Modelling Report

FPD200 TOM3 and TOM2 Models

Version 1.0

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Device Design and Modelling Group

Filtronic Compound Semiconductor Ltd.

Introduction

This report describes the models for the FPD200 discrete p-HEMT device. The models coupled with package models (given elsewhere). The model describes the device and the inbuilt inductance provided by the connecting bond wires. The metal fixture up until the connecting bond wires has been de-embedded.

Models

Two models are provided for different simulators these are as follows:

TOM3

This model provides a good fit to the measured data and has an advanced charge form. This allows the TOM3 model to accurately model the device over a wide range of operating conditions.

This model is recommended for use in most simulators

TOM2

This model is provided for the simulators that do not include TOM3 within there component set. This model employs a similar charge from to the TOM3 but only has a simple charge model. Consequently I recommend this model only be used when the TOM3 component is not present.

TOM3 Model

The TOM3 model was extracted for the FPD200 discrete part is shown below:

External Parasitics

The following network shows the external parasitics present in the device model:
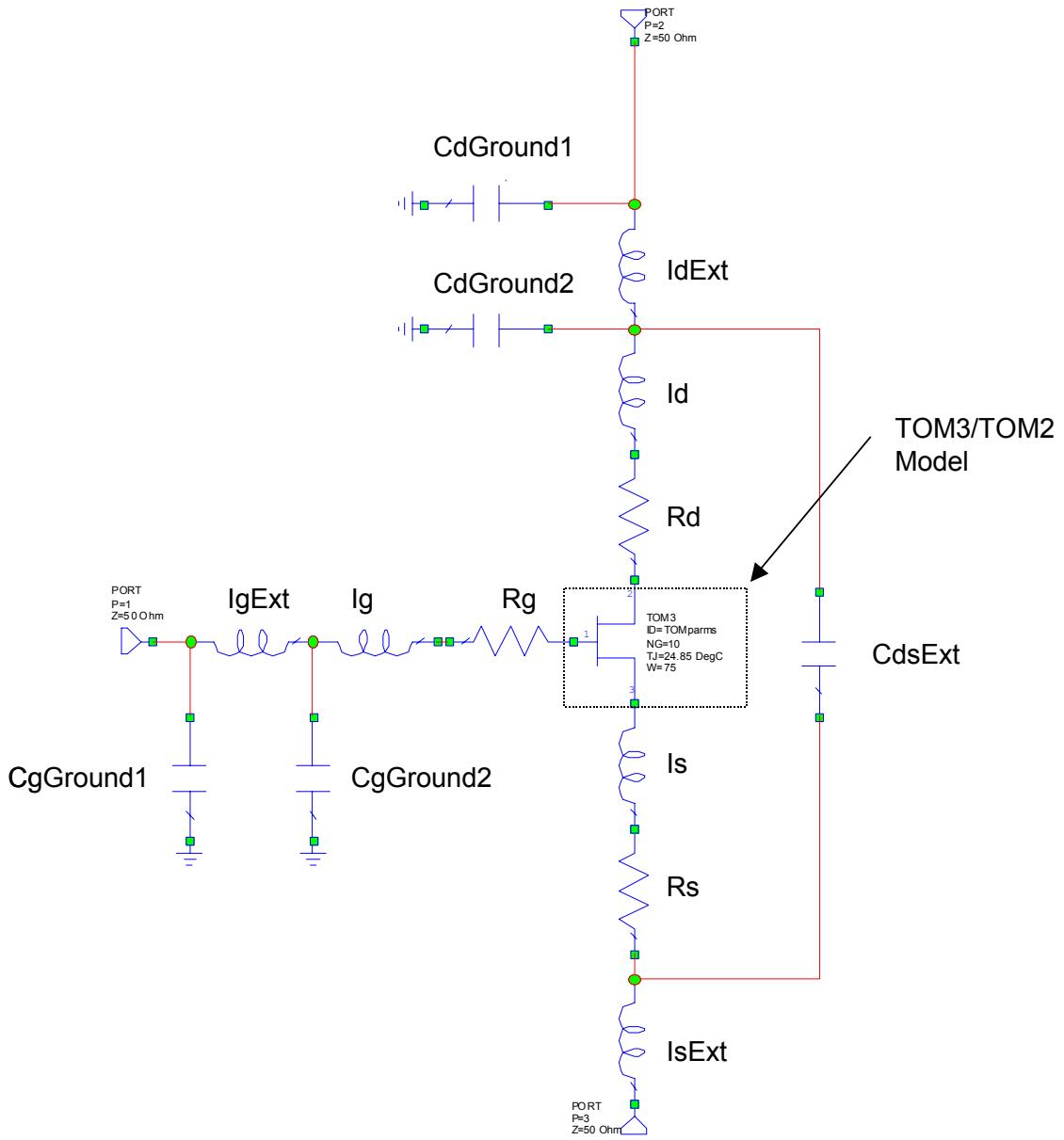
Figure 1 – Schematic of fitted model including external parasitics

Shown below is a table of the external parasitics.

CdGround1	0.024 pF	Ig	0.136 nH
CdGround2	0.057 pF	IsExt	0.0542 nH
CgGround1	0.01224 pF	Is	0.01 nH
CgGround2	0.121 pF	Rd	3.402 Ω
IdExt	0.2754 nH	Rs	3.302 Ω
Id	0 nH	Rg	3.243 Ω
IgExt	0.2907 nH	CdsExt	0.000156 pF

Table 1 – External parasitic values

TOM3 Model Parameters

The TOM3 model employs an excellent form for the charge relation within the p-HEMT discrete. Shown below are the extracted parameters for the FPD200 device:

VTO	-0.6471 V	QGG0	1.227E-16
ALPHA	3.053	CDS	0.000234
BETA	0.000682	IS	1E-11 mA
LAMBDA	-0.02432	EG	0.8 V
GAMMA	0.03358	N	1
Q	0.9352	XTI	2
K	4.279	TAU	0.001 ns
VST	0.05677	VBI	1 V
MST	0.2041	TAU_GD	1000 ns
ILK	1.8E-6 mA	KGAMMA	0.01194
PLK	1.5 V	RG	0.01Ω
QGQH	7.349E-16	RGSH	0Ω
QGSH	8.451E-16	RD	0.01Ω
QGDH	2.073E-17	RS	0.01Ω
QGIO	2.002E-6	LS	0 nH
QGQL	8.58E-16	LG	0 nH
QGAG	2.21	LD	0 nH
QGAD	2.241	NG	2
QGCL	7.715E-17	W	100
QGGB	144.55		

Table 2 – TOM3 Model Parameters

Add these parameters to the TOM3 model placed within the external parasitics.

TOM2 Model Parameters

The TOM3 model evolved from the TOM3 model and hence share almost exactly the same form for the calculation of the non-linear current. The TOM2 model only employs a simple charge form and hence should only be used when TOM3 components are not available. Shown below are the extracted elements for the FPD200 device:

VTO	-0.6471 V	VMAX	0.95 V
ALPHA	3.453	CGD	7.45E-5 pF
BETA	0.000682	CGS	0.002467 pF
GAMMA	0.0155	CDS	0.0002542 pF
DELTA	36.23	RIS	0.01 Ω
Q	0.9	RID	0.01 Ω
NG	2	VBR	17 V
ND	0	RDB	1.2E5 Ω
TAU	0.001	CBS	1500 pF
RG	0.01	LS	0 nH
RGSH	0	LG	0 nH
RD	0.01	LD	0 nH
RS	0.01	AFAC	200
IS	1E-11 mA	NFING	2
N	1	EG	0.8
VBI	1 V	XTI	2
VDELTA	0.2 V		

Table 3 – TOM2 Model Parameters

Add these parameters to the TOM2 model placed within the external parasitics.

Results – TOM2

IV

p1: Vstep = -1 V	p2: Vstep = -0.75 V
p3: Vstep = -0.5 V	p4: Vstep = -0.25 V
p5: Vstep = 0 V	
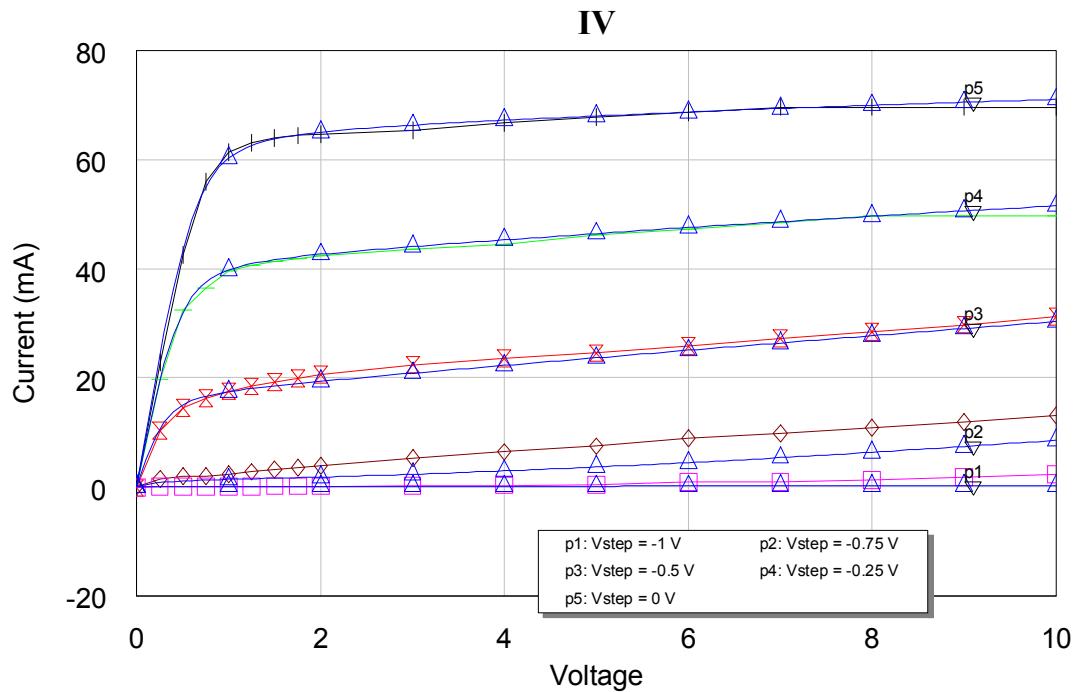
Figure 2 - Fitted vs. Modelled IV curves for the TOM2 model

Sparm Mid

Swp Max
28GHz

Swp Min
0.25GHz
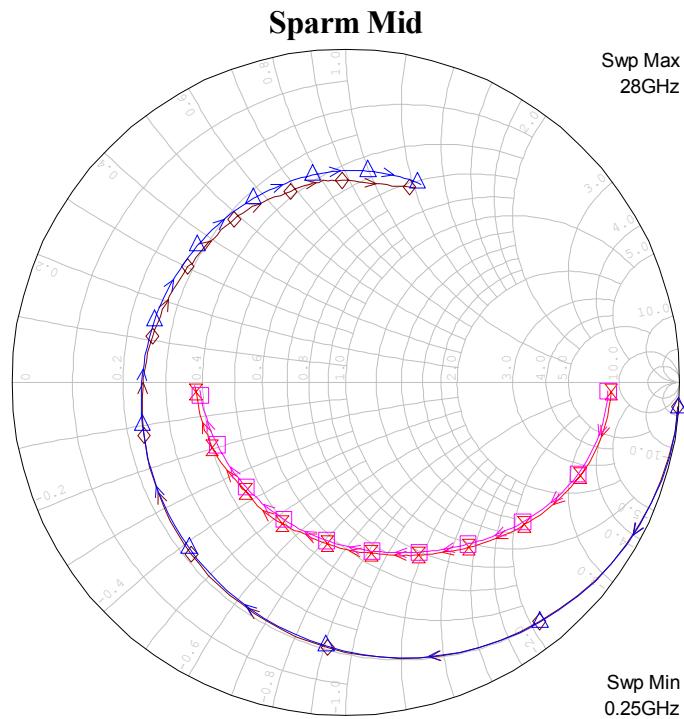
Figure 3 - Fitted vs. Modelled S-parameters for the TOM2 model (biased at Vg=-0.3V Vd=7V)

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Results – TOM3

IV

p5

p4

p3

p2

p1

p1: Vstep = -1 V	p2: Vstep = -0.75 V
p3: Vstep = -0.5 V	p4: Vstep = -0.25 V
p5: Vstep = 0 V	
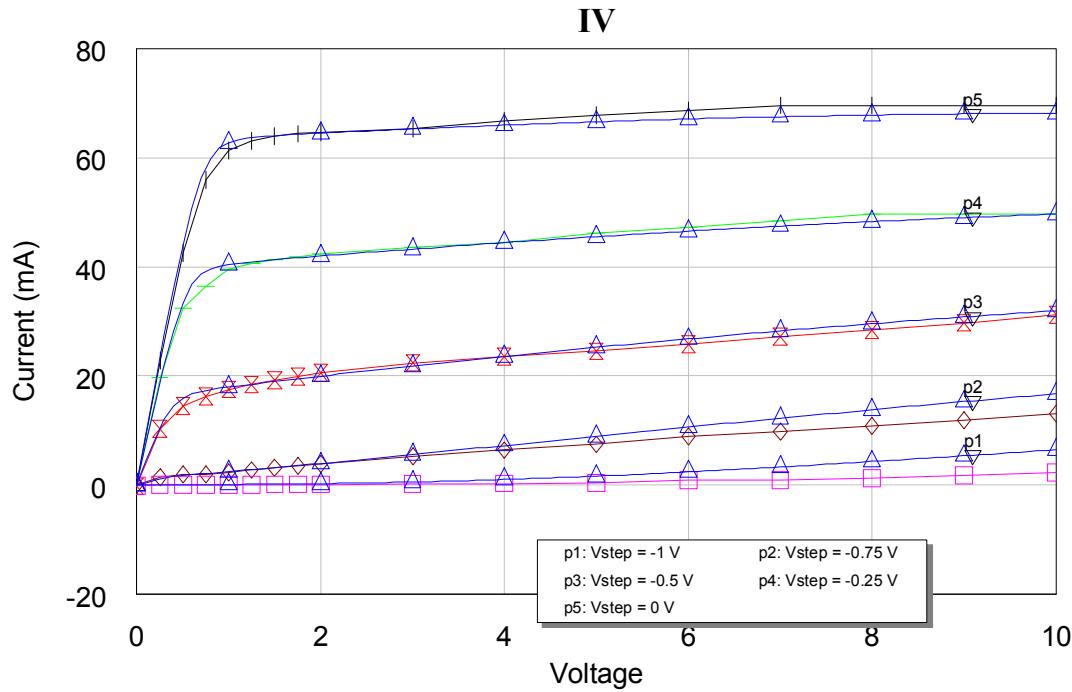
Figure 4 - Fitted vs. Modelled IV curves for the TOM3 model

**Sparm Mid**

Swp Max
28GHz

Swp Min
0.25GHz
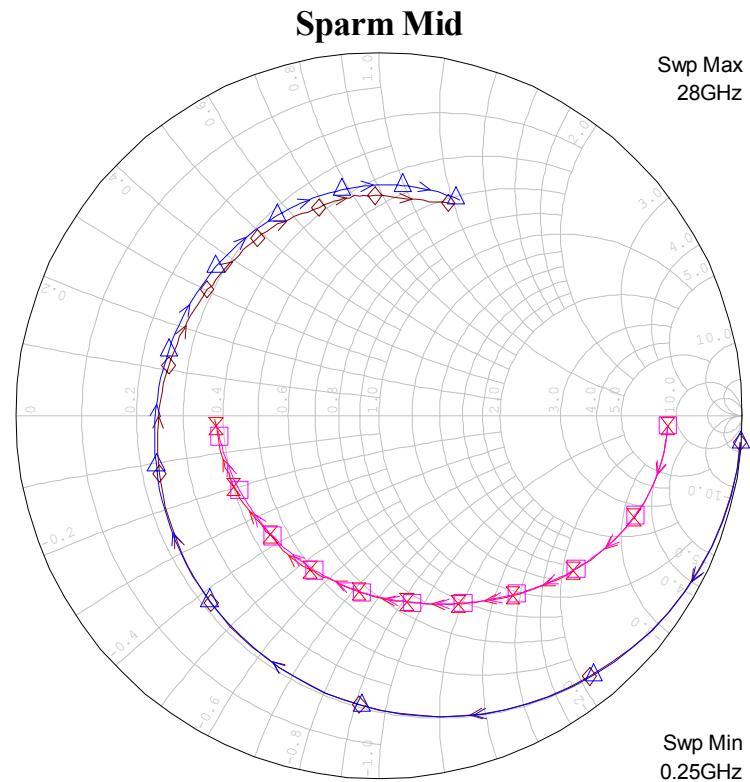
Figure 5 - Fitted vs. Modelled S-parameters for the TOM3 model (biased at Vg=-0.3V Vd=7V)