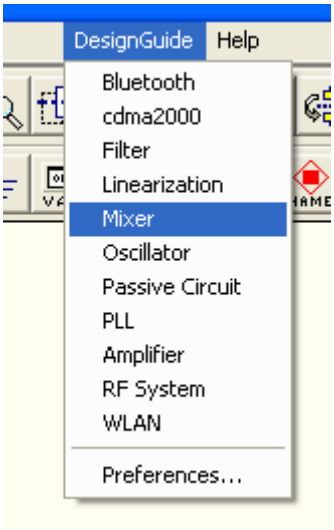
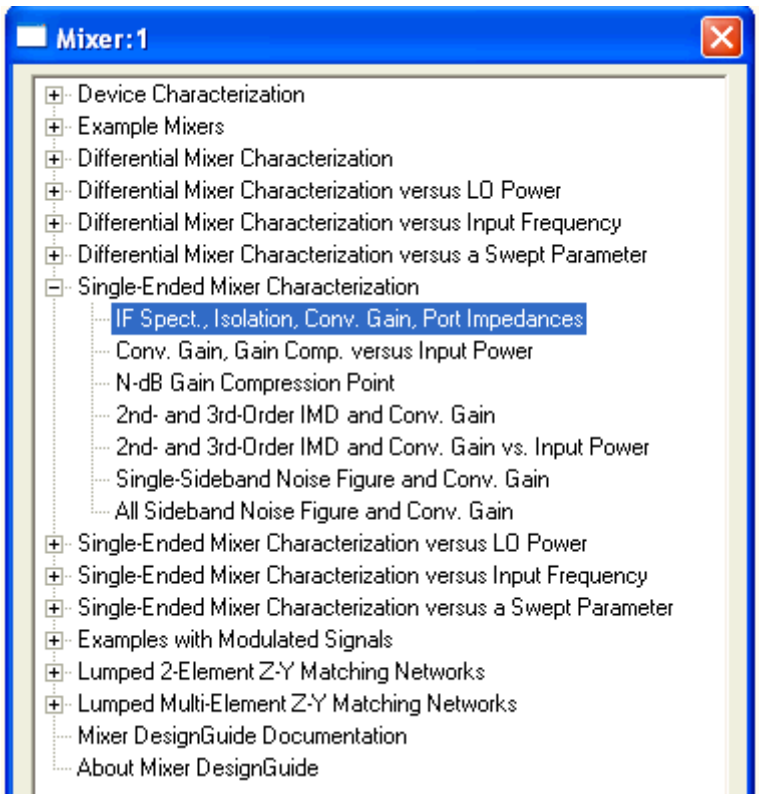
ADS Tutorial: Using the Mixer Design Guide

Agilent provides all ADS users with a large selection of "Design Guides" covering many areas of interest in microwave circuits and communications. These DGs consist of a collection of schematic and display templates that are preconfigured for relevant simulations. As you will quickly see, you can save days or weeks of time by importing the most relevant schematic/display pair and modifying it for your own application instead of starting from nothing.

To import into your ADS project, use the DesignGuide menu.



When you highlight and click, the menu expands as shown below.



You will find a large selection of mixer characterization templates and example mixers. These are grouped according to differential or single-ended mixer interfaces. Within each group, you will find 4 categories of measurements, all using the harmonic balance simulation mode.

1. **Mixer Characterization**. These are either fixed (non-swept) simulations or they are RF input power sweeps.
2. **Mixer Characterization vs. LO Power**. The same set of simulations with the LO power swept.
3. **Mixer Characterization vs. Input Frequency**. RF Input frequency is swept.
4. **Mixer Characterization vs. Swept Parameter**. Use this if you want to evaluate some aspect of mixer performance as a function of any other swept parameter (bias voltage or current, component value, device widths, etc.)

Within each category, there is a set of 7 measurement templates.

a. **IF Spect, Isolation, Conv. Gain, Port Impedances**. Spectral display of the IF output; LO – IF, LO – RF, and RF – IF isolation; Conversion gain at fixed input power; small signal input impedances.

b. Conv. Gain Gain Comp. vs. Input Power. Simulate conversion gain plot gain compression while sweeping the RF input power.

c. N-dB Gain Compression. A more limited version of b. No plots, just a table.

d. 2^{nd} and 3^{rd} order IMD and Conv. Gain. Simulate two-tone intermodulation power and intercepts with a fixed RF and LO input power.

e. 2nd and 3rd order IMD and Conv. Gain. Vs. Input Power. This performs the RF power sweep and plots fundamental, 2nd order, and 3rd order powers on a dB vs. log freq. plot.

f. SSB Noise Figure and Conv. Gain. A harmonic balance single sideband noise figure simulation. This accounts for large signal effects and mixing of noise from LO harmonics.

g. All Sideband Noise Figure and Conv. Gain. This uses the hot-cold noise figure simulation method and calculates a double-sideband NF, again using harmonic balance.

When you select one of the template pairs, it will import the files into your ADS project. You are then free to modify it for your own application. Paste in your own mixer in place of the default one. Modify frequencies, powers, change parameters, sweeps etc. as needed.

Convergence Woes

Any user of the harmonic balance simulator will eventually encounter convergence problems. Unfortunately, when this happens, no useful information is provided by the simulator. Problems with convergence generally arise when the circuit under simulation is or becomes highly nonlinear. In the case of mixers, there are inherent nonlinearities that are required for the mixing process, but these are usually not so bad unless you are seriously overdriving one of the inputs. If the simulation fails, check the biasing of the transistors. HB doesn't do well with BJTs driven into their saturation region. If that is not the problem, then try decreasing either LO power or the RF power sweep range. You may be driving the mixer well beyond saturation when using default power levels in mixer DG templates. As a last resort, you can try using the Direct solver rather than Krylov, but this will increase simulation time by a large factor.

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