Yannis Tsividis

Operation and Modeling of The MOS Transistor

Second Edition

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Selected List of Symbols

Certain symbols used only locally within a section, or whose meaning is clear from the context, are not included in this list.

Symbol	Description	Section
C'_b	Depletion region capacitance per unit area	2.6
C_{bd}	Body-drain intrinsic capacitance	8.3.2
C_{bs}	Body-source intrinsic capacitance	8.3.2
C_{gb}	Gate-body intrinsic capacitance	8.3.2
C'_{gb}	Gate-body capacitance per unit area	2.6
C_{gd}	Gate-drain intrinsic capacitance	8.3.2
C_{gs}	Gate-source intrinsic capacitance	8.3.2
C'_i	Inversion layer capacitance per unit area	2.6
C'_{it}	Interface traps capacitance per unit area	2.6
C_j	*pn* junction capacitance	1.5
C'_j	*pn* junction capacitance per unit area	1.5
C_m	Difference between C_{dg} and C_{gd}	9.2.1
C_{mb}	Difference between C_{db} and C_{bd}	9.2.1
C_{mx}	Difference between C_{bg} and C_{gb}	9.2.1
C_{ox}	Total oxide intrinsic capacitance	8.3.2
C'_{ox}	Oxide capacitance per unit area	2.2
d_B	Depletion region depth	2.5
$\mathscr{E}$	Electric field	
$\mathscr{E}_c$	"Critical" field in velocity saturation formulation	6.5
$\mathscr{E}_x$	Longitudinal electric field	6.5
$\mathscr{E}_y$	Transverse electric field	4.10
g_{bd}	Body-drain small-signal conductance	8.2.3
g_m	Gate small-signal transconductance	8.2.2
g_{mb}	Body small-signal transconductance	8.2.2
g_o	Output small-signal conductance	8.2.2
g_{sd}	Source-drain small-signal conductance	8.2.2
g_{ss}	Source small-signal conductance	8.2.2
I_B	Body current	4.1, 7.2
I_D	Drain current	1.6, 6.6, 7.2
I_{DB}	Drain-to-body current	6.6
I_{DS}	Drain-to-source current (channel current)	4.3, 6.6
I'_{DS}	Value of I_{DS} at the onset of saturation	4.5.1
I_{DSN}	Nonsaturation I_{DS}	4.5.1
I_{DS1}	Component of I_{DS} due to drift	4.3
I_{DS2}	Component of I_{DS} due to diffusion	4.3
I_G	Gate current	4.1, 7.2
I_M	Value of I_{DS} at upper limit of weak inversion	8.3.2
I'_M	Value of I_{DS} at upper limit of weak inversion, normalized to (W/L)	4.6
I_S	Source current	7.2
I_T	Transport current	7.2
I_Z	Characteristic current in moderate inversion	8.2.7
i_{DA}	Charging component of drain current	7.3
i_{SA}	Charging component of source current	7.3
k	Boltzmann's constant	1.2
L	Effective channel length	1.6
l_p	Length of pinchoff region	6.2
N_A	Acceptor concentration	1.2
N_D	Donor concentration	1.2
n	1. Free electron concentration	1.2
	2. The quantity $(d\psi_{sa}/dV_{GB})^{-1}$	2.5
n_i	Intrinsic carrier concentration	1.2
p	Hole concentration	1.2
Q_B	Depletion region charge	7.2
Q'_B	Depletion region charge per unit area	2.5
$\hat{Q}_B$	Effective depletion region charge	6.3
Q_I	Inversion layer charge	2.5, 7.2
Q'_I	Inversion layer charge per unit area	2.5
Q'_{IL}	Value of Q'_I at drain end of channel	4.3
Q'_{I0}	Value of Q'_I at source end of channel	4.3
Q_G	Gate charge	2.5, 7.2
Q'_G	Gate charge per unit area	2.5
Q'_o	Effective interface charge	2.2
q	Magnitude of electronic charge	1.2
q_D	Drain-associated inversion layer charge	7.3

Symbol	Description	Section
q_S	Source-associated inversion layer charge	7.3
T	Absolute temperature	1.2
t_{ox}	Oxide thickness	2.2
V_A	Characteristic voltage in first-order channel length modulation formula	6.2
V_B	Body voltage	7.2
V_{CB}	Channel-body voltage	3.2
V_D	Drain voltage	7.2
V_{DS}	Drain-source voltage	1.6, 4.1
V'_{DS}	Value of V_{DS} at onset of saturation	4.5.3
V_{FB}	Flat band voltage	2.2
V_G	Gate voltage	7.2
V_{GS}	Gate-source voltage	1.6, 4.1
V_H	Value of V_{GC}, or of V_{GS}, at onset of strong inversion	3.4, 4.4
V_{HB}	Value of V_{GB} at onset of strong inversion	3.4
V_{H0}	Value of V_{HB} for two-terminal structure	2.5
V_L	Value of V_{GC}, or of V_{GS}, at onset of weak inversion	3.4, 4.4
V_{LB}	Value of V_{GB} at onset of weak inversion	3.4
V_{L0}	Value of V_{LB} for two-terminal structure	2.5
V_M	Value of V_{GC}, or of V_{GS}, at onset of moderate inversion	3.4, 4.4
V'_{MB}	Value of V_{GB} at onset of moderate inversion	3.4
V_{M0}	Value of V_{MB} for two-terminal structure	2.5
V_p	Pinchoff voltage	3.5, 4.5
V_Q	Value of channel-body voltage at the boundary between strong and moderate inversion, for a given V_{GB}	3.5, 4.4
V_S	Source voltage	7.2
V_{SB}	Source-body voltage	1.6, 4.1
V_T	Extrapolated threshold voltage in terms of V_{GC} or V_{GS}	3.4.2, 4.5.3
$\hat{V}_T$	Effective V_T	6.3.2
V_{TB}	Extrapolated threshold voltage in terms of V_{GB}	3.4.2
V_{T0}	Value of V_{TB} for two-terminal structure	2.5.2
V_W	Value of channel-body voltage at the boundary between weak inversion and depletion, for a given V_{GB}	3.5, 4.4
v_d	Drift velocity	1.3, 6.5
x	Distance along the channel	4.1
y	Distance in direction perpendicular to the surface	2.5
y_m	Gate transadmittance	9.3
y_{mb}	Body transadmittance	9.3
W	Effective channel width	1.6
α	Coefficient of first-order term in expansion for $-Q'_B/C'_{ox}$	4.3.2, 4.5.3
α_1	Value of α for expansion around the source potential	4.3.2, 4.5.3
γ	Body effect coefficient	2.5, 3.3
Δ	Symbol denoting a change in the quantity following it	
$\Delta\phi$	Difference between the actual strong-inversion surface potential and its classical value of $2\phi_F$	2.5
ϵ_o	Permittivity of free space	1.2
ϵ_{ox}	Permittivity of SiO_2	2.2
ϵ_s	Permittivity of silicon	2.2
η	Degree of nonsaturation	4.5.3
μ, μ_{eff}	Effective surface mobility	4.3, 4.10
μ_B	Bulk mobility	1.3
τ	Transit time	1.2, 7.5
ϕ_{bi}	Built-in potential *pn* junction	1.5
ϕ_F	Fermi potential	1.4
ϕ_{MS}	Contact potential of body material to gate material ("work function difference" potential)	2.2
ϕ_t	Thermal voltage, kT/q	1.2
ϕ_Z	Moderate inversion region width in terms of surface potential	3.4
ϕ_{Z0}	Moderate inversion region width in terms of surface potential for two-terminal MOS structure	2.5
ϕ_0	Surface potential of two-terminal MOS structure in strong inversion	2.5
ψ_{ox}	Oxide potential	2.2
ψ_s	Surface potential	2.2
ψ_{sa}	Surface potential in the absence of inversion layer, for a given V_{GB}	2.5, 3.2, 4.6
ψ_{sL}	Value of surface potential at drain end of channel	4.3
ψ_{s0}	Value of surface potential at source end of channel	4.3
ω_o	Characteristic angular frequency	8.3.2
ω_{Ti}	Intrinsic transition angular frequency	8.3.2

Values for some useful quantities

Magnitude of electronic charge, q	1.602×10^{-19} C
Thermal voltage, $\phi_t = kT/q$, at 300 K	0.0259 V
Permittivity of silicon, ϵ_s	1.04×10^{-12} F/cm
Permittivity of silicon dioxide, ϵ_{ox}	3.45×10^{-13} F/cm
$\sqrt{2q\epsilon_s}$	$5.79 \times 10^{-16}\ \mathrm{F \cdot V^{1/2} \cdot cm^{-1/2}}$

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