AN EFFICIENT IMPLEMENTATION OF THE ACM MOSFET MODEL IN ELDO FOR VLSI CIRCUIT DESIGN

Osmar Franca Siebel (osiebel@yahoo.com.br),
Carlos Galup-Montoro (carlos@eel.ufsc.br),
Márcio Cherem Schneider (marcio@eel.ufsc.br)
Federal University of Santa Catarina (http://eel.ufsc.br/~lci/)

Introduction

The ACM (Advanced Compact MOSFET) model is a charge-based physical model that consists of simple, accurate and single equations that represent the device behavior in all regimes of operation, using well-known physical parameters (http://eel.ufsc.br/~lci/acm/index.html).

Implementation

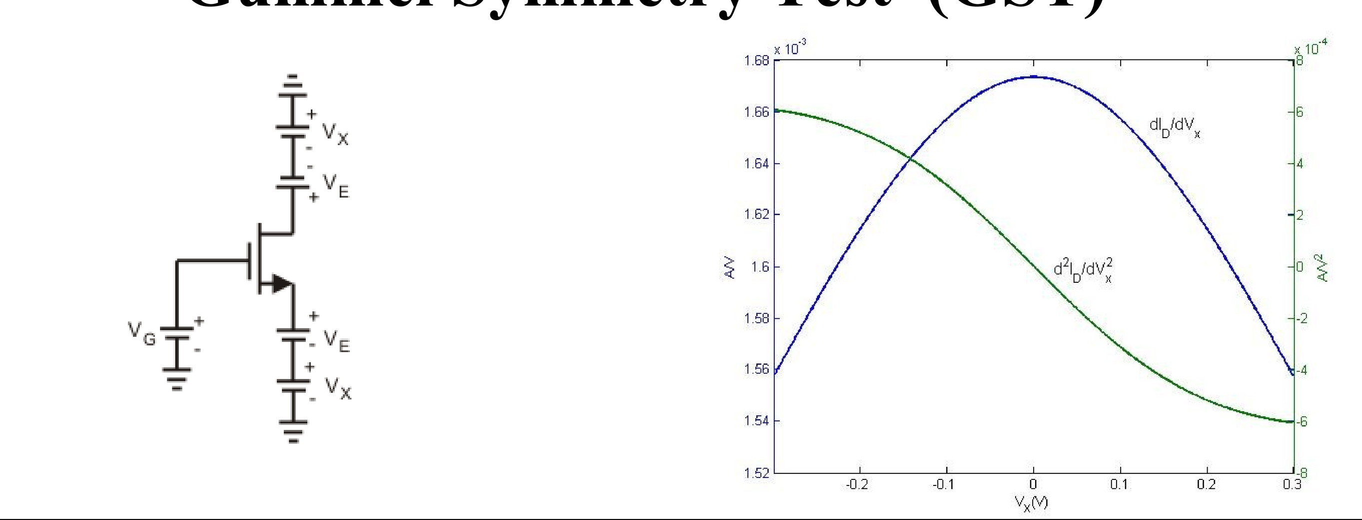
The ACM was implemented into the ELDO simulator using the UDM (User Definable Model) module. The model code was written in C. The iterative algorithm used for the numerical calculation of the inversion charge in the UCCM needs only one iteration to obtain relative errors of less than 10-7 in the whole inversion range.

Parameters

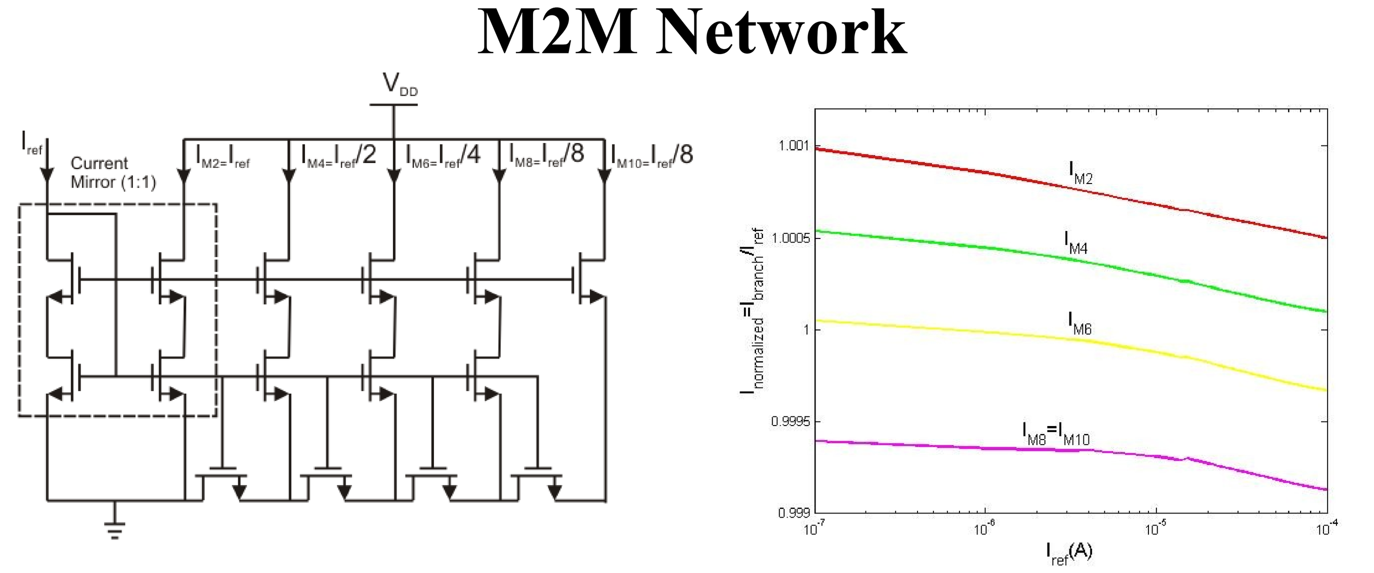
PARAMETERS	DESCRIPTION	UNIT
UO	Carrier mobility	$m^2/V.s$
TOX	Gate oxide thickness	m
VTO	Threshold voltage	V
NA	Acceptor densities	cm^{-3}
PHISO	Surface potential	V
GAMMA	Body effect factor	$V^{0.5}$
LAMBDA	Channel length modulation factor	-
THETA	Mobility reduction factor	1/V
M	Temperature factor	-
VMAX	Velocity saturation	m/s
XJ	Junction depth	m
SIGMA	Drain-induced barrier lowering factor	m^2

Benchmark tests

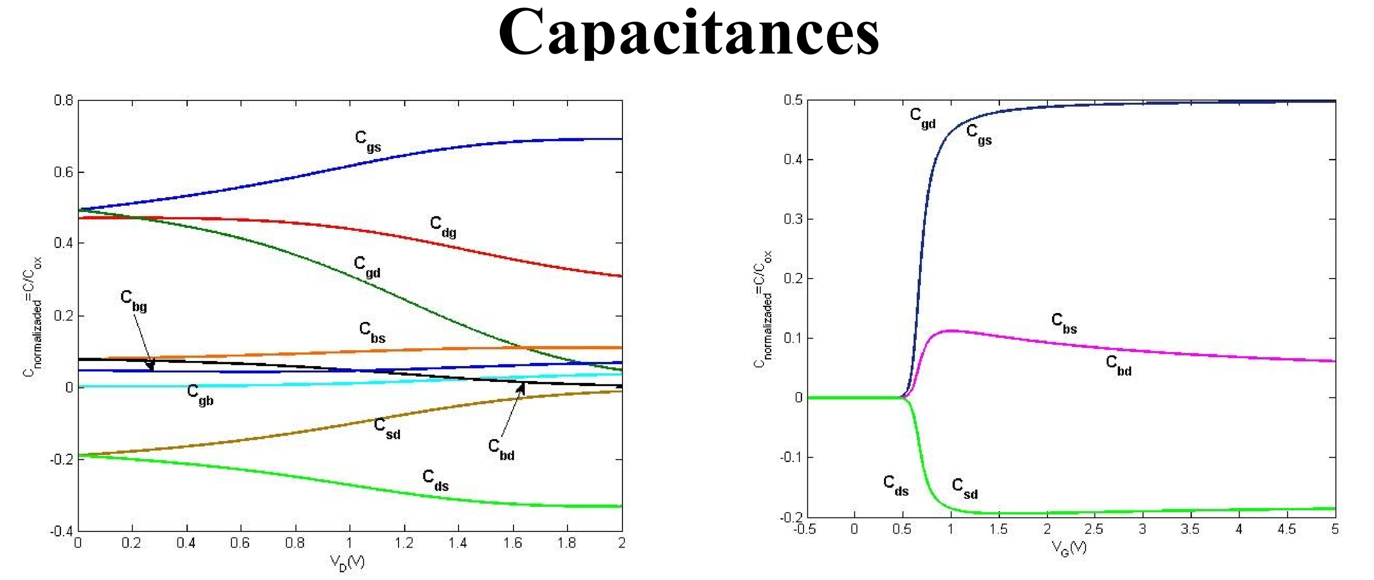
Gummel Symmetry Test (GST)



M2M Network



Capacitances



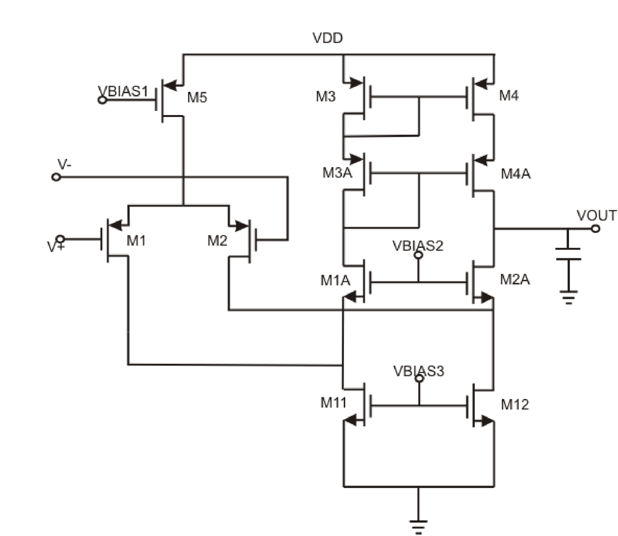
Simulation Time

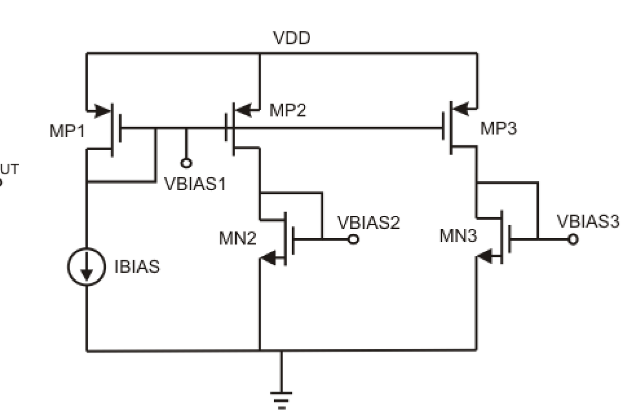
Normalized simulation times (with respect to ACM_{cap}) using the different models available in ELDO.

Circuit	Analysis	ACM_{cap}	ACM	EKV	MM11	HiSIM	PSP	BSIM4
schmitfast	DC	1s580ms	1.02	0.84	2.14	1.63	1.87	1.16
schmitslow	DC	2s430ms	1.00	0.70	1.75	1.60	1.93	1.28
g1310	TRAN	640ms	0.98	0.92	1.28	1.23	1.31	1.19
hussamp	TRAN	3s020ms	1.07	1.11	1.02	1.06	1.11	1.06
ab_ac	AC	1s400ms	1.03	1.02	2.35	1.63	1.86	1.25
ab_integer	TRAN	1s370ms	1.00	0.98	1.09	1.01	1.13	0.98

Design Example

In this example, we designed a folded cascode operational amplifier using the ACM equations.





	Spec	Simulation	Unit
GBW	10	9.77	MHz
A_{vo}	>100	141	dB
SR	>4	5	V/µs

Transistor	L(µm)	W(µm)
M1,M2	0.5	13.5
M11,M12	0.5	27
M3,M4	0.5	13.5
M1A,M2A	0.5	13.5
M3A,M4A	0.5	13.5
M5	0.5	27
MP1,MP2,MP3	0.5	13.5
MN2	2(4x 0.5)	3.5
MN3	0.5	13.5

Conclusions

The results show that ACM is a powerful and useful tool for simulation and design because it consists of simple, accurate and single equations together with a small number of physical parameters.