Measure satellite output multiplexers and circulators under real conditions

The R&S®ZNA vector network analyzer offers a dynamic range that is unbeatable on the market. This kind of sensitivity unlocks potential applications that previously could not be addressed with a vector network analyzer.

Your task

Output multiplexers (OMUX) used in communications satellite payloads are designed to combine the various filtered channels into a common feed to the antenna. These waveguide based devices contain the necessary filtering for each of the channel bands of interest and typically handle powers up to 300 W within the Ku and Ka (downlink) frequency bands. Channel filters often contain temperature compensation techniques, improving footprint and mass compared to previous generation Invar based concepts. The key to a channel's performance is the temperature compensation, which depends critically on the temperature in the vicinity of the compensation unit. This temperature is notoriously hard to predict by analysis.

Similarly, the performance of high-power 300 W circulators in the Ku and Ka (downlink) bands critically depends on the local temperature in the ferrite. It is also difficult to reliably predict this temperature by analysis.

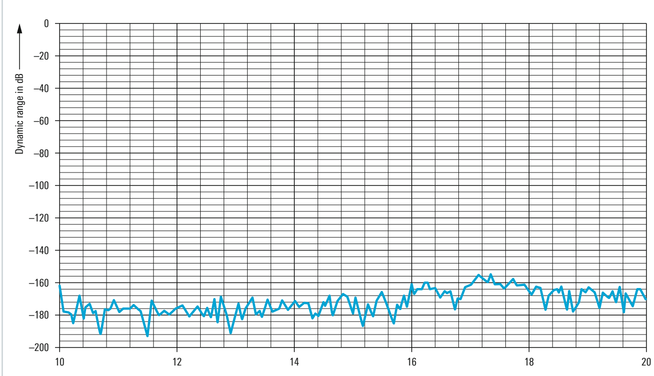
Until now, it was not possible to test these devices at high power to reveal their true frequency response since they would normally be fed with a travelling wave tube amplifier (TWTA), which is not suitable for fast switching between frequencies. Instead, they are typically tested at low power levels with a vector network analyzer, and the OMUX or circulator is heated up to a calculated effective temperature to simulate the effects of power dissipation within the device.

The problem with this method is that it is difficult to calculate an effective homogeneous temperature, particularly for temperature-compensated OMUX channel filters and circulators. In the real application, heat is not dissipated evenly throughout the device. Hotspots are created at points where more power is dissipated within the structure, which affects the electrical behavior in a way that is not easy to recreate.

Rohde & Schwarz solution

The R&S®ZNA network analyzer offers the highest dynamic range of any network analyzer on the market.

Achievable dynamic range in the Ku (downlink) frequency band (using 1 Hz measurement bandwidth)



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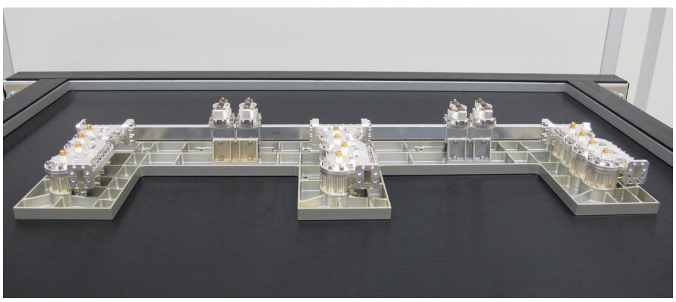
Application Card | Version 01.01

This dynamic range enables real S-parameter measurements to be made through high-power couplers that have a high coupling factor.

With the setup below, the TWTA is used to provide a high-power CW stimulus to the OMUX at the wanted frequency, which creates the desired heating effects. The S-parameter measurements are coupled in through the high-power waveguide couplers. These devices have a coupling factor ranging from 50 dB to 60 dB. This protects the network analyzer ports from damage due to the high power, but it creates a challenge for the measurement instrument since a high signal-to-noise ratio (i.e. dynamic range) is needed for the receivers to be able to see the transmitted and reflected signals.



Example of waveguide OMUX (courtesy of TESAT)

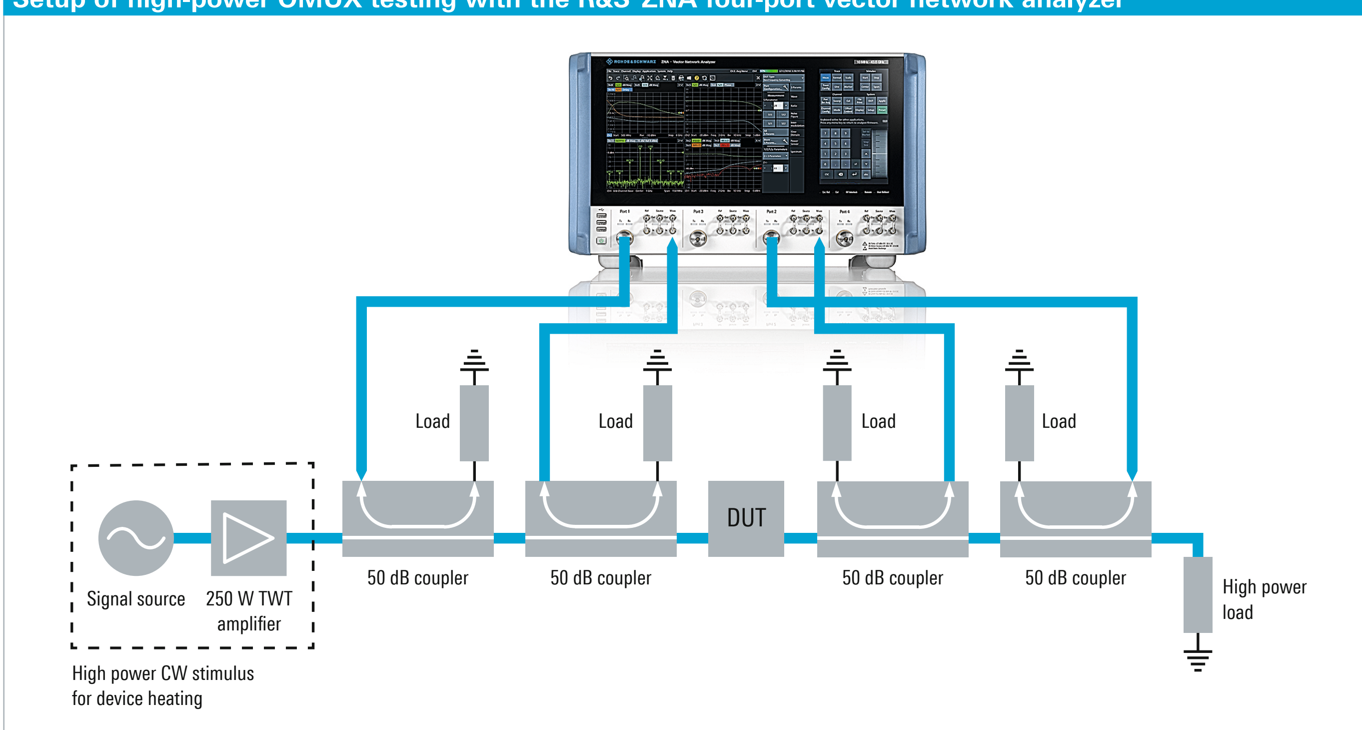
Summary

The unparalleled dynamic range of the R&S®ZNA vector network analyzer opens up a new measurement method for testing high-power waveguide devices. Now, for the first time, it is possible to test these kind of devices under real operating conditions and gain further understanding of the temperature compensation effects with respect to frequency.

See also

www.rohde-schwarz.com/product/ZNA
"Application Notes"

Setup of high-power OMUX testing with the R&S®ZNA four-port vector network analyzer



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Data without tolerance limits is not binding | Subject to change

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