Hierarchical FPD3000 Simulations using AWR

John Hoversten - 3 Feb 2009

The intrinsic device must be modeled with a TOM3.

Reference: Filtronic "Modelling Report - FPD3000 TOM3 and TOM2 Models"

1) Create a new circuit schematic for the device (called something like "device").
   a) Place a "TOM3" element (find in "Nonlinear"->"FET")
   b) Double click the element, choose "Parameters" tab, click "Show Secondary" button.
c) Fill in all the extracted parameters ("VTO", "ALPHA", "BETA", ...) from the reference on page 5. Parameters appear in the "Parameters" list in the same order as specified in the reference with the exception of the "W" parameter. Also, note the units of the CDS parameter. It is unclear what the unit should be for the Is parameter - AWR has mA units, but none are indicated in the datasheet. Results are nearly identical regardless of the interpretation.

d) Leave all parameters not specified in the reference at their default values.

e) Add external parasitics (this is the fixture that was used when modeling the device) referred to in the reference on page 3. In hindsight, this is probably an unnecessary step, as it is only really useful to verify the IV curves found on page 8 of the Modelling Report. The actual SOT89 package (coming up soon) will take the place of this fixture.
i) Use ideal components (find in "Lumped Element"->"Inductor"->"IND", "Lumped Element"->"Resistor"->"RES", and "Lumped Element"->"Capacitor"->"CAP". Watch for correct units!

ii) Place grounds where appropriate using "Ctrl-G".

iii) Place ports 1, 2, and 3 at gate, drain, and source respectively using "Ctrl-P".

2) Create a new circuit schematic for the measurement setup (called "Device IV Curves")

a) Place your device (find in "Subcircuits"->"device"). Remember the ports 1-3 correspond to GDS, respectively.

b) Place an "IVCURVE" element (find in "MeasDevice")

   i) Connect "SWP" port to the drain and "STEP" port to the gate.

   ii) Enter appropriate values for gate and drain step and sweep.

   ```
   SUBCKT ID=S1 NET="device"
   IVCURVE ID=IV1
   VSWEEP_start=0 V
   VSWEEP_stop=10 V
   VSWEEP_step=0.1 V
   VSTEP_start=-1.5 V
   VSTEP_stop=0 V
   VSTEP_step=0.25 V
   ```

   ![IVCurve schematic](image)

   ![Graph showing Device IV Curves](image)

   c) Create a new graph.

   i) Add a measurement: "IVCurve" (find in "Nonlinear"->"Current"->"IVCurve") specify the "Device IV" schematic as the source for data.

   ii) Run the simulation and verify results against the plot in the reference on page 8. DO NOT CONTINUE UNTIL THE RESULT MATCHES THE PLOT IN THE REFERENCE!!!
The package is modeled with lumped elements.

Reference: Filtronic "Modelling Report - Discrete Package Models"

3) Add another circuit schematic, call this one "packaged".
   a) Reproduce the lumped element circuit shown on page 2 of the reference for the SOT89 package.
   b) Ports 3, 4, and 5 are G, D, and S respectively.

4) Create another circuit schematic, call this one "packaged device".
   a) Place the "package" and tom3 model subcircuits and connect appropriately.
   b) Place ports 1 and 2 on the "package" subcircuit.
c) The "packaged device" subcircuit can be used in simulations to represent the device in a common source configuration where ports 1 and 2 are gate and drain, respectively.

5) To verify S-parameters match those published, create a new circuit schematic called "Packaged Device Sparms".
   a) Add the "packaged device" subcircuit and two ideal bias tees (find in "General"->"Passive"->"Other").
   b) Connect voltage sources to bias the device via the bias tees (find in "Sources"->"DC"->"DCVS").
   c) Set gate and drain voltages to those specified in the S-parameter file you wish to verify the model with.
   d) Add ports 1 and 2 to the schematic at RFIn and RFOut respectively.
e) Adjust gate bias until the desired quiescent drain current point is reached.

Notes about these models:
1) The TOM3 model has rather poor agreement with the published S-parameters for reflection parameters.
2) It also indicates that 240uA of gate current are drawn, while the S-parameter file provided for the 5V, 300mA case indicates that 4uA should be drawn.
3) The TOM2 model was implemented and showed a gate current of 0.7uA for the same condition. S-parameter agreement was about the same.
4) The fixture shown in Fig 1 (page 2) of "Modelling Report - FPD3000 TOM2 and TOM3 Models" was (I think) only used for model extraction, and was de-embedded. Therefore it is of no use to us. All we need from this app note is the intrinsic die model represented by the TOM2/3 block.
5) The SOT89 package of Fig 1 (page 2) in "Modelling Report - Discrete Package Models" includes the actual bond wire effects for the package in use. The combination of this circuit diagram and a TOM2/3 model should be correct.
TOM3 vs. S-Parameter Data File for 5V, 300mA FPD3000SOT89_Lot4984_5V_300mA_1R1.s2p
240uA gate current
TOM3 vs. S-Parameter Data File for 5V, 300mA FPD3000SOT89_Lot4984_5V_300mA_1R1.s2p
240uA gate current
TOM2 vs. S-Parameter Data File for 5V, 300mA FPD3000SOT89_Lot4984_5V_300mA_1R1.s2p
0.7uA gate current

Packaged Device 11 Comparison

Packaged Device 21 Comparison
TOM2 vs. S-Parameter Data File for 5V, 300mA FPD3000SOT89_Lot4984_5V_300mA_1R1.s2p
0.7uA gate current

### Packaged Device 12 Comparison

![Graph showing comparison of S-parameters for Packaged Device 12.](image)

### Packaged Device 22 Comparison

![Graph showing comparison of S-parameters for Packaged Device 22.](image)
TOM3 vs. S-Parameter Data File for 5V, 300mA FPD3000SOT89_Lot4984_5V_300mA_1R1.s2p
240uA gate current

Packaged Device Reflection Sparms
IV Curves (with SOT89 package) for TOM3 (dark blue) and TOM2 (light blue)

IV Curves (with model extraction fixture) for TOM3 (dark blue) and TOM2 (light blue)