Triquint (TOM) Intrinsic Model MesfetTOM

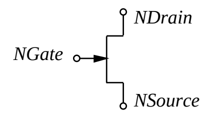

Figure 1: TOM Mesfet element.

Description:
This element is a GaAs MESFET Model developed for Triquints foundary, hence Triquint's Own Model (TOM).

Form: `MesfetTOM:`⟨`instance name`⟩ n_1 n_2 n_3 ⟨`parameter list`⟩

instance name	is the model name,
n_1	is the drain node,
n_2	is the gate node,
n_3	is the source node.

Parameters:

Parameter	Type	Default value	Required?
beta	DOUBLE	0.1	no
vt0	DOUBLE	-2	no
gama	DOUBLE	0	no
q	DOUBLE	2	no
delt	DOUBLE	0	no
alfa	DOUBLE	2	no
T	DOUBLE	0	no
cgs0	DOUBLE	0	no
cgd0	DOUBLE	0	no
vb1	DOUBLE	0.8	no
is	DOUBLE	0	no
n	DOUBLE	1	no
ib0	DOUBLE	0	no
nr	DOUBLE	10	no
vbd	DOUBLE	Inf	no

Example:

```
MesfetTOM:m1 1 2 3
```

Bugs:

None.

Version:

2003.05.15

Credits:

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1. Capacitance Model

In the Capacitance Model, the Statz equation for the gate change is widely used in large signal models [1,2]. The simplicity and the strict convergernce criteria for changes and capacitances make it attractive for simulators. Equation [1,2] fulfill the demand of change conservation and maintain the symmetry to V_{ds} . For these monotone equations no additional parameters are needed in comparison to the Statz equation. The voltages V_{gsi} and V_{gdi} result in the capacitances C_{gs} and C_{gd} respectively:

$$C_{gs} = C_{gs0}*((F_1*F_2)/(1-(V_{new}/V_{bi}))^{1/2})+ C_{gd0}*F_3 \qquad [1]$$

$$C_{gd} = C_{gs0}*((F_1*F_3))/(1-(V_{new}/V_{bi}))^{1/2})+C_{gd0}*F_2 \qquad [2]$$

Where:

$$F_1 = ½(1+((V_{eff}-VT)/(((V_{eff}-VT)^2 + \delta^2)))^{1/2})$$

$$F_2 = ½(1+((V_{gsi}-V_{gdi})/((V_{gsi}-V_{dsi})^2+(1/ALFA)^2)^{1/2})$$

$$F_3 = ½(1-((V_{gsi}-V_{gdi})/((V_{gsi}-V_{gdi})^2+(1/ALFA)^2)^{1/2})$$

$$A_1 = ½(V_{eff} + VT + ((V_{eff}-VT)^2+\delta^2)^{1/2})$$

$$V_{max} = 0.5$$

If $A_1 < V_{max}$ $\quad V_{new} = A_1$

Else $\quad V_{new} = V_{max}$

$$V_{eff} = ½(V_{gsi} + V_{gdi} + ((V_{gsi}-V_{gdi})^2+(1/ALFA)^2)^{1/2})$$

$$VT = V_{t0} + \gamma*V_{dsi}$$

2. Diode Model

The parameters of Diode Model is Igs and Igd, The current's change of Igs and Igd depend on the change of Cgd , Cgs, dVgs/dt, dVgd/dt. The result in the diode Igs and Igd is respectively:

$$I_{gs} = is*(e^{(Vgsi/n*Vt)} -1) - ib0 * e^{-(Vgsi+vbd)/(nr*Vt)} \qquad [4]$$

$$I_{gd} = is*(e^{(Vgdi/n*Vt)} -1) - ib0 * e^{-(Vgdi+vbd)/(nr*Vt)} \qquad [5]$$

So the total current of diode Igs and Igd respectively:

$$I_{gs} = I_{gs} + C_{gs}* dV_{gs}/dt$$

$$I_{ds} = I_{ds} + C_{gd}* dV_{gd}/dt$$

3. DC current model

From TOM Model figure we know, the parameter Ids represent DC current model. The static and temperature result is respectively:

$$I_{ds} = I_{ds0}/(1+\beta*I_{ds0}*V_{dsi}) \qquad [6]$$

Example:
tom:m1 1 2 3

Model Documentation

The Triquint (TOM) Intrinsic Model is one of the GaAs MESFET Model. This model has the feature of GaAs MESFET Model. As you know, for the design of GaAs integrated circuits, a simple and precise simulation model is required. Analytical models have been reported and are frequently used in common simulators. Most of these topologies use a constant, bias independent drain source resistance to model the dispersion of the output conductance. Another approach uses Statz equation for the gate change to improve the modeling of the gate drain capacitance, an equation for the bias dependent drain source diode, and a DC current. This approach is used by the TOM Model in my project.
Another approach uses an additional feedback network to distinguish between DC and AC behavior, thereby rapidly increasing computation time and causing convergence problems. Additionally, measurements indicate that the output conductance is strongly dependent on the drain source voltage. Furthermore the Statz gate charge formula, is improved to better predict the gate drain capacitance C_{gd}, while the originally accurately described gate source capacitance C_{gs} remains almost unchanged. These refinements have been added to a TOM model. The simulation with these changes shows much better agreement with measurements especially in the linear region. Thus, the new model is ideally suited for simulation of switched and mixers.

References:
FET GaAs MESFET Model for Nonlinear RF Simulation

Sample Netlist:

tom.net to use to run the element in fREEDA

```
*** Sample netlist for a TOM using the Curtice model ***

.options f0 = 5.1e9 jupdm=4 output=0

.svhb n_freqs = 15 fundamental = f0  steps=0 deriv=0

ind:l1 4 2 l=1e-9 time_d=0
cap:c1 2 3 c=20e-11 time_d=0

ind:l2 3 7 l=15e-9 time_d=0
res:r2 7 8 r=100.

ind:l3 1 5 l=15e-9 time_d=0
res:r3 5 6 r=10.
cap:cload 1 9 c=20e-12 time_d=0
res:rload 9 0 r=50.

vsource:vbias 8 0  vdc = -.2
vsource:vdrain 6 0 vdc = 3.
res:rin 11 4 r = 50.
vsource:vs 11 0 f = f0 vac = .2

res:rs 12 0 r=1.144

*** TOM
tom:t1 3 1 12
*+ a0 = .016542 a1 = .0500214 a2 = .02012 a3 = -.00806592
+ gama = 2.16505 t = 5e-12 beta = -.0394707 is = 1e-9
+ vbd = 15 nr = 10 ib0 = 1e-9 cgs0 = .52785e-12 cgd0 = .087e-12

.out plot term 1 vf term 12 vf sub invfft 1 repeat in "Tom.vds"
.out plot element "tom:t1" 0 if invfft 1 repeat in "Tom.ids"

.end
```

Validation:

Output tom.vds and tom.ids waveform.

Known Bugs:

None.

Credits:

Name Affiliation Date Links

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