From February 2009 *High Frequency Electronics*

AWR and Anritsu Integrate EDA Software with a New Vector Network Analyzer

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Embedding AWR's Microwave Office software with Anritsu's new VectorStar MS4640A integrates the simulation and measurement environments for the first time

It almost goes without saying that simulation and measurement of microwave circuits are "joined at the hip," since they not only complement each other but are essential to each other's success. That said, it seems likely now that since most microwave instruments have Microsoft Windows as their operating system, high-frequency design tools would be integrated into vector network analyzers (VNAs), the defining microwave measurement tool. The basic benefits are obvious, and upon further inspection even greater benefits emerge. However, the two domains remained separate until January, when Anritsu and AWR announced that Anritsu's new flagship VNA, the 70 kHz-to-70-GHz VectorStar MS4640A, includes a complete version of AWR's Microwave Office high-frequency design software integrated within its firmware.

AWR and Anritsu have collaborated to embed AWR's Microwave Office EDA software into Anritsu's new VectorStar VNA.

The solution, called AWR Connected for Anritsu, is part of the "AWR Connected" series of solutions for integrating previously disconnected design domains. For example, AWR Connected for Mentor Graphics joins the printed circuit board and high-frequency design domains far more seamlessly than other attempts at this solution. Similarly, AWR Connected for Anritsu integrates the measurement and design domains, since Microwave Office high-frequency design software is a standard component of the VectorStar MS4640A.

This gives the instrument the distinction of being the first in the world to physically embed a full suite of design tools within its firmware. The VectorStar MS4640A itself sets at least one new benchmark as the first VNA to continuously cover 70 kHz to 70 GHz. It delivers dynamic range of 100 dB at 70 GHz and measurement speed of 20 ms/point, among other achievements (see accompanying article). The Microwave Office software installed in the VNA is not a "preview" or "demo" version—it is the full version of the product. It provides all the tools necessary for high-frequency IC, printed circuit board, and module design, including linear circuit simulators, electromagnetic (EM) analysis tools, and integrated schematic and layout.

The VNA/EDA Integration Scenario

The most obvious benefit of placing high-frequency design software within the

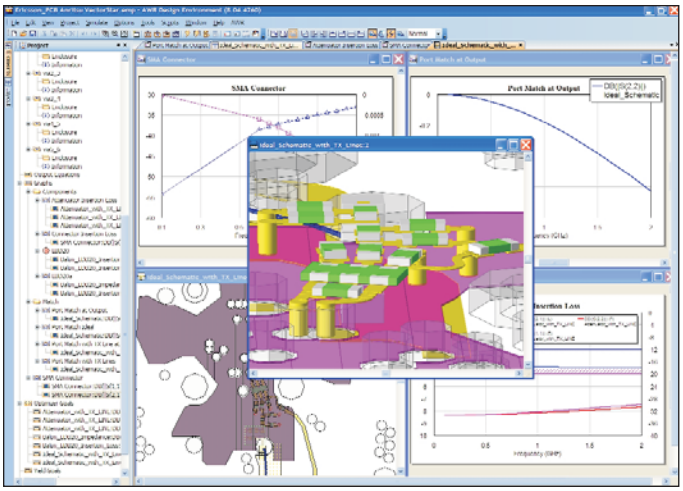

Figure 1 · Test fixtures are an excellent example of how the integration of Microwave office software on the VectorStar MS4640A can save time and effort.

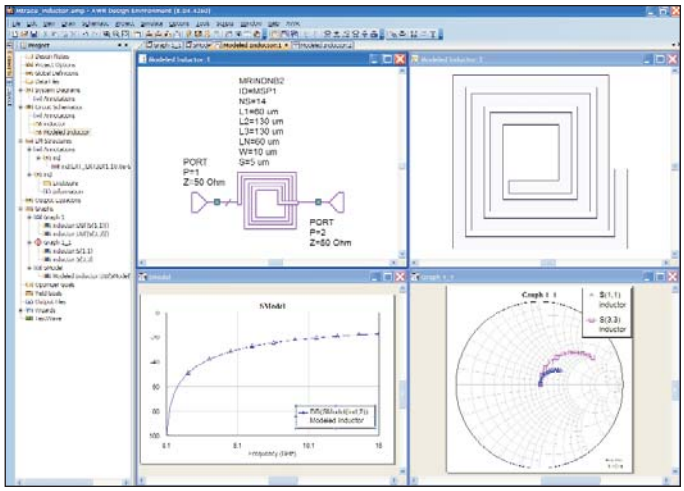

Figure 2 · Modeling of spiral inductors is greatly simplified when preliminary simulation can be performed on the VNA.

VectorStar MS4640A is that data measured by the instrument can be easily embedded into a circuit simulated with Microwave Office software in order to accurately guide changes in measurements and test fixtures. The measurement essentially becomes a model within the circuit simulation, so the designer can quickly validate measured results, accept them, and move on to another measurement or make further changes to the design. The alternative to this approach, which is the norm throughout high-frequency design, is to physically move back and forth from measurement to simulation (often from one room to another), trying out the measurement or simulation results until a reasonable outcome is obtained.

Considering the obvious advantages of being able to simultaneously work in the simulation and measurement domains, a reasonable question might be why no one has integrated these domains before. Among the reasons are:

- *Inertia*—While people have no doubt considered it, no one did it until now.
- *Windows OS*—Only recently has Windows (and principally Windows XP Embedded) become the operating system in microwave instruments, making it possible to load standard Windows applications in firmware.
- *Economics*—The time-to-market window for high-tech products continues to shorten. This pushes productivity levels higher, which requires both simulation and measurement to be as streamlined as possible.

Some Examples

Designers invariably make measurements with a VNA and go back and forth between the instrument and the EDA software, taking more data after performing a simulation, and so on. With Anritsu's VectorStar MS4640A, much of the preliminary work can be performed on the instrument to reduce recalibration and save time. A good example in this regard is in design of text fixtures (Figure 1), which on the VectorStar MS4640A can now be created in Microwave Office software and then used as the basis for deembedding or to ensure accurate calibration. The uncalibrated test fixture data can be compared to what the software indicates it ought to be in order to evaluate the calibration.

Two other scenarios illustrate the benefit of integrating these environments. The first is for the designer whose primary job is to model and characterize devices.

People who create circuit models often need to make measurements and find a way to parameterize the results so they can easily have a clearly defined set of parameters—a compact circuit model (or just "model")—with which they can change a few parameters and allow the remainder of the measurements to be accurately obtained.

Using spiral inductors of different sizes as an example (Figure 2), designers will perform these measurements to see what happens if changes are made to parameters such as the number of turns and spacing between them or the width of the conductor. Evaluating and changing these parameters to produce the right model is a tedious process that can be made considerably less so if the model fitting and extraction can be performed "on the fly" as each inductor is measured. When an adequate fit is achieved, the remaining structures can be used to validate the extraction.

Unfortunately, the normal process of performing this requires trying to fit all the acquired data to the model. If there are 20 or 30 spiral inductors and only 15 are measured (for the sake of designer's sanity, perhaps), it is very likely that the result will not be sufficient to produce an

VectorStar Microwave VNA Establishes New Performance Benchmark

Anritsu Company demonstrates its capabilities in Vector Network Analyzer (VNA) technology with the introduction of the VectorStar™ premium series of microwave VNAs. The MS4640A delivers wide frequency coverage of 70 kHz to 70 GHz, dynamic range of 103 dB at 67 GHz, and measurement speed of 20 ms/point to establish a new performance benchmark for *S*-parameter measurements on RF, microwave, and millimeter wave devices.

The VectorStar MS4640A family offers three standard frequency ranges that go to 20 GHz, 40 GHz, and 70 GHz. This high-performance 2-port engine is designed to add future capabilities, and is compatible with existing 4-port and broadband mmW systems for 70 kHz to 110 GHz measurements, or waveguide banded measurements up to 500 GHz. The instrument brings new performance to traditional VNA markets like aerospace/defense, satellite, commercial communications, materials measurement and advanced research.

For true broadband applications such as device modeling, the 70 kHz low-end provides seven octaves of additional information below the traditional 10 MHz cutoff of conventional microwave VNAs. This improves the error-prone task of DC-approximation, providing better device models and circuit simulation. The result is designs that work as predicted the first time. The low-end frequency also improves stability as it eliminates the problem of coupler roll-off below 1 GHz.

VectorStar's 100 dB dynamic range at 70 GHz enables exceptionally high accuracy in a microwave VNA. Supplementing the wide dynamic range is the MS4640A's excellent receiver compression level. The VNA's receiver has a +10 dBm 0.1 dB compression level at 70 GHz. With the new Precision AutoCal for 70 kHz to 40 GHz or 70 GHz calibrations, residual directivity of 42 dB can be achieved at 70 GHz, and up to 50 dB at 20 GHz. This level of performance allows devices to be more tightly specified with greater confidence.

Today's engineering environments, from R&D through to manufacturing, require fast measurement speed. VectorStar's 20 ms/point real measurement speed—without any performance restrictions—allows the MS4640A to acquire the data necessary for device characterizations over multiple physical and environmental conditions, drive levels and frequency ranges.

Innovative New Platform

VectorStar MS4640A achieves outstanding performance because it features a completely new VNA platform that uses an innovative architecture. For applications from 70 kHz to 2.5 GHz, a mixer-based receiver with bridges for directional devices is used. Above 2.5 GHz, a harmonic-sampling receiver is incorporated, with the traditional couplers for directional devices. Since the couplers are not taxed by extending to low frequencies, raw directivity is not traded for frequency coverage, resulting in superior stability.

Non-Linear Transmission Line (NLTL) technology, also known as Shockline technology, is used for the receiver, resulting in uncompromising performance to 70 GHz and beyond. This monolithic sampling technology, along with the usage of a higher LO frequency, provides extraordinary conversion flatness, isolation, and dynamic range.

The digital and mainframe architectures behind VectorStar take advantage of the latest off-the-shelf technology. This strategy allows the platform to remain current, and helps it handle the fast-changing pace of digital standards and operating systems.

The MS4640A is built on a Windows XP Pro OS, and offers a 26 cm touch-screen LCD display with USB 2.0, Ethernet, and GPIB connectivity. The VNA has enough memory and graphics capability to offer 16 independent channels, with 16 traces each, 13 makers per trace, and up to 25,000 points per channel. For applications such as time domain, 100,000 points are available when VectorStar operates in single-channel mode.

New Precision AutoCal

The new 70 kHz to 70 GHz Precision AutoCal exceeds the performance of previously available e-calibrators. This type of performance has been achieved because the new AutoCal is designed with advanced software algorithms and new switching hardware, and references an LRL calibration up to 70 GHz. Anritsu's 70 GHz switching technology provides the lowest parasitics to produce the lowest losses and best matches to create the most accurate corrected residuals.

Pricing for the VectorStar starts at $80,950 for the base 20 GHz VNA.

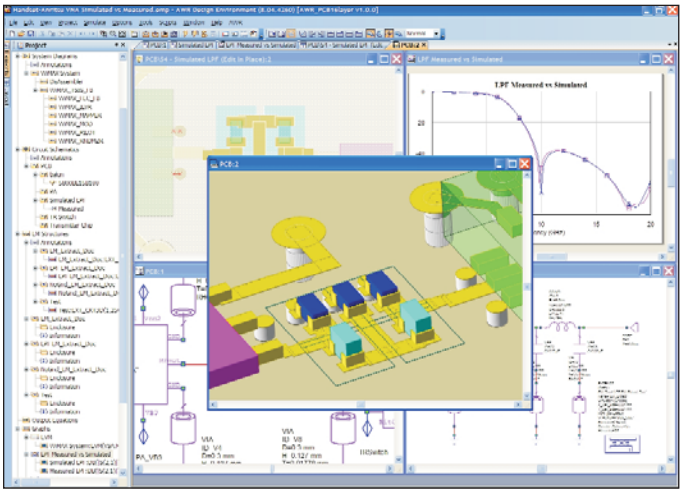

Figure 3 · Designers can use Microwave Office on the VectorStar MS4640A to gain a better understanding of virtually any circuit design, such as this handset filter.

accurate model. This likely means that recalibration will be required and that all the data must be retaken. If the simulation tool is integrated within the VNA, this process can be performed step by step without ever leaving the instrument. It also alleviates the risk that the data is partitioned improperly when divided into two domains (one for tests or structures used to form the model and another in "reserve" to validate the model). In the case of AWR Connected for Anritsu, the designer starts with two or three measurements and then incrementally adds more in order to create the model until an accurate fit is achieved. In this way, data is efficiency partitioned and the number of steps is minimized.

The second example addresses the typical high-frequency circuit designer. These designers typically begin every new project by taking a lot of measurements and using them either as the model or to form the basis of it. He or she will measure parts of the design and drop the measured data into the simulation to see how they compare and continue to do so in a "test, tweak, tweak, test" flow until the results in the two domains match. When the Microwave Office-equipped VectorStar MS4640A is used, these steps are performed directly at the instrument, so the only measurements required are those needed to give the designer reasonable comfort that the model is good enough to use when starting the circuit design (Figure 3).

Finally, users can enable Microwave Office software to control various functions of the VNA by means of a script that provides an additional level of automation and time savings. For example, if a designer is creating an amplifier and needs to know where to bias an RF power transistor, an optimization loop can be created in which the bias point is sent to the VNA, which measures the device and brings back *S*-parameters. The current procedure is to take perhaps 20 bias points and use the one nearest the current level rather than the actual one that can only be obtained through measurements. However, by integrating the VNA and Microwave Office software through a simple script, the actual bias point can be used, since it can be located by simulating it. The point to remember in this example is that in addition to saving time, the most potent benefit is that more accurate results can be achieved and the actual design work can begin based on a better grasp of the problem.

Summary

Integration of high-frequency EDA software within a VNA is a capability whose time has come, not just because it can now technologically be achieved, but because designers now have less time than ever to produce their creations. Minimizing precious time spent on redundant activity is a necessity. In addition, integrating these two complementary functions tends to give the designer a better understanding of the upcoming challenge at the beginning of the design cycle, where it is most beneficial.

Customers of the VectorStar MS4640A can register their Microwave Office software on line at http://web.awrcorp.com/anritsu/vectorstar/ and can take advantage of a promotion for an additional seat of Microwave Office software for their desktop PC.

About the Author

Dr. Michael Heimlich joined AWR in 2001 as technical marketing director for AWR's Microwave Office product. Prior to joining AWR, he was the chief technology officer and founder of Smartlynx, an EDA interoperability company. Earlier, Dr. Heimlich held several positions at M/A-COM including CAE Manager for the IC Business Unit and principal engineer in IC product development. He also designed GaAs MMICs for Pacific Monolithics and designed space-qualified millimeter-wave mixers at Watkins Johnson. Dr. Heimlich received his BSEE, MSEE, and PhD EE degrees from Renssalear Polytechnic Institute.

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