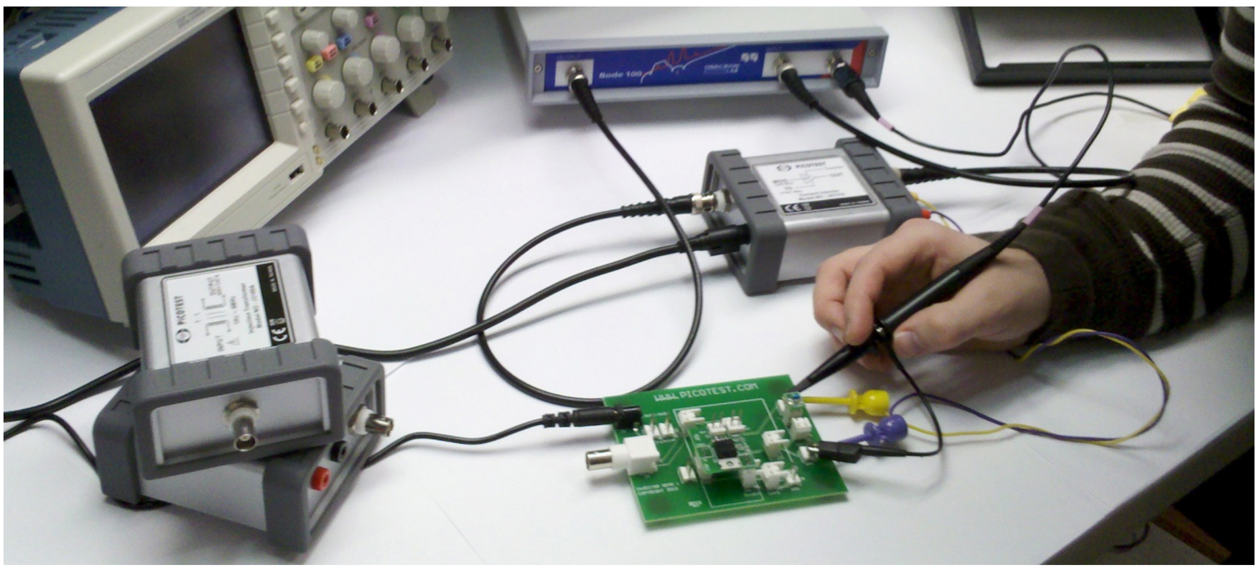
Reverse Transfer Measurement

Using the Bode 100 and the Picotest J2111A Current Injector



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Contact support@picotest.com for technical support.

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Notes: Basic procedures such as setting-up, adjusting and calibrating the Bode 100 are described in the Bode 100 user manual.

The Picotest J2110A Current Injector does not require calibration.

All measurements in this application note have been performed with the OMICRON Lab Bode 100 Analyzer Suite V2.31. Use this version or a higher version to perform the measurements detailed in this application note.

You can download the latest version at http://www.omicron-lab.com/downloads.html.

You can download the latest Picotest Injector manual at https://www.picotest.com/support.html.

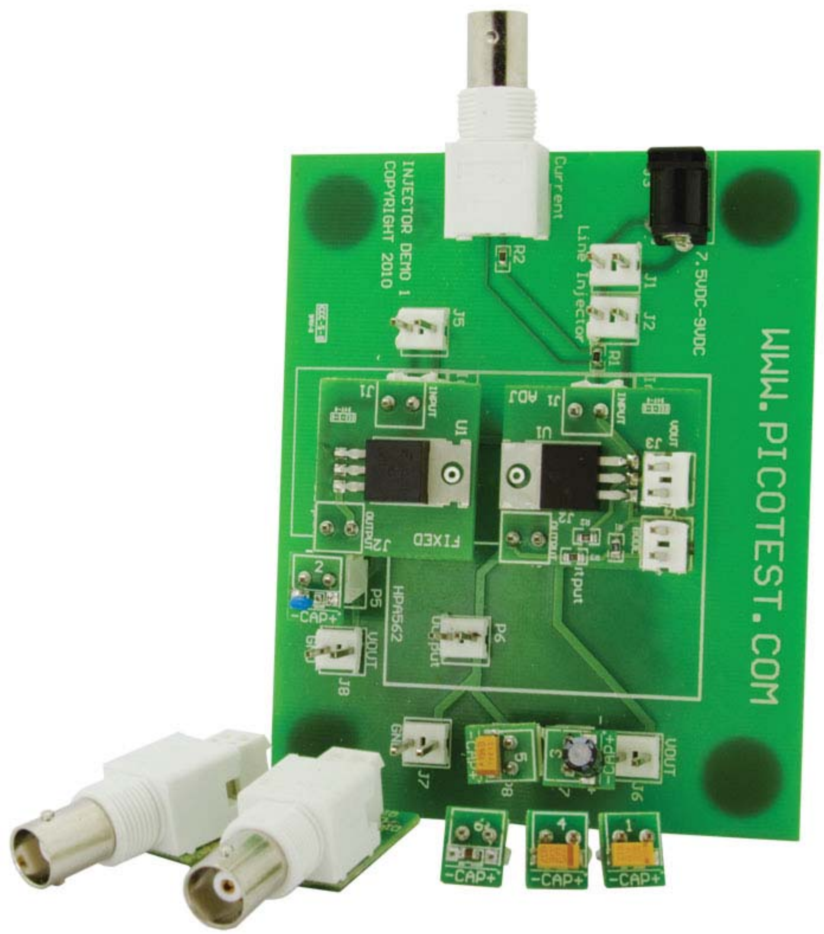
1 Executive Summary

This application note shows how the reverse transfer characteristic of a linear voltage regulator (LM317) 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 the Picotest Voltage Regulator Test Standard (VRTS) testing board[1]Picotest.

2 Measurement Task

The VRTS can be used to help perform most of the common voltage regulator measurements using the Bode 100 in conjunction with the Picotest line of Signal Injectors. The VRTS kit includes the regulators and capacitors used for the measurements in this application note.



Voltage Regulator Test Standard board, Source (1)

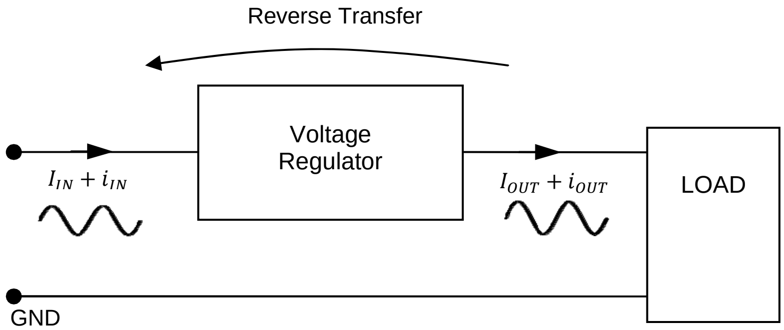
[1] See: http://www.picotest.com/products_injectors.html

3 Measurement Setup & Results

The Reverse Transfer characteristic describes how a change in the output current (load current) passes through the voltage regulator to the supply side. We define the reverse transfer to be measured in dB and, therefore:

$$RT \equiv 20 \cdot \log \frac{i_{OUT}}{i_{IN}}$$

where i_{OUT} and i_{IN} are the AC ripple of the input and output current, respectively.

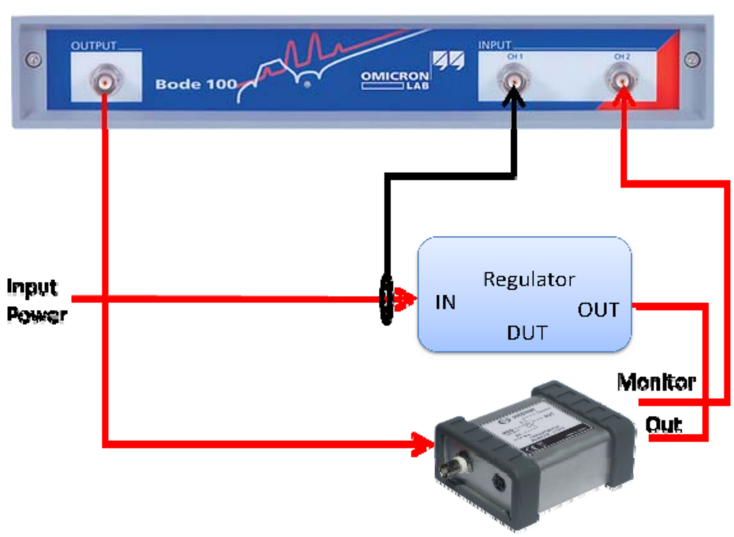


In general, the low frequency reverse transfer of a series voltage regulator will be 0 dB as the current that flows out of the output also flows into the input. This result is impacted by the stability of the regulator.

3.1 Measurement Setup

The Reverse Transfer can be measured by applying a sinusoidal ripple on the load current and measuring the gain from the output current to the input current of the regulator.

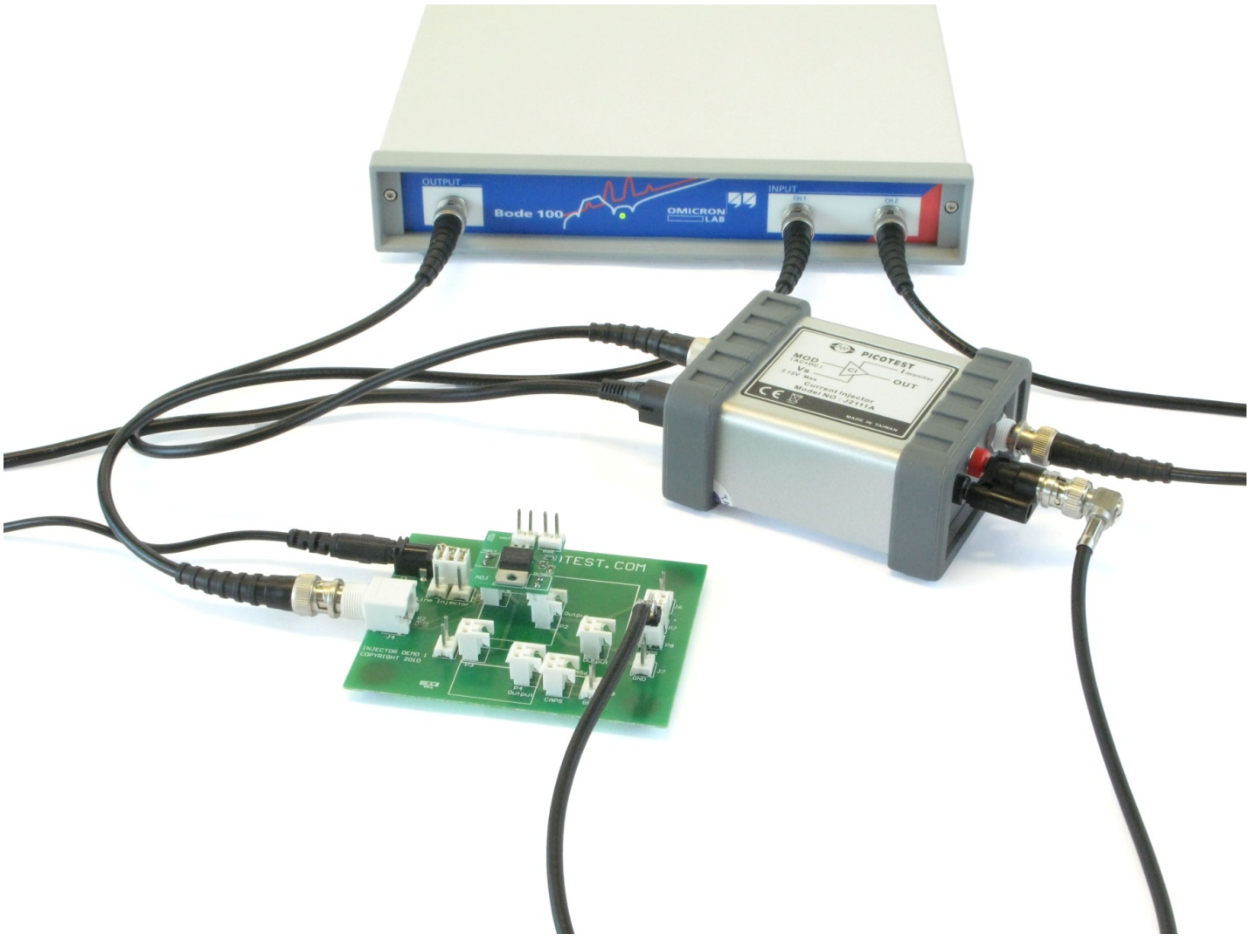
The Picotest J2111A Current Injector modulates the output current, in parallel with any other particular loading that is applied, according to the sinusoidal output voltage of the Bode 100. The reverse transfer is then measured by comparing the output current to the input current of the voltage regulator. The following figure shows the principle measurement setup:



Reverse Transfer measurement setup, Source (1)

The J2111A Current Injector can also act as a load for the voltage regulator. To do that we 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:

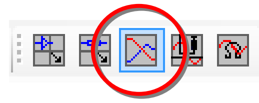


Reverse Transfer example measurement setup.

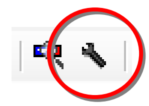
3.2 Device Setup

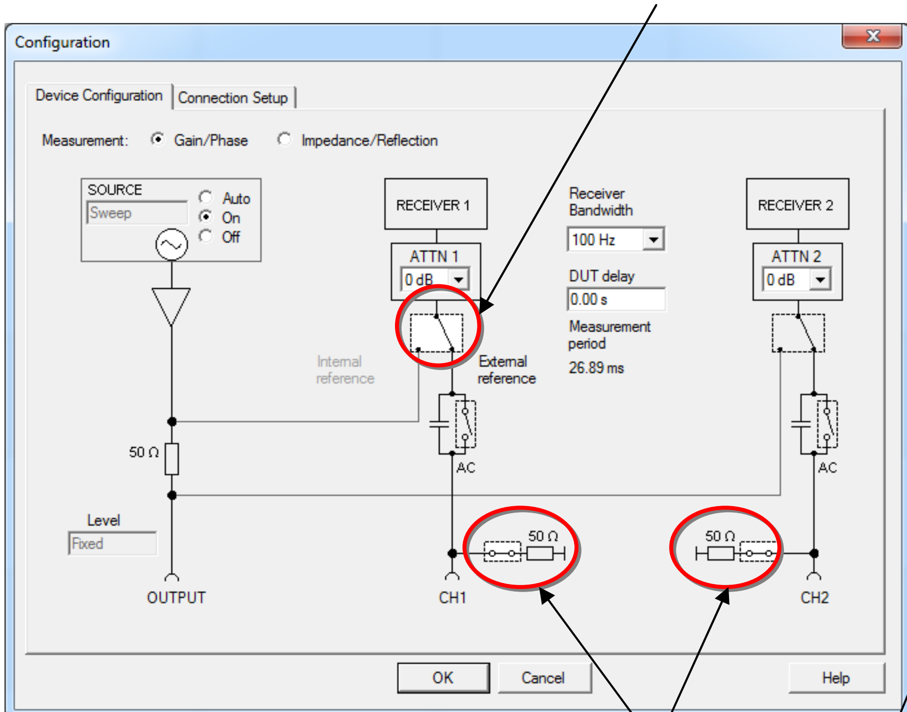
The Reverse transfer measurement can be performed directly with the Bode 100 using the external reference. The Bode 100 is set-up as follows:

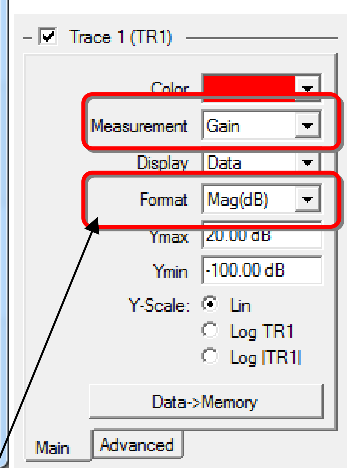
Measurement Mode:	Frequency Sweep Mode
Start Frequency:	10 Hz
Stop Frequency:	10 MHz
Sweep Mode:	Logarithmic
Number of Points:	201 or more
Receiver Bandwidth:	100 Hz
Attenuator 1 &2:	0 dB
Level:	10 dBm



To switch on the external reference start the device configuration window and click on the external reference switch symbol:





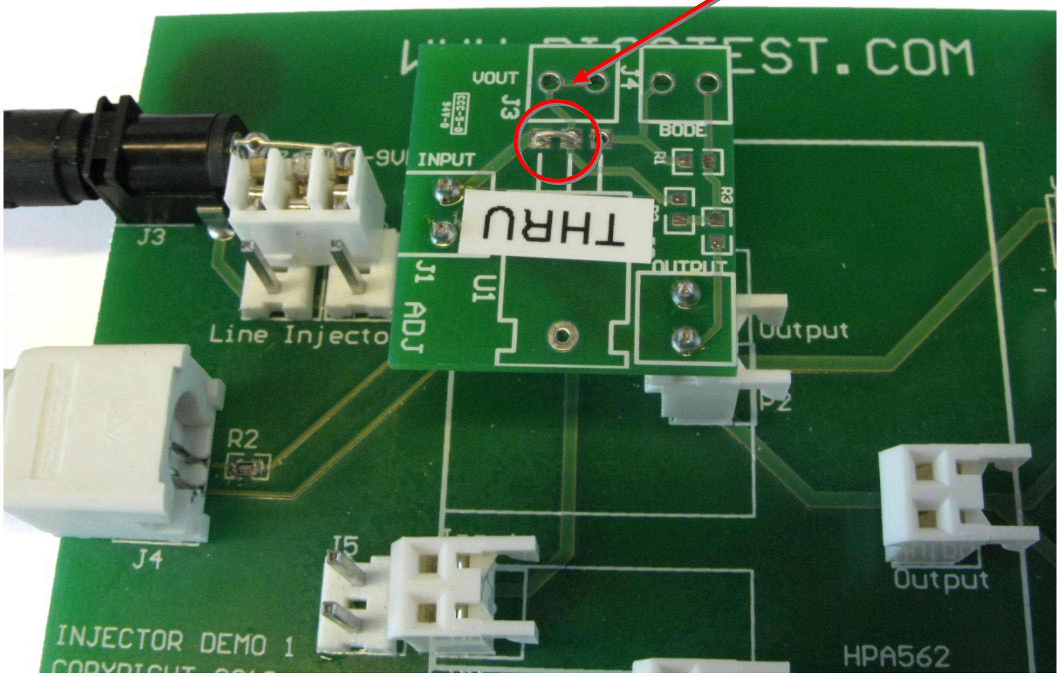


Both channels are set to 50Ω input impedance.

Trace 1 Measurement is set to Gain and Format to Mag(dB).

3.3 Calibration

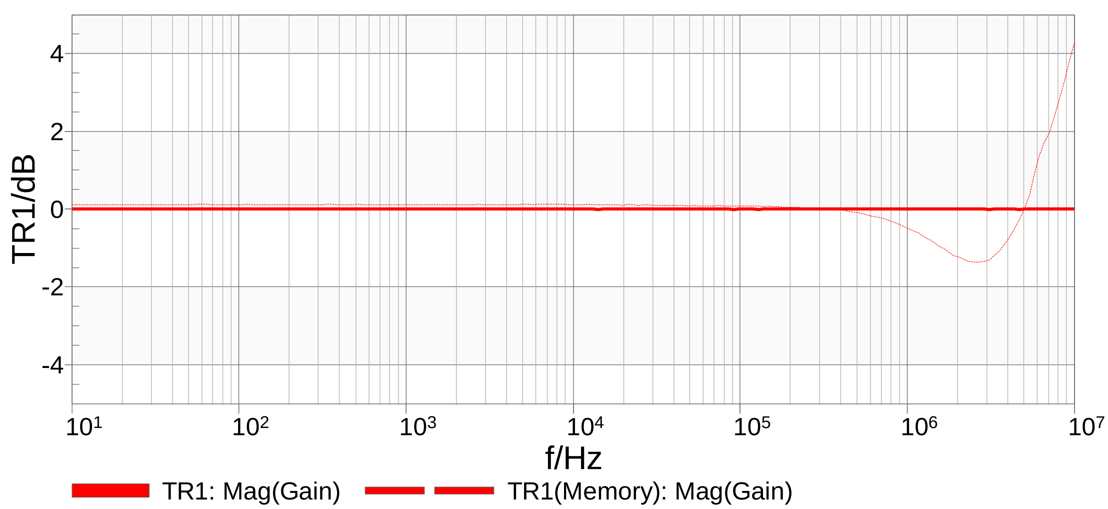
To remove the influence of crosstalk on the measurement result it is recommended that a “thru” calibration be performed. During the calibration, the LM317 is replaced by a short connection board as shown in the picture below.



Short connection during THRU calibration.

It is also recommended that a “probe” calibration be performed. To do this, the thru board has to be connected as shown in the picture above.

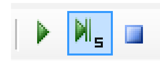
The graph below shows the influence of the calibration. The thin line shows the gain response of the thru-board before calibrating and the thick line after calibration:

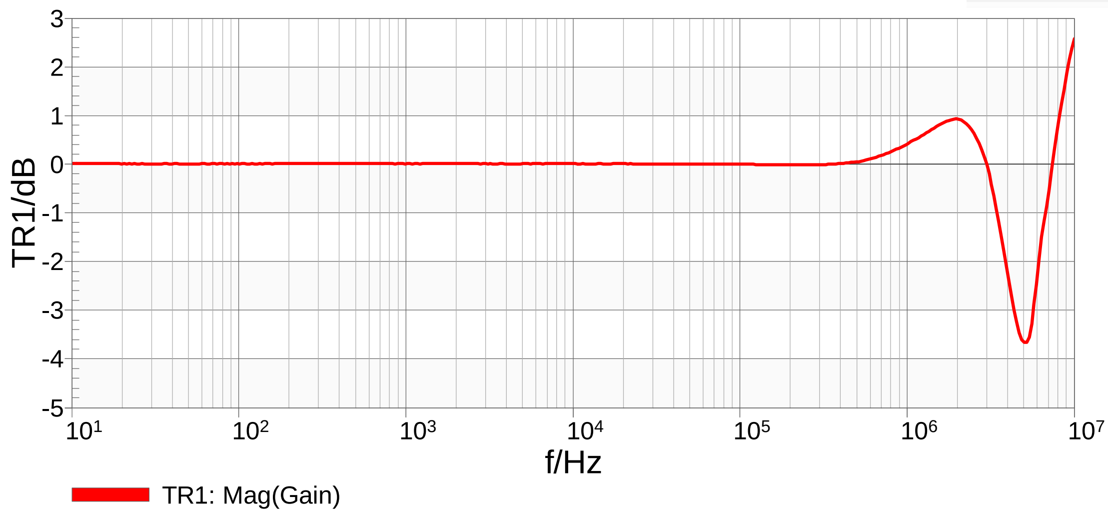


Before and after THRU calibration.

You can get started with the measurement using the setup and calibration shown above.

Performing a single sweep leads to the following Reverse Transfer:





Reverse Transfer plot.

As mentioned in the beginning, the reverse transfer of the LM317 at low frequencies equals 0dB.

4 Conclusion

Reverse transfer is an unappreciated and rarely discussed characteristic, defining the attenuation of the load current perturbations at the regulator input. When multiple regulators are connected to the same input bus, poor Reverse Transfer of one regulator could potentially cause noise or oscillations at the output of another. This effect is particularly damaging if a regulator has poor Power Supply Rejection Ratio, or PSRR performance.

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

References

1. Voltage Regulator Test Standard. Version 1.0c. 2010.
2. Signal Injector Documentation. Version 1.0c. 2010.