ECEN 325

MOSFET Custom Models

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The custom MOSFET models allow the flexibility to edit key device parameters ($V_{TN/P}$, $KP_{N/P}$, λ , W, L etc...) and also provides a more standard symbol. These use of these models is required in Lab 12 and may also help your matching between simulation and measurements for Labs 10 and 11. For both the NMOS and PMOS models, the body terminal is shorted to the source. Thus, it is only a 3-terminal model.

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The custom MOSFET models are available for download from the class website in the Lab Section.

http://www.ece.tamu.edu/~spalermo/ecen325/UsrComp_S_ECEN.usr

In order to use the custom models, follow the procedure outlined on Page 7 of the MultiSim and Analog Discovery 2 Manual.

http://www.ece.tamu.edu/~spalermo/ecen325/ms-ad2.pdf

Using Custom NMOS to Mimic 2N7000 Example

The default 2N7000 NMOS transistor model has a β =102mA/V² and V_{TN}=2.0V. This can be emulated with the custom "MOS_N" model with the following steps.

- 1. Place the MOS_N model in your schematic.
- 2. Double click on the MOS_N symbol. The following window will pop up.

· · · · · · · · · · · · · · · · · · ·	MOS N			X	<u>.</u>	 	 	 		
	MO3_N				· · ·	 	 	 		100 A
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	Instance parameters:		Tool	s ▼ <u>V</u> iews ▼ 🛗 🗣	a		 	 		
	Name Description	Value Units	Use default	Show on schematic		 	 	 		
	L Length	100u m		Value	1 I I I	 	 	 		
	W Width	100u m		Value	a a a	 	 	 		
	M Multiplicity	1		None		 	 	 		
	AD Drain area	0 m ²		None	a 14 A.		 	 		· · · ·
	AS Source area	0 m ²	1	None	1 I I I	 	 	 		
	PD Drain perimeter	0 m	2	None		 	 	 		
	PS Source perimeter	0 m	2	None	a 14 A.					1
	NRD Drain squares	1	2	None	11.1	 	 	 		
	NRS Source squares	1	1	None	M	 	 	 		
	TEMP Instance temperature	27 °C	1	None	u					
	OFF Device initially off	0	2	None		 	 	 		
	ICVDS Initial D-S voltage	0 V	2	None		 	 	 		
	ICVGS Initial G-S voltage	0 V	2	None			 	 		
	ICVBS Initial B-S voltage	0 V	2	None		 	 	 		
	Device model level: MOS 1 (Level 1)		ſ	Edit component in DB		 	 	 		
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3. Click on Edit model. Another window will pop up.

Edi	it Model			×	N
	Model				
	Hodel				
	.model NMOSMOS1 nmos		<u>T</u> ools	• <u>V</u> iews • 🖀 •	
	Name Description	Value	Units	Use default 🔺	
	Level Device model level	MOS 1 (Level 1)			
	VTO Threshold voltage	0	v	2	
	KP Transconductance parameter	2e-5	A/V ²	✓	
	GAM Bulk threshold parameter	0	V^0.5	2	
	PHI Surface potential	0.6	v	2	
	LAM Channel length modulation	0	1/V	2	
	RD Drain ohmic resistance	0	Ω	2	
	RS Source ohmic resistance	0	Ω	2	
	RG Gate ohmic resistance	0	Ω		
	RB Bulk ohmic resistance	0	Ω	¥	
	RDS Drain source shunt resistance	0	Ω	¥	
	CBD Bulk-drain junction capacitance	0	F	2	
	CBS Bulk-source junction capacitance	0	F	2	
	IS Bulk junction saturation current	1e-14	Α	2	
	PB Bulk junction potential	0.8	v	2	
	CGSO Gate-source overlap capacitance	0	F/m	- V	
	Change component				
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4. To edit the transistor parameters, unclick the "Use default" box and edit the value in the "Value" field. Below is an example to emulate the default 2N7000 NMOS transistor model, with β =102mA/V² and V_{TN}=2.0V. As the custom model has a default W/L=1, only the KP_N value is edited to give a β =102mA/V².

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Name	Description	Value	Units	Use default		· ·	·
Level	Device model level	MOS 1 (Level 1)					•
VTO	Threshold voltage	2.0	V		-	· ·	•
KP	Transconductance parameter	102e-3	□ A/V ²		=	· ·	•
GAM	Bulk threshold parameter	0	V^0.5	\checkmark		· ·	•
PHI	Surface potential	0.6	V	\checkmark		· ·	·
LAM	Channel length modulation	0	1/V			· ·	•
RD	Drain ohmic resistance	0	Ω	\checkmark			•
RS	Source ohmic resistance	0	Ω	\checkmark		· ·	•
RG	Gate ohmic resistance	0	Ω	\checkmark			
RB	Bulk ohmic resistance	0	Ω	\checkmark			
RDS	Drain source shunt resistance	0	Ω	\checkmark			
CBD	Bulk-drain junction capacitance	0	F	\checkmark			
CBS	Bulk-source junction capacitance	0	F				
IS	Bulk junction saturation current	1e-14	A	\checkmark			
PB	Bulk junction potential	0.8	V				
CGSO	Gate-source overlap capacitance	0	F/m	V	-		
Cha Cha R	ange component nge all components teset to default					· · · · · · · · · · · · · · · · · · ·	
			Edit	model			

5. To commit these changes, click on "Change component". The transistor parameter window will disappear. Then click on "OK" and you will be back in your main schematic.

You can use a similar procedure for the PMOS device and other MOSFET transistors.