ミリ波無線機のための 20GHz Push-Push 電圧制御発振器

A 20GHz Push-Push Voltage-Controlled Oscillator for a MM-Wave Frequency Synthesizer

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1. Introduction

In the design of RF front-ends of a direct-conversion transceiver for IEEE 802.15.3c, a low-power 60 GHz LO with a phase noise of at least -90dBc/Hz is required for a 16QAM modulation scheme [1]. Using a combination of sub-harmonic 20GHz VCO and super-harmonic 60GHz QILO is preferred due to the better phase noise performance at 60GHz [2]. Because of its sensitivity over PVT-variations, a calibration of QILOs has recently been demonstrated [3]. However, for 65nm CMOS, the best overall quality factor of oscillator tank falls around 10 GHz [4]. Therefore, a novel approach is proposed in Fig. 1 using a 10 GHz QVCOs as main oscillator to generate a differential 20GHz VCO as a sub-harmonic VCO for a quadrature 60GHz LO generation.

2. Circuit Design and Implementation

A 3-bit capacitor and a varactor are used in NMOS cross-coupled 10GHz main QVCOs for a wide tuning range in Fig. 2. The common nodes of main oscillator, X and Y, are forced by cross-coupling transistors to have a 180^o phase difference.

The impedance of the second harmonic resonator $Z_p(f)$, composed of an inductor and 2-bit capacitor, is designed to peak at the second harmonic of the main VCO. As a result, this attenuates the first harmonic and enhances the second harmonic outputs. In addition to the gain enhancement, a lower phase noise can be achieved from second harmonic resonator since it acts like a tail filtering. As well as, similar to tail feedback [2], cross-coupling transistors modulate tail current to maximize when amplitude of ISF is at its minimum resulting in an improved phase noise.

3. Measurement Results

The proposed 20 GHz VCO is implemented in a 65nm CMOS process. As shown in Fig. 3, the measured phase noise at 19.1 GHz is -105 dBc/Hz@1MHz offset. The measured tuning range is from 16.3 GHz to 19.3 GHz. Table I compares the calculated performance of the proposed VCO for the 60 GHz frequency synthesizer proposed in [2]. From characteristic of third harmonic injection locking, if implemented in [2], the phase noise of this work would be -95dBc/Hz which satisfies the requirement for 16QAM. Comparing with [2], this work reduces power consumption of 20 GHz VCO from 19 mW to 7.5 mW.

4. Conclusion

Using a 20GHz push-push oscillator and a 60 GHz QILO as millimeter-wave frequency synthesizer, it shows a capability of maintaining a low phase noise with 11.5mW power reduction.

TABLE 1: PERFORMANCE SUMMARY

	Features	Freq. [GHz]	Phase noise [dBc/Hz]	Power [mW]
[2]	VCO@20G+60GHz ILO	58-63	-96@1MHz	80
This	PP VCO@10GHz	16.3-19.3	-105@1MHz	7.5
	PP VCO@10GHz +60GHz ILO [2] (based on calculation)	48.6-57.9	-95@1MHz	68.5

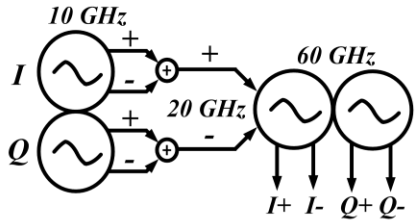

Fig. 1. Proposed 60GHz Quadrature LO

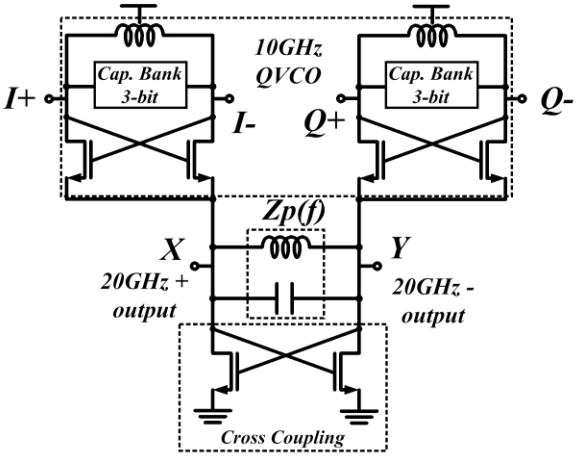

Fig. 2. Schematic of proposed 20 GHz VCO

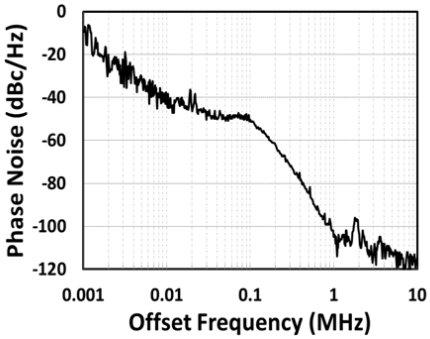

Fig. 3. Measured phase noise at 19.1 GHz

Acknowledgements

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