Design of Low Power Pierce Crystal Oscillator Using CMOS Technology

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Abstract : ***— Crystal Oscillators are key parts employed in several electronic circuits, similar to in portable applications, digital and microprocessor-based devices. so as to save lots of power, low-power consuming circuit is commonly desired. A high demand of oscillator in portable instruments leads to high performance crystal oscillators to implement in silicon chip. A 20 MHz Pierce crystal oscillator is designed in a 0.13m CMOS process using Mentor Graphics with 1V supply. This exhibits approximately a section noise of -60dB/Hz at one megahertz offset. This employed in communication system similar to Electronic Warfare system.***

IndexTerms - CMOS, Low Power, Crystal Oscillator, Pierce Oscillator.

I. INTRODUCTION

Oscillators essentially measure ac signal generator generates sine wave of wanted magnitude, at wanted frequency. Material like quartz exhibits a singular property referred to as piezo electrical property. It states that if mechanical forces applied to quartz then it generates electrical potential. If we tend to apply mechanical vibrations to quartz then below the correct operative conditions we are able to acquire electrical oscillations from it. [3]

A crystal oscillator has fascinating characteristics for tuned oscillator circuit applications as a result of the natural oscillation frequency of the crystal is extremely stable with changes in temperature, power offer voltage, or mechanical vibration. The oscillation frequency of a oscillator may be approximated by the subsequent equation:

$$f_{osc} = \frac{1}{2\Pi\sqrt{L_1}+C_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

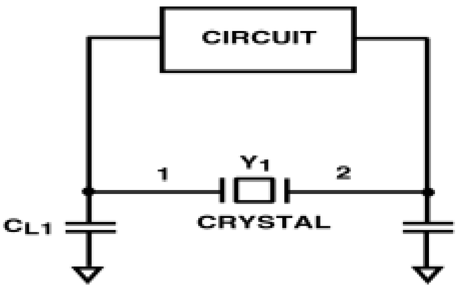

FIGURE 1: Crystal Oscillator Network

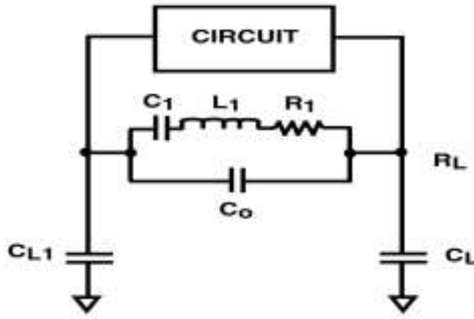

FIGURE 2: Crystal Equivalent Circuit Network.

The electrical equivalent circuit for a crystal oscillator circuit is shown in Figure 2. This electrical equivalent circuit is a model of the crystal's electrical and mechanical behaviors. It does not consist of these actual circuit elements; therefore it tends to operate under a more limited set of electrical conditions. The crystal electrical equivalent circuit consists of C1, L1, R1 and C0. The components C1, L1, and R1 are called the motion arm and they model the mechanical behavior of the crystal element. C0 models the electrical behavior of the crystal element and its holder. C1 models the elasticity of the quartz, the area of the electrodes on the face, and the thickness and shape of the quartz wafer. L1 models the vibrating mechanical mass of the quartz in motion. R1 models and represents the real resistive losses within the crystal. C0 represents the sum of capacitance due to the electrodes on the crystal plate and stray capacitance due to the crystal holder and enclosure.

High frequency stability is the biggest advantage of employing a oscillator. The frequency of a oscillator remains stable in spite of changes in temperature, voltage, wetness or different parameters. Thanks to high demand in transportable instrument, high performance oscillator is required to be enforced on chip. It offers blessings similar to low power and correct in frequency

.

Types of crystal oscillator:

Pierce oscillator
Miller oscillator

Pierce oscillator circuit has been accustomed maintain the synchronization and organize the periodic awaken systems. To operate over a long period of time the low power consumption is required for wireless applications. [1]

It is not easy to reduce power consumption in any electronic device; Trade-off exists between totally different parameters of generator. Balancing of that trade of we have to achieve a design for low power oscillator.[10] Phase noise, oscillation frequency, offer voltage, power dissipation, and CMOS feature size are measure factors to touch upon while styling Oscillator.

II. RESEARCH METHODOLOGY

PIERCE CRYSTAL OSCILLATOR is simple circuit; the crystal determines the frequency of oscillations and operates on its series resonant frequency giving a low impedance path between output and input. There is a 180° phase shift at resonance, making the feedback positive. The amplitude of the output sine wave is limited to the maximum voltage range at the Drain terminal. Resistor, R1 controls the amount of feedback and crystal drive while the voltages across the radio frequency choke , RFC reverses during each cycle. Most digital clocks, watches and timers use a Pierce Oscillator in some form or other as it can be implemented using the minimum of components.

The crystal oscillator design using Mentor Graphics tool kit based on 0.13µm technology. Schematic layout has 6 PMOS and 7 NMOS transistors. There is negative and positive two output are existed which represents the differential structure of the circuit. The supply voltage is V_{DD} which is 1.2V and AC signal input is 1V. [1]

Table 1: Parameters in Crystal Oscillator Design

PARAMETER	VALUE
Voltage supply	1.2V
Vin	1V
Width	(0.5µm)PMOS (0.25µm)NMOS
Length	(0.13µm)PMOS & NMOS

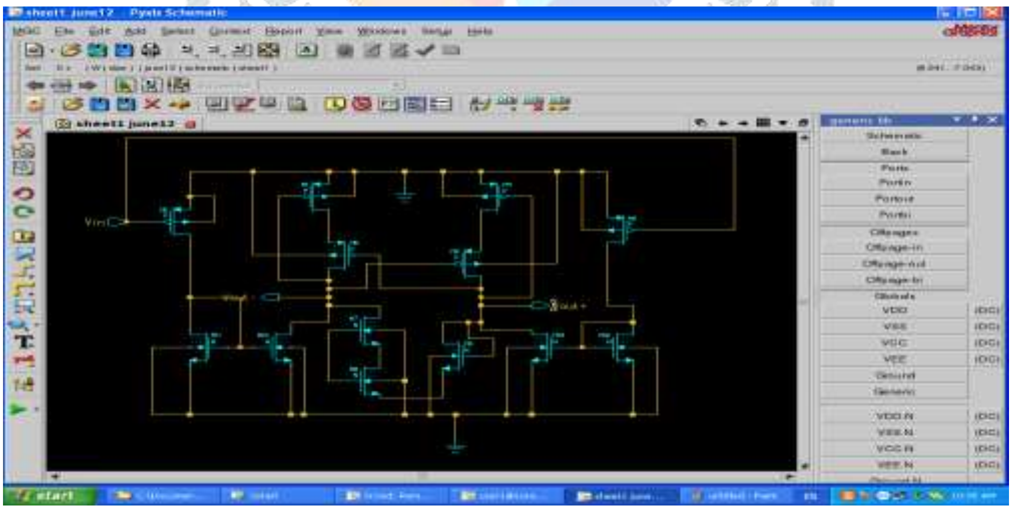

FIG 3: The crystal oscillator design in 0.13µm standard CMOS process using Mentor Graphics.

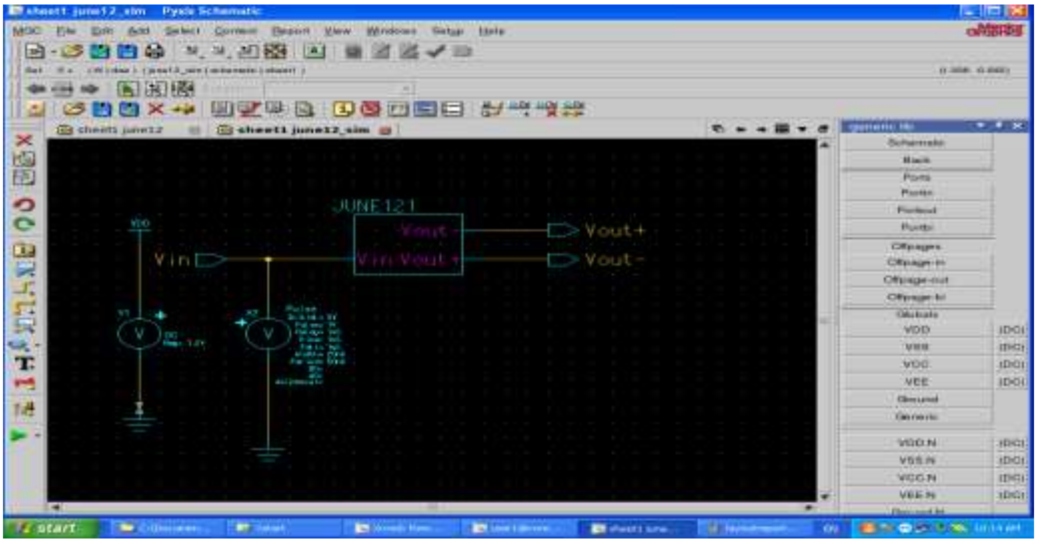

FIG 4: Symbol design for crystal oscillator circuit

III. RESULTS AND DISCUSSION

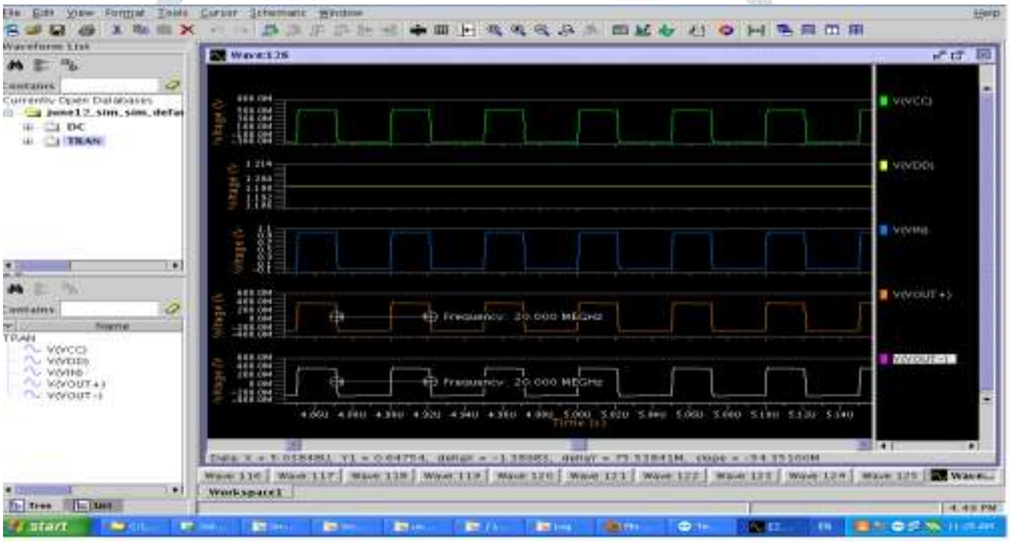

FIG 5: The results of Transient Analysis

Above Fig. showing transient analysis for a designed crystal oscillator using EZwave tool. As per the required result we get the 20MHz oscillator frequency within minimum power consumption which is 1V. There are two output present Vout+ and Vout- because of the differential behavior of the pierce crystal oscillator.

The differential structure crystal oscillator is successfully designed with the aim of minimum power dissipation, less phase noise and more stable frequency. The designed work carried out using 0.13um CMOS process technology using mentor Graphics tool. For further improvement we again reduce the feature size and power consumption considering the trade-off between crystal oscillator parameters.

IV. ACKNOWLEDGMENT

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