Design and Test Solutions for 
Automotive & Energy

Deliver innovations faster and better with high-performance design and test platforms for cross-domain technologies
The Intelligent Car is Here

The automotive industry is accelerating its electronic technology revolution and fusing with the clean energy ecosystem. By 2020, 90% of cars will be connected and by 2030, 30% 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, 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.

LEARN MORE: AUTOMOTIVE INNOVATIONS 2020
Table of 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.
Disruptive innovations in automotive electro-mobility 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 renewable energy 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 Solutions

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 BT2191A and BT2152A self-discharge measurement solutions provide a revolutionary reduction in the time to measure and characterize self-discharge performance of Li-Ion cells for both design and verification phases and mass production phases. Instead of using the conventional time-consuming open-circuit voltage measurement method, Keysight uses a potentiostatic method to directly measure the self-discharge current of the cell.

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
E-Mobility Solutions

Cells and Batteries

SOLUTION: BT2200 CHARGE-DISCHARGE PLATFORM

The Keysight BT2200 Charge-Discharge Platform offers modular configurations to support cells requiring maximum currents ranging from 6 A to 200 A, with 8-256 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
E-Mobility Solutions

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: SCIENLAB CHARGINGDISCOVERYSYSTEM (CDS)**
*Scienlab*, a Keysight company, has been helping equipment suppliers of HEV/EV charging with the ChargingDiscoverySystem (CDS), which emulates the charging communication of the HEV/EV or electric vehicle supply equipment. Various electrical parameters can be measured and tested at the same time for compliance with industry standards.

**BENEFITS**
The CDS offers flexibility and a wide range of applications:
- Comprehensive testing of all charging elements including charging stations, wall chargers, charging controller, battery management system and batteries
- Fully-programmable and versatile AC or DC charging station
E-Mobility Solutions

HEV/EV Converters

SCENARIO

The diversification of the automotive market into HEVs and EVs creates new challenges in design and manufacturing. The primary issue is the integration of high-voltage, high-power batteries in the 300 V range or higher on platforms traditionally using 12 V. These high voltages generate additional costs and risks in ensuring smooth safe power conversion for the various onboard electrical sub-systems.

SOLUTION: POWER CONVERTER TEST SOLUTION FOR HEV/EV AND HEMS

The Keysight EV1003A high-power/high-voltage power converter test solution enables safe and effective testing of power converters and onboard charging sub-systems present in HEVs and EVs also applicable to home energy management systems.

BENEFITS

This innovative solution is designed to help you:

- Comply with safety, regulatory, and environmental requirements of the HEV/EV market
- Reduce costs for cooling and electricity with its eco-friendly design as conversion efficiency returns more than 85% of power to the grid during regeneration
SCENARIO
As the demand for clean energy continues to increase, the photovoltaic (PV) industry is shifting to a higher voltage to drive cost down and increase efficiency. Developing and verifying the performance of inverter maximum power point tracking (MPPT) algorithms is challenging. Not only are MPPT algorithms complex, but under-the-sun testing with a comprehensive set of temperature and irradiance conditions is difficult, expensive and time-consuming.

SOLUTION: PHOTOVOLTAIC ARRAY SIMULATION
Keysight’s PV array simulation solution consists of the N8900APV Series Photovoltaic Array Simulators and SAS Control software.

The Keysight N8937APV and N8957APV photovoltaic array simulators are capable of testing PV inverters up to 1,500 V. They can quickly simulate I-V curve characteristics under different simulated environmental conditions.

BENEFITS
PV inverter designers can:
• Quickly and easily develop, verify and maximize the performance of their inverter’s maximum power point tracking (MPPT) algorithms
• Test all scenarios with no weather constraints
• Test to the European Standard EN50530 with as little as one click
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 Solutions

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

The Keysight E8740A automotive radar signal analysis and generation solution performs 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 Keysight W1908 SystemVue automotive radar library software for simulation of multi-target detection and automotive radar 3D scan.

- Cover the 3 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 (–150 dBm up to 110 GHz)
- Flexible application of many simulation scenarios
The Keysight E8707A radar target simulator helps automotive electronics manufacturers confidently simulate radar targets in various realistic scenarios. It is a flexible and dynamic solution for product test engineers looking for a fast, accurate and reliable test solution that balances throughput and quality, or for design and verification engineers who need to quickly validate the performance of their radar products.

**BENEFITS**

Provides radar simulation for both range and cross section for targets in the 76-77 GHz range with a full simulated range from 10 m to 450 m:

- Saves valuable manufacturing floor space thanks to a minimum physical distance of 1 m between simulator and device-under-test
- Scalable and configurable with a broad distance range
- Expandable with an optional signal source for simulation of Doppler relative object speed
Autonomous Driving Solutions

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 BroadR-Reach, 100Base-T1, and 1000Base-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
Keysight’s automotive Ethernet compliance solutions provide automated compliance testing for BroadR-Reach V3.2, IEEE 802.3bw (100Base-T1) and IEEE 802.3bp (1000Base-T1) designs. These automotive Ethernet electrical test software packages let you automatically execute tests and display the results in a flexible report format. In addition to the measurement data, the report provides a margin analysis that shows how closely your device passed or failed each test.

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
Autonomous Driving Solutions

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's N9038A MXE EMI compliance receivers and pre-compliance spectrum analyzers keep your EMI test queue flowing. The EMPro (Electro-Magnetic Professional) 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
Integration with industry’s leading RF and microwave circuit design environment, Advanced Design System (ADS) for fast and efficient RF and microwave circuit design.

- Easily identify the frequencies of peak emissions prior to final measurement with monitor spectrum
- Design flow integration: create 3D components simulated together with 2D circuit layouts and schematics within ADS, using EM-circuit co-simulation
- Broad simulation technology: set up and run analyses using both frequency-domain and time-domain 3D EM simulation technologies Finite Element Method (FEM) and Finite Difference Time Domain (FDTD)
- Efficient user interface: quickly create arbitrary 3D structures and time-saving simple GUI and advanced scripting features
Autonomous Driving Solutions

Antenna Design

SCENARIO

With so many radio frequency (RF) systems and devices to integrate into automotive architectures, engineers need to design RF products such as cellular communications, wireless networks, radar, and satellite communications systems.

SOLUTION: EESOF ELECTRONIC DESIGN AUTOMATION (EDA) SOFTWARE

The Keysight W1720 Phased Array Beamforming Kit 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
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.
Connected Car Solutions

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 E6950A 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
Connected Car Solutions

Wireless Communications

SCENARIO
Various wireless connections in connected cars aim to improve safety, security, performance, reliability, and infotainment. Automotive designers and developers need to verify many types of wireless technologies including 2G, 3G, 4G LTE and LTE-Advanced (and soon 5G), WLAN, Bluetooth®, Near Field Communication (NFC), and more to guarantee the reliability and the performance of the communication capabilities.

SOLUTION: KEYSIGHT SYSTEMVUE
The Keysight E6640A EXM Wireless Test Set and the X-Series Signal Analyzer support a broad range of radio formats: Cellular (LTE/LTE-A, W-CDMA, GGE, C2K, 1xEV-DO, and TD-SCDMA) and short-range wireless communications (802.11a/b/g/n/ac, BT 1.0-4.0, GNSS, digital video)

BENEFITS
The user-friendly GUI is suitable for both development and manufacturing and produces the best throughput and productivity.

- Enables transmitter/receiver tests
- Provides various measurements, including noise figure, phase noise, modulation analysis, and EMI in a single instrument
- Covers a broad range of radio formats in a single instrument
- Supports spurious measurements pursuant to the Radio Act
- Enables noise analysis with the real-time Signal Analysis (SA) feature
- PSAP software supporting Live Network Mode
SCENARIO
Audio Visual (AV) devices such as in-vehicle displays and car navigation systems use high-speed serial communication interfaces like HDMI, MHL, and USB. Such interfaces, originally developed for home electronics and PCs, are required to work in the harsh electrical environment of automobiles without failure. Furthermore, it is also assumed consumer devices such as video cameras may sometimes be brought into an automobile to connect with the automotive system; therefore, interconnectivity and compliance tests are important as well.

SOLUTION: MEASUREMENT TOOLS FOR HDMI, MHL, USB, AND OTHER INTERFACES
The Keysight M8190A Arbitrary Waveform Generator not only generates waveforms under the worst-case conditions specified in the standards but also arbitrary waveforms by calculating the amplitude and jitter on demand every time. This allows evaluating the maximum performance of the receiver flexibly and efficiently. The Keysight E5071C ENA Option TDR performs fast and accurate hot TDR measurements for transmitting and receiving circuits/ICs for HDMI, MHL, USB 3.0, and other interfaces. The U8903B Analyzer handles up to 8 channels in a single unit and performs multiple frequency, AC voltage, and Total Harmonic Distortion plus Noise (THD+N) measurements at the same time.

BENEFITS
Keysight’s measurement tools can realize easy and flexible, yet precise performance validation and compliance tests for today’s high-speed digital AV interfaces. In addition, Keysight’s measurement tools allow you to perform compliance tests under the same conditions and with the same software as Authorized Test Centers (ATCs) because HDMI ATCs and MHL ATCs have also adopted the same measurement tools.

- Simple and easy-to-understand operation, high-speed yet accurate measurement, and high ESD robustness
- Highly precise and flexible tests with high signal fidelity and large sample memory
- Time-saving simultaneous measurement of frequency, AC voltage, and THD+N with multiple channels for audio system evaluation for car stereos
Connected Car Solutions

Broadcast/Satellite Radio

SCENARIO
The diversity and multiple broadcast receiver systems create a tremendous number of broadcast testing configurations. Creating all the test scenarios and running them is highly time-consuming and prone to errors.

SOLUTION: SIGNAL STUDIO SOFTWARE
The Keysight N7611B Signal Studio software is a flexible suite of signal creation tools that reduce the time spent on signal simulation. For broadcast radio standards including FM Stereo/RDS, DAB, DAB+, T-DMB, and XM, Signal Studio’s performance-optimized reference signals enhance the characterization and verification of devices. Through its application-specific user interface you’ll create standards-based and custom test signals for component, transmitter, and receiver test.

BENEFITS
Set up your signals in Signal Studio, then download them to a variety of Keysight instruments. Signal Studio software complements these platforms by providing a cost-effective way to tailor them to your test needs in design, development and production test.

- Quickly test components and transmitters by creating and customizing waveform files with waveform playback mode
- Easily configure signal parameters, calculate the resulting waveforms, and download files for playback from the user-friendly interface
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.

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.
Service and Support

Keysight Services

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.

LEARN MORE: ABOUT THESE SERVICE OFFERINGS
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.