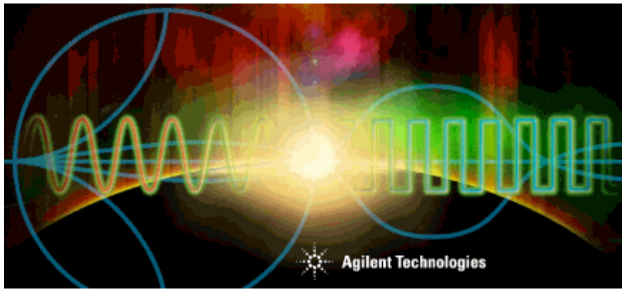
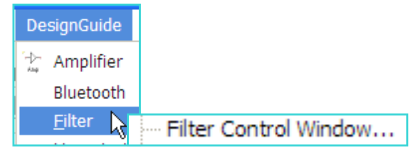
Topic 6:

DesignGuide,Transient, Momentum and the DAC



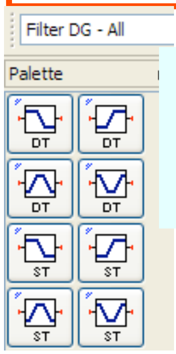
Filter DesignGuide

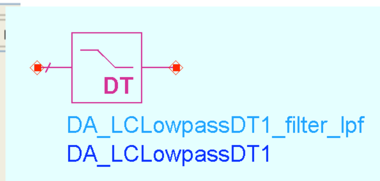
Schematic



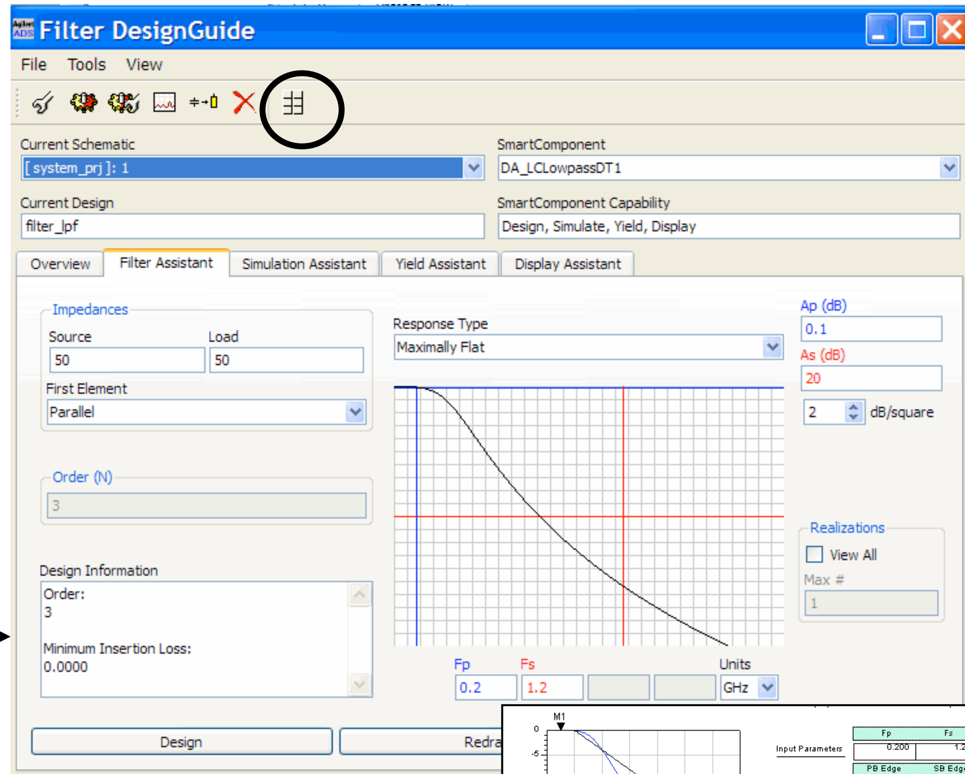
[Design low / high pass or band pass / stop filters...]()

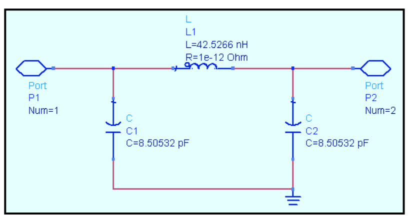
1) Insert the component from the palette.



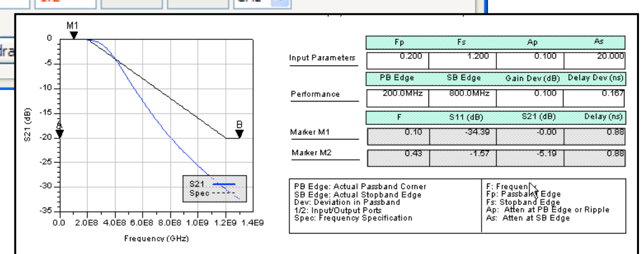


2) Specify the response, Zo, etc., by entry or spec lines on graph.





3) View the design and simulate!



Momentum

Momentum

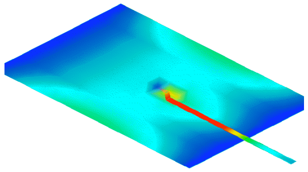
3-D MOM engine gives S-parameter results

What is Momentum? **EM (electro-magnetic) 3-D solver using Method of Moments technique and Green's functions to compute the current in layout structures, including vias, coupling between surfaces, and thick metal (3D).**

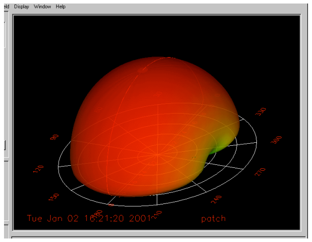
Why use Momentum?

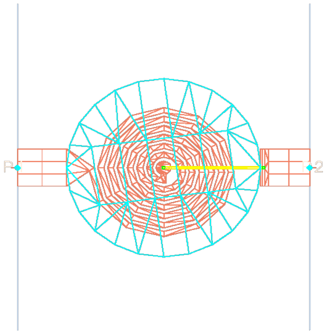
- You have no accurate model for a passive layout.
- You want to know the coupling effects between structures.
- You want to optimize the layout real-estate, performance, etc.
- Your other structure simulator takes too long to simulate.
- You want to visualize currents.
- You want to use the results in ADS simulations.

Visualize Current!



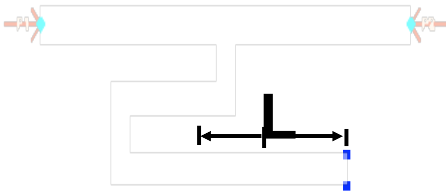
Radiation!





Spiral meshed as a "strip" geometry. Hole in ground plane is meshed as a "slot", which is more efficient than meshing the entire ground plane.

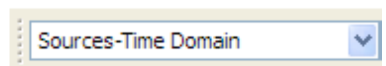
Optimize!



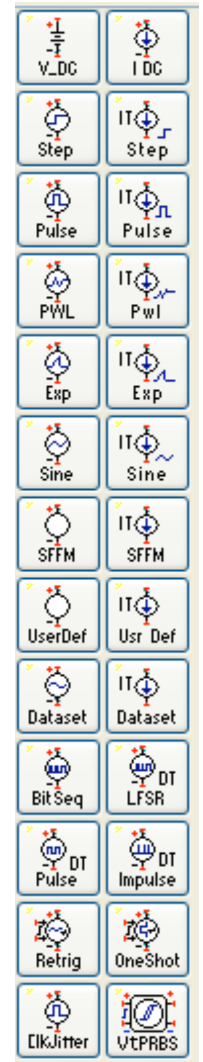
Next, Transient…

Transient simulation

- Analysis performed in the Time Domain
- Use any Source
- Solutions use Newton_Raphson iterations
- You get Amplitude vs. Time
- Time Domain data can be transformed: fs ( )
- Available solution file for HB convergence
- Use Transient data for Eye Diagrams

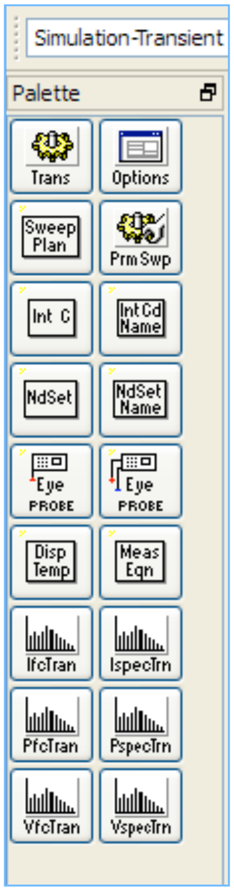


Use these sources for time domain simulations!

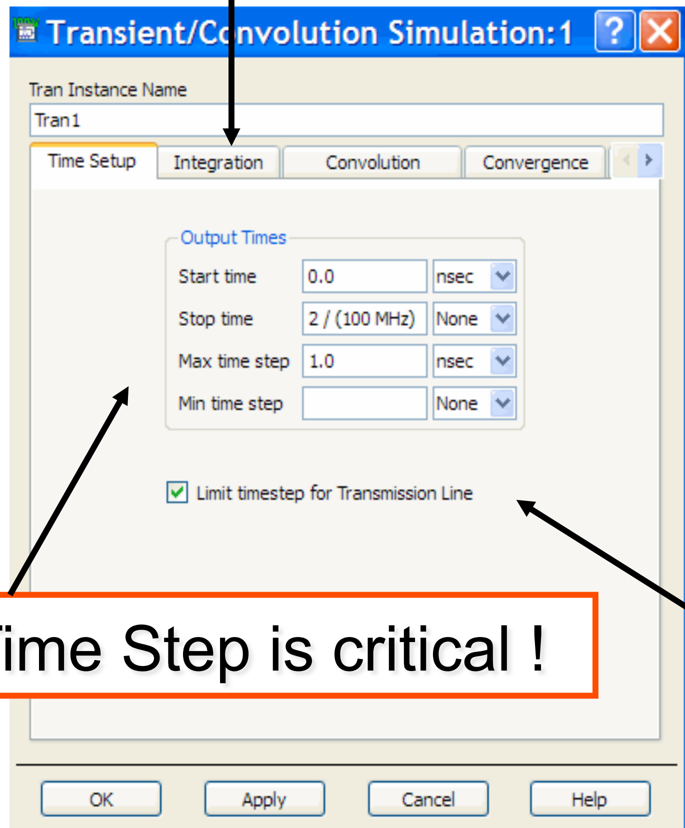


Transient simulation controller settings

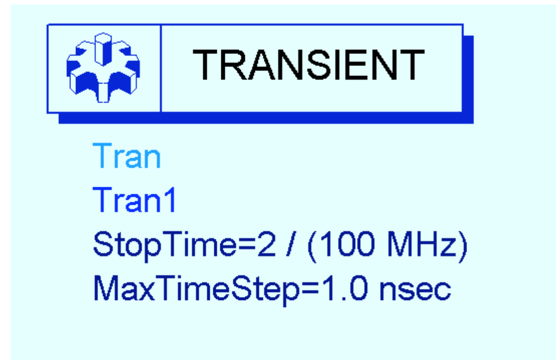
Transient simulation controller



Integration: step control & error (default:TruncError)



Time Step is critical !



Ignored if no TL's

NOTE on Convolution:

Frequency domain models (microstrip) can be converted to the time domain - then convolved with a time-domain input signal to obtain the time-domain output signal. The convolution tab in the transient simulator allows you to define methods and settings.

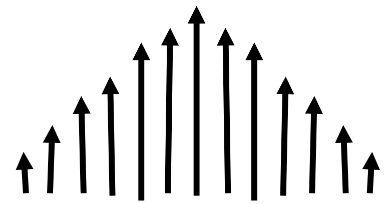
Next, time step...

Setting the Transient Time Step

Start time: sampling begins

Stop time: sampling ends

Time step: sampling rate

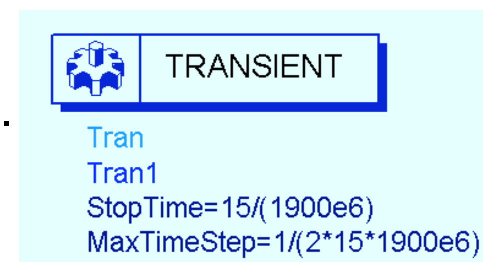


Sample @ 2 x BW

Use the Nyquist rule: Sample at 2 x or more the rate of the highest frequency of interest:

To sample the fundamental (1900 MHz) plus harmonics, you must calculate @ 2 x (rate of highest harmonic desired).

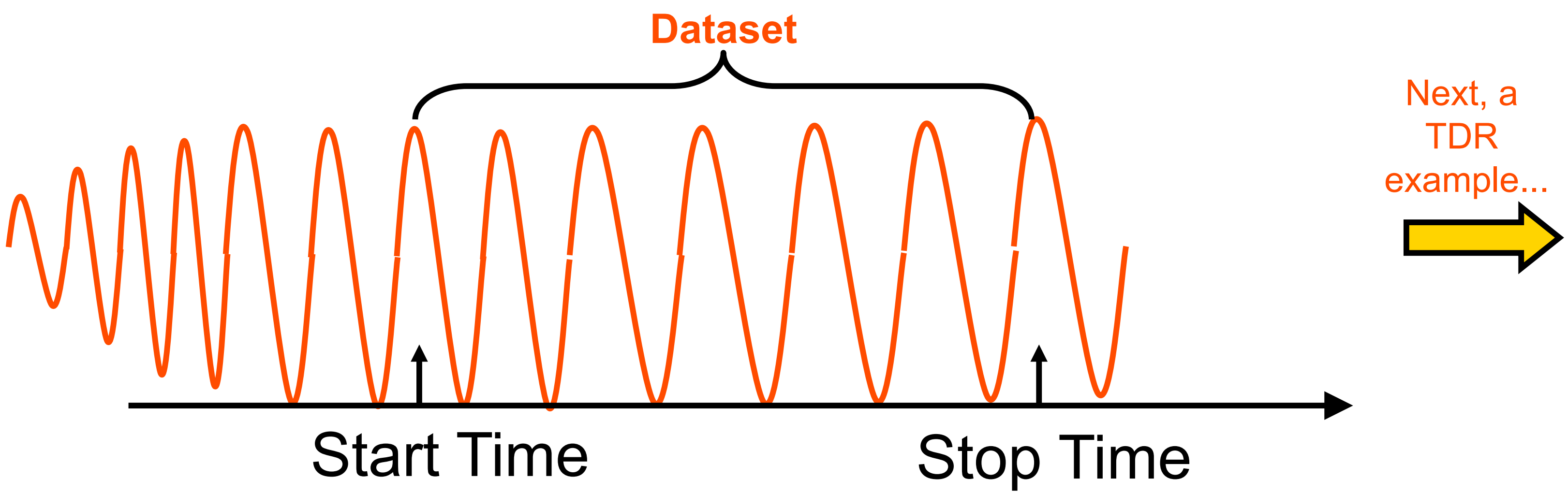
1 / (2 x 15 x 1900MHz) = 17.54 picoseconds.



Next, stop time...

Setting the Transient Stop Time

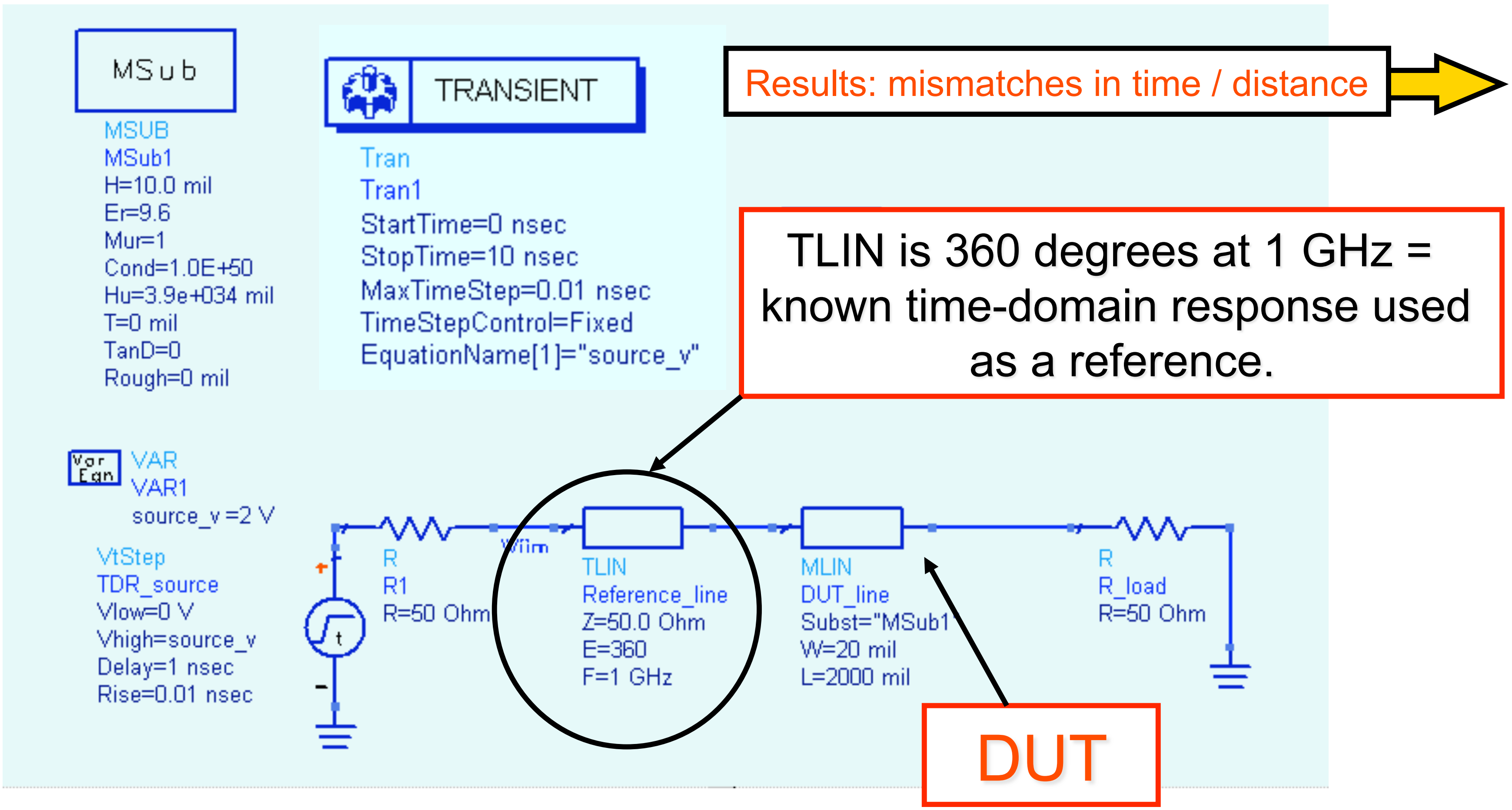
For many circuits: stop time should allow for **periodic - settling**.



NOTE: Transient analysis can be tricky. Sampling before a circuit reaches steady state will not give correct results when transformed into the frequency domain. Also, use a time step that is at least 1 / twice the highest frequency of interest.

EXAMPLE: Transient TDR Setup

NOTE: After the course, you can use this slide as a reference if you need it!



EXAMPLE: TDR Data Display results...

Results:
mismatch
delay time
rho
BW
VSWR
mtrs to mils

Eqn Er = 9.6

Eqn velocity = 3e8 / sqrt(Er)

Eqn distance_mtrs = (velocity * (indep(m2) - indep(m1))) / 2

Eqn distance_mils= distance_mtrs * (1e5/2.54)

Eqn bw=0.35/0.1e-9

bw
3.500E9

Eqn z_line = Zo * ((1 + rho) / (1 - rho))

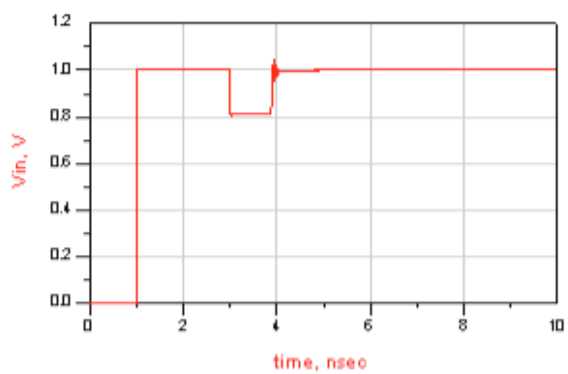
Eqn Zo = 50

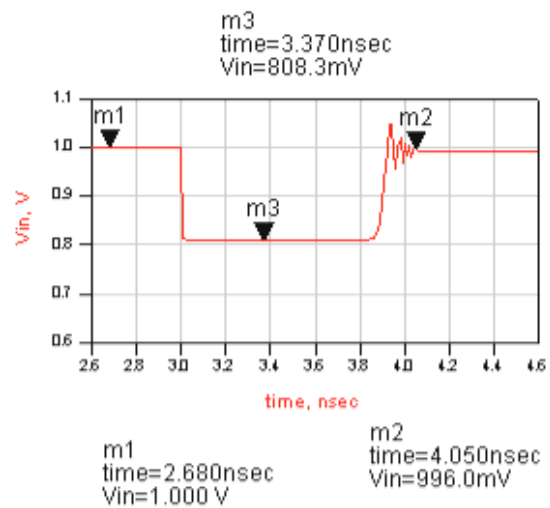
Eqn rho = (m3 - ref_v) / (ref_v)

Eqn ref_v = source_v [1]/ 2

rho	z_line	ref_v
-0.192	33.916	1.000

distance_mtrs	distance_mils
0.066	2611.214





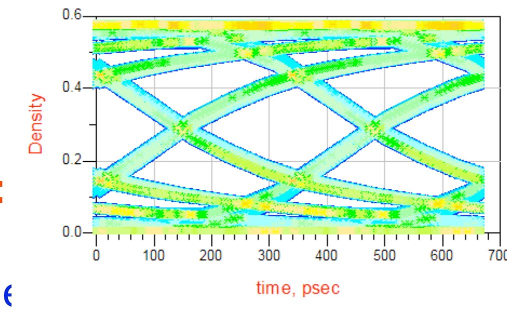
Eqn VSWR = (1 + mag (rho)) / (1 - mag (rho))

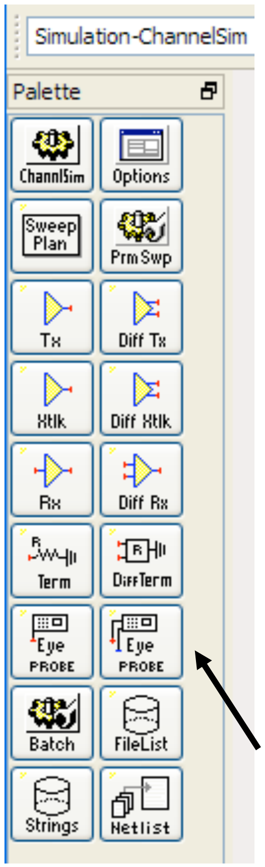
VSWR
1.474

Next, Channel Simulator…

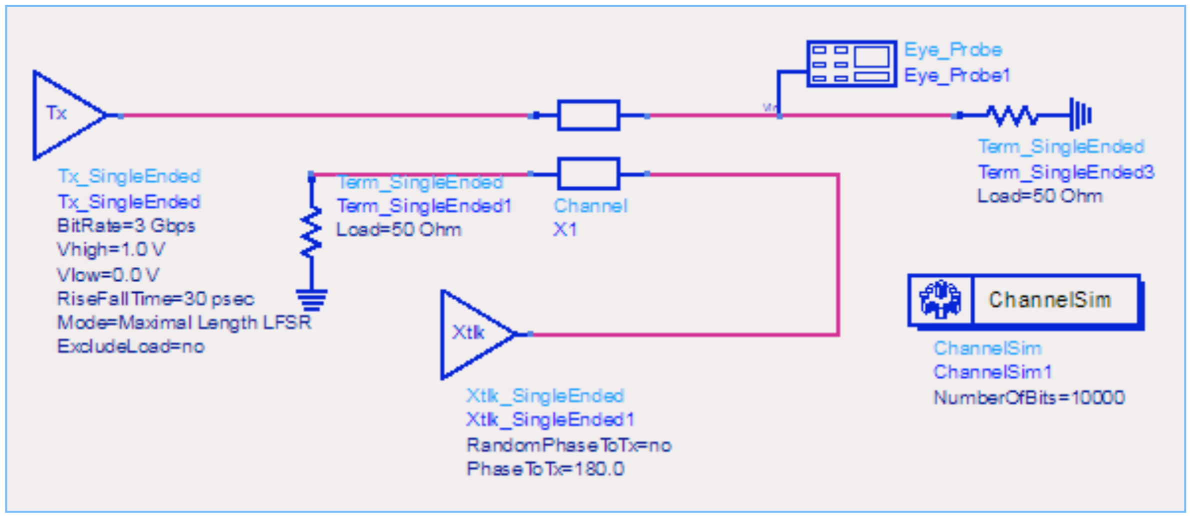
Channel Simulator…

A fast form of time domain (Transient) simulation for linear / time invariant systems:





Tx source (pulse with jitter) is injected and a de
diagram) results without having to store all the transient data = fast.



SEE: examples\SignalIntegrity\ChannelSimulatorTutorial_prj\DocExample.dsn

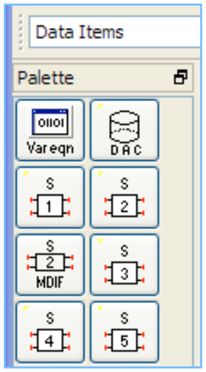
Eye probes are also available in the Transient palette, and can be used for nonlinear systems with Transient.

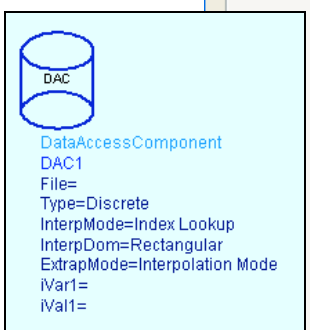
Next, the DAC...

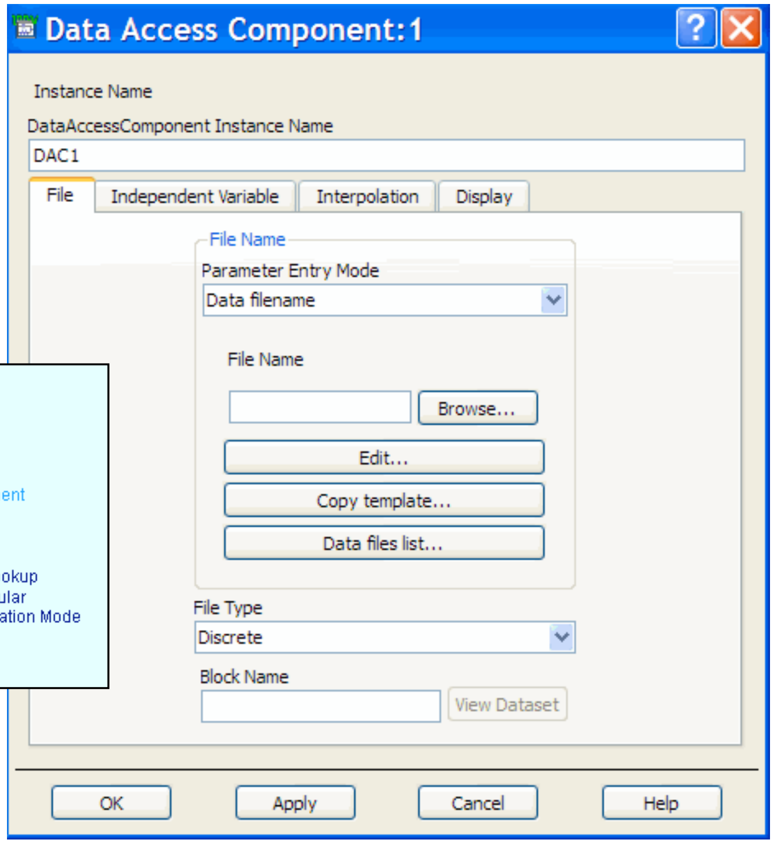
DAC (data access component)

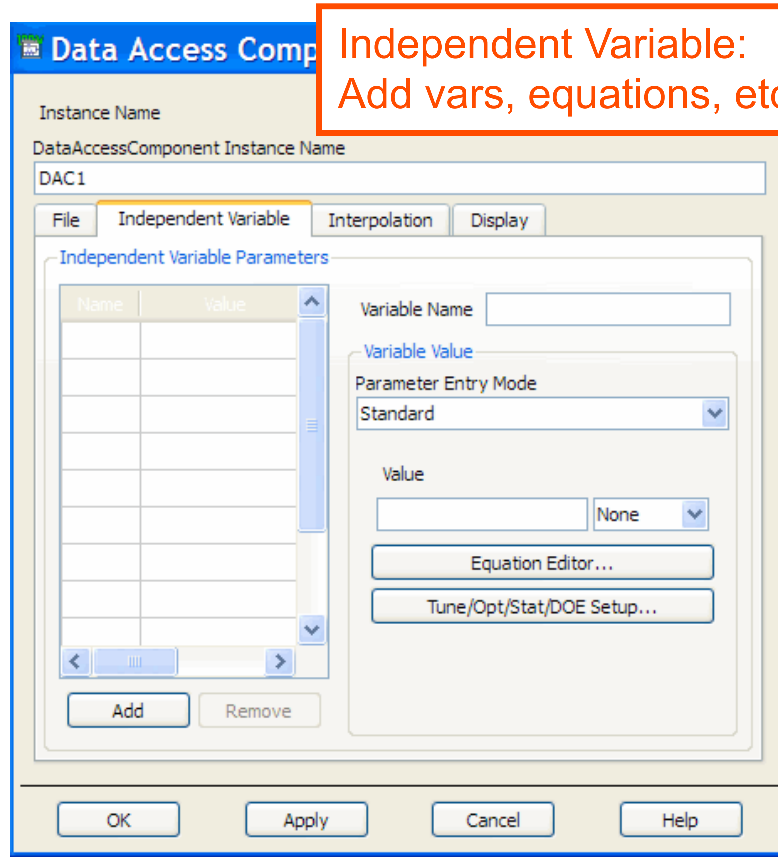
The DAC points to a file and reads it: use for measured data or any tabular data.

File tab: Specify the file location, mode, edit, etc.









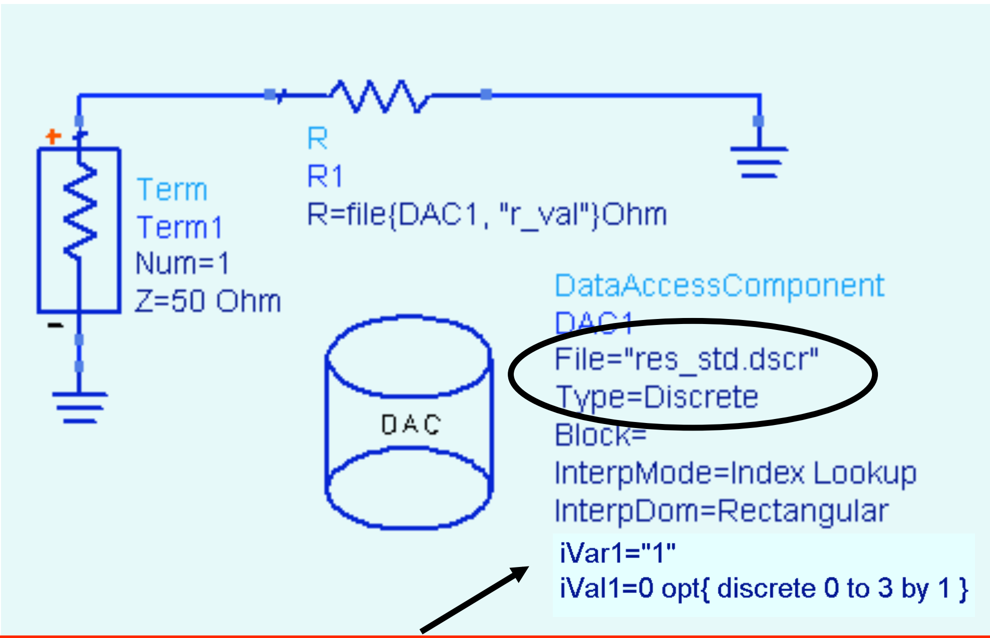
Independent Variable: Add vars, equations, etc.

NOTE: DACs are covered in detail in the Advanced class.

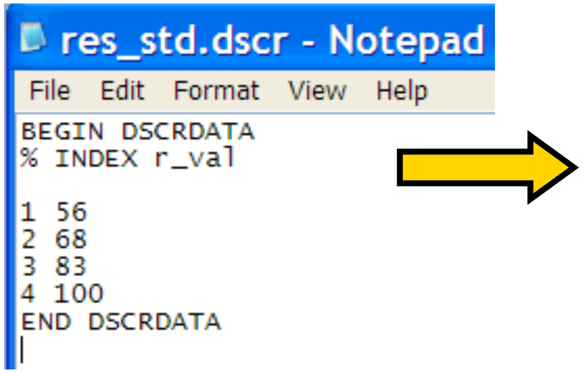
DAC example:

DAC example: discrete file

For optimization, R1 is assigned to a file which is read by the DAC. “res_std.dscr” contains an index and a list of values (r_val). In the DAC, variable iVal1 is enabled over the range of indexed values beginning with iVar1 which is the first index point in the file.



NOTE: iVar1 always = 1 for Discrete (index at first column).
However, iVal1 always starts = 0 (same as ADS data).



The file must be in the DATA directory and must be in correct format. The circuit simulation manual has information on file formats such as DSCR..

DAC Optimization: OPT setup and results

GOAL

Goal
OptimGoal1
Expr="my_dbs11"
SimInstanceName="SP1"
Min=
Max=-23
Weight=
RangeVar[1]=
RangeMin[1]=
RangeMax[1]=

MeasEqn
meas1
my_dbs11= db(S(1,1))

OPTIM

Optim
Optim1
OptimType=Discrete
DesiredError=0.0
StatusLevel=4
FinalAnalysis="None"
NormalizeGoals=no
SetBestValues=yes
SaveSolns=no
SaveGoals=no
SaveOptimVars=no
UpdateDataset=yes
SaveNominal=no
SaveAllIterations=no
UseAllOptVars=yes
UseAllGoals=yes
SaveCurrentEF=no

Save values = no. Only the MeasEqn is sent to the dataset with the final iVal1 which is 0 = 56 ohms and which gives the least reflection. Also, click Simulate > Update Optimization Values to update the iVal in the DAC.

res_std.dscr - Notepad

File Edit Format View Help

```
BEGIN DSCRDATA
% INDEX r_val

1 56
2 68
3 83
4 100
END DSCRDATA
```

freq	my_dbs11	iVal1
1.000GHz	-24.943	0.000

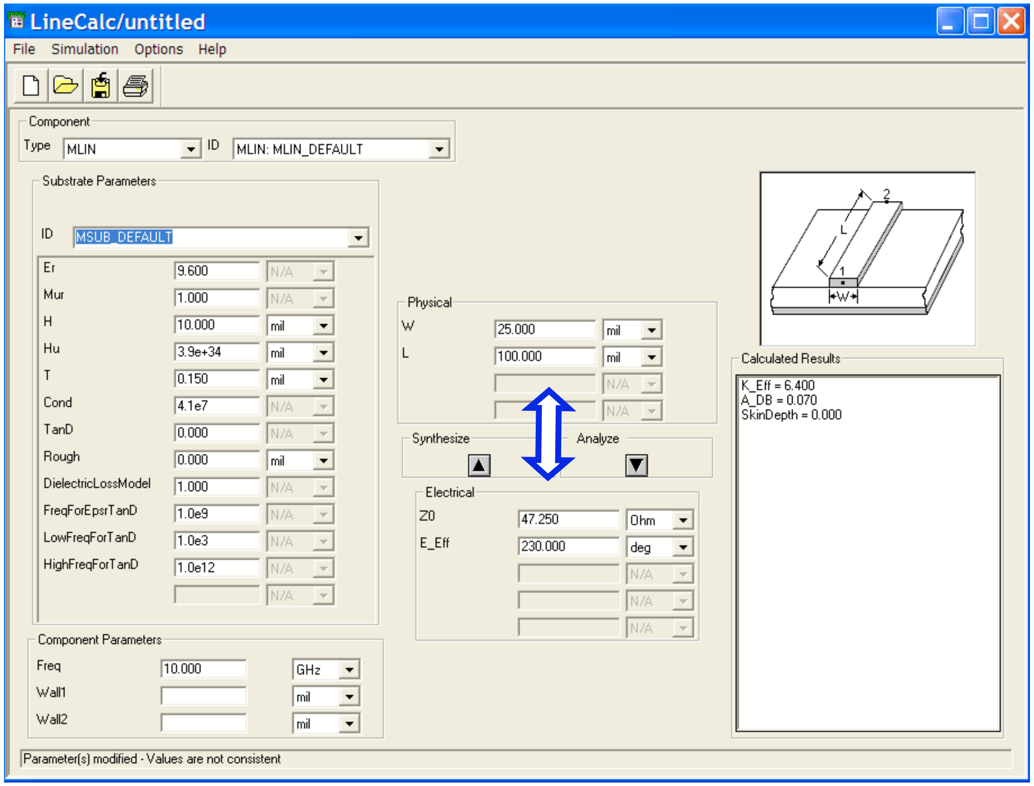
DataAccessComponent
DAC1
File="res_std.dscr"
Type=Discrete
Block=
InterpMode=Index Lookup
InterpDom=Rectangular
iVar1="1"
iVal1=0 opt{ discrete 0 to 3 by 1 }

NOTE: iVar1 must =1 only for Discrete.

Next, LineCalc...

EXTRA INFORMATION: LineCalc and Model Composer

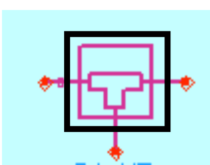
Go to schematic, click Tools > LineCalc > Star LineCalc



LineCalc is still available!

LAB exercise…

- Define the substrate
- Enter L & W to get electrical
- Enter electrical to get L & W



MODEL COMPOSER. Generate passive library models (parameterized) for simulation. AMC (Advanced) is even more powerful. You get circuit simulation speed with EM simulation accuracy (Momentum) for any substrate definition.

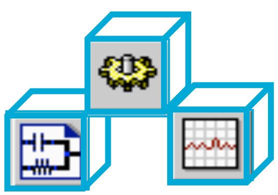
What the lab is about ...

Lab 6:

Filters: DesignGuide, Momentum, Transient and the DAC

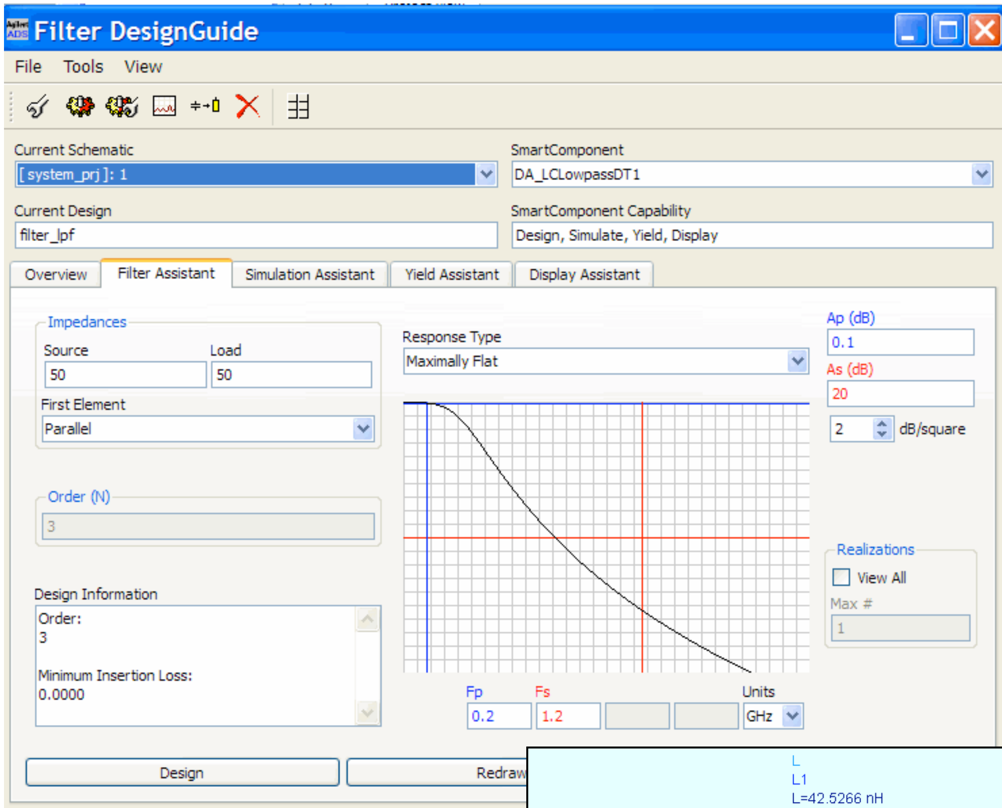
Steps in the Design Process

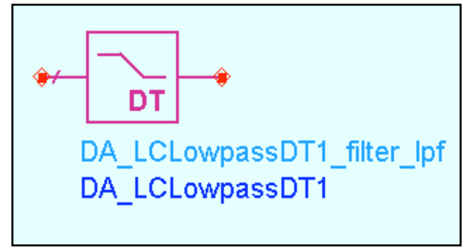
You are here: →



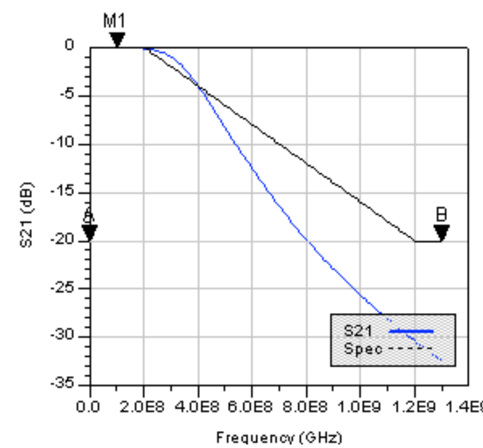
- Design the RF sys behavioral model receiver
- Test conversion gain, spectrum, etc.
- Start amp_1900 design – subckt parasitics
- Simulate amp DC conditions & bias network
- Simulate amp AC response - verify gain
- Test amp noise contributions – tune parameters
- Simulate amp S-parameter response
- 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

Design a 200 MHz LPF with Filter DesignGuide

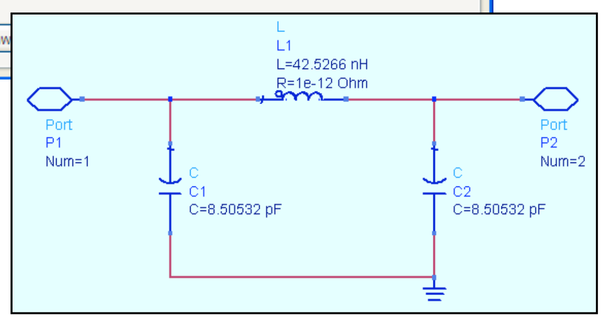




Design and simulate!

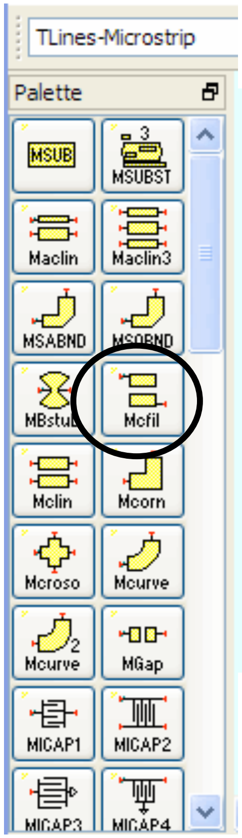


Filter will be used at the IF output (100 MHz) of the receiver.

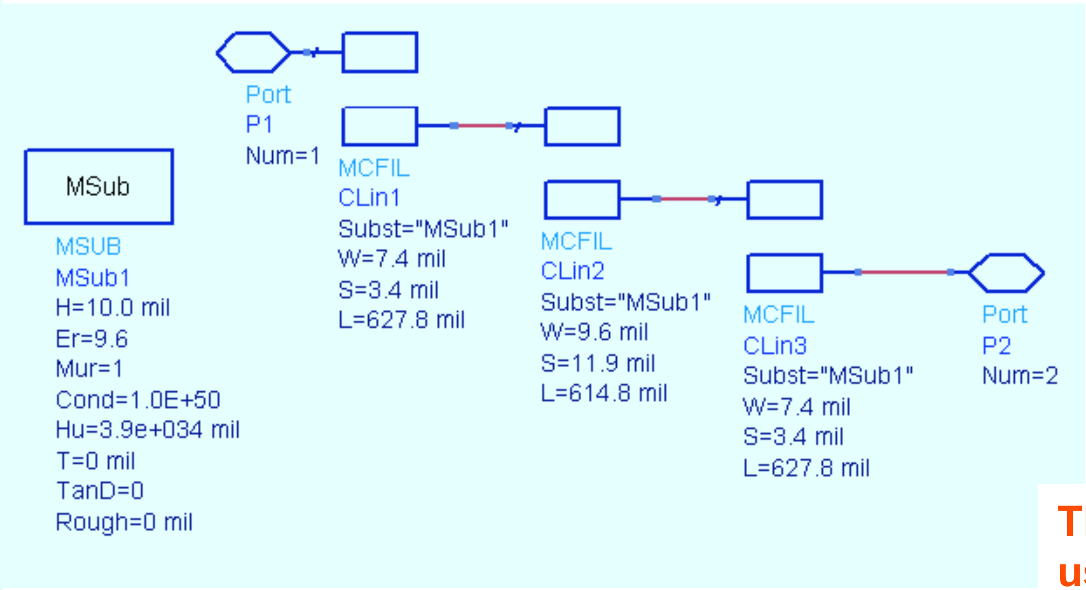


Next, BPF...

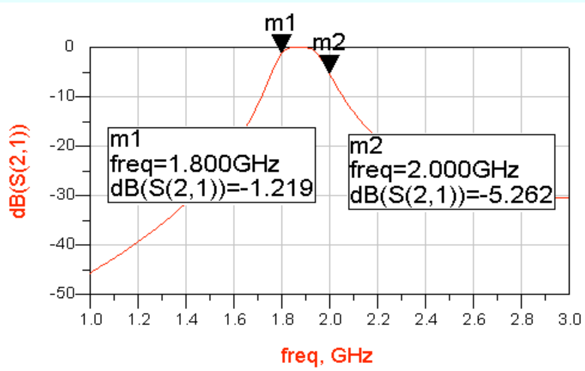
Create a Microstrip BP Filter: 1900 MHz



Microstrip coupled line filter with substrate MSUB



This filter will be used on the input to the RF system.

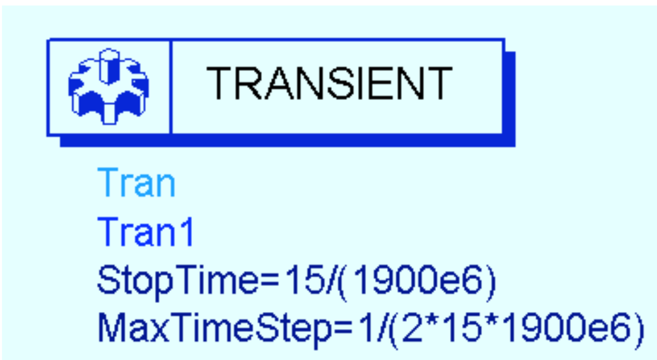


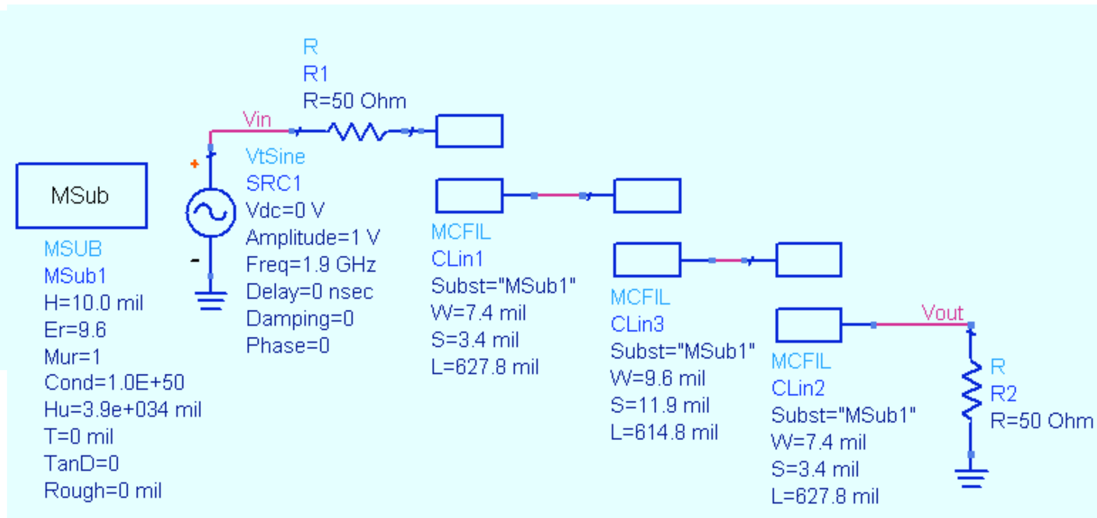
Filter response shown plotted for lab - no need to run S-param simulator.

Next, Transient

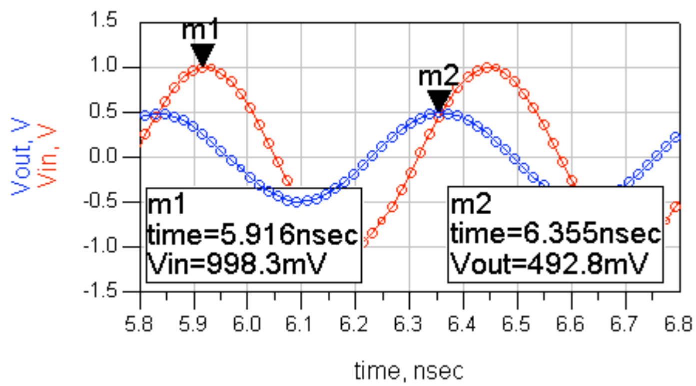
Transient simulation of 1900 MHz BPF

Microstrip coupled line filter with substrate and VtSine source.
Stop time after 15 periods and step using Nyquist for 15 harmonics.





Transient results show input vs output waveforms:



Write an equation using markers and the <u>indep</u> function to calculate delay:

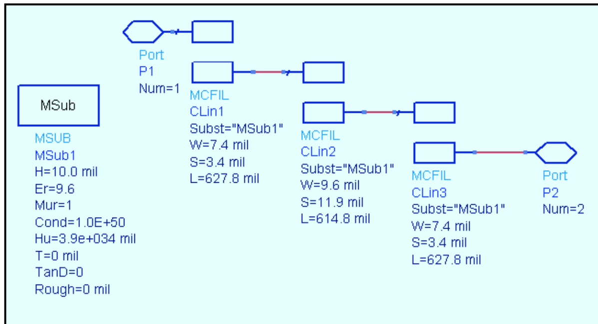
Eqn marker_difference = indep (m2) - indep (m1)

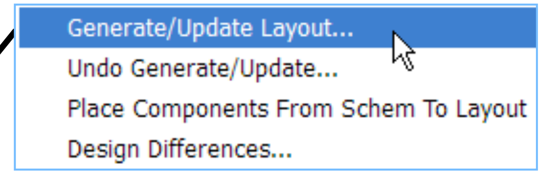
marker_difference
4.386E-10

Next, generate a layout for Momentum

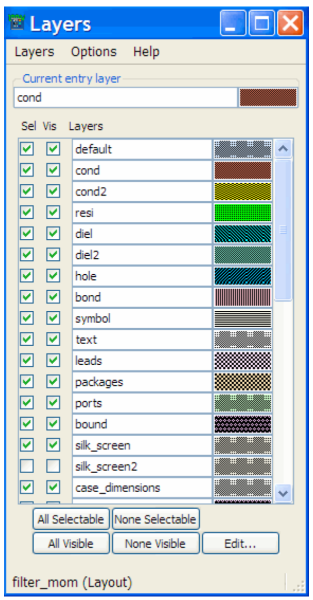
Generate the Layout of 1900 MHz BPF

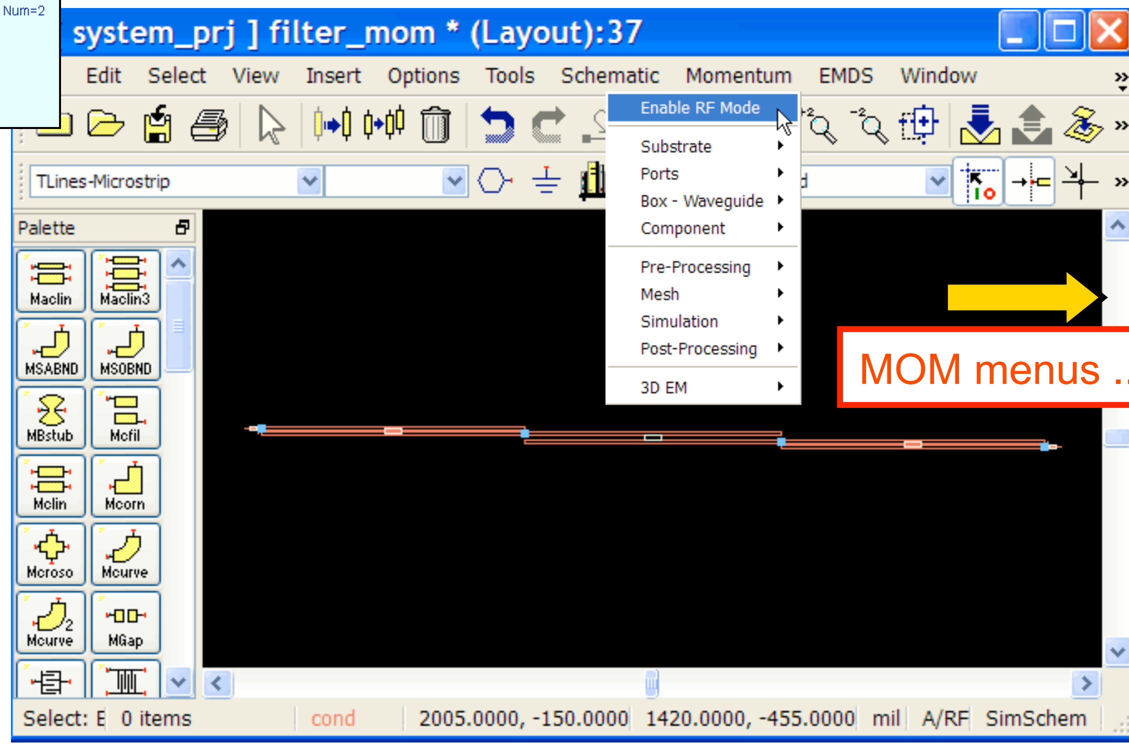
BPF automatically generated and ready for MOMENTUM simulation!





Entry Layer window:

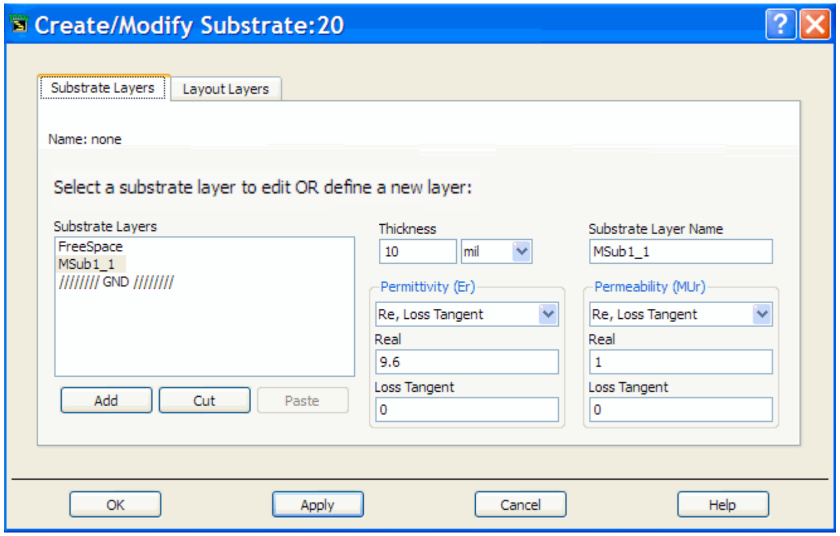


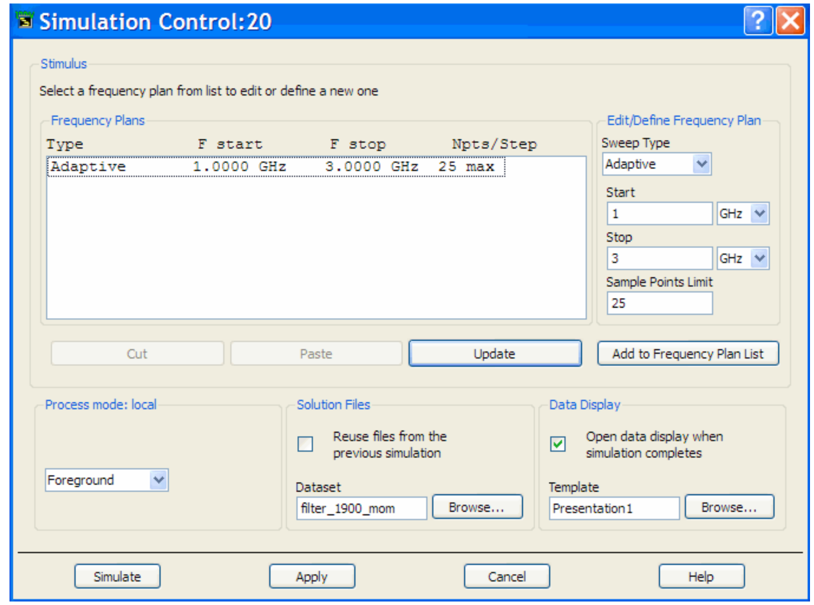


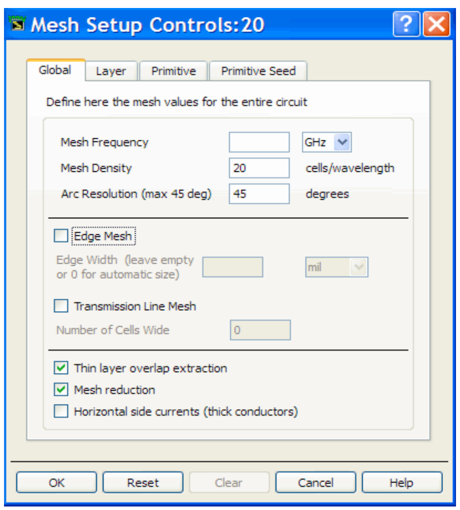
MOM menus ...

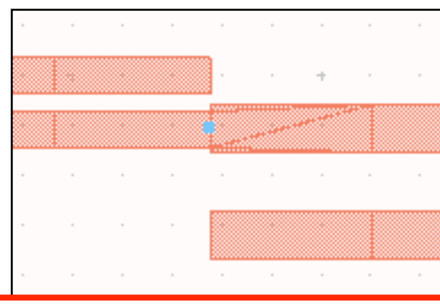
BPF now appears in Layout Window...

Momentum: substrate, mesh, simulation

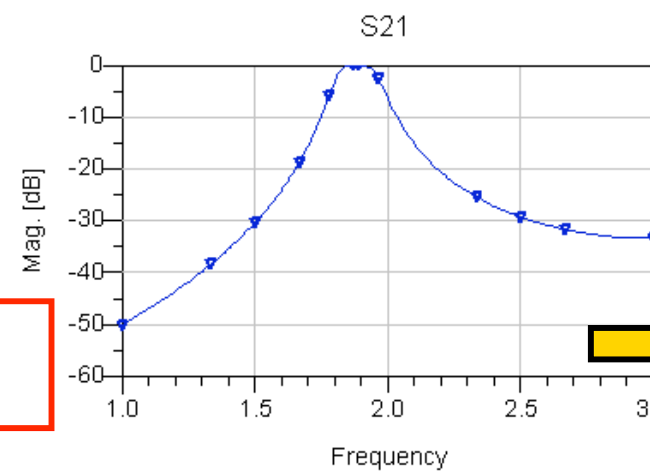








Look at the Mesh and verify the results!

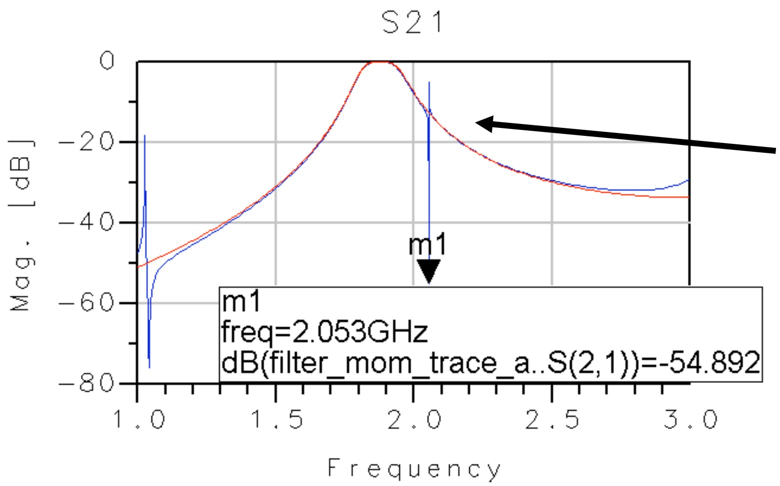


Use MOM to display coupling effects

Use the same layout but add a rectangle alongside the filter:

Coupled Line Filter

…draw a trace in close proximity

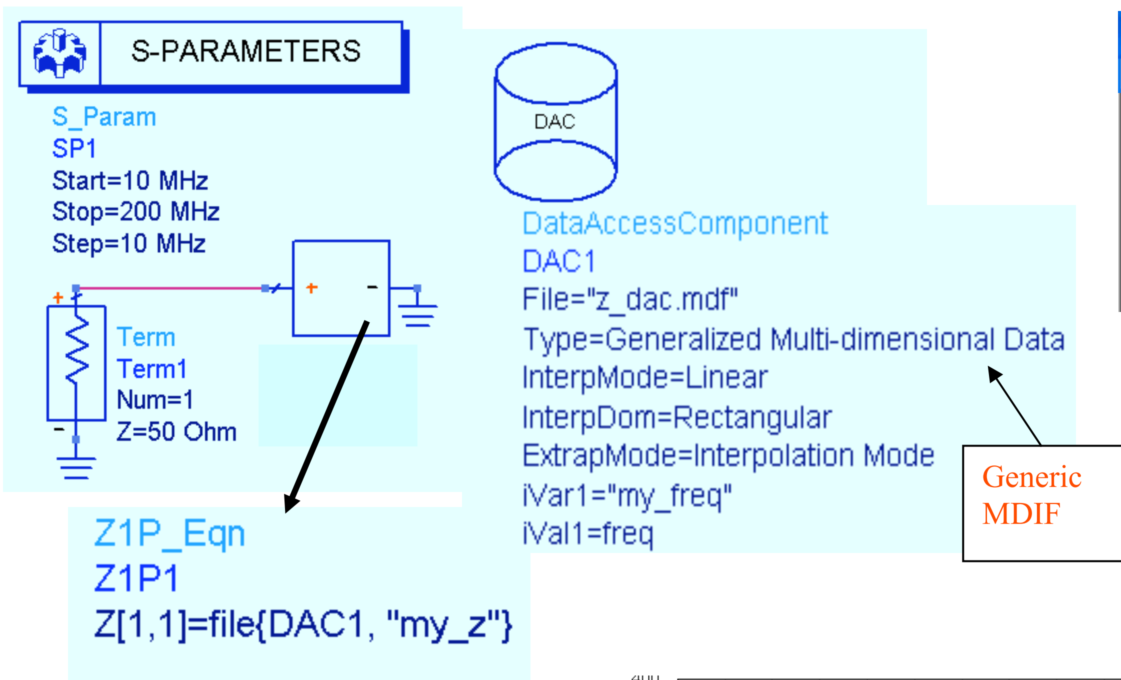


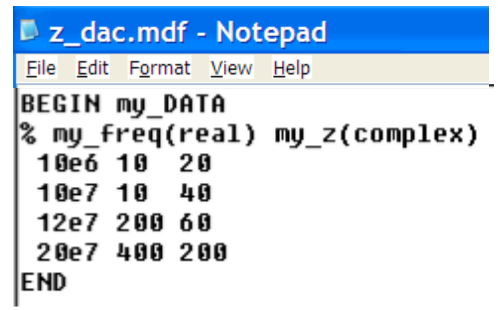
Momentum simulation shows resonance from coupling.

Next, the DAC

OPTIONAL - DAC exercise

Write the file:

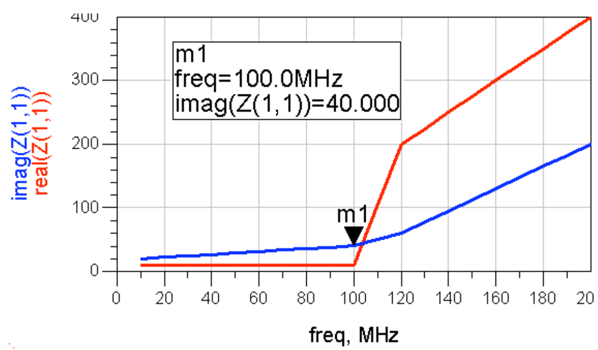




z_dac.mdf - Notepad

File Edit Format View Help

```
BEGIN my_DATA
% my_freq(real) my_z(complex)
 10e6 10  20
 10e7 10  40
 12e7 200 60
 20e7 400 200
END
```



After S-parameter simulation to calculate Z, plot the results.