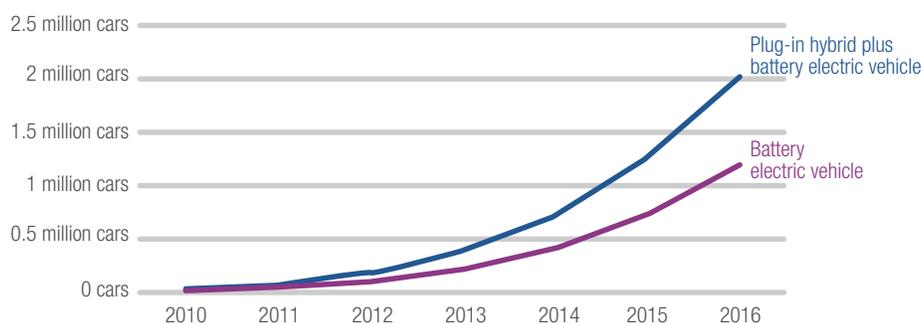


Design and Test Solutions for Electro Mobility (E-Mobility) Applications

In the automotive world, electro mobility or e-mobility is one of the hottest buzzwords today. It encompasses technology and applications that help designers achieve electric drivetrains, reduced carbon emission, and less dependence on fossil fuels.

Better battery performance, improved electric drivetrains, availability of charging stations, and power conversion technology in the entire e-mobility ecosystem has enhanced the range of both hybrid and electric vehicles. This, in turn, has helped the vehicle electrification market to grow steadily as consumer confidence increases. The global vehicle electrification market is anticipated to reach over \$125 billion by 2025, according to a 2018 report by Grand View Research, Inc.

This guide explores the e-mobility landscape, and the new design and test challenges and solutions to help bring these disruptive technologies to reality faster.



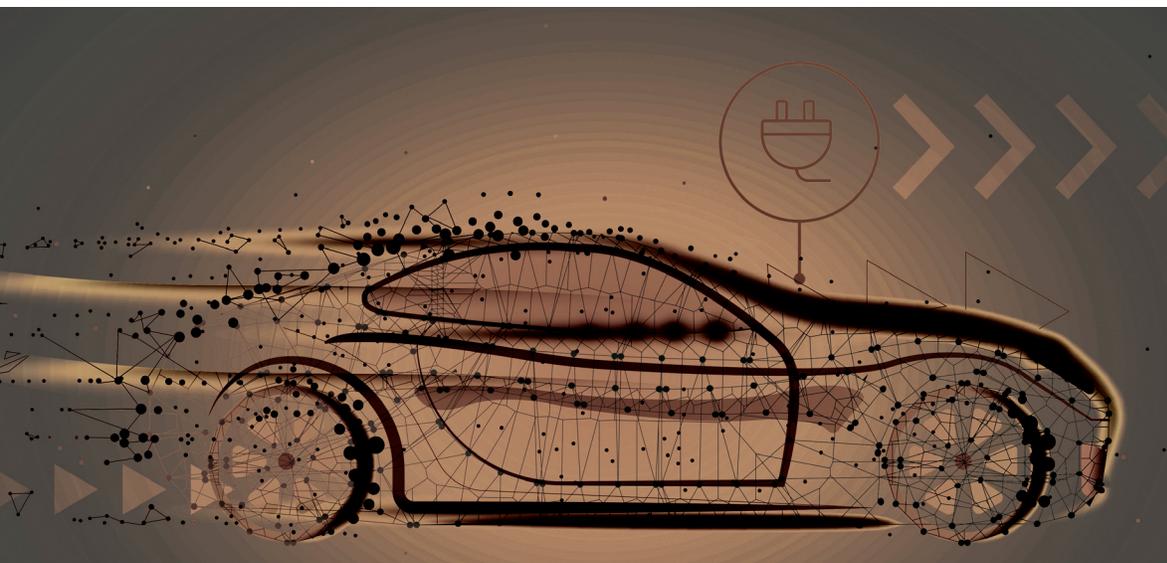
Source: IEA Analysis, 2017*



The global vehicle electrification market is anticipated to reach over \$125 billion by 2025.

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* This work is partially based on the Global EV Outlook 2017 report developed by the International Energy Agency, © OECD/IEA [2017] but the resulting work has been prepared by Keysight Technologies and does not necessarily reflect the views of the International Energy Agency.

Automotive Power Conversion

Hybrid electric vehicle (HEV) and electric vehicle (EV) technologies can significantly improve automotive fuel efficiency, and at the core of these technologies is the electrified power train. However, it is hard to design reliable and efficient circuits using only the information supplied by device and component manufacturers.

Keysight offers unprecedented solutions for component-level design and test verification, from R&D to actual functional test stages at manufacturing.

Automotive Power Device Testing

Scenario:

Automotive power conversion designs have become increasingly complex with tighter control loops and faster switching speeds. The introduction of wide band gap (WBG) devices with their fast rise and fall slew rates also call for more complex impedance analysis. Relying on traditional semiconductor time domain analysis tools and simple lumped-sum models for circuit simulation will not produce reliable, real-world results for WBG devices.

While WBG switching frequencies may only be in the hundreds of kHz, what designers might not realize is WBG device's edge (on/off) speeds are over five times faster than traditional silicon devices and result in frequency components in the 100s of MHz. Traditional semiconductor models do not contain the device's parasitic characteristics, which react to these high frequencies, and therefore cannot accurately predict conditions that are key to the safety and reliability of the circuit.

You need fast and reliable tools to evaluate, characterize, and model WBG devices for your next generation automotive power converter designs.



Solutions

PD1000A Power Device Measurement System for Advanced Modeling

Trust Keysight's PD1000A power device measurement system for advanced modeling allowing you to eliminate design cycles by simulating real-world models.

Benefits

- Easily create models for any WBG device with real measurements
- Exclusive WBG device modeling that results in accurate simulations of EMI, in-rush, overshoots, switching time, etc.
- Causes of EM noise can be identified easily in simulation before a design is finalized

More information: www.keysight.com/find/PD1000A



B1505 Power Device Analyzer/Curve Tracer for Circuit Design

The B1505A Power Device Analyzer/Curve Tracer is a flexible single-box solution with next generation curve tracer functionality that can accurately evaluate and characterize power devices at up to 10 kV and 1500 A.

Benefits

- Handles all types of power device evaluation with wide current and voltage operating ranges
- Fast pulsing capability (10 μ s), $\mu\Omega$ level on-resistance measurement resolution and sub-pA level current measurement capability
- Two independent analog-to-digital (A/D) converters on each channel support a 2 μ s sampling rate for accurate monitoring of the critical timings that can affect device behavior

More information: www.keysight.com/find/B1505A

B1506A Power Device Analyzer/Curve Tracer for Circuit Design

The B1506A Power Device Analyzer/Curve Tracer for Circuit Design is a complete solution that can help power electronic circuit designers maximize the value of their power electronics products by enabling them to select the correct power devices for their applications.

Benefits

- Evaluate all relevant device parameters under a wide range of operating conditions, including IV parameters such as breakdown voltage and on-resistance, as well as three terminal FET capacitances, gate charge and power loss
- Identify substandard devices under actual circuit operating conditions, including a wide voltage and current range (3 kV and 1500 A), and a wide temperature measurement range (-50°C to +250°C)
- Unique plug-in style device test fixture socket adapter eliminates cable connection and other human-related errors

More information: www.keysight.com/find/B1506A

Other Supporting Solutions

B1500A Device Parameter Analyzer

Offers a full range of measurement capabilities from basic IV/CV characterization to leading-edge ultra-fast, transient, pulsed IV measurement for semiconductor characterization.

B2900A Series Precision Source/Measure Unit (SMU)

Offers broad voltage (210 V) and current (3 A DC and 10.5 A pulsed) sourcing capability, excellent precision (minimum 10 fA/100 nV sourcing and measuring resolution). Supports conventional SMU SCPI command set for easy test code migration when integrating the SMUs into systems for production test.

E4980A Precision LCR meter

Measure inductance (L), capacitance (C), and resistance (R) of power devices with the E4980A which offers fast measurement speed and outstanding performance at both low and high impedance ranges.

Advanced Design System (ADS)

The fast edges of modern switching devices such as SiC and GaN require new thinking about EDA tools. Traditional SPICE (Simulation Program with Integrated Circuit Emphasis) modeling falls short because it is limited to the time domain and to lumped elements. Keysight's ADS supports HEV/ EV electronics engineers in the circuit design validation phase with its powerful circuit simulation capabilities.

Automotive Power Analysis and Testing

Scenario:

The increase in vehicle electrification in the automotive market brings with it new challenges in high-voltage, high-power batteries to a platform that is traditionally 12 volts. Hybrid electric and full electric batteries are 300 volts and higher. This calls for a greater need for automotive power analysis and testing in the various sub-systems of the vehicle.



Solutions

PA2200 Series IntegraVision AC/DC Power Analyzer

The PA2200 Series IntegraVision Power Analyzer is designed for testing the design challenges of today's EV/HEV/PHEVs. Its powerful features offer versatile tests for battery and battery management, drivetrain motor control systems, electric motors, and DC-DC converters.

Benefits

- Touch-driven oscilloscope visualization
- Accurate measurements (0.05% basic accuracy) for high-efficiency measurements
- Supports capture and measurement of dynamic power waveforms

N6705C DC Power Analyzer

Motors and solenoids cause vehicle power system voltage transients and dropouts. Vehicle electronics require adequate power transient immunity, and their mission-critical nature requires thorough testing of ECUs, electromechanical components, infotainment, and telematics. The N6705C runs a variety of DC transient tests right on your bench.

Benefits

- Easy to use R&D tool for sourcing and measuring DC voltage and current into the DUT
- Integrates up to four advanced power supplies with DMM, scope, arbitrary waveform, and data logger features
- Access all capabilities from the front panel, or for even greater control and analysis functions, use the 14585A Control and Analysis Software

N6900 and N7900 Advanced Power Systems (APS)

Keysight's N6900 and N7900 APS for DC power and transient testing provide stimuli up to 2000 W or up to 200 A for your most demanding higher power testing applications. At the core of Keysight's APS is the exclusive VersaPower architecture, which delivers a fast and accurate integrated power system to help you overcome your toughest power test challenges.

Benefits

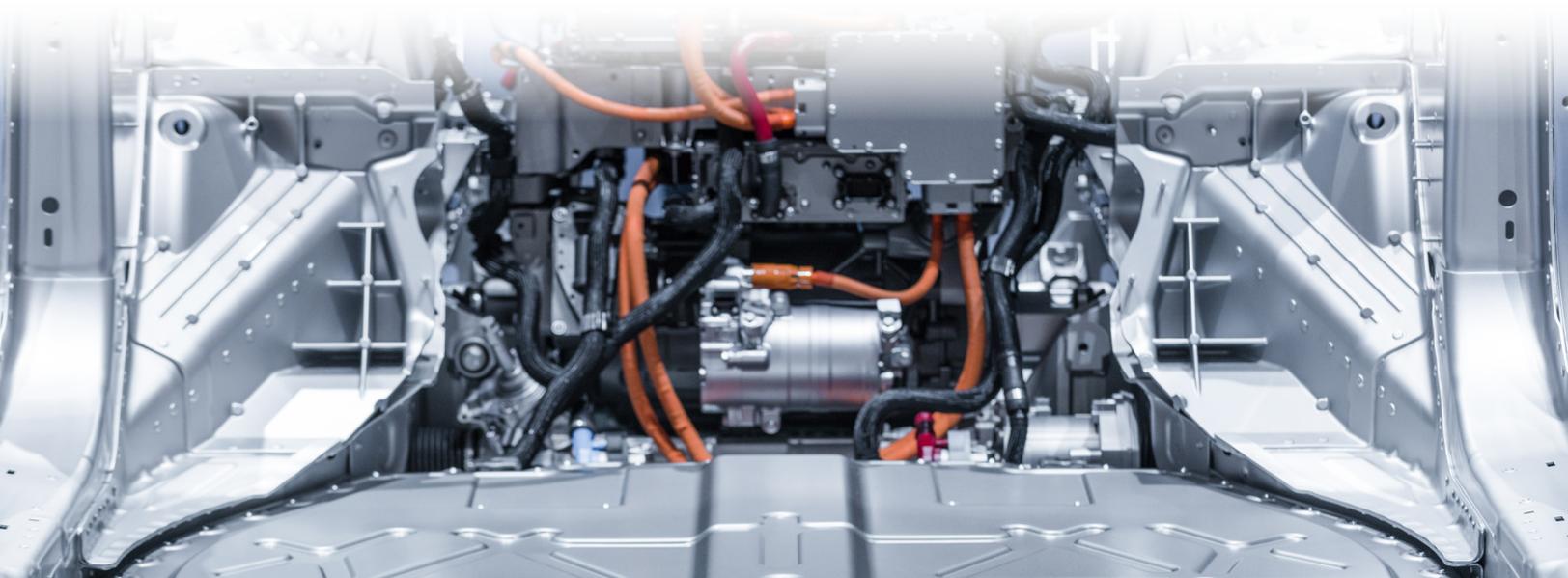
- Extremely fast up and down programming speeds
- Generates transients to simulate many engine cranking and other transients required by the ISO 16750-2, ISO 7637-2, LV-124, and LV-148 standards
- Define and easily modify arbitrary waveforms with the 14585A Control & Analysis Software

More information: www.keysight.com/find/aps

Other Supporting Solutions

Switching characteristics are an important part of automotive component level test, and Keysight has both oscilloscopes and pulse generators that can help evaluate these parameters.

The InfiniiVision 4000 X-Series oscilloscopes provide sufficient bandwidth and resolution at a reasonable cost, and if necessary, they can be used with a current probe. The 81110A pulse generator also provides voltage pulses fast and large enough to characterize automotive components.



DC-DC Power Conversion

Scenario:

In most hybrid electric and electric vehicle (HEV/EV) architectures, the motor/generator, inverter and battery components have bidirectional power flow. Bidirectional power flow requires test solutions that are capable of sourcing and sinking power to the power converter. This is traditionally accomplished by connecting a power supply and an electronic load in parallel. However, external circuitry and cumbersome programming typically does not allow for smooth signal transitions between sourcing and sinking power, reflecting an inaccurate simulation of the operating conditions. Moreover, EVs and HEVs use high-voltage, high-power batteries of 300 V or higher, a big jump from the traditional 12 V. These high voltages bring with them additional costs and risks which need to be mitigated.

Solutions

EV1003A Power Converter Test Solution for HEV/EV and HEMS

Keysight's EV1003A is specifically designed to address the safety, regulatory, and environmental issues mentioned above. This solution is the only commercial-off-the-shelf regenerative power system with highly integrated safety features that protect your devices under test and your people.

Benefits

- Sourcing (power supply) and sinking (electronic load) up to 950 V, up to 40 A, and up to 10 kW
- Highly integrated safety features that protect your devices under test and your people
- Regenerative capabilities enable the energy consumed to be put back onto the grid cleanly

More information: www.keysight.com/find/EV1003A



Keysight TS-8989 PXI Functional Test System

Functional testing of a DC-DC converter generally requires a combination of emulation, simulation, and measurement:

- Emulation of power input
- Load simulation of electronic devices
- Measurement of power efficiency and stability of the ECU, etc.

Keysight has a family of off-the-shelf test instrumentation designed for testing automotive DC-DC converter electronic control units (ECUs). They are easily configured and accelerate your test development time.

Benefits

- Powerful, modular PXI-based system includes measurements, switching and loads to help manufacturers standardize a solution platform with simplified integration
- Bundled with Keysight TestExec SL software, designed specifically for the development and execution of automotive electronic functional testing
- Compact size reduces rack space; enables manufacturers to conserve limited facilities for line expansion

More information: www.keysight.com/find/TS8989



Cell and Battery Performance

E-mobility has escalated the need for better cells and batteries with a common goal – better storage and longer life along with improved performance and range. These devices must be high quality and meet the demands for power and energy density, safety, durability. Costs must be optimized to survive in the marketplace. For these reasons, comprehensive tests must be carried out to ensure successful battery production.



Cell Self-Discharge Testing

Scenario:

Today, Li-Ion cell self-discharge is typically measured by how much the open-circuit voltage (OCV) of the cell changes over time, as an indicator of how much the state-of-charge (SoC) changes due to self-discharge. Since most Li-Ion cells have minute changes in OCV, it takes weeks or months to monitor changes in the cells' SoC. For manufacturers running production batch tests, this incurs substantial costs for warehousing, and possible safety and fire hazards.

Solutions

Self-Discharge Measurement Systems

Keysight's revolutionary BT2191A and BT2152A cell self-discharge solutions for R&D and manufacturing slash measurement time while providing efficient tests for the cells' performance. For smaller cells like cylindrical 18650 or 21700 cells, you can quickly



Li-Ion pouch and cylindrical cells.

measure stable self-discharge current in as little as 30 minutes to 2 hours, depending on the cell characteristics. And for larger capacity pouch cells (e.g., 10-60 Ah), this takes as little as 1-4 hours.

Benefits

- Directly measure self-discharge current in as little as one to two hours
- Rapidly discern good versus bad cell self-discharge performance in manufacturing in minutes, and dramatically decrease work-in-process inventory
- Quickly measure and analyze self-discharge current during cell design and evaluation, reducing design cycle time and achieving faster time to market

More information: www.keysight.com/find/self-discharge



Keysight's innovative Li-Ion cell self-discharge solutions can differentiate good and bad cells in a fraction of the time it traditionally takes to characterize the cells during R&D or manufacturing.

Charge-Discharge Platform for Cell Forming

Scenario:

Li-Ion cell formation is a critical step in the manufacturing process that turns a freshly assembled cell into something capable of storing an electrical charge. Before the forming process, the Li-Ion cell is merely an assembly of its components; mainly an anode, a cathode, a separator, terminals, electrolyte, and packaging that holds it all together. Then, during forming, a series of charge-rest-discharge-rest cycles are applied in a specific way to make it capable of storing a charge. Subtle differences in the forming process and equipment can either enhance or be a detriment to the performance and quality of the cell.



Solutions

BT2200 Charge-Discharge Platform

The Keysight BT2200 Charge-Discharge Platform is cost-effective and easily reconfigurable for Li-Ion cell forming. Modular configurations support cells requiring maximum currents ranging from 6 A to 200 A, with 8-256 cells or user channels per chassis.

Benefits

- Modular configurations from 6 A to 200 A, 8 to 256 channels; up to 8 modules per chassis, 32- channels per module
- $\pm 6.25A$ per physical channel, and up to 32-channels can be paralleled to increase range up to $\pm 200 A$ per user channel, with 1 s sampling intervals
- Charging 0-6 V; discharging 1.2-6 V at 0 A, 1.55-6 V at 50% max current, 1.9-4.73 V at max current, with 1 s sampling intervals

More information: www.keysight.com/find/BT2200

Scienlab Energy Storage Test Systems

Scienlab, now part of Keysight Technologies, offers added depth and breadth when it comes to solutions for energy storage. Leveraging the industry-leading software EnergyStorageDiscover (ESD), it offers customer-specific performances and functions, such as:

- Aging and environmental tests as well as standardized and standard-compliant tests (e.g. ISO, DIN EN, SAE) that can easily be carried out
- Wide choice of battery modules and battery packs ranging from $\pm 150 \mu A$ in cells to $\pm 600 A$ for battery packs ($\pm 2,400 A$ when switched in parallel)

Benefits

- All Scienlab battery test and formation systems have high regeneration capabilities, with over 90% of the energy fed back into the main system
- With a standard VDA cycle test on a 70 Ah cell with 100 test channels, savings can amount to over \$70,000 annually compared to non-regenerating systems
- Offering configuration flexibility, the module can be used as a cell test system and the pack can be used as a module test system

More information: www.scienlab.com



Charging Technology

The charging process between the charging infrastructure and the HEV or EV is a complex ecosystem involving numerous stakeholders: vehicle manufacturers and suppliers, certification bodies, manufacturers and operators of charging infrastructure such as wall boxes or charging columns, and workshops.

Charging Infrastructure & Charging Components

Scenario:

Interoperability of electric vehicle supply equipment (EVSE) is important to ensure seamless operations of service providers and trouble-free journeys for end users. The charging infrastructure (EVSE) must satisfy extensive requirements before it is introduced to the market. Apart from faultless communication, power is a prime consideration. The challenges include compatibility with different HEVs and EVs, charging interfaces and power grids. Varying international standards must also be met.

In addition, the plethora of charging components in this complex ecosystem must be thoroughly tested. These include charging cables, through to the on-board charger and/or inverter, to the HEV/EV battery and the associated battery management system.

Solution

Scienlab ChargingDiscoverySystem (CDS)

The ChargingDiscoverySystem (CDS) emulates the charging communication of the HEV/ EV or EVSE. At the same time, various electrical parameters can be measured and tested for compliance with industry standards.

Benefits

- Supports all available communication methods; basic communication (PWM) according to IEC 61851-1 and high-level communication according to DIN SPEC 70121, ISO 15118, (PLC), CHAdeMO and GB/T (CAN)
- Efficiently tests charging stations, wall boxes, charger, charging controller, battery management system and battery, including related peripheral devices
- The CDS can also act as a freely programmable AC or DC charging station by connecting it to a power source

More information: www.scienlab.com





Energy Ecosystem

Upstream in this e-mobility energy ecosystem is the \$1 billion question: How best to harness solar power to fuel and feed an energy-hungry world?

We have already briefly touched upon the new technology challenges and available solutions to downstream energy ecosystem applications from power conversion in devices, to storage and charging. Now let's look at the exciting possibilities, challenges, and solutions for the world of solar energy.

Photovoltaic Inverter Testing

Scenario:

Substantial growth in the solar power generation industry has intensified the need for solar inverter test and measurement solutions. To keep solar power at grid parity with competing methods of power generation, performance and power conversion efficiency are increasingly important. Small increments in power production have a dramatic effect on the profitability of solar power generation.

Solution

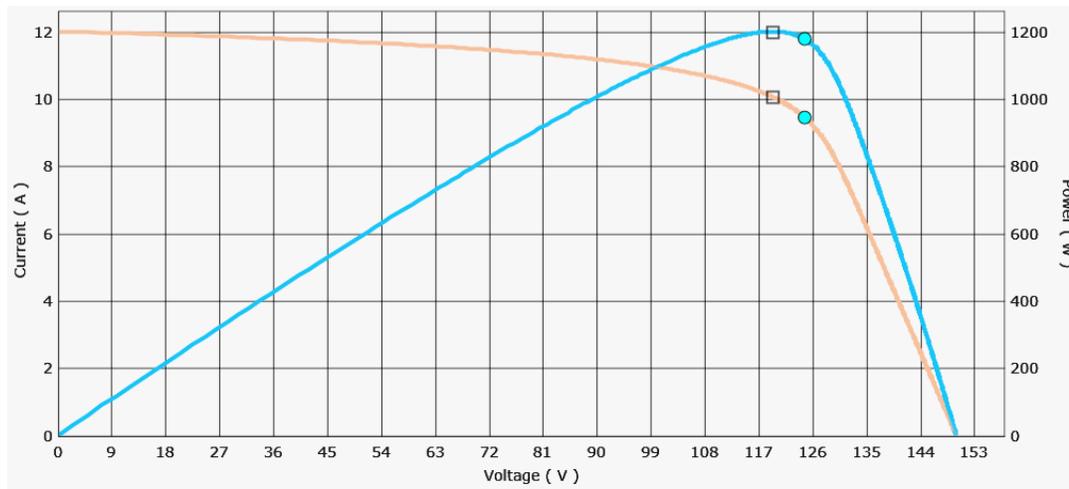
N8900APV Photovoltaic Array Simulator Solutions, up to 1,500 V

Keysight's N8900APV Series Photovoltaic Array Simulators and SAS Control software enable PV inverter designers to quickly and easily develop, verify and maximize the performance of their inverter's maximum power point tracking (MPPT) algorithms, as well as test to the European Standard EN50530 with as little as one click.

Benefits

- Autoranging, programmable DC power sources simulate the output characteristics of a PV array under different environmental conditions (eg: temperature, irradiance, age, cell technology, etc.)
- Quick and comprehensive testing of inverter maximum power point tracking (MPPT) algorithms and inverter efficiency
- Quickly create and download photovoltaic I-V curves to gain insights into your MPPT algorithms

More information: www.keysight.com/find/N8900APV



Keysight's N8900APV PV simulators offers an SAS Control software upgrade to do automated MPPT Efficiency testing.

Solar Cell Testing

Scenario:

The goal of achieving ever-increasing solar cell efficiency and reduced cost demands accurate, repeatable, fast, and reliable test results. The research, design, and development work necessary to attain superior performing, highly manufacturable solar cells, modules and arrays require high performance test equipment. Besides ensuring your solar inverters can convert the maximum power that is available from the solar array, each individual solar cell plays a vital role to boost overall power production.

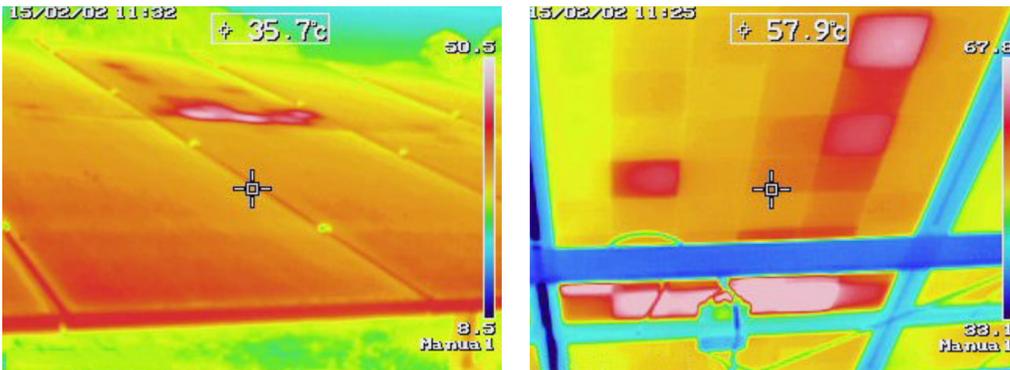


Keysight offers a wide variety of power, measurement, and switching products you can use as building blocks for characterizing the electrical properties of solar cells and modules.

Solutions

U5855A TrueIR Thermal Imager, 350°C

The U5855A helps you to easily detect the location of anomalies, especially for a matrix of solar cells on a large solar module. Once the location of anomalies is identified, thermocouples could be placed at the affected location for more accurate temperature measurement to determine the cause of the anomalies.



Thermography scan with thermal images using Keysight U5855A TrueIR thermal Imager shows multiple hotspots detected on a solar panel, indicated in pink/red.

Benefits

- Ideal for proactive maintenance activities, from hot spot detection, to thermal profiling
- Offers 320x240 fine resolution with image logging and temperature trending capability at a lower price than typical 320x240 thermal imagers in the market.
- Designed for ease of use, with configurable quick access buttons to easily change settings with one hand



34980A Multifunction Switch/Measure Unit

The Keysight 34980A is a flexible, reliable switching and data acquisition platform with more than 20 modules to help you customize your test system. Available at a price that is up to 40% less than comparable modular solutions in VXI or PXI. It offers features that make it a good fit for solar cell test systems.

Benefits

- Temperature measurement capabilities with thermocouples, resistance temperature detectors (RTDs), or thermistors
- Up to 560 2-wire multiplexer channels or 4096 matrix cross-points in one mainframe
- Optional built-in 6½digit DMM lets you make measurements at greater than 3000 readings/second

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 car initiatives, 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, car battery performance is directly linked to human life. Recently, major battery makers began increasing their investment in R&D to improve fault detection technology in response to the tightening needs of automakers. Around the world, the death toll from traffic accidents is 1.25 million per year. Electrification is opening up new technologies to address this problem. 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 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 signal analysis tools. 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 Car Initiatives

Cleaner car initiatives, focused on lowering emissions, are driving the requirement for power train and higher battery efficiency. The demand for electronics has 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 to 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 offers One-stop Calibration for 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.

Literature Resources

1. [How to Select Test Instrumentation for Temperature Profiling of Battery Charge and Discharge](#). December 1, 2017; Make accurate battery charge and discharge temperature measurements so that you can make the appropriate capacity or lifespan trade-offs, and improve the reliability of your product or device.
2. [Battery Temperature Profiling While Charging and Discharging](#). September 29, 2017; Temperature profiling is crucial as the charging and discharging rate of battery-powered devices inadvertently heats up the batteries. Here are ways to perform this task efficiently and effectively.
3. [How to Shorten Li-Ion Self-Discharge Test Time?](#) January 26, 2018; High levels of Li-Ion cell self-discharge are indicative of latent failures. The new potentiostatic solution from Keysight addresses cell self-discharge measurement challenges with revolutionary reduction in time, save cost and accelerate time-to-market.
4. [Evaluate Self-Discharge of Lithium Ion Cells in a Fraction of the Time Traditionally Required](#). August 21, 2017; This new way to determine a cell's self-discharge by measuring its self-discharge current allows cells with excessively high self-discharge to be identified and isolated much quicker vs traditional open-circuit voltage approaches.
5. [Emerging solutions to HEV/EV DC-DC Converter Design and Test](#). December 18, 2017; This paper discusses design and test challenges for DC-DC converters in electric vehicles (EV), and the new EV test solutions needed to reduce cost pressures and provide performance assurance
6. [Testing Automotive DC-DC converter with Keysight TS-8989](#). December 1, 2017; A high-power DC-DC converter electronic control unit (ECU) is designed to prevent phenomena that may interrupt a car's various electronic devices during operation of a car's start-stop system, by stabilizing the electrical supply to electronic devices on board the vehicle when a car starts or stops on the road.
7. [GaN Power Devices Start to be Designed into Power Sources: Transphorm Details Know-how around Circuit Design and Associated Layouts](#). November 24, 2017; GaN (Gallium Nitride) Power Devices Start to be Designed into Power Sources: Transphorm Details Know-how around Circuit Design and Associated Layouts Commercial use of GaN devices.
8. [Challenges and Solutions for Power Testing in Automotive Applications](#). November 13, 2017; This is a synopsis of automotive electronic systems, the challenges they face and what tools automotive electronics engineers need to meet them.

9. Temperature Measurement Solution for Solar Cell and Module Testing. October 25, 2017; This application note highlights key products that can be used to help you effectively and efficiently test solar cells and solar modules, and ensure that they are able to perform optimally.

10. Understanding the Importance of Maximum Power Point Tracking Efficiency for Solar Inverters. July 10, 2017; This application note discusses the importance of MPPT efficiency testing. MPPT Efficiency is the metric used to ensure a solar inverter is operating at the maximum power point as often as possible, to maximize solar energy usage from the PV array.

11. Benefits of Moving to 1,500 V Photovoltaic Inverters. June 19, 2017; This application note discusses the benefits of 1500 V photovoltaic strings and inverters and some challenges which need to be overcome as their adoption gains momentum.

12. Power Conversion Efficiency Measurement Methods. May 9, 2017; Accurate measurement of power conversion efficiency is paramount for reducing energy consumption. This applies not just to conventional household appliances, but to high-power devices supporting solar grids and vehicle electrification systems. Learn about various methods to evaluate power efficiency, each with its own set of advantages and disadvantages.



Calibration and Repair Services

Having the right measurement solution is only the beginning. Design engineers count on repeatable results across work groups to avoid discrepancies that can impact development cycle time, time-to-market and budgets. Manufacturing strives to meet production goals, but inaccurate measurements can affect yield and product quality. Keysight calibration and repair services keep instruments operating to warranted specifications over their lifetime, ensuring accurate, repeatable measurements across R&D and manufacturing.

Our Partnership with You

Keysight offers a broad portfolio of services and support to address all your test equipment needs:

- Start-up assistance and training help you quickly and effectively use your new equipment
- Calibration and warranty assurance plans provide coverage for up to 5, 7 or 10 years
- Flexible service delivery, such as on-site mobile labs that reduce your calibration turnaround time from days to hours
- Premium used equipment includes the same high performance and 3-year standard warranty as new units
- Trade-in programs (available on both Keysight and non-Keysight models) offer you significant credits to upgrade to the latest Keysight technology

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at:

www.keysight.com/find/contactus

