# Extraction of SPICE Model Parameters from *ATLAS* Device Simulation Using *UTMOST*

Many users would like to extract SPICE models from their process and device simulation using *ATHENA* and *ATLAS* to be used in actual circuit simulation without actually fabricating the device.

Using SILVACO's *UTMOST* you can extract SPICE model parameters from the simulation results of *ATHENA* and *ATLAS*.

To guide users on how to go about extracting SPICE model parameters an example which extracts BSIM3v3 model from process/device simulation is used in this article.

All these commands can be executed from a single software – *DeckBuild*.

The commands are heavily commented so that you know their functions and purpose.

Here we will concentrate on the *UTMOST* batch mode commands. Here we only cover a very simple case and there is no local optimization. The *UTMOST* interactive mode can be used save the *UTMOST* setup into a file . *UTMOST* interactive cannot be executed from *DeckBuild*.
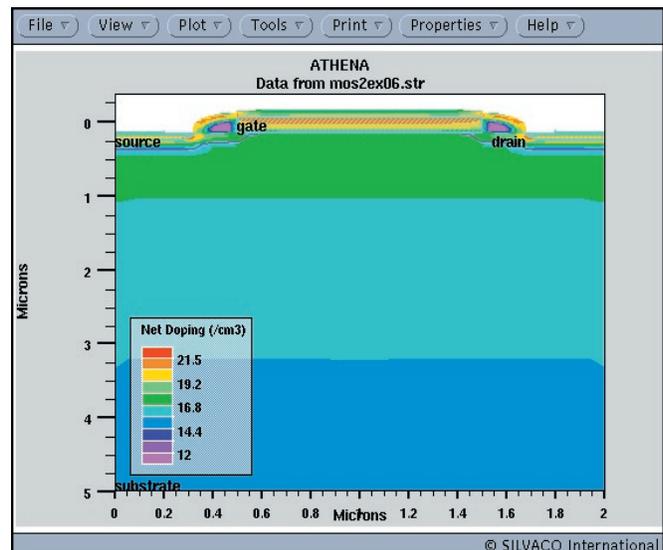


Figure 1. *TonyPlot* of Decice structure.



Figure 2. *DeckBuild* screen.

----------- start of deckbuild commands -------------

```
# Commands that can be used in deckbuild to extract
# Spice model Parameters. The deck for TCAD is
# not  complete . Below are examples of commands that
# maybe used in VWF Athena and Atlas to obtain the
# device characteristics

###### START ATHENA SIMULATION ###
# Run process simulation
go athena

# Extract the poly length LD

extract name="ld" thick poly y.val=0
extract name="utmost_ld"($ld*1.0e-4)
....
extract thickness oxide mat.occno=1 name="tox"
extract name="utmost_tox" ($tox*1.0e-10)
....

###### START ATLAS DEVICE SIMULATION ##

go atlas
```

```
######  Create the IdVg-Vb IV matrix ###

load infile=solve1.log
log outf=mos2ex06_IdVg-Vb.log
solve name=gate vgate=0 vfinal=5 vstep=0.2
load infile=solve2.log
solve name=gate vgate=0 vfinal=5 vstep=0.2
load infile=solve3.log
solve name=gate vgate=0 vfinal=5 vstep=0.2
....

# Simulate device ID/VG characteristics

solve vgate=1 vstep=0.25 vfinal=1.5 name=gate  \
outf=solve_tmp0 onefile
solve vgate=1.75 vstep=0.25 vfinal=3 name=gate  \
outf=solve_tmp1 onefile
solve vgate=3.25 vstep=0.25 vfinal=4.5 name=gate  \
outf=solve_tmp2 onefile
....

#####  Create the IdVd-Vg IV matrix #######

log outf=mos2ex06_IdVd-Vg.log
....
solve name=drain vdrain=0 vfinal=5 vstep=0.2
solve name=drain vdrain=0 vfinal=5 vstep=0.2
solve name=drain vdrain=0 vfinal=5 vstep=0.2
....

#### START UTMOST SIMULATION ####

#*************************************
# Jump to UTMOST MOS module

go utmost
utmost type = mos

# The model command loads Utmost setup file
# created by interactive session  .

model MOS_vwf_bsim3_n

# change the Value for gate oxide thickness for
#Opt(imization) and Fit Columns .

device TOX = $utmost_tox
```

```
# define  parameters to be set when the data is
# read from ssf file from ATLAS

setup NRS=0.04  NRD=0.04 width=1.0  \
      length=$utmost_ld polarity=N

# load Atlas log files simulated earlier.
# the master option tells UTMOST the file is in
# VWF ssf format

init inf=mos2ex06_IdVg-Vb.log master

# Load in append mode, more results from the logfile

init inf=mos2ex06_IdVd-Vg.log master append

# select required characteristics for device 1
# unselect all ID/VG-VB first the select device 1
# (there is only 1 device)

deselect ID/VG-VB all
select ID/VG-VB device 1

# unselect all ID/VD-VG first, then select device 1

deselect ID/VD-VG all
select ID/VD-VG device 1

# Defines the routine for which data is to be stored
# in ssf format  (standard structure format)

output ID/VD-VG

# Stores measured data (simulated by ATLAS) to
# ssf log File  in uniform steps as required by UTMOST

log outf=mos2ex06_data.log measured

# setup the UTMOST log file to store
# The measured (simulated data from ATLAS).

log outf=mos2ex06_ut.log utmost

# set up output log file for simulated data created
#by UTMOST  routine which was last referred to
#by batch mode output command  i.e ID/VD-VG

log outf=mos2ex06_sim.log simulated
```

# Perform curve fitting for selected routines
# and then do local optimization sequences
# if they are defined in setup file.

**fit ID/VG-VB**
**fit ID/VD-VG**

# perform simulation for selected routines

**simulate ID/VD-VG**

# Output Utmost parameters for extraction.
# Save results to file in a ssf file. If
# append option is used the parameters are appended
# to an existing file.

**save outf=mos2ex06.ssf**

##### Extract UTMOST parameters ########

# load output parameter file from UTMOST

**extract init infile="mos2ex06.ssf"**

# Save the current parameter set from the
# Optimization column of UTMOST parameter
# to a model library  file

**create library=mos2ex06.lib**

# EXIT

**quit**

------------ end of Deckbuild commands -----------

A portion of mos2ex06.lib file is as follows.
.LIB CMOS
*
.MODEL MMOD NMOS (  LEVEL   = 8
+TNOM  = 27        TOX  = 1E-8        XJ = 1.5E-7
+NCH=1.7E17         NSUB=6E16        VTH0 =0.5776647
+K1= 0.5          K2 = -0.0186       K3 = 80
+K3B= 0          W0= 2.5E-6        NLX = 1.74E-7
+DVT0W= 0         DVT1W= 0         DVT2W =-0.032
+DVT0 = 2.2        DVT1   = 0.53     DVT2   = -0.032
+VBM= -5         U0 = 670          UA= 2.25E-9

+UB= 5.87E-19      UC= -4.65E-11      VSAT= 8E4
+A0  = 1         AGS = 0          B0= 0
+B1  = 0         KETA = -0.047      A1 = 0
+A2  = 1         RDSW = 0          PRWG  = 0
+PRWB = 0        WR    = 1         PRWG  = 0
+LINT  = 0       DWG   = 0         DWB   = 0
+VOFF  = -0.1      NFACTOR = 1       CIT   = 0
+CDSC  = 2.4E-4   CDSCD   = 0       CDSCB   = 0
+ETA0  = 0.08      ETAB   = -0.07     DSUB   = 0.56
+PCLM  = 1.3      PDIBLC1 = 0.39     PDIBLC2 = 8.6E-3
+PDIBLCB= 0       DROUT   = 0.56     PSCBE1  = 4.24E8
+PSCBE2 = 5E-5    PVAG   = 0        DELTA  = 0.01
+MOBMOD = 1      PRT    = 0        UTE  = -1.5
+KT1   = 0       KT1L   = 0        KT2  = 0
+UA1 = 4.31E-9    UB1  = -7.61E-18   UC1 = -5.6E-11
+AT    = 3.3E4     NQSMOD  = 0      WL    = 0
+WLN   = 1        WW    = 0        WWN    = 1
+WWL  = 0        LL    = 0        LLN    = 1
+LW    = 0        LWN   = 1        LWL    = 0
+CAPMOD  = 1           )
*

## References

1] *UTMOST III User's Manual* – Chap 14. Batch Mode Operation

2] *UTMOST III Extractions Manual , Vol. 1-* Appendix A – BSIM3v3 Extraction Tutorial

3] Silvaco example file examples/mos2/mos2ex6.in

4] *TCAD Tutorial and Examples* Vol.1 p.2-26