VERY HIGH POWER ADDED EFFICIENCY PHEMT AMPLIFIERS FOR GSM AND DCS 1800 APPLICATIONS.

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ABSTRACT

A InGaAs/AlGaAs power amplifier MMIC kit designed for GSM handset phone systems has been developed. It includes two power amplifiers (PA), one GSM 900MHz and one for 1800MHz. Both parts are manufactured using a 0.5µm gate length PHEMT process. Under a low single supply voltage of 3.5V the GSM PA provides 35dBm with 60% PAE and the DCS PA achieves 33dBm with 54% PAE, they are housed in small leadless packages.

INTRODUCTION

Competition for shares of the communication market leads manufacturers to offer customers more attractive, smaller and longer talk time handsets.

In this paper we present two high performances PA developed for GSM/DCS1800 handsets.

The use of PHEMT process that provides high gain, power density and high power added efficiency (PAE) at low drain supply voltage, is a key element to meet size and power consumption reduction. Another key element for size reduction is packaging. Leadless packages allow the reduction of the area allocated to the PA on the handset board.

PHEMT POWER BASE CELL PERFORMANCES

The 0.5µm pseudomorphic process, PPH50, has been developed by UMS for handset PA applications. PPH50 is designed to achieve a very high power density and a maximum added efficiency for a gate to source bias voltage of 0 Volts. This leads to further reduce the size and complexity of the power amplifiers because no external or internal DC converters have to be added.

Power load pull measurements have been performed on different PHEMT topologies. Terminal impedances have been tuned for power and PAE optimisation at Vgs=0 Volt and Vds=3.5Volts. The typical Pout and PAE versus Pin obtained on a 8x300µm power cell is shown in figure 1. A PAE above 80% can be achieved with a power density higher than 350mW/mm. Load pull technique enables an analysis of power performances versus terminal impedances.

The figure 2 shows PAE and power density for different matching loads (M1,M2,M3) at Vds=3.5 Volts. The knowledge of this intrinsic behaviour is very helpful during the design of the amplifiers, as it allows the best compromise between PAE and power density which is a key feature for the die size and cost issue.

GSM AND DCS1800 POWER AMPLIFIERS

The main critical parameters for GSM/DCS1800 power amplifiers are output power and efficiency. Indeed the minimum output power required at the antenna is 33dBm for GSM and 30dBm for DCS. Once the output power is achieved, the parameter that singles PA out is power added efficiency, thus the higher the PAE is, the longer the talk time.

For accurate power and PAE optimisation UMS developed scaled large signal PHEMT models, and also took into account package parasitic elements, epoxy board and SMD component influence in the design.

The GSM power amplifier integrates two amplifier stages that operate in the 880MHz to 915MHz frequency band. The on board last stage output network uses three standard SMD capacitors.

Typical performances under 3.5V and with an input power of 5dBm are 35dBm output power and 60% PAE. The output versus input power is shown in figure 3 and the same parameters versus the frequency band are presented figure 4.

The output power can be controlled by lowering the Vd from 3.5V to 0V. Drain power control achieves more than 45dB range and provides a smooth and reproducible characteristic. Furthermore, the drain control exhibits a very interesting feature as the PAE remains high from $Pout_{max}$ down to $Pout_{max}$–10dBm (obtained at Vd=1.0 Volt). Figure 5 presents the output power and PAE versus drain supply voltage. Table 1 presents the output power at the harmonic frequencies.

The DCS power amplifier operates in the DCS1800 frequency band. It consists of three amplifier stages. As for the GSM part, the DCS measurements have been performed using standard epoxy board and SMD components.

Typical performances under 3.5V and for an input power of 5dBm are 33dBm output power and 54% PAE. The figure 6 shows the output versus input power. Table 1 presents the output power at the harmonic frequencies.

As compatibility with standard assembly test and packing equipments is a key point for cost issue, the PAs are housed in standard plastic leadless packages. Figure 7 presents a photography of the DCS packaged amplifier.

Associated together these PAs can fit with dual band needs. One single chip solution is in development

CONCLUSION

Very attractive GaAs power amplifiers for GSM/DCS1800 handset systems using state-of-the-art and low cost power PHEMT devices have been designed. With one single positive supply voltage they achieve both high power and efficiency, 35dBm output power with 60% PAE for GSM and 33dBm with 54% PAE for the DCS, in small and low cost packages. Those properties make the two power amplifiers valuable products for GSM and DCS handsets.

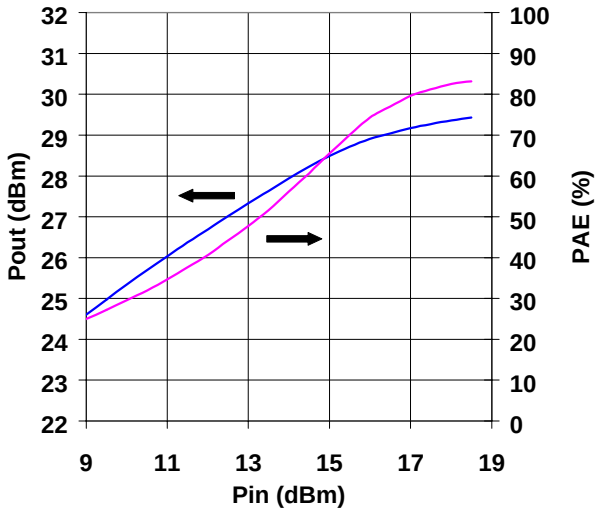

Figure 1 : Pout and PAE vs Pin under Vds=3.5V for a 3x800µm transistor

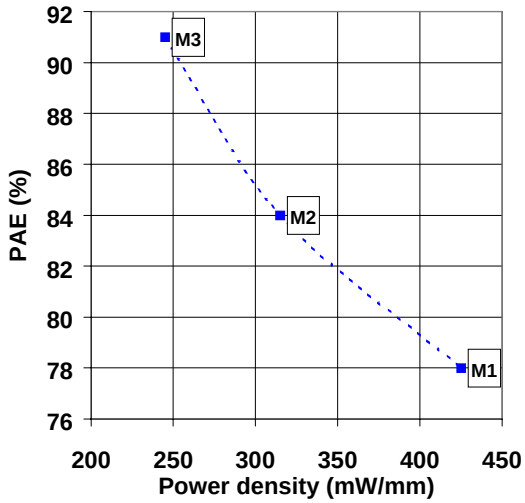

Figure 2 : PAE vs Power density under Vds=3.5V for different matching loads

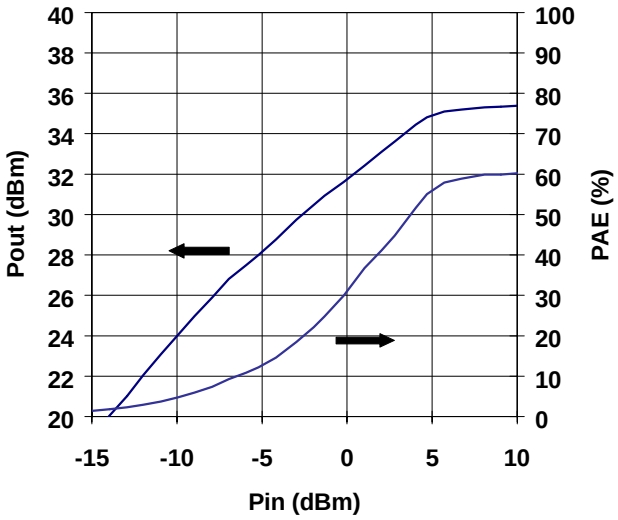

Figure 3 : Pout and PAE vs Pin under Vd=3.5V Freq=900MHz

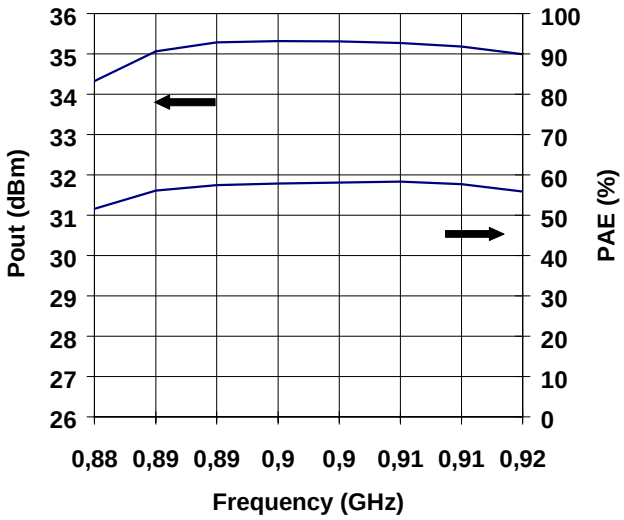

Figure 4 : Pout and PAE vs frequency for Pin=8dBm under Vd=3.5V

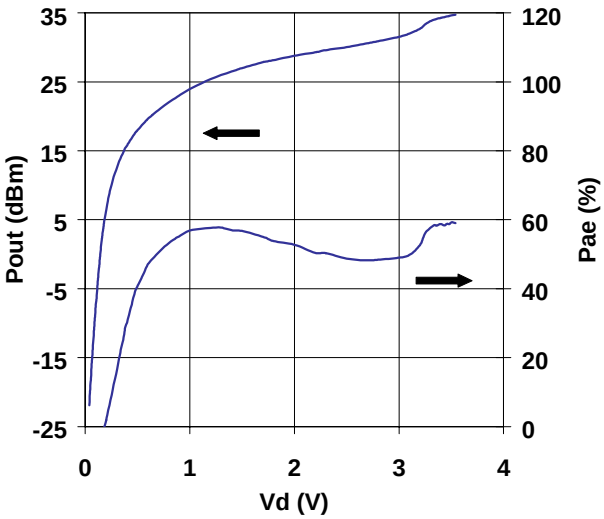

Figure 5 : Pout and PAE vs Vd for Pin=5dBm Freq=900MHz

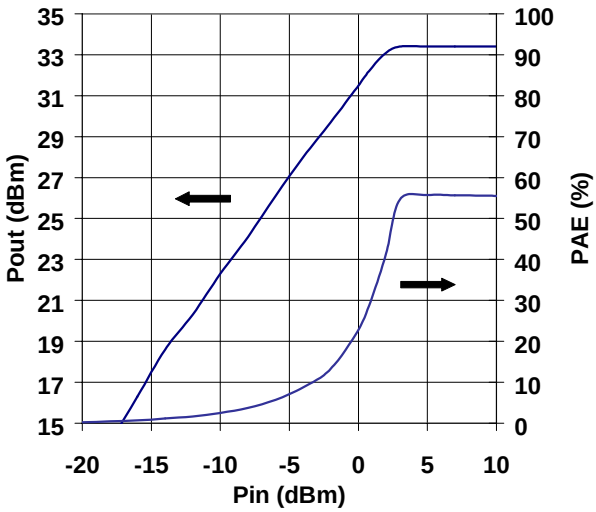

Figure 6 : Pout and PAE vs Pin under Vd=3.5V freq=1750MHz

	Pout (GSM)	Pout (DCS)
F0	35dBm	33dBm
2F0	-38dBc	-35dBc
3F0	-53dBc	-60dBc

Table 1. Vd=3.5V Pin=5dBm

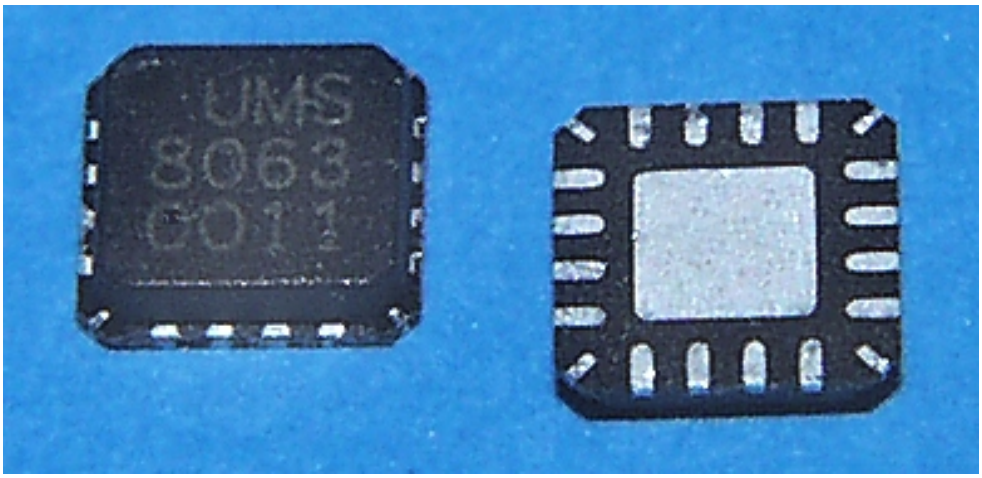

*Figure 7 :Photography of the packaged DCS1800 amplifier 4mm*4mm*