Device Modeling Systems Solutions from Agilent EEsof EDA

Complete, Turnkey Modeling Solution for Today's Semiconductor Devices

Agilent Technologies

Device modeling — A strategic part of your design process

Device modeling systems from Agilent Technologies consist of complete, single-source systems of test hardware and modeling software. These systems are designed to meet the growing need to accurately and efficiently extract the model parameters used in circuit simulations.

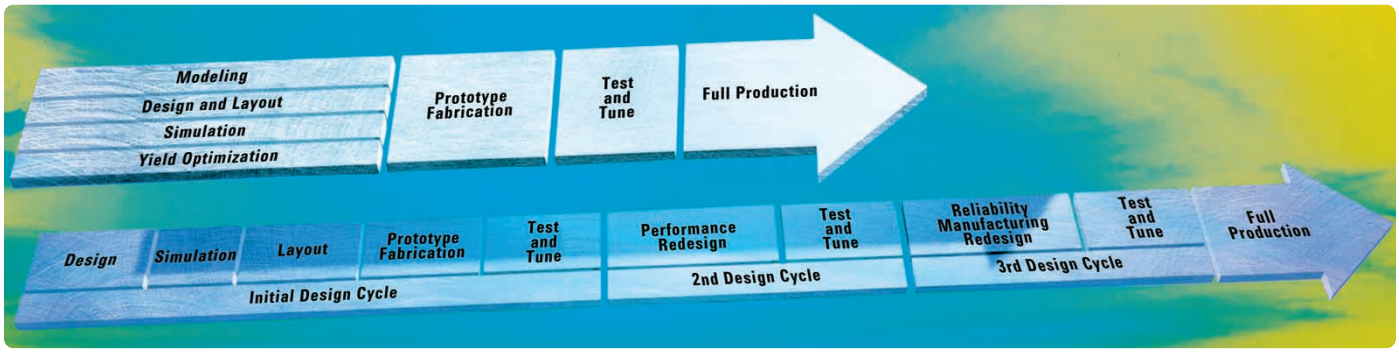
Start designs using accurate models

Agilent device modeling systems provide you with significant competitive advantages for designing your products. As competition increases in the digital, analog, RF, and microwave electronics markets, improvements in product performance and cost are critical. Circuit simulation tools are now available to maximize product performance, reduce time-to-market, and shrink product costs. Accurate simulations require the most up-to-date device models. Agilent device modeling systems allow you to build these models.

Systems at a glance

Agilent provides the following application-focused systems:

- **85225A performance modeling system**
  For high-precision, high-performance modeling results over a wide range of frequencies up to 50 GHz using Agilent's latest Performance Network Analyzers (PNA)
- **85122A precision modeling system**
  For highly precise modeling results over a wide range of frequencies up to 50 GHz using the Agilent 8510C Vector Network Analyzer (VNA)
- **85123A RF modeling system**
  An economic solution for devices used at frequencies under 3 GHz (optionally up to 40 GHz)
- **85226A millimeter-wave modeling system**
  For advanced and high-precision modeling results up to 110 GHz using the Agilent E7350A (8510XF) network analyzer system
- **85124A pulsed modeling system**
  For isothermal device modeling that includes the temperature dependent effects such as self-heating phenomena in high power devices using synchronized pulsed DC and RF stimuli



The bottom arrow represents the older design process, while the top arrow shows how the modern design process helps get your products to market faster. The modern process relies on electronic design automation software and modeling tools.

Maximize product performance

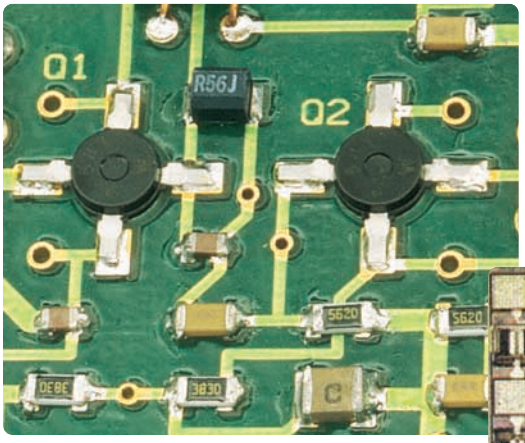
Accurate device models are key to increasing your product performance. They are the foundation for circuit simulations, which can predict nonlinear analog circuit behavior, such as gain compression and harmonic distortion, and digital circuit behavior, such as gate delay and leakage current. The accuracy of your simulations is only as accurate as the device models you use.

Reduce time-to-market

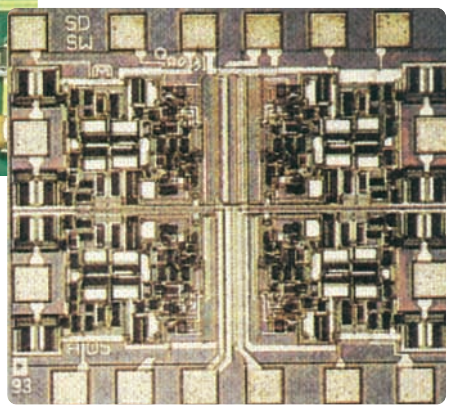
With accurate device models, your circuits can be designed and optimized with confidence before you build the actual circuit. This gives you the ability to replace traditional "design-build-test-redesign" methods with a "model-design-simulate-validate" approach. By eliminating the need for redesign, you can produce circuits that work the first time and speed time-to-market.

Shrink product costs

Reducing the number of design iterations not only reduces your time-to-market, it also directly reduces your design costs. In addition, you can use accurate device models in Monte Carlo analysis to identify sensitivities to manufacturing variations. By designing around sensitive components, you can increase your yield and reduce the average product cost.



Agilent modeling systems can be used to extract industry-standard model parameters for discrete transistors, such as those used in this PCB design.



Agilent modeling systems can also be put to work to develop new models for your IC process.

Complete device modeling and design solutions

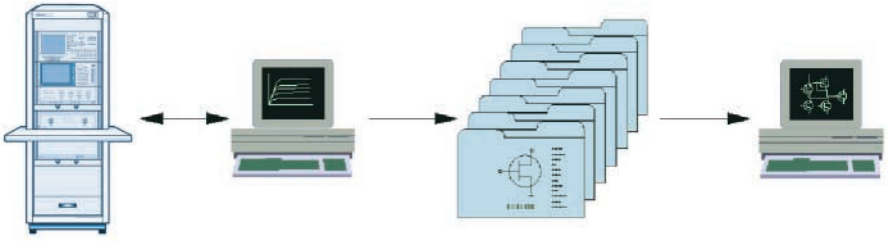
High performance device modeling systems
Before you can build accurate device models, it is essential to begin with accurate device measurements. Agilent Technologies provides state-of-the-art measurement systems with superior performance and reliability. This ensures the highest measurement accuracy, which directly translates to model parameter accuracy, and ultimately, to the accuracy of your circuit simulations.

Agilent device modeling systems are configured, integrated, and tested at the factory. The systems can be delivered to your site fully integrated, well documented, and ready to use, thus saving you development costs and resulting in immediate productivity. The systems include a one-year, on-site warranty to ensure your initial and on-going modeling success.

The modeling systems can be readily interfaced to the RF/Microwave probe stations from Cascade Microtech, Inc. Applying Cascade's proprietary calibration techniques, these systems can be well calibrated for highly accurate on-wafer measurement results.

IC-CAP device modeling software provides the most flexible software environment for modeling system control, data acquisition, and parameter extraction

Powerful modeling software
IC-CAP software controls test instrumentation to obtain measured data and extracts model parameters by interfacing with built-in SPICE simulators or commercial simulators such as Spectre, Eldo, HSPICE, Saber, and the Agilent EEsof EDA's Advanced Design System. Industry-standard modeling routines for BJT, MESFET, HEMT, MOSFET, and TFT devices help you get started immediately extracting model parameters and building accurate, up-to-date model libraries. IC-CAP also provides tools for developing custom models and extraction techniques for your fabrication process.

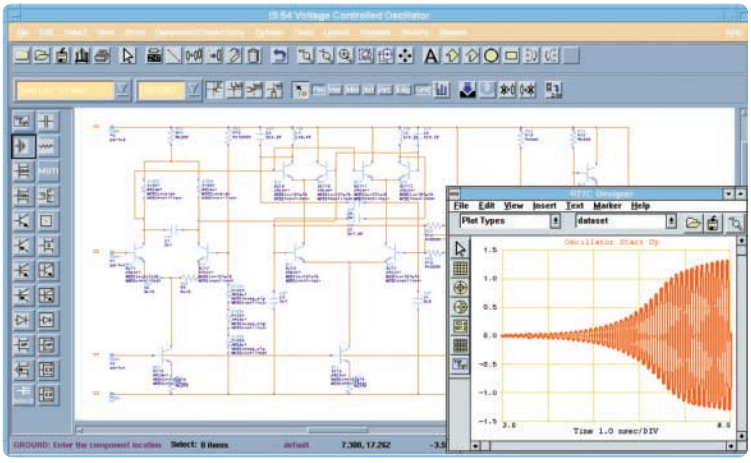


World-class simulators

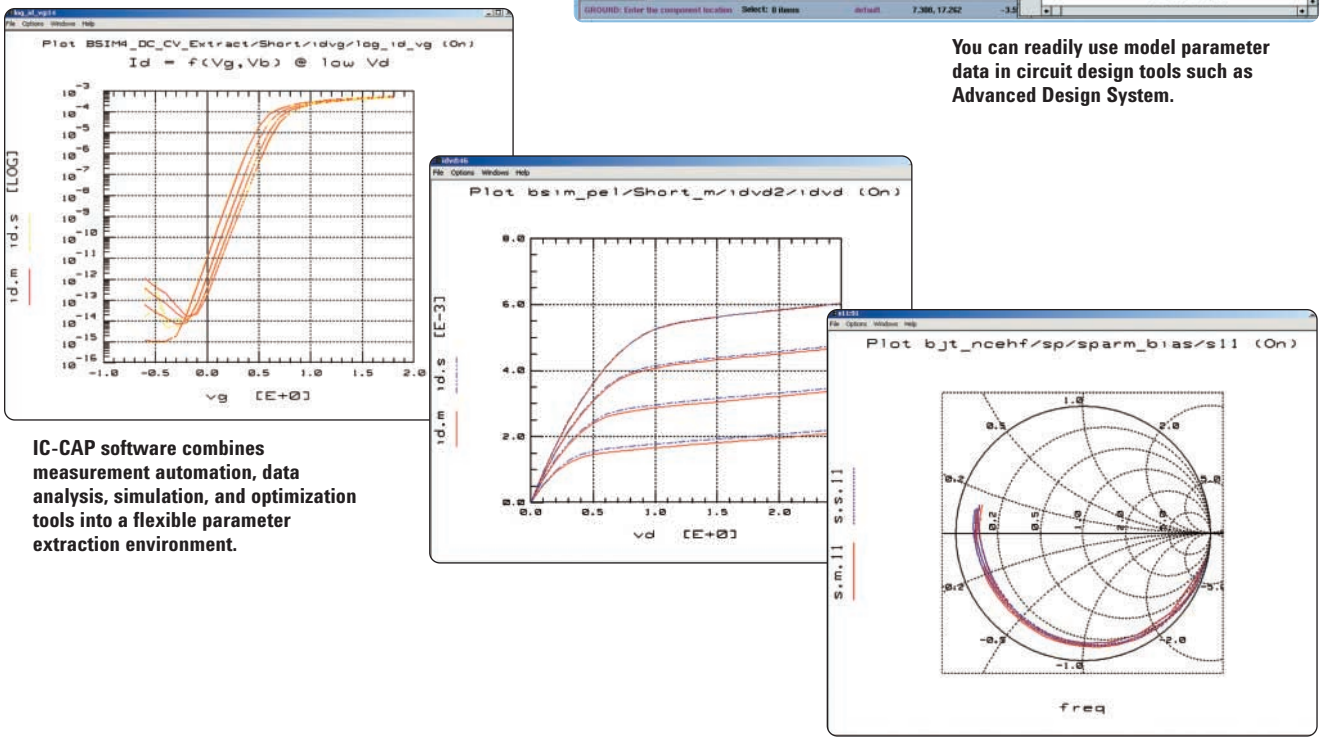
Once accurate model parameters of the device have been extracted, they are ready to be used in your circuit design. Agilent EEsof EDA offers a complete line of circuit simulation tools. Advanced Design System lets you analyze both linear and nonlinear circuits with maximum efficiency and accuracy. Using these tools, you can quickly analyze, tune, and optimize the performance of a large variety of RF and microwave circuits. High-frequency layout capability that is tightly linked to the schematic is also available, enabling you to simulate directly from the layout.

Technical support and training

To ensure your success in device modeling, Agilent provides comprehensive technical support by phone, fax, e-mail, and customer education classes. These services help guide you through the extraction procedure. Complete documentation is also included with the modeling systems.



You can readily use model parameter data in circuit design tools such as Advanced Design System.



IC-CAP software combines measurement automation, data analysis, simulation, and optimization tools into a flexible parameter extraction environment.

Complete systems available only from Agilent EEsof EDA

Choose the right system for your application

Agilent device modeling systems provide everything from DC, CV, 1/f Noise to S-parameter measurements under CW and pulsed bias conditions for building complete sets of nonlinear model parameters. You can choose a standard configuration or a customized version that fits your application. For example, you can request a customized system that allows you to perform DC and low frequency noise (1/f noise) characterization or to measure the S-parameters up 50 GHz under pulsed bias conditions. A team of system specialists can configure a system that tailors to your specific requirements. If you already own some components of a modeling system, you can integrate them into a complete system. This lowers your overall system cost and protects your initial investment.

Each system combines a network analyzer with a DC parametric analyzer. The 4156C Precision Semicondutor Parameter Analyzer is used to make current-versus-voltage (I-V) measurements for extracting DC model parameters. The network analyzer measures the S-parameters as shown above. S-parameters are used to extract important RF parameters. In addition, a network analyzer can perform very accurate C-V measurements for extracting capacitance models.

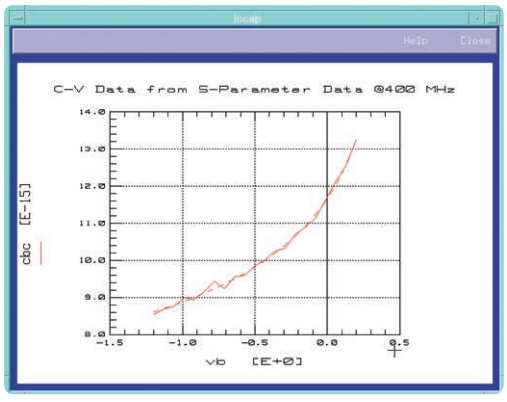
A complete modeling system from Agilent combines a DC parametric analyzer, network analyzer, and accessories. Shown is the 85122A precision modeling system.

85122A precision modeling system

The system offers complete DC-to-RF device characterization capabilities up to 50 GHz with high precision results. The system uses Agilent high performance instruments such as the 8510C VNA and the 4156C Precision Semicondutor Parameter Analyzer for highly accurate measurement results over a wide range of frequencies.

85123A RF modeling system

The system is designed as an economic solution for many RF modeling applications that do not require the use of the high performance 8510C network analyzer. For those applications, the 85123A system offers a cost effective solution while still delivering excellent measurement results. The standard 85123A 3 GHz RF modeling system can be custom configured for other frequencies up to 40 GHz. For example, the 20 GHz system uses the Agilent 8720ES 20 GHz VNA instead of the 8753ES 3 GHz VNA.



Calibrated accuracy of an Agilent network analyzer allows precision capacitance measurements down to a few femptofarads without special attention to shielding.

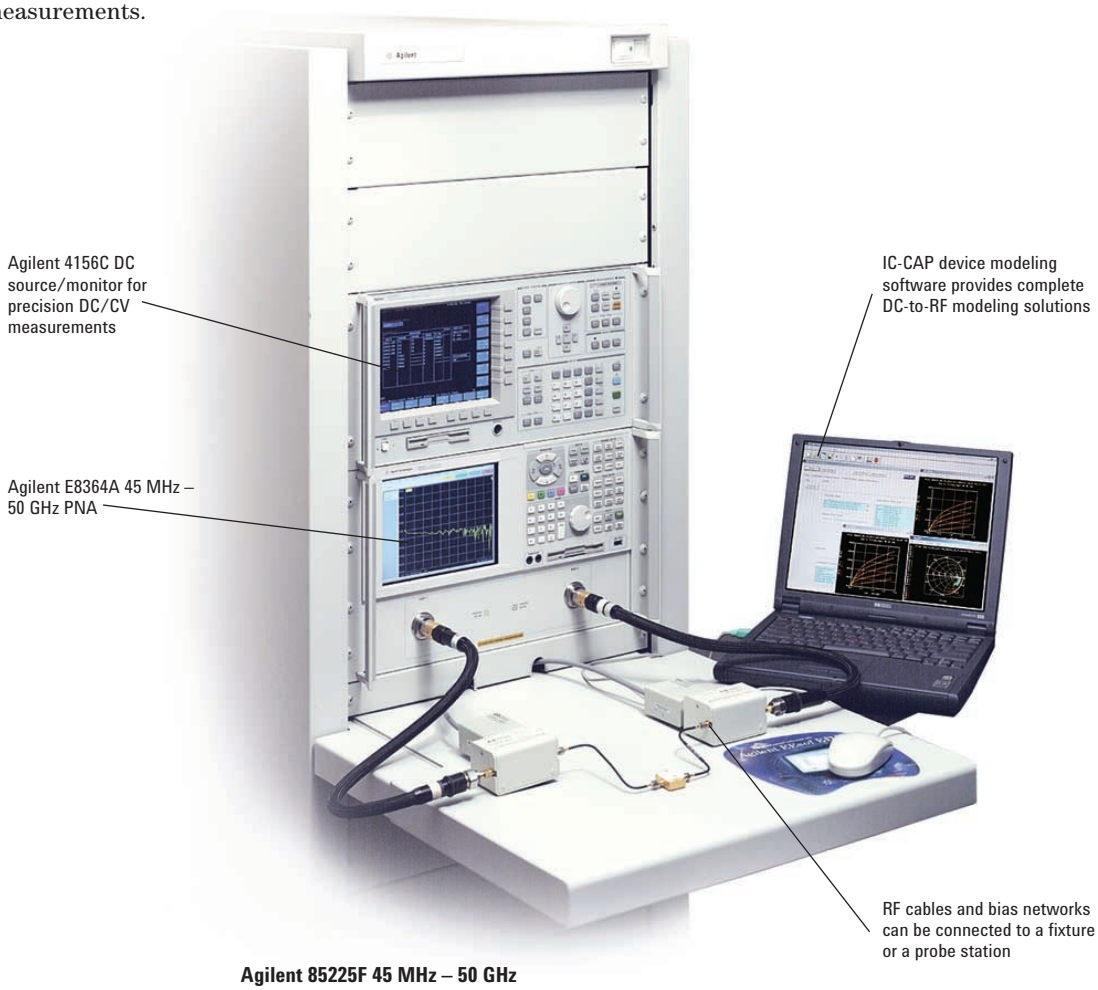
85225-series performance modeling systems

The systems in this family have been designed for high performance DC-to-RF device measurements and modeling. The RF sub-system includes a high performance network analyzer (PNA) that offers exceptionally high dynamic range, very low trace noise, and fast measurement time with improved usability. Each system carries a PNA that offers a specific measurement frequency range. For example, the 85225A includes the E8356A 300 KHz – 3 GHz PNA. Table 1 shows the systems in this family with the PNAs and their frequency range. The DC sub-system includes the 4156C Precision Semicondutor Parameter Analyzer for highly precision DC measurements.

In addition, the system includes the bias networks for combining the DC and RF signals and making standard Kelvin measurements.

Performance modeling systems	Network analyzer	Frequency range
85225A	Agilent E8356A	300 KHz - 3 GHz
85225B	Agilent E8357A	300 KHz - 6 GHz
85225C	Agilent E8358A	300 KHz - 9 GHz
85225D	Agilent E8362A	45 MHz - 20 GHz
85225E	Agilent E8363A	45 MHz - 40 GHz
85225F	Agilent E8364A	45 MHz - 50 GHz

Table 1. 85225 performance modeling systems using Agilent high performance network analyzers.



Agilent 85225F 45 MHz – 50 GHz performance modeling system

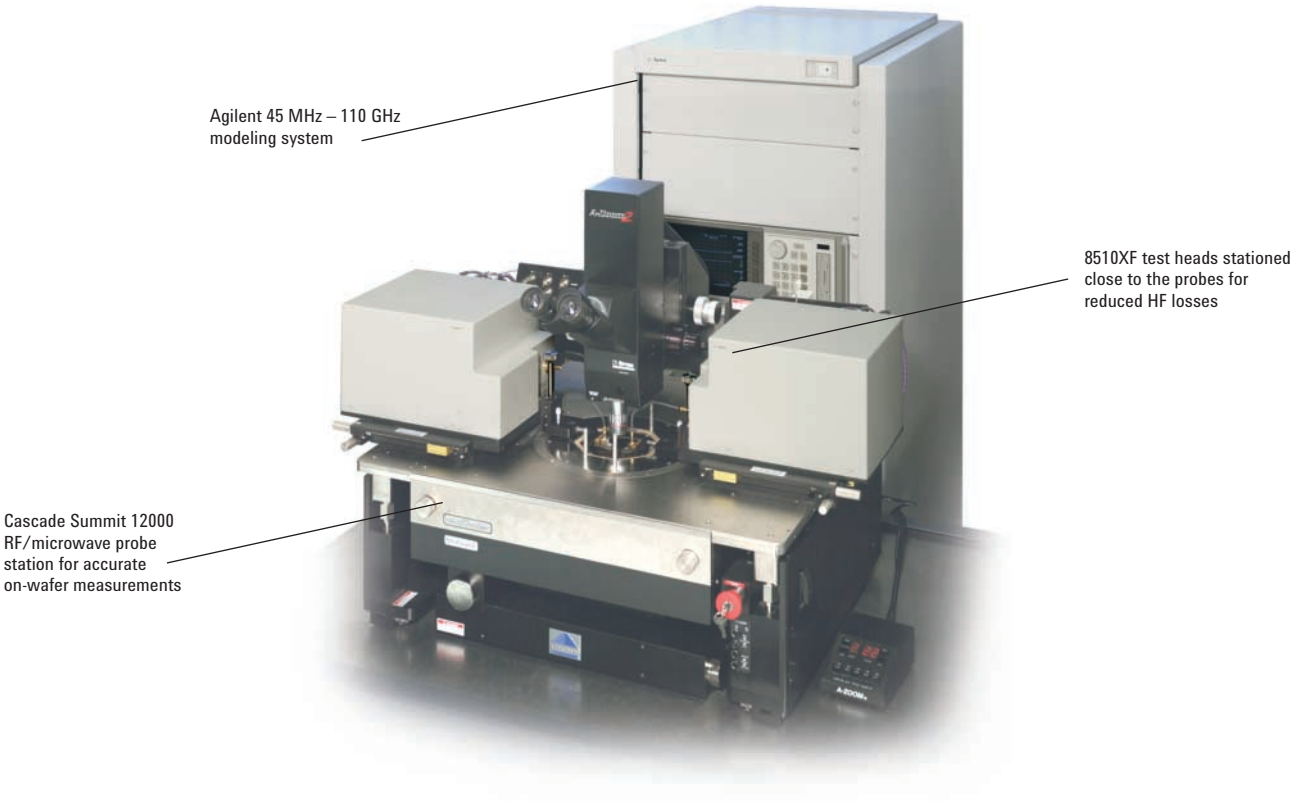
Advanced modeling solutions for leading edge high-frequency devices

85226A millimeter-wave modeling system
The advance of semiconductor processes enables devices to operate at much higher frequencies. Devices with operating frequencies up to 110 GHz have been reported. Thus, a modeling system that provides accurate solution at such high frequencies is highly desired to test and extract the important RF characteristics such as the maximum frequency, F_{max}, and the transit frequency, F_t. The Agilent 85226A millimeter-wave modeling system is a complete and fully integrated system that offers modeling frequencies from 45 MHz to 110 GHz in a single sweep.

The system combines the Agilent E7350A (8510XF) 45 MHz – 110 GHz network analyzer system with the 4156C DC parameter analyzer. The entire system is completely controlled by IC-CAP device modeling software for automated device measurements. At such high frequency as 110 GHz, there are no bias networks for standard Kelvin measurement. Instead, IC-CAP offers a Parasitic Connectivity Correction (PCC) technique that can accurately correct the parasitic DC losses. The PCC technique is a software module that helps determine the actual bias signals applied at the device terminals. The correction leads to more accurate measurement results, which are critical for parameter extraction of bias dependent models.

The system can be interfaced to a Cascade's RF/Microwave probe station such as the Summit 12000 or S300. Using Cascade's advanced 110 GHz probes and Wincal software with proprietary calibration methods, LRRM, the system can be very well calibrated.

The combination of Agilent high performance system, a flexible and powerful IC-CAP modeling software, and Cascade's advanced probing system provides the most advanced and comprehensive modeling system available for 110 GHz device modeling.

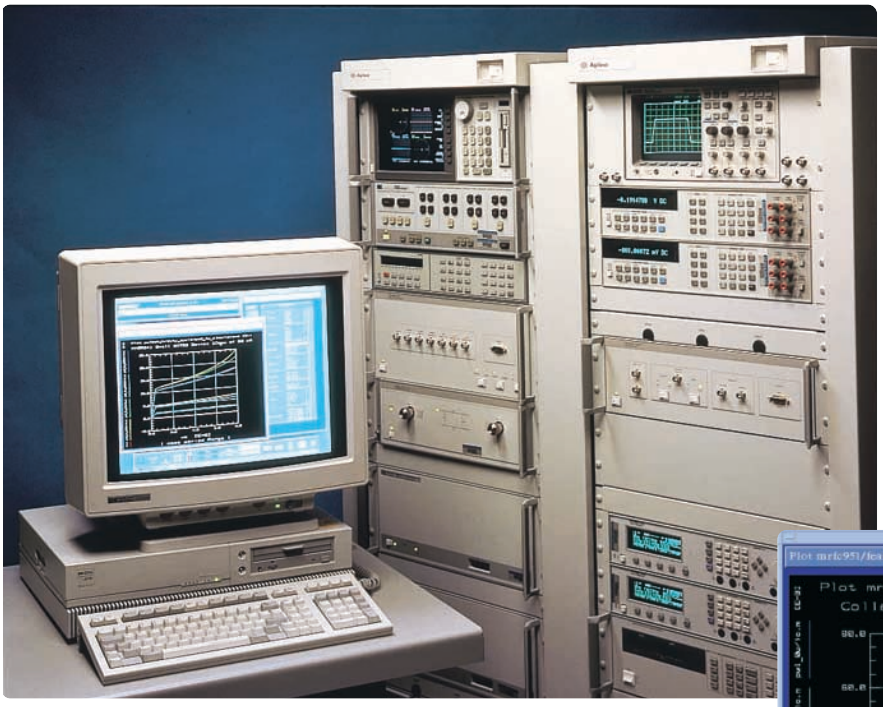


Agilent 85226A 110 GHz millimeter-wave modeling system integrated to Cascade advanced RF/microwave probe system

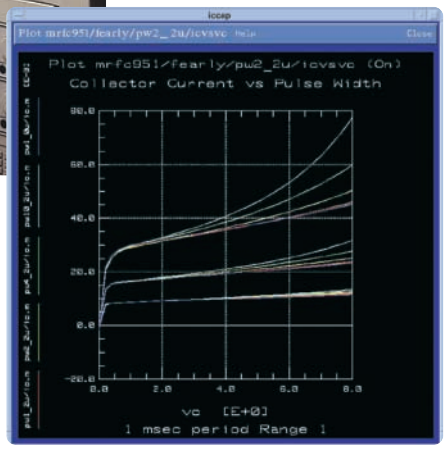
Characterization with pulsed measurements
Many devices heat up significantly during operation and during characterization. This self-heating is seen in medium- to high-power devices and even in small devices where the power density is high. Self-heating directly impacts device and circuit performance, but traditional models do not include these thermal effects.

The Agilent Technologies 85124A pulsed modeling system combines an 8510C pulsed-RF network analyzer system with pulsed-bias and precision-pulsed DC current-versus-voltage (I-V) subsystems. By pulsing the bias and RF stimuli to the device during characterization, self-heating can be controlled. This will enable you to develop new models that incorporate thermal effects and thus improve circuit simulation accuracy.

The pulsed modeling system also extends the range over which your devices can be characterized. With on-wafer characterization where heat-sinking is not available, continuous-bias techniques can damage devices due to excessive heating. Pulsed characterization shows nondestructive on-wafer measurements, even at power levels beyond the normal safe operating region. This is important for developing and validating models that are accurate over wide ranges of bias and RF power levels.



IC-CAP software gives you complete control of the pulsed modeling system so that you can measure effects such as collector current versus pulse width.



The pulsed modeling system is a completely integrated tool for investigating device self-heating and for developing new thermal models.

Standard Device Modeling System Configurations

85225A 300 KHz – 3 GHz performance modeling system includes:
- E8356A 300 KHz – 3 GHz performance network analyzer
- 4156C precision semiconductor parameter analyzer
- Bias networks, cables, adapters, and rack cabinet

85225B 300 KHz – 6 GHz performance modeling system includes:
- E8357A 300KHz – 6 GHz performance network analyzer
- 4156C precision semiconductor parameter analyzer
- Bias networks, cables, adapters, and rack cabinet

85225C 300 KHz – 9 GHz performance modeling system includes:
- E8358A 300 KHz – 9 GHz performance network analyzer
- 4156C precision semiconductor parameter analyzer
- Bias networks, cables, adapters, and rack cabinet

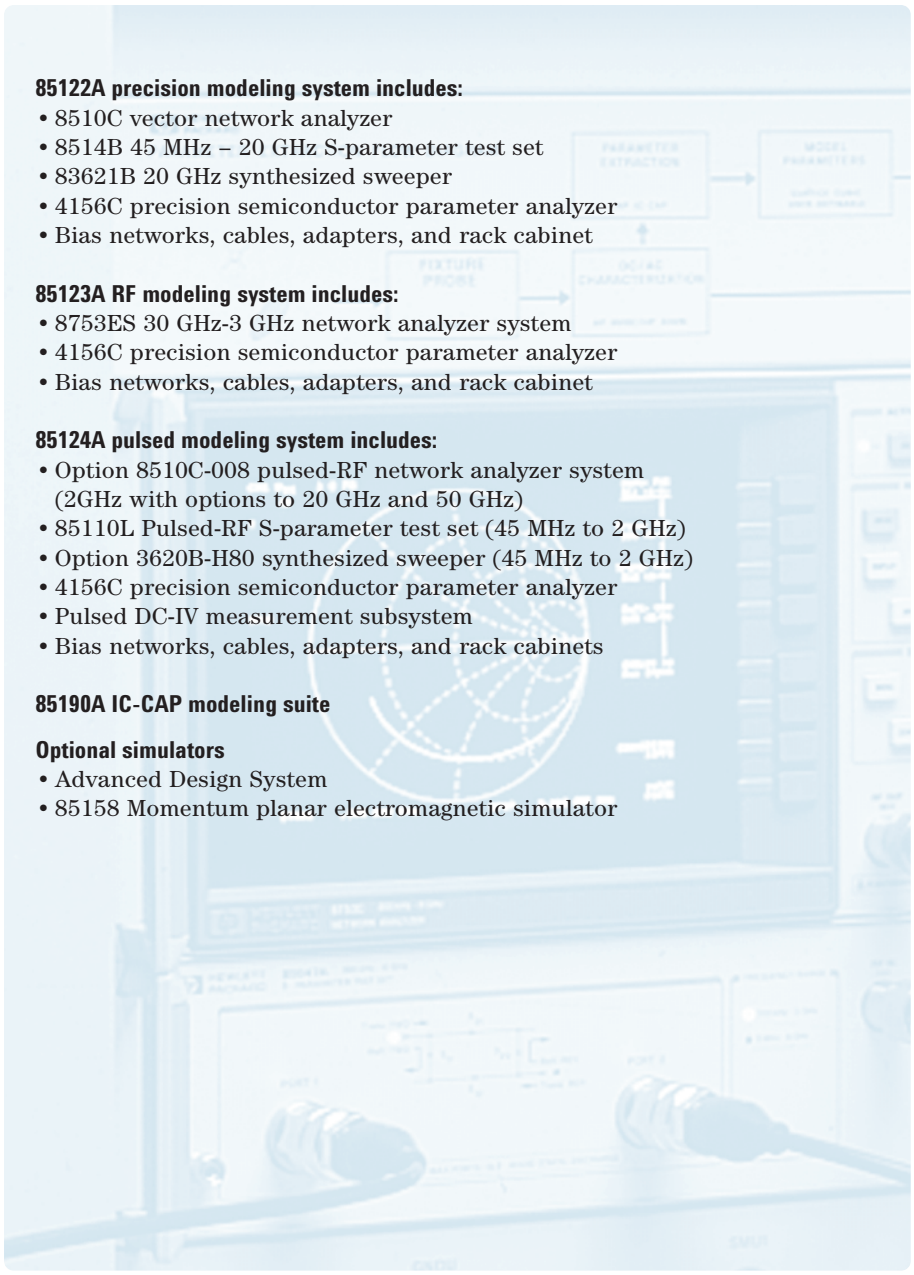
85225D 45 MHz – 20 GHz performance modeling system includes:
- E8362A 45 MHz - 20 GHz performance network analyzer
- 4156C precision semiconductor parameter analyzer
- Bias networks, cables, adapters, and rack cabinet

85225E 45 MHz – 40 GHz performance modeling system includes:
- E8363A 45 MHz – 40 GHz performance network analyzer
- 4156C precision semiconductor parameter analyzer
- Bias networks, cables, adapters, and rack cabinet

85225F 45 MHz – 50 GHz performance modeling system includes:
- E8364A 45 MHz – 50 GHz performance network analyzer
- 4156C precision semiconductor parameter analyzer
- Bias networks, cables, adapters, and rack cabinet

85226A 45 MHz – 110 GHz millimeter-wave modeling system includes:
- E7350A-005 45 MHz – 110 GHz network analyzer system
- 4156C precision semiconductor parameter analyzer
- Option 41501B-410 SMU and pulsed generator expander with HPSMU
- 85059A precision calibration kit, 45 MHz to 110 GHz
- Cables, adapters, and rack cabinets

Standard Device Modeling System Configurations - continued



85122A precision modeling system includes:
- 8510C vector network analyzer
- 8514B 45 MHz – 20 GHz S-parameter test set
- 83621B 20 GHz synthesized sweeper
- 4156C precision semiconductor parameter analyzer
- Bias networks, cables, adapters, and rack cabinet

85123A RF modeling system includes:
- 8753ES 30 GHz-3 GHz network analyzer system
- 4156C precision semiconductor parameter analyzer
- Bias networks, cables, adapters, and rack cabinet

85124A pulsed modeling system includes:
- Option 8510C-008 pulsed-RF network analyzer system (2GHz with options to 20 GHz and 50 GHz)
- 85110L Pulsed-RF S-parameter test set (45 MHz to 2 GHz)
- Option 3620B-H80 synthesized sweeper (45 MHz to 2 GHz)
- 4156C precision semiconductor parameter analyzer
- Pulsed DC-IV measurement subsystem
- Bias networks, cables, adapters, and rack cabinets

85190A IC-CAP modeling suite

Optional simulators
- Advanced Design System
- 85158 Momentum planar electromagnetic simulator

For more information about Agilent EEsof EDA visit:
www.agilent.com/eesof-eda

For more assistance with your test and measurement needs visit:
www.agilent.com/find/assist

Phone or Fax
United States:
(tel) 800 452 4844

Canada:
(tel) 877 894 4414
(fax) 905 282 6495

China:
(tel) 800 810 0189
(fax) 800 820 2816

Europe:
(tel) (31 20) 547 2323
(fax) (31 20) 547 2390

Japan:
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Korea:
(tel) (82 2) 2004 5004
(fax) (82 2) 2004 5115

Latin America:
(tel) (305) 269 7500
(fax) (305) 269 7599

Taiwan:
(tel) 0800 047 866
(fax) 0800 286 331

Other Asia Pacific Countries:
(tel) (65) 6375 8100
(fax) (65) 6836 0252
Email: tm_asia@agilent.com

Product specifications and descriptions in this document subject to change without notice.

Printed in U.S.A., *July 19, 2002*
5968-6082E

Agilent Email Updates

www.agilent.com/find/emailupdates
Get the latest information on the products and applications you select.

Agilent Technologies