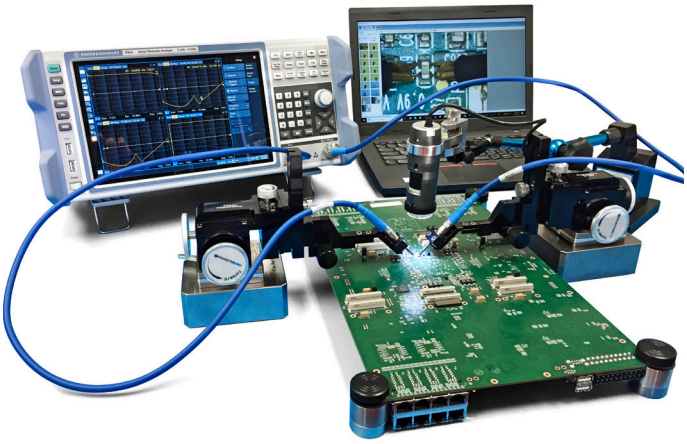
IMPEDANCE MEASUREMENTS FOR POWER DELIVERY NETWORKS

Impedance measurements with vector network analyzers require maximum precision. The R&S®ZNL is able to characterize a broad range of impedances with the lowest uncertainty among its competitors in the same class.



Your task

On a printed circuit board (PCB), each conductive trace that connects a voltage regulator module (VRM or DC/DC converter) to the power supply input of one or more circuits is commonly defined as power rail. The set of all these traces characterizes a PCB's power delivery network (PDN).

Due to the nature of its purpose, a PDN is expected to have a characteristic impedance in the range of milliohms (mΩ). Moreover, its impedance should ideally not increase or decrease with frequency from its nominal value. An analysis of a PDN frequency response is meaningful because the current flowing from the VRM to the served circuits undergoes transient phases (i.e. during power-on, with dynamic loads, etc.), extending its spectrum up to several hundred megahertz.

At these frequencies, each interconnect of the PDN begins to play an active role in the power transmission, since they behave as coils or capacitors depending on their physical properties. The power rails themselves act as transmission lines, each characterized by their own inductance and capacitance. A current flowing through these resonating structures often represents a problem for the served circuits (i.e. signal integrity issues, electromagnetic field emissions, etc.). The precise characterization of a PDN's impedance is therefore paramount for example in PCB test and troubleshooting phases.

Not every instrument is able to perform impedance measurements, because some cannot measure low impedances due to the lack of an appropriate dynamic range, some cannot sweep up to the desired frequency and its harmonics, and some do not have the appropriate interface to the PCB. Vector network analyzers (VNA) offer all of the above, but the precision of their impedance measurements is proportional to the instrument's matching and reflection or transmission accuracy.

Accuracy of transmission measurements		
Above 5 kHz	+5 dB to –35 dB	< 0.05 dB or < 0.5°
	–35 dB to –50 dB	< 0.1 dB or < 1°
	–50 dB to –65 dB	< 0.2 dB or < 2°

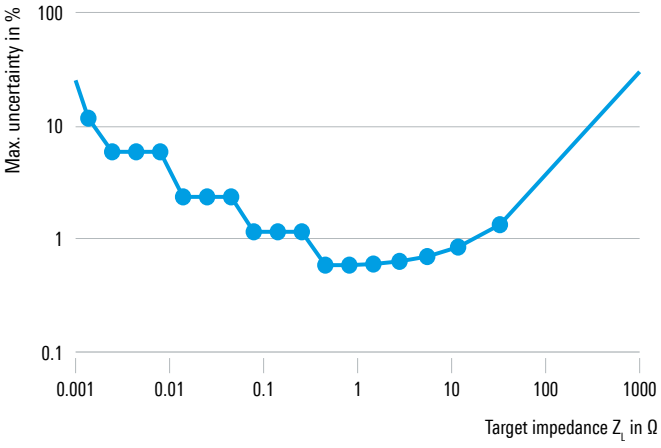
Specifications are based on a matched DUT, a measurement bandwidth of 10 Hz and a nominal source power of –10 dBm.

R&S®ZNL calibrated specified transmission accuracy (magnitude and phase), valid for the entire spectrum

Application Card
Version 02.00

ROHDE&SCHWARZ
Make ideas real

Notice that for a PDN, an error of 1 mΩ can affect the outcome of a pass/fail test altogether. Therefore, the choice of the appropriate VNA and the correct test setup positively contributes on the production yield by ensuring low measurement uncertainty, thus decreasing the chance of false positives.



Impedance accuracy for the low impedance setup calculated from R&S®ZNL calibrated specified transmission accuracy and valid for the entire spectrum. Data between –65 dB and –90 dB is extrapolated.

Rohde&Schwarz solution

The R&S®ZNL vector network analyzer offers the best matching and accuracy in its class, and its versatility makes the instrument suitable for measurements in the most challenging circumstances, be it on a test bench in a lab or outdoors.

The interface of the R&S®ZNL is very intuitive and enables even users without deep RF knowledge to set up a measurement easily and visualize the data in all the necessary formats. In order to perform an impedance test, the user simply selects one of the following options in the measurement menu:

- Z ← S_{11} – Impedance from reflection
- Z ← S_{21} – Impedance from transmission
- Z ← S_{21} Shunt – Impedance from shunt-transmission

Each one of these corresponds to a certain measurement setup and is best suitable for a specific range of impedances.

The combination of the third option and a correct calibration with Rohde&Schwarz high-quality calibration kits enables the lowest uncertainty for PDN whose impedance is as low as a fraction of a milliohm.

Summary

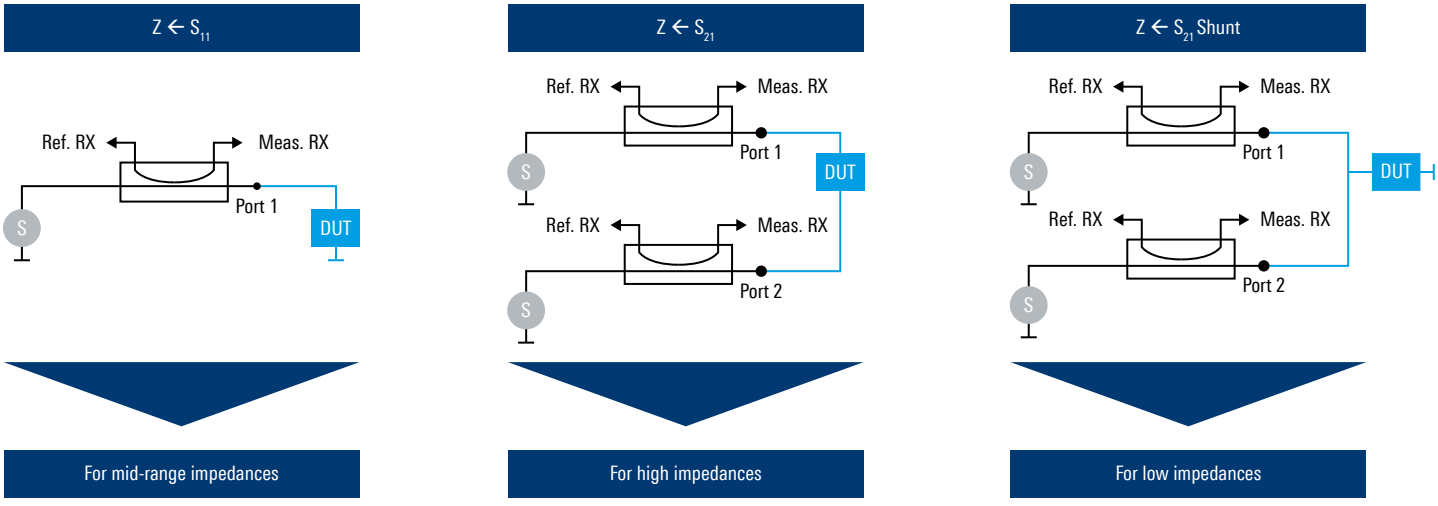
The R&S®ZNL vector network analyzer allows even users without deep RF knowledge to set up impedance measurements for a broad range of test scenarios (from very low to very high impedances), and its accuracy makes the results trustworthy where most vector network analyzers in the same class fail.

Functionalities such as spectrum analysis and a battery pack can be installed optionally to make the R&S®ZNL the perfect allrounder for every measurement scenario.

See also

www.rohde-schwarz.com/product/ZNL
R&S®ZNL data sheet (PD 3607.1071.22)

Correspondence between instrument functions and measurement setups for a correct impedance calculation



Rohde&Schwarz GmbH&Co. KG
www.rohde-schwarz.com

Rohde&Schwarz training
www.training.rohde-schwarz.com
Rohde&Schwarz customer support
www.rohde-schwarz.com/support

PD 3608.0910.92 | Version 02.00 | August 2021 (as)
Impedance measurements for power delivery networks
Data without tolerance limits is not binding | Subject to change

3608091092
3608.0910.92 02.00 PDP/PDW 1 en