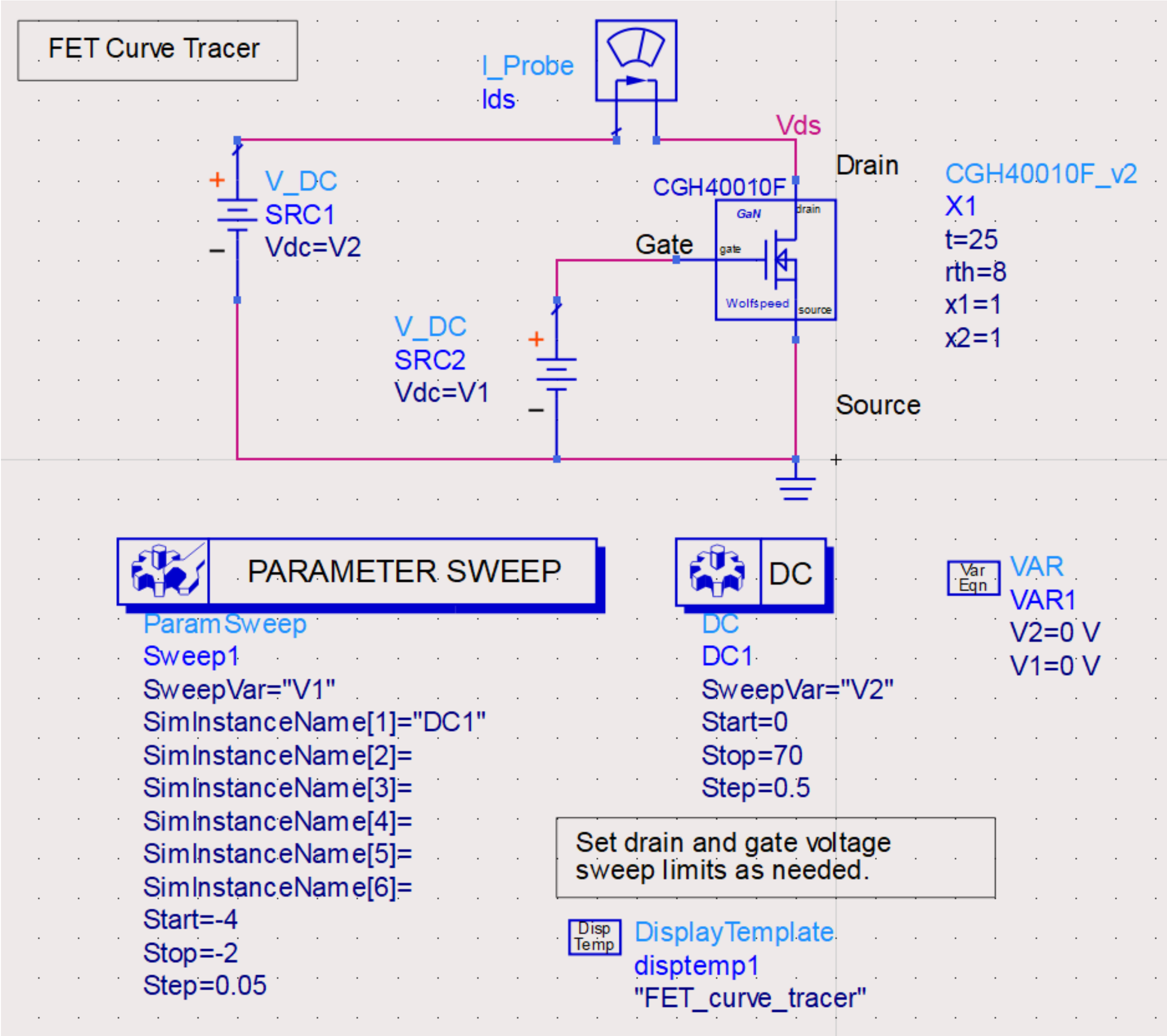
PROBLEM STATEMENT –

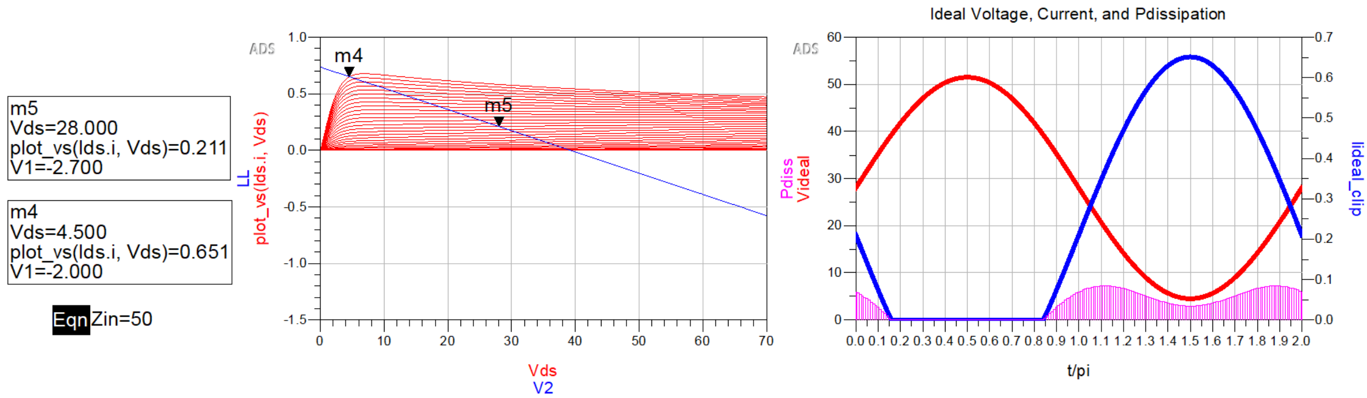
Design a harmonically tuned power amplifier to efficiently operate in S-band frequency for satellite communications.

Steps involved in designing of a power amplifier –

1. DC biasing
2. Stability analysis
3. Load pull analysis
4. Input and output Impedance matching
5. Optimize the design for required specifications.

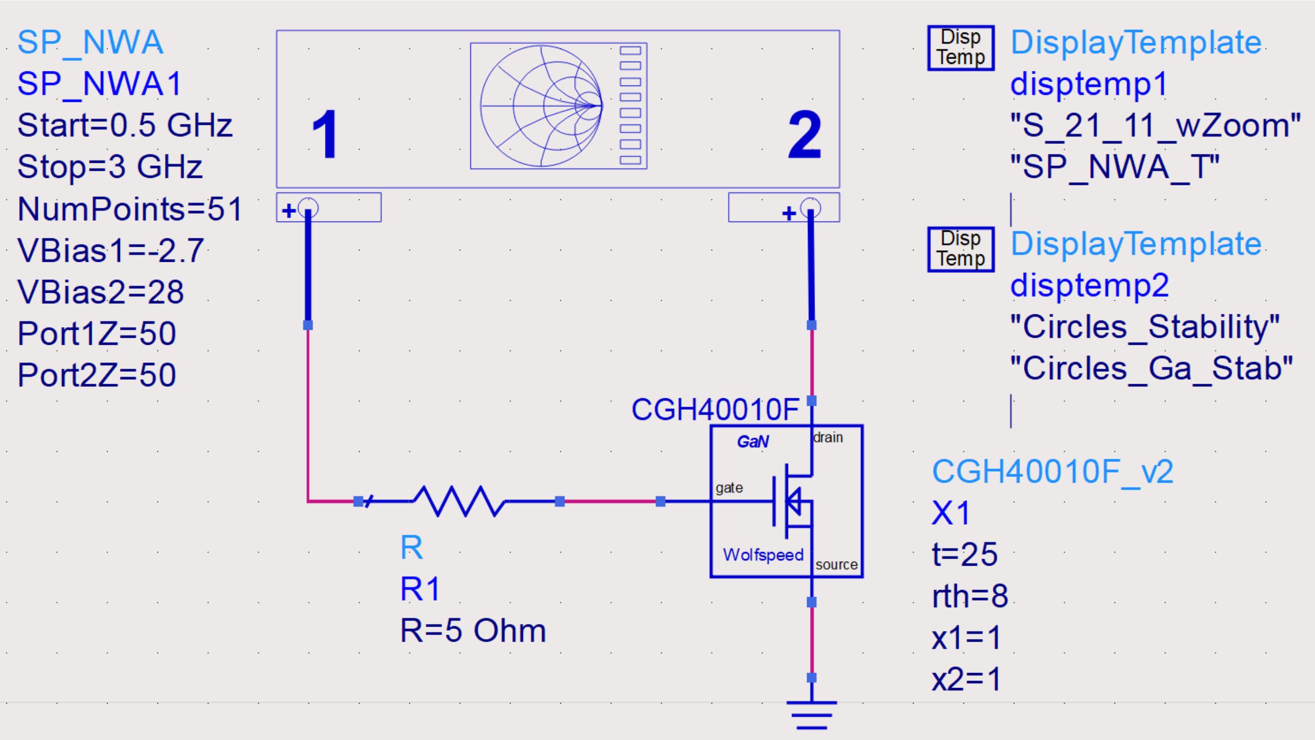
DC Biasing

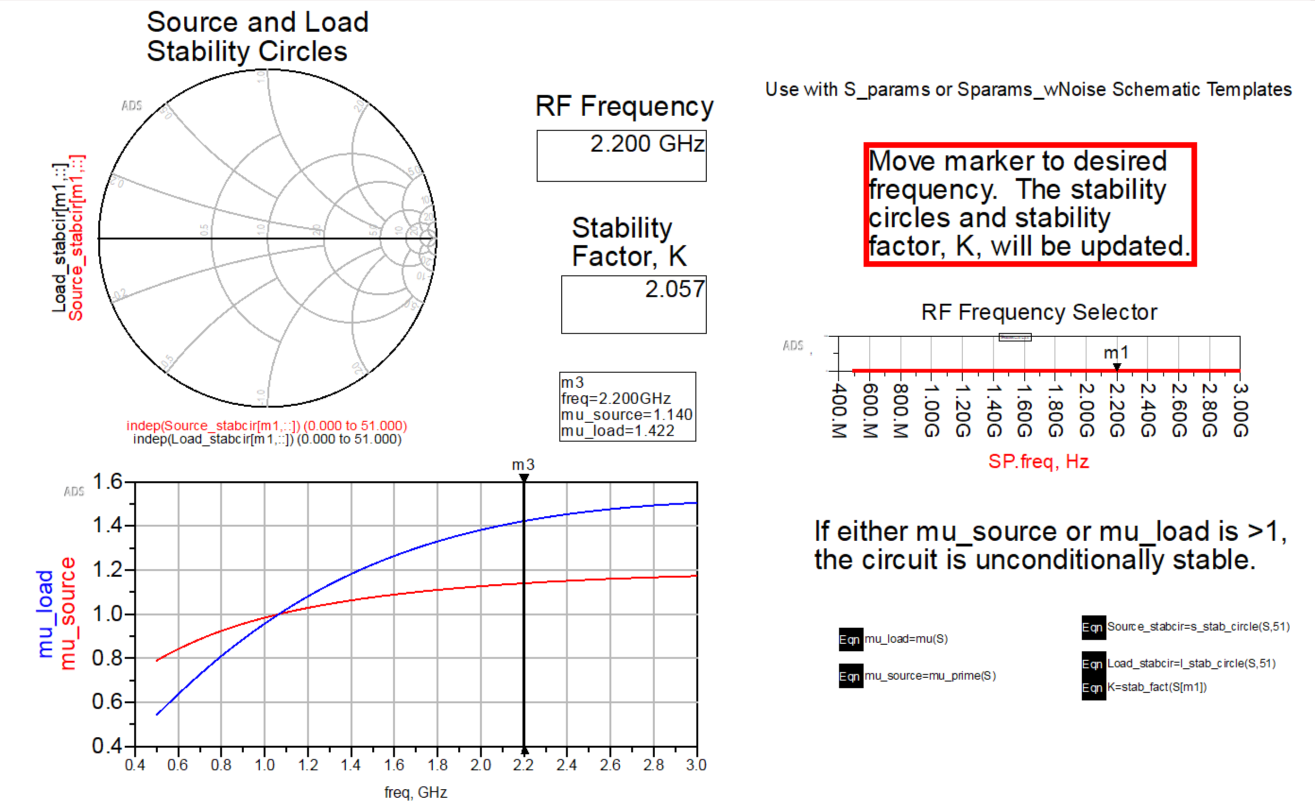




Pout_Max	n_max	RL	Idc	Conduction_Angle	Duty_Cycle
35.83	48.35	72.15	0.28	262.50	72.92

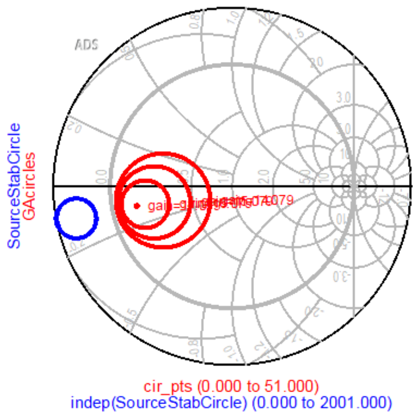
Stability analysis - [with resistor]





Use with 2-port S-parameter simulations

Available Gain Circles
& Source Stability Circle



Set step size and number of circles:

Eqn num_GAcircles=3

Eqn GAstep_size=1

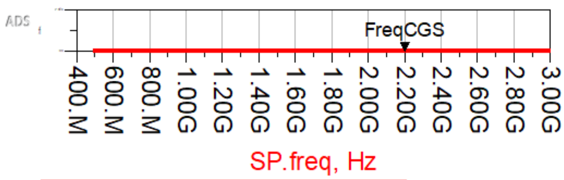
Stability Factor, K

2.057

MaxGain is the maximum available gain if K>1. If K<1, it is the maximum stable gain, 10*log(|S21|/|S12|).

MaxGain
17.081

RF Frequency Selector



Source Stable Region
(inside or outside circle)

s_stab_region(S[FreqCGS])
Outside

Eqn MaxGain=max_gain(S[FreqCGS])

Eqn GAvalue1=MaxGain-.002

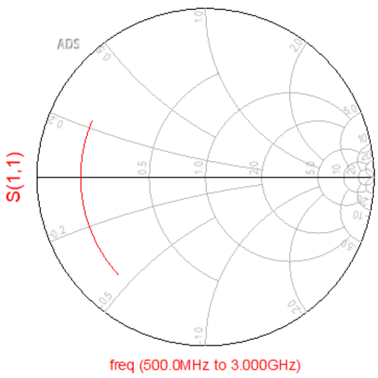
Eqn GAcircles=ga_circle(S[FreqCGS],GAvalue1-[0::num_GAcircles]*GAstep_size,51)

Eqn SourceStabCircle=s_stab_circle(S[FreqCGS],2001)

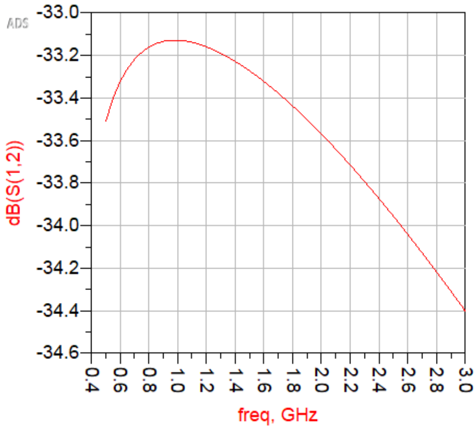
Move marker to desired frequency to update plot.

FreqCGS
indep(FreqCGS)=2.200G
vs([0::sweep_size(SP.freq)-1],SP.freq)=34.00

Input Reflection Coefficient

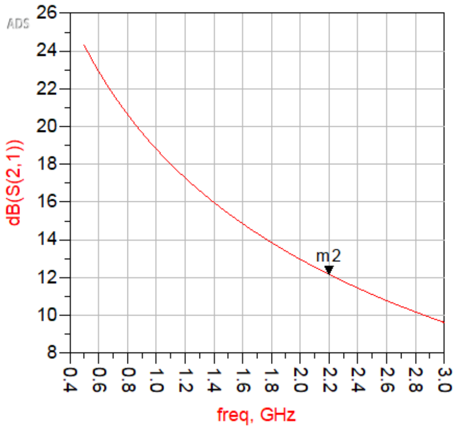


Reverse Transmission, dB

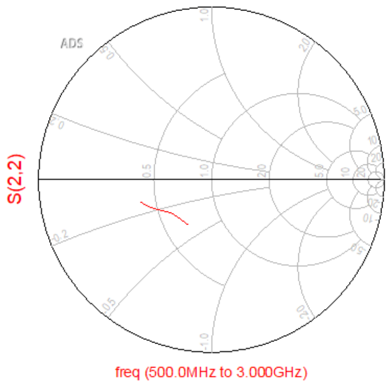


Forward Transmission, dB

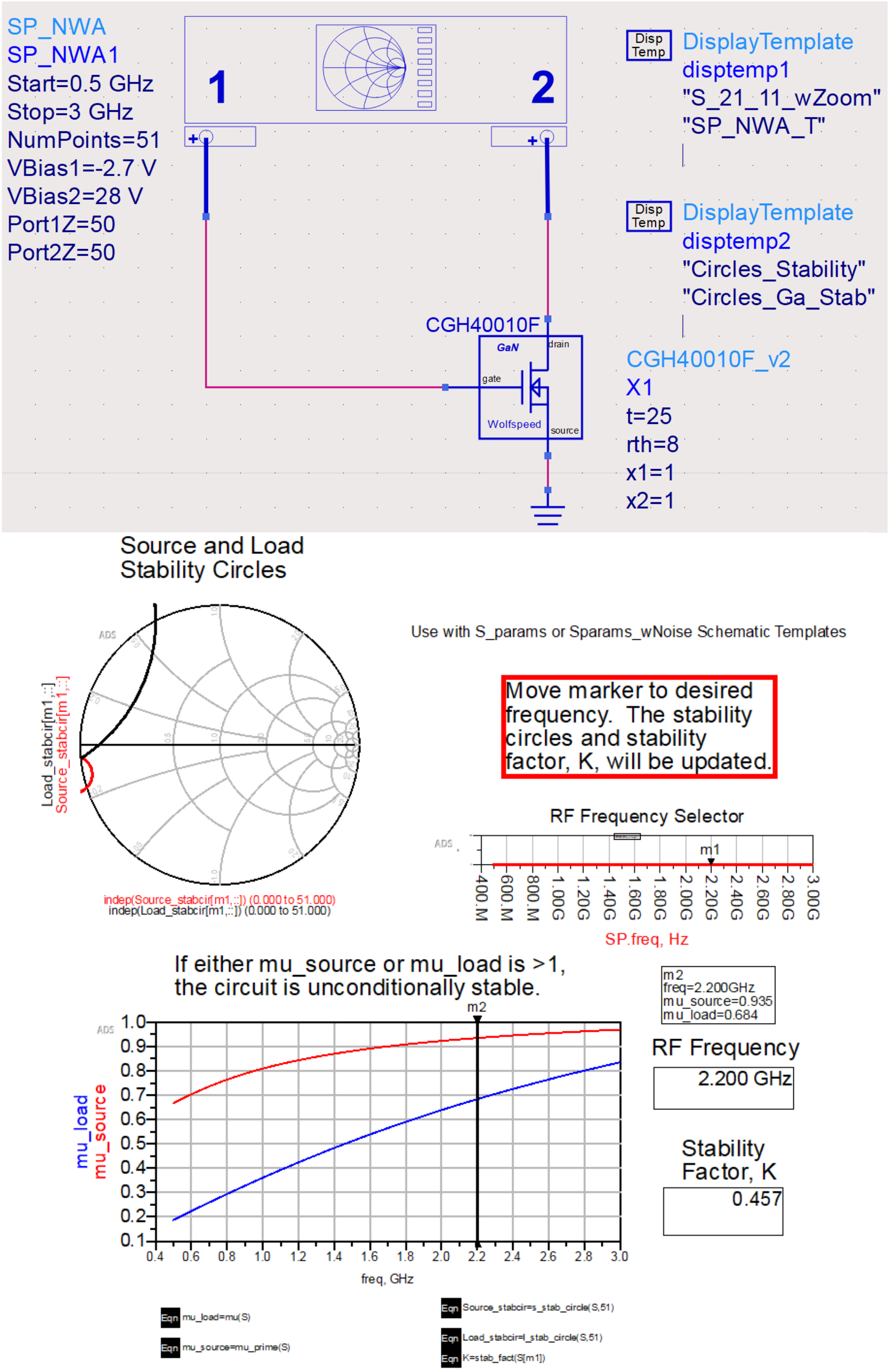
m2
freq=2.200GHz
dB(S(2,1))=12.166



Output Reflection Coefficient

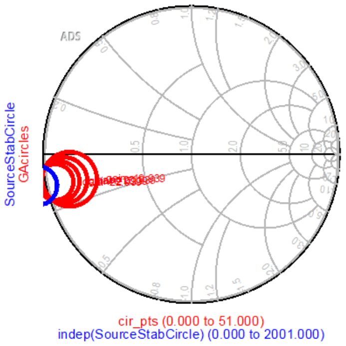


Stability analysis – [without resistor]



Use with 2-port S-parameter simulations

Available Gain Circles
& Source Stability Circle



Set step size and number of circles:

Eqn num_GAcircles=3

Eqn GAstep_size=1

Stability Factor, K

0.457

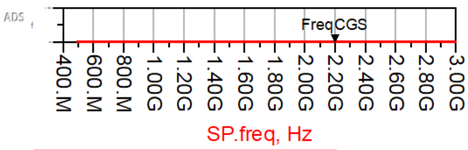
MaxGain is the maximum available gain if K>1. If K<1, it is the maximum stable gain, 10*log(|S21|/|S12|).

MaxGain
22.941

Source Stable Region (inside or outside circle)

s_stab_region(S[FreqCGS])
Outside

RF Frequency Selector



Eqn MaxGain=max_gain(S[FreqCGS])

Eqn GAvalue1=MaxGain-.002

Eqn GAcircles=ga_circle(S[FreqCGS],GAvalue1-[0::num_GAcircles]*GAstep_size,51)

Eqn SourceStabCircle=s_stab_circle(S[FreqCGS],2001)

Move marker to desired frequency to update plot.

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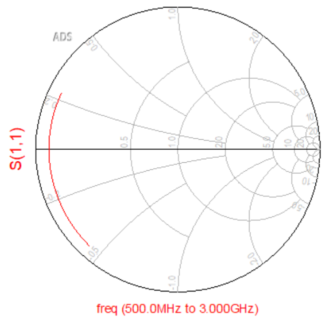
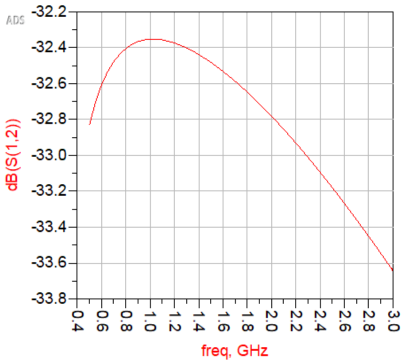
vs([0::sweep_size(SP.freq)-1],SP.freq)=34.00

Input Reflection Coefficient



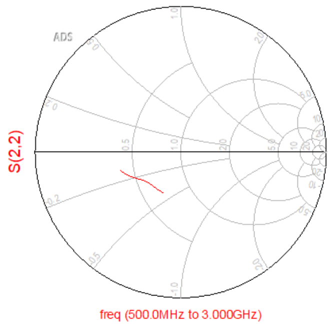
Reverse Transmission, dB



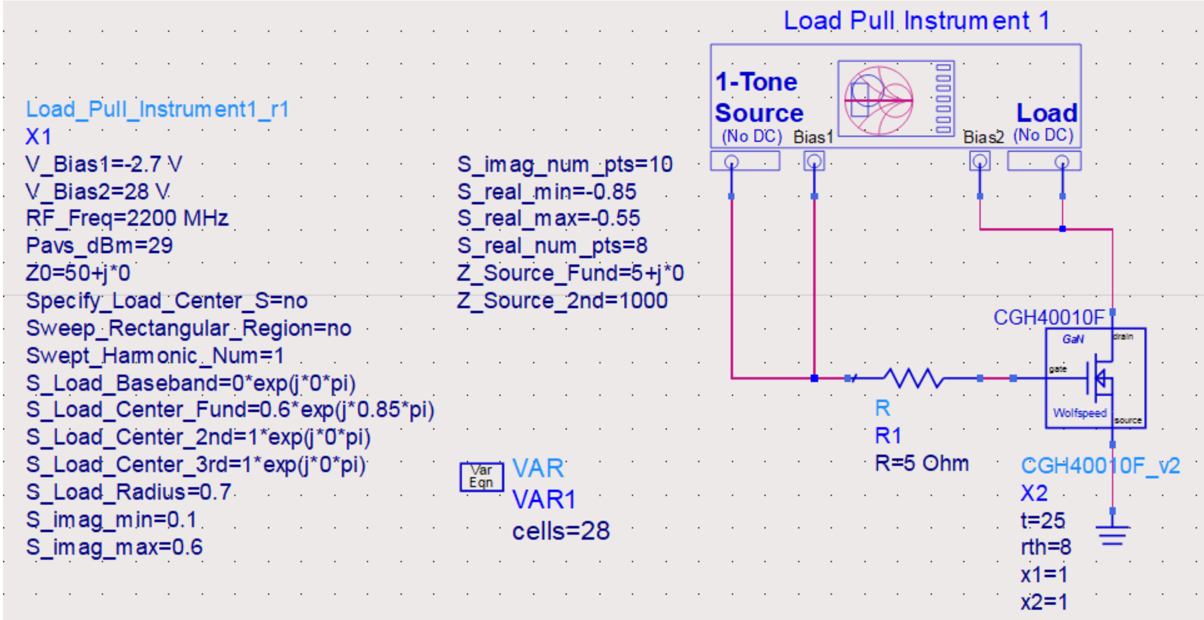
m3
freq=2.200GHz
dB(S(2,1))=12.950

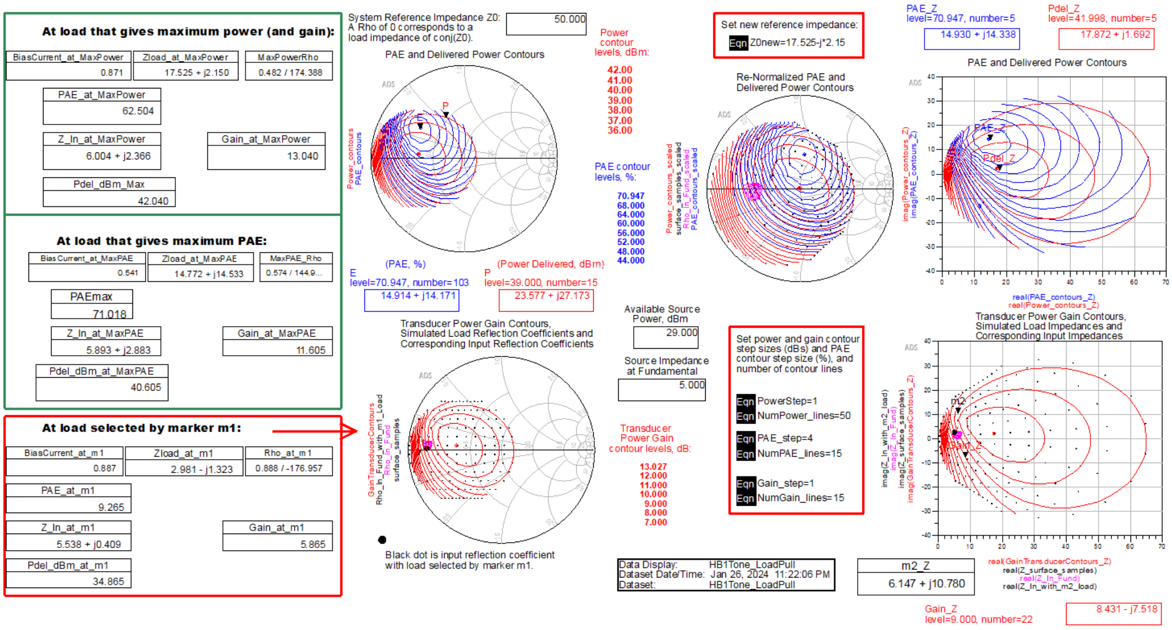
Forward Transmission, dB

Output Reflection Coefficient



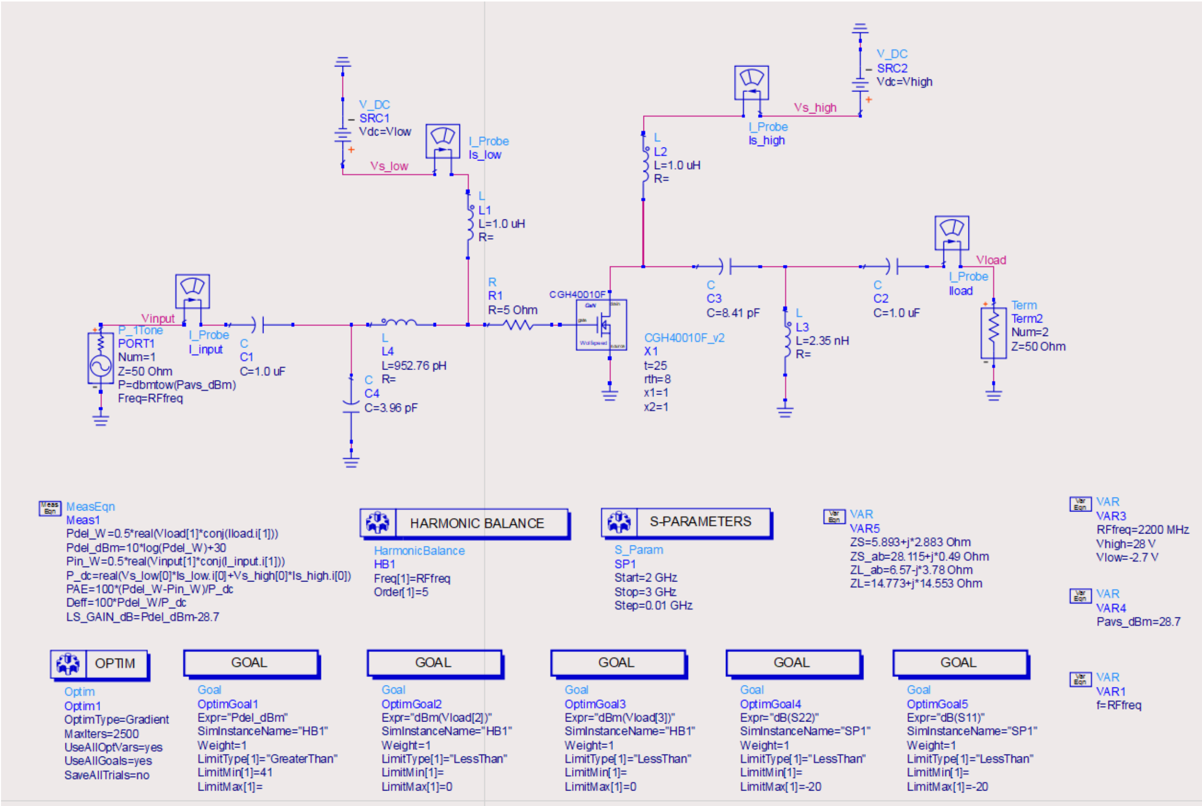
Load pull Analysis



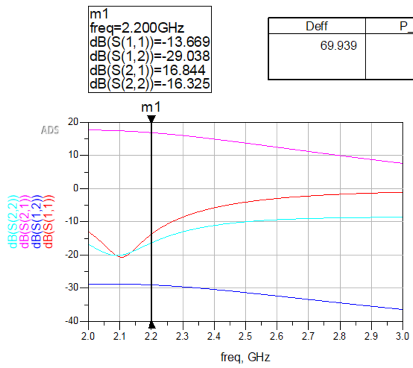


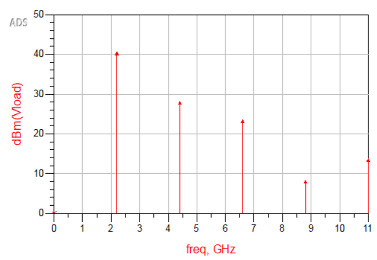
Matching network with Lumped components.

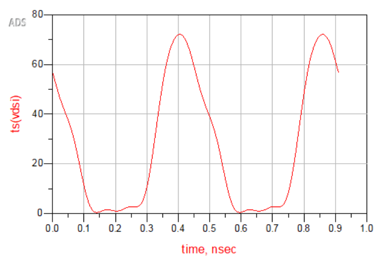
Textbook



Deff	P_dc	PAE	Pdel_dBm	Pdel_W	Pin_W	LS_GAIN_dB
69.939	16.672	65.494	40.667	11.660	0.741	11.967

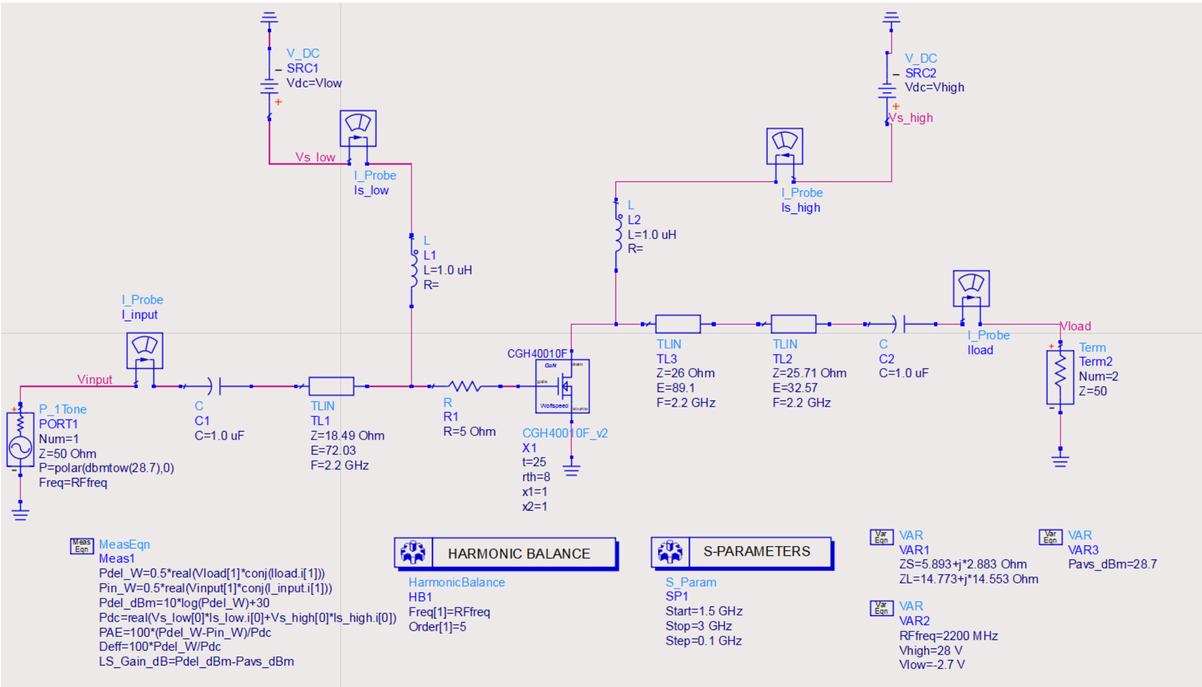


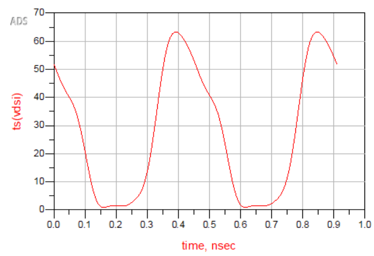


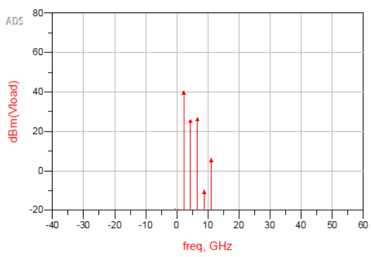


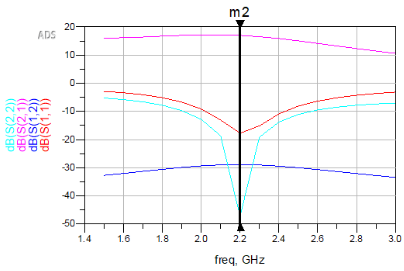
Matching network with Transmission lines.

Complex impedance matching Journal.





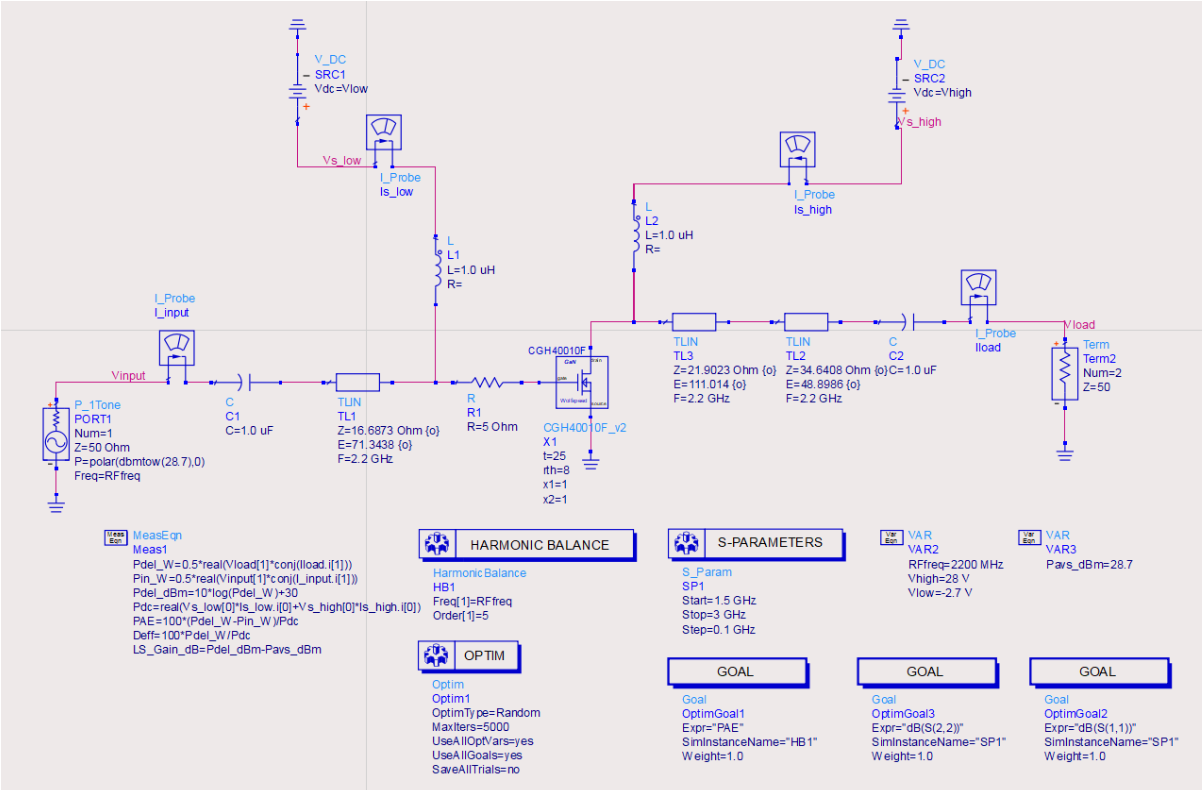


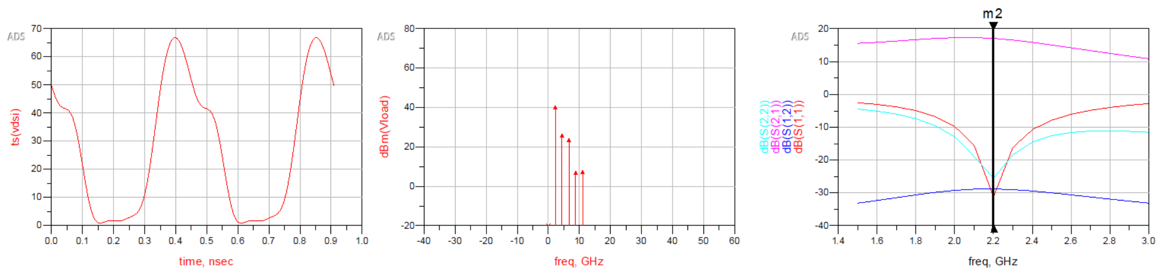


LS_Gain_dB	PAE	Pdc	Pdel_dBm	Pdel_W	Pin_W	Deff
11.989	56.585	19.464	40.689	11.720	0.706	60.214

m2
freq=2.200GHz
dB(S(1,1))=-17.702
dB(S(1,2))=-28.882
dB(S(2,1))=17.000
dB(S(2,2))=-47.144

Matching network with TLINs with optimized values targeting PAE of 60% +.





LS_Gain_dB	PAE	Pdc	Pdel_dBm	Pdel_W	Pin_W	Deff
12.307	60.183	19.765	41.007	12.610	0.715	63.802

m2
freq=2.200GHz
dB(S(1,1))=-31.145
dB(S(1,2))=-28.821
dB(S(2,1))=17.060
dB(S(2,2))=-25.445