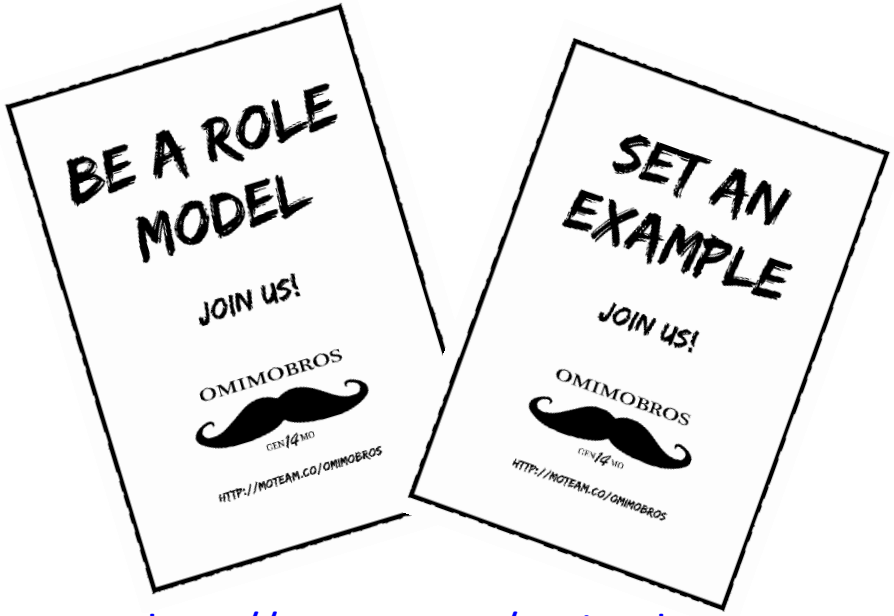
Power Supply Loop Stability Measurement

OMICRON Lab Webinar Nov. 2014

OMICRON LAB

Let‘s start with a question

- Why do the presenters wear moustaches?



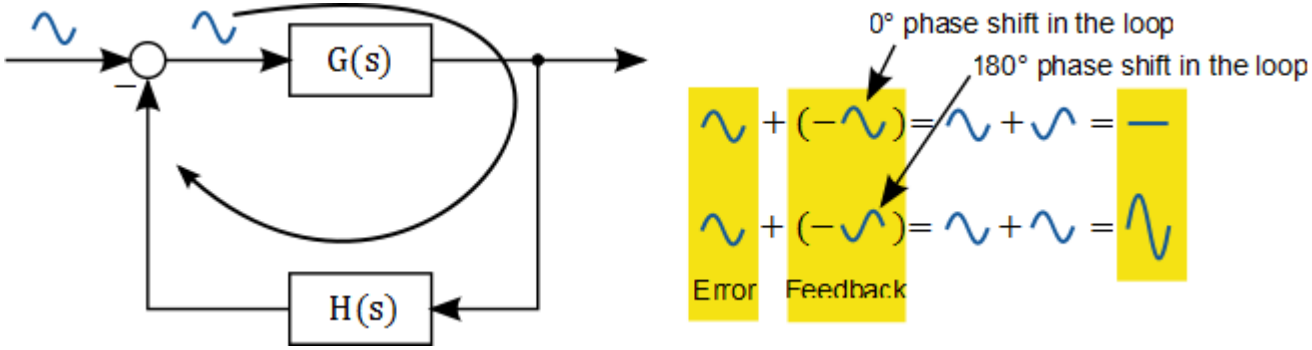
http://moteam.co/omimobros

Agenda

- Introduction
- What is stability?
- Choosing the right injection point
- Choosing the right value for the injection resistor
- Choosing the right injection level
- Practical stability measurement
- Interpretation of the results

Stability

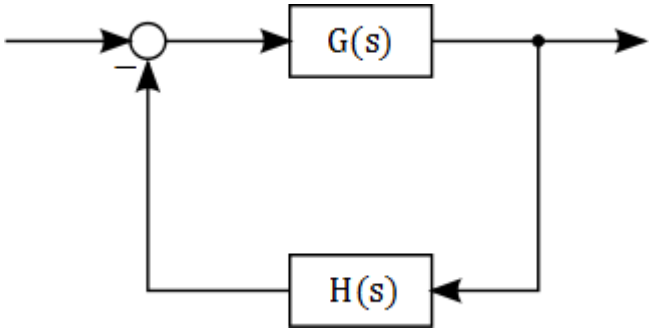
Negative feedback system



- Negative feedback → stable
- Positive feedback → oscillating (instability)

How to Determine Stability?

By analyzing the loop gain T and ensure that there is sufficient stability margin.

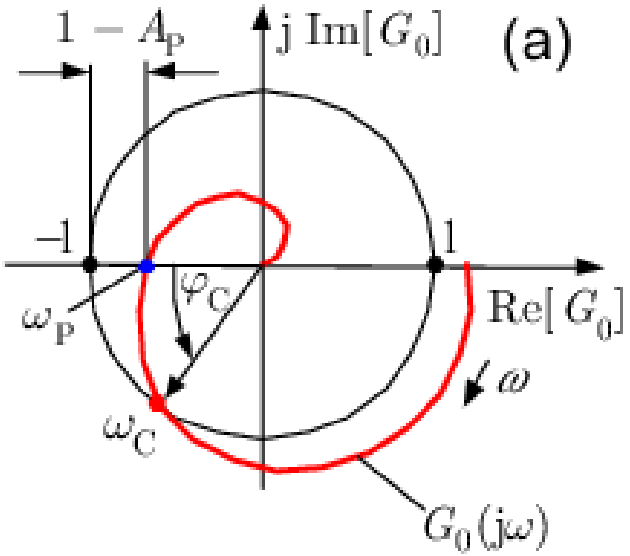


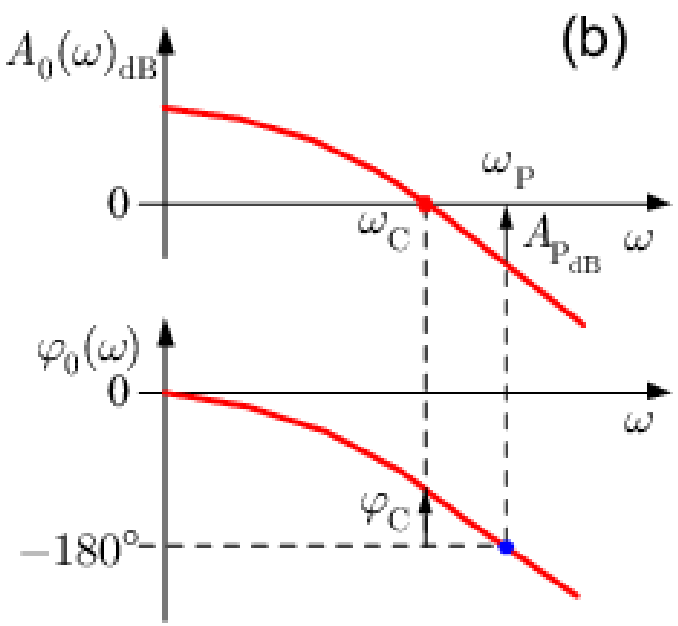
$G(s)$…Plant
$H(s)$…Compensator

$T(s) = G(s) \cdot H(s)$ … Loop Gain

Loop Gain is the product of all gains around the loop

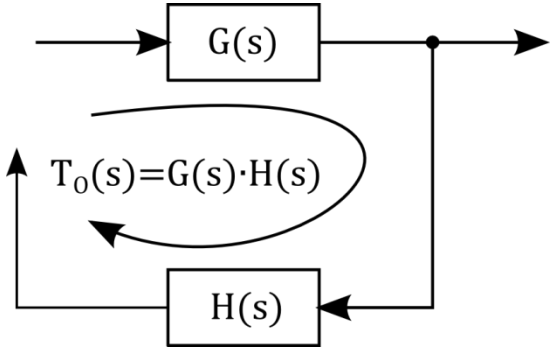
Stability Margins



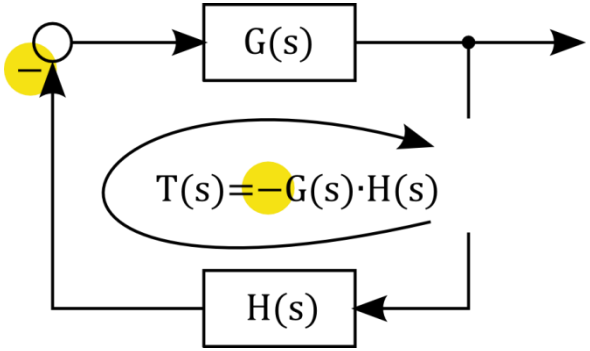


Why do we refer to 0° instead of -180°?

Open loop gain $T_O(s)$

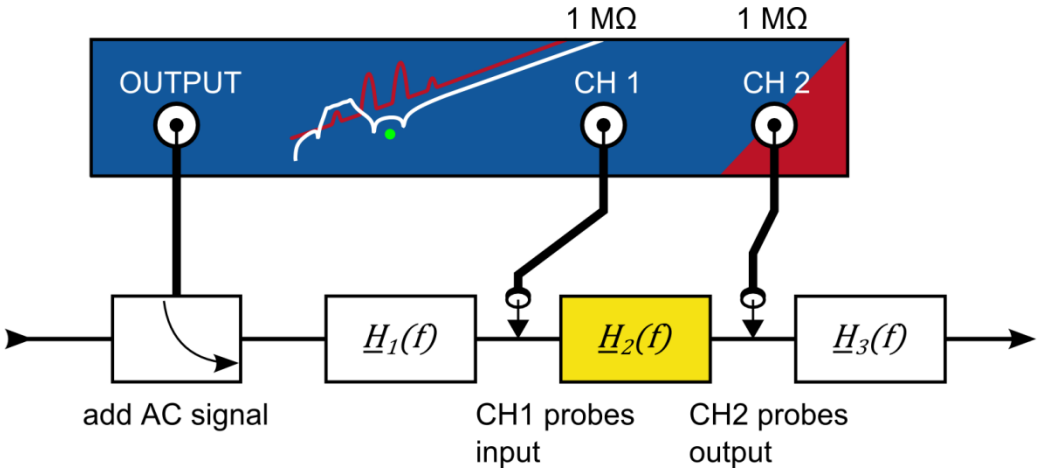


Measured loop gain T(s)



Transfer function measurement

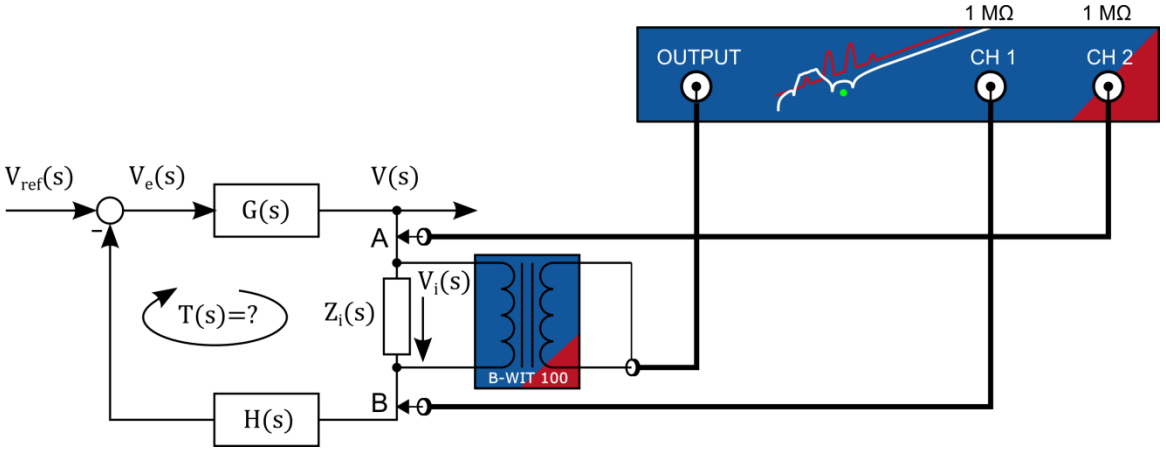
Bode 100 measures the transfer function $\underline{H}_2$ from CH1 to CH2



Note: Use the external reference function of the Bode 100 to enable CH1 input!

Loop Gain Measurement

Voltage Injection Method (measures voltage loop gain)



Selecting the Injection Point

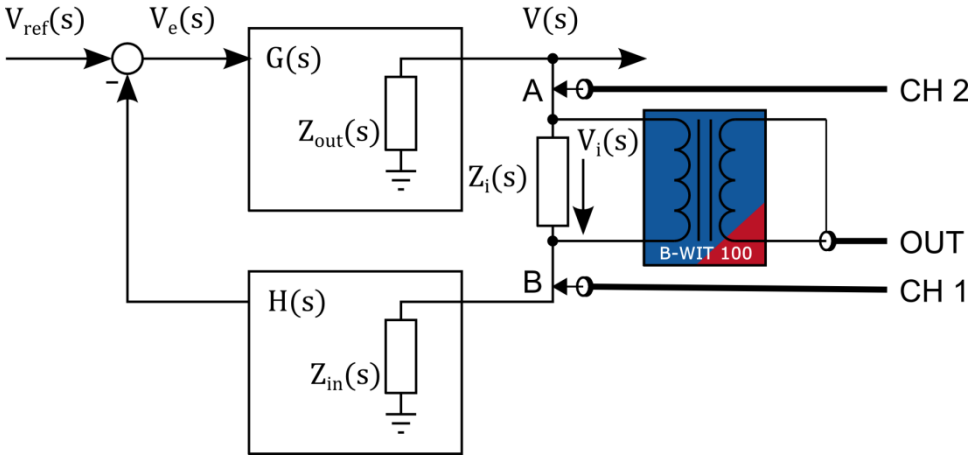
The following conditions needs to be fulfilled to ensure that the measured loop gain equals the „real“ loop gain!

- Condition 1

$$|Z_{in}| \gg |Z_{out}|$$

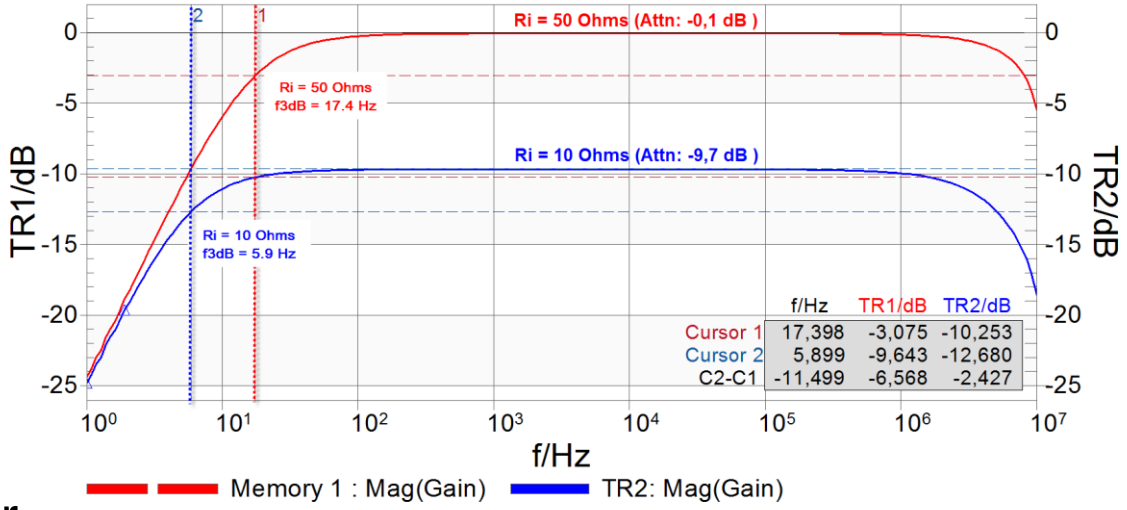
- Condition 2

$$|T| \gg \left|\frac{Z_{out}}{Z_{in}}\right|$$

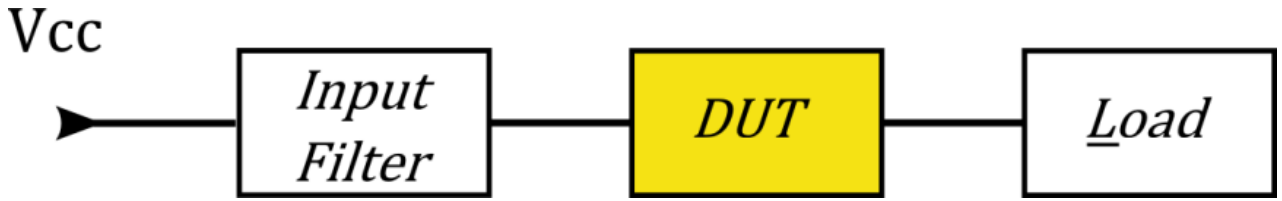


Choosing the right size of the injection resistor R_i

- R_i << feedback divider
- smaller R_i = smaller injected voltage
- smaller R_i = lower 3dB start frequency of the injection transformer



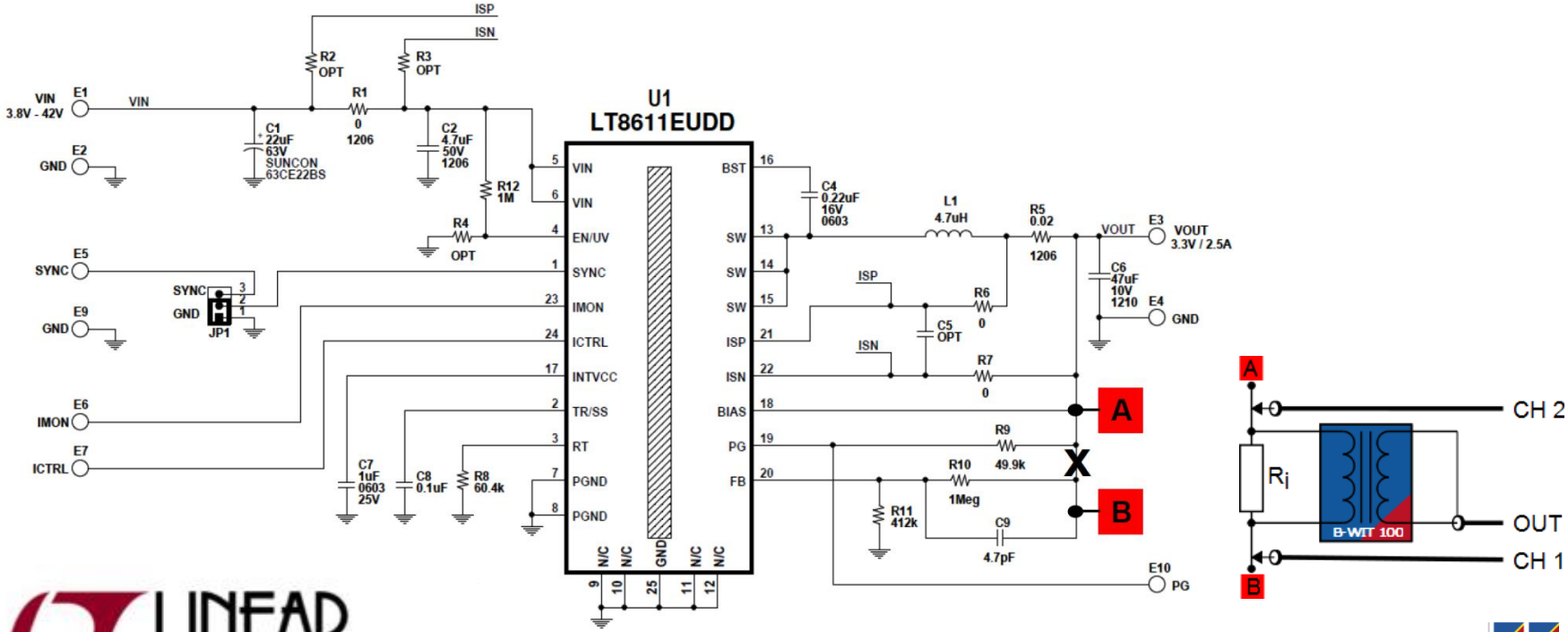
In-system measurements are important



- The input filter can influence the stability (Middlebrook)
- The load influences the stability margin

Always measure the loop gain under **all expected load conditions** and with the **input filter** connected.

Injection Point Examples
LT8611 Voltage Control loop



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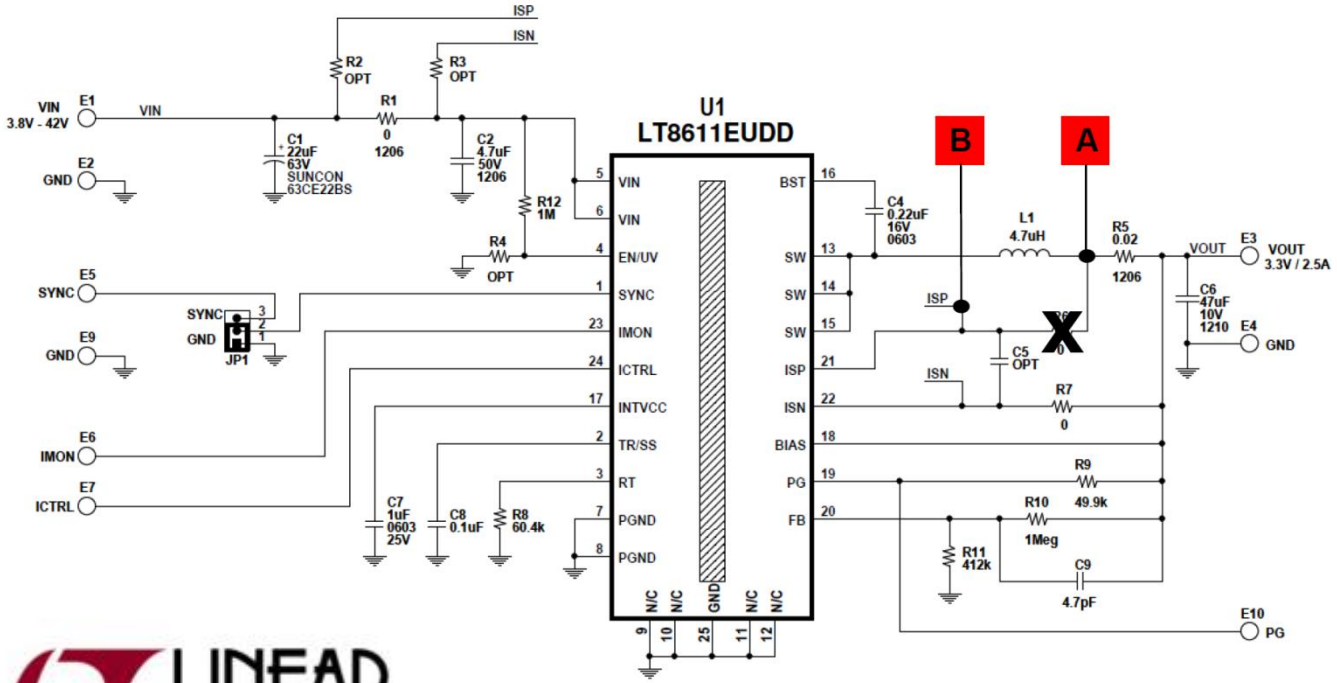
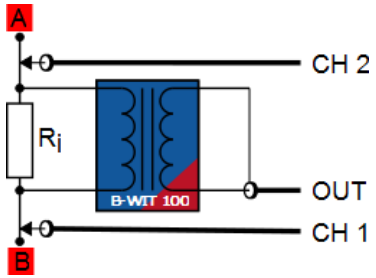
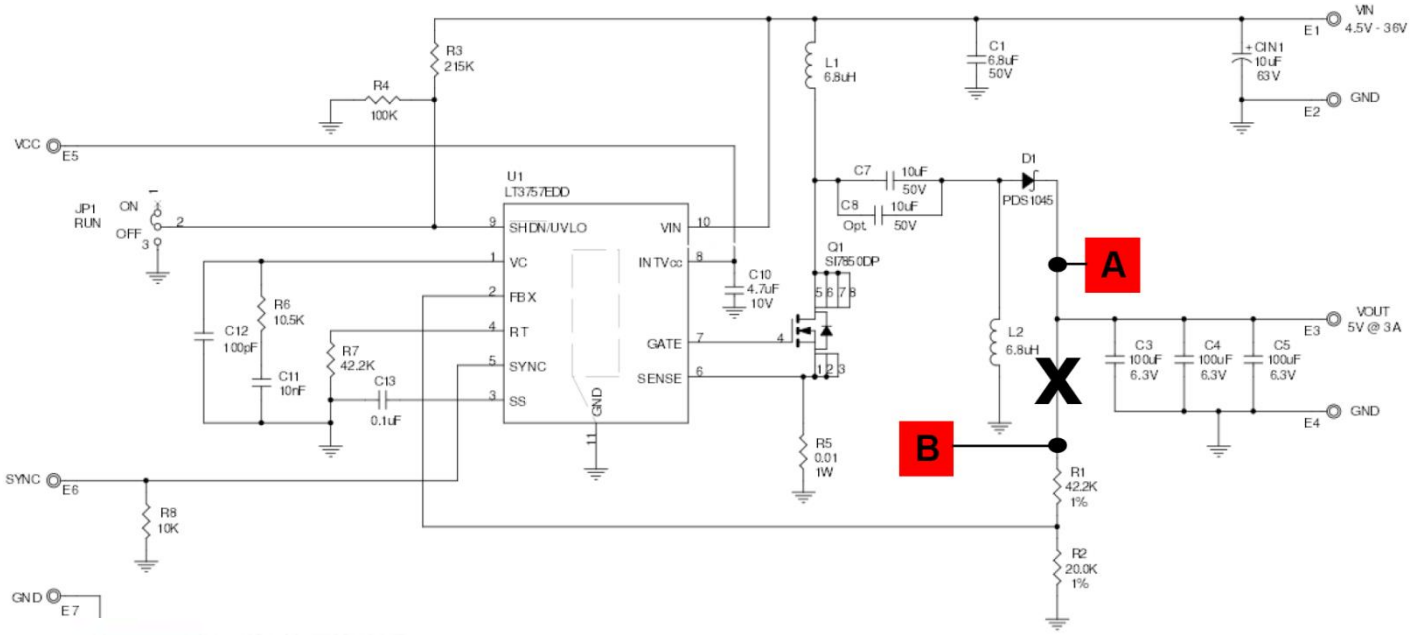
Injection Point Examples
LT8611 Current Control loop





Injection Point Examples
LT3757 SEPIC Converter



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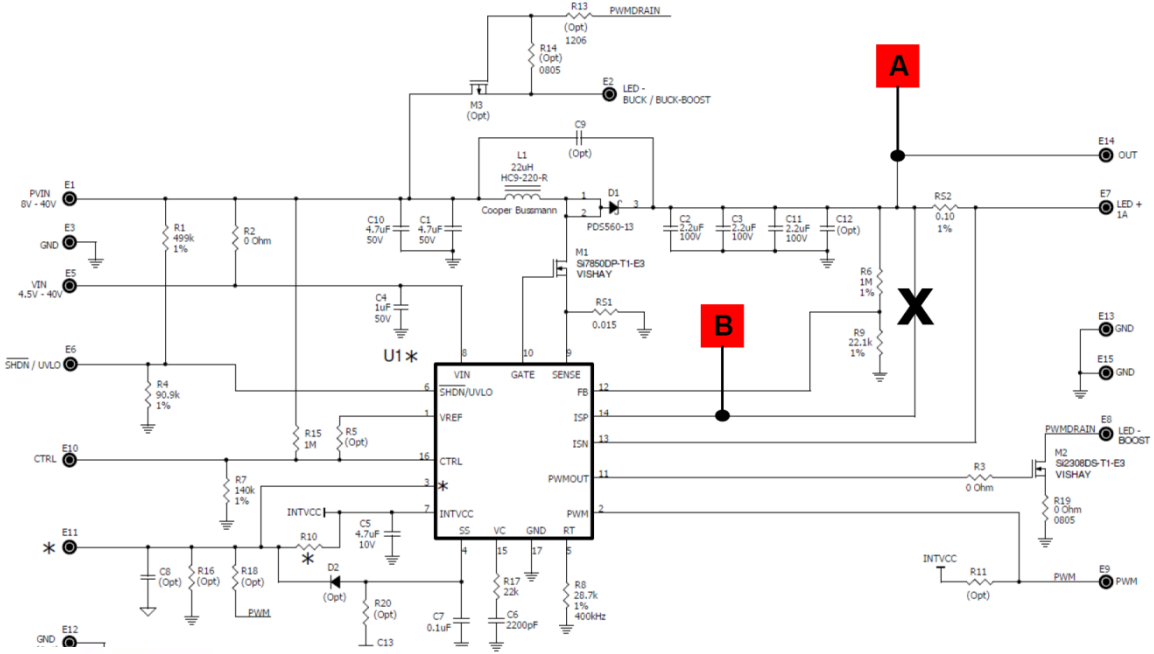
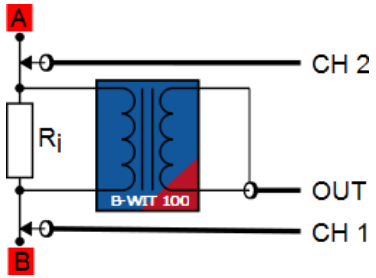
Injection Point Examples
LT3755-2 Boost LED Driver





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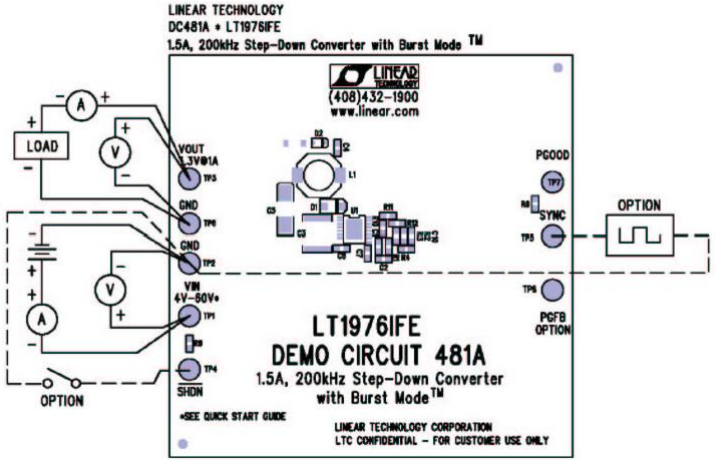
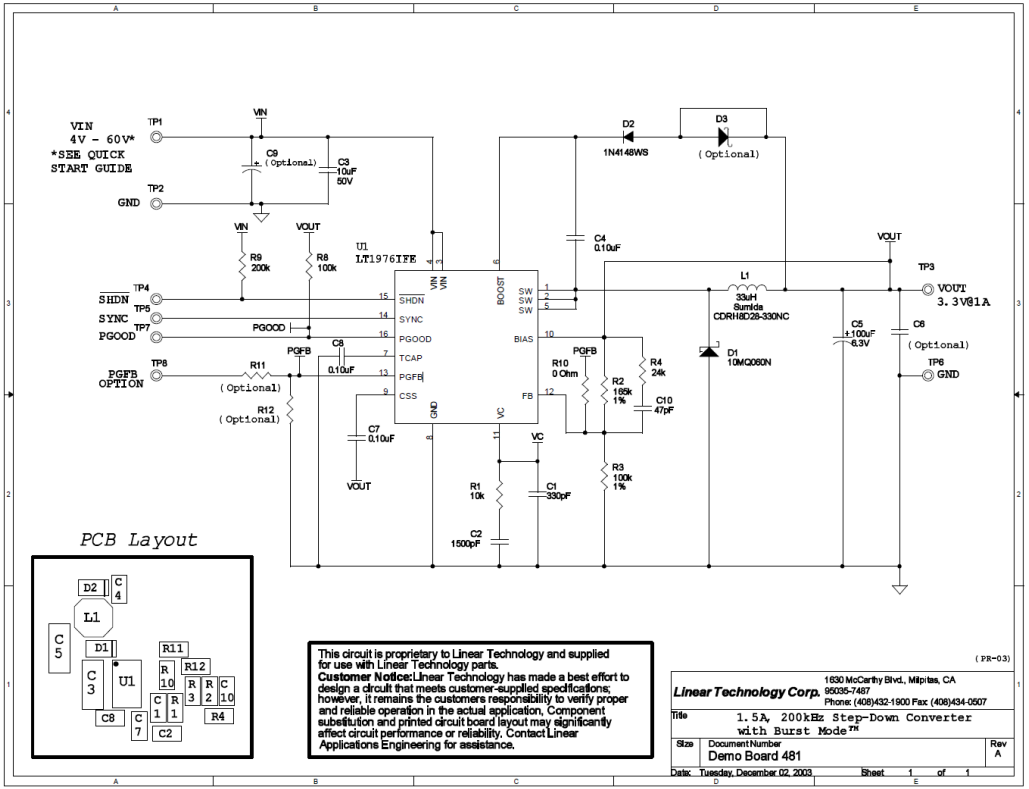
Measurement Example 1

LT1976 Buck converter

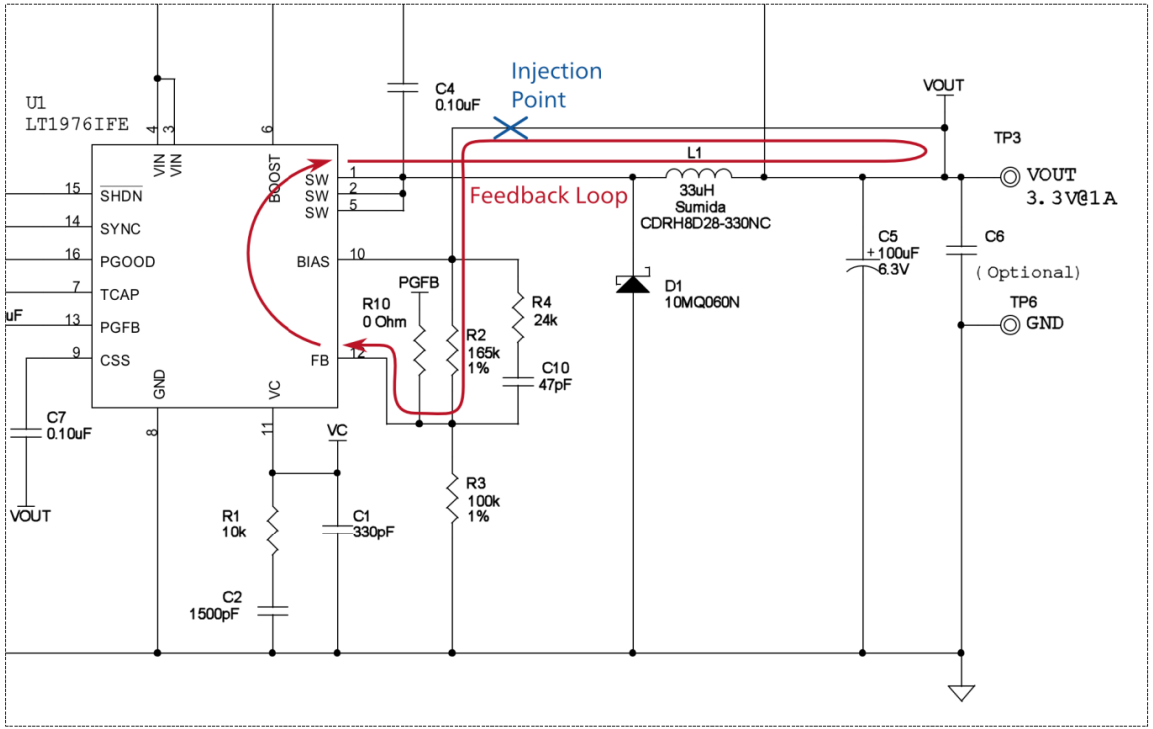


Input voltage: 4 V – 60 V
Output voltage: 3.3 V
Output current: 1 A
Switching frequency: 200 kHz

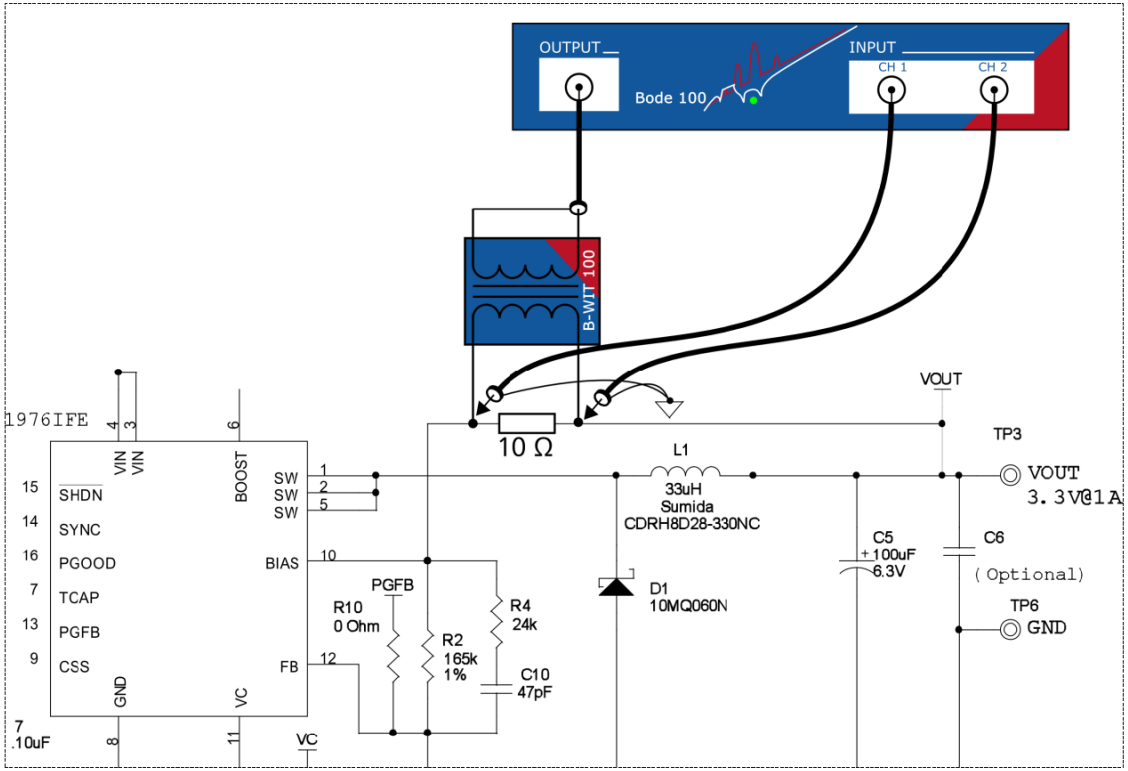
Measurement Example 1



Measurement Example 1

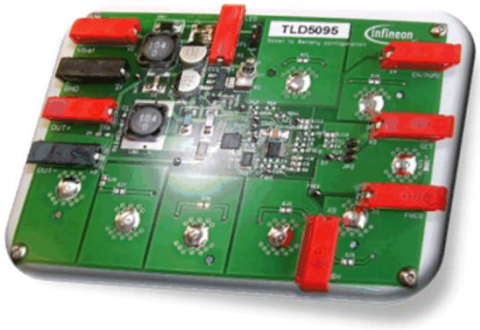


Measurement Example 1



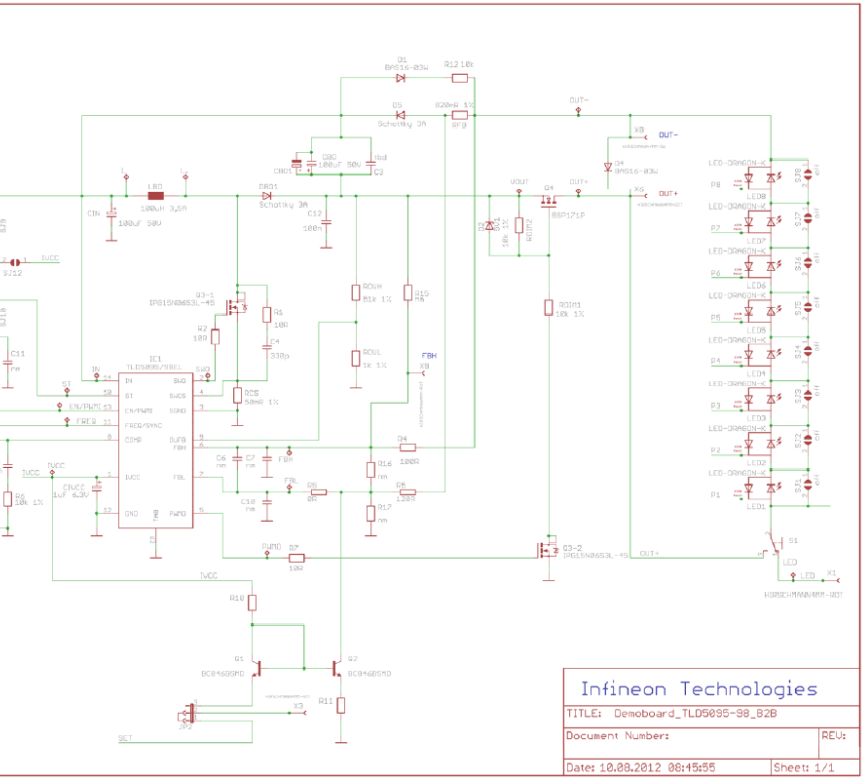
Measurement Example 2

Infineon TLD5098EL boost to battery configuration



Input voltage: 12 V
Output voltage: ≈ 30 V
Constant output current to drive LEDs

Measurement Example 2



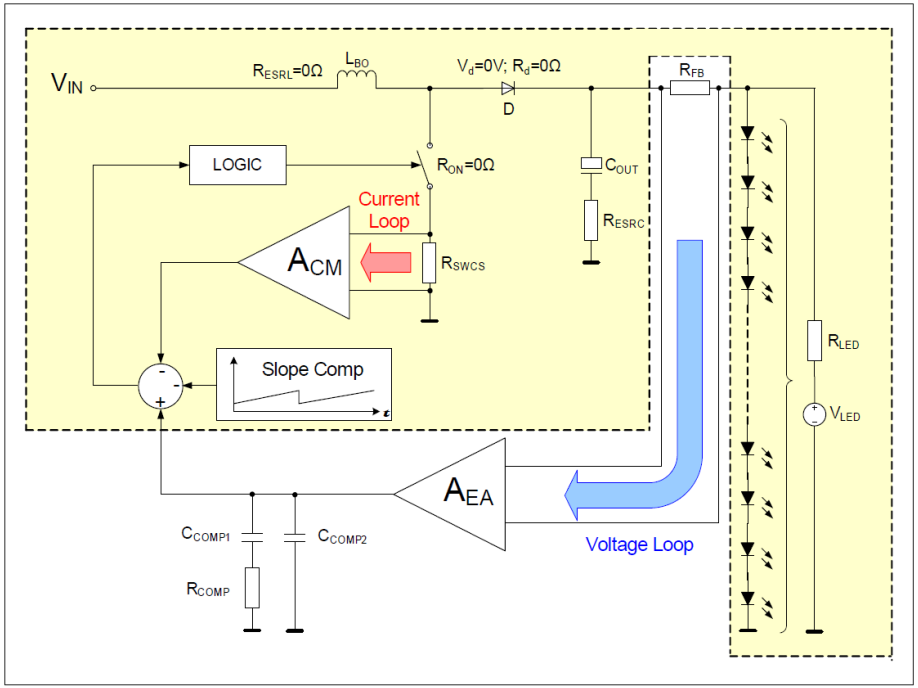
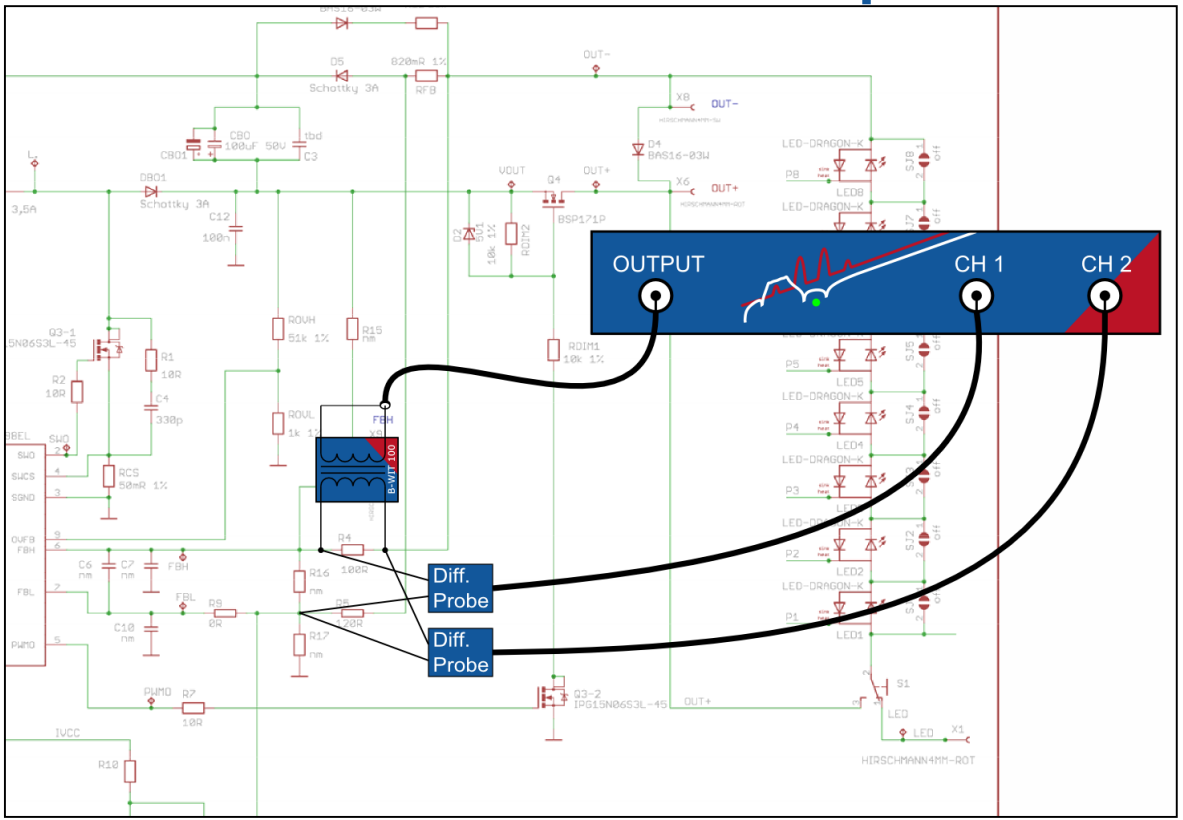
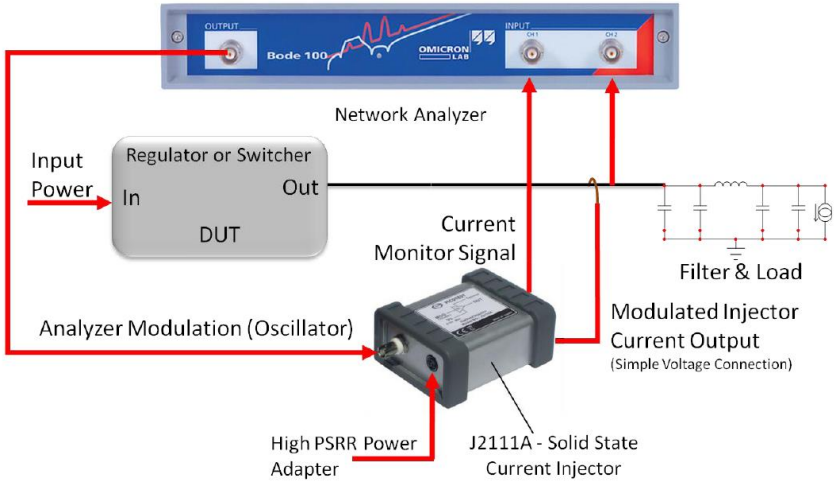


Figure 23 TLD5095/98 closed loop schematic

Measurement Example 2



What can you do if you can‘t break the feedback loop?



- loop stability can be derived from the output impedance
- non-invasive stability measurement with the Picotest J2111 current injector
- See also our webinar tomorrow!

PICOTEST

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Further Power Supply Measurements

- Non-Invasive Stability
- Output impedance
- PSRR (power supply rejection ratio)
- Input impedance (input filter stability)
- Crosstalk
- Reverse rejection

Which topic would be most interesting for you?
Send us an e-mail to info@omicron-lab.com

Feel free to ask questions via the chat function...

If time runs out, please send us an e-mail and we will follow up.

You can contact us at: info@omicron-lab.com

Thank you for your attention!

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