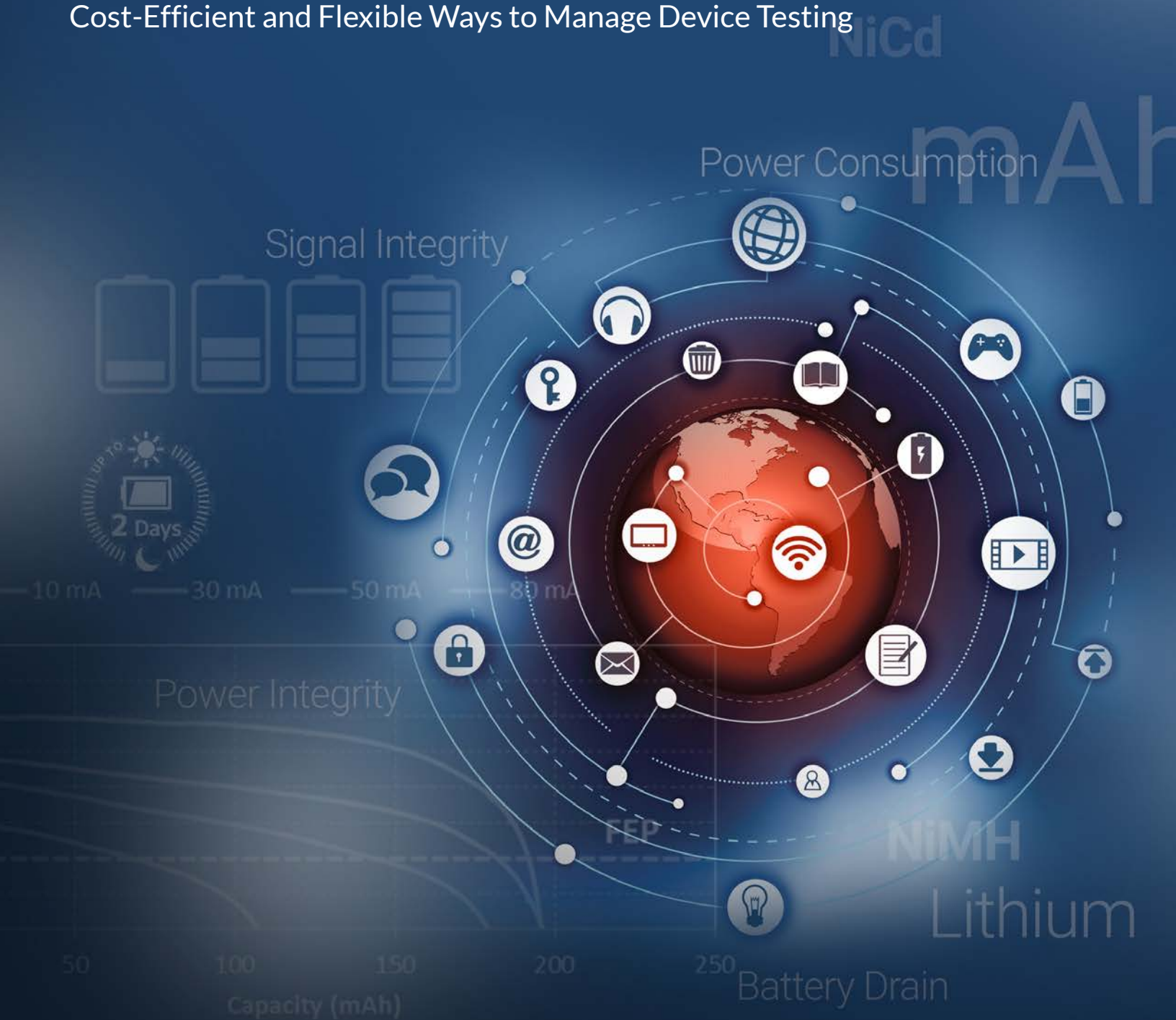# OPTIMIZE YOUR INVESTMENTS IN IoT TESTING

Cost-Efficient and Flexible Ways to Manage Device Testing

Contents

Overview

For organizations working on IoT devices, battery testing and power management can be a major challenge. Managing this challenge efficiently will increase your opportunity from advances in artificial intelligence (AI), communications (5G NR), device automation (IoT) and industrial automation (IIoT). Virtually every sector will be affected, including manufacturing, transportation, healthcare, agriculture, construction and more. Together, these developments signify the start of the Fourth Industrial Revolution (Industry 4.0).

Soon, 5G networks, devices and services will be coming online. In conjunction with IoT devices, the combination of 5G's increased bandwidth, greater speed and lower latency will give rise to applications that were previously considered impossible. Theoretical maximum speeds of 10 Gbps and an expected 10-year battery life for low-power sensors and machine-type devices mean that a massive wealth of data can be collected, analyzed and acted upon.

In the era of IoT and 5G, a flood of new products will come to market, increasing the burden on R&D teams and test equipment and making operational efficiency and productivity even more of a key competitive advantage.

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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.

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).

Connectivity will also bring a future where cars communicate with each other, the infrastructure, pedestrians, cyclists, data centers and networks via IoT devices. All of this is 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, adding to the list of challenges.
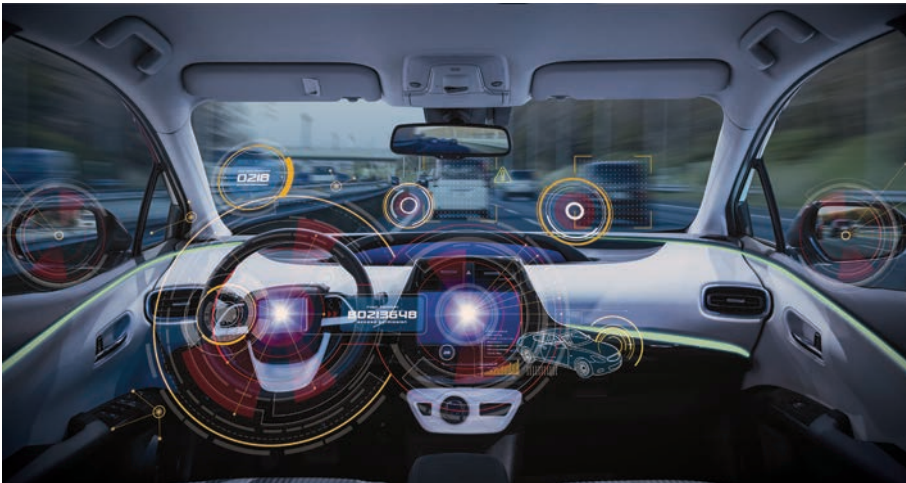
Since so many IoT devices are battery powered, energy-efficient functioning is critical. Low power components must be used, along with techniques to de-energize these components when not in use. For optimized battery life, components have to be tested under realistic scenarios and conditions to ensure that the right components are chosen to maximize the life of IoT devices.

What Does This Mean for Me?

Ensuring the integrity of device power is a critical success factor. R&D engineers and lab managers need high-quality test and measurement tools to get the job done efficiently. Program managers, finance teams and procurement need to ensure that the solutions are cost-effective.

Companies will need trusted partners that can provide brand-independent guidance on product selection and financing options, as well as recommendations to streamline and optimize the test fleet, increasing operational efficiency and employee productivity.

Today's challenges include:

- Increased need for better ROI in R&D labs and for testing/verification

- Pressure to reduce development times and increase time-to-market

- The need for regulatory testing on power

- The consumer need for extended battery life

To get the most from investments in investments in test and measurement equipment, leading companies across industries gain leverage by:

- Increasing Speed to Market

- Optimizing Test Equipment Usage

- Reducing Capital Cost and Associated Recurring Costs for Maintenance and Repair

- Examining True Cost of Ownership

- Improving R&D Test Equipment Utilization

#1. Increase Speed to Market

Customized Sourcing Solutions May Offer the Best Balance of Cost and Flexibility

What if you could have the equipment you need, exactly when you need it and only for as long as you need it? Many companies, including global semiconductor and device manufacturers, use renting to manage fluctuating projects, fulfill urgent or short-term testing needs and increase time to market.

Consumer IoT and industrial IIoT will result in significantly higher demand for product testing and verification services. In combination with 5G networks, IoT may be the catalyst that accelerates widespread change across industries and society.

The proliferation of consumer devices for smart homes, IoT sensors for smart buildings and cities, and increased manufacturing efficiency via widespread adoption of cloud robotics means that the testing world may change significantly in the near future. In addition, with automated data transfer and vehicle-to-everything (V2X) communication, the interconnectedness of society is set to increase exponentially. By 2020, Gartner predicts that there will be more than 20 billion connected devices.

For companies that need multiple pieces of test equipment for a wide range of projects and timelines, customized sourcing solutions may offer the best balance of cost and flexibility. At one end of the spectrum, when the need is continuous, as on a production line, or when the product is established and constantly in use, an outright purchase or long-term lease may be appropriate.

At the other end, when the equipment is needed periodically— even up to several years or more— renting can represent significant savings. Importantly, renting offers the flexibility to return, change or upgrade the equipment at any time. Many leading telecommunications, semiconductor and device manufacturers find that actively managing this process makes a difference to their profitability. However, many companies still incur unnecessary costs due to habit or through the notion that outright asset ownership is always preferable.

With automated data transfer and V2X communication, the interconnectedness of society is set to increase exponentially. By 2020, Gartner predicts that there will be more than 20 billion connected devices.

Renting offers the flexibility to return, change, or upgrade the equipment at any time if needs change. Many leading telecommunications, semiconductor and device manufacturers find that actively managing this process makes a difference to their profitability.

Whether you need week-to-week support for a short-term project, or long-term solutions for several years, renting, for example, ensures continued access to the latest technology without the associated long-term ownership costs. Maintenance and calibration are covered by all rental agreements. Optimize utilization by renting only what you need, only when you need it.

With renting, your organization can get to market faster, at lower cost. You can forget about ownership expenses, avoid maintenance and calibration costs and technological obsolescence, free cash for other investments and acquire and dispose of equipment, as needed, to fulfill urgent needs or short-term requirements.

#2. Optimize Test Equipment Usage

Market Leaders Use Savvy Sourcing Techniques to Increase Profitability

Using the cloud, a variety of IoT sensors will be used across industries for automated data transmission and remote device control. In the Internet of Everything era, connectivity will become commonplace.

Soon, people will interact with billions of connected devices, sensors, machines and vehicles to share massive amounts of data, images and video. This means that a flood of devices will need testing and verification.

Soon, people will interact with billions of connected devices to share massive amounts of information. This means that a flood of devices will need testing and verification.

In dynamic R&D environments, trying to achieve optimal efficiency with a single acquisition strategy—such as purchasing assets outright for full ownership—is unlikely to produce the best results. That's not to say that outright ownership is not appropriate in certain circumstances. However, expertise in test equipment sourcing is required to discern the optimal (most cost effective) mix of purchase, certified pre-owned, lease and rental equipment for your entire asset pool.

For long-term projects, where no changes are expected or the equipment will be in use for many years, a purchase or long-term lease might be best. Often, a pre-owned option may be available, which will drive large savings. For short-term projects, where the timeline is less certain or testing protocols or requirements might change, renting could be an ideal solution. In many cases, renting or leasing is often more cost-effective than outright purchase. A business case is available to show how the numbers compare with our free rent-vs-buy analysis.

In dynamic R&D environments, trying to achieve optimal efficiency with a single acquisition strategy— such as purchasing assets outright for full ownership—is unlikely to produce the best results. Expertise is required to discern the most cost-effective mix of purchase, certified pre-owned, lease and rental equipment for your entire asset pool.

Based on current and intended future utilization, a mix of acquisition methods often saves money, reduces the size of the asset pool and eliminates the expense of unintended, redundant or duplicate purchasing of equipment. Leading companies use a mix of sourcing strategies to mitigate risk, save time and money, shorten procurement cycles, improve labor utilization and avoid unnecessary spending.

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It's all about having the right test equipment at the right time so projects get done quickly, on-time and under budget. With a combination of acquisition methods companies gain the flexibility to return, exchange, or upgrade certain equipment if conditions or project needs/timelines change. Among the many benefits of renting and leasing is avoiding technological obsolescence.

With renting, when new technology arrives, you can simply return the equipment and upgrade to the latest technology. You pay only for what you use, return it when you no longer need it, and avoid long-term ownership costs for calibration, repair, downtime and taxes. Renting also allows you to try before you buy.

Consider a mix of acquisition methods to accomplish your testing objectives. By leveraging the right product and sourcing information, R&D managers and test engineers can choose the best combination of equipment and sourcing methods on a case-by-case basis—without the need for compromise.

#3. Reduce Capital Cost and Recurring Expenses

Many R&D Managers Cite Cost-of-Test as One of Their Biggest Concerns

Across all business sectors, there are increasing demands to improve operational efficiency, forcing organizations to keep a close eye on costs as they pursue rapidly–evolving market opportunities in IoT. Within R&D, testing and verification is an area that holds great opportunity for improvement. Research from Frost & Sullivan shows that many test assets are purchased each year to satisfy existing needs without considering future requirements.

Power Management in IoT is a challenging and rapidly changing area. Which equipment do I need and when? Will it change in the future? Sometimes, engineers may order equipment to meet certain specifications and find that it quickly becomes obsolete. However, once the capital investment has been made, it is usually too late.

Furthermore, the outright purchase of test assets restricts funding that may be needed elsewhere. Asset ownership represents a long-term commitment that may present a challenge if testing standards or protocols change, or if equipment needs evolve—as may be the case with IoT. Outright asset ownership involves many annual and recurring costs that are often overlooked. Some of these include:

- Sales and property tax

- Cost of capital, financing and interest

- External cost and labor for calibration, maintenance, repair and downtime

Power Management in IoT is a challenging and rapidly changing area. Which equipment do I need and when? Will it change in the future? Sometimes, engineers may order equipment to meet certain specifications and find that it quickly becomes obsolete.

- Cost for tracking, logistics, security and storage for unused or underutilized assets

- The cost of using outdated or technologically obsolete equipment

To stay competitive and ahead of the competition, industry leaders are always looking to optimize their spending on test equipment and exploring other, more cost-effective ways to achieve similar outcomes with lower expenses and fewer associated costs.

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#4. Understand the True Cost of Ownership

Tailor the Sourcing Method to Accommodate Current Needs and Future, Intended Use

There are a variety of acquisition methods to consider. Depending upon needs, there is likely to be more than one procurement option to meet current and future objectives. The reality is that the up-front purchase price is only half the story. When you consider all ownership costs, both upfront (i.e. sales tax) and recurring (i.e. property tax), the real cost becomes apparent.

There are many costs to consider. There is the cost of capital, interest and financing, as well as depreciation, which starts immediately. On an annual basis, there will be costs for calibration and maintenance, as well associated labor and management time for these expenses. At some point, repairs may also be needed. There are also recurring yearly costs for managing each test asset, including procurement and vendor sourcing, asset management and tracking, inventory control, shipping and logistics, and security and storage.

The reality is that the up-front purchase price is only half the story. When you consider all ownership costs, both upfront (i.e. sales tax) and recurring (i.e. property tax), the real cost becomes apparent.

If the equipment becomes obsolete or no longer meets project requirements, additional funds may be needed to upgrade or buy another unit. When you take these factors into account, the real cost of ownership is often close to twice the original purchase price.

Many organizations mitigate risk and uncertainty by considering some simple, but essential questions prior to making decisions. Knowing the answers to these questions can lead to informed decision making and smart choices. In our experience, making informed decisions around product selection and financing alternatives can be just as important as technical equipment specifications.

In many cases, the true cost of ownership is simply overlooked. It is only later, when audits are undertaken, that it becomes apparent that money was spent unnecessarily. To understand the true cost of test equipment, consider all the expenses involved.

Below are some questions to consider:

What is the estimated use timeline?
- How long will the equipment be needed?
- Is it for sporadic use or continuous use?
- Is it for a specific project or initiative?
- Is there guaranteed use beyond the intended period?

What is the product lifecycle?
- Is it a new product with likelihood of change or an established product?
- What is the risk of obsolescence?
- Are there frequent upgrades?

What are the financial priorities?
- Is capital limited?

- How important is cash-flow?
- What is the cost of borrowing or internal rate of return?

What is the likelihood of change?
- Is the environment dynamic?
- Do you need flexibility to respond to changing market conditions?

How will equipment be managed, tracked, calibrated, and maintained?
- Will regular calibration and maintenance be performed? By whom?
- Does an asset management system exist?
- Is there staff allocation to track and manage assets?
- Who will keep everyone informed about asset status? How will they do so?
- If there are multiple units in operation at different sites, who will manage the logistics?
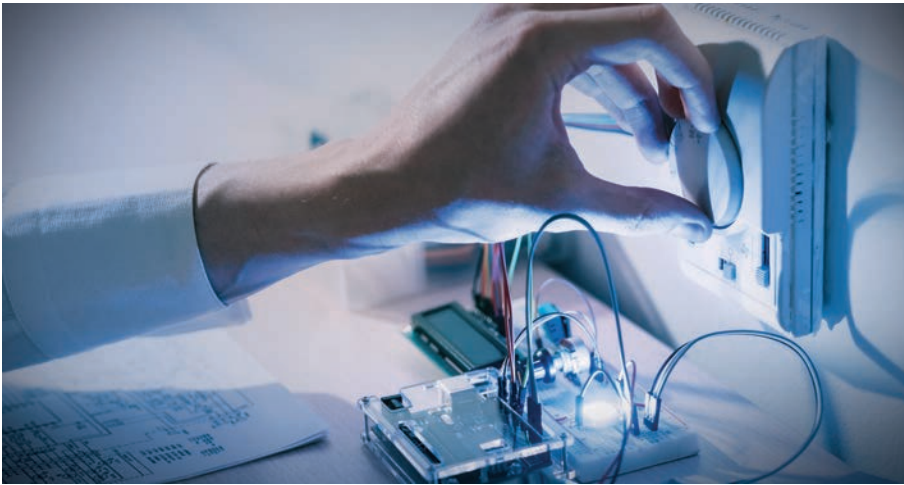
How will asset disposal be managed at end of life?
- How will you dispose of unwanted or obsolete equipment?
- Can you free cash for new investments by selling obsolete equipment?

In many cases, the true cost of ownership is simply overlooked. It is only later, when audits are undertaken, that it becomes apparent that money was spent unnecessarily. To understand the true cost of test equipment, consider all the expenses involved. When you take all the factors into account, the real cost of ownership is often far higher than the original purchase price.

#5. Improve R&D Test Equipment Utilization

To Reduce R&D Test Spending, Consider Asset Optimization Services

With increased attention on spending and ROI, R&D departments are coming under greater scrutiny. Whether you represent a medium or large organization or a start up, you want to be able to focus on your core technology and not divert your resources on expensive test equipment.

Globally, leading companies are streamlining their operations and reducing costs to improve both operational efficiency and employee productivity. Efforts are underway to gain higher visibility into the test asset pool, reduce expenses, and improve asset sharing and equipment utilization.

Compounding the problem, asset information in many companies is maintained via a variety of inaccurate/incomplete spreadsheets or partial software solutions not designed for test and measurement equipment. Without reliable data on the total asset pool and an effective way to track calibration and repair activities, time-consuming re-testing is often required, increasing expenses and delaying projects.

Unfortunately, many companies end up with too many assets in their test pool and very low utilization. According to Frost & Sullivan, "the typical utilization of test assets at many companies is in the 30% range". This surplus of equipment that doesn't fit requirements is also costly to track, manage and maintain. In our interactions with

Whether you represent a medium or large organization or a start up, you want to be able to focus on your core technology and not divert your resources on expensive test equipment.

clients across industries, we find that companies tend to suffer from a variety of system and process inefficiencies, including:

- Lack of a centralized system to track equipment

- Legacy systems that prevent visibility into the asset pool

- Ongoing project delays and cost overruns due to equipment unavailability

- Severe technological obsolescence with utilization rates lower than 20%

- No way to track maintenance, calibration and repair

Collectively, these issues have a tremendous cost—actual and opportunity—to each organization. Real costs include equipment overspending, redundant purchasing, high testing costs and project delays. Hidden costs, include:

- Low asset utilization and employee productivity

- The opportunity cost of capital from having more assets than needed

- Reduced operational efficiency from inefficient asset tracking systems and processes

- Outright purchasing with recurring ownership costs, when renting may have served the need

Unfortunately, many companies end up with too many assets in their test pool and very low utilization. According to Frost & Sullivan, "typical utilization of test assets at many companies is in the 30% range".

To increase utilization and optimize spending, many companies engage with trusted third-parties to implement asset management software systems, or in some cases, to completely manage the entire optimization process as an outsourced activity. Both options allow organizations to focus on their own core competencies, while leaving the optimization of test assets and related spending to those with experience and expertise in these areas.

To increase utilization and optimize spending, many companies engage with trusted third-parties to implement asset management software systems, or in some cases, to completely manage the entire optimization process as an outsourced activity.

With Electro Rent Asset Optimization Solutions, engineering and R&D teams can quickly and easily track and manage test assets and allocate project costs. These systems can also maintain and track repair and calibration history, calibration certificates, cost-of-test, rental and lease expirations and provide advance notifications when calibration is due, or rentals are about to expire. By being well-informed about all the options, R&D managers and test engineers can choose the best combination of equipment and sourcing methods on a case-by-case basis, without the need for compromise.

Conclusion

As technologies like IoT, IIoT, cloud robotics and automation evolve, there will be increased demand for testing and verification, especially to support the challenges of power management. Market requirements and testing standards may change. To mitigate this risk and reduce up-front and ongoing costs, leading companies use a mix of sourcing techniques that allow their R&D groups and engineers to get what they need, when they need it, at the lowest cost.

With more than 50 years of experience, Electro Rent is well positioned to provide advice and recommendations and to help users make more informed decisions regarding product selection, acquisition method and asset optimization. We offer an array of sourcing and asset optimization solutions across the entire project lifecycle, from concept and prototyping to development and full-scale production. Instruments can be sourced via new or certfied pre-owned purchase, renting and rent-to-buy programs.

We have a proven track record of reducing testing and asset costs for world-class organizations across industries. We have 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.

To become more competitive and profitable, companies should reconsider the way they source test equipment. There are many new ways to acquire, manage and optimize investments in test equipment, and leading organizations have become more efficient and profitable with this approach.

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

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

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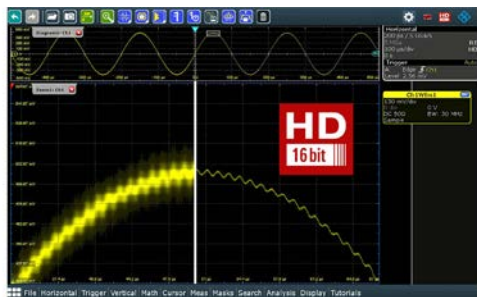
The Rohde & Schwarz RTx-K31software option provides essential measurement functions for analyzing power electronics, including inrush current, output spectrum and safe operating area. A measurement wizard with detailed instructions guides the user through the test setup. The oscilloscope configures itself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

Available on the following oscilloscopes

• RTO2000

• RTM3000

• RTA4000

# Power Integrity Tests

Tektronix
PA3000
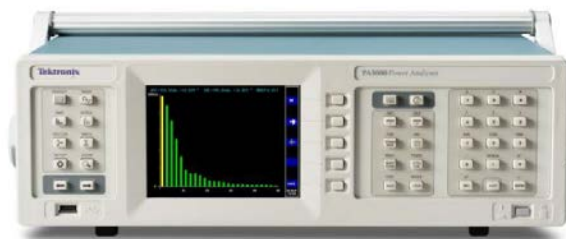
The Tektronix PA3000 is a one-to-four-channel power analyzer that is optimized for testing today's single and multi-phase, high efficiency power conversion products and designs. Use it to quickly visualize, analyze and document power efficiency, energy consumption, and electrical performance to the latest 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
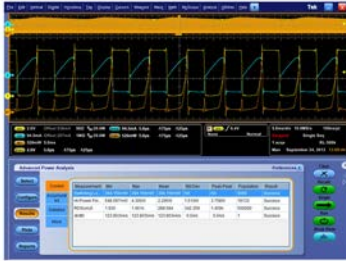
DPOPWR, Advanced Power Measurement and Analysis software for the Tektronix MDO4104C, allows power supply designers to configure multiple measurements with custom defined settings, measure and analyze power dissipation in switching devices and measure and analyze magnetic parameters in a single acquisition.

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.

**Keysight
6000 X-Series**

**Keysight
DSOX6PWR**

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.

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.

Signal Integrity Tests for IoT

Tektronix
MDO4104C/PWR + TCP0150
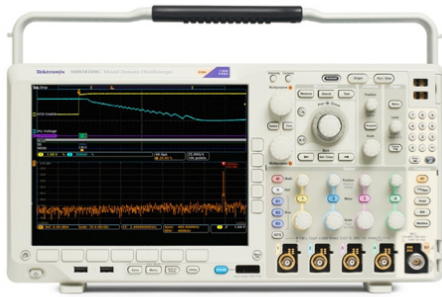
Introducing the high performance 6-in-1 integrated oscilloscope that includes a spectrum analyzer, arbitrary/function generator, logic analyzer, protocol analyzer and DVM/frequency counter.

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.

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