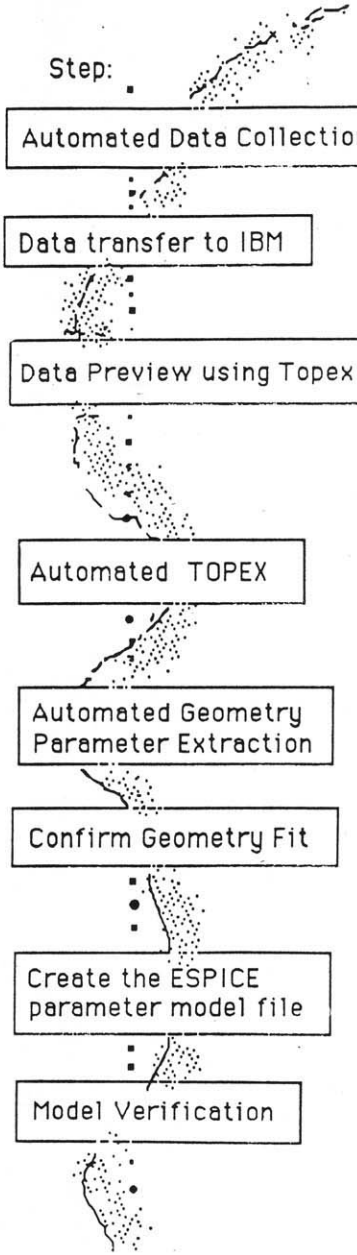
Extraction of MOS Model 7 DC Parameters using Automation Tools



Computer Usage:	Files:
Accutest 3600, PDP11	input: Test Table output: fn.out
DEC Ethernet, VMS VAX, IBM VM.	fn*.out (many *.out files
Uses TOPEX in manual, local mode to draw device characteristic graphs.	Topex command file(*.topex), Topex init file (*.data), Accutest data.
Merge Accutest files, Prepare *.list file, Run "TOPBAT" & "TOPRDR"	input: *.list, *.out. output: *.total
Run "ALLMAX"	input: *.total output: *.maxise
Run "VIEWMINI"	input: *.total *.maxiset data output graphs
XEDIT	input: old *.EDOS
"FASTSLOW"	input: *.EDOS, Accutest data

PRLS, Device Physics and Modeling Group

To: E. Wolsheimer
From: Fred Wahl
Subject: MOS Model 7C Equations

Date: April 13, 1987

cc: J. Schaper
A. Tabibi

Model 7C:

(1) $$T = T(^\circ C) + 273.15$$

(2) $$T_n = T_{nom}(^\circ C) + 273.15$$

(3) $$V_t = \frac{kT}{q}$$

(4) $$V_{t_n} = \frac{kT_n}{q}$$

(5) $$E_g(T) = 1.16 - \left(\frac{7.02 \times 10^{-4} T^2}{T + 1108.}\right)$$

(6) $$n_i(T) = n_i \cdot \left(\frac{T}{T_n}\right)^{\frac{3}{2}} \exp\left(\frac{E_g}{2V_{t_n}} - \frac{E_g(T)}{2V_t}\right)$$

(7) $$2\Phi_F = PHI \cdot \left(\frac{T}{T_n}\right) + V_t \cdot \ln\left(\frac{n_i}{n_i(T)}\right)$$

(8) $$V_{TNT} = VTN|_{V_{sb}=V_{sb_{ref}} \& T=T_n} + TCVT \cdot (T - T_n)$$

(9) $$\beta_N = BETAN \cdot \left(\frac{T_n}{T}\right)^{TBETA}$$

(10) $$\theta'_{3N} = TH3N + TTH3N \cdot (T - T_n)$$

(11) $$G\theta'_{3N} = GTH3N + TGTH3N \cdot (T - T_n)$$

(12) $$W = W_N + WTOL$$

(13) $$L = L_N + LTOL - 2 \cdot LAP$$

(14) $$K = KN + GKN \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) + DKN \cdot \left(\frac{1}{W} - \frac{1}{W_{ref}}\right)$$

(15) $$Ko = KON + GKON \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) + DKON \cdot \left(\frac{1}{W} - \frac{1}{W_{ref}}\right)$$

(16) $$VSBX = VSBXN + GVSBXN \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) + DVSBXN \cdot \left(\frac{1}{W} - \frac{1}{W_{ref}}\right)$$

(17) $$V_{TOT} = V_{TNT} - K \cdot \left(\sqrt{V_{sb_{ref}} + 2\Phi_F} - \sqrt{2\Phi_F}\right)$$

(18) $$V_{TO} = V_{TOT} + GVTN \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) + DVTN \cdot \left(\frac{1}{W} - \frac{1}{W_{ref}}\right)$$

$$\theta_1 = TH1N + GTH1N \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) + DTH1N \cdot \left(\frac{1}{W} - \frac{1}{W_{ref}}\right) \tag{19}$$

$$\theta_2 = TH2N + GTH2N \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) + DTH2N \cdot \left(\frac{1}{W} - \frac{1}{W_{ref}}\right) \tag{20}$$

$$\theta_3 = \theta'_{3N} + G\theta'_{3N} \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) + DTH3N \cdot \left(\frac{1}{W} - \frac{1}{W_{ref}}\right) \tag{21}$$

$$\gamma = GAMMAN + GGAMN \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) + DGAMN \cdot \left(\frac{1}{W} - \frac{1}{W_{ref}}\right) \tag{22}$$

$$SH = SHIFTN + GSHIFT \cdot \left(\frac{1}{L^2} - \frac{1}{L_{ref}^2}\right) \tag{23}$$

$$n = NN + GNN \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) \tag{24}$$

$$p = PN + GPN \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) \tag{25}$$

$$a = AVA + GAVA \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) + DAVA \cdot \left(\frac{1}{W} - \frac{1}{W_{ref}}\right) \tag{26}$$

$$b = AVB + GAVB \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) + DAVB \cdot \left(\frac{1}{W} - \frac{1}{W_{ref}}\right) \tag{27}$$

$$c = AVC + GAVC \cdot \left(\frac{1}{L} - \frac{1}{L_{ref}}\right) + DAVC \cdot \left(\frac{1}{W} - \frac{1}{W_{ref}}\right) \tag{28}$$

$$DELVX = 0.3 \tag{29}$$

$$Kap = \sqrt{V_{sb} + 2\Phi_F} - \sqrt{2\Phi_F} \tag{30}$$

$$Kap1 = \sqrt{VSBX - DELVX + 2\Phi_F} - \sqrt{2\Phi_F} \tag{31}$$

$$Kap2 = \sqrt{VSBX + DELVX + 2\Phi_F} - \sqrt{2\Phi_F} \tag{32}$$

$$If(Kap \leq Kap1) \quad Then$$

$$V_{TS} = V_{TO} + Ko \cdot Kap \tag{33}$$

$$\delta = \frac{Ko}{2\sqrt{1 + V_{sb} + 2\Phi_F}} \tag{34}$$

$$If(Kap \geq Kap2) \quad Then$$

$$V_{TS} = V_{TO} + \frac{(Ko - K)(Kap1 + Kap2)}{2} + K \cdot Kap \tag{35}$$

$$\delta = \frac{K}{2\sqrt{1 + V_{sb} + 2\Phi_F}} \tag{36}$$

$$If(Kap1 < Kap < Kap2) \quad Then$$

$$V_{TS} = V_{TO} + Ko \cdot Kap - \frac{(Ko - K)(Kap - Kap1)^2}{2(Kap2 - Kap1)} \tag{37}$$

$$\delta = \frac{Ko - \frac{(Ko-K)(Kap-Kap1)}{(Kap2-Kap1)}}{2\sqrt{1 + V_{sb} + 2\Phi_F}} \tag{38}$$

$$\Delta V_T = SH \cdot (1 + p \cdot V_{sb}) \cdot V_{ds}^n \tag{39}$$

$$V_T = V_{TS} - \Delta V_T \tag{40}$$

$$Vo = 0.5 \tag{41}$$

$If((V_{gs} - V_T) > 2Vo)\ Then$

$$V_{GT} = V_{gs} - V_{TS} + \gamma \cdot V_{ds} \tag{42}$$

$If((V_{gs} - V_T) \leq 2Vo)\ and\ ((V_{gs} - V_T) \geq 0)\ Then$

$$V_{GT} = V_{gs} - V_T + \frac{(\gamma \cdot V_{ds} - \Delta V_T)}{2Vo} \cdot (V_{gs} - V_T) \tag{43}$$

$If((V_{gs} - V_T) < 0)\ Then$

$$V_{GT} = V_{gs} - V_T \tag{44}$$

$$SUBTHN = 2 \cdot M \tag{45}$$

$$V_{ON} = SUBTHN \cdot V_t \tag{46}$$

$$V_{GT_{orig}} = V_{GT} \tag{47}$$

$If(V_{GT} \leq V_{ON})\ Then$

$$V_{GT} = V_{ON} \tag{48}$$

$If(\theta_3 \leq 1 \times 10^{-6})\ Then$

$$\theta_3 = 1 \times 10^{-6} \tag{49}$$

$$V_{DSS} = \left(\frac{1}{\theta_3}\right) \cdot \left(\sqrt{1 + \frac{2\theta_3 V_{GT}}{(1+\delta)}} - 1\right) \tag{50}$$

$$V_r = V_{DSS} \tag{51}$$

$If(V_{ds} < V_{DSS})\ Then$

$$V_r = V_{ds} \tag{52}$$

$$I_d = \beta_N \frac{W}{L} \cdot \frac{\left(V_{GT} - \frac{(1+\delta)}{2} \cdot V_r\right) \cdot V_r}{(1 + \theta_1 \cdot (V_{gs} - V_{TS}) + \theta_2 \sqrt{V_{sb} + 2\Phi_F}) \cdot (1 + \theta_3 \cdot V_r)} \tag{53}$$

$If(V_{GT_{orig}} \leq V_{ON})\ Then$

$$I_d = I_d \cdot \exp\left(\frac{V_{GT_{orig}} - V_{ON}}{M \cdot V_t}\right) \tag{54}$$

$$V_{EM} = c \cdot V_{DSS} \tag{55}$$

$$I_b = 0 \tag{56}$$

$If(V_{ds} > V_{EM})\ Then$

$$I_b = I_d \cdot a \cdot \exp\left(\frac{-b}{V_{ds} - V_{EM}}\right) \tag{57}$$

$$I_d = I_d + I_b \tag{58}$$