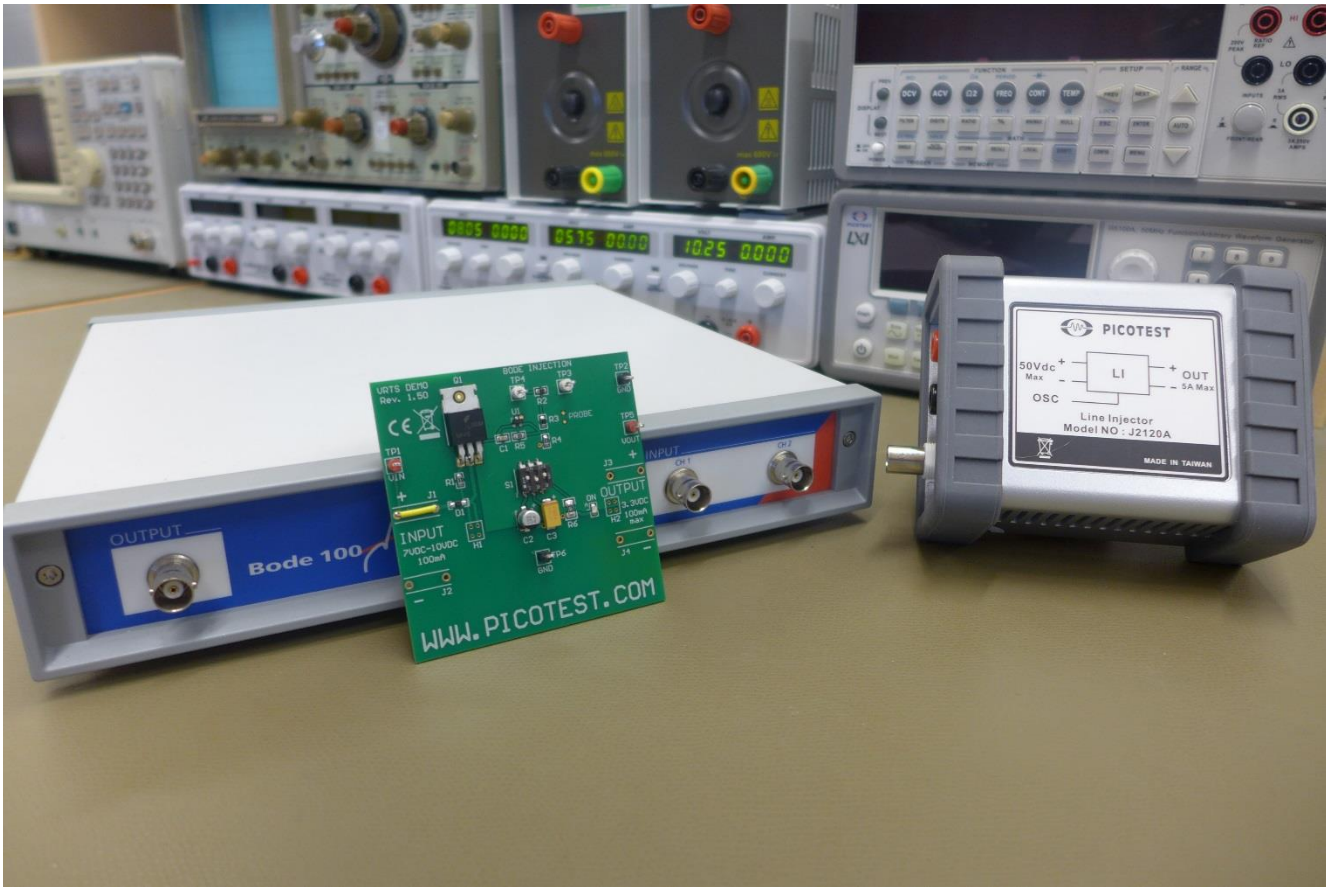
Bode 100 - Application Note

Power Supply Rejection Ratio Measurement

Using the Bode 100 and the Picotest J2120A Line Injector



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

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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

The Picotest J2120A Line Injector does not require calibration.

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 Power Supply Rejection Ratio, or PSRR of a linear voltage regulator (TIP120) 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 Rev. 1.5 using the PICOTEST J2120A Line Injector.

2 Measurement Task

The PSRR of the TIP120 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 1.5 is used as the basis for the testing. The VRTS 1.5 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 1.5 board includes the regulator and output capacitors as well as a load used for the measurements in this application note.

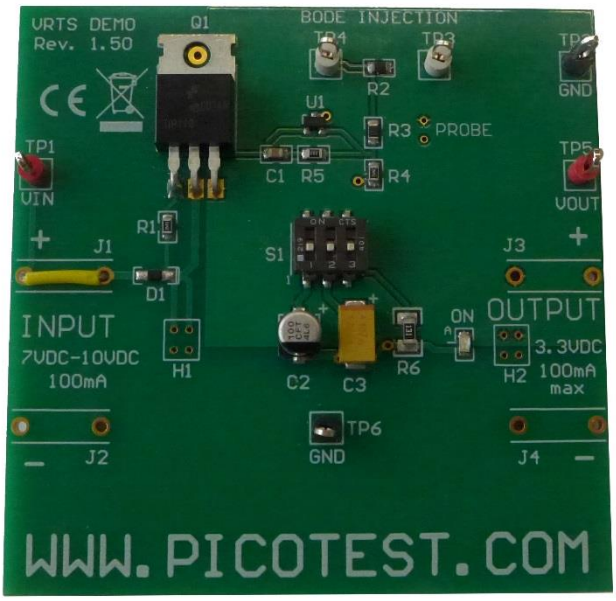

Figure 1: Voltage Regulator Test Standard board (VRTS 1.5)

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:

$$PSRR = 20 \cdot \log \frac{v_{OUT}}{v_{IN}}$$

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

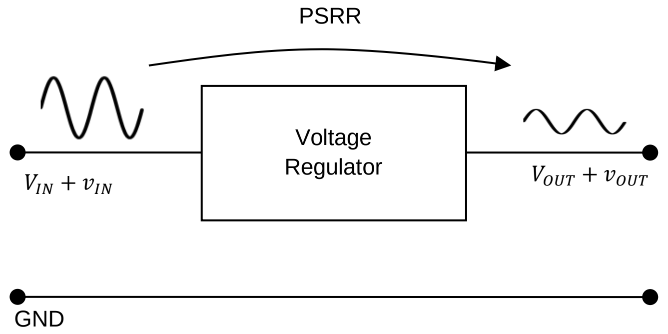

Figure 2: Measurement principle

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.

The following figure shows the principle measurement setup:

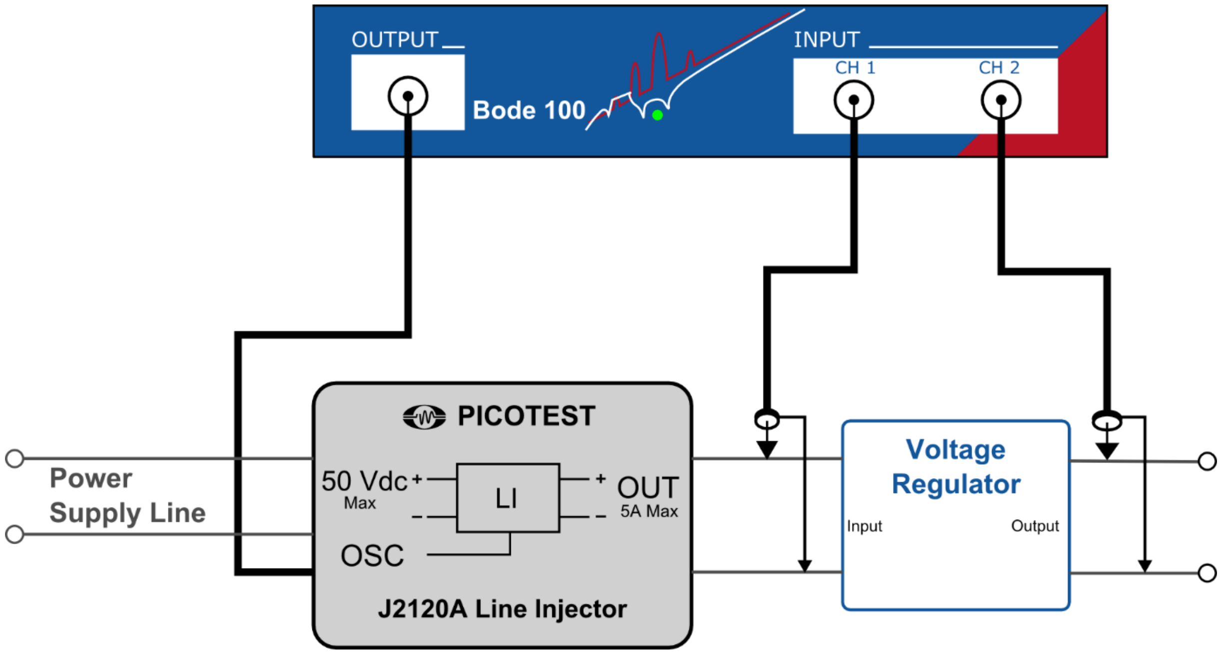

Figure 3: PSRR measurement setup

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

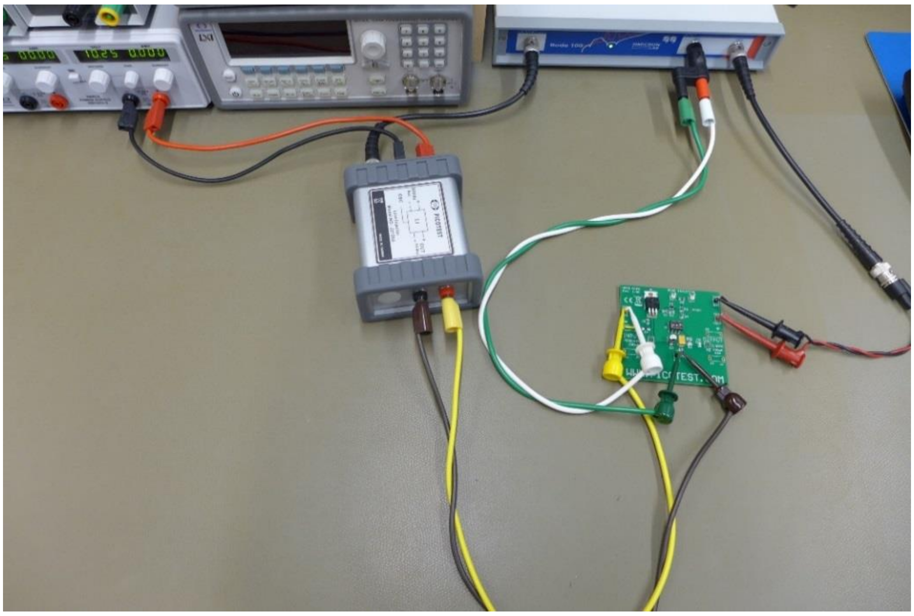

Figure 4: PSRR example measurement setup

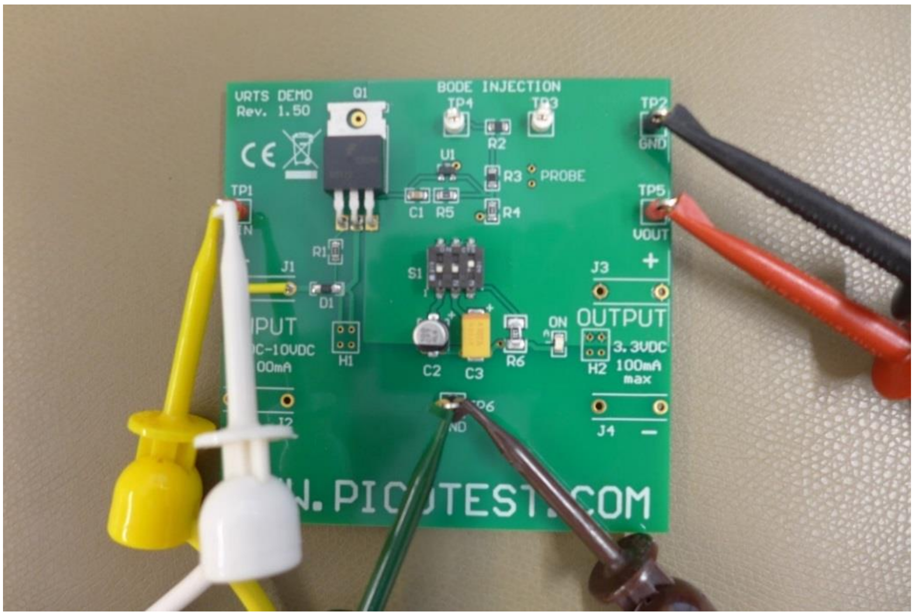

Figure 5: PSRR example measurement setup – close-up

Note:
The resistor R6 has to be enabled by the switch S1 to get a load. Later on, C2 will be enabled too.

3.2 Device Setup

The PSRR measurement can be performed directly with the Bode 100 using the Gain / Phase measurement type.

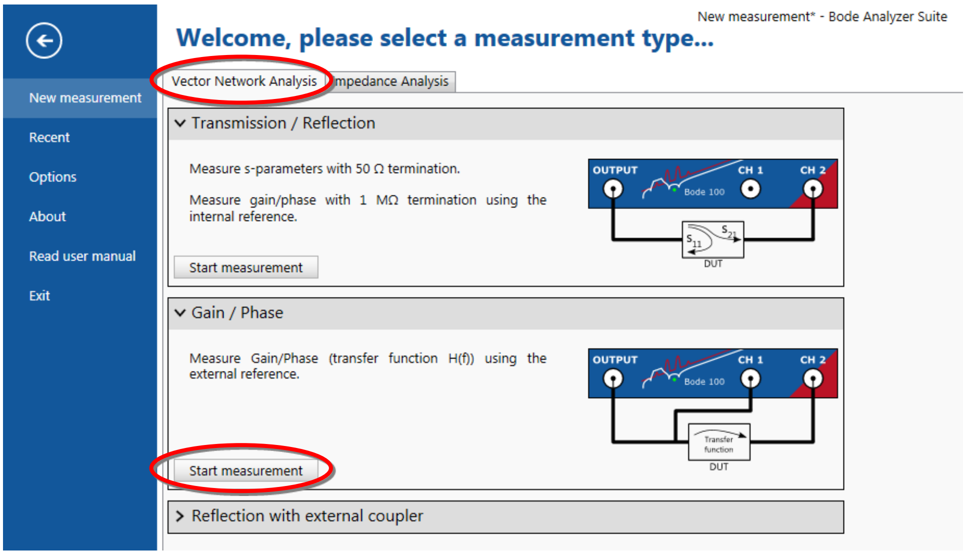

Figure 6: Start menu

The Bode 100 is set up as follows:

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

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.

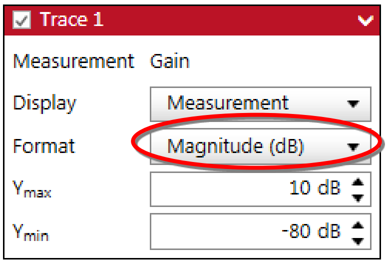

Figure 7: Settings Trace 1

Trace 1 format is set to Magnitude (dB).

3.3 Calibration

Before we start the measurement, we need to calibrate the Bode 100. This will provide the accuracy of the measurement. To do so, press the Full Range calibration button.

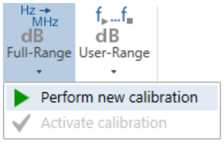

Figure 8: perform calibration

The window called “Full Range Calibration” opens where you are able to perform the calibration.

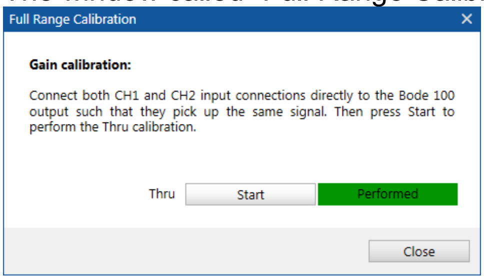

Figure 9: Full Range Calibration window

Now connect OUTPUT, CH1 and CH2 as shown below and perform the calibration by pressing the Start button.

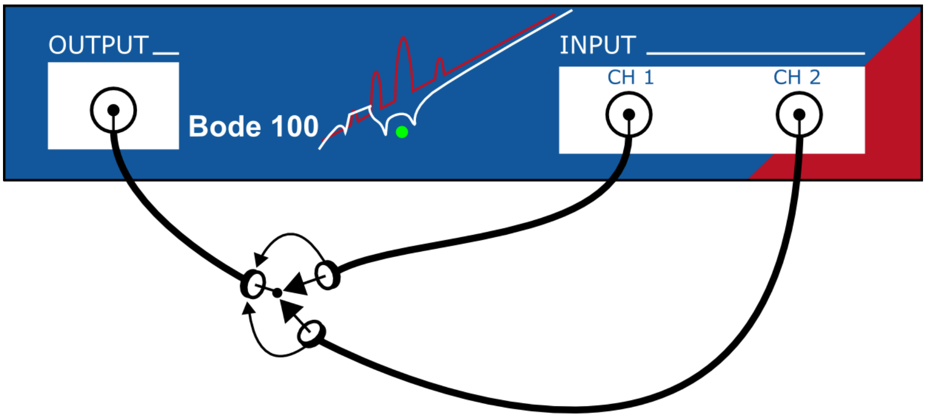

Figure 10: Calibration setup

3.4 Measurement

Performing a single sweep leads to the following PSRR curve:

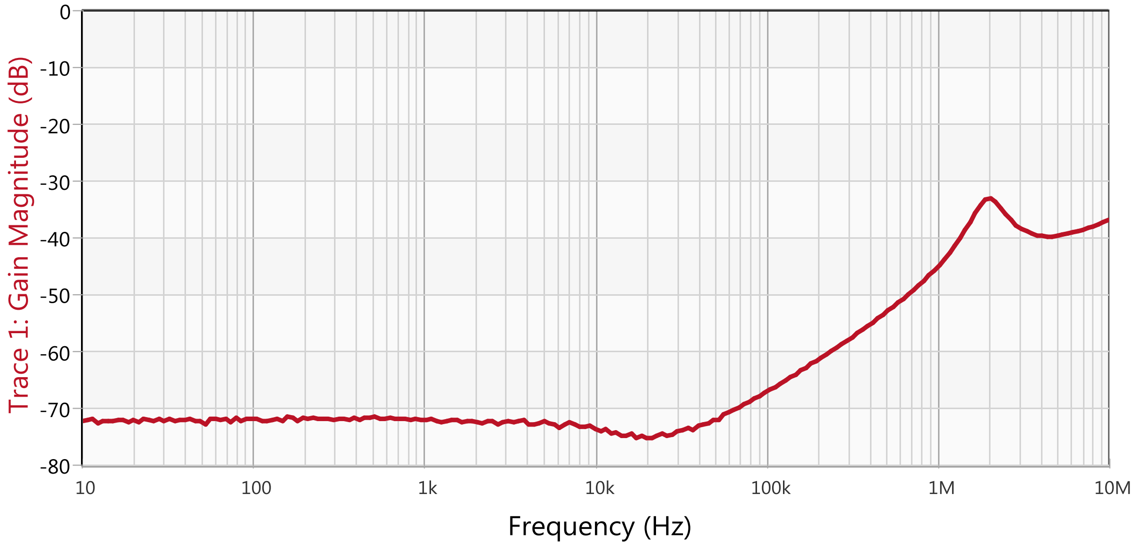

Figure 11: PSRR curve

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 pretty small.

To see the influence of an output capacitor on the PSRR the VRTS capacitor C2 is additionally disabled by the switch on the board. This 0.1 µF capacitor changes the PSRR curve as follows:

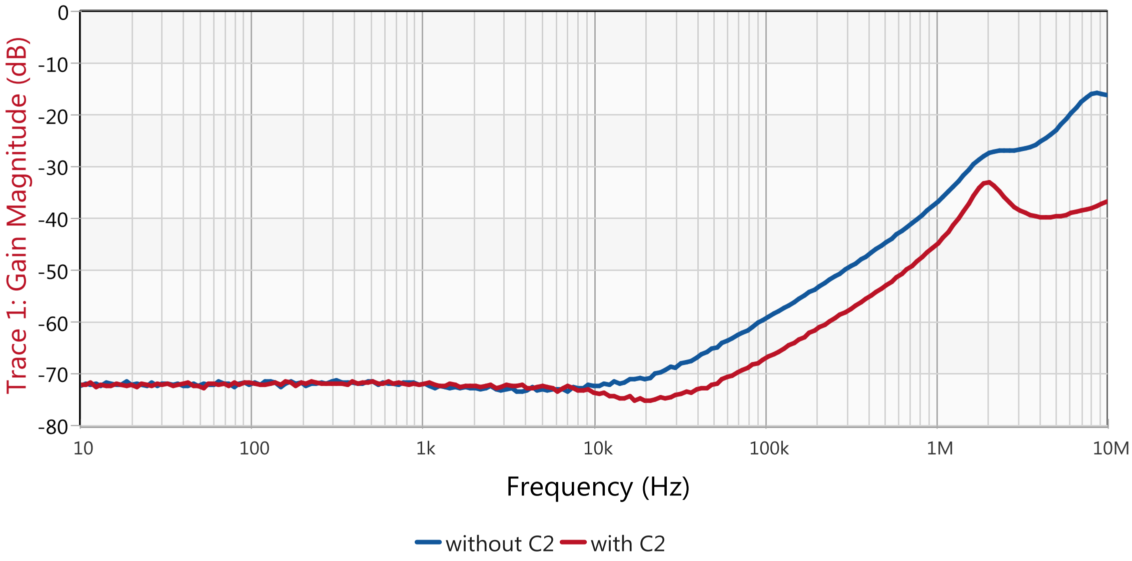

Figure 12: PSRR curve - comparison

Note: The differences between the measurement with and without an output capacitor are even bigger if the PSRR is worse (closer to 0 or even >0).

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.

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