Razavi rf microelectronics lectures

VLSILow-yield, high-power, high-cost option Heterojunction devices PA, front-end switches 2. Motivating competitive manufacturers to provide phone sets Higher performance and lower cost Present goal – reduce power consumption and price by 30% every year 5. -> RF Circuits 2. RF IDs(RF Identification Systems) 4. Sankaran Aniruddhan (IIT Madras) He is an assistant professor in the VLSI group of the department of Electrical Engineering of the Indian Institute of Technology Madras. Textbooks: 1) RF Microelectronics by Behzad Razavi (Publisher: Pearson) 2) The Design Of CMOS Radio-Frequency Integrated Circuits by Thomas H. 1 RF MICROELECTRONICS BEHZAD RAZAVI 2 Contents Ch.1 Introduction to RF & Wireless Technology1.1 Complexity Comparison 1.2 Design Bottleneck 1.3 Applications 1.4 Analog and Digital Systems 1.5 Choice of Technology Ch.2 Basic Concepts in RF Design 2.1 Nonlinearity and Time Variance 2.2 Intersymbol Interference 2.3 Random Processes and Noise 2.4 Sensitivity and Dynamic Range 2.5 Passive Impedance Transformation 3 1. Multidisciplinary Field RF DesignCommunication Theory, Microwave Theory, Signal Propagation, Multiple Access, Wireless Standards, CAD Tools, IC Design, Transceiver Architectures, Random Signals 7 1.2 Design Bottleneck 2. Guglielmo Marconi Successfully transmitted radio signals across the Atlantic Ocean in 1901. 18 2.1 Nonlinearity and Time VarianceThird Intercept Point(IP3) If the difference between w1 and w2 is small, the components at 2w1-w2 and 2w2-w1 appear in the vicinity of w1 and w2 19 2.2 Intersymbol InterferenceLinear time-invariant systems can also distort a signal if they do not have sufficient bandwidth Each bit level is corrupted by decaying tails created by previous bits Solution Pulse shaping(Nyquist signaling) Raised cosine 20 2.2 Intersymbol InterferencePulse Shaping The shape is selected such that ISI is zero at certain points in time 21 2.2 Intersymbol InterferenceRaised Cosine α : roll off factor 22 2.3 Random Processes and NoiseA family of time functions 1) Statiscal Ensembles Doubly infinite(infinite measurements X infinite time) Time average (n(t) : noise voltage) Ensemble average(Pn(n) : PDF) 23 2.3 Random Processes and NoiseSecond-order average(mean square) 24 2.3 Random Processes and Noise2) PDF(Probability Density Function) Px(x)dx = probability of x < X < x+dx X is the measured value of x(t) at some point in time Gaussian distribution PDF of the sum approaches a Gaussian distribution 25 2.3 Random Processes and Noise3) PSD(Power Spectral Density) 26 2.3 Random Processes and Noise1) Thermal Noise resistor base and emitter resistance of bipolar devices channel resistance of MOSFETs 2) Input-Referred Noise 27 2.3 Random Processes and Noise3) Noise Figure SNR - Analog circuits NF – RF circuits Consider noise of the circuit & SNR of the pre-stage 28 2.4 Sensitivity and Dynamic RangeMinimum signal level that the system can detect with acceptable SNR. WLAN(Wireless Local Area Network) 2. VLSI High-quality inductors and capacitors Higher levels of integtation Lower overall cost 3. 12 Ch.2 Basic Concepts in RF Design2.1 Nonlinearity and Time Variance 2.2 Intersymbol Interference 2.3 Random Processes and Noise 2.4 Sensitivity and Dynamic Range 2.5 Passive Impedance Transformation 13 2.1 Nonlinearity and Time VarianceIf input x1(t) and x2(t) x1(t) -> y1(t), x2(t) -> y2(t), ax1(t) + bx2(t) -> ay1(t) + by2(t) Not satisfy -> Nonlinear x(t) -> y(t), x(t-τ) -> y(t- τ) Not satisfy -> Time variant 14 2.1 Nonlinearity and Time Variance1. He obtained B. Modulation [Notes Video] Lecture 3 - S and ABCD parameters; Resonance in LC circuits [Notes Video] Lecture 4 - Impedance transformations and matching; L-matches [Notes Video] Lecture 5 - L-matches; Pi- & T-matches; Other matches [Notes Video] Lecture 6 - RF Inductors [Notes Video] Lecture 7 - RF Inductors (contd.) & Transformers [Notes Video] Lecture 8 - Capacitors and Varactors [Notes Video] Lecture 9 - MOS Device Operation [Notes Video] Lecture 10 - Introduction to RF Systems [Notes Video] Lecture 11 - Basic RF Concepts - Nonlinearity, Time Variance etc [Notes Video] Lecture 12 - IIP3, different expressions/calculations for IIP3 [Notes Video] Lecture 13 - Noise in RF Circuits [Notes Video] Lecture 14 - Classical Two-port Noise Theory [Notes Video] Lecture 15 - Noise Figure of Cascaded Systems [Notes Video] Lecture 16 - Sensitivity, SFDR, MOSFET 2-port Noise Parameters [Notes Video] Lecture 17 - LNA Design - 1 [Notes Video] Lecture 18 - LNA Design - 2 [Notes Video] Lecture 19 - LNA Design - 3; Introduction to Mixers [Notes Video] Lecture 20 - Two- and Three-port Mixers [Notes Video] Lecture 21 - Gilbert Mixers [Notes Video] Lecture 22 - Linearity and Noise of Gilbert Mixers [Notes Video] Lecture 23 - Noise in Mixers (contd.); Other Linearisation Techniques [Notes Video] Lecture 24 - Other Mixers; Tx Architectures [Notes Video] Lecture 25 - Rx Architectures - I (Direct-Conversion Rx) [Notes Video] Lecture 26 - Rx Architectures - II (Heterodyne Rx; Image-Reject Rx) [Notes Video] Lecture 27 - VCOs - 1 [Notes Video] Lecture 28 - VCOs - 2 [Notes Video] Lecture 29 - VCOs - 3: Colpitts Oscillator; Quadrature Oscillators; [Notes Video] Lecture 30 - Phase Noise - LTI Analysis [Notes Video] Lecture 31 - Phase Noise - LTV Analysis [Notes Video] Lecture 32 - VCO Design - 1 [Notes Video] Lecture 33 - VCO Design - 2 [Notes Video] Lecture 34 - Wideband Amplifiers - 1 [Notes Video] Lecture 35 - Wideband Amplifiers - 2 [Notes Video] Lecture 36 - Power Amplifiers [Notes Video] Lecture 37 - Analog and RF Layout - 1 [Notes Video] Lecture 38 - Analog and RF Layout - 2 [Notes Video] CMOS Technology Characterization for Analog and RF Design Author : Behzad Razavi ... In RAHRF201 you would get deeper into Radio Frequency Design Theory and Principles. Future (wrote in 1998) GPS(Global Positioning System) PCS(Personal Communication Services) 5 1.1 Complexity Comparison 6 1.2 Design Bottleneck 1. GPS 1.5Ghz range 3. degree in Electrical Engineering from IIT Madras, in 2000 then graduated with M.S. and Ph.D. degrees from the Electrical Engineering Department at the University of Washington, Seattle in June 2003 and June 2006 respectively. GaAs, Silicon Bipolar, BiCMOS 2. He worked at the System-on-Chip Laboratory under the guidance of Prof. Blocking Gain drop to Zero (α3 < 0) A1 Wireless technology 1.1 Complexity Comparison 1.2 Design Bottleneck 1.3 Applications 1.4 Analog and Digital Systems 4 1. Home Satellite Network 10Ghz 9 1.4 Analog and Digital Systems1. Between 2006 and 2011, He worked as a Senior/Staff Engineer in the RF-Analog group at Qualcomm Inc., San Diego where He designed integrated circuits for Cellular RF applications. Lee (Publisher: Cambridge University Press - 2006) 3) VLSI for Wireless Communication by Bosco Leung (Publisher: Prentice Hall - Electronics and VLSI Series) Lecture 1 - Introduction; RF Design Tradeoffs; Fading; Diversity [Notes Video] Lecture 2 - Multiple Access Techniques; Ana. Invention of the transistor Development the conception of the cellular system Car phone -> Cellular phone 4. David Allstot in the area of Phase-Locked Loops for Wireless Applications. Pin.min = -174dBm/Hz + NF + 10logB + SNRmin Noise floor : -174dBm/Hz + NF + 10logB 29 2.4 Sensitivity and Dynamic RangeRatio of the maximum input level that the circuit can tolerate to the minimum input level at which the circuit provides a resonable signal quality. Telephones have gotten much more complicated. RF Design Hexagon 3. Tech. & Dig. SFDR(Spurious-Free Dynamic Range) Upper end of the dynamic range on the intermodulation behavior Lower end on the sensitivity F : Noise floor 30 2.5 Passive Impedance TransformationQ of the series combination : 1/RsCsw Q of the parallel combination : RpCpw If Q is relatively high and the band of interest relatively narrow, then one network can be converted to the other 31 2.5 Passive Impedance Transformation Video Lecture Series from IIT Professors : RF Integrated Circuits by Prof. Sankaran Aniruddhan Sir Prof. GPS900Mhz, 2.4Ghz 2. He work in the area of RF integrated circuit design. CMOS High transit frequency Substrate coupling, parameter variation, etc. Introduction to RF & Wireless Technology3. Analog System 10 1.4 Analog and Digital SystemsSignal Processing Analog < Digital 11 1.5 Choice of Technology 1. Introduction to RF & Wireless Technology1. Design Tools Trade OffSPICE – Linear and Time invariant models RF circuits – Nonlinearity, Time variance, Noise 8 1.3 Applications 1. ... Share your videos with friends, family, and the world Effects of Nonlinearity 1) Harmonics 15 2.1 Nonlinearity and Time Variance2) Gain Compression 1dB compression point Input signal level that causes the small-signal gain to drop by 1dB If α3 < 0 , gain is decreasing function of A 16 2.1 Nonlinearity and Time Variance3) Desensitization and Blocking Desensitization Since a large signal tends to reduce the average gain of the circuit, the weak signal may experience a vanishingly small gain.