Eldo RF

D A T A S H E E T

The analysis and measurement capabilities of Eldo RF help designers verify complex RF IC designs more quickly and accurately. From simple compression or intermodulation analysis to complex digital modulation, Eldo RF powerful algorithms make genuine verification a reality.

High-Performance RF IC Verification

For the Most Challenging Telecom and Wireless Designs

Facing the explosive growth of mobile communication and wireless products, RF IC designers are given the daunting task of analyzing and fully verifying the most critical part — the RF section. Time-to-market pressures and steadily increasing levels of integration and complexity call for new high performance and high capacity RF IC verification tools.

Extending Mixed-Signal Simulation to the RF Domain

The Mentor Graphics® Eldo™ RF simulator provides the necessary performance and capacity breakthroughs for RF IC simulation, taking the baton where existing tools reach their limits. Consistently extending the capabilities of Eldo, the Mentor Graphics best-in-class analog simulator, Eldo RF provides a set of dedicated algorithms to accurately and efficiently handle the multi-GHz signals in modern wireless communication applications.

Key product benefits:

- Full-chip RF IC verification for wireless applications
- Seamless integration into Mentor Graphics and other leading IC design flows

Major product features:

- Third generation RF IC algorithm highly optimized for both capacity and performance
- Multi-tone, steady-state analysis for large RF IC designs containing thousands of elements
- Modulated steady-state analysis and digitally modulated sources covering all wireless standards
- Built-in optimization
- System-level simulation capability using Verilog-A
- All the features of the Mentor Graphics prominent analog transistor level simulator, Eldo, for a complete analysis and verification package

RF Analysis Capabilities

Steady-State Analysis

Steady-state analysis of RF IC circuits excited with periodic (single-tone) or quasi-periodic (multi-tone) sources is easy with Eldo RF. Multi-tone steady-state analysis allows users to quickly analyze amplifiers, filters, and mixers. Analysis features automate computation of intermodulation products, compression points, intercept points, and extraction of large-signal S parameters.

Modulated Steady-State Analysis

For the analysis or realistic modulated signals, Eldo RF provides dedicated algorithms. The actual signals in a wireless system consist of RF high-frequency carriers modulated by a low-frequency signal. Regular transient analysis is unable to handle efficiently such signals because the RF carriers are simply too fast and a huge number of time points have to be simulated.

Steady-State Noise Analysis

Steady-state noise analysis can determine the output noise spectrum and the noise figure, with results sorted by the individual contribution of every noisy device. Eldo RF has the remarkable capability that non-linear noise analysis can be performed under large signal multi-tone conditions, which is mandatory for the accurate simulation of mixers.

Oscillator and Phase Noise Analysis

Eldo RF computes the steady-state response of circuits containing oscillators or voltage-controlled oscillators in a fraction of the time needed by transient-based methods.

Other fundamental frequencies are allowed, so large signal analysis of combinations such as VCO and mixer are easy to analyze. Users don't need to worry about the startup conditions or the oscillator, everything is computed in the frequency domain. Phase noise and amplitude noise are easily and accurately analyzed, using proprietary algorithms, which yield accurate results both close to and far from the carrier.

Frequency dividers

Eldo RF also supports the analysis of frequency dividers combined with voltage controlled oscillators. Phase noise can also be predicted at the output of the dividers.

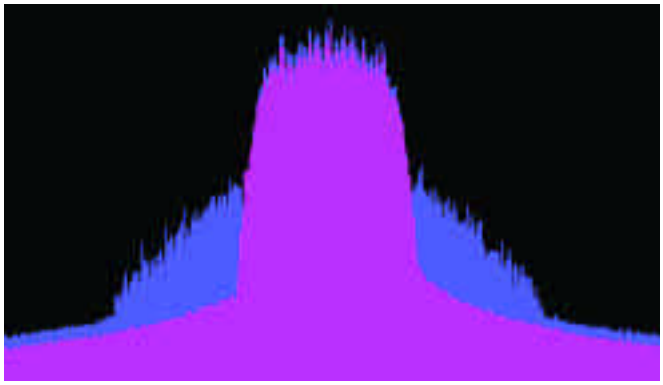
Modulated Steady-State Analysis

To accurately predict effects such as Adjacent Channel Power Ratio, Eldo RF supports a dedicated algorithm, which handles modulated signals. A time-varying spectrum is computed by this algorithm, which basically merges the steady-state and the transient algorithms, decoupling the resolution of the RF carriers from the slow-varying modulation information. It captures the transient behavior of circuits at startup, or provides a modulation spectrum from which Noise Power Ratio or ACPR can be computed. The speedup provided by this algorithm may reach one or two orders of magnitude over brute force transient simulation, with no loss of accuracy.

A variety of standard outputs such as IQ trajectory diagram, constellation diagram or Eye diagram is available.

Digitally Modulated Sources

To accommodate different wireless standards, Eldo RF supports all common digital modulation formats, such as GMSK, MPSK, MQAM, MFSK, EDGE etc. Built-in sources deliver signals modulated according to these schemes, including the standard baseband filters such as Root Cosine or Gaussian filters. The input signal can be either explicit binary sequences, or CCITT-compliant PRBS sequences.



Accurate prediction of Adjacent Channel Power Ratio requires modulated steady-state analysis.

Arbitrary IQ modulators can also be used, which read the IQ information from external user-defined tables.

Parametric Sweeping

Take advantage of efficient parametric sweeping to vary signal power, fundamental frequencies, temperature, power supply level, component values, or any parameterized value for a complete verification of RF IC designs.

Efficient parametric sweeping is critical for many RF simulations such as compression points or intermodula-

tion, and the algorithms in Eldo RF are extremely well suited for that purpose.

Dedicated Built-in RF Measurements

Eldo RF speaks the language of RF designers

A set of RF-dedicated functions plus a powerful post-processing measurement and extraction language allow full customizations, making characterization easy. The following standard RF measurements are supported:

- 1dB Compression Points
- Nth order Intercept Points
- Nth order Intermodulation Products
- Mixer Conversion Gain
- SSB and DSB Noise Figure
- Minimum noise figure
- Gamma Opt
- Input and output stability circles
- Gain and power circles
- Impedance/Admittance Locus vs. Frequency
- Large-signal S parameters & K factor
- Total Harmonic Distortion
- Power Added Efficiency

Fitting Standard IC Design Environments

Best-in-class Analog Simulation Included

Eldo RF includes all the capabilities of the Mentor Graphics prominent analog transistor-level simulator, Eldo. It supports all industry-standard transistor models, and benefits from strong foundry support. Device models include BSIM4, BSIM3v3.0/v3.1/v3.2, BSIM3SOI, MM9, HICUM, VBIC, MEXTRAM, Curtice, Statz, as well as user-defined models. Most importantly for the RF designer, large-signal S parameters can be extracted, and multiple lossy transmission lines are also supported. Eldo RF also supports the W elements.

Mentor IC Flow Integration

Eldo RF is part of the Mentor IC design flow, which includes Design Architect® IC and IC Station® for front-end and back-end analog and mixed-signal design.

A complete simulation interface in Design Architect IC controls the simulation setup and the netlisting process. Simulation results may be analyzed using Design Architect IC or Xelga™, with the help of a powerful schematic cross-probing facility.

IC Station provides links with the industry-standard Calibre® and xCalibre® tools, allowing post-layout simulation including parasitics with Eldo RF.

Cadence Framework Integration

Eldo RF is also integrated in the Cadence® Analog Design Environment through the Artist Link layer provided by Mentor. Simulation setup, direct netlisting, waveform processing, and cross-probing are fully supported.

Powerful Waveform Post-processing

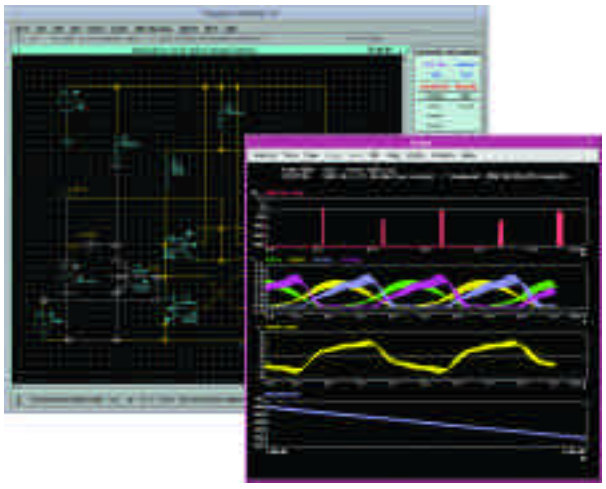
The Xelga waveform processor provides the advanced features needed to operate on RF, low-frequency base-band analog, and digital signals. It manipulates data in both the frequency and time domains. Smith Charts, Eye diagrams, FFT with sophisticated windowing or signal-to-noise calculation are just some of the built-in features.

The modulated steady-state analysis handles common wireless standard - here the IQ trajectory of an EDGE modulated signal.

Delivering Unprecedented Performance

Multi-threaded Frequency Algorithms

Eldo RF uses a high-performance multi-threaded algorithm that incorporates advanced numerical analysis techniques (XCT, Krylov-Newton and Harmonic Balance).



Eldo RF is fully integrated in the Mentor IC design flow, for a complete front-end to back-end RF design and verification solution.

Operating in the frequency domain, it gracefully and efficiently handles difficult circuits with multi-tone inputs, distributed elements or high-Q elements, when time-domain algorithms such as the shooting method use to fail or perform poorly.

Tested on a series of customer circuits containing several thousands of transistors, Eldo RF demonstrated a 10x to 100x speed improvement compared to the reference simulators, without sacrificing accuracy.

Simulation of close strong interferers is extremely fast, as the algorithms are not sensitive to the relative spacing of the input and output frequencies. Users are completely free to choose the amplitudes and frequencies of the signals, so that they can verify the genuine specifications. Also, the intrinsic accuracy of the algorithms is ideal for the analysis of signals with widely different scales. Simulating signals with -150dB dynamic range is a routine task with Eldo RF.

Design Optimization

Powerful Built-in Optimizer Included

Eldo RF incorporates powerful optimization algorithms to assist the designer in the fine-tuning of circuit performances.

The optimization facility does not require any external tool, it is all integrated in the simulation kernel, for maximum efficiency. It supports continuous and discrete, constrained or unconstrained parameters, and concurrent optimization of several simulations and analyzes. Complete curve fitting is also available.

Use of the optimizer is particularly efficient for regular performance optimization (gain, matching networks, power dissipation, IP3 etc.) when the design parameters are strongly coupled, and simple 'sweeping'are not convenient. Another ideal application is the so-called process retargeting, when a design must be 'ported'from one technology to the next-generation technology, and the performance must be maintained.

System Level Simulation with Verilog-A

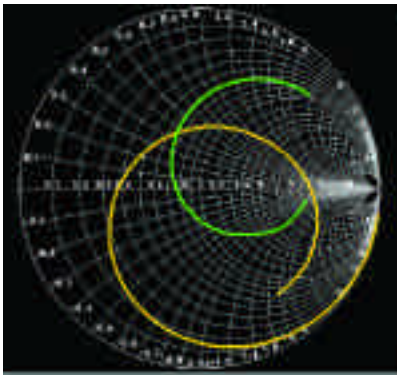
Analog Behavioral Simulation

When the size of the circuit is such that transistor-level simulation is too slow, using analog behavioral modeling can be an effective methodology to reduce the CPU time.

To that end, the Verilog-A option of Eldo RF supports an arbitrary mix of Verilog-A descriptions and transistor-level SPICE netlists. The models can be used with all analyses based on steady-state analysis and most importantly, for modulated steady-state as well.

Low noise amplifiers, mixers, oscillators, filters or IQ modulators can be described in Verilog-A to save CPU time when simulating large systems.

Using parameterized models also allows efficient architectural exploration, tuning the system performance as required in minutes.



Eldo RF features a complete RF toolbox, including Smith Chart diagrams, gain and stability circles, minimum noise figure etc

Verilog-A is a very simple language, ideally suited to capture the kind of equations needed for these models, and its usage in Eldo RF is amazingly simple. Verilog-A models are included in the SPICE netlist, instantiated as subcircuits, and simulated along the rest of the circuit.

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Printed on Recycled Paper

10-01 HDG 1019500