Small-signal model for RF graphene transistors

Francisco Pasadas
David Jiménez
Departament d'Enginyeria Electrònica, Escola d'Enginyeria, Universitat Autònoma de Barcelona, Campus UAB 08193 Bellaterra, Spain.
francisco.pasadas@uab.cat

The most common approach to model the intrinsic capacitances of graphene field-effect transistors (GFETs) relies on the use of a Meyer-like capacitance approach (Fig. 1a). However, it assumes that the intrinsic capacitances of a transistor are reciprocal (charge conservation is not guaranteed), which is not the case in real devices. In fact, we have found significant discrepancies in calculations of GFET RF figures of merit found in the literature [1-5] (Fig. 2) if a charge-based capacitance model is assumed instead. Thus, the intrinsic capacitances are considered as non-reciprocal and charge conservation is restored. In doing so, a new charge-conserving small-signal equivalent circuit for three-terminal GFETs is proposed in Fig. 1b. In addition, a methodology for parameter extraction from DC and S-parameter data has been proposed as well.

References

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Figures and tables

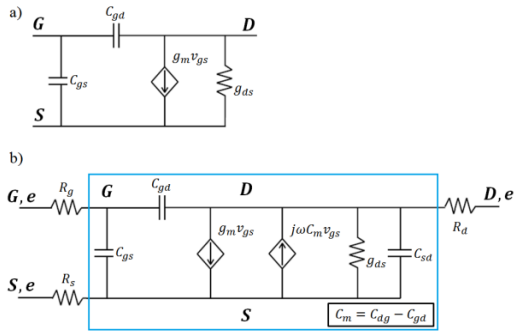

Figure 1: Small-signal equivalent circuit of a GFET assuming a) Meyer-like and b) charge-based intrinsic capacitance model.

TABLE I: INPUT PARAMETERS OF A PROTOTYPE GFET [6]

T	300 K	L	1 μm
μ	2000 cm²/Vs	W	10 μm
V_{gs0}	0 V	L_t	12 nm
Δ	0.08 eV	ε_{top}	9
R_s, R_d	200 Ω·μm	R_g	5 Ω

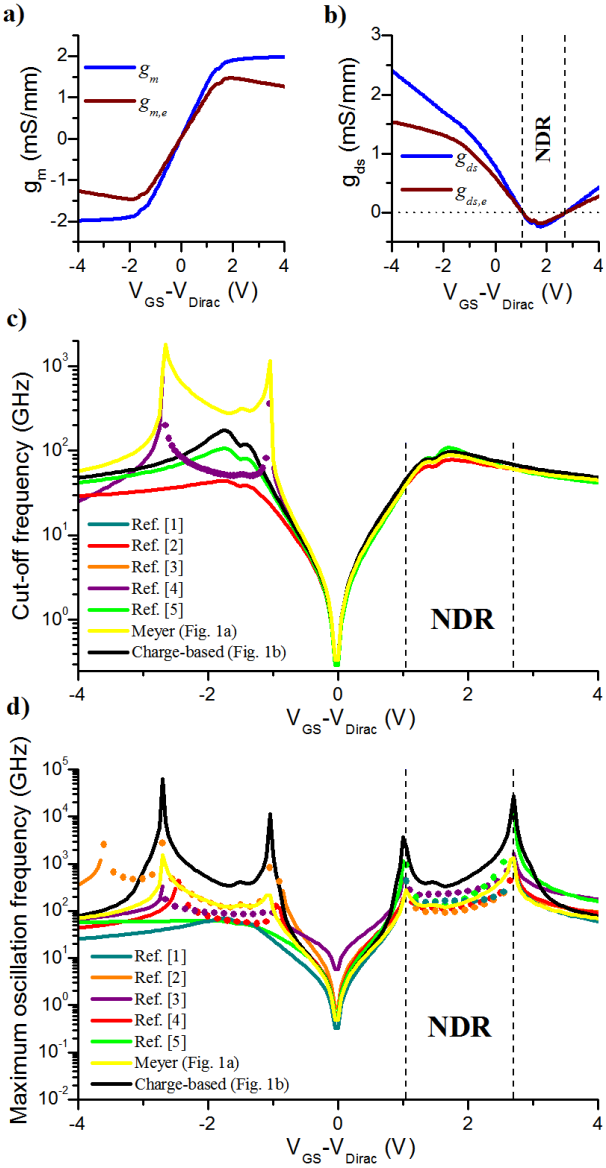

Figure 2: Gate bias dependence of the small-signal parameters and RF FoMs of the GFET described in Table I for a drain bias V_{DS} = 3 V. The closed circles represent the absolute value of the frequency because the value is negative and/or imaginary. a) Intrinsic (g_m) and extrinsic ($g_{m,e}$) transconductance; b) intrinsic (g_{ds}) and extrinsic ($g_{ds,e}$) output conductance; c) cut-off frequency (f_{Tx}); and d) maximum oscillation frequency (f_{max}).