

EM characterization of Switched Mode Power Supply

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18 Nov 2013

Brief Background of NILM

Idea: Infer state of appliances non-intrusively

Need:

Indoor activity sensing

Indoor localization

Individual Energy apportionment

Insights in to NILM

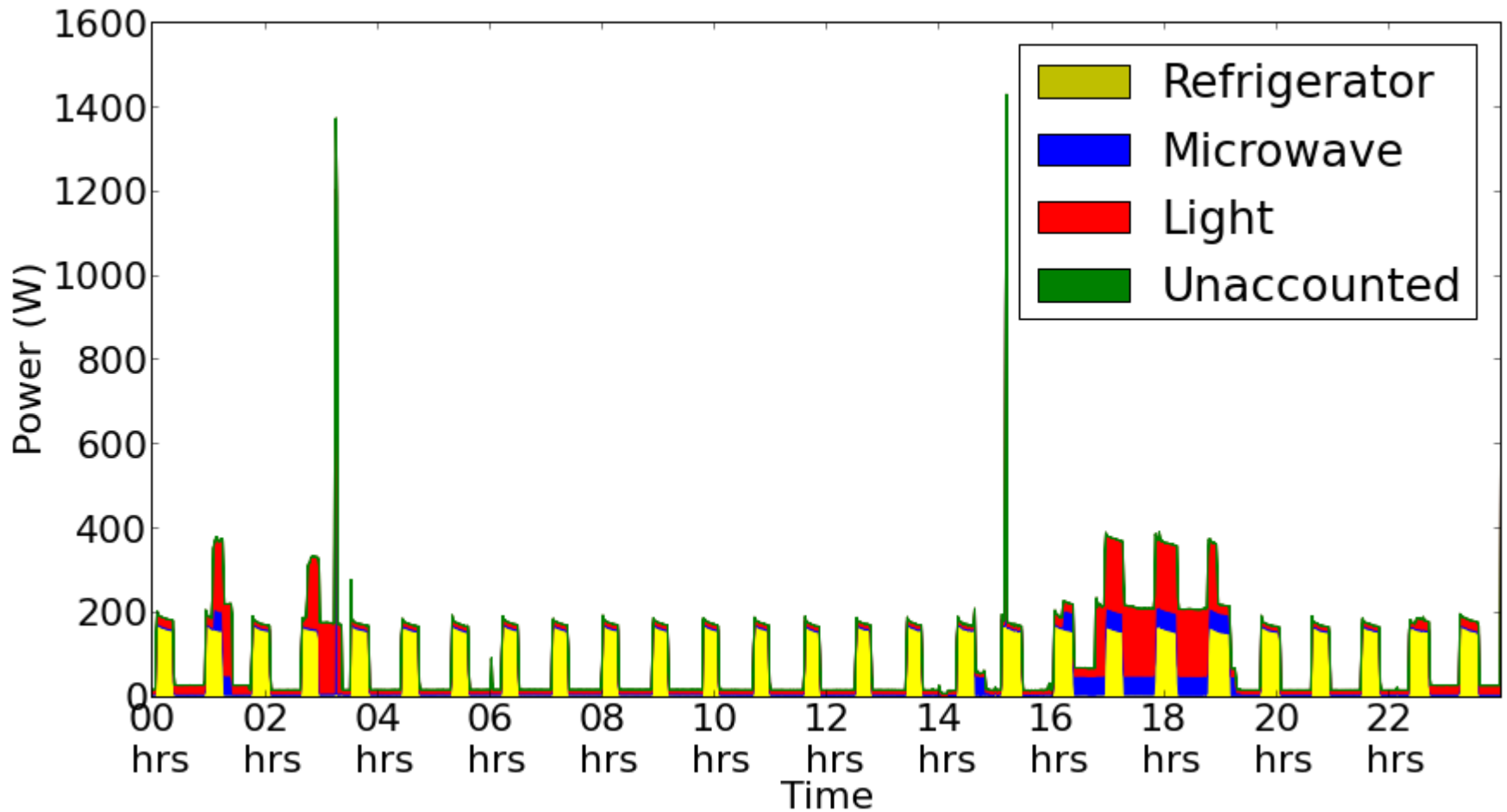
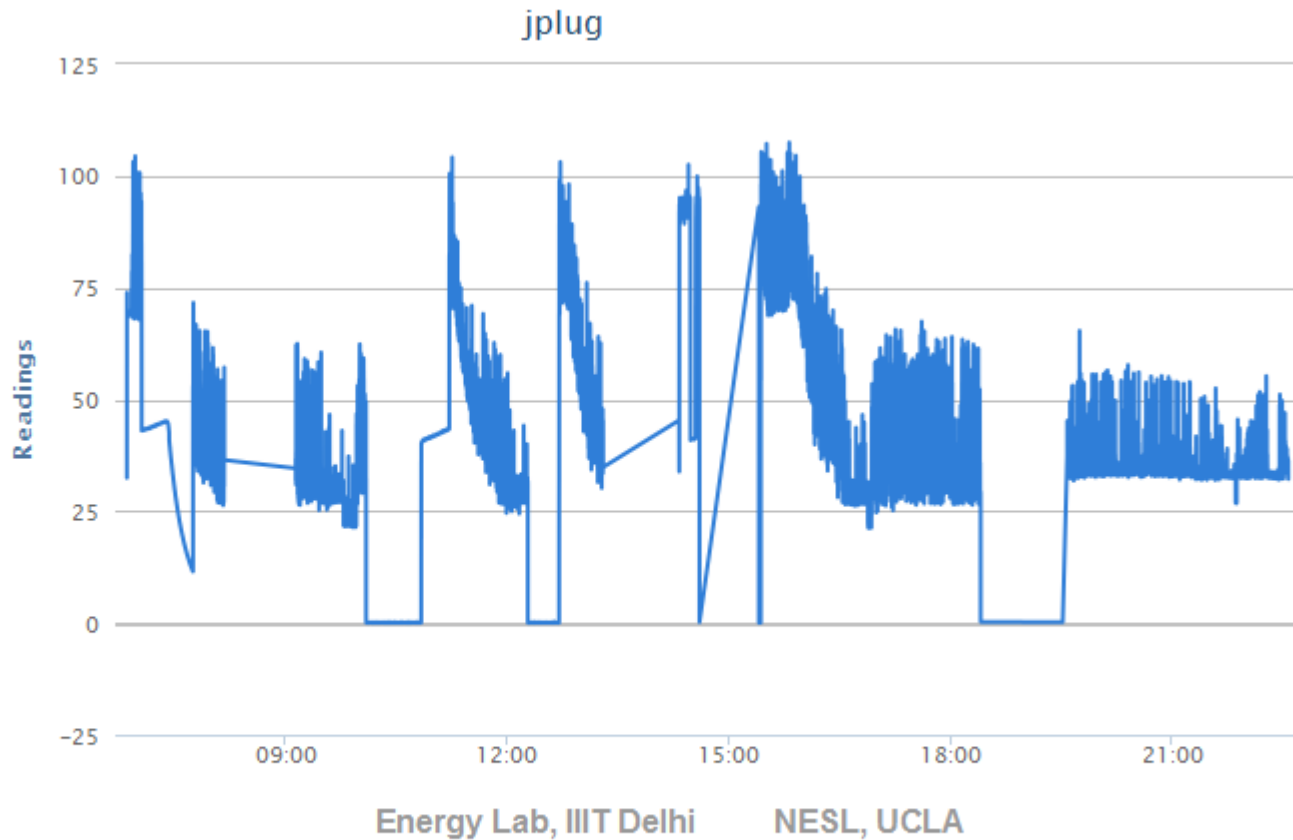
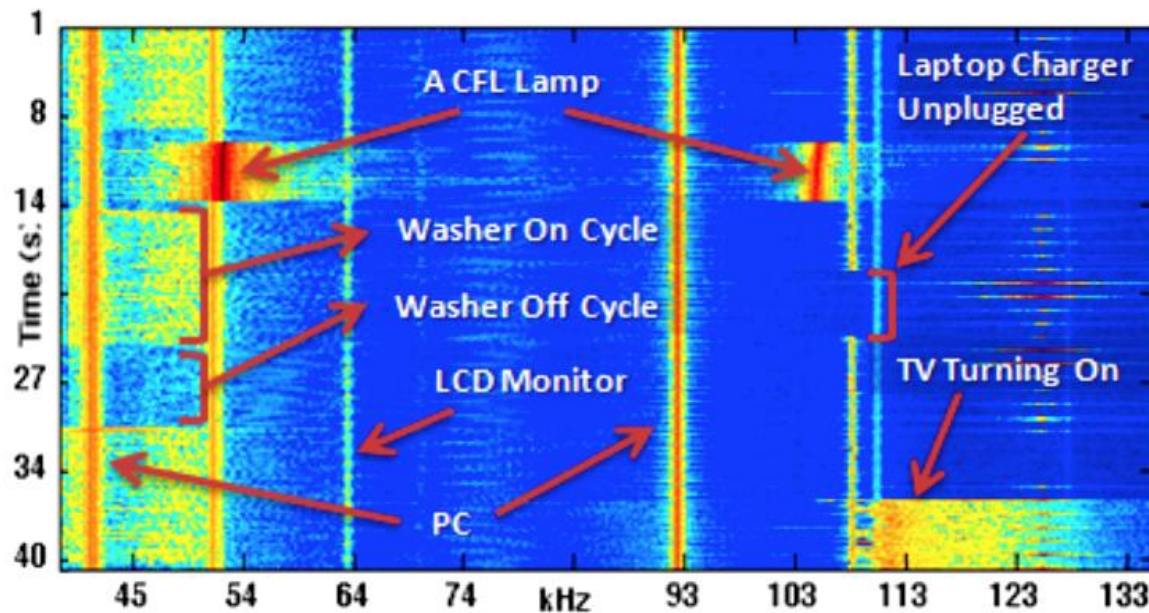


Image taken from NILM work done at IIITD

Power trace from Laptop

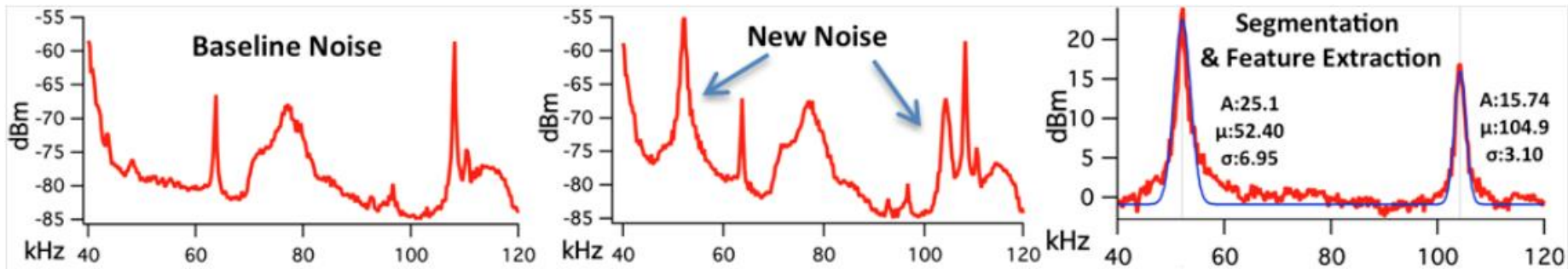


ElectriSense



ElectriSense:
Single-Point Sensing Using EMI for Electrical Event Detection and Classification in the Home

ElectriSense

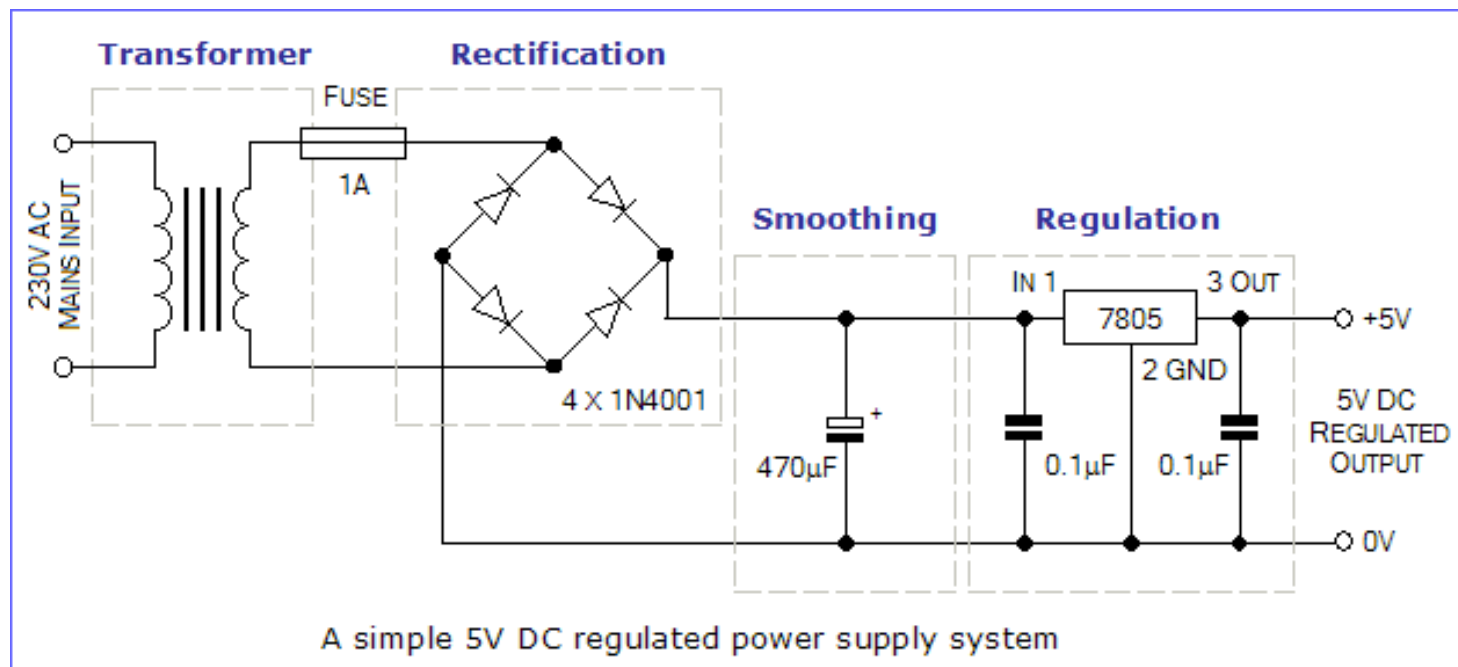


Probabilistic modeling for EMI trace using Gaussian curve fitting

ElectriSense:

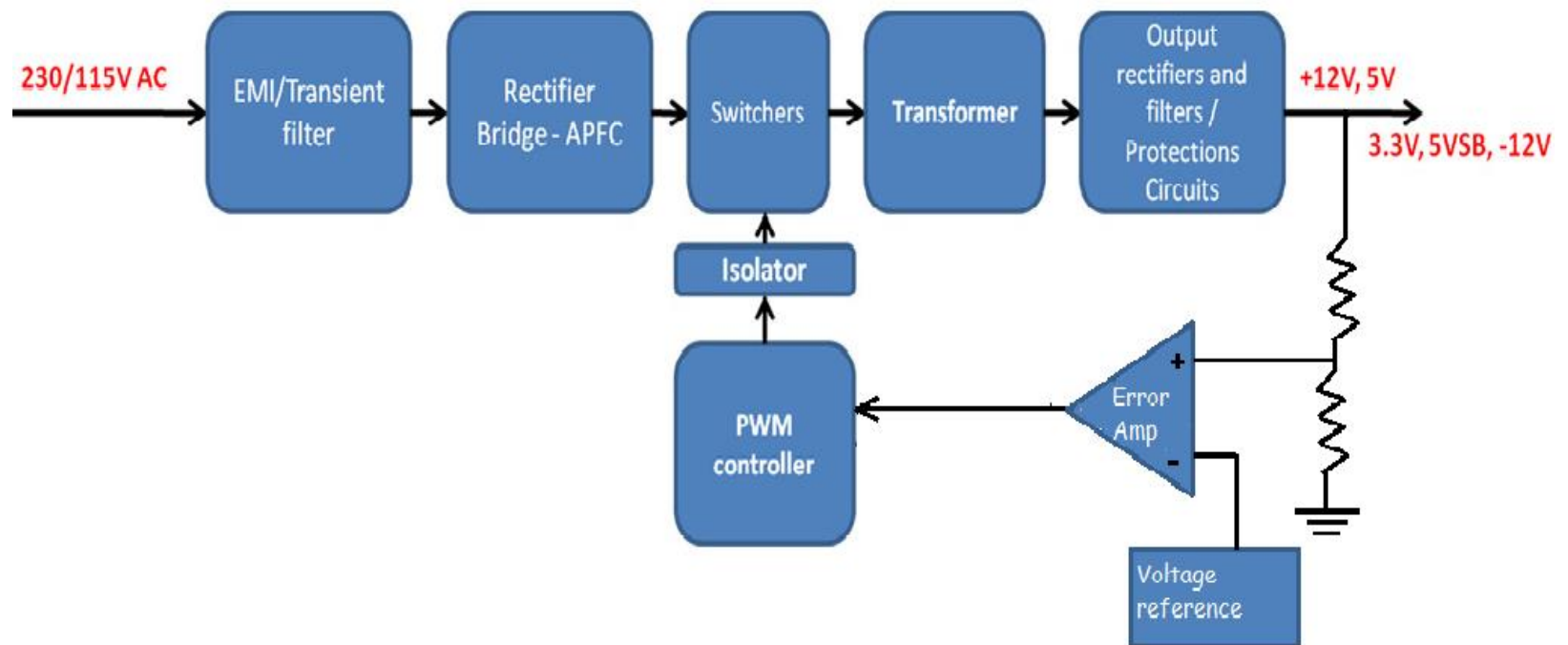
Single-Point Sensing Using EMI for Electrical Event Detection and Classification in the Home

Linearly Regulated Power Supply



SMPS

Switched Mode Power Supply



Idea: EM Characterization in SMPS

Need: Modelling approaches by NILM folks fails on complex loads.

Why EMI ?

EMI signals are stable and predictable

Origin: Switching action of SMPS

Effect on Design: EMI filters and suppression req.

EM noise

- Conducted EMI
- Radiated EMI

EM noise propagation

- Resistive (or Galvanic) coupling
 - Noise signal propagates through electrical connections
 - 'Common impedance' can be classified as galvanic coupling
 - Occurs due to sharing of current paths [1] [2]
- Capacitive coupling
 - Electric fields form the main coupling path
- Inductive coupling
 - High frequency switching currents in Inductors
 - Cause strong magnetic fields at high frequencies
 - Occurs quite often in SMPS
- Wave coupling
 - Noise is transmitted via Electromagnetic wave
 - Come in to picture at high frequencies usually in Ghz

[1] http://www.learnemc.com/tutorials/Common_Impedance_Coupling/conducted_coupling.html

[2] http://www.learnemc.com/tutorials/Current_Paths/Current_Paths.html

DC-DC Converter

- Buck Converter (Step down)
- Boost Converter (Step up)
- Buck Boost Converter (Step up/down)

Simple Buck Regulator (Open-loop)

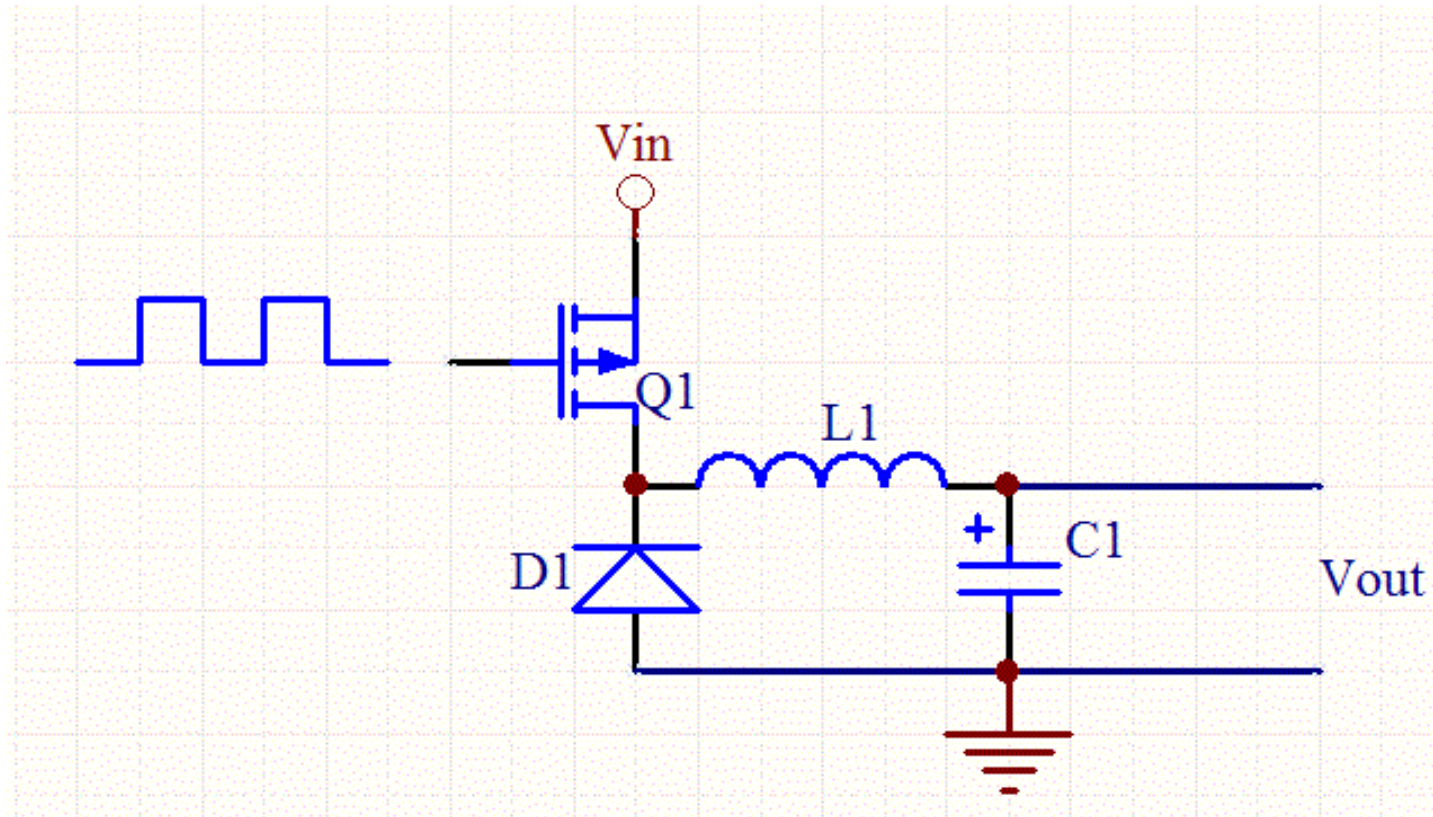


Image Courtesy:

<http://www.daycounter.com/LabBook/BuckConverter/Buck-Converter-Equations.phtml>

Buck Regulator (Closed-loop)

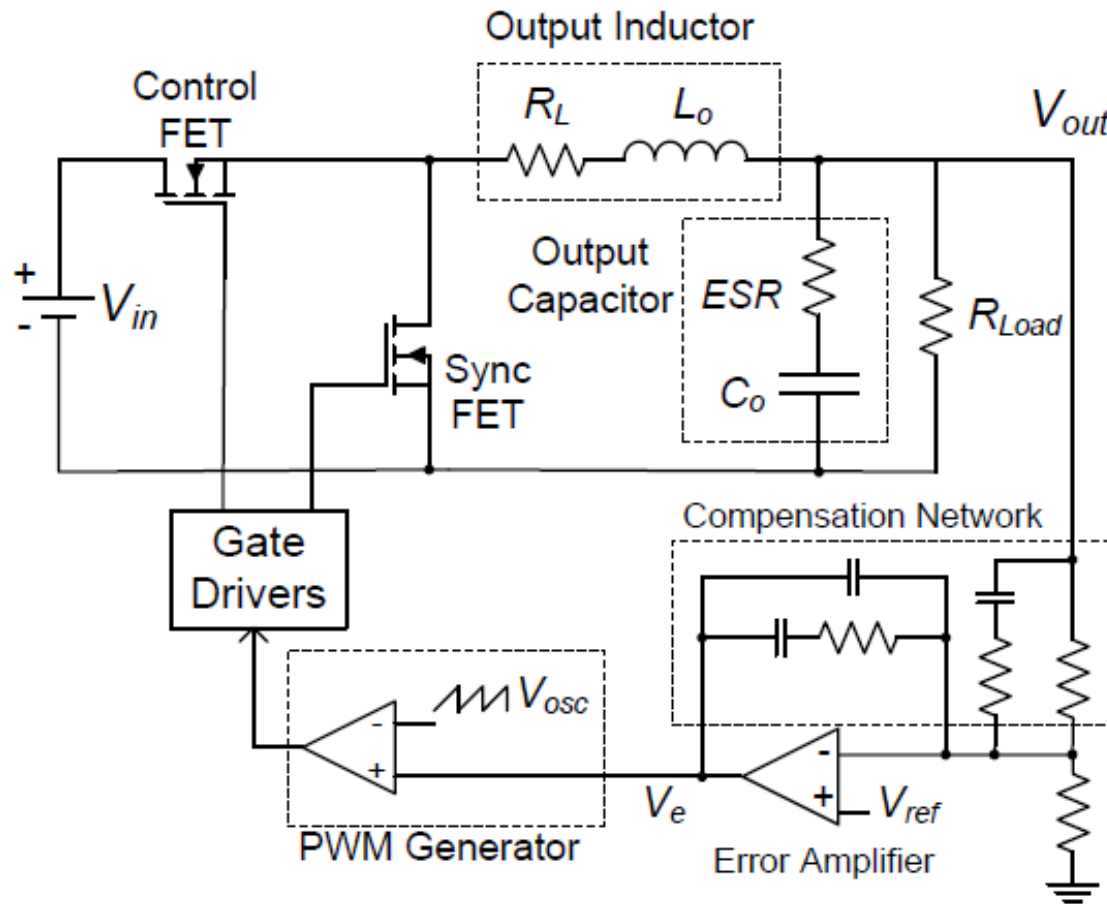
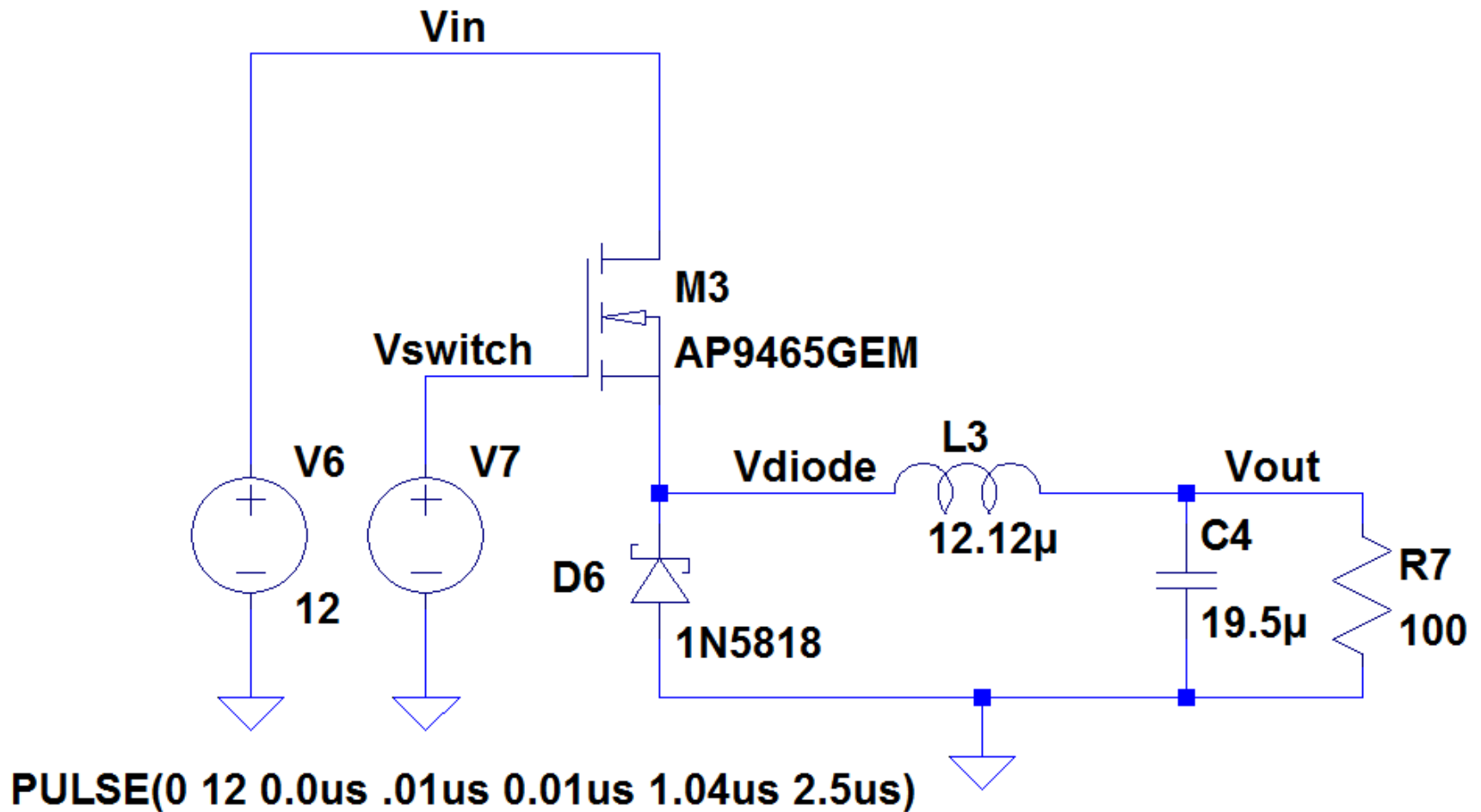


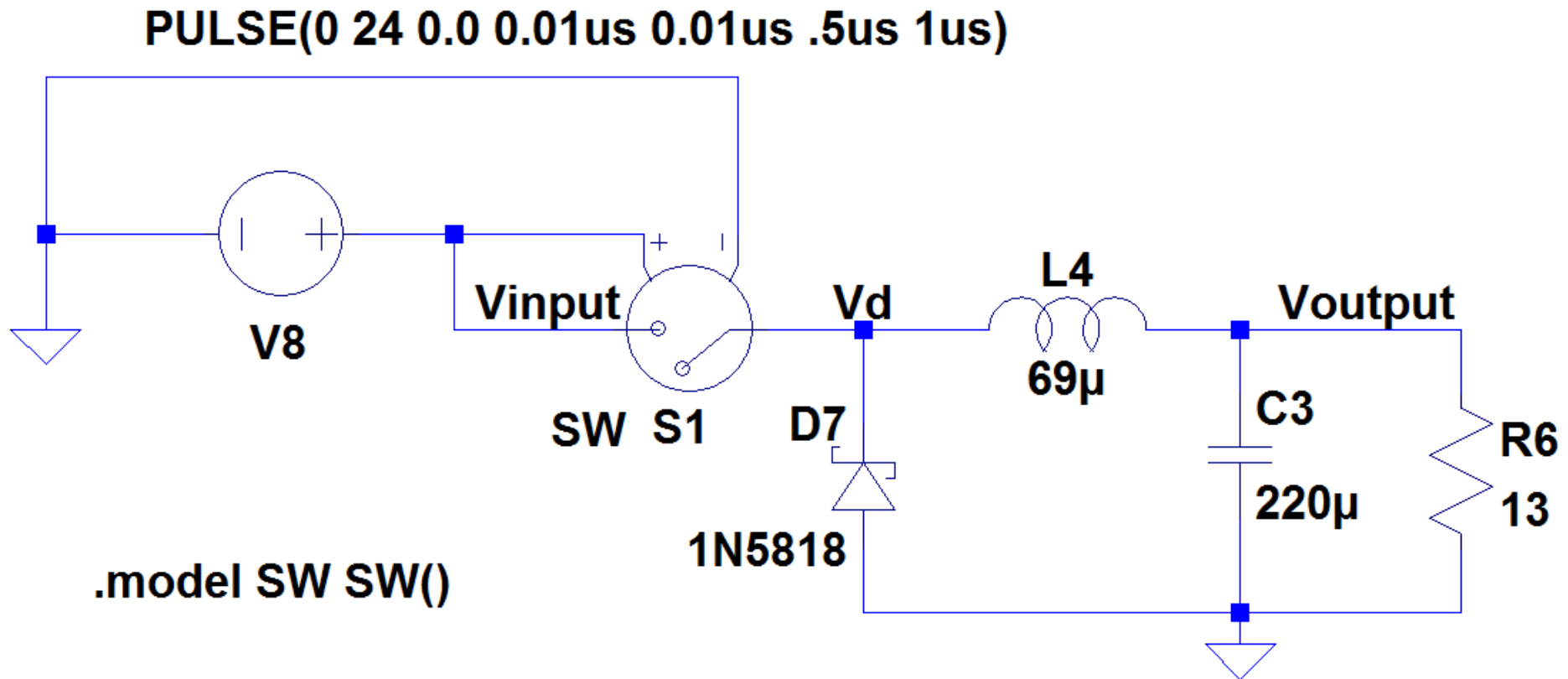
Image Courtesy:

AN: 1162 Compensator Design Procedure for Buck Converter with Voltage-Mode Error-Amplifier

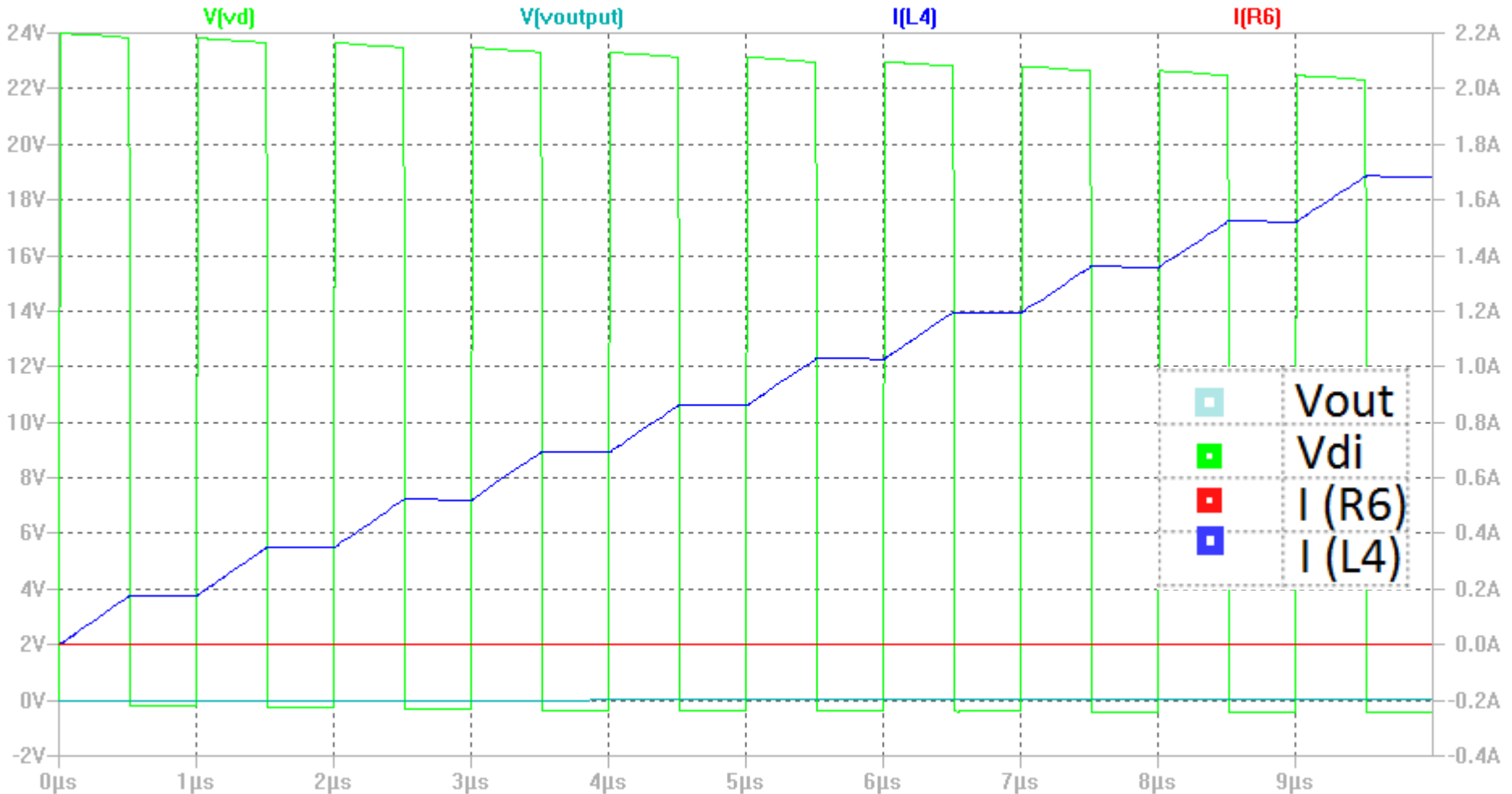
Buck Regulator



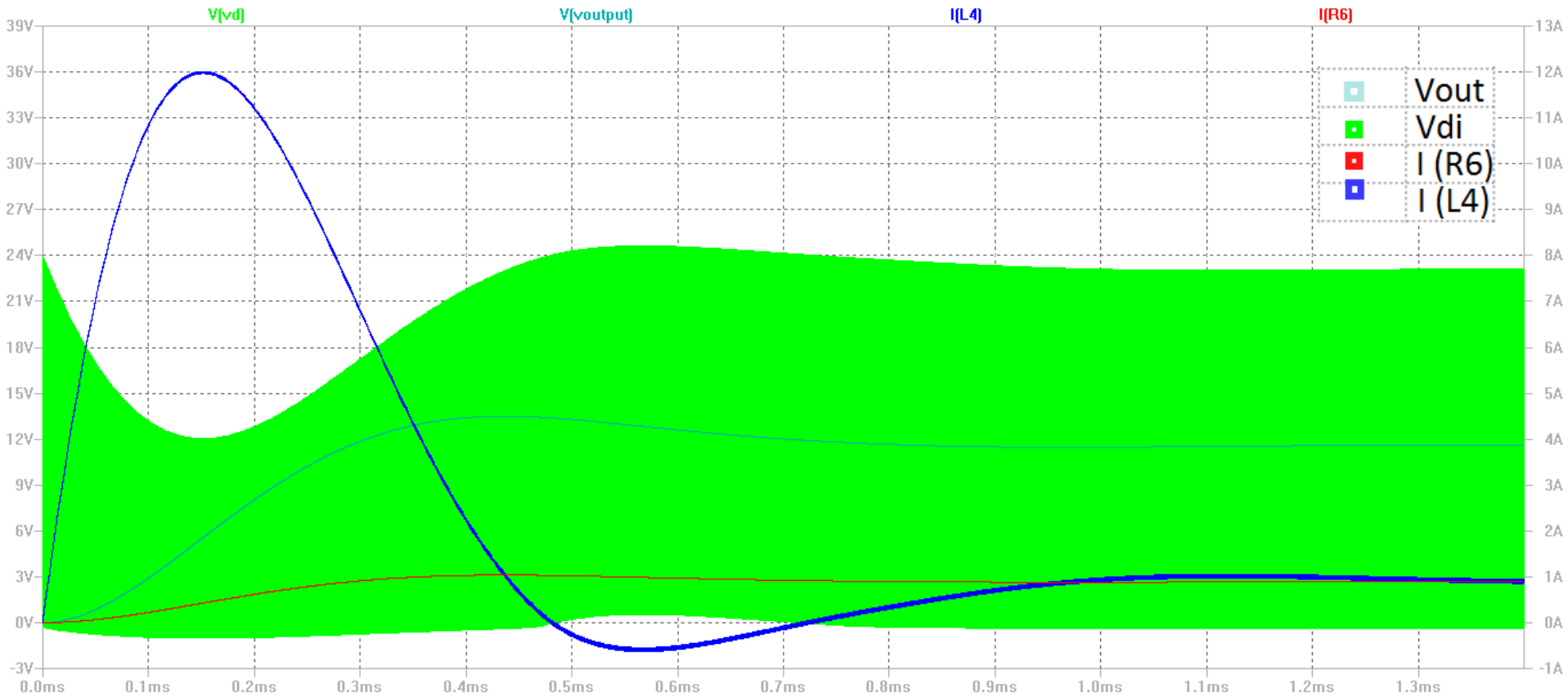
Simplified Buck Convertor



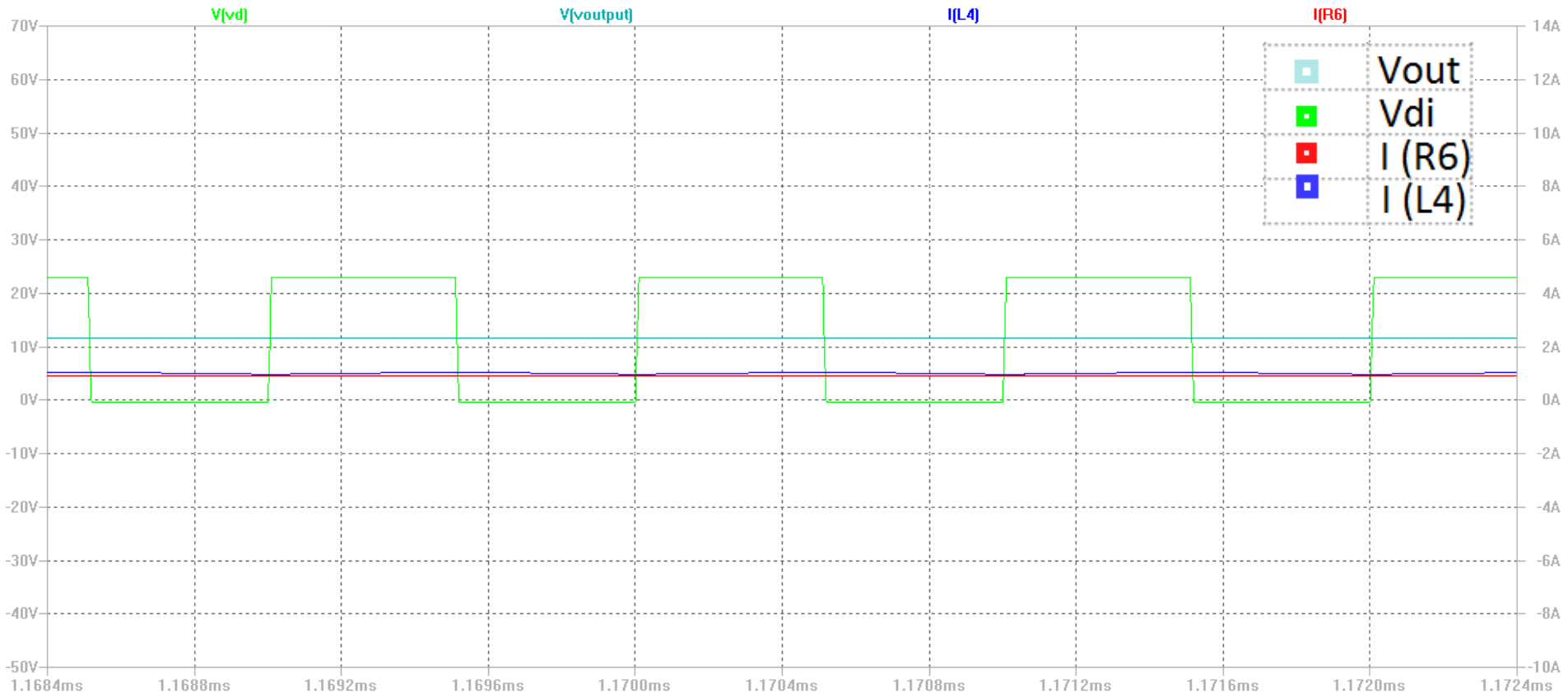
Transient Analysis



Steady State Analysis

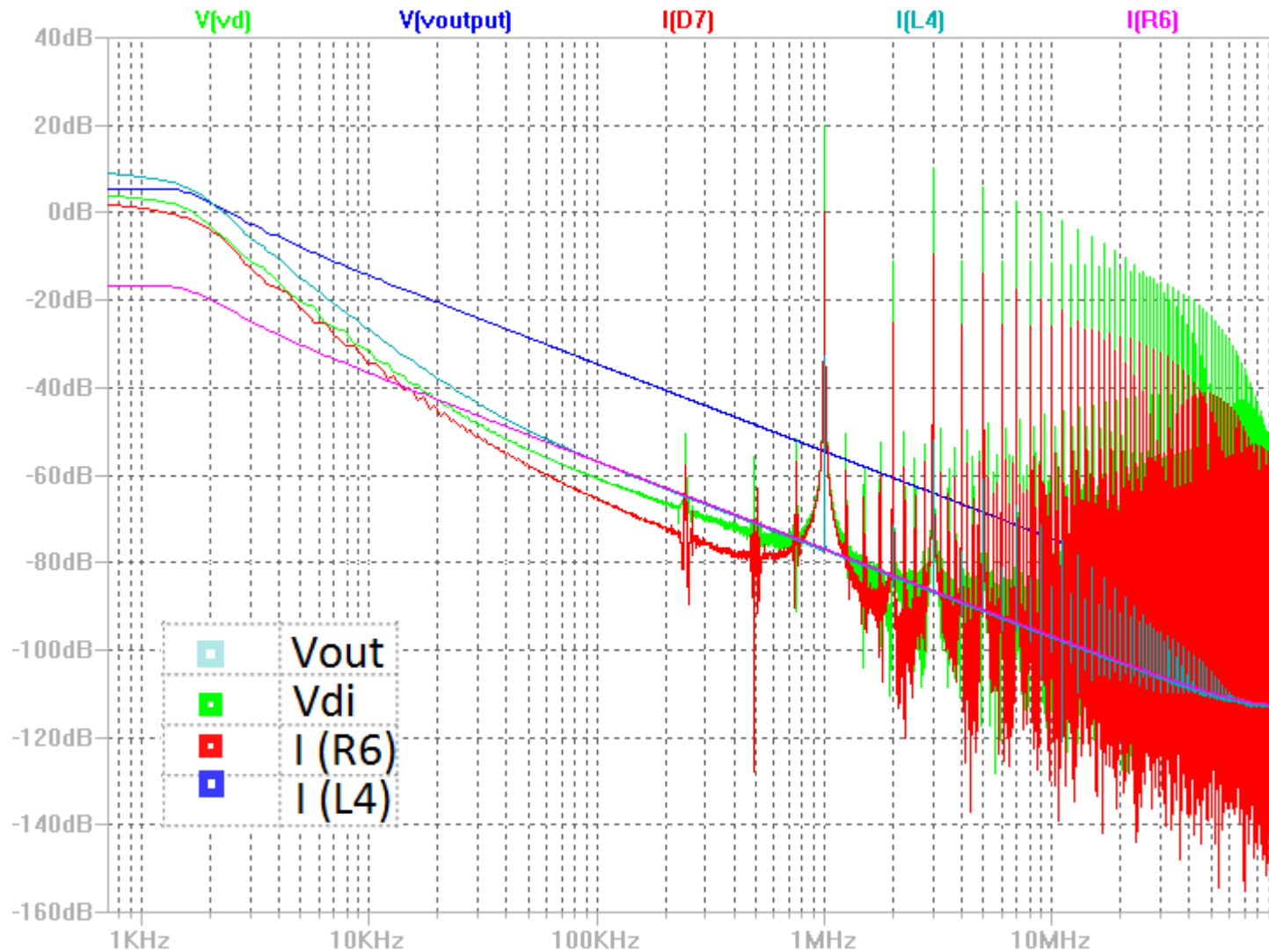


Steady State Analysis

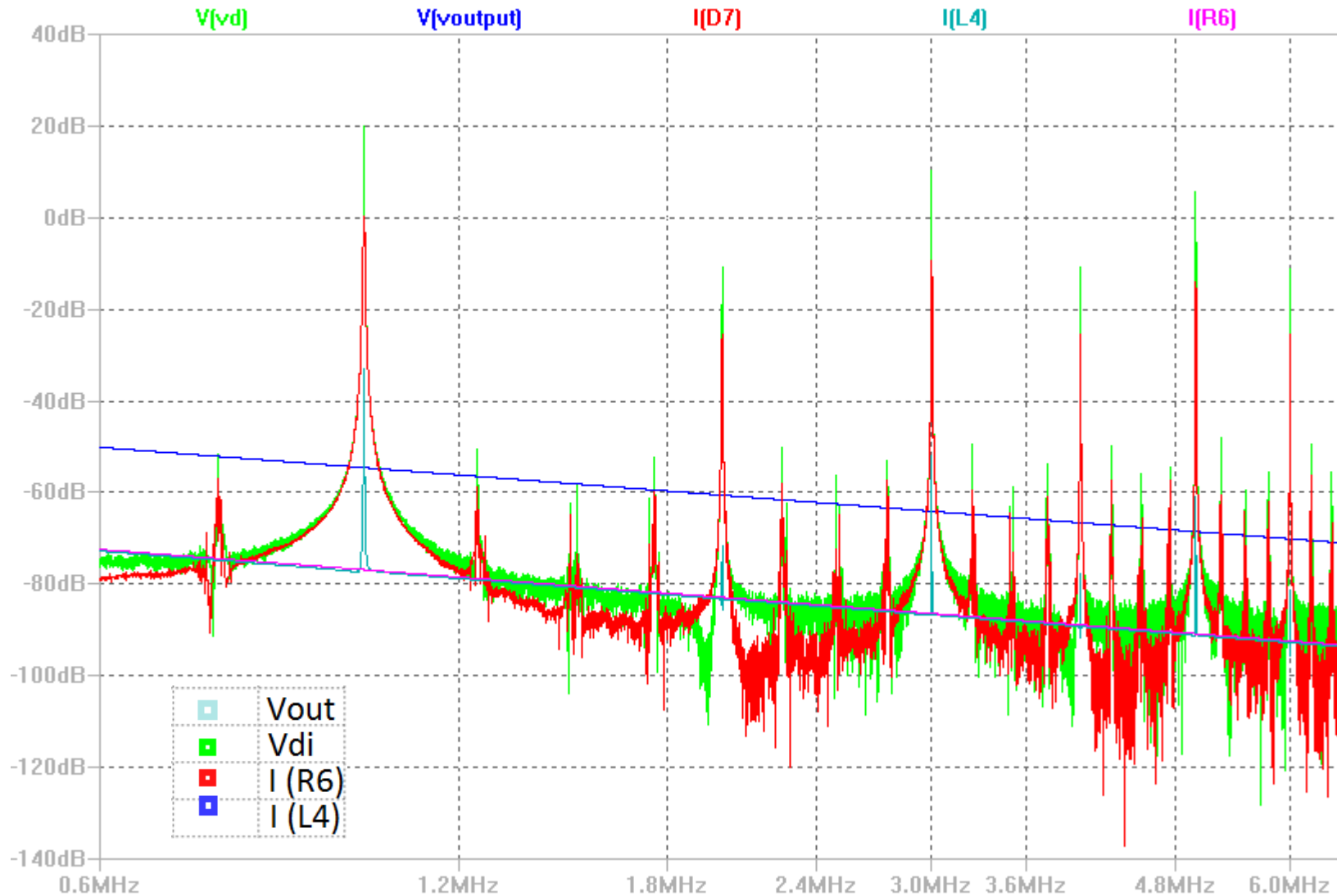


After Zooming

Frequency Domain Analysis



Frequency Domain Analysis



Acknowledgements

Dr. Hashmi PhD EC University of Cardiff

Dr. Shobha Sundar Ram PhD EC UT Austin

Mr. Makarand Mijar Senior Design Engineer
Qualcomm, India

I will be working on this project in December, 13
if anyone interested to work along with me
please drop a mail at manojg@iiitd.ac.in

Thanks for your concentration.

Slides available on request.