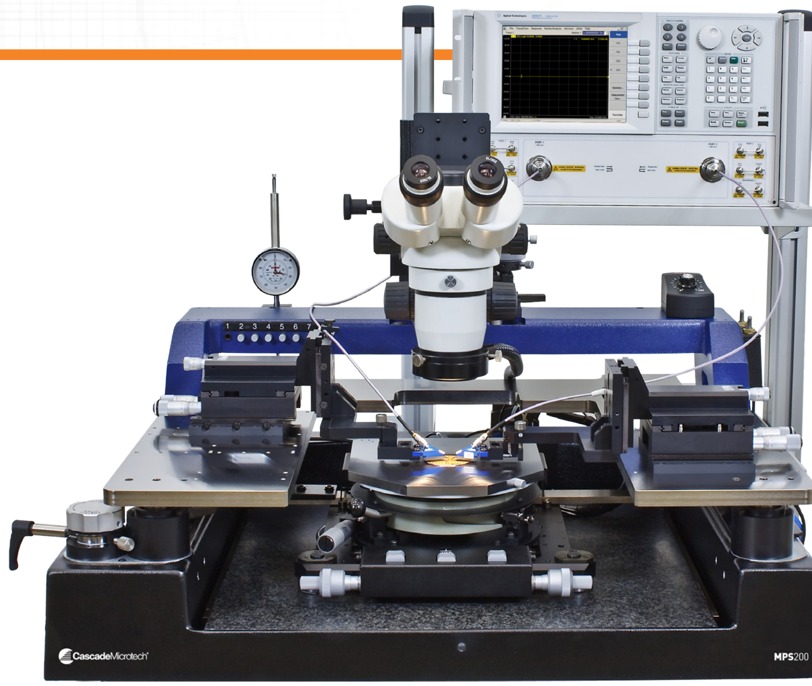
EPS200RF

A complete 200mm manual probe system SMART package for RF applications up to 67 GHz

TECHNICAL REVIEW



Introduction

The EPS200RF is an application-focused package that is a complete solution for best-in-class RF measurement results up to 67 GHz. Based on leading technology in RF probing and probe system design, and over 27 years of experience and application expertise, this SMART package solution is the key to achieving accurate measurement results in the shortest time—with maximum confidence.

The EPS200RF SMART package is based on the PM8 probe system platform and includes RF probe platen, scope bridge, scope transport, camera-ready microscope, positioners, probe arms, dedicated RF chuck, and RF cables and adapters optimized for two-port S-parameter measurement RF probing requirements up to 67 GHz. Additionally, the package includes light source, integrated vibration-isolation solution and probe accessories such as Probe Polish and contact substrate. Included in the EPS200RF SMART package is a full license for WinCal XE™ calibration software as well as your choice of a pair of 40, 50, or 67 GHz single-ended standard RF probes from our Infinity Probe®, |Z| Probe® or ACP probe families that correspond to the frequency range, contact pad configuration and contact pad metallization material of your device, as well as one calibration substrate that supports your probes.*

Solutions incorporated in the EPS200RF SMART package address multiple needs common for universities, start-ups and shared R&D labs:

- **Application-ready – right out of the box**
- **Consistently deliver credible, accurate measurement results**
- **Effortlessly probe RF devices with pads as small as 25 µm x 35 µm**
- **Minimize training efforts by operating with ease and confidence**
- **Gain free time with simplified system re-configuration and minimized errors**

** (Terms and conditions apply. See sales representative for details)*

Consistently deliver credible, accurate measurement results

Contact Performance

Consistency of RF data strongly depends on the contact repeatability, reliability and stability for both calibration and measurements. Unreliable and inconsistent contact leads to re-contacting and re-measurement of the device under test (DUT), repeated calibration and significant increases in test time. Moreover, unnecessary touchdowns on the calibration standards and DUT pads decrease the lifetime of the calibration substrate, destroy DUT pads and make further probing and/or bounding difficult or impossible. The EPS200RF contact-separation drive (Fig. 1) that features +/-1 micron repeatability (Fig. 2), together with solid and stiff probe arms of the RPP305 positioner (Fig. 3) ensure repeatable, reliable and consistent contact force. A dedicated RF chuck with excellent surface planarity enables consistent overtravel across the entire wafer and calibration substrate (Fig. 4).

Current technologies for semiconductor development utilize different contact pad metallization materials. RF probes must provide reliable and consistent contact on all types of contact pad material—from soft and very low-resistant gold, to aluminum, which builds a highly-resistive, hard-to-break-through oxide layer under atmospheric conditions (Fig. 5). With EPS200RF you receive your choice of a pair of 40, 50, or 67 GHz single-ended standard RF probes from our ACP [1], Infinity Probe[2] or |Z| Probe[3] families and will gain uncompromised contact performance independent from your DUT pad metallization material.

Particles from the contact pads can be accumulated on the RF probe tips, significantly reducing the accuracy and consistency of data. Depending on the contact pad material, probe design and operator experience, cleaning of the RF probe can be required after a few contact cycles[4]. EPS200RF includes a non-destructive Probe Polish cleaning accessory that is optimized for all RF probe types (Fig. 6).

RF characterization of an active device in a hot mode requires S-parameter measurement at different DC bias points. Applying DC sweep adds a new dimension to the device data, exponentially increasing the measurement time. Depending on the number of bias points and the frequency list, RF probes may need to stay in contact for half an hour or longer when characterizing just one transistor. Therefore, contact quality and contact stability over time are essential for accuracy and consistency of such measurements. Parasitic vibrations that may be generated by laboratory equipment or outside sources and transmitted to the measurement platform over the laboratory floor and table can turn long-term measurements into a very challenging exercise. The solid system mainframe with the granite base and integrated vibration isolation solution decouple the DUT from possible vibrations.

Figure 1. Contact-separation drive

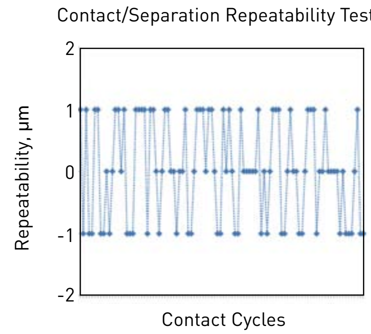


Figure 2. Measured repeatability of the contact/separation drive over 100 cycles

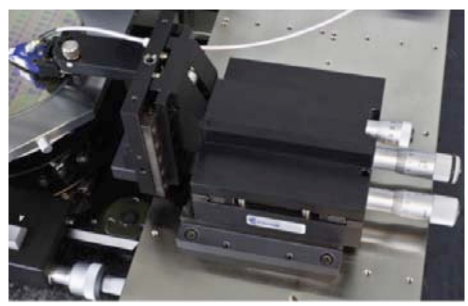


Figure 3. RPP305 positioner with a solid and stiff probe arm provides accurate probe placement, consistent contact force and overtravel

Figure 4. Dedicated RF chuck with excellent surface planarity and small vacuum holes

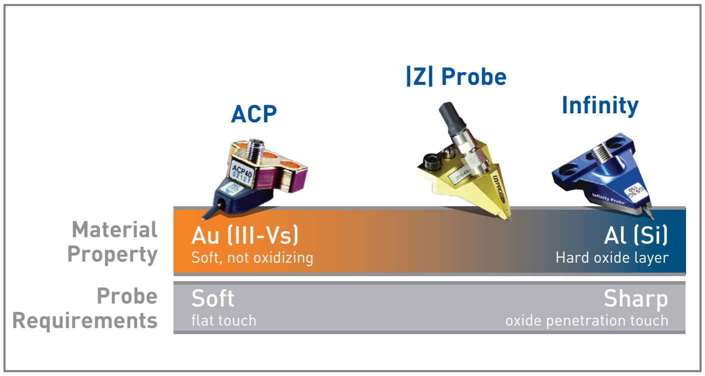


Figure 5. Cascade Microtech's ACP Probes, |Z| Probes and Infinity Probes address needs of the entire spectrum of pad metallization

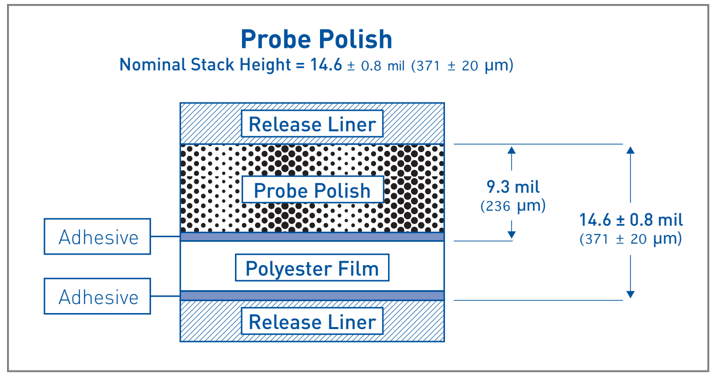


Figure 6. Cross section of probe cleaning material

Solution	**Advantage**	**Benefit**
Platen contact-separation drive with +/- 1 micron repeatability Integrated gauge for visual feedback on the platen position	Repeatable and reliable contact force Reduces risk of damaged probes, DUT pads and calibration standards by precisely controlling overtravel	Repeatable and reliable data Saves money and time
Solid and stiff probe arms	Consistent contact force and overtravel Increases lifetime of probe, DUT pads and standards due to minimal overtravel	Consistent calibration and measurement data Saves money and time
Trinocular 6.7x stereo zoom microscope with 20x eyepieces	Excellent optical resolution and field-of-view for accurate probe placement pads as small as 25 µm x 35 µm	Consistent calibration and measurement data Ready for future requirements Save money
Dedicated RF chuck with excellent surface planarity and small vacuum holes	Consistent overtravel over entire wafer and calibration substrate Constant contact resistance over the entire wafer Probe height re-adjustment is not required Protect probes, DUT pads and calibration standards from unnecessary damage	Consistent calibration and measurement data Ease of use Saves time Saves money
Your choice of a pair of ACP Probes, Infinity Probes, or |Z| Probes	Optimal probe contact performance to your DUT pad metallization material	Consistent data Save money
Probe Polish cleaning accessory	Constant contact resistance Optimized non-destructively clean material	Consistent data Long probe lifetime Saves money
Integrated vibration-isolation solution	Decouple probe system from possible vibration transmitted over the laboratory table Minimized pad damage Constant contact resistance of long-term measurements	Consistent calibration and measurement data Save time and money

Consistent calibration and measurement boundary conditions

Modern microwave integrated circuits implement various design types of transmission media: microstrip (MS), coplanar waveguide (CPW), grounded-CPW (or GCPW) and some others. The unique feature of the CPW design is that all conductors are on the same side (on the top) of the substrate. This attribute simplifies manufacturing, scaling, characterization and integration of CPW circuits.

CPW design is common for semi-insulating, high-resistive III-V substrates (e.g. GaAs). The resistivity of the wafer material sufficiently isolates the DUT from possible impact of the metal chuck (such as parasitic coupling and cross-talk). However, special care of the chuck surface must be taken to provide consistent electro-magnetic boundary conditions across the entire wafer for repeatable and location-independent measurement results.

With an increase of measurement frequency of about 20 GHz, parasitic coupling of the electro-magnetic energy through the surface of the metal chuck can also affect the accuracy of the probe-tip calibration[5]. To suppress it, calibration substrates can be placed on a special RF absorbing holder[6]. However, it elevates the calibration substrate much higher above the wafer surface increasing the risk of unexpected probe damage.

Further increase of the measurement frequency may lead to unwanted signal coupling and higher propagation modes[7]. The DUT measurement results may exhibit unexpected and difficult-to-interpret behavior[8]. The specially-designed dedicated RF chuck of the EPS200RF has small vacuum holes (Fig. 4) and an integrated ceramic inlay on the AUX chuck (Fig. 7) to optimize measurement and calibration boundary conditions at higher frequencies (Fig. 8).

Figure 7. Embedded ceramic AUX chuck for optimized calibration boundary conditions

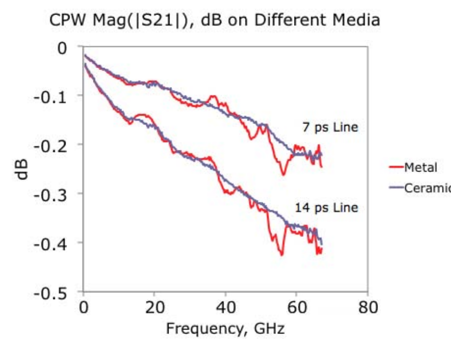


Figure 8. Optimized boundary conditions provided by ceramic AUX chuck improve characteristics of calibration standards

Solution	Advantage	Benefit
Dedicated RF chuck with small vacuum holes and excellent planarity of the surface	Homogeneous measurement conditions across entire wafer Consistent and accurate measurement data No data post-processing and system debug	Reduce time and cost of test
Dedicated ceramic AUX site	Homogeneous calibration conditions across the ISS Reduce parasitic coupling with the metal chuck Increase calibration accuracy and confidence in calibration verification Calibration substrate is at DUT height for simplified contact height readjustment for test/calibration /verification	Reduce time and cost of test Ease of use Ready for future upgrades

Accurate probe placement on calibration standards

Accurate S-parameter measurements can only be obtained after determining the vector network analyzer (VNA) error coefficients. This step is also called "VNA calibration." Various calibration methods are known and used in engineering practice depending on application requirements. In the commonly available SOLT method all standards must be fully known and specified[9].

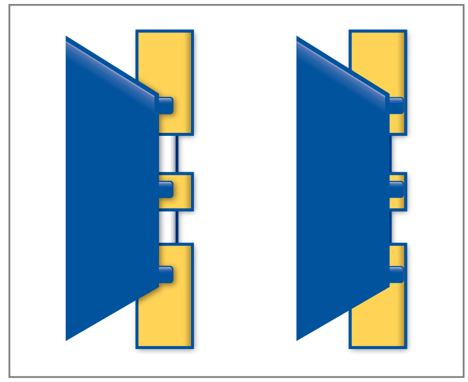


Figure 9. Example of different probe placement on the Load standard

In contrast to the coaxial or waveguide applications, actual frequency response of a planar standard critically depends on the probe placement (Fig. 9, Fig. 10)[10-12]. Implementation of special alignment marks can improve consistency of probe placement, but their use remains subject to operator interpretation. Subtle differences in probe placement seem inevitable, and limit calibration accuracy and reproducibility.

As a result, calibration residual errors caused by disagreement between the actual standard response and its definition may lead to misinterpretation of the DUT performance: inaccurate model parameters, over/under estimation of the figure of merits (e.g. fMAX, Fig. 11)[13].

Dedicated probe-tip calibration available from WinCal XE, such as LRRM method with automated compensation of the Load inductance variation,[12] significantly minimizes impact of the probe misplacement on calibration and measurement results.

Solution	Advantage	Benefit
Solid and stiff probe arms	Consistent contact force and probe forward skating	Consistent calibration and measurement data
Trinocular 6.7x stereo zoom microscope with 20x eyepiece	Excellent optical resolution and field-of-view for accurate probe alignment and placement	Consistent calibration and measurement data
WinCal XE LRRM calibration with patented load inductance determination procedure	Automated compensation for possible variation in the Load standard frequency response	Accurate and consistent calibration and measurement data

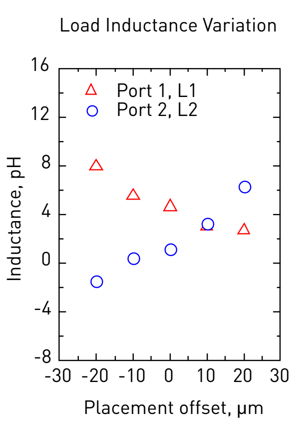


Figure 10. Variation of the equivalent inductance of the Load standard due to different probe placement

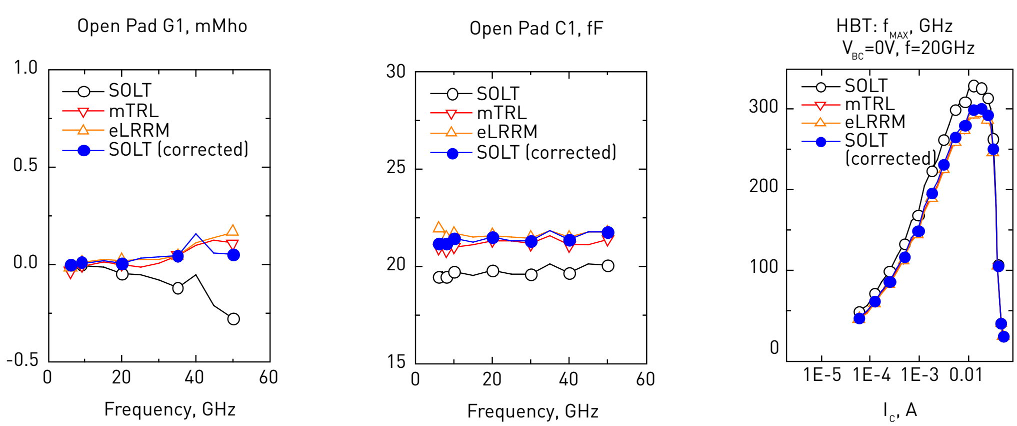


Figure 11. Extracted conductance G1 and capcitance C1 of test OPEN dummy element and maximum oscillation frequency fMAX of a high-performance HBT with respect to SOLT, multi-line TRL, LRRM and SOLT-corrected for the probe placement error

Verified calibration standards

Establishment of a solid traceability chain for wafer-level RF measurement results is still underway. However, substantial achievements have already been made toward developing reliable methods for verification and comparison of planar calibration standards and wafer-level calibration methods[14-17]. This work enabled the comparison of Cascade Microtech's ISS and CSR substrate families (Fig. 12) and calibration methods (Fig. 13) to national references[18-21].

Furthermore, implementing the calibration comparison technique developed in conjunction with NIST[18], the WinCal XE verification tool provides metrological-level analysis of calibration and measurement accuracy (Fig. 14)[22].

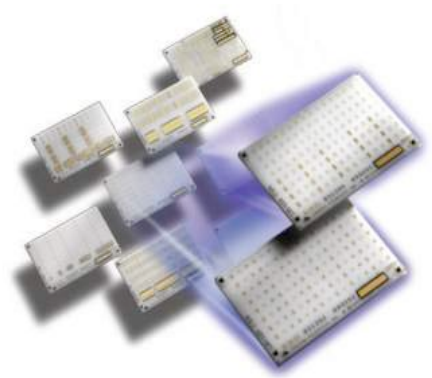


Figure 12. Impedance Standard Substrates (ISS)

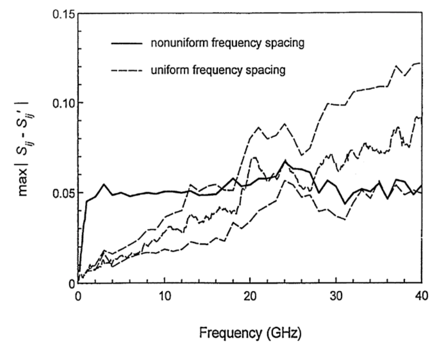


Figure 13. Verification results of probe tip LRRM calibration

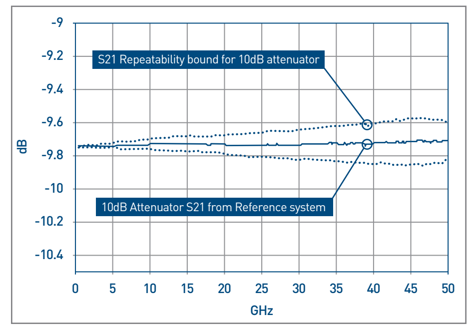


Figure 14. Measurement accuracy verification for a sample DUT calculated by WinCal XE tool

Solution	Advantage	Benefit
ISS and CSR calibration substrate families	Accurately trimmed resistance of the Load standard Optimized and verified characteristic impedance of the thru/ line standards	Confidence in calibration and measurement results
WinCal XE calibration comparison and validation tool	Quick and insightful procedure to gain confidence in an on-wafer measurement system of unknown accuracy	Confidence in calibration and measurement results Ease of use

Dedicated wafer-level calibration methods

Vector network analyzers do not provide the front-panel calibration methods optimized to wafer-level measurement needs, e.g. insensitivity to the probe placement and dispersion of characteristic impedance of CPW lines[9]. Such methods are only available from the wafer-level calibration software WinCal XE (Fig. 15, Fig. 16, Table 1)[12,23-30].

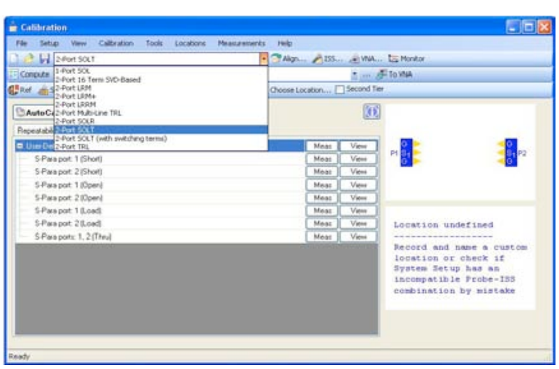


Figure 15. The extensive package of wafer-level calibration methods available from WinCal XE addresses needs of a wide variety of applications: from the probe-tip and up to in-situ calibration on semi-conductive wafer materials.

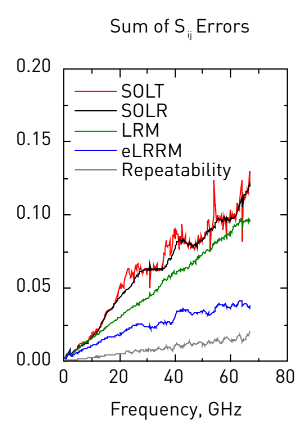


Figure 16. Comparison of different probe-tip calibration methods

Table 1. Recommended application of wafer-level calibration methods

Method	Application
SOLR	Off-wafer (ISS) calibration of rectangular configurations
NIST-Style TRL	On-wafer (in-situ) calibration on III-Vs (e.g. GaAs)
LRM+	On-wafer (in-situ) calibration on Si
LRRM	Off-wafer (ISS) calibration

Solution	Advantage	Benefit
Unique, wafer-level optimized calibration methods such as LRRM, LRM+, NIST-style multiline TRL and hybrid calibration available from WinCal XE	Out-of-box accurate and repeatable calibration and measurement of any DUT type Confidence in DUT extracted parameters Eliminates the need for calibration trouble-shooting	Save time and money
WinCal embedded extensive database of probe and calibration substrates	Quick and easy calibration setup Definition of calibration standard models is not required	Ease of use Save time

High quality cables

Often entry-level manual systems are equipped with cheap, low-quality cables. The impact of the phase and magnitude instability of such cables on calibration and measurement results increases drastically with the frequency. As a result, the system must be re-calibrated more often, which costs time and reduces the lifespan of high-value calibration standards.

In order to reduce calibration and measurement accuracy degradation, the EPS200RF package includes high-quality Gore cables (Fig. 17) that guarantee maximum amplitude and phase stability with flexure and minimal performance degradation with the time and assemble/dis-assemble cycles (Fig. 18)[31].

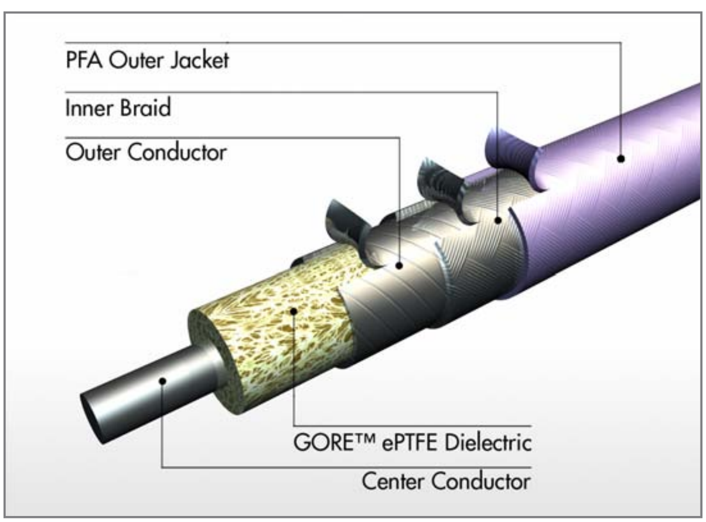


Figure 17. Construction of Gore cable assembly

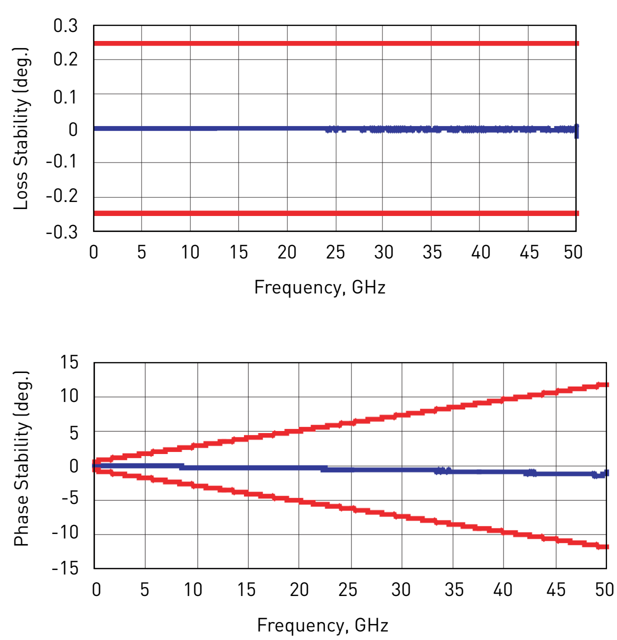


Figure 18. Amplitude and phase stability of Gore cables with flexure

Solution	Advantage	Benefit
Phase-stable, high-quality industry benchmark Gore cables	Repeatable, consistent calibration Minimal performance degradation over time	Ease of use Save time Protect your investment
67 GHz cables with two V(f)-K(m) adapters	System capability for 40, 50 and 67 GHz measurements without additional investment in cables/ adapters	Protect your investment for future system upgrade

Probing on small pads

RF probes are built on the cantilever force delivery mechanism that requires additional pad space supporting the probe forward skate. The probe skate might be up to some tens of microns long when probing on silicon wafers and aluminum pad metallization.

On the other hand, the impact of parasitic capacitance of the DUT contact pads increases with the frequency. It is common that measurements from approximately 3 GHz and above require significant minimization of the pad size. Nowadays, the unitization of contact pads as small as 50 µm x 50 µm is a common engineering practice for RF and mm-wave devices and circuits.

Probe-to-pad misalignment, which is in most cases caused by inaccurate location of positioners, unstable probe arms and inaccurate theta adjustment of the wafer, makes probing on small pads very challenging if not impossible—misaligned probes skate off of the pad or damage pads.

Aligning the 200 mm wafer, port-to-port adjustment of the magnetic or vacuum-based positioners can easily become a lengthy procedure.

The RF probe platen of the EPS200RF system, together with the bolt-down RPP305 RF positioner, its short and stiff probe arm, and "blind" operation concept, together with the fine-theta adjustment of the chuck (Fig. 19) and high-quality microscope configuration (Fig. 20) provide easy, accurate and consistent RF probe adjustment and placement.

In addition, Infinity Probe technology (Fig. 21)[2] enables probing on pads as small as 25 x 35 microns, even with Al metallization.

Figure 19. Chuck stage design with integrated coarse X/Y movement, fine X/Y positioning and fine-theta adjustment

Figure 20. Trinocular 6.7x stereo zoom microscope with 20x eyepieces included in EPS200RF package

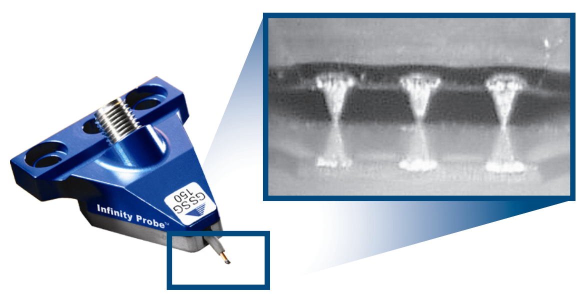


Figure 21. Infinity Probe technology

Solution	Advantage	Benefit
Fine-Theta adjustment of the wafer	Precise wafer-to-probes alignment	Ease of use
Bolt-down RPP305 positioners	Eliminate the need for port-to-port positioner adjustment	Ease of use
RPP305 positioners	Backlash-free, precise probe adjustment to the DUT pad	Ease of use
Solid and stiff probe arms with integrated planarization micrometer	Backlash-free, precise probe adjustment to the DUT pad Minimize pad damage	Ease of use
Contact substrate	Simple and effective probe planarization and planarization verification	Ease of use
Trinocular 6.7x stereo zoom microscope with 20x eyepiece	Optimal combination of the field-of-view / optical resolution for probing on pads as small as 25 µm x 35 µm Quick probe adjustment/ planarization	Ease of use Save money
Marked and one-side located micrometers of the RPP305 positioner	X, Y, Z final probe adjustment under continues optical DUT inspection ("blind operation")	Ease of use

Operation by inexperienced users

Inconsistent calibration and measurement results

It is common that universities and research institutes do not have dedicated, experienced RF operators of the measurement system, and the measurement setup is shared between different groups, with multiple users that access the test system infrequently. The lack of operator hands-on experience often leads to inaccurate probe alignment, inconsistent probe placement and contact force on both calibration standards and the DUT. As a result, measurement data obtained for the same device can vary significantly from operator to operator, and between different measurement and calibration sessions for the same operator.

Figure 22. Integrated gauge for precise adjustment of overtravel and live feedback of the probe platen position

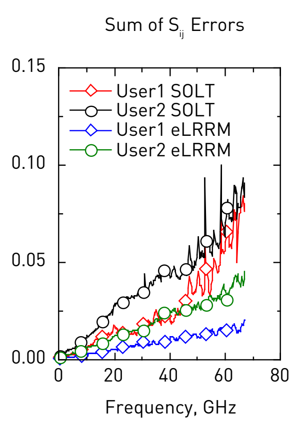


Figure 23. LRRM calibration provides consistent results that are less operator dependent

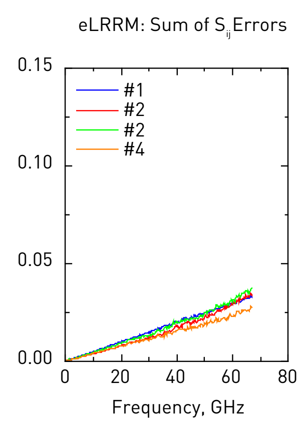


Figure 24. Highly repeatable LRRM calibration available from WinCal XE (included in package)

The probe platen of the EPS200RF integrates a gauge that provides live feedback on the platen position and supports even the inexperienced operator in setting accurate and consistent contact and overtravel heights across the entire wafer, ISS and measurement sessions (Fig. 22).

The enhanced LRRM calibration available from WinCal XE additionally improves the consistency of measured data as it is less sensitive to the probe placement on calibration standards and as a result, less sensitive to operator experience (Fig. 23, 24).

An extensive library of wizards, tutorials and examples available from WinCal XE supports inexperienced users for quick and correct system configuration and operation (Fig. 25).

Figure 25. WinCal XE embedded wizards and tutorials supporting inexperienced operators

Solution	Advantage	Benefit
WinCal XE LRRM calibration with patented load inductance determination procedure	Automated compensation for possible variation in the Load standard frequency response Minimized impact of inexperienced operator on calibration accuracy	Accurate and consistent calibration and measurement data
WinCal XE calibration wizards, extensive tutorials and library of examples	Quick and correct configuration and execution of calibration procedures	Minimized risk, simplified complexity of system RF calibration task Save time
Trinocular 6.7x stereo zoom microscope with 20x eyepiece	Optimal combination of the field-of-view / optical resolution for quick and accurate probe placement	Ease of use
400 micron platen contact-separation drive with +/- 1 micron repeatability	Consistent contact force over all calibration standards and wafer Gentle, smooth and simultaneous device contacting by all probes at the same time Constant probe-to-probe distance between calibration standards	Ease of use
Gauge for measurement of probe platen position	Live feedback of the applied overtravel Contact force consistency comparable to semi-automated system	Repeatable and consistent calibration and measurement
Phase and magnitude stable Gore cables	Reduces need for system recalibration after accidental touch/move of cables	Save time

Avoid high risk of damaging RF probes, calibration standards and DUT pads

A lack of experience also increases risk for damage RF probes, calibration standards and DUT pads when operating a manual system. The design of the RF probe platen and the platen drive mechanism prevents the probes from crashing unexpectedly. The adjustable marker on the platen gauge (Fig. 22) and the fixed and marked position of the contact/separation handle (Fig. 1) help to minimize risk of moving the chuck while it is in contact.

The robustness of the |Z| Probe technology with 200 micron tip compliance supports the first steps of inexperienced operators in building their confidence in wafer probing (Fig. 26).

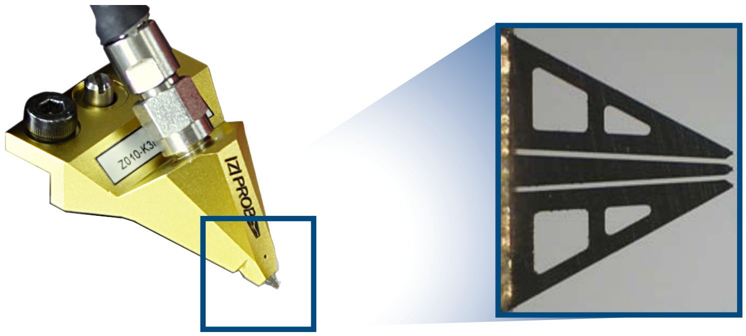


Figure 26. Long MEMS-fabricated coplanar contacts of |Z| Probe provide 200 micron tip compliance and are less sensitive to critical actions

Solution	Advantage	Benefit
Platen drive designed to keep the platen fixed at any arbitrary position between contact and separation	No risk for probe damage due to accidental platen drop from separation to contact position	Ease of use Save time Protect your investment
Available |Z| Probes	Guaranteed 200 micron tip compliance	Save money

The need for frequent system re-configuration

Shared laboratories or limited-budget projects frequently require a system that must support multiple applications on a single platform. Changeover from IV/CV to RF and microwave measurements, from measurement of passive devices to ICs, and from two to 3- or 4-port configurations, can turn into a complicated and time-consuming task that is associated with a high risk of possible mistakes. The new configuration of the DUT, such as different contact pitch, pad layout, frequency range, contact pad material and port count, requires the change and re-adjustment of RF probes. Moreover, the new probe connection coefficients have to be entered manually from the VNA front panel as a new calibration kit and the system must be re-calibrated. In some cases, modification of the probe platen may be required.

System reconfiguration is always associated with re-connecting, re-locating and re-banding RF cables. RF cables have a limited lifetime, as every mechanical stress degrades cable performance of low-quality cables.

Often, engineers are asked to probe small parts of the wafer or even diced single chips. The small geometry of the test element does not allow it to be properly fixed on the chuck. Insufficient fixation of the device under test on the chuck due to lack of vacuum holes makes probing very difficult, reduces contact quality and, as a result, leads to inconsistent measurement data.

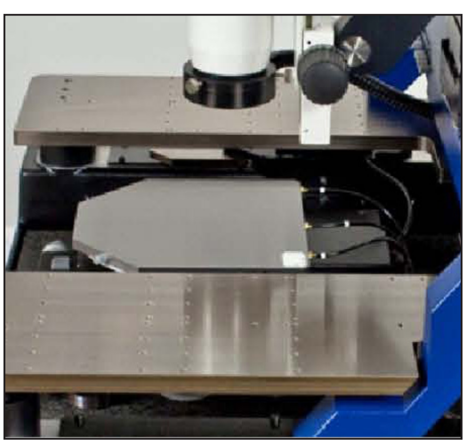


Figure 27. Multi-purpose RF platen supporting various positioner configurations

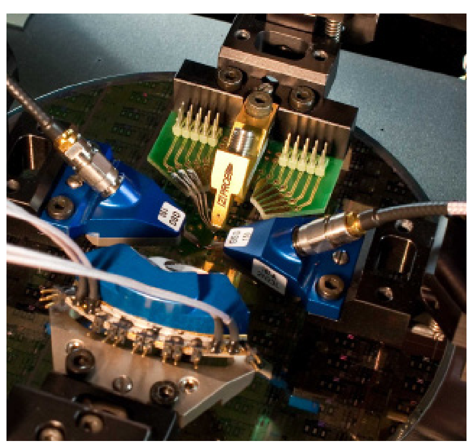


Figure 28. Four-port configuration option for IC verification and debug

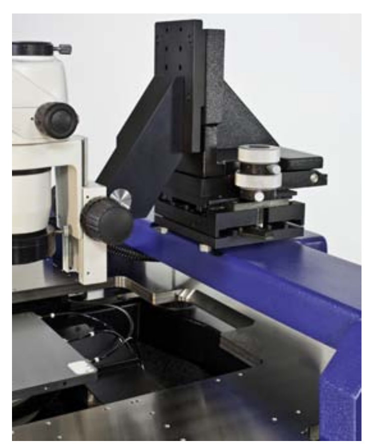


Figure 29. Solid design of the microscope RF bridge and transport with tilt lift

The EPS200RF multi-purpose RF platen with bolt-down RPP305 positioners (Fig. 27), pre-configured options for 4-port probing (Fig. 28), the design of the microscope bridge and transport with the quick-tilt lift (Fig. 29) makes frequent system re-configuration quick and seamless.

The chuck of the EPS200RF has additional four vacuum holes at its center (Fig. 30) to support probing on diced chips (Fig. 31).

A complete database of probe calibration coefficients and calibration standards embedded in WinCal XE makes switching the probe configuration as simple as a mouse click (Fig. 32).

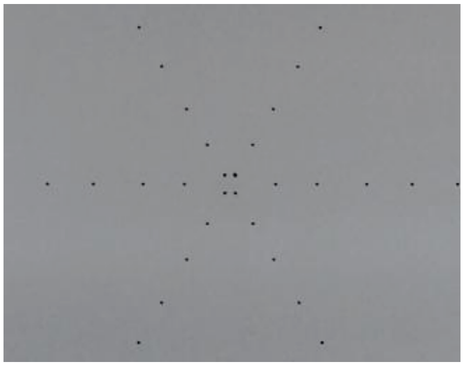


Figure 30. Vacuum holes of the RF chuck supporting single chip probing

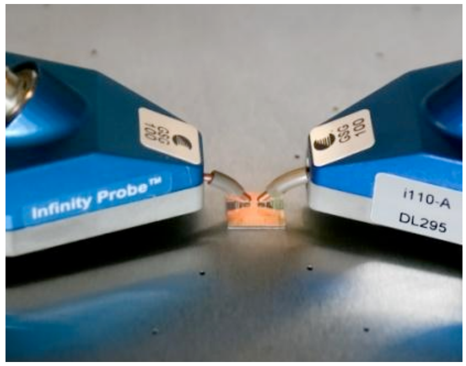


Figure 31. Probing of a single chip on RF chuck of EPS200RF

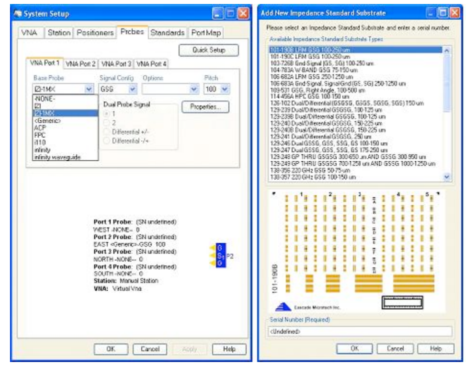


Figure 32. Complete database of Cascade Microtech's RF probes and calibration substrates embedded in WinCal XE

Solution	**Advantage**	**Benefit**
RPP305 E/W probe arms in NW/SE, full 4-port compatible	Ready for the full 4 RF ports E/S/W/N configuration Ready for additional bias ports	Save money, protect your investment
Multi-purpose RF Probe platen	Holes supporting different RPP305 locations as well as full 4 port configuration	Quick and easy system reconfiguration and upgrade
Option for 4-port RF configuration	Two additional RPP305 positioners with S/N probe arms included in one part number	Quick ordering Eliminates mistake of misconfigurations
Stiff RPP305 probe arms	Stable and precise handing of multi-contact and mixed-signal probes	Ease of use
High-quality cable with durable construction that resists crushing, twisting, and kinking	Long cable service life	Save money
WinCal XE embedded extensive database of probe and calibration substrates	Quick and easy calibration setup Definition of calibration standard models is not required	Ease of use Save time and money
Additional holes at the chuck center	Probing diced chips on the chuck without additional chip holders	Saves time and money

Convenience and ease of use

Quick and precise navigation

The test chip typically consists of different device geometries and associated contact pad de-embedding dummy elements. Often there are several test chips that are distributed over the wafer. Testing a targeted DUT requires long-distance navigation over the entire wafer (chip-to-chip or site-to-site) as well as precise movement within a test chip (sub-site).

Calibration standards, calibration verification elements and probe cleaning pads are located off-wafer on AUX chucks. Switching between measurement mode and system calibration/verification and probe clean up requires long-distance chuck travel.

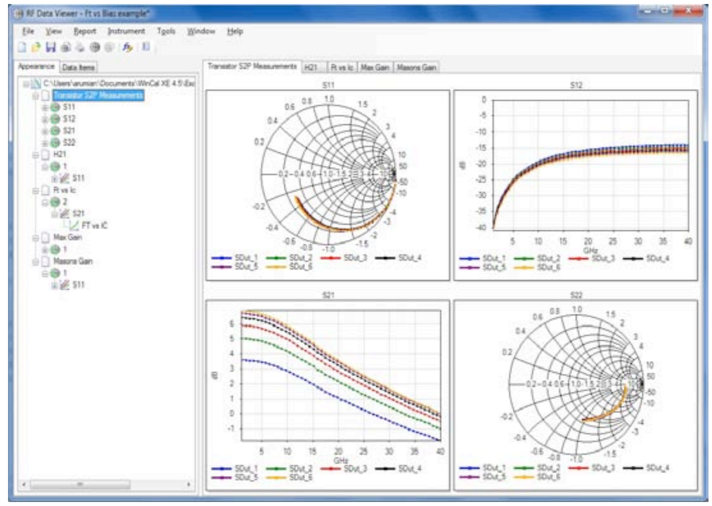


Figure 33. Example of measurement data taken with WinCal XE

The unique design of the chuck stage (Fig. 19) enables quick and simultaneous coarse movement in both X and Y axes and precise fine adjustment around the targeted position provides switching from measurement (on-wafer) to calibration or probe cleaning (on AUX chuck) in a second. The capability for independent coarse movement for Y or X axes significantly simplifies and speeds up the chip-to-chip stepping.

An extensive collection of measurement examples and data report styles available from the WinCal XE measurement tool helps to take data of various DUT types right away (Fig. 33). No additional measurement software is needed.

Solution	Advantage	Benefit
Unique design of the chuck X/Y stage	Quick coarse movement and sub-micron positioning Quick switch between DUT measurement (on-wafer) and calibration/verification/ probe clean (on AUX chuck) Integrated navigation marker Independent X/Y stepping	Ease of use
400 micron contact/separation platen drive	Quick measurement /navigation switch Navigation always in focus on DUT/wafer	Ease of use
WinCal XE DUT measurement tool with extensive set of examples	Quick start-up Additional measurement software is not required in most cases	Ease of use Save money

Stable optical system

Positioning and re-adjustment of the microscope to the probes and DUT after the system re-configuration become an ongoing exercise if the system is not equipped with the solid, rigid microscope bridge and transport system. The same is true for navigating over the long test devices that do not fit to the scope field-of-view such as multi-functional ICs and long transmission lines.

Dedicated RF microscope bridge and transport of the EPS200RF (Fig. 29) supports quick and easy navigation over the wafer in-line with the chuck stage.

Solution	Advantage	Benefit
Dedicated RF microscope bridge	Rigid and stable microscope position	Ease of use
Microscope drive	Microscope navigation over the wafer in-line with the chuck X/Y stage	Ease of use

Changeover for calibration, measurements and probe cleaning

Depending on the technology, material and application, the thickness of the wafer varies in a wide range and may be very different from that of calibration and contact substrates as well as the probe cleaning pads. As a result, cleaning probes and/or re-calibrating the system may require a lengthy and time-consuming re-adjustment of the contact height.

The EPS200RF platen drive with a 400 micron contact/separation quick move and the capability to fix the platen at an arbitrary position (Fig. 1) significantly simplifies switchover between measurement, calibration, calibration verification and probe clean.

Integrated ceramic AUX chuck of the RF chuck holds the calibration substrate at comparable with the wafer height (Fig. 7). It eliminates the need to re-adjust contact height between calibration and measurement.

Solution	Advantage	Benefit
45 mm platen drive with 400 micron contact/separation mechanism that can be used at arbitrary positions	Positioner re-adjustment in Z is not required when changing between measurements, calibrations or when cleaning probes	Ease of use
RF chuck with two integrated AUX sites	Eliminates the need for change over between measurement, calibration and probe cleaning as wafer, ISS and cleaning pads are held on the chuck simultaneously.	Ease of use

Summary

Characterization of modern RF devices and integrated circuits is associated with serious challenges. Engineers are called upon to deliver high-precision measurement results, dealing with structures and multi-functional ICs that continuously decrease physical dimensions, increase operation frequencies and increase the level of integration complexity.

The EPS200RF SMART package is an uncompromised solution that quickly supports every engineer in achieving the highest level of accuracy and confidence in measurement results. It delivers flexibility and enables probing on cutting-edge technologies as a complete solution – ready for your application – right out of the box!

References

[1] E. M. Godshalk, J. Burr, and J. Williams, "An air coplanar wafer probe," in European Microwave Conference, 24th, 1994, pp. 1380-1385.

[2] A. M. E. SafWat, M. Andrews, L. Hayden, K. R. Gleason, and E. Strid, "A probe technology for 110+ GHz integrated circuits with aluminum pads," in ARFTG Microwave Measurements Conference-Spring, 59th, 2002, pp. 60-66.

[3] M. Wollitzer, S. Thies, and S. Schott, "New probing technology now enables impedance controlled on-wafer probing," in Microwave Conference, 2001. 31st European, 2001, pp. 1-4.

[4] "Recommended procedures for using Probe Clean™ (PN 134-208) cleaning materials," PCLEAN-0705, Cascade Microtech, Inc., 2005.

[5] E. M. Godshalk, "Surface wave phenomenon in wafer probing environments," in ARFTG Microwave Measurements Conference-Fall, 40th, 1992, pp. 10-19.

[6] A. J. Lord, "Comparing the accuracy and repeatability of on-wafer calibration techniques to 110GHz," in European Microwave Conference, 1999, pp. 28-31.

[7] F. J. Schmueckle, R. Doerner, G. N. Phung, W. Heinrich, D. Williams, and U. Arz, "Radiation, multimode propagation, and substrate modes in W-band CPW calibrations," in Microwave Conference (EuMC), 2011 European Manchester, UK, 2011.

[8] A. Rumiantsev, R. Doerner, and E. M. Godshalk, "Influence of calibration substrate boundary conditions on CPW characteristics and calibration accuracy at mm-wave frequencies," ARFTG Microwave Measurements Conference-Fall, 72nd, pp. 168-173, 2008.

[9] A. Rumiantsev and N. Ridler, "VNA calibration," Microwave Magazine, IEEE, vol. 9, pp. 86-99, 2008.

[10] A. M. E. Safwat and L. Hayden, "Sensitivity analysis of calibration standards for fixed probe spacing on-wafer calibration techniques," in Microwave Symposium Digest, 2002 IEEE MTT-S International, 2002, pp. 2257-2260.

[11] E. Strid, "Planar impedance standards and accuracy considerations in vector network analysis," in ARFTG Microwave Measurements Conference-Spring, 27th, 1986, pp. 159-166.

[12] A. Davidson, K. Jones, and E. Strid, "LRM and LRRM calibrations with automatic determination of load inductance," in ARFTG Microwave Measurements Conference-Fall, 36th, 1990, pp. 57-63.

[13] A. Rumiantsev, P. Sakalas, N. Derrier, D. Celi, and M. Schroter, "Influence of probe tip calibration on measurement accuracy of small-signal parameters of advanced BiCMOS HBTs," in Bipolar/BiCMOS Circuits and Technology Meeting (BCTM), 2011 IEEE Atlanta, GA, 2011.

[14] D. Williams, R. Marks, K. Phillips, and T. Miers, "Progress toward MMIC on-wafer standards," in ARFTG Microwave Measurements Conference-Fall, 36th, 1990, pp. 73-83.

[15] R. B. Marks and D. F. Williams, "Characteristic impedance determination using propagation constant measurement," IEEE Microwave and Guided Wave Letters, vol. 1, pp. 141-143, June 1991.

[16] D. F. Williams and R. B. Marks, "Transmission line capacitance measurement," Microwave and Guided Wave Letters, IEEE, vol. 1, pp. 243-245, 1991.

[17] F. Williams, "Characterization of thin-film calibration elements," in ARFTG Microwave Measurements Conference-Fall, 38th. vol. 20, 1991, pp. 25-35.

[18] D. F. Williams, R. B. Marks, and A. Davidson, "Comparison of on-wafer calibrations," in ARFTG Microwave Measurements Conference-Fall, 38th. vol. 20, 1991, pp. 68-81.

[19] "Technique verifies LRRM calibration for GaAs measurements," Cascade Microtech, Inc, 1994.

[20] A. Rumiantsev, R. Doerner, and S. Thies, "Calibration standards verification procedure using the calibration comparison technique," in 36th European Microwave Conference, 2006, pp. 489-491.

[21] D. Williams, "On-wafer microwave standards at NIST," in ARFTG Microwave Measurements Conference-Fall, 34th, 1989, pp. 5-10.

[22] J. R. Fenton, "Validation of on-wafer vector network analyzer systems," in ARFTG Microwave Measurements Conference-Fall, 68th, 2006, pp. 50-54.

[23] L. Hayden, "A commercial multi-line TRL calibration," in ARFTG Microwave Measurements Conference-Fall, 70th, 2007, pp. 91-95.

[24] R. F. Scholz, F. Korndorfer, B. Senapati, and A. Rumiantsev, "Advanced technique for broadband on-wafer RF device characterization," in ARFTG Microwave Measurements Conference-Spring, 63rd, 2004, pp. 83-90.

[25] R. B. Marks, "A multiline method of network analyzer calibration," Microwave Theory and Techniques, IEEE Transactions on, vol. 39, pp. 1205-1215, 1991.

[26] A. Ferrero and U. Pisani, "Two-port network analyzer calibration using an unknown `thru'," Microwave and Guided Wave Letters, IEEE, vol. 2, pp. 505-507, 1992.

[27] L. Hayden, "An enhanced Line-Reflect-Reflect-Match calibration," in ARFTG Microwave Measurements Conference-Spring, 67th, 2006, pp. 143-149.

[28] R. Doerner and A. Rumiantsev, "Verification of the wafer-level LRM+ calibration technique for GaAs applications up to 110 GHz," in ARFTG Microwave Measurements Conference-Spring, 65th, 2005, pp. 15-19.

[29] A. Rumiantsev, S. L. Sweeney, and P. L. Corson, "Comparison of on-wafer multiline TRL and LRM+ calibrations for RF CMOS applications," ARFTG Microwave Measurements Conference-Fall, 72nd, pp. 132-135, 2008.

[30] A. Rumiantsev, P. Sakalas, F. Pourchon, P. Chevalier, N. Derrier, and M. Schroter, "Application of on-wafer calibration techniques for advanced high-speed BiCMOS technology," in Bipolar/BiCMOS Circuits and Technology Meeting, 2010. BCTM '10. IEEE Austin, TX, 2010, pp. 98-101.

[31] "GoreTM microwave test assemblies for use in making precision electrical measurements ", W. L. Gore & Associates, 2005.

Contact height gauge
- Precise overtravel adjustment
- Reliable and repeatable contact quality

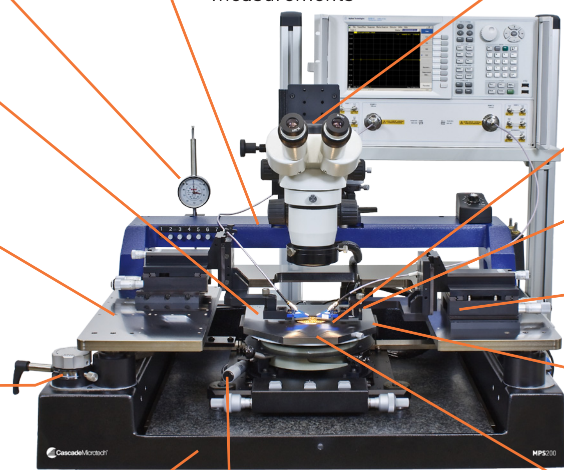
Unique chuck stage
- Quick coarse Y/X movement and sub-micron positioning
- X/Y stepping with independent axes lock

Tailored RF platen and 45 mm platen drive
- Precise mount of up to four positioners
- Flexibility for wafer-level and package test

Unique 400 µm platen contact/ separation drive
- Highest contact accuracy and consistency over entire wafer
- Convenience and ease of use

Vibration isolation solution
- Stabilizes contact and minimizes pad damage

High-quality industry benchmark 67 GHz cables
- Long lifetime and consistent measurements



Fine Theta adjustment
- Precise probe-to-pad alignment for small pads

Trinocular 6.7x stereo zoom scope with 20x eyepiece
- Optimized field of view
- Accurate probe placement on small pads
- Camera-ready

Dedicated RF chuck
- Consistent measurement boundary conditions over entire wafer

Unique ceramic AUX site
- Homogeneous and optimized calibration conditions

Solid and stable positioners
- Accurate probe positioning, consistent contact force and overtravel

Verified calibration standards
- Accurate calibration, verification and measurement assurance

ACP Probes, Infinity Probes or |Z| Probes
- Your choice of application-optimized probes for best measurement accuracy*

** Terms and conditions apply. See sales representative for details*

Ordering Information

Part Number	Description
EPS200RF	SMART 200 mm RF manual station package
EPS-ACC-200RF-4P	4-port option for EPS200RF package containing two RPP305 positioners and two N/S RF arms
EPS-ACC-TV	Analog TV option for EPS packages containing C-mount PAL TV camera, cables, power supply and 17" TV monitor

For more information contact us at 1-800-550-3279 (1-503-601-1000) or email sales_support@cmicro.com

EPS200RF-TR-0212

Cascade Microtech, Inc.
Corporate Headquarters
toll free: +1-800-550-3279
phone: +1-503-601-1000
email: cmi_sales@cmicro.com

Germany
phone: +49-89-9090195-0
email: cmg_sales@cmicro.com

Japan
phone: +81-3-5615-5150
email: cmj_sales@cmicro.com

China
phone: +86-21-3330-3188
email: cmc_sales@cmicro.com

Singapore
phone: +65-6873-7482
email: cms_sales@cmicro.com

Taiwan
phone: +886-3-5722810
email: cmt_sales@cmicro.com

CascadeMicrotech®