A Compact Wideband Front-End Using a Single-Inductor Dual-Band VCO in 90nm Digital CMOS

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Outline

- Wideband front-end architecture
- RF LNA (90nm technology and inductorless)
- LO synthesis with the dual-band VCO
- Measurements of the full front-end
Wideband Front-end Architecture
The LNA and The Mixer

(a) Shunt-shunt feedback LNA with RFB=250Ω (b) differential pair balun © half-passive mixer with 15K Ω biasing resistors
Characteristics of the LNA

LNA standalone measured performance. (a) Gain(squares), input matching(solid line). IIP3 (circle). And (b) noise figure.

Gain: 16.5 dB
6.5 GHz bandwidth
IIP3 ranging from -7 dBm to 2 dBm
NF: 2.7 dB
Compact Dual-Resonance VCO Tank

\[ \omega^2_{L,H} = \frac{C_EL_E + C_EL_I + C_IL_I}{2L_IL_EL_EC_IE} \]

\[ \pm \frac{\sqrt{[C_EL_E + C_EL_I + C_IL_I]^2 - 4L_IL_EL_EC_IE}}{2L_EL_EC_IE} \]

Compact dual-resonance VCO tank and single-ended version without coupling
Oscillation is achieved when $1 \pm G_m R(Z_{12}) < 0$
Inductor Remodeling and S-parameters

S-parameters measurements are symbols while solid lines are model data.
Z-Parameters of the Inductor

\[ Z_{\text{diff}13} = Z_{11} + Z_{33} - Z_{13} - Z_{31} \]
\[ Z_{\text{diff}24} = Z_{22} + Z_{44} - Z_{24} - Z_{42} \]
Tuning Range of the Dual-band VCO

VCO tunable from 3.1 to 3.9 GHz and 8.8 to 11.2 GHz
The measured phase noise in the low and high band is -122 dBc/Hz and -117 dBc/Hz, respectively, at 2.5 MHz offset.
Measured Spectrum of the VCO

3.2GHz DIV-by-2 spectrum

10GHz DIV-by-4 spectrum
Front-end Chip Micrograph
Front-end Performance

(a) Measured $S_{11}$ is from -15dB to -11dB (b) conversion gain are 31dB(770MHz) and 26 dB(5.6GHz) (c) minimum NF is 4.5dB
Front-end Measurement

Measured of the OIP3 of the front-end for an LO (a) at 2GHz and (b) at 5 GHz. The tone separation is 2 MHz.
Conclusion

• An inductorless wideband LNA designed with NF of 2.7dB, gain of 16.5dB, 6.5GHz bandwidth, and an IIP$_3$ ranging from -7dBm to 2dBm.

• A dual-band VCO with compact tapped-inductor tank is designed and measured. The tuning ranges are 3.1 to 3.9GHz and 8.8 to 11.2 GHz. Phase noise of -122dBc/Hz and -128 dBc/Hz at 3.9GHz and 10GHz.
Thanks!