

Design and Test Solutions for E-Mobility and Autonomous Driving

**Deliver innovations faster and better with
high-performance design and test platforms
for cross-domain technologies**



INTRODUCTION

The Intelligent Car is Here

The automotive industry is accelerating its electronic technology revolution and fusing with the clean energy ecosystem. By 2030, 4.2 million cars will be autonomous and 50% will be electric.

Dramatic increases in the number of sensors and applications in new automobiles have evolved the vehicle from a peripheral role to a network hosting clusters of connected devices. Cars now need to be optimized for:

- power efficiency
- sensor fusion
- communications
- high-power processing
- high throughput data connectivity

“Coupled with Keysight’s experience in a wide spectrum of test and measurement applications for connected and autonomous cars, their participation will bring valuable insights to our association as we work on developing intelligent transport systems of the future for the automotive industry.”

Dino Flore, first Director General of the 5GAA



Introduction

What are automobile engineers and manufacturers trying to accomplish by integrating so many diverse technologies?

Innovations in current and next-generation automobiles are expanding capabilities and performance to serve three new key areas.

Automotive electronics is the underlying platform for all operations and diagnostics, convenience and comfort, safety and security, and main support for the three areas of innovation.

- E-mobility, applying clean renewable electric power to transportation. Hybrid or fully-electric drivetrains with improved batteries, more efficient power conversion and electronics power draw.
- Autonomous driving, increasing safety and enabling new business models. advanced driver assistance systems (ADAS) and autonomous driving with radar and light detection and ranging (LIDAR) sensors, camera arrays, and artificial intelligence algorithms running on powerful computing systems.
- Connected car, communicating with everything and everybody.





Contents

Many different technology elements can be assembled in various combinations depending on what automotive engineers are intending to bring to market. While the number of permutations are too numerous to cover, these are the major design and test solution areas that most, if not all, professionals of the automotive and energy ecosystem will be involved with.



CHAPTER 1

E-Mobility

Disruptive innovations in automotive electromobility are reducing air pollution. These efficiency innovations are possible because of advancements in electronics, chemistry, and integration testing.

Whether you are designing new power electronics to facilitate vehicle-to-grid (V2G) integration, developing technological advancements in electric and hybrid electric vehicles, or engaged in powering home energy management systems, design and test parameters are evolving rapidly in the energy ecosystem.

Bring your breakthrough energy innovations to market faster and more safely with the latest test solutions.



E-Mobility

Cells and Batteries

Scenario

E-mobility's soaring demand is creating a quest for cells and batteries with better charge / discharge and higher capacity, to offer improved performance and range without compromising quality. Production of these batteries must meet the growing demand for energy density, safety, and durability at costs optimized to be market-competitive. Effective and comprehensive testing solutions can help accelerate design and production of new generations of batteries for e-mobility.

Solution: Li-ion Cell Self-Discharge Measurement Systems

Keysight's **self-discharge measurement solution** provide a revolutionary reduction in the time to measure and characterize self-discharge performance of Li-Ion cells in design, verification, and production phases. Instead of using the conventional time-consuming open-circuit voltage measurement method, Keysight uses a potentiostatic method to measure the self-discharge current of the cell directly.

Benefits:

Keysight's innovative approach to characterizing the self-discharge behavior of cells can help you:

- Reduce design cycle time and get to market faster.
- Decrease testing time from weeks to hours and save inventory and space in manufacturing.



Cells and Batteries

Solution: Li-ion Cell Formation Platform

The Keysight **Charge-Discharge Platform** offers modular configurations to support cells requiring maximum currents ranging from 6 A to 800 A, with up to 256 cells or user channels per chassis.

Benefits:

This cost-effective and easily reconfigurable solution for Li-Ion cell forming provides:

- Flexible modular configurations as your cell requirements and capacities change.
- Accurate measurements of current, voltage, and capacity made at 1s sample intervals.



Cells and Batteries

Solution: Battery Cell, Module, and Pack Test

Keysight's **battery test solutions** are innovative and modular test systems equipped with the best-in-class **Energy Storage Discover** (ESD) software to run customized performance, function, aging, and environmental tests. Our solutions can be used in every stage of battery development: cell chemistry research, cell characterization, and validation of battery modules and packs.

Benefits:

- Regeneration capabilities that ensure optimal energy and cost efficiency.
- Precise measuring technology, with highly reliable power electronics for accurate measurement results.
- Modular concept for a flexible layout of the test environment to adapt to future test requirements.
- Integration of external components into the test environment, eg. climate chambers, BMS.
- Standardized and standard-compliant tests (for example, ISO, DIN EN, SAE).
- Determination of internal resistance, charge, energy, capacity, efficiency, cyclic and calendrical durability, temperature behavior, electrochemical impedance measurement, and cyclic voltammetry, etc.
- Holistic approach, including hardware, software, project management, service, and support.



Cells and Batteries

Scenario

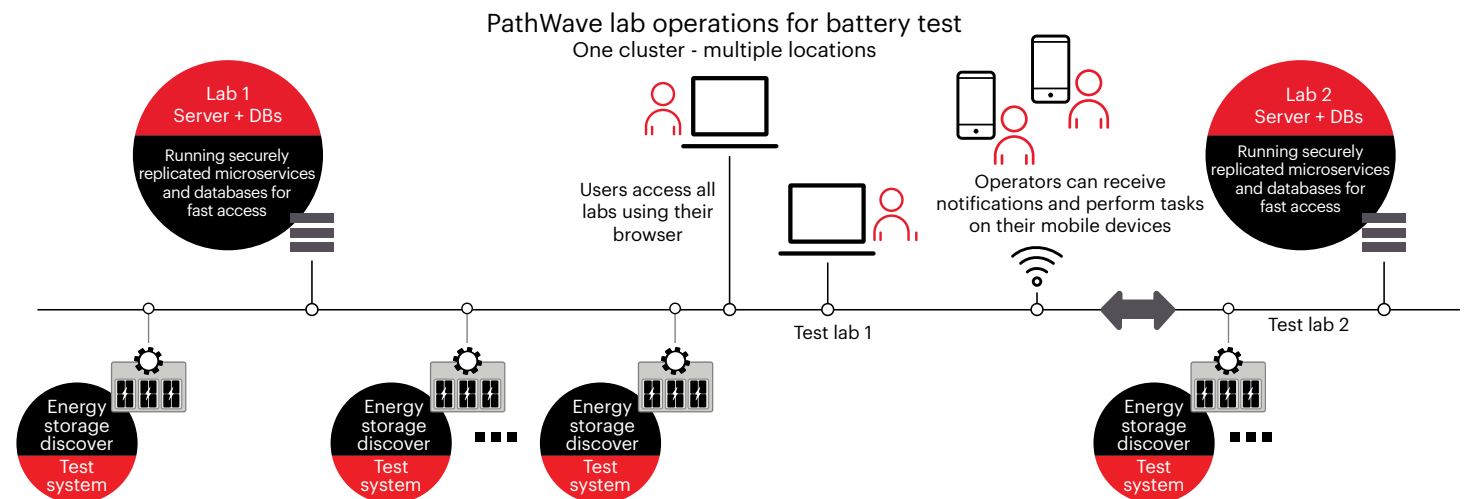
Electric cars these days have hundreds to thousands of cells. Understanding and verifying the performance of cells and batteries becomes critical for both cell designers and manufacturers. As the number of test systems grows to meet these testing demand, it becomes more important that the software supports the need to maintain and improve the productivity in the test laboratory.

Solution: PathWave Lab Operations for Battery Test

The Keysight **PathWave Lab Operations for Battery Test** enables efficient planning and coordination of your entire battery test laboratory. It helps you manage all resources, including test fields, test systems, and your devices under test (DUT).

Benefits:

- Enables efficient management and remote control of the entire test lab.
- Integrated, web-based lab management platform.
- Modernizes test workflows, eliminating legacy paper-based processes, and increases data integrity and traceability.
- Powerful set of tools improves test throughput in the lab.
- Helps to fulfill the testing requirements for projects on-schedule and optimizes test asset utilization.



HEV / EV Charging

Scenario

Ensuring that the charging function is correctly performed between the charging infrastructure and the HEV / EV is a complex process involving numerous stakeholders: vehicle manufacturers and suppliers, certification bodies, manufacturers and operators of charging infrastructure such as in-vehicle chargers, wall chargers, or charging columns. The primary goal of testing is to ensure interoperability between all of these EV charging equipment.

Solution: Charging Discovery System (CDS)

Keysight's **CDS** is an all-in-one system that covers all charging test areas and provides independent, reproducible testing of any EV and EVSE charging interface through real-time emulation of all electrical interfaces (including communication signals and energy transfer) of the counterpart.

Control the CDS models with the **Charging Discover test software**, which allows you to visualize, measure values, record test sequences, and generate reports tailored to your needs.

Keysight's **TTCN-3 Charging Communication Test Automation software** is also designed to operate with the hardware, enabling fully automated conformance tests for CCS charging communication.



Benefits:

With CDS – **Portable**, EMC, and **High-Power Series**, Keysight helps you to comply with current and future charging standards up to 900 kW (only with the High-Power Series), to ensure conformance and interoperability.



HEV / EV Charging

Scenario

To ensure interoperability and conformance between the electric vehicle (EV) and electric vehicle supply equipment (EVSE) communication controllers, it is critical to run validation, approval, and manufacturing tests based on the latest standards.

Solution: EV - EVSE Charging Communication Interface Tester (Com Tester)

The **EV - EVSE Charging Communication Interface Tester** (Com Tester) is designed for component-level tests of electric vehicle communication controllers (EVCC) and supply equipment communication controllers (SECC). It supports Combined Charging System (CCS) communication (IEC 61851-1, DIN SPEC 70121, and ISO 15118). The Com Tester supports the following use cases:

- Performing case emulation for development testing of EVCC and SECC.
- Administering conformance test cases for type approval testing of EVCC and SECC.
- Running scenario-driven tests for manufacturing testing of EVCC and SECC.
- Conducting hardware-in-the-loop (HiL) integration tests on the component level.

Keysight's **EV - EVSE Smart Charging Emulation Software** is designed to work with the Com Tester and enables customizable and configurable emulation environments for functional and scenario-driven tests.

Keysight's **TTCN-3 Charging Communication Test Automation** software was also designed to operate with the Com Tester and provides a means for fully automatized conformance tests for CCS charging communication.

EV - EVSE Charging Test Robot Series can connect to SL1550A to incorporate mechanical actuators in the CCS test automation process.

Benefits:

- Accelerates testing by emulating EVCC and SECC for charging communication and protocol testing.
- Offers software / firmware updates to ensure testing to the latest standard specifications.
- Uses EV - EVSE Charging Test Robot Series to simplify the testing process and allow for fully automated testing sequences with hundreds of test cases by automating the human-machine interface (HMI) interaction with the system under test.



HEV / EV Charging

Scenario

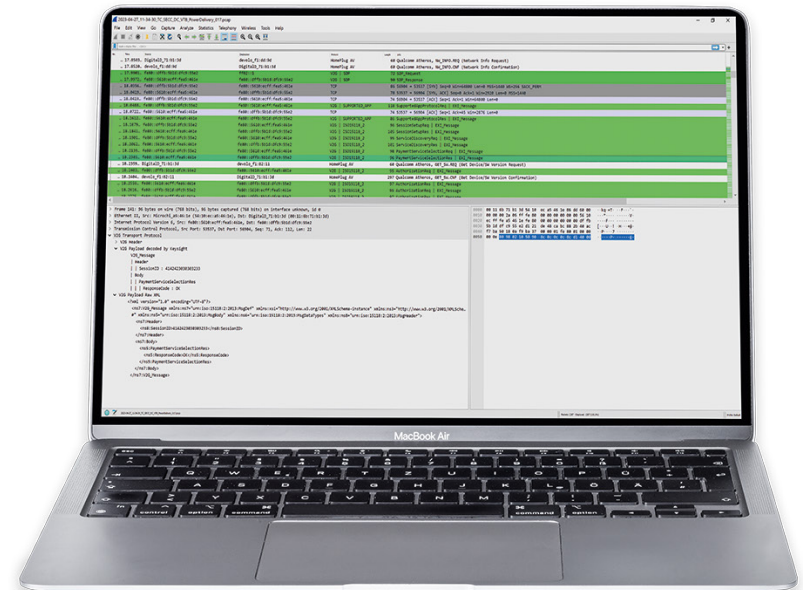
To ensure interoperability between EV and EVSE communication controllers, it is important to analyze over-the-wire data transfer.

Solution: CCS Charging Protocol Tracer (CCS Tracer)

The Keysight **CCS Charging Protocol Tracer** (CCS tracer) enables seamless observation of the CCS communication channel between a charging station (EVSE) and an electric vehicle (EV). In combination with the **CCS Charging Protocol Trace Viewer** (CPT), you can analyze over-the-wire communication traffic, which is communicated via HomePlug Green PHY powerline communication (HP GP PLC) on the control pilot (CP) line.

Benefits:

- Provides easy analysis of CCS charging communication.
- Sports a smaller footprint that enables direct usage on the EV or EVSE.
- Delivers seamless observation of the communication between EVs and EVSE.
- Offers flexible operating modes including a non-invasive test interface for direct coupling or optional inductive cable clamp for inductive coupling.





DC Emulation

Scenario

Testing EV fast chargers requires sinking very high power to a DC load. Using a physical battery for testing purposes is a nonideal choice for multiple reasons. With a physical battery, achieving consistent and repeatable testing conditions is difficult as battery characteristics vary over time since it charges and discharges. Also, physical batteries have overheating, fire, or explosion risks. Some manufacturers may want to test a wide range of battery types and conditions, which is impossible with a single type of physical battery.

Solution: Regenerative DC Emulator

The **Regenerative DC Emulator** from Keysight solves the challenges associated with physical batteries and boasts bidirectionality, integrated DC voltage and current controllers, high dynamics, and regenerative energy feedback capacity. The DC emulator is an all-in-one system for efficient and effective testing of power electronic components in EVs and EVSE. The Regenerative DC Emulator is available for high-voltage and 48 V applications.

Benefits:

- Packs a smaller footprint compared to systems with similar power.
- Provides 1.5 MW power due to parallelization.
- Offers up to 1500 VDC for emulating high-voltage batteries.
- Delivers new high-voltage silicon carbide technology.
- Offers high efficiency with a recovery capability of up to 96%.
- Reduces energy consumption and cooling water.

Grid Emulation

Scenario

The growth of variable renewable energy and distributed energy resources, battery storage, and vehicle electrification will create significant demand on the power grid. As the energy mix intensifies, so does the challenge of managing the way we produce, distribute, and consume electricity. New “smart” inverters with grid support functionality are a key enabler for this emerging energy ecosystem. However, inverter manufacturers need to ensure these inverters meet grid compliance / interconnection standards via rigorous testing in this high-power environment.

Solution: AC Emulator with Regenerative Bidirectional Power

The Keysight **Regenerative 3-Phase AC Emulator** can emulate the AC power grid to fully test EV and EVSE charging with the 400 kW and 900 kW charging discovery systems. It can fully test photovoltaic (PV) inverters when used with Keysight **PV simulators**.

Benefits:

The AC emulator handles all your three-phase AC test needs by:

- Providing up to 1200 VL-L; up to 130 A; up to 630 kVA.
- Achieving 1200 VL-L at full specifications without extra equipment, such as a transformer.
- Saving energy with 100% regenerative (bidirectional) power solution with > 85% efficiency.
- Ensuring conformance and interoperability.
- Simulating various distributed energy resource uses cases to test various interconnection standards.



High-Power Devices

Scenario

Higher density and more efficient wide bandgap (WBG) power semiconductors such as SiC and GaN offer fast switching speeds, operate efficiently at high voltage and high temperatures, and are smaller than conventional power devices. These features make them a popular option to enable better range and performance in electric vehicles. However, manufacturers find these WBGs challenging to characterize, especially when they need repeatable and reliable measurements to meet emerging JEDEC GaN JC70.1 and SiC JC-70.2 standards for dynamic testing of WBGs.

Solution: Repeatable, Reliable Dynamic Double-Pulse Tester

The Keysight **dynamic power device analyzer / double pulse tester** delivers reliable, repeatable measurements of wide-bandgap SiC and GaN semiconductors. This platform ensures user safety and protection of the system's measurement hardware.

Benefits:

- Delivers repeatable double-pulse test results using Keysight's expertise in high-frequency gigahertz range testing and low leakage femto-ampere range measurements using pulsed power at 1,500 A current, 10 μ s resolution.
- Enables testing for all your power modules and devices with an expandable, upgradeable, and modular platform so you can meet future requirements.
- Provides a safe test environment for both the DUT and the user.





CHAPTER 2

Autonomous Driving

One of the most ambitious areas of automotive innovation is autonomous driving. Advanced driver assistance systems (ADAS) for current mainstream human-driven vehicles and autonomous driving systems in prototype stage are dramatically improving safety and will save many lives.

Car makers, automotive suppliers, governments, academics, and even non-automotive technology providers, are jointly developing a new automotive ecosystem by combining a wide variety of advanced technologies to make autonomous driving a mass market reality.

Sensor fusion, high-speed information systems, and vehicle-to-everything (V2X) communications form the foundation feeding real-time data to powerful artificial intelligence (AI) that can then direct critical actions such as steering or braking in milliseconds.

To prove their mission-critical technologies are perfectly safe, designers and engineers must not only implement the most reliable technologies, they also must validate and demonstrate accuracy and dependability by using the best simulation and test solutions.



Autonomous Driving Emulation

Scenario

During the development of autonomous vehicles, confidence in advanced driver assistance systems (ADAS) safety requires detailed testing. ADAS are complex, and their decision-making algorithms must be trained to tackle roadway scenarios reliably. With an unproven system, premature roadway testing is too risky, expensive, and can miss important corner cases. Physical drive testing to ensure reliable ADAS involves sensors, code, artificial intelligence (AI) logic, and more.

Solution: Autonomous Drive Emulation Platform

Keysight's **Autonomous Drive Emulation (ADE) platform** is the environment emulator for in-lab testing using all types of realistic roadway scenarios. The platform exercises ADAS software using time-synchronized inputs to the actual sensors using total scene generation. Its open architecture also closes the loop with your existing hardware-in-the-loop (HIL) systems and 3D modelers, enabling you to keep pushing ADAS towards Level 5.

Benefits:

- Accelerates the development of new ADAS software features.
- Helps you gain deeper insights into the ADAS software behavior earlier in the development cycle by identifying potential issues earlier in the development process to reduce the likelihood of post-release failures.
- Validates line-of-sight-based sensors such as radar and cameras with synchronous testing of communication-based systems, such as C-V2X.



Radar Scene Emulation

Scenario

Achieving the next phase in vehicle autonomy demands robust algorithms trained to interpret radar reflections detected by automotive radar sensors.

Solution: Radar Scene Emulator

Keysight's first-to-market **radar scene emulation technology** combines hundreds of miniature radar target simulators into a scalable screen that can emulate objects with up to 512-pixel resolution and at distances as close as 1.5 meters. This breakthrough solution overcomes conventional radar sensor test solutions that have a limited field-of-view (FOV) and cannot simulate objects at distances less than 4 meters.

Benefits:

- Provides 512-rixel resolution with a contiguous horizontal FOV of ± 70 degrees and vertical ± 15 degrees.
- Generates static and dynamic targets at ranges of 1.5 meters to 300 meters and with velocities of 0 – 400 km/h.
- Addresses multi-target, multi-angle scenarios with mechanically fixed RF Front ends that provide repeatable angle of arrival accuracy.
- Emulates complex, RF-dense urban scenes with realistic interference testing.
- Enables improved detection and differentiation of objects via 3D point clouds and multiple reflections.



Automotive Radar

Scenario

Automotive radars are evolving from convenience functions, like adaptive cruise control and safety warning systems, to intelligent detection and collision mitigation systems. Automotive developers are driving towards the adoption of higher-frequency radar systems, offering higher performance with greater reliability and more accurate spatial resolution between different objects, enhancing the vehicle's ability to respond to potential dangers on the road. Globally, there is also a push towards standardizing usage of 77-79 GHz high-resolution vehicular radars.

Keysight offers a range of innovative solutions for radar test technology – from analog and vector signal generators, spectrum analyzers, vector signal analyzers, to vector network analyzers.

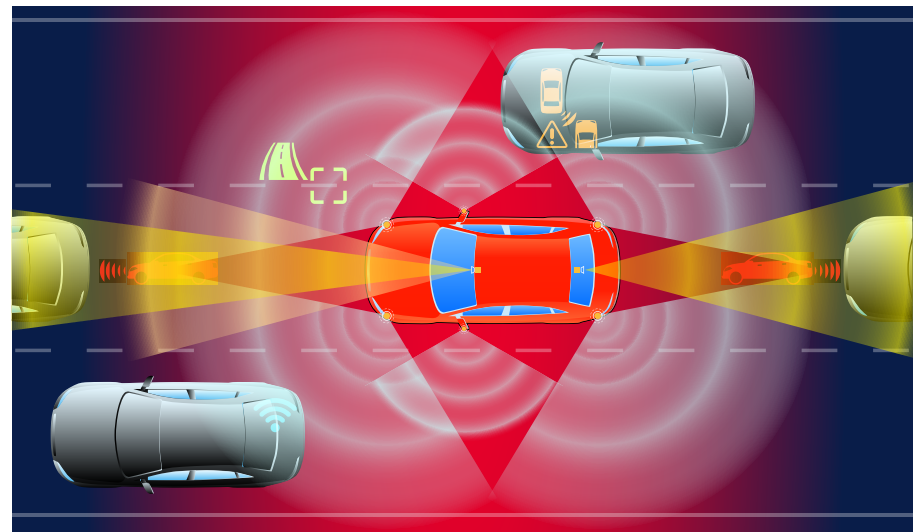
Solution: Automotive Radar Signal Analysis and Generation

Keysight's **automotive radar signal analysis and generation solutions** perform analysis and generation of automotive radar signals across full frequency ranges for legacy 24 GHz and new 77 GHz and 79 GHz bands. It provides scalable analysis bandwidth from 2.5 GHz to > 5 GHz that new millimeter-wave technology tests demand.

Benefits:

The solution can be customized to test requirements and budget with one configuration for signal generation, and six configurations for analyzing automotive radar signals. Test capabilities can be expanded by integrating the **PathWave Automotive Library** software for simulation of multi-target detection and automotive radar 3D scan.

- Cover the 2 Hz to 110 GHz spectrum in one continuous sweep.
- Test 79 GHz radar signals for compliance with ETSI spurious specs using a single instrument.
- No external mixing, no down conversion, and no compromises.
- Great sensitivity and dynamic range ensure better signal to noise ratio (-149 dBm/Hz at 110 GHz).
- Flexible application of many simulation scenarios.



Radar Target Simulation

Scenario

Imaging radars, also known as 4D radars with their increased antenna array provide a “visual” 3D image of the environment, a massive improvement over the standard radar sensor. This advancement comes with a higher demand on test equipment, such as more bandwidth and better distance accuracy.

Solution: Automotive Radar Target Simulator

Keysight's **radar target simulator** offers a full 5 GHz of instantaneous bandwidth and an improved distance accuracy of 5 cm. The radar aligns with performance expectations from future imaging radars. A new over-the-air calibration feature improves path loss and minimizes uncertainties in radar test setups.

Benefits:

- Covers radar sensors for 76 – 81 GHz with 5 GHz of instantaneous bandwidth.
- Simulates a broad range of distances from 3 m to 300 m.
- Comes as a single simulator or multi-target simulator — three targets with second and third targets at fixed distances.



Lidar Target Simulation

Scenario

Lidar sensors are gaining adoption in advanced driver assistance systems (ADAS) and autonomous driving (AD) applications, but cost, quality, and time-to-market challenges must be overcome. Validation and testing will play a key role in addressing the challenges impacting the future of lidar applications in autonomous vehicles.

Solution: Automotive Lidar Target Simulator

Keysight's **Lidar Target Simulator** simulates targets with both distance and reflectivity in a compact benchtop form factor. Its advanced features and analytical software will help you gain insights into lidar sensor performance.

Benefits:

- Simulates and automatically sweeps in distance and reflectivity.
- Covers both solid-state and mechanical rotating lidar sensors.
- Performs 3D / real-world object simulations.
- Improves quality and yield with insights from innovative visualization and analytical software.



EMI / Noise Evaluation

Scenario

With in-vehicle, lab, and manufacturing equipment emitting all sorts of electromagnetic interference, the ability to accurately test mission critical autonomous driving functions is challenging.

Solution: Automotive Emissions and Immunity Testing

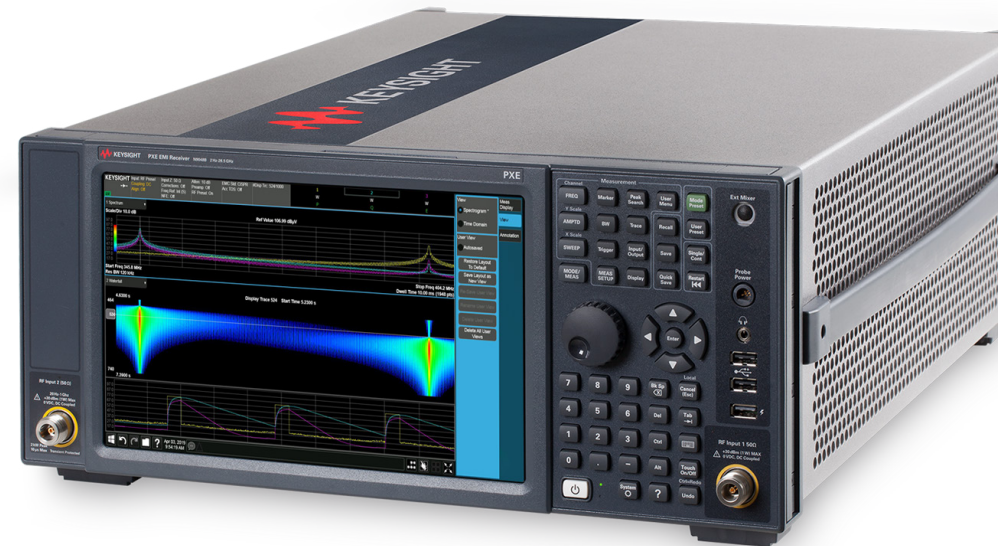
The Keysight **PXE EMI Test Receiver** is a standards-compliant EMI test receiver equipped with an RF pre-selector and LNA designs. Shorten your overall test time and easily perform gapless signal capture and analysis with real-time scan (RTS) capabilities.

The compliance receivers and pre-compliance spectrum analyzers keep your EMI test queue flowing. The **EMPro 3D EM simulation software** analyzes the 3D EM effects of components such as high-speed and RF IC packages, bond wires, antennas, on-chip and off-chip embedded passives and PCB interconnects.

Benefits:

The N9048B helps you test EMI with confidence and obtain accurate, repeatable, and reliable measurements.

- Select from wider analysis bandwidth options.
- Maximize measurement sensitivity with the built-in pre-amplifier.
- Gain leverage with the multi-touch user interface and EMC measurement application software.
- Use real-time scan for gapless signal capture and analysis in up to 350 MHz bandwidth, simultaneously viewing frequency domain, time domain, and spectrogram.



Antenna Design

Scenario

With so many radio frequency (RF) systems and devices to integrate into automotive architectures, engineers need to design RF components that are used in cellular communications, wireless networks, radar, and satellite communications systems.

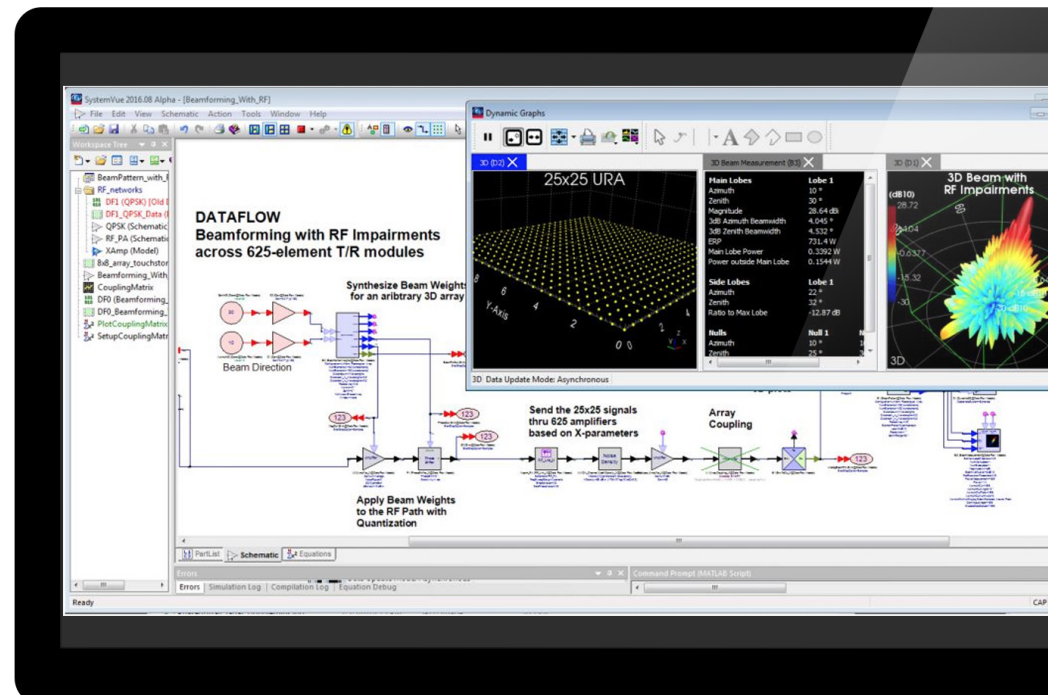
Solution: EEs of Electronic Design Automation (EDA) Software

The Keysight's **PathWave Phased Array Analysis** tool provides system architects in 5G, radar / EW, and satellite communications with the essential tools to evaluate phased array and beamforming subsystems, including RF, digital, and hybrid beamforming architectures. It allows system designers to consider RF nonlinear and noise effects, gain / phase quantization, and Monte Carlo variations effects on total beam quality, sidelobe levels, and effective radiated power. It also supports dynamic system-level scenarios with algorithms for adaptive beamforming.

Benefits:

Design and refine phased array antenna of any size and configuration quickly: 5G beamforming and high order MIMO, radar / EW and automotive beamforming.

- General system-level modeling and design.
- Robust mission critical antenna design from element failure analysis.
- Broad dataflow simulation support with beamforming synthesis, analysis, and dynamic visualization.



Automotive Lab Operations

Scenario

Today's automotive research and development (R&D) laboratory faces many new challenges — from integrating new technologies, standards, and test methods — to operational tasks like finding the right instrument, person, or software program to run a crucial test. The new reality amplifies the challenges lab managers face regarding team productivity, asset utilization, project-level visibility, standards compliance, and overall workflow efficiency.

These issues also increase the likelihood of over-budget equipment buys and erroneous test results, leading to problems with product quality. A new tool is necessary to manage the more complex workflows to enable more in-depth insights into your test lab.

Solution: PathWave Lab Operations for Connectivity

The Keysight **PathWave Lab Operations for Connectivity** tool is a powerful lab management software tool that gives you a 360-degree view into the workflow of your lab, from instrument control to data analysis and data storage.

Benefits:

- Provides a 360-degree view of the validation process and across your entire lab.
- Enables fast assessment of product readiness for compliance testing and pilot production.
- Streamlines management of assets, logistics with repeatable test automation.
- Releases test operators to work on other activities.





CHAPTER 3

Connected Car

The connected car has transitioned from a passive approach to a fully interactive and integrated multi-technology communication system. In 1930, the one-way car radio receiver was the first step to connecting people on the go. It remained the only mass-produced automotive communication system until the 1980s when the 1G mobile network introduced the mobile phone, providing two-way communications.

The 21st century connected car is made of computerized systems using a variety of multi-connectivity networked systems such as cellular, WiFi, and satellite. The diversity and integration of communication technologies demand a rigorous testing regimen during design and production. And Keysight provides the expertise across all these technologies to help you deliver on your new connected car vision.



5G C-V2X

Scenario

Designing and implementing 5G cellular vehicle-to-everything (C-V2X) capabilities can be a daunting task. The technology, equipment, and expertise needed to build and maintain a test setup that addresses all the latest standards and specifications can be costly and time-consuming.

As 5G continues to evolve, the test requirements for C-V2X will be a moving target. The ability to thoroughly validate the performance of C-V2X designs depends on a test platform that can perform RF, protocol, and application-layer testing while staying current with changing test scenarios.

Solution: Cellular-Vehicle-to-Everything Test

Keysight offers the only solution that is tracking along with the evolving C-V2X standard. The Keysight **C-V2X test solution** is also the first to gain OmniAir Qualified Test Equipment (OQTE) status, helping the automotive industry accelerate cellular vehicle-to-everything (C-V2X) device certification. The solution supports RF, protocol and application-layer testing, while the underlying platform will support future releases of 5G New Radio (NR) C-V2X.

Now you can further accelerate verification of compliance and interoperability of V2X applications across the ITS environment with Keysight's WaveBee tool chain. This end-to-end V2X testing solution provides the foundation of use-case validation in the lab, around the track, and on the road.

Benefits:

- Covers V2X testing from application to physical layers.
- Simplifies C-V2X protocol and RF measurements with an intuitive user interface.
- Emulates GNSS signals with an RF vector signal generator.
- Protects your initial investment in the solution.
- Accelerates deployment of new technologies that enable advanced safety features.



Emergency Call Conformance

Scenario

eCall / ERA-GLONASS Conformance Test Solution is a European Union and Russian Federation initiative created to combine mobile communication and satellite positioning to provide rapid assistance to passengers in the event of a collision. Generally, an eCall module consists of an embedded computer that continuously monitors the crash sensors and vehicle position via satellite receivers. In the event a crash sensor is activated, the in-band modem will establish a connection to enable transmission of a minimum set of data (MSD) to the most appropriate public safety answering point (PSAP). A microphone and speaker system enable the driver or passenger to communicate with the PSAP operator. Each of these components plays an important role, hence they need to be tested for functionality in a real-world environment to ensure overall system performance. Testing of eCall / ERA-GLONASS modules brings many challenges; hence, the test solution should meet the required minimum viable functionalities.

Solution: eCall / ERA-GLONASS Conformance Test

The Keysight **eCall/ERA-GLONASS Conformance Test Solution** simulates a PSAP and controls a UXM / 8960 and MXG signal generator to emulate a cellular network. It provides GNSS coordinates required by the in-vehicle system to compile the MSD. This setup makes it possible to verify if the IVS or modem can trigger an emergency call, send the correct raw MSD data and establish a voice connection with the PSAP, testing both Pan European and ERA-GLONASS platforms – fully independent of any real-world mobile network. Optional audio analyzer for parallel testing of speech quality is available.

Benefits:

Keysight's eCall solution helps developers in the automotive industry enhance their capability to release conformant and high-quality eCall products while ensuring fastest time-to-market.

- Pan-European eCall and ERA-GLONASS support.
- No external PC required since PSAP can run inside UXM.
- Static and dynamic GNSS simulation.
- Automated test Cases for eCall and ERA-GLONASS.
- PSAP software supporting Live Network Mode.



Automotive Cybersecurity

Scenario

The modern connected car is no different from our laptop or mobile phone because it also contains hackable personal data. A closer look at the sub-systems enabling vehicular communication reveals numerous points of vulnerability. Hackers can launch various attack paths, ranging from cryptographic attacks at the hardware level to over-the-air (OTA) protocol attacks.

Connected cars offer cybercriminals the ability to remotely access and manipulate the data these systems rely on, which can lead to problems such as exposure of personal information, compromised vehicle security mechanisms, or even complete control of the vehicle itself. A single cyberattack can cost carmakers untold financial losses, not to mention damage to reputation and customer trust. It's therefore no wonder car makers are starting to view automotive cybersecurity seriously.

Solution: Automotive Cybersecurity Test

The Keysight **Automotive Cybersecurity Test Platform** is a scalable platform that enables you to validate the robustness of your ECU / TCU, subcomponents, and the entire car against cyber-attacks.

Benefits:

- Helps you meet UN R155 regulation for automotive cybersecurity.
- Covers penetration test needs from the hardware level through all layers of the OSI stack with one solution.
- Provides you updated data feeds to ensure current application and threat intelligence via access to the subscription-based Keysight Application and Threat Intelligence (ATI) library.
- Helps you detect and fix vulnerabilities quicker, for a faster time to market.



Automotive Ethernet

Scenario

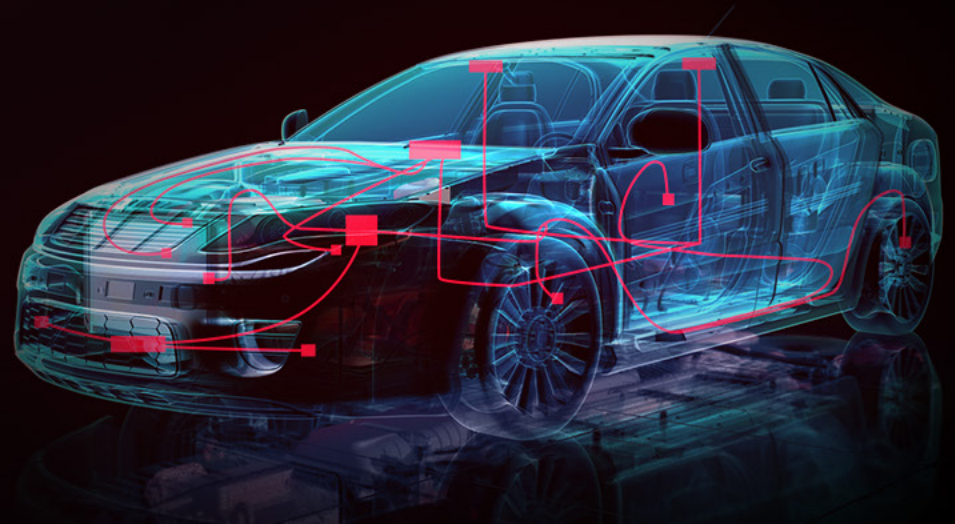
The complexity, cost, and weight of wiring harnesses have increased so rapidly that today, wiring is the third most expensive and heaviest component in a car. With more sensors, controls, and interfaces using higher bandwidth, a new type of automotive network is required for faster data throughput and better reliability. Automotive Ethernet uses an Ethernet-based network for connections between in-vehicle electronic systems. It helps cut production costs and reduces design complexity by providing a centralized, high-performance communication network.

However, the tests and setup to validate 10BASE-T1S, 100BASE-T1, 1000BASE-T1, 2.5GBASE-T1, 5GBASE-T1 and 10GBASE-T1 specifications for physical media attachment (PMA), physical layer solutions (PHY), and physical coding sublayer (PCS) are complex and time-consuming. Automotive Ethernet compliance testing requires 15 different configurations covering up to 10 different pieces of test equipment, wiring harnesses, cables, connectors and, test fixtures to comply with all required Tx, Rx, and link segment tests.

Solution: Automotive Ethernet Compliance

The following Keysight [Automotive Ethernet Compliance Solutions](#) are available:

- Transceiver testing for Open Alliance TC1, TC8, TC12, TC15 and IEEE 802.3cg, 802.3bw, 802.3bp, and 802.3ch.
- Receiver testing for OPEN Alliance TC1, TC12, IEEE 802.3bw. and 802.3bp.
- Protocol trigger and decode for IEEE 802.3bw and 802.3bp.
- Channel testing for Open Alliance TC1, TC9, TC15, IEEE 802.3bw, 802.3bp, and 802.3ch.



Benefits:

Keysight has removed the complexity involved in setting up and executing the tests necessary for compliance with automotive Ethernet standards. Whether your focus is on design or validation, our automotive Ethernet solutions will accelerate your innovations from debug to characterization, to compliance, to completion.

- Quick and easy setup, configuration, and test with the setup wizard.
- Faster and easier standards conformance through a wide range of tests.
- Accurate and repeatable results from precision instrumentation.
- Automated reporting in a comprehensive HTML format with margin analysis.



Automotive SerDes

Scenario

Camera sensors for ADAS require high data rates and transmission speeds to function as designed. Increasingly, developers are turning to serializer / deserializer (SerDes) connections to link these cameras to the vehicle's image-processing electronic control units. SerDes connections convert parallel data to serial data and vice-versa, enabling faster communication between devices using lower-cost cables and connectors. Currently, individual vendors deliver SerDes solutions using closed, proprietary standards, but that is set to change. The industry recognizes that transparent and unified standards and test requirements will enable chip vendors, automotive Tier 1 suppliers, and automakers to accelerate their development cycles, lower costs, and improve interoperability with other commercial devices.

Solution: Automotive SerDes

The Keysight **Automotive SerDes test platform** provides cable and channel validation, MIPI A-PHY® receiver compliance, and ensures interoperability and data integrity for physical layer transmission of MIPI A-PHY or Automotive SerDes Alliance (ASA) data.

Benefits:

- Provides comprehensive physical layer bit error ratio tests for receiver compliance with MIPI A-PHY compliance test specifications.
- Covers crucial SerDes transmit tests for frequency, distortion, jitter, droop, and medium-dependent interface (MDI) return loss.
- Enables an easy and accurate way to verify and debug MIPI A-PHY harness assemblies, cables, and connectors.





SERVICE AND SUPPORT

Keysight Services

Keysight offers a broad portfolio of services targeted at assisting engineers working in the automotive industry, specifically as it pertains to safety, infotainment, cleaner cars, EMC testing, and lowering costs.



Keysight Services

Safety

Safety is a critical concern in key areas such as electric car batteries, autonomous driving and connected car. Unlike mobile devices batteries, a car battery performance is directly linked to human life. Recently, major battery makers are increasing their investment in R&D to improve technology to detect faulty units in response to the tightening needs of automakers. Around the world, the death toll from traffic accidents is 1.25 million per year. To this end, radar solutions are moving to mmWave for higher data rates, faster speeds, and less interference. The industry is working to improve radar resolution for driver assistance as well. Yet, radar is complex with both wide bandwidth and mmWave challenges.

To assist, Keysight offers Education Services such as **eLearning** to help boost your team's measurements skills and Start-Up Assistance to speed time-to-first measurement. Our Education Services can help train for precise signal characterization and control per your conformance specifications. In addition, our Consulting Services can customize to your needs to share our product, industry and test application knowledge. We can help optimize mmWave OTA test and calibration methods.

Infotainment

The infotainment area has expanded dramatically now that cars are more like a mobile device with a multitude of co-existing technologies such as GPS, TPMS and Bluetooth. This results in mandatory time-consuming coexistence tests of electronics using digital, optical and mmWave signals. Keysight offers Consulting and Education Services to help speed up the learning curve. In addition, with our Technology Refresh Services, you can seamlessly transition to the latest test technology. You can trade-in underutilized assets for credit towards new instruments or you can upgrade to newer bandwidths. You can also save money with high quality, like-new Premium Used equipment, and get "same as new" performance and warranty.

Cleaner cars

The trend towards cleaner cars is driving the requirement for power train and higher battery efficiency. The demand for electronics have increased more than ever due to autonomous driving and EV/HEV. There are over 30,000 components used in one car and that means a complex ecosystems which places high pressure on test. Keysight's Consulting Services can help with test optimization of your electronic control unit (ECU) test and to improve time to battery efficiency and fault detection. For your large, complex test systems that cannot be moved we offer Onsite System Uptime Services for keep your test systems operating with the least disruption.

EMC testing

Do you lack capacity / facilities for your automotive EMC testing or need access to the latest test equipment to minimize your risk of a redesign or product recall? Keysight's Test-as-a-Service just introduced a new accredited EMC Test Lab in Boeblingen, Germany to simulate, debug and certify to over 50 global standards and regulations. The facility includes a radiated emissions chamber, conducted emissions test site, radiated immunity chamber, wireless test site, environmental test chamber, and a safety test site. You can now perform pre-compliance testing or compliance testing / certification for all of your EMC tests without the need for your own facility.

Lowering costs

Improving quality while driving for lower costs in production lines is critical. To help drive down costs, Keysight offer One-stop Calibration on most of your measurement devices, no matter which brand you use. This reduces logistic complexity, achieves economies of scale, and ensures the ongoing accuracy of your test assets. In addition, Keysight Financial Services offers flexible options to get new technology without large outlays in capital or operating expenses. Keysight Instant Buy enables paying 0% interest over 12 or 18 months. Keysight Rent to Own is available if you are not quite ready to buy and Keysight Lease helps make the most of your capex and opex budgets.



Building Tomorrow's Cars Today

The rate of innovation in the automotive industry is exciting and keeps accelerating.

With the rapid advances in e-mobility, autonomous driving, and connected cars, the capabilities we marvel at today may seem basic in just a few years. Successfully combining so many diverse innovative breakthroughs is not for the faint of heart, but the automotive industry is up to the challenge and transforming into a captivating center of high technology integration.

Keysight brings innovations in design and test solutions to the automotive industry designers and manufacturers to help create high-quality and high-performance products while mitigating safety risks across their entire lifecycle.





Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com

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