FormFactor™

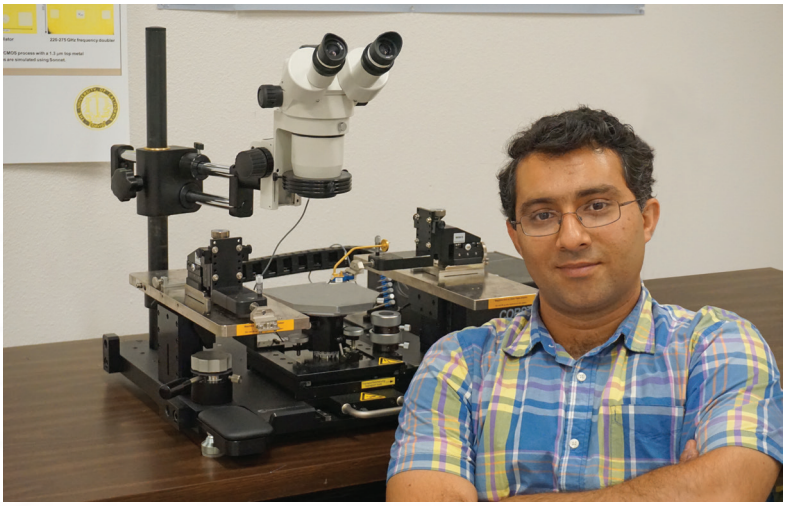
Optimize Your Research Lab for Discovery

150 mm Probe Systems

Exploring the Outer Limits of High-Frequency CMOS Circuitry

Numerous technologies, such as radar, imaging and spectroscopy, require the generation of signals that range into the millimeter-wave (mmW) region and beyond into the terahertz range. In response, researchers are actively developing radio frequency (RF) circuitry implemented at the chip level, where substantial size and cost benefits can be realized.

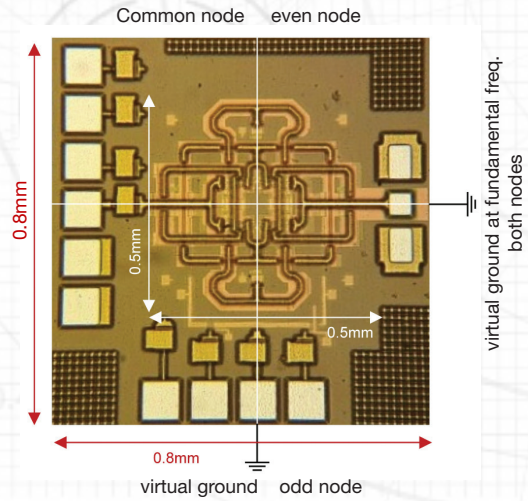
One such group includes Dr. Omeed Momeni and his colleagues at the University of California Davis. Their long-term goal is to push CMOS-based circuitry to its theoretical limits in the 700 GHz range. In pursuit of this vision, they recently focused on the design of a voltage-controlled oscillator (VCO) targeted at a 130 nm BiCMOS process. In a paper delivered at the 2016 International Solid State Circuits Conference, Dr. Momeni and his colleague Rouzbeh Kananizadeh reported successful operation of this on-chip VCO at frequencies up to 190 GHz with a tuning range of 20.7% and a maximum power output of -2.1 dBm (Figure 1).



Dr. Omeed Momeni, University of California, Davis, CA

To verify this circuit, they assembled a test and measurement system that included FormFactor's 150 mm probe station to contact the on-chip output pads connected to the VCO circuitry. The EPS150RF probe station's compact architecture occupied a minimum of valuable lab space, and FormFactor minimized the team's startup time by completing the initial system assembly.

The fabricated VCO circuit was delivered to the lab in the form of individual die each containing a single copy of the circuit. Consequently, Dr. Momeni's team configured the EPS150RF for probing by mounting each die on its own board, which was then vacuum-sealed onto the probe station's chuck for probing operations. Each board included wire bonding to deliver various DC voltages and ground connections to the chip, which also contained two additional pads that were probed to capture the VCO's output.



The RF output frequencies of the VCO required exceptional probe performance to deliver accurate, repeatable results, and FormFactor met this challenge with its Infinity Probe, which delivers dependable results into the 500 GHz range and beyond. It minimizes probe loss while substantially reducing unwanted coupling and transmission modes.

Figure 1: A series of precision measurements confirmed the VCO's output across a tuning range of 20.7% with a center frequency of 190.5 GHz. This particular display shows a spectrum analyzer measurement taken at a 210.1 GHz output.

In this particular application, the Infinity Probe's waveguide was coupled with a harmonic mixer to complete the signal path to a spectrum analyzer, which conducted the frequency measurements. It verified a tuning range of 20.7% at a center frequency of 190.5 GHz. Figure 2 shows one of multiple measurements made across the tunable spectrum, this particular measurement at 825 MHz.

The power output of the VCO was verified with a similar probe setup which created a signal path from the chip's output pads to a power meter. In this case, a waveguide attachment with a 90 degree E-bend helped position the Infinity Probe in acceptable physical proximity to the power meter. It verified a maximum output power of -2.1 dBm. In all cases, EPS150RF and its Infinity Probe provided the low, stable contact resistance required for consistent, accurate measurements at the RF frequencies produced by the VCO.

For Dr. Momeni and his colleague on this project, Rouzbeh Kananizadeh, the successful fabrication and operation of this BiCMOS circuit represents a significant performance milestone in progress toward the integration of RF circuitry onto relatively low-cost semiconductors. FormFactor is proud to have played a part in their research.

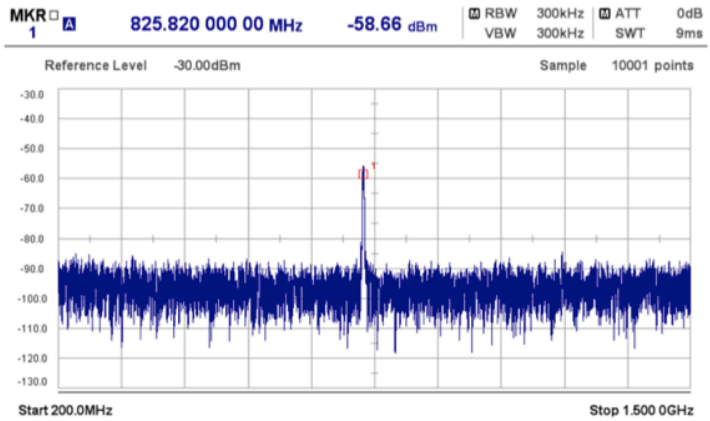
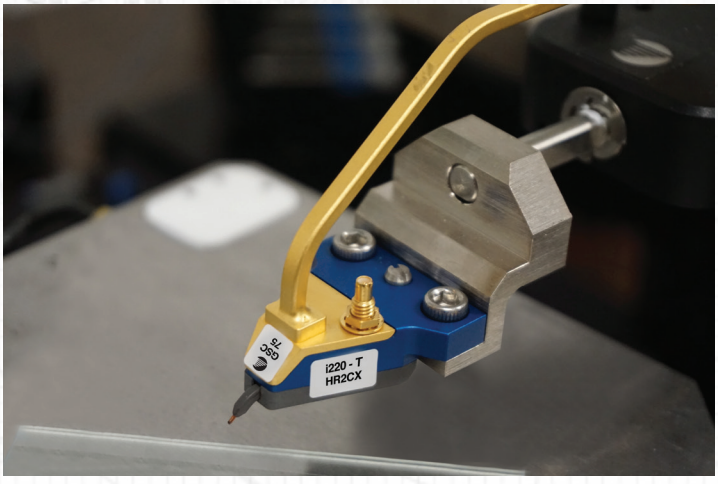
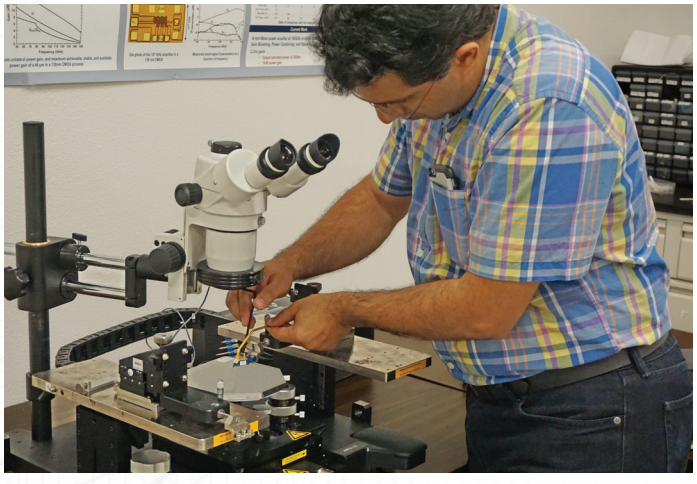


Figure 2: A BiCMOS process with a 135 nm feature size was used to fabricate the VCO. The pads on the left and bottom were wire-bonded to a mounting board to provide power supplies and control voltages. The two pads on the right were the oscillator output and the targets of the Infinity Probes.



FormFactor's Infinity Probe



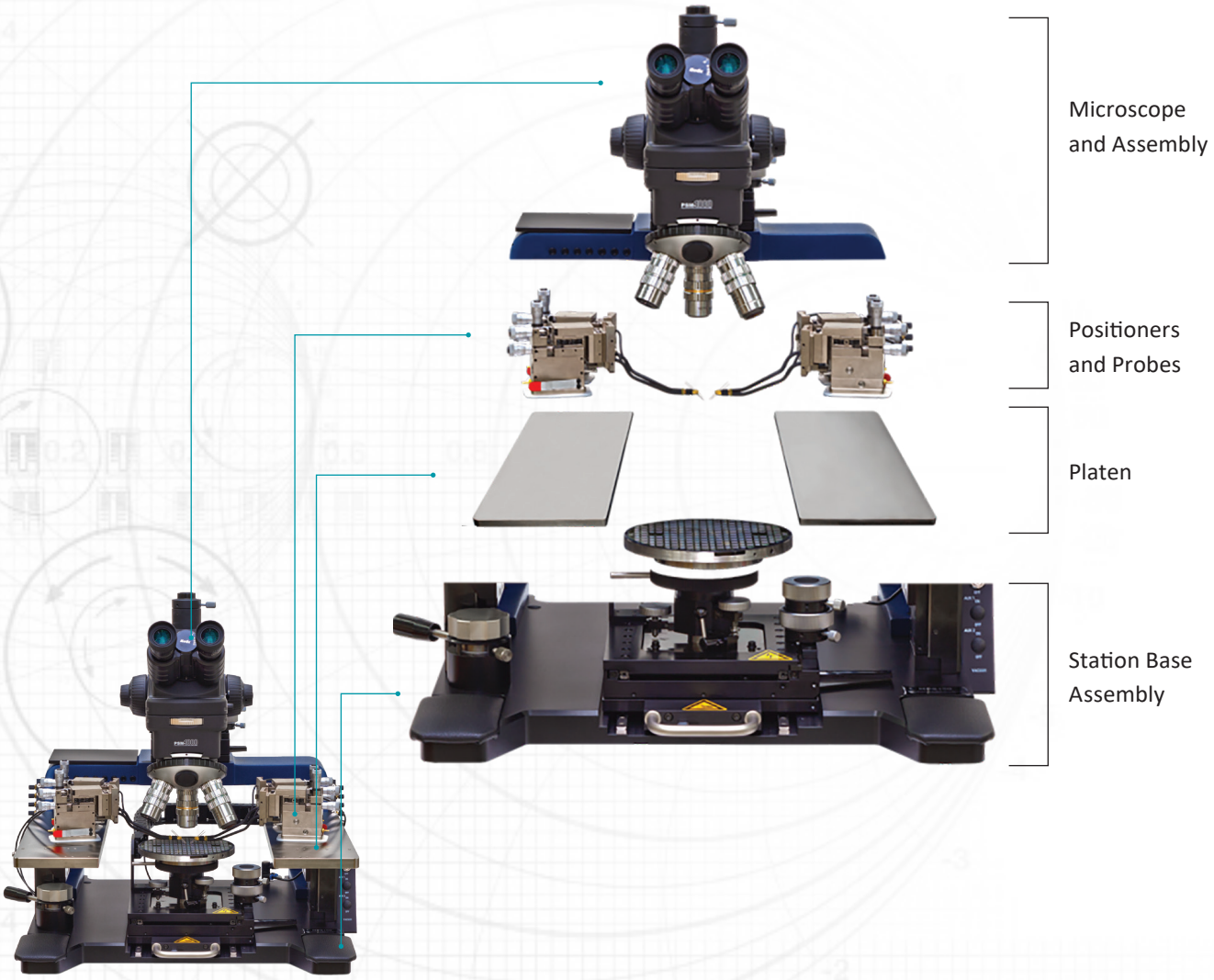
Dr. Momeni installing the Infinity Probe on his EPS150RF probe system.

Supporting Your Journey from the Theoretical to the Factual

All good science demands that theory be validated through experiment, and the semiconductor field is no exception. Contemporary device technology demands extremely precise, repeatable measurements to validate new ideas. Within this context, wafer probing becomes a vital link in the test and measurement process.

Engineering research facilities may engage in a wide diversity of technical pursuits, but they share a common set of needs when it comes to test and measurement: they all require equipment that delivers maximum performance, yet remains easily accessible and usable—all the while providing the highest possible confidence level in test results.

In response, FormFactor offers application packages based on the MPS150 manual probe platform. Each package is targeted at a specific test and measurement application area. You can choose a pre-configured solution that fits your specific needs and gets you up and running with a minimum of setup time. We also offer a diversity of ownership options to fit your specific requirements.



Combining superior performance with ease of use

Our modular 150 mm probe station provides this link with a platform designed to readily adapt to your lab environment. The MPS150 probe platform's modular architecture can be designed to accommodate your specific applications with unmatched electrical and mechanical precision. A variety of chuck types, probe arms, and microscope stages combine with an adjustable platen to present an optimized probe environment for virtually any test and measurement scenario. The MPS150 can be customized to readily integrate third-party instrumentation with a System Integration for Measurement Accuracy (SIGMA™) kit that is tested to ensure immediate, successful operation.

30 years of technical excellence built into our systems

In 1983, FormFactor played a prominent role in probe design and development. Today, our probe systems can be found at all of the world's 20 largest semiconductor manufacturers, where we've formed a long-term collaboration with customers and industry leaders to advance the state-of-the-art in wafer probing. As the frontiers of research into semiconductors continually expand, FormFactor is committed to keeping pace and remaining at the forefront of semiconductor technology.

Adapts to research demands with no sacrifice in performance

Given the relentless pace of global progress in semiconductors, research laboratories need probe systems that can be rapidly deployed with no compromise in performance. Each station rests on a solid base frame with built-in vibration isolation and a rigid microscope fixture to ensure accuracy. The adjustable platen can accommodate up 16 probe positioners for complex measurement scenarios.

In many labs, the principle equipment users are researchers who split their time between pure research and lab work. Accordingly, the EPS150 packaged probe systems focus on ease of use, with an ergonomic layout and simple operation that minimize setup times with no loss in performance or accuracy.

Applications:

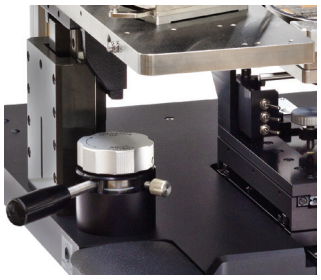
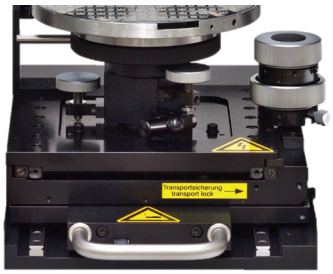
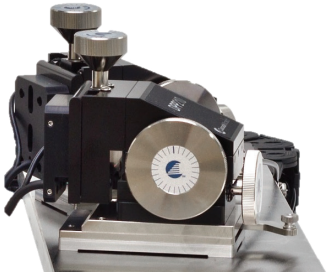
- C-V / I-V
- RF/mmW
- THz measurements
- Device and wafer characterization (DWC)
- Optoelectronic engineering test
- Failure analysis (FA)
- Submicron probing
- MEMS

EPS150COAX and EPS150COAX^{PLUS}

Perform Fundamental I-V / C-V Measurements

DC parametric test solution with an optimized signal path down to pA levels to ensure fast, accurate ultra-low-level measurements over temperature. An intuitive operation workflow ensures ease of operation for both the novice and the expert user.

PRODUCT HIGHLIGHTS

	MOVABLE PLATEN*	CHUCK STAGE	MAGNETIC POSITIONERS
			
TECHNICAL ADVANTAGES	200 µm contact / separation stroke	Operation with adjustable friction and stage lock capability	100 TPI with 2 µm accuracy
	± 1 µm repeatability	Unique Z chuck adjustments	Industry-standard capability
	40 mm height adjustment	90 mm pull-out	3 linear axes with precision ball bearings
BENEFITS	Probe-to-pad alignment without losing focus	Convenient operation	High positioning accuracy
	Consistent contact force and overtravel	More flexibility in adjustment	Proven quality standards
	Easy to switch between wafers, packages and DUT boards	Fast and safe wafer loading with probes or probe cards	Fast and precise positioning

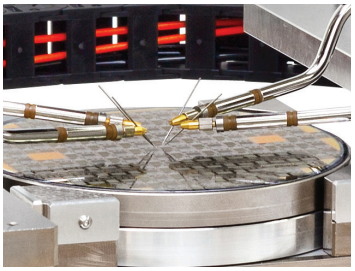
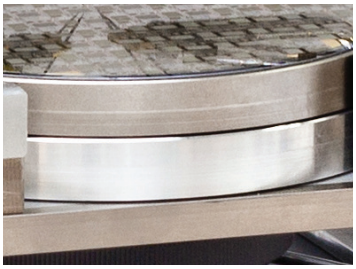
** Available only on EPS150COAX PLUS*

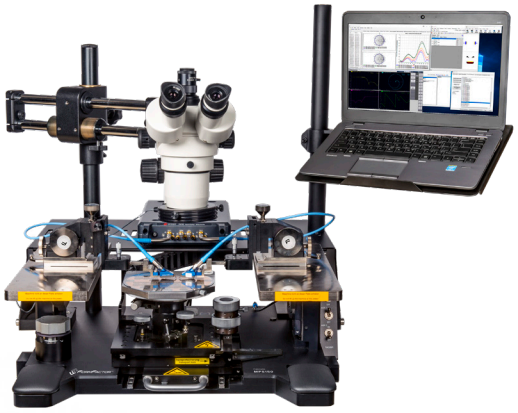
EPS150TRIAX

Investigate Sensitive Device Measurements

I-V/C-V measurement solution down to fA levels with an optimized full triaxial design in an ideally quiet and dry environment. Low noise chucks with Kelvin connections, as well as triaxial probe arms and cables, deliver a high degree of measurement confidence.

PRODUCT HIGHLIGHTS

	STEREO MICROSCOPE	OPTIMIZED TRIAX DESIGN	TRIAX STAGE
			
TECHNICAL ADVANTAGES	Stereo zoom	High-quality triax cables	±8 fine theta chuck rotation
	15x - 100x magnification with large field of view	Four triax probe arms	Three auxiliary areas (two with vacuum)
	Camera-ready C-mount	Light/EMI shielding (optional)	Chuck surface with ± 5 µm planarity
BENEFITS	Precise 3D navigation	Measurement results with maximum noise reduction	East/West to North/South measurements with single setup
	Easy navigation and precision positioning	Perfectly adjusted setup	Easy to move from DUTs to calibration and cleaning substrates
	Camera upgrade for documentation	Upgrade option for fF-level measurements	Consistent contact force and overtravel



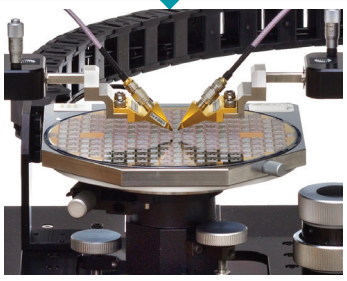
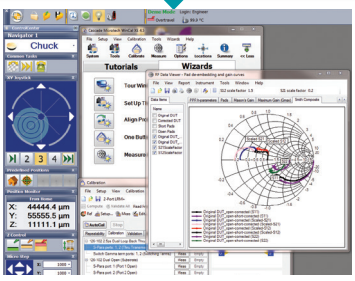
EPS150RF

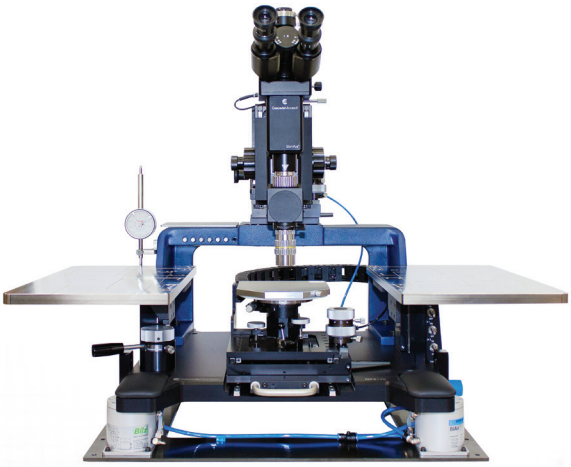
Become an RF Genius

Our packaged RF solution enables precise probe placement on pads as small as 25 µm x 35 µm with 1 µm contact repeatability. Choose from three RF probe technologies to achieve the best solution for the widest application spectrum. WinCal XE™ software provides LRRM and LRM+ methods superior calibration accuracy.

* *Dedicated RFgenius educational package (left) is a fully validated and integrated turn-key solution, including Keysight Technologies Streamline series network analyzer for various frequency ranges up to 26.5 GHz.*

PRODUCT HIGHLIGHTS

	THREE PROBE TECHNOLOGIES	PRECISE CONTACT SOLUTIONS	WINCAL XE CALIBRATION SOFTWARE
TECHNICAL ADVANTAGES			
	Infinity Probe: best for Al (Si)	RF chuck with ‹ ± 3 µm surface planarity	Exclusive 1-, 2-, 3-, and 4-port on-wafer calibration algorithms
	ACP Probe: best for AU (III-Vs)	Unique 200 µm platen contact/separation stroke	Automated calibration monitoring
	|Z| Probe: a robust solution with long lifetime	‹ ± 1 µm accuracy for repeatable contact	Unique measurement and analysis methods
BENEFITS	Precision contact on a wide variety of materials from 26 GHz to 67 GHz	Precision probe alignment	Accurate S-parameter measurements
	Accurate results with excellent crosstalk	Consistent contact force and overtravel	Automatic calibration setup for higher efficiency
	Matching cables and substrates included	Stable contact performance	Fast and easy data interpretation and reporting

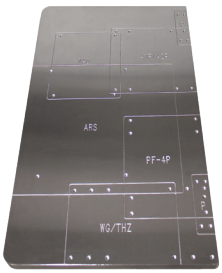
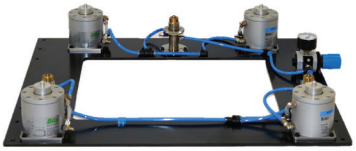


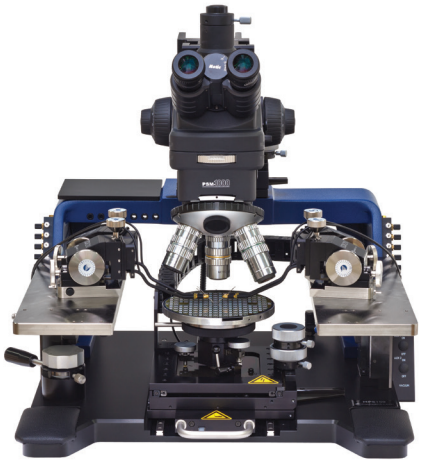
EPS150MMW

Take the Shortest Path to Highest Accuracy

Tailored solution that addresses measurement needs for active and passive components through the terahertz frequency range. It enables the highest dynamic range and directivity—all without compromising electrical accuracy or mechanical stability.

PRODUCT HIGHLIGHTS

	SLIMVUE™ MICROSCOPE	APPLICATION-SPECIFIC SIGMA KITS	VIBRATION-ISOLATION PLATFORM
			
TECHNICAL ADVANTAGES	Quick lens exchange	Engraved guides on mmW platen	High vibration damping
	1 µm opitcal resolution	Supports broadband, load pull, coax RF and banded waveguide configurations	Compact and solid base table
	Minimized scope footprint	Optical feedback on platen position (gauge)	Earthquake protection available (option)
BENEFITS	Fast change from navigation optics to high-resolution optics	Adaptable to any mmW/sub-THz applications	Maintain precise contact over time
	Resolving ‹ 50 µm pads	Seamless integration with any mmW modules and tuners	Protect devices and probes from damage
	Simple integration with any mmW modules	Fast mounting and setup change	Eliminate the need for additional anti-vibration table

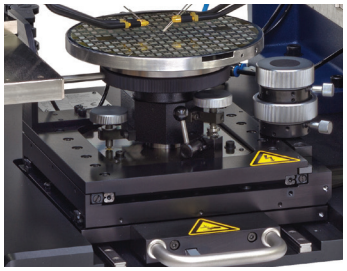
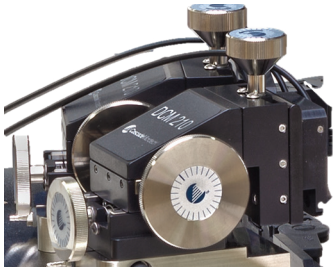


EPS150FA

Visualize Success by Analyzing Sub-Micron Failure

Electrical failure verification, localization and debug with the ability to probe features smaller than 1 µm. Flexibility to adapt from wafer-to-chip-to-package investigation in a matter of seconds, minimizing time-to-data and ultimately delivering faster time to market.

PRODUCT HIGHLIGHTS

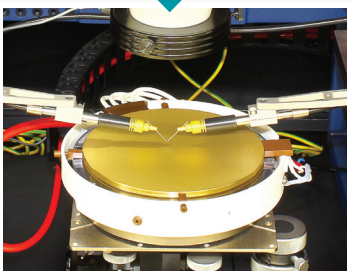
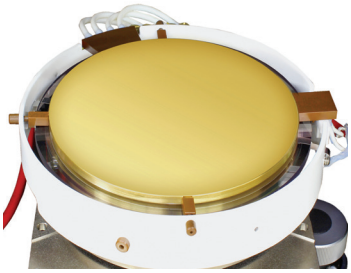
	HIGH-MAGNIFICATION OPTICS	FLEXIBLE DESIGN	VACUUM MACHINES
			
TECHNICAL ADVANTAGES	Stable microscope bridge design and XY microscope	Probe card simultaneously used with single needles (option)	200 TPI with < 1 µm accuracy
	Up to 4000x magnification (option)	Movable platen enables single DUT holder	DPP450 positioner with nanometer resolution and accuracy (option)
	Laser cut and camera ready	Chuck ready for single DUT	Backlash free
BENEFITS	Easy navigation and high-quality image	Flexible and fast setup change	High positioning accuracy comparable to semi-automated systems
	Contact submicron features	Quickest transition from wafer-to-chip-to-package	Fast and precise positioning
	Easy upgrade	Versatile upgrade paths	Probe smallest DUTs without damage

EPS150TESLA

Energize Your Power Measurements

High-voltage probing solution to test breakdown voltages up to 3,000 volts, and high-current probing up to 40 amps for lowest on-state resistance. A shielded environment reduces noise and provides safe operating conditions.

PRODUCT HIGHLIGHTS

	OPTIMIZED MEASUREMENT SETUP	HIGH-POWER CHUCK	SAFE OPERATION
			
TECHNICAL ADVANTAGES	Multi-purpose SIGMA instrument integration kit	Triax design for low-leakage measurements up to 3 kV	Arcing protection
	Shorter cabling and universal chuck connection	Special chuck surface coating	Shield Enclosure with interlock
	Triax probe with protected guard	High-isolation ready	Advanced grounding concept
BENEFITS	Optimized signal path	High-current measurement up to 100 A with lowest contact resistance	Maximum protection from high-voltage shock for users and devices
	Safe probe tip exchange	Optional upgrade for 10 kV (coax) operating voltage	Common ground protection for all instruments
	Seamless integration of various analyzers	Thin wafer handling capability	EMI/light-tight shielded environment

A Probe Package to Suit Every Application

Through a broad array of technical features, the EPS150 packaged solutions are pre-configured to fit your specific application.

APPLICATIONS	MPS150	EPS150COAX	EPS150COAX^{PLUS}	EPS150TRIAX	EPS150RF-LITE	EPS150RF	EPS150MMW	EPS150FA	EPS150TESLA
I-V / C-V coaxial probing down to pA-level	○	●	●	●	○	○	○	●	●
I-V / C-V triaxial probing down to fA-level	○	○	○	○	○	○		○	●
C-V measurement at fF-level	○			○					
RF probing up to 67 GHz	○				●	●	S		
RF probing from 70 GHz up to 1.1 THz	○						S		
Low noise I-V / C-V measurement	○			●					●
High-current / high-voltage device test	○								●
Failure analysis	○							●	

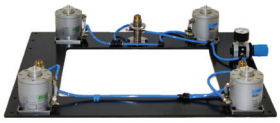
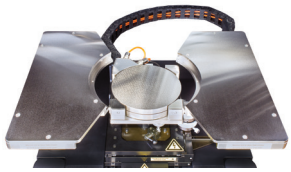
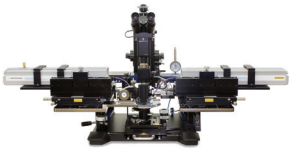
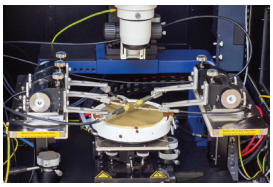
● Best recommended ○ Capable **S** SIGMA kit required

CHARACTERISTICS									
FEATURES									
Adjustable platen (40 mm) with 200 µm contact/separation stroke	○		●	●	●	●	●	●	●
Manual scope adjustment	○	●	●	●	●	●			●
Manual scope transport	○	○	○	○	○	○	●	●	○
High-stability microscope bridge	○	○	○	○	○	○	●	●	○
Vibration isolation solution	●	●	●	●	●	●	●	●	●
Vibration isolation platform	○	○	○	○	○	○	●	○	○
Shield enclosure	○	○	○	○	○	○	○	○	●
CHUCK									
Single-handed chuck stage operation	●	●	●	●	●	●	●	●	●
Auxiliary area(s)	○	○	○	●	●	●	●	○	
90 mm roll-out stage	●	●	●	●	●	●	●	●	●
Fine theta adjustment	○	○	○	○	●	●	●		○
High temperature (up to 200°C)	○	○	○	○	○	○	○	○	○
High temperature (up to 300°C)									○
ACCESSORIES									
Backlash-free DC positioners (4)	○	●	●	●	○	○	○	●	S
Backlash-free RF positioners (2)	○				●	●	○		
RF/mmW probes, and matching cables and calibration substrates	○				○	●	●		
WinCal XE calibration software	○				●	●	●		
PROGRAMS AND SERVICES									
Certification: CE, cNRTLus, CB	●	●	●	●	●	●	●	●	CE
One-year warranty	●	●	●	●	●	●	●	●	●
Educational Savings Program*	○	○	○	○	○	○	○	○	○
Installation service	○	○	○	○	○	○	○	○	○
Training programs	○	○	○	○	○	○	○	○	○
Financing programs	○	○	○	○	○	○	○	○	○
SourceOne™ buy-back and trade-in programs	○	○	○	○	○	○	○	○	○

● Standard ○ Available as an option **S** SIGMA kit required

* Includes two-year warranty and free shipping.

150 mm Options Deliver Additional Advantages

OPTION		ADVANTAGE
High-resolution Scope and Bridge Upgrade Replacement for boom stand and stereo microscope included in EPS150COAX, EPS150COAXPLUS, EPS150TRIAX and EPS150RF.		Precise and intuitive navigation with high-zoom range. Quick objective exchange mechanism and flexibility for future camera upgrades.
HDTV Kit Add a CCD digital camera (1080p HDMI) and a wide-screen monitor to your EPS150 system, enabling high-definition microscopy.		Fast documentation through high-resolution image for video recording and live view, without a computer.
Vibration Isolation Platform Add a compact vibration damping platform compatible with Shield Enclosure. Earthquake protection available as option.		Precise and stable contact, minimizing the damage to devices and probes.
Add-on Platen Extend the platen area for mixed application and high positioner-count setups, and for probe card setup.		RF and DC mixed configurations with up to 16 positioners and probe card applications in combination with DC needles.
SIGMA Kit for mmW and RF Applications Integrate EPS150MMW with test instrument and/or tuners and/or mmW heads for broadband, load pull, coax RF and banded waveguide applications.		Fast setup and seamless integration for improved measurement accuracy when testing in RF/mmW and THz frequency ranges.
SIGMA Kit for High-power Applications Integrate EPS150TESLA with Keysight B1505A and associated accessories.		Fast setup and seamless integration for improved measurement accuracy when testing power devices in high-current/high-voltage test conditions.

You Have Options – From Financing to Technical Support

FormFactor understands that labs dedicated to research operate under a wide range of administrative conditions. In response, we offer many different acquisition scenarios to accommodate your particular situation.

Take advantage of our Educational Savings Program

Our Educational Savings Program offers a generous discount schedule combined with the best possible price/performance available from any probe equipment source worldwide. To ensure that your EPS150 package keeps pace with evolving research requirements, we offer an additional ten percent discount on upgrades for two years after purchase. Our Educational Savings Program provides free shipping worldwide, a two-year warranty, 90 days of no-cost online support, and four years of free WinCal XE updates.

New or reconditioned systems with a wide range of financing options

To achieve long-term ownership at a reasonable cost, turn to our SourceOne program for reconditioned systems. The like-new equipment comes with a full factory warranty and the option to trade in your old equipment. All SourceOne equipment undergoes a complete refurbishment to exacting FormFactor standards. Parts are expertly reconditioned, and, if applicable, the latest software is installed. SourceOne equipment is automatically covered under our standard one-year warranty.

FormFactor offers numerous financing options for leasing and rental. We provide, or have partnered with qualified finance partners who offer a wide range of lease options that include fair market value (FMV) or lease to own.

Global service, support, installation and training

We have industry-leading applications experts with comprehensive product knowledge to help minimize your initial setup time. We offer full installation services. Our certified field engineers can provide a complete training program to qualify your staff for efficient operation of your probe system.

First in Quality, Dependability and Performance

FormFactor's 150 mm probe solutions are ideally positioned to meet all your research needs. All backed by global service and application support, no matter where you're located. Our products come with over 30 years of engineering quality and innovation built into every station. When it comes time to reconfigure or upgrade, you can protect your investment with the industry's broadest product portfolio of both systems and accessories.

And no matter what your needs, we have a global network of sales offices, technical support teams and training/certification programs standing ready to help. At FormFactor, we treat your research with the same passion and intensity that you do, and take pride in being a partner on your journey of discovery.

See how our 150 mm probe solutions can put the very best in wafer probing technology in your lab. For more information contact your local sales representative or visit us at www.formfactor.com/education.

Terms and Conditions

The Educational Savings Program applies to 150 mm manual pre-configured probe systems designed specifically for qualified educational institutions. Educational Savings Program discounts cannot be combined with any other program discounts unless stated otherwise.

- 10% discount on regular list price for all accessories (see our Probe Station Accessory Catalog for more details) purchased as upgrades to the packages during the two-year warranty.
- Special conditions apply to certain regions: • India and South America have free transportation to loading dock of the customer via FormFactor's selected freight forwarder. • Customs clearance/taxes/duties are the sole responsibility of the customer (except for US deliveries) • Exceptions: China, India, Africa, Russia, South and Central America due to country regulatory restrictions, we pay transport up to closest international airport for these regions.

Corporate Headquarters
7005 Southfront Road
Livermore, CA 94551
Phone: 925-290-4000
www.formfactor.com

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