Introduction to sensing structure simulation model

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Sensing structure model specifications

1. General considerations

The Sensing structure simulation model is written in PSpice and is compatible with OrCAD PSpice, Tina Industrial and SIMetrix simulators.

2. Functionality

Model performances:

- Capable of modeling frequency behavior of a sensing structure and its sensitivity
- Available for AC, DC and Transient simulations

Implemented features:

- Sensing structure Sensitivity

3. Descriptions of ports/pins

Port name	Port function
IP+	Positive current pin
IP-	Negative current pin
VBFIELD	Output voltage pin representing magnetic field intensity

Table 1: List of pins/ports

4. Model parameters

Parameter name	Default value
P_R_SENSITIVITY	1m
P_R1	1m
P_R2	1m
P_R3	1m
P_R_L1	1m
P_R_L2	1m
P_R_L3	1m
P_C_L1	1f
P_C_L2	1f
P_C_L3	1f
P_C_H1	1f
P_C_H2	1f
P_C_H3	1f

Table 2: List of parameters

Below is presented the model schematic used to adjust the AC characteristics of the sensing structure.

Can be observed that each component is parametrized.

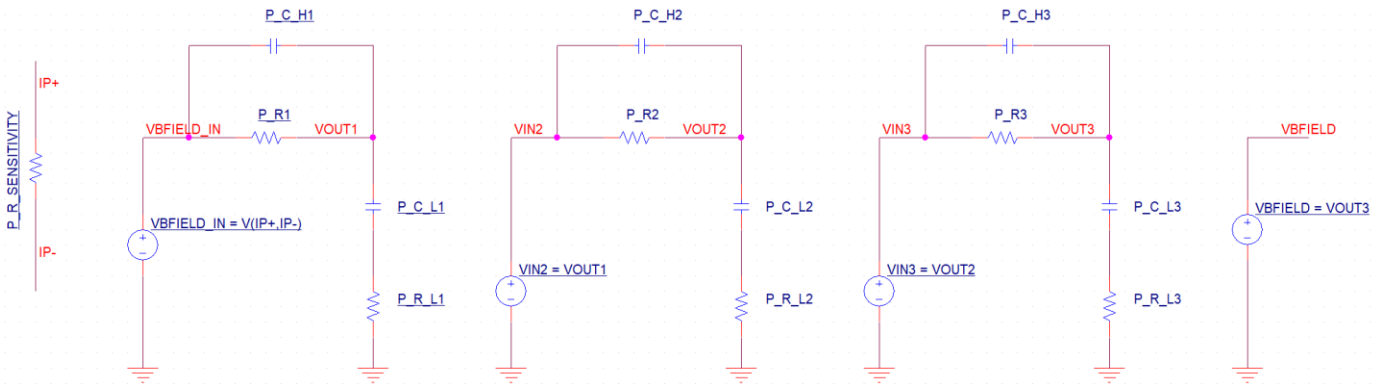


Figure 1: Sensing struture circuit

AC characteristics

Using the default parameter value from Table 2, Sensing structure model will have the frequency behaviour presented in *Figure 1* with red colour.

Note: the gain is -60dB because P_R_SENSITIVITY = 1m

The desired characteristics are represented in figure 1 with green colour.

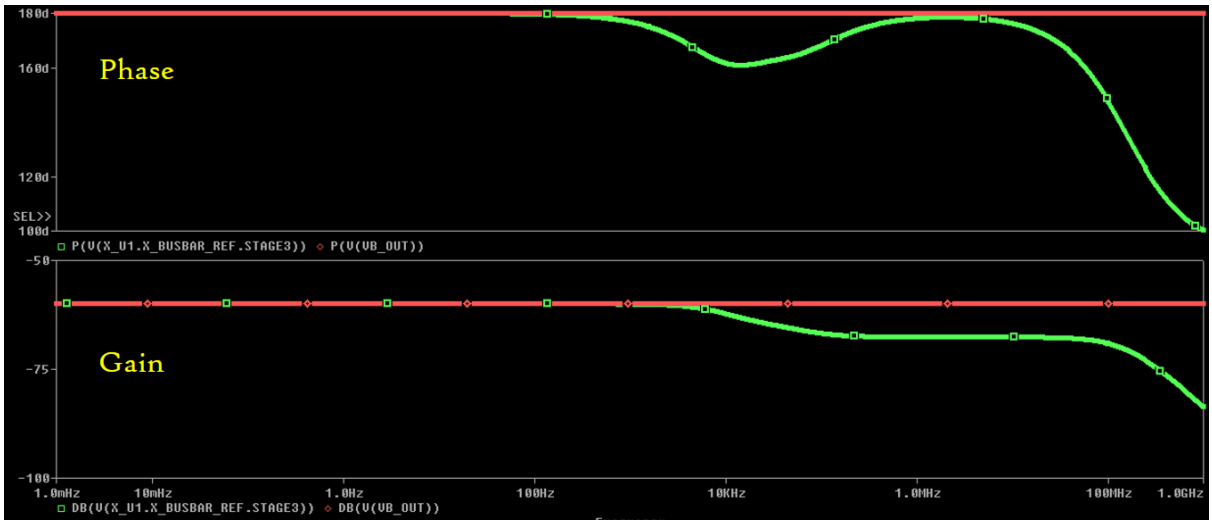


Figure 1: The reference characteristics (green) and the characteristics of the Sensing structure circuit using the default parameter values (red)

In the following, the steps by which we can obtain the characteristics of the circuit shown in figure 1 will be presented. The goal is to obtain characteristics as close as possible to the desired ones.

Step 1: Phase decrease @ ~10KHz

Phase decreasing @10KHz is influenced by the **P_R1** and **P_C_L1** parameters.
By changing the values to: **P_R1=1k** and **P_C_L1=10n** the characteristics depicted in *Figure 2* are obtained (red color).

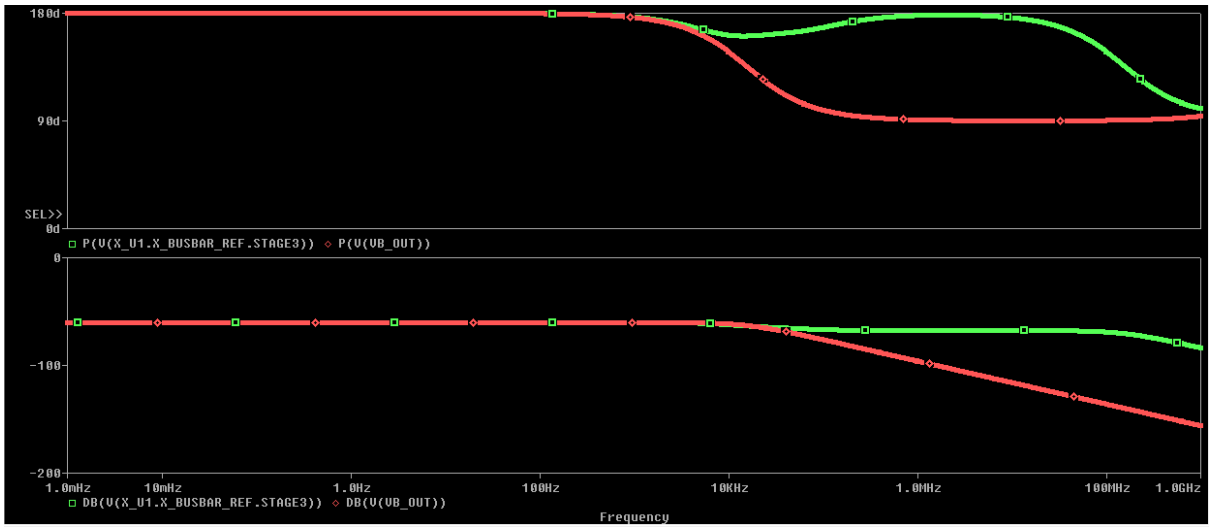


Figure 2

Step 2: Phase increase @ frequencies higher than 10KHz

Phase increasing for frequencies higher than 10KHz is influenced by the value of **P_R_L1** parameter and a **parametric analysis** is necessary to be performed.
The lines below show the command for an AC parametric analysis (PSpice)

```
.AC DEC 100 1m 1G
.STEP DEC PARAM P_R_L1 0.1k 10k 10
```

In this analysis, the P_R_L1 parameter is varied between 0.1KHz and 10KHz with 10 points per decade. From the obtained simulation results, the best fit found is for P_R_L1 = 1k. Below, in *Figure 3* can be observed the waveforms obtained (green color).

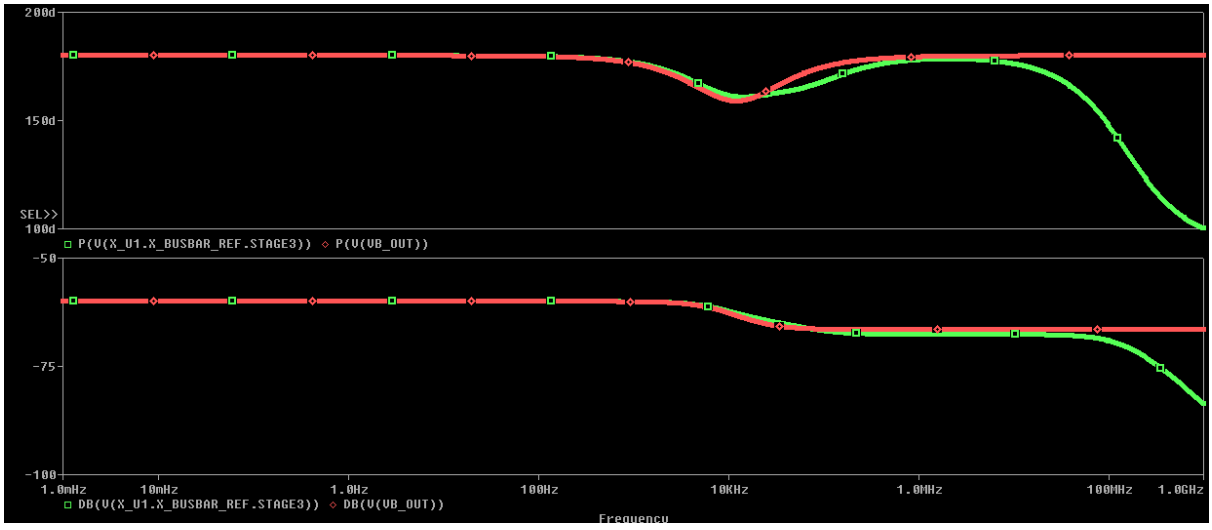


Figure 3

Step 3: Phase increase @ frequencies higher than 30KHz

Phase increasing for frequencies higher than 30KHz is influenced by the value of **P_R2** and **P_C_L2** parameters.
The parameter P_R2 is set to 1k (**P_R2=1k**).
In order to find the parameter value, a **parametric analysis** is necessary to be performed. The lines below show the command for an AC parametric analysis (PSpice)

```
.AC DEC 100 1m 1G
.STEP DEC PARAM P_C_L2 0.1n 10n 10
```

The P_C_L2 parameter is varied between 0.1n and 10n with 10 per decade.
From the obtained simulation results, the best fit found was for **P_C_L2 = 0.5n**. Below, in *Figure 4* can be observed the waveforms obtained (green color).

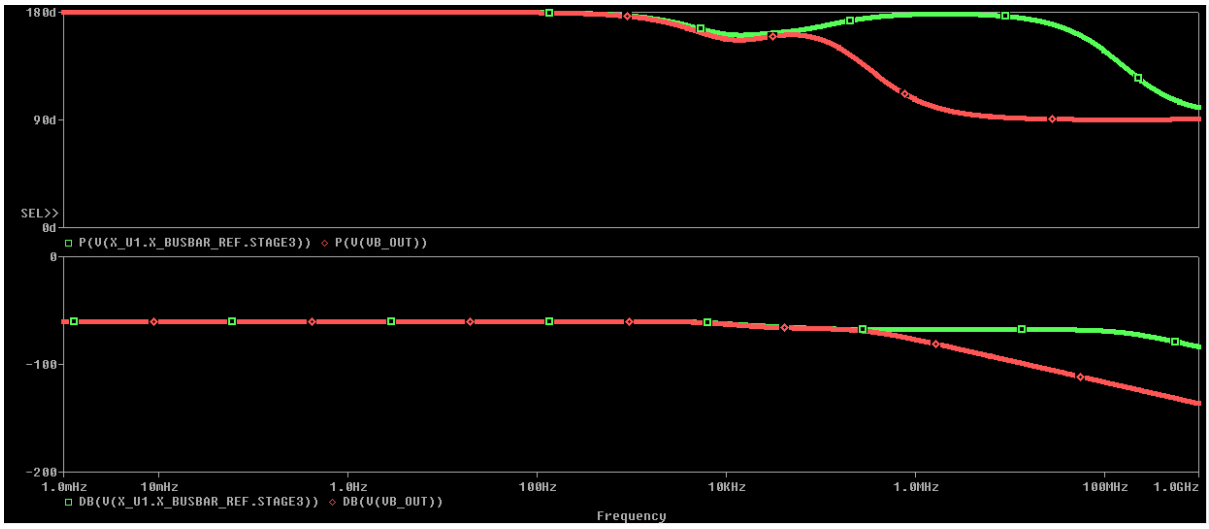


Figure 4

Step 4: Phase increase @ frequencies higher than 10KHz

Phase increasing for frequencies higher than 10KHz could be modeled by the value of **P_R_L2** parameter.
In order to find the parameter value, a **parametric analysis** is necessary to be performed. The lines below show the command for an AC parametric analysis (PSpice)

```
.AC DEC 100 1m 1G
.STEP DEC PARAM P_R_L2 0.1k 10k 10
```

The P_R_L2 parameter is varied between 0.1k and 10k with 10 per decade.
From the obtained simulation results, the best fit found was for **P_R_L2 = 3k**. Below, in *Figure 5* can be observed the waveforms obtained (green color).

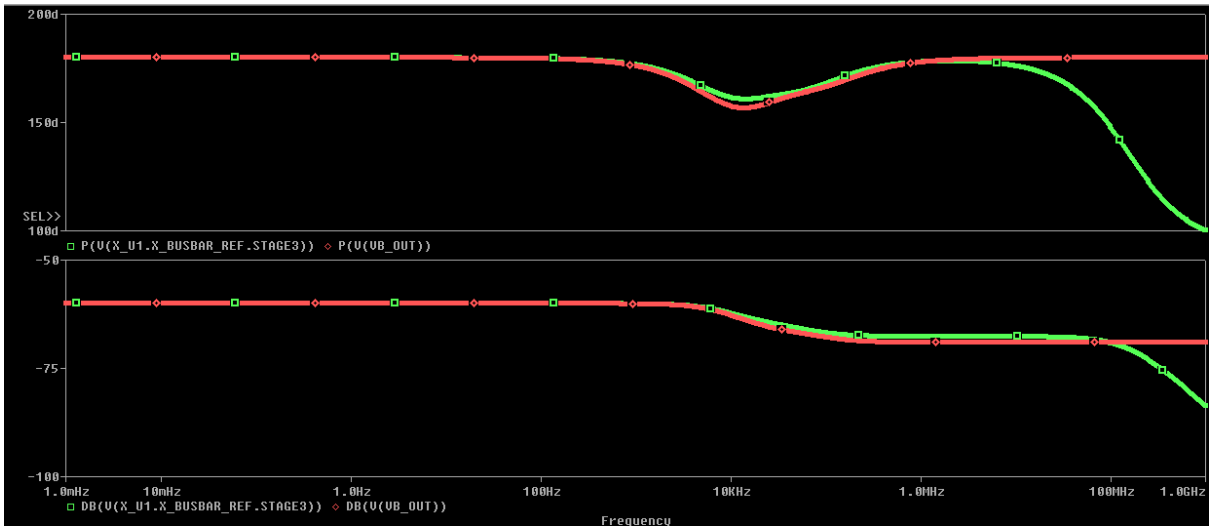


Figure 5

Step 5: Improving of the accuracy

1KHz to 10kHz: P_C_L1 < 10n

P_C_L1=8n is the value found. *Figure 6* shows the obtained waveforms.

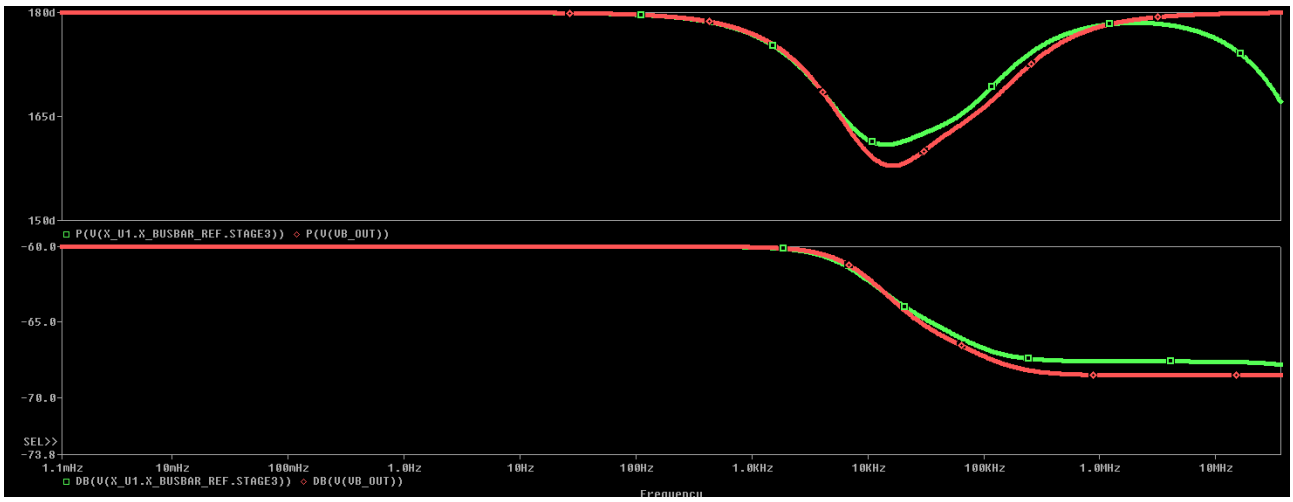


Figure 6

10kHz and 1Mhz: P_R_L1 > 1k

P_R_L1 = 1.2k is the found value. *Figure 7* shows the obtained waveforms.

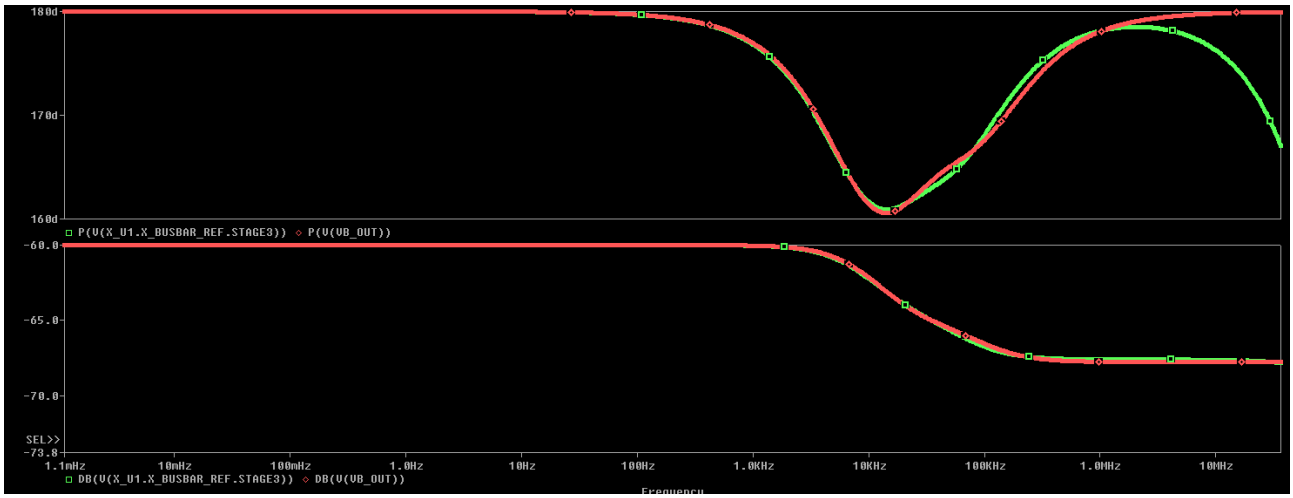


Figure 7

10kHz and 100kHz: P_C_L2 > 0.5n

P_C_L2 = 0.55n is the found value. *Figure 8* shows the obtained waveforms.

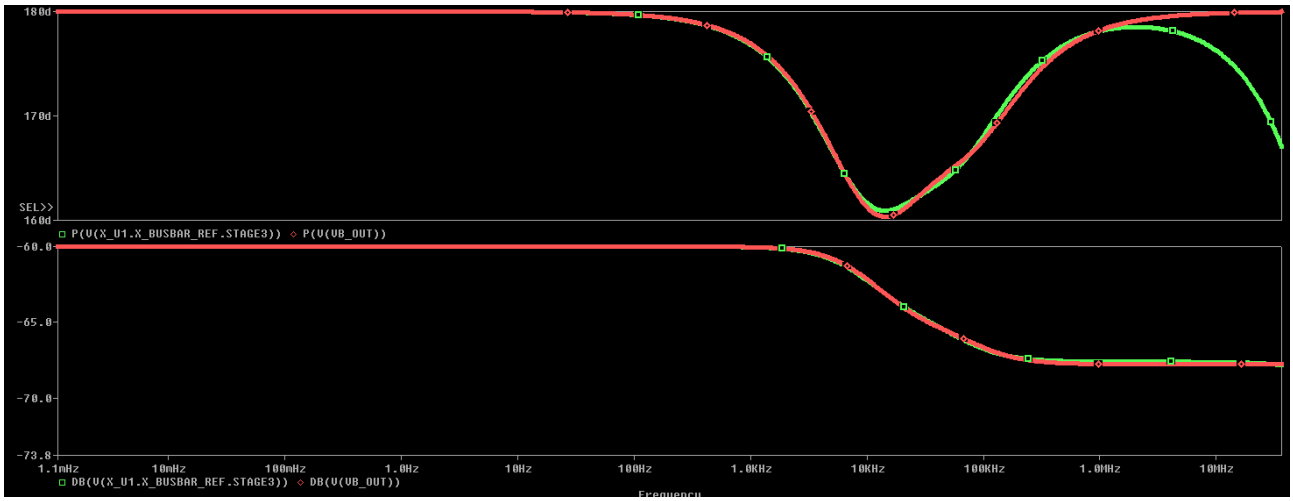


Figure 8

10kHz and 100MHz: P_R_L2 > 3k

P_R_L2 = 3.1k is the found value. *Figure 9* shows the obtained waveforms.

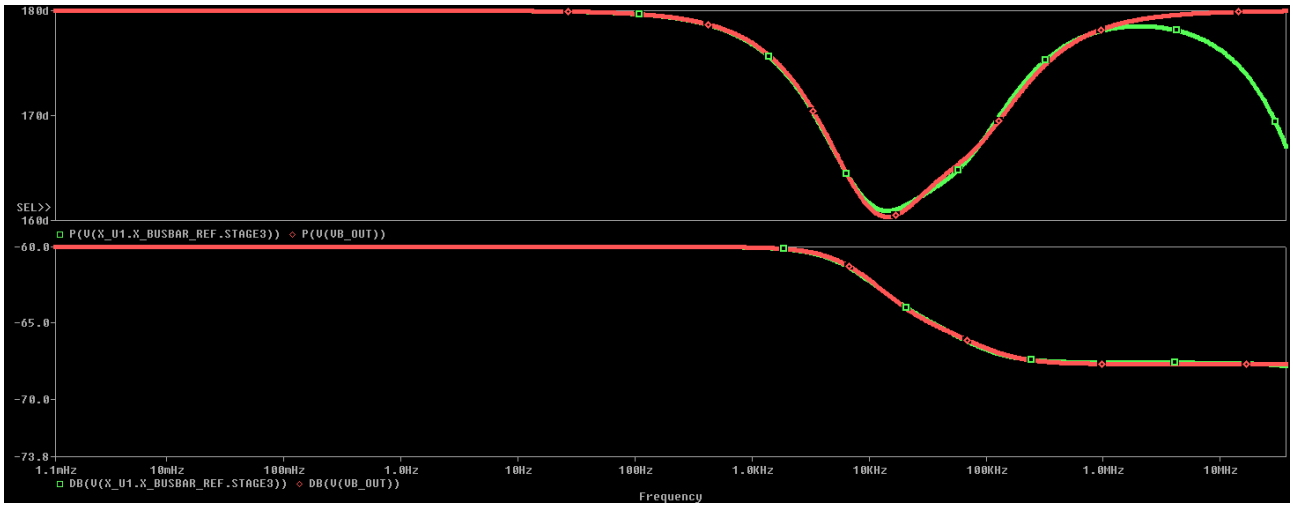


Figure 9

Step 5: Phase decrease @ frequencies higher than 1MHz

Phase decreasing for frequencies higher than 1MHz could be influenced by the value of **P_R3** and **P_C_L3** parameters.
The parameter P_R3 is set to 1k (**P_R3=1k**).
In order to find the parameter value, a **parametric analysis** is necessary to be performed. The lines below show the command for an AC parametric analysis (PSpice)

```
.AC DEC 100 1m 1G
.STEP DEC PARAM P_C_L3 0.1p 100p 10
```

The P_C_L3 parameter is varied between 0.1p and 100p with 10 per decade.
From the obtained simulation results, the best fit found was for **P_C_L3 = 1p**. Below, in *Figure 10* can be observed the waveforms obtained.

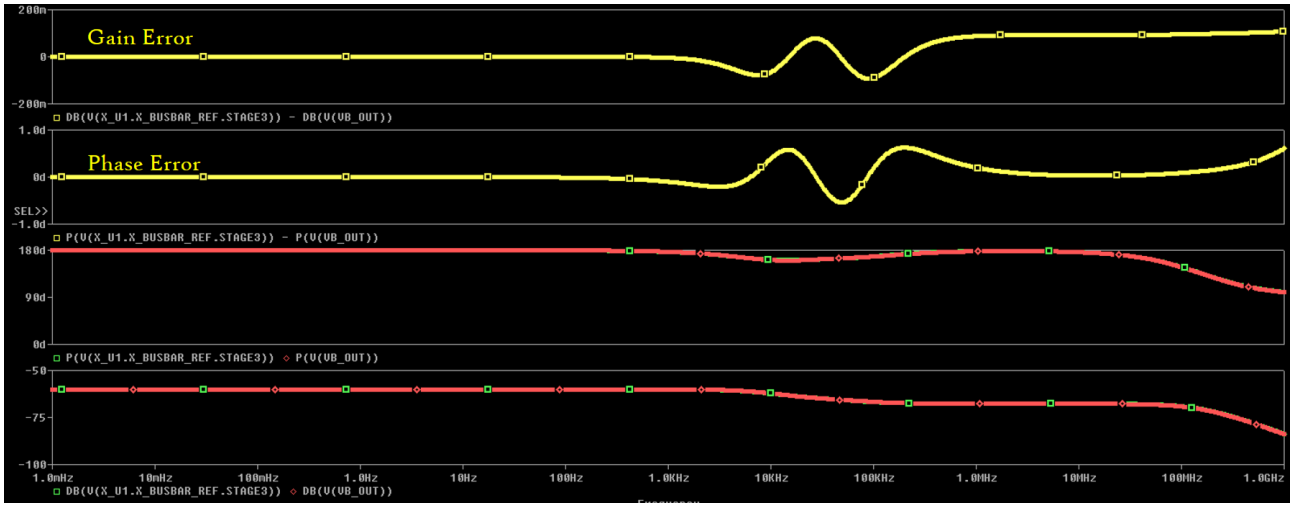


Figure 10

Summary

The simulation model explained in the previous chapter is a generic one. Using the presented steps, the simulation model of different sensing structures could be obtained.

More information on the different possible sensing structures can be found in the Sensing Structure Design Application note:

https://www.infineon.com/cms/en/product/sensor/current-sensors/tle4973-ae35s5-s0001/#!?fileId=8ac78c8c7fb5929e017fbc95cd130e32