SmartSpice RF

Frequency and Time Domain RF Circuit Simulator

SmartSpice RF employs a combination of Time-Domain Shooting and Frequency-Domain Harmonic Balance methods to provide accurate simulation of GHz range RF ICs. It accurately and efficiently simulates periodic steady-state, harmonic distortion, intermodulation products, gains, noise, oscillator's phase noise in non-linear circuits using SPICE and SPECTRE™ netlists.

- **Performs complete set of periodic and quasi-periodic steady-state analysis for large-signal and/or small-signal applications by Harmonic Balance**
- **Employs time-domain Shooting method to simulate periodic steady-state of highly non-linear circuits**
- **Provides mixed time-frequency domain Envelop simulation of the circuits driven by digitally modulated sources for most wireless standards**
- **Provides simulations and measurements of the spectral re-growth, I/Q parameters, ACPR, NPR, EVM, BER in amplifiers/mixers, and characterization of the transmission link quality in communications systems, etc**
- **Accurately and efficiently simulates circuits with up to 16 port S-elements in frequency and time domain**
- **Silvaco's strong encryption is available to protect valuable customers and third party intellectual property**

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Applications

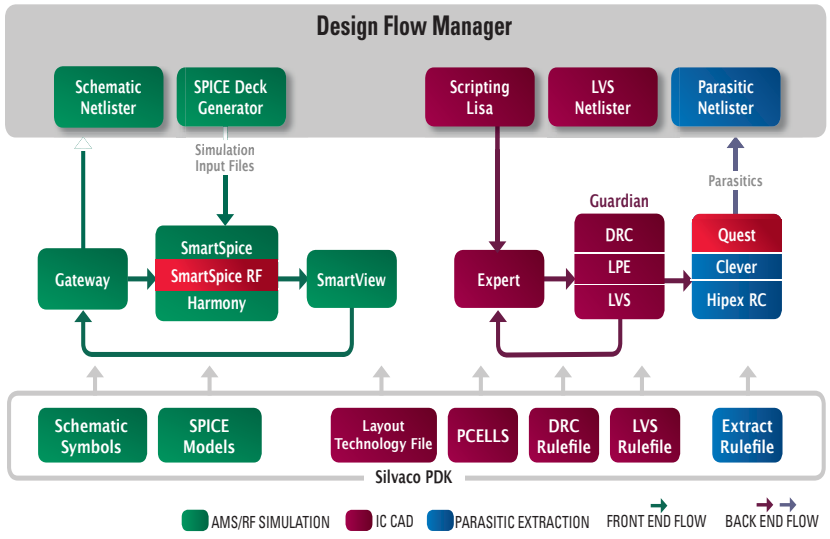
- Applications cover amplifier, mixer, multiplier, oscillator, VCO, AGC, PLL, Mux, Demux, Clock, CDR, and Switched-Capacitor Filter designs
- SmartSpice RF supports the analysis needs of wireless standards GMSK, MPSK, MQAM, MFSK, EDGE, OFDM, WCDMA, etc.

Frequency and TIme Domain Simulation Engines

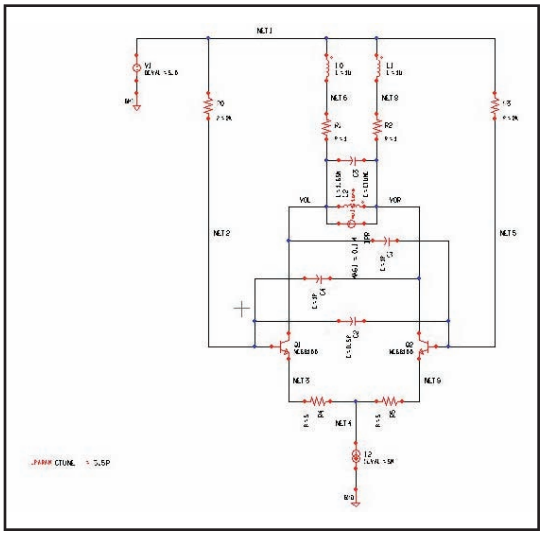
- SmartSpice RF harmonic balance engine provides frequency-domain steady-state, large-signal analysis of non-linear circuits driven with multi-tone sources
- Time-domain Shooting method engine simulates periodic steady-state of highly nonliner circuits
- Optimal convergence with a complete set of interactive control parameters - spectral Newton, continuation method, and GMRES solvers

Integration into Complete RF Design Flow

- Integrated with Gateway schematic editor for schematic entry, simulation control interface, and testbench design
- May be intergrated with popular analog/mixed-signal/RF design flows
- Integral part of Silvaco's complete, PDK supported, mixed-signal/RF design flow



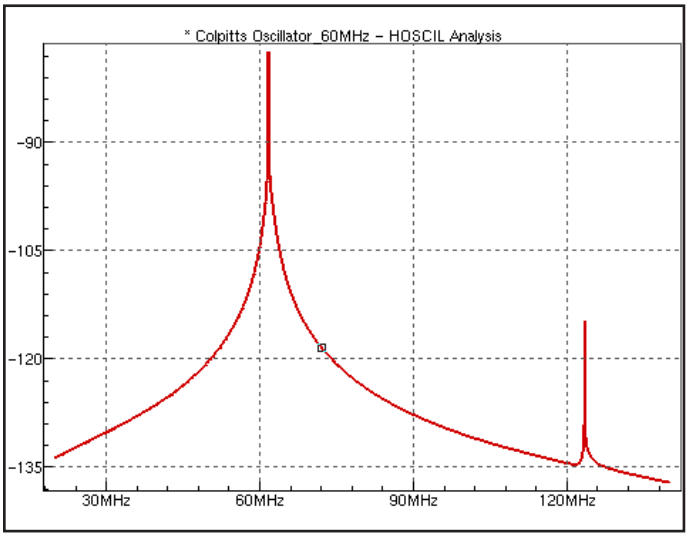
Silvaco RF Design Flow with RF PDK.



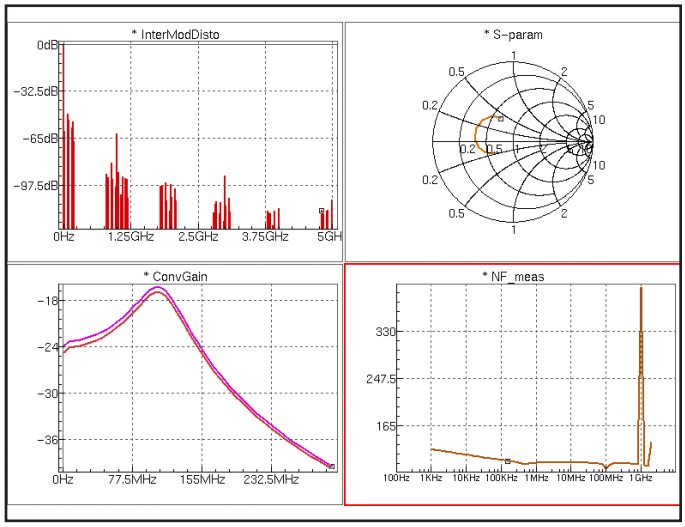
Gateway schematic capture.

SmartSpice RF Analyses Capabilities and Their Applications

- Supports periodic steady-state analysis of single-tone excitations using frequency domain (Harmonic Balance) and time domain (Shooting) methods
- Quasi-periodic steady-state (Spectral) analysis for multi-tone excitations
- Steady-state AC (HAC, SPAC) small-signal analysis
- Steady-state transfer functions (HTF, SPTF) for conversion efficiency, image and sideband rejection, LO feed-through and power supply rejection
- Steady-state NET (HNET, SPNET) to compute S-parameters of two-port circuits exhibiting frequency translation with scattering (S), impedance (Z), admittance (Y), and hybrid (H) parameters, stability factors, different gains, stability circles, etc.
- Steady-state noise (HNOISE, SPNOISE) for output noise spectrum of amplifiers, mixers, and oscillator phase noise
- Direct periodic steady-state oscillator analysis by Harmonic Balance (HOSCIL) with phase noise extraction
- Periodic stability analysis (PSTB) to evaluate the local stability of a time-varying feedback circuits
- Circuit envelope simulation enables spectral re-growth, I/Q parameters, ACPR, NPR, EVM, BER simulations of amplifiers/mixers and characterization of the transmission link quality of communications systems using time-swept harmonic balance method



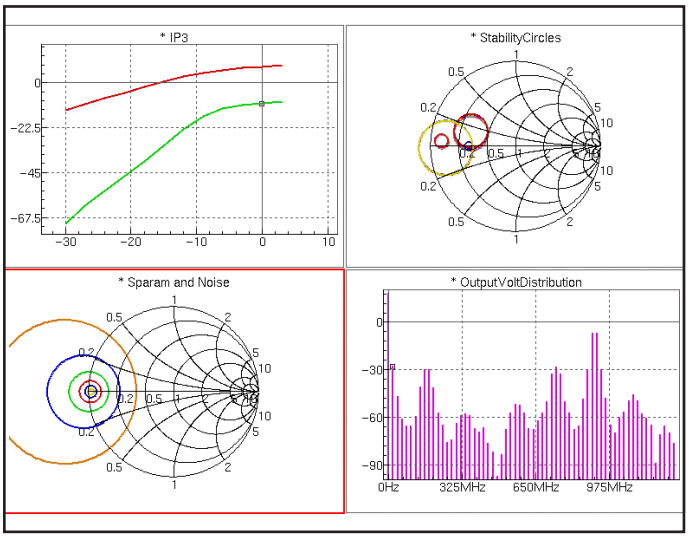
Phase noise simulation of an oscillator.

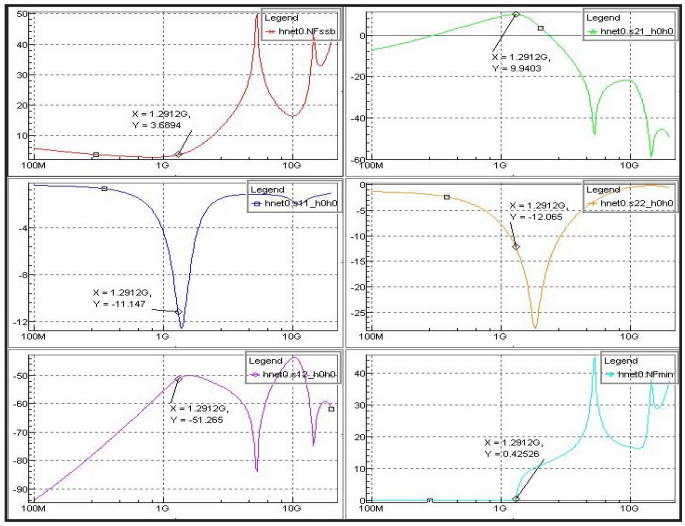


A complete simulation of a mixer

Examples Available in Gateway

- Frequency domain sources
- Time domain sources
- Modulated sources
- Noise sources
- Voltage/Current controlled sources
- Passive components (RLC)
- Diode models
- Transistor components for MOS, BJT, HBT
- S-parameter models
- Filter, amplifier, mixer and PLL components

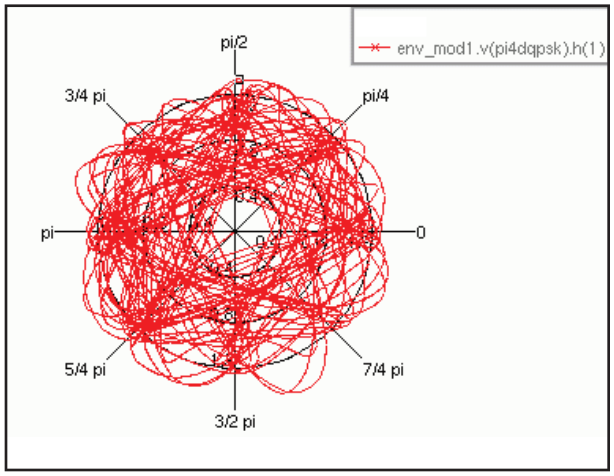




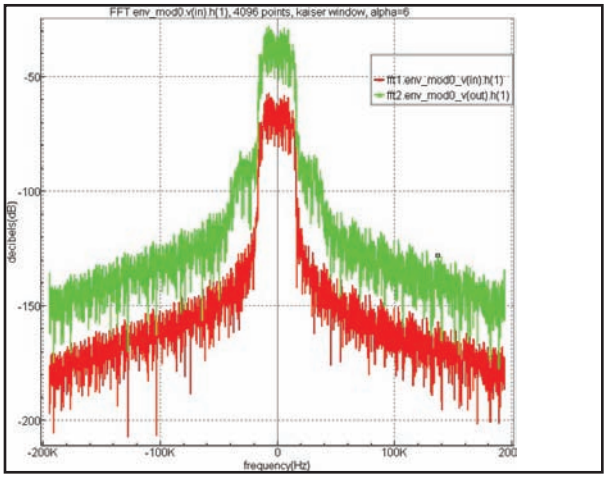
Low Noise Amplifier Design (LNA).

Powerful Support Environment for RF Design

- Smith charts, eye diagrams, spectral plots, histograms, signal-to-noise calculations, gain and stability circles, constellation diagrams, etc.
- Circuit and parameter optimizer for gain, matching networks, IP3, and power dissipation for process migration
- Sources include independent multi-tone voltage/current sources, multi-tone resistive ports, and complete output port device parameters
- Development of complete foundry MS/RF Process Design Kits available
- Interface to Quest for RF modeling of spiral inductors and S-parameters for RF interconnects



PI/4-DQPSK trajectory diagram.



Power amplifier ACPR simulation.

RF Measurement Capabilities

- 1dB Compression Point
- Nth order Intercept Points
- Nth order Intermodulation Products
- Mixer conversion gain
- Two-port noise parameters
- SSB and DSB Noise figure
- Output noise power spectral density
- Minimum noise figure
- Phase noise
- Gamma Opt
- Input and Output Stability Circles
- Gain Circles
- Impedance/Admittance Locus vs. Frequency
- Large-signal S-parameters and K-factor
- Total Harmonic Distortion
- Power Added Efficiency
- S-Parameters

SmartSpice RF Inputs/Outputs

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