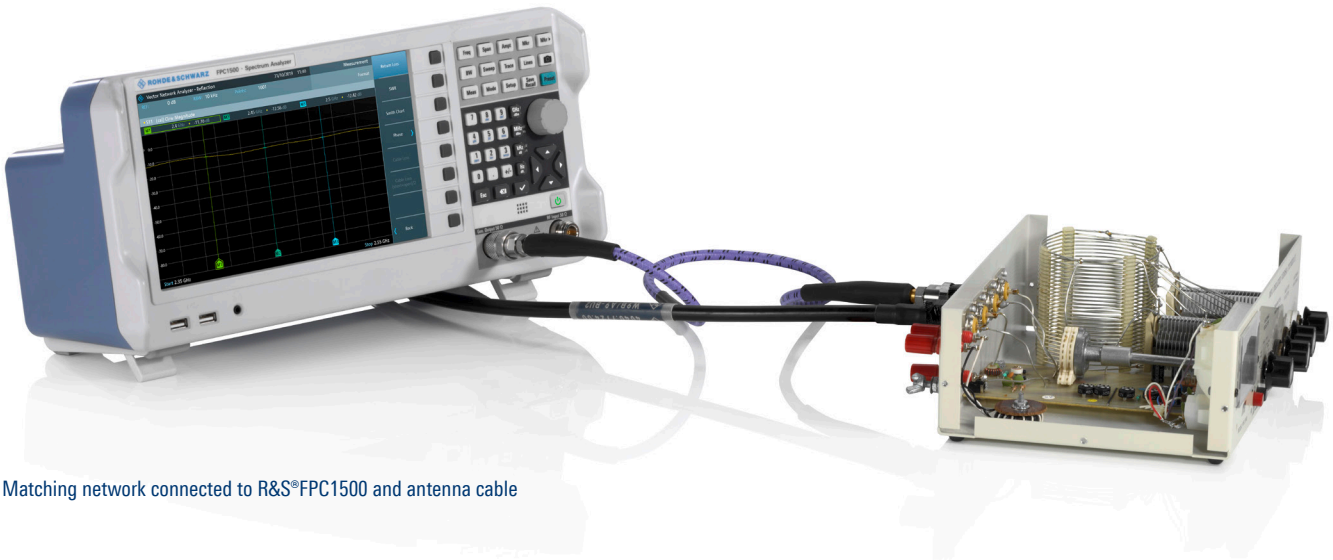# ANTENNA MATCHING IN IoT AND LOW POWER DEVICES

Antennas have become an integral part of consumer electronics, even in small portable devices that rely on an energy source with limited capacity. Consequently, antennas need to be physically small and power efficient.

Matching network connected to R&S®FPC1500 and antenna cable

Your task

Antenna matching is an important aspect of any transmitting RF system in order to achieve the best coverage and lowest power consumption. A contradicting aspect is the physical antenna footprint. The small antennas typically required in IoT applications battle with performance trade-offs due to size constraints. The inefficiency of small antennas is usually included in the link budget calculation and is overcome by increased transmit power, which is detrimental to system performance, e.g. battery life. This makes proper antenna matching extremely important, as a well-matched antenna maximizes the radiation efficiency of the power it receives as an input.

Rohde & Schwarz solution

Calibration at the measurement plane, i.e. the interface between coupling network and network analyzer cables, is an extremely important step in order to compensate for the effects of cables and connectors. Manual calibration is error prone and time-consuming when the open-short-load standards are toggled manually. The R&S®ZN-Z103 calibration unit automates toggling the standards. This helps reduce connection error, and reduces the calibration time to a few seconds. The steps for matching an antenna are:

▶ Calibration
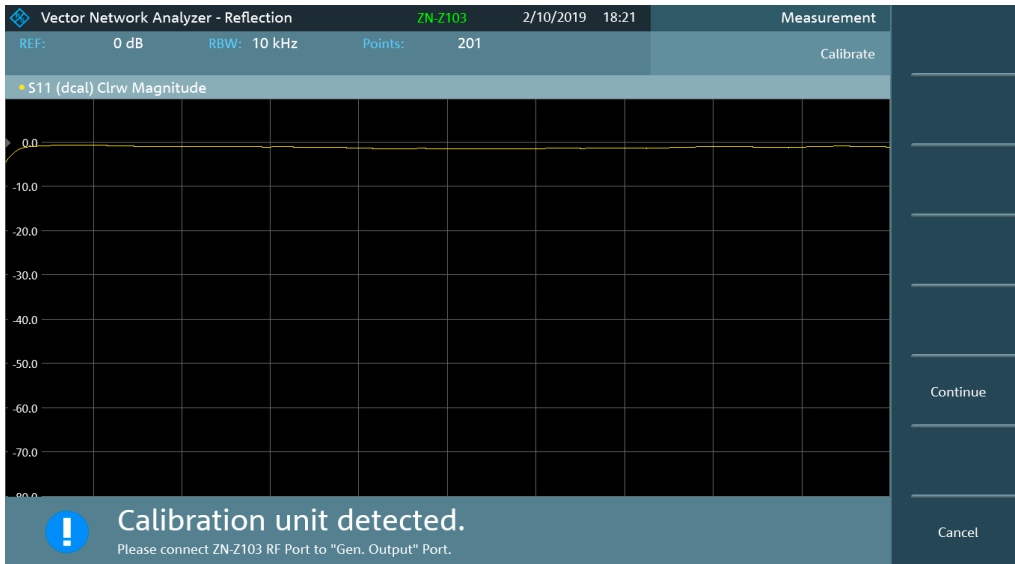▶ Measurement
▶ Adjustment

ROHDE & SCHWARZ

Make ideas real

Calibration

First, set the measurement conditions: desired frequency range, resolution bandwidth and number of measurement points. Then connect the R&S®ZN-Z103 to the USB port of the R&S®FPC1500. The instrument automatically recognizes the calibration unit. Next, screw one end of the coaxial cable to the output port of the R&S®FPC1500 and the other end to the calibration unit. Press "Calibrate → Full 1-port". The instrument is now calibrated.


R&S®ZN-Z103 calibration unit at USB port detected

Measurement

Objects in the vicinity of an antenna, such as an enclosure, lab equipment, cables or measurement devices, will alter the antennas radiation pattern and its input impedance. It is therefore important to place the antenna in a way that resembles the environment of its desired operation area as closely as possible.

The easiest way to visualize matching status is in a Smith chart, which is available via the R&S®FPC-K42 vector reflection measurement option.

Record the R + jX impedance value of the marker. This is probably best done in mid-band or at multiple frequencies using multiple markers.
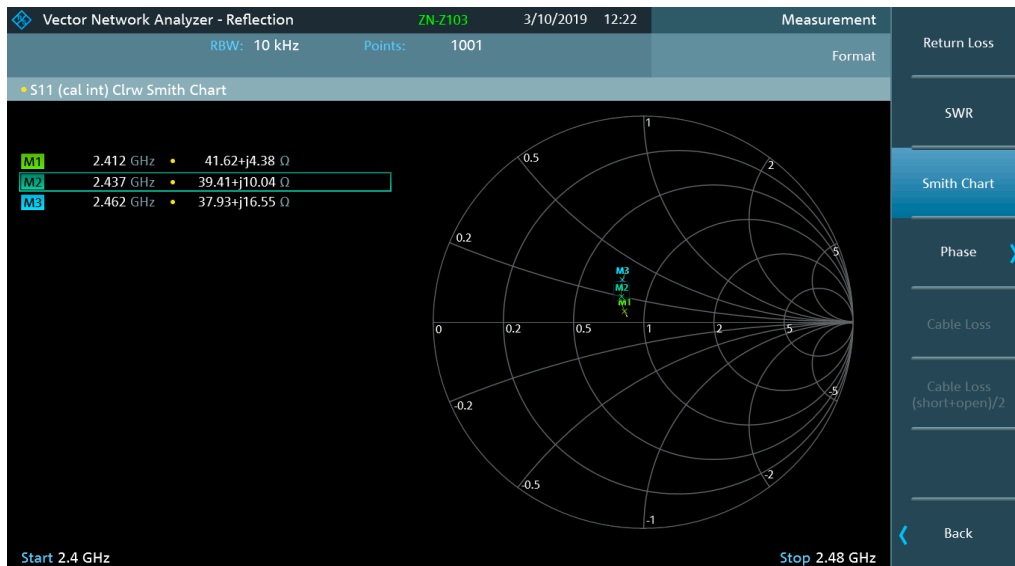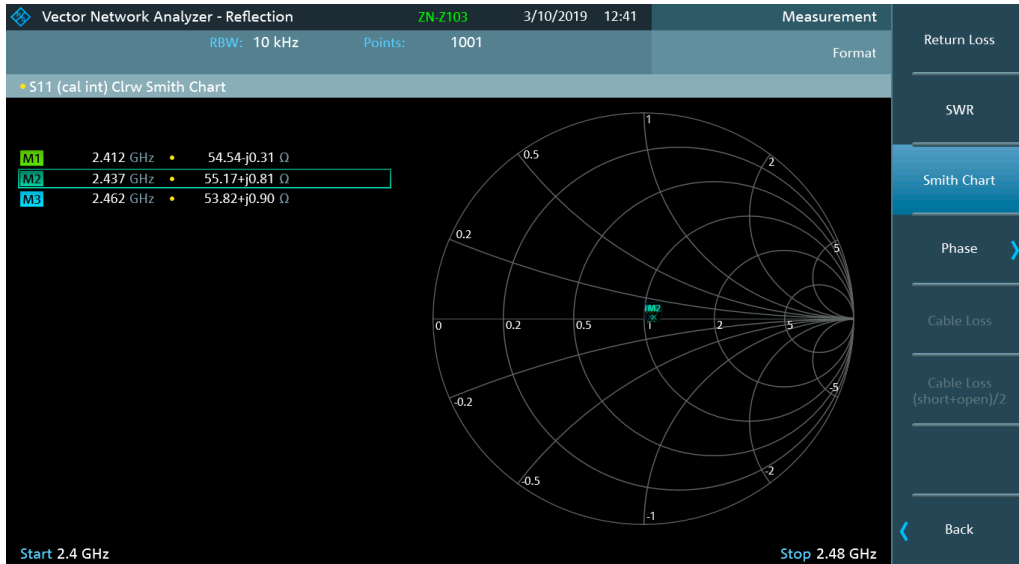

Recording the R + jX impedance value using multiple markers

Adjustment

There are a number of simulators available to calculate the required matching network. Once calculated, it can be built and attached to the antenna. Check the antenna integration by re-measuring the antenna with matching network in order to verify the matching quality.

Slight adjustments may be necessary. Tracking these changes is easy: record and compare them in R&S®InstrumentView, the PC software that comes free of charge with the instrument.

Vector Network Analyzer - Reflection	ZN-Z103 3/10/2019 12:41	Measurement
RBW: 10 kHz Points: 1001		Format

S11 (cal int) Clrw Smith Chart

M1	2.412 GHz	•	54.54-j0.31 Ω
M2	2.437 GHz	•	55.17+j0.81 Ω
M3	2.462 GHz	•	53.82+j0.90 Ω

Return Loss
SWR
Smith Chart
Phase ❯
Cable Loss
Cable Loss (short+open)/2
Back ❮

Start 2.4 GHz   Stop 2.48 GHz

Summary

Antenna matching in IoT and low power devices is about finding the right balance between physical size, power consumption and signal coverage. The R&S®FPC1500 measures antenna reflection performance, which aids in rectifying designs for optimum matching of antennas in order to achieve the best user experience in terms of battery life and signal coverage or reception.

Designation	Type	Order No.
R&S®FPC1500 spectrum analyzer, 5 kHz to 1 GHz, with tracking generator	R&S®FPC1500	1328.6660.03
Frequency upgrade, 1 GHz to 2 GHz	R&S®FPC-B2	1328.6677.02
Frequency upgrade, 2 GHz to 3 GHz	R&S®FPC-B3	1328.6683.02
Vector reflection measurement	R&S®FPC-K42	1328.7396.02
Calibration unit, 1-port, 2 MHz to 4 GHz	R&S®ZN-Z103	1321.1828.02

Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

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▶ Energy efficiency and low emissions
▶ Longevity and optimized total cost of ownership

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