Small-Signal Modeling of HJFET Using Analytical Methods and Particle Swarm Optimization

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An accurate small signal modeling of a FET (MESFET or HJFET) has an important role in CAD algorithm. The modeling is normally carried out using either optimization or analytical techniques. The 15-element small signal equivalent circuit shown in Fig. 1 is widely used to indicate electrical linearity behavior of them over entire range of frequencies at a specific bias point (E. S. Mengistu, PhD Dissertation, University of Kassel, Kassel, Germany, 2008). In this paper, the 15-element small signal equivalent model parameters of AlGaN/GaN HJFET device are evaluated with an analytical procedure. Then these values are used as initial values for optimization approaches such as particle swarm optimization (PSO) and genetic algorithm (GA) to achieve accurate values over broad range of frequency between 2 to 18 GHz. The Optimization problem of S-parameter curves is included their real and imaginary parts. The objective function is the sum square errors between the simulated and measured S-parameter values (A. Jarndal, and G. Kompa, IEEE Trans. Microw. Theory Tech., 53, 3440-3448, 2005). The results are given in Table I. The results show the S-parameter values with PSO has 0.059 error compared to the measured data. While the S-parameter values with GA optimization has 0.13 error compared to the measured data. The proposed optimization technique assures good accuracy and reliability in the parameter extraction problem of HJFET devices.

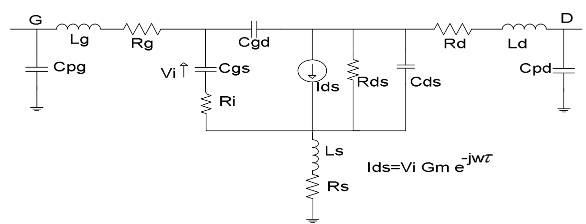

Fig. 1. Small-signal equivalent circuit of HJFET.

Table I. Comparisons of the extracted elements.

Parameters	**Initial Value**	**GA**	**PSO**
Rs (Ω)	1.048	1.29	2.055
R_d (Ω)	2.59	4.79	4.69
R_g (Ω)	1.233	1.67	3.51
L_s (pH)	144	126.741	116.34
L_g (pH)	478	568.165	562.56
L_d (pH)	543	638.739	572.2
C_{pd} (fF)	110	66.154	73.46
C_{pg} (fF)	52.218	51.525	63.72
C_{gd} (fF)	23.74	25.92	25.62
C_{gs} (pF)	0.663	0.2248	0.226
C_{ds} (fF)	125.79	122.576	122.58
R_i (Ω)	14.83	1.06	1.06
G_m (mmho)	141.55	90	90
τ (ps)	0.3649	3.166	3.166
R_{ds} (Ω)	128	216.415	216.415
Error	**1.21**	**0.13**	**0.059**