How to setup Momentum-Virtuoso Substrate Stack

Torleif Skår

University of Oslo

October 2, 2019

Outline I

Outline II

Preface

This tutorial here assumes you have set up Moment-Virtuoso on the UiO servers. If not, read the other tutorial first.

Why a tutorial is needed for the substrate stack-up

In general, to be able to simulate for EM, one needs to have information about the materials that are being used under production. Information such as conductivity, resistivity, thickness, width, spacing etc. about all the different layers are required for accurate EM modelling. This information is usually stored in something called a 'substrate stack-up' which is provided by the different foundries.

TSMC's stack-up information [1]

'Substrate stack-up file for Electromagnetic Simulation: TSMC shares only one file format, iRCX, that contains the substrate stack-up information.'

One minor issue, since UiO is not a direct customer of TSMC, getting these files takes *a bit more time* when compared to being direct customers. However, in this tutorial, we'll go through how to get a (pretty) good approximate of the stack-up that's being used for TSMC's 65 nm (1P9M_6Mx1Mz1Mu+Al_Rdl, to be exact).

Assumptions

Server

We're assuming you're connected to one of UiO's RHEL6 servers (rh6login.ifi.uio.no)

Working directory

In this tutorial we assume you'll stay in directory where you're Cadence session is installed. If you followed the guide as in [2], then your working directory is: ∼/`cadence616_tsmc65nmlp_oa`

Momentum main window

If you've finished the previous tutorial you should know how the Momentum main-window looks like, we'll start from there in this tutorial.

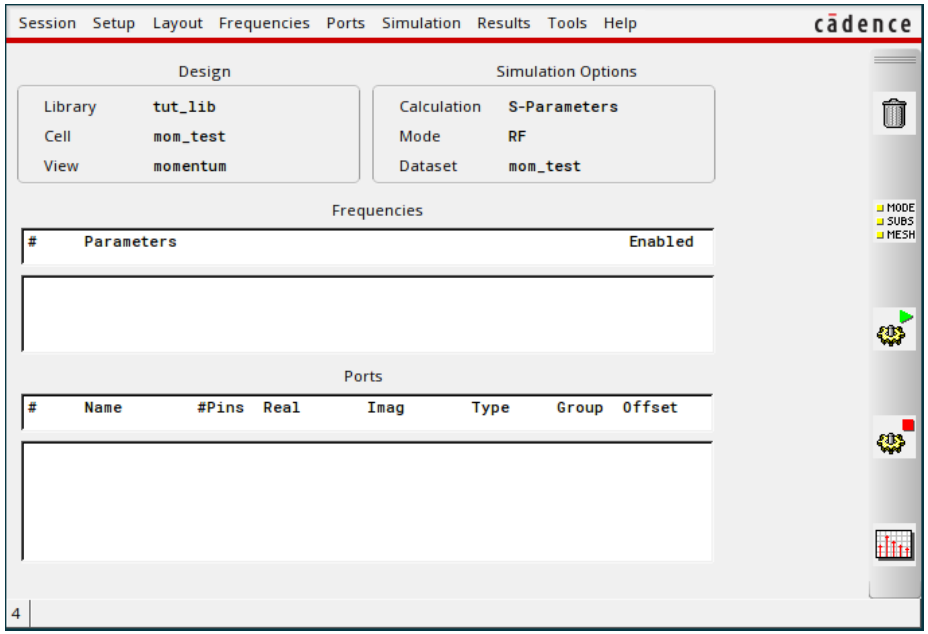

Figure: Momentum main-window

Assuming you've already made a Momentum cell-view, then the main-window should open, as you open the Momentum cell-view & launch Momentum from that cell-view. If not, check the previous tutorial.

Substrate Editor

From the main-window, open ‘Setup’ and then ‘Substrate. . . ’, such as:

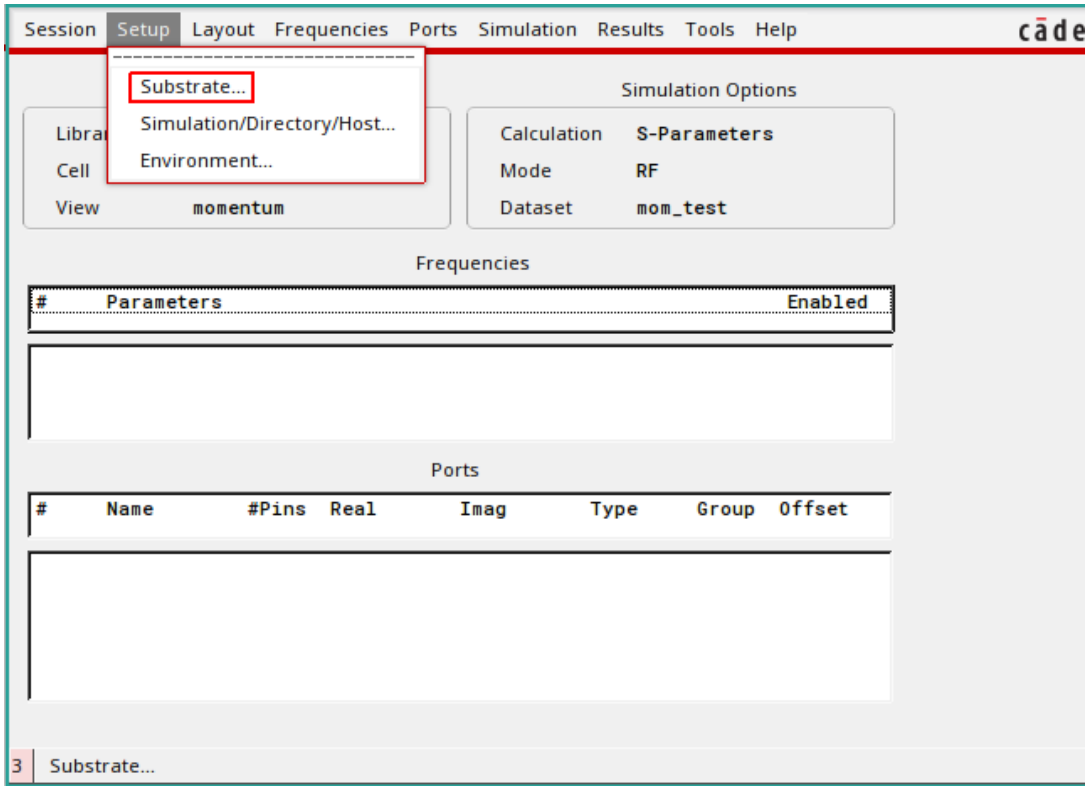

Figure: How to enter the subsrate editor

Then the substrate menu should pop up, here we need to choose an alternative substrate, and then click on new:

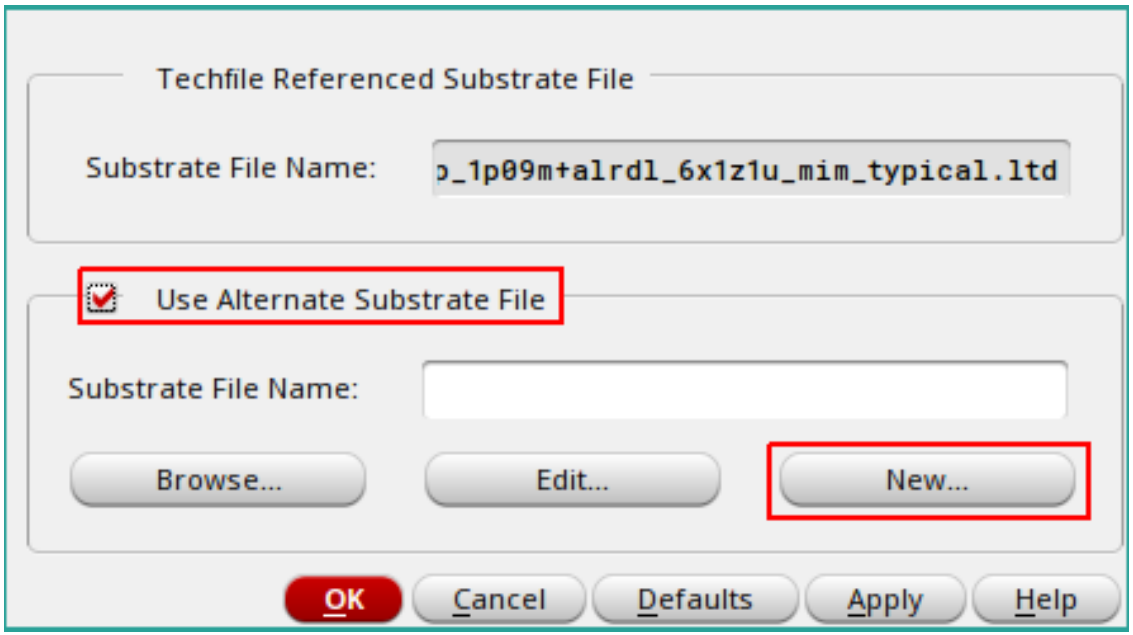

Figure: Making a new substrate, ignore the filename above (for now)

From the substrate editor, click ‘File’ and then ‘Import ITF File. . . ’, such as:

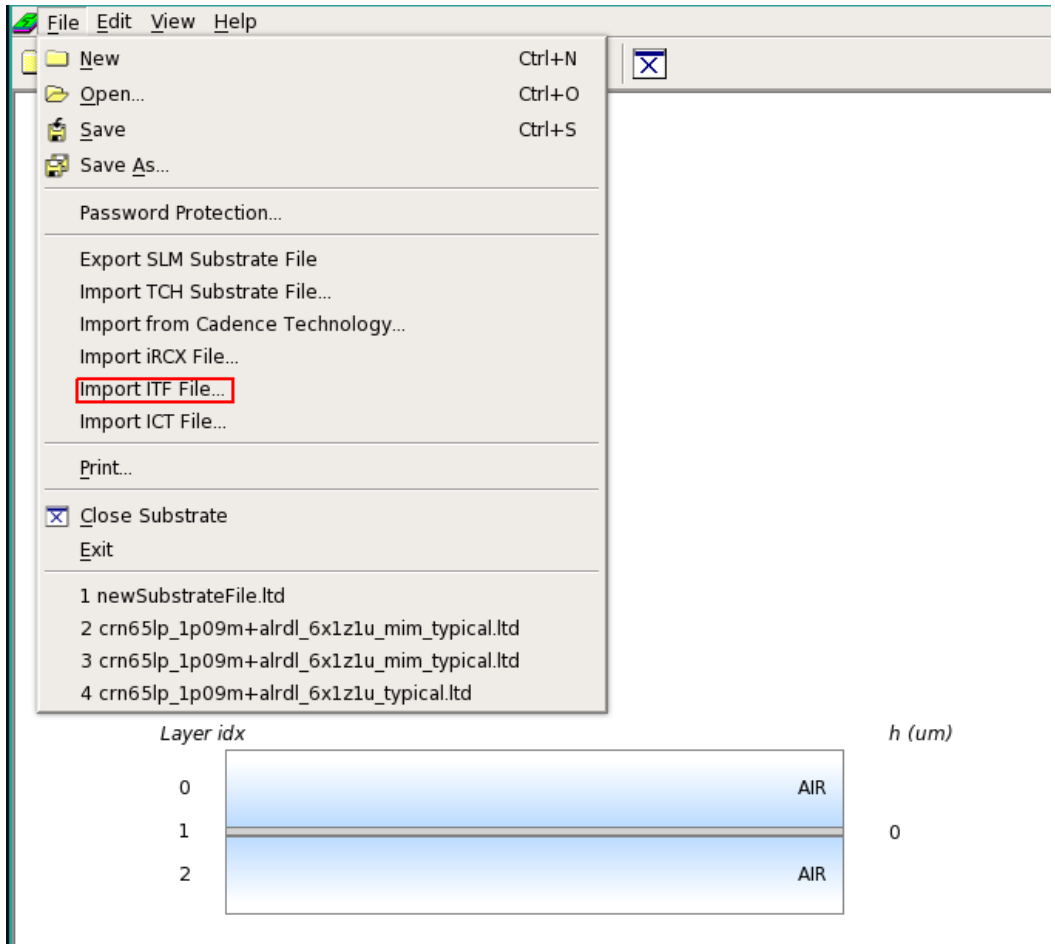

Figure: What kind of file we want to extract the substrate information from

ITF-import

Here, you'll see the import window for .itf files;

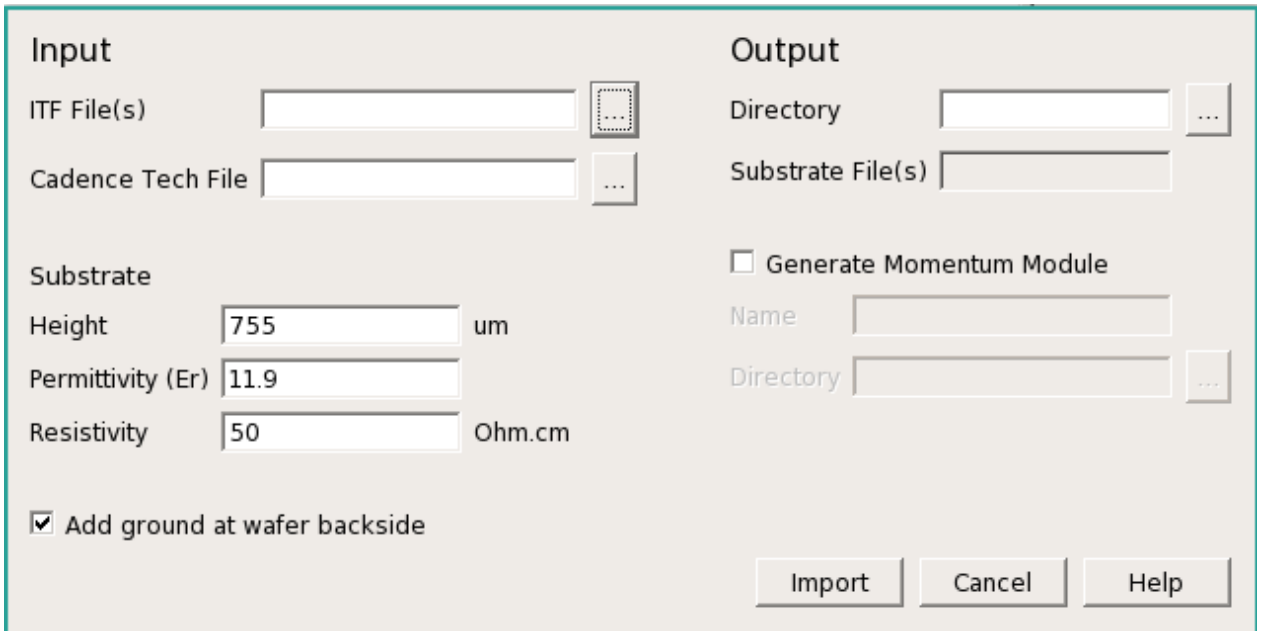

Figure: Import .ITF files, main window

In the next slides we'll go through the different options, and where to find the different files:

The ITF-file

The ITF file itself is stored with the installation of the PDK, in our case, this can be found at:

`/projects/nanus/PDK/TSMC65nmLPRF_OA/CCI/CCI_decks/crn65lp_1p09m+alrdl_6x1z1u_mim_typical.itf.`

Cadence Tech File

The Cadence Tech File, usually just called the techfile is also at the location of the PDK installation:
`/projects/nanus/PDK/TSMC65nmLPRF_OA/techfile`

Substrate info

Here, we'll just go with some semi-emprically data:

- Height $= 700\ \mu m$, seems to be a pretty typical value
- Permivittivity (Er) 11.9, don't know the specific doping levels of the wafer, so let's just leave it at default.
- Resistivity $= 10\ \Omega \times cm$, from [3], we have a value between $8 - 12\ \Omega \times cm$, therefore using the average.

Output directory

The only thing here is that one needs to use an output directory which one has write access to, therefore the default one is not good enough.
In this tutorial, we'll use the working directory as an example (where Cadence is 'installed'): ~/cadence616_tsmc65nmlp_oa

Momentum module

We also want to generate a Momentum module, with that, we can set default substrate stack-up for every momentum cell-view we want to model, rather than looking it up manually for each time.
Again, you'll need to save the module in a place where you have write access, we will again stick to the working directory, and then set:

- Name: `TSMC65nm_MOM`, the name is arbitrary
- Directory: `~/cadence616_tsmc65nmlp_oa`

ITF-import summarized

With the information above, we end up with the following:

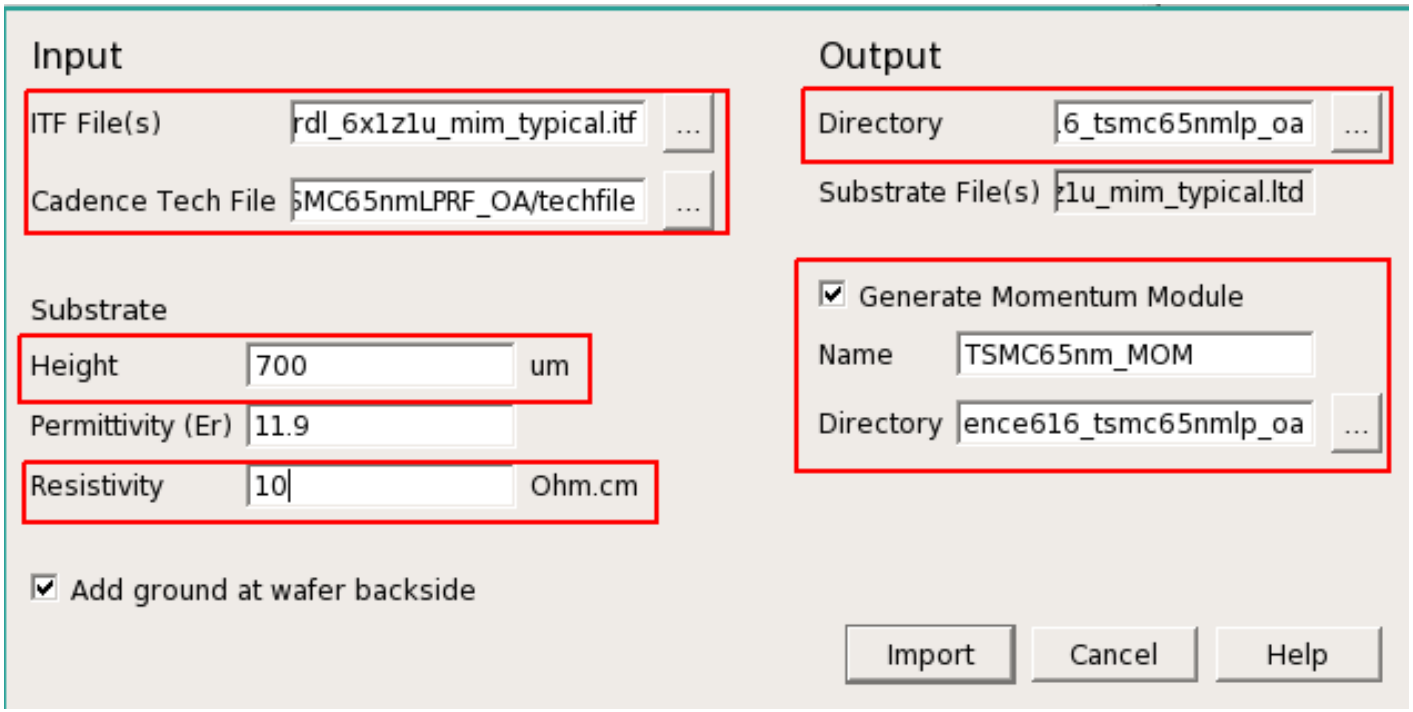

Figure: Overview over the changed items in the ITF import menu

Error on importing

When pressing import from the ITF-file, you probably got the following error:

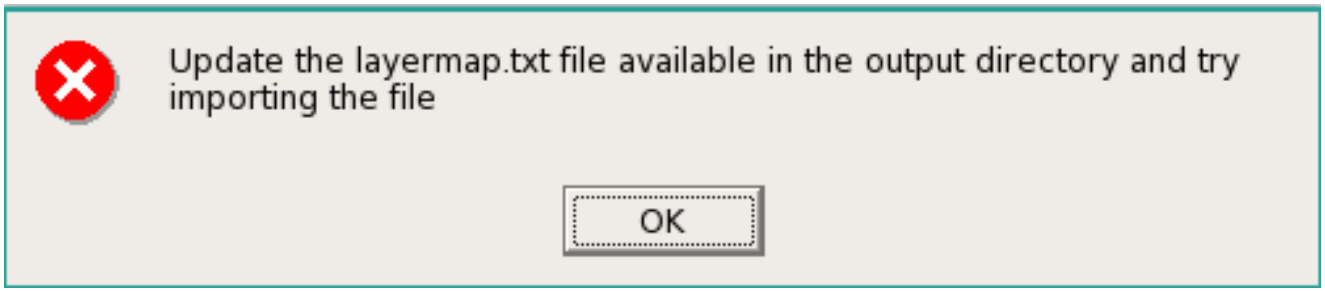

Figure: Error upon importing from .ITF

layermap.txt

As the error said, you need to update ‘layermap.txt’, which is a textfile that got generated in the output directory you set. This file is a mapping between the layer names (given in the .ITF file) and the Cadence Tech File layer names. Considering the different layers are NDA material, they can’t be publicized here, instead they’ll be emailed to you.
When you get the layermap.txt, put into the output directory that you set, and then try again to import.

layermap.txt - fully done

If you managed to fill out the layermap.txt, you'll see something like this:

Figure: Layermap & import of ITF sucessful

And now you have the substrate stack-up done, both as a substrate file (.ltd) and as Momentum module.

Momentum module

The reason we wanted a Momentum module, is that we can set this module as the default substrate for every Momentum cellview, rather than having to find the substrate for each time.

.cdsinit

Edit .cdsinit, again

To be able to set the default, we need to help Cadence locate the Momentum module, this is done through editing the .cdsinit file in the working directory.

```
$ vim .cdsinit
Add the following at the bottom:

; Momentum default substrate:
printf("START OF Momentum Module Customization\n")
(if getShellEnvVar("MOM_MODULE_PATH") !=nil then
  load(strcat(getShellEnvVar("MOM_MODULE_PATH") "/aa/cdsinit"))
else
  printf(".cdsinit: Environment variable MOM_MODULE_PATH is not set!\n")
); if
printf("END OF Momentum Module Customization\n")
; End of Momentum default substrate
```

Session file

If you saw from the previous slide, we need to define the path variable `MOM_MODULE_PATH`, which we are to define in the session file (CRN65LP_session_IC616):

Edit session file

```
$ vim CRN65LP_session_IC616
Add the following at the bottom:

# Default substrate setting:
export MOM_MODULE_PATH=<Path to your momemtum module>
```

As you can see, you need to define the complete path to your Momentum module, for example, if we are to use the example we used earlier, we get:

```
export MOM_MODULE_PATH=$HOME/cadence616_tsmc65nmlp_oa/TSMC65nm_MOM
```

Verify default substrate - CIW

To verify that the default substrate gets loaded, we get the first sign of verification when we're opening Virtuoso:

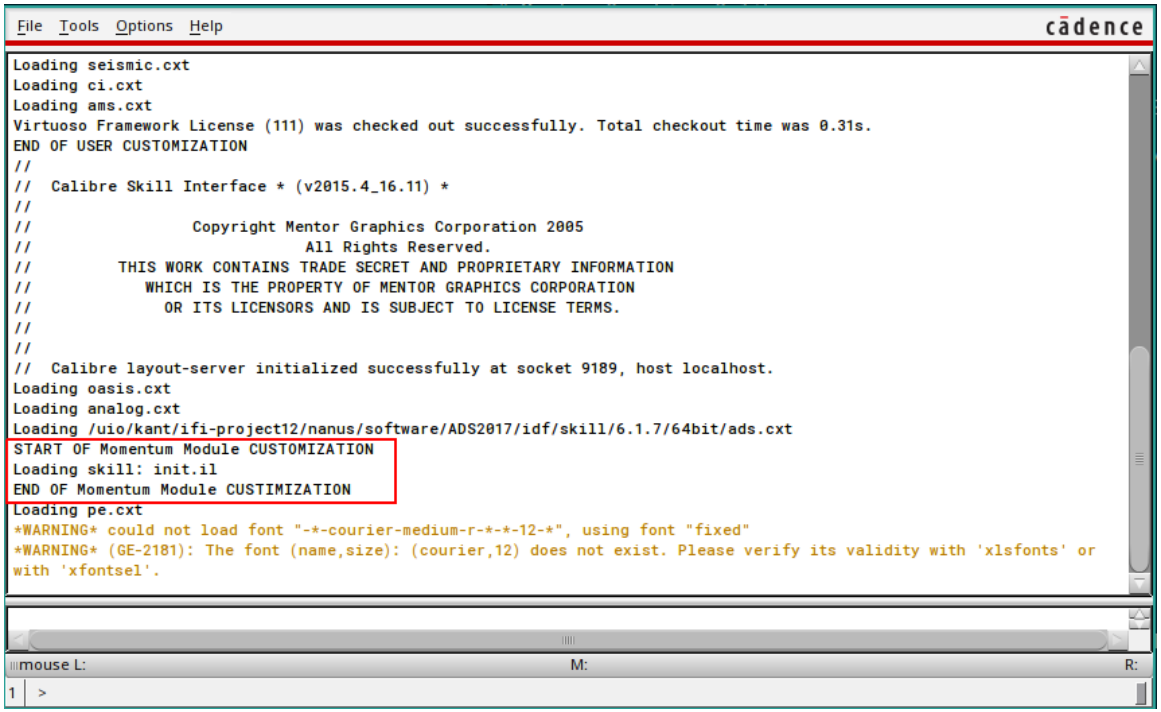

Figure: Verifying that the Momentum Substrate Module gets loaded

If you get an error here, you most likely has either not defined the variable `MOM_MODULE_PATH`, or the variable is set to an invalid path (it doesn't find an eligible Momentum module).

Verify default substrate - Momentum

Now, if you open Momentum (main window), and then go to 'Setup' $\rightarrow$ 'Subtrate', you should see something like:

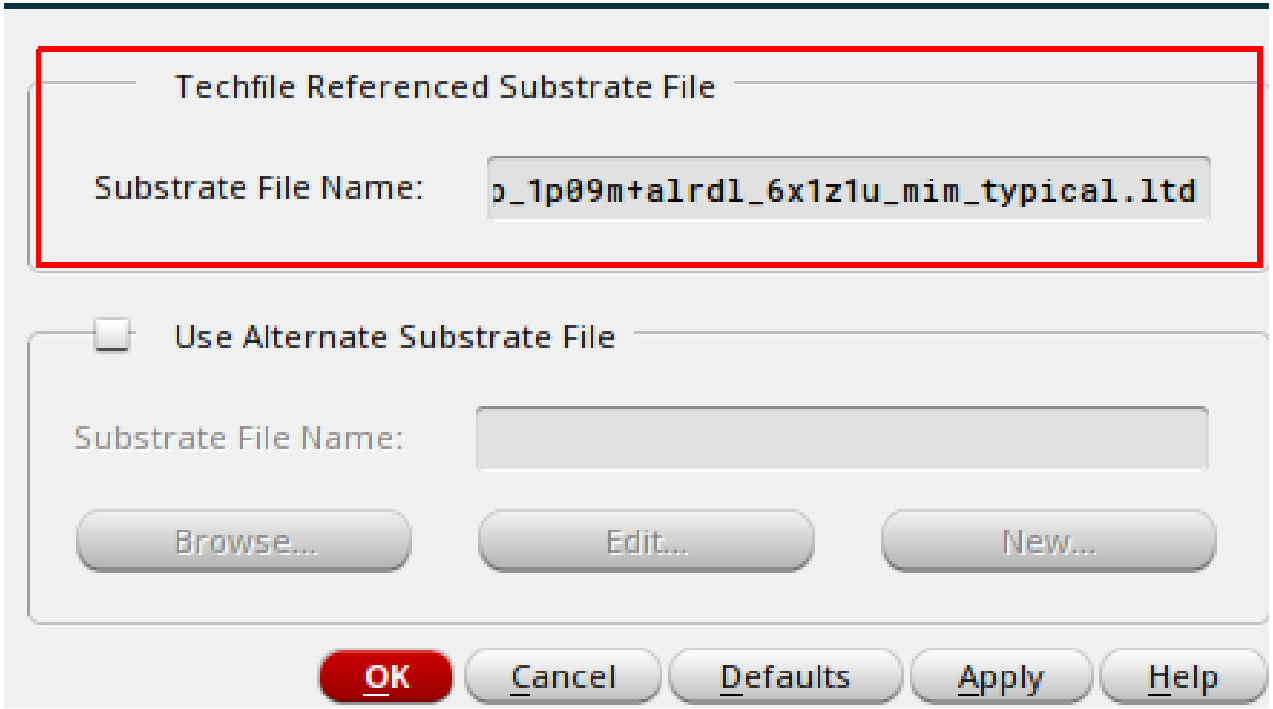

Figure: Substrate file correctly loaded as default

If you don't get as above, then you probaby have the same error as with the CIW error i.e. `MOM_MODULE_PATH` is either unset, or not an eligible path.

Still not working?

If you still can't manage to get it working, you can always send me a mail. My email-address is embedded in my name in this document, and/or you can find me on UiO.

Good luck!

Steps forward

Now all of the basics for running Momentum should be over, and you can start simulating. There should also be a short tutorial on how to get started on the course page.

References I


Keysight Technologies. *Foundry Program Partner - TSMC*. [Online; accessed 2019-09-30]. 2019. URL: https://www.keysight.com/main/editorial.jspx?cc=NO&lc=eng&ckey=2645987&nid=-34275.0.02&id=2645987.


Nano Wiki contributors. *Startup TSMC65nmLPRF OA*. [Online; accessed 2019-09-30]. 2017. URL: https://nano.wiki.ifi.uio.no/Startup_TSMC65nmLPRF_OA.


Europratice IC. *65nm CMOS Logic or MS/RF, Low Power TSMC Technology*. [Online; accessed 2019-09-30]. 2019. URL: http://europractice-ic.com/mpw-prototyping/asics/tsmc/.