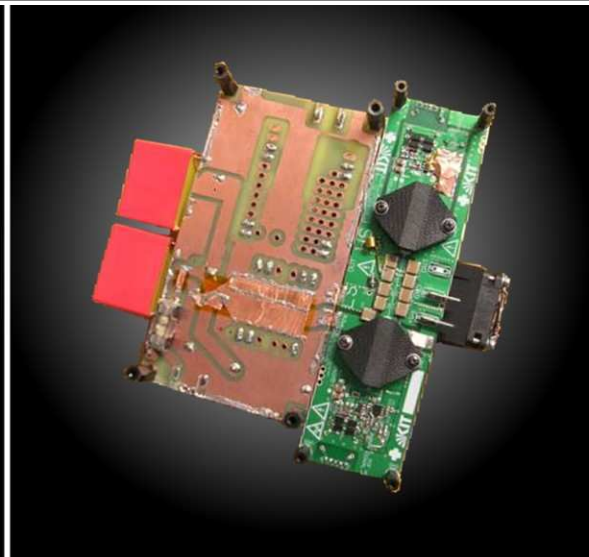


Impedance Characterization of High Frequency Power Electronic Circuits

Michael Meisser, Karsten Haehre, Rainer Kling

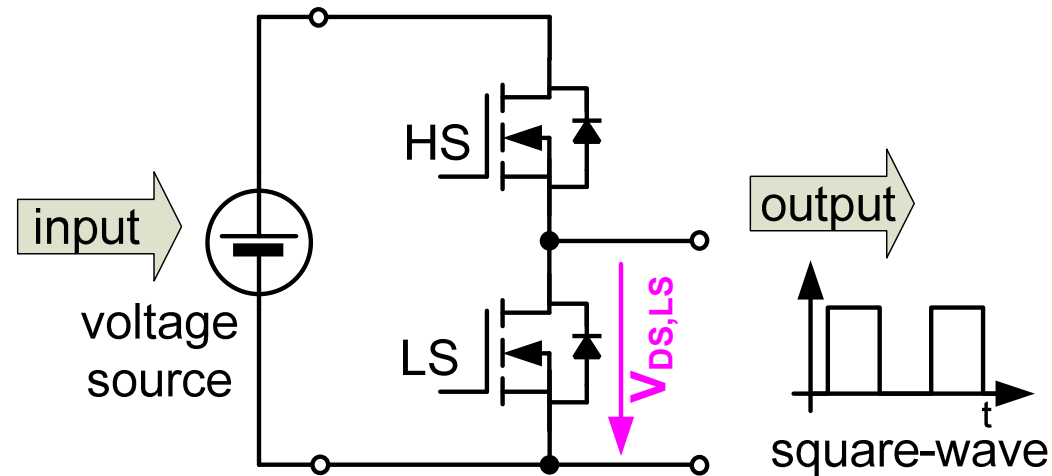
Light Technology Institute (LTI), Department of Electrical Engineering and Information Technology



LTI

Introduction: Half-Bridge at Challenges

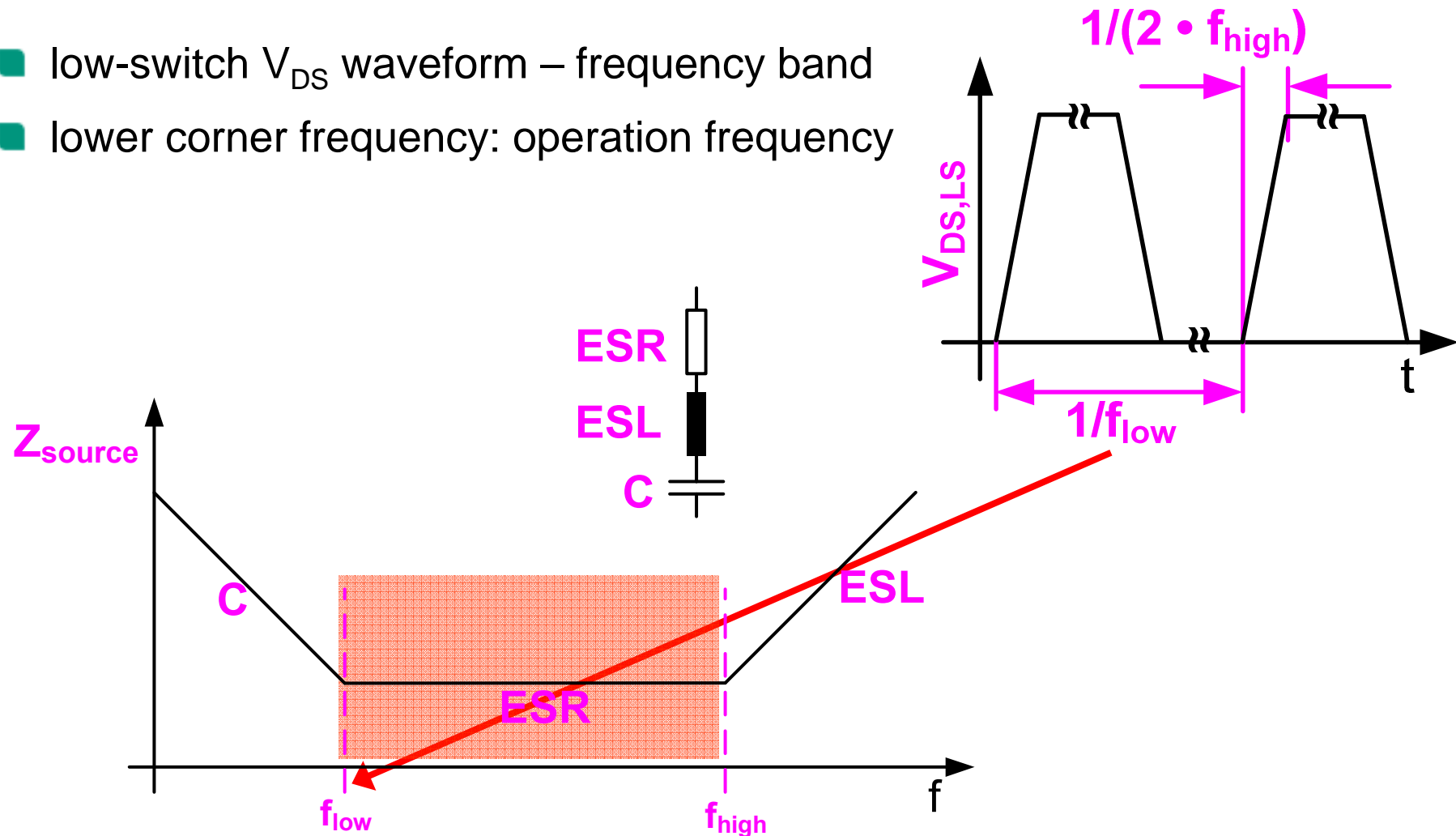
- input: ideal voltage source:
no resistance, no AC impedance
- output: storage elements, resonant tanks



- task: higher operating frequency **1 – 100 MHz**
- capacitively coupled plasma sources (discharge lamps)
- inductively coupled plasma sources (discharge lamps)

Challenge 1: Providing Broadband Voltage Source Input

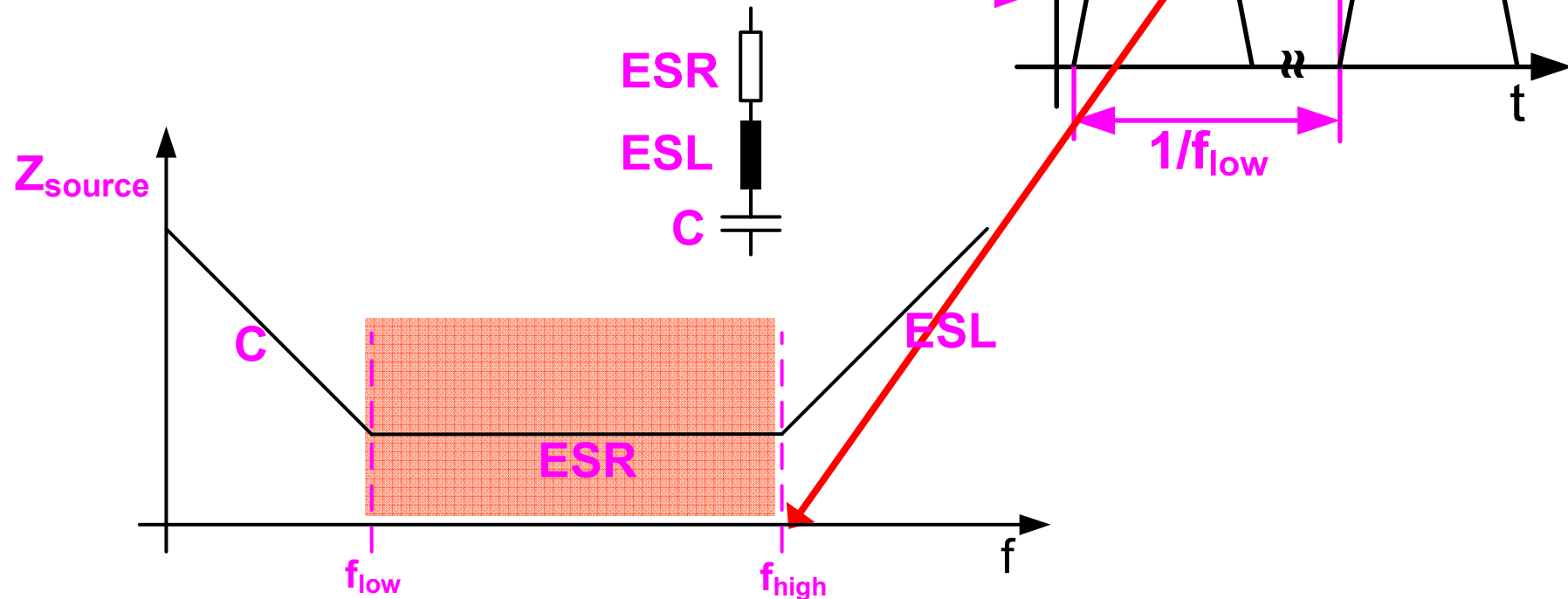
- low-switch V_{DS} waveform – frequency band
- lower corner frequency: operation frequency



- DC_{link} capacitor must provide low impedance between $f_{low} - f_{high}$

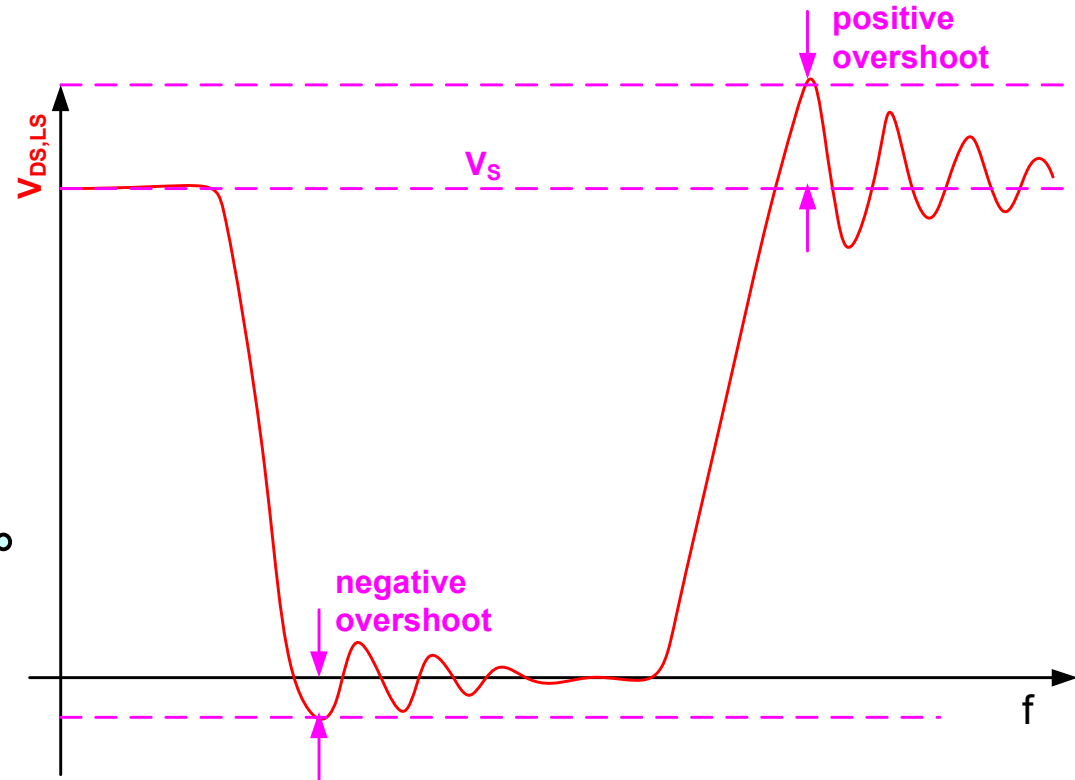
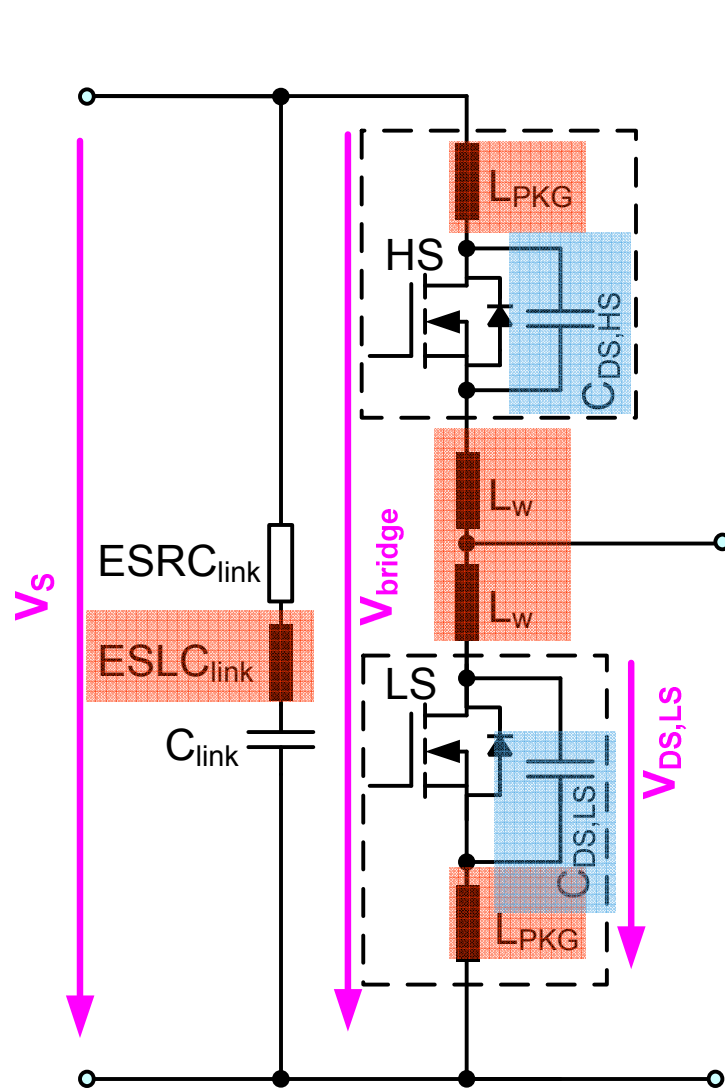
Challenge 1: Providing Broadband Voltage Source Input

- low-switch V_{DS} waveform – frequency band
- lower corner frequency: operation frequency
- higher corner frequency: maximum slope



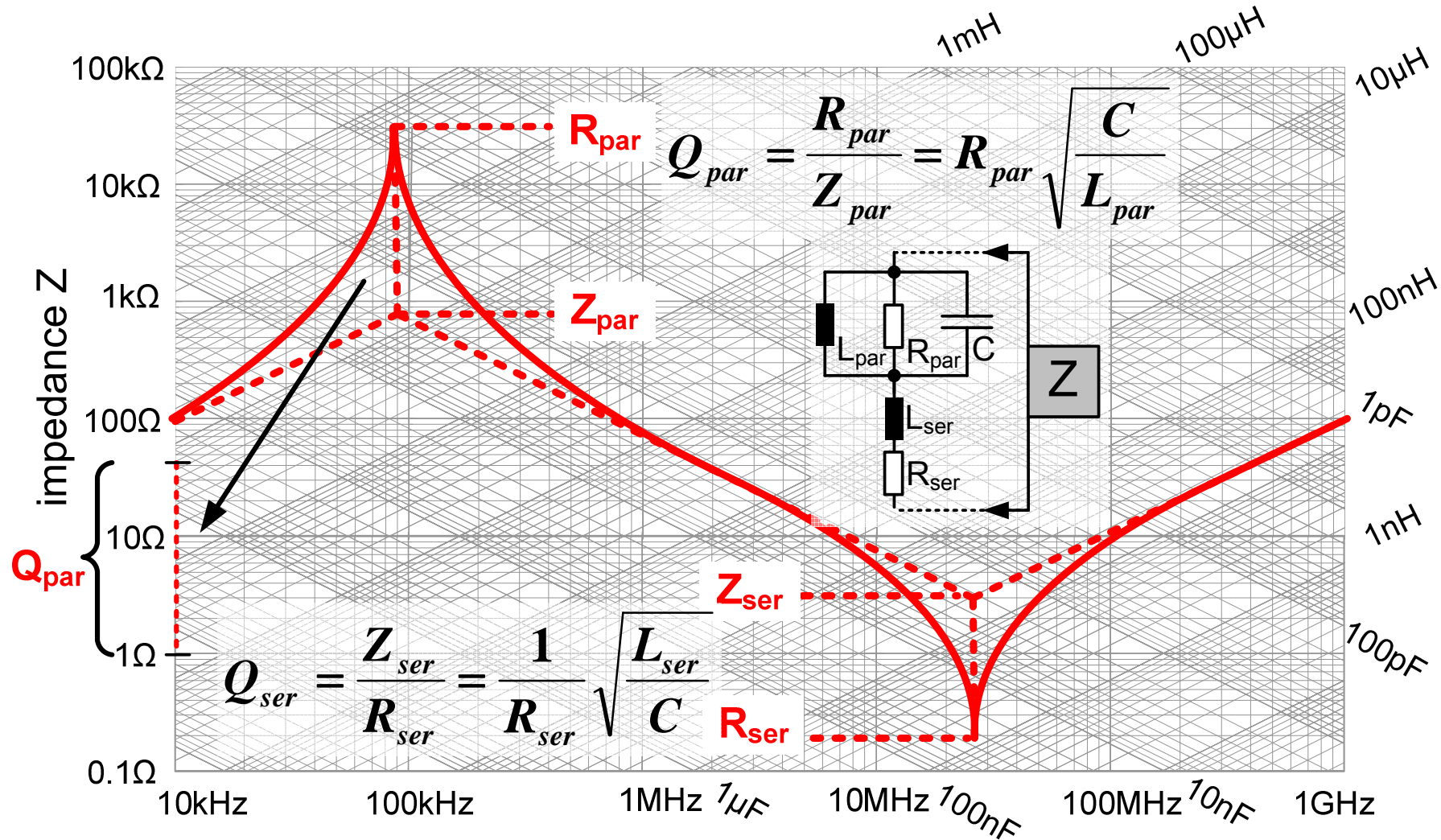
- DC_{link} capacitor must provide low impedance between $f_{low} - f_{high}$

Challenge 2: Providing low Series Inductance

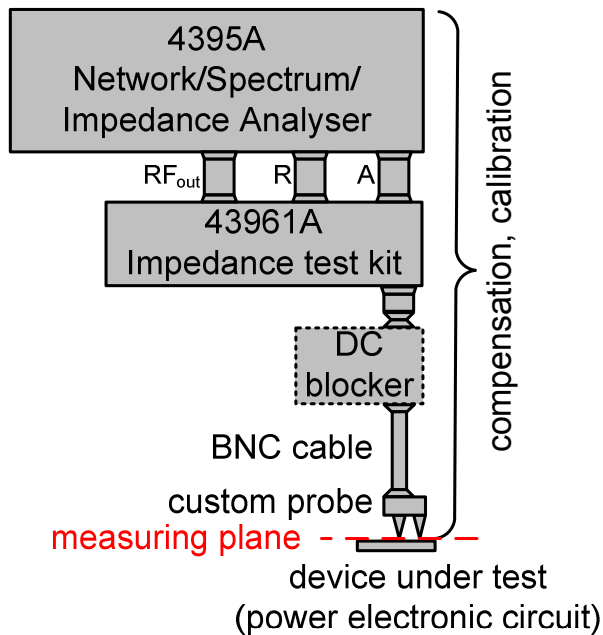
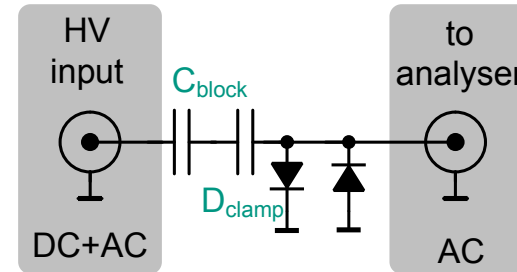


- prevent voltage overshoot
- lower electromagnetic radiation

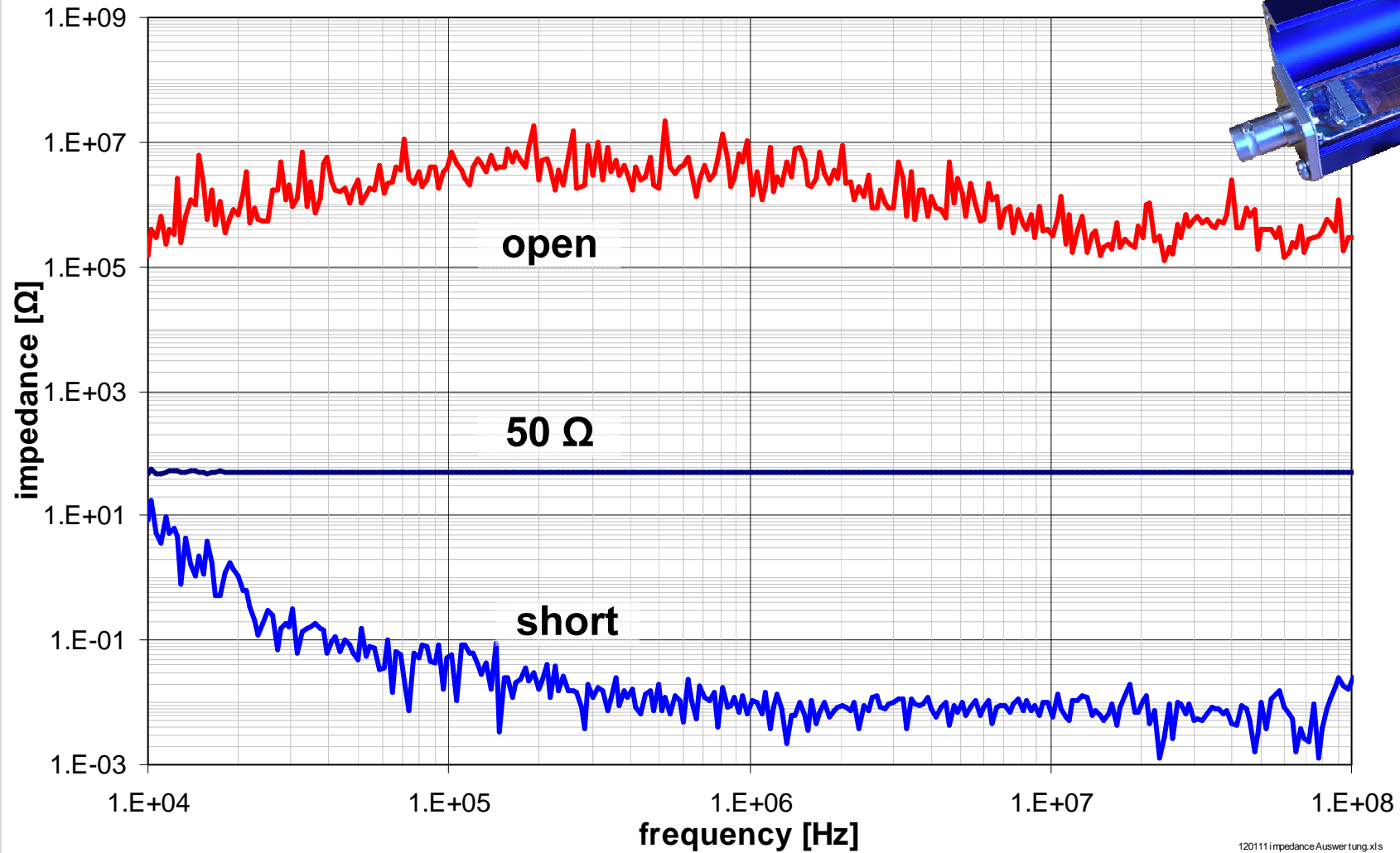
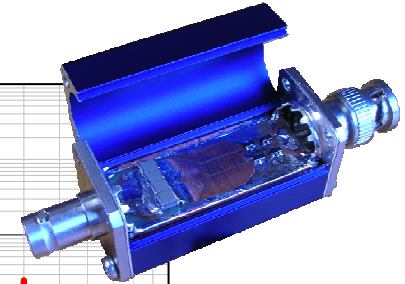
Impedance Measurement – Information to be Extracted



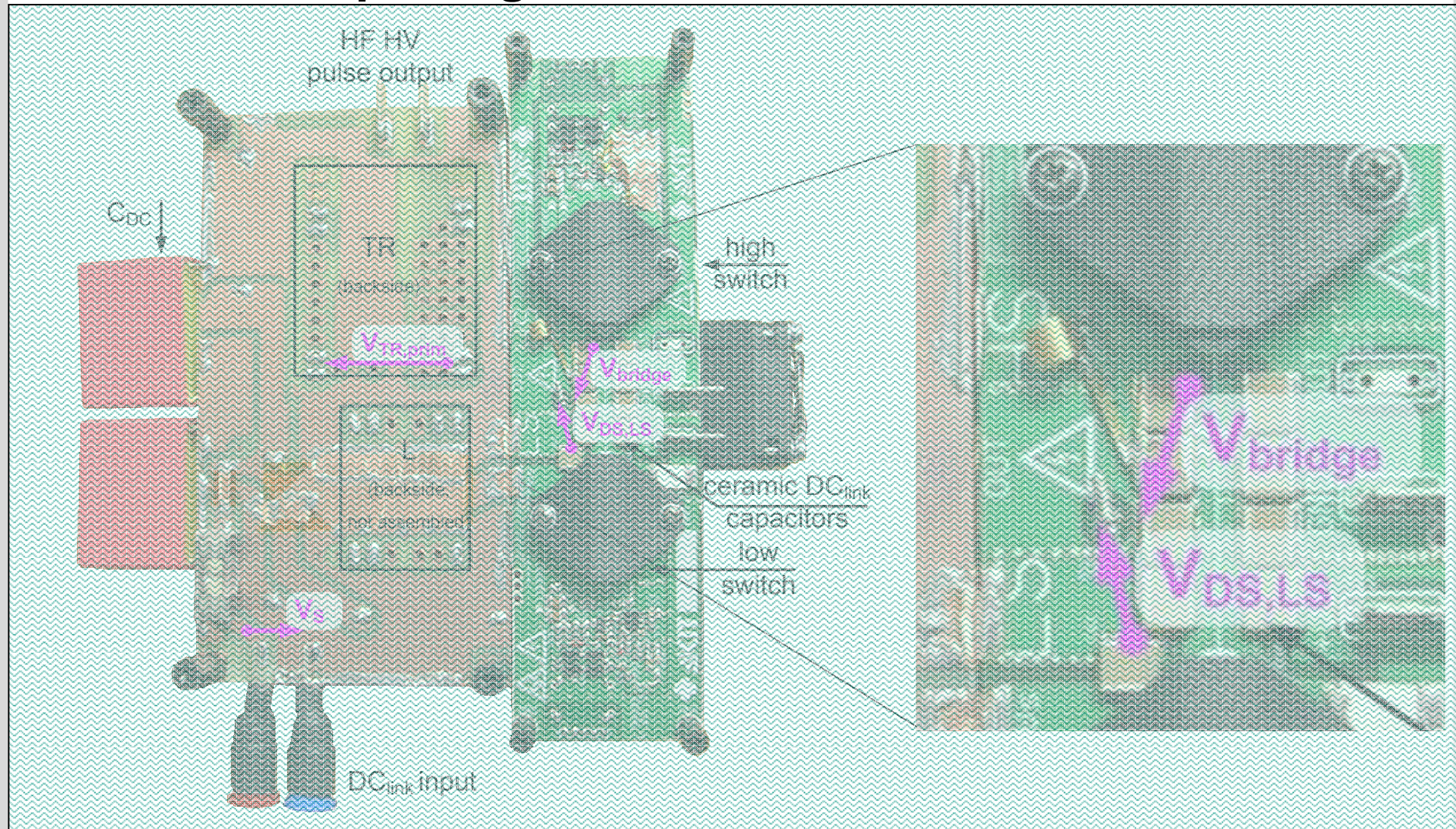
Impedance Measurement Setup with DC-bias



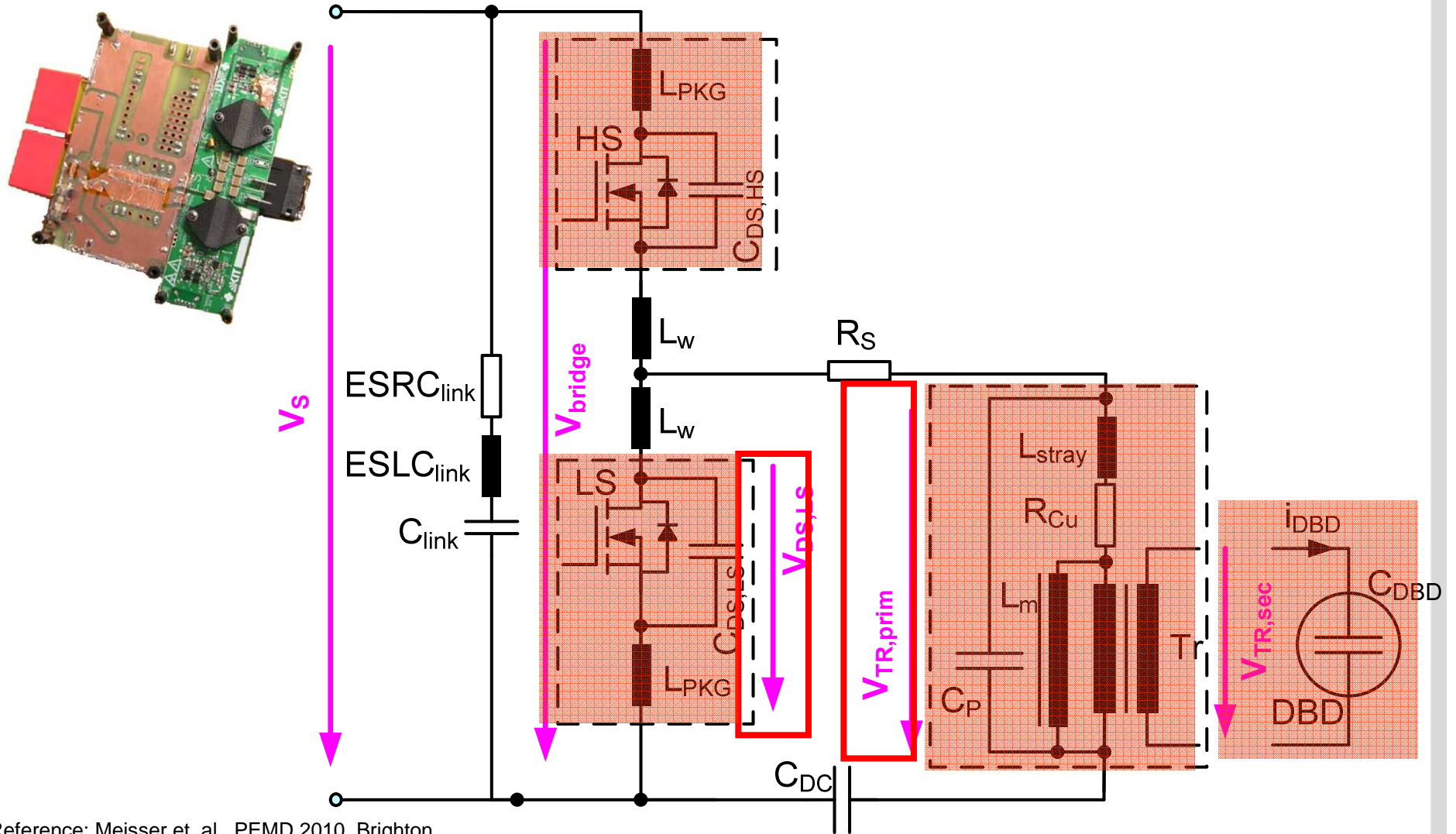
Impedance Measurement – DC-blocker validation



RF resonant pulse generator

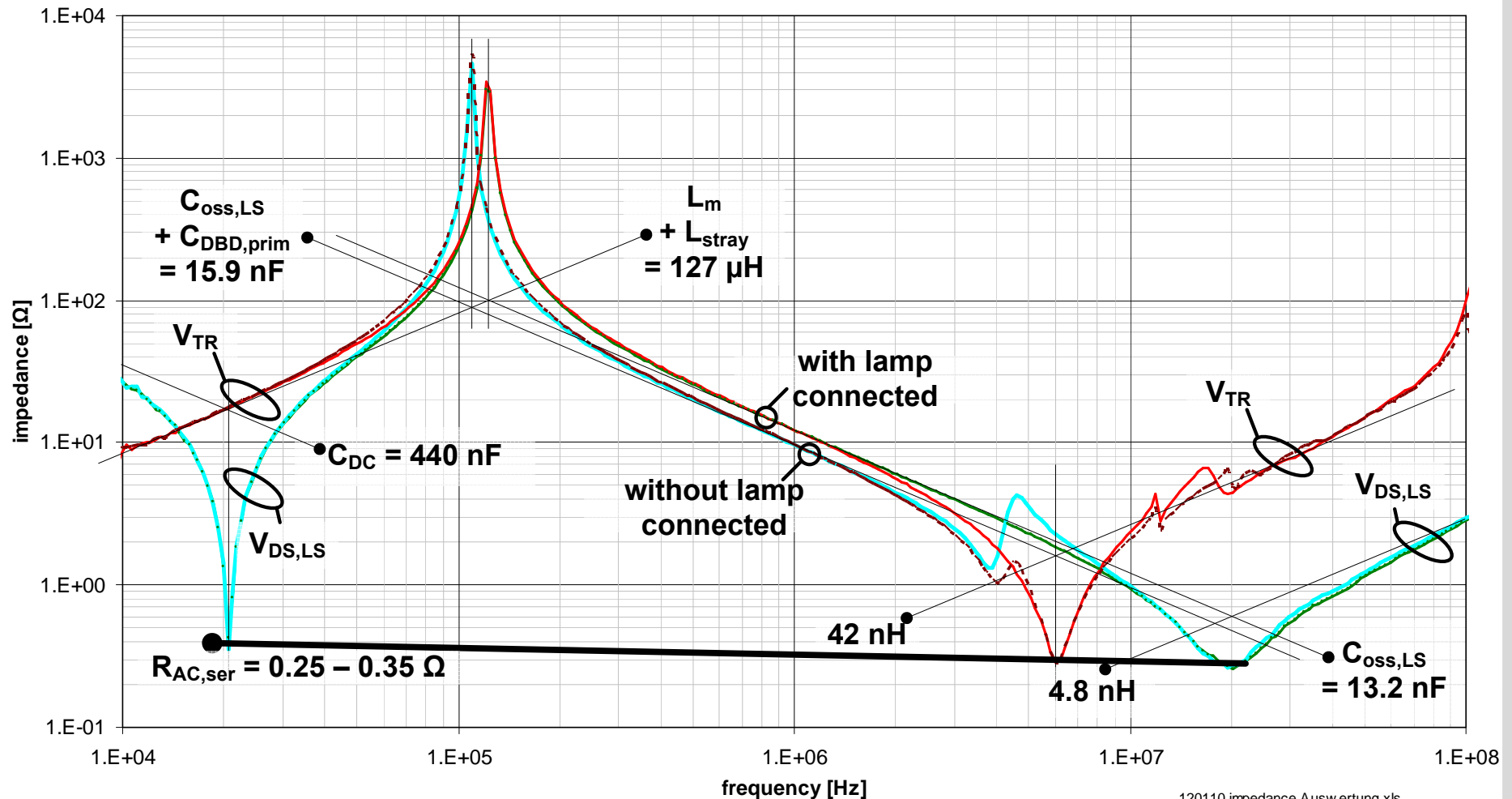


RF resonant pulse generator



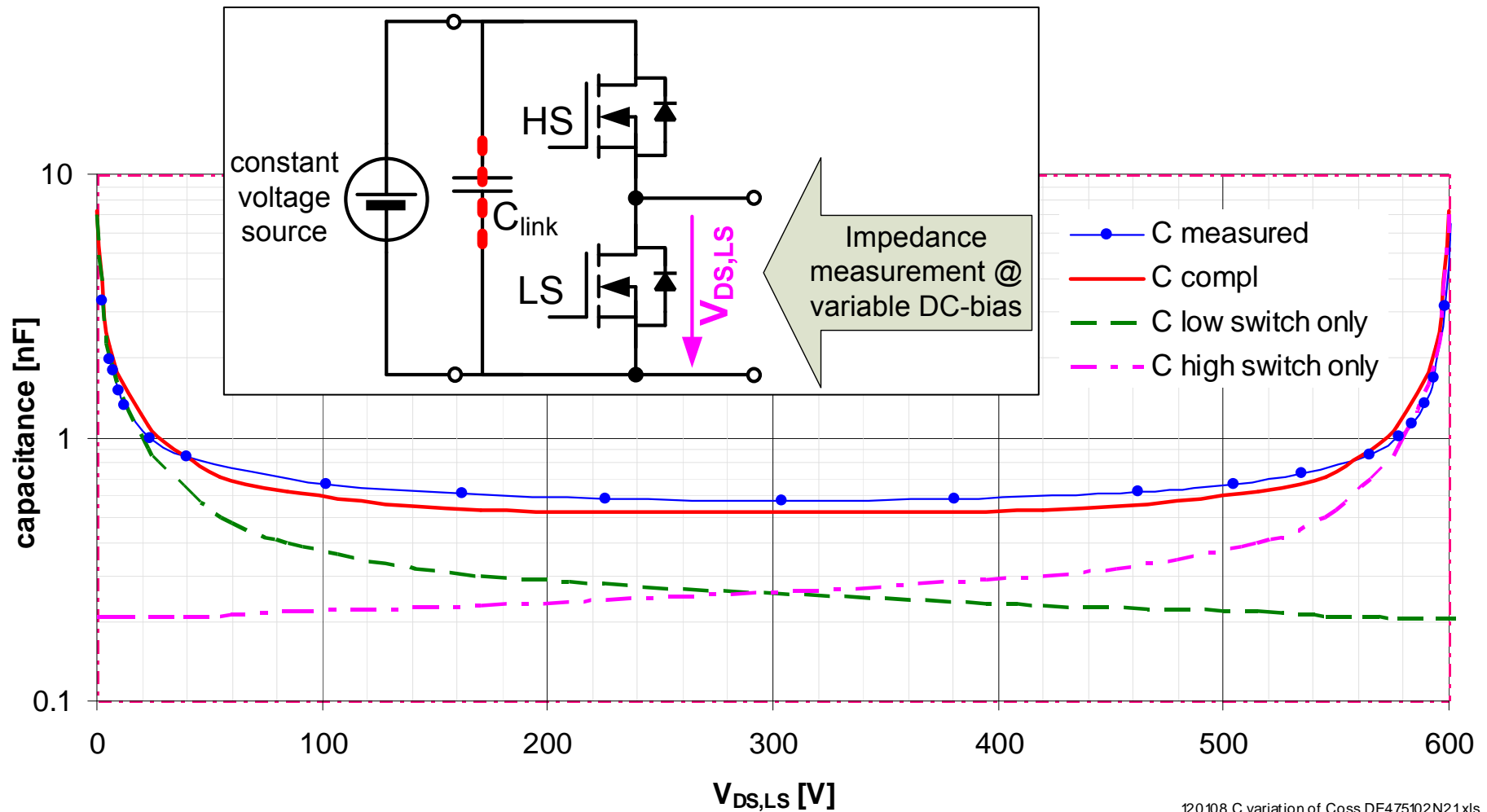
Reference: Meisser et. al., PEMD 2010, Brighton

Resonant Behaviour Without DC-bias



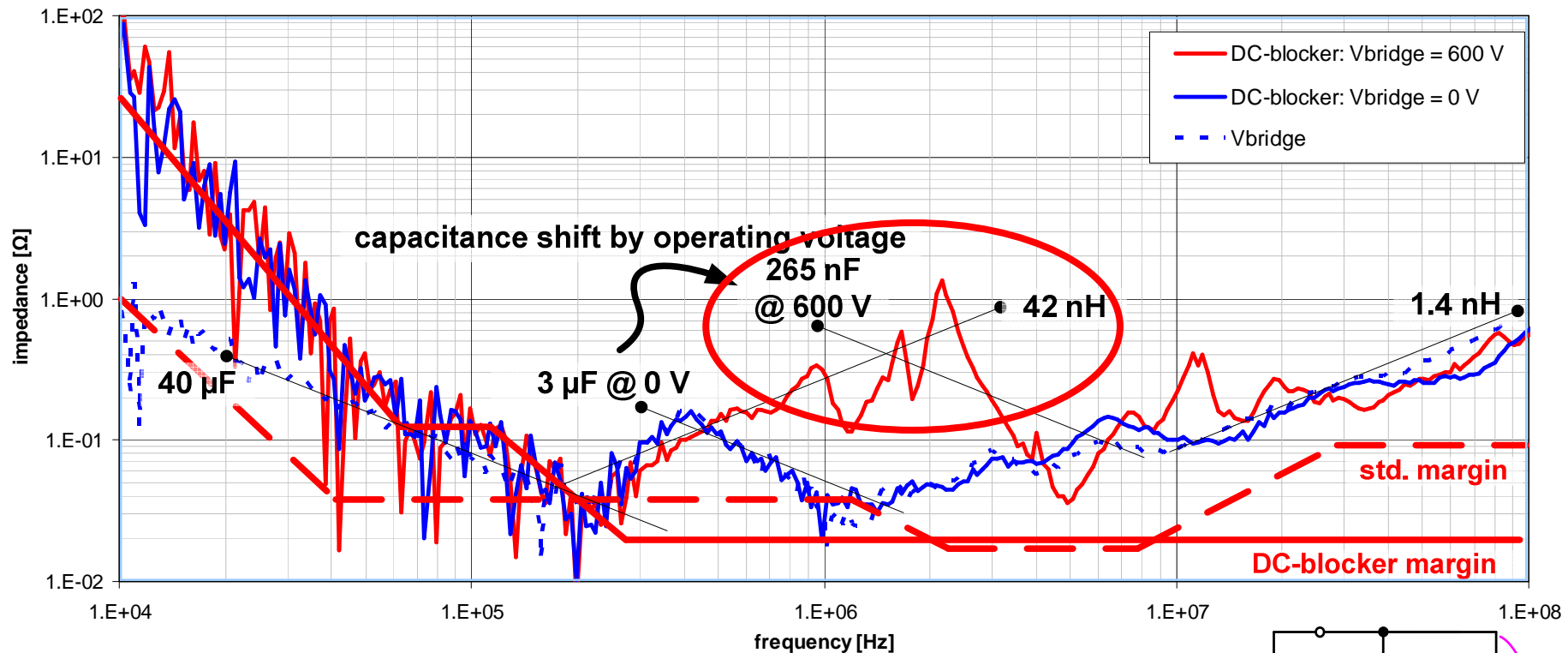
■ resonances of freewheeling circuit, both switches off

Variance in Switch Output Capacitance

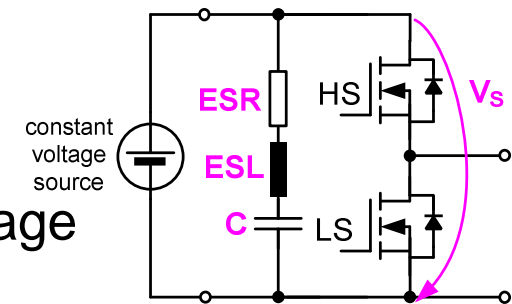


120108 C variation of Coss DE475102N21.xls

RF-half-bridge Decoupling Performance



- impedance rises to 1 Ω at 2 MHz and 600 VDC
- HF DC-rail decoupling performance fails at high voltage (X7R ceramic drift)

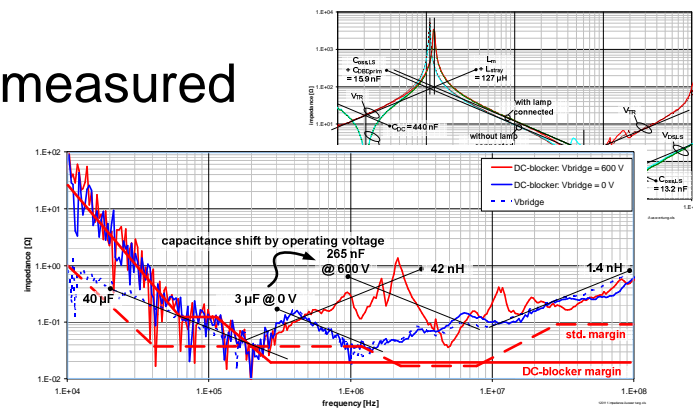
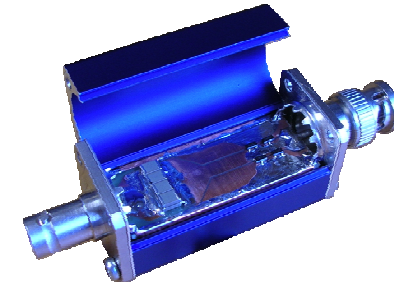
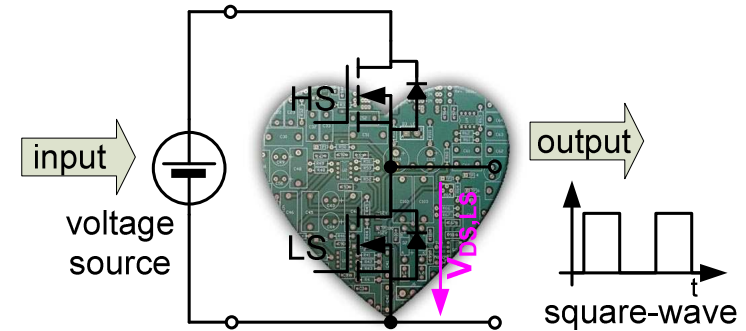


Summary

- RF half-bridges:
- ensure low leg inductance
- ensure low source impedance

- Impedance measurement with DC bias:
- DC-blocker built and characterized
- investigates RF circuit performance

- Resonance behaviour of RF half-bridge measured
- Bottleneck detected:
impedance peak due to X7R ceramics



Question and Answer Part

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... please visit <http://www.lti.kit.edu>

