



# 3-Port ADS Amplifier Simulation

## Rev 2

08/27/26

We will cover basic building blocks in ADS linear (small signal) amplifier simulation.

1. For a 2-Stage amplifier we collect a 3 port S-Parameter file. This is because there is the need for matching on the output of the first stage of the 2-stage amp, and matching on the output of the second stage.
2. In ADS we can hook up the S3P block and produce an S2P response, that way we can include the interstage matching contributions to generate a more accurate simulation.
3. Pay attention to trace lengths between matching components and the DUT. These spacing lengths are critical to producing an 'accurate' ADS output.
4. You'll want to double the length from the DUT (Port3) to the choke inductor. From what we measure in length, this is a peculiar oddity that needs the actual distance in mils to be doubled from what is measured. This makes the sim become more accurate to real world results.



## Overview of the .s3p simulation with labeling. We will discuss key blocks separately.

#1 – Optimization block

#2 – Optimization Goals

#3 – PCB substrate and trace width variable

#4 – .s3p simulation

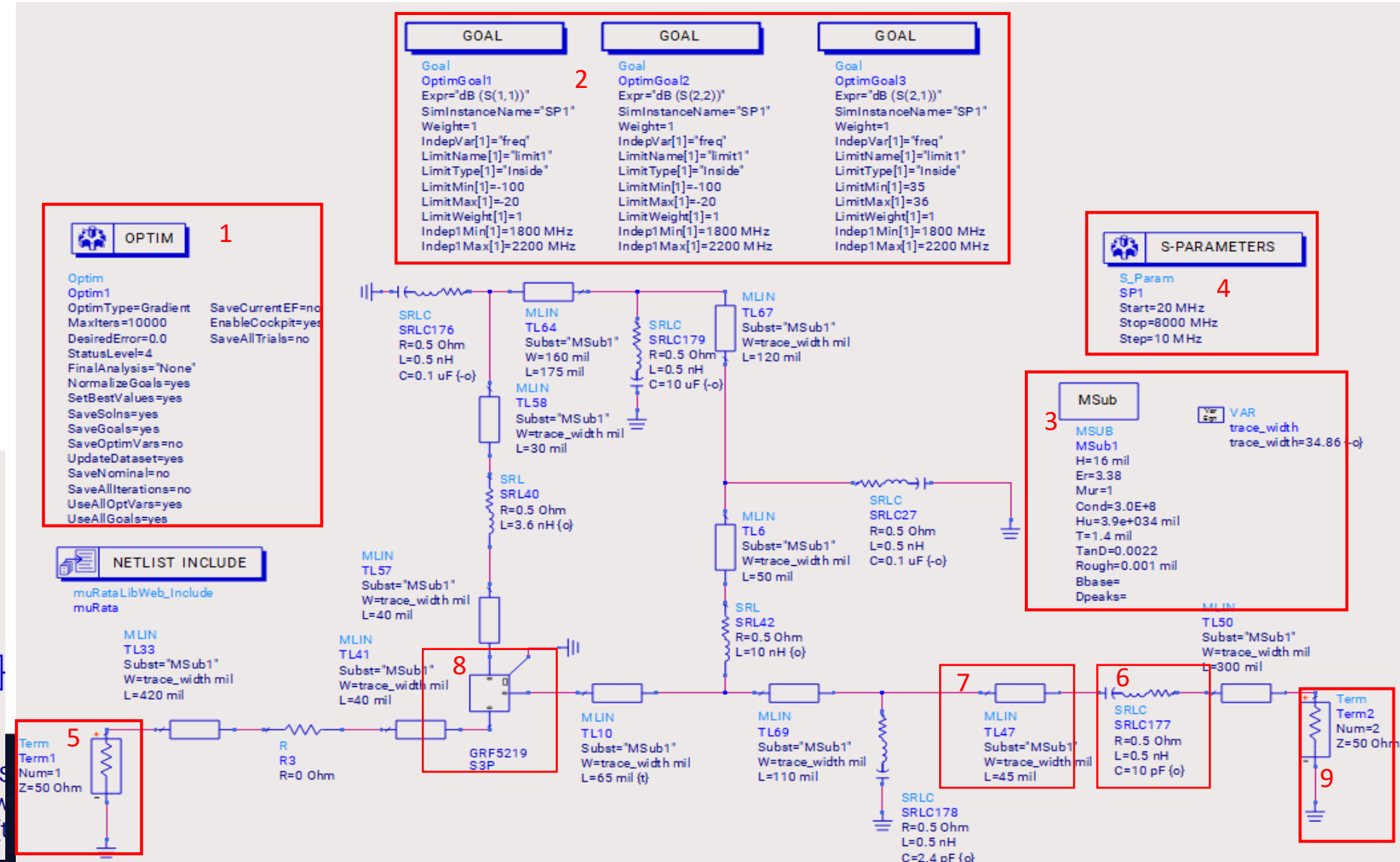
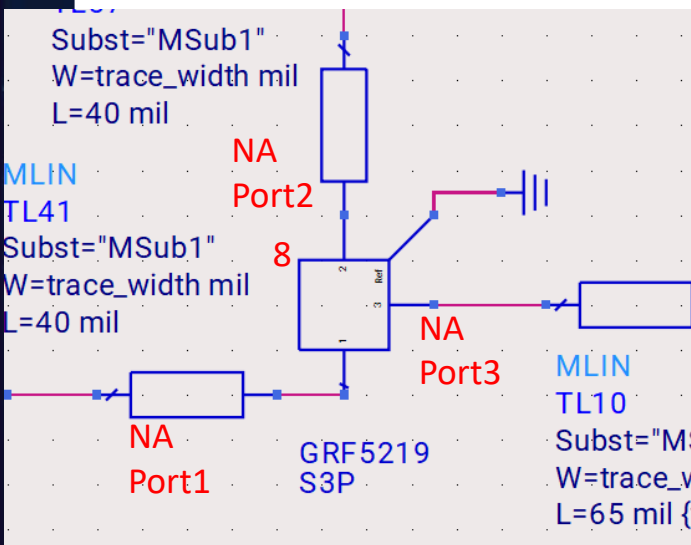
#5 - .s3p port 1

#6 – matching component model

#7 – 50 ohm trace model

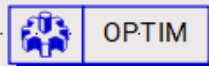
#8 – GRF5219 .s3p file

#9 - .s3p Port 2



## #1 & #2 – Optimization block and goals:

Allow us to use the ADS optimizer. We usually use OptimType = Gradient as this mode will zero in on best solution then stop. The other mode that works well is Random. The optimizer works to obtain Goals. See that we have goals for S11, S22, and S21. These can vary and help create return losses and center gain as desired.



Optim  
Optim1  
OptimType=Gradient  
MaxIters=10000  
DesiredError=0.0  
StatusLevel=4  
FinalAnalysis="None"  
NormalizeGoals=yes  
SetBestValues=yes  
SaveSols=yes  
SaveGoals=yes  
SaveOptimVars=no  
UpdateDataset=yes  
SaveNominal=no  
SaveAllIterations=no  
UseAllOptVars=yes  
UseAllGoals=yes  
SaveCurrentEF=no  
EnableCockpit=yes  
SaveAllTrials=no

GOAL

Goal  
OptimGoal1  
Expr="dB (S(1,1))"  
SimInstanceName="SP1"  
Weight=1  
IndepVar[1]="freq"  
LimitName[1]="limit1"  
LimitType[1]="Inside"  
LimitMin[1]=-100  
LimitMax[1]=-20  
LimitWeight[1]=1  
Indep1 Min[1]=1800 MHz  
Indep1 Max[1]=2200 MHz

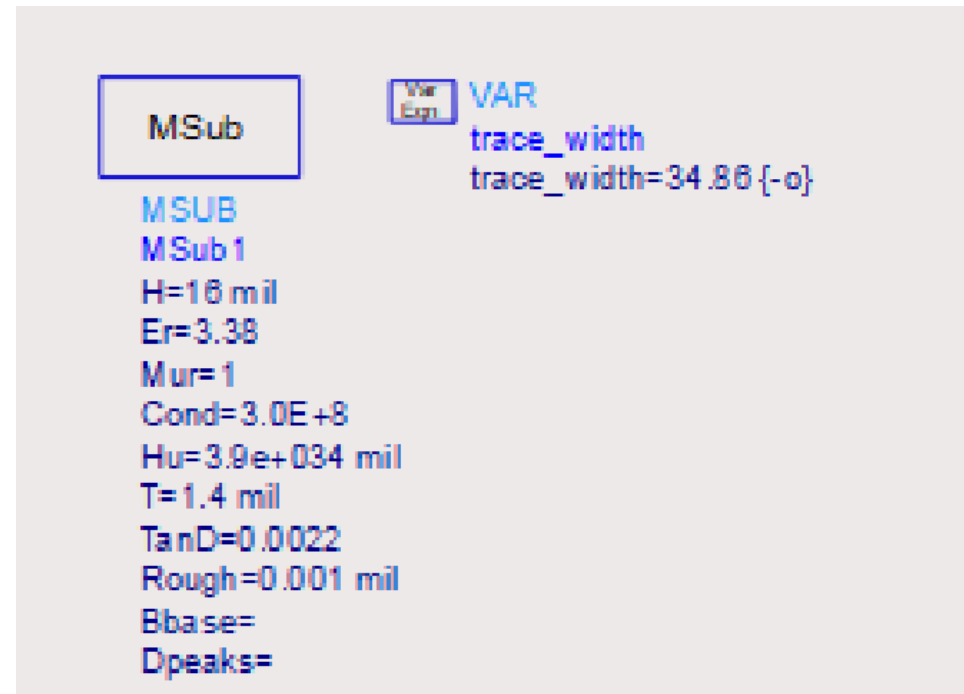
GOAL

Goal  
OptimGoal2  
Expr="dB (S(2,2))"  
SimInstanceName="SP1"  
Weight=1  
IndepVar[1]="freq"  
LimitName[1]="limit1"  
LimitType[1]="Inside"  
LimitMin[1]=-100  
LimitMax[1]=-20  
LimitWeight[1]=1  
Indep1 Min[1]=1800 MHz  
Indep1 Max[1]=2200 MHz

GOAL

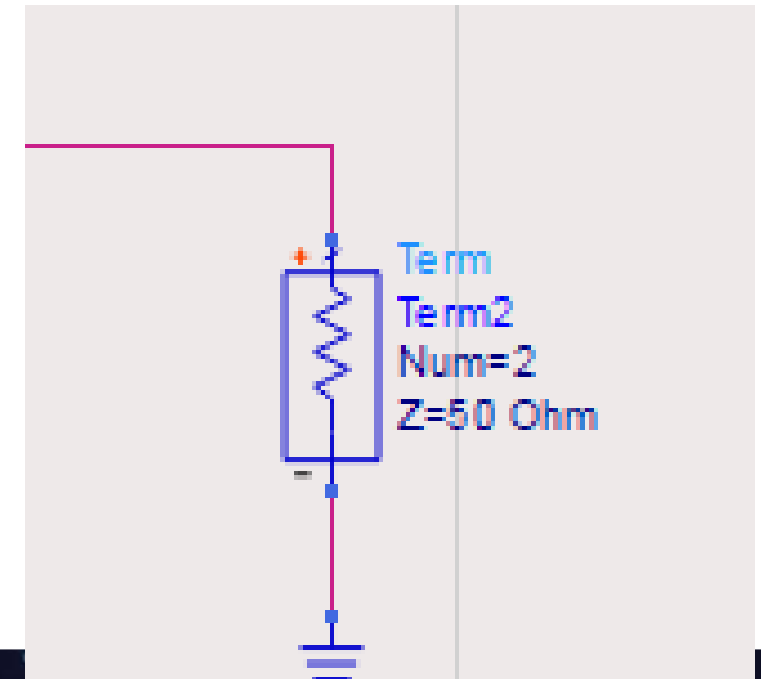
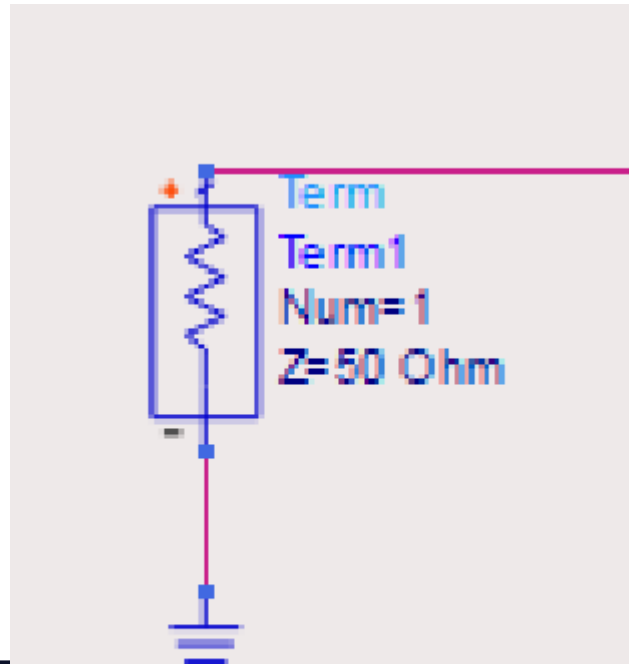
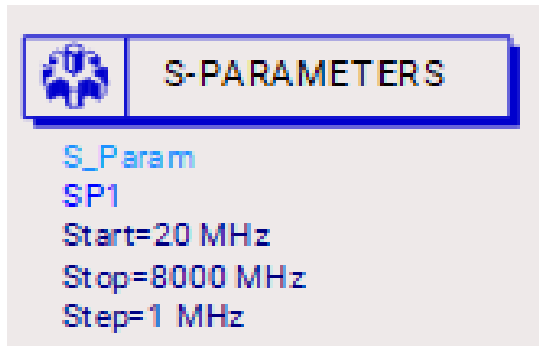
Goal  
OptimGoal3  
Expr="dB (S(2,1))"  
SimInstanceName="SP1"  
Weight=1  
IndepVar[1]="freq"  
LimitName[1]="limit1"  
LimitType[1]="Inside"  
LimitMin[1]=35  
LimitMax[1]=36  
LimitWeight[1]=1  
Indep1 Min[1]=1800 MHz  
Indep1 Max[1]=2200 MHz

#3 – PCB substrate and trace width variable: Substrate parameters are not critical. Trace width needs to be such that trace impedance = 50 ohm. This was established in a separate simulation where trace width was optimized for 50 ohm impedance.

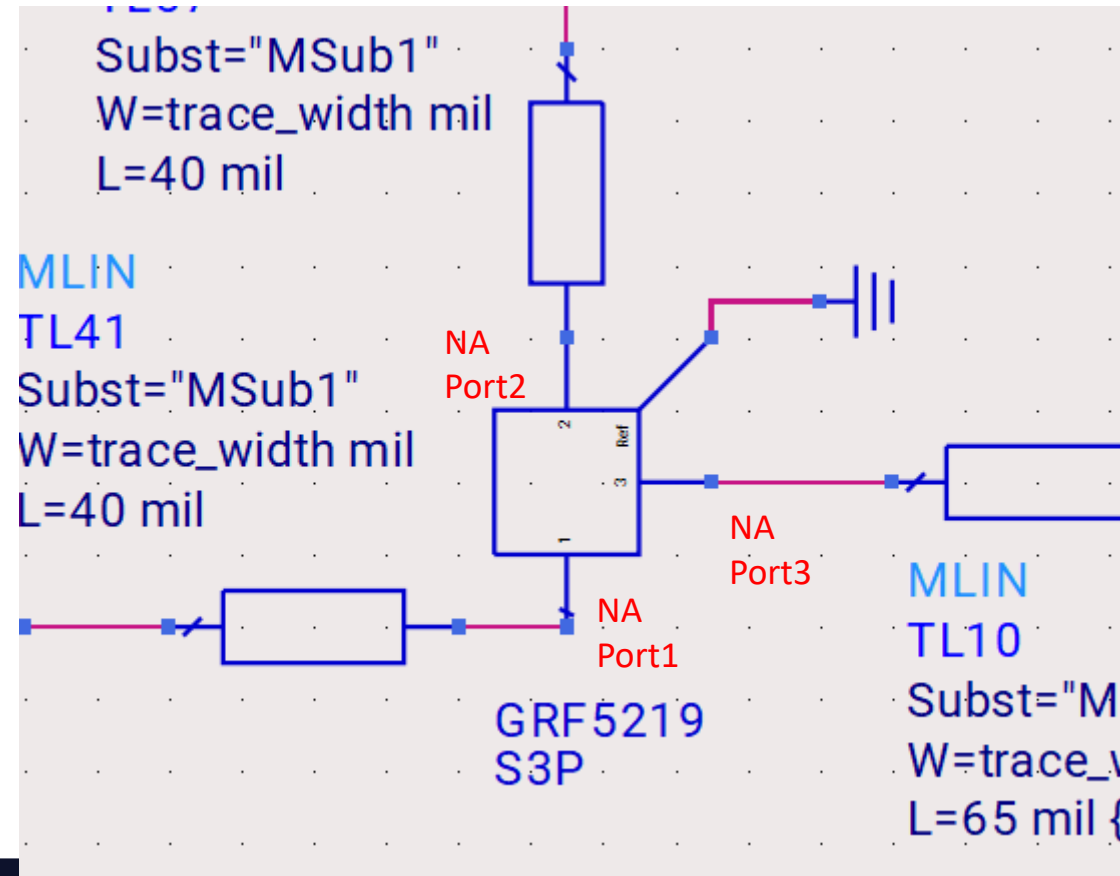


#4 – .s2p simulation, #5 - .s2p port 1, #9 - .s2p port 2: these three are required to run the .s2p simulation along with device.s3p file.

While the S-Parameter file is a .s3p we are looking at an output of an .s2p, the S3P file allows us to include the interstage, PA stage 1, matching contribution.



#8 – GRF5219 .s3p file: the basis for our .s2p simulation output = .s3p de-embedded to device pins allows for a more accurately model close to the matched device.

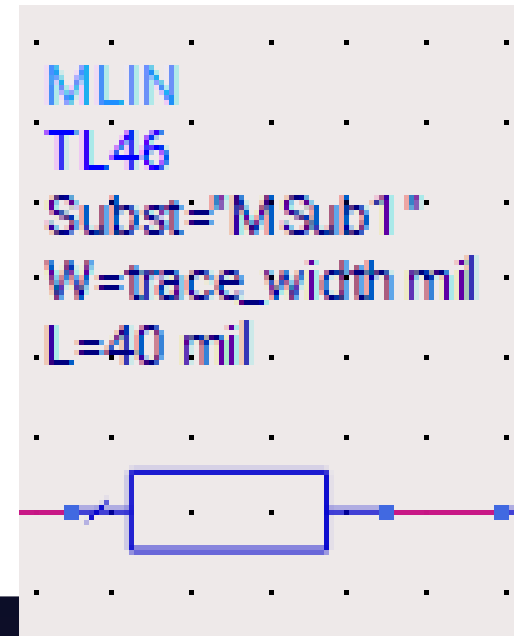
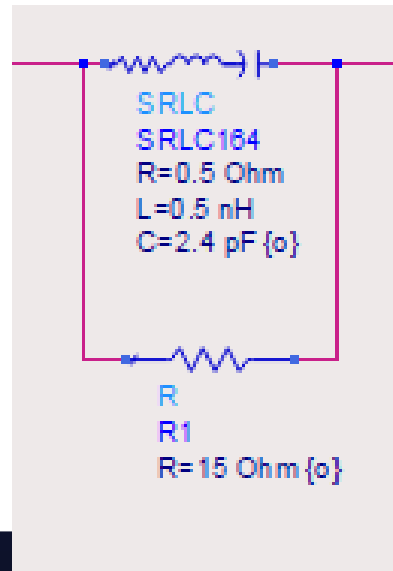
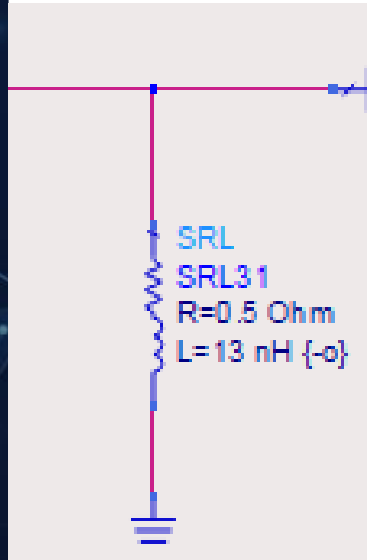


## #6 – matching component models and #7 – 50 ohm trace model:

We use hand built L/C/R models as shown, with “optimize” handle enabled (o) or disabled (-o).

These models, perhaps not perfectly accurate, have historically yielded very good results that repeat when the actual board is built.

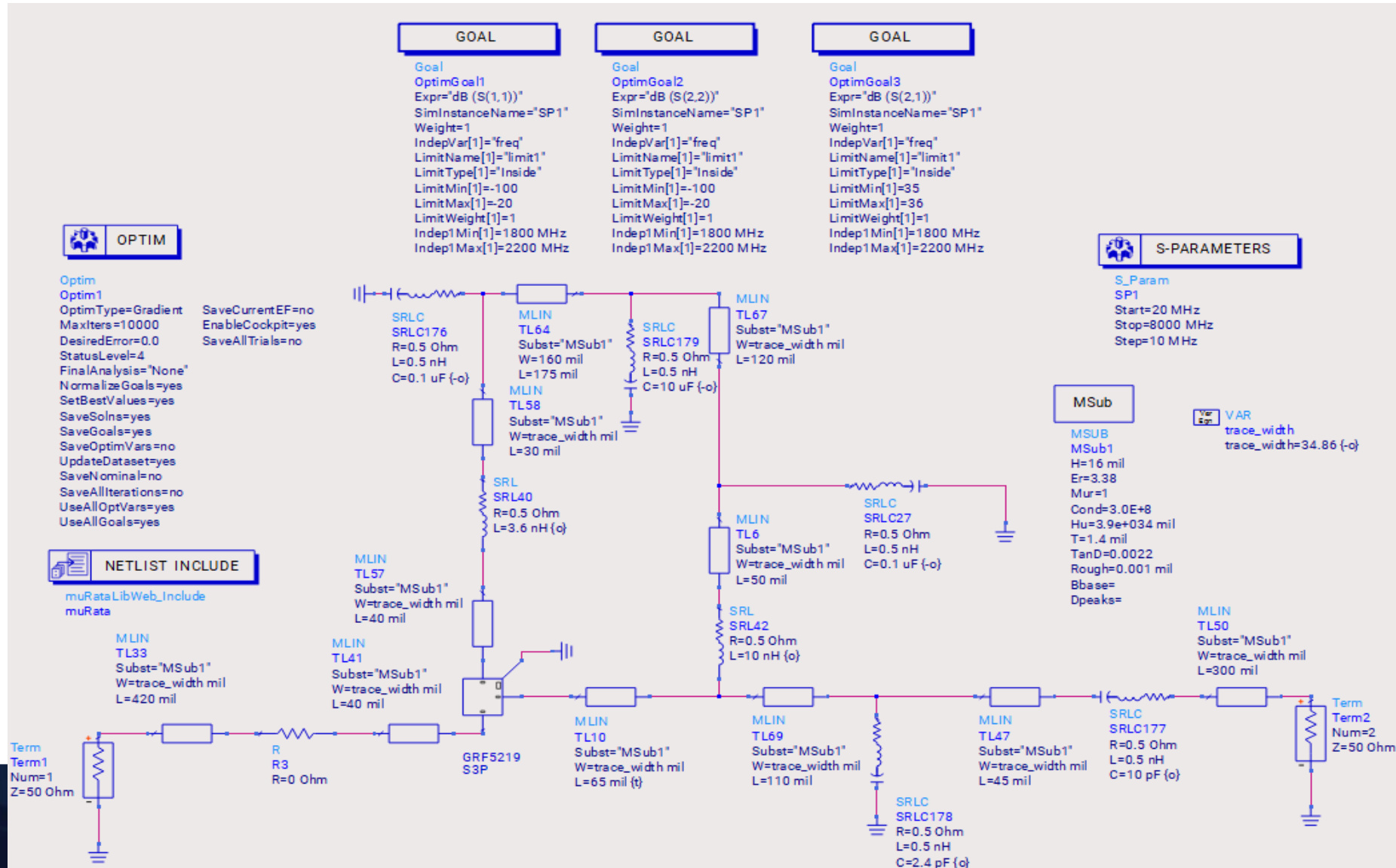
Trace lengths are used as well since EVB has them in place. They can be measured with a caliper on EVB and entered here in mil. See we use “MLIN” model. Coplanar wave guide (CPWG) model can also be used, but either seem to work just as well. See that the MLIN has the “trace\_width” parameter discussed in slide 5.





# Actual data vs. ADS sim in this presentation

Sim setup  
using S3P



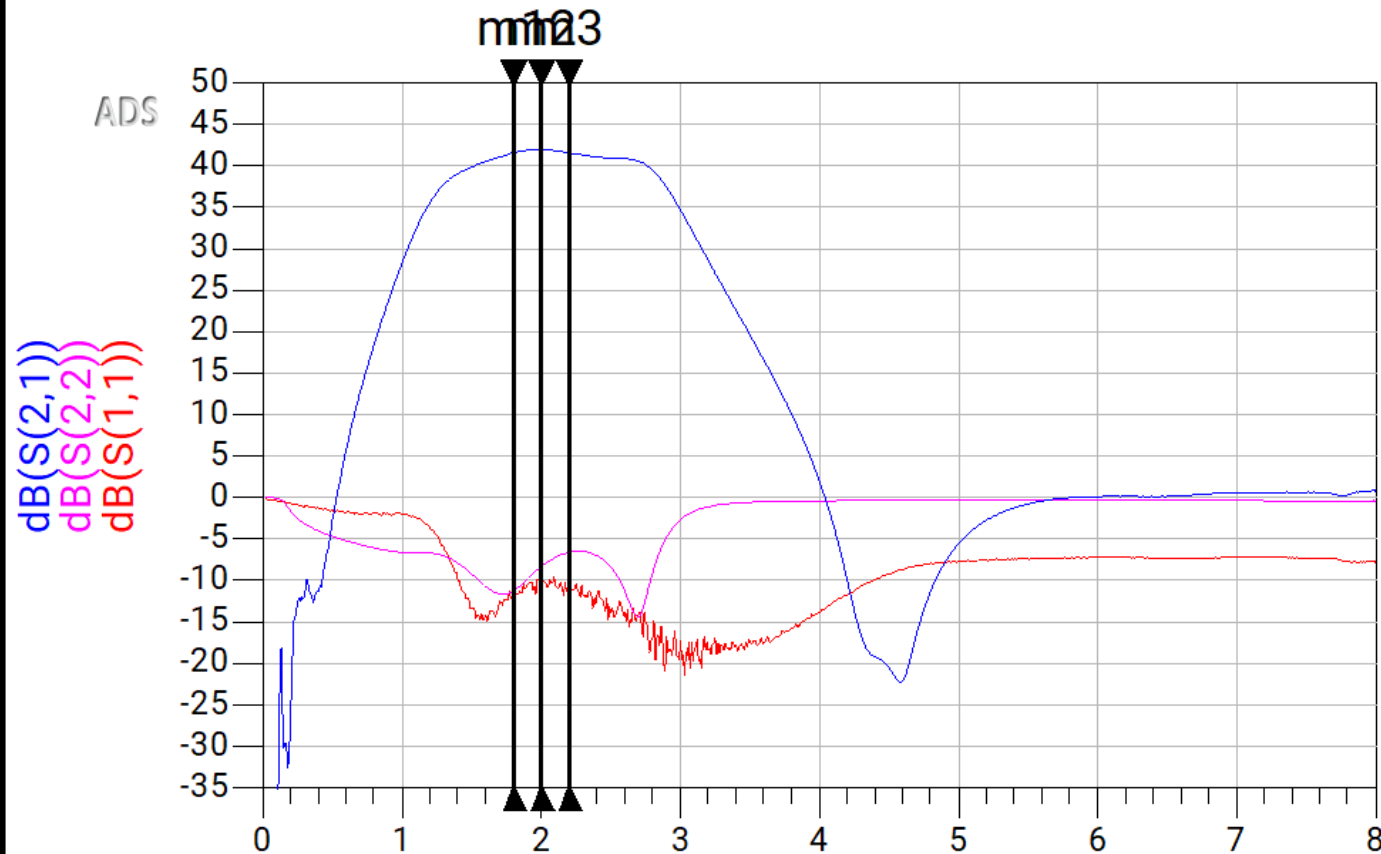
Sim output  
using S3P

Sim vs. Real  
output values  
close within  
reason

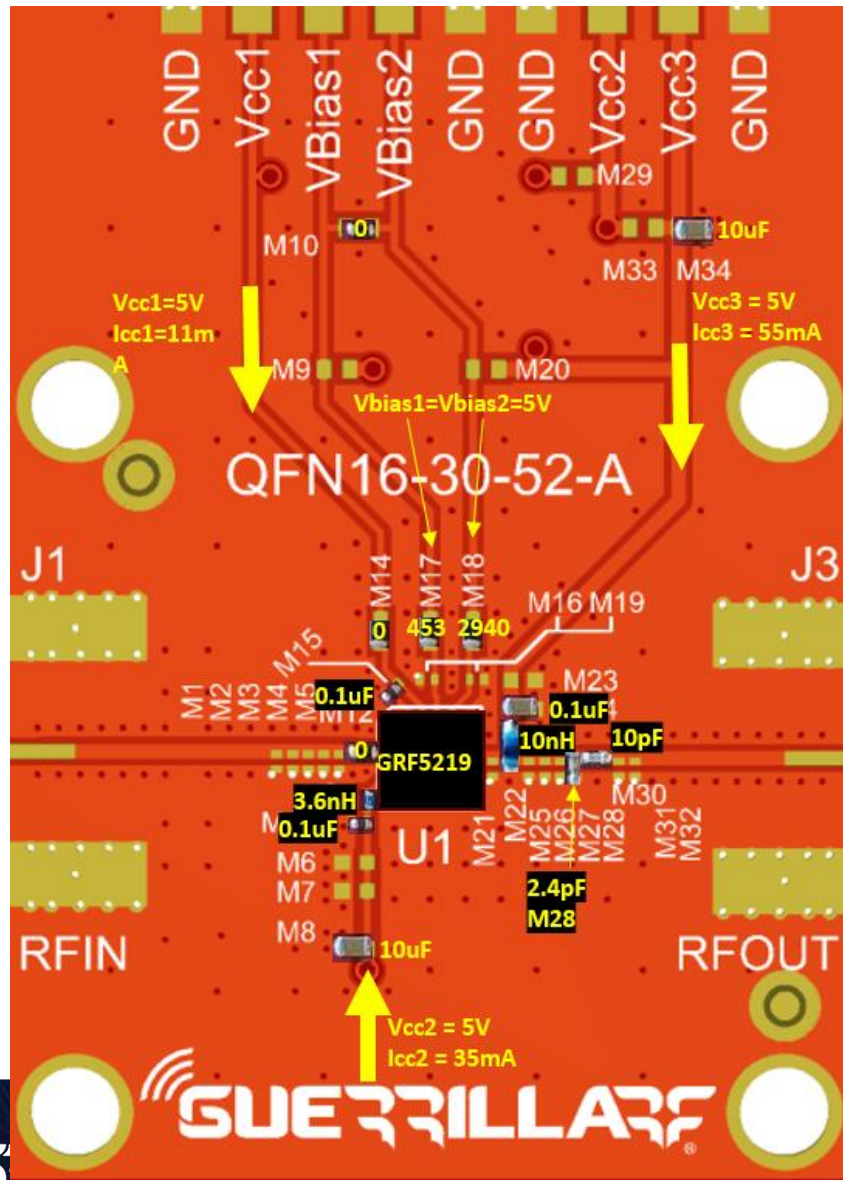
m1  
freq=1.800 GHz  
 $\text{dB}(S(1,1))=-11.336$   
 $\text{dB}(S(2,2))=-11.161$   
 $\text{dB}(S(2,1))=41.589$

m2  
freq=2.000 GHz  
 $\text{dB}(S(1,1))=-10.142$   
 $\text{dB}(S(2,2))=-8.264$   
 $\text{dB}(S(2,1))=41.966$

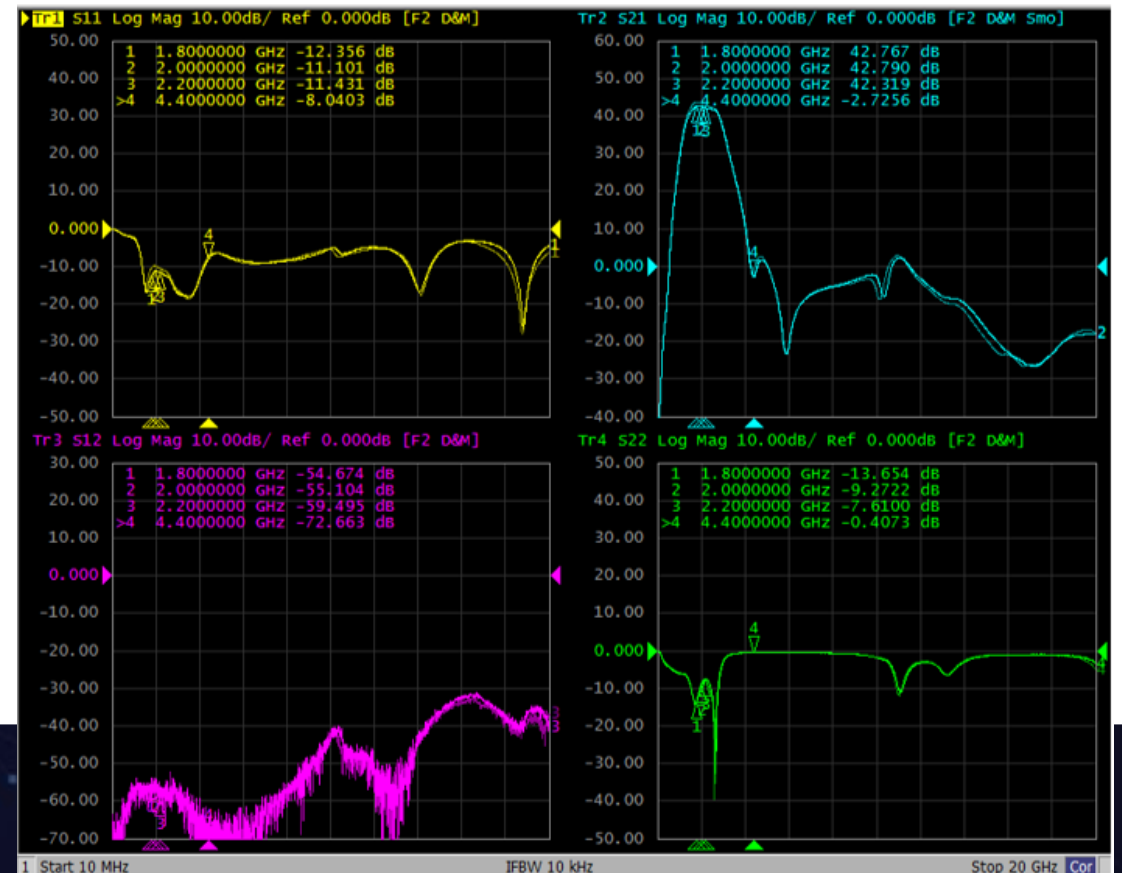
m3  
freq=2.200 GHz  
 $\text{dB}(S(1,1))=-10.389$   
 $\text{dB}(S(2,2))=-6.589$   
 $\text{dB}(S(2,1))=41.549$



## Actual EVB BOM



## Actual EVB Measured S-Parameters





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