

SINGLE SOURCE PIERCE OSCILLATOR CIRCUIT TOPOLOGY FOR MEMS SAW RESONATOR

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1. Introduction

Today, most of the transceiver circuit system is based on off-chip resonators and it does not have Integrated Circuits (ICs) compatible fabrication methods [1]. With these factors, the major challenge for a designer is to achieve completely silicon based heterodyning transceiver. In transceiver system, resonators act as the key components that being used for frequency selection in the RF and intermediate-frequency (IF) stages. As the network technology becomes complex, Micro-Electro-Mechanical-Systems (MEMS) technology have successfully shows its capability to fulfil the criteria and demands especially in communication systems areas. Based on [2]–[4], various kinds of novel MEMS devices and components have been successfully implemented by using CMOS fabrication techniques and with this advantage, MEMS technology can have brought us a step nearer towards achieving the ultimate objective of single chip for transceiver systems [5]. By using the same CMOS fabrication, the losses due to wire bond that connects the passive devices to the circuit in the transceiver circuit can be controlled and reduced. In the other hand, by using the same CMOS fabrication process, it will help reducing the parasitic, attenuation and thus improving the performance of the developed transceiver system.

Oscillator is the key component that generates carrier signal with different frequency and amplitude. Generally, the frequency standard for each communication systems is determined by the carrier frequency that being generated by the local oscillator itself. For example, personal connectivity such as Bluetooth technology requires carrier frequency range from 2.4 to 2.485-GHz while for WLAN technology, it requires carrier frequency range from 5.15 to 5.35-GHz for its operation. To produce and integrate multiple standard frequency operation in a single system, all the required carrier frequency must be generated locally by the same or different oscillator. Normally, the development of individual and different oscillator for each of the frequency standards will consume large area and power. In order to solve this problem, a reconfigurable oscillator is one of the solutions. Oscillators based on MEMS are mostly used to generate the reference frequency and timing in electronic systems due to their small size and it potential to undergo fabrication with standard CMOS process, enabling novel single chip systems [6] with higher frequency which are suitable for wireless communications. Compatibility with CMOS and multi-frequency operation on a single chip [7], [8] has successfully made MEMS based oscillator to draw significantly and plays a big role in gigahertz radiofrequency (RF) applications. In [9]–[12], MEMS based oscillators have shown high quality factors ($Q > 1000$) and operates gigahertz ranges. In [27], it reports on the first demonstration of a 1.05 GHz MEMS oscillator using pierce oscillator circuit topology based on Lateral-Field-Excited (LFE) piezoelectric AIN contour-mode resonator and it results shows that these devices suitable for post-CMOS integrated on-chip direct gigahertz frequency synthesis in reconfigurable multiband wireless communications systems. This chapter presents the design and simulation of a single source pierce oscillator topology micro-electromechanical (MEMS) based oscillator.

2. Basic Oscillator Circuit

Figure 7.1 shows the block diagram for a basic structure of a feedback oscillator circuit [13] which it consists of an amplifier $A(\omega)$ and a feedback network, $B(\omega)$ connected in a positive feedback loop. In this