APPENDIX A: Parameter List

A.1 BSIM3v3 Model Control Parameters

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
none	level	BSIMv3 model selector	8	none	
Mobmod	mobmod	Mobility model selector	1	none	
Capmod	capmod	Flag for the short channel capacitance model	1	none	
Nqsmod	nqsmod	Flag for NQS model	0	none	
Noimod	noimod	Flag for noise model	1	none	

A.2 DC Parameters

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Vth0	vth0	Threshold voltage @Vbs=0 for Large L.	0.7 (NMOS) -0.7 (PMOS)	V	nI-1
K1	k1	First order body effect coeffi-cient	0.5	$V^{1/2}$	nI-2

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
K2	k2	Second order body effect coefficient	0.0	none	nI-2
K3	k3	Narrow width coefficient	80.0	none	
K3b	k3b	Body effect coefficient of k3	0.0	1/V	
W0	w0	Narrow width parameter	2.5e-6	m	
Nlx	nlx	Lateral non-uniform doping parameter	1.74e-7	m	
Vbm	vbm	Maximum applied body bias in Vth calculation	-5.0	V	
Dvt0	dvt0	first coefficient of short-channel effect on Vth	2.2	none	
Dvt1	dvt1	Second coefficient of short-channel effect on Vth	0.53	none	
Dvt2	dvt2	Body-bias coefficient of short-channel effect on Vth	-0.032	1/V	
Dvt0w	dvt0w	First coefficient of narrow width effect on Vth for small channel length	0	1/m	
Dvt1w	dvtw1	Second coefficient of narrow width effect on Vth for small channel length	5.3e6	1/m	
Dvt2w	dvt2w	Body-bias coefficient of narrow width effect for small channel length	-0.032	1/V	
$\mu 0$	u0	Mobility at Temp = Tnom NMOSFET PMOSFET	 670.0 250.0	$cm^2/V/sec$	

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Ua	ua	First-order mobility degradation coefficient	2.25E-9	m/V	
Ub	ub	Second-order mobility degradation coefficient	5.87E-19	$(m/V)^2$	
Uc	uc	Body-effect of mobility degradation coefficient	mobmod =1, 2: -4.65e-11 mobmod =3: -0.046	m/V^2 1/V	
νsat	vsat	Saturation velocity at Temp = Tnom	8.0E4	m/sec	
A0	a0	Bulk charge effect coefficient for channel length	1.0	none	
Ags	ags	gate bias coefficient of Abulk	0.0	1/V	
B0	b0	Bulk charge effect coefficient for channel width	0.0	m	
B1	b1	Bulk charge effect width offset	0.0	m	
Keta	keta	Body-bias coefficient of bulk charge effect	-0.047	1/V	
A1	a1	First non-saturation effect parameter	0.0	1/V	
A2	a2	Second non-saturation factor	1.0	none	
Rdsw	rdsw	Parasitic resistance per unit width	0.0	Ω-μm^{Wr}	
Prwb	prwb	Body effect coefficient of Rdsw	0	$V^{-1/2}$	
Prwg	prwg	Gate bias effect coefficient of Rdsw	0	1/V	

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Wr	wr	Width Offset from Weff for Rds calculation	1.0	none	
Wint	wint	Width offset fitting parameter from I-V without bias	0.0	m	
Lint	lint	Length offset fitting parameter from I-V without bias	0.0	m	
dWg	dwg	Coefficient of Weff's gate dependence	0.0	m/V	
dWb	dwb	Coefficient of Weff's substrate body bias dependence	0.0	$m/V^{1/2}$	
Voff	voff	Offset voltage in the subthreshold region at large W and L	-0.08	V	
Nfactor	nfactor	Subthreshold swing factor	1.0	none	
Eta0	eta0	DIBL coefficient in subthreshold region	0.08	none	
Etab	etab	Body-bias coefficient for the subthreshold DIBL effect	-0.07	1/V	
Dsub	dsub	DIBL coefficient exponent in subthreshold region	drout	none	
Cit	cit	Interface trap capacitance	0.0	F/m^2	
Cdsc	cdsc	Drain/Source to channel coupling capacitance	2.4E-4	F/m^2	
Cdscb	cdscb	Body-bias sensitivity of Cdsc	0.0	F/Vm^2	
Cdscd	cdscd	Drain-bias sensitivity of Cdsc	0.0	F/Vm^2	
Pclm	pclm	Channel length modulation parameter	1.3	none	

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Pdiblc1	pdiblc1	First output resistance DIBL effect correction parameter	0.39	none	
Pdiblc2	pdiblc2	Second output resistance DIBL effect correction parameter	0.0086	none	
Pdiblcb	pdiblcb	Body effect coefficient of DIBL correction parameters	0	1/V	
Drout	drout	L dependence coefficient of the DIBL correction parameter in Rout	0.56	none	
Pscbe1	pscbe1	First substrate current body-effect parameter	4.24E8	V/m	
Pscbe2	pscbe2	Second substrate current body-effect parameter	1.0E-5	V/m	
Pvag	pvag	Gate dependence of Early voltage	0.0	none	
δ	delta	Effective Vds parameter	0.01	V	
Ngate	ngate	poly gate doping concentration	infinite	cm^{-3}	
$\alpha 0$	alpha0	The first parameter of impact ionization current	0	m/V	
$\beta 0$	beta0	The second parameter of impact ionization current	30	V	
Rsh	rsh	Source drain sheet resistance in ohm per square	0.0	Ω/ square	
Jso	js	Source drain junction saturation current per unit area	1.E-4	A/ m^2	

A.3 AC and Capacitance Parameters

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Xpart	xpart	Charge partitioning rate flag	0	none	
CGS0	cgso	Non LDD region source-gate overlap capacitance per channel length	calculated	F/m	nC-1
CGD0	cgdo	Non LDD region drain-gate overlap capacitance per channel length	calculated	F/m	nC-2
CGB0	cgbo	Gate bulk overlap capacitance per unit channel length	0.0	F/m	
Cj	cj	Bottom junction per unit area	5e-4	F/m^2	
Mj	mj	Bottom junction capacitance grating coefficient	0.5		
Mjsw	mjsw	Source/Drain side junction capacitance grading coefficient	0.33	none	
Cjsw	cjsw	Source/Drain side junction capacitance per unit area	5.E-10	F/m^2	
Pb	pb	Bottom built-in potential	1.0	V	
Pbsw	pbsw	Source/Drain side junction built-in potential	1.0q	V	
CGS1	cgs1	Light doped source-gate region overlap capacitance	0.0	F/m	
CGD1	cgd1	Light doped drain-gate region overlap capacitance	0.0	F/m	

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
CKAPPA	ckappa	Coefficient for lightly doped region overlap capacitance Fringing field capacitance	0.6	F/m	
Cf	cf	fringing field capacitance	calculated	F/m	nC-3
CLC	clc	Constant term for the short channel model	0.1E-6	m	
CLE	cle	Exponential term for the short channel model	0.6	none	
DLC	dlc	Length offset fitting parame-ter from C-V	lint	m	
DWC	dwc	Width offset fitting parameter from C-V	wint	m	

A.4 NQS Parameters

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Elm	elm	Elmore constant of the channel	5	none	

A.5 dW and dL Parameters

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Wl	wl	Coefficient of length dependence for width offset	0.0	m^{Wln}	
Wln	wln	Power of length dependence of width offset	1.0	none	
Ww	ww	Coefficient of width dependence for width offset	0.0	m^{Wwn}	
Wwn	wwn	Power of width dependence of width offset	1.0	none	
Wwl	wwl	Coefficient of length and width cross term for width offset	0.0	$m^{Wwn+Wln}$	
Ll	ll	Coefficient of length dependence for length offset	0.0	m^{Lln}	
Lln	lln	Power of length dependence for length offset	1.0	none	
Lw	lw	Coefficient of width dependence for length offset	0.0	m^{Lwn}	
Lwn	lwn	Power of width dependence for length offset	1.0	none	
Lwl	lwl	Coefficient of length and width cross term for length offset	0.0	$m^{Lwn+Lln}$	

A.6 Temperature Parameters

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Tnom	tnom	Temperature at which parameters are extracted	27	^{o}C	
μte	ute	Mobility temperature exponent	-1.5	none	
Kt1	kt1	Temperature coefficient for threshold voltage	-0.11	V	
Kt1l	kt1l	Channel length dependence of the temperature coefficient for threshold voltage	0.0	V*m	
Kt2	kt2	Body-bias coefficient of Vth temperature effect	0.022	none	
Ua1	ua1	Temperature coefficient for Ua	4.31E-9	m/V	
Ub1	ub1	Temperature coefficient for Ub	-7.61E-18	$(m/V)^2$	
Uc1	uc1	Temperature coefficient for Uc	mobmod=1, 2: -5.6E-11 mobmod=3: -0.056	m/V^2 1/V	

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
At	at	Temperature coefficient for saturation velocity	3.3E4	m/sec	
Prt	prt	Temperature coefficient for Rdsw	0	Ω-μm	

A.7 Flicker Noise Model Parameters

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Noia	noia	Noise parameter A	(NMOS) 1e20 (PMOS) 9.9e18	none	
Noib	noib	Noise parameter B	(NMOS) 5e4 (PMOS) 2.4e3	none	
Noic	noic	Noise parameter C	(NMOS) -1.4e-12 (PMOS) 1.4e-12	none	
Em	em	Saturation field	4.1e7	V/m	
Af	af	Frequency exponent	1	none	
Ef	ef	Flicker exponent for noimod=2	1	none	
Kf	kf	Flicker noise parameter for noimod=1	0	none	

A.8 Process Parameters

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Tox	tox	Gate oxide thickness	1.5e-8	m	
Xj	xj	Junction Depth	1.5e-7	m	
$\gamma 1$	gamma1	Body-effect coefficient near the surface	calculated	$V^{1/2}$	nI-4
$\gamma 2$	gamma2	Body-effect coefficient in the bulk	calculated	$V^{1/2}$	nI-5
Nch	nch	Channel doping concentration	1.7e17	$1/cm^3$	nI-3
Nsub	nsub	Substrate doping concentration	6e16	$1/cm^3$	
Vbx	vbx	Vbs at which the depletion region width equals xt	calculated	V	nI-6
Xt	xt	Doping depth	1.55e-7	m	

A.9 Bin Description Parameters

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Lmin	lmin	Minimum channel length	0.0	m	
Lmax	lmax	Maximum channel length	1.0	m	

Symbols used in equation	Symbols used in SPICE	Description	Default	Unit	Note
Wmin	wmin	Minimum channel width	0.0	m	
Wmax	wmax	Maximum channel width	1.0	m	
binunit	binunit	Bin unit scale selector	1	none	

A.10Model Parameter Notes

nI-1. If Vtho is not specified, it is calculated using:

$$V_{tho} = V_{FB} + \phi_s + K_1\sqrt{\phi_s}$$

where VFB=-1.0. If Vth0 is specified, VFB is calculated using

$$V_{FB} = V_{tho} - \phi_s - K_1\sqrt{\phi_s}$$

nI-2. If k1 and k2 are not given, they are calculated using:

$$K_1 = gamma_2 - 2K_2\sqrt{\phi_s - V_{bm}}$$

$$K_2 = \frac{(gamma1 - gamma2)(\sqrt{\phi_s - V_{bx}} - \sqrt{\phi_s})}{2\sqrt{\phi_s}(\sqrt{\phi_s - V_{bm}} - \sqrt{\phi_s}) + V_{bm}}$$

where the parameter phi is calculated using:

$$\phi_s = 2v_t \ln\left(\frac{Nch}{n_i}\right)$$

$$v_t = \frac{k_B T}{q}$$

$$n_i = 1.45x10^{10}\left(\frac{T}{300.15}\right)^{1.5} \exp\left(21.5565981 - \frac{E_g(T)}{2v_t}\right)$$

$$E_g(T) = 1.16 - \frac{7.02x10^{-4}T^2}{T + 1108}$$

where $E_{g(T)}$ is the energy bandgap at temperature T.

nI-3. If nch is not given and gamma1 is given, nch is calculated from:

$$N_{ch} = \frac{gamma1^2 C_{ox}^2}{2q\varepsilon_{si}}$$

If both gamma1 and nch are not given, nch defaults to 1.7e23 $1/m^3$ and gamma1 is calculated from nch.

nI-4. If gamma1 is not given, it is calculated using:

$$gamma_1 = \frac{\sqrt{2q\varepsilon_{si} N_{ch}}}{C_{ox}}$$

nI-5. If gamma2 is not given, it is calculated using:

$$gamma_2 = \frac{\sqrt{2q\varepsilon_{si} N_{sub}}}{C_{ox}}$$

nI-6. If vbx is not given, it is calculated using:

$$V_{bx} = \phi_s - \frac{qN_{ch}X_t^2}{2\varepsilon_{si}}$$

nC-1. If cgso is not given then it is calculated using:

if (dlc is given and is greater 0) then,

cgso = p1 = (dlc*cox) - cgs1

if (the previously calculated cgso <0), then

cgso=0

else cgso = 0.6 xj*cox

nC-2. If cgdo is not given then it is calculated using:

if (dlc is given and is greater than 0) then,

cgdo = p2 = (dlc*cox) - cgd1

if (the previously calculated cgdo <0), then

cgdo=0

else cgdo = 0.6 xj*cox

nC-3. If cf is not given then it is calculated using:

$$CF = \frac{2\varepsilon_{ox}}{\pi}\ln\left(1+\frac{4\times 10^{-7}}{Tox}\right)$$