Structuring a SMPS Course, Part I: Lectures

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Mai 26th 2022

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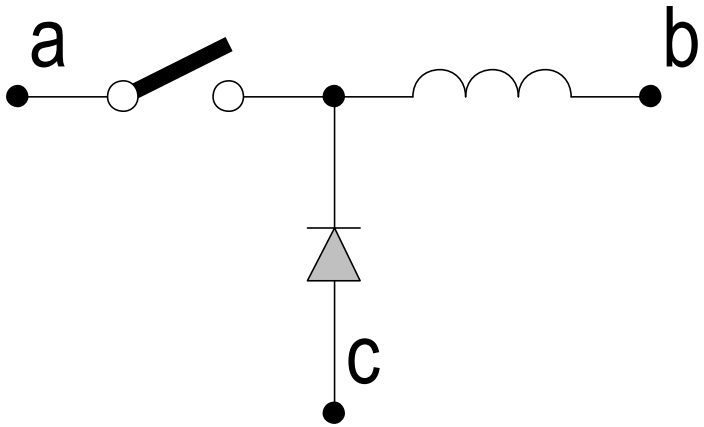
Switched Mode Power Supply Lectures
What to teach?

- Textbooks
- Design and visualization Tools
- Simulation and Animation
- Multidisciplinary approach (Electronics, analog/digital, EMI)

Outline of the lectures

Switched Mode Power Supply Lectures
Knowledge

- Entry level
  Components, basic electronics, magnetic fields, opamp-bandwidth
- Examination
  After full semester, or multiple smaller test?



LSD switching cell containing an inductor L, switch S and diode D.

Topics: Converters or design

What to teach?

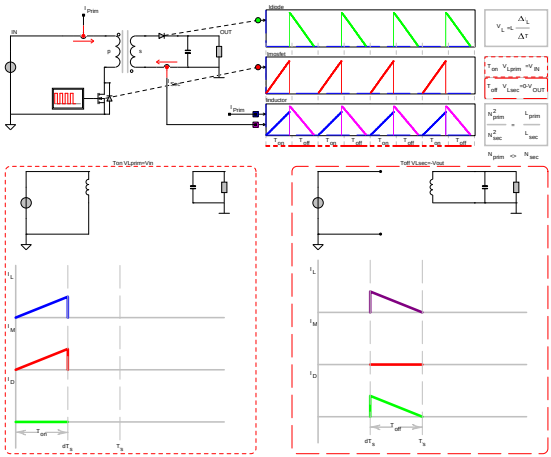
- Buck, Boost and Buck-Boost
- Isolated Converters
- Basic operation, Waveforms and Application
- Sepic, Cuk and resonant converters
- Control
- PCB design and EMI

Methods

Tools and methods:

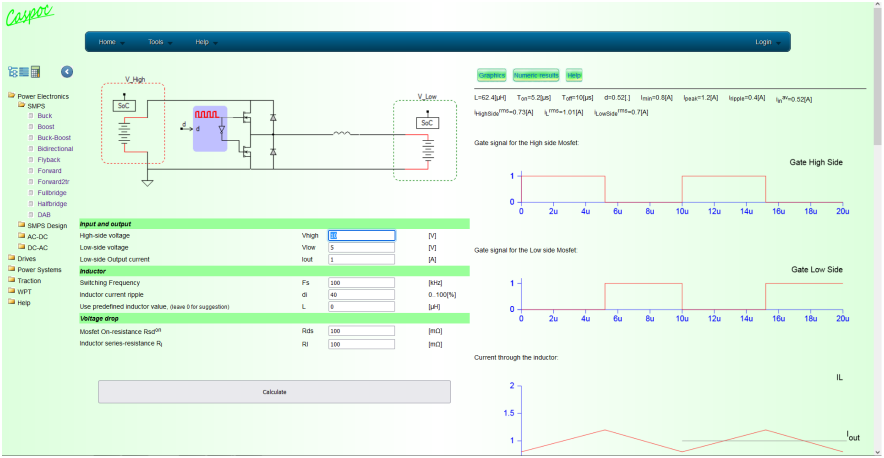
- Principle
- Mathematical relations
- Parameters and Waveforms
- Behavior
- Performance

Methods-tools: Cheat sheets



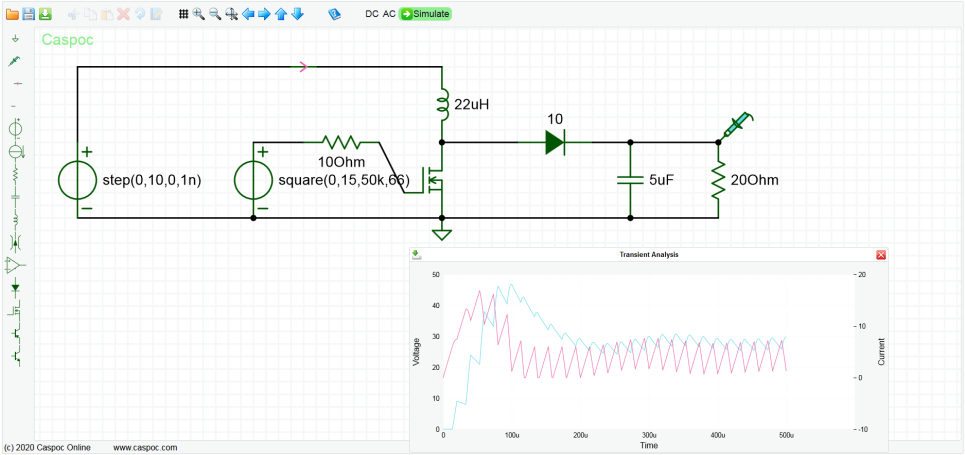
Cheat sheet for the flyback converter.

Methods-tools: Design and visualization tools



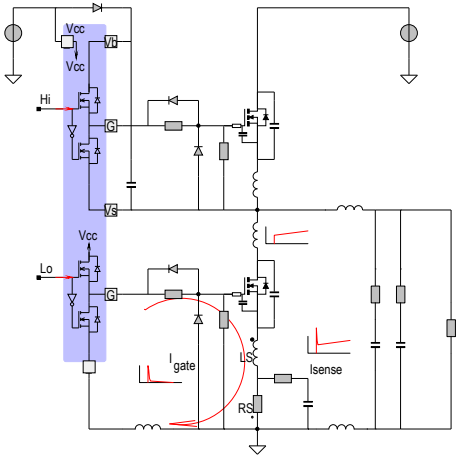
Design tool for the bidirectional Buck-Boost converter.

Methods-tools: Simulation and Animation



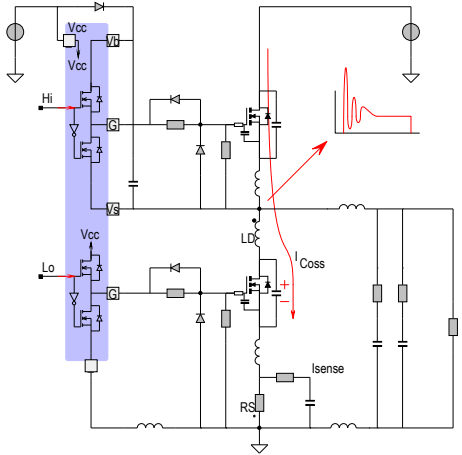
Online simulation of the boost converter to see the start up current.

Methods: Behavior



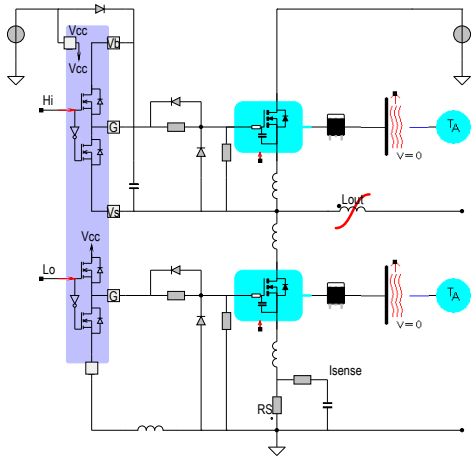
Influence of the gate current in the measured Drain-Source current through *RS* creating a high voltage peak during turn-on of the low side Mosfet.

Methods: Performance



Influence of the leakage inductance *LD* and ringing of the voltage on the switching node creating EMI noise during turn-off of the low side Mosfet. The current through the high side Mosfet that is turned off, is charging the output capacitance of the low side Mosfet.

Methods: Performance



Losses and self-heating of the Mosfets change the on resistance of the Mosfets and thereby the conduction losses. The saturation of the inductor will affect the inductor current waveform.

Basic Objectives

Basic objectives

U LSD
Principle of the basic switching cell.Without the understanding[U] of this objective, the students do not have enough knowledge for the other objectives, and will fail examination.

C Power balance
Calculate the voltage, current and power levels and their relation depending on the regulation(dutycycle).

A Waveforms
Reproducing all voltage and current waveforms at the input and output, as well as for each component.

C Main Components
Calculation of all main component values required for storage and filtering

A Datasheet
Ability to read, understand and apply the datasheet parameters and graphs for the magnetic and semiconductor components

Tabel: Basic objectives

Extended Objectives

Extended objectives

A PCB design
Optimizing gatedriver and power switch PCB layout, to reduce switching losses and EMI. Students learn the influence of PCB layout on performance.

C Magnetic design
Basic principle of core type selection, core size calculation, estimating core and winding losses, including techniques to reduce skin effects and proximity losses.

C Control
Calculate the parameters of a feedback for voltage mode and peak current mode control for the basic converter designs

Tabel: Extended objectives

Conclusion

- Textbooks
- Design tools, online simulation, Simulation and Animation
- Behavior and Performance
- Objectives (Basic and Extended)

Thank you!
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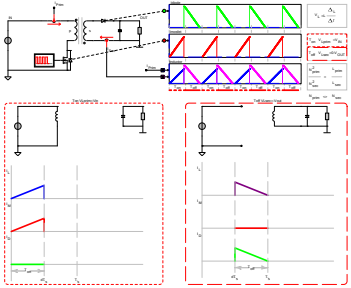

Thanks to Christian Nagy, Koen de Bruin and Holly Engelbrecht for designing and constructing the SMD-PCB board.