Questions for the Oral Examination
RF Circuit Design

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RF Front-end Architectures

1. Effects of distortion.
2. Two-tone test and third-order intercept point (IIP3).
3. Theorem of maximum power transfer and its application to the impedance matching of amplifiers. Definition of power gains.
4. Matching networks: Resonant networks.
5. Matching networks: Transformers.
6. Noise figure of lossy circuits and cascaded systems.
7. *RF receivers*: Sensitivity and dynamic range.
8. *Heterodyne receivers*: Advantages. Image problem and filtering. Selectivity/Sensitivity trade-off. Block schematic from antenna to matched filter.
9. *Heterodyne receivers*: Problem of half-IF (IF/2).
10. Second-order nonlinearity. Intercept point IIP2 and link with 2nd-order harmonic distortion.
11. *Dual-IF receivers*: Architecture, advantages and drawbacks. Comparison with single-IF architecture.

12. *Zero-IF receivers*: Architecture, advantages and drawbacks. DC offsets and cancellation techniques.

13. *Zero-IF receivers*: Impact of I/Q mismatches on SNR. Impact of LO leakage.

14. *Image-reject receivers*: Shift-by-90 operation. Hartley architecture and effect of mismatches and Image-Rejection Ratio (IRR).

15. *Image-reject receivers*: Weaver architecture: advantages and drawbacks.

16. *Transmitters*: Effect of I/Q mismatches. Direct-conversion architecture.

17. *Transmitters*: Two-step transmitters. Single-Sideband (SSB) mixer.

Frequency Synthesizers

18. AM and FM disturbances of a carrier. Relationship between phase spectrum and voltage spectrum of the carrier.

19. Effects of phase noise in RF receivers and transmitters: EVM degradation. Reciprocal mixing in presence of blockers.

20. Phase detectors based on multiplier. Derivation of the phase model of the PLL. Nonlinear differential equation.

21. *Second-order PLLs*: Analysis of stability and transfer functions. Static phase error after n-th order input signal, frequency response.

22. *Second-order PLLs*: Frequency tracking and lock acquisition.

23. *Charge-pump PLLs*: Phase-frequency detector, phase-domain model, stabilizing zero, analysis of loop dynamics.

24. Limits of validity of the continuous-time model of PLLs.

25. Sources of ripple in a PLL. Reference spur problem in an integer-N loop. Methods to reduce the level of reference spur.

26. Design and simulation of a PLL.

RF Circuits

27. *LNAs*: Scattering parameters, insertion loss, reverse isolation, stability, linearity. Methods to increase reverse isolation.

28. *LNAs*: MOS noise model. Common-gate and shunt-feedback LNA topology.

29. *LNAs*: Inductor-degenerated topology.

30. *LNAs*: Noise canceling technique and application to shunt-feedback topology.

31. *Oscillators*: Feedback model and Barkahusen criterion. Negative-resistance model. Amplitude stabilization methods. Oscillation startup and effective gain.

32. *Oscillators*: Frequency stabilization. Effect of loop delay in oscillators. Meaning of quality factor in oscillators.

33. *Oscillators*: Phase Noise calculation in LC oscillators.

34. *Oscillators*: Noise/Power Trade-off.

35. *Oscillators*: Circuit topologies of voltage-controlled oscillators (VCOs). Noise on tuning voltage: calculation of FM noise.

36. *Oscillators*: Single-transistor and differential LC oscillator topologies: analysis with feedback and negative-resistor model.

37. *Oscillators*: Design and simulation of an RF oscillators in CMOS.

38. *Mixers*: Return-to-zero passive mixers in CMOS, conversion gain, noise.

39. *Mixers*: Single-balanced and double-balanced topologies, port-to-port isolation.

40. *Mixers*: Active mixers in CMOS, conversion gain, noise, port-to-port isolation.