Hierarchical Approach in Modeling and Simulation of Power Electronics for Education

THUAS Delft, The Netherlands

Prof oP. dr.ir. P.J. van Duijsen(presenter), ing D.C. Zuidervliet

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Types of models
What to teach?

- Basic ideal model
- Generic functionality model
- Detailed component model

Tabel: Engineering questions and design issues dependency on the modeling approach

	open-loop	closed-loop	Power Loss	EMI
Basic	++	+	-	-
Generic	+	++	0	0
Detailed	+	0	++	+

TABLE II
SIMULATION GOALS

|	Basic	Generic	Detailed
Control	• Steady state Behavior, • Start up,Stability	• Control limits, • Stability	• Component non-linearity
Losses	• Conduction, • Inductor winding loss, • Capacitor ESR loss	• Conduction, • Inductor winding loss, • Capacitor ESR loss	• Conduction, Switching, • Inductor winding loss, • Core loss approximation, • Capacitor ESR loss
EMI	• Harmonics from the switching waveforms	• Harmonics from the switching waveforms and parasitic components	• EMI from the parasitic components combined with dynamics from semiconductors
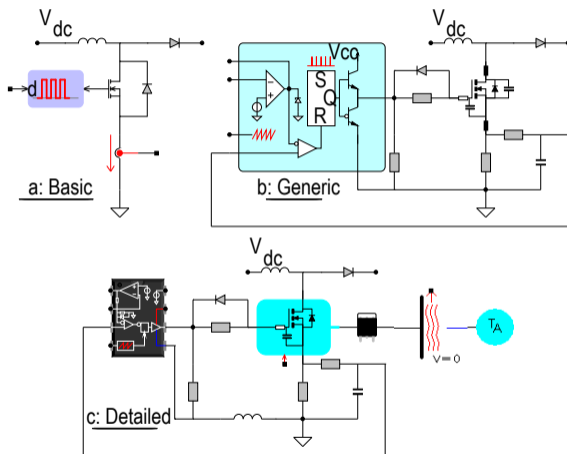
Modeling approaches for SMPS.
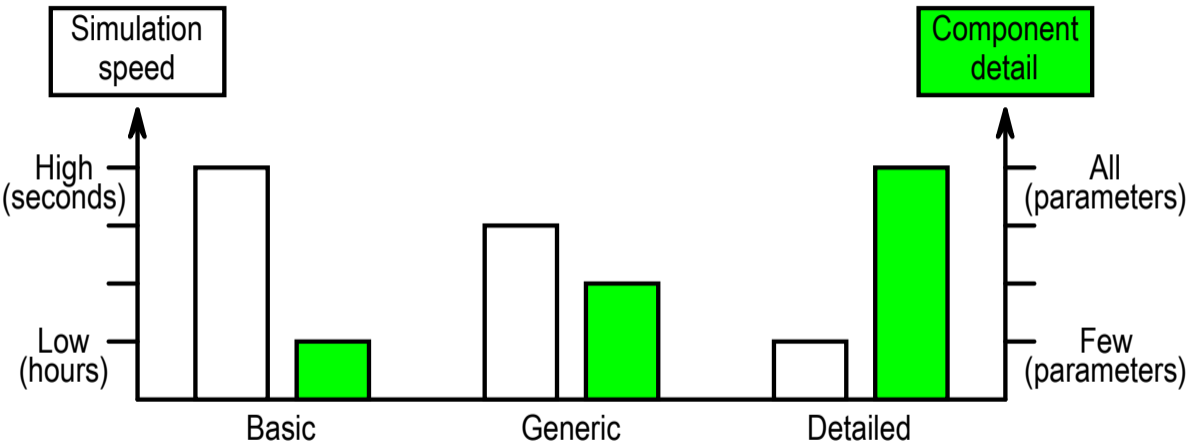
Simulation speed decreases, while component detail increases, when going from a Basic towards a Detailed model.
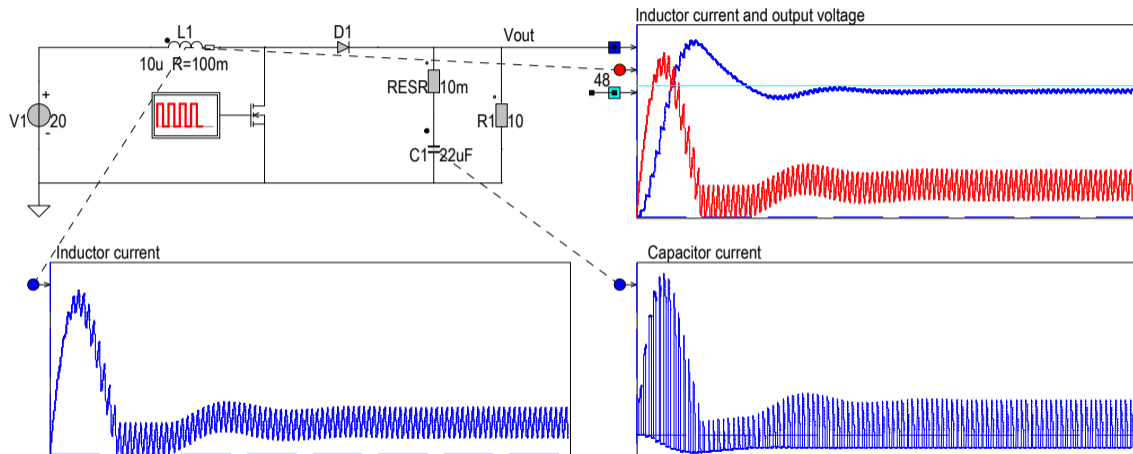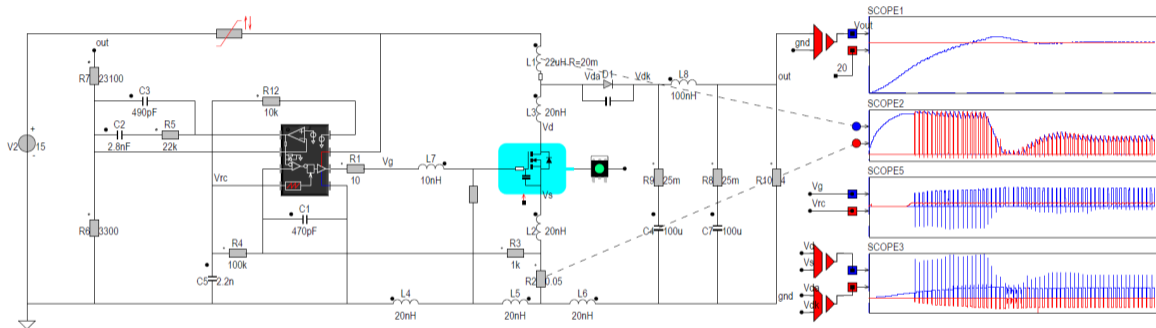
Basic model for the open-loop simulation.

Generic models for voltage mode(left) and current mode(right) controllers.
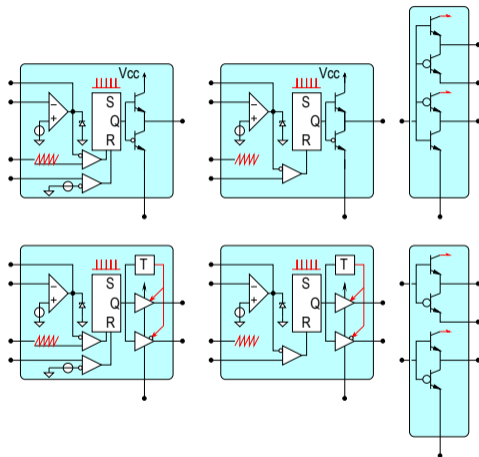
Generic models for voltage mode(left) and current mode(right) controllers.
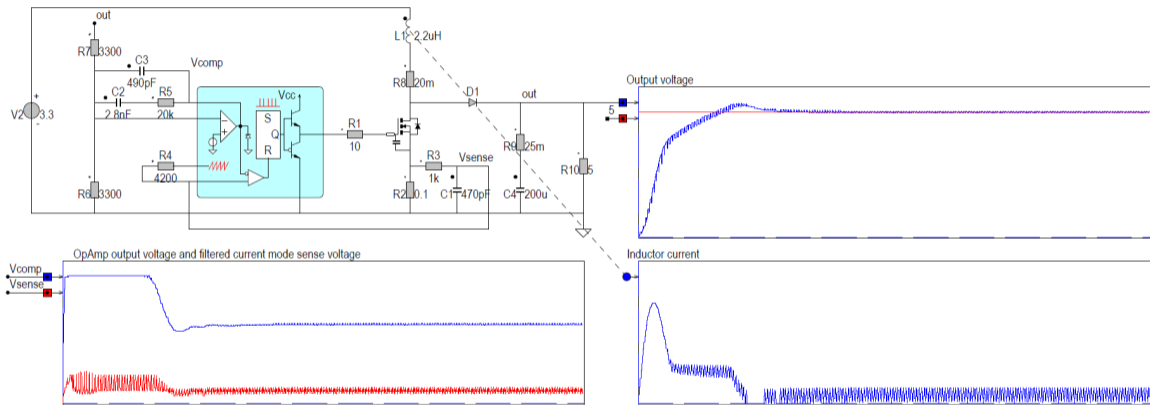
Generic model for the peak-current-mode control and semiconductor in the simulation.

Detailed model for the peak-current-mode control IC and Mosfet in the simulation.

- Hierarchical Approach
- Only use and show these items that students need
- Basic/Generic/Detailed models
- Objectives: Depending on the students needs, provide the complexity of the model

Thank you!
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