

How to Measure LDO PSRR

Measure LDO PSRR with Network Analyzer

Power supply rejection ratio (PSRR) or some time called power supply ripple rejection measurements are often difficult to measure, especially when the device under test (DUT) is heavily loaded. Typically regulator PSRR is measured with a network analyzer. The network analyzer output signal is AC-coupled into LDO (low dropout) voltage input (Figure 1). The network analyzer generates a sinewave ridding on top of the DC voltage. The LDO input DC voltage is provided by VCC through a small resistor (1 to 10 ohm). The network analyzer is then measure the sinewave amplitude at the LDO input and output using Input-A and Input-B. The ratio of the sinewave at LDO output and input is PSRR.

This method works well if the LDO output is no load or very light load. At heavy load there will be too much voltage drop across the series resistor. Because most network analyzer source output is 50 ohm, it cannot effectively drive the LDO at heavy load (i.e. 1A load). For that reason, regulator PSRR testing often is done at no load or light load. LDO PSRR tends to decrease at heavier load and generally worst at maximum specified load. Measuring power supply rejection at no load is not representative LDO PSRR.

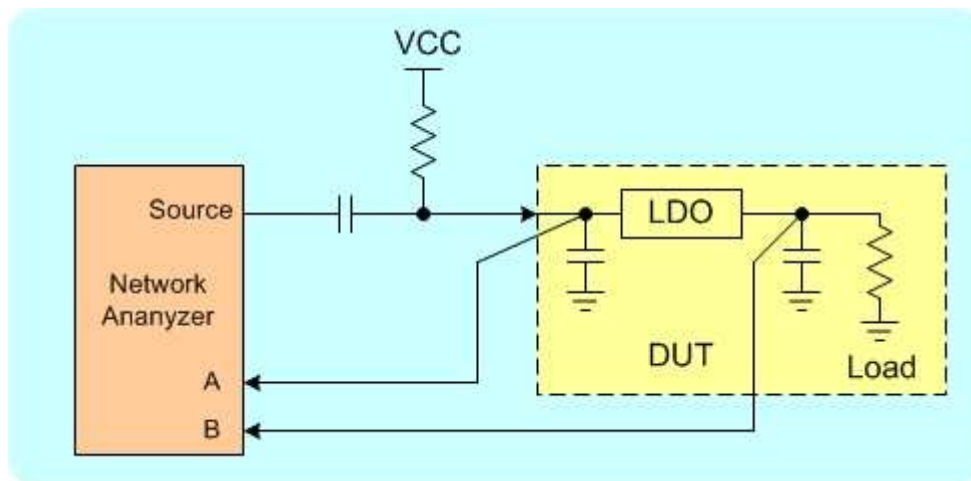


Figure 1. Conventional LDO PSRR test setup is limited to no load or light load.

To test LDO PSRR at heavy load, a high current driver is needed. The TS200 Modulated Power Supply is extremely useful for power supply rejection measurement for such devices as LDOs and power amplifiers. Figure 2 shows how to measure PSRR. PSRR measurement technique involves a network analyzer, the TS200 power amplifier, and the device under test (DUT).

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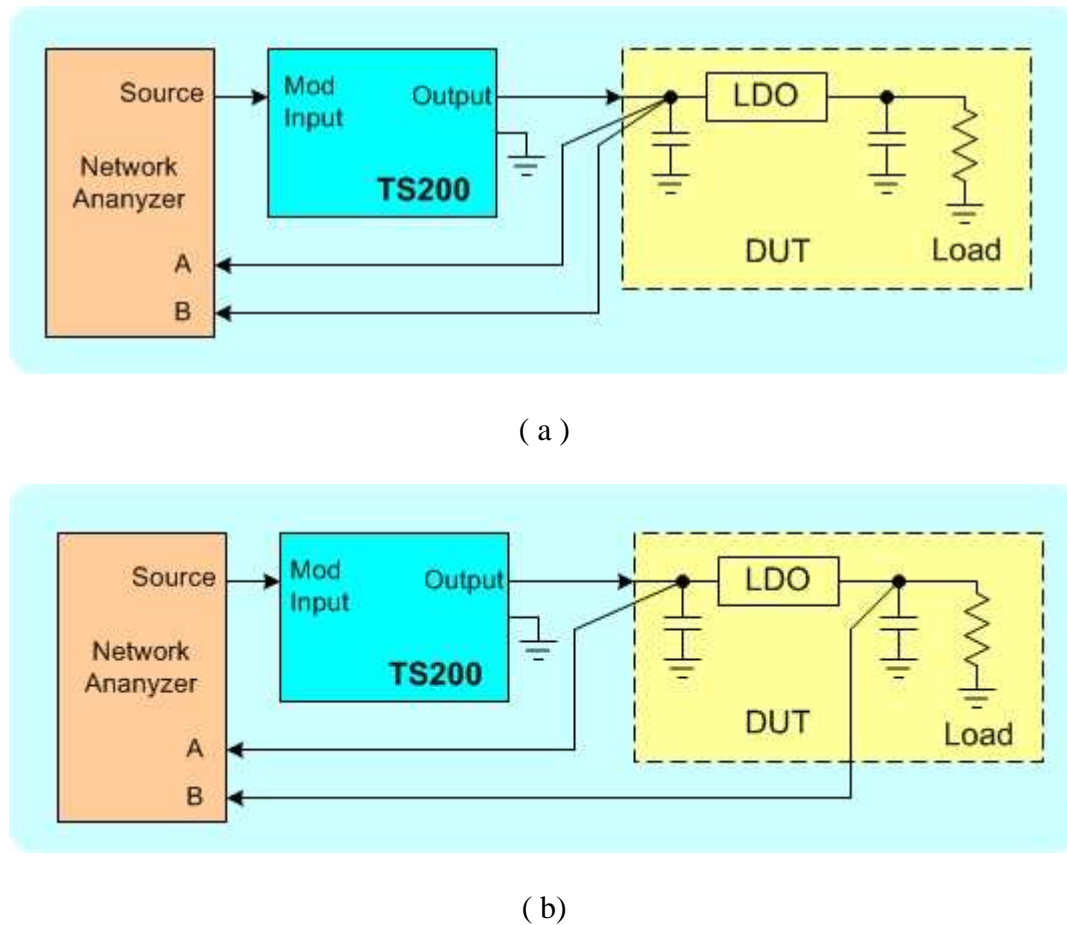


Figure 2. LDO PSRR measurement setup. (a) calibration the setup, (b) Measuring LDO PSRR.

Figure 2 shows the LDO power supply rejection ratio measurement setup. Using a network analyzer, the source is connected to the TS200 modulation input. The TS200 DC and AC output is connected to the LDO supply input. It is recommended to reduce the LDO input capacitance to minimum. Since the TS200 can drive heavy load, thus the LDO output can be loaded with the desired loading resistor (i.e. maximum specified load).

Set the TS200 modulation input to AC-coupled. Adjust the DC Offset knob until the output DC voltage reaches the desired voltage (i.e. 3.3V). Typically for PSRR testing, the supply ripple amplitude is 200mVpp. If you are using the A-version, set the network analyzer output to 200mV. If you are using the B-version and consider the modulation gain is 20dB, set the network analyzer output amplitude to 20mVpp.

First the network analyzer and the TS200 need to be calibrated. Figure 2a shows the calibration setup. The network analyzer input-A and input-B are connected together at one point on the DUT board near the LDO supply input. Set the network analyzer to calibration mode and sweep over the

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frequency range (i.e. 100Hz to 100kHz) to be measured. Save the calibration data for later use. Refer the network analyzer manual for detailed calibration setup.

After calibration, LDO PSRR measurement setup is shown Figure 2b. The network analyzer input-B is moved to the LDO output near the capacitor while keeping input-A at the LDO input. Again sweep the network analyzer over the desired frequency range. You may refer to the network analyzer manual for details. After subtracting the calibration data, PSRR data is plotted. Figure 3 shows an example of PSRR plot. Table 1 shows a list of network analyzers can be use with TS200.

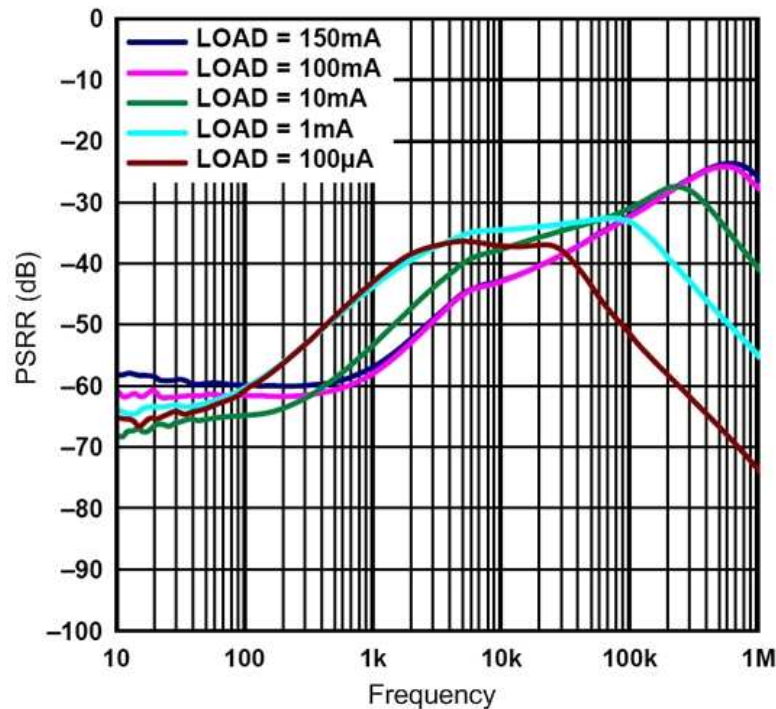


Figure 3. Example of LDO PSRR vs. frequency at various load current.

Table 1. List of network analyzers

Manufacturer	Model
AP Instruments	Model 300
Omicron	Bode 100
Agilent	4395A
Audio Precision	SYS2722

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LDO PSRR Measurement with Oscilloscope

If a network analyzer is not available, an alternative method for regulator PSRR measurement is done by using an oscilloscope. This method requires manually taking data over frequency. Because an oscilloscope has a higher noise floor and lower sensitivity, it is difficult to measure PSRR better than 60dB. Power supply ripple rejection test using an oscilloscope is acceptable for spot-checking if a network analyzer is not available.

Place the oscilloscope probes as shown in Figure 4. CH1 probe is connected to LDO supply input near the capacitor and CH2 probe is connected to LDO output near the capacitor. 1x probe is recommended to reduce the effect of oscilloscope noise floor.

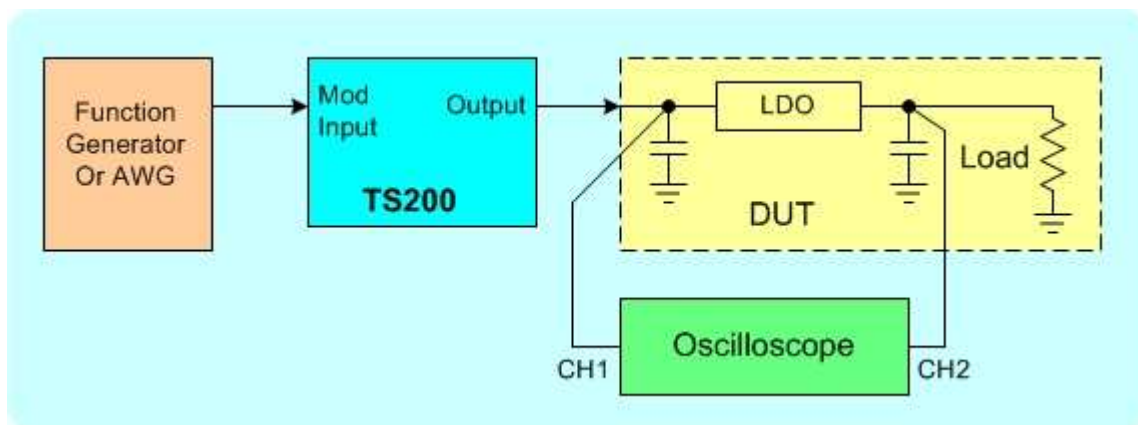


Figure 4. LDO PSRR testing using an oscilloscope if network analyzer is not available.

Connect a function generator to the TS200 Modulation input. Set the function generator output to 200mVpp sinewave or 20mV if B-version is used. Set the frequency to the frequency of interest (i.e. 1kHz). Then set the TS200 modulation to AC-couple. Adjust the DC Offset knob until the TS200 output voltage reaches the desired voltage (i.e. 3.3V).

Using the oscilloscope, you can measure the amplitude voltage at CH1 and CH2. Divide CH2 by CH1 is the PSRR. You can use the below equation for PSRR calculation in dB.

$$\text{PSRR} = 20\log(\text{CH2}/\text{CH1})$$

If PSRR is better than 40dB, it is recommended to increase the TS200 output ripple voltage 500mVpp due to an oscilloscope has lower sensitivity than a network analyzer.

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