Applied Fields and Waves

Practical Power Amplifier

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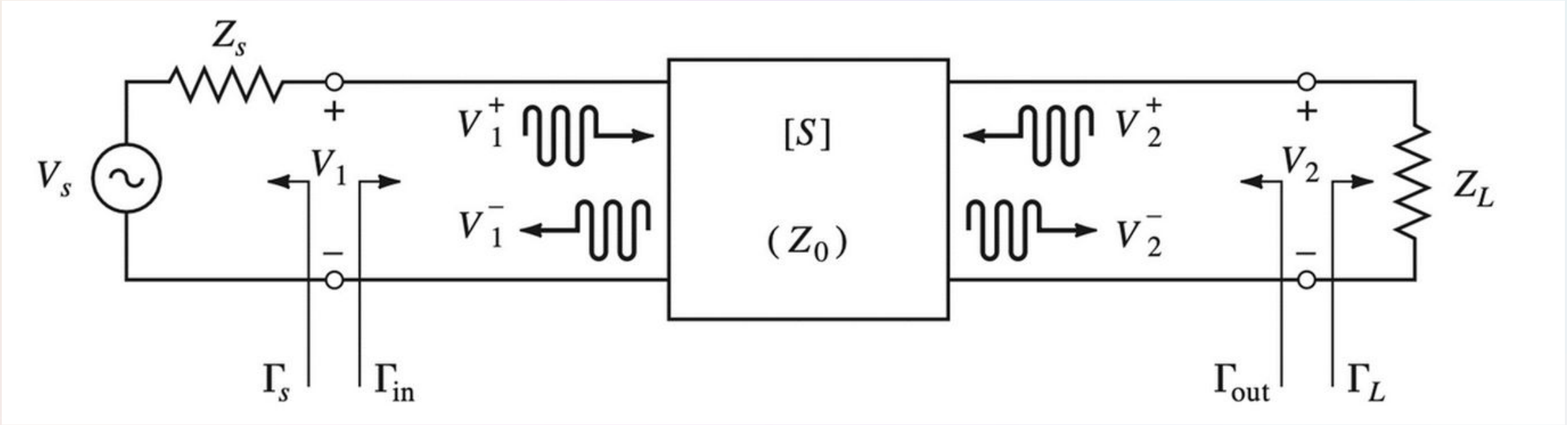
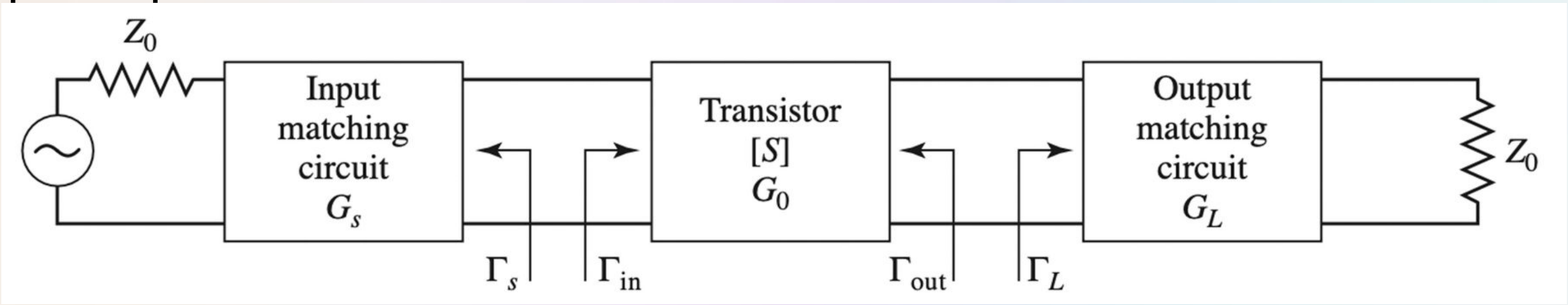
Introduction

- Power amplifier: Converts low-power signal to a higher power.
- It is a two port network device.
- Used in a wide variety of applications including Wireless Communication, TV transmissions, Radar, and RF heating



- A single-stage transistor amplifier: A circuit where matching networks are used on both sides of the transistor to transform the input and output impedance.



The general transistor amplifier circuit

Drain efficiency

(or collector efficiency)

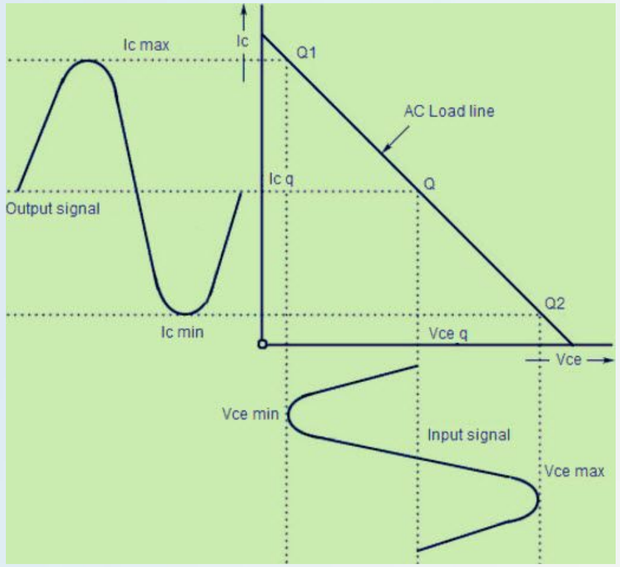
$$\eta = \frac{P_{out}}{P_{DC}}$$

Power added efficiency

$$\eta_{PAE} = \text{PAE} = \frac{P_{out} - P_{in}}{P_{DC}}$$

Class A Power Amplifier

- Simplest and most linear amplifier.
- Conduction angle 360 degree.
- Maximum efficiency of this is 50%.
- No distortion of the input signal



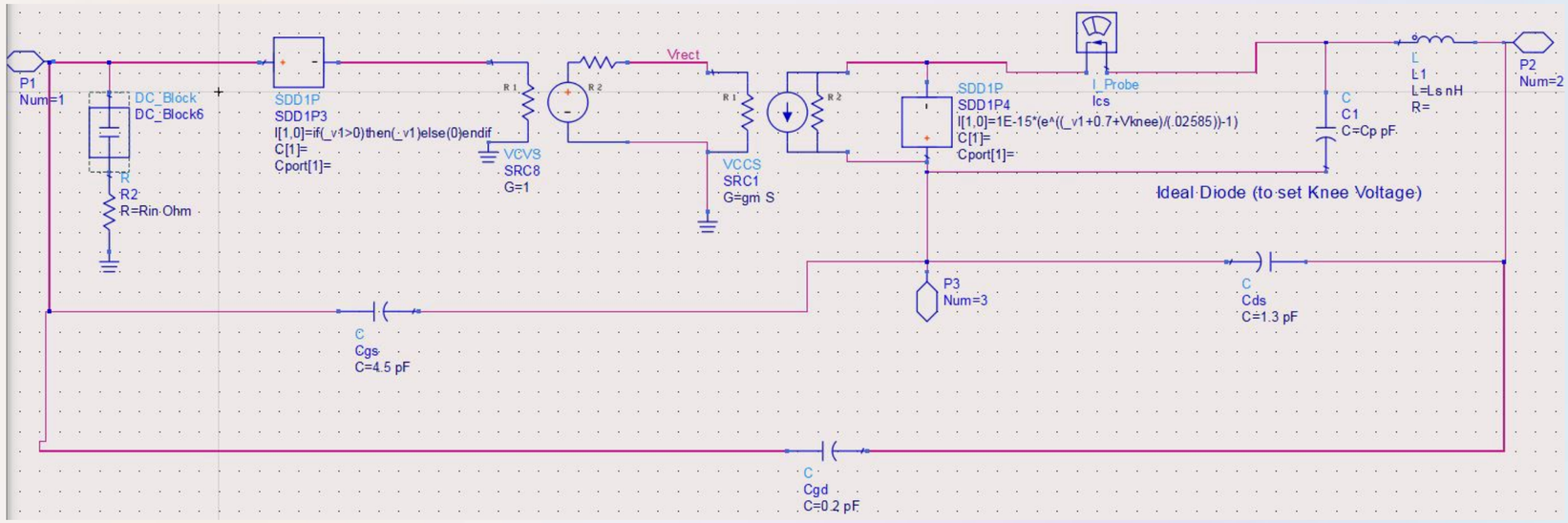
Disadvantages

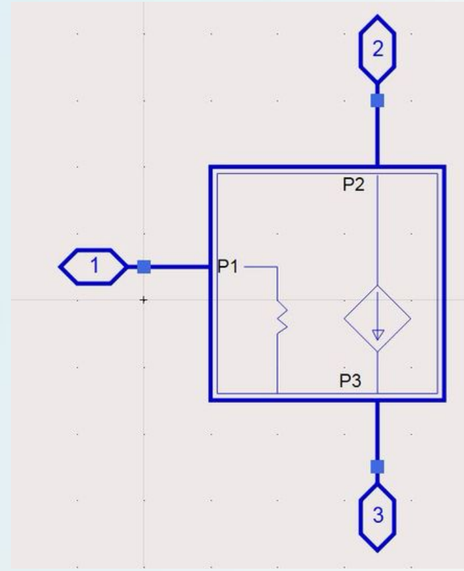
- Due to the large power supply and heat sink, class A amplifier is costly and bulky.
- It has Poor Efficiency.

Application

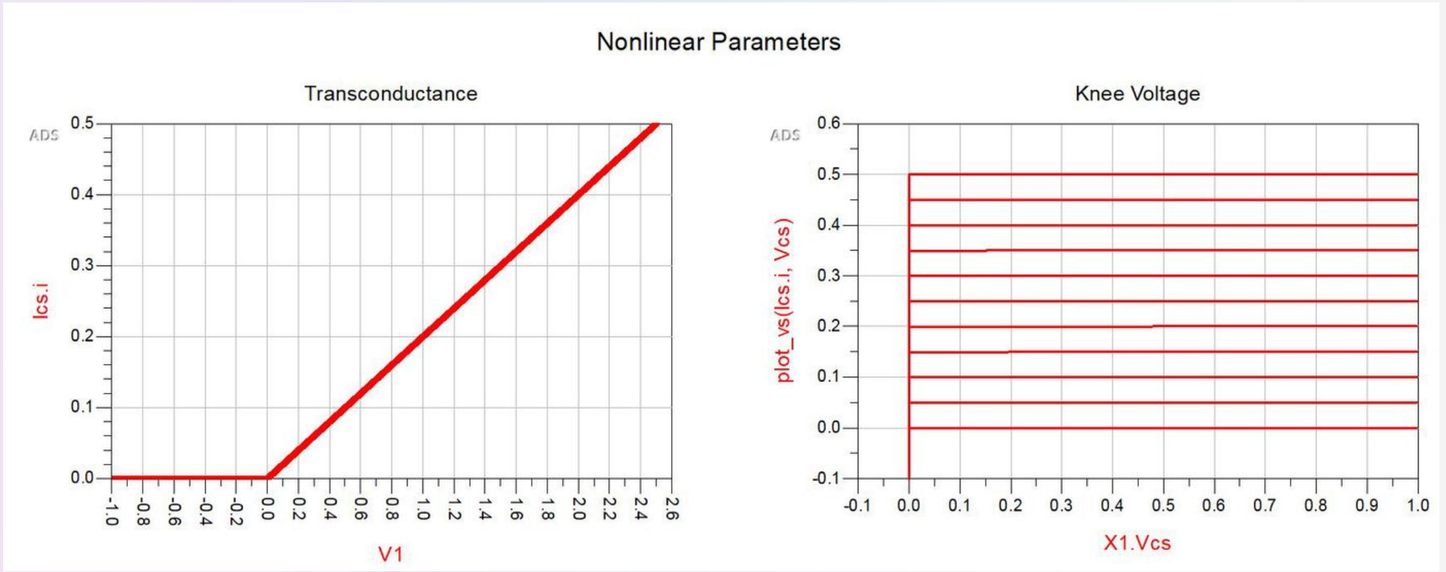
- Places where information in signal is more important that its strength.
- Microphones Pre Amplifiers

Ideal Device



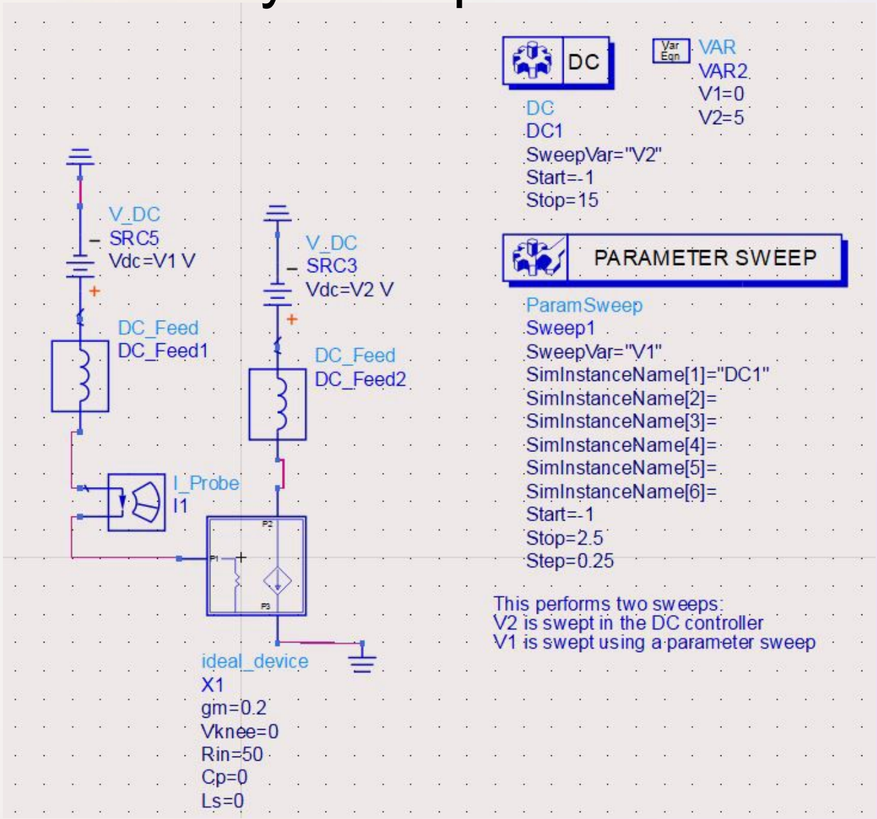


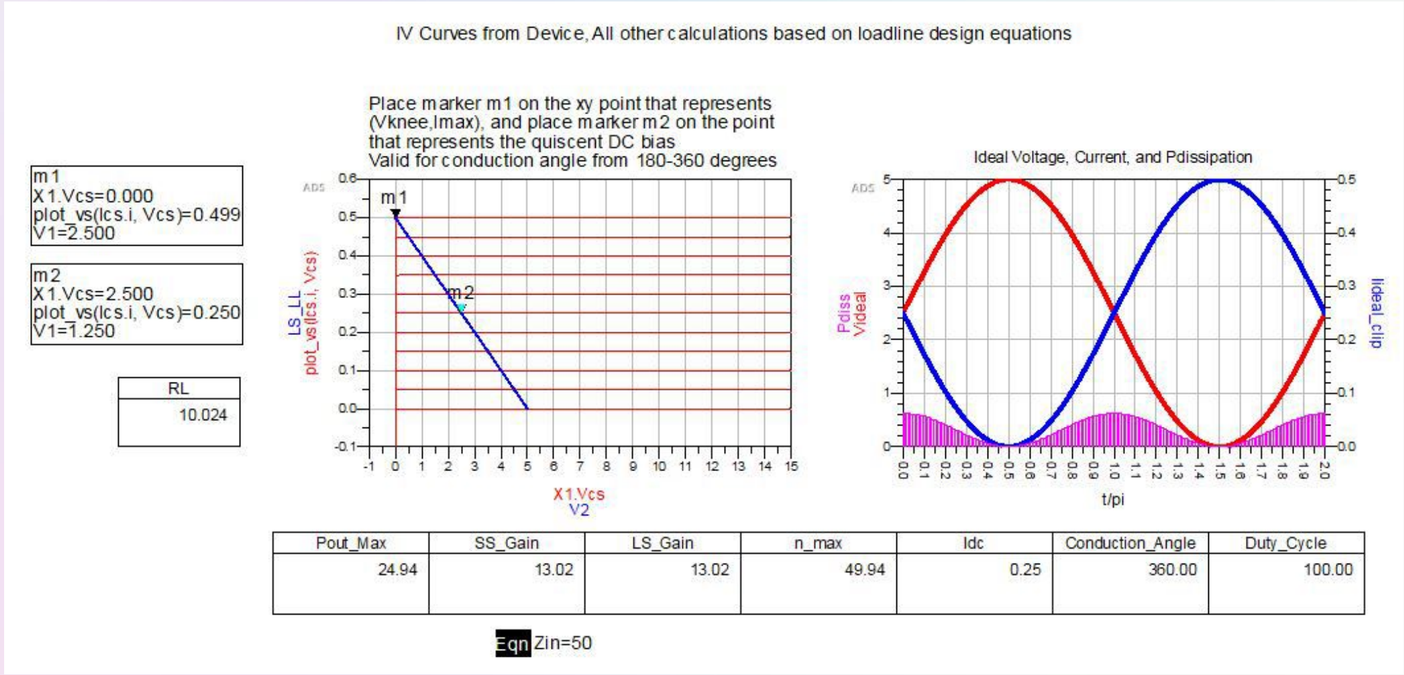
- Made an equivalent circuit for a non linear device
- Use equation for Transconductance and Knee Voltage



DC-Biasing

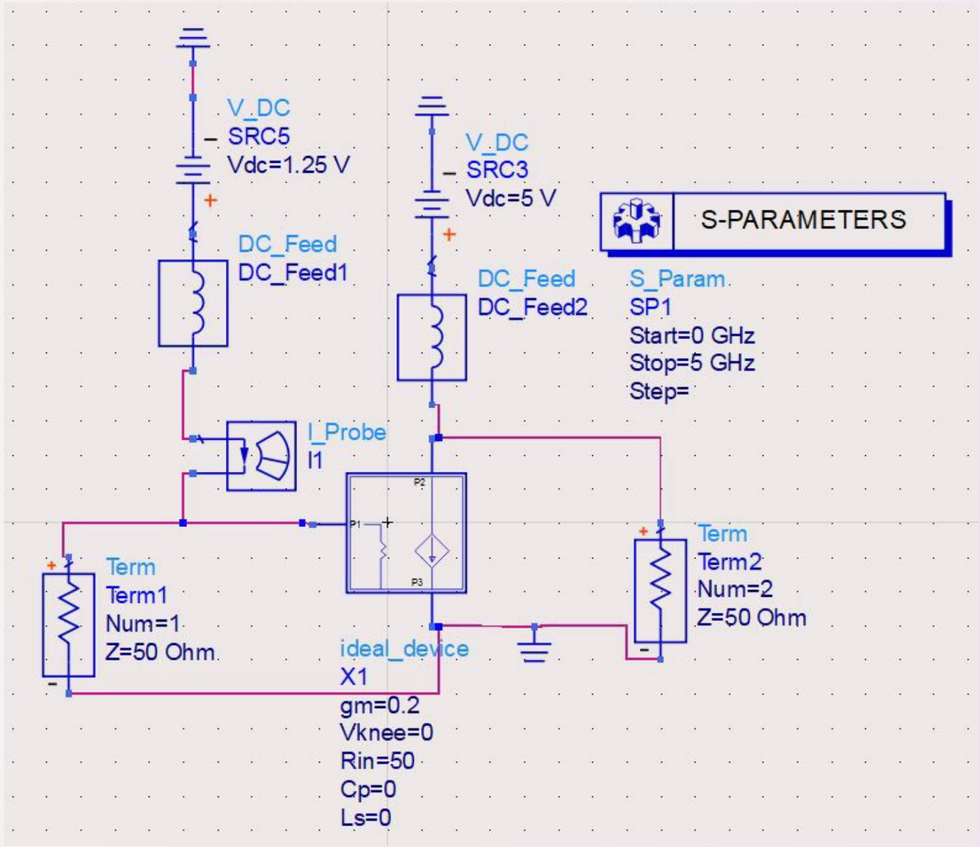
- Setting a transistors DC operating voltage or current conditions
- Here we set DC bias such that the conduction angle is 360 degree i.e of a Class A amplifier.
- Efficiency is 50 percent

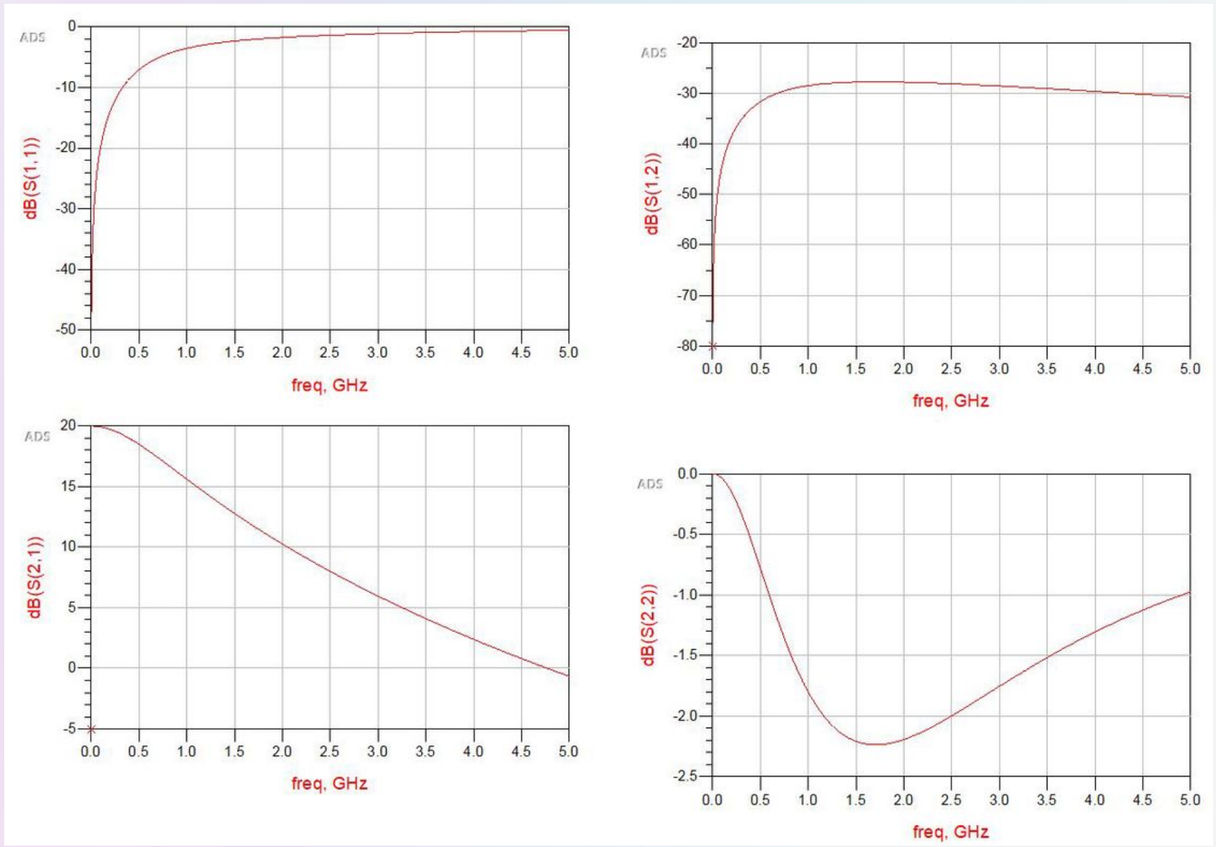




S-Parameter of DC Bias Ideal Device

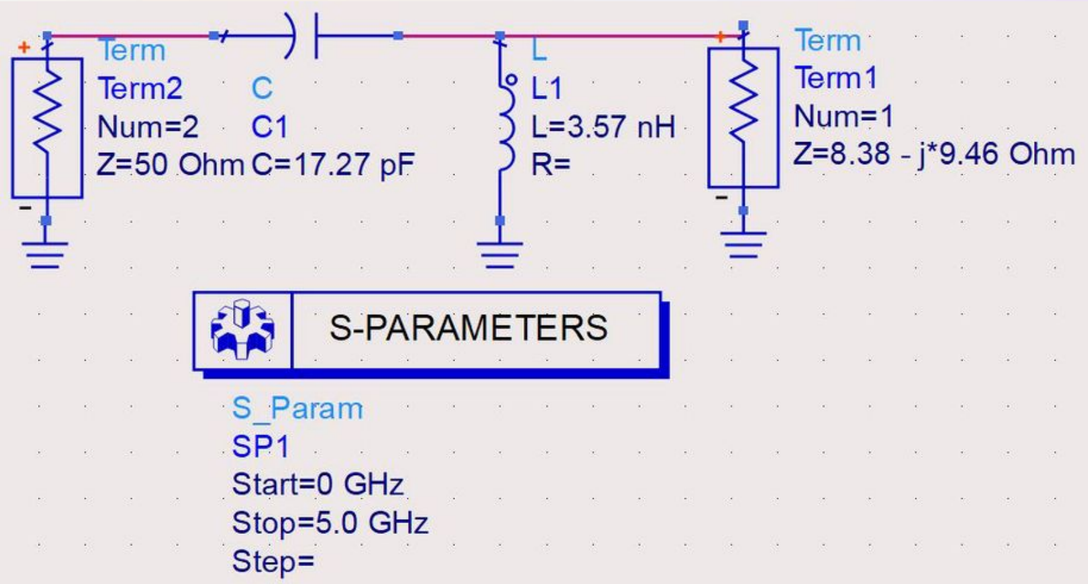
- Use S - parameter tool to sweep over frequency
- It is an ideal device having Dynamic Characteristics of CGH40010



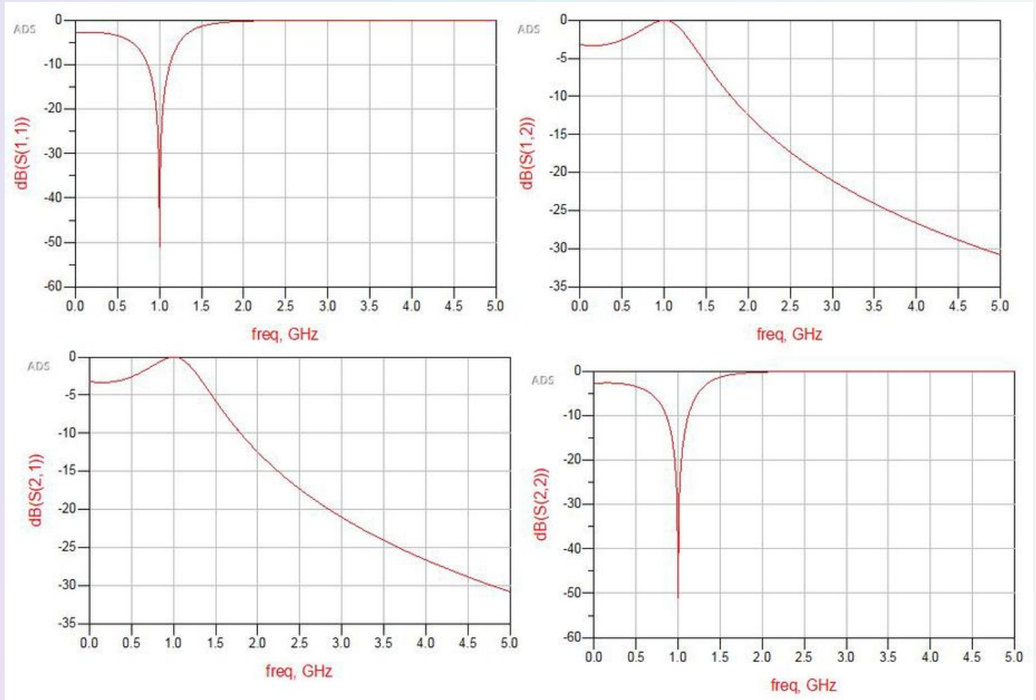


Input matching

- The available power from the source is entirely delivered to the input of the gain element.
- Zs = 8.38 + j9.46 (at 1 GHz)
- Zo = 50 ohm

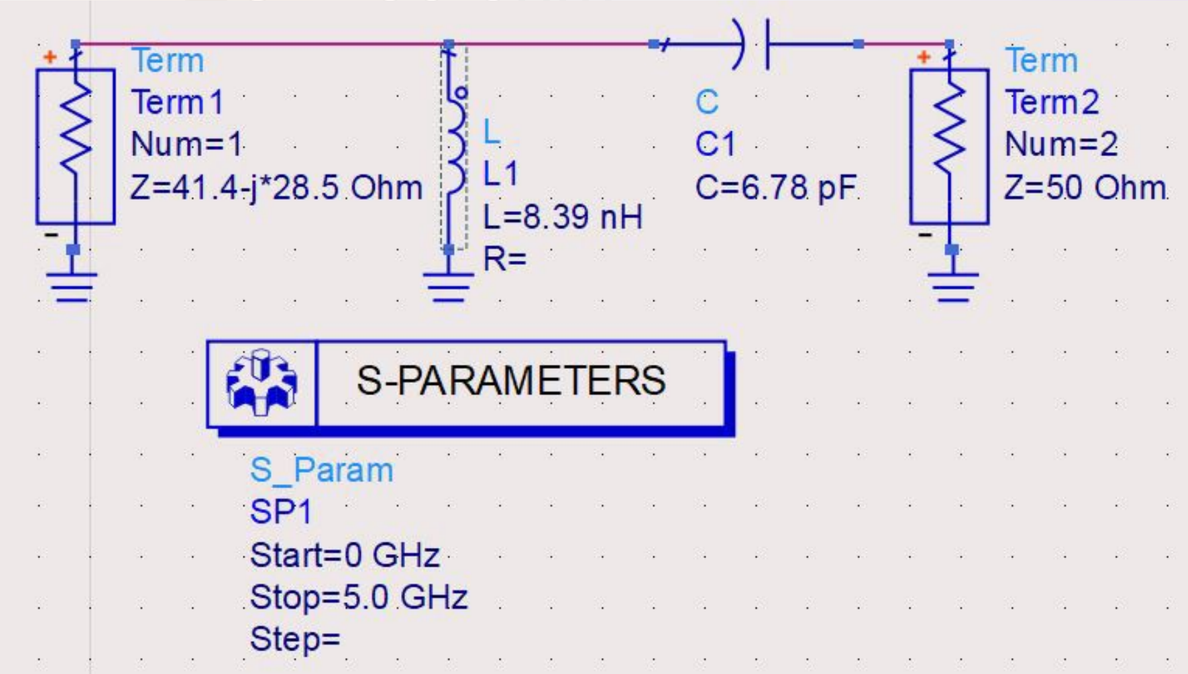


S - parameters

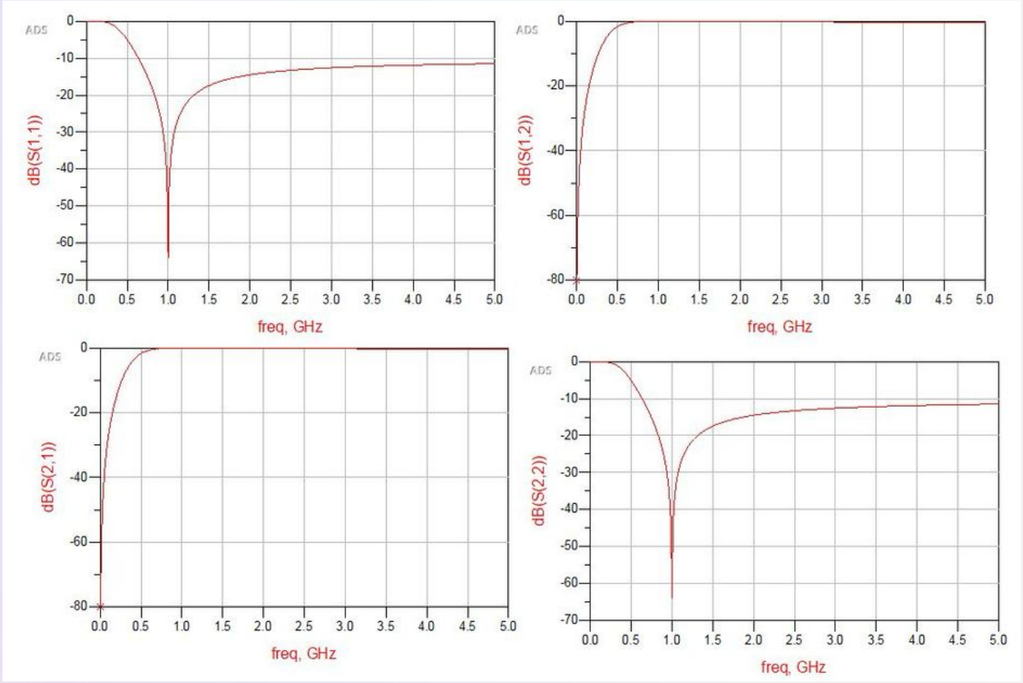


Output matching

- The available power from the output of the gain element is entirely delivered to the load
- ZL = 41.4 + j28.5 ohm (at 1 GHz)
- ZO = 50 ohm



S - parameters



Gain Parameters

- Efficiency is a measure of its ability to convert the DC power (Pdc) of the supply, into the signal power delivered to the load (Pout)
- Power gain: ratio of power dissipated in the load ZL to the power delivered to the input of the two-port network.
- S12 of Transistor is too small. Assume it zero, this make amplifier unilateral.

$$G_S = \frac{1 - |\Gamma_S|^2}{|1 - S_{11}\Gamma_S|^2},$$

$$G_0 = |S_{21}|^2,$$

$$G_L = \frac{1 - |\Gamma_L|^2}{|1 - S_{22}\Gamma_L|^2}.$$

$$G_T = G_S G_0 G_L$$

Gs = Input Matching network Gain

Go = Transistor Gain

GL = Output Matching network Gain

GT = Unilateral transducer gain

Work Distribution

- Ankit Kumar Pal: Realisation of circuit equivalent of the transistor, DC analysis of the Transistor, and Finding Operating Point
- Sangam Rai: S-parameter calculation of the Model, Input, and Output impedance matching network.
- We together work for presentation and coordinate where is the needed.

References

- Debidas Kundu Sir
- Keysight Reference
- Anurag Bhargava Lecture
- Matching Network
- Microwave_Engineering_D.M_Pozar
- Class Lectures