A Low-Noise Voltage-Controlled Ring Oscillator in 28-nm CMOS Technology

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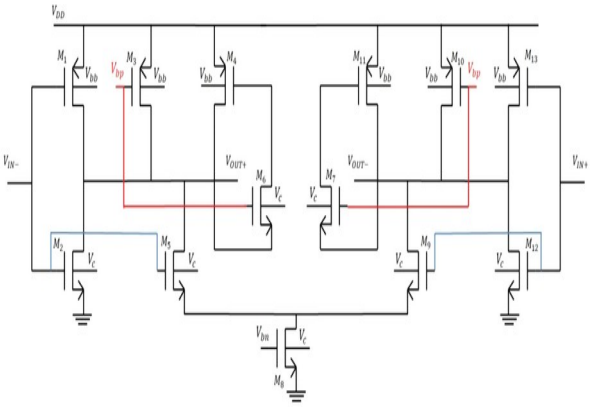
***Abstract*—this paper presents a low phase noise ring based voltage-controlled-oscillator (VCO) for ultra-wide band (UWB) applications. The circuit is implemented in a 28-nm CMOS technology. The VCO delay cell is characterized by a 3.75mW power consumption and benefit from a new voltage control through the transistor body bias in order to achieve high performance with a wide tuning range. In the frequency range from 29 to 49 GHz, the lowest phase noise result is -132dBc/Hz at 1 MHz frequency offset while operating at 49 GHz. These measurement lead to an excellent figure of merit (FoM) of -220dBc/Hz.**

Keywords—Symmetrical load differential VCO, Swing-Enhanced block, Self-Excitation tune,etc.

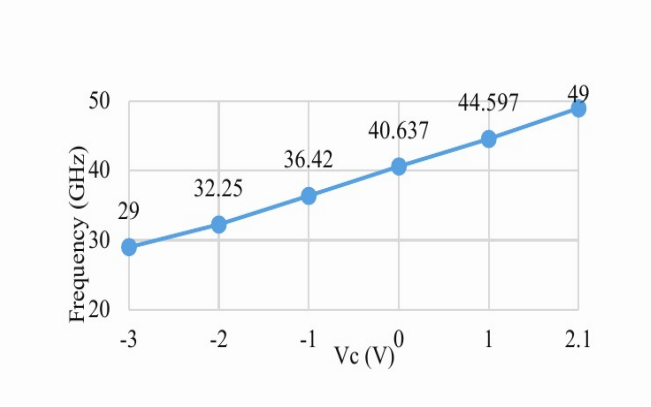
I Reference Circuit Details

From a long time, the wireless multimedia market is growing rapidly to meet the demands for greater data rates and bandwidth. It is identified that a broad spectrum around the 40-50 GHz frequency of operation is able to support very high-rate wireless communications. But these systems need to solve several challenging issues before being used such as high channel loss, limited amplifier gain and increased phase noise in the designed transceivers. This paper focus on the problem of the phase noise of the VCO in the emerging 40-50 GHz (UWB) range of operation frequency. Common VCO implementations are LC oscillators and ring oscillators. In integrated circuits, inductors is difficult since these devices occupy a large area and thus LC tank voltage-controlled oscillator becomes inappropriate. Concurrently, Ring Oscillator benefit from the rapid advance of the technology in IC industry, to occupy more and more small area on the chip, while keeping all its appealing characteristics such as the large frequency tuning range, and the good linearity, making it widely used in industrial products and academic. The basic circuit structure of this study is designed and implemented using the symmetrical load differential VCO structure, because it has many advantages. Single-ended ring oscillators suffer from the low phase noise performance and frequency limitations, therefore other architectures can be applied. Moreover, additional techniques can be used to reach wide range of frequencies with lower levels of phase noise. In this work, a 3-stage ring oscillator is used, where the structure chosen is a modified differential symmetrical load. There are two additional elements used to design new differential VCO extension, the swing enhanced block and self-excitation tube. The main idea is to eliminate the drawbacks of the proposed VCO structure, while maintaining their advantages. This combination will help to design a new extension delay structure, so that a cascade of 3 stages of these units constitute a High-Performance Voltage-Controlled Oscillator (HPVCO), characterized by a stable output voltage with a wide range of frequencies controlled by the body bias control voltage.

II Reference Circuit



III Reference Waveform



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