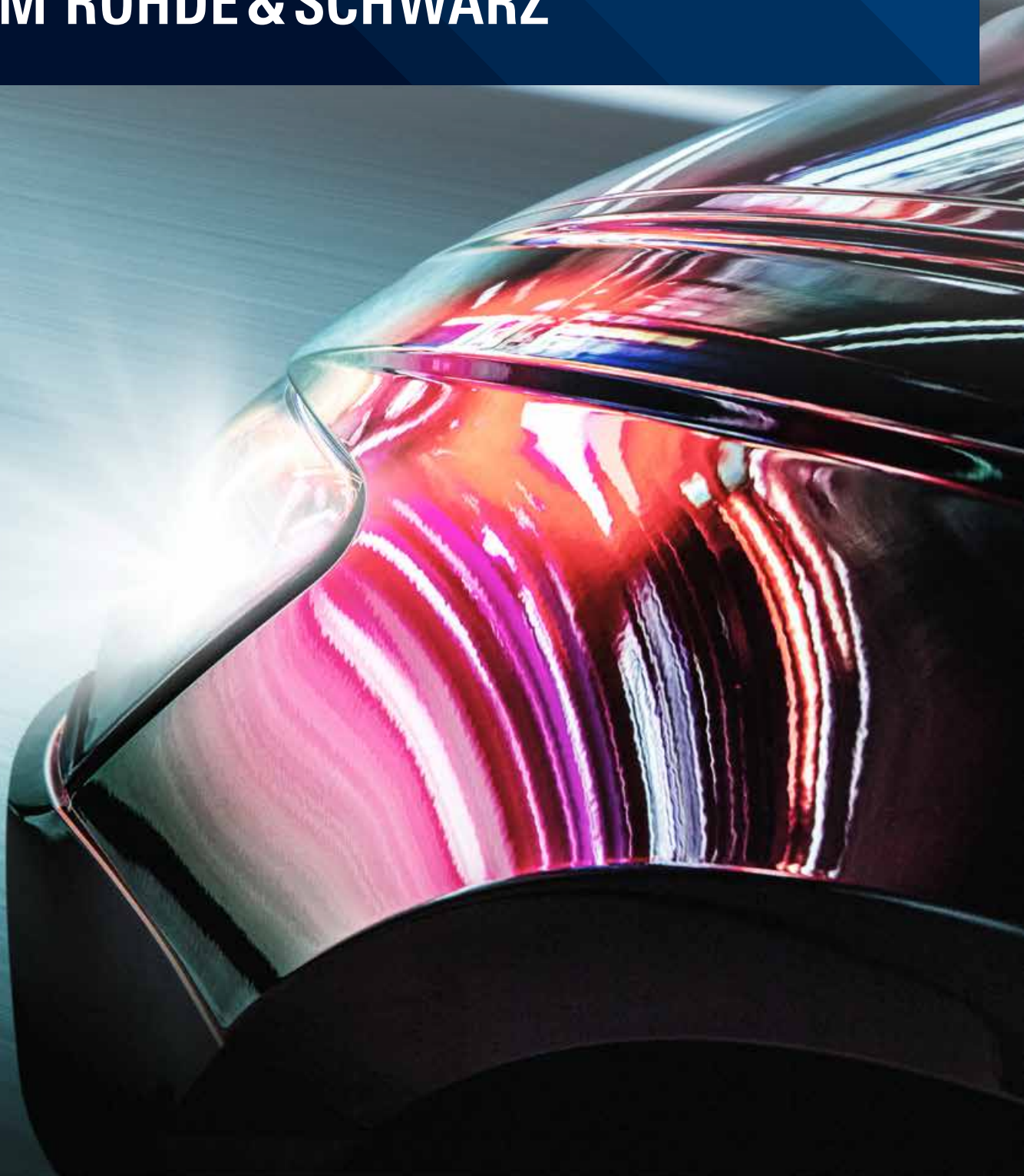


ROHDE & SCHWARZ

Make ideas real



AUTOMOTIVE TEST SOLUTIONS FROM ROHDE & SCHWARZ



AUTOMOTIVE TEST SOLUTIONS

Instruments, software and systems to advance the automotive industry's vision of autonomous driving, electrification and connectivity

The automotive industry is facing multiple challenges as it works to realize software defined vehicles and higher levels of autonomous driving, navigate the transition to electrical propulsion, and deliver new user experiences and services.

Solving these challenges requires the development of advanced sensors such as imaging radar, adoption of new wireless technologies, implementation of higher voltage, fast-switching semiconductors, and use of higher data rate in-vehicle networks. Each development needs innovative test solutions to ensure correct functioning and performance.

THE FUTURE OF MOBILITY IS...



AUTOMATED



CONNECTED



ELECTRIFIED

As a global provider of innovative test and measurement instruments, software and systems, Rohde&Schwarz employs its technical expertise to advance the automotive industry's vision of autonomous driving, electrification and connectivity. OEMs, chip suppliers, Tier1s and engineering service providers, as well as certification organizations around the world rely on our test solutions for radar, connectivity including antennas, infotainment, in-vehicle networks, electric drive-train components and electromagnetic compatibility. We support our customers over the entire automotive lifecycle from R&D to production and beyond. Test it. Trust it.

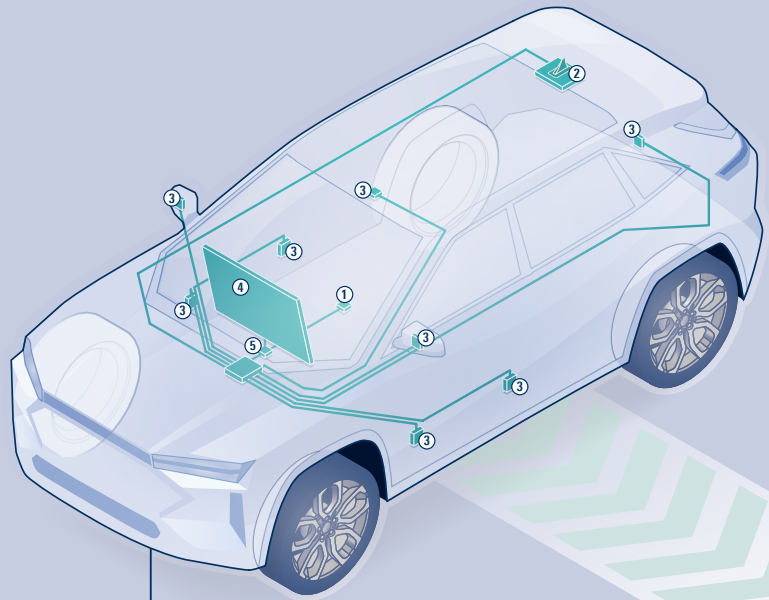
TEST IT. TRUST IT.



ROHDE & SCHWARZ AUTOMOTIVE TEST SOLUTIONS FOR THE ENTIRE VEHICLE

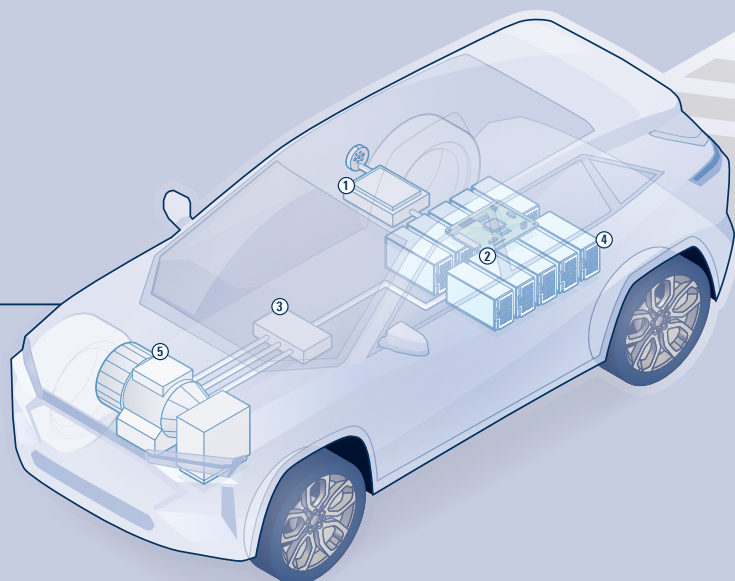
This infographic shows the primary electrical systems in modern vehicles, identifies the main components, and shows how they are connected.

For each system, from in-vehicle networks and connectivity to electric drivetrain and radar, Rohde & Schwarz offers leading-edge test solutions to help you maximize efficiency and performance.

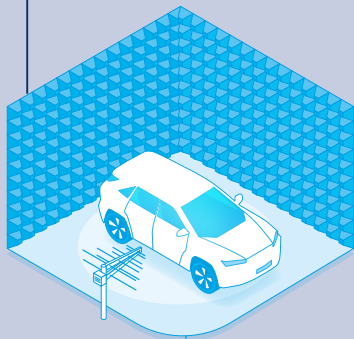


CONNECTIVITY
AND INFOTAINMENT

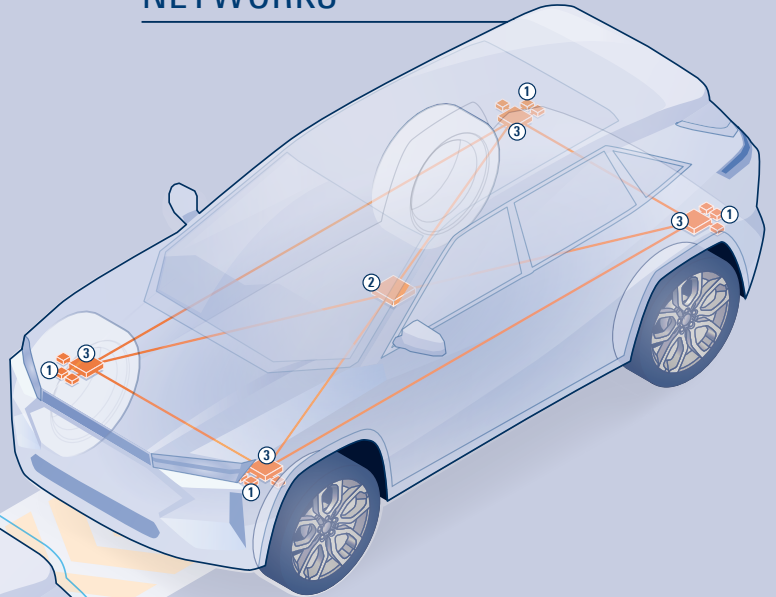
ELECTRIC
DRIVETRAIN



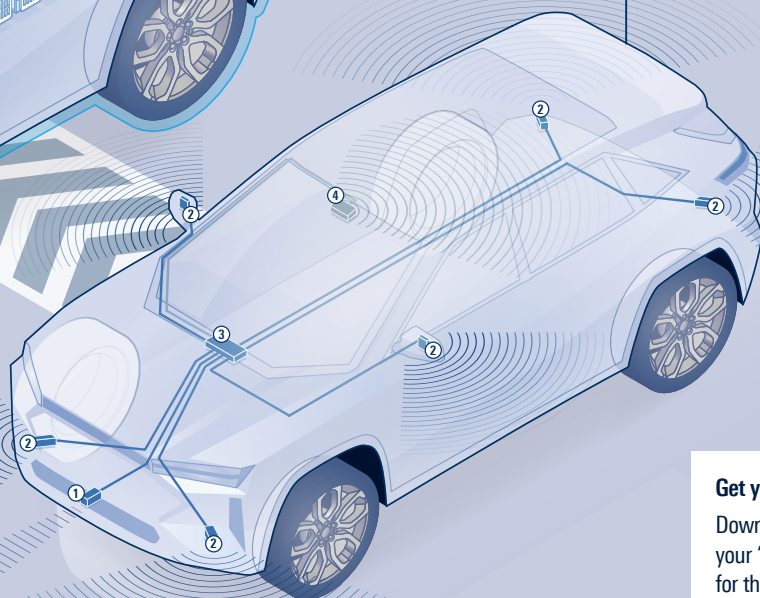
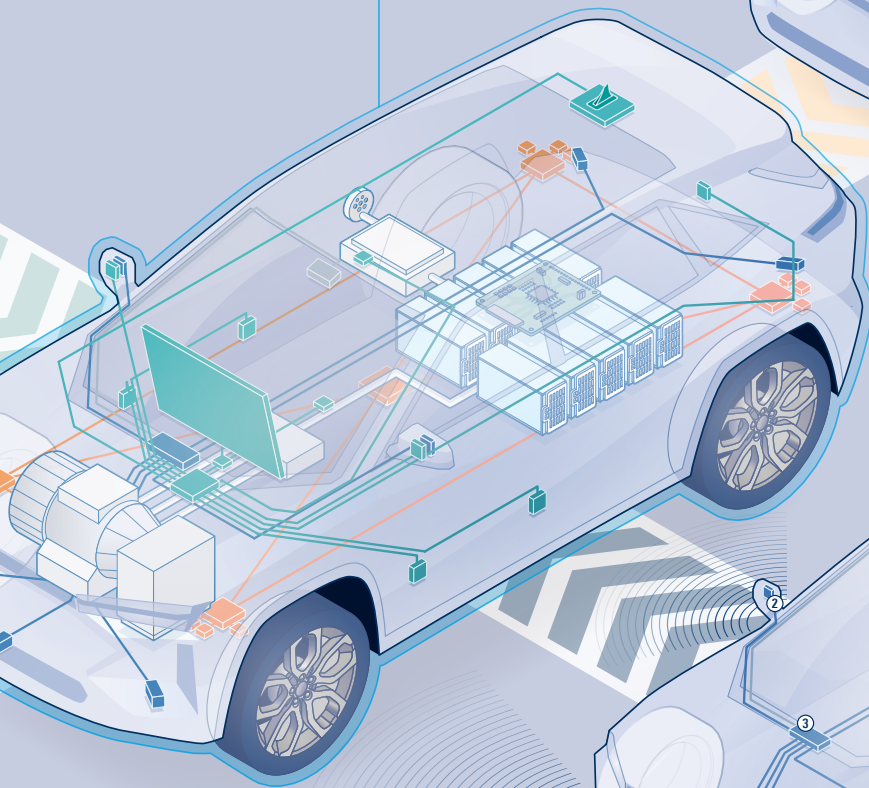
ELECTROMAGNETIC COMPATIBILITY (EMC)



IN-VEHICLE NETWORKS



RADAR



Get your own poster!

Download or order
your "Test solutions
for the entire vehicle"
poster here:





AUTOMOTIVE RADAR

Seeing with radio waves

Leading-edge test solutions for the development, integration and production of high-performance automotive radar chipsets, sensors and systems

Radar is the key technology for the development of advanced driver assistance systems (ADAS) that are able to instantaneously measure distance, angle and velocity and produce detailed images of the surroundings. Since ADAS enables safety-critical features such as emergency braking, it should be clear that chipsets, sensors and modules need to be tested thoroughly at each phase from development and conformance through production to ensure correct functioning even under demanding environmental and RF conditions.

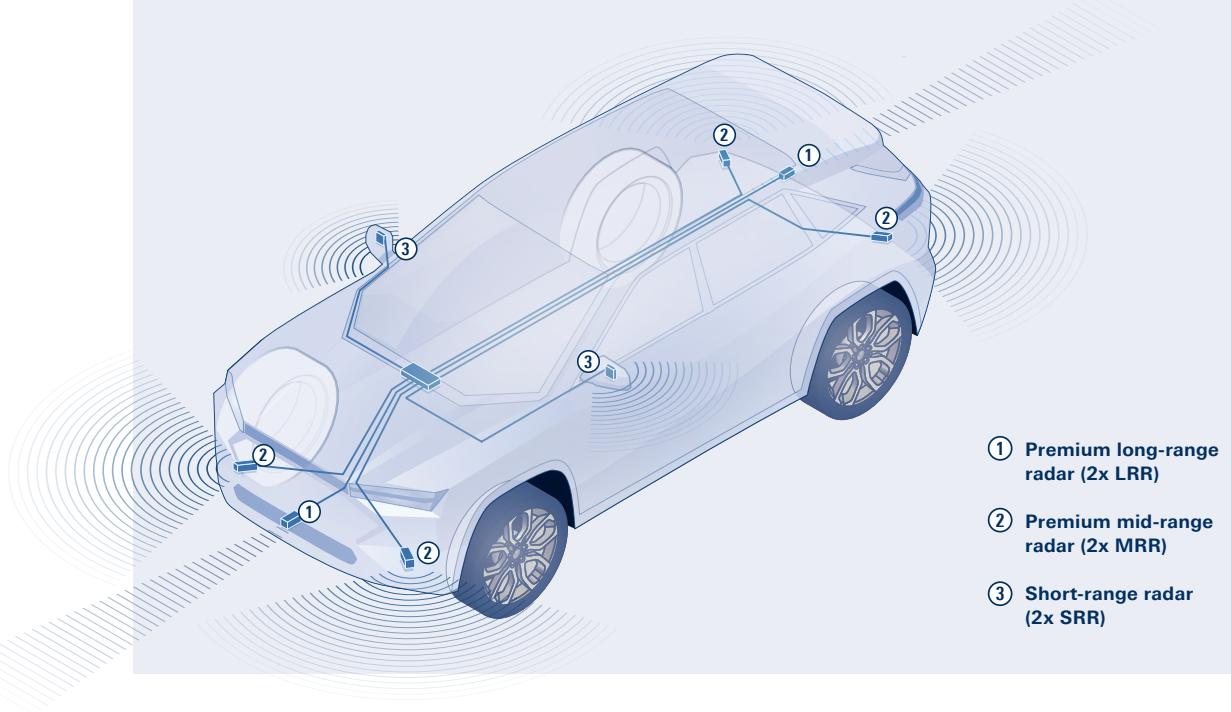
Our radar test solutions, ranging from compact to scalable, complex target simulators as well as advanced instruments and OTA chambers, cover the entire lifecycle from development and validation through production and beyond. We support our partners to provide complete systems covering HiL, ViL, DiL and production testing, and thus enable the automotive industry to develop high-performance radars and transition seamlessly from R&D to production.

YOUR CHALLENGES

- ▶ Continually evolving design specifications, e.g. higher resolution, massive MIMO and new frequency bands require fast innovation cycles
- ▶ Increasing number and complexity of ADAS functions mean additional lab testing to complement road testing
- ▶ Absence of global industry standards for automotive radar performance necessitates the development and execution of robust test procedures
- ▶ Expectation to comply with more demanding safety requirements with every SAE level drives increased test coverage and quality assurance
- ▶ Ensuring the operation of sensors when integrated into ADAS systems and under real-world conditions demands comprehensive in-the-loop testing

AUTOMOTIVE RADAR

The number and complexity of radar sensors are increasing to enable higher levels of autonomous driving. Advanced modulation schemes, new frequency bands, higher-order MIMO and sophisticated digital processing are being developed, and this requires a new generation of test solutions.



FEATURES OF OUR RADAR SOLUTIONS

- ▶ Advanced, multiple-object target generation with no moving parts
- ▶ Fully scalable from ultra-compact to complex scenario emulation
- ▶ Object distance generation down to the airgap to FMCW radar
- ▶ Parallel testing of multiple sensors in production
- ▶ Precise and repeatable EOL sensor calibration and alignment
- ▶ Complete radome material quality analysis

BENEFITS OF ROHDE & SCHWARZ SOLUTIONS

- ▶ Accelerate development of sensors with emulation software and powerful and flexible target generation hardware
- ▶ Efficient validation of sensors with comprehensive characterization chamber and instruments and software solution
- ▶ Seamless transition from lab to production using same target generator
- ▶ Cost and time efficient compact target generator covers complete lifecycle from development to post-production

TEST SOLUTION HIGHLIGHTS

R&S® AREG800A Automotive radar echo generator



- ▶ Generation of multiple objects with individual distance, size, radial velocity and direction even for very close objects
- ▶ Up to 4 GHz instantaneous RF bandwidth
- ▶ Modular and scalable to create complex traffic scenarios

Radar compliance testing

Radar object simulation for validation

Radar production testing

R&S® RadEsT



- Versatile and precise target generation
- Verify radar sensor signal level (EIRP)
- Ultra-compact and battery powered

AUT radar object simulation for validation

AUT radar production testing

ADAS periodic technical inspection

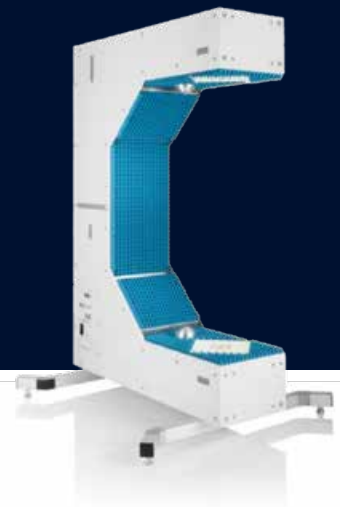
R&S® QAT100 Advanced antenna array



- Unique electronically steerable antenna array
- Extremely flexible and scalable
- High radial resolution and field-of-view coverage

Radar object simulation for validation

R&S® QAR50 Quality automotive radome tester



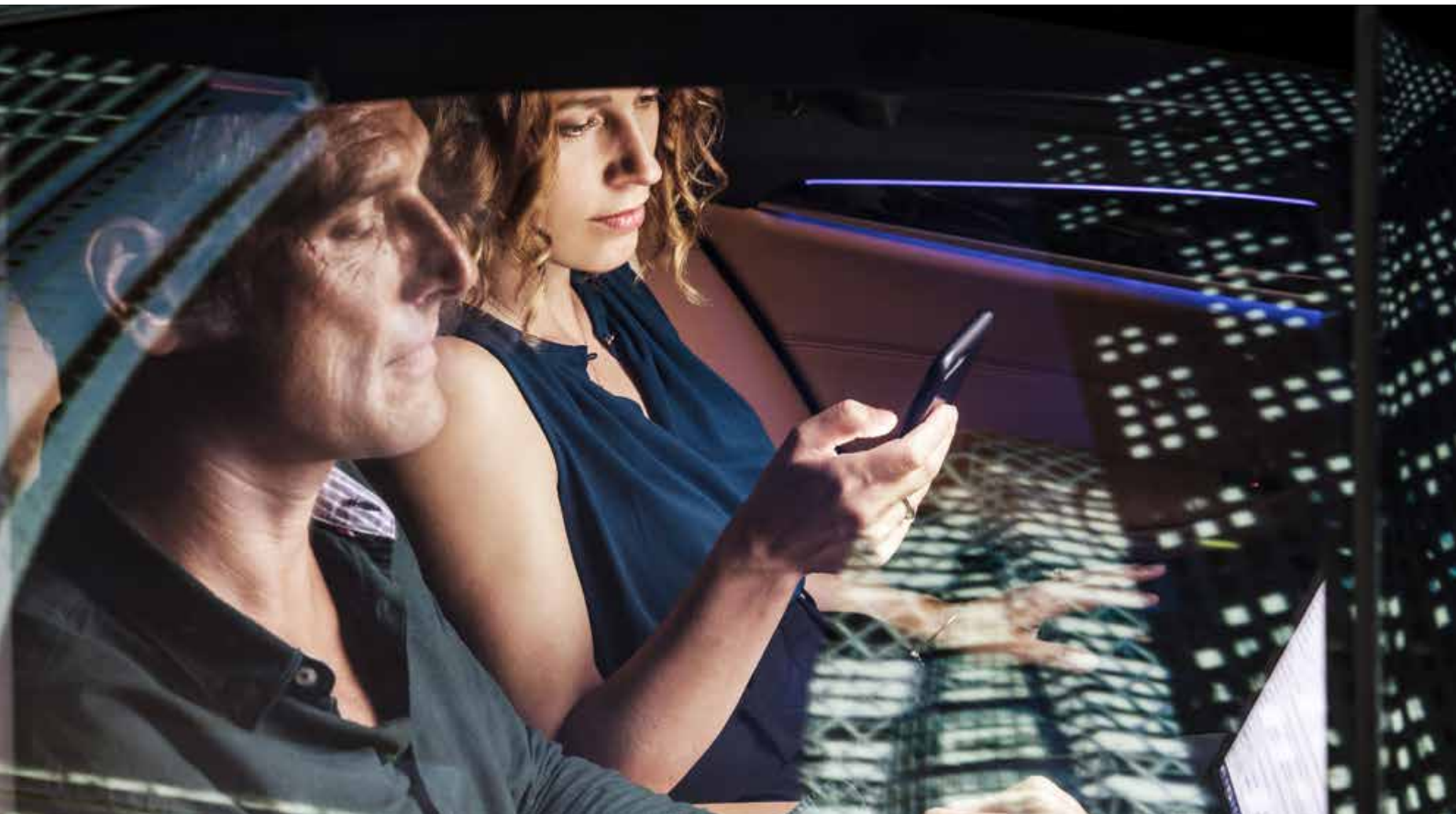
- Precise transmission loss and reflection measurements plus frequency response
- Spatially resolved transmission phase and high resolution reflection image
- Extremely short cycle time of 4 seconds ensures high throughput in production

Radome and bumper testing in R&D and production

AUTOMOTIVE CONNECTIVITY AND ANTENNA TESTING

Testing the increasingly complicated range of wireless technologies for performance, function and interoperability

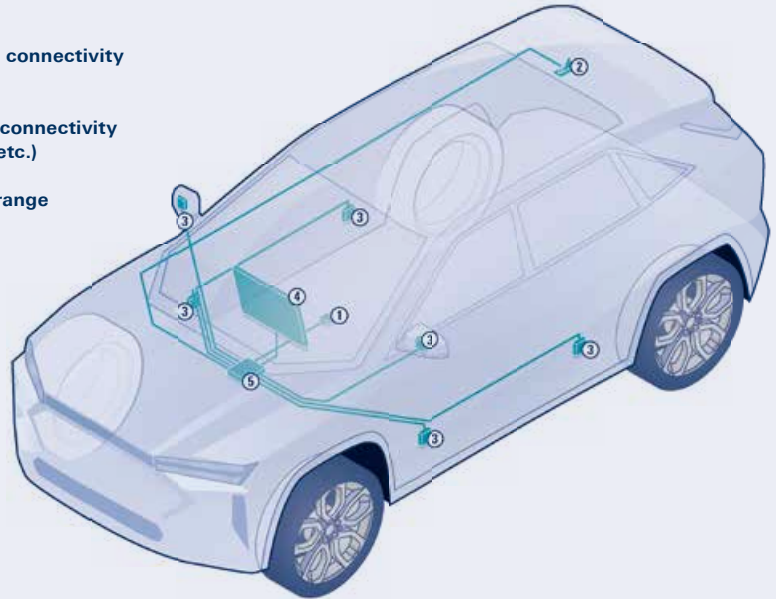
Vehicle manufacturers are integrating more and more wireless connectivity to enable safety features and new user experiences. Our test solutions cover all wireless technologies used in the automotive industry from 5G and Ultra-Wideband to eCall and Non-Terrestrial Networks. They allow antennas and wireless modules to be thoroughly tested on the RF, application and protocol level to ensure the required performance. We cover the entire automotive connectivity lifecycle from development to certification in accordance with industry standards through high-volume production in collaboration with our IPTE production partner.



AUTOMOTIVE CONNECTIVITY

Wireless technologies are leveraged to enable connectivity inside and outside the vehicle for the provision of services. The components and the entire system must be tested on the RF, protocol and application level throughout the development and integration process.

- ① Wireless module for internal connectivity and monitoring (WiFi)
- ② TCU for long-range external connectivity (4G/5G, GNSS, C-V2X, DAB etc.)
- ③ Wireless modules for short-range external connectivity (UWB and BLE)
- ④ Phone and infotainment screen
- ⑤ Gateway



YOUR CHALLENGES

- ▶ Ensure a seamless user experience of safety and infotainment features enabled by wireless connectivity
- ▶ Integrate new technologies and capabilities into the telematic control unit (TCU)
- ▶ Fully characterized antennas should be checked to verify the receive and transmit performance and ensure RF robustness
- ▶ Ensure in-vehicle coverage and wireless coexistence
- ▶ Test end-to-end functioning to validate applications and services

FEATURES OF OUR TEST SOLUTIONS

- ▶ Wireless standards, industry body and regulatory compliant signal generation, analysis and network emulation
- ▶ Complete wireless test coverage including RF, protocol and end-to-end application
- ▶ Antenna testing solutions from compact chambers to digital twins and full vehicle OTA

BENEFITS OF ROHDE & SCHWARZ SOLUTIONS

- ▶ Lower development effort through the use of Rohde&Schwarz leading solutions for testing wireless technologies throughout the entire product lifecycle
- ▶ Increase the quality of your developments by using industry-proven products
- ▶ Future-proof investments in products from a supplier who strategically focuses on telecommunications technology

TEST SOLUTION HIGHLIGHTS

R&S® CMX500 5G one-box signaling tester



- ▶ Chipset, TCU and vehicle-level testing of automotive connectivity, covering all wireless standards and frequency ranges
- ▶ Support of 5G standalone mode / non-standalone mode
- ▶ Standards compliant emulation of NG eCall, non-terrestrial networks, C-V2X and other automotive relevant technologies

5G including NTN

Vehicle-to-Everything

Automotive emergency call

FULL VEHICLE ANTENNA TESTING



- Optimize antenna positioning
- Ensure wireless coexistence
- Validate end-to-end vehicle functions

Antenna testing

5G, eCall and NTN

Vehicle-to-Everything

R&S® SMBV100B Vector signal generator



- Frequency range from 8 kHz to 3 GHz or 6 GHz
- Ultra high output power up to +33 dBm
- GNSS emulation, including HP-GNSS

5G in automotive

Automotive emergency call

Satellite positioning

R&S® CMP180 Radio communication tester



- Frequency up to 8 GHz and bandwidth up to 500 MHz
- UWB development and production testing
- Parallel testing with multiple ports

5G in automotive

TCU production testing

Wi-Fi automotive

AUTOMOTIVE ELECTROMAGNETIC COMPATIBILITY

YOUR CHALLENGES

- ▶ Ensure compliance with automotive EMI and EMS standards
- ▶ Understand EMC implication of new automotive technologies
- ▶ Design test solution/system for your specific requirements
- ▶ Optimize process for time, cost and utilization efficiency

R&S®ELEKTRA
EMC software



The entire range of automotive EMC measurements from a single source

EMC testing ensures that automotive components and systems can operate without causing or being influenced by electromagnetic interference. The introduction of electric vehicles and higher levels of ADAS create new EMC requirements including support for dynamic driving scenarios, use of reverberation chambers, and functional end-to-end testing in a controlled EMC environment.

As a world market and technology leader with decades of experience in EMC testing, Rohde&Schwarz offers test and measurement equipment, automation software and customizable, turnkey test systems for performing EMI and EMS measurements on vehicles and components in line with all major automotive EMC standards, such as CISPR, ISO, UN/ECE and EC directives as well as OEM and country-specific test specifications.

- ▶ Intuitive design for interactive and automatic EMC measurements
- ▶ Covers all automotive EMC standards with predefined templates
- ▶ Create EUT-specific test plans and reports

BENEFITS OF ROHDE & SCHWARZ SOLUTIONS

- ▶ Complete confidence from using EMC test equipment 100 % compliant to the relevant standards from the de facto supplier
- ▶ Time savings and wider test coverage due to automation of dynamic scenario testing using R&S®ELEKTRA
- ▶ High utilization rate as the equipment can be used for both functional ADAS/AD tests and regulatory EMC tests
- ▶ Efficiency from using a single supplier for your complete EMC test programs - from preformance EMI to full EMC compliance, design, service and support and training

R&S® ESW EMI test receiver



- ▶ Frequency ranges from 1 Hz to 8 GHz, 26.5 GHz or 44 GHz
- ▶ Up to 1 GHz of receiver bandwidth for ultra-fast measurements
- ▶ Highest dynamic range and accuracy

R&S® BBA300 Broadband amplifier



- ▶ Continuous RF signal sweeps across ultra-broad frequency ranges up to 18 GHz
- ▶ Linear RF output power up to 1000 W with outstanding noise power density and excellent harmonic characteristics
- ▶ Supports amplitude, frequency, phase, pulse and complex OFDM modulation modes

R&S® TS9981A Automotive radiated immunity test system



- ▶ In line with ISO 11452-2
- ▶ Full range field strength up to 300 V/m, field strength radar bands up to 600 V/m
- ▶ Optional system extension for conducted immunity testing in line with ISO 11452-4



ELECTRIC DRIVETRAIN

Component testing

Solutions for electric drivetrain component optimization

The automotive industry is accelerating its transition to electric vehicles (EVs). These new EVs must meet consumer expectations in terms of price, performance, weight, space, charging time and range. As such, component suppliers must embrace advanced technologies such as fast switching silicon carbide (SiC) semiconductors, higher voltage systems, wireless battery management systems and three phase inverters.

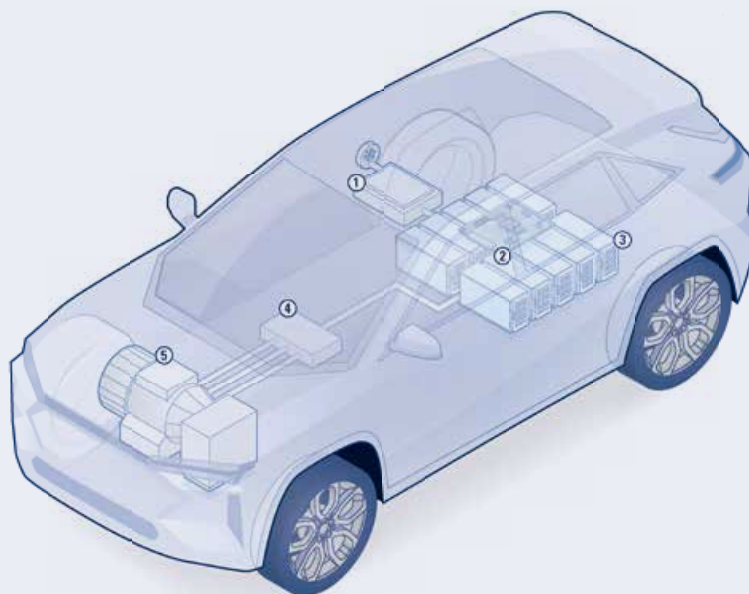
Even marginal improvements in electric drivetrain efficiency and performance can significantly enhance overall vehicle operation. Therefore, it is essential for OEMs and their suppliers to fully characterize each drivetrain component and identify areas for optimization.

YOUR CHALLENGES

- ▶ Minimizing switching losses and maximizing thermal efficiency
- ▶ Verifying stability under different loads and environmental conditions
- ▶ Ensuring maximum efficiency at high switching frequencies and multiple output voltages
- ▶ Ensuring correct switch timings to verify control algorithms
- ▶ Achieving EMI compliance when using new wide-bandgap semiconductors
- ▶ Validation of the complete BMS system including software simulation and HiL testing
- ▶ Maximizing throughput and yield in production

ELECTRIC DRIVETRAIN

Even marginal improvements in electric drivetrain component performance can significantly enhance overall vehicle operation, particularly range. We offer a comprehensive portfolio of electric drivetrain component test solutions to fully characterize (wireless) battery management systems, inverters and on-board chargers, identify areas for optimization, and achieve efficient production testing.



- ① On-board charger
- ② Battery management system
- ③ Battery pack
- ④ Traction inverter
- ⑤ Electric motor

FEATURES OF OUR TEST SOLUTIONS

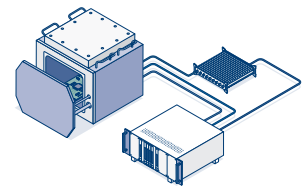
- ▶ Fast-sampling, multichannel oscilloscopes featuring a multitude of test applications from RF switching analysis and power efficiency optimization to EMI precompliance and power integrity
- ▶ High-precision impedance analysis for measuring ESL to nH and ESR to μOhm over a wide frequency range
- ▶ Double-pulse tester system with PE Systems, able to characterize high voltage SiC and GaN semiconductors
- ▶ Isolated probing system with exceptional common mode rejection ratio (CMRR)
- ▶ Simulation, monitoring and control of individual battery cells
- ▶ Analyze/decode multiple frames of CAN, LIN, SPI, UART buses over long periods of time

BENEFITS OF ROHDE & SCHWARZ SOLUTIONS

- ▶ Versatility of multichannel, high-performance oscilloscopes and probes reduces costs
- ▶ Early validation with accurate impedance analyzers minimizes risk of DC link capacitor overheating and voltage spikes
- ▶ Early identification of inefficiencies allows for fast optimization

TEST SOLUTION HIGHLIGHTS

WIRELESS BMS TEST SOLUTION



- ▶ Conducts all necessary wBMS wireless calibration, RX, TX and DC tests
- ▶ Parallel testing of up to eight devices
- ▶ Easy 1-button test execution and automated HTML report generation

Wireless BMS testing

R&S® MX05 AND R&S® RT-ZISO

Oscilloscope and
isolated probing system



- ▶ Eight channels with 2 GHz bandwidth
- ▶ World's fastest oscilloscope with > 4.5 million wfms/s
- ▶ >90 dB common mode rejection ratio at 1 GHz

Electric vehicle component testing

ZES ZIMMER LMG671

Precision power analyzer



- ▶ One-shot narrowband, full spectrum and harmonics power measurement
- ▶ Outstanding accuracy of 0.015 % of measured value
- ▶ Full dynamic range of 500 μ A to 32 A and 3 mV to 1000 V per channel in single instrument

Electric vehicle component testing

ZURICH INSTRUMENTS MFIA

Impedance analyzer



- ▶ Accurately measures very low and high impedance from 1 m Ω to 1 T Ω
- ▶ Precisely measures impedance frequency response from 1 mHz to 5 MHz
- ▶ LabOne software and toolset including scope, sweeper and spectrum analyzer

Electric vehicle component testing

IN-VEHICLE NETWORKS

and ECU testing

Automotive Ethernet, ASA and other protocols

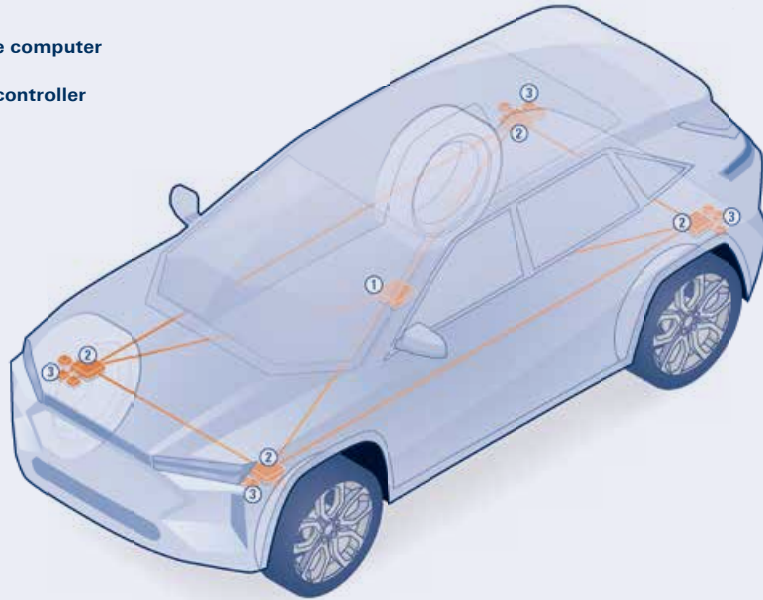
The development of higher levels of autonomous driving and new services delivered by automotive connectivity requires high-performance computers connected by in-vehicle networks with higher and higher data rates. Our in-vehicle network test solutions ensure seamless network communications by supporting the development, debugging and validation of CPUs, ECUs, cables and connectors up to the latest multi-gigabit standards.



IN-VEHICLE NETWORKS

With today's vehicles containing at least a hundred ECUs, the automotive industry is now focusing on a zonal controller architecture to simplify network design, save weight, reduce cost and facilitate higher levels of autonomous driving.

- ① Vehicle computer
- ② Zonal controller
- ③ ECUs



YOUR CHALLENGES

- Ensure compliance and interoperability of all parts of in-vehicle networks up to highest data rates
- Eliminate signal imperfections and EMI anomalies during debugging process
- Ensure optimized throughput and yield during ECU production testing

FEATURES OF OUR SOLUTIONS

- ▶ Trigger and decode capability for CAN, CAN-FD, LIN, FlexRay, CXPI, SENT, Ethernet, ASA-ML and GMSL
- ▶ Compliance tests for automotive Ethernet (10BASE-T1S, 100BASE-T1, 1000BASE-T1, 2.5/5/10GBASE-T1) in accordance with standards such as 802.3cg, 802.3bw, 802.3bp, 802.3ch
- ▶ Channel and connector testing (100BASE-T1, 1000BASE-T1, 2.5/5/10GBASE-T1) according to OPEN Alliance TC9
- ▶ EMI debugging, IVN signal & power integrity verification and analysis
- ▶ Test solutions for all parts of in-vehicle networks including HPC, domain controllers, zonal controllers, cables, buses and connectors

BENEFITS OF ROHDE & SCHWARZ SOLUTIONS

- ▶ Assurance from compliance testing using approved solutions
- ▶ Faster development times due to rapid identification of automotive bus and ECU signal anomalies
- ▶ Maximized ECU production test efficiency from multifunction, parallel testing using the TSVP platform

TEST SOLUTION HIGHLIGHTS

R&S® RTP
Oscilloscope



- ▶ Bandwidth: 4 GHz to 16 GHz
- ▶ Compliance testing of high-speed protocols up to multi-gigabit
- ▶ Max. memory depth: 3 Gpoints per channel

ECU, controller and HPC development and de-bugging

IVN compliance testing

R&S® ZNB3000

Vector network analyzer



- Frequency range from 9 kHz to 43.5 GHz
- In-vehicle network compliance testing, including mixed mode
- Wide dynamic range of up to 140 dB

Domain controller and ECU development

R&S® MX03

Oscilloscope



- Versatile tool for debugging and low-speed bus testing
- World's fastest oscilloscopes with 4.5 million waveforms/s and up to 99 % real-time capture
- Industry-leading architecture with 12-bit ADC and 18-bit HD mode

Signal and power integrity

CAN, LIN & SENT testing

DC POWER SUPPLIES



- Fits wide variety of test and measurement scenarios
- Offerings ranging from basic bench models to high-performance products that can easily power industrial labs
- Comes with modular capabilities for ECU, controller and HPC development and debugging

Service at Rohde & Schwarz You're in great hands

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

Rohde & Schwarz

The Rohde & Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test & measurement, technology systems and networks & cybersecurity. Founded more than 90 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and 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

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

More Rohde & Schwarz certificates



Rohde & Schwarz training

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Rohde & Schwarz customer support

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