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Electromagnetic Modeling of a MESFET transistor using the MOM-GEC

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Abstract—the communications and radar systems demands give arise to new developments in the domain of active integrated antennas (AIA) and arrays. Traditionally, antennas have been considered as static and passive devices with time- constant characteristics. Once the design of the antenna is confirmed, its operational characteristics remain the same in the system use. While the development of antenna method increases, its role in communication systems remains the same. Gain, bandwidth, polarization, antenna feature size, etc. are the achievable quantities of concern. However, the initiation of dynamic radiating structures has disposed the antenna designer an additional degree of freedom to satisfy these design goals. The active integrated antenna has been the solution to various existing problems in wireless communications such as noise machine, power saving and size reduction; which research has been expanding in recent years.

In the previous approaches, researchers have used independent simulators that deal with part of the problem in detail and develop simplifying assumptions about other aspects of the problem. For example, we are interested in the transport model: to deal with all the details of materials and devices, but voluntarily to use a simple EM model inside the system and to represent an external system like equivalent circuit and aims versa. The integrated active antenna problem is the coupling between the electromagnetic model and the transport model that will be affected in the high frequencies. Global modeling of active circuits is important for simulating EM coupling, interaction between active devices and the EM waves, and the effects of EM radiation on active and passive components.

The present work studies the integration of active circuit (MESFET transistor) into passive antenna, which offers a lot of advantages such as increasing the effective length of short antennas, augmenting bandwidth, improving noise factor, impedance matching and sensitivity of receiver antennas. The current review focuses on the modeling of the active element which is a MESFET transistor in a rectangular waveguide. The proposed EM analysis is based on the Moments Method combined with the Generalized Equivalent Circuit method (MOM-GEC). The Method of Moments which is the most common and powerful software as a numerical techniques have been used in resolving the electromagnetic problems.

In the class of numerical techniques, MOM is the dominant technique in solving of Maxwell and Transport's integral equations for an active integrated antenna. Initial boundary conditions can be described by this method which define the discontinuity surfaces and reduce the problem dimensions. The resolution will become more convoluted as the structure's complexity rises. In this situation, the equivalent circuit is introduced to the development of an integral method formulation based on the transposition of field problems in a generalized equivalent circuit that are simpler to treat. To simplify the resolution of Maxwell's equations, the method of Generalized Equivalent Circuit (MGEC), was suggested in order to represent integral equations circuits that describe the unknown electromagnetic boundary conditions. The equivalent circuit presents a true electric image of the studied structures for describing the discontinuity and its environment. The aim of our developed method is to investigate the antenna parameters such as the input impedance and the density current distribution and the electric field distribution. In this work, we propose a global EM modeling of the MESFET AsGa transistor using an integral method as a first step of the global modeling of an active integrated antenna. We will begin by modeling the structure using an equivalent EM scheme that translates the electromagnetic equations considered in the generalized equivalent circuits' domain. From electromagnetic calculations, we were able to determine the input impedance, the density current distribution and the electric field distribution of the MESFET transistor model.