GaAs-MONOLITHIC IC's FOR AN X-BAND

CRYSTAL-STABILIZED SOURCE

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1.Introduction

A M.M.I.C. realization of voltage controlled oscillator(V.C.O.) for X-BAND application and frequency stabilization is presented Fig.1.

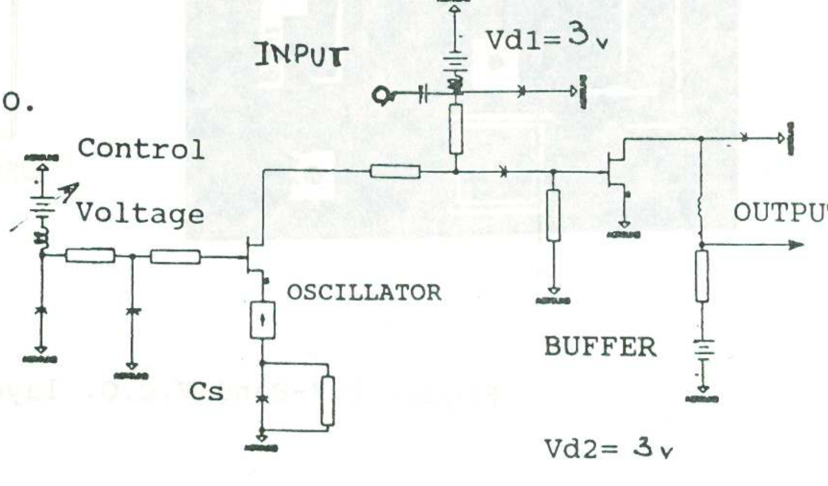
Conventional V.C.O. is based on the association of a Ga As MESFET and a varactor diode followed by a buffer amplifier.Among them ,an original one is proposed here:it is mainly based on the suppression of the varactor diode.Instead ,the variations of a HEMT gate-to-source capacitance allow to realize frequency variation on the oscillator.This approach offers good frequency stability,low tuning sensitivity to temperature,low phase noise and obviously simpler design.

On the other hand,the .present configuration of the microwave oscillator can be used to realize an injection-locked oscillator.For this purpose, we suggest an alternative approach for the design of stabilized microwave source without cavity-stabilization , such as dielectric resonator (DRSO), or phase locked loop (PLL) system in order to obtain both simpler design and good performance such : high temperature stability and linear amplitude modulation with low cost and small size.

2.Design approach

The principle of the V.C.O.,shown in Fig.1 ,is based on a FET oscillator under series feedback configuration which is realized by means of a capacitance Cs.Frequency tuning is achieved by the fact that the gate source capacitance Cgs varies as a function of the gate-to-source voltage Vgs.Since the resonant frequency is strongly dependant on Cgs, by varying Vgs, the output frequency may be changed.

Figure 1 Schematic diagram of the V.C.O.



High performance can be achieved by using a submicrometer high electron mobility field effect transistor(HEMT).Indeed,such a device can provide a high constant value of the transconductance and create a high slope on the Cgs capacitance curve.This acts as a function of the gate-source bias voltage ,consequently, a wideband frequency is reached.

Fig.1 shows that a second stage (buffer amplifier) has been used.Despite the increase in the complexity and area which is necessary for realizing the circuit,it is introduced for three reasons:

-increase of the available output power.

-decrease of the load pulling by separating the load and the oscillator.

-matching of the load impedance.

3.M.M.I.C. realization

Fig.2 shows the V.C.O. layout .The chip size is 2 mm X 1.5 mm.The active layer is fabricated by Picogiga (France) by Molecular Beam Epitaxy and the M.M.I.C. has been realized by the foundry of Watkins Johnson (USA).The gate size for the HEMT is 0.3 X 200 micron which exhibits a maximum transconductance value of 300 mS/mm for a gate voltage close to -0.2 V.The pinchoff voltage gets close to -1.5 V and the saturated drain current is about 60 mA.

Computer aided analysis and synthesis approaches have been used to reach optimum performance in the chosen frequency range.

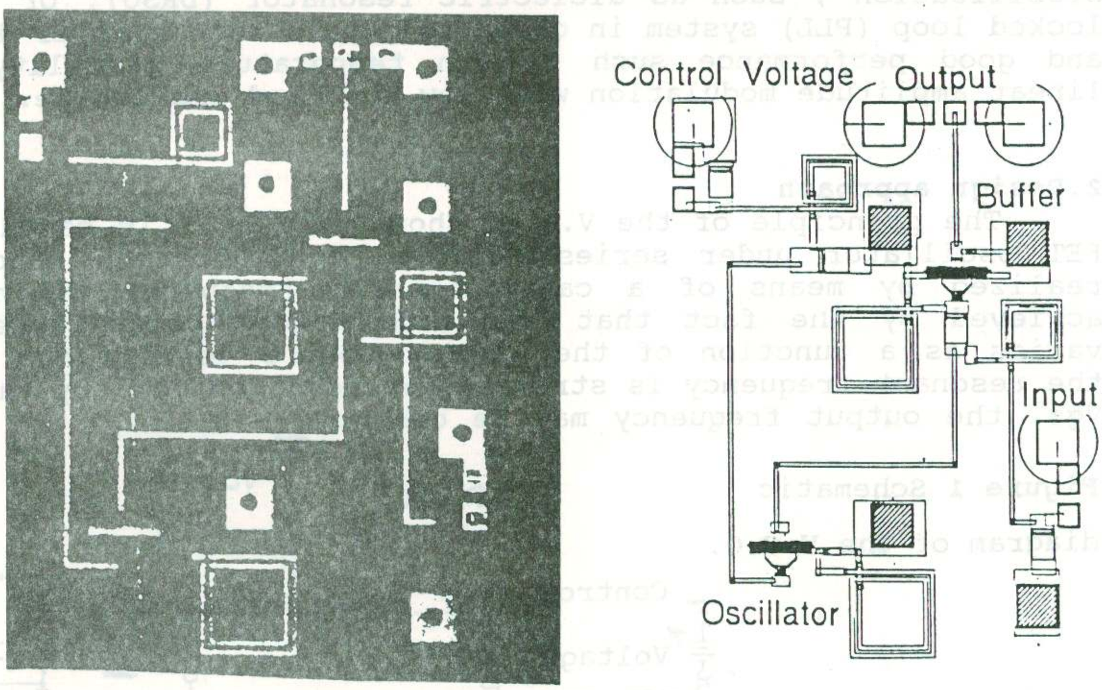


Figure 2:X-Band V.C.O. layout.

4.V.C.O. microwave performance

Fig.3 displays the variation of the output frequency and the output power as a function of the control voltage.The oscillator is tunable over almost 2 GHz with a good frequency voltage linearity and with an almost constant output amplitude of more than 14.6 mW.Indeed, the V.C.O. exhibits high modulation susceptibility of 950 MHz per Volt with an efficiency of 17 per cent .

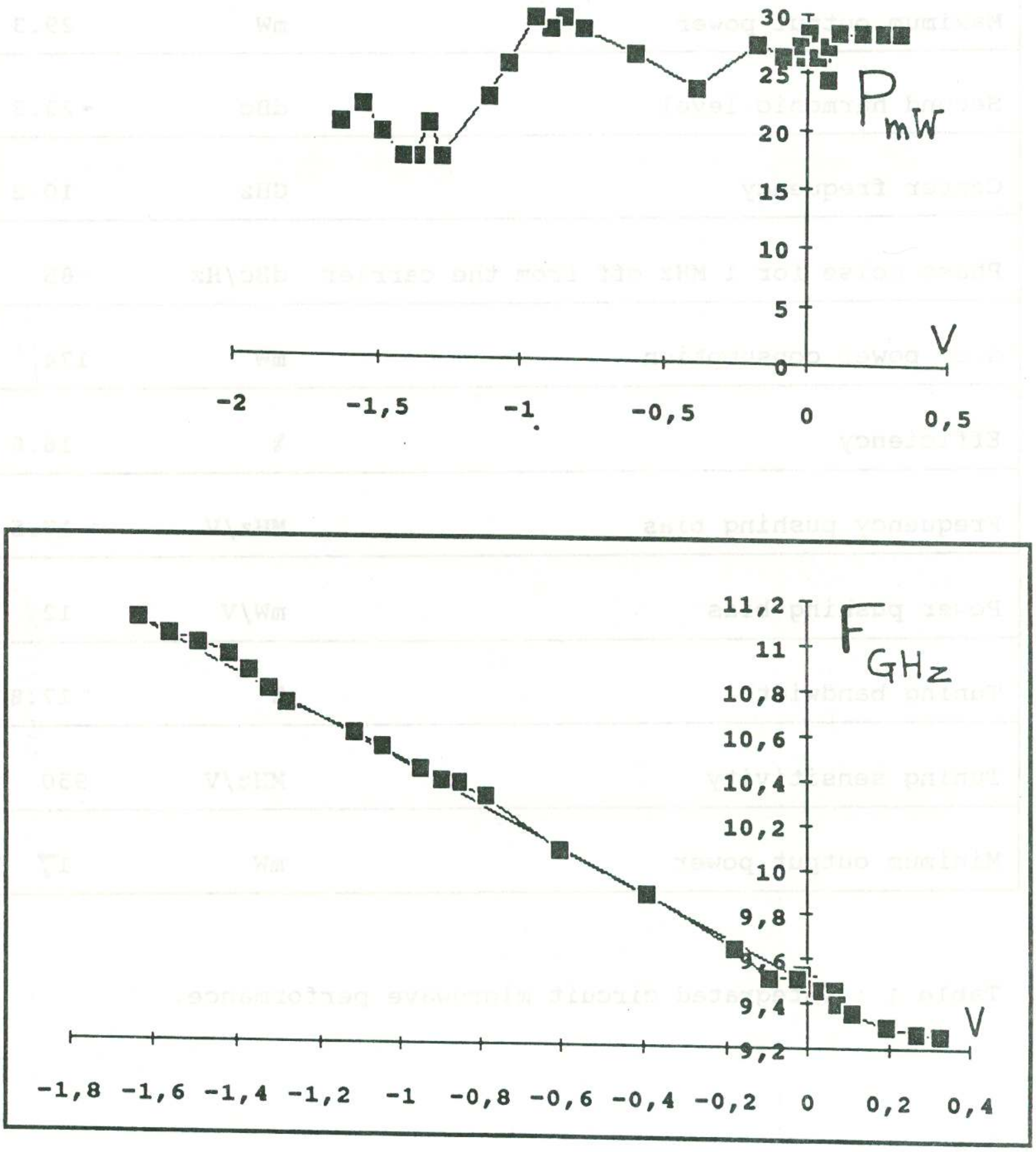


Figure 3:Oscillator output power and frequency versus bias voltage.

The main microwave measured performances of the series feedback oscillator are summed up in Table 1.

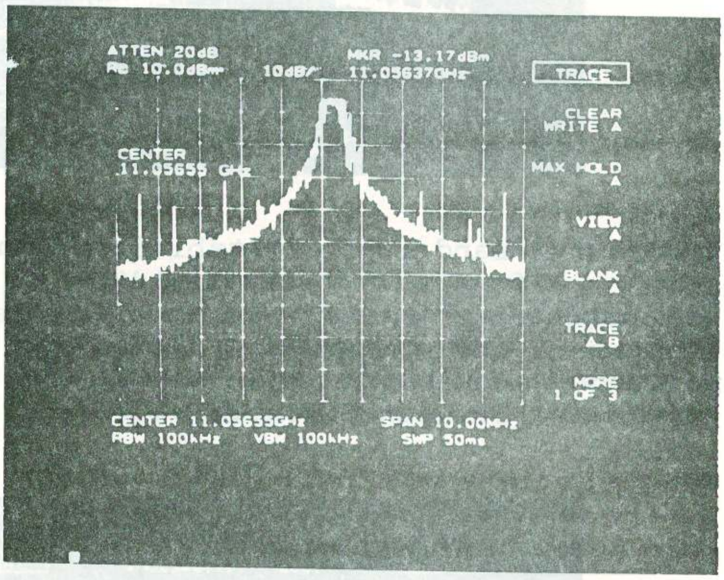
PERFORMANCE	UNITY	VALUE
Maximum output power	mW	29.3
Second harmonic level	dBc	-23.3
Center frequency	GHz	10.2
Phase noïse for 1 MHz off from the carrier	dBc/Hz	-85
d.c. power consumption	mW	174
Efficiency	%	16.8
Frequency pushing bias	MHz/V	< 17.5
Power pushing bias	mW/V	12
Tuning bandwidth	%	17.8
Tuning sensitivity	MHz/V	950
Minimum output power	mW	17

Table 1 : Integrated circuit microwave performance.

5.X-Band crystal-stabilized source

The M.M.I.C. can be used to realize an injection-locked oscillator by applying a signal source to the input port Fig.1 with a frequency close to those of the frequency oscillator.In this case,improvement of the spectral purity and the phase noise is observed as shown in Fig.4.

(a)



(b)

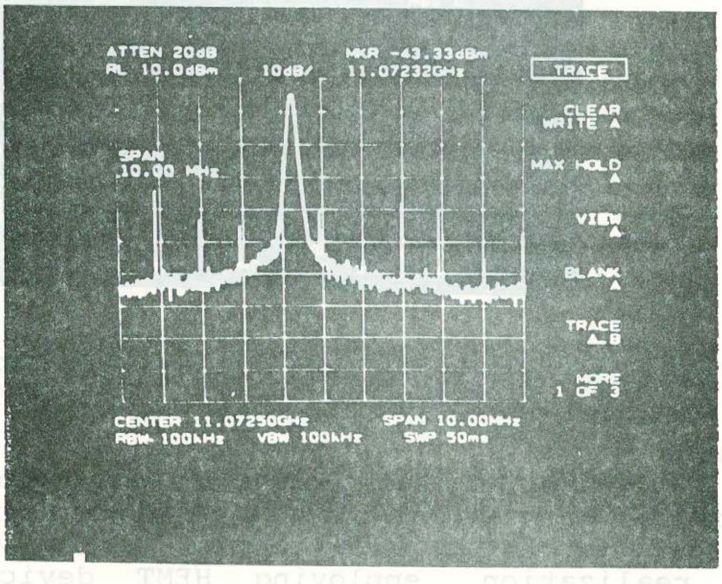


Figure 4: Signal spectrum of the:
(a)-Free running oscillator.
(b)-injection-locked oscillator
(by drive level of 1 dBm).

In the particular case , where a subharmonical frequency signal is used, we have found that higher frequency ratio up to 100 can be employed which allow us to realize a quartz crystal stabilized oscillator as shown in Fig.5.

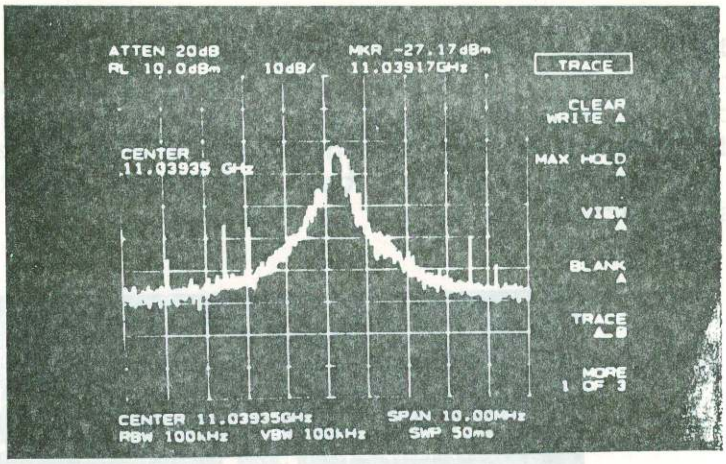


Figure 5:X-Band crystal-stabilized source
(frequency ratio of 100)

As a consequence,injection-locked oscillator exhibits an improved frequency and temperature stability , offers Fig.6 linear amplitude modulation and shows the possibility to realize a microwave frequency demodulator.

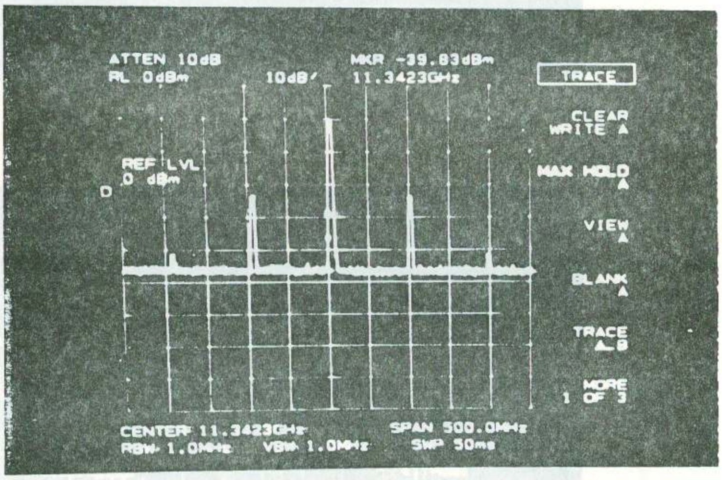


Figure 6:Amplitude modulation of the oscillator.

6.Conclusion

We have demonstrated that a wideband voltage controlled oscillator can be realized without a varactor diode in order to obtain a simpler design and a better microwave performance.An M.M.I.C. realization, employing HEMT devices , has been presented.

On the other hand ,this integrated circuit offers good capabilities to fabricate a quartz crystal stabilized oscillator.

Acknowledgment

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