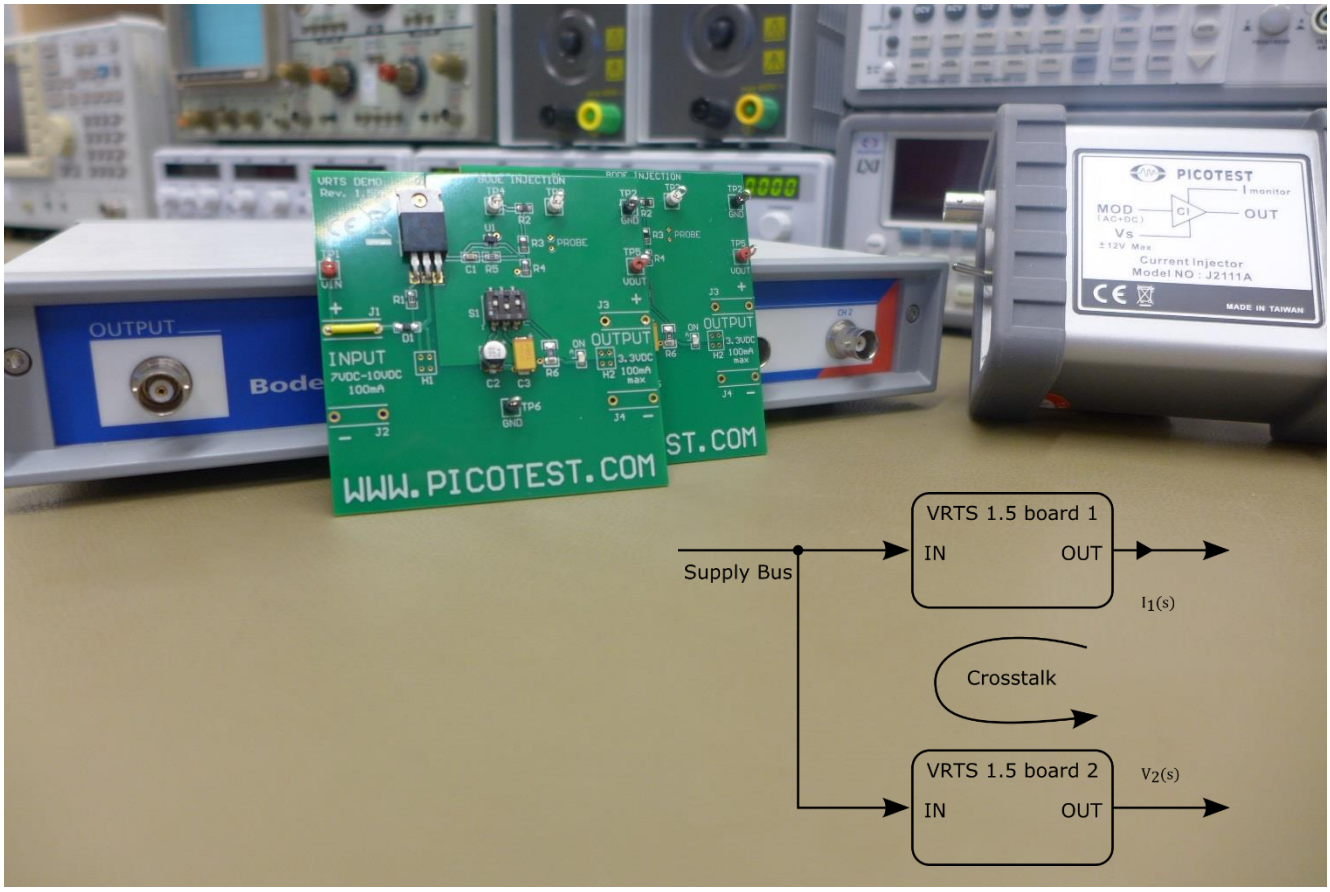
Bode 100 - Application Note

Power Supply Crosstalk Measurement

Using the Bode 100 and the Picotest J2111A Current Injector



By Florian Hämmerle & Steve Sandler

Visit www.omicron-lab.com for more information.
Contact support@omicron-lab.com for technical support.

Table of Contents

1 EXECUTIVE SUMMARY 3

2 MEASUREMENT SETUP & RESULTS 3

2.1 MEASUREMENT SETUP 4
2.2 DEVICE SETUP 6
2.3 MEASUREMENT 8

3 CONCLUSION 9

4 REFERENCES 9

Note: Basic procedures such as setting-up, adjusting and calibrating the Bode 100 are described in the Bode 100 user manual. You can download the Bode 100 user manual at www.omicron-lab.com/bode-100/downloads#3

Note: All measurements in this application note have been performed with the Bode Analyzer Suite V3.0. Use this version or a higher version to perform the measurements shown in this document. You can download the latest version at www.omicron-lab.com/bode-100/downloads

1 Executive Summary

This application note shows how the crosstalk characteristic of a system of two linear voltage regulators can be measured using the OMICRON Lab Bode 100 and the Picotest J2111A Current Injector. The same technique can be used to measure switching regulators as well.

The measurements are performed on Picotest Voltage Regulator Test Standard 1.5 (VRTS) which comes with one of the two needed regulators (TIP110) to perform the measurements shown in this document. Because we have only one regulator, we connect two boards with each other to measure the crosstalk between these two.

The VRTS 1.5 can be used to help performing a high variety of voltage regulator measurements using the Bode 100 in conjunction with the Picotest line of Signal Injectors.

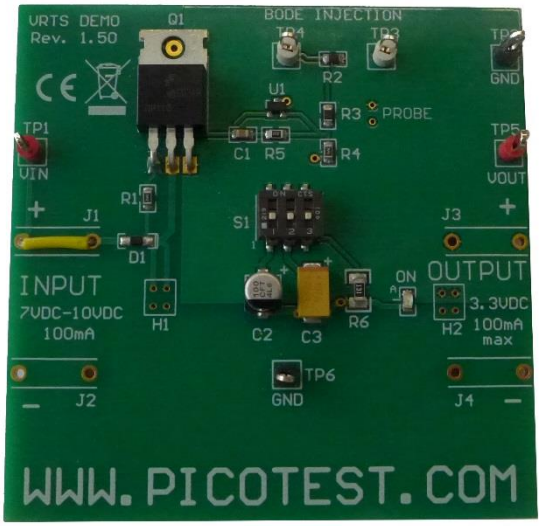


Figure 1: Voltage Regulator Test Standard board (VRTS 1.5)

2 Measurement Setup & Results

The Crosstalk characteristic is an important parameter of systems with multiple voltage regulators connected on one single supply bus.

It describes how a change in the output current (load current) of one regulator appears as an unwanted voltage change in the output voltage of another regulator.

The crosstalk characteristic CT is defined by

$$CT = 20 \cdot \log \frac{v_2}{i_1} \qquad (1)$$

where i_1 is the AC part of the load current of the first voltage regulator and v_2 is the voltage ripple of the output voltage of the second voltage regulator.

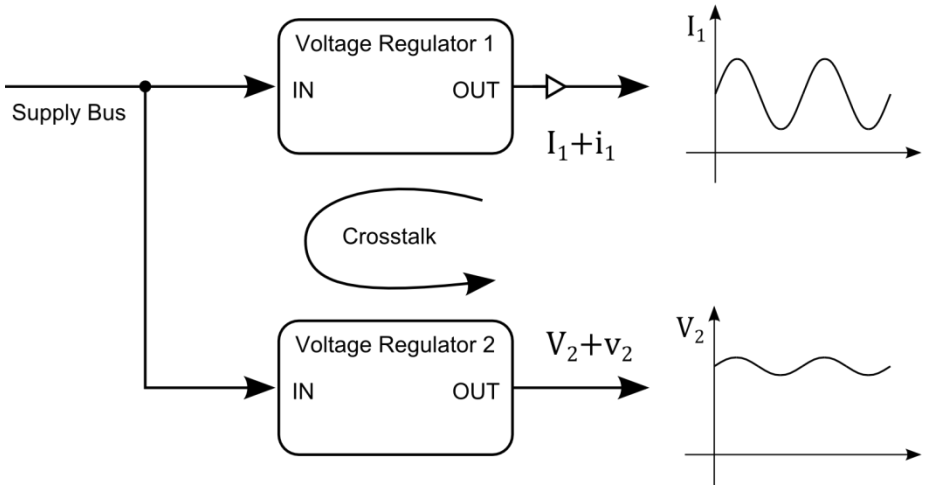


Figure 2: Measurement principle

The Crosstalk is closely related to the Reverse Transfer characteristic of the first regulator and the PSRR[1] of the second regulator. Information on how to measure the Reverse Transfer and PSRR can be found under the application note section of our webpage: https://www.omicron-lab.com/bode-100/application-notes-know-how/application-notes.html

2.1 Measurement Setup

The Crosstalk can be measured by applying a sinusoidal ripple on the load current of the first regulator and measuring the gain factor between the output current and the output voltage ripple of the second regulator.

The Picotest J2111A Current Injector adds a modulated output current, in parallel to any other particular loading that is applied. The added current is modulated according to the sinusoidal output voltage of the Bode 100. The Crosstalk is then measured by comparing the modulated load current with the output voltage of the second voltage regulator.

[1] Power Supply Rejection Ratio

The following figure shows the crosstalk measurement setup:

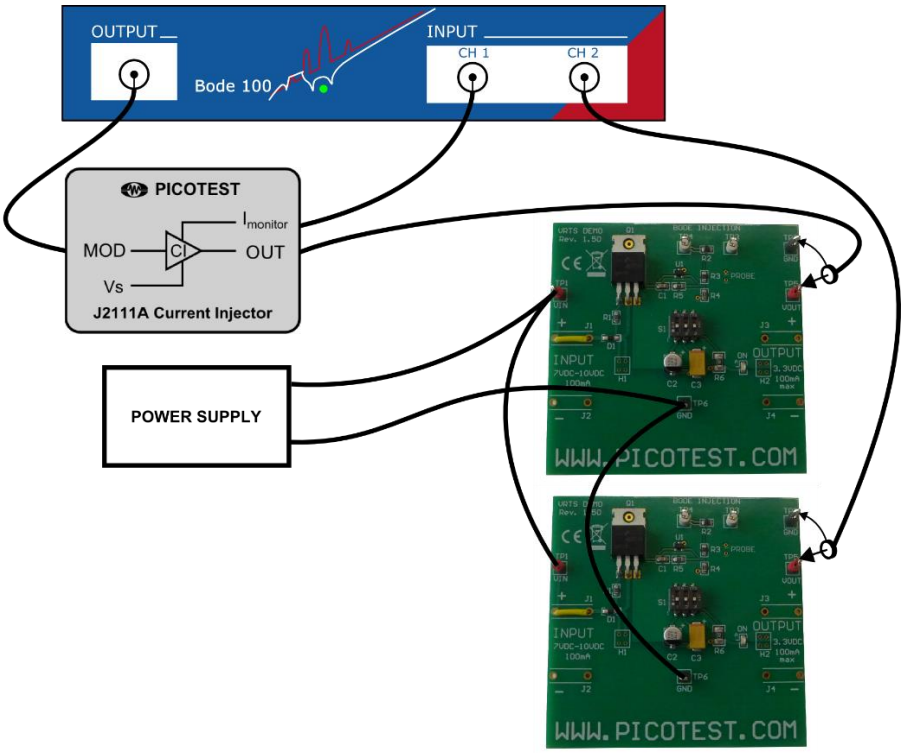


Figure 3: Connection setup

The J2111A Current Injector can also act as a load for the voltage regulator. To achieve this, switch on the +bias of the J2111A resulting in a constant current load of 25 mA. The Bode 100 and the Current Injector are connected to the VRTS board as shown in the following picture:

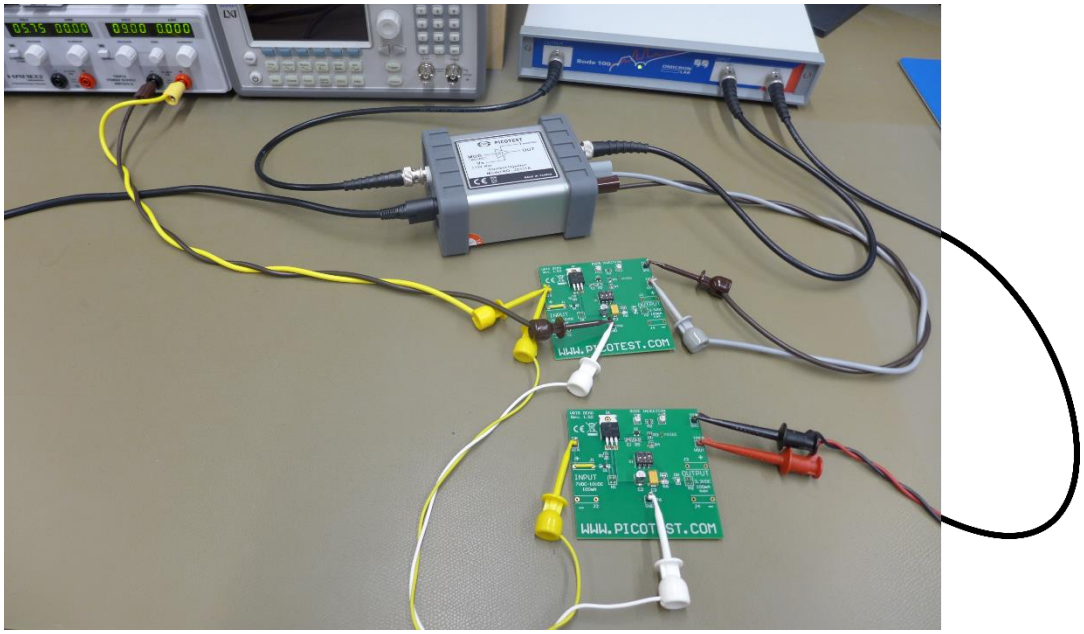


Figure 4: Setup with 2 VRTS 1.5 boards

2.2 Device Setup

The crosstalk measurement can be performed directly with the Bode 100 using the Gain / Phase measurement type. The Bode 100 is set up as follows:

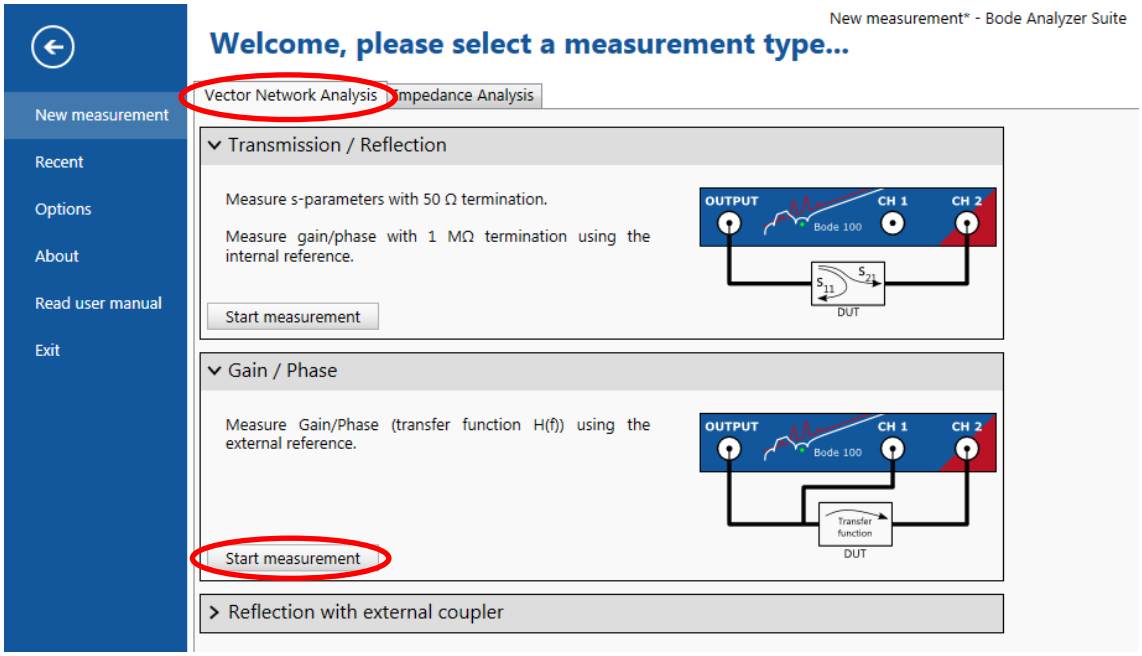


Figure 5: Start menu

Start Frequency:	10 Hz
Stop Frequency:	10 MHz
Sweep Mode:	Logarithmic
Number of Points:	201 or more
Level:	13 dBm
Attenuator 1:	20 dB
Attenuator 2:	20 dB
Receiver Bandwidth:	100 Hz

To check the internal settings click on the *Hardware Setup* button.

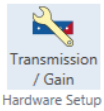


Figure 6: open *Hardware Setup*

This will lead us to the hardware setup window where the channel 1 can be set to 50 Ω because the Picotest J2111A current injector is connected there.

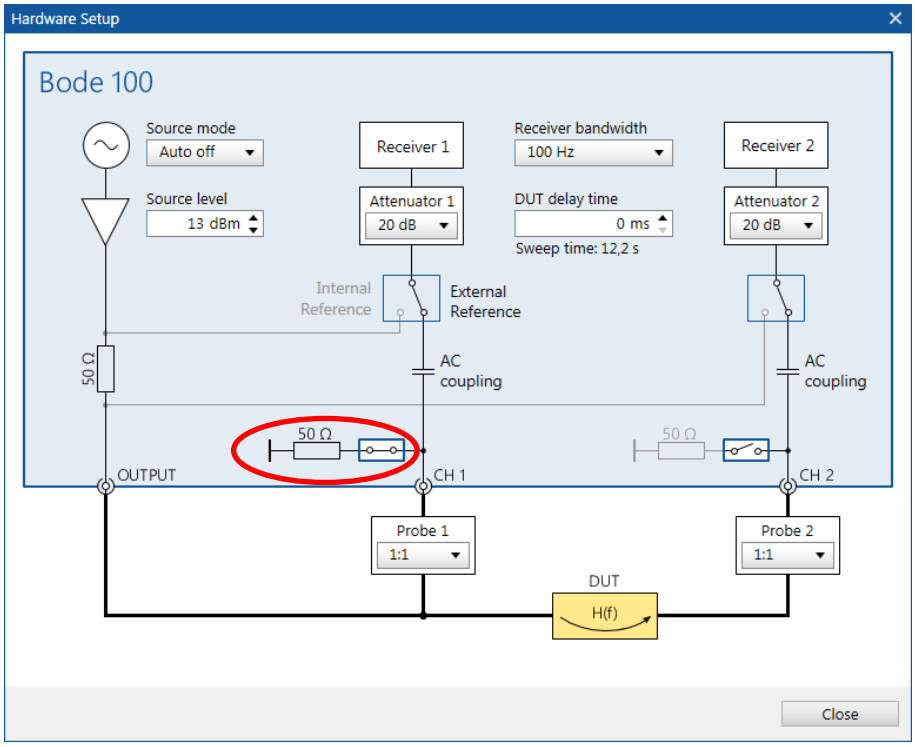


Figure 7: Hardware Setup window

Set Trace 1 Format to Magnitude (dB).

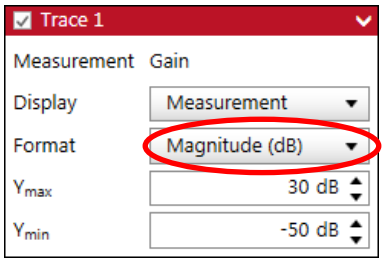


Figure 8: Settings Trace 1

2.3 Measurement

Performing a single sweep leads to the following crosstalk plot:

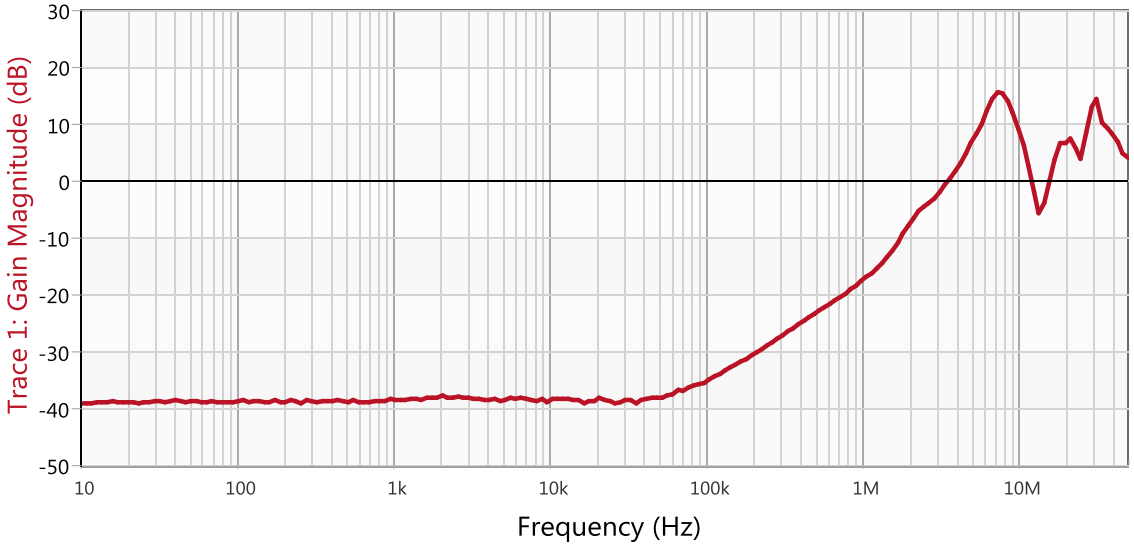


Figure 9: Crosstalk – Gain Magnitude

From the measurement result can be seen that the crosstalk from regulator 1 to regulator 2 is very high in the high frequency range.

Output Capacitor:

Adding capacitor no. 2 (100µF aluminum capacitor) to the output of the second regulator and restarting the measurement leads to the following result:

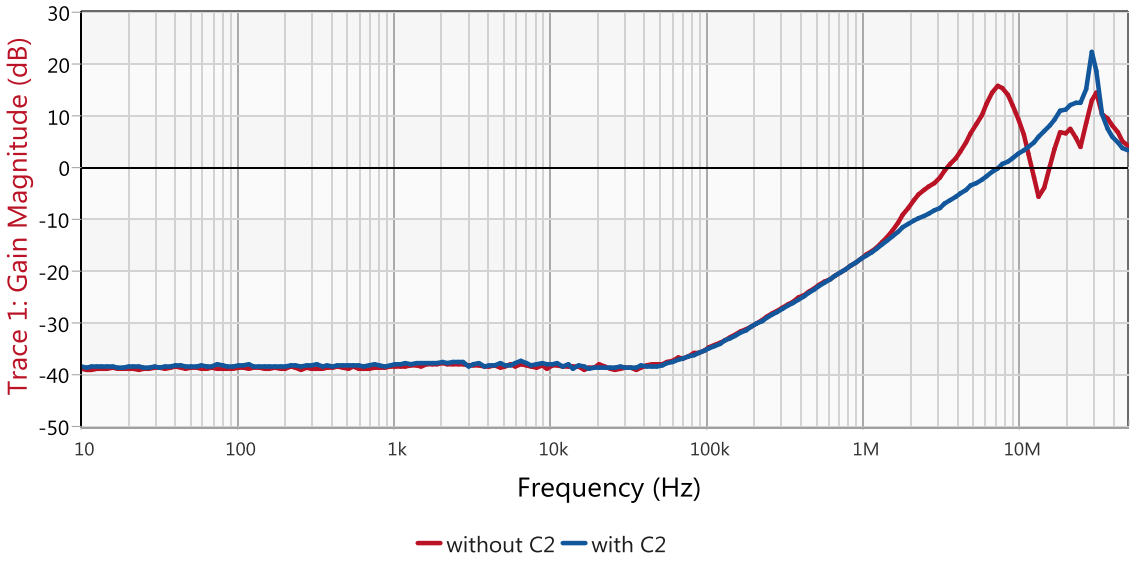


Figure 10: Crosstalk – Gain Magnitude (with C3 in comparison to without C3)

The output capacitor of the second regulator reduces the high frequency ripple on the regulator output which results in less crosstalk.

Directivity:

Reversing the measurement shows that crosstalk characteristic can be directive. The load current excitation is now applied to regulator 2 and the voltage ripple measured at the output of regulator 1. Starting a sweep leads to the following result:

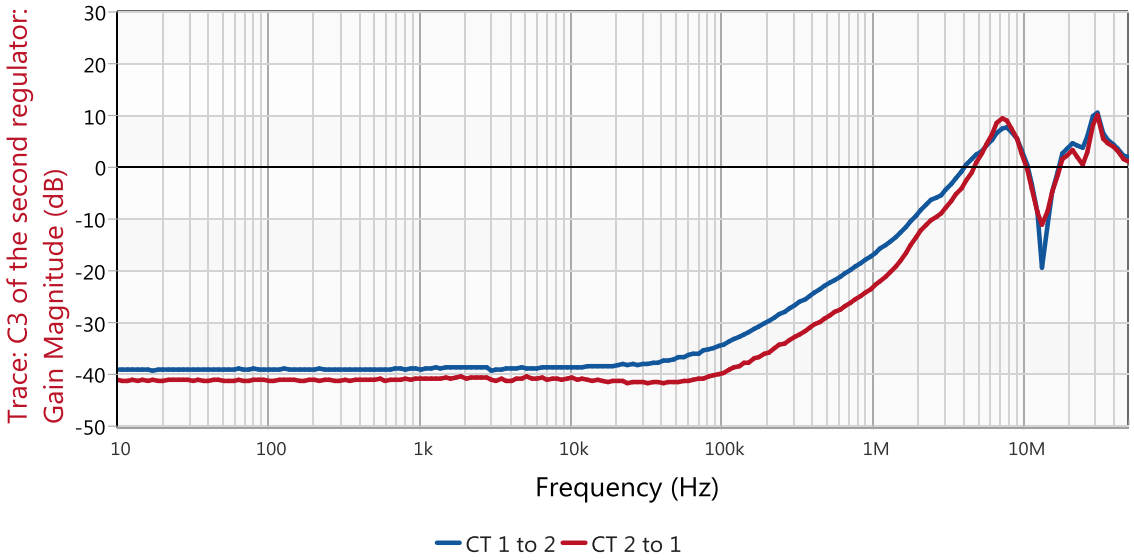


Figure 11: Crosstalk – Gain Magnitude (reversed measurement)

The red line shows the result for the crosstalk from regulator 2 to regulator 1. The result differs a little bit from the previous measurement (blue line) showing the directivity of the measurement.

3 Conclusion

Crosstalk is an important measure for power supply systems with multiple voltage regulators connected to a supply bus. The crosstalk is strongly related to the Reverse Transfer characteristic and the PSRR of the regulators. Input and output filters do strongly influence the crosstalk result.

The Bode 100 in combination with the J2111A Current Injector offers a test set that enables simple and fast crosstalk measurements in a wide frequency range.

4 References

1 **Picotest.** Voltage Regulator Test Standard. *Version 1.5.*
2 Signal Injector Documentation. *Version 1.9c. 2010.*

OMICRON Lab is a division of OMICRON electronics specialized in providing Smart Measurement Solutions to professionals such as scientists, engineers and teachers engaged in the field of electronics. It simplifies measurement tasks and provides its customers with more time to focus on their real business.

OMICRON Lab was established in 2006 and is meanwhile serving customers in more than 50 countries. Offices in America, Europe, East Asia and an international network of distributors enable a fast and extraordinary customer support.

OMICRON Lab products stand for high quality offered at the best price/value ratio on the market. The products' reliability and ease of use guarantee trouble-free operation. Close customer relationship and more than 30 years in-house experience enable the development of innovative products close to the field.

Europe, Middle East, Africa
OMICRON electronics GmbH
Phone: +43 59495
Fax: +43 59495 9999

Asia Pacific
OMICRON electronics Asia Limited
Phone: +852 3767 5500
Fax: +852 3767 5400

Americas
OMICRON electronics Corp. USA
Phone: +1 713 830-4660
Fax: +1 713 830-4661

info@omicron-lab.com • www.omicron-lab.com