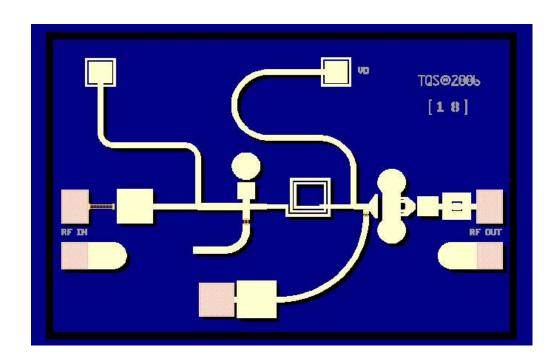**Agilent EEsof EDA**

MMIC Design Solutions

Preliminary

- Complete front-to-back MMIC design in a single integrated design flow.
- Complete, up-to-date process design kits from all major MMIC foundries for designs that meet the latest specifications.
- Design For Manufacturing (DFM) tools for high yield, high-quality MMIC designs that work right the first time and reduce development costs.
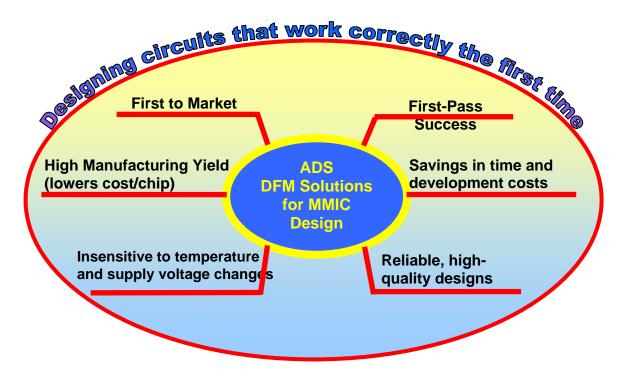
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Achieving First Pass Success and High Yield

A successful Monolithic Microwave Integrated Circuit (MMIC) design does more than just meet specifications. When manufactured, especially in big quantities, variation in components and in manufacturing process parameters around nominal values can result in failure to meet specifications in many final products. Design iterations and extra wafer runs can become necessary, but they take time and can cost hundreds of thousands of dollars. Consequently, today's advanced technology MMIC designs – especially those being used for high volume products - require the use of Design for Manufacturing (DFM) techniques. Designs employing these techniques are less sensitive to process variation and result in first-pass success, as well as much higher yield; saving both time and money.

Today, MMICs are at the core of most high-frequency, high-speed electronic products such as cellular phones and other mobile devices, performing functions such as microwave mixing, power amplification, low noise amplification, and high-frequency switching. To be competitive in the various product markets, MMIC designers are continually challenged to reduce costs and get their devices to market fast, and ahead of the competition. Advanced Design System (ADS) from Agilent EEsof EDA allows today's MMIC designers to meet these challenges.

Advanced Design System is a powerful electronic design automation software system. It is a crucial part of the complete MMIC design flow and is used throughout the process. It provides designers with:

- A unique and advanced set of tools to create robust designs, first pass success, and high yield.
- Complete and continuously updated process design kits from all major MMIC foundries.
- A complete set of advanced simulation tools, seamlessly integrated into one single environment, from schematic entry through to production and packaging of the MMIC.
- The ability to verify, prior to fabrication, that a MMIC meets all specifications in its final package, using seamlessly integrated Planar EM and 3D-EM tools.
- The ability to provide "True Circuit" verification to all wireless standards, prior to and post fabrication, using a complete set of the most accurate wireless verification tools.

ADS DFM tools create robust designs with first pass success and high yield.
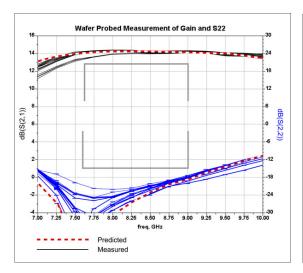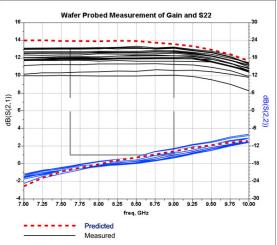
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MMIC Designs that Work Correctly the First Time

With its innovative Design For Manufacturing (DFM) capabilities, ADS helps designers create and manufacture high-yield, high-quality MMIC designs that work correctly the first time.

A complete set of MMIC process design kits (PDK) - the only ones in the industry to be fully verified, supported, maintained, and continuously updated by today's leading GaAs foundries – further eases and speeds the MMIC design process. In addition, ADS continues to provide the most up-to-date functionality and performance required for cost-effective, efficient and fast MMIC design through recent and ongoing enhancements in usability, physical design functionality, productivity, and quality.
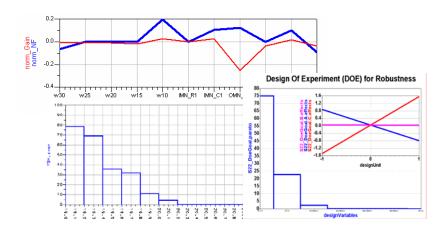
ADS features two unique solutions - Design of Experiments (DOE) and Yield Sensitivity Histograms (YSH) – both of which are designed to turn any standard design into a robust one by providing MMIC designers full insight into the circuit and interaction between its elements. The tools pinpoint any sensitive parts and sensitive matching networks in the design that may cause problems in yield. Designers then are able to fix the problems prior to production, resulting in robust, higher yield designs.

DFM design yields higher performance and more consistent designs with high yield. In the example graph on the left a DFM technique was used and yield was 100 percent. In the graph on the right, a standard design technique was employed. The resulting yield was only 5 percent.

In today's competitive environment, DFM techniques must be utilized to the fullest, especially in high-volume products. An effective DFM process is not possible without the ADS DOE tool. The ADS Data Display Post Processing capability is also required to extract and create YSHs, along with many other meaningful data.

The unique DFM tools in ADS pinpoint all sources of the design problem and allow you to fix them prior to fabrication.

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Access to Complete MMIC PDKs and Advanced Model Composer

Strategic partnerships with leading MMIC foundries demonstrate Agilent's established leadership in MMIC design. These relationships ensure that more and more foundry processes support the complete MMIC design flow in ADS, including physical design. ADS tools and techniques make it easy for foundries to add new processes, as well as to update existing design kits to support the latest ADS capabilities.

Agilent EEsof EDA has more MMIC PDKs than any other EDA vendor in the industry today, providing designers the widest choice of foundries for MMIC design with the best availability and price-performance. Unlike other EDA vendor-created PDKs, Agilent's PDKs are jointly created by Agilent and the foundry, and are fully validated and regularly maintained and updated. Consequently, designers always have access to the latest and most up to date foundry models that reflect the most recent processes.

An ever-growing list of major foundries supports the ADS MMIC design flow with continuously updated, complete Process Design Kits.
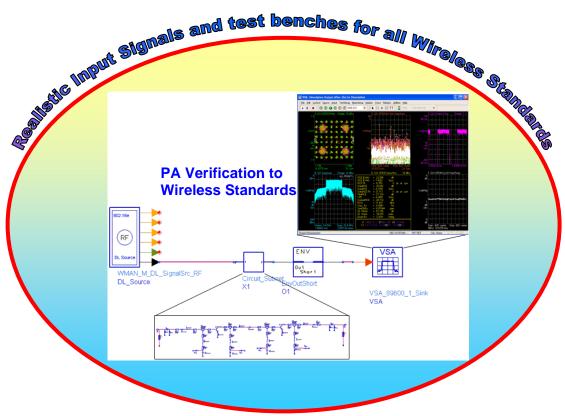
Advanced Model Composer

Advanced Model Composer (AMC) is a patented ADS technology that allows designers and foundries to create arbitrary passive structures and shapes with built-in EM effects. The resulting compact models can be used for fast tuning and optimization, enabling the designer to converge on specified parameters in seconds. AMC technology brings the accuracy of EM simulation and the speed of analytical models into a single, user-defined, compact model. It has been well adopted by the TriQuint foundry and is used in their design kits.

True Circuit Verification to All Wireless Standards

Power Amplifier (PA) verification to wireless standards plays an important role in the MMIC design flow, because verifying large MMIC/RFIC chips to wireless standards, prior to manufacturing, has been a major design flow barrier. Results accuracy" and simulation speed are the two main factors responsible for this barrier. With the ADS Automatic Verification Modeling (AVM) technology and wireless verification solution, this barrier has been eliminated.

AVM is a new circuit/system co-simulation feature which builds on the P2D modeling and circuit envelope simulation capability in ADS. It offers a more automated way to build an additional level of model abstraction within Agilent Ptolemy and is used for fast wireless system verification. Using the Circuit Envelope simulator AVM or Fast Cosim option, MMIC designers can generate a circuit model that can be simulated efficiently and with very high accuracy. Verification of large MMICs or RFICS against wireless standards is just not possible without AVM, and ADS is the only EDA design software with a set of wireless verification tools accurate enough to provide true circuit verification, prior to and post fabrication, to all wireless standards.

PA verification to wireless standards is automated and easy to use. Simply select the proper realistic wireless source, insert your circuit level PA, and simulate.

The ADS Wireless Verification solution uses realistic input signals and test benches for all wireless standards (for example, WiMAX, UWB and LTE). It is automated and easy to use. Simply insert the amp and simulate. The solution helps designers not only test and verify designs, but also get the best circuit performance. It offers speed increases of up to 100x over traditional methods, and can be modified for aerospace and defense applications through custom security and modulation capabilities.
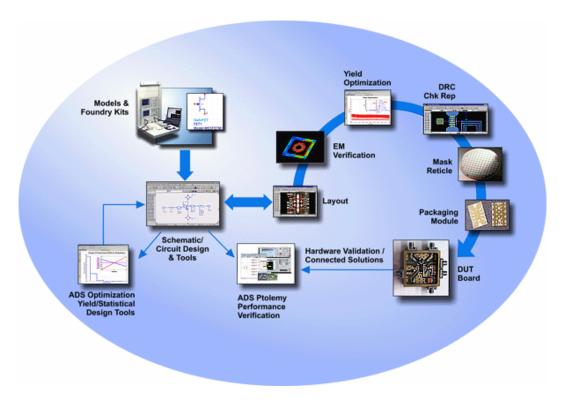
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A Full Front-to-Back MMIC Design Flow

ADS is the most capable integrated simulation environment for performance and yield optimization of MMIC designs. Its many design flow features provide designers with a guaranteed error-free integration into their physical design flow and bring a higher level of productivity to the MMIC design process.

Features include:
- Automated trace and via insertion
- 3D EMDS fully integrated in ADS
- Automatic DRC and design synchronization
- Increased simulation capacity with support for 64-bit datasets
- Simulated annealing optimization

ADS physical design tools fully support integrated reticle generation, as well as external step-and-repeat lithography, with fast import and export in industry-standard GDS II format.

A complete front to back MMIC design solution, all in a single environment.

Easy Creation of Physical Designs

Regularly updated foundry device models and layouts are synchronized in both schematic and layout pages. With ADS, it's easy to create physical designs, either by auto-generating a layout from the schematic via design synchronization or by manually placing the layout artwork.

ADS features three different synchronization modes between schematic and layout, providing optimum flexibility in the development of MMICs. With ADS, you are not constrained by always having the schematic and layout "automatically synchronized," which can introduce the risk of unintended MMIC layout modifications. Instead, ADS gives you the flexibility to choose from three different modes of synchronization:
- Single representation with No Synchronization.
- Dual representation with Half Synchronization.
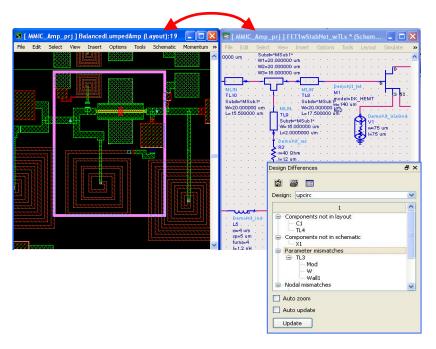- Always Automatic Full Design Synchronization between schematic and layout.

You can even switch back and forth between the three different modes while you are laying out the MMIC, allowing you to efficiently and accurately fit designs with many elements into small areas. The result is a smaller die size and lowered overall cost per chip.

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Powerful LVS Tools

Routing dense lines and elements to fit into a tiny MMIC chip space without incurring design re-spins requires access to good LVS design check tools. ADS can check the layout for errors and verify that the final layout reflects the schematic design and is correct and error-free prior to manufacture.

In ADS, Check Representation offers full functional-node checking to compare schematic and layout for mismatched nodal and parametric values. The Physical Connectivity Engine (PCE) allows you to check layouts for connectivity errors on-the-fly. ADS allows designers to easily detect and identify any design differences between layout and schematic to eliminate differences between layout and schematic. ADS can also export any schematic netlist to use with third-party LVS tools.
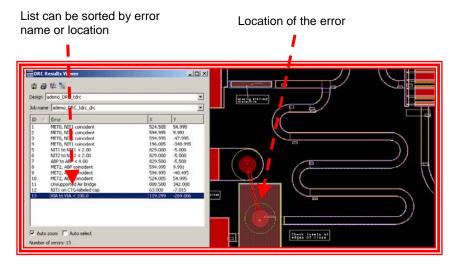

A new Design Differences Window identifies components in layout not in schematic, components in schematic not in layout, parameter differences, and nodal mismatches.

DRC - Rapid, Automatic Conformance Check

Design Rule Checker (DRC) is a simple, foundry-proven method for rapidly and automatically checking layout conformance to foundry process design rules. ADS features an enhanced version of its DRC tool that allows you to verify that your physical layouts conform to process rules. Now you can find all the errors and their exact x-y coordinate locations easily. You can sort the errors according to name or location to help you fix them. ADS DRC rules are now available for most of the major foundries' design kits.

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List can be sorted by error name or location

Location of the error

An improved Design Rule Checker locates layout errors faster.

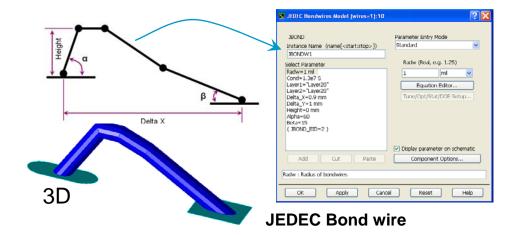## Accurate Interconnect Analysis

Improving interconnect performance and increasing confidence that the manufactured product will function as simulated is crucial in MMIC design. There are many types of physical layout components such as high speed connectors, bond wires, and dielectric bricks that require three-dimensional electromagnetic analysis for any arbitrary geometry.

To better address these concerns, the Momentum Planar EM and 3D Electromagnetic Design System (EMDS) simulators are now fully and tightly integrated into ADS 2008 and can be accessed in the same design environment, allowing you to verify the proximity effect of chip area compaction, as well as effects of bond wires and packaging, and then to take corrective action on performance and yield early in the design process.
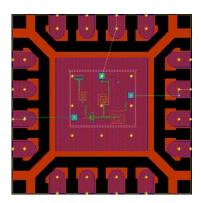
The Momentum simulator is the industry's first 64-bit, 3D planar EM solver, and it includes a new Krylov iterative solver. It hosts three unique solvers to address the varying degrees of EM modeling complexity and extend EM modeling efficiencies across a much wider application coverage area. As a result, you can solve bigger problems, previously not solvable, much faster.
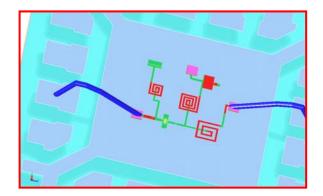
The full-wave and quasi-static solvers and adaptive mesh reduction available with Momentum cover EM analysis needs from microwave frequencies down to DC. This is especially important to MMIC designers because it allows fast design explorations without sacrificing accuracy. Momentum also features improved thick-conductor modeling capabilities. Horizontal current modeling on the metal interconnect sidewalls, as well as vertical currents, accurately predict loss or Q calculations at high frequencies.

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3D

JEDEC Bond wire

Fast and accurate bond wire drawing with JEDEC industry compliance for EM analysis.
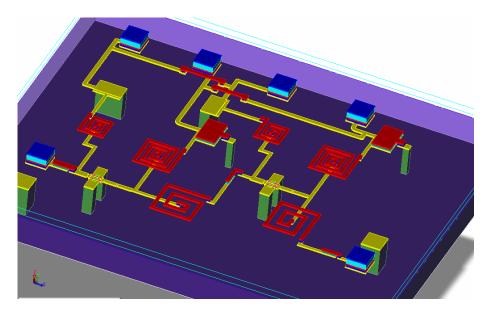

Accurate 3D EMDS simulation and verification of MMIC in package and with bond wires.

EMDS is integrated into ADS. Its features include a 3D viewer and a bond wire modeling capability with JEDEC parameter entry. Momentum and ADS eliminate the need to leave the design environment to perform EM analysis. With ADS and its integrated EM analysis capabilities, designers can perform full front-to-back design and EM verification all in the ADS environment.

After an MMIC is designed, it is packaged and mounted onto a board, and package effects must be considered in overall design performance. ADS can simulate not only the IC, but also the package and test board as well, so that you can accurately predict in-circuit performance. Momentum RF, a quasi-static EM simulation engine available in ADS, helps ensure accuracy when results are translated to time domain for further analysis. ADS assures MMIC performance both before and after you insert it into its package and attach input and output wire bonds.
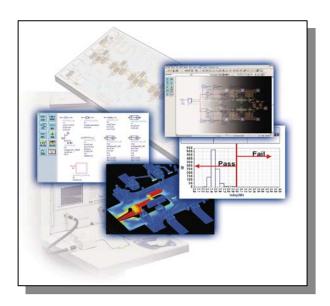
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A 3D viewer allows designers to check their final design layers and connections faster.

Design Optimal Transient Behavior

In some cases, MMIC requirements have transient response specifications (for example, VCO startup time and settling time, or amplifier pulsed response). ADS features a convolution simulator for transient simulation that allows seamless access to frequency-domain models extracted from Momentum and lets you read them directly into the convolution time-domain simulator. This unique convolution technology allows you to design optimal transient behavior of your MMIC, while helping you to complete your time-domain circuit analysis with high accuracy and first-pass success.

Advanced simulation technology tools integrated into one environment.

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Agilent EEsof EDA

A proven track record
Agilent EEsof EDA has a history of innovation and leadership that is widely recognized in the industry.

A Clear Roadmap
Agilent EEsof EDA has a clear roadmap to chart the way to the design flows of the future, with an eye to evolving technology as integration levels move ever higher.

Support for Your Future Expansion
Agilent EEsof EDA has the widest range of advanced simulation technology tools, integrated into a single platform. Agilent's EDA tools can be expanded according to your needs.

Test and Verification for Design Success
The pressure to reduce development time encourages connecting the EDA software and test environments. For wireless applications, complex stimulus signals created in the simulation domain must be available for use in the test domain and vice-versa. As various system component prototypes become available, measurement-based behavioral models of these components need to be combined with simulation-based models of early component designs.

Combining verification and test for built hardware with simulated parts pulls design verification up in the development schedule, saving costly redesign and reducing design risk.

Strategic partnerships with leading foundries demonstrate Agilent's Established Leadership in MMIC Design
You designed it, but can you build it? High-quality PDKs that have been rigorously validated by your foundry are critical for successful high frequency design. All the major foundries offer and maintain design kits for use with ADS.

Models for Simulation Accuracy
Agilent EEsof EDA has a large and accurate set of models for high-frequency passives, transistors, and block-level behavioral components..

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World-class support, training, and services

All Agilent EEsof EDA products are backed by a world-class team of experienced application and technical support engineers who are dedicated to providing the right software, support, and consulting solutions to increase engineering productivity and long-term success. We offer worldwide, local-language, technical support via telephone, fax, e-mail, and the worldwide web.

In addition, our web-based Agilent EEsof Knowledge Center is an around-the-clock resource for comprehensive support information and downloadable examples for all our products. It hosts software updates and has a tracking feature that makes it easy for you to submit and manage support cases and related enhancement requests. The search feature lets you quickly find available solutions and sort through them by date, popularity, or user ratings. The Knowledge Center also contains product discussion forums that put you in touch with other users, support engineers, and product developers. And, you can get training when and where you want it through e-learning short courses and technical information sessions.

Every team's design flow has aspects that are unique. To save time and get individual attention focused on your application, take advantage of our consulting solution services. We offer complete consulting in MMIC, RFIC, board/module, or system-level design.

Contact your Agilent EEsof EDA field sales engineer for more information or for a free evaluation.

For more information about Agilent EEsof EDA, visit:

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