HYBRID HBT OSCILLATOR AND MIXER

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Abstract : The HBT presents inherent low 1/f noise characteristic, which makes HBT a very promising candidate, compared to GaAs MESFET or Silicon BJT, for these high frequency low phase noise applications [1,2,3]. In this paper, the preliminary measured results on the conversion factor of low frequency noise to the phase noise of HBT oscillator will be presented, together with the first results of our HBT mixer.

Introduction: High frequency - low phase noise oscillator and low noise - high gain mixer are among the key elements in modern communication systems. Oscillators and mixers fabricated with GaAs FET's suffer from high level of phase noise, and those fabricated with Si bipolar transistors show excellent noise behavior thanks to its vertical structure, but are limited in high frequency operation. The continuous progress of III-V compound device technology has led to the development of the Heterojunction Bipolar Transistors (HBTs), which is now become a suitable candidate for these applications. In this paper, the preliminary measured results on the conversion factor of low frequency noise to the phase noise of HBT oscillator will be presented, together with the first results of the first HBT mixer.

The HBT is fabricated using conventional double mesa (no self-aligned) technique, the epitaxial structure have high base doping concentration. The chip is passivated with a thin layer (about 1000 Å) of silicon nitride. [fig.1].

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Layer	Al fraction	Thickness (Å)	Doping concentration (cm^{-3})
emitter cap n+	0	940	$3.5.10^{18}$
emitter n	0.3	1100	6.10^{17}
base p+	0	900	$5.2.10^{19}$
collector n	0	4930	$3.9.10^{16}$
subcollector n+	0	8400	$2.9.10^{18}$
substrate SI	0		-----

Figure 1. epitaxial multilayer structure of the tested microwave HBT.

The used HBTs have been measured from 1 to 18 GHz. Non-linear modified Gummel-Poon model parameters of the transistor have been obtained by fitting static characteristics and scattering parameters. [fig.2].

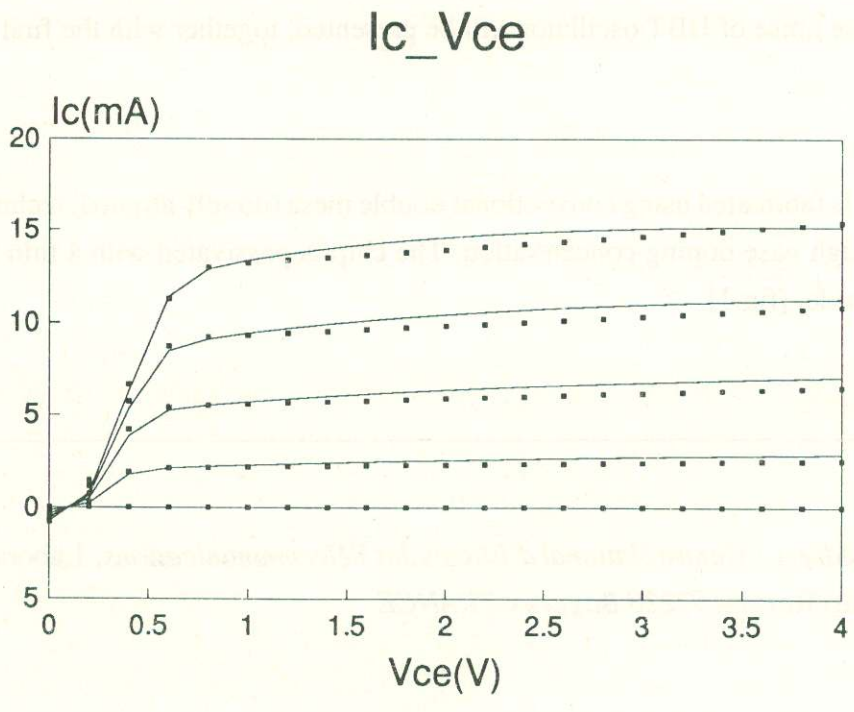

Figure 2.a) measured and calculated HBT characteristics

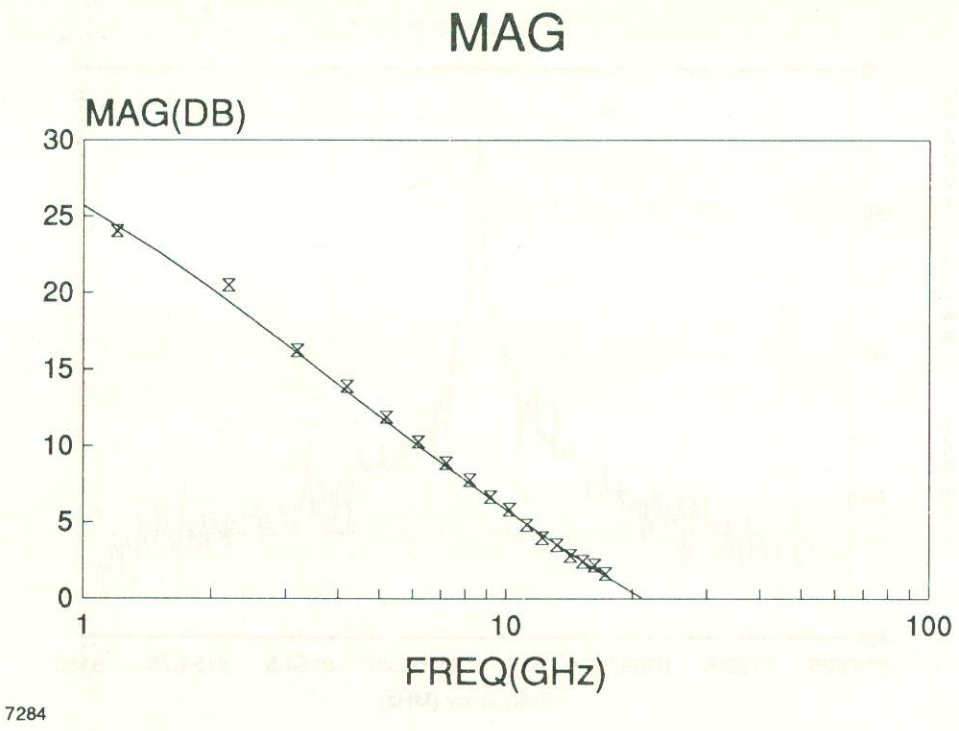

Figure 2.b) measured and calculated HBT power gain

The circuits were fabricated using thin film technology on alumina substrate. Measurements were made with spectrum analyzer.

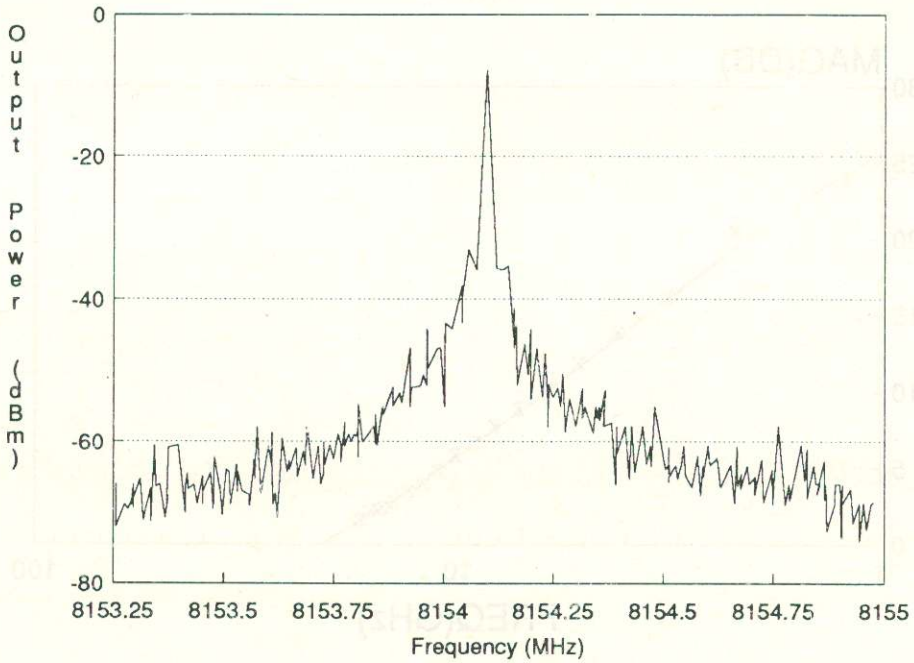

Figure 3 : oscillator spectrum.

In order to confirm the low phase noise characteristics of HBT oscillators [4,5,6] and to estimate the conversion factor of an HBT oscillator without cavities, an HBT oscillator operating at 8.2 GHz has been designed and then fabricated.

The single sideband noise spectrum at 10kHz from carrier frequency is about -61dBc/Hz for 8.2 GHz oscillator. The figure 3 shows the 8.2GHz oscillator measured spectrum.

The HBT's low frequency excess noise has been measured. The conversion factor is close to $4.5.10^{10}$ Hz/A. This result is similar to which of an MESFET.

A simple balanced mixer using two HBTs has been fabricated (figure 4). It operates with an output frequency IF of 100MHz with RF and LO frequencies about 1.4GHz and 1.3GHz respectively.

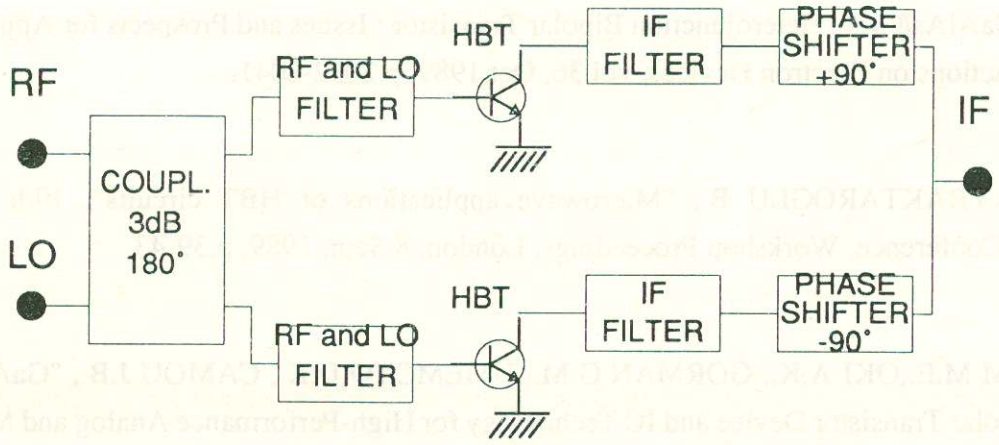

Figure 4 : simple balanced HBT mixer.

The conversion gain is about 4dB. Good isolation LO-IF was obtained. The third order intercept point of 4dBm has been measured with a LO power of 0dBm. The design of a double balanced 10 GHz HBT mixer is now in progress.

CONCLUSION :

GaAlAs/GaAs HBT oscillator and mixer have been fabricated and measured. The conversion factor of $4.5.10^{10}$ Hz/A has been obtained in a free-running 8 GHz oscillator. The first HBT mixer has shown a third order intercept point comparable to MESFET.

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