

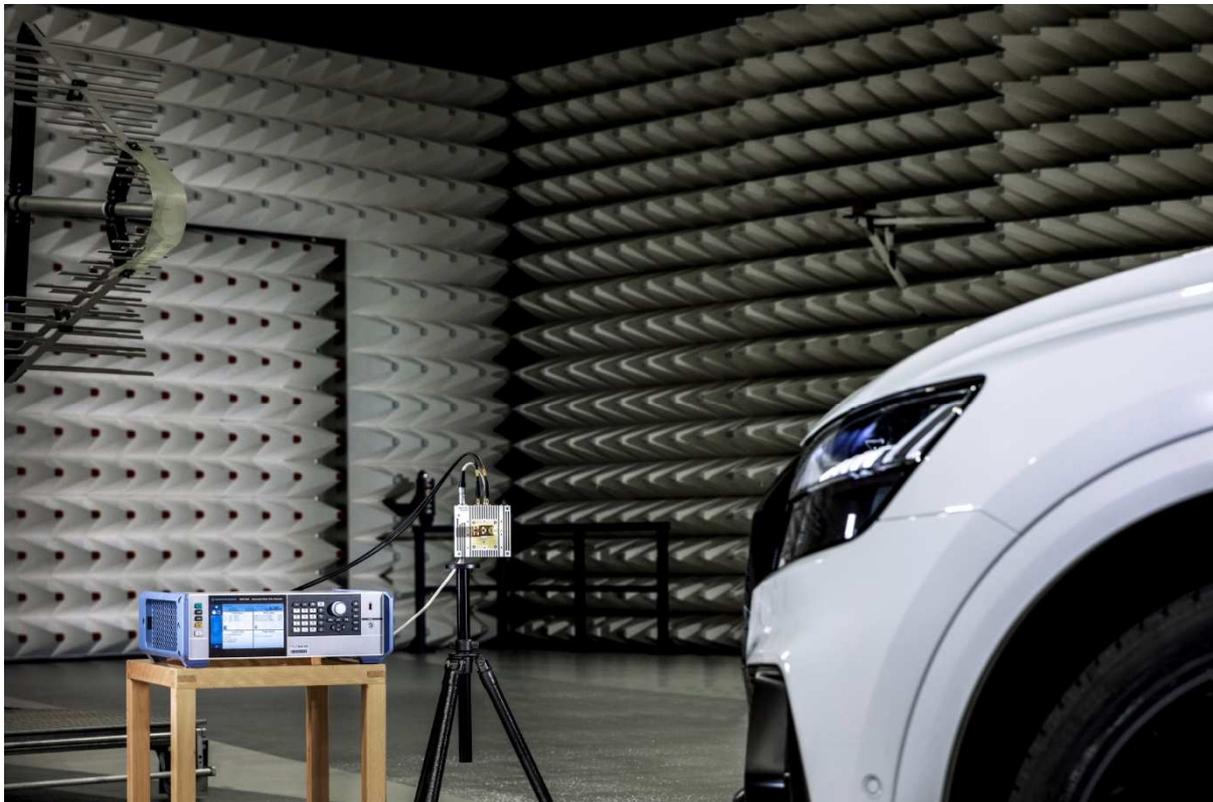


Rohde & Schwarz – Electronic Industry Awards 2021

## **An Innovative, Compact Test System for 77GHz Automotive Radar Development and Production**

The automotive industry urgently needs a practicable solution for testing 77GHz radar, as 24GHz systems are soon to be superseded. Responding to this need, Rohde & Schwarz is the first to combine a CATR system with a radar target generator. Moreover, the CATR introduces innovations to ensure high signal purity, which is extremely challenging at elevated operating frequency. These include an innovative reflector design with extremely high-quality surface finish, minimising signal distortion, and an advanced positioning solution for the radar under test that has angular resolution of 0.03°. The solution is suitable for multiple roles from development to production test.

Rohde & Schwarz has created a compact and transportable solution for testing the latest automotive radar systems that operate in the 77GHz band. A practicable test solution is urgently needed as ETSI in Europe and FCC in US plan to phase out 24GHz radar by 2022.



*R&S AREG100A*



### Background to 77GHz Test Challenges

The radars' performance needs to be tested over-the-air using a signal source (feed) positioned to ensure a plane wavefront is incident on the antenna. This calls for the feed to be positioned in the antenna's far field, which begins at the Fraunhofer distance ( $D_f$ ) and is dependent on the radar's aperture size ( $D$ ), and the emitted wavelength ( $\lambda$ ). In fact,  $D_f = \frac{2D^2}{\lambda}$ .

Because Direct Far-Field measurement at high frequencies requires impractically large test chambers, Compact Antenna Test Range (CATR) equipment is used instead. The CATR enables accurate Indirect Far-Field measurement using a compact and transportable test chamber. The CATR, used with a feed-signal source, synthesises plane wavefront that would be incident on the radar aperture as if the feed was positioned much further away. The device under test is placed inside the chamber where this wavefront exists, known as the quiet zone (QZ). The QZ size must be large enough in relation to the radar antenna aperture to exclude unwanted signal energy.

In particular, the surface roughness of the reflector significantly influences signal purity at higher frequencies. The maximum allowable deviation is proportional to the signal wavelength, given by  $\rho_{\max} = 0.007\lambda$ . At 77GHz, the theoretical maximum allowable roughness is 27 micron.

Moreover, an extremely accurate positioning mechanism is required for radar testing in terms of angle and position.

### Rohde & Schwarz' Innovative Solution

To permit testing of 77GHz radars operating at more than three times the frequency of their predecessors, Rohde & Schwarz has introduced the first ever CATR radar test system using the R&S®ATS1500C CATR chamber and R&S®AREG100A Automotive Radar Echo Generator.

The R&S®ATS1500C CATR contains a reflector produced using advanced techniques that achieve less than 1 micron RMS surface roughness. In addition, the reflector features rolled edges to minimise scattering and hence contribute further to minimising unwanted signal energy in the quiet zone.

An advanced positioning system with an angular resolution of  $0.03^\circ$  with standard deviation of  $0.02^\circ$  can be found in the R&S®ATS1500C. It has  $\pm 45^\circ$  of movement range in elevation and  $\pm 180^\circ$  in azimuth that can achieve high maximum rotation speed of  $120^\circ$  per second, enabling fast and accurate working.

In addition, a simple graphical user interface simplifies positioner control. Commands are ready to integrate with Python, Matlab, or C#. Hence users can create their tests using familiar knowhow and proven code.

Further optimisation of the equipment includes a wide variety of shielded feedthroughs, high shielding effectiveness of typically  $> 90$  dB and optimised absorber layout that minimises signal reflections to eliminate ghost targets.



R&S ATS1500C and R&S AREG100A



## System Performance

Together, the R&S®AREG100A and R&S®ATS1500C CATR allow users to test 77GHz radar antennas in a small-size chamber. The chamber has a footprint of 1.3m<sup>2</sup> (1.6m x 0.9m), is two metres tall, and is able to test large far-field distance.

The combined effects of Rohde & Schwarz' innovations result in a large quiet zone of 30cm diameter. This permits large MIMO radars to be tested. Leveraging the high quality of the reflector, the system achieves an effective far-field distance of 43 metres, within the extremely small footprint of the R&S®ATS1500C CATR.



R&S ATS1500C



R&S ATS1500C

## Multi-Role Flexibility

The R&S®ATS1500C and AREG100A create a complete test solution that is equally suited to the demands of radar-product developers, vehicle manufacturers, and test houses. The equipment can be used for ETSI RED and FCC in-band pre-compliance tests, interference tests, angular calibration, antenna characterization, and chirp analysis. It is suitable for multiple roles in the production of automotive radar, from engineering development of devices, modules, and antennas, through to testing production samples.

## Customer Feedback

Uhnder has used the R&S®ATS1500C CATR in a pre-production release to improve the calibration of new, fully digitally modulated 4D automotive radar sensors using up to 192 virtual receive channels. In a deep collaboration we compared radar sensor outputs (clutter, static and moving detections) of the sensor inside the CATR with a full size anechoic chamber (~5m x 9m) and have not found major difference in terms of quality of reflections and adsorption levels, which is remarkable considering the difference in size. The combination of the R&S®ATS1500C CATR, R&S®AREG100A and the advanced positioning solution for the device under test result into a portable, high-performance sensor calibration and test solution with outstanding performance.