20-90 MHZ CURRENT-CONTROLLED SINUSOIDAL OSCILLATOR

Hervé BARTHELEMY * and Alain FABRE **

* Laboratoire LEMMI, ISEM - Maison des Technologies
Place Georges Pompidou, 83000 Toulon, France.

** Laboratoire IXL, Université de Bordeaux I
351 Cours de la libération, 33405 Talence, France.

ABSTRACT: A current-controlled sinusoïdal oscillator based on the Wien bridge oscillator is presented. The circuit acts in current mode and uses a second generation current conveyor. Its oscillation frequency, which can be varied from 20 to 90 MHz is adjustable from the bias current of a floatting resistor. The circuit has been implemented from SGS THOMSON in a 2μm BICMOS technology. Measurement results are obtained in good accordance with simulation ones. At 50 MHz, the total power consumption is 50 mW under 5 Volts.

I - INTRODUCTION: Controlled oscillators are extremely useful circuits in telecommunication systems and many applications have been reported from them [1-3]. They play an essential part, for example in phase locked loops (PLL), clocks, sensors... It is well known that conventional op amp based RC active oscillators are frequency limited and so cannot be used at high frequency [2-3]. To overcome these limitations, the synthesis of sinusoïdal oscillators by using operational transconductance amplifier-capacitors (OTA-C) have been explored [3]. Nevertheless, to operate at high frequency, 4 OTAs and 4 capacitors are then necessary in conjunction with large bias currents (about to 10 mA for each OTA which inevitably leads to high power consumption). By another way, second generation current conveyors (CCII) can also be used as universal active elements and can operate up to frequencies located on the GHz range when they have been implemented in the translinear form [4-5]. The controlled sinusoïdal oscillator presented in this paper is based on the Wien bridge oscillator. It uses a class AB $CCII^+$ as active element and necessitates 2 capacitors only. Its oscillation frequency is adjustable from 20 to 90 MHz varying the bias current of a floating active resistance. The maximal value for the bias current of each active element is about 1mA. So, the circuit supplied under 5V dissipates 50 mW only for a 50 MHz output signal.

II - CIRCUIT DESCRIPTION: The schematic form of the oscillator, which acts in current mode is shown in Fig. 1. This implementation has directly been deduced from the well known Wien bridge oscillator, using the properties of the adjoint network transformations, [2].

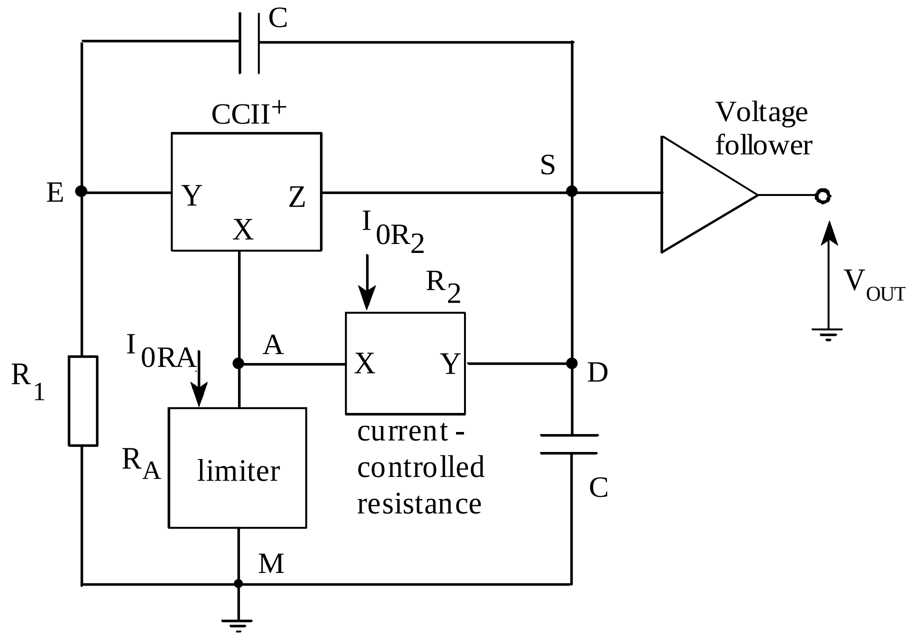


Fig. 1 : Schematic form of the current-mode sinusoïdal oscillator.

A voltage follower with a 50Ω output resistance has been added for measuring purposes. The use of the $CCII^+$ allows the oscillation frequency and the condition for oscillation to be adjusted independently. They are given as, [2]:

oscillation frequency : $\omega_0 = 1/C\sqrt{R_1 R_2}$ (1-a)

condition for oscillation : $R_A \leq R_1/2$ (1-b)

where R_A is the low-signal equivalent resistance of the limiter.

Fig. 2 shows the translinear class AB second generation current conveyor in a conventional form, which has been used. It has been biased from I_0 = 490 µA.

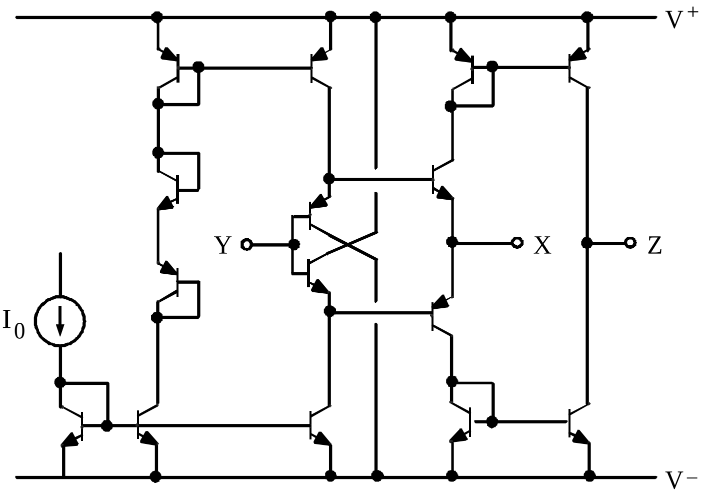
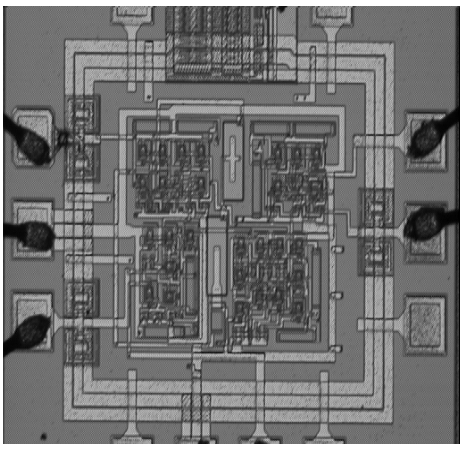


Fig. 2: Translinear class AB $CCII^+$.

The voltage follower in Fig. 1 has been obtained from the $CCII^+$ above using ports X and Y alone. Its bias current I_0 was adjusted to obtain a 50Ω output resistance. The magnitude limiter in Fig. 1 has also been obtained from the $CCII^+$. Its XY non-linear characteristic seen from port X has in this order greatly been increased, using minor modifications, so that the circuit saturates quickly for input currents equal to $\pm I_0$. Its low signal equivalent resistance R_A remains then controlled from I_0.



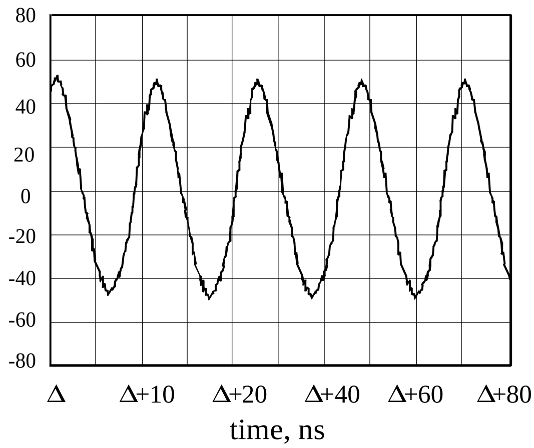


Fig. 3: **a)** Photograph of the oscillator **b)** output signal at 80 MHz

The controlled floating resistor R_2, in Fig. 1, has been implemented from two CCIIs as above but with minor changes. Fig. 3-a shows the photograph of the chip of the oscillator (total area: 1.2 mm^2) which was implemented from SGS-THOMSON using the HF2CMOS process (BICMOS 2μm). The following values were used for passive components: C = 5 pF and R_1 = 1 KΩ.

III - MEASURED RESULTS: The circuit was supplied with $V^- = 0V$ and $V^+ = 5V$. Fig.3-b shows the output signal obtained at 80 MHz. At this frequency, the total power consumption of the circuit is 70 mW. Fig. 4 shows the frequency variation as a function of the control current I_{0R_2}. Simulation results have been indicated together with measured ones to demonstrate the good accordance between them. Table 1 gives additional characteristics measured for f_0 = 50MHz.

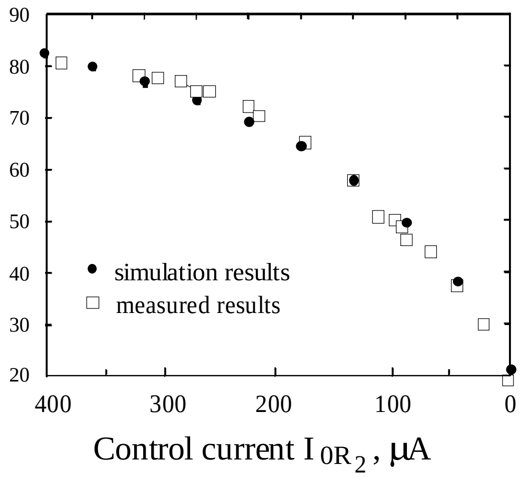


Fig. 4: Oscillation frequency as a function of the control current .

Output power: -10dBm
1st harmonic: -25 dBc
2st harmonic: -47dBc
Upper harmonics: <62dBc
Phase noise: -63 dBc offset 50KHz
Total power consumption: 50mW.

Table. 1: Measured results at f_0 = 50MHz, for 100 mV peak to peak output magnitude.

IV - CONCLUSION: A current controlled sinusoïdal oscillator operating in current-mode has been implemented using bipolar transistors. Varying the control current I_{0R_2} it is easily adjustable from 20 to 90 MHz.

V - REFERENCES :

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