GaN Non-Linear Modeling for Ka Band Resistive Mixer Design

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Mixers are a fundamental component in transmit and receive communications systems for military and space applications. The power handling capability and linearity specifications for mixer blocks has increased for these applications. Resistive mixers are an excellent option for achieving these specifications. A gate controlled variable drain resistance is used as the mixing element for this type of mixer. The local oscillator signal (LO) drives the gate of the device while the RF signal is applied to the drain of the device. The time varying reflection coefficient at the drain produces an intermodulated response which contains the down converted response. The linearity performance of these mixers is superior since the device is operated in the linear region of operation. The design goal is to maximize linearity and minimize the conversion loss.

GaN HEMT structures are an attractive device option when designing resistive mixers. Their high power handling capabilities, large knee voltage, and high operating frequency make them an excellent candidate for resistive mixer designs. Since $Al_xGa_{1-x}N$/GaN technology is relatively new, there exist problems with robustness and non-ideal device behavior. Trap induced dispersion produces gate and drain lag which in turn affects the large signal behavior of the device. In order to design resistive mixers with the GaN technology, accurate models must be produced which take into account both gate and drain lag and accurately model drain resistance over entire linear operating region. The non-linear model should also include accurate behavior of the gate to drain capacitance and the drain to source capacitance.

This paper presents a non-linear model and the design of a resistive mixer at 30GHz. The design will use an unreleased high speed GaN process from Triquint. The model is a modified version of Angelov's non-linear model. The model is modified to provide better fit for the drain resistance and large signal reactances over a larger range of bias voltages. The model also includes gate and drain dispersion effects.