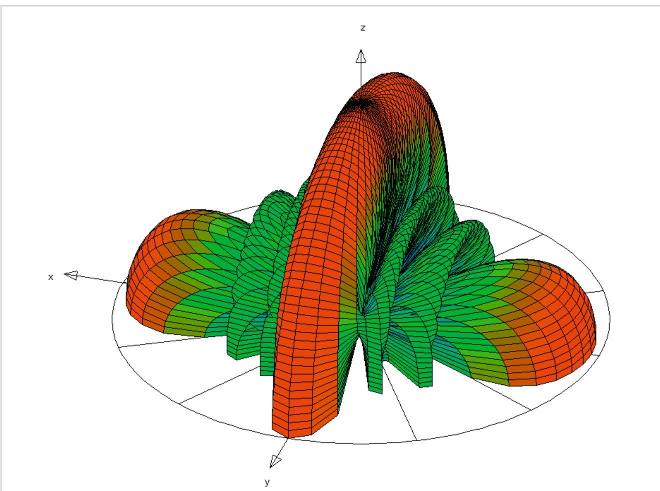
OTA characterization of passive array antennas for fast testing

Over-the-air (OTA) beamforming testing



Simulated linear array antenna radiation pattern with four elements; operating frequency: 28 GHz; element spacing: 16 mm.

Market trend

Beamforming is increasly becoming the technology of choice for both the wireless and satellite communications industry.

The wireless cellular community is currently transitioning from 4G to 5G. A commercial 5G network rollout would require the deployment of a large number of small cells (SC). Many base stations with multi-element array antennas used for beamforming will support this infrastructural upgrade.

Prototypes of user equipment (UE) for 5G applications are being designed with array antennas that will support adaptive beamforming and beamsteering.

In the satellite communications industry, a significant boom in the number of satellites in low Earth orbit (LEO) has made it necessary to replace earth stations' traditional parabolic dish antennas with beamforming array antennas. LEO satellites are extremely fast moving and have wider bandwidth transponders. Earth station antennas need to be able to electronically steer the beam with high beam pointing accuracy in order to maintain communications. It is therefore important in the R&D phase to generate a codebook for each individual array.

All these passive antenna arrays have to be tested and verified not only in the R&D lab, but also on the production line before being integrated into active beamforming antenna systems. Overlooking the importance of testing passive phased arrays in production can be expensive if a manufacturing or design flaw is not detected early on.

Measurement challenges

The traditional approach of using a network analyzer to test and characterize each individual antenna element for return loss or an anechoic chamber as a multiple receiver system to measure the antenna's radiation pattern, e.g. for different polarization modes for magnitude and phase, is too time-consuming and does not account for array performance. Full S-parameter characterization of multiple elements and testing the transmit beamforming performance of the array has to be done at high measurement speed.

The transmit (TX) mode beamforming measurement would require multiple phase coherent signals that retain calibration over a wide frequency range.

A key requirement for fast production line testing is to minimize testing time. Electronic switching between a full S-parameter characterization measurement and TX beamforming measurement without having to perform a complete reconnection cycle would save considerable time.

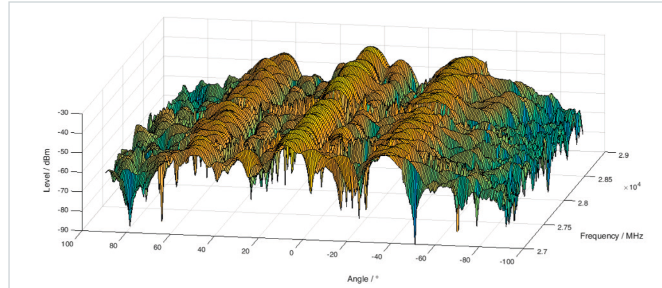
ROHDE & SCHWARZ

Rohde & Schwarz solution

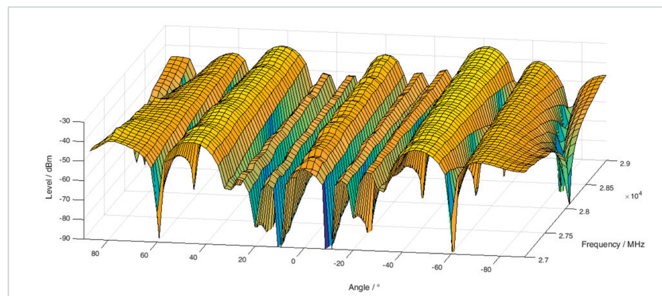
The R&S®ZVA is a unique vector network analyzer (VNA) that meet all the challenges of testing passive antenna arrays. The R&S®ZVA can electronically switch between full S-parameter characterization and TX beamforming measurement.

The R&S®ZVA is equipped with multiple internal sources that can be simultaneously active, and be programmed to generate signals with arbitrary frequency, phase, amplitude offsets and signal delays. To increase the number of coherent sources, multiple VNAs have to be cascaded. Thanks to the phase tuning algorithm, it is possible to daisy chain two or more VNAs while maintaining the calibrated phase relationship in the measurement plane. Crosstalk and mutual coupling between the antenna elements can also be tested. The VNA can apply vector error correction to accurately generate and measure the signals over a wide frequency range.

A spectrum analyzer or power sensor is placed in the far field on the receive side to verify the antenna radiation pattern or generate an array's TX beamforming codebook. The choice of receiver depends on the dynamic range requirement. The antenna array under test (AAUT) needs to be positioned on top of a turntable and rotated over a predefined turntable scan angle. To mitigate the beam squinting effect in applications where antenna arrays operate over a wide frequency range, time delay devices are preferred over phase shifters. The R&S®ZVA can generate both arbitrary phase offsets and true signal time delay.



Measured azimuth radiation plot for four-element array; operating frequency: 28 GHz; element spacing: 16 mm.



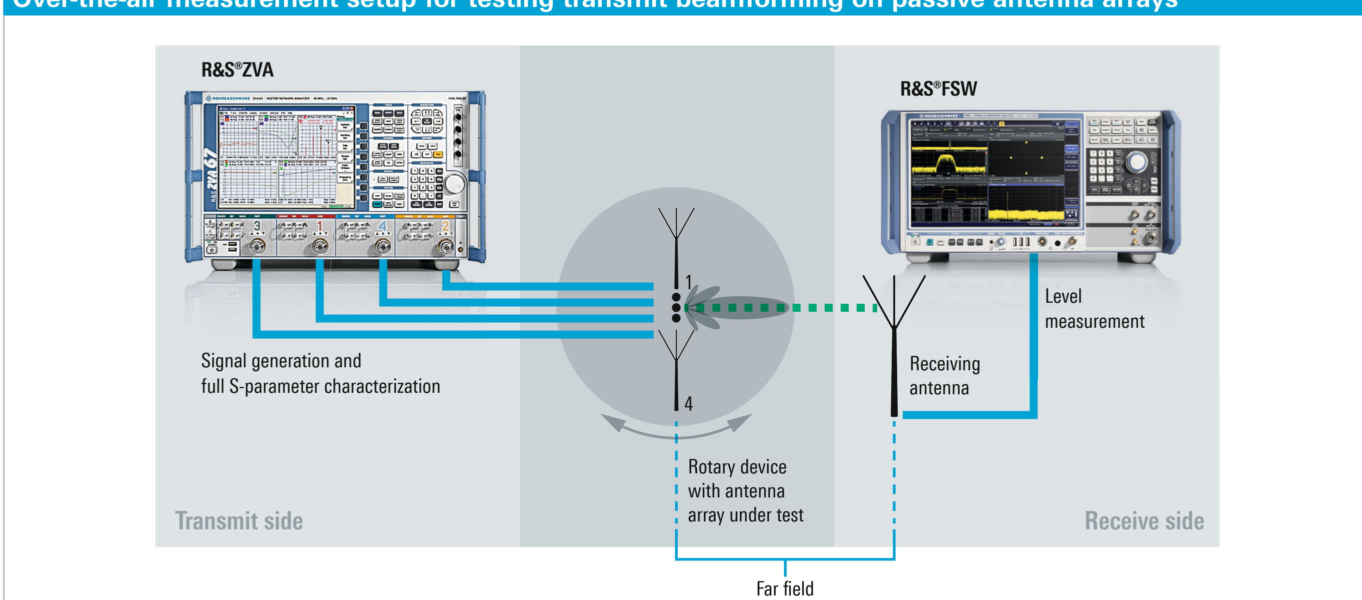
Simulated azimuth radiation plot for four-element array; operating frequency: 28 GHz; element spacing: 16 mm.

Inside the lab and on the production line – this Rohde & Schwarz solution offers speed, accuracy and convenience for testing TX beamforming passive array antennas.

See also

www.rohde-schwarz.com/appnote/1MA278

Over-the-air measurement setup for testing transmit beamforming on passive antenna arrays



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