Project memo AN 03.12.101

# PSCAD/EMTDC model for calculation of losses in hard-switched semiconductors

Objective

Losses and temperature conditions for semiconductor switching devices are important issues of a converter design (e.g. maximum temperature and temperature cycling). Proper simulation models for loss calculation is therefore needed.

A semiconductor loss calculation model has therefore been implemented in the PSCAD/EMTDC simulation software.

The new implemented model can be used for estimation of losses and temperature cycling in hard-switched semiconductors (thyristors, transistors and diodes).

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The loss calculation method
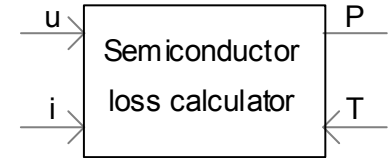
- The loss estimation is based on user input parameters that describes how switching and conducting losses depend on temperature, current and voltage.

- The parameters can typically be taken from data-sheets or from single-pulse measurements on a converter or laboratory model with representative parasitic capacitors / inductors, snubbers and gate drives.

- The losses are **not** based on simulation of voltage/current rise and fall in the switching interval (ideal, and fast, switch models are used)

Output data of loss simulation (as function of time)

- Instantaneous conducting losses [W]
- Energy loss at last turn-on [Ws]
- Energy loss at last turn-off [Ws]
- Average conducting losses in last average period[*] [W]
- Average switching losses in last average period[*] [W]
- Average total losses in last average period[*] [W]

[*]User defines the average periods to use

Thermal simulation

- A thermal simulation model can be run in parallel with the electric model such that the effect of temperature dependency of the losses can be included.

- The thermal simulation gives the temperature cycling of the semiconductor devices
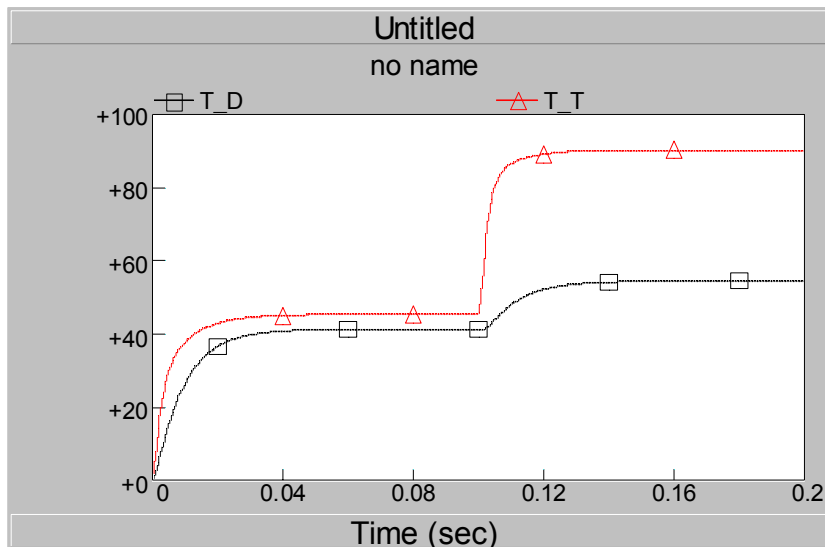
Diode temperature (black, °C) and transistor temperature (red, °C) after a step increase in duty cycle in a step-down converter.

PROJECT MEMO

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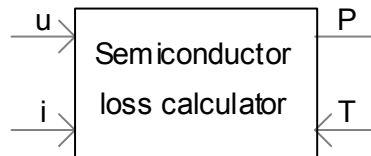
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MEMO CONCERNS

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Described is a new model developed for the PSCAD/EMTDC simulation program. The new model can be used for estimation of losses in switched semiconductors.

A thermal simulation can be run in parallel such that the effect of temperature dependency of the losses can be included. It will then also be possible to simulate the temperature cycling of the semiconductor devices (thyristors, transistors and diodes).

The estimation of losses is based on user input parameters that describe the dependency between temperature, current, voltage and switching and conducting losses. These parameters can typically be found from data-sheets or from single-pulse measurements on a converter or laboratory model with representative parasitic capacitors / inductors, snubbers and gate drives.

Note: The losses are **not** based on the simulation of voltage/current rise and fall in the switching interval. Ideal switch model is to be used in the simulation. The speed of the simulation will therefore not be much slowed down by the loss calculation.

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