

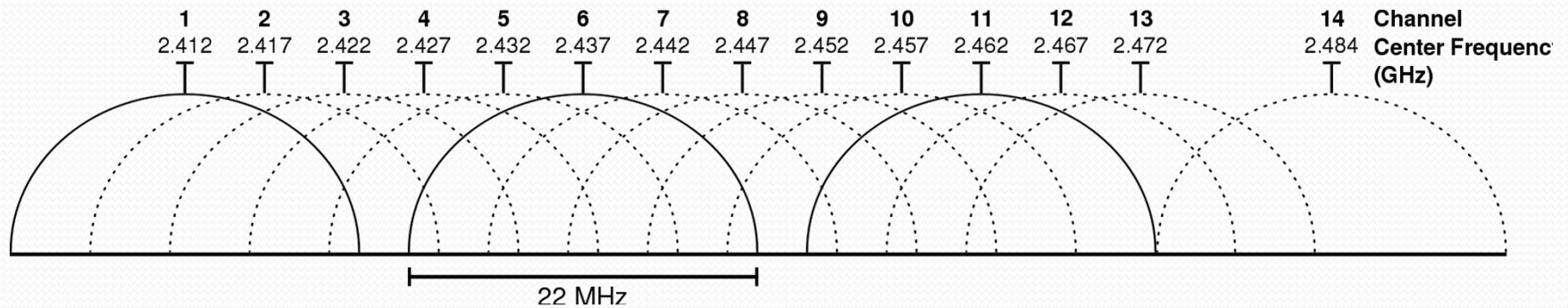
# A Fully-Integrated Direct-Conversion RF Front-End for Wi-Fi

Jianmin Li  
Zhengjia Lu  
Zhicheng Wei

# Wi-Fi Applications



# Wi-Fi Channels



➤ 2.4GHz – 2.4835GHz band is divided into 13 channels

➤ 802.11 standards

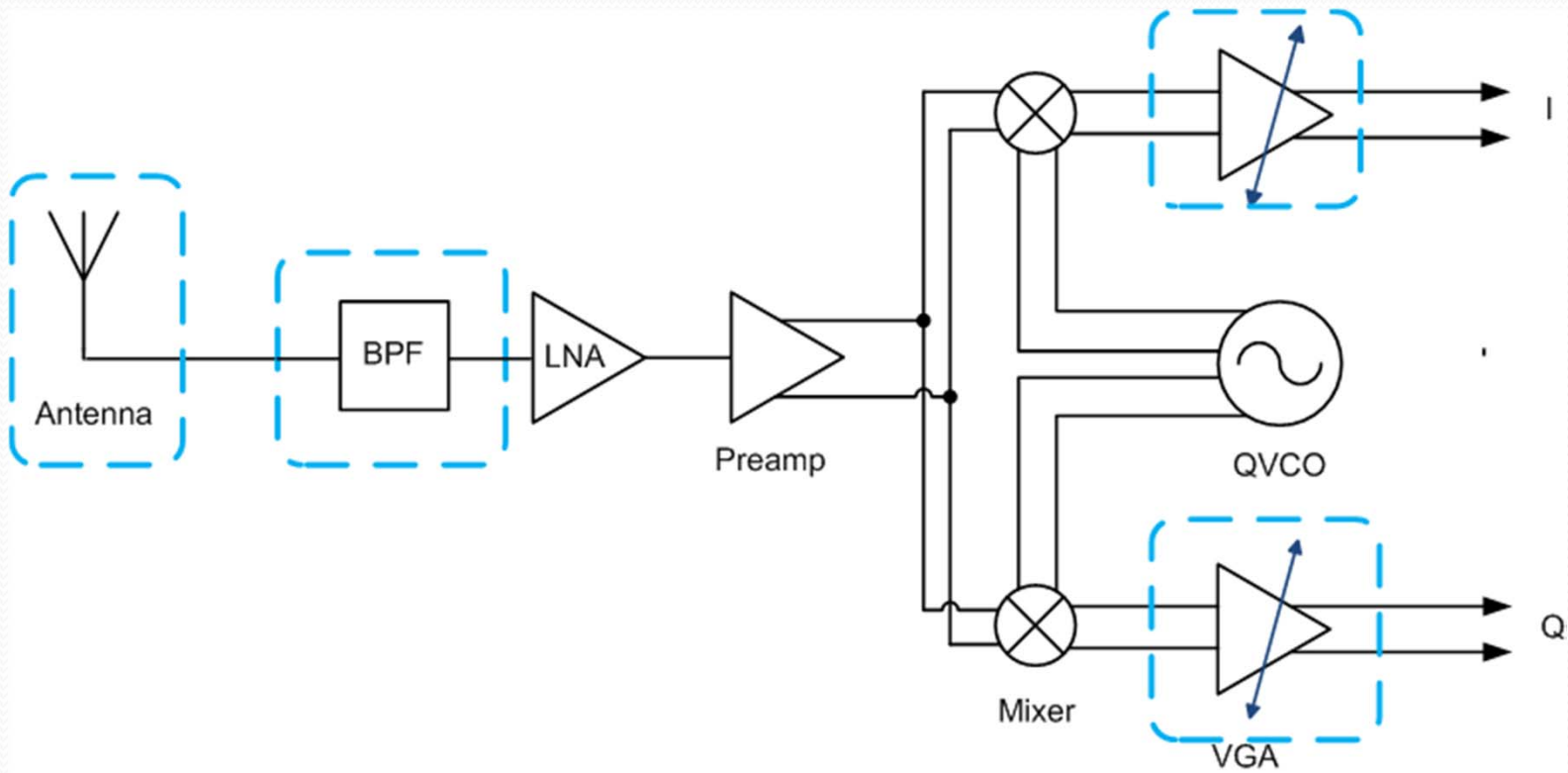




## SPECIFICATIONS OF THE RF RECEIVER DESIGN

Operating Frequency Band	2.4-2.4835GHz
Channel Bandwidth	22MHz
No. of Channels	14
Maximum Data Rate	11Mbps
Noise Figure	14.6dB
Input P1dB	-24dBm
IIP3	-25dBm
Sensitivity	-76dbm

# Black Diagram

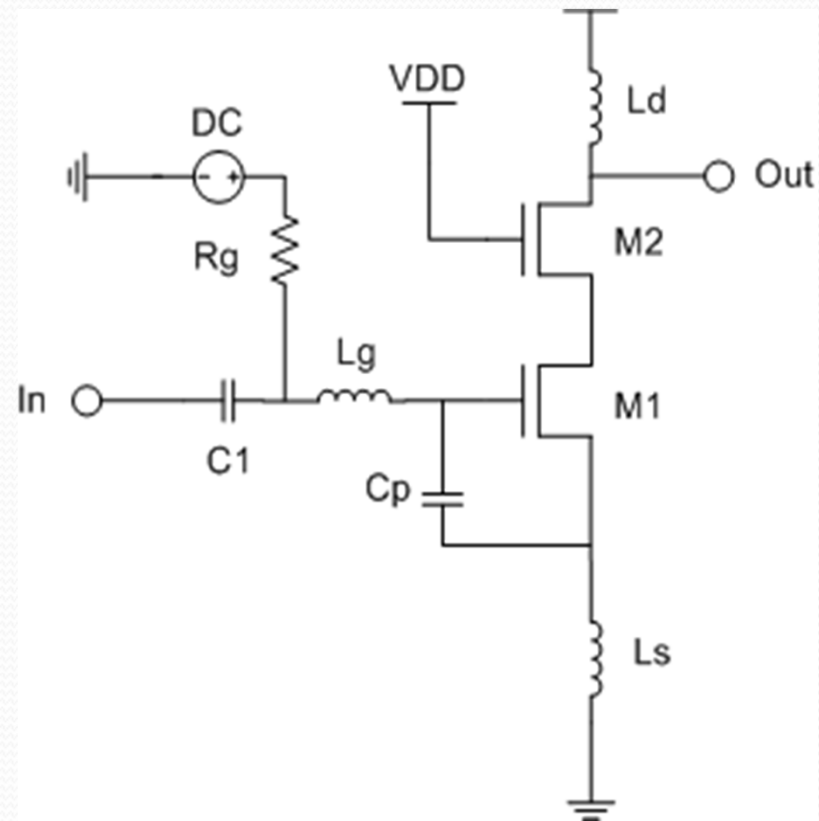


# LNA

➤ Cascode Structure

➤ Low Noise Figure

Gain	18.55dB
NF	1.242dB
S11	-19.17dB
P1dB	-9.3dBm
IIP3	-3.68dBm

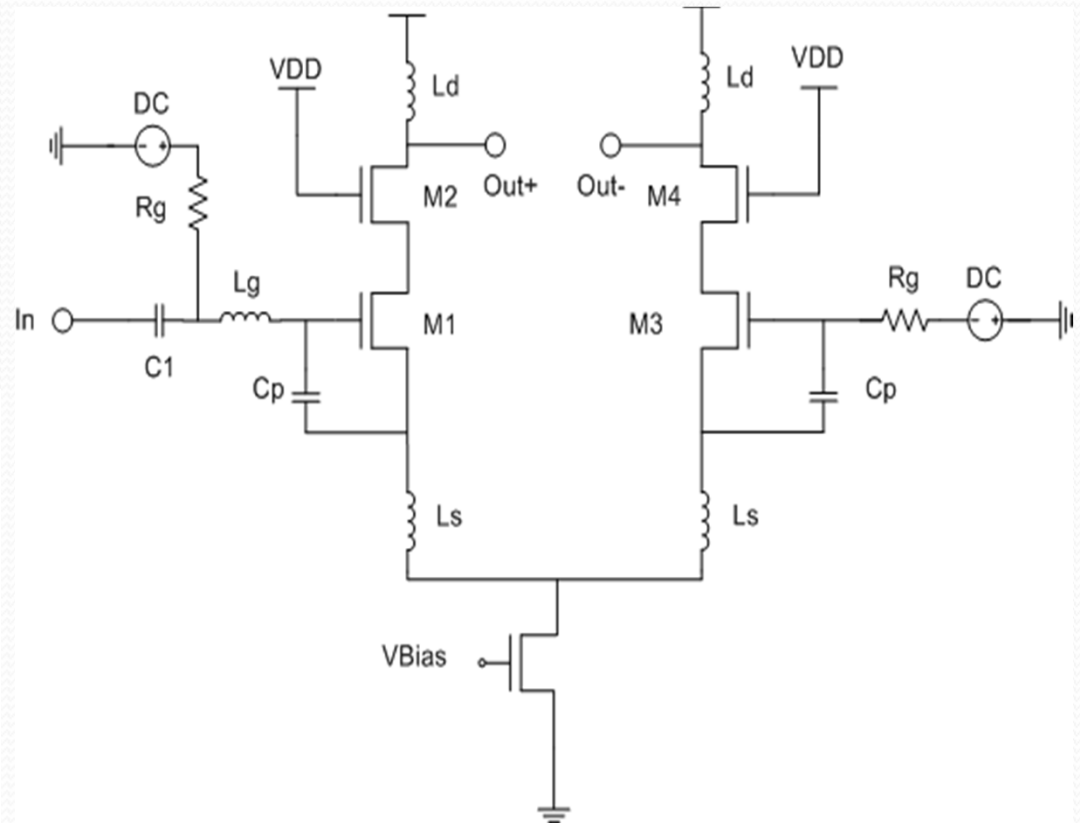




# Pre-Amplifier

- Differential Amplifier
- Single-ended-to-differential conversion

Gain	17.98dB
NF	1.78dB
S11	-21dB
P1dB	-11.7dBm
IIP3	-3.79dBm

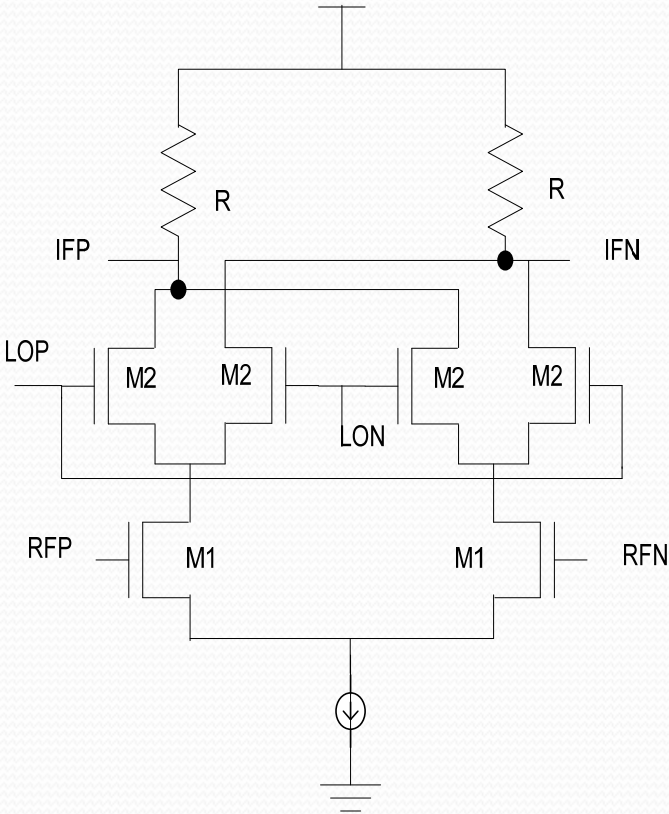




# Mixer

- Double- balanced Gilbert
- Small Area

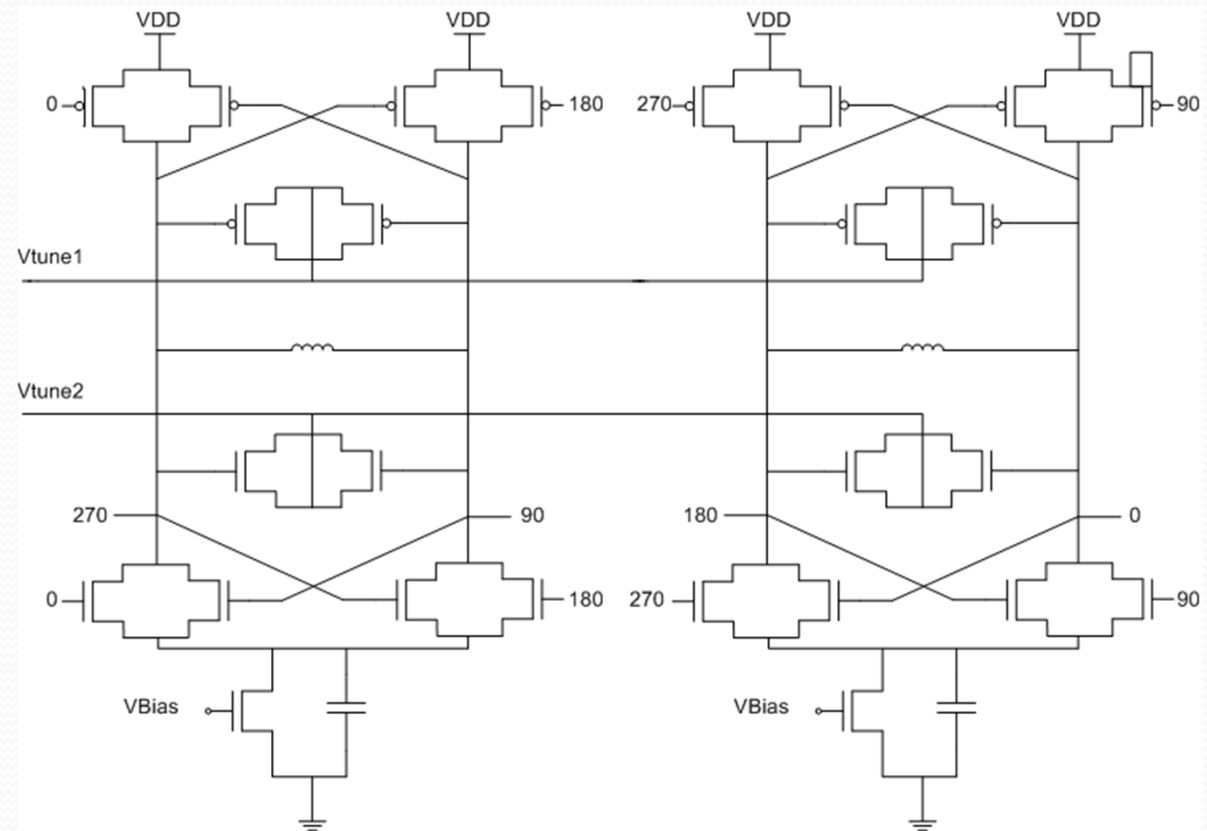
Gain	13.53dB
NF	32dB
S11	-21dB
P1dB	-9.3dBm
IIP3	0.57dBm
Power	4.95mW



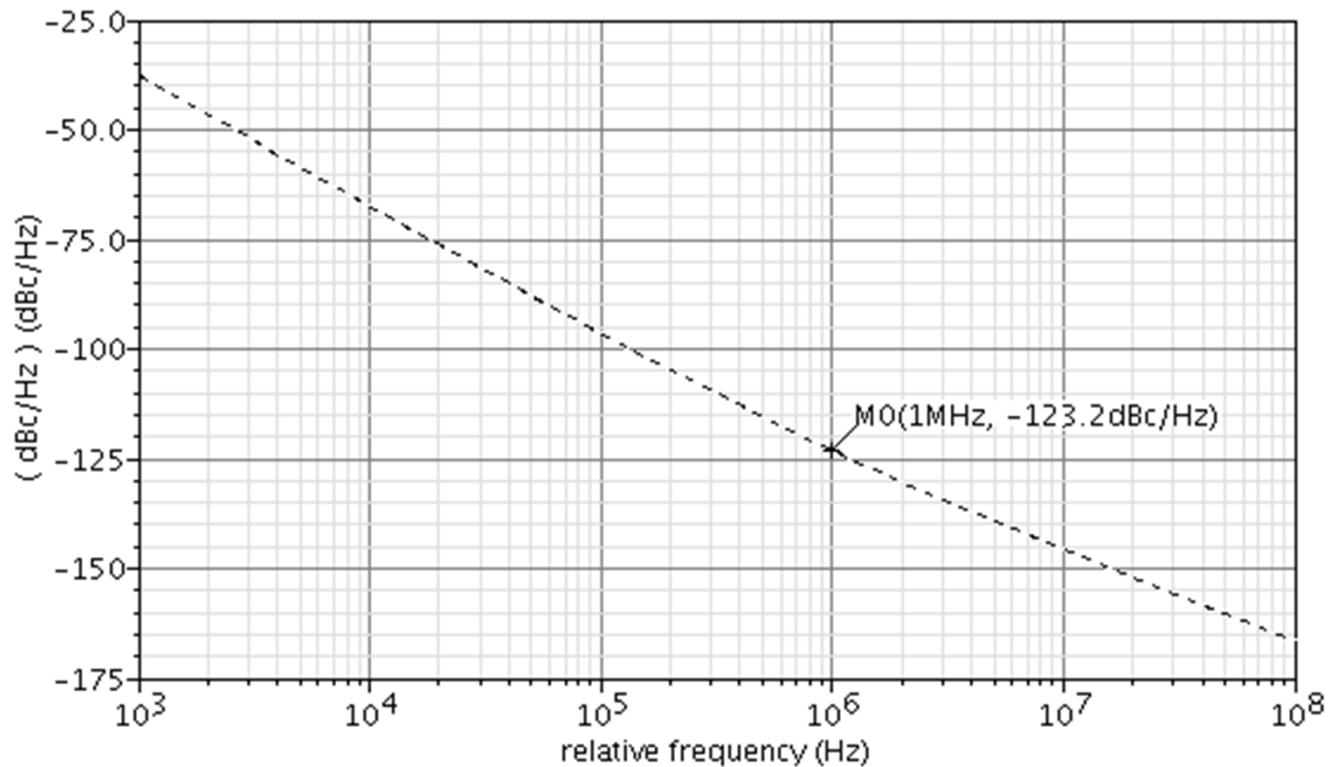


# Quadrature VCO

- Rail-to-rail swing
- Use tail capacitor to reduce phase noise
- Work in the edge of current limit and voltage limit regime

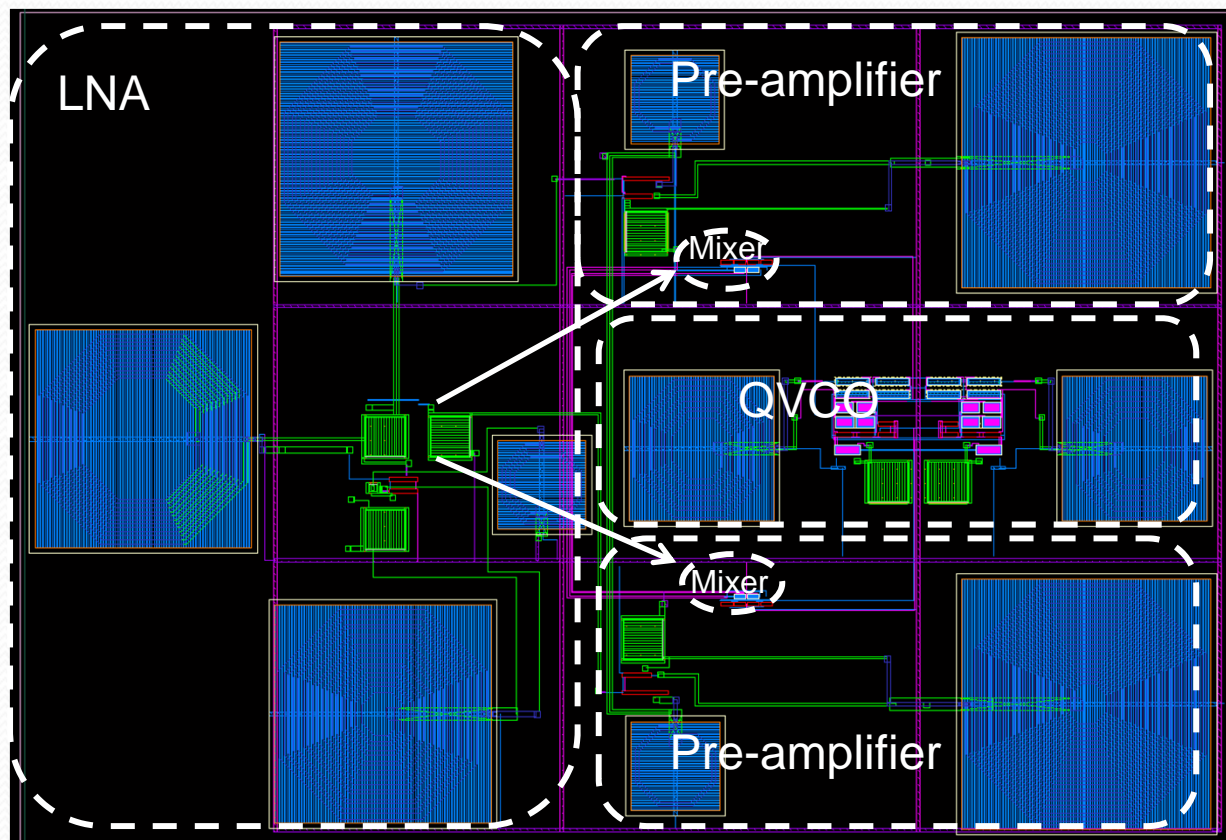


# Phase Noise Performance



➤ Low phase noise      -123.2dBc/Hz@1MHz

# Layout





# System performance

Specification	Targeted	Simulated	[2]	[3]	[4]
Process(um)	0.13	0.13	-	0.18	0.18
NF(dB)	<3	1.6	8.3	4.1	3.2
Gain(dB)	>25	50	34	25.1	34.5
S11(dB)	-	-19	-	-24.5	-
P1dB(dBm)	>-20	-18.92	-21	-	-
IIP3(dBm)	>-25	-11	-9	-11.6	-15
Power(mW)	-	55	80	22.7	4.5
Phase Noise	-	-123@1M	-	-	-
	<-123@44M	-158@44M	-	-	-



# Reference

- [1] B. Razavi, "A 2.4-GHz CMOS receiver for IEEE 802.11 wireless LANs," *IEEE J. Solid-State Circuits*, vol. 34, pp. 1382–1385, Oct. 1999.
- [2] W. Kluge, L. Dathe, R. Jaehne, S. Ehrenreich, and D. Eggert, "A 2.4GHz CMOS transceiver for 802.11b wireless LANs," in *IEEE ISSCC Dig. Tech. Papers*, 2003, pp. 360–361.
- [3] A. Ajikuttira et al., "A Fully-Integrated CMOS RFIC for Bluetooth applications," in *IEEE ISSCC Dig. Tech. Papers*, Feb. 2001, pp. 198–199.
- [4] K. Tsunekawa, "Diversity antennas for portable telephones," in *Proc. IEEE Veh. Tech. Conf.*, 1989, pp. 50–56.
- [5] Hyung Joon Kim, Mohammed Ismail, Delia Rodriguez De Llera Gonzalez, "2.4 GHz Concurrent Radio Transceiver Architecture for Bluetooth and Wi-Fi", *IEEE ISIE 2005*, June 20–23, 2005, Dubrovnik, Croatia
- [6] Ling Zhang, Hyung Joon Kim and Mohammed Ismail, "A triple-standard transceiver architecture for GSM, WCDMA and Wi-Fi applications" *IEEE ICECS 2005*, Page(s): 1 – 4
- [7] P. Vancorenland and M. Steyaert, "A 1.57-GHz fully integrated very low-phase-noise quadrature VCO," *IEEE J. Solid-State Circuits*, vol. 37, no. 5, pp. 653–656, May 2002.
- [8] R. Aparicio, and A. Hajimiri, "A Noise-Shifting Differential Colpitts VCO", *IEEE J. Solid-state Circuits*, pp. 1728–1736, Dec. 2002.
- [9] A. Rofougaran, J. Rael, M. Rofougaran, and A. Abidi, "A 900 MHz CMOS LC-oscillator with quadrature outputs," in *Proc. ISSCC'96 Conf.*, Feb. 1996, pp. 392–393.
- [10] A. Hajimiri and T. H. Lee, "A general theory of phase noise in electrical oscillators," *IEEE J. Solid-State Circuits*, vol. 33, pp. 179–194, Feb. 1998
- [11] A. Hajimiri, T. Lee, "Design issues in CMOS differential LC oscillators," *JSSC*, vol. 34, no. 5, May 1999, pp. 717–724.





The background is a solid blue gradient. At the top, there are several wavy, horizontal lines in shades of blue and cyan, creating a layered, water-like effect.

**Thank you!**