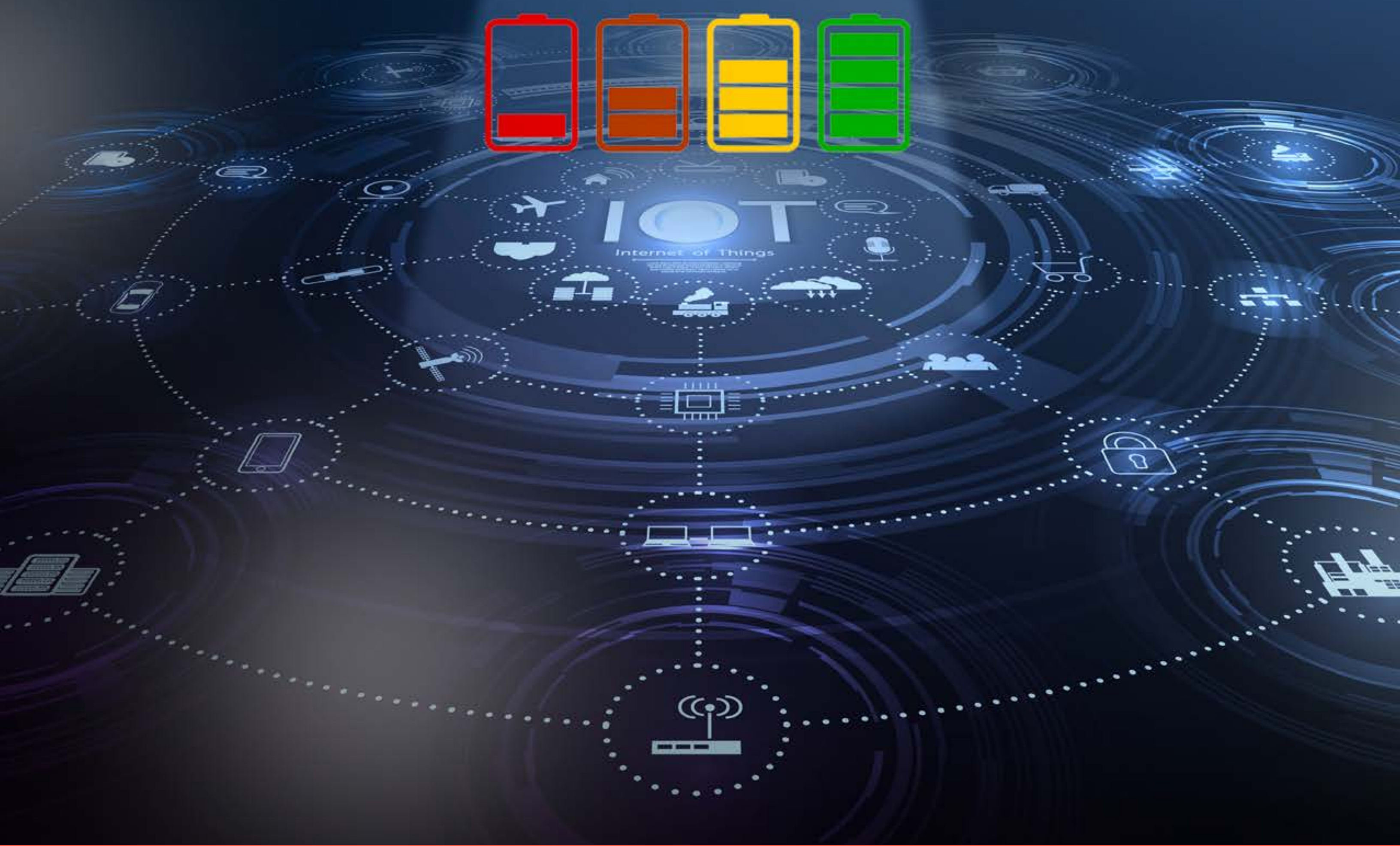
SOLVING THE TOP 5 IoT TESTING CHALLENGES

From Power Management to

Wireless Compliance and Performance



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Introduction

In the coming years, advances in computer science (AI), communications (5G NR), device automation (IoT) and industrial automation (IIoT) will accelerate the pace of change and innovation. Across industries, a variety of IoT sensors will be used for automated data transmission and remote device control. In the Internet of Everything era, connectivity will become commonplace. By 2020, Gartner predicts more than 20 billion IoT devices will be in use—up from 8.4 billion in 2017.

Soon, 5G will be coming online. In conjunction with IoT devices, 5G's increased bandwidth, greater speed and lower latency will give rise to applications that were previously considered impossible. Theoretical maximum 5G speeds of 10 Gbps and an expected 10-year battery life for low-power sensors and machine-type devices mean that a wealth of data can be analyzed and acted upon. In the IoT and 5G era, a flood of new products will need to be tested, increasing the burden on R&D teams and their test equipment.

IoT in Manufacturing

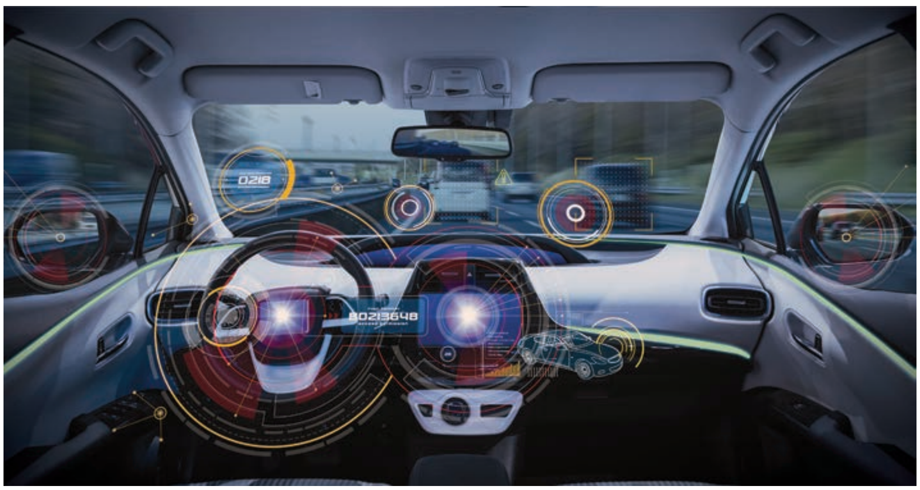
Next-generation manufacturing, also known as "Industrial Internet of Things" or the so-called smart factory, will leverage machine learning, cloud robotics and IoT to speed the flow of data across a factory. Using machine-to-machine communication, automated production systems will share real-time streams of data, images and video so they can learn and improve—largely on their own.

Theoretical maximum 5G speeds of 10 Gbps and an expected 10-year battery life for low-power sensors and machine-type devices mean that a wealth of data can be analyzed and acted upon. Soon, a flood of new products will need to be tested, increasing the burden on R&D teams and their test equipment.

IoT in Transportation

A transportation revolution is also underway, with electric vehicles, autonomous vehicles, and ride-sharing vying to disrupt the traditional automotive business model. In the not-too-distant future, personal vehicle ownership may be replaced by autonomous electric vehicles (EVs) operated by ride-hailing services and summoned by the user's smartphone (Transportation as a Service or TaaS).

This shift toward battery-electrics, however, requires massive investments in R&D and facilities for a market that represents less than two percent of U.S. sales. For automakers that rely on internal-combustion-engine vehicles for the majority of profits, this is a big bet on an uncertain future.



Traditional automakers and technology companies are also moving toward a self-driving vehicle future. Waymo, a division of Alphabet, Inc. and Google sister company, currently operates a self-driving (Level 4), commercial ride-sharing service 24X7 in cities around Phoenix in Tempe, Mesa and Chandler.

As ride-sharing and ride-hailing services become more popular, operators will begin to acquire and manage their own EV fleets, driving down the cost of transportation to the point where it may become less expensive to use ride sharing services than to own a car. Connectivity will also bring a future where cars communicate with each other, the infrastructure, pedestrians, cyclists, and data centers and networks via IoT devices, known as vehicle to everything (V2X).

IoT in Healthcare

In healthcare, the power of IoT and 5G mean that mass patient monitoring and remote medical treatment become possible, extending the reach of patient care, reducing hospital visits and lowering costs. With artificial intelligence and machine learning, mass analysis of patient records can identify early warning signs of serious conditions.

Remote robotic telesurgery also becomes practical, allowing for physical distance between surgeon and patient. The potential benefits of telesurgery include improved precision, lower invasiveness, reduced trauma, faster recovery times—and ultimately, lower healthcare costs.

IoT for Consumers

On the consumer side, we have already seen a proliferation of smart home devices, including security systems, lighting controls, HVAC/comfort systems and appliances. Wearables will also proliferate, with many devices having the capability to monitor various health metrics. Soon, we will see smart buildings, the first smart cities—, and benefit from automated traffic and utility grid management systems.

Meeting the IoT Challenge

As the pace of innovation quickens, engineers, designers, suppliers and manufacturers will face increased pressure to get to market faster. For IoT devices, each generation of products needs to be smaller, more robust, easier to configure and use less power than previous designs.

Since so many IoT devices are battery powered, energy-efficient functioning is critical. Low power components must be used, along with techniques to de-energize these components when not in use. For optimized battery life, components have to be tested under realistic scenarios and conditions to ensure that the right components are chosen to maximize the life of IoT devices.

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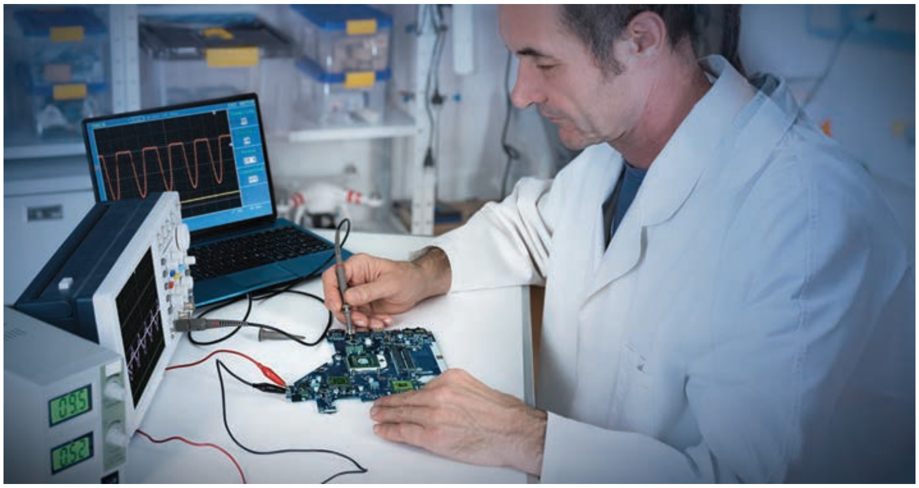
IoT Challenge #1 – Power Management

As IoT devices are often deployed remotely or in a mobile environment, most will use a battery as their primary source of power. Understanding the power-consumption profile of the device is key to ensuring maximum reliability and performance during the device lifetime.

To fully characterize the power consumption of an IoT device, measurements must be made under all operating conditions that will typically be encountered. Since IoT devices are designed to minimize power consumption, they may only be active for short periods of time, spending most of their operational life in 'sleep' mode.

Accurately measuring the consumption profile of the device in all operating modes can present challenges using the usual current-measuring techniques such as shunts, digital multimeters (DMM) or current probes. While in sleep mode, currents may be in the 'nA' or 'uA' range. While in active modes, such as when transmitting data, current may spike into the 'mA' to 'A' range. Moreover, these large spikes in current demand often occur in microseconds, transitions that can be challenging for some test instruments to capture.



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Although they have the capability to be very accurate when used in the right context, current shunts can be problematic to use for these kinds of measurements due to the large dynamic range involved, which may require multiple shunts. Even using multiple shunts, it may be necessary to test the active modes and sleep modes separately, making it extremely difficult to get a true picture of current drain. Also, due to the inherent voltage drop, the shunt itself runs the risk of impacting the test device if too large a value is chosen to maximize the measurement of dynamic range.

DMMs, which are often used in conjunction with shunts, can also limit measurement accuracy. Some are simply too slow in acquiring and processing the data to present an accurate and complete picture of the rapidly-changing current values in IoT devices. Use of fixed-measurement ranges can help alleviate the delay caused by the DMM during auto-ranging, but this puts a limitation on dynamic range. Reverting to auto-ranging, however, runs the risk of losing data during the DMMs 'blind' period, while switching and settling from one range to the next.

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When used with oscilloscopes, most conventional current probes do offer high bandwidth, which increases the likelihood that rapidly-changing current transitions will be captured. However, most do not offer the dynamic range to fully characterize the current demands of a device, nor are they as accurate as a shunt in most applications. Also, the oscilloscope itself can add noise into the measurement system, making currents measurements in the lower end difficult to resolve sufficiently.

IoT Challenge #2 – Signal and Power Integrity

Mixed-signal ICs, which can include sensors/MEMS, analog and digital signals on the same IC operating at comparatively low power, are often used in IoT device design. They are extremely susceptible to crosstalk. Low power distribution networks often have very small operating tolerances, which increases the chance that ripple and noise riding on the power rail could adversely impact clocks and digital data. The small physical structure of many IoT devices also necessitates that channels for high speed signals are densely packed, increasing the risk of crosstalk and coupling.

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Using good signal integrity design principles such as point-to-point signal routing topology when possible, controlling trace impedance throughout the PDN and interconnects, keeping return path lengths short and maintaining adequate space between adjacent traces to reduce coupling, can all help to alleviate signal integrity issues. Although observing good design principles such as these is vital to achieving a reliable design, having the capability to thoroughly characterize the electrical performance of the structures that carry signals throughout the device is also crucial.

Vector Network Analyzers (VNA) are among the most common tools for describing the electrical properties of any interconnect or transmission line. Important characteristics that impact signal integrity such as insertion loss, attenuation, reflections, crosstalk, delay, as well as differential to common mode conversion, can all be assessed with a VNA properly configured for the application. In addition, some VNAs have the capability (usually via a software option) to perform a time domain transformation on S-parameter measurements which will show the impulse response of the channel.

With regard to power integrity, one of the most recent tools developed to assist with making ultra-low noise measurements on power rails is the power rail probe, used in conjunction with an oscilloscope. Depending upon manufacturer, features of these probes generally include:

- Up to 60V offset to ensure that power rails are fully shifted onto the oscilloscope display.
- Dynamic range up to 1V.
- Gigahertz operating bandwidths to ensure that high frequency noise does not go undetected.
- 1:1 attenuation ratio to reduce measurement system noise.
- 50 kΩ impedance to reduce loading.

Choosing the right tools to detect signal and power integrity issues is important to adequately identify and resolve the cause(s) of poor performance, as well as to validate the true performance of your design. VNAs, power rail probes and oscilloscopes are only some of the tools available to help accomplish this goal.

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IoT Challenge #3 – Wireless Standards Compliance

Whether you are developing devices that connect in close proximity, via Zigbee or Wi-Fi, or devices that connect over long distances via LoRaWan or LTE-M, the wireless protocol of choice will dictate the way your device connects and shares data with the world.

Ensuring interoperability by adhering to the specifications of the wireless standard is key to achieving maximum market impact. As with EMI/EMC, testing early in the design cycle can help identify issues that can cause delays and increase expense in development design prior to the qualification stage.

Vector signal generators with the capability to generate standards-compliant signals and spectrum/signal analyzers with the capability to demodulate these signals are ideal tools to evaluate device performance with the wireless standard of choice.

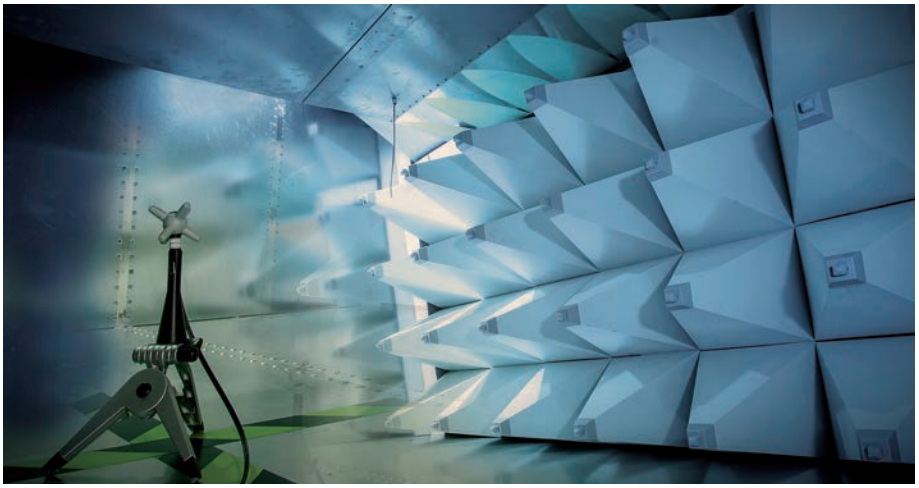
IoT Challenge #4 – EMI/EMC and Coexistence Testing

We can define EMC as a measure of whether a product performs as intended, while also not impeding the ability of another product to perform as intended in a shared operating environment. EMI can also be defined as any electromagnetic energy that impedes a device from performing as intended.

As the number of devices that communicate wirelessly continues to increase exponentially, the electromagnetic noise in the operating environment increases accordingly, as does the risk that performance will be degraded due to interference.

Although the use of pre-certified RF modules can help to diminish the likelihood that the completed device will fail to pass regulatory EMC compliance tests, it is not a guarantee that the final product will be compliant.

Use of good EMI engineering countermeasures from the onset of design, as well as assessing the actual EMC performance of the device prior to the compliance test stage (pre-compliance testing), helps to avoid costly redesigns and delays that can impact time to market.



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One portion of the IoT device market that has seen tremendous growth in recent years is the medical device market. Devices that can transmit real-time vital signs, whether stationary, wearable, or implantable, are becoming increasingly common in hospital and home care environments. Just like other IoT devices, medical devices also have the potential to be the source of, and recipient of, interference in the operating environment. However, given their use in the delivery of medical services, this can pose life threatening consequences should they fail to operate as expected.

Due to the critical functions these wireless devices perform, coexistence testing has become an important part of the IoT medical device design process.

IEEE/ANSI C63.27 is a standard that outlines test procedures and methods to validate the ability of wireless devices to coexist with other wireless services that operate in the same RF bands. AAMI TIR69 is a standard that provides guidance specific to medical devices and how wireless technology should be evaluated in relationship to potential hazards in the operating environment, including external hazards that may be beyond manufacturer control.

As with EMC testing, the completed product may be sent out to a compliance test house for final testing. However, preliminary coexistence testing during the design process can used to determine device tolerance to other radio signals and to ensure that an acceptable level of operation can be achieved. Should performance issues be discovered early, mitigation techniques can be employed and performance can be re-evaluated before the final design has been established.

Spectrum/signal analyzers are a key piece of test equipment for both EMC pre-compliance testing and coexistence testing. Although a fully compliant EMI receiver is required for full EMC test, many modern analyzers can be equipped with software packages to help facilitate pre-compliance testing of both radiated and conducted emissions, including CISPR and MIL-STD compliant bandwidths, detectors and band presets, as well as limit lines for internationally- established EMC standards limits, with options to create user selectable limits.

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Coexistence testing makes use of real-time spectrum analyzers that utilize a high-speed analog-to-digital converter (ADC) to continuously sample the spectrum, then use real-time fast Fourier transform (FFT) to present a spectral view of the RF environment in which the test device is operating. Vector signal generators are also used to generate the types of signals, such as WiFi and Bluetooth, that will be encountered in the expected operating environment to be simulated.

IoT Challenge #5 – RF Performance for Wireless Connectivity

Although some IoT devices will use wireline communications, most will rely on some form of wireless technology to gain access to the network. Designers of IoT devices are faced with numerous decisions when determining how best to implement wireless communications. The most important among these is identifying which wireless communication technology and protocol to use (WiMax, Wi-Fi, Zigbee, BLE, LoRaWan, Z-Wave, and NB-IoT, just to name just a few) — and whether to use a pre-made RF wireless module or an in-house design.

Regardless of how these design questions are resolved, the performance of the RF communications must be tested under real-world conditions with equipment suitable to the task. Some common tests include:

Transmitters

- Transmit Power
- Adjacent Channel Power
- Modulation Accuracy
- Spectrum Mask
- Spurious Emissions

Receivers

- Sensitivity
- Max Input Level
- Adjacent Channel Selectivity
- Intermodulation Immunity
- Fading and AWGN

Antennas

- VSWR and Return Loss

Spectrum analyzers/signal analyzers are often the tool of choice for transmitter measurements, while signal generators are usually used to generate signals for the receiver measurements. Network analyzers are typically used for the antenna measurements.

Many modern signal generators and signal analyzers offer software application support for most common wireless communication standards being implemented in IoT devices. Standards based waveforms can be generated and test signals can be analyzed using measurement applications that run either on the test equipment itself, or on a PC with remote control. There are also applications that can be helpful if your wireless connection uses a customized design.

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Conclusion

As new technologies are developed and testing standards change, innovations in IoT, cloud robotics and automation evolve, there will be increased demand for testing and validation, especially to support the existing and still unknown challenges of power management.

All of this new technology needs power and verification. Managing power for the IoT devices is a challenging task because the devices must always be powered up and function at full capacity even in the most challenging of environments.

As a leading global supplier for test and technology, rental and asset optimization solutions, Electro Rent specializes in delivering innovation and continuous improvement to optimize client investments in test equipment.

With a proven track record of reducing testing and asset costs for world-class organizations across industries, Electro Rent has helped numerous organizations generate more value from their test fleet by disposing of underutilized, technologically obsolete, or unwanted equipment; manage peak demand with renting or leasing; reduce duplicate asset purchasing, and maximize value from unneeded assets.

Battery Drain Analysis

Keithley
2281S-20-6 Battery Simulator

The Series 2281S Battery Simulator and Precision DC Power Supply integrates battery simulation with the functions of a high-precision power supply for battery testing. Analyze the DC power consumption of a device under test, test a battery and generate a battery model based on the battery charging process and simulate a battery based on the battery model.

The 2281S-20-6 can output up power to 20 V and 6 A and sink current up to 1 A.

- Simulate battery output during the charge and discharge cycles.
- Create, edit, import and export battery models.
- Display the real-time change of the SOC, Voc and Vt for the simulated battery.
- Compute battery capacity in Amp-Hours and Equivalent Series Resistance (ESR).
- Program the battery SOC, Voc, capacity and resistance.
- Monitor charge/discharge current and voltage.
- Output up to 120 W of low-noise, linear-regulated power.
- Monitor load currents from 100 nA to 6 A with high accuracy.
- Measure voltage and current with 6 1⁄2-digit resolution.
- Sink current up to 1 A and source current up to 6 A.
- GPIB, USB and LAN interfaces.

Battery Drain Analysis

Keysight
N6705C/056 DC Power Analyzer
Battery Drain analysis modules for sourcing and measuring current consumption and battery drain analysis

The N6705C DC Power Analyzer provides productivity gains for sourcing and measuring DC voltage and current into the DUT by integrating up to four (4) advanced power supplies with DMM, Scope, Arb and Data Logger features. Eliminates the need to gather multiple pieces of equipment and create complex test setups, including transducers (such as current probes and shunts) to measure current in your DUT.

The DC Power Analyzer also eliminates the need to develop and debug programs to control a collection of instruments and take useful measurements because all functions and measurements are accessible on the front panel.

When automated bench setups are required, the N6705C is fully programmable over GPIB, USB, LAN and is LXI Compliant. The N6705C offers flexible configuration to meet your power sourcing and analysis requirements

- 4-slot mainframe holds up to 600 W of total power and up to 4 modules.
- More than 30 DC power modules to choose from (modules ordered separately).
- Voltmeter accuracy: Up to 0.025% + 50 μV, up to 18 bits.
- Ammeter accuracy: Up to 0.025% + 8 nA, up to 18 bits.
- Arbitrary waveform generator function: Bandwidth up to 100 kHz, output power up to 500 W.
- Scope function: Digitizes voltage and current at up to 200 kHz, 512 kpts, up to 18 bits.

Battery Drain Analysis

Keysight
N6781A / N6785A

The N6781A and N6785A offer the features to accurately capture the power consumption of portable, battery-powered devices from 20 W to 80 W. When used with the Keysight 14585A software, the N6781A and N6785A become an even more powerful battery drain analysis solution, offering greater insights into your measurements.

Whether the DUT is an e-Book reader, MP3 player, mobile phone, "phablet," tablet, or IoT device, the N6781A and N6785A's seamless measurement ranging, programmable output resistance and auxiliary DVM combine to create a solution to help you deliver exceptional battery life.

- Deliver exceptional battery life with insight into device power consumption.
- Measure all modes of operation simultaneously without the need to change measurement ranges and seamless, dynamic measurements down to nA and µV.
- Accurately emulate battery performance with internal resistance of a battery using the programmable output resistance of the N6781A and N6785A.
- Perform tests with the actual battery. Monitor battery voltage with the built-in auxiliary voltage measurement system while using the SMU's ammeter mode (zero-burden current shunt) to perform real-world battery rundown tests.
- Easily understand your measurements, including scope, data logger, and cumulative distribution function (CCDF) statistical analysis.

Device Power Consumption Testing

Keithley
2636B

The Keithley 2636B is a 2600B series dual channel system SourceMeter® (SMU) instrument (0.1fA, 10A pulse). It is a leading current/voltage source and measure solution. This dual channel model combines the capabilities of a precision power supply, true current source, 6 1/2 digit DMM, arbitrary waveform generator, pulse generator and electronic load all into one tightly integrated instrument.

The result is a powerful solution that significantly boosts productivity in applications ranging from bench-top I-V characterization through highly automated production test. It has 100mV to 40V voltage, 100nA to 10A current measurement range (source).

This is a tightly-integrated, 4-quadrant voltage/current source and measure instrument that offers high performance with 6 1/2digit resolution. Built-in web browser-based software enables remote control through any browser, on any computer, from anywhere in the world.

- Compatible with the Keithley IVy mobile app.
- Simplifies semiconductor component test, verification and analysis.
- Ethernet, IEEE-488, USB 2.0, LXI-C, GPIB, RS-232 and digital I/O interfaces.
- SMU per pin parallel testing with TSP-Link technology.
- 100V to 250VAC, 50Hz to 60Hz (auto sensing) power supply, 240VA maximum power consumption.
- Perform Quick I-V characterization with Android devices.

Device Power Consumption Testing

Keithley
2450

The 2450 is Keithley's next-generation SourceMeter.

The 2450 is the SMU for everyone: a versatile instrument, particularly well-suited for characterizing modern scaled semiconductors, nanoscale devices and materials, organic semiconductors, printed electronics and other small-geometry and low-power devices.

With front panel input banana jacks, this rear panel input source measure unit (SMU) instrument truly brings Ohm's law (current, voltage and resistance) testing to your fingertips. The innovative graphical user interface (GUI) and advanced, capacitive touchscreen technology allow intuitive usage and minimize the learning curve to enable engineers and scientists to learn faster, work smarter and invent easier.

- Capabilities of analyzers, curve tracers, and I-V systems at a fraction of the cost.
- Five-inch, high-resolution capacitive touchscreen GUI.
- 0.012% basic measure accuracy with 6½-digit resolution.
- Enhanced sensitivity with new 20mV and 10nA source/ measure ranges.
- Built-in, context-sensitive front panel help.
- Four "Quickset" modes for fast setup and measurements.
- Source and sink (four-quadrant) operation.
- 2450 SCPI and TSP scripting programming modes.
- Front panel USB memory port for data/programming/ configuration I/Ole capacitance effects.

Device Power Consumption Testing

Keysight
B2900A Series
Precision SMU's for sourcing and measuring low voltage and current

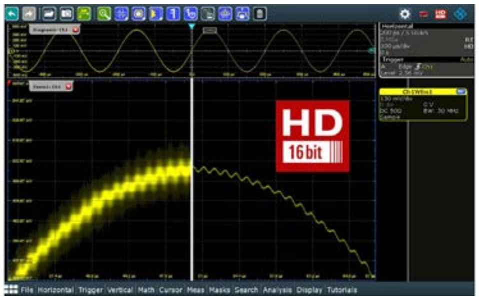
The Keysight B2900A Series of Precision Source/Measure Units are compact and cost-effective bench-top Source/Measure Units (SMUs) with the capability to source and measure both voltage and current. These capabilities make the B2900A Series ideal for a wide variety of IV (current versus voltage) measurement tasks that require both high resolution and accuracy.

The Keysight B2900A Series of SMUs have broad voltage (±210 V) and current (± 3 A DC and ±10.5 A pulsed) sourcing capability, high precision (minimum 10 fA/100 nV sourcing and measuring resolution) and a superior color LCD graphical user interface (GUI). In addition, several task-based viewing modes dramatically improve productivity for test, debug and characterization

- Integrated 4-quadrant sourcing and measuring capabilities.
- Measurement range: ±210 V, ±3 A (DC), ±10.5 A (pulsed).
- Source and measurement resolution down to 10 fA and 100 nV.
- User-friendly front panel GUI with 4.3 inch color LCD display supports both graphical and numerical view modes.
- 10 microsecond digitizing capability.
- Small form factor with USB2.0, LAN, GPIB and digital I/O interfaces.

Power Integrity Tests

Rohde & Schwarz
RTO-K31



The Rohde & Schwarz RTx-K31software option provides essential measurement functions for analyzing power electronics, including inrush current, output spectrum and safe operating area. A measurement wizard with detailed instructions guides the user through the test setup. The oscilloscope configures itself automatically and delivers quick results.Optimal display configuration for each task.

Available on the following oscilloscopes

- RTO2000
- RTM3000
- RTA4000

Power Integrity Tests

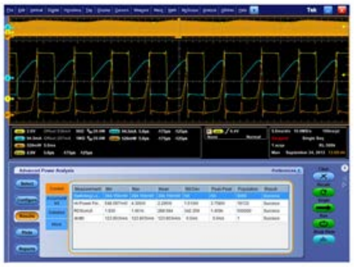
Tektronix
PA3000

The Tektronix PA3000 is a one-to-four-channel power analyzer that is optimized for testing today's single and multi-phase, high efficiency power conversion products and designs. Use it to quickly visualize, analyze and document power efficiency, energy consumption, and electrical performance to the latest regional and international standards, including Level VI, EnergyStar, CEC, IEC 62301, CQC-3146 and more.

- One to four channels support single and three-phase applications.
- 10 mW standby power measurement.
- 1 MHz bandwidth with 1 MS/s sampling rate.
- 16-bit A/D.
- Harmonic analysis to 100th order.
- ±0.04% basic voltage and current accuracy.
- Measurements to 30 Arms and 600 Vrms Cat II (2000 Vpk).
- High accuracy supports testing to Level VI efficiency standards for external AC/DC power supplies.
- Dedicated energy consumption testing in integration mode for standards like Energy star and CEC.
- Complete solution for full compliance testing to IEC 62301 standby power requirements.
- High 1 MHz bandwidth supports the LED module energy certification requirements of CQC-3146, as well as harmonic analysis of designs with higher fundamental frequencies.
- More than 50 standard measurement functions, including harmonics, frequency and star-delta computation.
- Built-in ±15 V supplies for external transducers to support high-current applications.
- USB and LAN interfaces standard (GPIB option).

Power Integrity Tests

Tektronix
DPO4PWR for MDO4104C



DPOPWR, Advanced Power Measurement and Analysis software for the Tektronix MDO4104C, allows power supply designers to configure multiple measurements with custom defined settings, measure and analyze power dissipation in switching devices and measure and analyze magnetic parameters in a single acquisition.

The addition of new measurements such as Inrush current, Capacitance and Reactive power provides more insight into the input/output characterization of power supplies. Designers who otherwise spend a lot of time manually analyzing power dissipations per cycle can now, with the Switching loss plot and the Time trend plot, measure power dissipation at all switching cycles graphically.

A single .mht format with the append feature provides an easy way to generate reports that include measurements, test results, and plot images. This solution elevates your productivity to a new level and helps SMPS designers meet pre-compliance requirements.

Signal Integrity Tests

Keithley
DMM7510

The DMM7510 combines all the advantages of a precision digital multimeter, a graphical touchscreen display, and a high speed, high resolution digitizer to create an industry first: a graphical sampling multimeter.

The digitizer gives the DMM7510 high signal analysis flexibility; the five-inch capacitive touchscreen display makes it easy to observe, interact with, and explore measurements with "pinch and zoom" simplicity. This combination of high performance and ease of use offers deep insights into your test results.

- Precision multimeter with 3½ to 7½ digit resolution.
- Capture and display waveforms or transients with 1 MS/sec digitizer.
- Large internal memory buffer; store more than 11 million readings in standard mode or 27.5 million in compact mode.
- 14 PPM basic one-year DCV accuracy.
- 100 mV, 1 Ω, and 10 μA ranges offer the sensitivity to measure low level signals such as portable device sleep mode currents.
- Make accurate low resistance measurements with offset compensated ohms, four-wire and dry circuit functions.
- Auto-calibration feature improves accuracy and stability by minimizing temperature and time drift.
- Readings and screen images can be saved quickly via the front panel USB memory port.
- Multiple connectivity options: GPIB, USB and LXI- compliant LAN interfaces.

Signal Integrity Tests

Keysight
34470A

The Keysight 34470A 7½ digit, Performance Truevolt DMMs offer higher levels of accuracy, speed and resolution. Get more insight quickly: Truevolt DMM's graphical capabilities such as trend and histogram charts that offer insights quickly. Both models also provide a data logging mode for easier trend analysis and a digitizing mode for capturing transients.

Measure low-power devices: The ability to measure very low current, 1 µA range with pA resolution, allows you to make measurements on very low power devices. Maintain calibrated measurements: Auto calibration allows you to compensate for temperature drift, so you can maintain measurement accuracy throughout your workday.

- Resolutions up to 7½ digits.
- Reading rates up to 50,000 readings/s.
- Memory up to 2 million readings.
- Voltage ranges from 100 mV to 1,000 V.
- Current range from 1 µA to 10 A.
- USB and LAN interfaces, optional GPIB.
- BenchVue software enabled.

Signal Integrity Tests for IoT

Keysight
34972A

The Keysight 34970A data acquisition/data logger switch unit consists of a three-slot mainframe with a built-in 6 1/2 digit digital multimeter. Each channel can be configured independently to measure one of 11 different functions without the added cost or hassle of signal-conditioning accessories.

Choose from eight optional plug-in modules to create a compact data logger, full-featured data acquisition system or low-cost switching unit. On-module screw-terminal connections eliminate the need for terminal blocks, and a unique relay maintenance feature counts every closure on every switch for easy, predictable relay maintenance. The module 34901A features a built-in thermocouple reference and 20 two-wire channels.

- 3-slot mainframe with USB and LAN.
- 6 ½-digit (22-bit) internal DMM, scanning up to 250 channels per second.
- 8 switch and control plug-in modules to choose from.
- Built-in signal conditioning measures thermocouples, RTDs and thermistors, AC/DC volts and current; resistance; frequency and period.
- 50k readings of non-volatile memory holds data when power is removed.
- Hi/LO alarm limits on each channel, plus 4 TTL alarm outputs.
- BenchVue software enabled: BenchVue DAQ Control and Analysis app enables you to create tests without programming.

Signal Integrity Tests for IoT

Keysight
6000 X-Series

The 6000 X-Series delivers an affordable 6-GHz bandwidth and an low noise floor of 210 µVrms at 1 mV/div to help you make the most accurate measurements. The 6000 X-Series' 450,000 waveforms-per-second update rate coupled with the exclusive hardware-based zone touch trigger provide unprecedented visualization power to help you isolate waveforms of interest.

Add a new depth of "visualization" to your designs with a 12-inch multi-touch capacitive touch screen with gesture support, embedded-OS-oscilloscope optional jitter/real-time eye analysis and standard histogram and color grade.

The 6000 X-Series has 7-in-1 integration, combining digital channels, serial protocol analysis, a built-in dual-channel waveform generator, frequency response analysis, built-in digital multimeter and built-in 10-digit counter with totalizer.

N2820A

This N2820A current probe comes with two parallel amplifiers possessing different gain settings. The low-gain side allows you to see the entire waveform (or the 'zoomed out' view) and the high gain amplifier provides a 'zoomed in' view.

The precision sense resistor is positioned in the interchangeable Rsense head that is plugged into the probe body. The probe body can be found at the same location as the differential amplifier. On the 'user-defined' sense head, there is no resistor, which allows the probe to be used with the user's sense resistor on the target. The user will need to enter the sense resistor value into the scope.

Signal Integrity Tests for IoT

Keysight
DSOX6PWR

The Keysight DSOX6PWR is a power measurement and analysis option integrated into InfiniiVision 6000 X-Series scopes.
The embedded application provides a quick and easy way of analyzing the reliability, efficiency and performance of your switching and linear power supplies.

Signal Integrity Tests for IoT

Keysight
N7020A

The N7020A power rail probe is for users making power integrity measurements that need mV sensitivity when measuring noise, ripple and transients on their DC power rails. The probe is designed for measuring periodic and random disturbances (PARD), static and dynamic load response, programmable power rail response and similar power integrity measurements. Many of today's products have tighter tolerances on their DC power rails than the previous generations of these products, and the N7020A power rail probe is designed to help users assure that their products meet these tighter tolerances.

The N7020A power rail probe can be used with the Keysight InfiniiVision 3000T and 4000 X-Series oscilloscopes, InfiniiVision 6000 X-Series oscilloscopes ordered after Feb 1, 2016, the Infiniium S-Series DSO and MSO high-definition oscilloscope and the Infiniium 9000 Series DSO and MSO oscilloscopes running software revision 5.20 or newer. If you need higher bandwidth, the N7024A power rail probe has a bandwidth of 6 GHz and can be used with S, V, and Z-Series Infiniium oscilloscopes.

- Low noise: 1:1 attenuation ratio probe adds only 10% to the baseline noise of the oscilloscope to which it is attached.
- Large offset range: Has a large +/-24 V offset range, enabling users to set their oscilloscope at maximum sensitivity and have the signal centered on the screen.
- Low DC loading: 50 kΩ DC input impedance will not significantly load DC power rails.
- Large active signal range: Has a +/-850 mV active signal range in addition to its large offset range so users can measure large transitions of their power rails.
- High bandwidth: 2-GHz bandwidth makes it very useful for finding high-speed transients that can have detrimental effects on clocks and digital data.

Signal Integrity Tests for IoT

Rohde & Schwarz
RTO2014

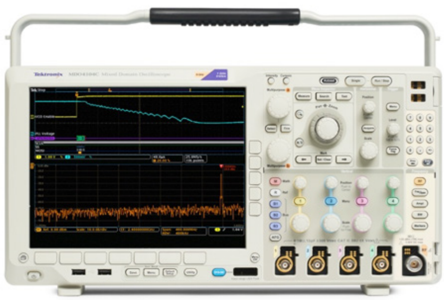
Rohde & Schwarz RTO oscilloscopes perform precise measurements at a high input sensitivity and very low inherent noise. The unique high-definition mode enables up to 16-bit resolution. With an acquisition rate of up to one million waveforms per second, these oscilloscopes detect sporadic signal faults very quickly.

The RTO oscilloscopes are engineered for multi-domain challenges and to facilitate debugging of systems with different signal types. The oscilloscopes enable simultaneous time, frequency, logic and protocol analysis and displays the results referenced over time. For the first time, a special tool is available for these applications: a zone trigger that can be used in both the time domain and in the frequency domain.

These oscilloscopes are extremely easy to use. Gesture operation simplifies measurement tasks. You can even customize the waveform display. The app cockpit provides fast access to all available applications.

- Precise measurements due to very low noise level: 1 % of full scale at 1 mV/Div and 1 GHz.
- High dynamic range due to single-core A/D converter.
- Wide selection of measurement functions: over 90 automated measurements.
- High-resolution touchscreen for ease of use.
- Color coding for clear overview.
- Class-leading 400 MHz logic analysis: 5 Gsample/s and 200 Msample memory on 16 channels.
- High definition: see more with up to 16-bit vertical resolution.

Tektronix
MDO4104C/PWR + TCP0150



Introducing the high performance 6-in-1 integrated oscilloscope that includes a spectrum analyzer, arbitrary/function generator, logic analyzer, protocol analyzer and DVM/frequency counter.

The MDO4000C Series has the performance to solve the embedded design challenges quickly and efficiently. When configured with an integrated spectrum analyzer, it provides simultaneous and synchronized acquisition of analog, digital and spectrum, ideal for incorporating wireless communications (IoT) and EMI troubleshooting. The MDO4000C is completely customizable and fully upgradeable, so you can add the instruments you need at any time.

Oscilloscope

- 4 analog channels.
- 1 GHz, 500 MHz, 350 MHz, and 200 MHz bandwidth model's bandwidth is upgradeable up to 1 GHz.
- Up to 5 GS/s sample rate.
- 20 M record length on all channels.
- > 340,000 wfm/s maximum waveform capture rate.
- Standard passive voltage probes with 3.9 pF capacitive loading and 1 GHz or 500 MHz analog bandwidth.
- Spectrum Analyzer (Optional) Frequency range of 9 kHz - 3 GHz or 9 KHz - 6 GHz.
- Ultra-wide capture bandwidth ≥1 GHz.
- Time-synchronized capture of spectrum analyzer with analog and digital acquisitions.
- 50 MHz waveform generation.

Contact Us Today

Contact us today to learn more about our complete portfolio of cross-industry IoT and IIoT products.

You can reach us by email **info.asia@electrorent.com**, **info.india@electrorent.com** or WhasApp **+60 12 998 8753.** Our IoT experts and application engineers are available to assist with your product testing and financing needs.

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