Reliability in DK

Simulation Guidelines

1   Introduction.

This module is an add-on of DK, for reliability/ageing simulation with eldo simulator.

NBTI reliability simulations relies on "Dynamic reliability models", which are based on actual operating conditions with an evaluation of the stress seen by each individual device. In other words the simulation is run in two passes, a first pass which evaluates how each individual device is stressed and a second one which takes into account the degradation of the device itself.

❏ Simulation for dynamic reliability models is currently only available with Eldo (version >= 6.3) on DKs supporting NBTI feature.

❏ For more in-depth information about the technology trends w.r.t Reliability in terms of Negative Bias Temperature Instability (NBTI) and Hot-Carrier Injection (HCI) degradation, relevant documentation is available in ADCS .

❏ Moreover there is a Reliability-Oriented NBTI training whose material will be provided upon request (please contact your prime Unicad/DK support interface).

2   Prerequisites and get-started clues

- The reliability simulation is either available within the Cadence Analog Design Environment (ADE-ARTIST), or could be performed in stand-alone mode.
- Eldo version >= 6.3
- Eldo simulation needs to be run with an optional keyword, in order to integrate the ST-specific ageing model -> see details further.
- The Eldo model cards (in .lib file) contain extra information for reliability simulations. So both the .include and .lib statements in the input netlist need to be modified to be linked to those modified models -> see further.
- Reliability simulation is available under Sun/Solaris, Linux/i686 and HP pa-risc OS.
- The "NBRUN" funtionality (Eldo feature -> refer to AMS documentation) is documented but not available in this release.
- The "age" boolean parameter (refer to AMS doc) is not accessible on individual mos from the current model structure.

2.1   Available documentation

The reference ADCS document describes in a very detailed section the reliability phenomenon and the way to simulate it.

The Eldo "eldo_udrm.pdf" in the AMS doc directory ($anacad/ documentation) provides all the specific instructions/command, buts its reading may be confusing, since it also explains all the C coding to perform. This C coding is already done and is part of this delivery (shareable object part).

2.2   How to use dynamic reliability model (.param agesimulation) ?

The analog model libraries are built to handle/interact with the presence of

the Eldo global parameter called "agesimulation".

When this flag is set to 0 (default value), no reliability simulations are available, however when it turns to 1, 2 or 3 or higher, dynamic reliability mode is allowed.

In fact, th parameter agesimulation can take 8 values :

0 : no aging effects: nmos:HCI(no);pmos:HCI(no);NBTI(no)

1 : all aging effects: nmos:HCI(yes);pmos:HCI(yes);NBTI(yes)

2 : only NBTI: nmos:HCI(no);pmos:HCI(no);NBTI(yes)

3 : NBTI and NMOS HCI: nmos:HCI(yes);pmos:HCI(no);NBTI(yes)

4 : only PMOS aging: nmos:HCI(no);pmos:HCI(yes);NBTI(yes)

5 : only NMOS aging: nmos:HCI(yes);pmos:HCI(no);NBTI(no)

6 : only HCI(P&N MOS): nmos:HCI(yes);pmos:HCI(yes);NBTI(no)

7 : only PMOS HCI: nmos:HCI(no);pmos:HCI(yes);NBTI(no)

3 Structure of the WC NBTI support in DK

All data related to reliability simulations are in a directory called "age". This directory is located in the same location than the directory containing the "CORNERS" directory from Eldo DK module (within DK MODULES)

The "age" directory contains the following:

• an "example" directory, featuring an eldo netlist and its output files.
Note: this directory is not yet available.

This example could be performed in case of misunderstanding/issue/concern and the output files compared.

This example shows also the eldo extra statements for reliability simulation -> this is a good getting-started way

• a "lib: directory, with shareable objects (libeldoudrm.so) for each architecture of supported hardware/OS.

The different objects are located in sub-directories named "sparc-solaris2", "ix86-linux", "hppa1.1-hpux", etc.. Those names are the value returned by the command 'ukerGetMachine' on the different architectures.

The eldo model libraries (*.lib files) are the same for all simulations.

The methodology to enable various simulations is handled through flags setting.

4 How to run reliability simulation outside ADE-Artist environment ?

- Firstly a valid and viable eldo netlist is required
- In the netlist, no need to modify the way the WC NBTI models are made accessible
- In the netlist (or somewhere within the netlist) the variable "agesimulation" must be set to "1" as an example:

☞   .param agesimulation=1

In the ADE-Artist environment this value is initialized to 0 in file called "hiddenOptions", located at the same level than the final eldo netlist.

Do pay attention that this file is (re)written each time a netlist is generated.

If this option is inserted in the main netlist, it must be added at the very bottom of the netlist (after the model inclusion).

- In the netlist, the instruction related to reliability simulation needs to be added. Best way to do so is to refer to the example given within this module. Explanation of the usability of each statement is given in AMS/ eldo documentation ($anacad/documentation/eldo_udrm.pdf).
- The command running eldo needs to be modified, in order to tell eldo to use the ST-specific shareable object including ageing equations such as:

One way to do it, is to define an Unix alias which could be as is :

☞   alias eldo_rel eldo -stver -lib <path_to_this_package>/age/lib/ 'ukerGetMachine'

- Lastly, run the simulation.

❑ In case of issues please contact your prime Unicad/DK support interface.

By the way when Eldo simulation starts, it gives as log message the name of all shared objects (*.so files) which are currently loaded. Please double check that the libeldoudrm.so from the design kit structure is well loaded instead of the ones from the AMS/Eldo directories.
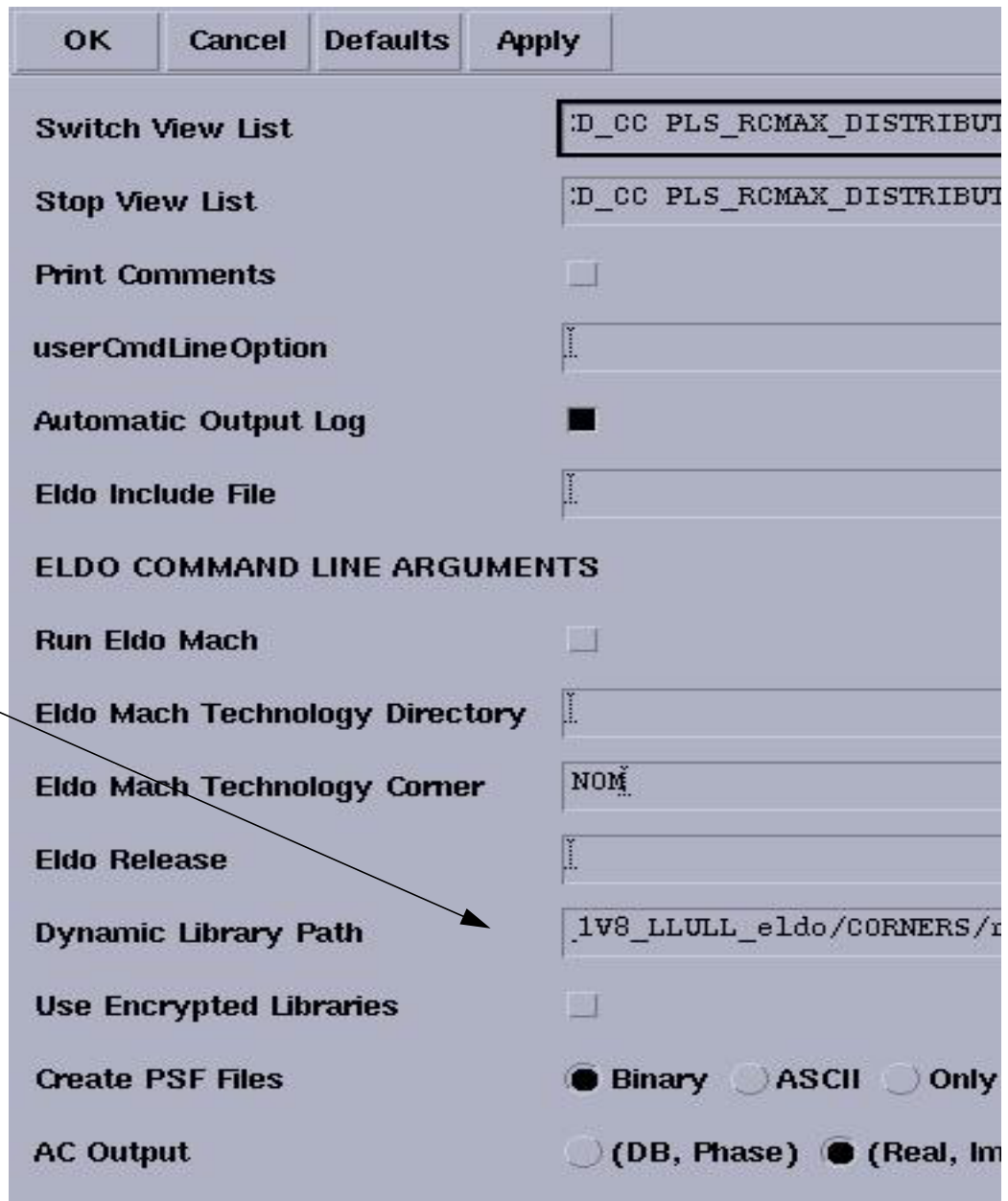
5   How to run reliability simulation inside ADE-Artist environment ?

5.1 ADE-Artist automatic setting (dynamic reliability simulation).

Such an integration in the DK within ADE-Artist environment takes into account the CAD-related aspects of the flow given in previous section:

The suitable pointer (set to the shared library) is automatically done at Eldo execution time (-lib option).

The ADE-Artist environment is also updated when DK is loaded within the CDS session as shown in the following snapshot (Artist->Setup->environment menu) :

OK	Cancel	Defaults	Apply

Switch View List `:D_CC PLS_RCMAX_DISTRIBUT`

Stop View List `:D_CC PLS_RCMAX_DISTRIBUT`

Print Comments ☐

userCmdLineOption

Automatic Output Log ■

Eldo Include File

ELDO COMMAND LINE ARGUMENTS

Run Eldo Mach ☐

Eldo Mach Technology Directory

Eldo Mach Technology Corner `NOM`

Eldo Release

Dynamic Library Path `.1V8_LLULL_eldo/CORNERS/`

Use Encrypted Libraries ☐

Create PSF Files ● Binary ○ ASCII ○ Only

AC Output ○ (DB, Phase) ● (Real, Im

CAUTION:

At this stage two things must be set by designer :

• the agesimulation variable and

• the .age command.

Those above statements may be added within ADE-Artist environment, inside the setup corner command (do not forget to save corner after edition).
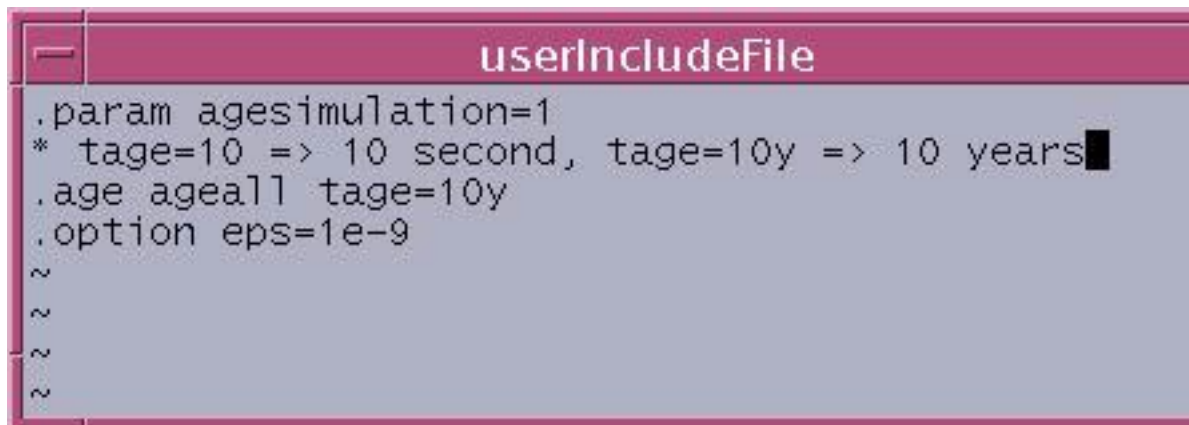
5.2 Double-check that NBTI shared library is loaded.

Loading the required shared library is necessary and should therefore be checked in eldo log as follows :

File

```
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldodio.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldojfet.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldosoi.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldomos4.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldoasitft.s
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldohisim.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldospmod.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldomoto.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldost.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldobnr.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldorockw.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldopubhicu
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldotftsh.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldobta.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldofas.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldofascm.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldova.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldovafnc.so
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldosdsim.so
/work/dkh9/DK/source_5.0/installDK/tmp_20040219_1/DK_hcmos9gp_RF
/work/mentor/ams/2004.1/eldo/v6.3_1.1/sun4/os5.8/libeldowire.so


              Software under License
     Copyright Mentor Graphics Corporation
```
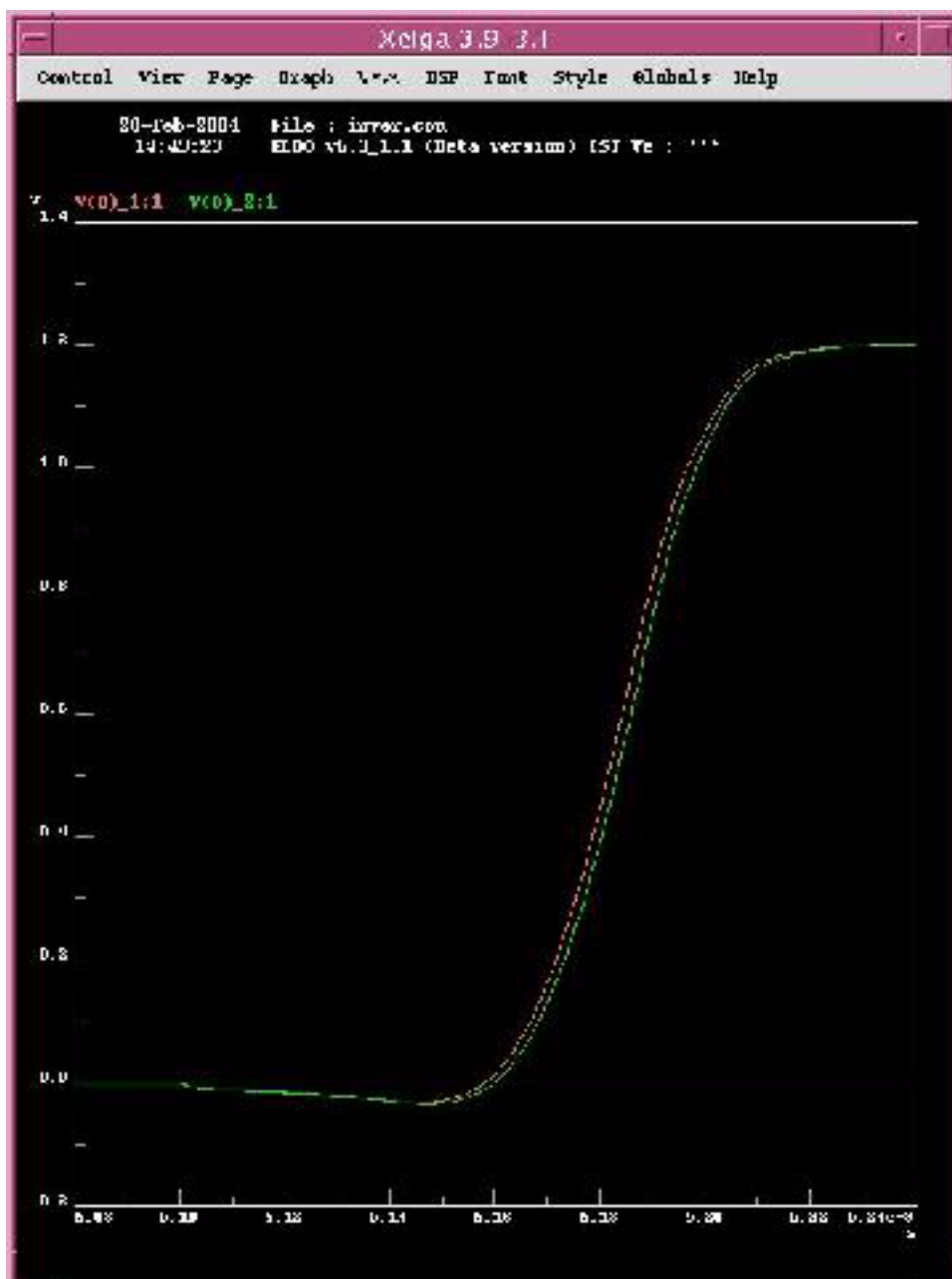
5.3   **Waveform display**

The ADE-Artist waveform display shows first (non-aged) simulation only.

Ezwave / Xelga feature full support of double-simulation method, and therefore displays both pre- and post-ageing data.

6   Known problems and solutions.

- The effect of nbrun (eldo feature not yet supported) in the .age command is not correct for values different than 1.

- The Dynamic reliability isn't available for Monte-Carlo/Statistical analysis.

- The Dynamic reliability simulation is not compatible with noinclib eldo option.

- ADE-Artist waveform display is not properly working with dynamic reliability model -> the workaround is to use xelga / ezwave.

- Two warnings messages are issued by Eldo on tstart and tstop time.