MAURY

RF Device Characterization Systems

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  - AMTSv2
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- Noise Receiver Modules
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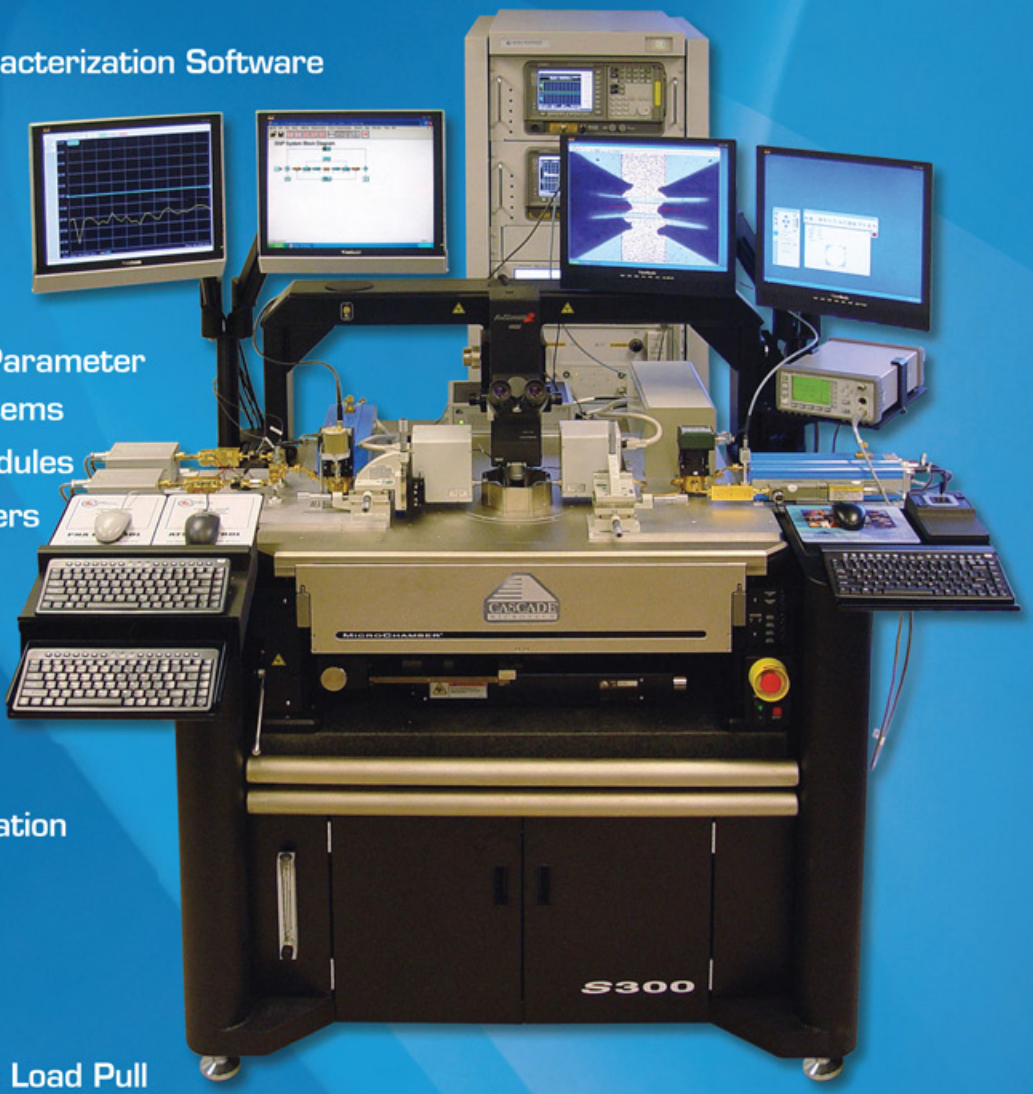
- Load Pull Test Fixtures
- Automated Sliding Shorts
- Manual Tuners
- Device Characterization System Integration
- Advanced Device Characterization Systems
- Mixed-Signal Active Load Pull Systems
- Pulsed IV Systems



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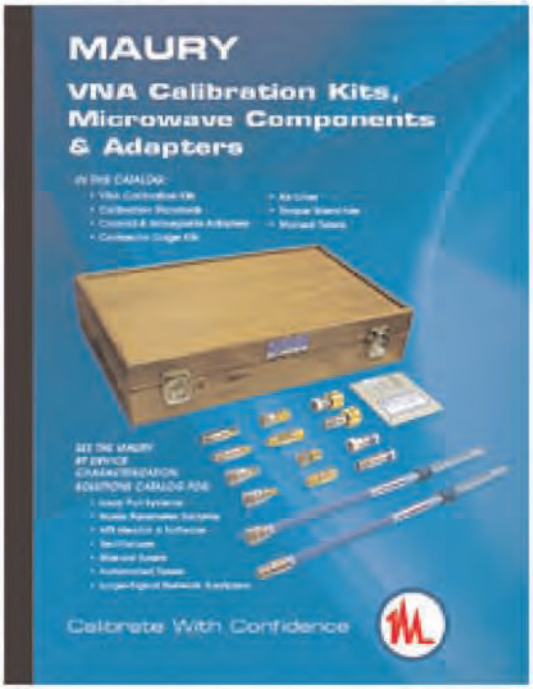
VNA Calibration Kits, Microwave Components & Adapters Catalog



Precision VNA, PNA & ENA Calibration Kits

For Optimum Performance and Accuracy in Measurement

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  - 1.85mm Coaxial Adapter Options
- 2.4mm Coaxial Calibration Kits
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- 2.92mm Coaxial Calibration Kits
  - 2.92mm Coaxial Adapter Options
- 3.5mm Coaxial Calibration Kits
  - 3.5mm Coaxial Adapter Options
- 7mm Coaxial Calibration Kits
- Type N Coaxial Calibration Kits
  - Type N Coaxial Adapter Options
- Type N 75 Ohm Coaxial Calibration Kits
- TNC Coaxial Calibration Kits
- AFTNC Coaxial Calibration Kits
  - AFTNC Coaxial Adapter Options
- TNCA Coaxial Calibration Kits
  - TNCA Coaxial Adapter Options
- BNC Coaxial Calibration Kits
- OSP™ Coaxial Calibration Kits
- 14mm Coaxial Calibration Kits
- 7-16 Coaxial Calibration Kits
  - 7-16 Coaxial Adapter Options
- Waveguide Calibration Kits (Standard)
- Optimized Millimeter Waveguide Calibration Kits
- Millimeter Waveguide Calibration Kits
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Precision VNA Calibration Kit Components

In all of the Connector Types or Waveguide Sizes Shown for Cal Kits

- Coaxial and Waveguide Opens
- Coaxial and Waveguide Opens
- Coaxial Precision Air Lines & 2-Port Mismatch Air Line Sets
- Coaxial Precision Mismatches & Mismatch Sets
- Waveguide 2-Port Mismatch Standards Sets
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- Coaxial Directional Couplers
- Torque Wrenches

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- In-Series Coaxial Adapters
- Between Series Coaxial Adapters
- Test Port Adapters
- Waveguide-to-Coaxial Adapters
- Waveguide Flange Adapters
- Waveguide Transmission Lines and Test Port Adapters
- Flexible and Semi-Rigid Cable Assemblies
- Precision Semi-Rigid Assemblies (90° Bends & Right Angle Test Port Adapters
- Coaxial Connectors
- Slide Screw and Stub Tuners

Visit Us Online at maurymw.com

Maury Device Characterization Systems

Maury Microwave Has the Most Complete Selection of Load Pull Solutions! We Are Your Complete Measurement & Modeling Solutions Partner!

In This Volume:

RF Device Characterization Methods

Accurate de-embedded performance evaluation of the power, intermodulation distortion, adjacent channel power, noise and network (S-parameter) characteristics of packaged or on-wafer devices under various conditions of impedance matching is the foundation of successful design, manufacture, and use of RF and microwave devices. Maury device characterization systems support the best industry-recognized test and measurement methods.

Pitfalls To Avoid When Purchasing A Device Characterization System

An automated device characterization system can greatly simplify test and measurement operations and quickly provide reliable empirically-based data for design and modeling of new products. But finding the right system is not simple. There are mistakes to be avoided if you are to maximize return on investment, achieve your test and measurement goals, and get your products to market. Here is some valuable advice from the experts at Maury.

Device Characterization Software (IVCAD, ATSv5 and AMTSv2)

Maury IVCAD software is the newest and most advanced measurement and modeling software in the market. It supports multiple load pull techniques, performs noise parameter, DC-IV and pulsed-IV measurements, and incorporates sophisticated device modeling tools. Maury's ATS software (ATSv5) includes a comprehensive set of upgrades, improvements, and additions to the classic ATS test and measurement tools.
Maury's Automated Mobile Test System software (AMTSv2) is designed specifically to automate the testing of mobile phones in transmit and receive modes, for output power and sensitivity. It now includes support for GSM, WCDMA and CDMA2000.

Load Pull and Noise Parameter Systems

Maury offers fully integrated, automated tuner-based systems configured to operate from 0.25 to110 GHz. These complete turnkey systems can be customized to support Basic (power, gain and PAE) and Advanced Load Pull characterization (modulation, optimal ACPR, CDP, and Harmonic LP). Maury Noise Parameter systems are available in electromechanical and solid state versions that can be customized to perform on-wafer or in-fixture noise parameter characterization at frequencies from 0.25 to 110 GHz.

Automated Tuners, Controllers And Hubs

Maury USB-controlled automated tuners and hubs are described in detail, with their respective specifications and applications.

Accessories

Maury offers a number of accessories to support your test bench needs, including automated tuner controllers, noise receiver modules, diplexers and triplexers, pre-matching probe mounts, manual tuners, and automated sliding shorts.

Advanced Device Characterization Systems

Maury now offers Mixed-Signal Active Load Pull systems, and the AMCAD Engineering PIV/PLP family of Pulsed IV systems.

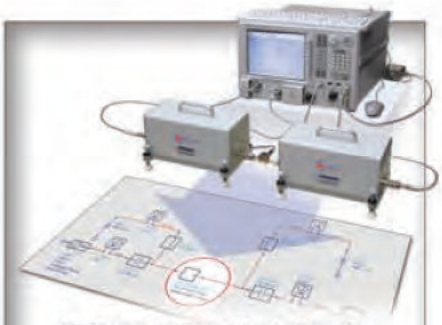
You Have Load Pull Needs – We Have You Covered!

Maury Microwave Has the Most Complete Selection of Load Pull Solutions

MAURY's Mixed-Signal Active Load Pull Allows Wideband Modulated Impedance Control for Base Station PAs

Active and Hybrid Load Pull Using PNA-X Simplifies Harmonic Tuning with Gamma = 1

Pulsed-Bias Pulsed-RF Harmonic Load Pull for GaN and Wide Band-Gap Devices



X-Parameter Modeling for First-Pass Advanced Amplifier Design at over 200W!

Ultra-Fast Noise Parameter Method Gives More Accurate Results in Less Than 1/100th the Time to 110 GHz!

Stability and Conformance Testing of Mobile Phones for GSM, CDMA, WCDMA...

Advanced Integration of On-Wafer Load Pull and Noise Parameters to 110 GHz

USB and TCP-IP Tuners for Do-It-Yourself Programing Using DLL or Direct ASCII Commands

The Most Accurate and Repeatable Manual Tuners for Simple Tuning Requirements

Maury Microwave – Your Complete Measurement & Modeling Solutions Partner

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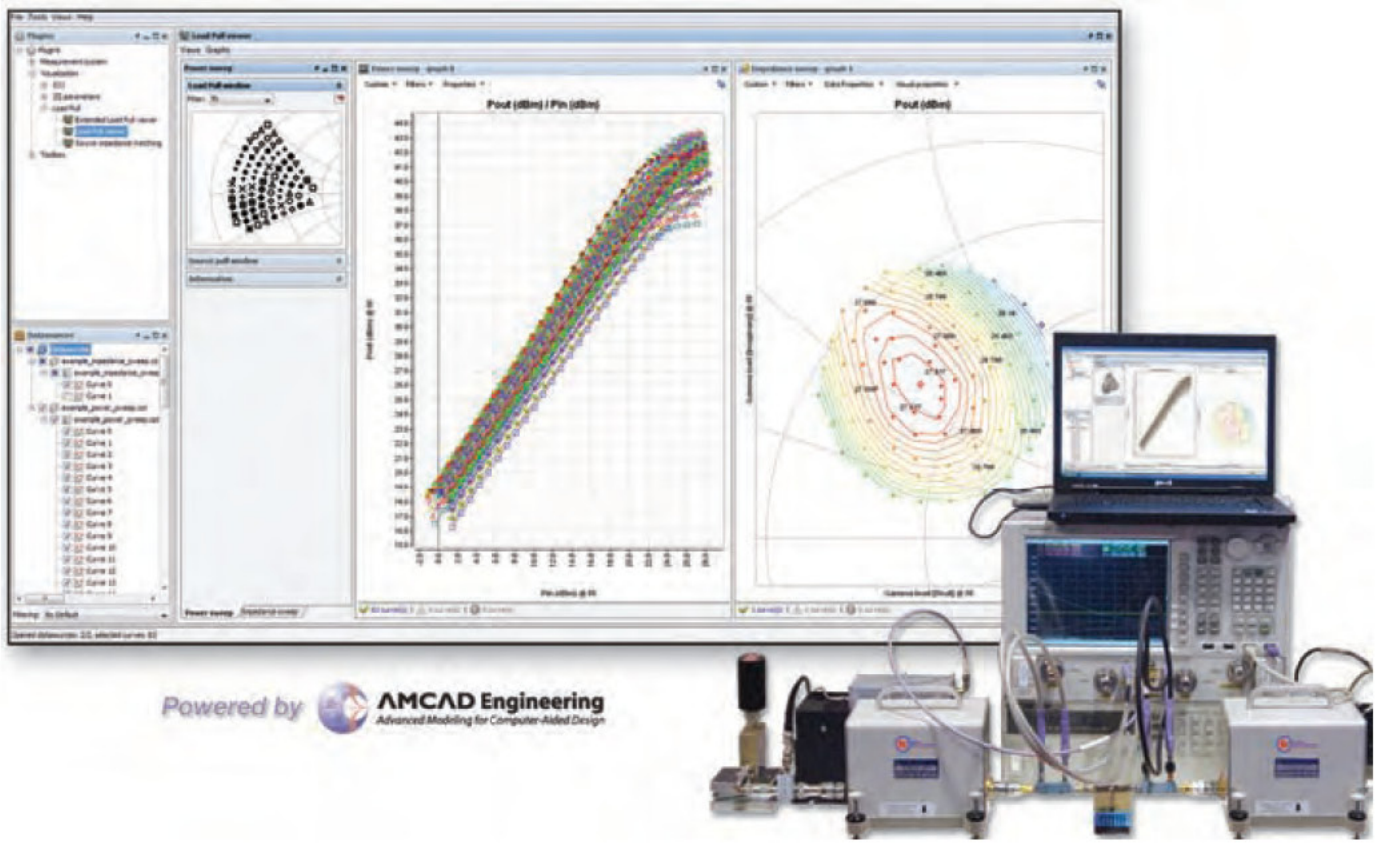
IVCAD Advanced Measurement & Modeling Software



MT930 Series

Maury IVCAD Software Completes the Cycle from Pulsed-IV and S-Parameters, to Harmonic Load Pull, to Compact Transistor Models!

Introduction

IVCAD advanced measurement and modeling software, offered by Maury Microwave and AMCAD Engineering supports multiple load pull techniques including traditional load pull using external instrumentation, VNA-based load pull, active load pull and hybrid load pull. It performs noise parameter measurements, DC-IV and pulsed-IV measurements and incorporates device modeling tools. Its modern visualization capabilities give users a greater ability to view, plot and graph measurement data in an intuitive manner.

IVCAD Software Suite Models

- MT930A – IVCAD Basic Application
- MT930B – IVCAD Visualization Suite
- MT930C – IVCAD Vector-Receiver Load Pull
- MT930D – IVCAD Traditional Load Pull
- MT930E – IVCAD IV Curves for Load Pull
- MT930F – IVCAD Basic S-Parameters
- MT930G – IVCAD Time-Domain Waveforms
- MT930H – IVCAD Active Load Pull
- MT930J – IVCAD Pulsed IV Curves
- MT930K – IVCAD Pulsed S-Parameters
- MT930L – IVCAD Scripting Language
- MT930M1 – IVCAD Linear Model Extraction
- MT930M2 – IVCAD Non-linear Model Extraction
- MT930M3 – IVCAD Electro-thermal Model Extraction
- MT930N – IVCAD Database Analysis
- MT930P – IVCAD Measurement Toolbox

MT930A IVCAD Basic Application

IVCAD Base Application is needed to operate any of the following IVCAD measurement, modeling and visualization modules.

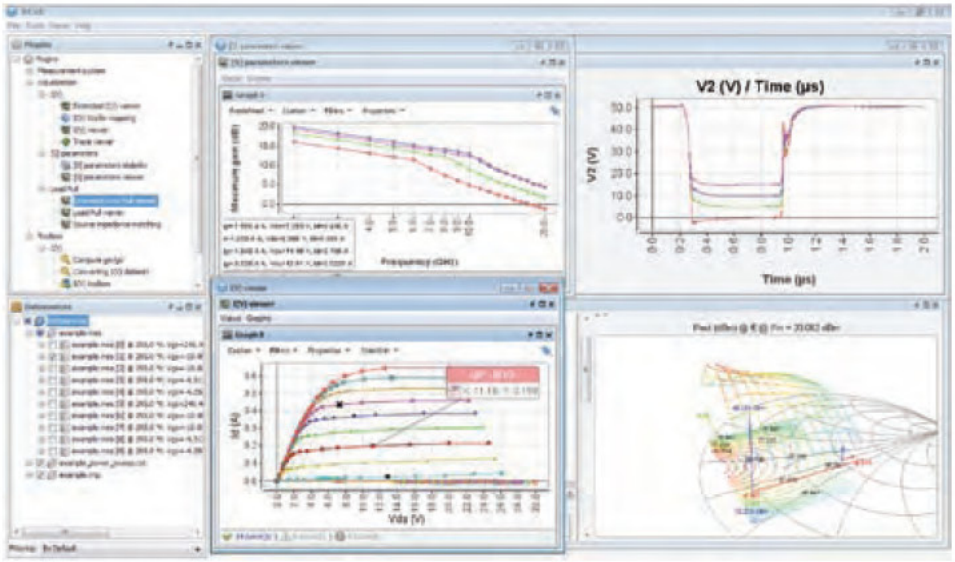
MT930B IVCAD Visualization Suite

IVCAD offers a modern and intuitive visualization package for IV, S-Parameters and Load Pull data.

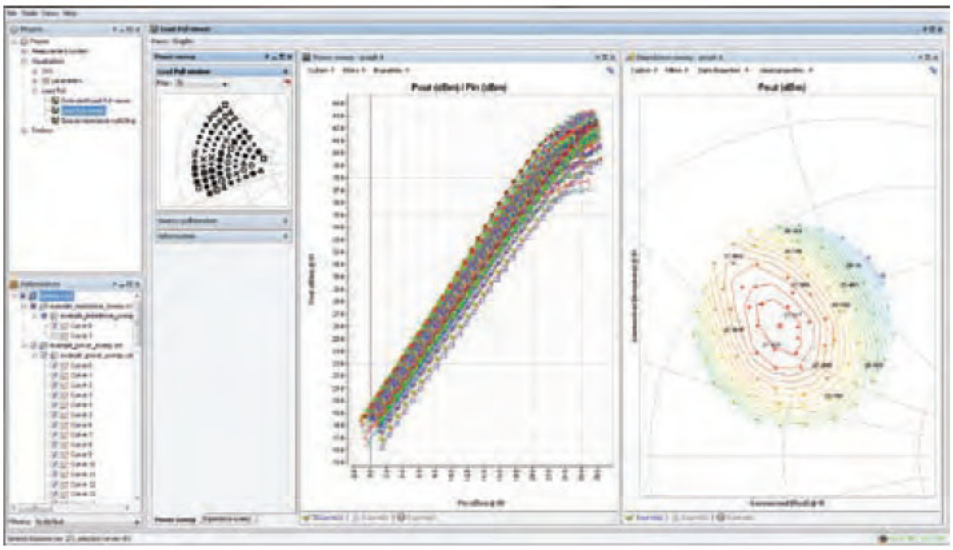
- S-parameters can be viewed in standard and custom formats
- Stability circles are optionally plotted on source and load
- Basic load pull visualization allows the plotting of power sweeps or impedance curves with capability of filtering measurement results.
- Extended load pull visualization plots power sweeps and impedance contours simultaneously, where contours are redrawn as the user-defined input/output/source power is changed. Multiple parameters, including frequency, can be viewed on the same Smith Chart. Graphing can be performed in 2D or 3D.
- Advanced filtering allows multiple definitions to be entered in order to limit the measured impedances to those that meet specific criteria.

Using the dockable window functionalities, it's possible to create custom IVCAD environments.

Visualization is compatible with Maury Microwave and Focus Microwaves load pull data formats.



Visualization of S-Parameters, IV Curves, Pulse Shape and 3D Load Pull Contour

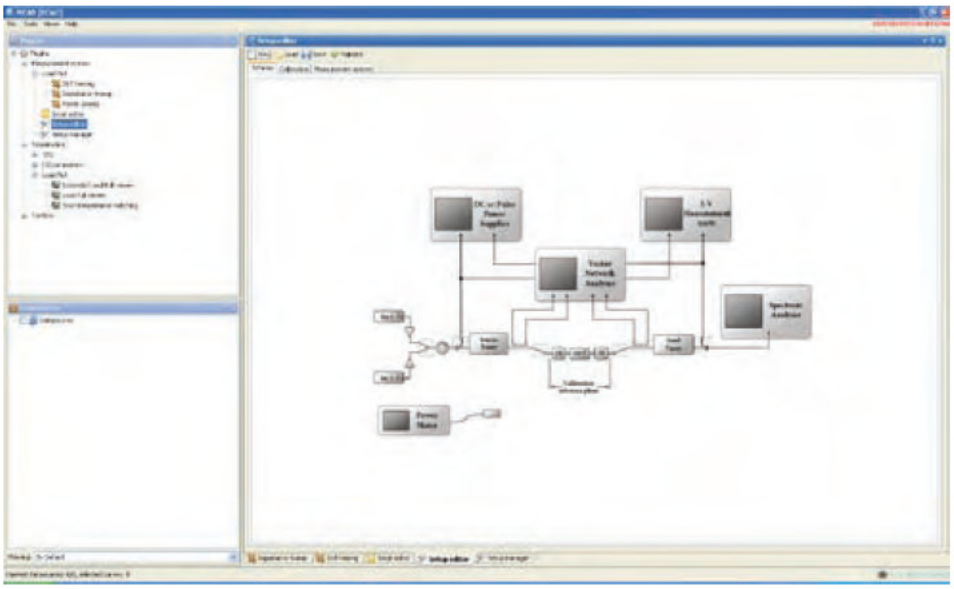


Visualization of Advanced Sweep Plan Load Pull

MT930C IVCAD Vector-Receiver Load Pull

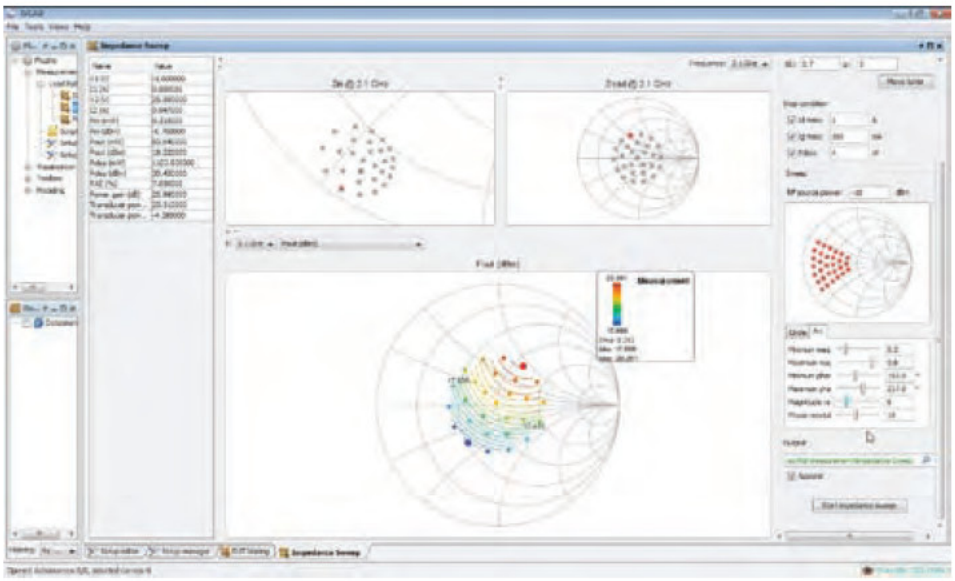
Key Features:

- Real-Time Contouring of Measured Data
- Interactive Bias Control
- Full Vector Parameters Including AM-PM
- CW or Pulsed Measurements
- Time Domain Waveform Reconstruction
- Model Validation
- Export Data to MDIF



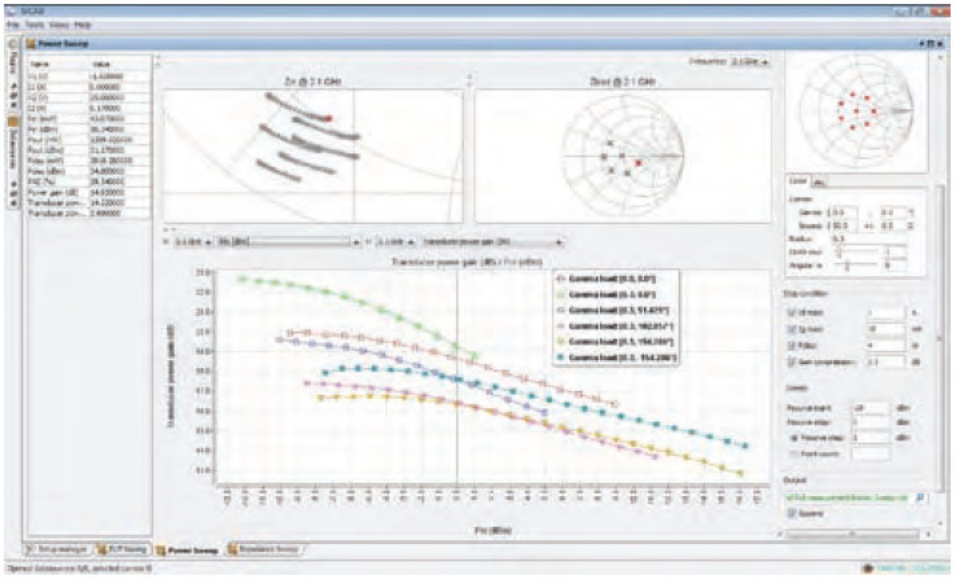
Vector-Receiver Load Pull Setup Editor

IVCAD offers a modern, efficient methodology for load pull measurements, with low-loss couplers between the tuners and DUT of the setup, instead of the traditional placement behind the tuners. Connecting the couplers to a VNA allows real-time measurement of a- and b-waves at the DUT reference plane, presenting vector information not normally made available. IVCAD measures the actual impedances presented to the DUT without assumptions of pre-characterized tuner positioning or losses. Extremely accurate transistor's input impedance derived from the a- and b-waves results in properly-defined input power, power added efficiency and true power gain measurements. Output powers at each frequency, fundamental and multiple harmonics, are made available, as are multi-tone carrier and intermodulation powers.



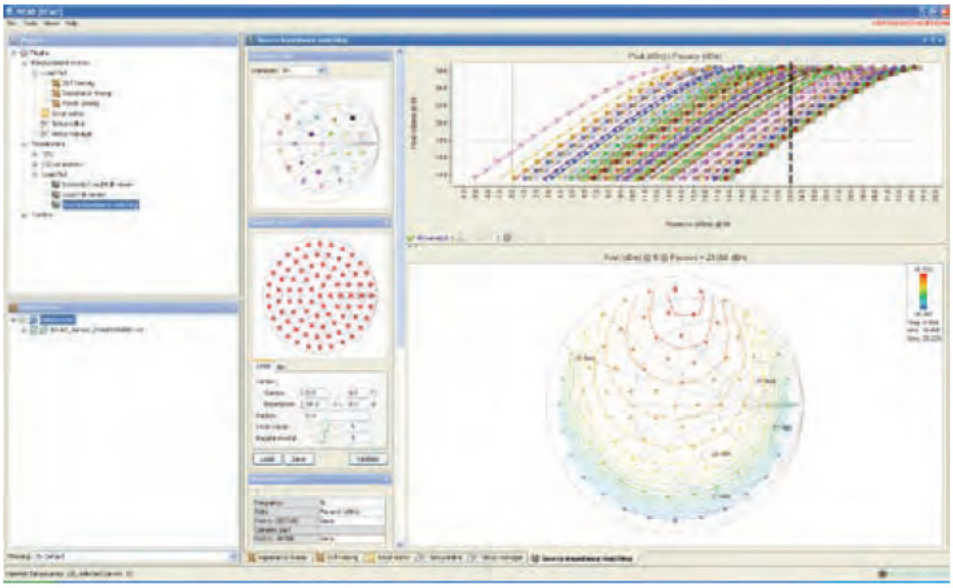
Impedance Sweep at Fixed Power

Advanced Sweep Plan — by performing power sweeps at multiple impedances, sufficient data is gathered that target parameters can be changed post-measurement without the need for additional measurement iterations. The same data set can be used to plot selected parameters at a constant input power, parameters at a constant output power, parameters at constant compression level. This process greatly reduces total measurement time by gathering sufficient data first-pass, and shifting capabilities towards data visualization and analysis.



Power Sweep at Multiple Impedances

Source Impedance Matching – Large signal input impedance can be found by measuring DUT a- and b-waves at the DUT reference plane. A patent-pending technique simulates source matching, without varying the source impedance. Even under extremely mismatched conditions this "virtual source matching" is highly reliable, provided the DUT is sufficiently unilateral (S21~ >S12+50dB). Simulated source contours are drawn, and trade-offs between maximum gain, efficiency and other parameters can be viewed in real-time without multiple source-load measurement iterations. Direct computation of the input VSWR versus source power and source impedance is also enabled.



Source Impedance Matching – Virtual Source Pull

MT930D IVCAD Traditional Load Pull

IVCAD offers traditional load pull methodology consisting of power meters for absolute power readings de-embedded to the DUT reference plane, and spectrum analyzers for harmonic content and multitone intermodulation parameters.

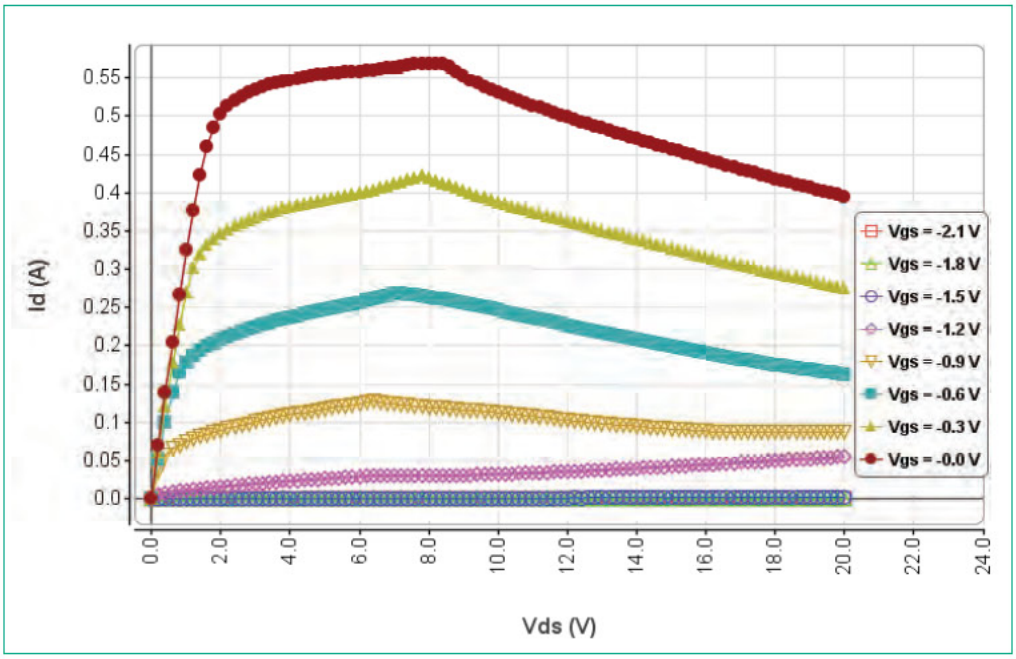
Traditional load pull is also used for modulated signals where a vector signal generator and vector spectrum analyzer are needed to measure ACPR, EVM, CCDF and other modulated parameters.

With traditional load pull, a vector network analyzer is only used to calibrate/characterize the system and is not used for actual measurements.

Release date: Summer 2011.

MT930E IVCAD IV Curves

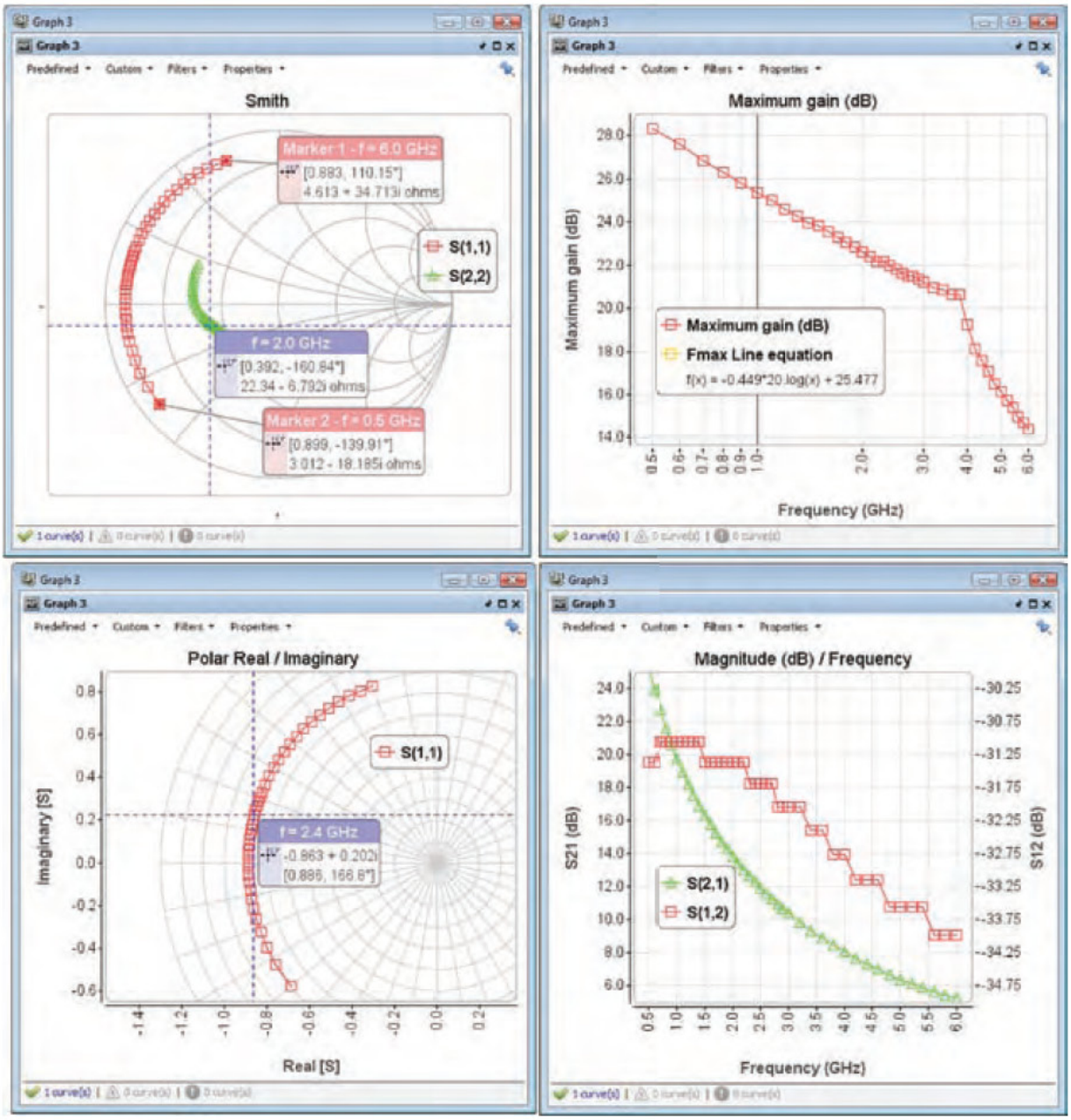
MT930E is an add-on module for MT930C and MT930D which enables basic DC-IV curves to be generated for a list of drain and gate voltages.



CW IV Curves Under Load Pull Conditions

MT930F IVCAD S-Parameters

MT930F is an add-on module for MT930C and MT930D, which enables CW S-Parameters to be read from a Vector Network Analyzer (VNA) and saved in SnP format.



MT930G IVCAD Time Domain Waveforms

MT930G is an add-on module for MT930C Vector-Receiver Load Pull which enables time-domain waveform reconstruction in conjunction with appropriate hardware. With the collected data, a- and b-waves, voltage and current waveforms, and load lines can be displayed for each measured impedance de-embedded to the device reference plane.

Currently supported instruments include Agilent PNA-X with NVNA option, and VTD SWAP.

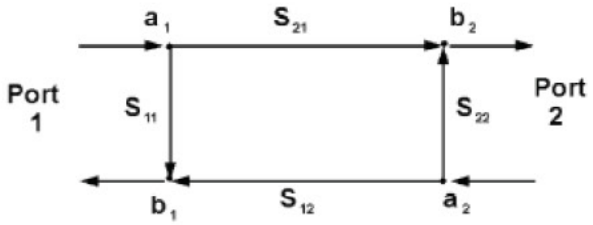
Release date: Spring 2011.

MT930H IVCAD Active Load Pull

MT930H is an add-on module for MT930C Vector -Receiver Load Pull which enables active load pull in conjunction with internal and external sources for fundamental and harmonic load pull measurements.

Considering our DUT as a two-port device shown below, Γ_L is nothing more than a_2/b_2, or the ratio between the reflected- and forward-traveling waves. A generalized form of the formula can be written as

$$\Gamma_{x,n}(f_n) = \frac{a_{x,n}(f_n)}{b_{x,n}(f_n)}$$



Two-port Scattering Parameter Model

A closer examination of the formula $\Gamma_L=a_2/b_2$ reveals that there is no limitation on separating the sources of a_2 and b_2. It is obvious that b_2 is the wave coming from the device, of which we have no direct control; however a_2 need not be a reflected version of b_2 but can be a new signal entirely!

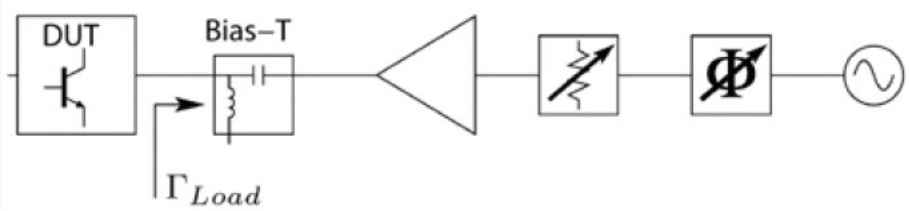
Active Load Pull – Active injection load pull, more commonly referred to as active load pull, relies on external sources to inject a signal into the output of the DUT, thereby creating a_2. Because a_2 is no longer limited to a fraction of the original reflected signal, as is the case with the traditional passive mechanical tuner, external amplifiers may be used to increase a_2 nearly indefinitely so that Γ_L can achieve unity ($\Gamma_L>1$ is theoretically possible but has no practical consideration).

The simple active tuning chain consists of a signal source, a variable phase shifter and a variable gain stage, shown in the diagram below. Common signal generators that have built-in amplitude and phase control of the injected signal and are ideal for active load pull.

Harmonic load pull, or tuning impedances at multiple frequencies simultaneously, becomes simple when using active load pull techniques. A multiplexer can be used to merge multiple active tuning paths, one per frequency, so that is satisfied. Any loses inherent to multiplexers are easily overcome by the amplifiers used in each active tuning chain.

Hybrid Passive-Active Load Pull – Both traditional passive mechanical tuner systems and active injection load pull systems have their advantages and disadvantages. While mechanical tuners are simple, less expensive and can handle high power, there is no physical way to overcome the losses involved with the system that limit achievable Γ_L. While active load pull systems are extremely quick, capable of $\Gamma_L=1$ and easily integrated for harmonic measurements on-wafer, high-power setups require more-expensive band-limited amplifiers.

It is possible to obtain the advantages of both systems while minimizing the disadvantages, using a technique referred to as hybrid load pull. Hybrid load pull refers to a combination of active and passive tuning in the same system. Traditional passive mechanical tuners can be used to reflect high power at the fundamental frequency allowing a much smaller active injection signal, using much smaller amplifiers, to overcome losses and achieve $\Gamma_L=1$. Additionally, since the powers at harmonic frequencies are often well below the power of the fundamental signal, less-expensive wideband amplifiers may be used with active tuning to accomplish active harmonic load pull with $\Gamma_{L,nf}=1$. In both cases, only a low power is required for active tuning.



Open-Loop Active Tuning Block Diagram

MT930J IVCAD Pulsed IV Curves

MT930J is a stand-alone module for advanced Pulsed IV measurements using dedicated pulsing hardware (e.g., AMCAD's AMBILT system).

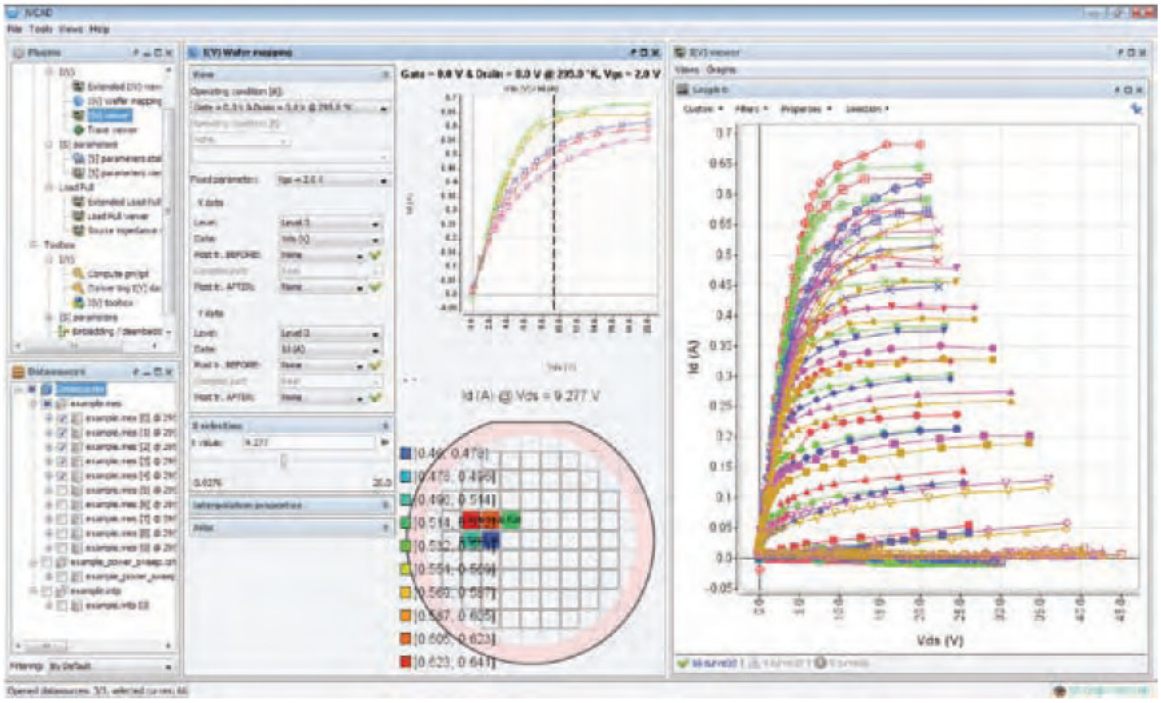
Current-voltage (IV) measurements are used to describe the relationship between the input and output currents and voltages of a device. Standard GaN Field Effect Transistors (FETs) are characterized by measuring the output current as a function of output voltage for swept input voltages. Because GaN devices tend to self-heat and are susceptible to trapping effects, it is important to pulse voltages between a quiescent and hot value and define appropriate pulse-widths. By pulsing the voltage, a lower average power will be delivered to the device thereby reducing self-heating. Such a measurement allows for near-isothermal performance.

IVCAD enables the visualization of trapping phenomena, gate lag and drain lag, on GaN transistors. It is a simple task to view trapping effects as a function of varying quiescent bias.

IVCAD has implemented full wafer control by interfacing with Cascade Nucleus software.

Key Features:

- Easy Data Management
- Cohesion Between Pulsed IV and Corresponding Pulsed S-Parameter Data (Requires MT930K)
- Automated Probe Station Control
- Import/Export Data to/from ICCAP, ADS, Microwave Office



Pulsed IV Data From Different Quiescent Points (0V/0V; –7V/0V; –7V/50V)

MT930K IVCAD Pulsed S-Parameters

MT930K is an add-on module to MT930J which enables synchronized Pulsed S-Parameter measurement in conjunction with Pulsed IV.

MT930L IVCAD Scripting Language

MT930L is an add-on module to MT930C/D/J/K which enables complex test sequencing through a dedicated scripting language.

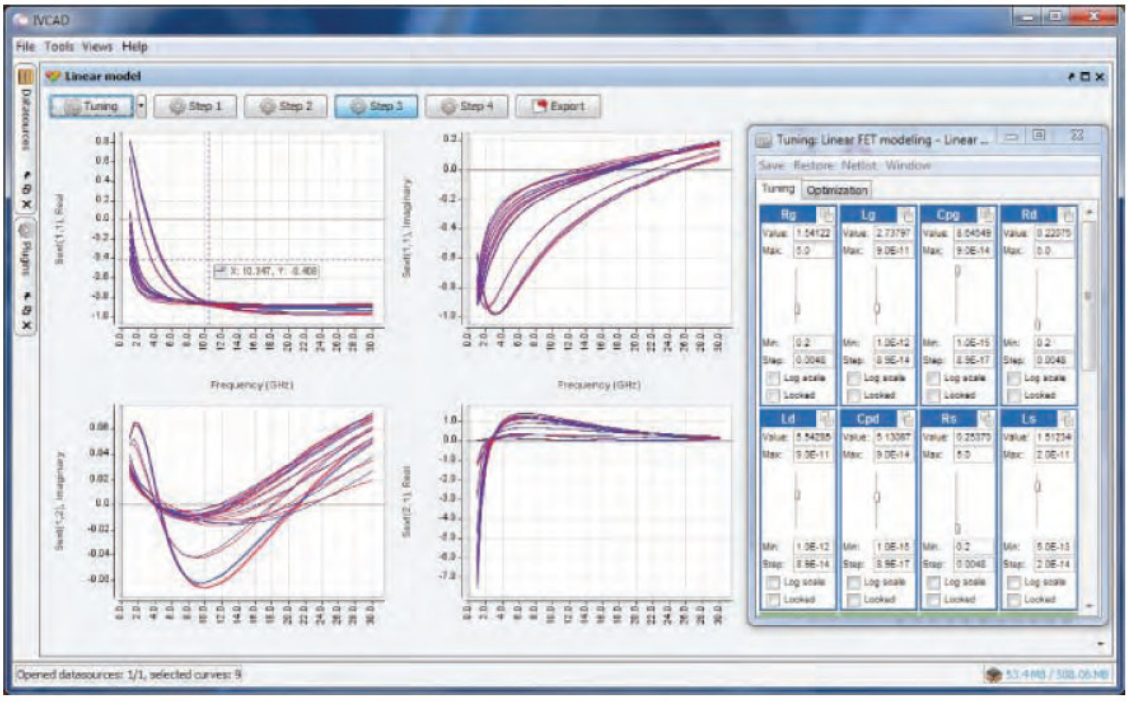
Release date: Fall 2011.

MT930M1 IVCAD Linear Model Extraction

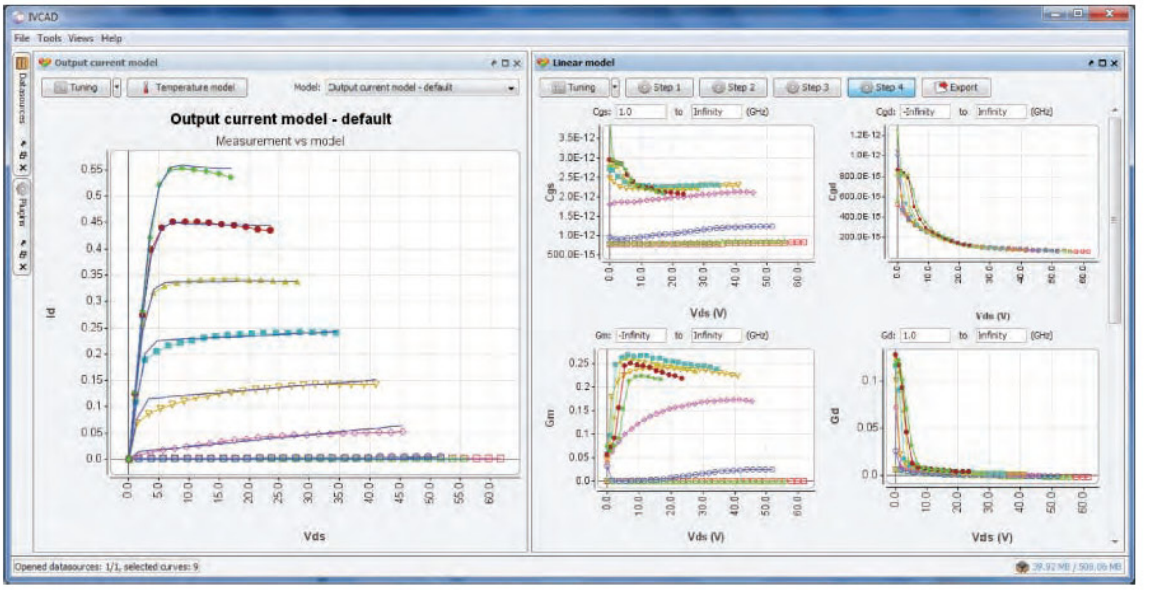
MT930M1 is an add-on module to MT930J and MT930K for Linear Model Extraction using dedicated pulsing hardware (eg., AMCAD's AMBILT system).

Linear Model Extraction is used to determine the extrinsic parameters (parasitic elements) of a FET. Linear modeling compares measured data to default model data. The model is manually tuned or automatically optimized by varying the values of Rg, Lg, Cpg, Rd, Ld, Cpd, Rs, Ls.

To verify the linear model behavior, it is essential to compare intrinsic elements through a multi-bias extraction. The resulting linear model can be used with MT930M2 to generate a Non-Linear Model or directly exported to ADS.



Linear Model Comparing Measured And Optimized Data



Multi-Bias Extraction Comparison Between Measured And Modeled Data

MT930M2 IVCAD Non-linear Model Extraction

MT930M2 is an add-on module to MT930M1 for Non-Linear Model Extraction.

The extrinsic parameters measured through linear modeling (MT930M1) are used to extract intrinsic parameters.

Capacitance Model Extraction – A capacitance curve comparing Cgd as a function of Intrinsic Vgd is plotted showing both measured and modeled data.

As with the linear model extraction, the model is manually tuned or automatically optimized by varying the capacitance model parameters.

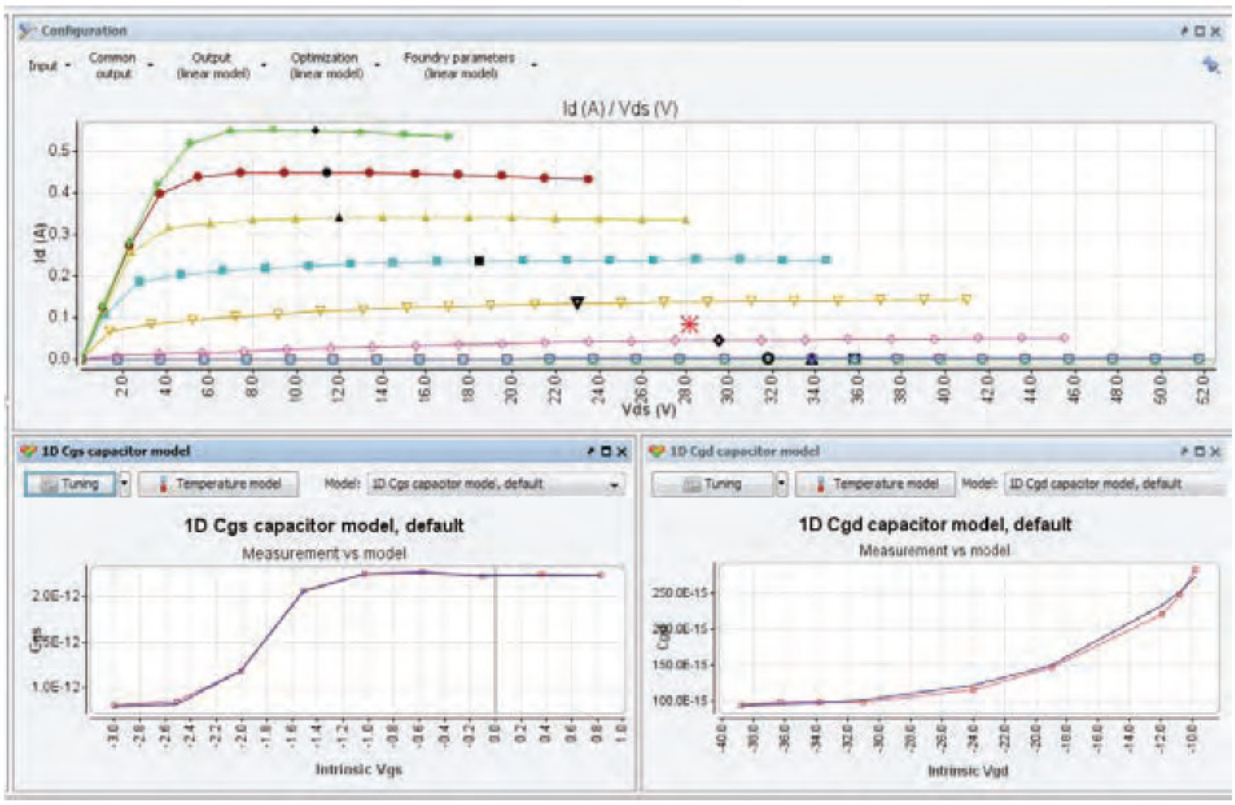
Cgs versus Vgs is tuned or optimized in the same manner.

Diode Parameter Extraction – An IV curve comparing Ig as a function of Vds is plotted showing both measured and modeled data.

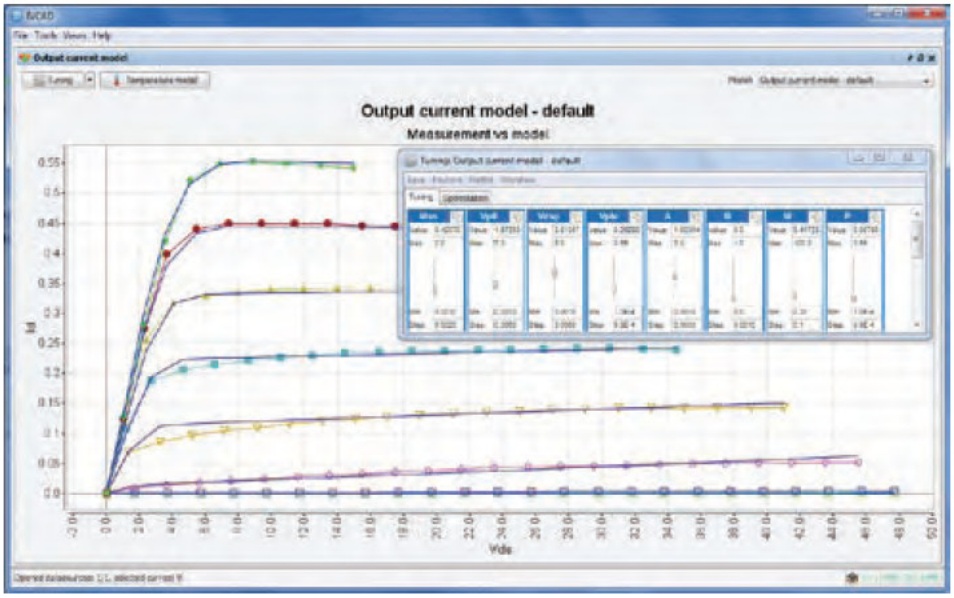
The model is manually tuned or automatically optimized by varying the diode model parameters.

Current Source Extraction – An IV curve comparing Id as a function of Vds is plotted showing both measured and modeled data.

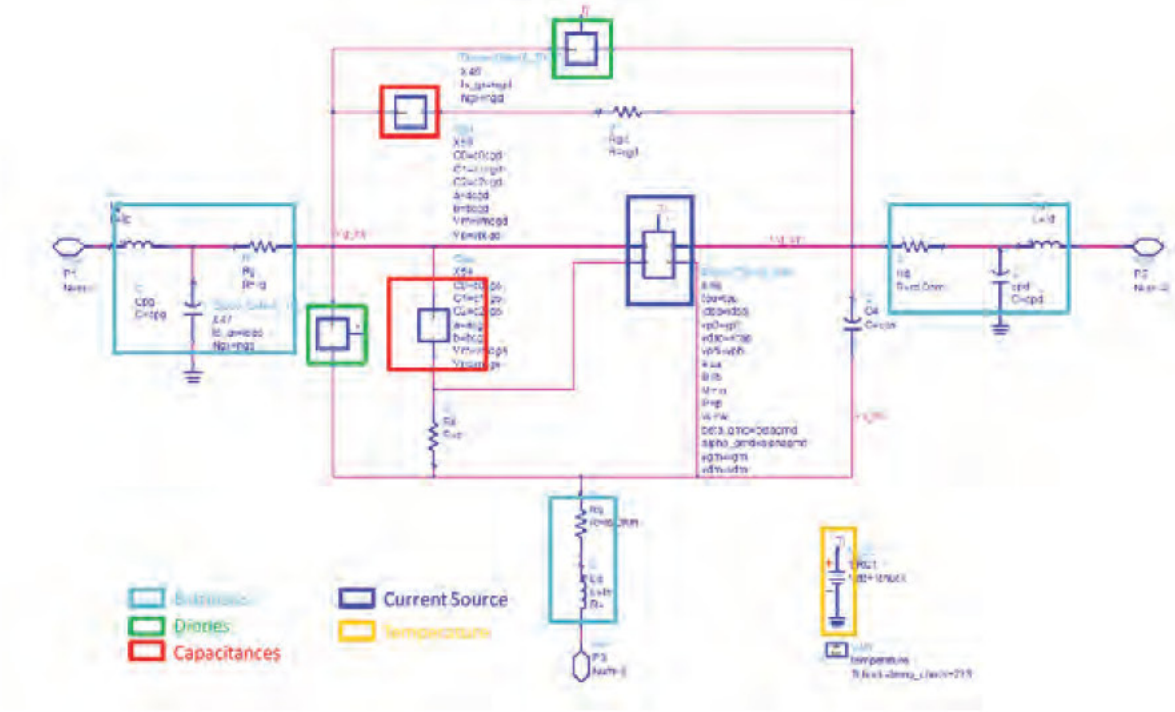
The model is manually tuned or automatically optimized by varying the current source model parameters.



Capacitance Model Extraction Showing Excellent Match Between Measured And Modeled Data



Current Source Extraction Showing Excellent Match Between Measured And Modeled Data



AMCAD Model Implementation

MT930M3 IVCAD Electro-thermal Model Extraction

MT930M3 is an add-on module to MT930M2 for Electro-thermal Model Extraction.

Electro-thermal Model Extraction is used to determine the thermal behavior of a FET, taking into account ambient temperature and self-heating effects.

MT930N IVCAD Database Analysis

MT930N is an add-on module to MT930B for advanced database analysis and filtering. Data obtained from multiple measurement platforms (pulsed IV, pulsed S-Parameters, load pull...) can become overwhelming and difficult for some users to manage. Database analysis and filtering offers a solution to sort through multiple dimensions of data and select only those that are of interest to the user.

Release date: Fall 2011.