IDEC Chip Design Contest

Design of a 15.4–17 GHz Current-Reused Coupled VCO and Improved Noise Circulation with Enhanced Flicker Noise Suppression at 1/f³ Corner

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Introduction

VCOs are vital for frequency synthesizers and PLLs, with performance impacting phase noise (PN), tuning range, supply pushing, start-up, and power consumption. These parameters are interdependent, making optimization difficult, especially at millimeter-wave frequencies. A key trade-off exists between low PN and wide tuning range, limiting performance at higher frequencies.

Proposed Circuit Design

- The proposed VCO uses a current-reused coupled oscillator with triode-biased degeneration to enhance ISF symmetry and suppress flicker noise. Capacitive coupling replaces bulky transformers, and a tail inductor filters second harmonics while maintaining high tank Q.

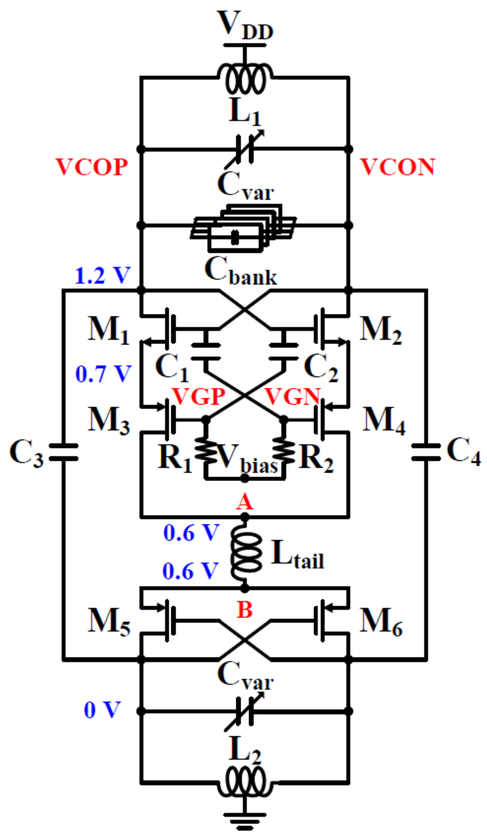


Fig 1. Schematic of the proposed VCO

- The implemented prototype circuits, where the output of VCO is post-processed by divide-by-4 and output buffer.

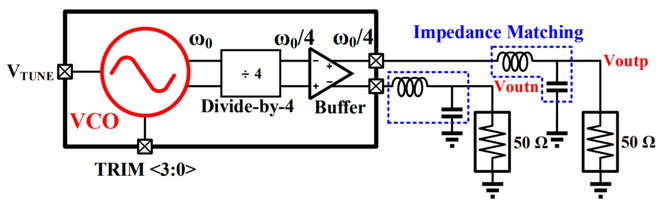
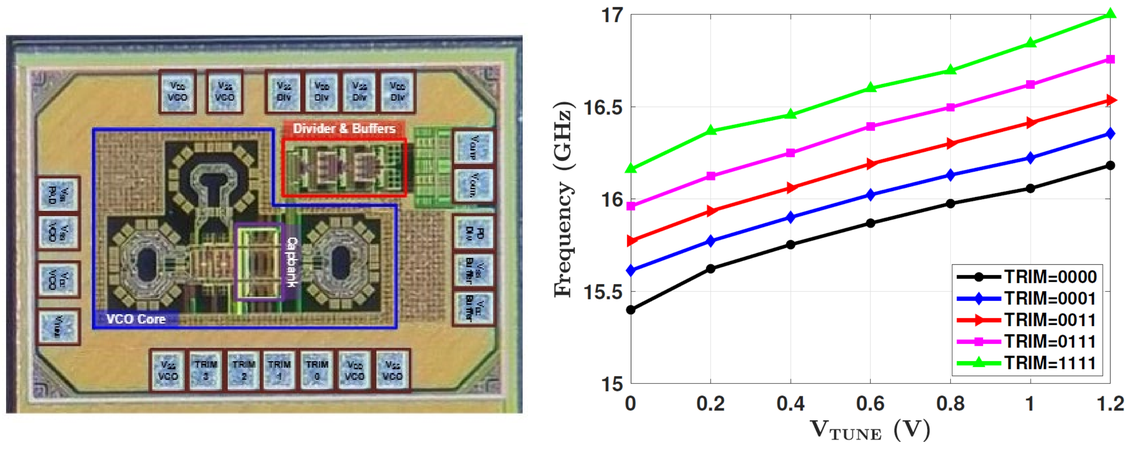


Fig 2. Block diagram of the prototype circuits consisting of the proposed VCO, divide-by-4, and output-buffer.

Fabrication & Measurement Result

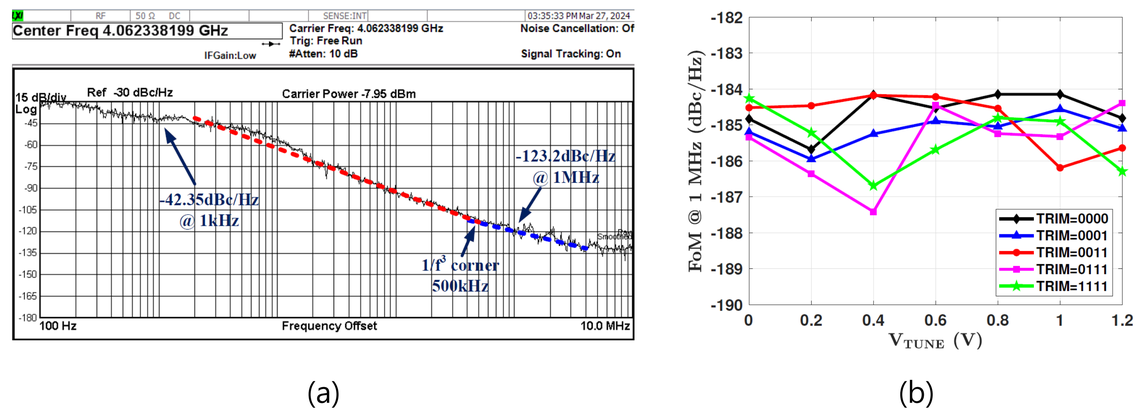
- The prototype circuit was fabricated in a 65nm CMOS technology. The entire chip occupies 590 × 850 μm^2. The VCO consumes 6.72 - 5.9 mW with tuning range from 15.4–17 GHz.



(a) (b)

Fig 3. (a) Chip micrograph of the proposed VCO (b) Measurement results of frequency tuning range.

- The measured best phase noise reached at -123.3 dBc/Hz at 1MHz frequency offset with 500 kHz 1/f³ corner at 4.06 GHz output frequency.



(a) (b)

Fig 4. (a) Measured PN after divide-by-4 of the prototype circuit at best PN frequency (b) FoM of the proposed circuit over different capacitor bank trims and control voltages at 1 MHz offset.

Conclusion

A VCO design achieving low phase noise, low power, and high K_{VCO} VCO is presented. Measured at 16.25 GHz, phase noise is –30.3 dBc/Hz at 1 kHz and –111.2 dBc/Hz at 1 MHz offsets shows the best performances at the proposed VCO. The improved noise circulation technique reduces close-in noise while preserving 1/f² performance.

Acknowledgment

The chip fabrication and EDA tool were supported by the IC Design Education Center.