and DECT including GaAs components as key elements. The reason is that the indesign phase has not started before 1992 in Europe and that the US and Japan systems still operate at 900 MHz.

So in the following, we can only report on GaAs devices for related L-band applications. US companies are involved in the development of GPS receivers for military and civil applications since some years (4,5). Several subcircuit MMICs have been realized including LNAs, VCOs, IFAs, LNCs and digital circuits. More recently, Philips-LEP reported up to now without test results a single chip GPS front-end (6) including analogue and digital functions.

Matsushita published a mixer-oscillator MMIC for CATV converters with Gc of 3-5 dB and NF < 7 dB using 9 V power supply (7). Work directed to mobile communication, i.e. comparable to this paper, has been reported by NTT (8). They achieved 12.5 dB of conversion gain and also NF for a mixer operated with 3 V, 8 mA.

OKI is also developing 1 GHz RF modules (VCO, mixer, power amplifier) for handheld radio terminals using 5-6 V designs (9). Again Philips-LEP has published a higher integrated IC (10). A 2 GHz enhancement mode GaAs downconverter IC for satellite TV tuners has been developed including RF and IF amplifiers, a mixer and a VCO. The single chip LNC showed 9 dB of gain and 10.5 dB SSB-NF at 1 GHz using a 5 V design.