Measuring the PSRR of Voltage References

In this article we detail the process of measuring a key performance characteristic of voltage references, power supply rejection ratio or "PSRR", using the Picotest J2120A Line Injector and the OMICRON Lab Bode 100 VNA.

There are many types of voltage references, including series references, shunt references and several that can perform as either series or parallel devices. The general performance metrics include DC voltage accuracy, temperature coefficient, noise, output impedance, PSRR and stability. The requirements vary greatly from application to application, though the general characteristics remain the same.

PSRR is a significant performance concern as even small amounts of high frequency ripple voltage at the input can significantly degrade the output precision of the device and impact downstream circuitry. The stability of the reference plays a large role in the PSRR and for that reason the measurements in this application note are performed with and without a small ceramic output capacitor across the reference output.

For convenience, we created a PC board that allows both series and shunt references in many common packages to be mounted on the VRTS motherboard[1]. While these measurements can certainly be made without a test fixture, we will use the PCB to keep the measurement setups simple and the parasitics controlled.

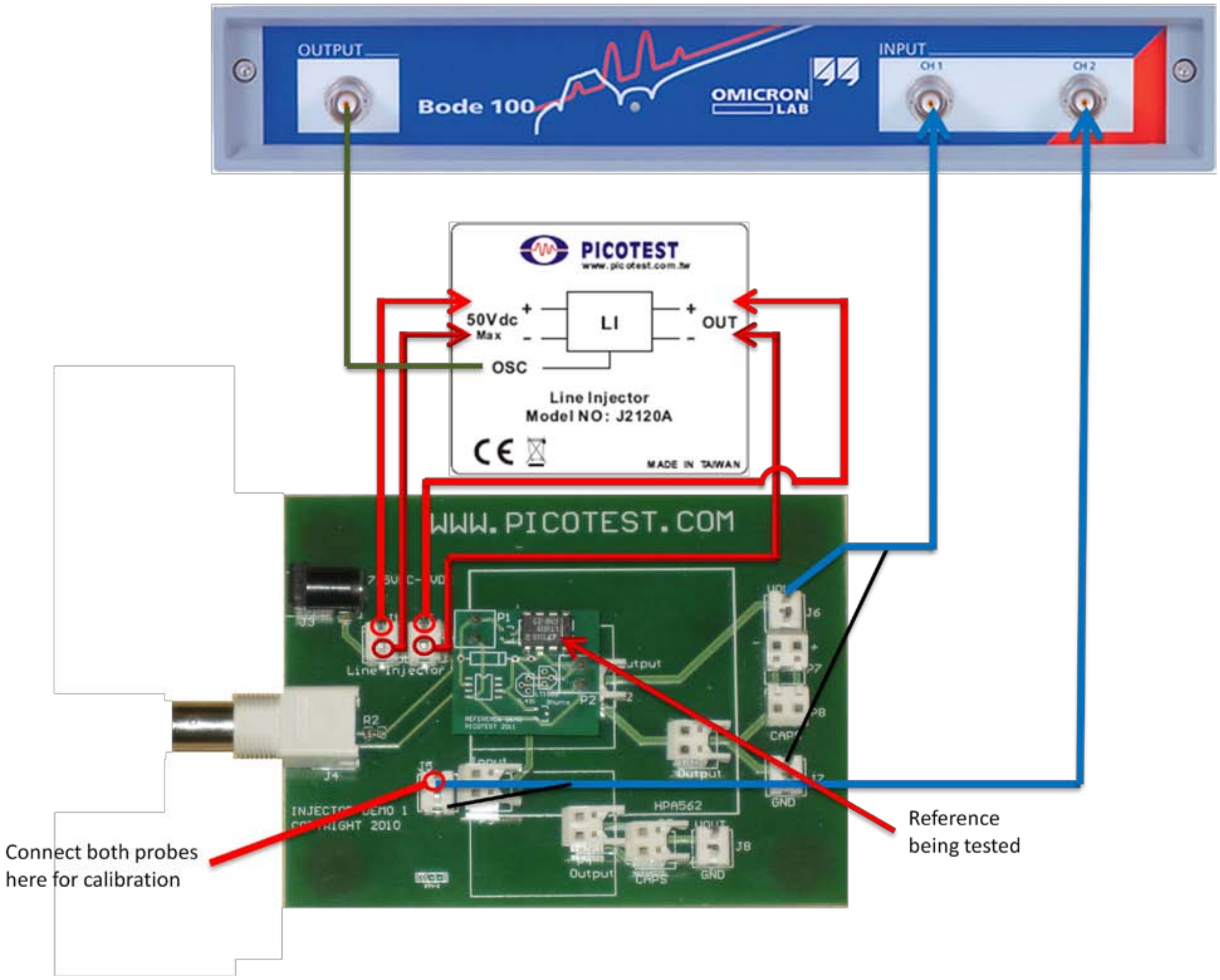

Figure 1 – Connection diagram for the Line injector, VNA and voltage reference (center of the VRTS board).

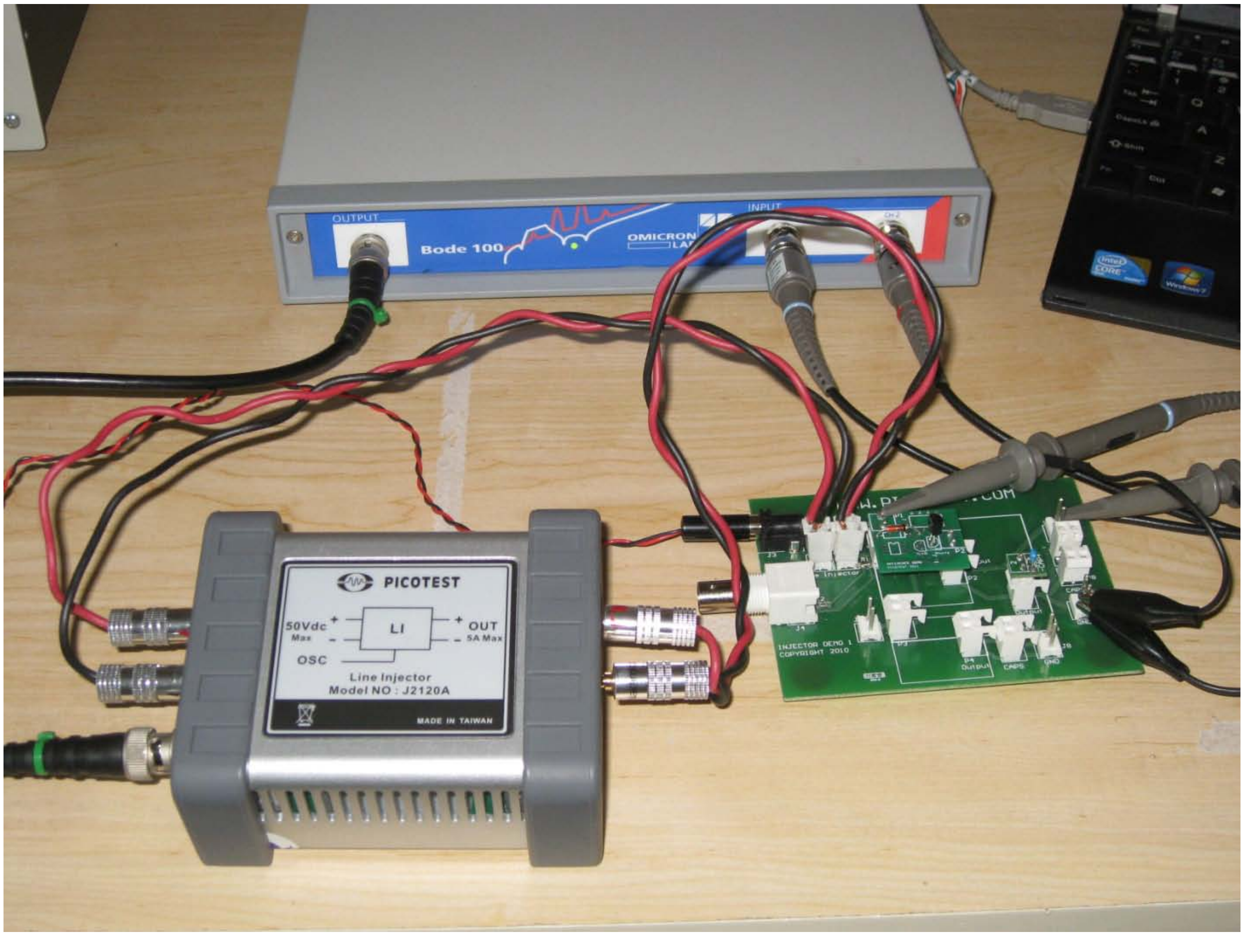

Figure 2 – Injecting AC. Photo showing a LT1009 reference device mounted in a VRTS "daughterboard" for the measurement. The VNA oscillator output is connected to the Line Injector where it combines with a DC input voltage signal.

Calibrating the Measurement

This measurement is made using a frequency sweep and is displayed as a gain curve. With the equipment connected as shown in Figure 1 and power applied, we can connect both the CH1 and CH2 probes to the top pin of J5 on the VRTS motherboard.

Under the Bode 100 Calibration menu, select the PROBE calibration function and choose "THRU" calibration. This calibration will adjust for the differences in frequency response of the two probes.

For additional details regarding calibration, see "Calibrating the Bode 100" in the Bode 100 user manual.

Making the Measurement

	Frequency	Trace 1		Trace 2	
Cursor 1	61.315 kHz		-46.587 dB		23.538 µs
Cursor 2					
delta C2-C1					
Phase Margin C1	61.315 kHz			4.534	12.784 °

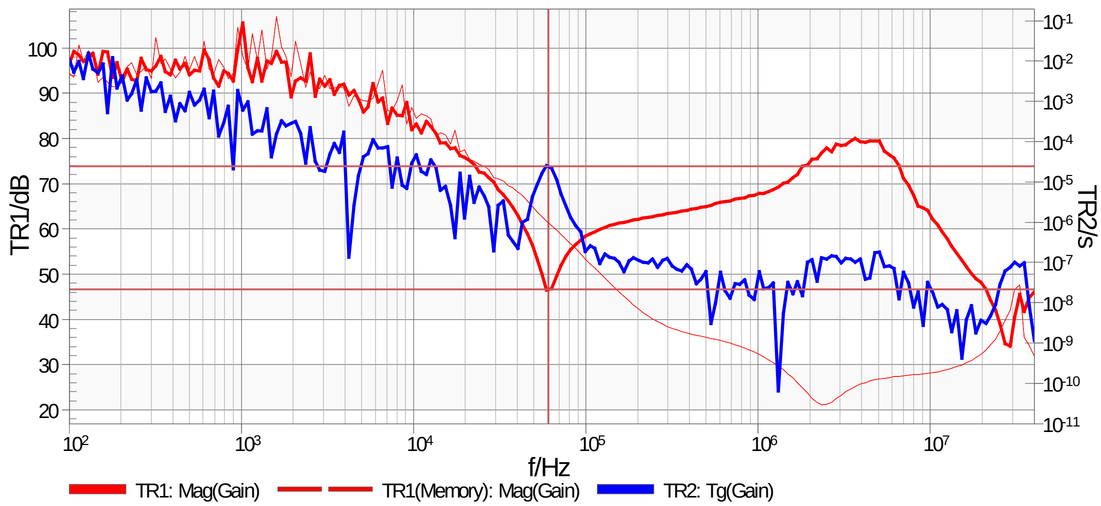

Figure 3 – The LT1019 PSRR with and without a 0.1uF ceramic capacitor. Note the high Q due to the 0.1uF capacitor at 61kHz which results in a 15dB PSRR degradation at 61kHz. The non-invasive cursor calculator displays the phase margin of the reference control loop, which is 12.8 Deg with the 0.1uF ceramic capacitor installed.

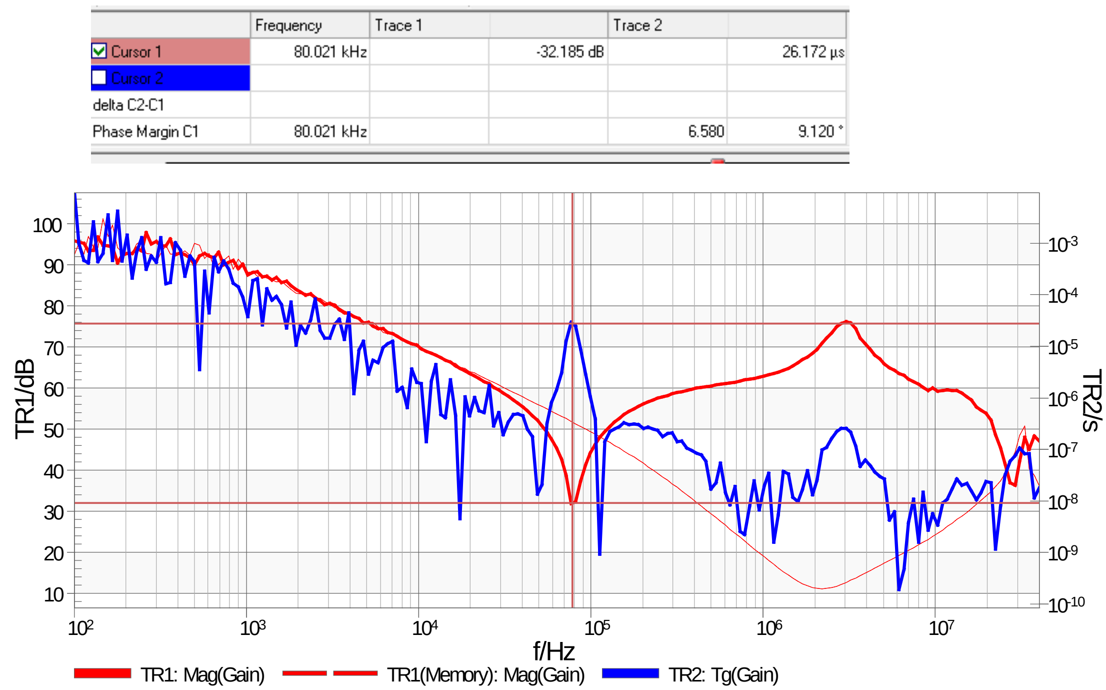

Figure 4 – REF03 PSRR with and without a 0.1uF ceramic capacitor. Note the similar high Q due to the 0.1uF capacitor at 80kHz which results in a nearly 20dB PSRR degradation at 80kHz. The non-invasive cursor calculator displays the phase margin, which is 9.1 Deg with the 0.1uF capacitor installed.

Conclusion

The OMICRON Lab Bode100 Vector Network Analyzer, combined with the Picotest J2120A Line Injector, makes accurately measuring the PSRR of reference devices simple. This measurement clearly shows how the addition of a capacitor degrades the PSRR at the bandwidth of the device. Similar to the output impedance measurement, the non-invasive phase margin indicator also works in this PSRR measurement, directly providing the regulator phase margin and system Q.

Using the methods in the Power Electronics article on regulator ESR determination[2], the ESR or series resistance required for stable performance can easily be determined for any operating current, thereby improving the dynamic performance of the reference.

[11] VRTS, Voltage Regulator Test Standard Manual, v1.0c
[22] Simple Method to Determine ESR Requirements for Stable Regulators, Steven M. Sandler, Power Electronics Technology, Aug 2011