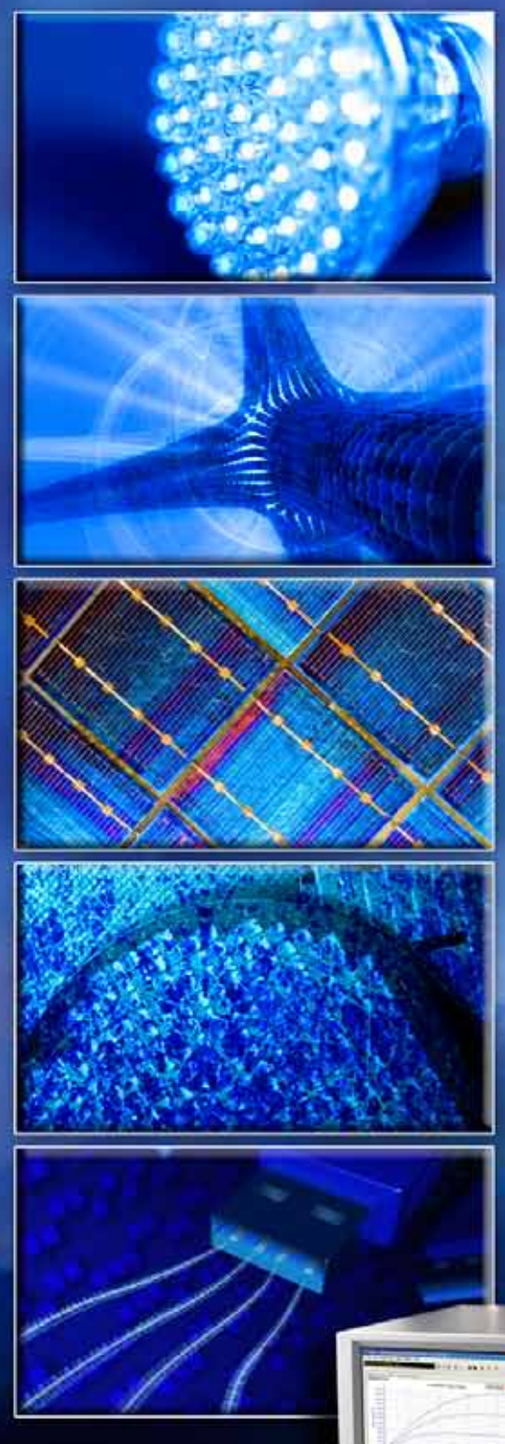
KEITHLEY



Exploring the boundaries of materials science or device development?

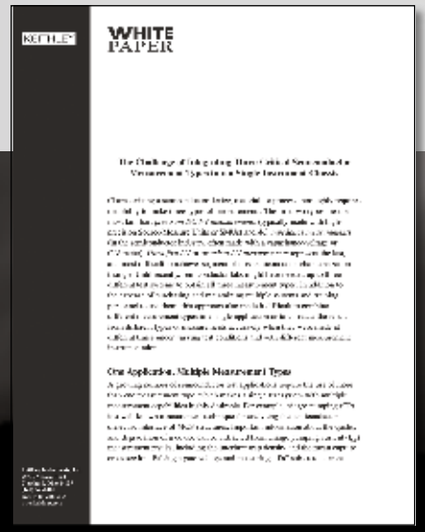
Learn the latest techniques for ensuring electrical measurement accuracy

CLICK ON RED BUTTONS FOR LARGER VIEWS

Learn how you can get better correlation of results when you perform multiple measurement types on a single system

Characterizing a semiconductor device, material, or process thoroughly requires the ability to make three types of measurements: precision DC I-V measurements, AC impedance measurements (often made with a C-V meter), and ultra-fast or transient I-V measurements. Until recently, labs might have required three separate test systems to obtain all three measurement types. In addition to added expense, using multiple systems makes it difficult to combine different measurement types in a single application or to correlate the results from different types of measurements accurately. **Learn more.**

Remote amplifier/switches and the multi-measurement performance cabling used to connect them to the probe manipulators on the wafer prober are critical to integrating accurate ultra-fast I-V, C-V, and precision DC I-V measurements into the same parametric analysis system.



Investigate how to get better results correlation at a lower cost. Download our **free white paper.**

Let us offer advice on your application. **Contact an applications engineer online.**

Tackle multiple test challenges with the Model 4200-SCS Semiconductor Characterization System

Only the **Model 4200-SCS Semiconductor Characterization System** can handle all three measurement types: precision DC I-V, AC impedance, and ultra-fast I-V or transient I-V. Low current measurement resolution can extend to 0.1fA. Capacitance measurements range from femtoFarads (fF) to nanoFarads (nF) at frequencies from 1kHz to 10MHz. And ultra-fast I-V sourcing and measurement is as easy as making DC measurements, and fast: measure both voltage and current simultaneously for up to one million samples at 5ns per sample. For all known BTI test methodologies, an optional BTI Package includes all necessary hardware and software, while Automatic Characterization Suite (ACS) software supports full wafer- and cassette-level automation and includes NBTI/PBTI test libraries with easy-to-use GUIs.

Need more details?
Download the Model 4200-SCS data sheet.

Ready to request a quote or place an order?

Call 1-800-492-1955 and
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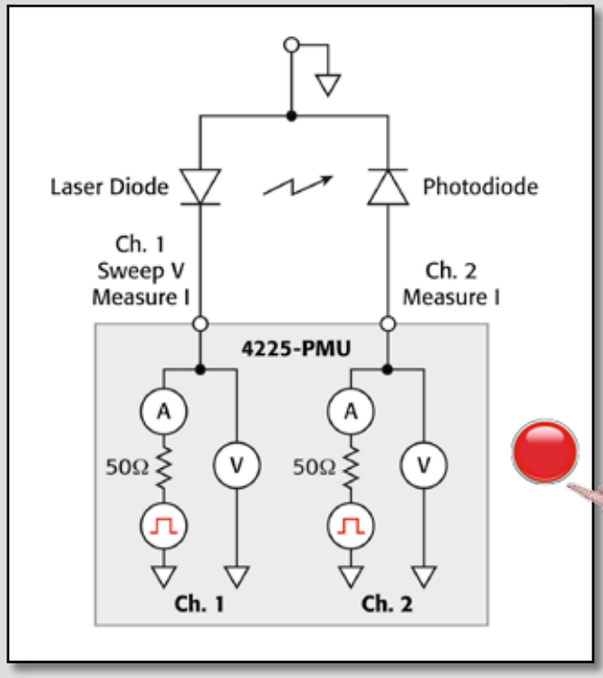
Ultra-fast I-V testing of compound semiconductor devices and materials

Pulsed I-V testing is often performed on devices made from III-V materials, such as GaN, GaAs, and other compound semiconductor materials. These larger band gap devices are often used in higher power and RF devices. Pulsed I-V measurements make it possible to manage or investigate the effects of dispersion during electrical characterization. Sometimes it is necessary to test devices at higher frequencies in order to simulate the conditions the actual device will encounter in regular use. Laser diodes and power MOSFETs are two common compound semiconductor devices that often require pulse I-V measurements for characterization. **Learn more.**



Laser diode test configuration

CLICK ON RED BUTTON TO VIEW LARGER IMAGE

Want to make ultra-fast I-V measurements?

Download our free guide to ultra-fast I-V applications.

View our webinar on making ultra-fast measurements.

Let us offer advice on your application.
Contact an applications engineer online.

Take control of ultra-high speed pulse sourcing and measurement with the Model 4225-PMU

The **Model 4225-PMU Ultra Fast I-V Module** is the latest instrumentation option for the Model 4200-SCS Semiconductor Characterization System. It integrates ultra-fast voltage waveform generation and signal observation capabilities into the Model 4200-SCS's already powerful test environment to deliver unprecedented I-V testing performance, expanding the system's materials, device, and process characterization potential dramatically. Just as important, it makes ultra-fast I-V sourcing and measurement as easy as making DC measurements with a traditional high resolution Source-Measure Unit (SMU).


4225-PMU
4225-RPM
4220-PGU
Ultra-Fast I-V Module for the Model 4200-SCS

Need more details? **Download our Model 4225-PMU data sheet.**

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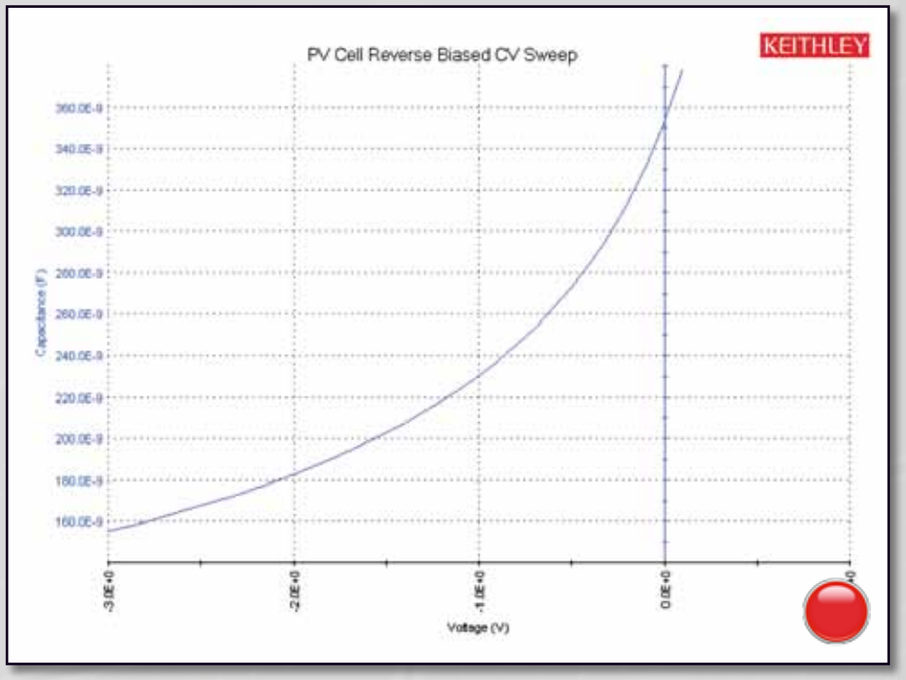
Learn how to determine solar cell efficiency using the latest electrical characterization techniques

Some of the electrical tests commonly performed on solar cells involve measuring current and capacitance as a function of an applied DC voltage. Electrical characterization is important in determining how to make the cells as efficient as possible with minimal losses. Capacitance measurements are sometimes made as a function of frequency or AC voltage. Some tests require pulsed current-voltage measurements. These measurements are usually performed at different light intensities and under different temperature conditions. A variety of important device parameters can be extracted from the DC and pulsed current-voltage (I-V) and capacitance-voltage (C-V) measurements, including output current, conversion efficiency, maximum power output, doping density, resistivity, etc. **Learn more.**



C-V sweep of a silicon solar cell


KEITHLEY
Application Note Series

Electrical Characterization of Photovoltaic Materials and Solar Cells with the Model 4200-SCS Semiconductor Characterization System

I-V, C-V, C-f, DLCP, Pulsed I-V, Resistivity, and Hall Voltage Measurements

Introduction

Making Electrical Measurements with the Model 4200-SCS

Discover how to make faster, more accurate C-V measurements on solar cells.
Download our application note.

Let us offer advice on your application.
Contact an applications engineer online.

Plug in to greater capacitance-voltage measurement capabilities with the Model 4210-CVU

The **Model 4210-CVU**, the Model 4200-SCS's optional capacitance meter, can measure capacitance as a function of an applied DC voltage (C-V), a function of frequency (C-f), a function of time (C-t), or a function of the AC voltage. The Model 4210-CVU can also measure conductance and impedance. The Keithley Test Environment Interactive (KTEI) package combines nine new solar cell test libraries with an expanded C-V frequency measurement range, which supports testing flat panel LCDs and organic semiconductors such as organic light-emitting diodes (OLEDs).

Need more details?
Download our applications flyer.

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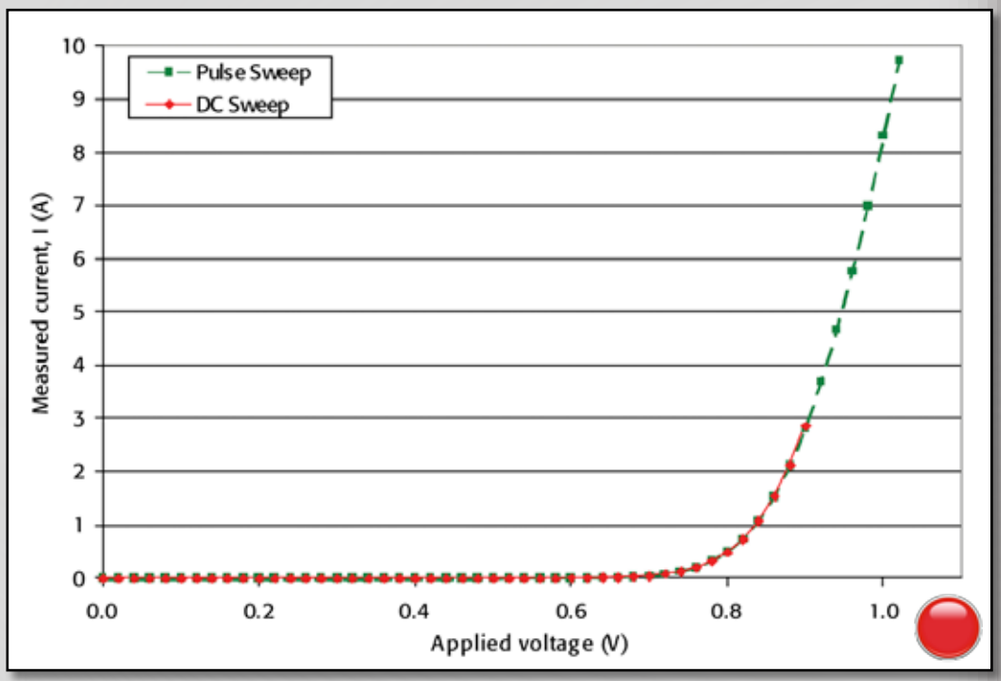
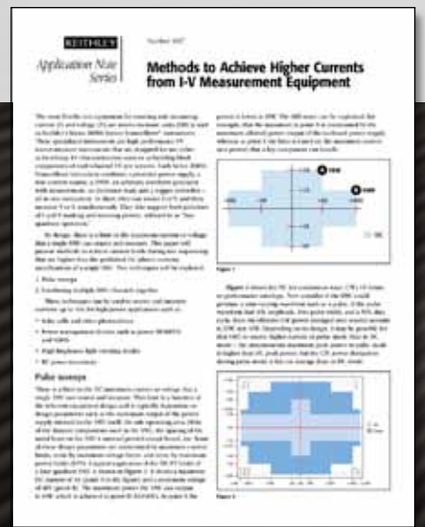
Put pulses to work to test high power devices

During high power continuous wave testing, a high power device's semiconductor material will start to dissipate the applied power. As the material in the device heats up, the conduction current decreases as the carriers have more collisions with the vibrating lattice (phonon scattering). Therefore, the measured current will be inaccurately low, due to joule heating. Because these devices are typically run in pulsed mode, intermittently, or AC rather than continuously, the currents as measured with DC techniques won't characterize a device's performance accurately. For many high power devices, pulsed I-V testing is necessary to obtain optimal results. **Learn more.**



DC and pulse sweeps


Application Note Series

Methods to Achieve Higher Currents from I-V Measurement Equipment

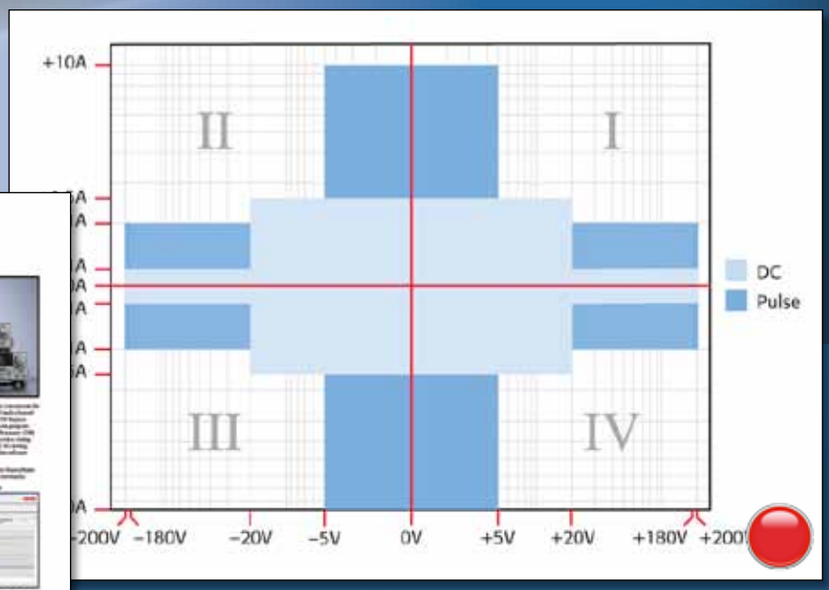
Learn how to achieve higher currents with your I-V measurement hardware. **Read our app note.**

Let us offer advice on your application.
Contact an applications engineer online.

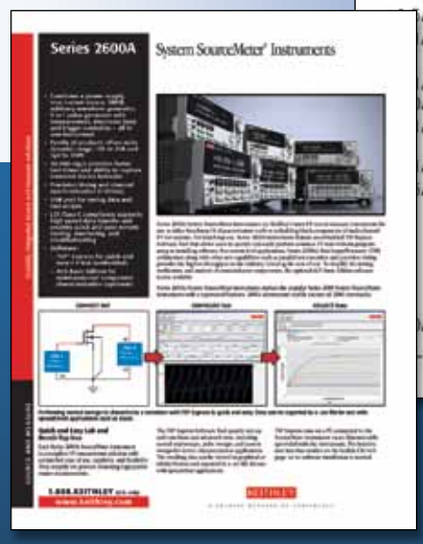
Get DC and pulsed measurements in the same box with Series 2600A System SourceMeter instruments

The **Models 2635A** and **2636A** are both the most sensitive (1fA) and the most powerful (10A pulse) members of the Series 2600A System SourceMeter family.

- Combines a power supply, true current source, DMM, arbitrary waveform generator, V or I pulse generator with measurement, electronic load, and trigger controller – all in one instrument
- 20,000 rdgs/sec provides faster test times and ability to capture transient device behavior
- Precision timing and channel synchronization (<500ns)
- LXI Class C compliance supports high speed data transfer and enables quick and easy remote testing, monitoring, and troubleshooting



Models 2635A and 2636A capabilities



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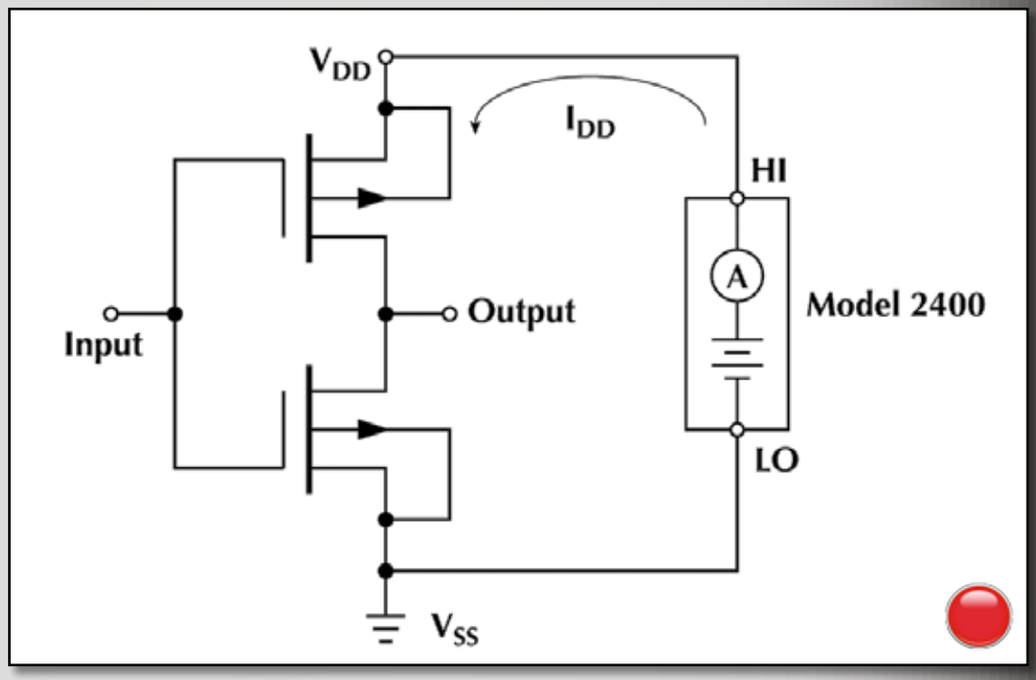
Want to learn more about the Model 2635A and 2636A?
Download the Series 2600A datasheet.

Characterize your IC's quiescent current

Manufacturers of CMOS integrated circuits must measure their devices' quiescent or standby power supply current to verify quality during production testing. This I_{DDQ} testing process involves measuring the current of the V_{DD} power supply while the IC is in the quiescent state in order to check for shorted gate oxide and other IC defects that may cause a failure over time. Testing must be performed as quickly as possible to ensure acceptable throughput but also thoroughly to ensure product performance. **Learn more.**



Measuring the quiescent current of a single CMOS inverter


KEITHLEY
Application Note Series
I_{DDQ} Testing and Standby Current Testing with the Model 2400 SourceMeter® Instrument

Introduction

I_{DDQ} Testing of CMOS ICs

Test Description

Learn more about I_{DDQ} testing.
Download our application note now!

Let us offer advice on your application.
Contact an applications engineer online.

Discover two great choices for applications that demand tightly coupled sourcing and measurement

The **Series 2400 SourceMeter® family** is designed specifically for applications that require tightly coupled sourcing and measurement. All SourceMeter models combine a highly stable DC power source and a true instrument-grade 5½-digit multimeter with high repeatability and low noise.

- The general-purpose **Model 2400** (200V, 1A, 20W) is suitable for testing a wide variety of devices, including diodes, resistors, resistor networks, active circuit protection devices, and portable battery-powered devices and components.
- Choose the **Model 2420** (60V, 3A, 60W) for testing higher power resistors, thermistors, I_{DDQ}, solar cells, batteries, and high current or medium power diodes, including switching and Schottky diodes.

Model 2400 and 2420 Source and Measure Ranges

Need more details?
Download our Series 2400 datasheet.

Ready to request a quote or place an order?

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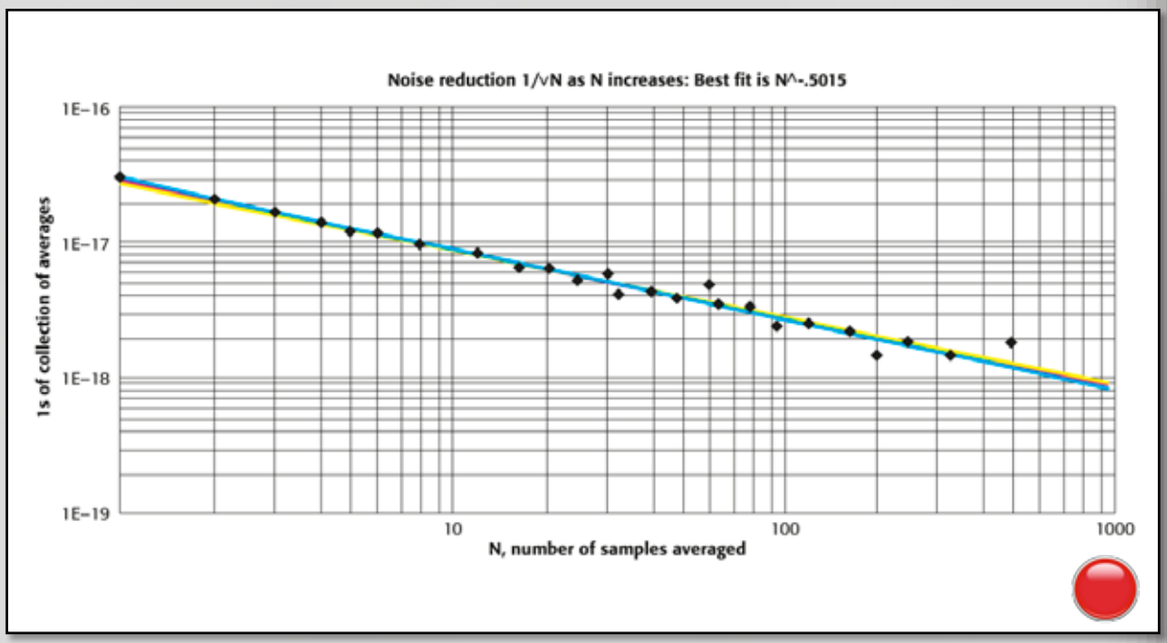
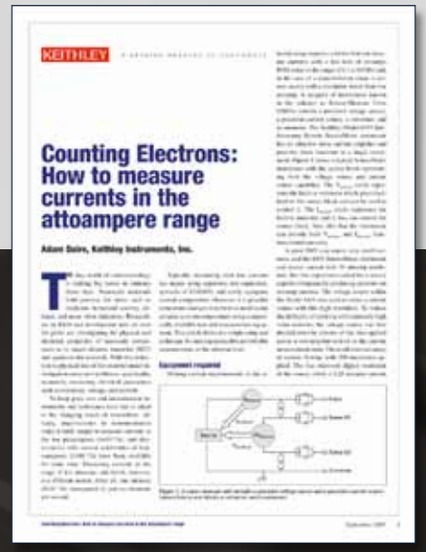
Explore the attoamp range on single electron devices

Researchers in R&D labs worldwide need ultra-low current measurement capabilities to investigate the properties of nanoscale components. Measuring currents of 100 attoamps or less is especially challenging: one attoamp (1×10^{-18}A) corresponds to a flow of just six electrons per second. Today, however, it is possible to measure changes in current as small as one attoamp at room temperature using commercially available test and measurement equipment. **Learn more.**




KEITHLEY

Counting Electrons: How to measure currents in the attoampere range

Adam Daire, Keithley Instruments, Inc.

Delve into the latest techniques for low current measurements.
Read our article.

Using a slow staircase input instead of a simple DC signal shows that a discernable signal can be retrieved from the noise. After every 90 measurements (about 18 seconds), the current source was incremented by 10 attoamps. Inverting the staircase generated the negative source period.

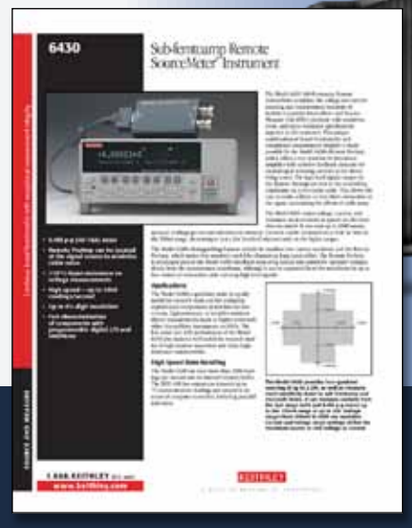
View our nanotechnology product tour.

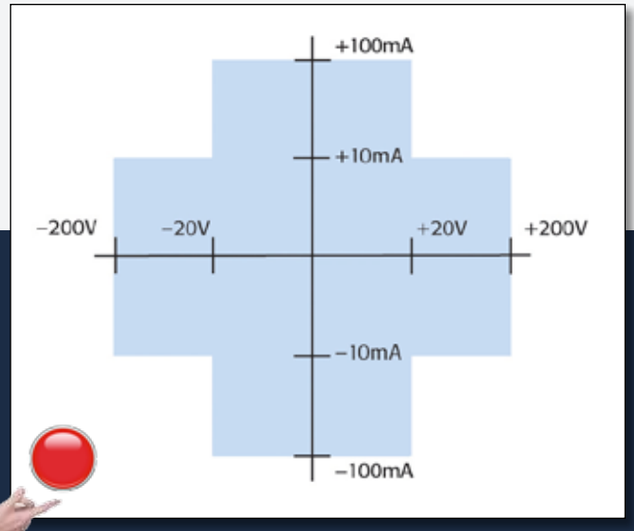
Let us offer advice on your application.
Contact an applications engineer online.

Get unmatched measurements with the Model 6430 Sub-Femtoamp Remote SourceMeter instrument

The **Model 6430 Sub-Femtoamp Remote SourceMeter** combines the sourcing and measurement functions of an SMU with sensitivity, noise, and input resistance superior to electrometers. However, it makes voltage, current, and resistance measurements at speeds no electrometer can match. The Model 6430 is equally useful for research work and for evaluating sophisticated components in test labs.

- 0.4fA p-p (4E–16A) noise
- Remote PreAmp can be located at the signal source to minimize cable noise
- $>10^{16}\Omega$ input resistance on voltage measurements





Model 6430 Capabilities

Want to learn more about the Model 6430?
Download the Model 6430 datasheet.

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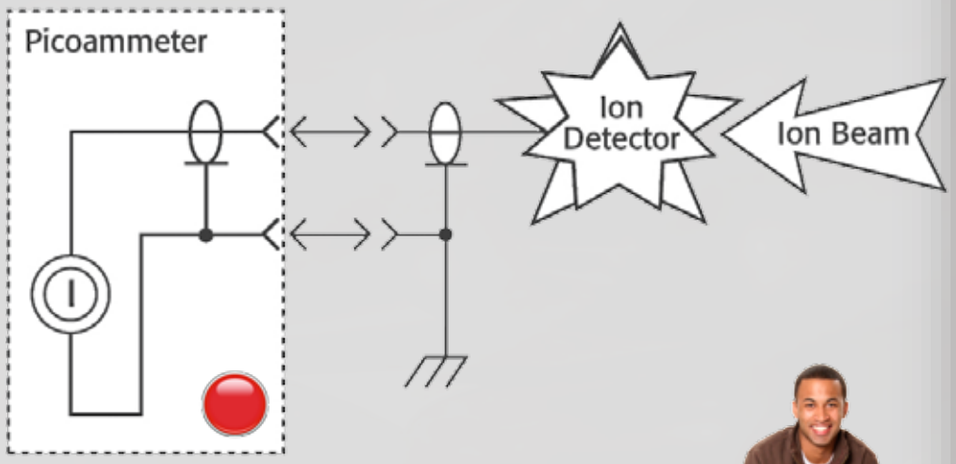
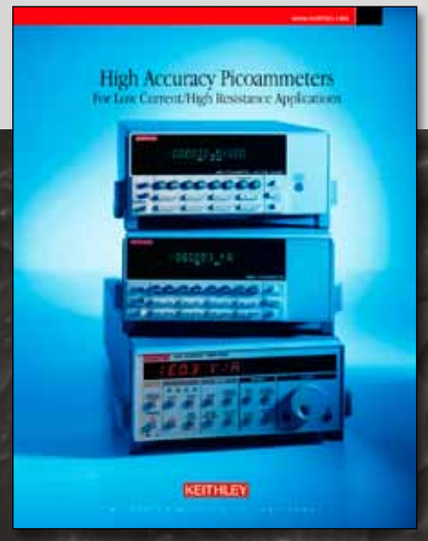
Monitor and control focused ion beam currents

In semiconductor fabrication, focused ion beam systems are often used for nanometer-scale imaging, micromachining, and mapping. Careful monitoring of the magnitude of the beam current with an ion detector is critical. The ion detector generates a secondary current that's proportional to the current of the primary ion beam. When this secondary current is measured, it can be used to control the intensity of the primary beam. However, this secondary current is very low, often just a few picoamps, so the instrumentation measuring it must provide high measurement accuracy and repeatability, as well as sub-picoamp resolution. **Learn more.**



Focused ion beam system



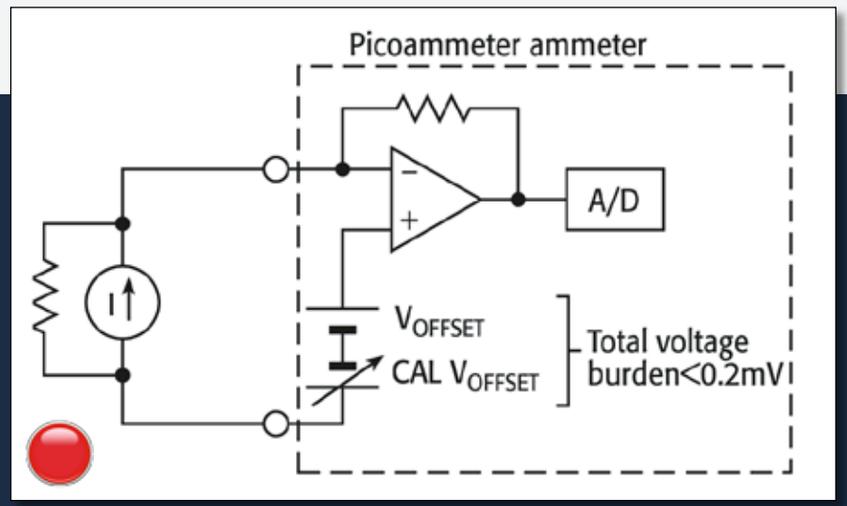
Discover economical tools for low current and high resistance measurements. **Download our picoammeter brochure.**

Let us offer advice on your application.
Contact an applications engineer online.

View our Low I, High Resistance demo.

Discover where low cost meets high sensitivity with Keithley picoammeters

The 5½-digit **Model 6485 Picoammeter** combines sensitive current measurements with a robust, cost-effective design. With eight current measurement ranges and high speed autoranging, it can measure currents from 20fA to 20mA at up to 1000 readings per second. Its 10fA resolution and superior sensitivity make it well suited for characterizing low current phenomena. The **Model 6487 Picoammeter/Voltage Source** adds a high resolution 500V source to the Model 6485's measurement advantages, and provides higher accuracy and faster rise times, as well as a damping function for use with capacitive devices. Alternating Voltage resistance measurements make it well suited for characterizing low current devices.



Unlike DMMs, picoammeters like the Model 6485 and 6487 employ a feedback ammeter design that reduces voltage burden dramatically for better measurement accuracy.

Want to learn more about these instruments?
Download the Model 6485 or Model 6487 datasheet.

Ready to request a quote or place an order?

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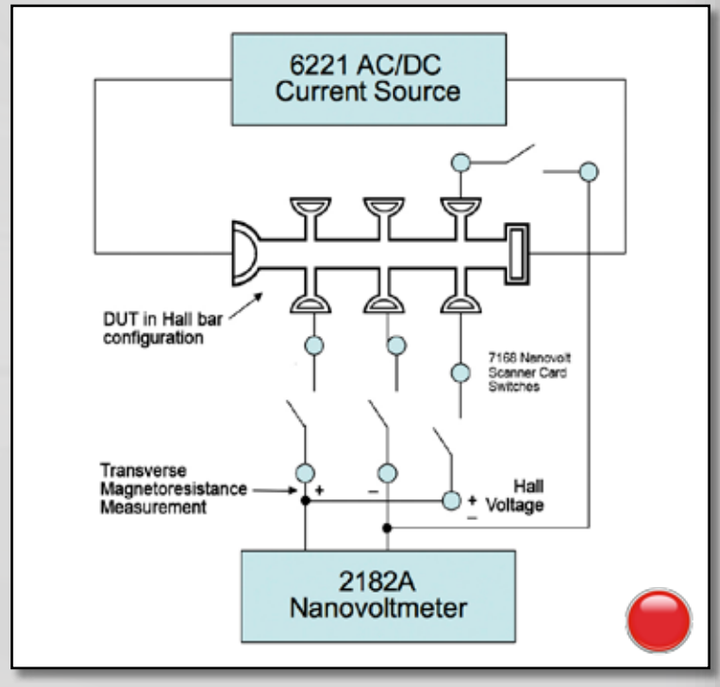
Learn about Hall Effect, an essential tool for studying Graphene-based nano-materials

In order to explore the potential for graphene-based nano-materials and other new materials, researchers increasingly turn to Hall Effect measurements. Hall Effect measurements are used to determine electrical properties, such as carrier mobility. With them, researchers are able to analyze quantum Hall Effects on one atom thick graphene structures. **Learn more.**



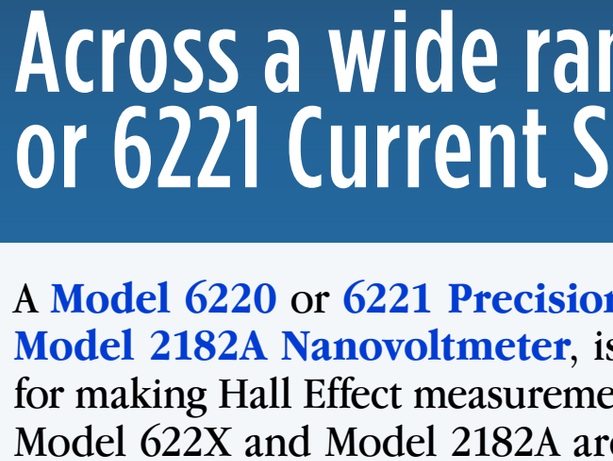
Test Setup for Both Hall Effect Measurements and Transverse Magnetoresistance Measurements (magnet and cryogenic chamber not shown)

Want to learn more? Learn more about Hall Effect measurements with our free online webinar. **View it now!**

Let us offer advice on your application. **Contact an applications engineer online.**

Across a wide range of resistances, choose a Model 6220 or 6221 Current Source and Model 2182A Nanovoltmeter

A **Model 6220** or **6221 Precision Current Source**, combined with the **Model 2182A Nanovoltmeter**, is the industry's most sensitive solution for making Hall Effect measurements at various ranges of resistances. The Model 622X and Model 2182A are easy to use because the combination can be treated as a single instrument. Their simple connections eliminate the isolation and noise current problems that plague other solutions. And the second channel in the Model 2182 can be used to measure temperature. Furthermore this same combination of instruments along with Keithley's low level switching capability can also perform van der Pauw resistivity measurements and magnetoresistance studies. **Read our white paper on how new instruments can lock out lock-in amplifiers**.



The 622X/2182A combination makes it simple to perform, analyze, and display differential conductance measurements.

CLICK ON THE GREEN DOTS TO SEE FRONT AND BACK VIEWS

Download the Model 6220/6221 or Model 2182A datasheet.

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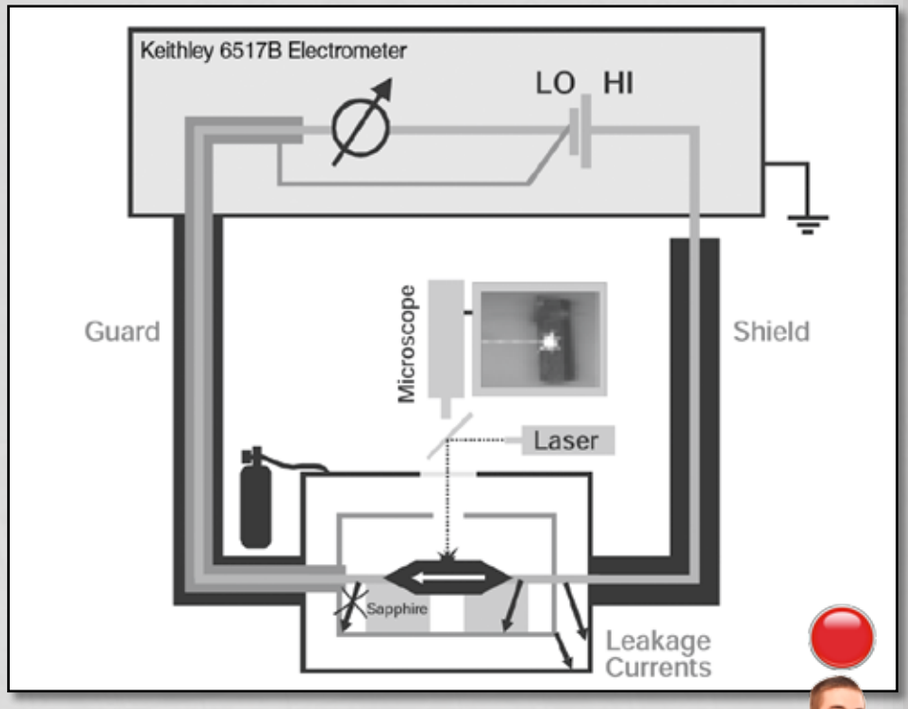
Explore the electrical characteristics of small crystals

Many materials researchers need to characterize the electrical properties of crystalline materials, such as their (anisotropic) conductivity and photoconductivity, as well as the temperature dependencies associated with these properties. Small crystals grown using a number of techniques can exhibit resistances as high as $10^{17}\Omega$, which must be measured in a specially designed measurement chamber, as well as in a Molecular Beam Deposition (MBD) system that allows making in-situ measurements during crystal or film growth. **Learn more.**



In this system configured for photocurrent measurements, the sample and the cable to the electrometer input are surrounded by a conductor at the same potential (guard) to prevent leakage currents.


KEITHLEY
Application Note Series

Making High Resistance Measurements on Small Crystals in Inert Gas or High Vacuum with the Model 6517A Electrometer/High Resistance System

Introduction

Test Description

Test System Configurations

Methods and Techniques

Contacts

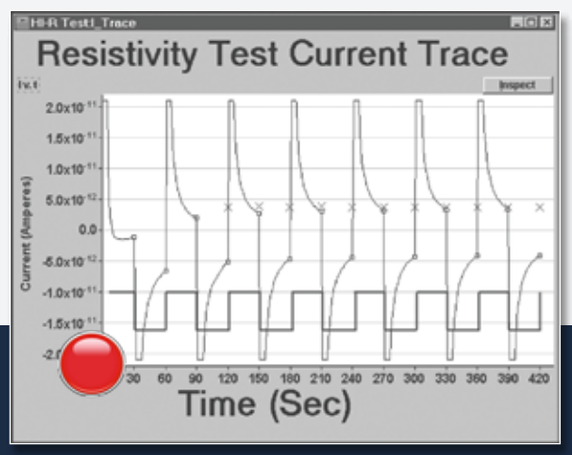
Let us offer advice on your application.
Contact an applications engineer online.

Want to learn more? Discover how to make high resistance measurements on small crystals in inert gas or high vacuum by reading our **online application note. Download your copy now.**

Find the answers you need with the Model 6517B Electrometer/High Resistance Meter

The 5½-digit **Model 6517B** offers accuracy and sensitivity specifications unmatched by any other meter of this type. A variety of features and options simplify measuring resistances as high as $10^{17}\Omega$, as well as volume and surface resistivity. With measurement speeds up to 425 readings/second, it's also significantly faster than competitive electrometers.

- Current measurements from 1fA to 20mA
- Voltage measurements from 10μV to 200V
- Resistance measurements from 50Ω to $10^{16}\Omega$
- Charge measurements from 10fC to 2μC



Alternating Polarity Method for Measuring Resistivity

The Model 6517B employs the Alternating Polarity method to measure high levels of volume or surface resistivity, virtually eliminating the effect of any background currents in the sample. When used with the optional Model 6524 software, users can see the actual current waveform that results from the applied Alternating Polarity DC voltage (the square wave). Users can easily determine whether the parameters used are appropriate for the material or device under test.

Need more detail?
Download the Model 6517B datasheet.

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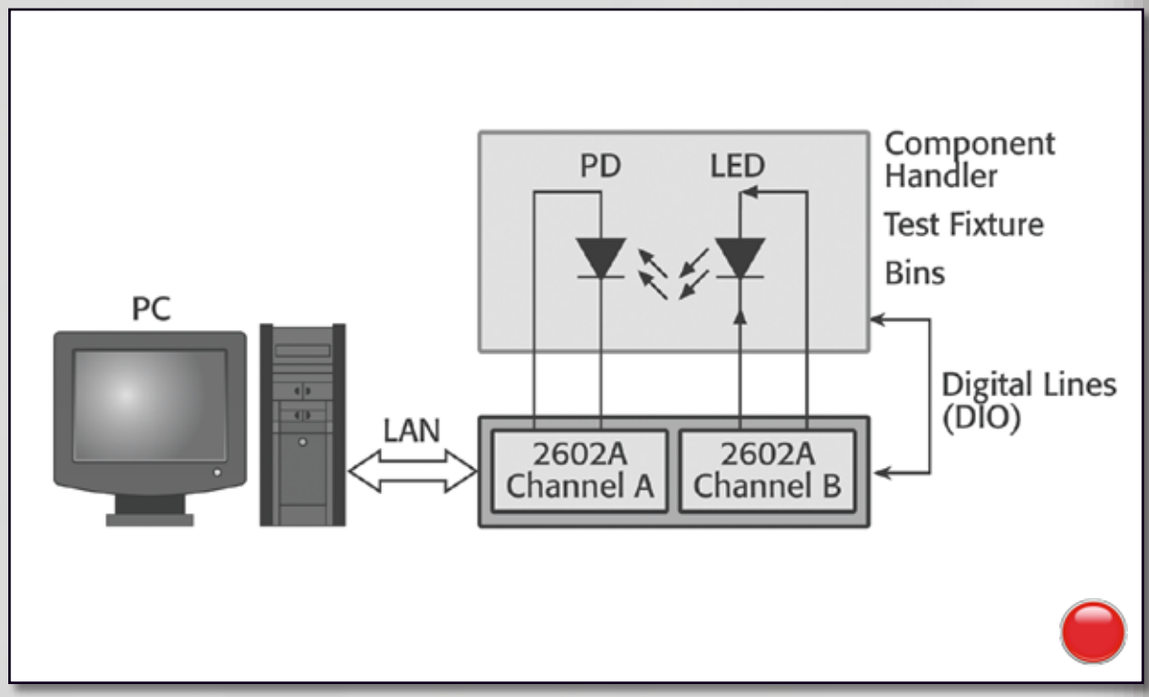
Improving high-brightness LED test efficiency

Advances in the performance of visible light emitting diodes (LEDs) are opening the door to a growing list of applications. More than ever, cost-effective testing methods are needed to ensure the reliability and quality of these devices. LED testing involves different types of test sequences at various stages of development and production. This application note provides solid information on the "ingredients" for various testing recipes, including how to probe for the diodes' characteristics and examples of test setups. It also outlines how to achieve throughput advantages using new test techniques and instruments. **Learn more.**



Block diagram of a Model 2602A SourceMeter-based single LED test system. For testing multiple LEDs, the Model 3706 System Switch/Multimeter is added.


KEITHLEY
Application Note Series
High Speed Testing of High Brightness LEDs

Introduction

Test Description

Forward Voltage Test (V_F) and Optical Tests

Reverse Breakdown Voltage (V_R) and Leakage Current (I_L) Tests

Learn how to test LEDs by **downloading our free application note.**

Learn more about the speed vs. accuracy trade-offs involved in making multi-channel measurements with a digital multimeter (DMM) and relay switching. **View the webinar.**

Let us offer advice on your application. **Contact an applications engineer online.**

Get high speed switching and high performance measurements all in one enclosure

The six-slot **Series 3700 System Switch/Multimeter** offers the accuracy and flexibility of instrument-grade switching integrated with low-noise, high performance multimeter measurements. The optional multimeter supports 13 built-in measurement functions, including both two- and four-wire ohms measurements, as well as extended low ohms (1Ω) and low current (10μA) ranges.

- LXI Class B compliance with IEEE 1588 time synchronization
- Flexible resolution from 7½ to 3½ digits
- Well-suited for a wide range of research and product development applications

Need more details?
Download our datasheet.

Ready to request a quote or place an order?

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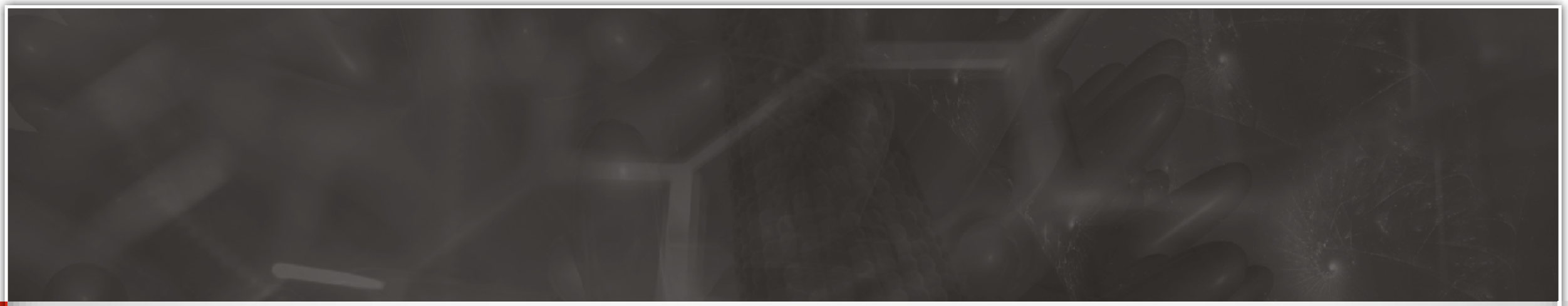

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