OMICRON Lab Webinar

Using WDS to Design:

1 - Analog Isolated Flyback

2 - Digital Buck

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Nov 2014

Forthcoming Workshops, Dates & Location

- Analog PSU Design Workshop
  - Dec 3rd to 5th and March 17th to 19th
  - Garching Germany
- Digital Power Workshop (Microchip dsPIC family)
  - Feb 10th to 12th 2015
  - Karlsruhe, Germany
- Digital PFC Workshop (TI C2000)
  - Feb 24th to 26th
  - Garching, Germany
- Digital Power Workshop (TI C2000)
  - April 21st to 23rd 2015
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Abridged DPS Workshop Syllabus

- **Day 1: Starting with Embedded MCU Programming for Analog Engineers**
  - MCHP MCU 16 or TI C2000 family's development tools & features
  - Use Biricha Digital's libraries to run MCU code with minimal programming
  - Programming the MCU for digital power (Interrupts, Templates, PWMs etc)
  - Programming exercises and Labs (PWMs/ADCs/Interrupts etc)
- **Day 2: Voltage Mode PSU Design**
  - Step by step design of digital power supplies
  - Stable Analogue and digital power supply Design
  - Discrete time control theory, Z transforms & digital convolution
  - Avoiding stability issues in your digital power designs
  - Voltage mode PSU labs
- **Day 3: Digital Peak Current Mode**
  - Analogue current mode control
  - Digital peak current mode and slope compensation
  - Current mode PSU labs

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- **Day 2: Analog PFC Design**
  - Basic principles and foundations
  - Understanding EU regulations (EN-61000-3-2)
  - Stable analog voltage loop, current loop and voltage feed forward filter design
  - Using the PLD design software to design analog PFCs down to component level
  - Analog Labs
- **Day 3: Digital PFC**
  - Step-by-step block level digital PFC (single phase and interleaved)
  - Easy digital PFC implementation using Biricha's digital power libraries
  - Stable digital control loop design
  - Digital PFC labs (single phase and interleaved)

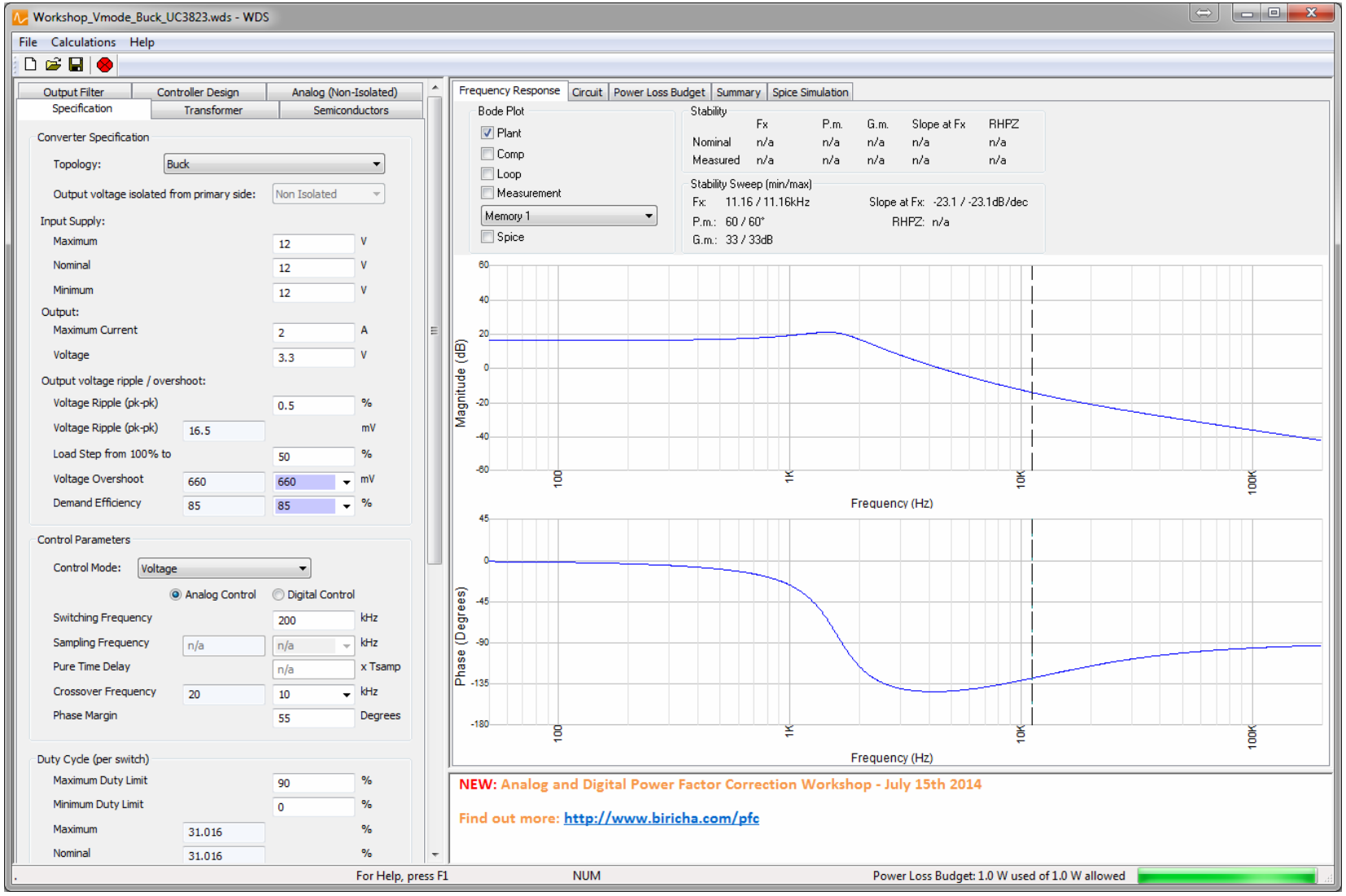
Abridged Analog PSU Design Workshop Syllabus

- Day 1: Introduction PSU Design, Control Theory, Test and Measurement
  - Fundamentals of power supply design
  - Frequency response analysis
  - Hands-on labs including:
    - Stable and robust voltage mode PSU design on a Forward type topology
    - Learning how to perform accurate loop measurement and stability analysis using a vector network analyser (each group will have their own network analyzer to use)
- Day 2: Peak Current Mode Control
  - Peak current design with state of the art modern ICs and controllers
  - Dealing with sub harmonic oscillations and slope compensation calculations
  - Hands-on labs including:
    - Designing a stable current mode power supply on Forward/Flyback topologies
    - Current mode controller transient response and loop measurement tests
- Day 3: Isolated Power Supply Design
  - Stable isolated PSU design and analysis
  - Designing with opto-couplers and programmable references (e.g. TL431)
  - Hands-on labs including:
    - Designing a stable opto-isolated power supply on Forward/Flyback topologies
    - Hands-on frequency response measurement of optoisolated compensators

Introduction to WDS

- WDS has been designed as the ultimate toolbox for the power supply design engineer.
  - Designs and stabilises analog and digital PSU control loops in minutes
  - Automatically calculates poles and zeros as well as component values of the worlds most popular topologies
  - Sophisticated control algorithms stabilise analog and digital power supplies
  - Automatic coefficient calculations for floating point, 32 bit and 16 bit processors
  - Automatic compensator design for isolated power supplies with TLx431/LMx431 and a host of industry standard optocouplers
  - Simulations in time domain, frequency domain and ability to superimpose real measurements on simulated data

Design Example Using WDS



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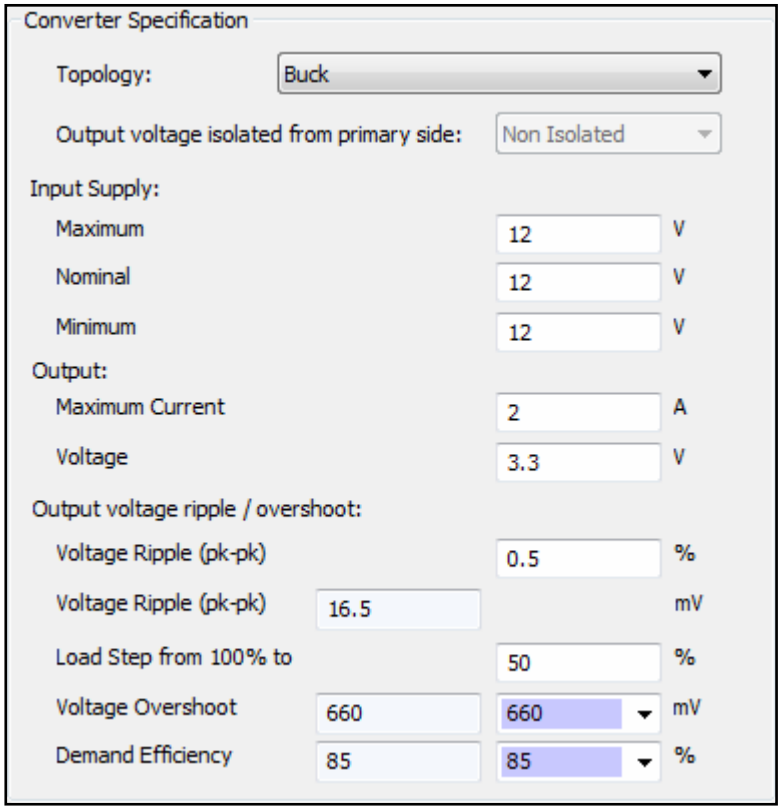

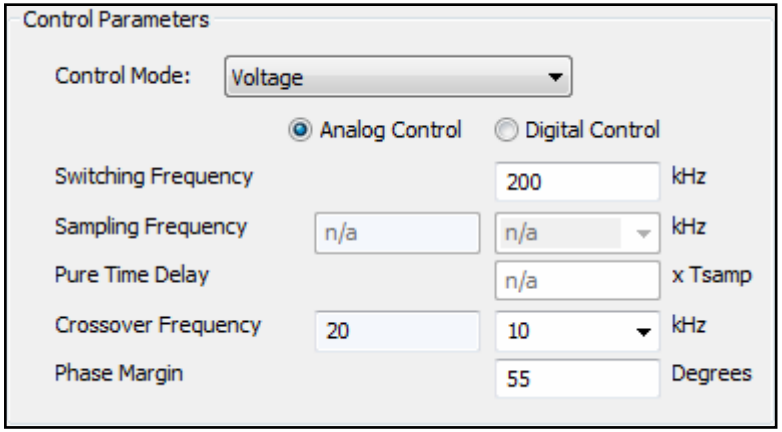

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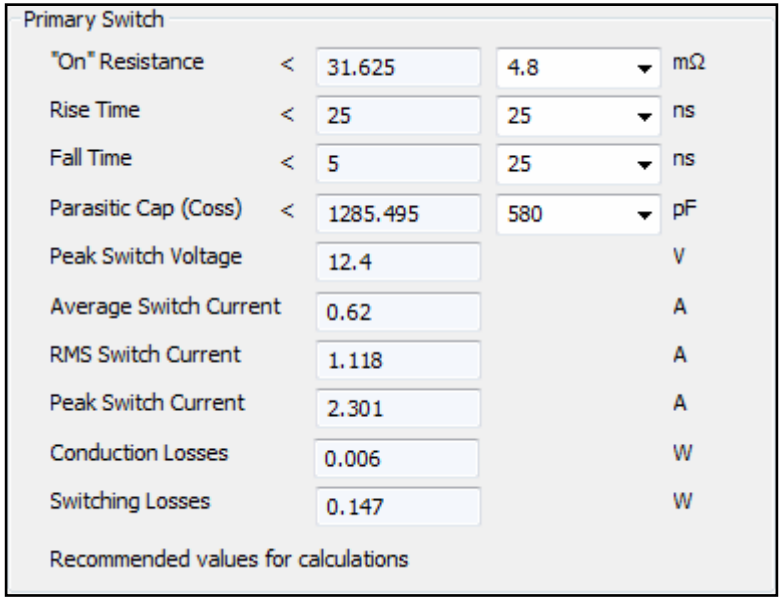

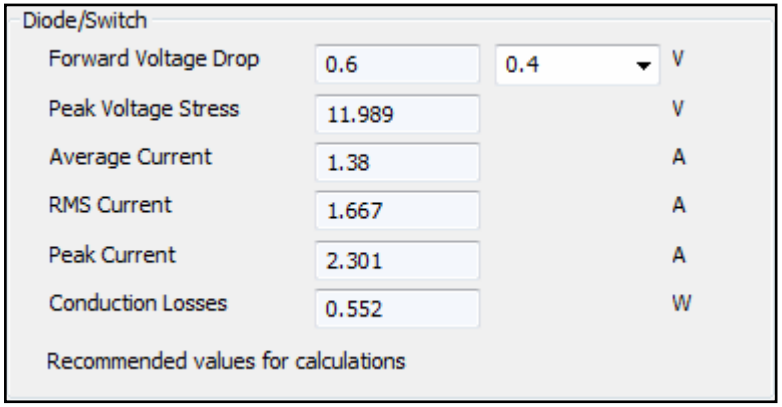

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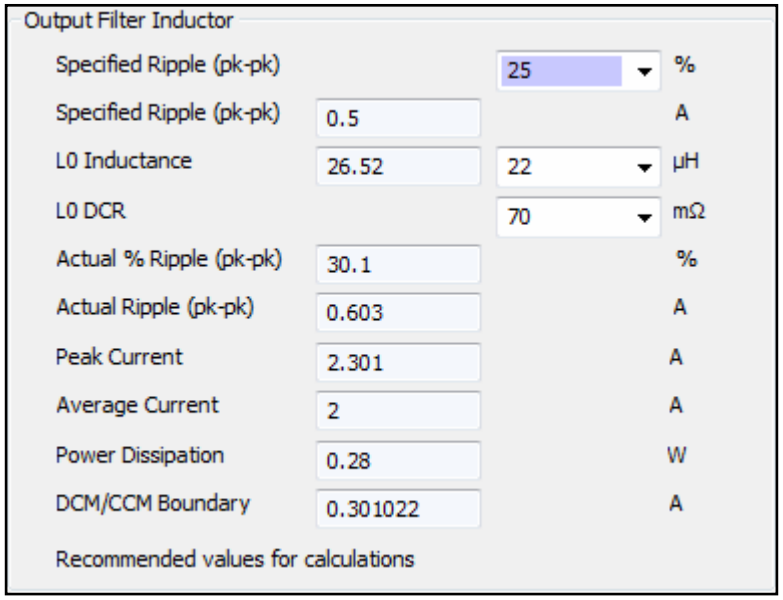
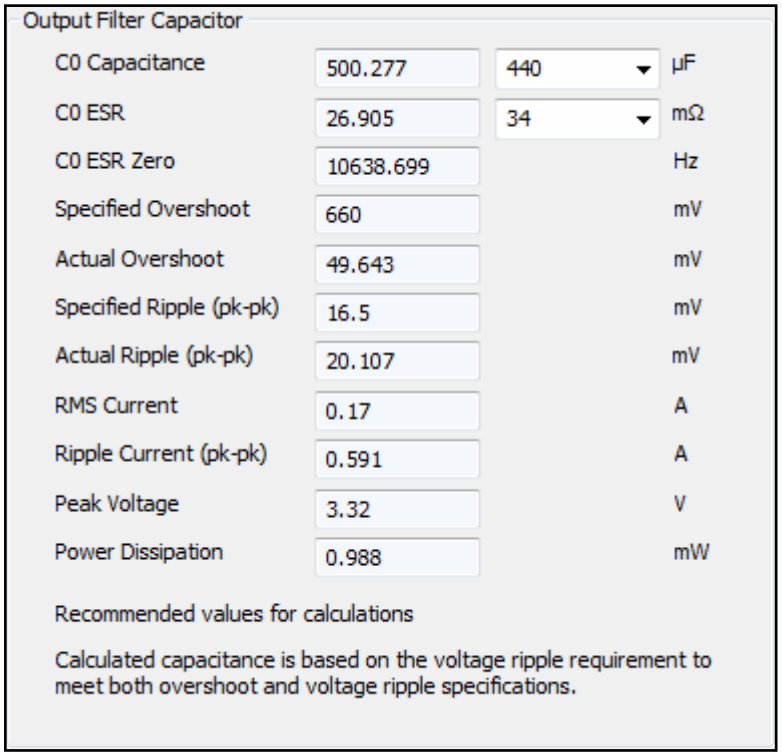




Design Example Using WDS

Controller Type

Type III

$$H_C(s) = \frac{\omega_{CP0}}{s} \times \frac{(s+\omega_{CZ1})(s+\omega_{CZ2})}{(s+\omega_{CP1})(s+\omega_{CP2})}$$

PWM Parameters

PWM Ramp Height	1.8	V

Controller Poles and Zeros

(•) Automatic placement ( ) Manual placement

Pole at the origin	3979.289	3979.289	Hz
First Pole	10638.699	10638.699	Hz
Second Pole	100000	100000	Hz
First Zero	4860.243	4860.243	Hz
Second Zero	1601.229	1601.229	Hz

Error Amplifier

Reference Voltage	2.55	V

Sampling Divider

Desired current through divider		0.15	mA
R1	5	10	kΩ
Rb	34		kΩ
Actual current through pd	0.075		mA

Controller Component Values

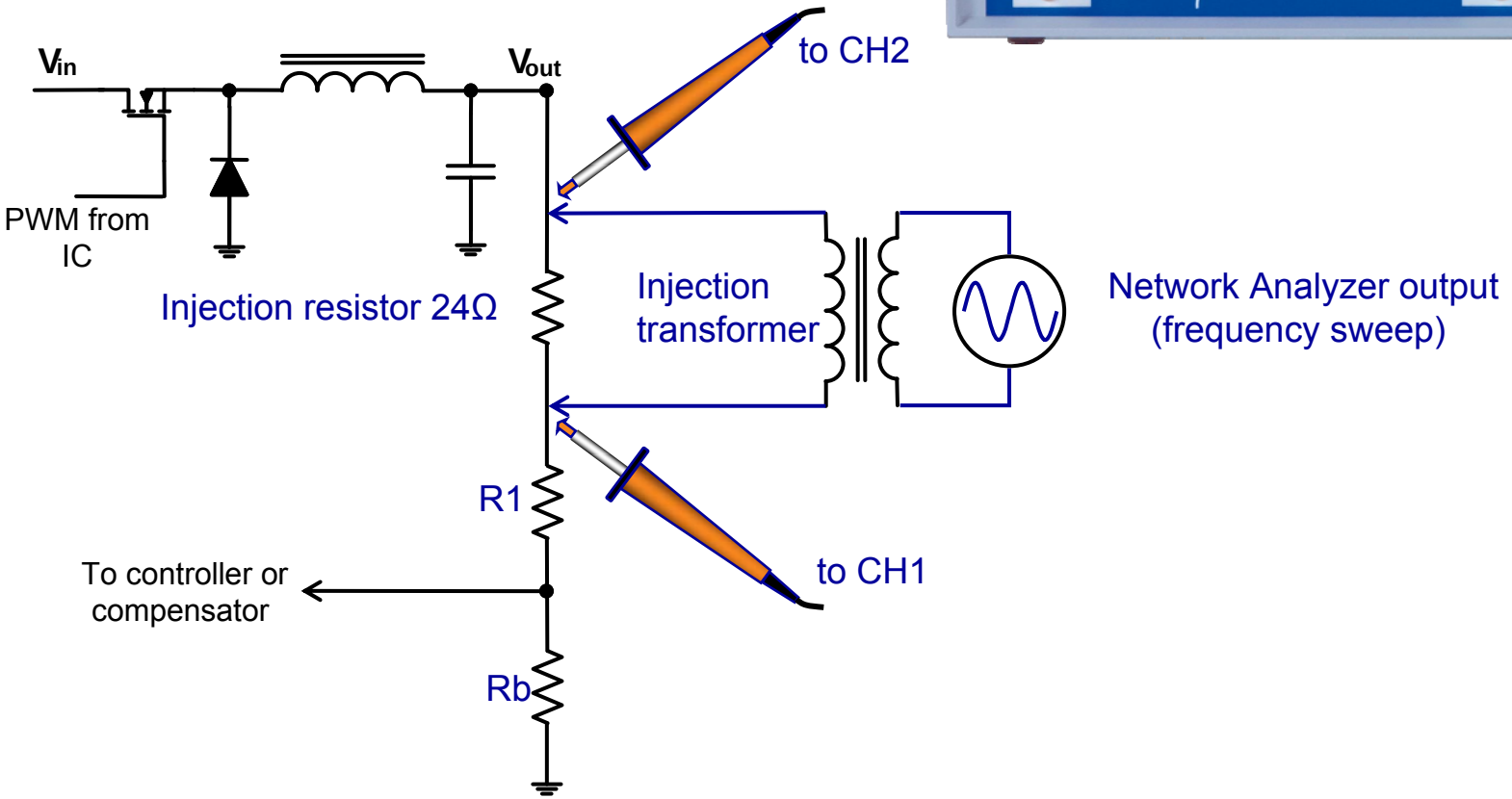
R2	15.074	14	kΩ
R3	0.163	0.18	kΩ
C1	2.172	2.2	nF
C2	9.78	10	nF
C3	1.827	1.5	nF

Actual Controller Poles and Zeros

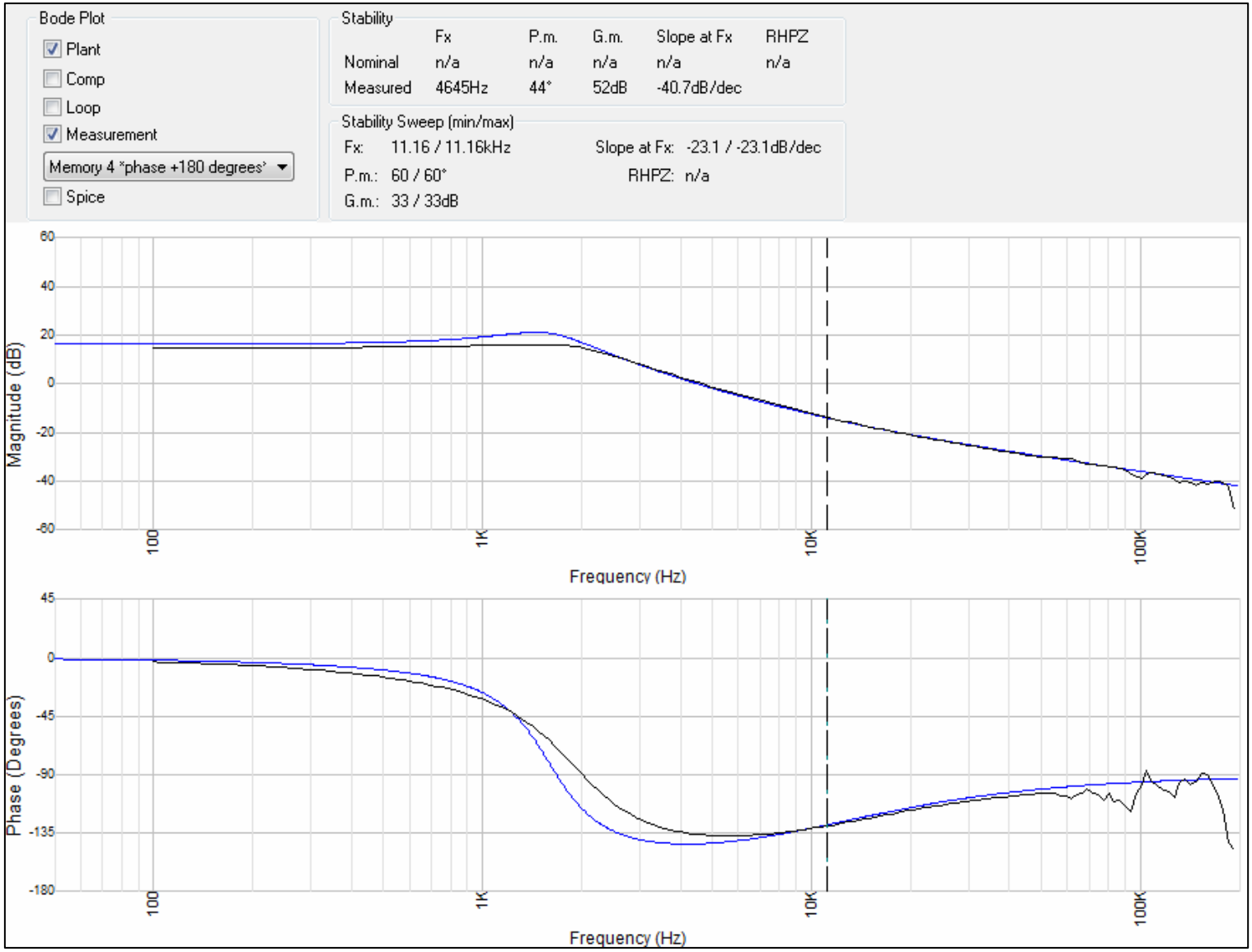
Pole at the origin	4301.485	Hz
First Pole	12746.175	Hz
Second Pole	88419.413	Hz
First Zero	5167.368	Hz
Second Zero	1563.408	Hz

Analyzing Your Converter in Frequency Domain

- Measurement setup with a network analyzer



Results from Exercise 1c



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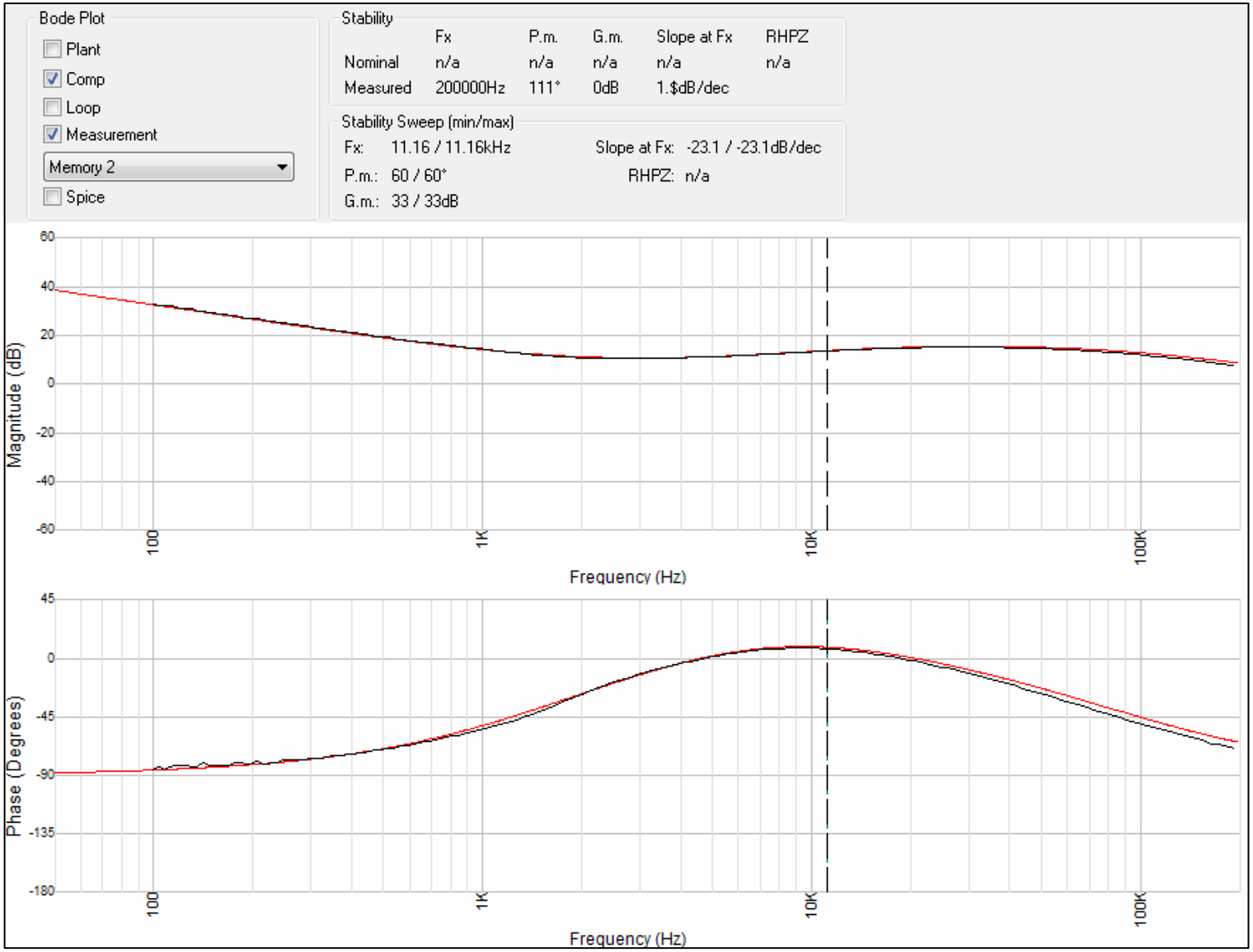

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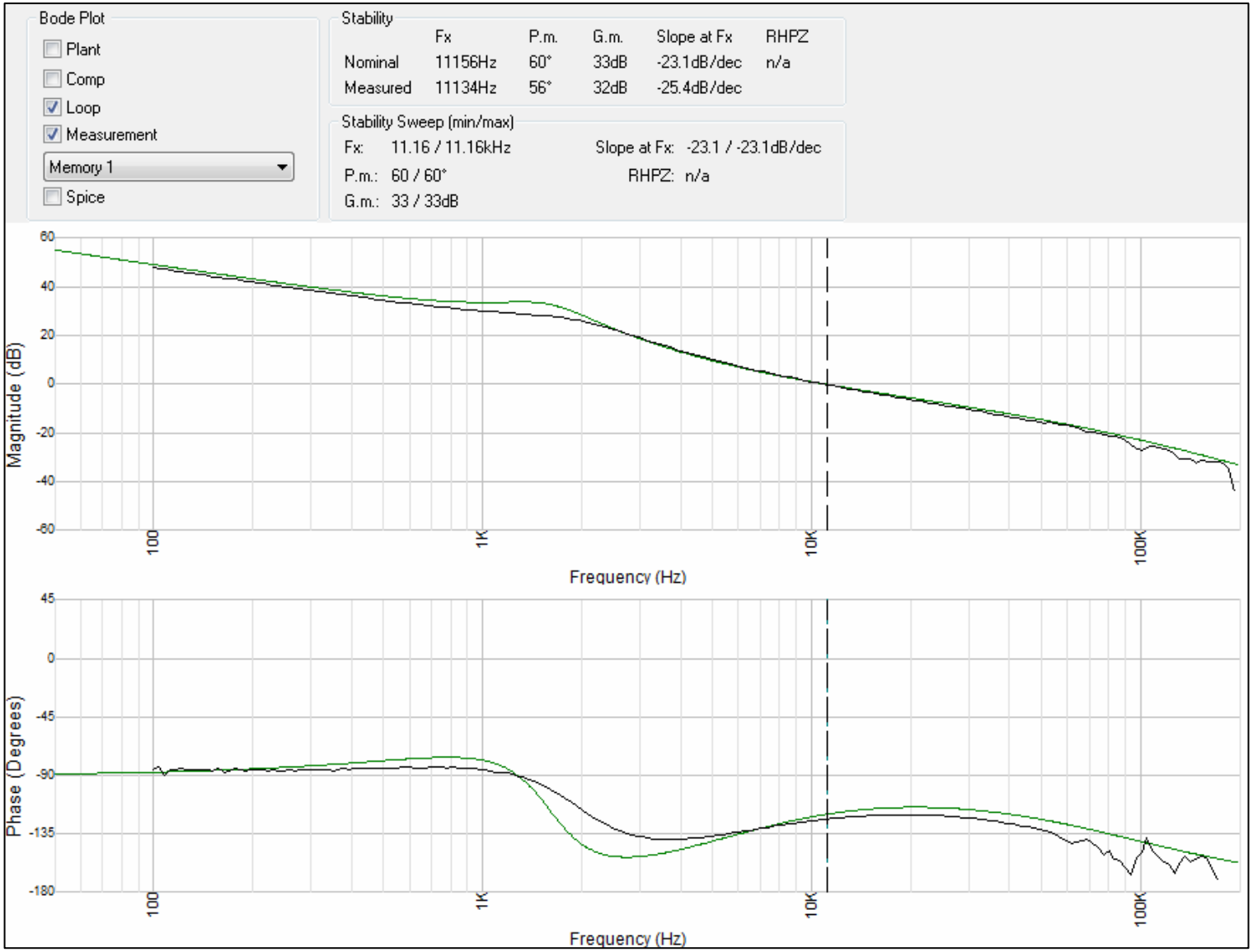
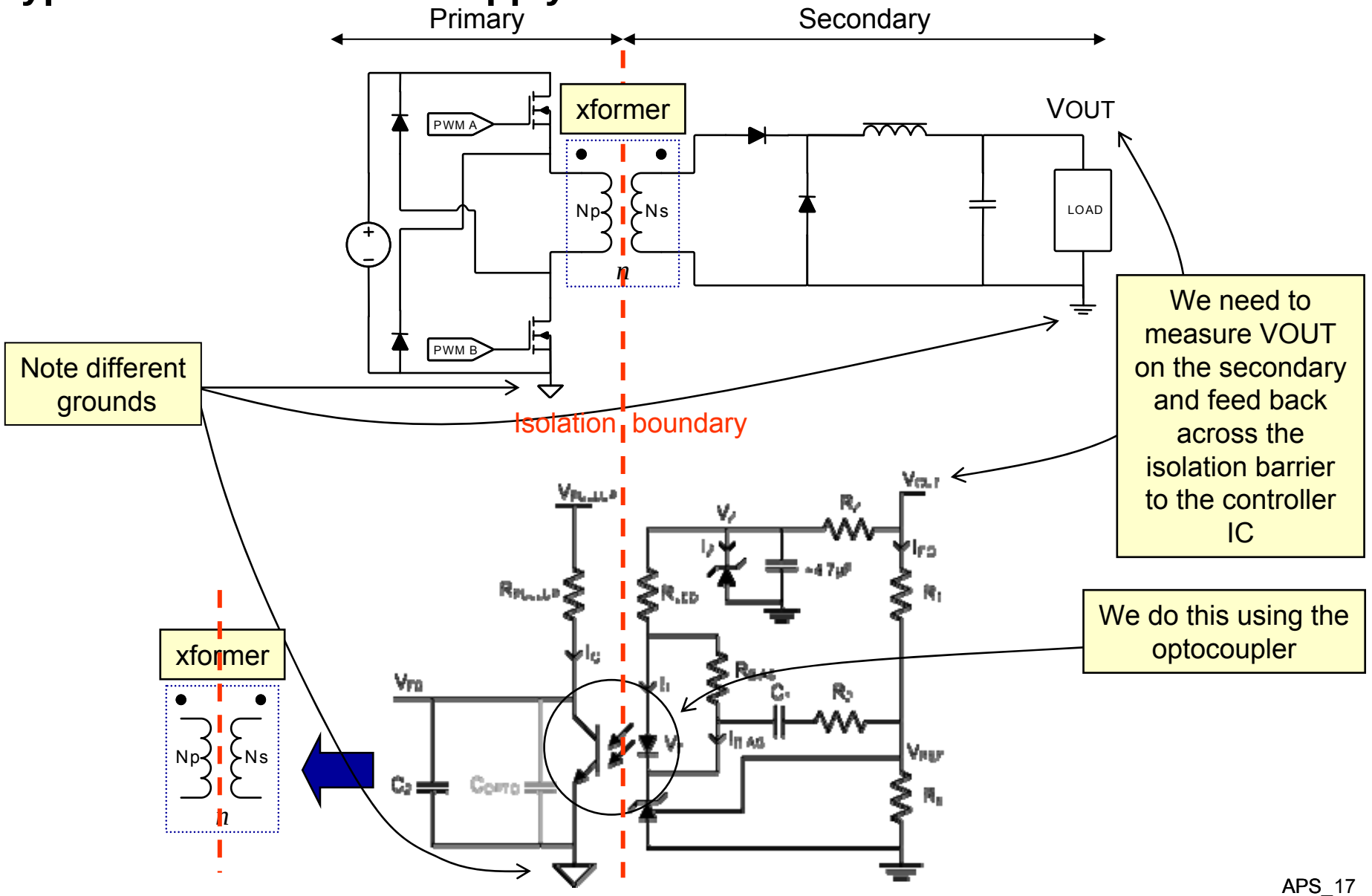
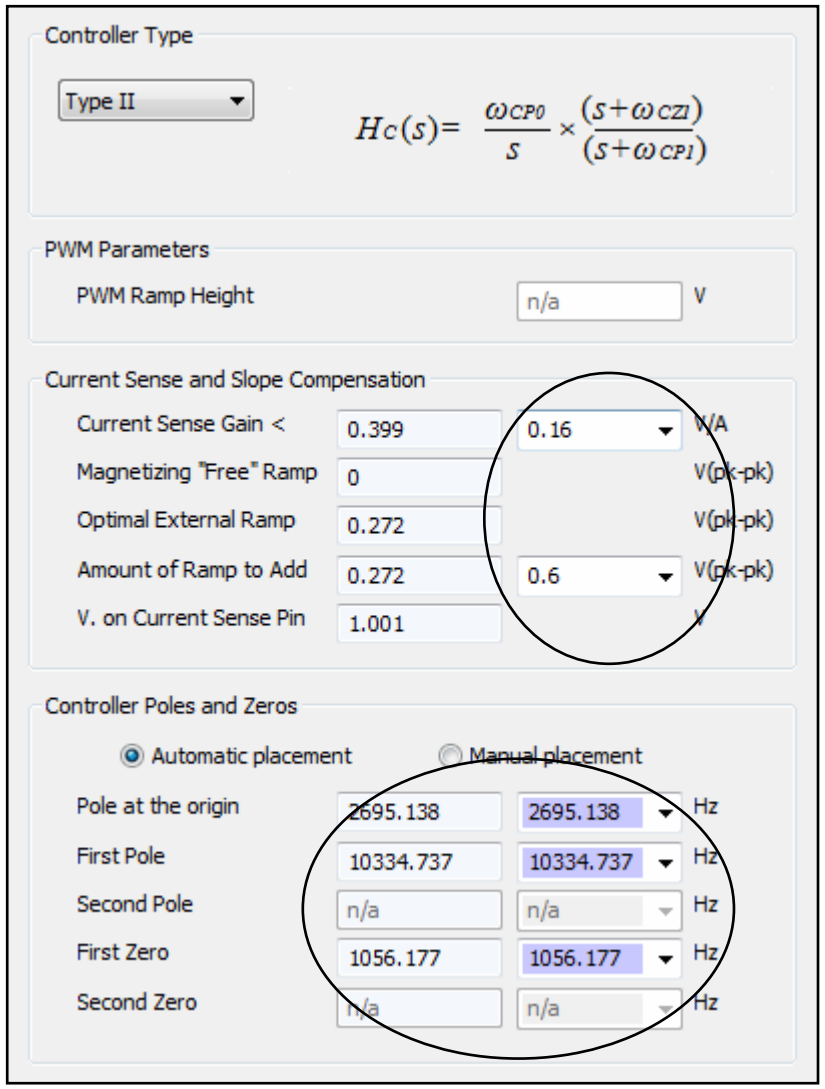


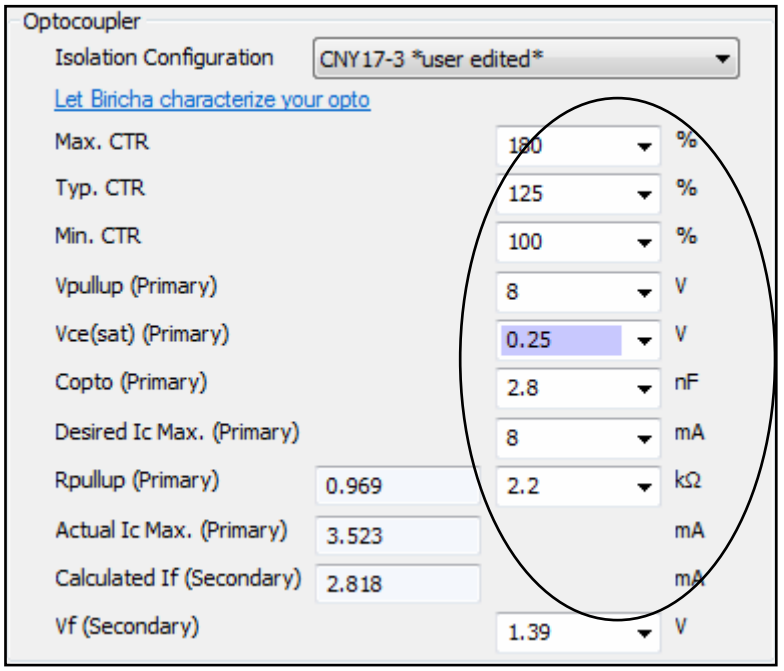
- Live Design Demo
  1 - Isolated Peak Current Mode Flyback
  2 – Digital Buck Converter

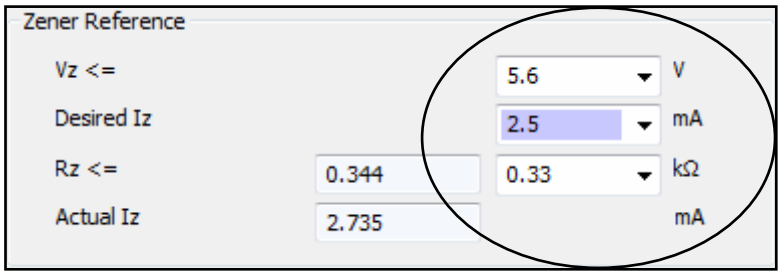
Typical Isolated Power Supply



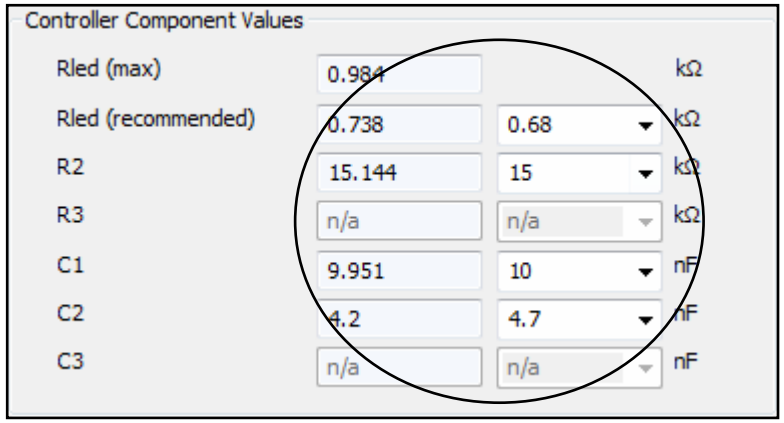
Real Life Design Example 1: Common Emitter with R_{PULLUP} = 2.2kΩ

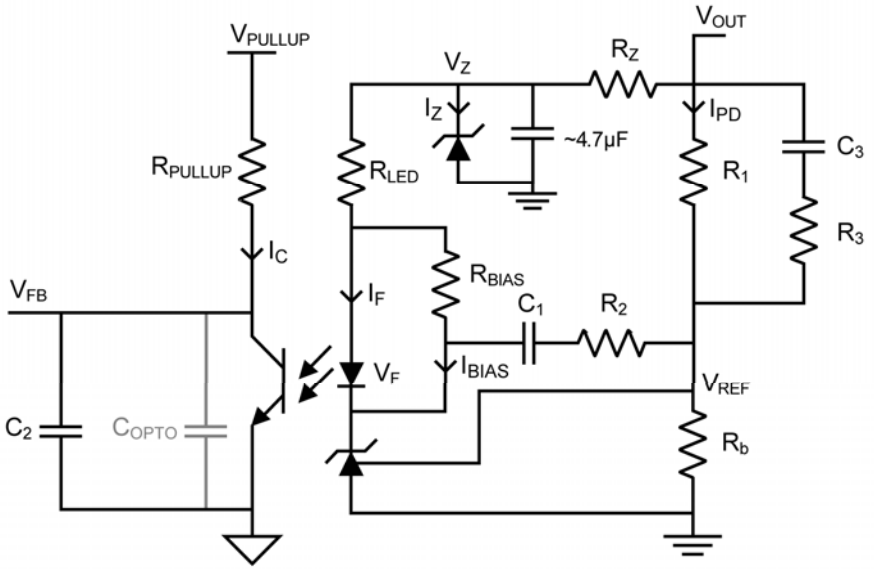






Real Life Design Example 1



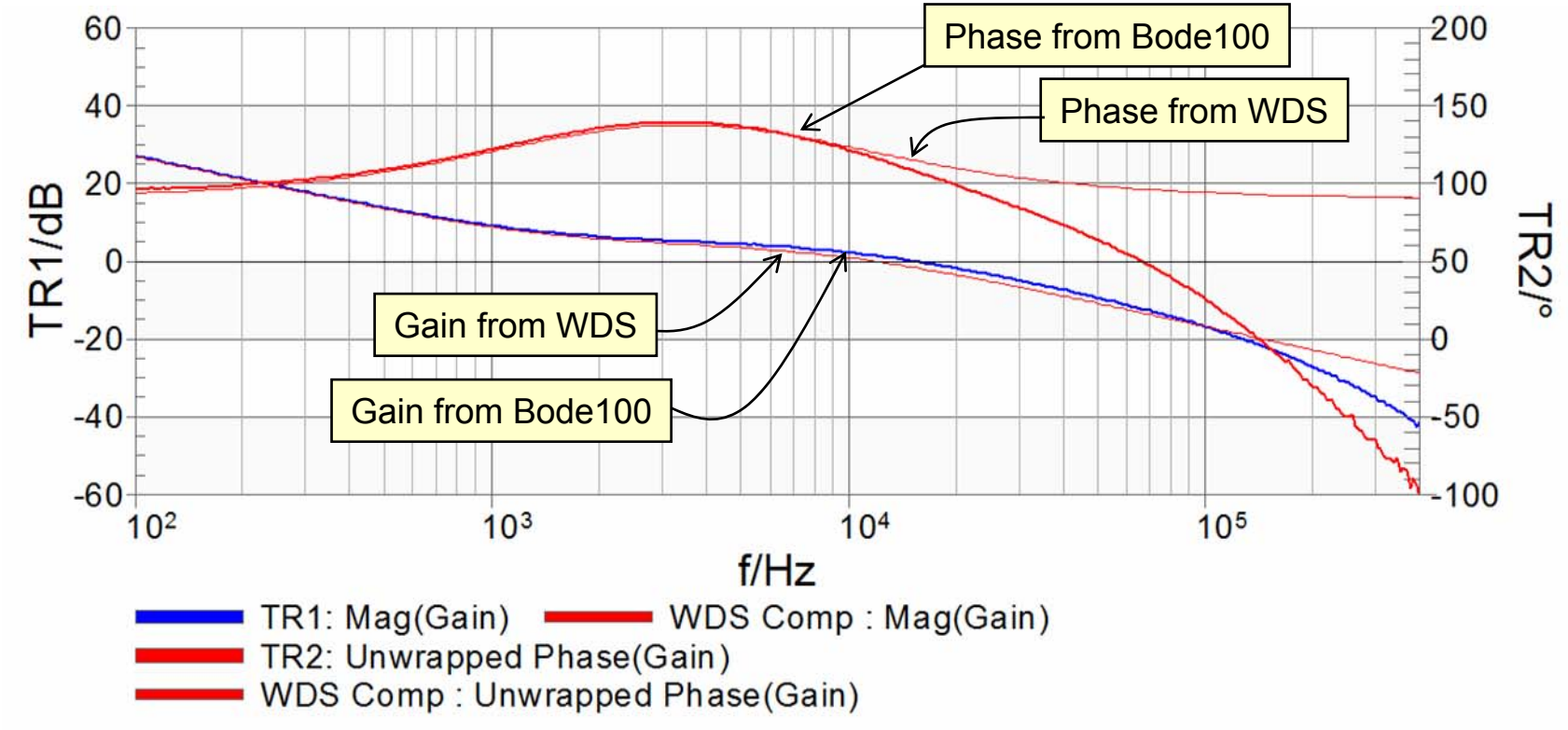


- Now that we have got our component values we can test *the compensator* to make sure that:
  - Our programmable reference is stable
  - Compensator poles and zeros are where we think they are
  - Opto bandwidth is not messing up our loop
  - Opto is being operated in the linear region

We can now run a lab to make sure the compensator works perfectly before moving on to our real power supply

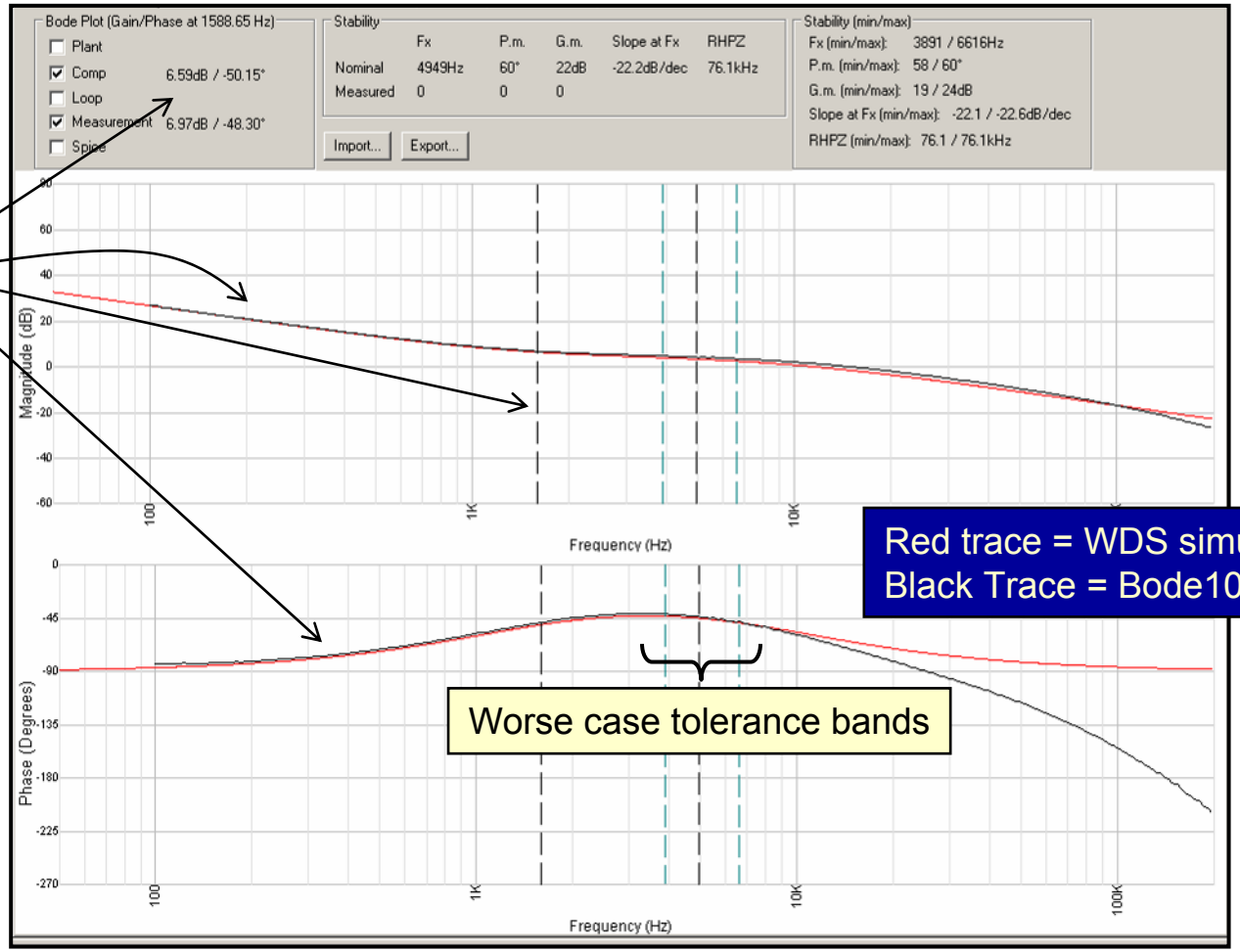
Exercise 3b: Isolated Compensator Design Using WDS

- Exported simulation into Bode Analyser Suite is almost a perfect match
  - This is a stable compensator with poles and zeros at correct locations



Exercise 3b: Isolated Compensator Design Using WDS

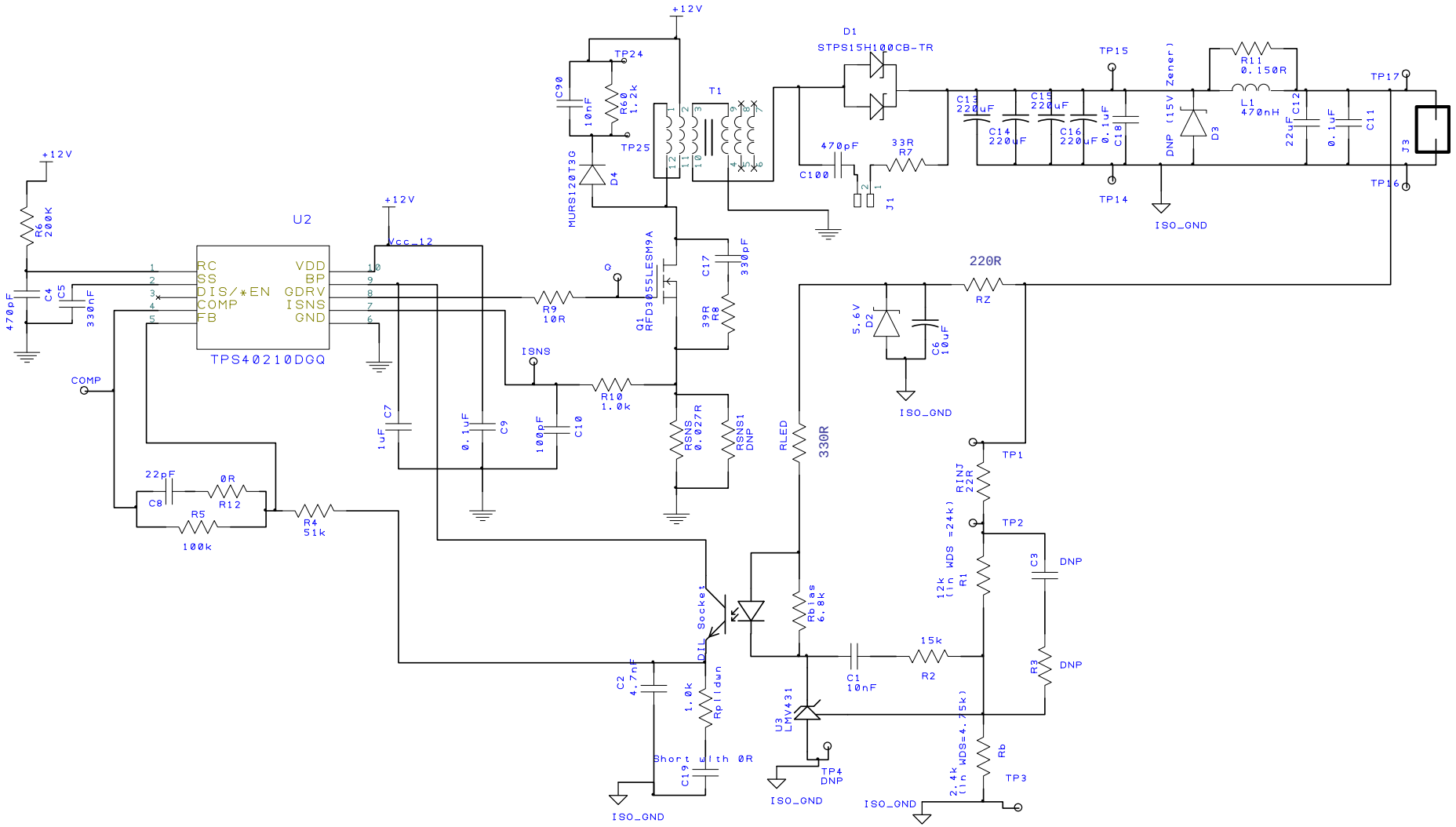
Almost a perfect match!
Red = WDS
Black = Bode100



Red trace = WDS simulation
Black Trace = Bode100

Worse case tolerance bands

Real Life Design Example: BDP-206



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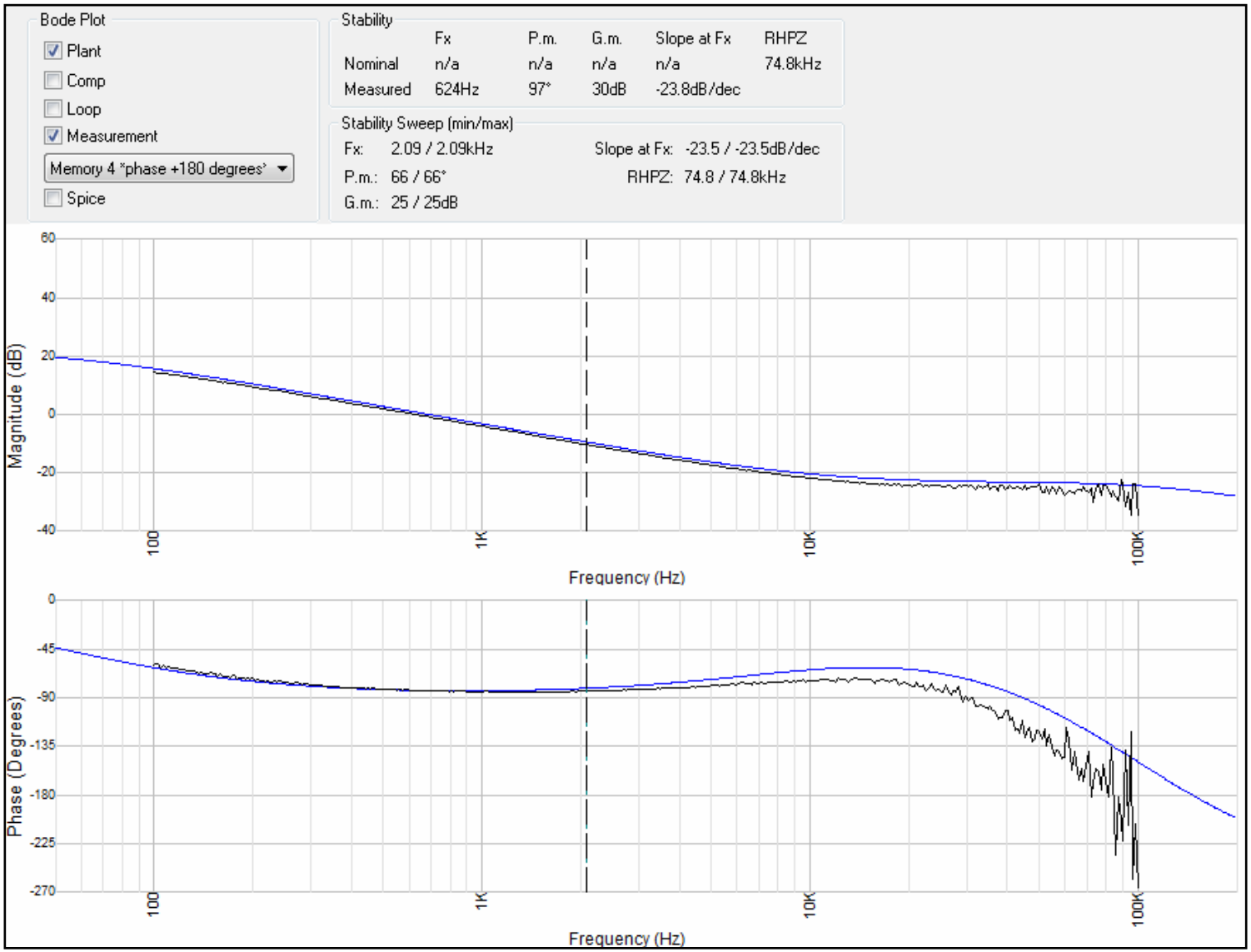

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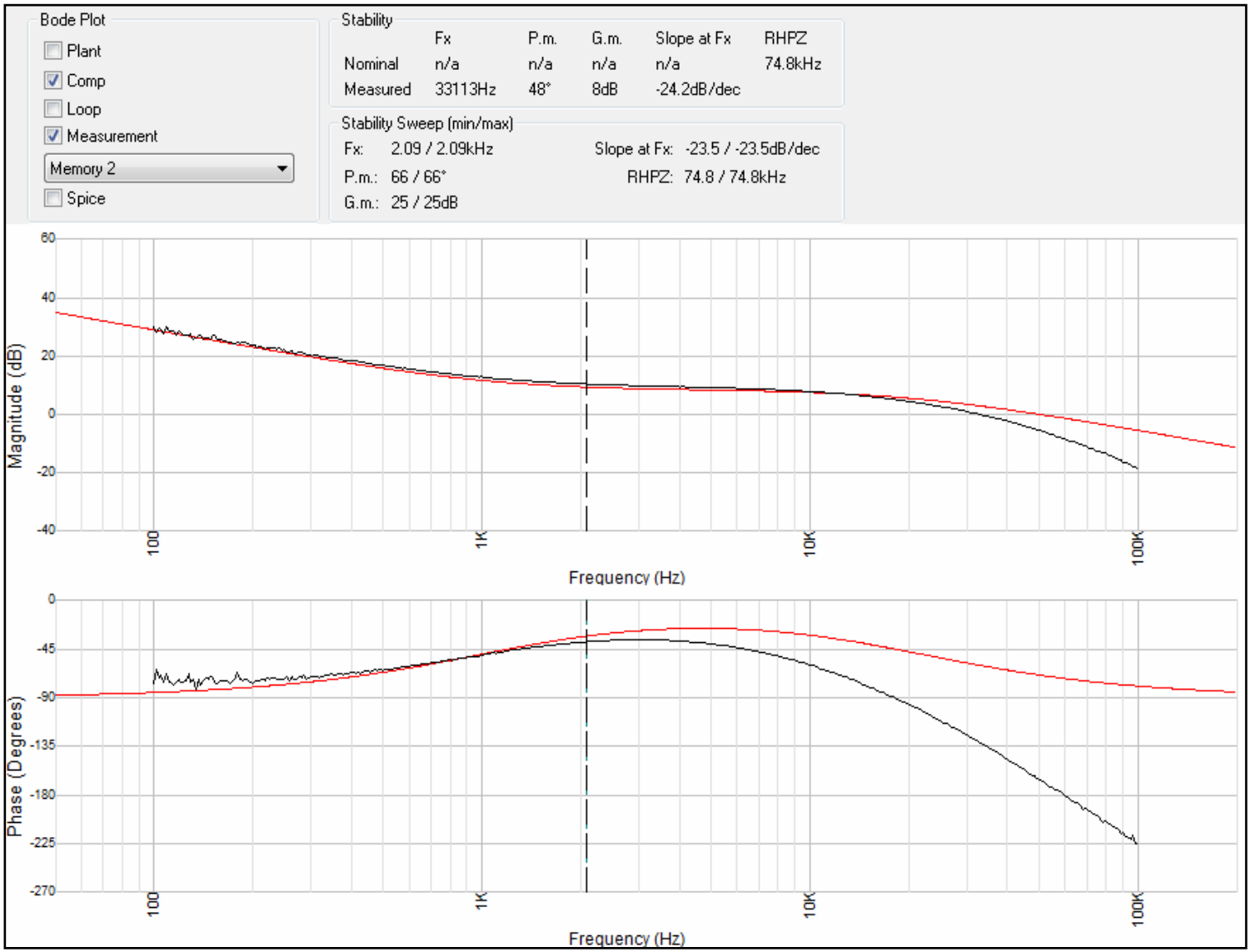

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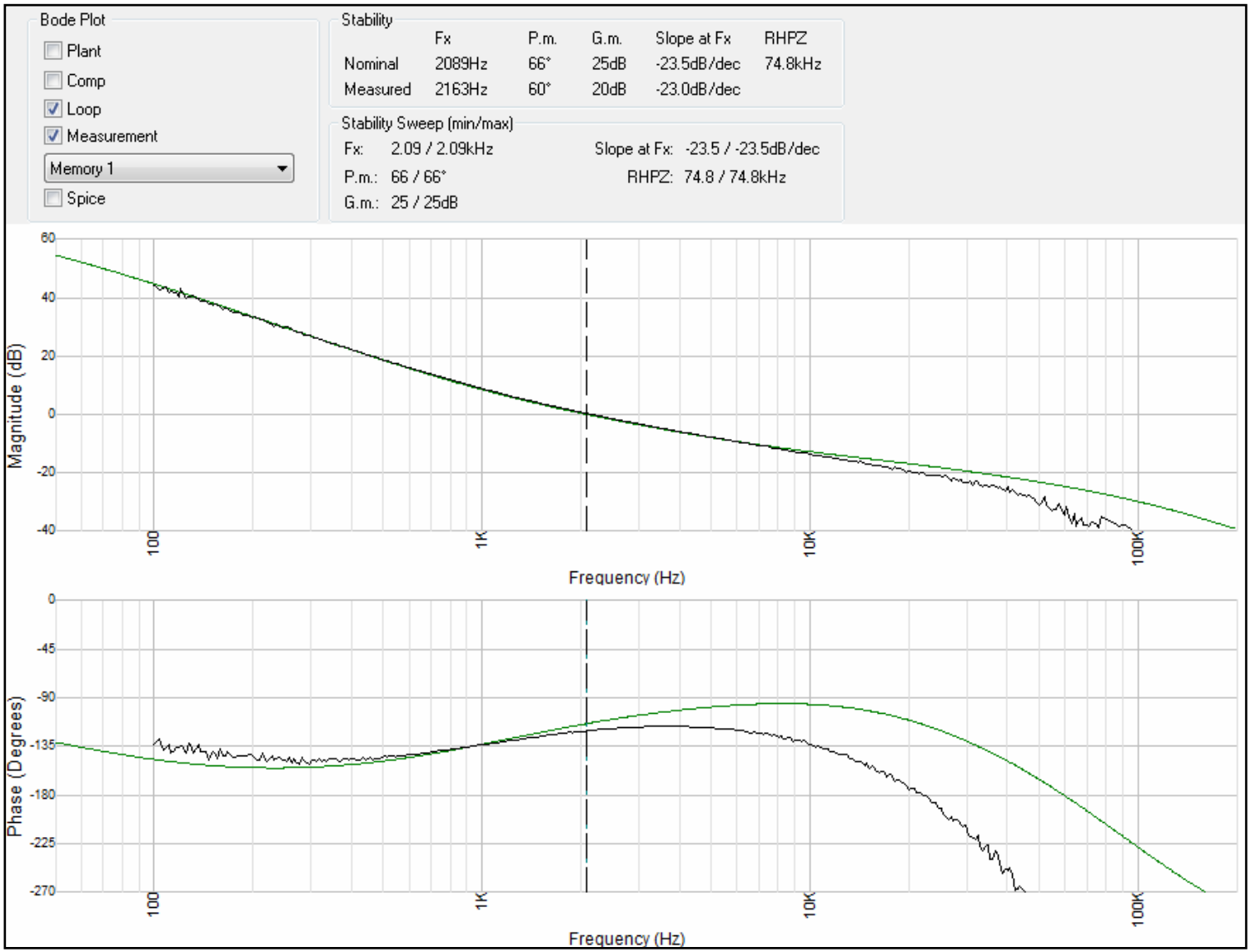

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    - Hands-on frequency response measurement of optoisolated compensators

End of the workshop
Thank you for taking part

Important Notice

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