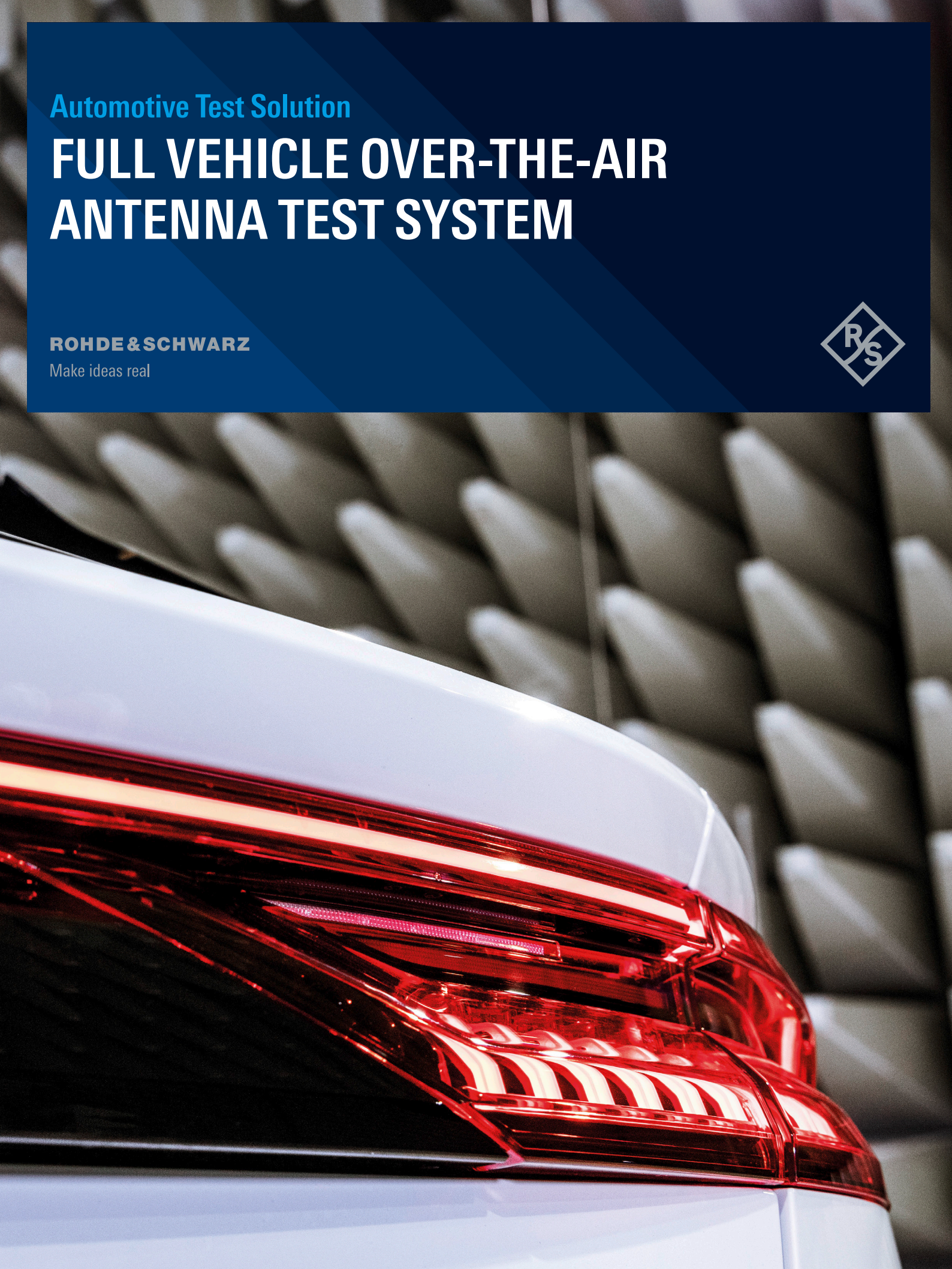
Automotive Test Solution

# FULL VEHICLE OVER-THE-AIR ANTENNA TEST SYSTEM

ROHDE&SCHWARZ

Make ideas real



# INTRODUCTION

Today's vehicles integrate an increasingly large number of wireless technologies including radar, LTE, Wi-Fi, UWB, GNSS, V2X and DVB to support a range of safety, infotainment and driver assistance features. Each wireless standard requires an antenna located in the interior or on the exterior of the vehicle to support the correct operation, function and performance of each individual service and must also be able to co-exist with all the other services.

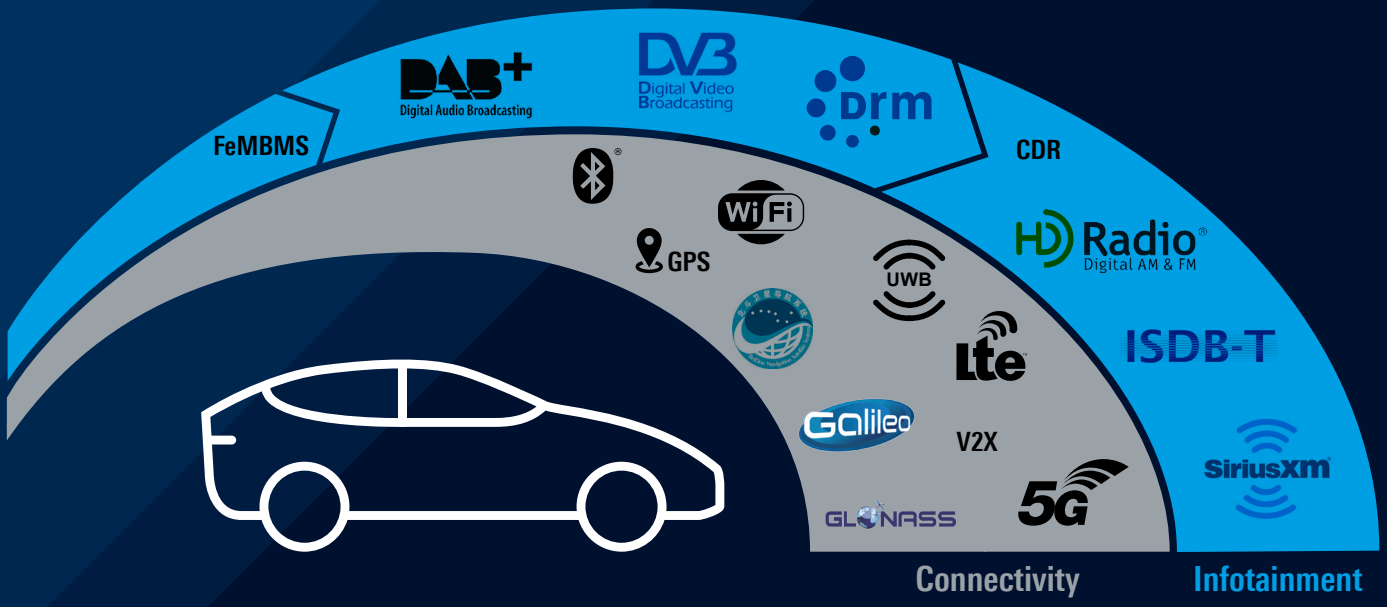
The vehicle manufacturer must ensure correct positioning of all of these high-performance antennas to reduce wiring and costs, while also ensuring optimal radiation patterns and reducing electromagnetic interference (EMI).

The shape of the vehicle, its surrounding materials, high speed data buses and the RF environment all influence the antenna and overall system performance. Therefore, tests must verify the correct operation and co-existence once integrated into the vehicle. This can be achieved best by thorough and accurate full-vehicle antenna testing over the air (FVAT-OTA) since in most cases antennas cannot be accessed directly for conducted performance measurements due to smart integration inside and outside the car.

Passive and active antenna TX and RX characteristics such as directivity, gain, efficiency, EIRP, sensitivity, and total radiated power need to be measured over the air in the controlled RF environment of an anechoic chamber to ensure accuracy and repeatability.

Particular attention should be paid to the test system probe configuration. Single probe test systems have several advantages over multi-probe systems, including higher measurement accuracy, faster calibration and finer angular resolution (important for narrow-beam antennas).

Overall measurement system performance can be adapted to your particular requirements. Many system parameters, such as frequency range, absorber reflectivity, measurement accuracy, vehicle size and mechanical tolerances can be integrated into the design.

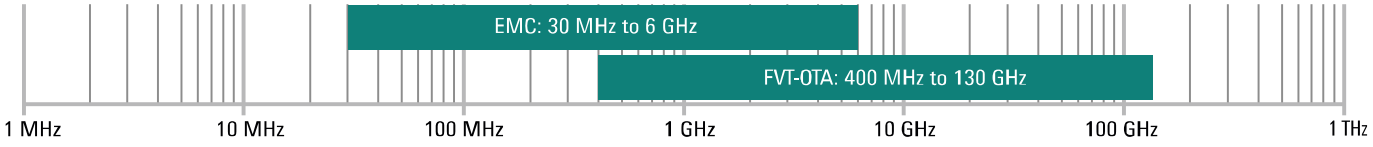


# YOUR CHALLENGE

Open area test sites do not provide the required accuracy due to high interference with transmission from the external environment and reflections from signals generated by the vehicle. The antenna characteristics need to be verified in a controlled RF environment, such as a fully anechoic chamber that provides over-the-air (OTA), reproducible full-vehicle and real-world scenario testing.

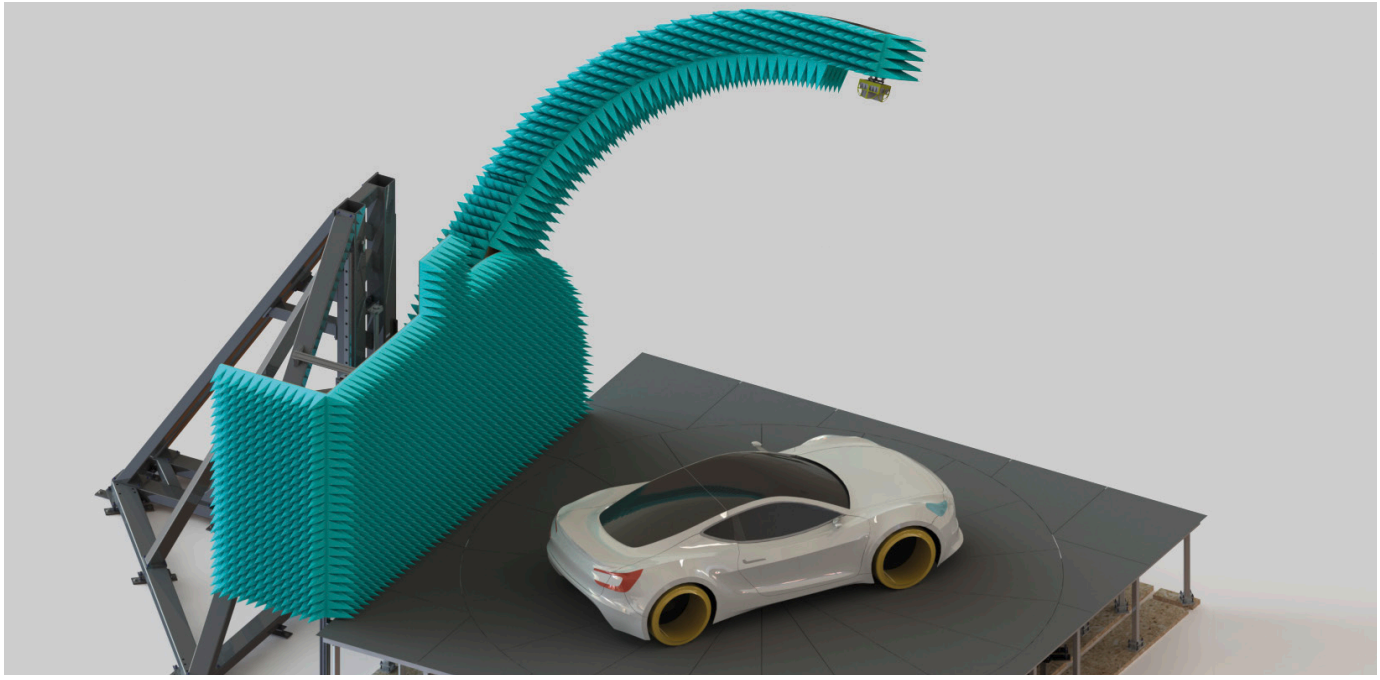
High accuracy antenna measurements with frequencies from 400 MHz to 130 GHz (next generation radar) require a dedicated FVAT chamber that conventional anechoic chambers used for automotive EMC measurements cannot generally provide.

EMC measurements are usually performed in anechoic chambers that are equipped with hybrid absorbers (foam + ferrite). However the reflectivity of hybrid absorbers (typ. around –20 dB) is not enough for OTA measurements that require a reflectivity of at least –40 dB. If pyramidal absorbers are used for EMC measurements at 30 MHz, they would be typically need to be 1.5 m tall, making them very expensive and would also require a very large chamber. In addition, OTA chambers should be fully anechoic with absorbers on all surfaces including the floor to verify 3D antenna patterns and also iclude a vehicle lift for measurements underneath the car.




**FVAT OTA measurement tasks:**

- ► Ensure individual vehicle communications system performance after integration
- ► Avoid interference between wireless services and onboard systems
- ► Validate antenna performance characteristics
- ► Conduct fast, repeatable and reliable measurements despite having no defined FVAT OTA test standards
- ► Remotely control the system using standard and custom automatic test routines
- ► Include arbitrary ground simulations
- ► Obtain sophisticated test reports with 2D and 3D spherical plots



Turntable with single-probe antenna gantry

# OUR SOLUTION

## OTA antenna measurements on a full vehicle from 400 MHz to 18 GHz with extensions possible beyond this frequency range

**Indoor test facilities**
High-performance fully anechoic chamber for precise and repeatable measurements.

**Reproducible tests**
Conducted in a controlled RF environment to ensure consistent and accurate measurements.

**Complete 3D solution**
With turntable, gantry, vehicle lift and single-probe moving antenna arm.

**Single-probe measurement antenna**
Lightweight, compact single-probe antenna provides increased accuracy, faster calibration, better mechanical precision and finer angular resolution.

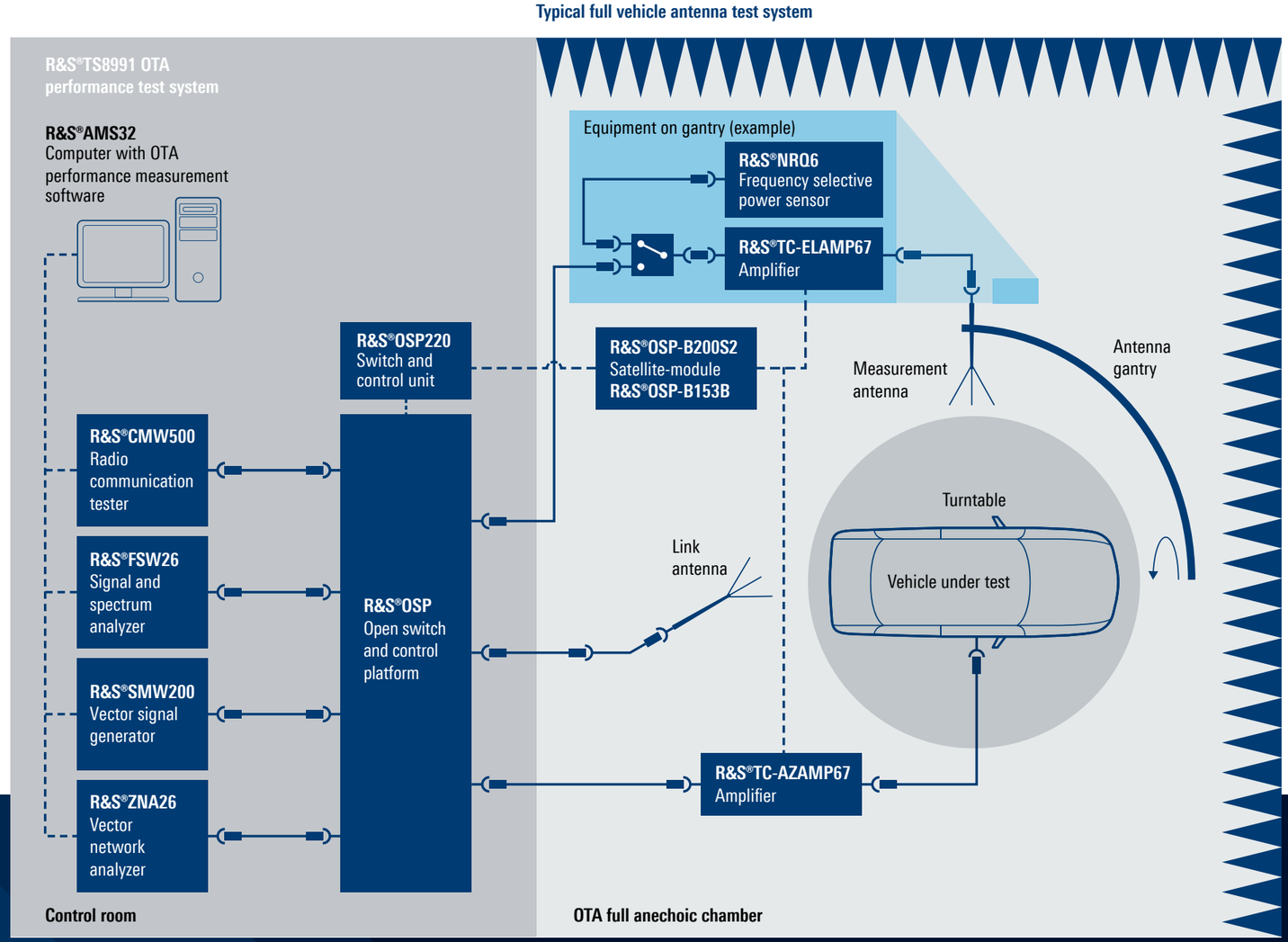
**Near-field to far-field (NF-FF) transformation**
Near-field measurements are converted into far-field results with a sophisticated algorithm (FIAFTA) developed by the Chair of High-Frequency Engineering of the Technical University of Munich.

**High positioning accuracy**
A mechanical system with extremely high positioning accuracy for accurate NF-FF transformation.

**High speed**
A continuously moving turntable for fast data acquisition.

**For complete 3D antenna characterization and analysis of vehicle antenna performance**

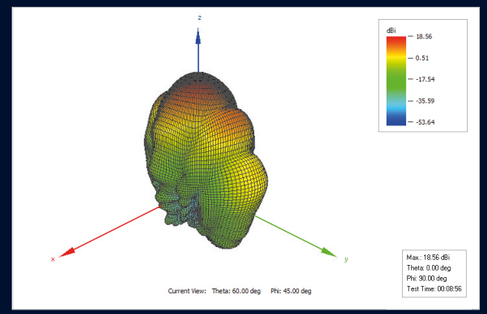
Typical full vehicle antenna test system




**Passive antenna measurements**
- Simultaneous TX and RX measurements
- Directivity, gain, realized gain, efficiency, total efficiency, 3D radiation pattern
- Phase center determination
- Arbitrary ground simulation

**Active antenna measurements:**
- Equivalent isotropic radiated power (EIRP)
- Total radiated power (TRP), total isotropic sensitivity (TIS)
- Sensitivity, beam width
- Error vector magnitude (EVM)
- Adjacent channel leakage ratio (ACLR)

**Wireless standards and services**
- 2G, 3G, 4G, 5G
- C-V2X
- GNSS
- Wi-Fi
- Bluetooth®




3D radiation pattern generated by R&S®AMS32 OTA performance measurement software

# FULL-VEHICLE ANTENNA TESTING SYSTEMS

Rohde&Schwarz designs, supplies and supports customized, high-performance over-the-air (OTA) antenna test systems that can accommodate a wide range of vehicle types and sizes. The complete turnkey test system includes all necessary components including an anechoic chamber, a turntable, a vehicle lift and a single-probe moving antenna arm with two-axis positioner.

The test equipment conducts high-precision active and passive antenna measurements to characterize transceiver performance and 3D antenna radiation patterns. Accompanying software enables data capturing, measurement sequencing, automatic system control and reporting. Rohde&Schwarz can also provide instruments and system components to the trusted system integrators preferred by the end user.

## Typical system components

| Component | Product(s) | Description and features |
|---|---|---|
| **Probe antenna** | R&S®TC-TA18 | cross-polarized Vivaldi test antenna, 400 MHz to 18 GHz frequency range |
| **Vector network analyzer** | R&S®ZNA26 | 4-port VNA, 10 MHz to 26.5 GHz |
| **Vector signal generator** | R&S®SMW200A | vector signal generator, 100 kHz to 44 GHz frequency range, 2 GHz bandwidth, +18 dBm output power |
| | R&S®SMBV100B | vector signal generator, 8 kHz to 6 GHz frequency range, 500 MHz bandwidth, up to +34 dBm output power |
| **Signal and spectrum analyzer** | R&S®FSW26 | 2 Hz to 26.5 GHz frequency range, up to 8.3 GHz bandwidth, sensitivity to –169 dBm |
| | R&S®FSV3013 | 10 Hz to 13.6 GHz frequency range, 1 GHz bandwidth, sensitivity to –167 dBm |
| **Radio communication tester** | R&S®CMW500 | wideband radio communication tester, network emulator, protocol tester, GSM, W-CDMA, LTE |
| | R&S®CMX500 | 5G radio end-to-end communication tester, network emulator, IP protocol tester |
| **Frequency selective power sensor** | R&S®NRQ6 | frequency selective power measurements from 50 MHz to 6 GHz, power measurement range: –130 dBm to +20 dBm, 100 MHz measurement bandwidth |
| **Open switch and control platform** | R&S®OSP220 | powerful control and RF relay modules up to 67 GHz |
| **Measurement and control software** | R&S®AMS32 | OTA performance measurement software |
| **Chamber with absorbers** | third-party | by trusted partners, features vary depending on application requirements |
| **Gantry** | third-party | by trusted partners, features vary depending on application requirements |
| **Turntable** | third-party | by trusted partners, features vary depending on application requirements |
| **Vehicle lift** | third-party | by trusted partners, features vary depending on application requirements |

# BENEFITS

- Cost benefits from superior measurement accuracy thanks to single-probe design, reduced error margin and minimized incorrect antenna failures
- Single-probe solution reduces setup, calibration and upgrade time as well as faster measurement time at millimeterwave frequencies
- One-stop shop FVAT vendor reduces complexity and offers customized turnkey solutions with full system responsibility, including design, setup, training, calibration and support from regional specialist service centers
- Future-proof solution, easy upgrade of test instruments for higher frequencies and new wireless standards
- Increased confidence of using a system from market leader in global EMC and OTA testing with regional specialist service centers, trusted by leading vehicle manufacturers and test establishments around the world

## ROHDE&SCHWARZ WORLDWIDE


- Locations in around 70 countries
- Over 60 subsidiaries
- Worldwide development centers, sales and service offices

## Service that adds value

- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

**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.

www.rohde-schwarz.com

**Sustainable product design**

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

**Rohde&Schwarz customer support**
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PD 3609.7748.32 | Version 01.01 | May 2021
Full vehicle over-the-air antenna test system
Data without tolerance limits is not binding | Subject to change


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PD 3609.7748.32 | Version 01.00