



## INTRODUCTION

The OpenWave Forum (OWF) is an alliance of RF and microwave firms formed to collaborate, create and promote a unified and transparent data exchange format for large-signal simulations, measurements and models.

## OWF BENEFITS

- More choice: standard data format provides choice of tools/vendors/solutions
- Less risk: reduces risk by providing flexible, non-proprietary data standards
- Additional insight: behavioural modeling data allows device performance to be simulated under exact operating conditions

## OWF: THE NEW LARGE-SIGNAL DATA EXCHANGE STANDARD

The founding members of the OWF include:

- Anritsu
- AWR
- HFE Sagl
- Mesuro
- NMDG
- Rohde & Schwarz
- Tektronix

## OWF INSPIRATION: POWER AMPLIFIER DESIGNERS

Designers of today's complex RF and microwave power amplifiers (PAs) rely on a wide range of large-signal transistor models. These models are intended to work with both steady-state and transient circuit simulators and provide accurate data over a wide frequency and instantaneous IV operating ranges. Conducting measurements and the subsequent parameter extraction for defining these models is far from trivial. Consequently, the resulting models do not always provide a robust solution. For example, transistor models that are accurate over a wide frequency range for Class A often do not provide the same accuracy when used with more modern amplifier switching modes. Availability of reliable, accurate and robust large-signal transistor models in a timely fashion is of paramount importance to PA designers.

The concept of using behavioural models in non-linear simulations has existed for 20 years or more but only recently have advances in measurement technology (improved arbitrary signal generation and sampling techniques) allowed practical implementation to become a reality. These new large-signal behavioural models make use of IV data tables or polyharmonic distortion tables and make no direct reference to device physics or electronics. Their appeal to the design community is the speed at which the data can be collected, transferred and used successfully within modern circuit simulators. For non-linear circuit design, this methodology is analogous to S parameters in linear circuit design. The OWF aims to ensure usability of these new models in large-signal simulations regardless of the measurement and modeling techniques that are used.



## OPENWAVE FORUM

A unified and transparent data exchange format for large-signal simulations, measurements and modeling

Visit [www.openwaveforum.org](http://www.openwaveforum.org) to learn more as well as to express your interest in joining.

Become a part of this important movement by joining OWF. Learn more about the organization, download examples and become a member. To get started, browse to [www.openwaveforum.org](http://www.openwaveforum.org).

## OWF CHARTER: BEHAVIOURAL MODELS FOR THE LARGE-SIGNAL DESIGN SPACE

The common data format of the OWF provides a better integration between measurement, modeling and simulation than has been previously available (Figure 1). Measurement data of incident and reflected RF current and voltage waveforms that are present at the input and output ports of a device under test (DUT) are stored in the frequency domain in a generic MDIF file format. This allows performance data of the DUT based on fundamental RF current and voltage waveforms to be used directly in simulators or in the creation of an analytical model. The open format allows new non-linear applications to be easily integrated into the common data platform.

A number of new behavioural modeling approaches are available:

- HFE and Anritsu provide state-of-the-art active load pull tuners, ultra-low-loss couplers and harmonic phase standard (HPS) designed to operate with the VectorStar® VNA. The nonlinear load pull system offers multiple behavioural analysis data including polyharmonic information representing current and voltage waveforms under large-signal conditions. Visit [www.hfemicro.ch](http://www.hfemicro.ch) for more details.
- Mesuro in partnership with Tektronix has developed a characterization system to provide polyharmonic IV tables using arbitrary harmonic impedances. The data is used to populate the Cardiff Model (developed by Cardiff University) providing an accurate behavioural model at powers of hundreds of watts at microwave frequencies. The model can be used directly within AWR's Microwave Office® simulation suite. Visit [www.mesuro.com](http://www.mesuro.com) for more details.
- NMDG offers its ICE platform that employs a Rohde & Schwarz VNA (or VNAs and high frequency oscilloscopes from other vendors) to characterize non-linear components under real life signal conditions and to produce S-function models. These S-functions accurately predict harmonic and modulation behavior of the device under test and can be used within ICE or an external simulation environment. Visit [www.nmdg.be](http://www.nmdg.be) for more details.
- Agilent supports X-parameters™ which are included in its N5242 non-linear vector network analyzer for large-signal measurements and Advanced Design System software. Applicable to large and small-signal conditions and for linear and non-linear components, X-parameters are a mathematical superset of S-parameters and reduce to S-parameters in the small-signal region. Visit [www.agilent.com](http://www.agilent.com) for more details.

## OWF: IN YOUR DESIGN FLOW, IT'S BIGGER THAN THE SUM OF ITS PARTS

The OpenWave Forum seeks to create and promote a unified data exchange format for an integrated non-linear methodology that will significantly benefit PA designers by delivering high simulation accuracy at the component and system levels. This methodology lets designers reduce risk by allowing them to use a greater number of tools, vendors and solutions. It also provides insight into the value of behavioral modeling data. The new data platform fosters a mutually-beneficial coexistence of measurement-and modeling-based design approaches, enabling a fast and efficient path to accurate CAD-based nonlinear design. Refer to [www.openwaveforum.org](http://www.openwaveforum.org) for additional examples from the founding member companies.

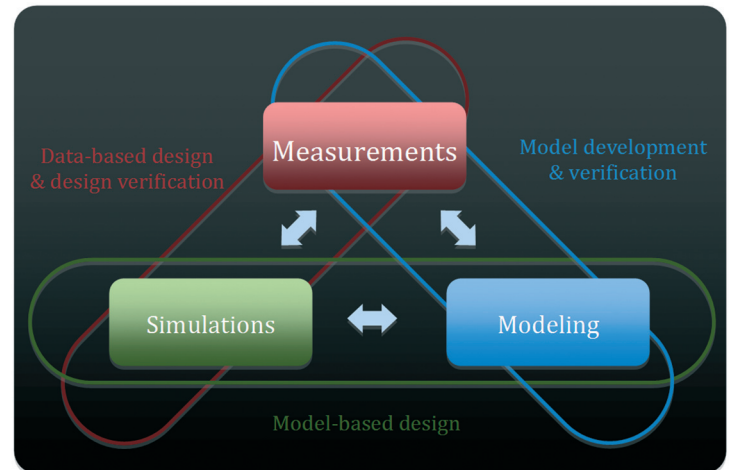


Figure 1. Illustration of OWF's emerging environment for large-signal behavioural modeling.

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