Modeling and Simulation of The Transistor BFG425W_ NPN_WideBand

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Abstract—**This paper describes Radiofrequency (RF) design and simulation issue using Quite Universal Circuit Simulator (QUCS). The RF device is BFG425W_NPN transistor with high (25GHz) transition frequency from NXP Semiconductors' company. The device characteristics are outlined and Spice model is computed using their parameters and integrated into QUCS software by using the Spice netlist to obtain the model in the Graphical User Interface (GUI). The simulation is performed and the results obtained are compared with the measurements results from NXP Semiconductors company. Finally, conclusion is performed based on results.**

***Index Terms*—Modeling, Simulation, High frequencies, Quite Universal Circuit Simulator, Transistor BFG425W**.

I. INTRODUCTION

Transistors play a great role in RF device and allow the signal to be amplifed in the receivers part. Hence, their process and design are very important.

This paper describes modeling and simulation of RF wideband transistor. The type of RF device is BFG425W NPN wideband transistor which is from NXP semiconductors company.

The study is divided into the following tasks:

- Theoretical description of the BFG425W NPN wideband transistor
- Simulation with QUCS tool and comparison with the actual measurements.

Firstly, the main characteristics of the transistor like features, applications and pin configuration in SOT340R package are decribed.

And then, the model of the transistor is computed and simulated using Quite Universal Circuit Simulator (QUCS). The simulation results will be discussed by comparing with the actual measured data.

II. DESCRIPTION OF THE TRANSISTOR

The transistor is BFG425W NPN wideband from NXP Semiconductors. Its main characteristics [1] are:

- Very high power gain
- Low noise figure
- High transition frequency (25 GHz)
- Emitter is thermal lead
- Low feedback capacitance

It is an NPN double polysilicon wideband transistor with buried layer for low voltage applications in a plastic, 4-pin dual-emitter SOT343R package (Fig.1) [1]. It is suitable for small integration and belongs to the 5th generation of transistors.

Table 1 Pin configuration of BFG425W

Pin number	Description
1	emitter
2	base
3	emitter
4	collector

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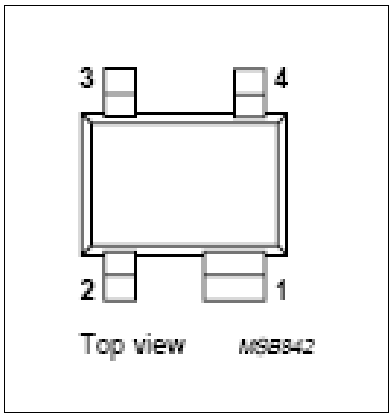

Fig. 1. Simplified outline SOT343R

This transistor is essentially used in:

- Radars detectors
- RF front end
- Satellite television tuners
- High frequency oscillators
- Wideband applications

III. Simulation

In this study, in order to simulate the device, we need to use the correct package, which is the SOT343R.

A. Parasitics Description

Eventhough the device has two emitter, the model which is used has only one emitter (Fig. 3). The parasitics of this model has been taken in account in spice netlist and reproduced in a shematic (Fig. 2).

NXP fifth generation double polysilicon wideband technology uses a steep emitter doped profile resulting in transistion frequencies over 20GHz [1], and with poly base contacts a low base resistance is obtained. Via the buried layer, the collector contact is brougth out at the top of the die. The substrate is connected directly to the emitter package lead, resulting in improved thermal performance.

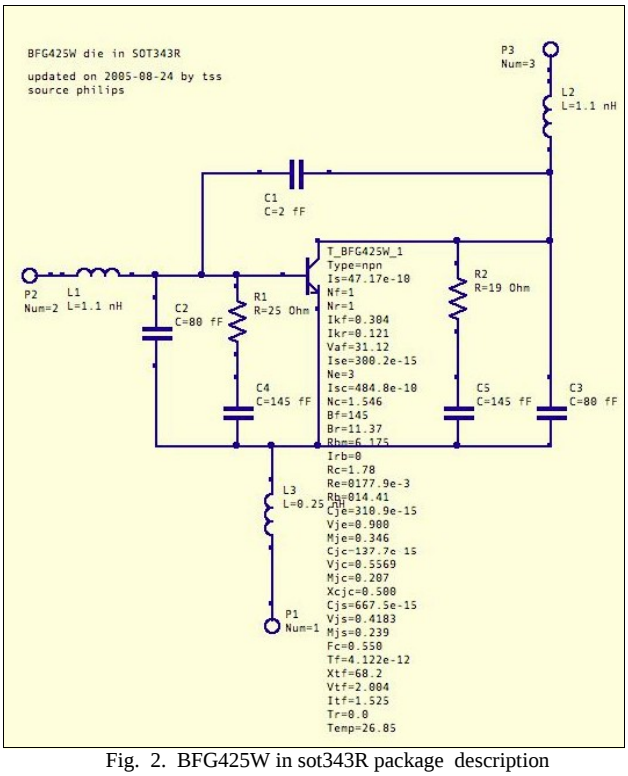

Fig. 2. BFG425W in sot343R package description

Before simulation is performed, the spice model for the transistor is computed. This task is performed with the transistor parameters extracted from NXP semiconductors [2].

After we obtained the spice model, it is supposed to be integrated in QUCS software using the SPICE netlist. Addionally, the Graphical User Interface (GUI) model is obtained, and is possible to use it in QUCS schematics.

B. Circuit

The transistor is integrated in the circuit (Fig. 3) for S-parameters simulation with QUCS.

The two AC power sources P1 and P2 are for a two-port S-parameter simulation. The additional block C1 at the base and the bias tee X1 on the collector are used to decouple the signal path of the biasing DC sources from the internal impedance of the AC power sources. Also the bias tee ensures that the AC signal from the P2 source is not shorted by the DC source V1. The same functionality is achieved by the DC current source I1 at the base. It represents an ideal AC open.

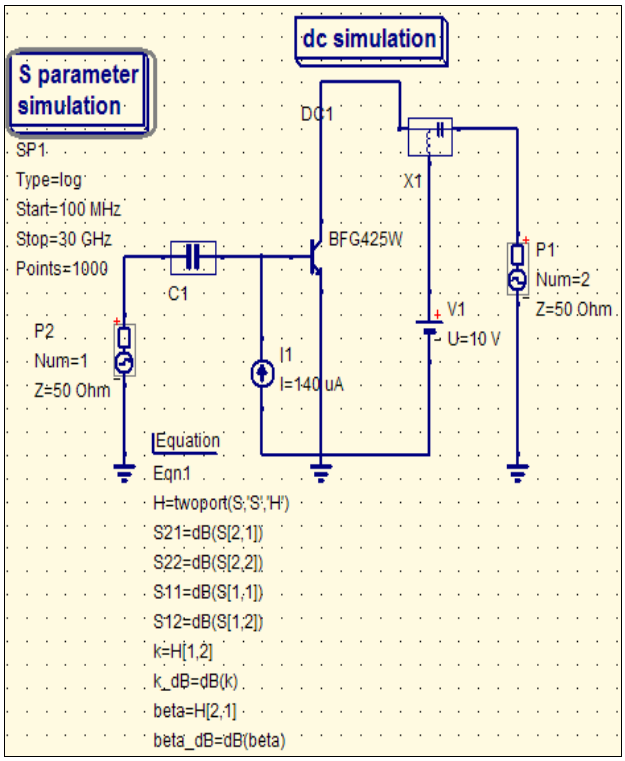

Fig. 3. BFG425W Transistor in the circuit

C. Results

The simulation results are showen in following figures.

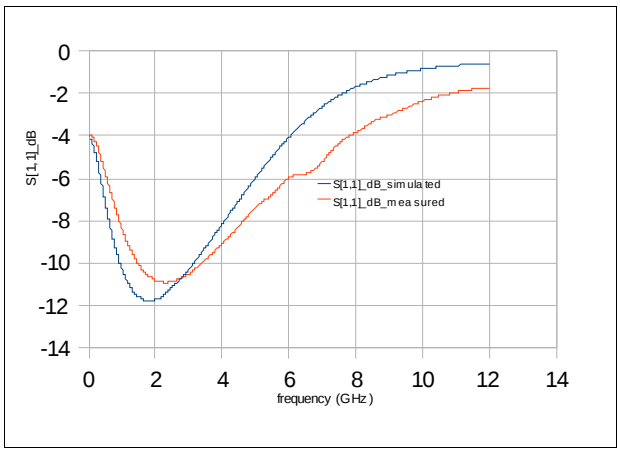

Fig. 4. S[1,1]_dB simulated and measured

The input reflection coefficient S11 is below to -10dB between 1-3GHz (Fig. 4).

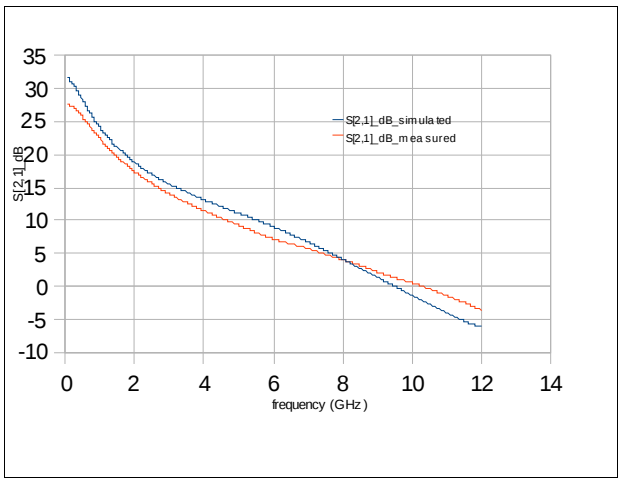

Fig. 5. S[2,1]_dB simulated and measured

The forward transmission S21 is always graeter than 11dB for all frequencies below to 5GHz (Fig. 5).

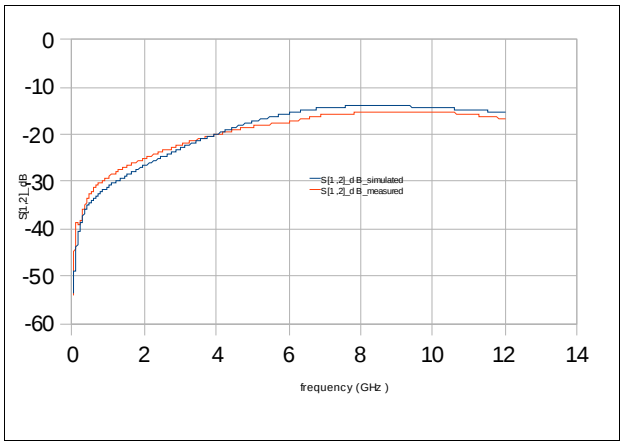

Fig. 6. S[1,2]_dB simulated and measured

The reverse transmission gain S12 is always lower than -14dB (Fig. 6).

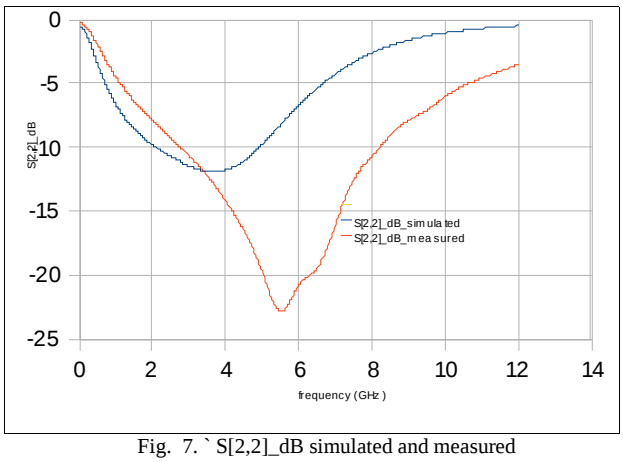

Fig. 7. ` S[2,2]_dB simulated and measured

The output refection coefficient S22 is below to -10dB between 2.8-5GHz (Fig. 7).

The simulation results shown above has a good matching with the measurements. Only S22 does not match accuratly at high frequencies. The reason of this shift is due to the presence of the voltage which inturn increases the parasitics.

IV. Conclusion

The BFG425W NPN Wideband Transistor from NXP semiconductors has been presented with its physical characteristics and parameters.

The simulated results has been performed using its model which is computed with Quite Universal Circuit Simulator (QUCS). The simulated results match well with that of the mesured ones from NXP semiconductors. This transistor is especially suited for RF device working at high frequencies between 1 to 3 GHz.

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References

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