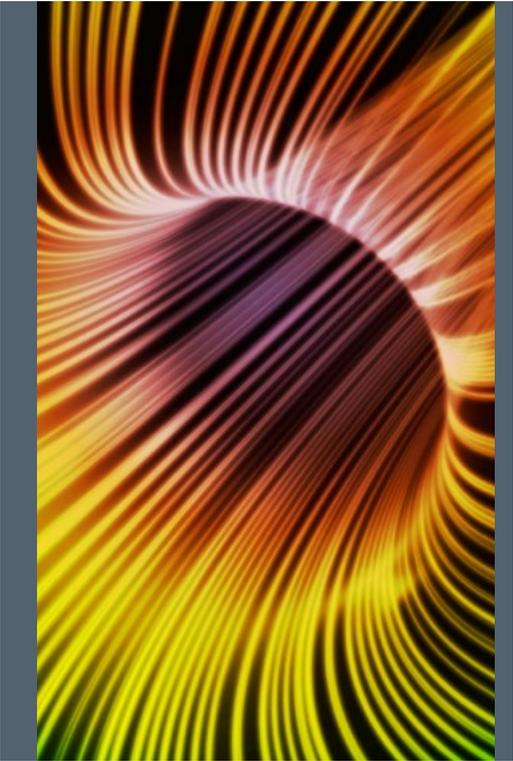
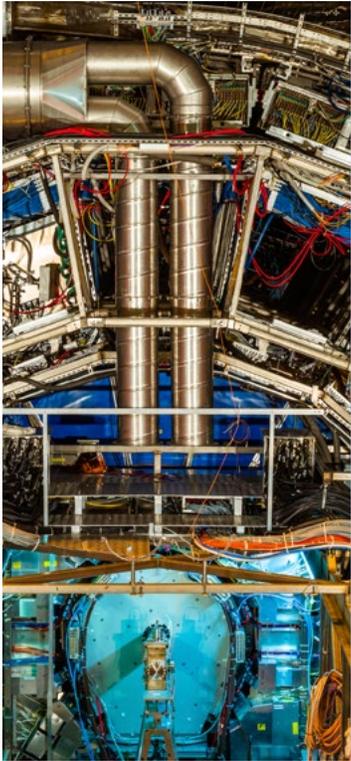
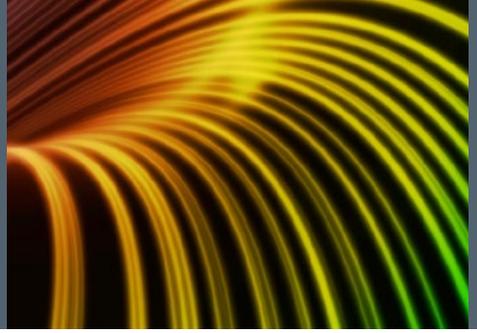
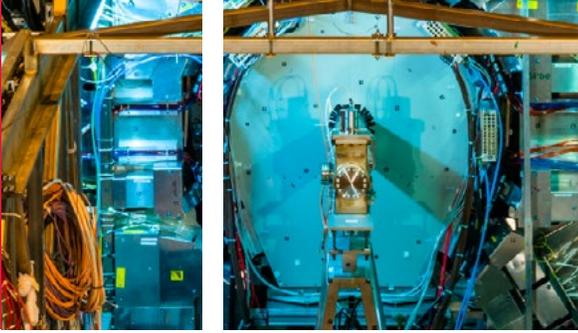


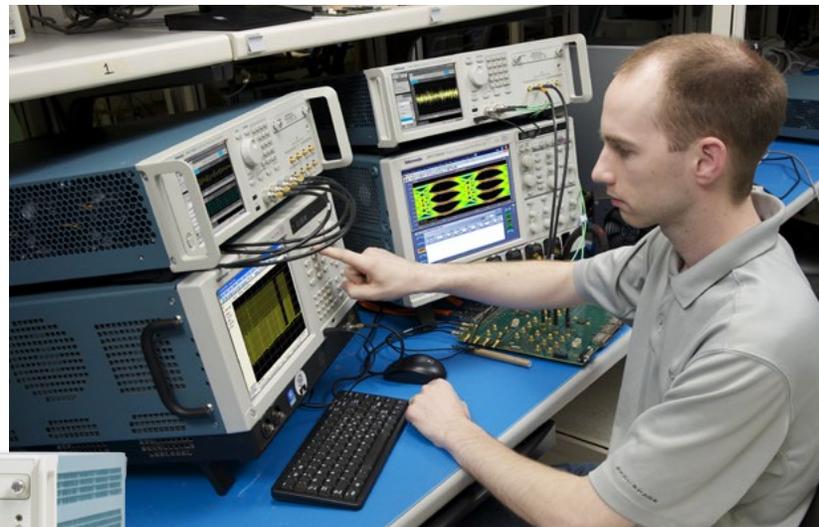
Solutions for Scientific and Engineering Research

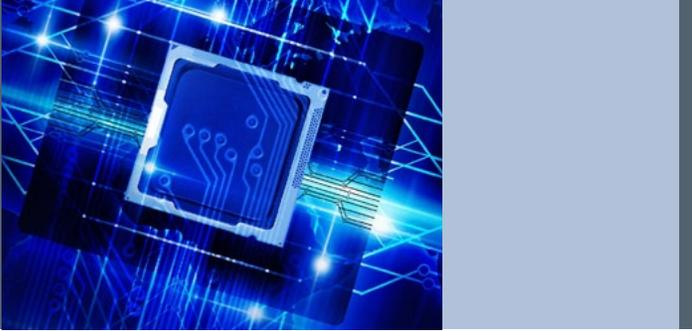




Whether you are applying the latest technology or conducting cutting-edge research Tektronix instruments can help you advance the frontiers of technology and science. Scientists and engineers around the world trust Tektronix instruments to capture, measure, analyze, and simulate the physical world.

- High Energy Physics Experimentation
- Nanotechnologies
- Optical Communications
- Energy and Efficiency Research
- Quantum Computing





Instruments for High Energy Physics

For capturing or simulating the fleeting events that represent the world of fundamental particles, Tektronix offers a range of real-time and equivalent-time solutions. Our oscilloscopes and pulse sources are also used in the quest to achieve longer-duration reactions, such as high gain nuclear fusion.

The World's Standard in Oscilloscopes

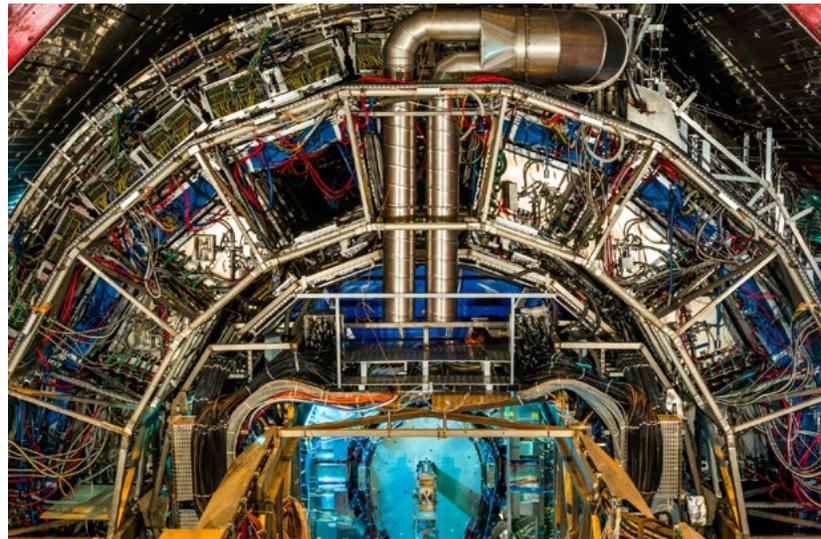
Scientists around the world trust Tektronix to capture high-speed pulses and test the latest generation of accelerators and synchrotrons. With the broadest portfolio of digital oscilloscopes available. The most extensive analysis capability, and our award-winning service and support, Tektronix has the right oscilloscope to meet your needs.

The World's Fastest and Most Versatile Signal Generators for Today's Complex Signals

With sample rates up to 50 GS/s, our 10-bit digital-to-analog technology enables AWG70000 Series Arbitrary Waveform Generators to cover a wide range of HEP applications, from replicating pulse detector signals to generating RF events. These signal generators can create virtually any signal - analog or digital, ideal or distorted, standard or custom. RFXpress software lets you experiment with complex RF/IF/IQ waveforms. SerialXpress helps you build serial data streams on your PC. And ArbExpress is free, general-purpose waveform editing software that lets you develop signals to simulate real world events.

World's leading Step, Pulse, and Impulse Generators.

Picosecond Pulse Labs products provide ultra-performance in a broad range of dimensions for step, pulse and impulse sources. These include shortest transition time, most versatile risetime/falltime control, maximum frequency and duration control and high signal amplitudes, providing the highest performance for this class of source products.



Real-Time Spectrum Analyzers

Real time spectrum analyzers are invaluable for tracking high-frequency electromagnetic interference and characterizing transient RF events.

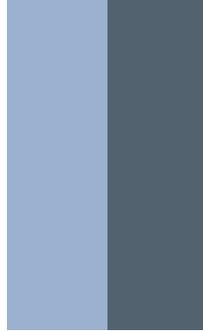
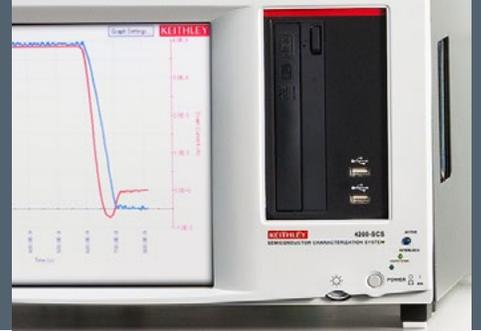
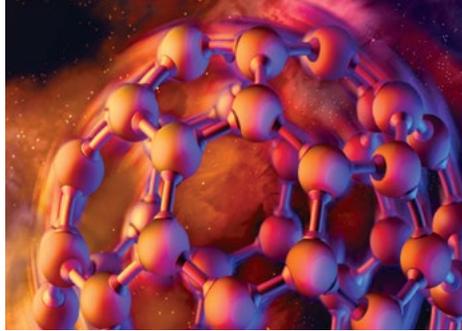
Resources

Fundamentals of Signal Integrity Primer – Review the challenges associated with sending and receiving high-speed signals. Learn measurement techniques that may be used to uncover problems and characterize performance.

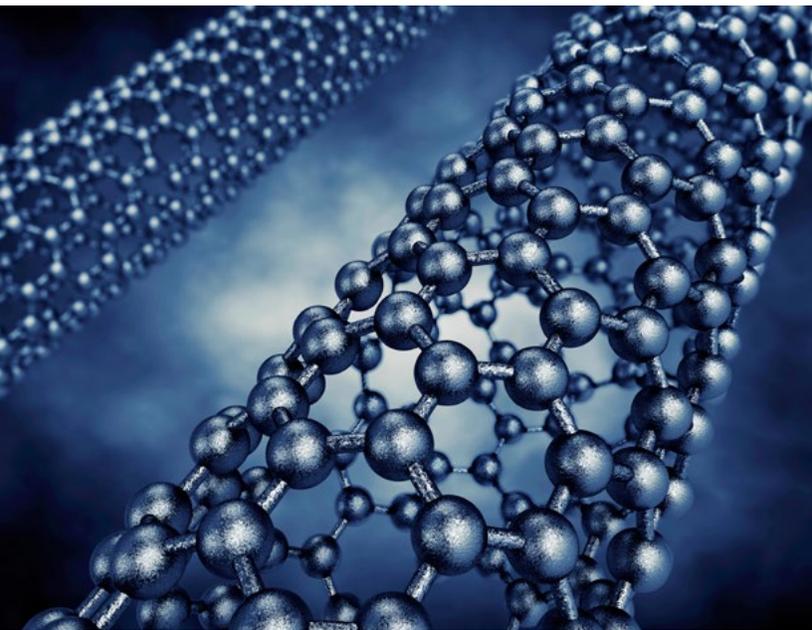
Fundamentals of Real-Time Spectrum Analysis Primer – Find out how real-time spectrum analyzers reliably detect and characterize rapidly changing RF signals.

Asynchronous Time Interleaving White Paper – Introduces new technology that will extend the bandwidth performance of real-time oscilloscopes to 70 GHz or more.

XYZ's of Signal Generators Primer – Explains the basics of Signal Generators, including the many types of generators, their applications and their contribution to a complete test and measurement solution.



Instruments for Nanotechnologies



Nano-scale science and engineering are advancing semiconductor electronics, optoelectronics, materials science, biotechnology, and energy technology. Electrical measurements, such as I-V characterization, on nano-scale materials reveal not only electronic characteristics, but can also indicate physical characteristics such as tensile strength, color, and electrical and thermal conductivity. However, meaningful measurements require highly sensitive instruments and sophisticated probing techniques.

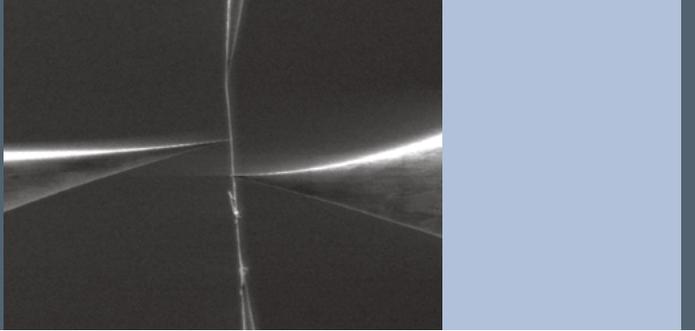
Source-Measure Units

Source-Measure Units or SMUs are ideal instruments for making nanoscopic material and device measurements. They are a smart alternative to separate power supplies and digital multimeters (DMMs). Keithley SMU instruments combine a:

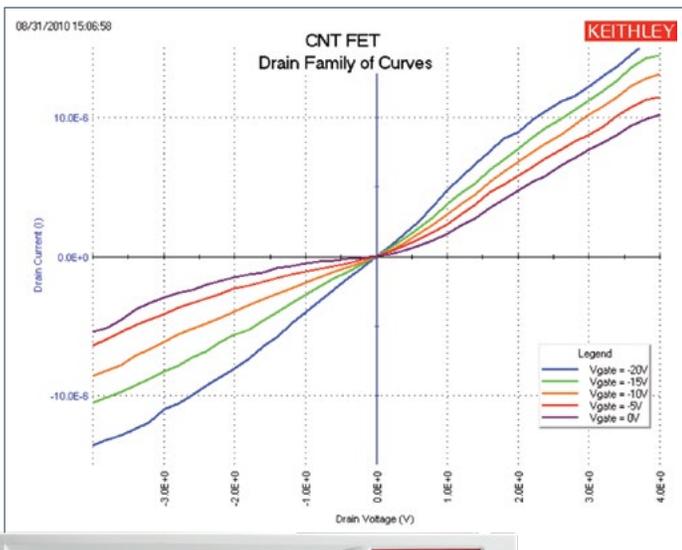
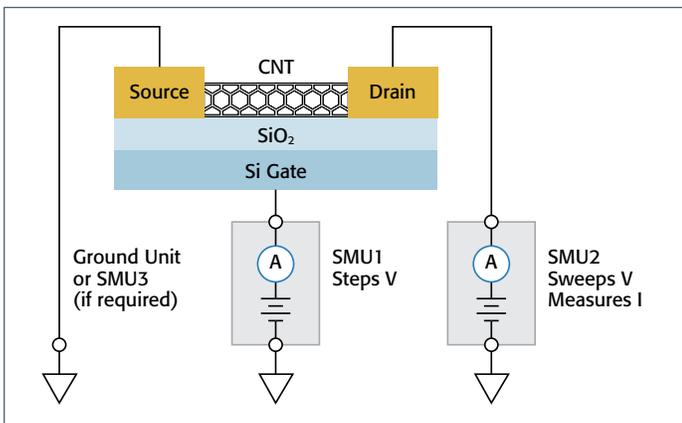
- Power supply
- True current source
- 6.5 digit DMM
- Arbitrary waveform generator
- V or I pulse generator with measurement
- Electronic load
- Trigger controller

– all in one instrument with a convenient DMM-like user interface.

A source and measure unit (SMU) can rapidly switch from outputting a specified voltage and accurately measuring the resulting current, to the other way around. When materials such as carbon nanotubes (CNTs) or graphene are in a high impedance state, the SMU can source voltage and measure current for fast, accurate measurements. When the material is in a low impedance state, the SMU can quickly reconfigure to source current and measure voltage. Furthermore, the SMU has a current compliance function that can automatically limit the DC current level to prevent damage to the material or device under test (DUT).



Here's an example setup for a carbon nanotube field effect transistor I-V test and the resulting I-V sweep.



Keithley has three SourceMeter® SMU Instrument families, the Series 2400, the Series 2600B, and the NEW 2450 Touchscreen SMU instrument. Series 2400 and 2450 SourceMeter SMU instruments are ideal for lab/bench R&D applications. Series 2600B System SMU instruments are designed for high speed test and are available in either single or dual channel models.

Parameter Analyzer

Keithley's 4200-SCS parameter analyzer is a modular, high performance, flexible system that performs comprehensive electrical characterization on semiconductor devices, nanoscale materials and devices and so much more.

- Basic I-V and C-V measurement sweeps
- Fast pulse I-V, waveform generation and capture
- Transient I-V measurements

Keithley's parameter analyzer is poised to handle your present and future test requirements.

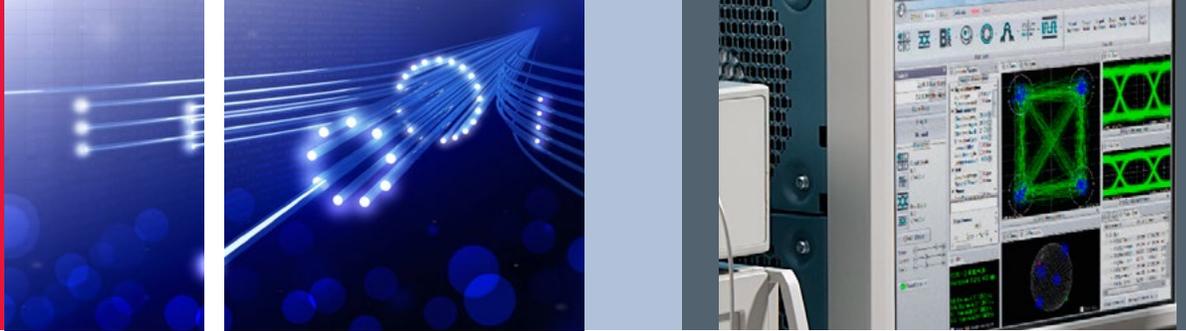
Keithley also offers the industry's most complete line of picoammeters, electrometers, and nanovoltmeters for highly sensitive voltage, current, and resistance measurements for nanoscience applications.

Resources

[Advances in Electrical Measurements for Nanotechnology eBook](#)

Learn why sensitive electrical measurement tools are essential for nanoscience research. Understand how these tools provide the data needed to understand the electrical properties of new materials fully and the electrical performance of new nanoelectronic devices and components.

[Electrical Characterization of Carbon Nanotube Transistors \(CNT FETs\) with the Model 4200-SCS Semiconductor Characterization System App Note](#) – Learn how to perform IV characterization on carbon nanotube FETs.



Instruments for Optical Research



Optical Communications

Whether you work on optical components, transceiver subassemblies or transmission systems, there are critical PHY layer tests that need to be done: eye diagrams and jitter performance, stressed receiver testing, crosstalk & BER tests, and optical modulation analysis. Tektronix provides you with the expertise and equipment to perform standards-compliant TX, RX and Coherent Optical testing to 400 Gb/sec and beyond.

As network demands increase, long-haul communications are becoming more complex. Advanced test tools are required to test the latest communication systems for 100G, 400G, 1Tb/s and beyond. Tektronix is the only test and measurement vendor that can offer a complete coherent optical test system from signal generation, to modulation, coherent detection, acquisition, and analysis.



Signal Acquisition and Analysis High-speed Oscilloscopes and Optical Analyzers

The MSO/DPO70000C/DX Series oscilloscope delivers exceptional signal acquisition performance and analysis capability. Discover your real signals with uncompromised acquisition on all 4 channels and capture more signal details with the industry's highest waveform capture capability. Automate setup, acquisition and analysis of high-speed serial data signals with a toolset engineered to deliver faster design and compliance testing.

Any of these oscilloscopes can be equipped with SignalVu Vector Signal Analysis (VSA) Software for wideband modulation analysis. In coherent optical research, SignalVu Software helps with phase correction using multi-tone calibration. It is ideal for demodulating orthogonal frequency division multiplexing (OFDM) modulation.

DSA8300 Series Sampling Oscilloscopes are suitable for accurate characterization of optical transmitter performance using built-in optical reference receivers and very low jitter noise floor. With an industry-leading intrinsic jitter of less than 100 fs, the DSA8300 Series provides support for today's optical communications standards, time domain reflectometry and S-parameter analysis. The DSA8300 Digital Sampling Oscilloscope is a complete high-speed PHY Layer testing platform for data communications from 155Mb/sec to 100G.

The OM4106D Coherent Lightwave Signal Analyzer, together with the MSO/DPO70000C/DX Series oscilloscopes, makes an ideal coherent optical signal acquisition system. The OM4106D optical modulation analyzer provides laboratory instrument-grade optics and optical-to-electrical conversion capable of handling the latest coherent optical signals up to 60 GBaud. The OM2210 Coherent Receiver Calibration Source provides a simple solution for calibrating the OM4106D or other coherent receivers.



Developed specifically for coherent optical analysis, the OM1106 Coherent Lightwave Signal Analyzer software provides state-of-the-art demodulation, measurements, and visualization tools for all of today's coherent optical standards including 400G superchannels. Unique Matlab integration provides unparalleled levels of algorithm, signal processing, and workflow customization. The OM1106 analysis software is available separately or included with the OM4106D Coherent Lightwave Signal Analyzer.

Setting the Standard for Signal Generation

The AWG70000 Series of arbitrary waveform generators represents the cutting edge in sample rate, signal fidelity, and waveform memory. The AWG70000 Series can reach sampling rates as high as 50 GS/s with 10 bits vertical resolution, enabling creation of multi-level signals such as 16QAM or 64QAM at up to 32 GBaud data rates. Up to 4 instruments can be synchronized to provide 4 channels at 50 GS/s each.

The PPG3000 Series is capable of generating patterns up to 40 Gb/s and offers up to 1, 2, or 4 channels in a single instrument for creation of dual-polarization I-Q waveforms.

The OM5110 Multi-format Optical Transmitter provides the flexibility to modulate all of the most common coherent optical formats at rates up to 46 GBaud. The OM5110 Multi-Format Optical Transmitter is a C- and L-Band transmitter capable of modulating the most common coherent optical modulation formats such as PM-QPSK and PM-16QAM. For those who are testing multi-carrier systems, the OM2012 Tunable Laser provides extra lasers in both C- and L-band.

Bit Error Rate Testing

PatternPro® PPG and PED Series Single and Multi-Channel Pattern Generators and Error Detectors are ideal for simultaneous BER testing of up to four lanes at 32Gb/s, and now includes pattern generation and error detection capability at rates up to 40 Gb/s.

BERTScope BSA Series Bit Error Rate Testers use long pseudo-random patterns and accurate BER measurements for comprehensive signal integrity measurements on communications systems up to 28 Gb/s.



Resources

[Physical Layer Tests of 100 Gb/s Communications](#)

Systems App Note – Learn how to prepare for compliance measurements on 100G standards.

[Coherent Optical Signal Generation with High Performance Arbitrary Waveform Generator App Note](#)

– Learn how instrument characteristics influence the ability to generate different modulation schemes, how to compensate for internal and external device imperfections, and to emulate component and link distortions.



Instruments for Energy and Efficiency Research



Sustainable energy research aims to meet the energy needs of the present without sacrificing the ability of future generations to meet their needs. The technologies are wide-ranging, including renewable energy sources, such as hydroelectricity, solar energy, wind energy, wave power, geothermal energy, artificial photosynthesis, and tidal power, as well as technologies to improve energy efficiency, such as power semiconductor and battery research. Tektronix offers several categories of instruments in the areas of precision power measurement, waveform analysis, transducers (probing), and semiconductor characterization.



Power Analyzers for Precise Line Power Measurements

Power analyzers are designed especially for making accurate power measurements on a wide range of power conversion systems: from cell-phone chargers to 1000 kW grid-connected inverters. PA4000 Series Power Analyzers can be configured with one to four input channels for testing three-phase devices, or for testing input and output power simultaneously. The PA4000 also includes special modes for testing PWM motor drives and electronic lighting ballasts. The PA1000 is designed for precision power analysis on single-phase devices. Both analyzers give you what you need to measure conversion efficiency and perform pre-compliance testing.

Power Supply Switching Analysis

A significant amount of power is lost during FET switching, and many Tektronix oscilloscopes can be outfitted with special power analysis software to quantify this important switching loss. For example, an MSO/DPO5000B equipped with DPOPWR power analysis software can measure switching loss, magnetic loss, safe operating area, and harmonics.

Making High-speed Current Measurements

Making accurate current amplitude measurements even at high slew rates is critical to achieving maximum power efficiency. Tektronix current probes provide industry-leading measurement sensitivity down to 1mA and bandwidths up to 100 MHz. When paired with today's Tektronix oscilloscopes the latest current probes automatically scale the readings to amperes and provide status information right on the oscilloscope display.



Characterizing Next Generation Power Semiconductors

In the quest for higher efficiencies, new power converters are being designed to switch higher voltage and higher current at higher rates. Researchers who are studying advanced materials such as Silicon Carbide and Gallium Nitride face tough challenges when it comes to test equipment. They have to precisely measure leakage currents under high voltage, and measure low voltages with high current flowing. Keithley offers Source Measure Units that rise to these challenges.

Model 2651A High Power System SourceMeter® Instrument

- Up to 50 A pulsed (up to 100 A with 2 units)
- Up to 2000 W pulse / 200 W DC power
- Pulse widths from 100 μ s to DC
- Model 2657 High Power Source Measurement Unit (SMU) Instrument
- Up to 3000 V, up to 180 W
- 1 fA measurement resolution



Keithley Parametric Curve Tracer systems include everything necessary for parametric and trace analysis of power semiconductors. They are available in a wide range of voltage levels, from 200 V to 3 kV, and a wide range of current levels from 1 A to 100 A.

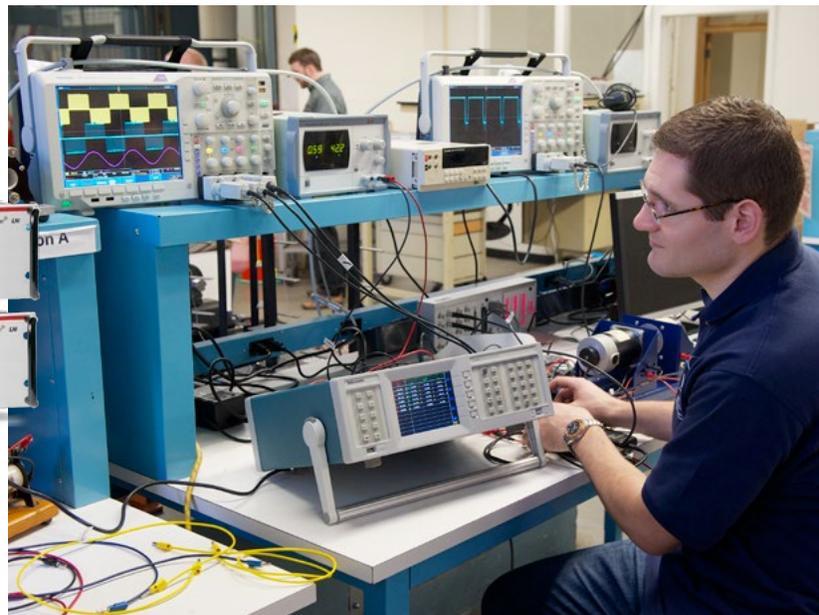
Resources

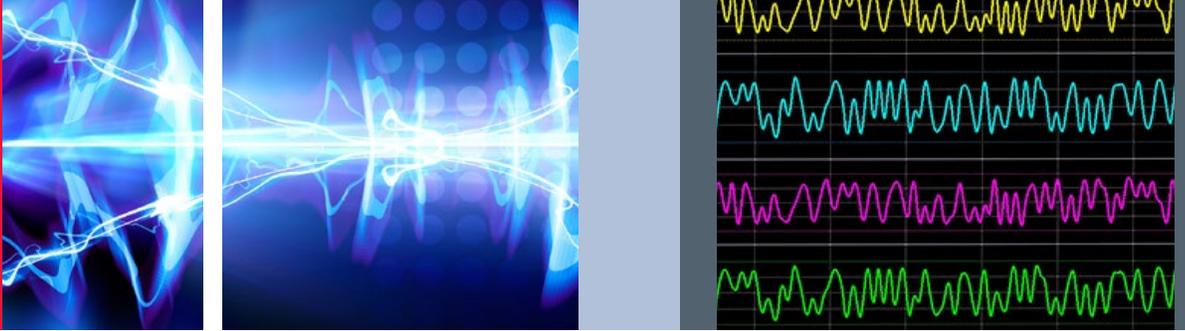
Power Supply Measurement and Analysis Primer –

Discover how to make many common power measurements including switching loss, safe operating area, magnetic power loss, and harmonic analysis.

Testing Power Semiconductor Devices with Keithley High Power System SourceMeter SMU Instruments –

Learn about the most commonly performed power semiconductor device tests, the challenges associated with them, and how SMU instruments can simplify the testing process.





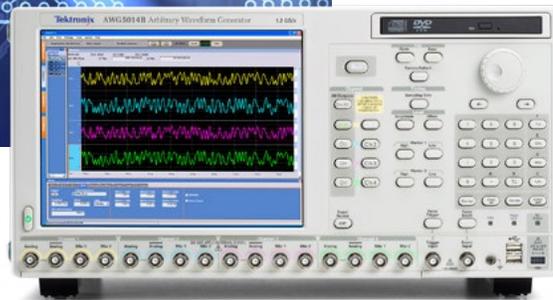
Instruments for Quantum Computing Research



Tektronix offers instruments that can help you as you work to harness the enigmatic qubit. Oscilloscopes not only help you debug your apparatus, but can also provide signal acquisition as an integral part of your system. High-speed signal sources provide system inputs with tight synchronization across multiple channels.

Multi-channel, High-speed Waveforms

With 14 Bit vertical resolution up to 1.2 GS/s, 4 analog, and 32 digital channel outputs, the AWG5000C Series Arbitrary Waveform Generator is the ideal solution for tightly synchronized mixed signal generation. The AWG5000C Series gives you a unique combination of analog and digital output performance for generating custom synchronized pulses. Dynamic jump capability allows the AWG5000C to change its outputs based on external changes.





Oscilloscopes for Troubleshooting and High-Speed Acquisition

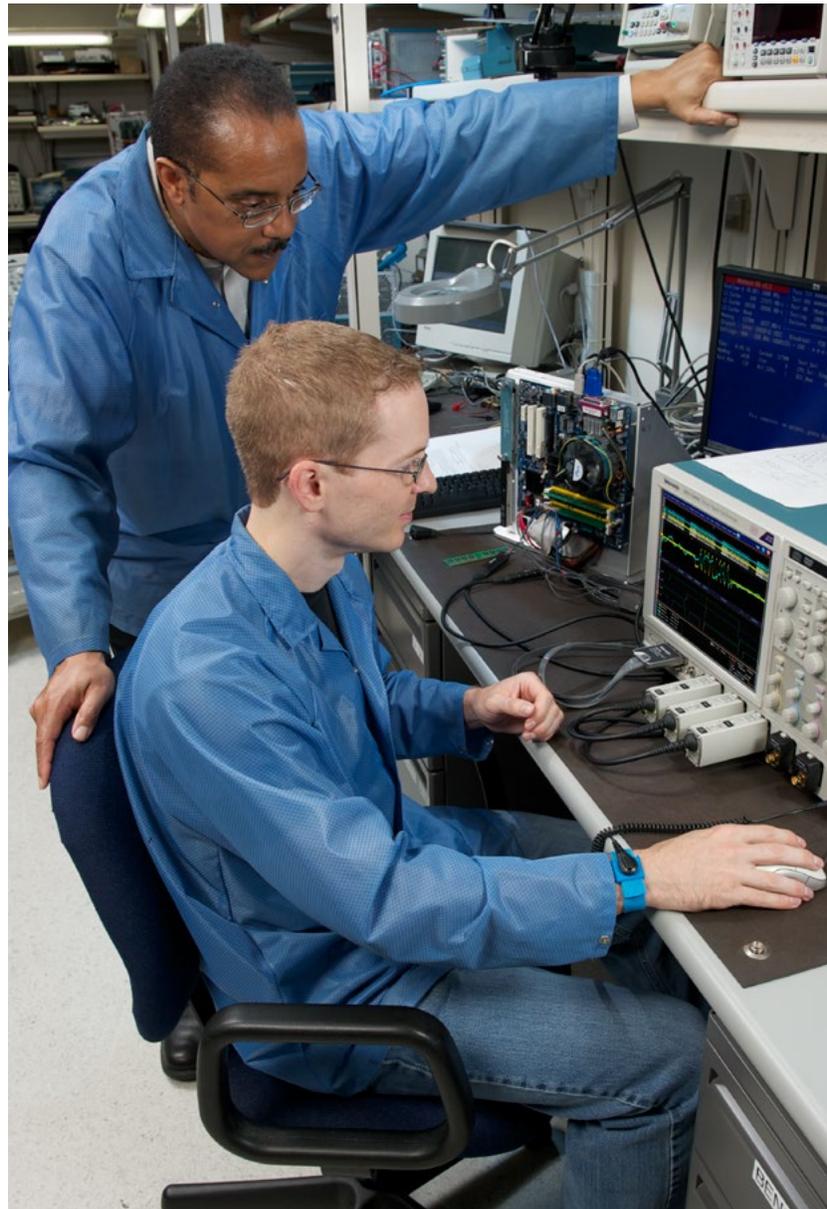
Tektronix builds oscilloscopes for applications from basic undergraduate lab work, to microwave signal analysis. Mixed Domain Oscilloscopes like the MDO3000 Series and MDO4000B Series combine an oscilloscope and spectrum analyzer in one instrument, providing visibility in both the time and frequency domains. They include digital inputs so you can see as many as 20 analog and digital signals at once. The MDO4000B lets you see both time and frequency information at the same time, so you can see how a spectrum changes with respect to other signals in the system. The MSO/DPO70000C/DX Series provides high-speed signal acquisition performance up to 33 GHz and 100 GS/s with over 30 customizable application-specific software analysis packages.

Resources

Measurement System Signal Integrity: Important Factors to Consider – Sufficient bandwidth is a key oscilloscope requirement for making accurate measurements. However, there are a number of other factors and specifications that can help you properly perform signal integrity characterization.

Fundamentals of the MDO4000B Series Mixed Domain Oscilloscope – Learn how a Mixed Domain Oscilloscope (MDO) offers time-correlated analog, digital, and RF signal acquisition for a complete system view. Discover the benefits of seeing both the time and frequency domains in one glance, and the advantages of viewing the RF spectrum changes over time.

XYZ's of Signal Generators Primer – Explains the basics of Signal Generators, including the many types of generators, their applications and their contribution to a complete test and measurement solution.



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Contact List Updated June 2013

For Further Information

Tektronix and Keithley maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit www.tektronix.com or www.keithley.com



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