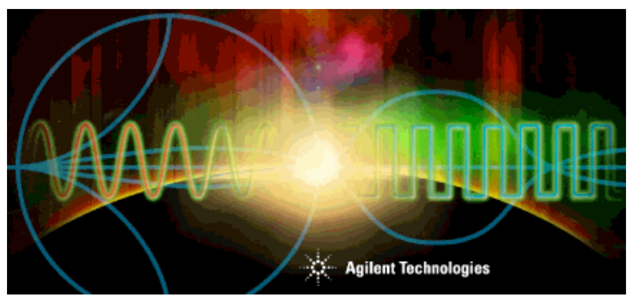
Topic 2:

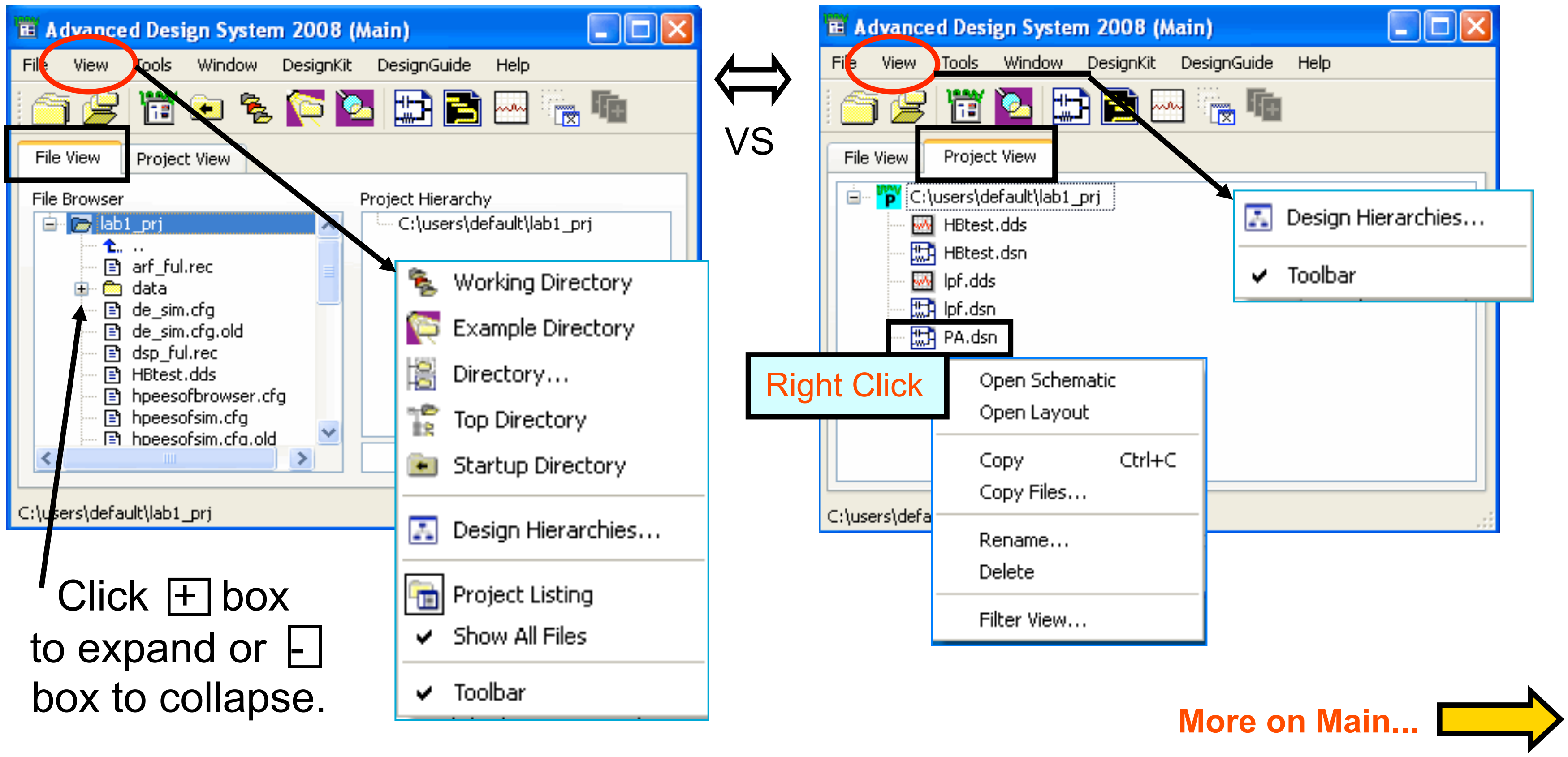
System Design Fundamentals



BEFORE starting with system design...some details on the ADS Main window:

Main Window: File or Project View

- **Use icons or commands:** all icons have commands - not all commands have icons.
- **Right clicking:** on files or objects gives you choices…
- **Dynamic icons & commands**: may change with the tabs, windows, or context…



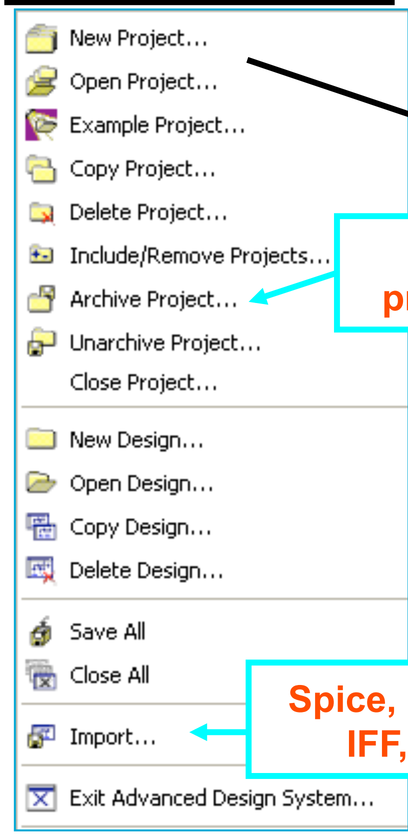
More on Main...

BEFORE starting with system design...some details on the ADS Main window:

Main Window and the File commands…

- Main window is for managing files and projects

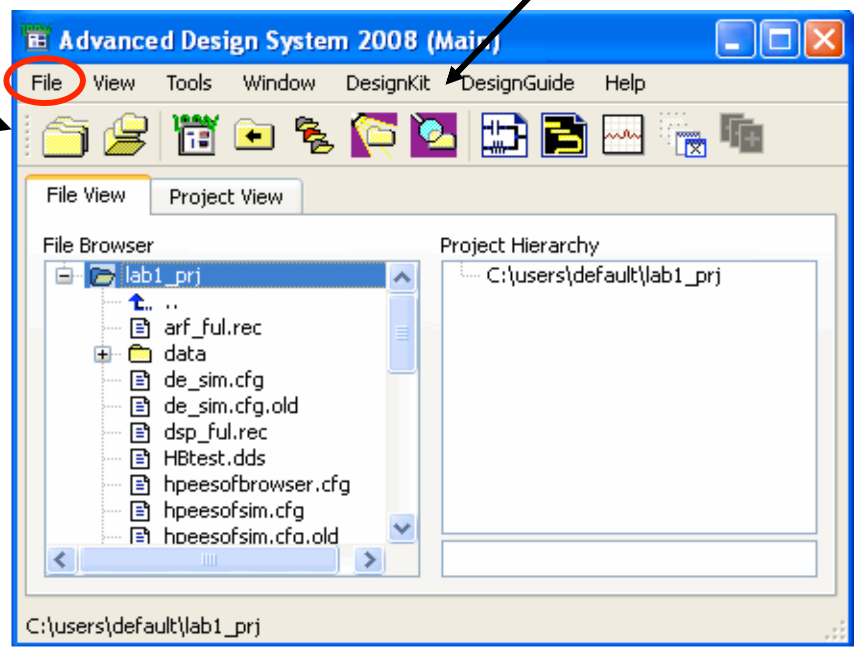
File commands:



Zap projects

Spice, Netlist, IFF, etc.

Design Kits (foundry specific)
Design Guide (like templates)

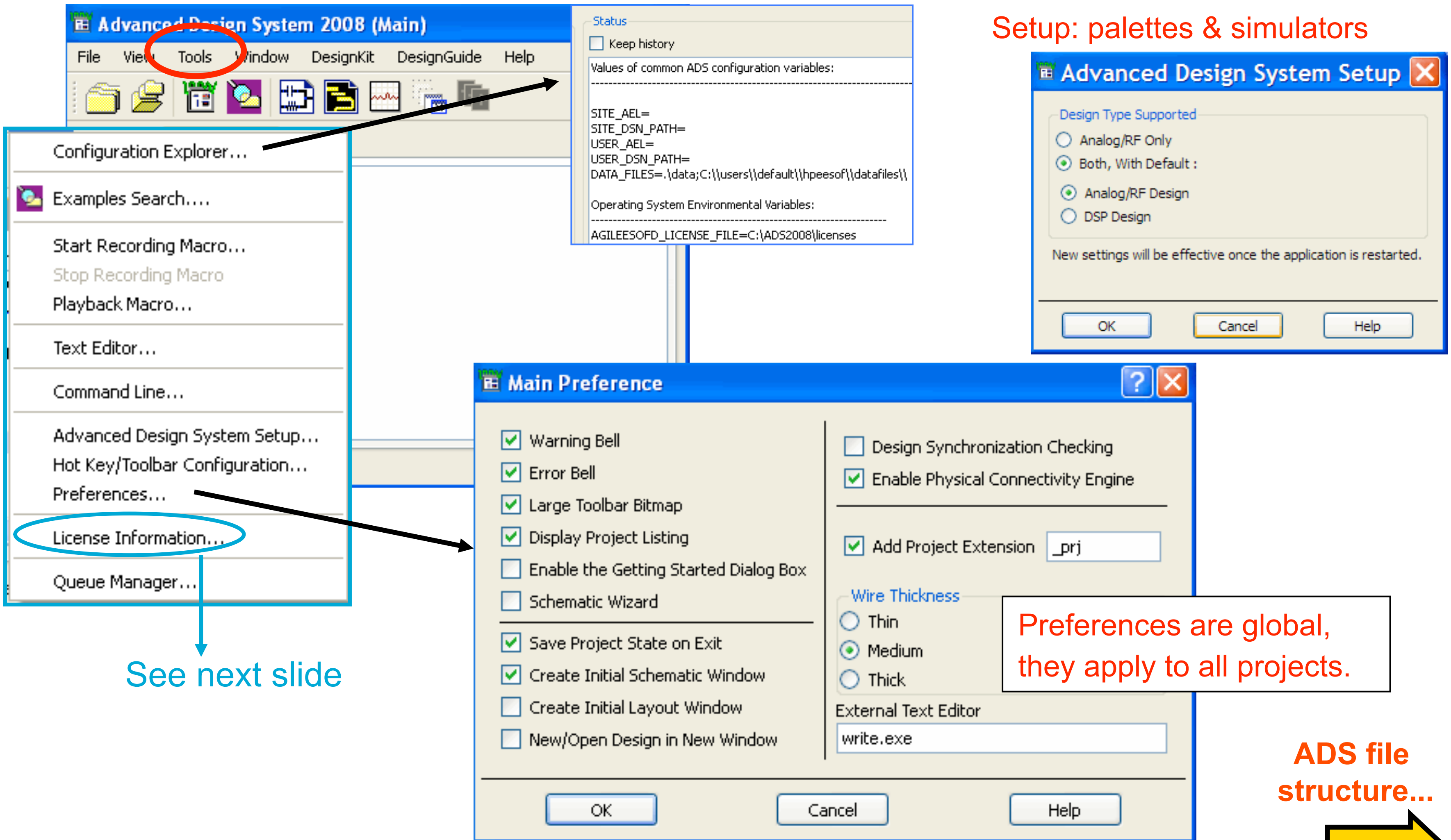


Next, Tools…

Main Window Tools…

Configuration Explorer: variables

Setup: palettes & simulators



See next slide

Preferences are global, they apply to all projects.

ADS file structure…

Loading ADS: Directories, Variables, and Licenses

When you load ADS, you are prompted for:

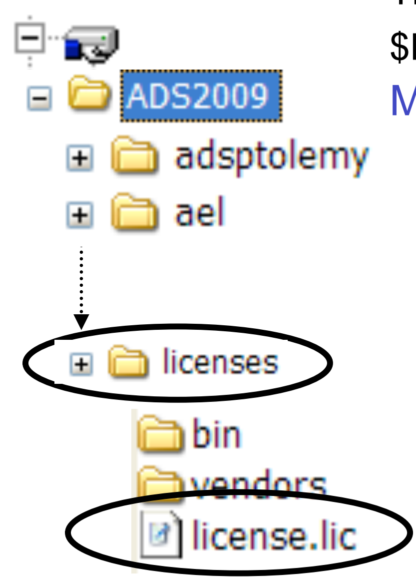
- **Install directory (location of ADS program) - C or D drive on a PC**

  $HPEESOF_DIR (UNIX variable) or %HPEESOF_DIR% (PC variable)

- **Home directory (location of your ADS design work) - C:\users\default on a PC**

  $HOME (UNIX variable) or %HOME% (PC variable)

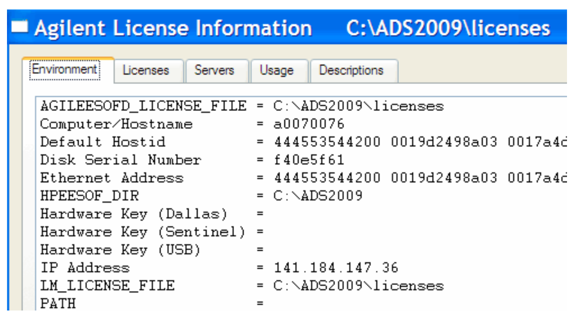
(C:) **Install DIR**



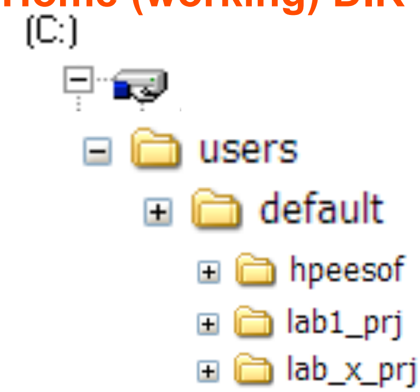
LICENSE Variable and File:

A variable points to the license.
The default is: AGILEESOF_LICENSE_FILE =
$HPEESOF_DIR / licenses / license.lic or .dat

Main window: Tools > License Information:



Home (working) DIR

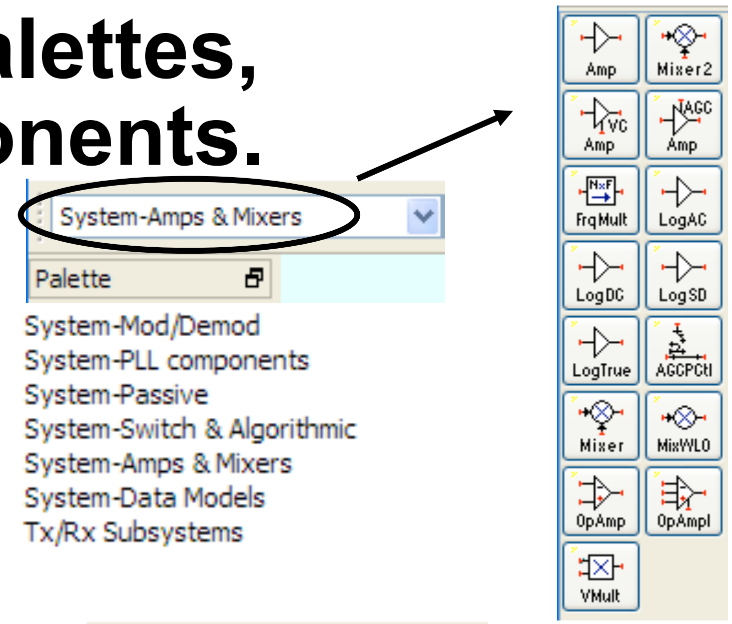


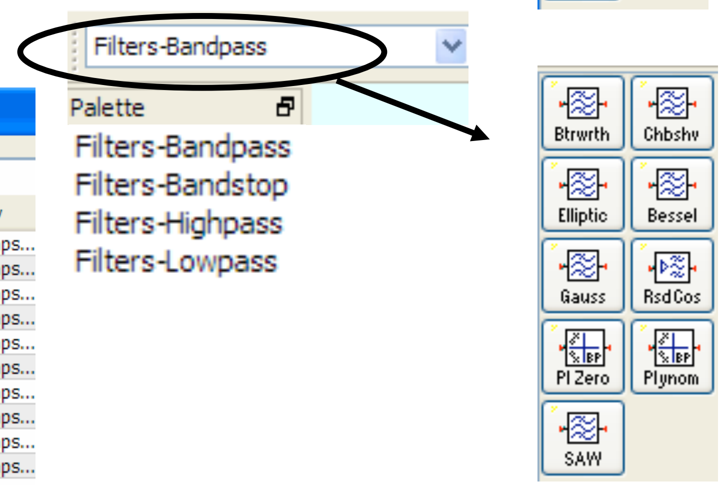
NOTE: License files contain code words for the simulators. Licenses can be networked or keyed to individual computers (node locked) using a hardware key (dongle) or Ethernet card (MAC address).

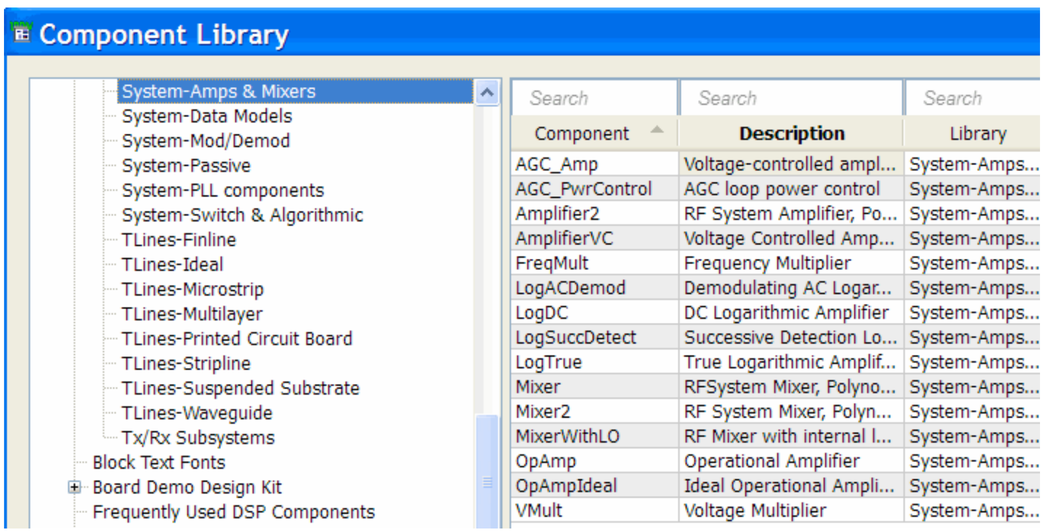
System design...

SYSTEM DESIGN: palettes, libraries, and components.

- System design is at the higher level, no circuit components are required.
- However, system components can be integrated with circuit components.
- The simulation and data display are the same for system and circuit.





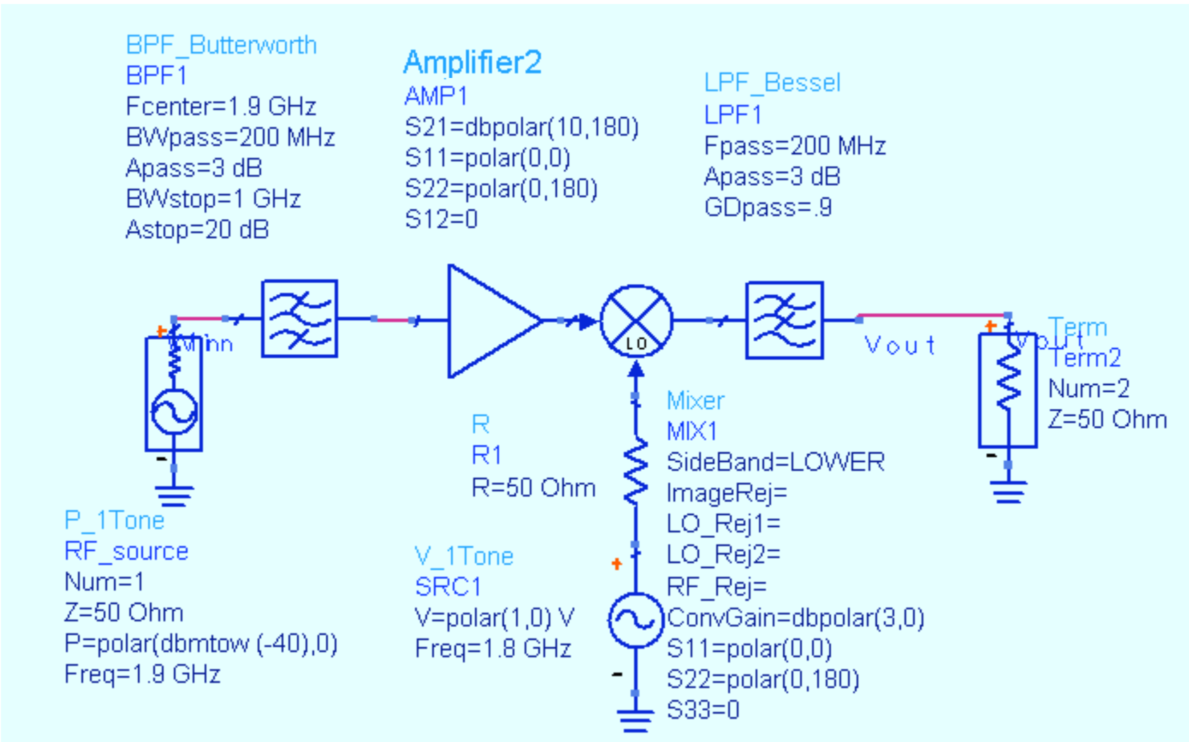


Component	Description	Library
AGC_Amp	Voltage-controlled ampl...	System-Amps...
AGC_PwrControl	AGC loop power control	System-Amps...
Amplifier2	RF System Amplifier, Po...	System-Amps...
AmplifierVC	Voltage Controlled Amp...	System-Amps...
FreqMult	Frequency Multiplier	System-Amps...
LogACDemod	Demodulating AC Logar...	System-Amps...
LogDC	DC Logarithmic Amplifier	System-Amps...
LogSuccDetect	Successive Detection Lo...	System-Amps...
LogTrue	True Logarithmic Amplif...	System-Amps...
Mixer	RFSystem Mixer, Polyno...	System-Amps...
Mixer2	RF System Mixer, Polyn...	System-Amps...
MixerWithLO	RF Mixer with internal l...	System-Amps...
OpAmp	Operational Amplifier	System-Amps...
OpAmpIdeal	Ideal Operational Ampli...	System-Amps...
VMult	Voltage Multiplier	System-Amps...

Typical RF system design...

Typical system design uses: behavioral models!

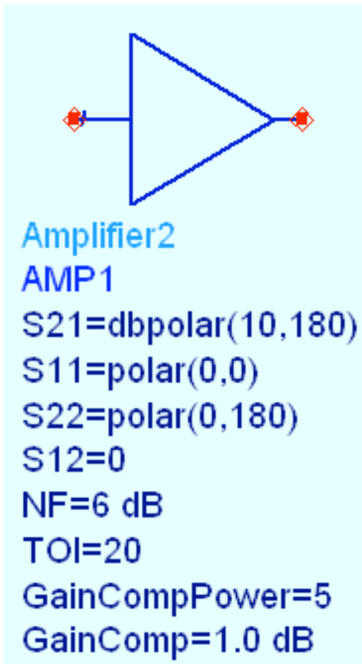
What are behavioral models?



- **Behavioral models are equation based.**
- **Equations describe node I and V and can also reference tables.**

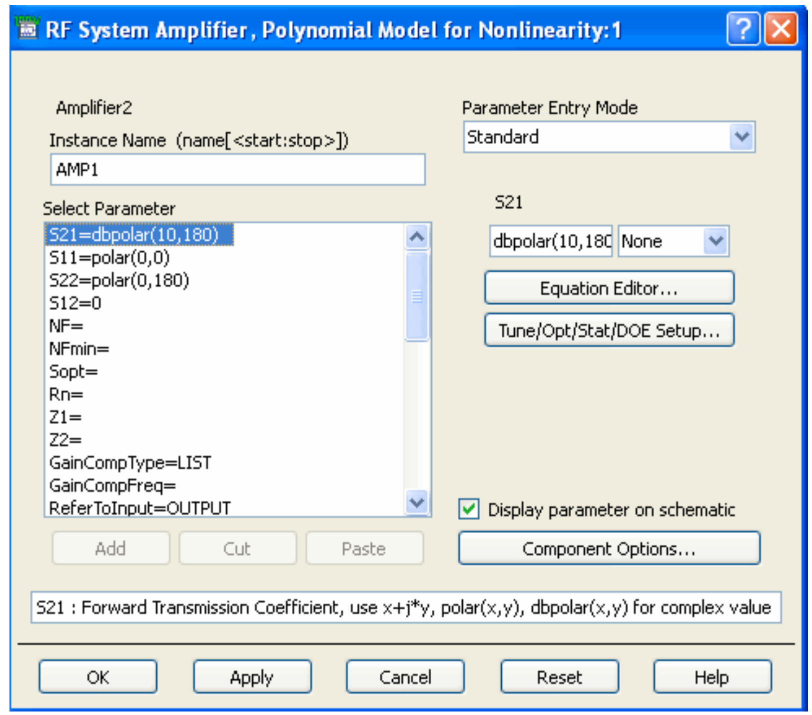
NOTE: You can also use measurement / data based models. For example: SNP components, Mixer IMT, Amplifier P2D, AmpH1H2 and others in the System libraries.

Typical system component: Amplifier



Behavioral model

Polynomial equations describe nonlinearity:

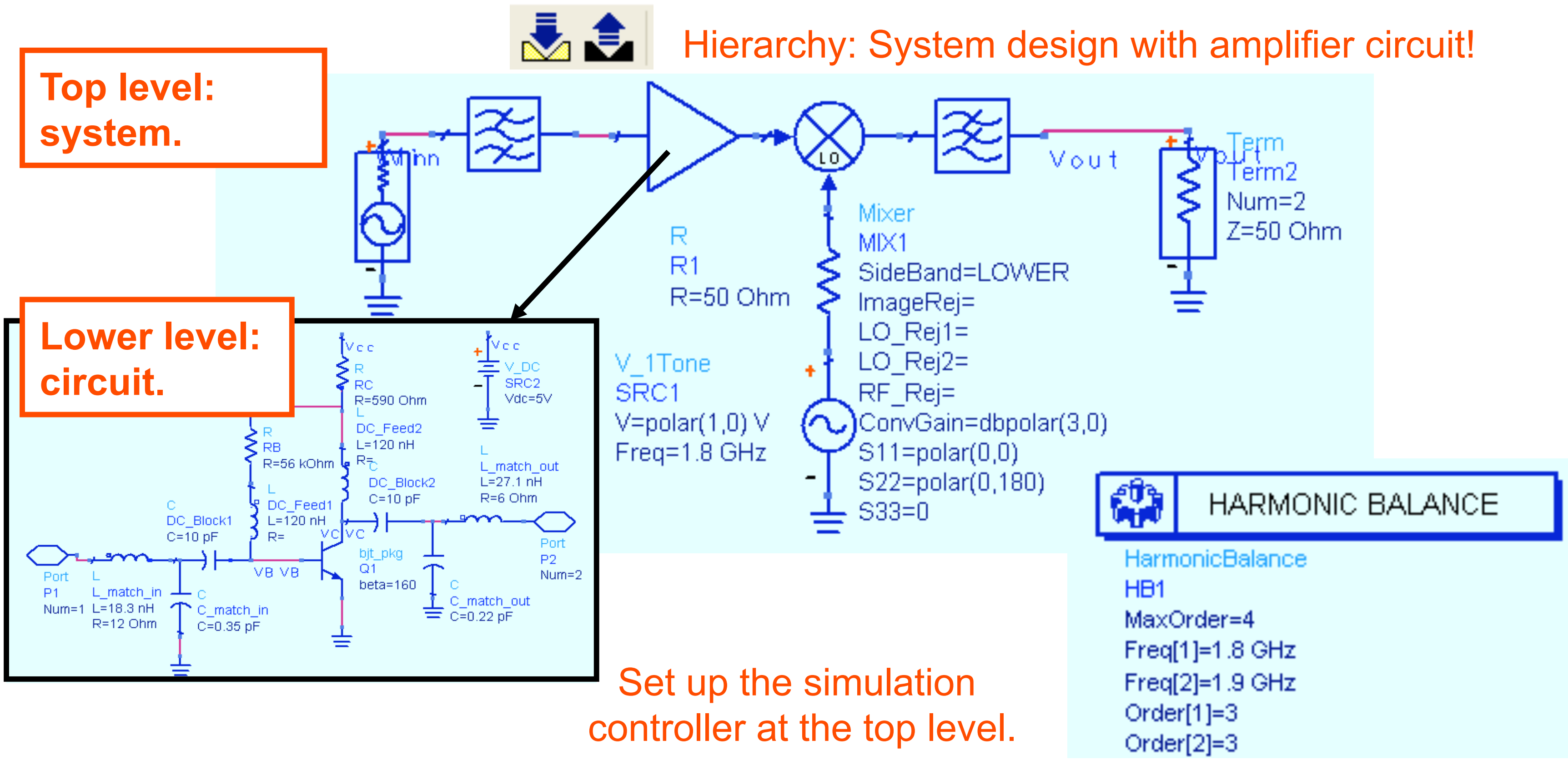


You specify the behavior:

NOTE: Other ADS components (AmplifierS2D) can be used with measured data.

Simulation is the same: system or circuit

Therefore, you can combine circuit and system designs for simulation as they are completed!

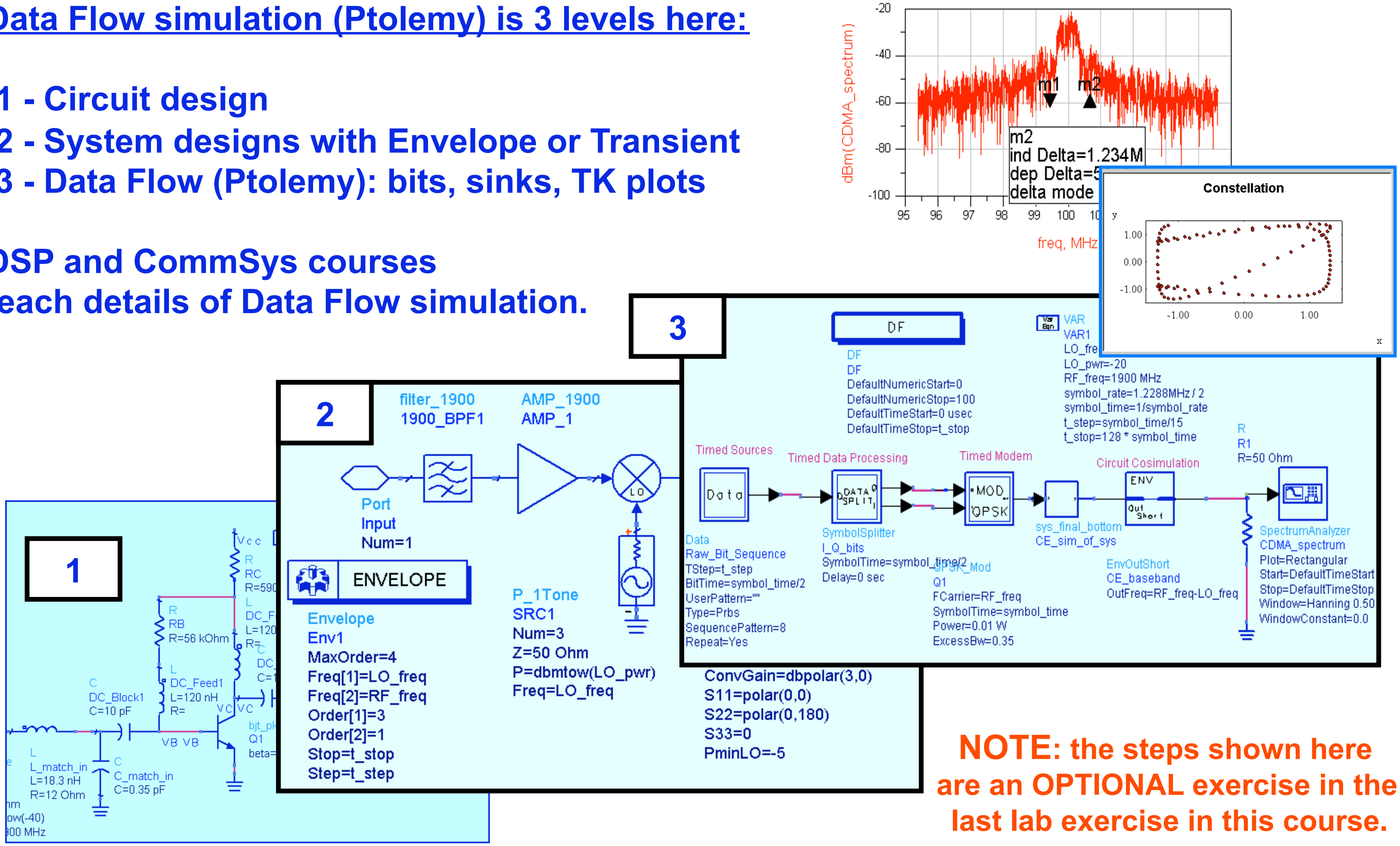


Also, ADS has Data Flow simulation

Data Flow simulation (Ptolemy) is 3 levels here:

1 - Circuit design
2 - System designs with Envelope or Transient
3 - Data Flow (Ptolemy): bits, sinks, TK plots

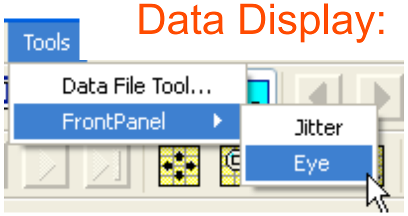
DSP and CommSys courses teach details of Data Flow simulation.



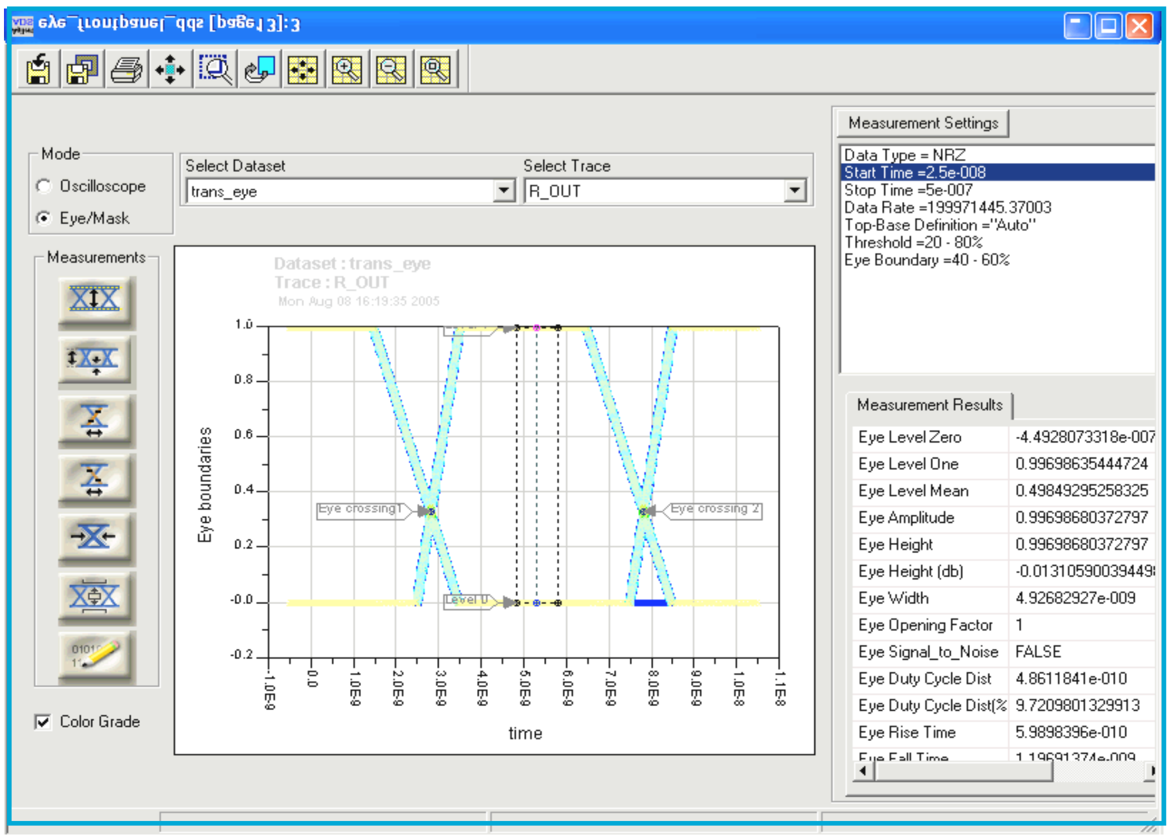
NOTE: the steps shown here are an OPTIONAL exercise in the last lab exercise in this course.

ADS also has a built-in Eye Diagram

Data Display:



Or Oscilloscope… with numerous front panel-like settings. Data is from Transient analysis (real & not complex) - usually a baseband signal.



Use of this tool
Is covered in the
ADS **signal integrity** course…

What the lab is about ...

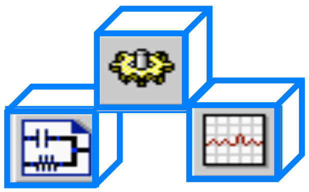
Lab 2:

System Design Fundamentals

Steps in the Design Process

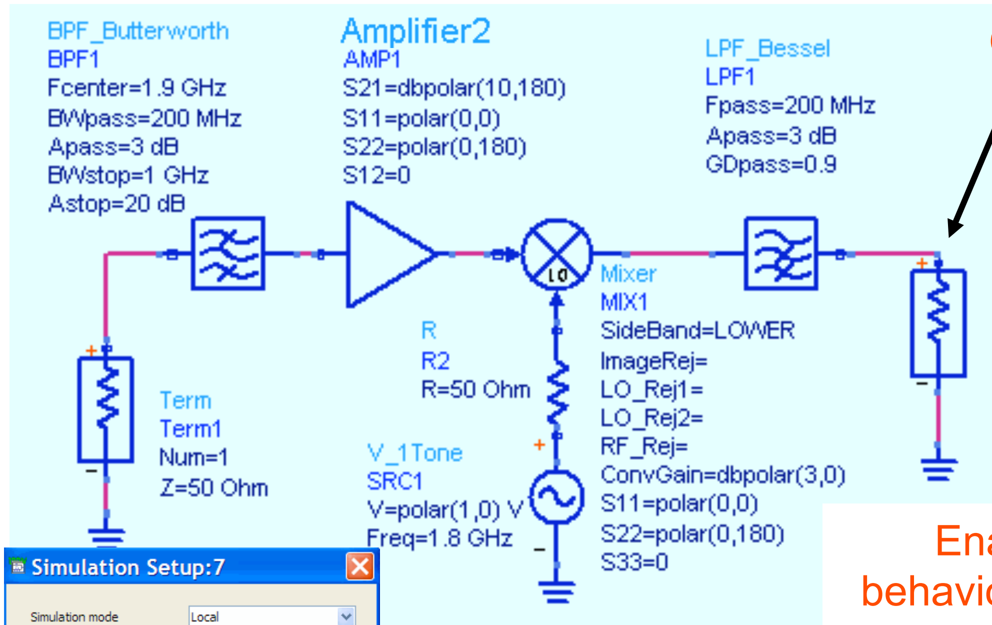
You are here:

- **[Design the RF sys behavioral model receiver]**
- **[Test conversion gain, spectrum, etc.]**
- Start amp_1900 design – subckt parasitics
- Simulate amp DC conditions & bias network
- Simulate amp AC response - verify gain
- Test for noise contributions
- Simulate amp S-parameter response
- Create a matching topology
- Optimize the amp in & out matching networks
- Filter design – lumped 200MHz LPF
- Filter design – microstrip 1900 MHz BPF
- Transient and Momentum filter analysis
- Amp spectrum, delivered power, Zin - HB
- Test amp comp, distortion, two-tone, TOI
- CE basics for spectrum and baseband
- CE for amp_1900 with GSM source
- Replace amp and filters in rf_sys receiver
- Test conversion gain, NF, swept LO power
- Final CDMA system test CE with fancy DDS
- Co-simulation of behavioral system

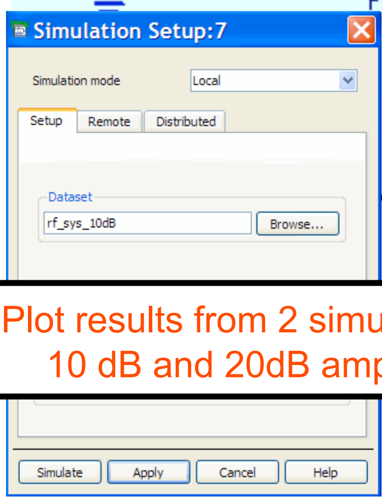


RF receiver system: S-parameters

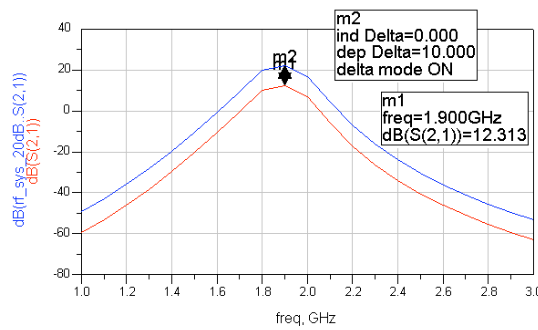
S-21 measurement tests conversion gain:



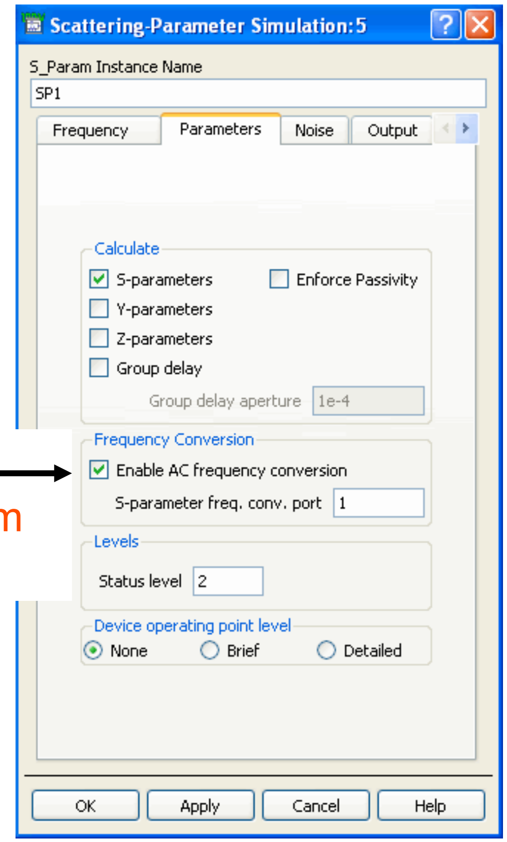
Converted Freq = 100 MHz IF



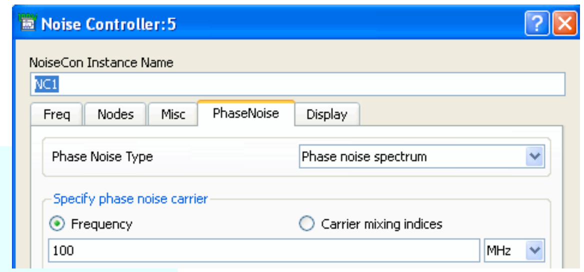
Plot results from 2 simulations: 10 dB and 20dB amp S21



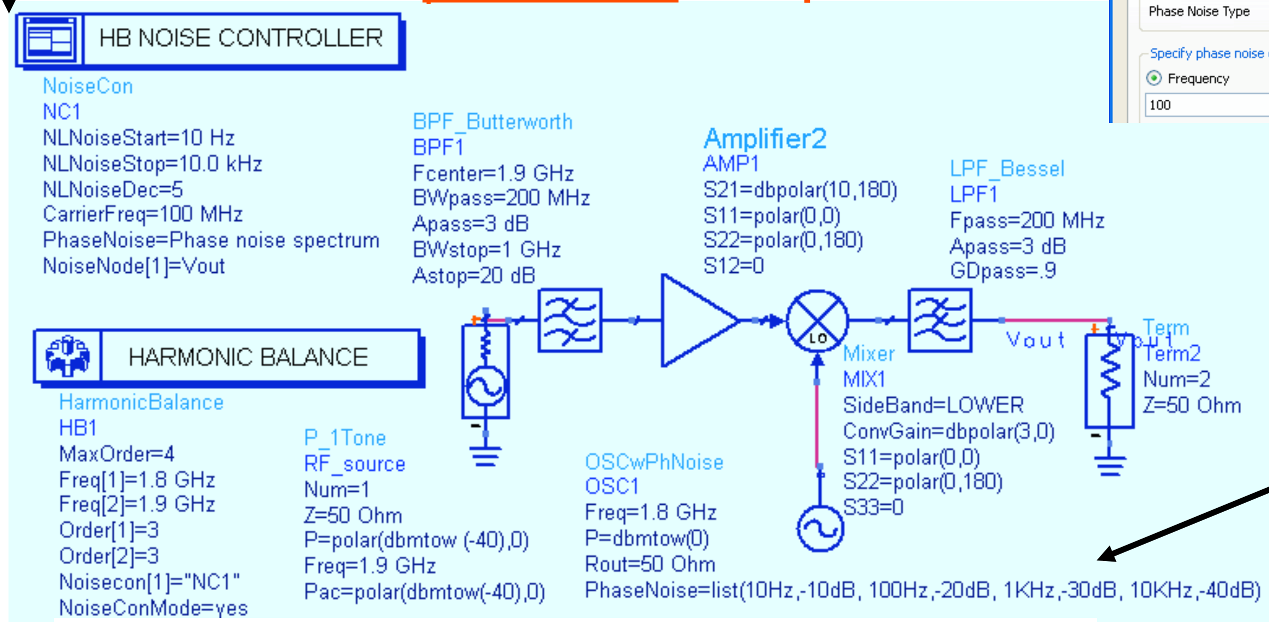
Enable for behavioral system models only.



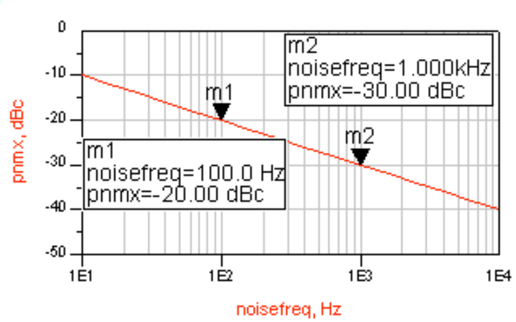
Harmonic Balance simulation using an <u>HB Noise Controller</u>

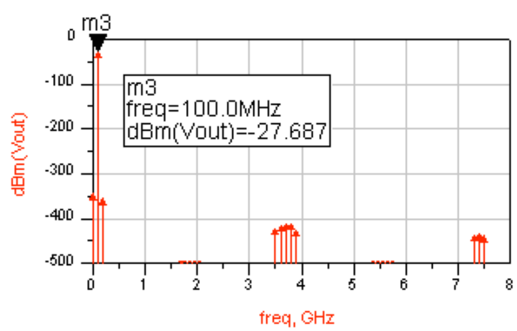


HB simulation: <u>phase noise</u> and spectrum of IF:



Set up LO with phase noise.

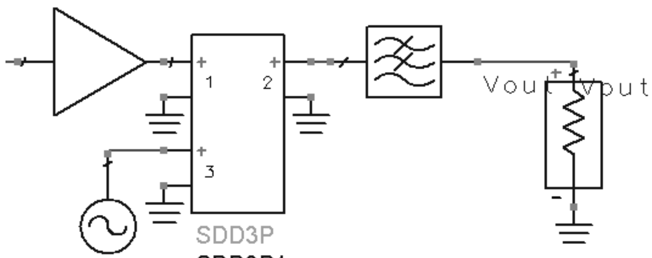




Plot phase noise and spectrum.

OPTIONAL: SDD used as a mixer

SDDs can define non-linear behavior...this is a brief introduction:



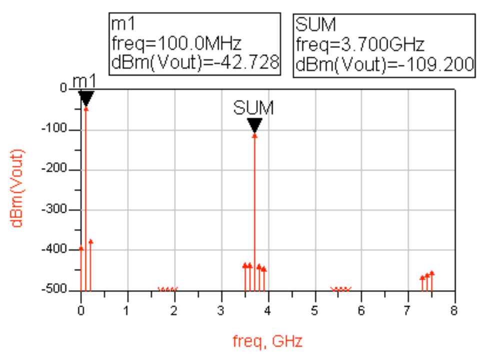
SDD3P1
I[1,0]=(_v1)/50.0
I[2,0]=(_v2 - _v1 *_v3) / 50.0
I[3,0]=(_v3)/50.0
C[1]=

HARMONIC BALANCE
HarmonicBalance
HB1
MaxOrder=4
Freq[1]=1.8 GHz
Freq[2]=1.9 GHz
Order[1]=3
Order[2]=3

TRANSIENT
Tran
Tran1
StopTime=4/100MHz
MaxTimeStep=1/(2*1800M)

Non-linear node currents are defined by equations: I = _V / Z.

HB results: Fundamental tones, harmonics, difference and sum frequencies are plotted. However, because no conversion gain is accounted for in the SDD equation, the results have a lower magnitude than the behavioral model mixer. Also, Transient results compare within 0.1dB of HB using **fs** function.



Eqn Vout2=dBm(fs(rf_sys_sdd_trans..Vout,,,,,,,10n,40n))