Understanding the Different Model Modes for Modelithics Amplifier Models in Keysight PathWave System Design (SystemVue)

April 2022

Nonlinear amplifier models included in the Modelithics System Components Library™ for Keysight PathWave System Design (SystemVue) include a parameter called Model_Mode. You may be surprised when you see that this parameter can actually be set to one of three different values. What exactly do each of these settings mean? Let's try to answer that question.

Let's look at the AMPXP-MCL-GVA63plus-001 model, which is a nonlinear behavioral model for the Mini-Circuits GVA-63+ high-gain amplifier (Fig. 1). When we open its properties, we see three different Model_Mode settings to choose from: 0 (Small Signal Mode), 1 (Large Signal Mode), and 2 (System Analysis Mode).
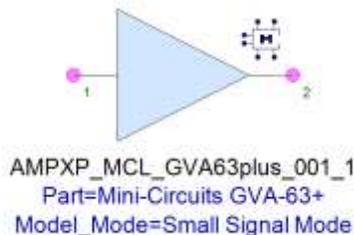

AMPXP_MCL_GVA63plus_001_1
Part=Mini-Circuits GVA-63+
Model_Mode=Small Signal Mode

Figure 1. AMPXP-MCL-GVA63plus-001 model for the Mini-Circuits GVA-63+ amplifier.

Let's dive into each of these settings to demonstrate how they can be utilized. We'll start with Model_Mode 0, which is the setting for Small Signal mode. This is the setting to use if you're interested in performing a linear analysis. For instance, maybe you just want to simulate S-parameters or noise figure. In that case, Small Signal mode is the way to go.

Let's go beyond linear analysis by moving on to RF system analysis, which should certainly be of more interest to system designers than linear analysis.

Share your feedback on this blog with the author and the Modelithics Blog Team.

Contact Us:
Modelithics, Inc.
3802 Spectrum Blvd., Suite 130
Tampa, FL 33612
blogs@modelithics.com
www.modelithics.com

About the Author

Chris DeMartino
Sales & Applications Engineer, Modelithics, Inc.
Chris DeMartino is a Sales and Applications Engineer at Modelithics. His experience includes developing and testing RF/microwave components and assemblies for various applications. In addition, Chris spent several years working as a technical editor for an industry publication, making him well equipped to create useful technical content. Some of his roles at Modelithics include designing application circuits, writing technical articles and application notes, and creating demonstration and tutorial videos. Chris has a B.S. in Electrical Engineering from the State University of New York at Binghamton and an M.S. in Electrical Engineering from Polytechnic University.

Have another topic that you would like Modelithics experts to cover? Email your suggestions to the **Modelithics Blog Team** and it could be featured in an upcoming post. Please include your contact information in the body of the email.

Premium Model Libraries • Custom Measurement & Modeling
Test Fixtures & Accessories • Vendor Sponsored Models, Data, & Libraries

Over 20 Years of Precision Measurements and Modeling Excellence!

Suppose you have an RF chain and you're interested in performing an RF budget analysis to view the cascaded gain and cascaded noise figure. In this scenario, you would want to use Model_Mode 0 for the amplifier models in the RF chain as long as the input drive level is low enough such that the amplifiers are operating in the linear region. Let's demonstrate this by looking at an example. Figure 2 shows a simple RF chain that consists of the same AMPXP-MCL-GVA63plus-001 model followed by a model for the Mini-Circuits KAT attenuator series that is set to 3 dB. Following the attenuator is another AMPXP-MCL-GVA63plus-001 model.
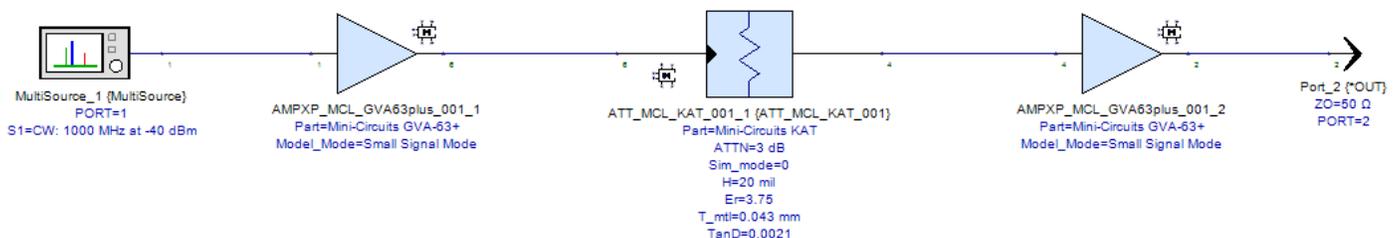

Figure 2. Simple RF chain.

Here, we want to perform an RF System Analysis to view the cascaded gain and cascaded noise figure. The input signal is a 1-GHz CW signal with a power level of −40 dBm. Since both amplifiers would be operating in the linear region, we'll set both amplifier models to Model_Mode 0. Figure 3 shows the simulated cascaded gain and cascaded noise figure. Note that Model_Mode 0 must always be used for noise simulations.

Premium Model Libraries • Custom Measurement & Modeling
Test Fixtures & Accessories • Vendor Sponsored Models, Data, & Libraries

Over 20 Years of Precision Measurements and Modeling Excellence!

Figure 3. Simulated cascaded gain (top) and cascaded noise figure (bottom) of the RF chain.

Moving on to the next setting, Model_Mode 1 is the setting for Large Signal mode. This setting requires Keysight's HARBEC module for harmonic analysis. Note that Model_Mode 1 will not work for RF system analysis. Model_Mode 1 is included mainly for compatibility reasons, as the HARBEC module is only compatible with this setting.

The third setting is Model_Mode 2, which is the setting for System Analysis mode. This setting provides much greater benefit to SystemVue users compared to Model_Mode 1. Of course, as the name implies, Model_Mode 2 is intended for RF system analysis, which we just briefly looked at. However, the simulation we performed was a linear simulation. For nonlinear system analysis, Model_Mode 2 is the setting you want to use.

To demonstrate, let's go back to the same RF chain from before (Fig. 2, again). This time, we'll set both amplifier models to Model_Mode 2. Let's now simulate this chain with the same 1-GHz CW input signal set to a power level of −40 dBm. Figure 4 shows the simulated output power spectrum that shows the 1-GHz fundamental output. In addition, the results illustrate the nonlinearity of the amplifiers since we can also see the harmonic components. As a side note, performing this simulation with the amplifier models set to Model_Mode 0 results in an erroneous power spectrum that does not display the harmonics.
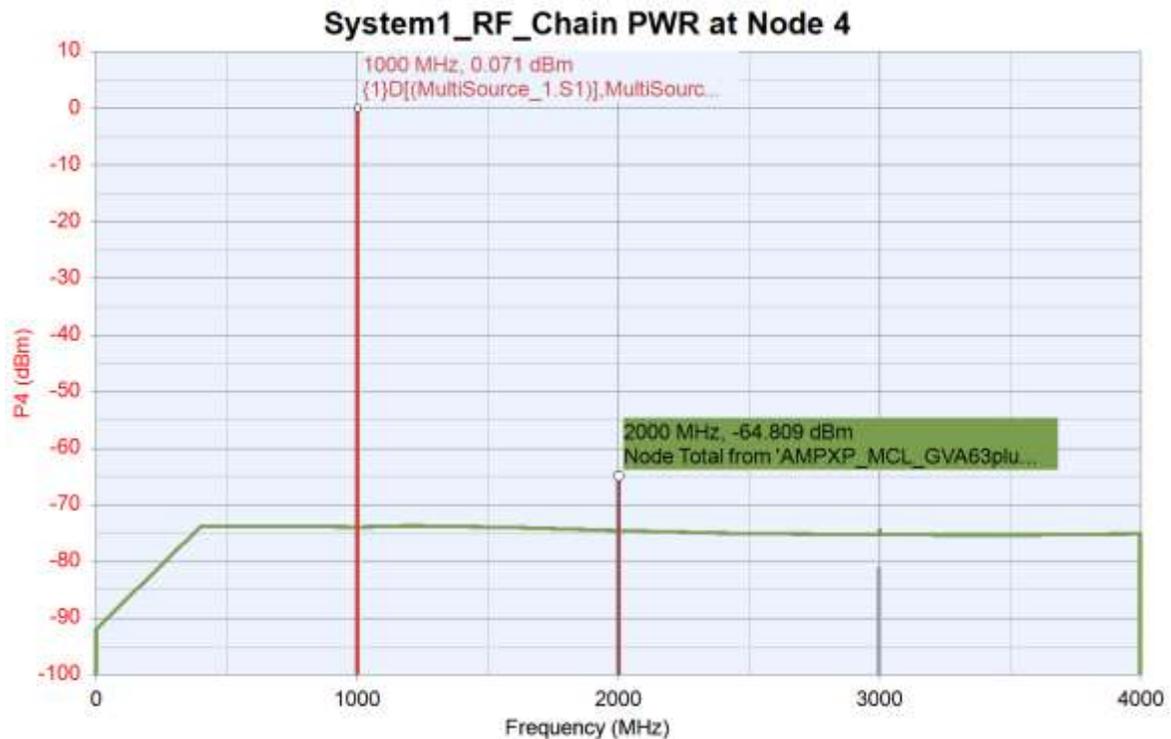
Figure 4. Simulated output power spectrum of the RF chain.

Let's now increase the power level of the input signal to −15 dBm and then run the simulation again. This higher power level causes the second amplifier to operate beyond its linear region. Figure 5 shows the simulated output power spectrum. We can see the nonlinear effects due to the increased drive level, as the difference in amplitude between the fundamental and harmonic outputs has decreased signficantly.
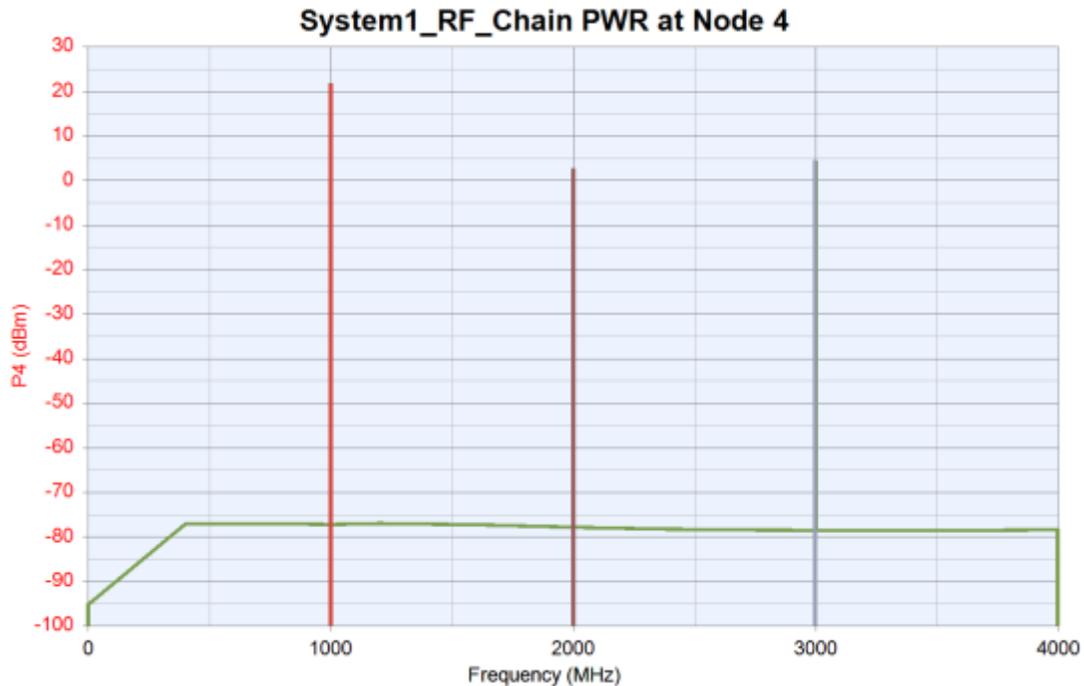
Figure 5. Simulated output power spectrum of the RF chain after increasing the input drive level.

We hope it's now clear how to use the Model_Mode parameter within the nonlinear amplifier models included in the Modelithics System Components Library for Keysight SystemVue. Hopefully, this blog post has explained why these models have this parameter and when each mode should be used. On a final note, you may also want to take a look at the article titled, "Highly Accurate RF System Modeling for Wi-Fi and Cellular Interference Analysis." This article features a 2.4-GHz receiver design and analyzes its performance in an environment that contains two interfering signals. Included in the receiver's RF chain is an amplifier model from the Modelithics System Components Library.

The Modelithics System Components Library contains models for system-level components like amplifiers, filters, attenuators, couplers, and packages. To request a free trial, visit www.modelithics.com or email sales@modelithics.com.