Microwave Amplifier Simulation in PathWave Advanced Design System (ADS)

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Abstract

This work is a short demonstration of a basic circuit-level simulation in ADS, the aim of this tutorial is to get familiar with several types of analysis at the circuit level that will later greatly help us to use in RFIC and MMIC design. We started with transient analysis, followed by DC, AC and S-parameters analysis.

From these analyses, particularly useful parameters can be determined, those such as noise figure, bandwidth, S parameter values, OIP3, IIP3 and many more.

The last part of this work is concerned with the solution of a task, in which according to the given values, the amplifier settings were modified and L, C values were calculated to create a scheme that complies with the requirements and from this the results were obtained.

1. DC analysis properties

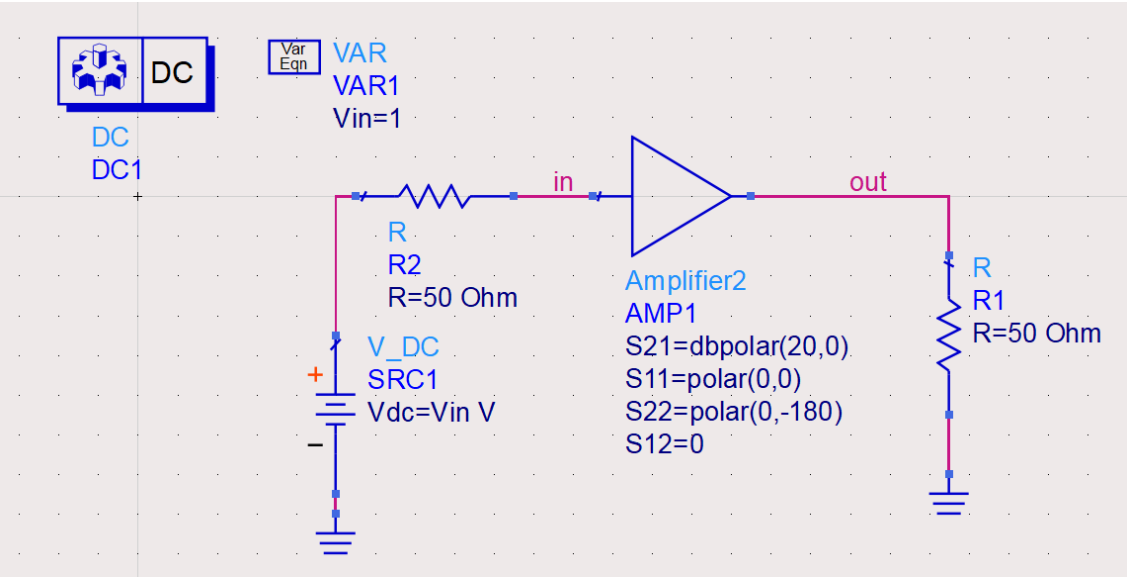

Fig 1. (The circuit diagram used for DC analysis)

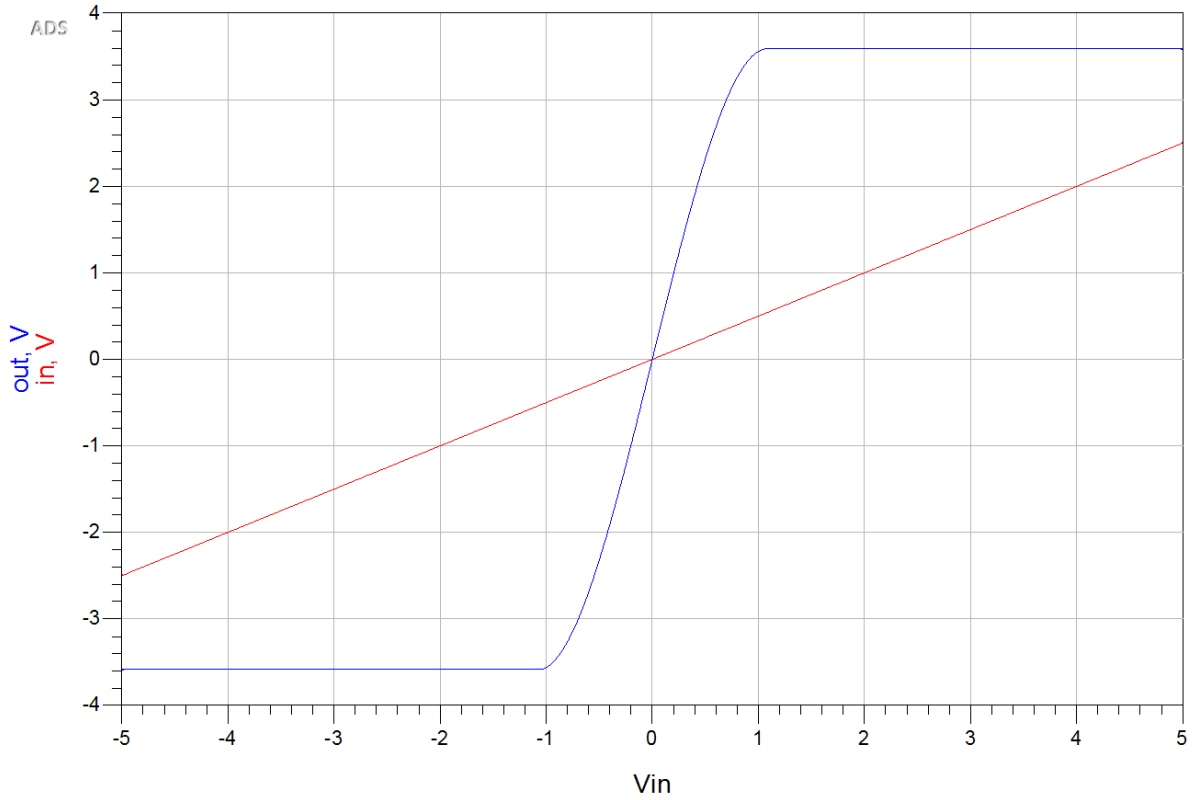

Fig 2. (Input versus output for DC analysis)

2. Transient analysis

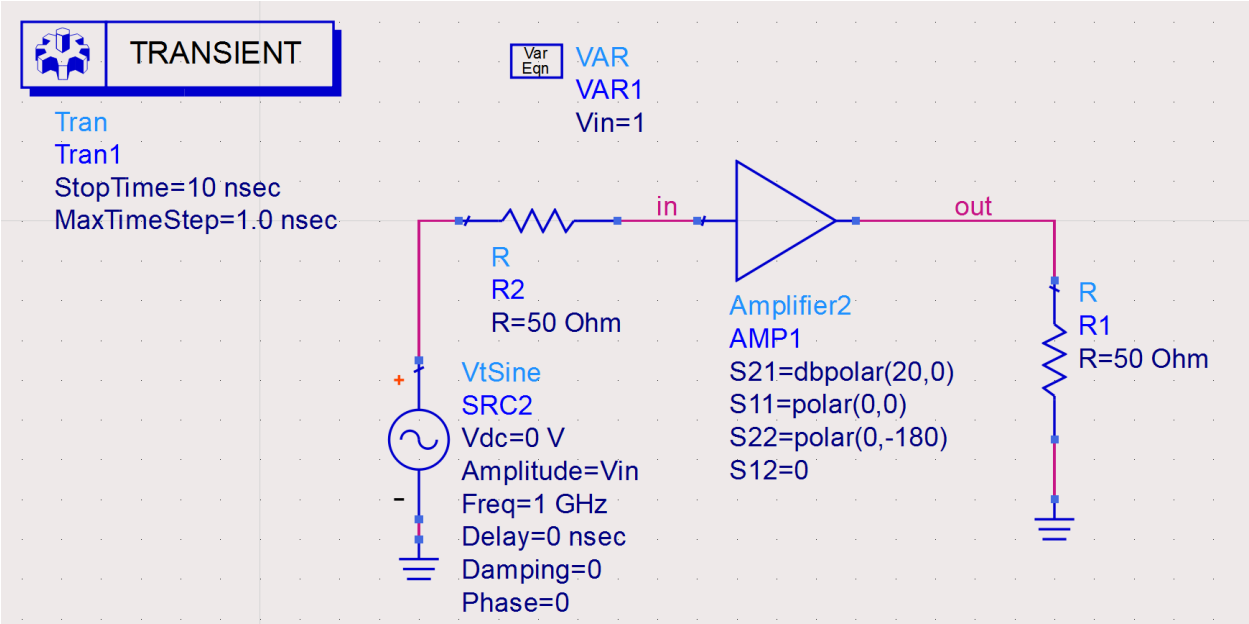

Fig 3. (Transient analysis scheme)

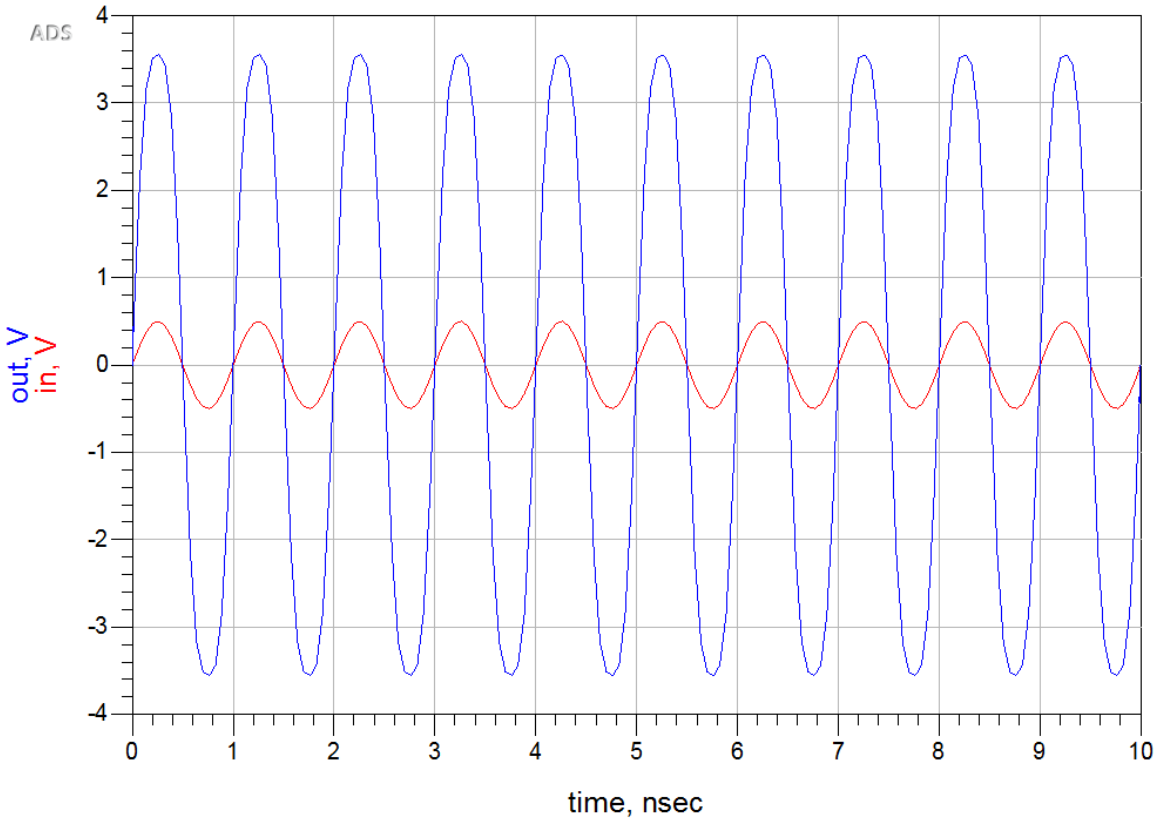

Fig 4. (Input vs output in time domain)

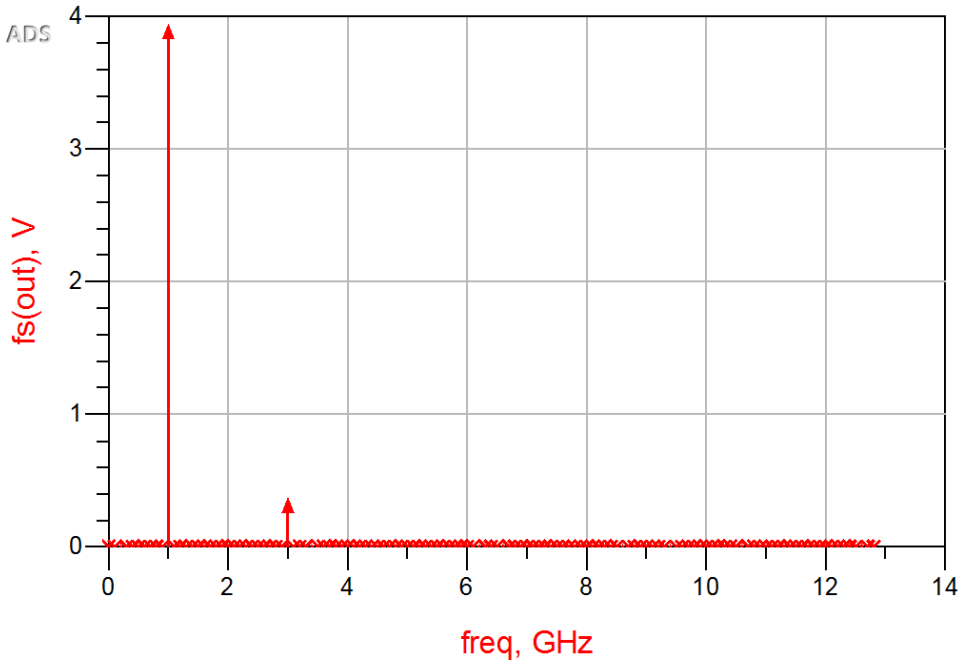

Fig 5. (Output signal in frequency domain)

Eqn freq=indep(fs(out))[1,::]

Eqn index1=find_index(freq,1GHz)

Eqn A0=fs(out)[::,index1]

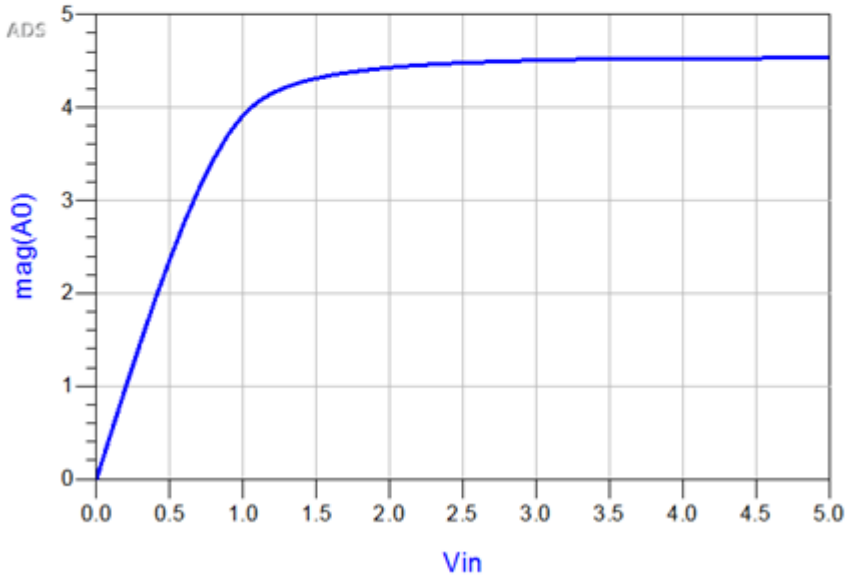

Fig 6. (Results of sweeping parameter Vin)

3. AC analysis

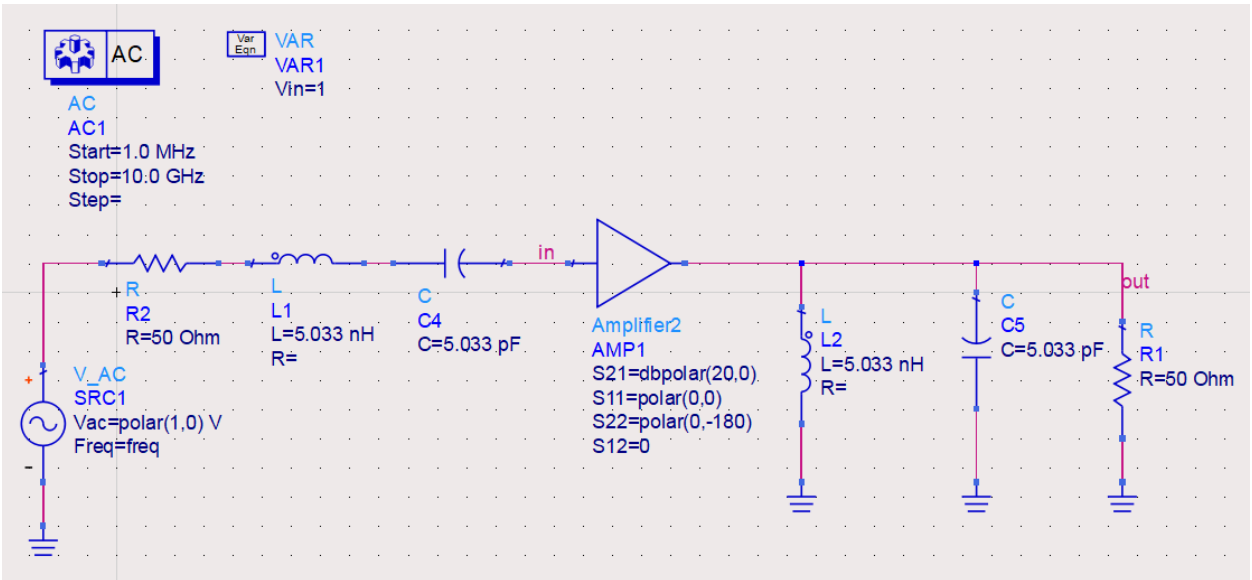

Fig 7. (AC analysis scheme)

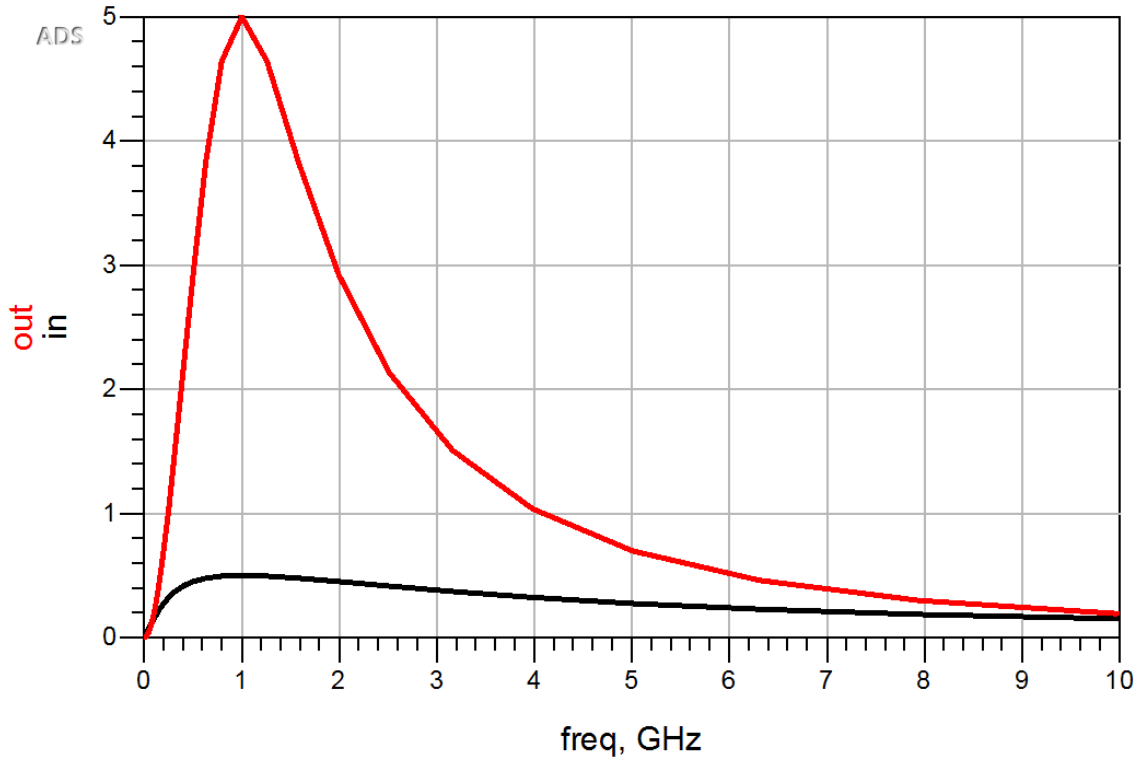

Fig 8. (AC analysis output response)

4. S parameters simulation

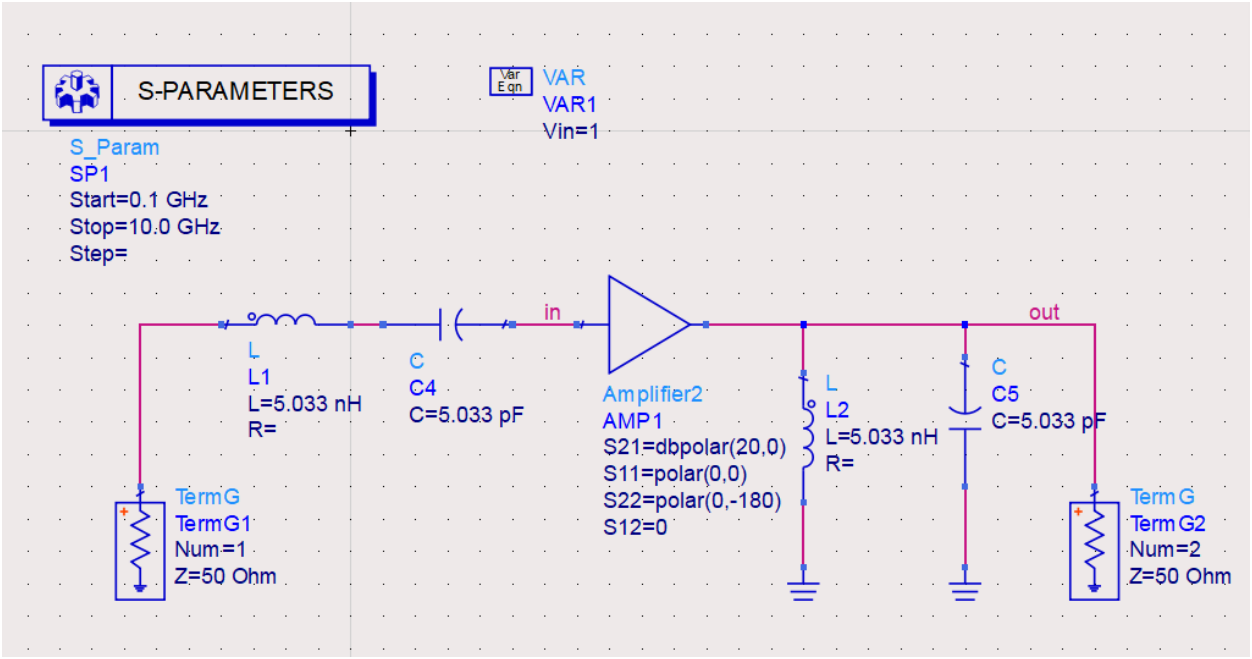

Fig 9. (Circuit used for S parameters)

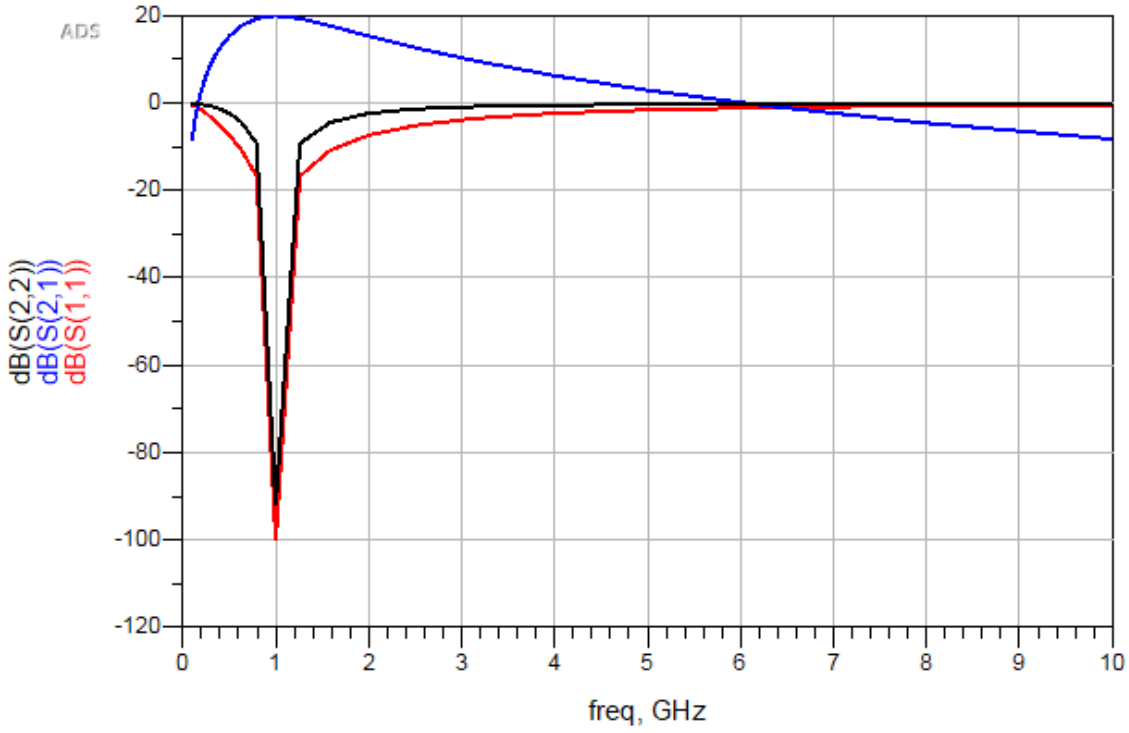

Fig 10. (S parameters plots)

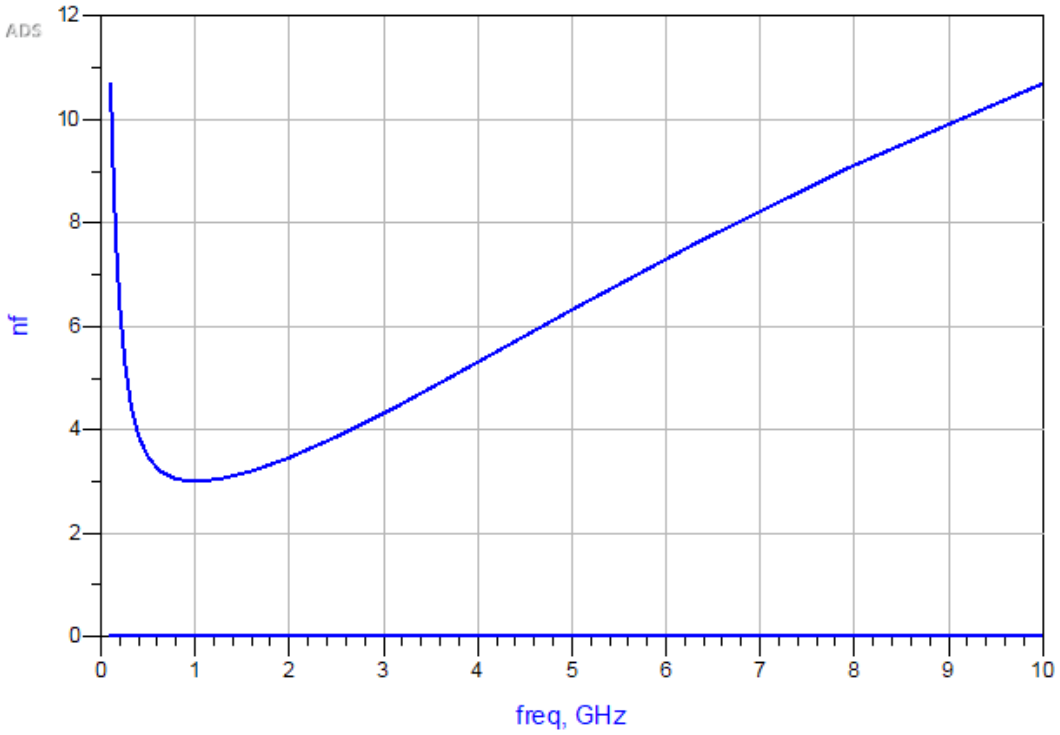

Fig 11. (Noise figure vs frequency plot)

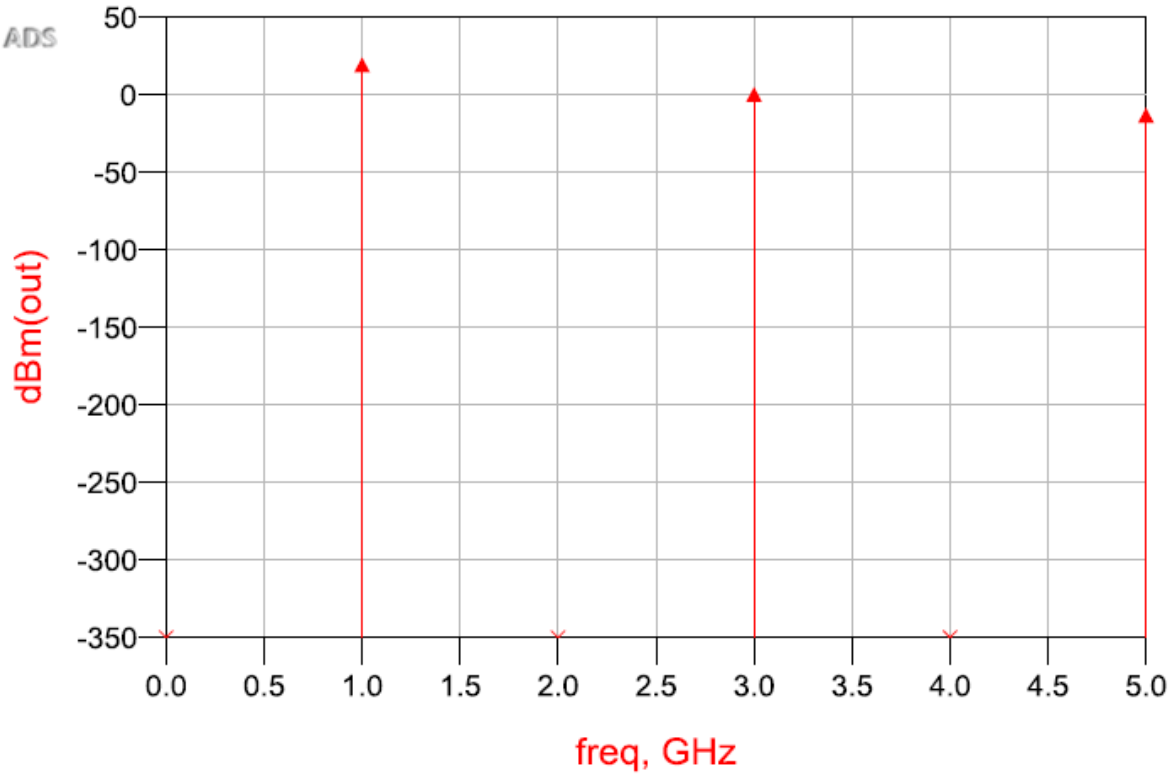

Fig 12. (Harmonics)

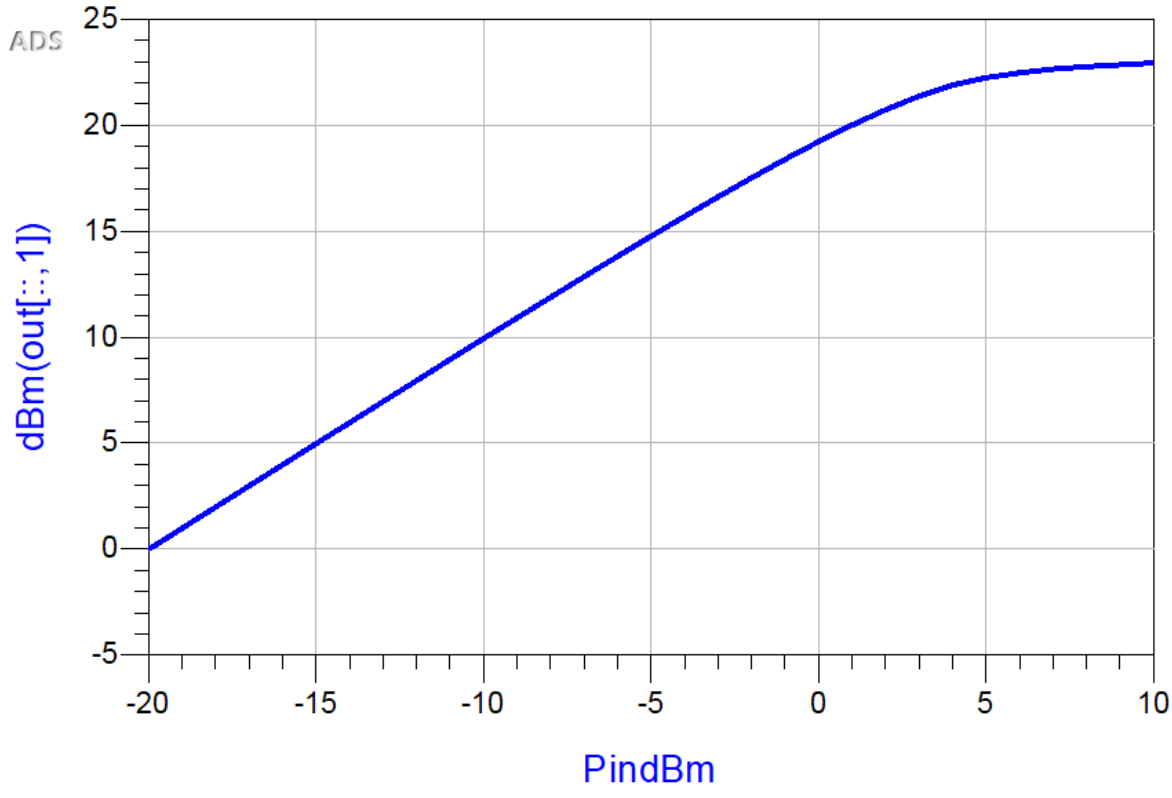

Fig 13. (Input power vs output power)

Task

The given parameters are:

$f_0 = 5\ GHz$; $Gain = 15\ dB$; $S_{11} = -20\ dB$; $S_{22} = -10\ dB$

$NF = 2{,}5\ dB$; $ICP1dB = 11\ dBm$; $IIP3 = 24\ dBm$; $P_{sat} = 31\ dBm$

$\boldsymbol{OIP3} = IIP3 + Gain = 39\ dBm$

$\boldsymbol{OCP1dB} = ICP1dB + Gain - 1\ dBm = 25\ dBm$

$$f_0 = \frac{1}{2\pi\sqrt{LC}} \rightarrow LC = \frac{1}{4\pi^2 {f_0}^2} = 1{,}013211 \cdot 10^{-21}\ \text{Henry, Farads}$$

If we choose $L = 4\ nH,\ this\ leads\ to\ C = 0.2533\ pF$

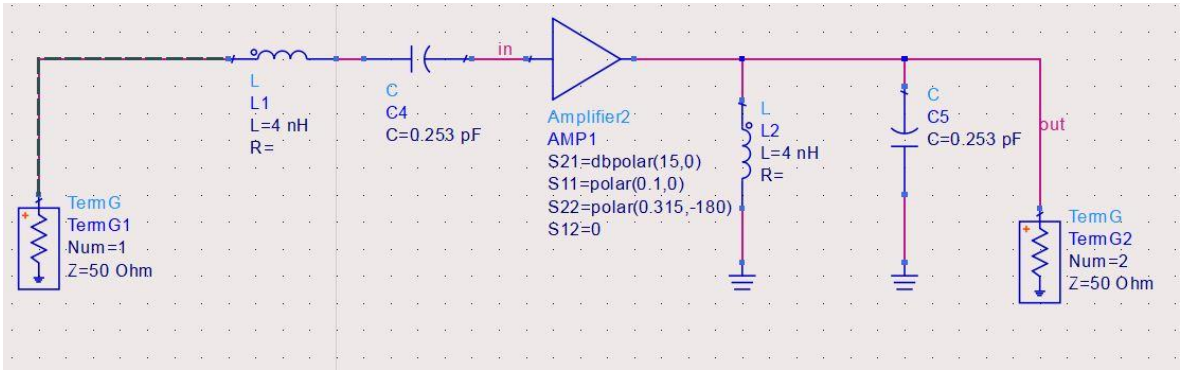

Fig 14. (Scheme used to calculate the parameters for personal task)

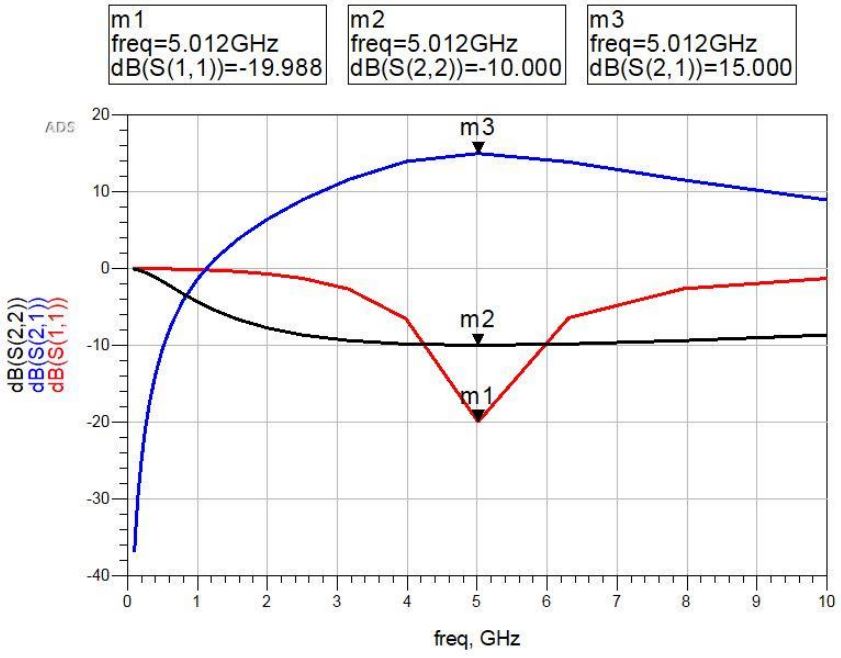

Fig 15. (S parameters)

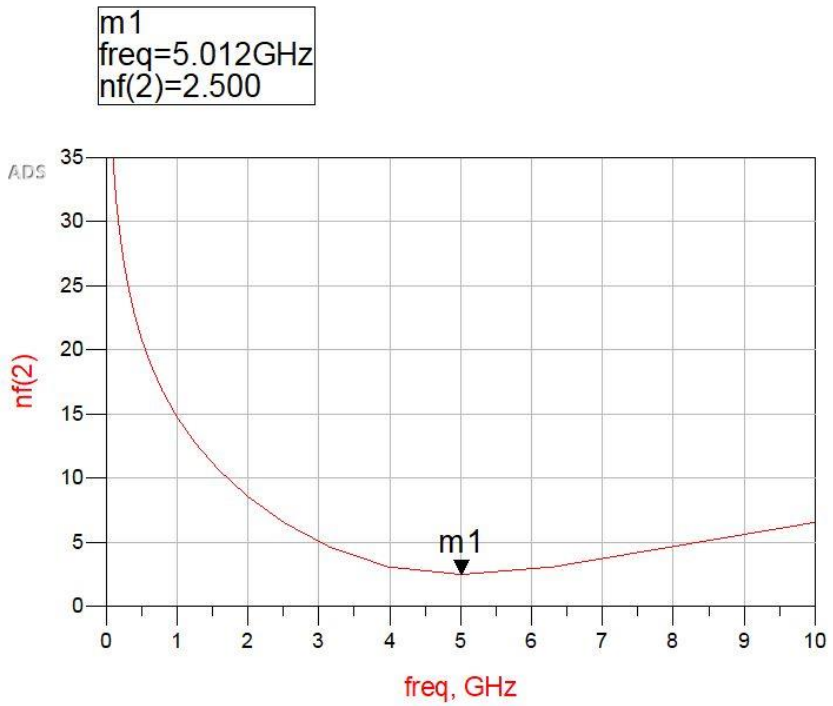

Fig 16. (Noise figure)

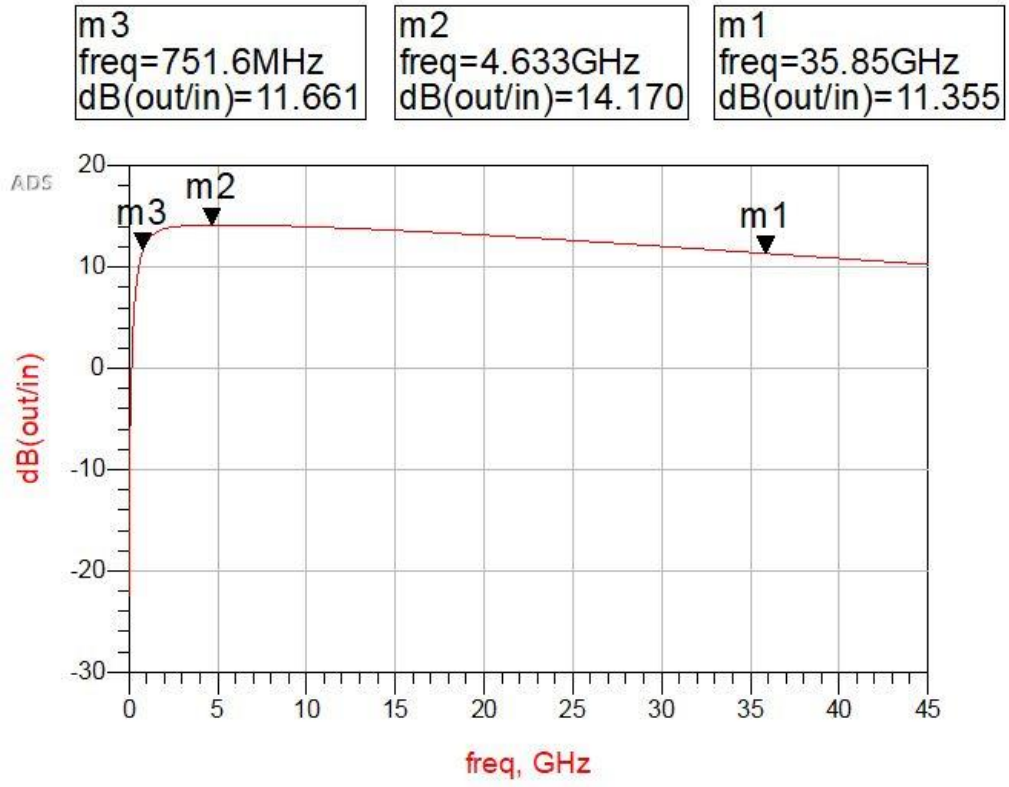

Fig 17. (Determining the bandwidth which is around 28.334 MHz)

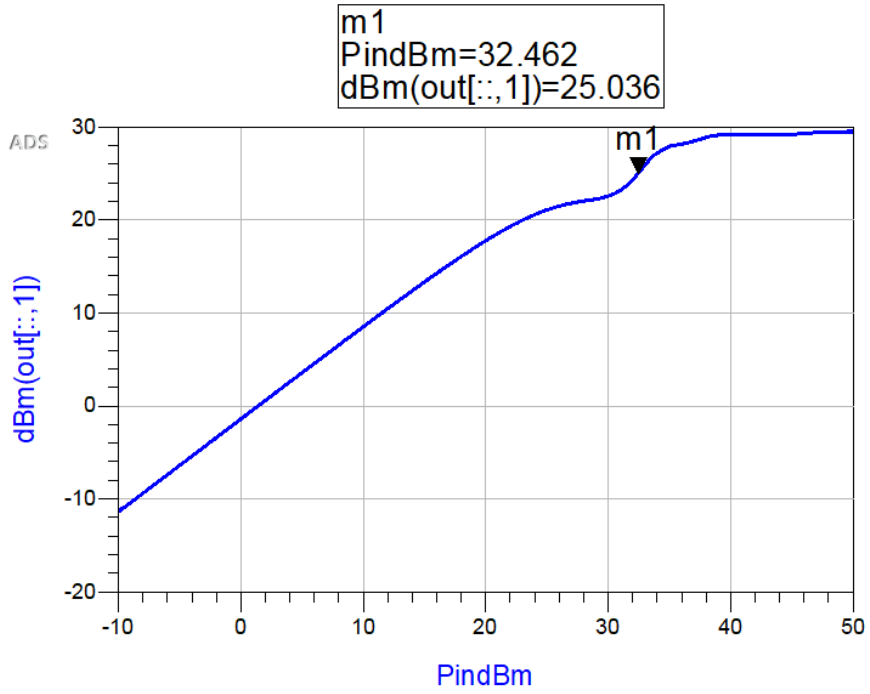

Fig 18. (The dBm is 25, it is correct according to our calculation)

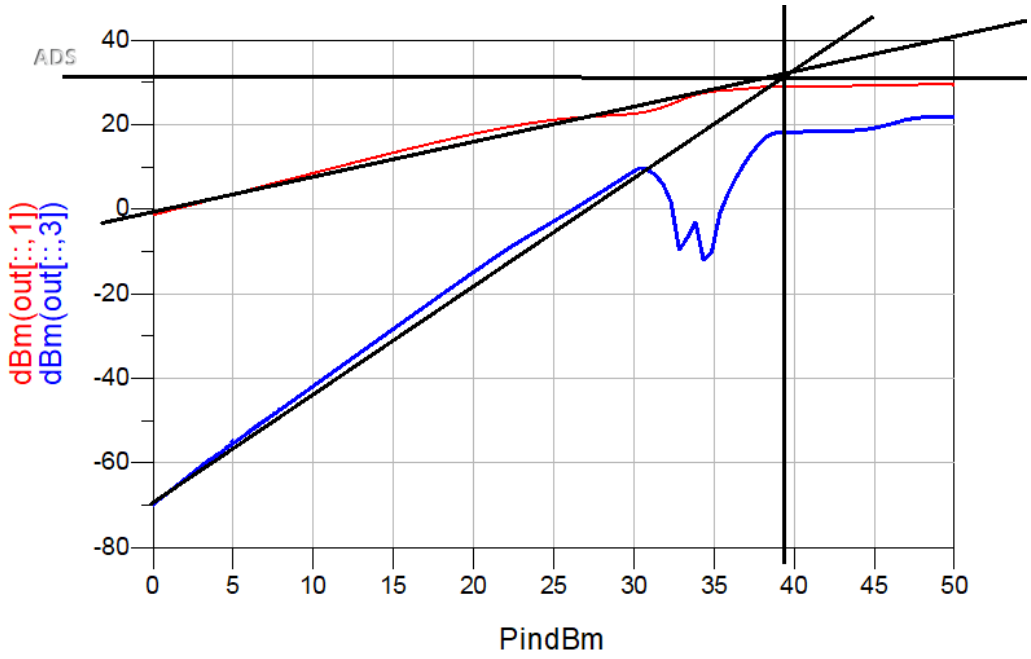

Fig 19. (Determining OIP3 and IIP3 graphically)

Conclusion

It can be seen that the values of OIP3 AND IIP3 are the same as in the task, $IIP3\ is\ 24\ dBm$ and $OIP3\ is\ 38\ dBm$, from this we may conclude that all the calculations were done correctly.