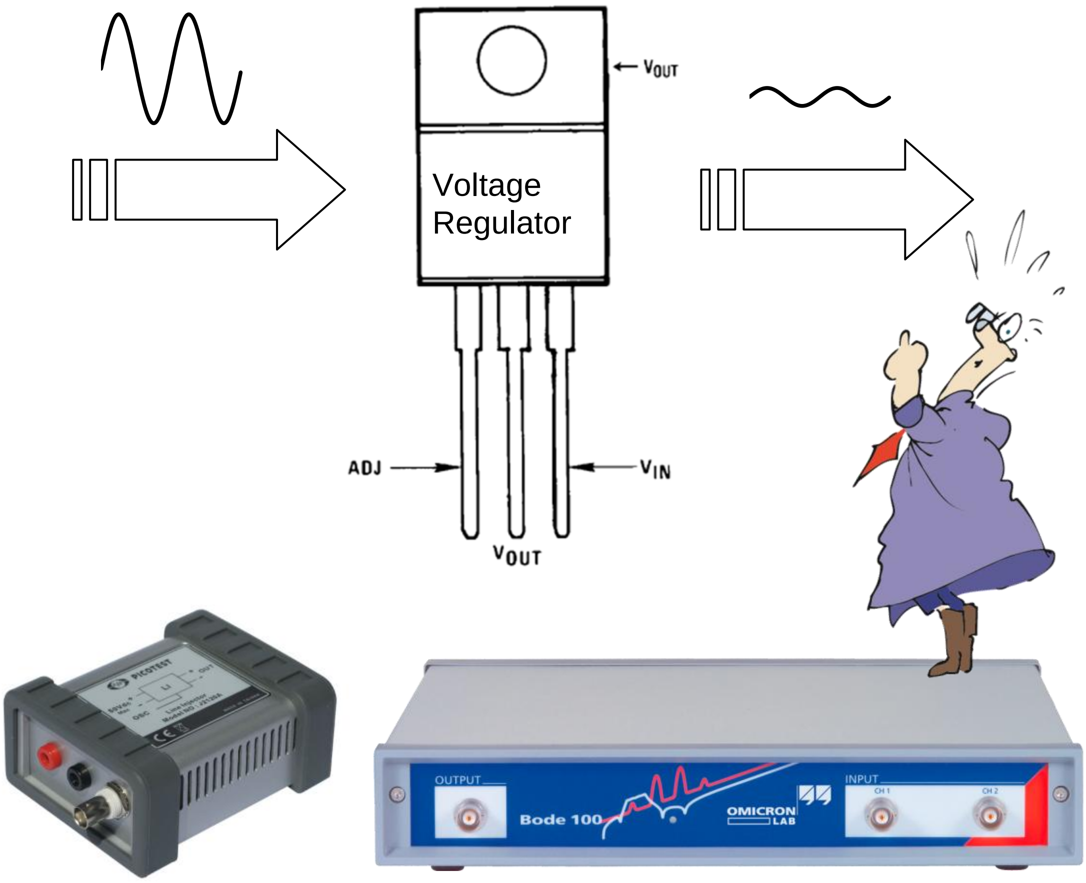
Power Supply Rejection Ratio Measurement

Using the Bode 100 and the Picotest J2120A Line 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 Task 4
3 Measurement Setup & Results 5
3.1 Measurement Setup 5
3.2 Device Setup 7
3.3 Calibration 8
3.4 Measurement 8
4 Conclusion 9

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

The Picoest J2120A Line Injector does not require calibration.

Note: All measurements in this application note have been performed with the Bode 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 http://www.picotest.com/products_injectors.html.

1 Executive Summary

This application note shows how the Power Supply Rejection Ratio, or PSRR of a linear voltage regulator (LM317) can be measured using the Bode 100 and additional accessories.

The same techniques can be used to measure switching regulators as well.

The measurements are performed on the PICOTEST Voltage Regulator Test Standard (VRTS) testing board[1] using the PICOTEST J2120A Line Injector.

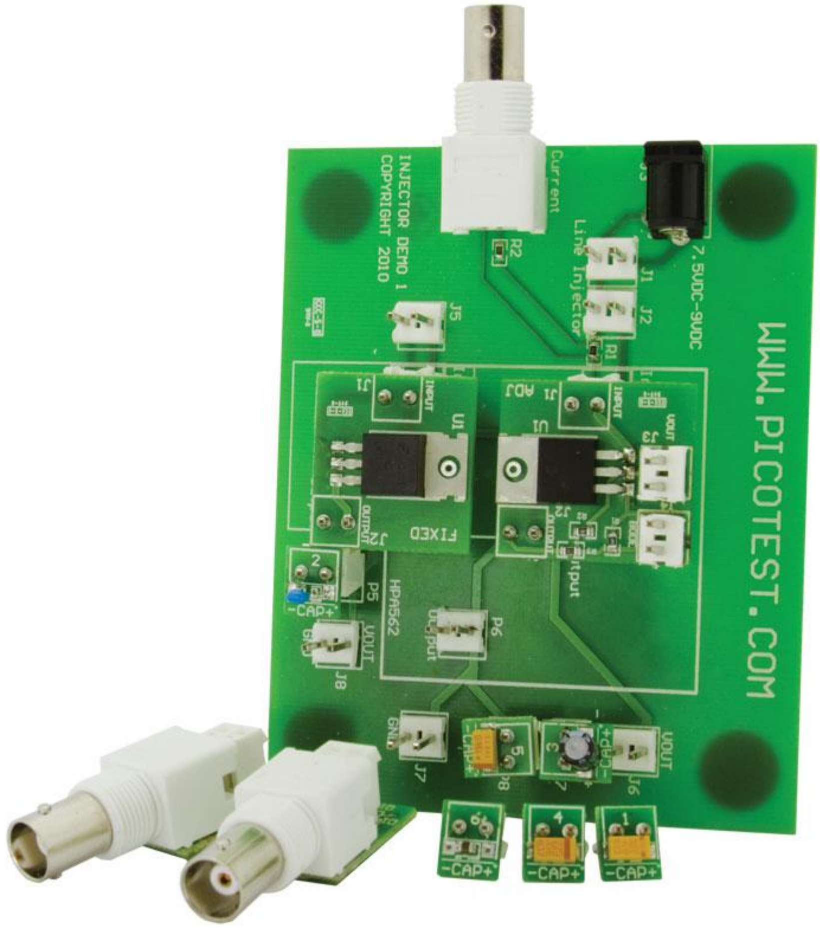
[1] See: http://www.picotest.com/products_injectors.html

2 Measurement Task

The PSRR of the LM317 linear voltage regulator is measured with the Bode 100 and the PICOTEST J2120A line injector.

A capacitor is then connected to the output of the regulator and the PSRR is again measured from 10 Hz to 10 MHz.

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



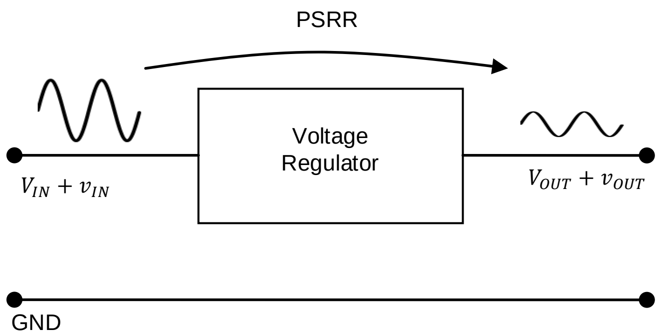
Voltage Regulator Test Standard board, Source (1)

3 Measurement Setup & Results

The PSRR describes how a signal on the DC input voltage of the regulator system is transmitted to the regulated output. The PSRR is generally measured in dB and defined to be:

$$PSRR \equiv 20\ \log \frac{v_{OUT}}{v_{IN}}$$

Where v_{OUT} and $v_{IN}$are the AC ripple of the input and output voltage, respectively.

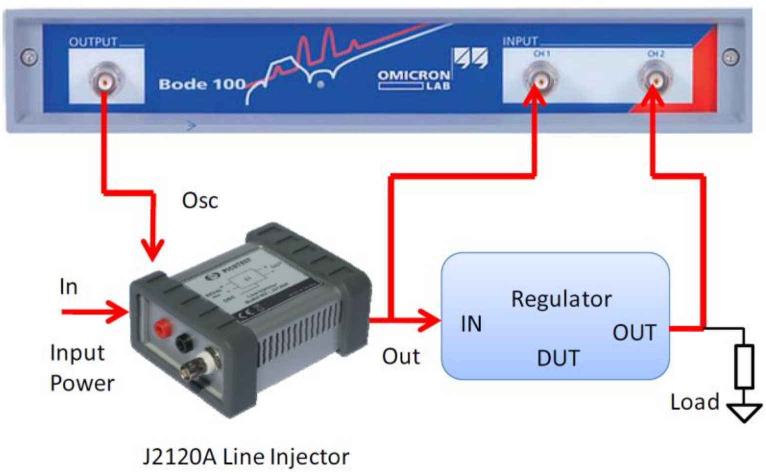


Depending on the definition the PSRR can be a negative or positive number. Using the above definition, the PSRR generally is a negative number.

3.1 Measurement Setup

The PSRR can be measured by applying a sinusoidal ripple on the supply voltage and measuring the gain from input to output of the regulator.
The PICOTEST J2120A Line Injector allows you to add the sinusoidal output voltage of the Bode 100 to the DC-supply voltage of the regulator. The PSRR is then measured by connecting two voltage probes to the input and output of the regulator. In this case two 1:1 voltage probes are used.

The following figure shows the principle measurement setup:

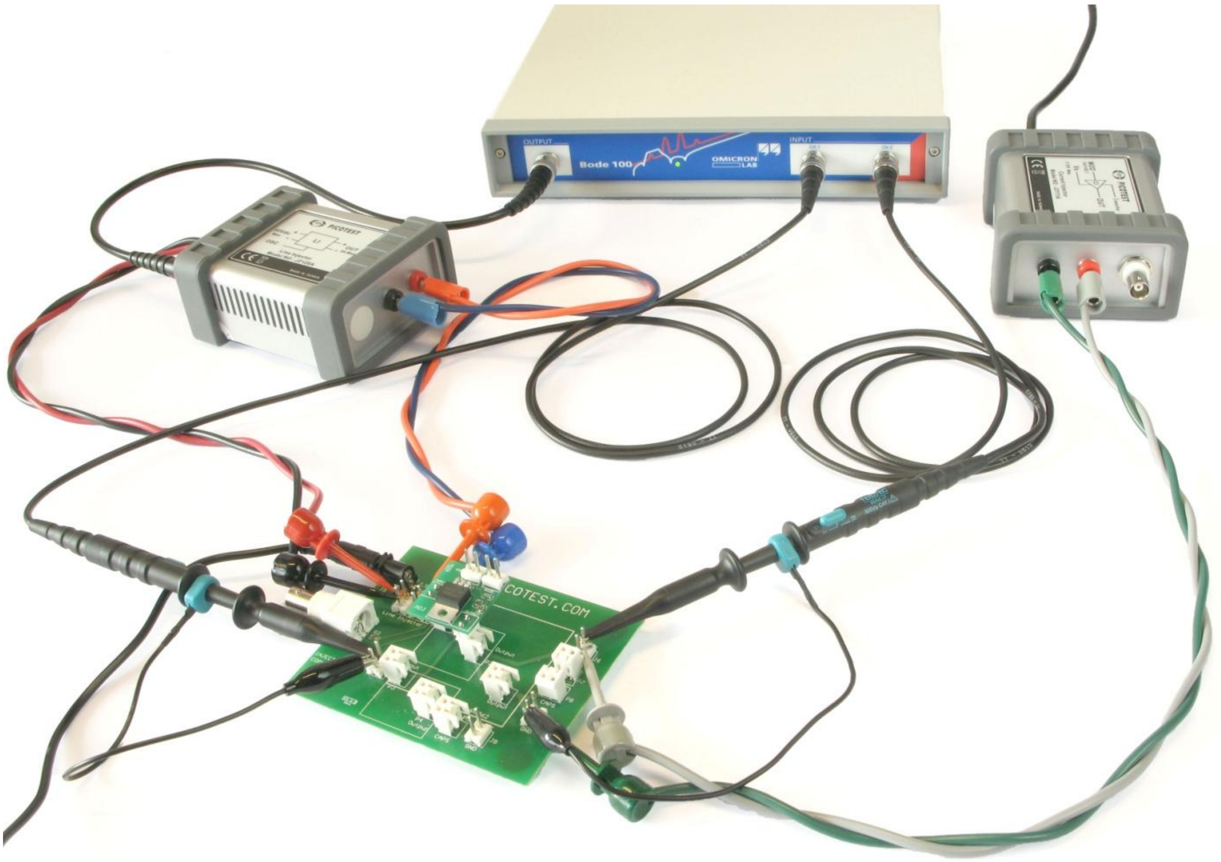


PSRR measurement setup, Source (1)

Note:
The output impedance of the J2120A is slightly resistive. An input capacitor on the regulator would, therefore, create a low pass network and change the PSRR results. The measurements shown in this application note are performed without an input capacitor!

The Picotest J2111A Current Injector acts as a load for the voltage regulator. The +bias of the J2111A is switched on resulting in a constant current load of 25 mA.

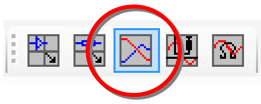
The voltage probes and injectors are connected to the Bode 100 and the VRTS board as shown in the following picture:



PSRR example measurement setup

3.2 Device Setup

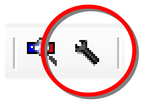
The PSRR measurement can be performed directly with the Bode 100 using the external reference. The Bode 100 is set up as follows:

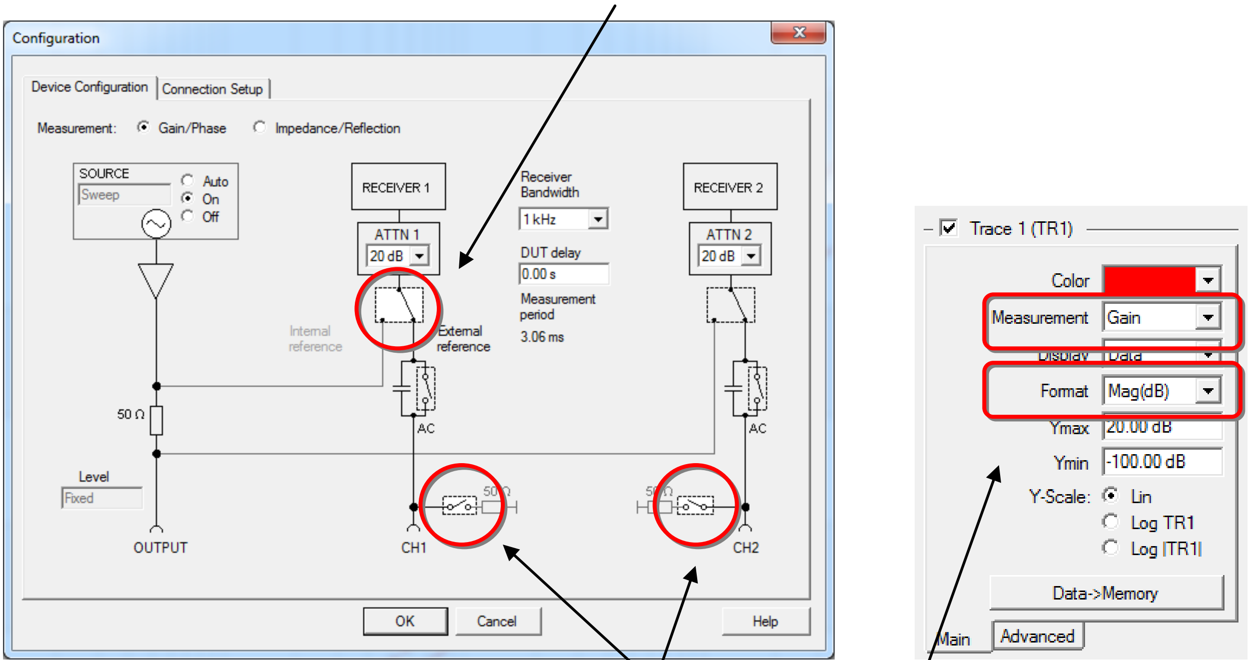
Measurement Mode: Frequency Sweep Mode 
Start Frequency: 10 Hz
Stop Frequency: 10 MHz
Sweep Mode: Logarithmic
Number of Points: 401 or more
Receiver Bandwidth: 100 Hz
Attenuator 1 &2: 10 dB
Level: -10 dBm

Note:
When the Bode 100 is used with the J2120A the output level should be set in the range from -20 to 10 dBm. The PSRR measurement is a small signal measurement and so the goal is only to maintain a level above the noise floor.

Note:
Use of the full speed mode is **not** recommended for measurements with the J2120A.

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



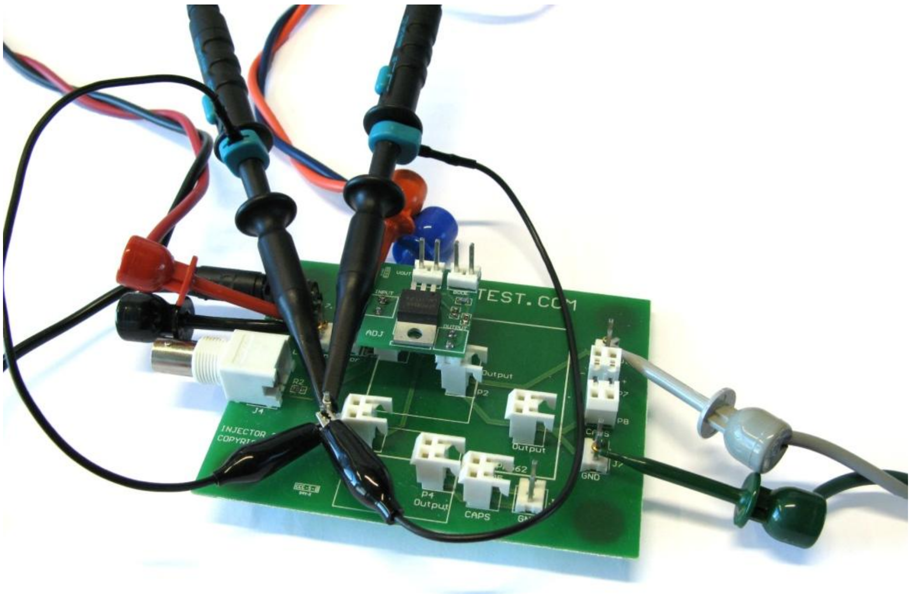


Both channels are set to high input impedance.

Trace 1 measurement is set to gain and the format to Mag(dB).

3.3 Calibration

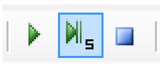
If two dissimilar probes are used for the measurements a thru calibration has to be performed before the measurement is carried out. During the thru calibration both probes have to be connected to the input point as shown on the following picture:

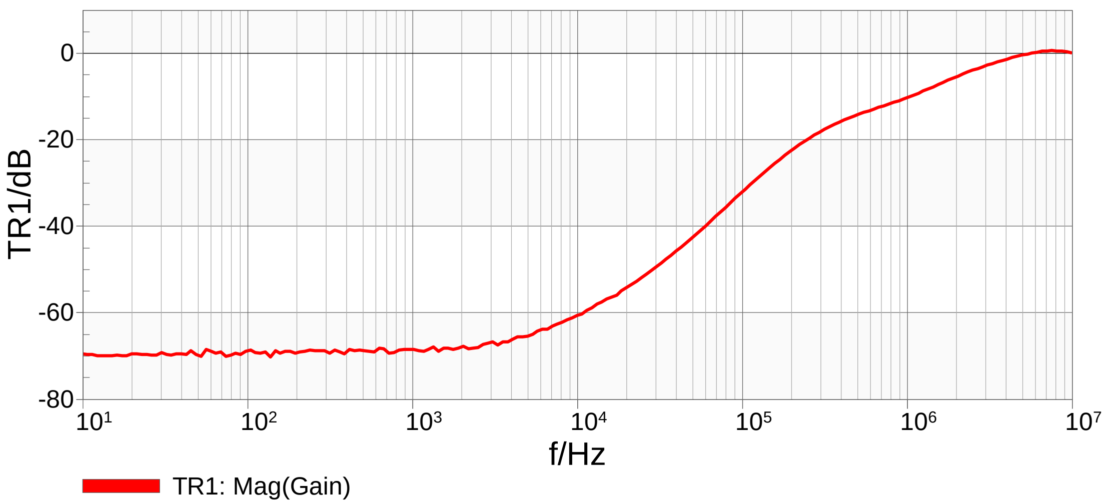


Probe connection during thru calibration

3.4 Measurement

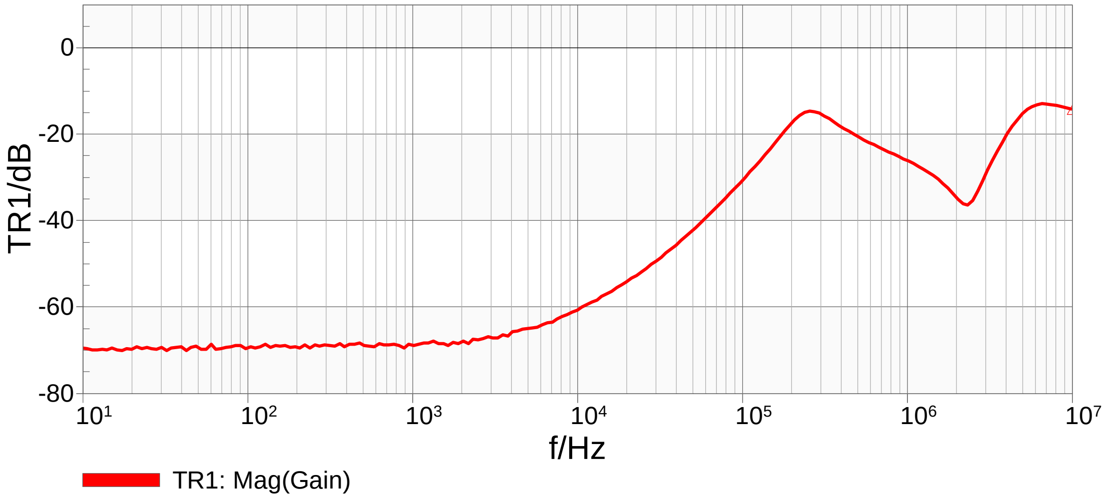
You can get started using the settings and setup from above the measurement.

Performing a single sweep leads to the following PSRR curve: 



At low frequencies the PSRR is very high which results in high suppression of disturbances from the supply line. In the higher frequency area of > 1 MHz the PSRR gets very small and even reaches 0 dB at 6 MHz. This means that a 6 MHz signal would pass through the regulator without attenuation.

To see the influence of an output capacitor on the PSRR the VRTS capacitor No.2 is connected to the regulator output. This 0.1 µF ceramic capacitor changes the PSRR curve as follows:



The PSRR does not drop below an attenuation of about 10 dB.

4 Conclusion

The Bode 100 in combination with the J2120A Line Injector offers a test set that enables simple and fast PSRR measurements in a wide frequency range starting at 10 Hz and reaching 10 MHz.

No injection transformer is necessary for the test set. This setup allows you to measure the PSRR even in systems with high DC currents up to 5 A without the danger of destroying an expensive transformer.

References:

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