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INFLUENCE OF PHYSICAL PARAMETERS ON THE TRANSCONDUCTANCE g_m OF CHANNEL FOR THE COMPONENT SUBMICRON

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Abstract

The component elements of the field effect transistors can be grouped into two distinct categories. Extrinsic elements representing different access structures such as parasitic resistances R_s and R_d . Among the intrinsic elements, the transconductance g_m is cited, which reflects by its nature the localized behavior of the physical structure of the transistors.

The transconductance g_m represents the control mechanism of the transistor; it is the variation of the drain current I_{ds} depending on the gate voltage for a constant drain voltage. In this work we studied:

- Transconductance variation g_m according to the gate length *L* and voltage V_{ds}.
- Transconductance variation g_m according to the resistance R_s and voltage V_{ds}.

Keywords: Transconductance ; parasitic resistances ; gate length ; MESFET ; GaAs;

1. Introduction

Transistors GaAs metal-semiconductor field effect (MESFET) are widely used in microwave and digital applications due to their superior characteristics at high frequencies [**1**], [**4**].

Simulation of nonlinear circuits based on GaAs requires the use of a precision MESFET model, if predicted circuit performance and completion are closely correlated. In industry, it usually starts with a computer simulation of the device or circuit manufacture. Development or improvement of new channels of components requires means for modeling, realization and characterization [**1**], [**2**].

It is therefore very important to predetermine the characteristics of the component, physical modeling here is one of its main applications. Depending on the application and chosen taking into account the complexity of the operation of a transistor gate field effect submicron, optimization of the component according to the geometrical and physical parameters is only possible by the experimental approach. [**2**], [**6**].

It is imperative to understand the phenomenon exists, and the variation of a single parameter technology may be able to have various effects on the characteristics and possibilities of the field effect transistor. Those are not easy to analyze without an accurate determination of internal parameters that govern [**3**], [**4**],

The component designer must know the influence of technological parameters, so that it may consider their influence on the behavior of the device. Especially when it comes to circuits monolithic microwave integrated [**5**], [**6**].

2. Calculation of the transconductance g_m

The expression of the transconductance is given by the equation:

$$g_m = \left.\frac{\Delta I_{ds}}{\Delta V_{gs}}\right|_{V_{ds}=Cte}$$

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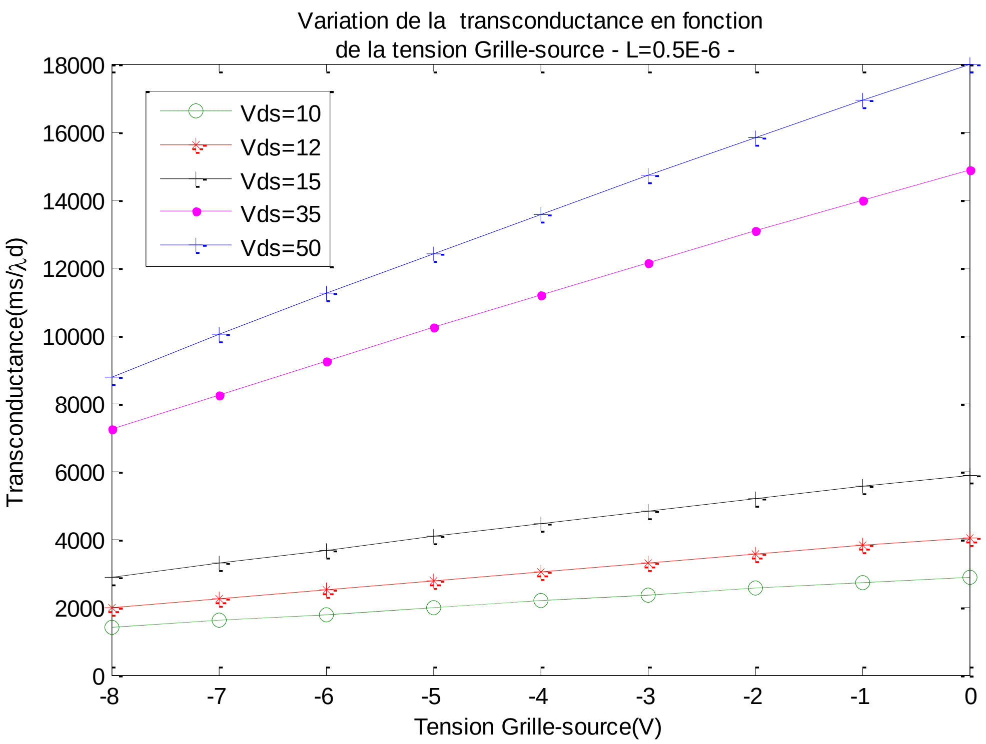
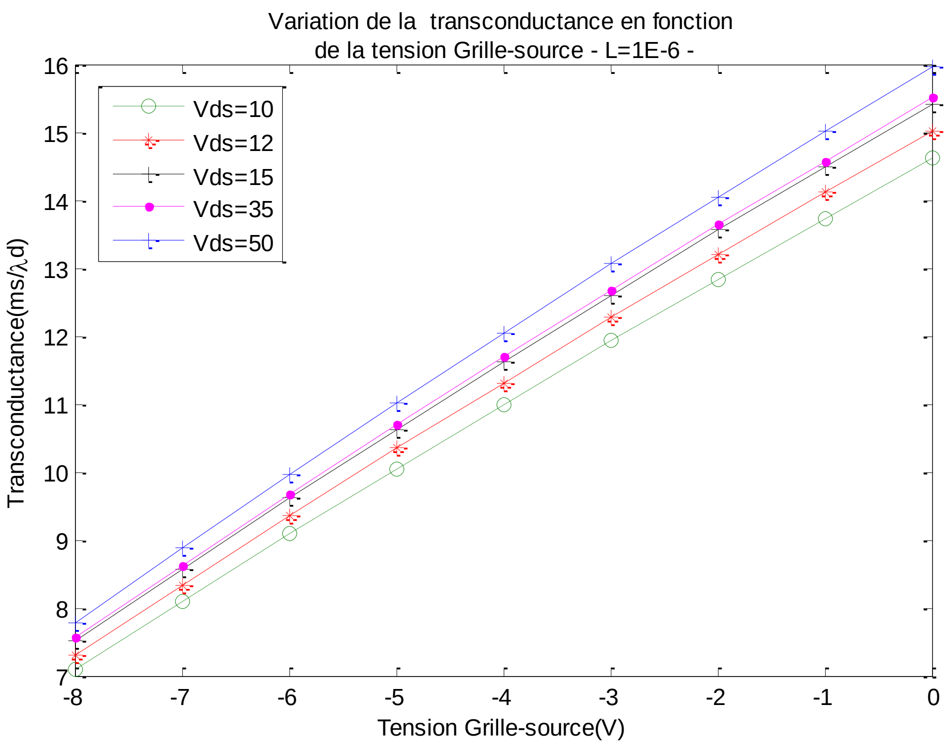
2.1. Variation of Transconductance g_m depending on the gate length L and voltage V_{ds} (we take R_s= 100 Ω)

(a)



(b)



(c)

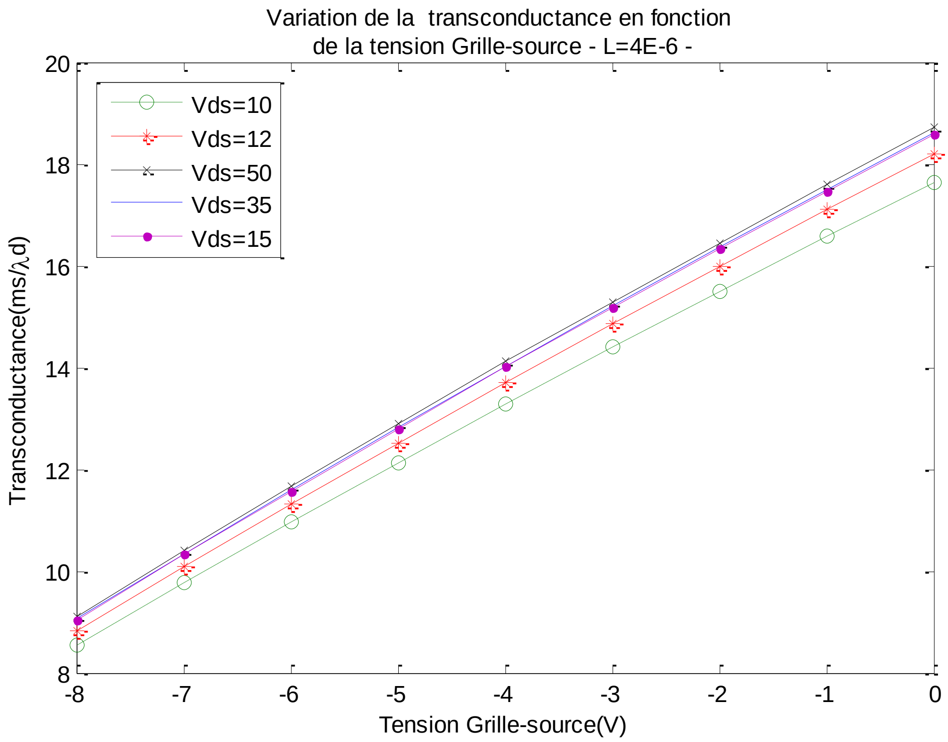
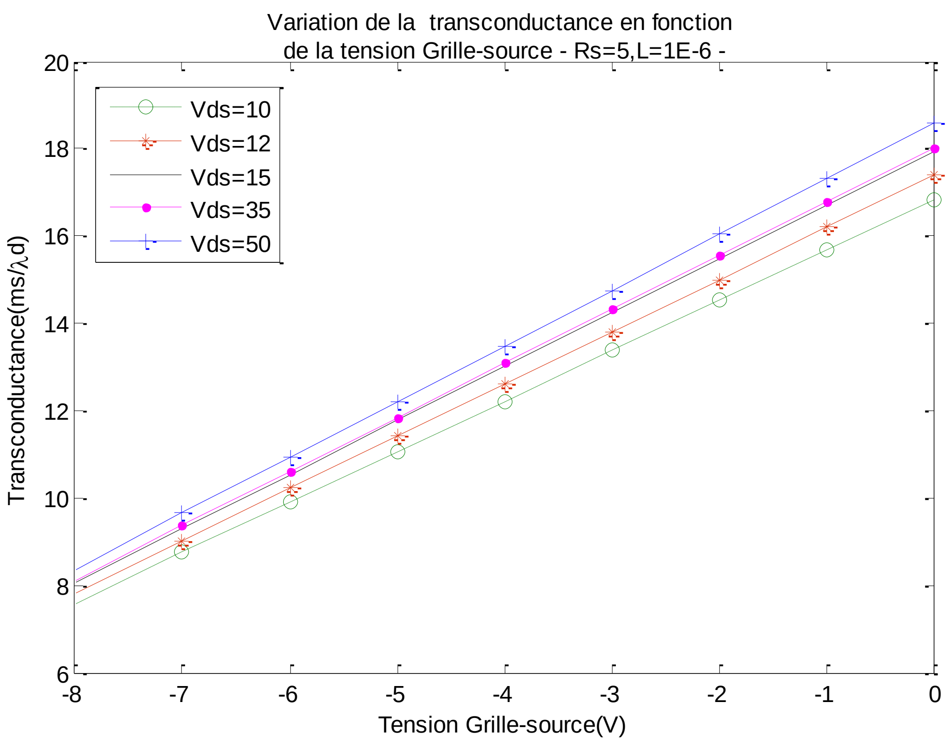


Fig. 1 Variation of Transconductance g_m depending on the gate length L and voltage V_{ds} (we take $R_s = 100\ \Omega$) [(a), (b), (c)]

We see that the value of the channel transconductance decreases with increasing width of the gate, which confirms the phenomenon of electrons over speed in the channel for submicron components.

2.2. Variation of the transconductance g_m according to the resistance R_s and the voltage V_{ds} (we take L=1E-6)

(a)



(b)

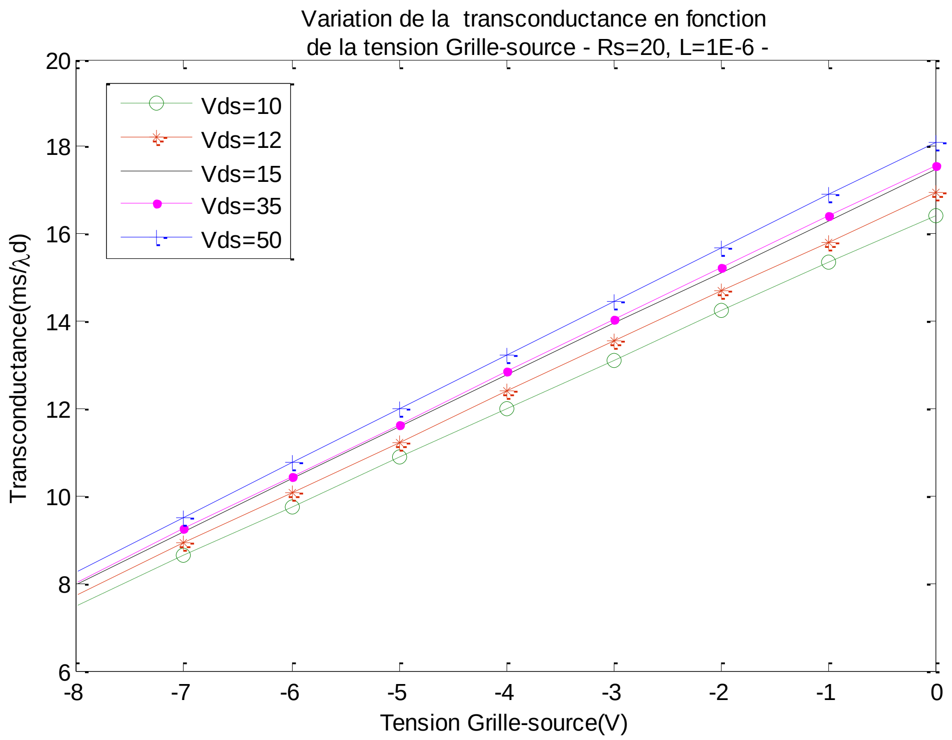


Fig. 2 Variation of the transconductance g_m according to the resistance R_s and the voltage V_{ds} (we take L=1E-6) [(a),(b)]

We note that the influence of the source parasitic resistance value R_s on the transconductance is minimal.

3. Conclusion

The results are in agreement with the literature under the same conditions, the method is applicable for all other geometries.

The Poisson equation can have an analytical formula for the depopulated area and the voltage; therefore have a better accuracy in the calculation of other parameters.

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