

RESEARCH ARTICLE

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Analysis of Gilbert Multiplier Using Pspice

Mayank Kumar, Prof.K.K.Singh

M. Tech, Amity University, Uttar Pradesh Lucknow

Assist. Prof, ASET, Amity University, Uttar Pradesh Lucknow

Abstract

In this paper, the implementation of gilbert multiplier has been done using pspice. In this paper the three analysis of Gilbert Multiplier have been done i.e. DC Analysis, AC Analysis and TRANSIENT analysis with the help of SPICE software. So Spice is a general purpose circuit program that simulates electronic circuits and can perform various analysis of electronic circuits. So with the help of pspice, the analysis of gilbert multiplier has been proposed in this paper.

Keywords- gilbert multiplier circuit, pspice software

I. INTRODUCTION

During the past, the laboratory prototype measurement was almost impossible to provide the good information about the circuit performance. So that's why pspice has been come to provide the correct information about the complex circuit. SPICE is a powerful purpose analog circuit simulator that is used to verify circuit designs and to analyse the circuit behavior.. It was for this reason the SPICE was developed at the Electronics Research Laboratory of the University of California, Berkeley (1975).

SPICE implies for Simulation Program for Integrated Circuits Emphasis.

SPICE can do several types of circuit analysis. Here are the most important ones:

- SPICE can done Non-linear DC analysis i.e. it calculates the DC transfer curve
- It can also done Non-linear transient analysis i.e it calculates the voltage and current as a function of time when a large signal is applied.
- It can also done Linear AC analysis i.e. it calculates the output as a function of frequency. In this analysis a bode plot is generated.
- Noise analysis and many more analysis can be done by SPICE

In analog-signal processing, there are two analog inputs signals [3] and produces an output proportional to their product. Such circuits are termed as analog multiplier. Analog multipliers [1] are largely used in analog signal processing and communication systems such as mixers in FM receivers [5], amplitude modulators and frequency traslators.

Analog voltage multiplication can be performed either by using the square law characteristics of transistors biased in saturation region or by using Gilbert Cell.

II. IMPLEMENTATION OF GLILBERT MULTIPLIER

The Gilbert multiplier cell is the basic multiplier for most integrated circuit. Balanced multiplier[2] says that the series connection of an emitter-coupled pair with two cross-coupled, emitter coupled pairs produces a useful transfer characteristic.

The Gilbert cell consists of two differential amplifier stages formed by emitter-coupled transistors pairs(Q6/Q3, Q2/Q4) whose outputs are connected(currents summed) with opposite phases. The emitter junctions of these amplifier stages are fed by the collectors of a third differential pair(Q1/Q5).

The output currents of Q1/Q5 become emitter currents for the differential amplifiers. Simplified, the output current of an individual transistor is given by

$$I_{co} = V_{be} \cdot g_m \quad (1)$$

And its transconductance(g_m) is given by

$$G_m = 40 \cdot I_{dc} \quad (2)$$

Combining these equations gives

$$I_{co} = 40 \cdot I_{DC} \cdot V_{be} \cdot I_o \quad (3)$$

However, IDC here is given by $V_{be} \cdot g_m \cdot r_f$

$$\text{Hence,} \\ I_{co} = 40 \cdot V_{be} \cdot I_o \cdot V_{be} \cdot g_m \cdot r_f \quad (4)$$

Which is a multiplication of $V_{be} \cdot I_o$ and $V_{be} \cdot r_f$. Combining the two difference stages output currents yields four-quadrant[4] operation

Where V_{be} is given by

$$V_{be} = V_t \ln(I_c/I_o)$$

V_t is the threshold voltage.

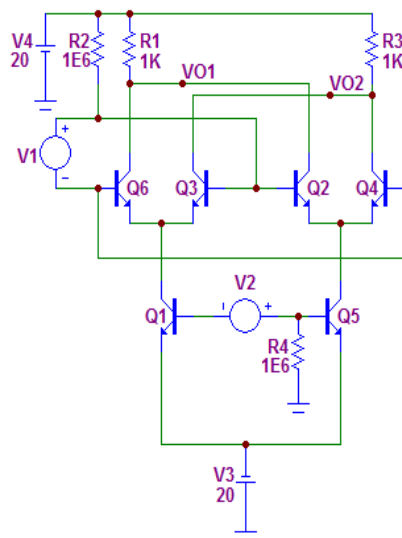


FIGURE 1. GILBERT MULTIPLIER CIRCUIT

III. SIMULATION RESULTS OF GILBERT MULTIPLIER

DC ANALYSIS OF GILBERT MULTIPLIER

DC Analysis is used for circuits with time-invariant sources(steady state dc sources). It calculates all the node voltages and branch currents over a range of values and their quiescent(dc) values

are the outputs. Hence Figure 2 shows the DC analysis of the Gilbert Multiplier. The expression for DC analysis is $\text{del}(v(vo1,vo2))/\text{del}(v(v2))$.

AC ANALYSIS OF GILBERT MULTIPLIER

AC Analysis is used for small small-signal analysis of circuits with source of variable frequencies. It calculates all node voltages and branch currents over a range of frequencies, and their magnitudes and phase angles are the outputs. Hence Figure 3 shows the AC analysis of the Gilbert Multiplier. It shows that frequency up to 10MHz the voltage relationship is fine but after 10MHz there is a decrement in voltage and it shows AC analysis.

TRANSIENT ANALYSIS OF GILBERT MULTIPLIER

TRANSIENT analysis is used for circuits with time variant sources(e.g. ac sources and switched dc sources). It calculates all node voltages and branch currents over a time interval, and their instantaneous values ar the outputs. Hence Figure 4 shows the Transient analysis of the gilbert multiplier. First signal shows voltage V2, second signal shows voltage V1 and the final waveform shows the relationship of voltage $V(Vo1,Vo2)$.

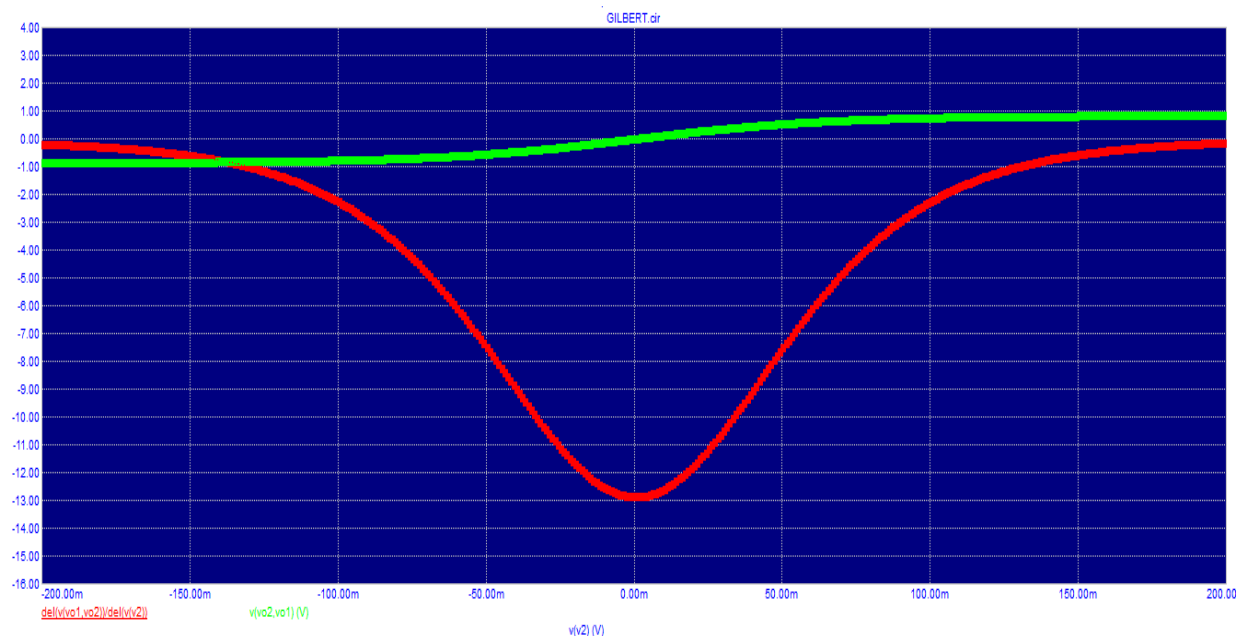


FIG.2 DC ANALYSIS OF GILBERT MULTIPLIER

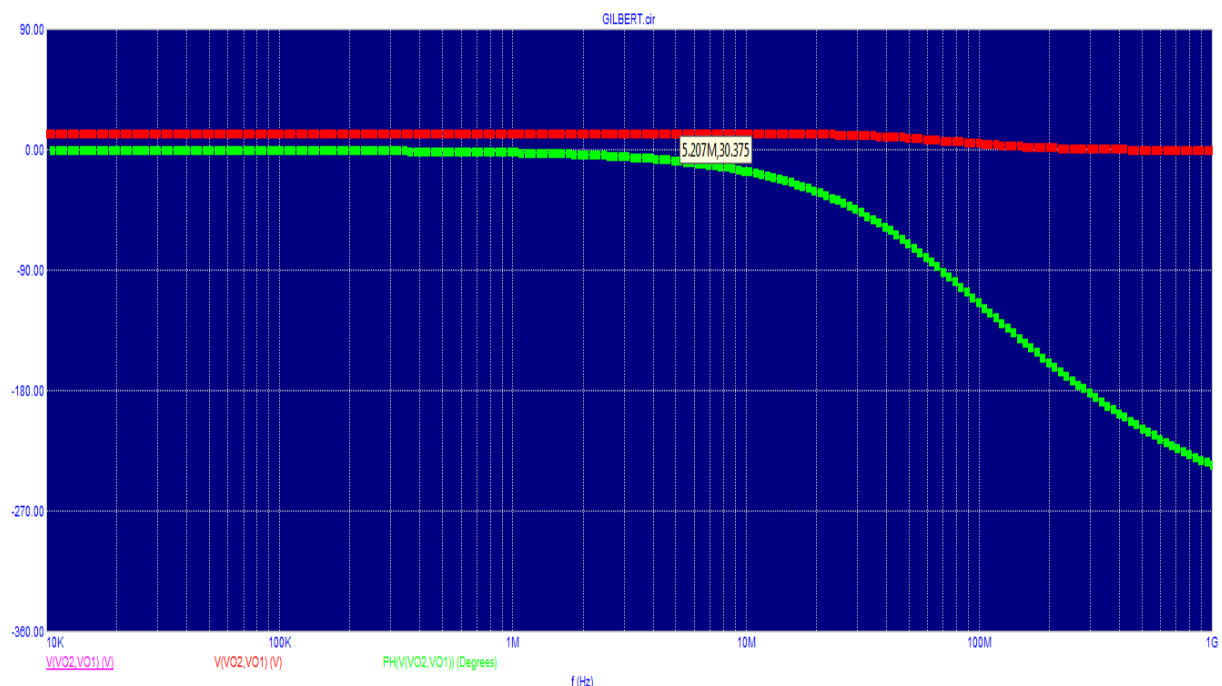


FIG 3.AC ANALYSIS OF GILBERT MULTIPLIER

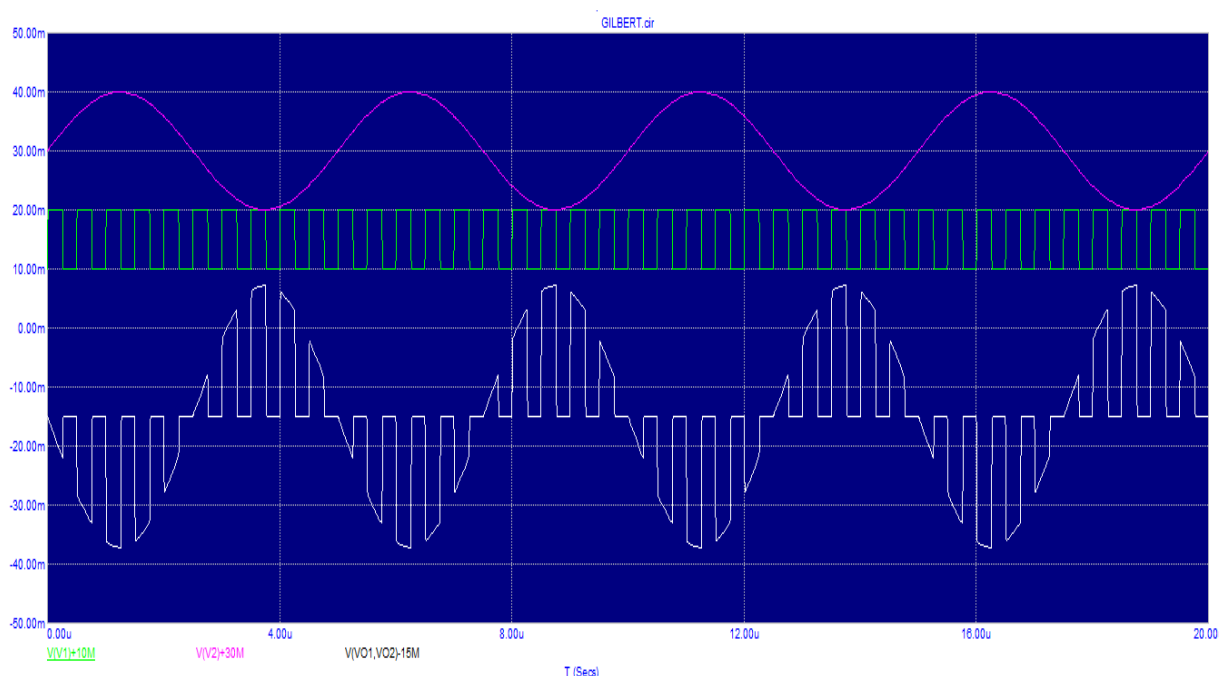


FIG 4. TRANSIENT ANALYSIS OF GILBERT MULTIPLIER

IV. CONCLUSION AND FUTURE ASPECTS

The Analysis Of Gilbert Multiplier Is Proposed In This Paper. This Circuit Is Simulated By SPICE. Simulation Results Shows The DC, AC, TRANSIENT Analysis Of Gilbert Multiplier. We Can Also Proposed The Phase Detection Of Gilbert Multiplier In Future And Also Used This Gilbert Multiplier For Lowering The Voltage Or Power Which Was Very Useful For Every Purposes.

REFERENCES

- [1] Shi-cai qin andrandy l.geiger senior member, IEEE, "A± 5-v cmos Analog Multiplier", IEEE 1987, Department of Electrical Engineering, Texas A&M University, pp.1143-1146
- [2] Chandra shekhar, Mr. Ajai gautam, saurabh chitransi, " Low Voltage Low Power Gilbert Cell based Multiplier Circuit", International journal of Engineering Research and

- Applications(IJERA), Vol.1, Issue 1,pp.011-014
- [3] Radu Gabriel BOZOMITU, Daniela Ionescu, Vlad Cehan, "Improvement of Gilbert cell's Dynamic Range by Predistortion of input signals, Department of Telecommunications, Faculty of Electronics and Telecommunications, "Gh. Asachi" Technical University, pp.41-45.
 - [4] A Low Voltage High Frequency Four Quadrant Analog Multiplier, 2010 International Conference on Mechanical and Electrical Technology (ICMET 2010).
 - [5] Design of Gilbert Cell mixer in .18um CMOS technology and IF filter For FM receiver, IEEE 2009.