ECE 692: Discrete Time Modeling of Power Electronics

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University of Tennessee Knoxville

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THE UNIVERSITY OF TENNESSEE KNOXVILLE

Course Info

- Course focuses on advanced topics in modeling and control of power electronics
  - Course website: http://web.eecs.utk.edu/~dcostine/ECE692
  - Goal of course is broad understanding of the modeling of switched systems, discrete time modeling and digital control
- Prerequisites: undergraduate Circuits sequence, Microelectronics, ECE 481 – Power Electronics, or equivalent
- Recommended: ECE 581 – High Frequency Power Electronics or equivalent experience

Contact Info

Instructor: Daniel Costinett

- Office: MK504
- E-mail: Daniel.Costinett@utk.edu
- Email questions will be answered within 24 hours (excluding weekends)
- Please use **[ECE 692]** in the subject line

Course Structure

- Course meets MWF 11:30 – 12:20
- Plan to spend ~9 hours per week on course outside of lectures
- Grading:
  - Homework: 40%
    - ~One homework per week
    - Assignments due on Fridays unless otherwise noted on course website
  - Midterm Project: 25%
  - Final Project: 35%

Lectures

- Powerpoint slides for lectures posted to website prior to class
- Annotated slides posted after class
- Lectures recorded and available on website
  - Accessible from UTK network
  - *Not* re-recorded in the event of a technical difficulty

Assignments

- Assignments due *at the start of lecture* on the day indicated on the course schedule
- No late work will be accepted except in cases of documented medical emergences
- Collaboration is encouraged on all assignments except exams; Turn in your own work
- All work to be turned in through canvas

Textbook and Materials

- The optional textbook for the course is

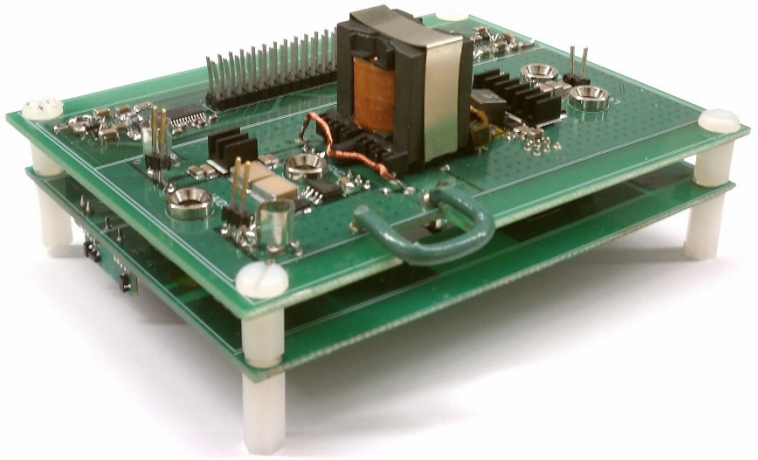
  L Corradini, D Maksimovic, P Mattavelli, and R. Zane *Digital Control of High-Frequency Switched-Mode Power Converters*, Wiley 2015
- MATLAB/Simulink, LTSpice will be used; All installed in the Tesla Lab
- Lecture slides and notes, additional course materials, homework, due dates , etc. posted on the course website
- Additional information on course website

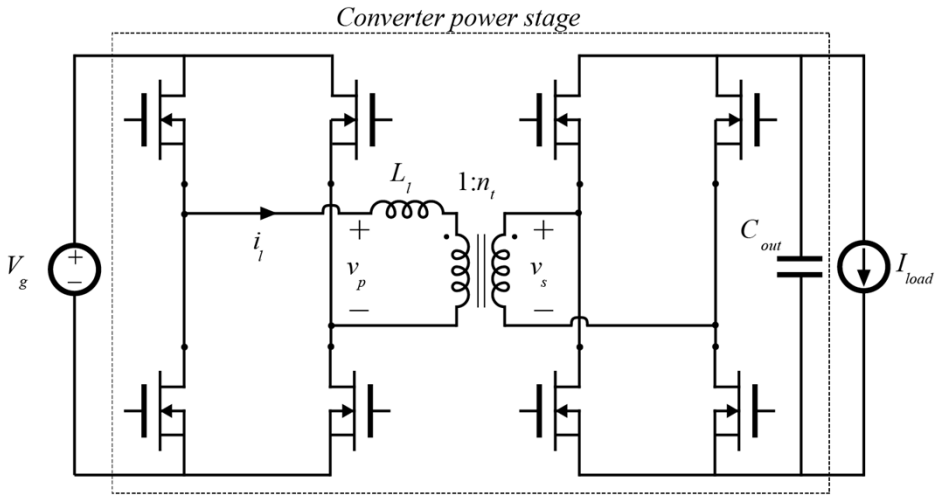
DAB Example

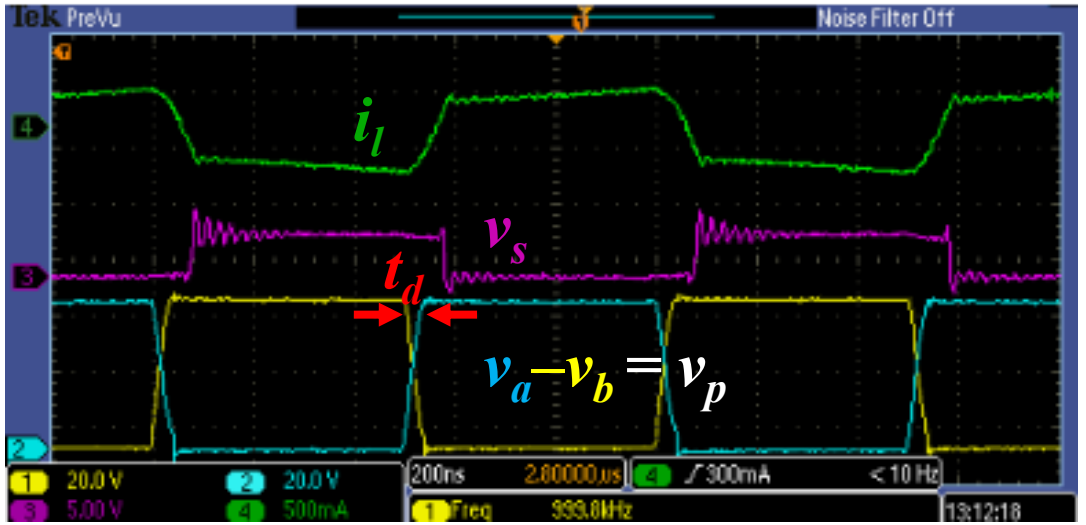
COURSE INTRODUCTION

Motivating Example

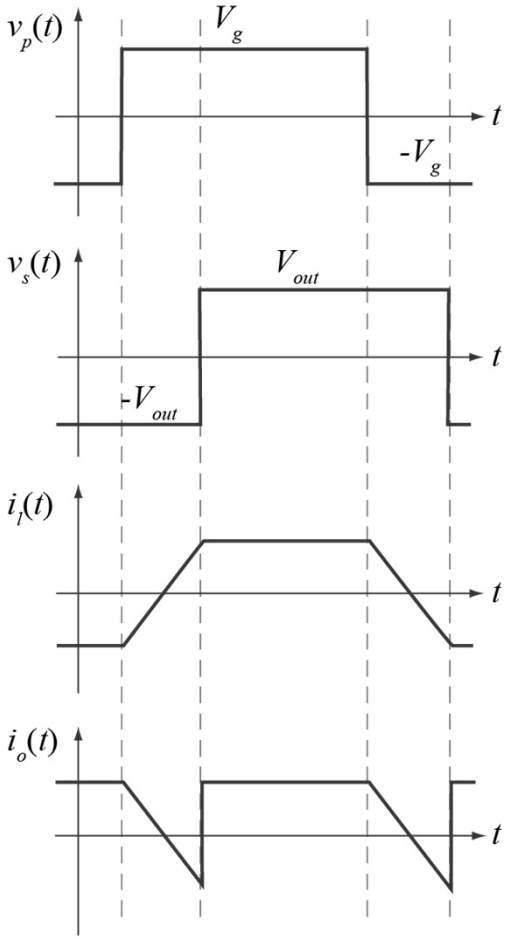
Parameter	Value
V_g	50 V
V_{out}	4 V
I_{load}	2.5-3.5 A
C_{out}	20 µF
L_l	9.5 µH
n_t	25:2
f_s	1 MHz
η_{pk}	97%

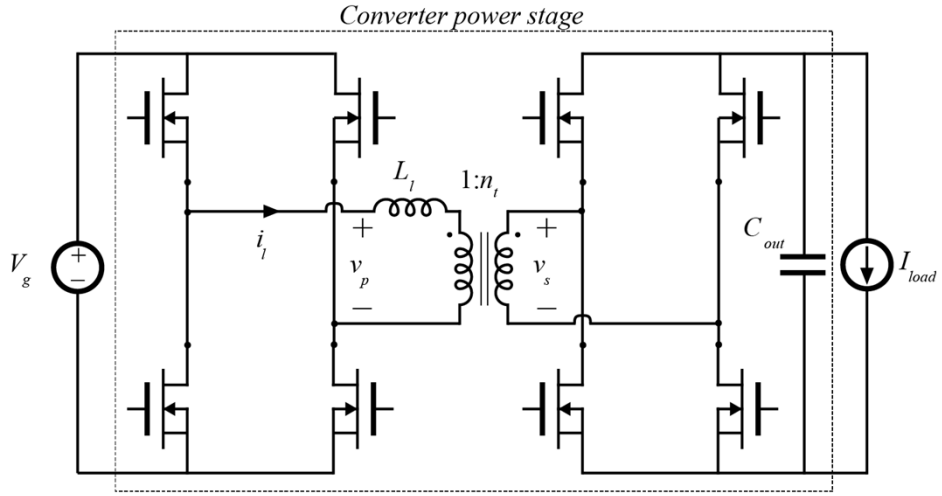






DAB Topology



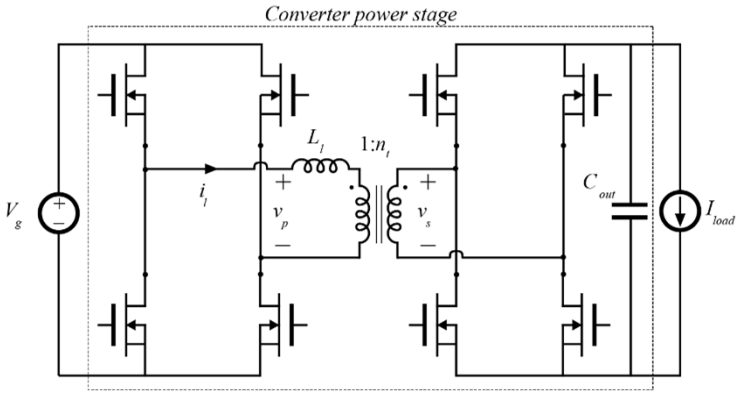


- Dual Active Bridge (DAB) with phase shift modulation
- Transformer isolation with incorporated leakage inductance
- Soft switching of all devices across a wide range of loads

Section 1

STEADY-STATE MODELING

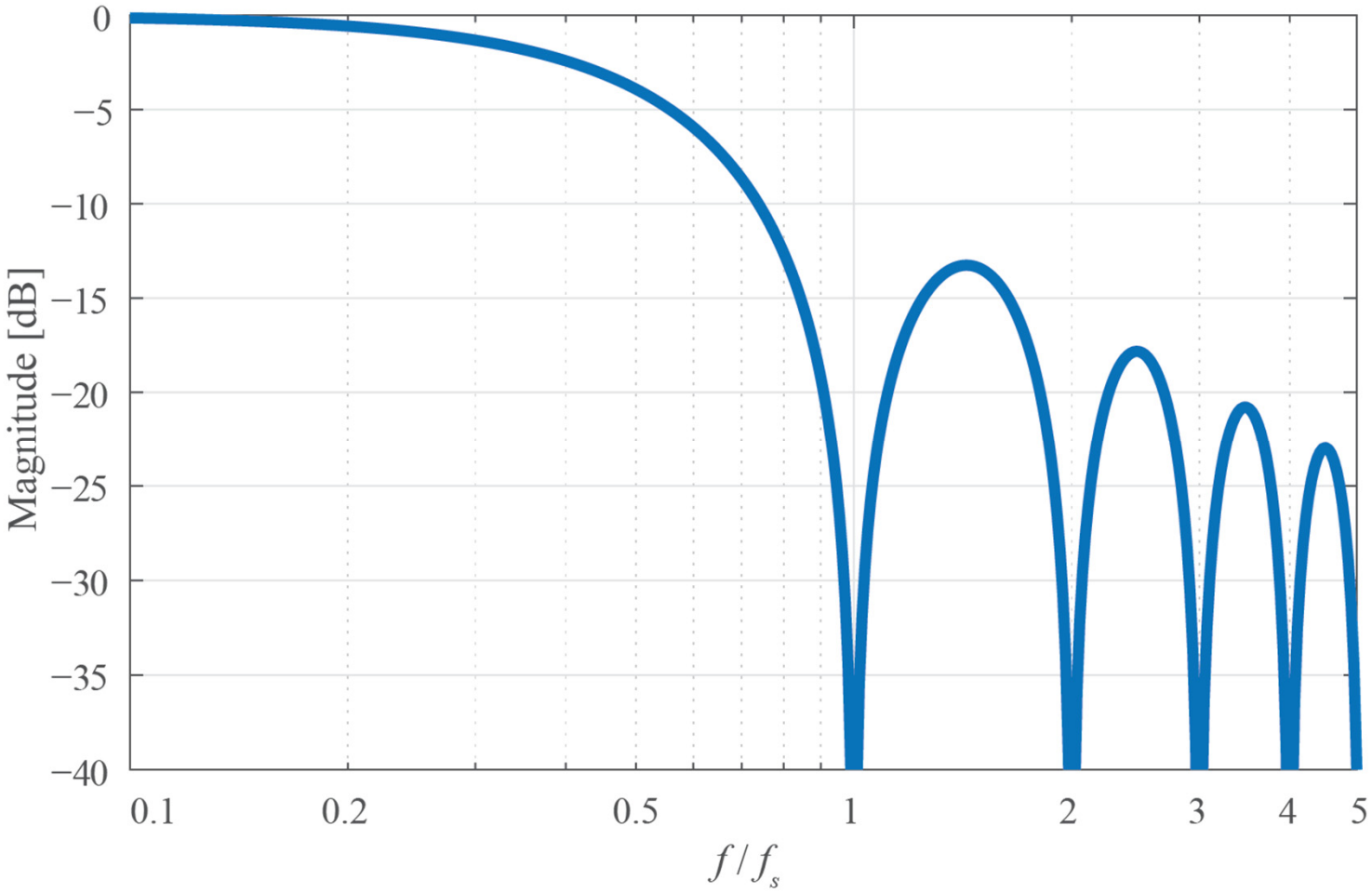
Averaged Modeling



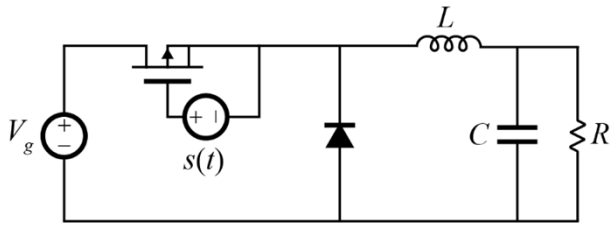
Limitations of Average Modeling

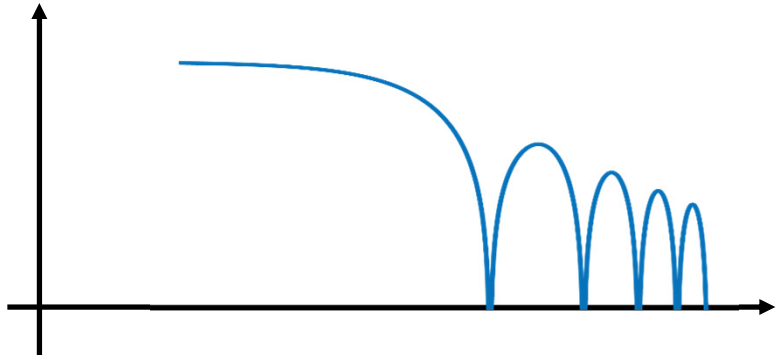
The Averaging Filter

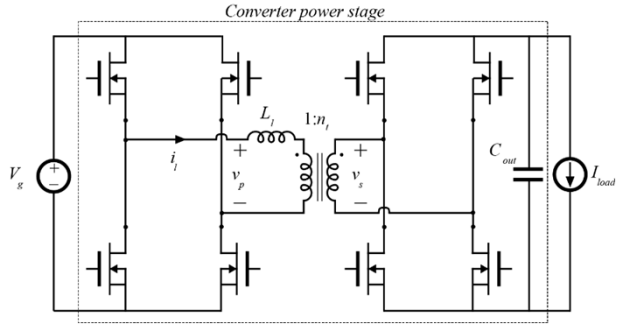
Averaging: Discussion

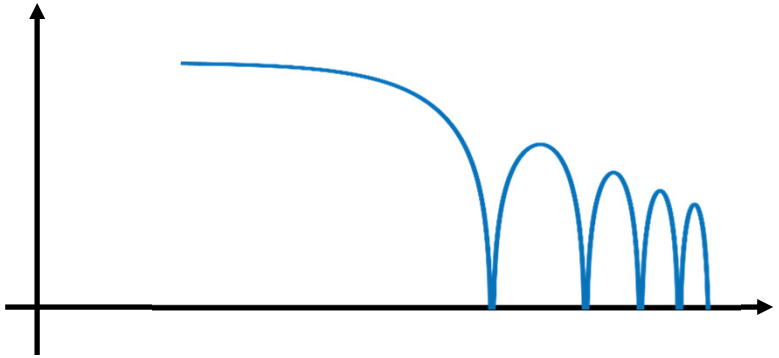


Applicability of Averaging









One Approach: Relaxing The Average