

PROBEPOINT™

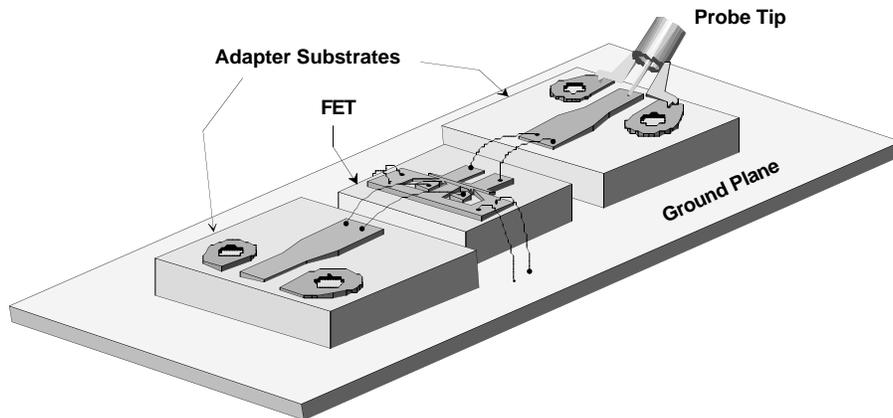
MICROPROBING TEST ACCESSORIES

**MICROPROBING TEST FIXTURES, TEST INTERFACE CIRCUITS
&
CALIBRATION STRUCTURES**

Applying On-wafer Microprobes To "Microstrip" Device Characterization

A Family of Coplanar Microprobe to Microstrip Circuit Adapter Products

- Reduce Cost, Improve Repeatability, Improve Accuracy -



Standard and Custom Products Available Include:

- Microprobing Test Fixtures -*
- Microprobing Test Cables -*
- Calibration Structures -*
- Adapter Substrates in 5, 10 and 15 mil Thickness -*
 - with Kelvin Test Point -*
 - with Microwave Signal Sample Port -*
 - with Series Resistor for bias stabilization -*



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PROBEPOINT™ 15, 10 or 05 Samples

The PROBEPOINT™ adapter substrates are easily configured to fixture a microstrip component for measurement with coplanar waveguide wafer probes.

Typical Fixture parts list:

- | | |
|--|--|
| <i>1. Carrier</i> | <i>Substrate or metal heatsink plate</i> |
| <i>2. Device to be Tested</i> | <i>Any microstrip compatible component</i> |
| <i>3. PROBEPOINT™ adapter substrates</i> | <i>PROBEPOINT™15, 10 or 05 Series</i> |

Typical Assembly Procedure

- 1. Attach DUT to carrier with epoxy or eutectic alloy*
- 2. Attach PROBEPOINT™ adapter substrates to carrier adjacent to DUT with either conductive epoxy or eutectic alloy.*

note: Spacing between adapter substrate and DUT should be similar to actual use environment or as close as possible to minimize the effect of wirebond parasitic reactance.

- 3. Wire bond between PROBEPOINT™ adapter substrate and the DUT. Bond wires should be minimal length or equal to the length expected in actual use.*

Test Method

I. Indirect Calibration - Limited to less than 20 GHz

- 1. Calibrate CPW probes using standard method with ISS (impedance standard substrates)*
- 2. Using the display control for the network analyzer, extend the calibrated reference planes for both the input and output ports 5.1 psec.*

II. Direct Calibration - Adequate calibrations to greater than 50 GHz.

Calibrate the CPW probes plus the adapter substrates by using the appropriate Calibration Structures Substrate, either a CM10, CM12, CM15 or CM05.



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Test Adapter Substrates Ease The Task of Measuring PHEMT FETs



Figure 1 - ProbePoint™1003 Adapter Substrate

Summary

A new method of fixturing microstrip die and other non-coplanar devices is described. An example Pseudomorphic High Electron Mobility Transistor (FET) measurement to 50 GHz is shown along with companion noise parameters to 26 GHz. The direct adapter substrate calibration technique is discussed and verification data shown.

Introduction and Background

The use of coplanar and coaxial microprobes has made many microwave measurements easier and more accurate. However, there are many products, including FETs, MMICs, chip capacitors, chip resistors, chip inductors that are designed for microstrip applications. None of these products have the required signal and ground pads orientation and the required spacing allowing microprobing. These devices will generally be wire bonded into a circuit, so that the wire bond becomes one of the circuit elements. Consequently, it is desired that the measured S-parameters of this device also include the bond wire response. For example, a low noise GaAs FET die will generally be die attached to a metalized ceramic substrate, and the gate, drain, and source are bond wired (using very short double bonds) to the specified pads on the substrate. Note that the bond wire lengths of the test samples must be identical with the specific application.

Until recently, these measurements have been difficult and tedious. A new set of adapters and associated calibration technique makes these measurements straightforward. The adapters, shown in Figure 1, adapt a coplanar probe to microstrip, which connects to the DUT with bondwires. A typical low noise FET application is shown in Figure 2.

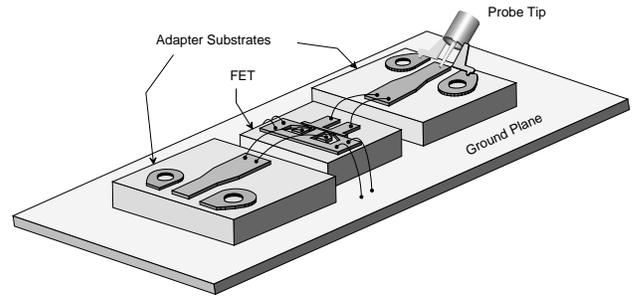


Figure 2. - PHEMT with Adapter Substrate

Double bonds (as used in the actual application) connect the gate and drain metalization to the adapter microstrip. The source metalization is wire bonded to the ground plane, which is common to the entire setup. Any gold metalized conductor works well for the carrier. The DUT dice and the adapter substrates are either attached with silver epoxy or eutectic solder, as required.

Example Measurements

Microwave semiconductor manufacturers and customers are using the adapters to measure advanced devices. An example use of the adapters is for recent measurements of the low noise Litton Solid State LP7512 PHEMT FETs S-Parameters to 50 GHz, and noise parameter measurements to 26 GHz. The DUTs were set up as shown above in Figure 2. using 10 mil thick adapter substrates. After calibration (described below), excellent data was obtained through 50 GHz. The S-parameter data is shown in Figure 3.

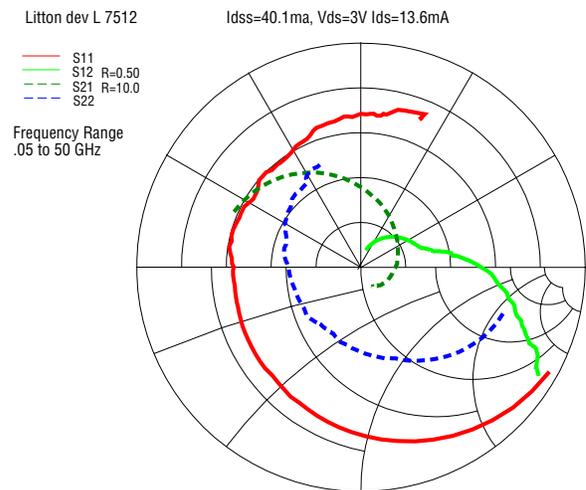


Figure 3. - LP7512 S-Parameters

The measured noise parameter data also looked equally as good and self consistent, particularly for such low noise devices. The quality of the data indicates that both the adapter substrates and the associated calibration techniques were performing properly, comparable to good "on-wafer" data. Important to the quality of the measurements is both the "transition" integrity from the microprobe tip to microstrip bond pad and the calibration precision.

Calibration

The calibration technique and standards are critical to the correct use of these adapters, particularly above 26 GHz. At lower frequencies, and for less demanding measurements, many people simply calibrate their Automatic Network Analyzer up to the probe tips, as before for on-wafer measurements. Then they move the reference planes out 5.1 ps to compensate for the adapter substrate delay. For more accurate requirements, and beyond 26 GHz, a better method is needed. This is provided by using a TRL calibration technique with the PP CM10 cal substrate. When used together with the cal kit available on floppy disk, the correct direct calibration of the adapter substrates is easily obtained. This technique was used in the above example.

Table 1. PP CM10 - Cal - Kit Description.

Cal Kit File Name	Cal Kit Name	Cal Method	Recommended Min/Max Frequency
CK_SOLT	PP10SOLT	Short, Open, Load, Thru	DC to 10 GHz
CK_LRM	PP10LRM	Line, Reflect, Match	DC to 50 GHz
CK_TRL	PP10TRL	Thru, Reflect, Line	1.5 to 50 GHz

The calibration technique is easy:

1. Load the TRL cal kit labeled CK_TRL into the network analyzer; see Table 1. If your Automatic Network Analyzer is not able to read the enclosed disk, a tabular listings for manual data input is available from J microTechnology.
2. Sequentially probe the standards standard identified in Figure 4, stepping through the cal process. It is important to place the probes at the same location with respect to the vias, when probing each calibration structure.
3. Verify the calibration. A one port verification can easily be performed by placing the probes, one at a time, on Line42S (see Figure 4). The response should be a spiral on a Smith chart, similar to Figure 5.

A two port cal can be verified by placing both probes on Line11 (a total 22.2 ps long line). Be sure to place the probes at the same position relative to the vias as during the cal process. The S11 and S22 response should be well controlled, with the maximum reflection of 30+ dB at 10 GHz, and 20-30 dB at 50 GHz. The delay should be 12 ps (read off the display of the Network Analyzer), demonstrating that the offset calibration is indeed offset by 5.1 ps on each port.

4. Proceed to measure

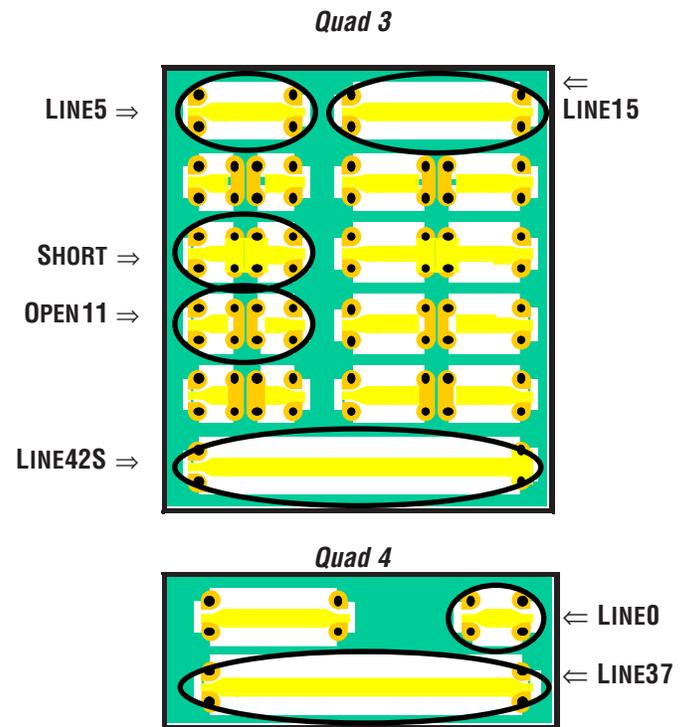


Figure 4 - TRL Calibration Structures on the ProbePoint™ CM10 Calibration Structures Substrate

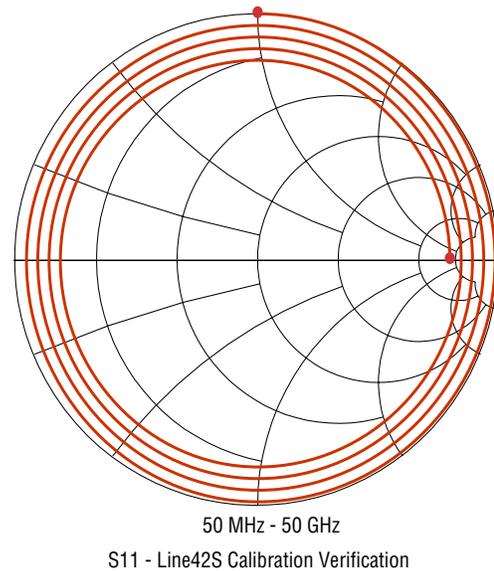


Figure 5. - Calibration Verification

Closing Discussion

In actual practice, it is relatively easy to get good calibrations to 50 GHz using the TRL methods, much easier than SOLT methods, for example. It is important though to consistently contact each calibration standard at the same position relative to the vias. This same relative position should be used also when performing measurements using the adapters substrates. Physical repeatability is key to achieve electrical repeatability.

J microTechnology, 3744 NW Bluegrass Pl., Portland, OR 97229; (503) 614-9509.



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ProbePoint™xx - Test Interface Circuits

J MICROTECHNOLOGY offers a family of thin film components to adapt the benefits of coplanar waveguide wafer probe test methods to the measurement of microstrip circuits. These components enhance productivity in product development and product assurance testing for semiconductors and packages. Test capability is also improved with the availability of "Kelvin" test points and broadband 10X signal sample points on adapter substrates. Some versions are available with series resistors to provide bias current stability. Calibration structures substrate and companion printed calibration kits are available for all adapter substrate configurations.

The problem:

The cost of preparing test samples for design verification or for "Group A" product testing is high when the device cannot be measured on wafer. The accuracy and repeatability of test is compromised when connectorized fixtures are used. The direct measurement of voltages at the device under test are difficult and waveform monitoring is nearly impractical.

The products:

The products are test adapter and interface circuits. Each adapter circuit type primarily transforms a signal path from coplanar waveguide to microstrip transmission mode. Additional features of Series resistors and DC and signal sense are present on some product types. The products are targeted at the GaAs MMIC and transistor semiconductor market segments. Physically they are available in 5, 10 and 15 mil thickness, making them compatible with a wide range of packages and high performance microwave semiconductors. The use of these devices results in lower cost test fixturing and higher quality product testing.

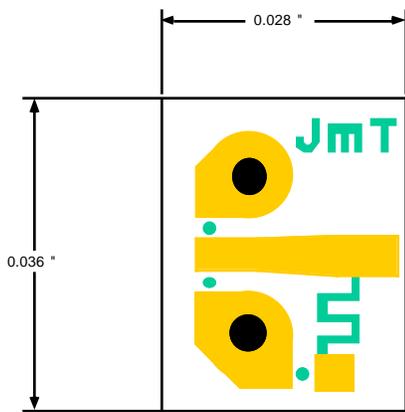
Products available include the following types in 5 and 10 mil versions. A description of the products can be found in the following pages.

ProbePoint™ Part Number			Description
5 mil	10 mil	15 mil	
0501	1001	-	Coplanar to Microstrip with a Kelvin sense point. The Kelvin sense point can be probed with a needle probe for DC voltage monitoring or with a G-S coplanar probe as a 20X signal sense point.
0502	1002	-	Coplanar to Microstrip with a Kelvin sense point. The Kelvin sense point can be probed with a needle probe for DC voltage monitoring or with a G-S coplanar probe as a 10X signal sense point.
0503	1003	1503	Coplanar to Microstrip.
-	-	1505	Coplanar to Microstrip with precision series resistor for bias stability
0504	-	-	Load Chip
0505			
CM05	CM10	CM15	Calibration substrate for the test adapter and interface circuit products. This substrate contains the standards necessary to calibrate using any of the normally used techniques, including SOLT, TRL, LRM, LRL. All adapter circuit patterns are represented which allows direct precision calibration of the test environment.
	CM12		
0510	-	-	Microstrip Transmission Lines
0520			
0530			

Application:

In use, the package, GaAs MMIC or Transistor would be mounted, either singly or in an array, on a carrier substrate/heat sink with the test adapter and interface circuits adjacent to each input bonding pad. This assembly can be contacted in a coplanar probing test environment. The result is that "microstrip" semiconductor chips and passive components can be probed with "coplanar" probes on low cost fixtures.

ProbePoint™ 0501 Test Interface Circuit - Coplanar to Microstrip with Kelvin (20X)



Test adapter and interface substrate for microstrip type active and passive components. Useful as a contact for test of devices which have a nominal “back-side ground.” Can also be used as a high impedance test point inserted into the signal path of active components.

Zo 50Ω
 Kelvin Point 950Ω nominal
 20X sample point

Metalization
 Front/Back Au
 Size 5 X 28 X 36 mils

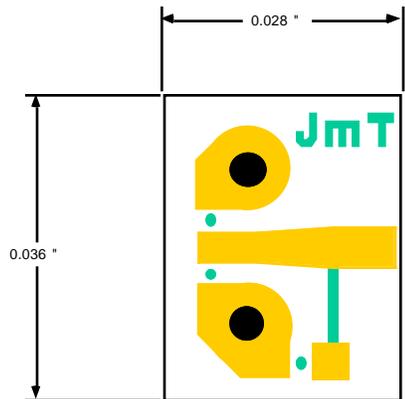
Features

- Compatible to coplanar probes 125μ to 250μ pitch
- Insertible circuit test point
- Kelvin test point
- 20X high speed test point
- Controlled impedance transition
- High quality backside vias

Benefits

- High precision
- High repeatability
- High accuracy measurements
- Calibration structures available
- Low cost test tooling

ProbePoint™ 0502 Test Interface Circuit - Coplanar to Microstrip with Kelvin (10X)



Test adapter and interface substrate for microstrip type active and passive components. Useful as a contact for test of devices which have a nominal “back-side ground.” Can also be used as a high impedance test point inserted into the signal path of active components.

Zo 50Ω
 Kelvin Point 450Ω nominal
 10X sample point

Metalization
 Front/Back Au
 Size 5 X 28 X 36 mils

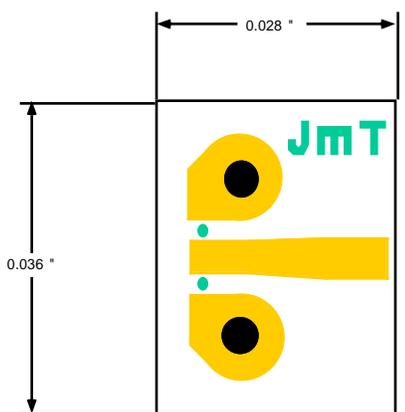
Features

- Compatible to coplanar probes 125μ to 250μ pitch
- Insertible circuit test point
- Kelvin test point
- 10X high speed test point
- Controlled impedance transition
- High quality backside vias

Benefits

- High precision
- High repeatability
- High accuracy measurements
- Calibration structures available
- Low cost test tooling

ProbePoint™ 0503 Test Interface Circuit - Coplanar to Microstrip



Test adapter and interface substrate for microstrip type active and passive components. Useful as a contact for test of devices which have a nominal “back-side ground.” Can also be used as a 50Ω transmission line inserted into the signal path of active components.

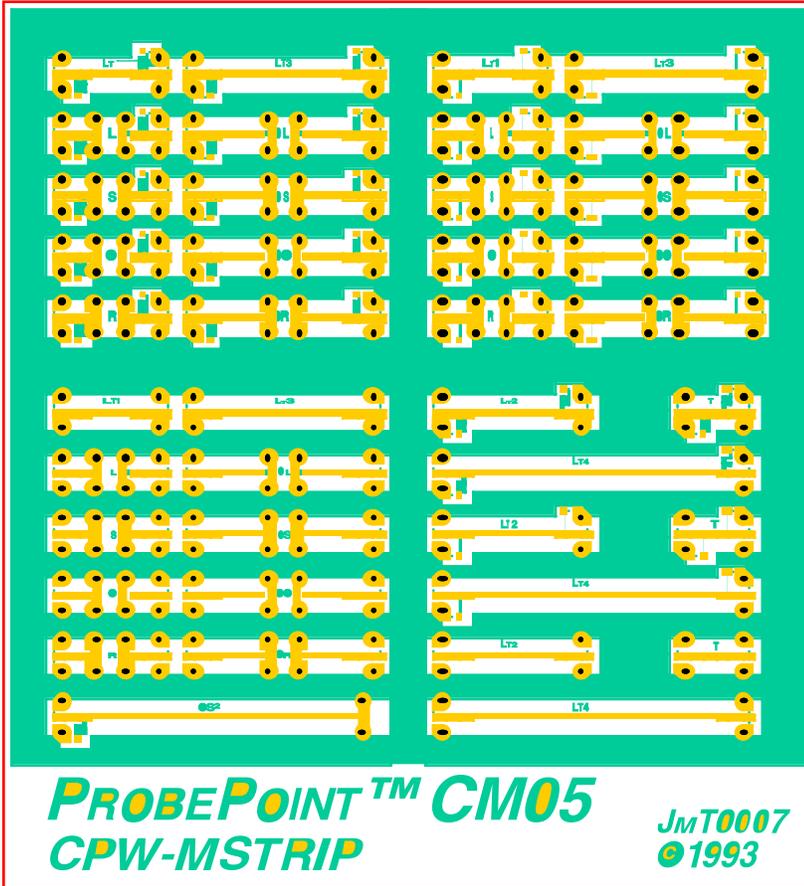
Zo 50Ω
 Metalization
 Front/Back Au
 Size 5 X 28 X 36 mils

Features

- Compatible to coplanar probes 125μ to 250μ pitch
- Controlled impedance transition
- High quality backside vias

Benefits

- High precision
- High repeatability
- High accuracy measurements
- Calibration structures available
- Low cost test tooling



This substrate contains calibration structures to be used in the establishment of measurement corrections terms for measurements using network and time domain analysis. A variety of microwave structures which support the popular calibration methods are available for all the ProbePoint™ 05 Test Interface Circuits. This allows direct calibration to the microstrip bond pad side of the ProbePoint™ Test Interface Structures.

Zo 50Ω nominal

Metalization

Front/Back Au

Resistors TaN

Size 15 X 525 X 480 mils

Features

- Compatible to coplanar probes

125μ to 250μ pitch

- Flexible to various calibration methods:

- SOLT

- LRM

- LRL

- TRL

- Laser trimmed resistors - ±1%

- Controlled impedance transition

- High quality backside vias

Benefits

- Direct Calibration

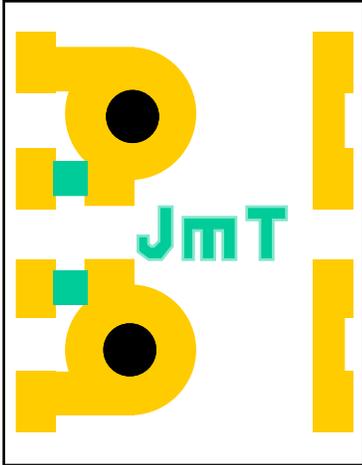
- High repeatability

- High accuracy calibration

- Low cost

- User flexibility

ProbePoint™ 0504 Test Load Circuit



Test load circuit for characterization of packages and interconnection structures. Useful as a “standard” electrical load element mounted at the nominal bond pad region of a package. Electrical elements are in pairs to allow adjacent lead test measurements for modeling cross coupling.

Load Resistor 50Ω nominal

Metalization

Front/Back Au

Resistor TaN
(thermally trimmed)

Size 5 X 28 X 36 mils

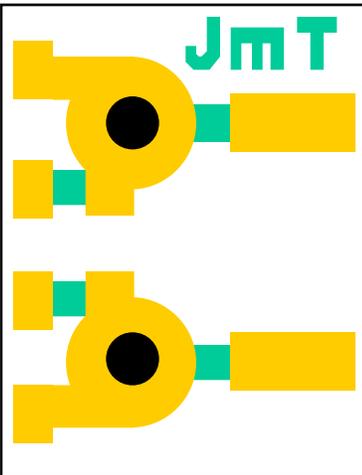
Features

- Compatible with the majority of semiconductor device packages.
- Three pairs of Standards
 - 2 ea 50 Ω “loads”
 - 2 ea “shorts”
 - 2 ea “thru lines”
- Wire bondable Au contacts
- Eutectic or epoxy die attach
- High quality backside vias

Benefits

- High precision and repeatability
- Highly flexible test tooling
- Low cost test tooling

ProbePoint™ 0505 Test Load Circuit



Test load circuit for characterization of packages and interconnection structures. Useful as a “standard” electrical load element mounted at the nominal bond pad region of a package. Electrical elements are in pairs to allow adjacent lead test measurements for modeling cross coupling.

Load Resistor 50Ω nominal

Metalization

Front/Back Au

Resistor TaN
(thermally trimmed)

Size 5 X 28 X 36 mils

Features

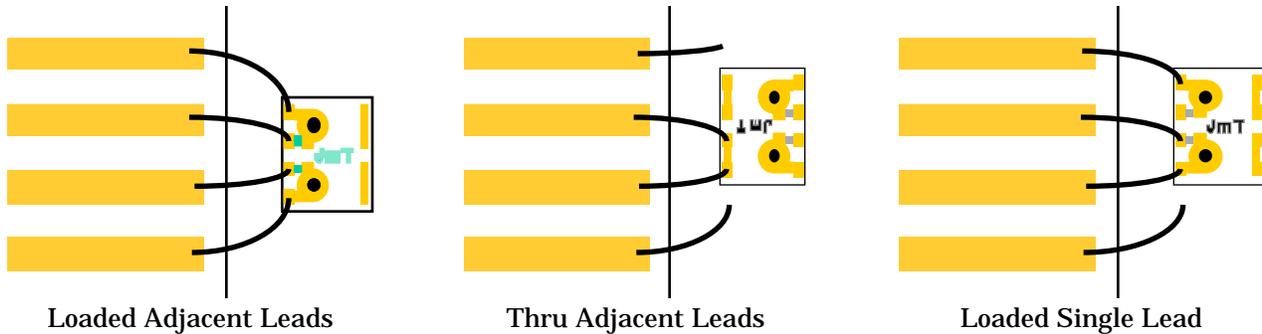
- Compatible with the majority of semiconductor device packages.
- Three pairs of Standards
 - 2 ea 50 Ω “loads”
 - 2 ea “shorts”
 - 2 ea offset 50 Ω “loads”
- Wire bondable Au contacts
- Eutectic or epoxy die attach
- High quality backside vias

Benefits

- High precision and repeatability
- Highly flexible test tooling
- Low cost test tooling

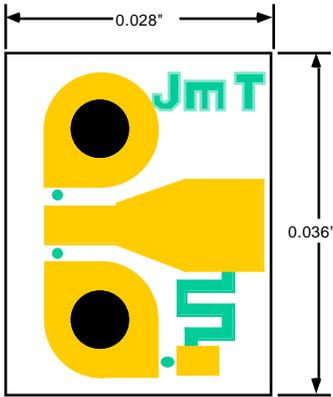
Typical Application of ProbePoint™0504 and ProbePoint™0505

The ProbePoint™0504 and 0505 test loads are general purpose tooling fixture accessories for use with package characterization. Package characterization requires making precision electrical measurements of the desired signal leads under various 'load' conditions. The diagrams below are some of the many options available, using the test load, to 'load' the leads with a specific impedance. The test configuration selected is dependent on the specific self or mutual electrical element to be studied. Mutual parameters are usually best measured using adjacent leads with thru connections, shorts, opens and resistors. Self inductance and capacitance can be determined from single leads, loaded in shorts, opens, or resistors. For all measurement cases it is important that the test load chip offers the test engineer a consistent physical reference point and consistent current return paths. The ProbePoint™0504 and 0505 offer this flexibility in test tooling.



For microstrip packages, other ProbePoint™ adapter substrates may be used as test points for test probes on the input signal leads, calibrated to the measurement system. Non-microstrip packages may require other methods and fixtures for attaching test probes to the desired signal leads.

ProbePoint™ 1001 Test Interface Circuit - Coplanar to Microstrip with Kelvin (20X)



Test adapter and interface substrate for microstrip type active and passive components. Useful as a contact for test of devices which have a nominal “back-side ground.” Can also be used as a high impedance test point inserted into the signal path of active components.

Zo 50Ω
 Kelvin Point 950Ω nominal
 20X sample point

Metalization

Front/Back Au
 Resistors TaN

Size 10 X 28 X 36 mils

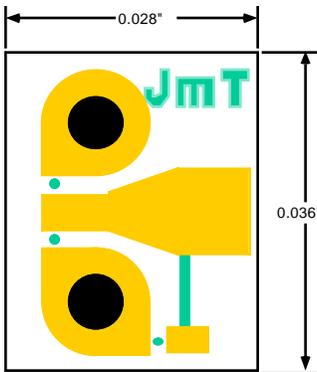
Features

- Compatible to coplanar probes 125μ to 250μ pitch
- Insertible circuit test point
- Kelvin test point
- 20X high speed test point
- Controlled impedance transition
- High quality backside vias

Benefits

- High precision
- High repeatability
- High accuracy measurements
- Calibration structures available
- Low cost test tooling

ProbePoint™ 1002 Test Interface Circuit - Coplanar to Microstrip with Kelvin (10X)



Test adapter and interface substrate for microstrip type active and passive components. Useful as a contact for test of devices which have a nominal “back-side ground.” Can also be used as a high impedance test point inserted into the signal path of active components.

Zo 50Ω
 Kelvin Point 450Ω nominal
 10X sample point

Metalization

Front/Back Au
 Resistors TaN

Size 10 X 28 X 36 mils

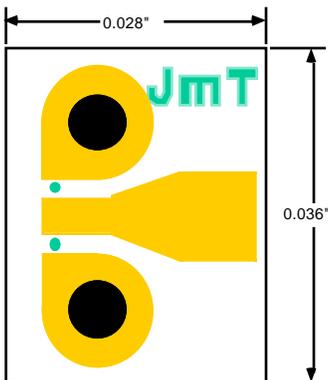
Features

- Compatible to coplanar probes 125μ to 250μ pitch
- Insertible circuit test point
- Kelvin test point
- 10X high speed test point
- Controlled impedance transition
- High quality backside vias

Benefits

- High precision
- High repeatability
- High accuracy measurements
- Calibration structures available
- Low cost test tooling

ProbePoint™ 1003 Test Interface Circuit - Coplanar to Microstrip



Test adapter and interface substrate for microstrip type active and passive components. Useful as a contact for test of devices which have a nominal “back-side ground.” Can also be used as a 50Ω transmission line inserted into the signal path of active components.

Zo 50Ω

Metalization

Front/Back Au

Size 10 X 28 X 36 mils

Features

- Compatible to coplanar probes 125μ to 250μ pitch
- Controlled impedance transition
- High quality backside vias

Benefits

- High precision
- High repeatability
- High accuracy measurements
- Calibration structures available
- Low cost test tooling

ProbePoint™ 10-cal Calibration Substrate - Coplanar to Microstrip (10 mil)

This substrate contains calibration structures to be used in the establishment of measurement corrections terms for measurements using network and time domain analysis. A variety of microwave structures which support the popular calibration methods are available for all the ProbePoint™ 10 Test Interface Circuits. This allows direct calibration to the microstrip bond pad side of the ProbePoint™ Test Interface Structures.

Zo 50Ω nominal

Metalization

Front/Back Au
Resistors TaN

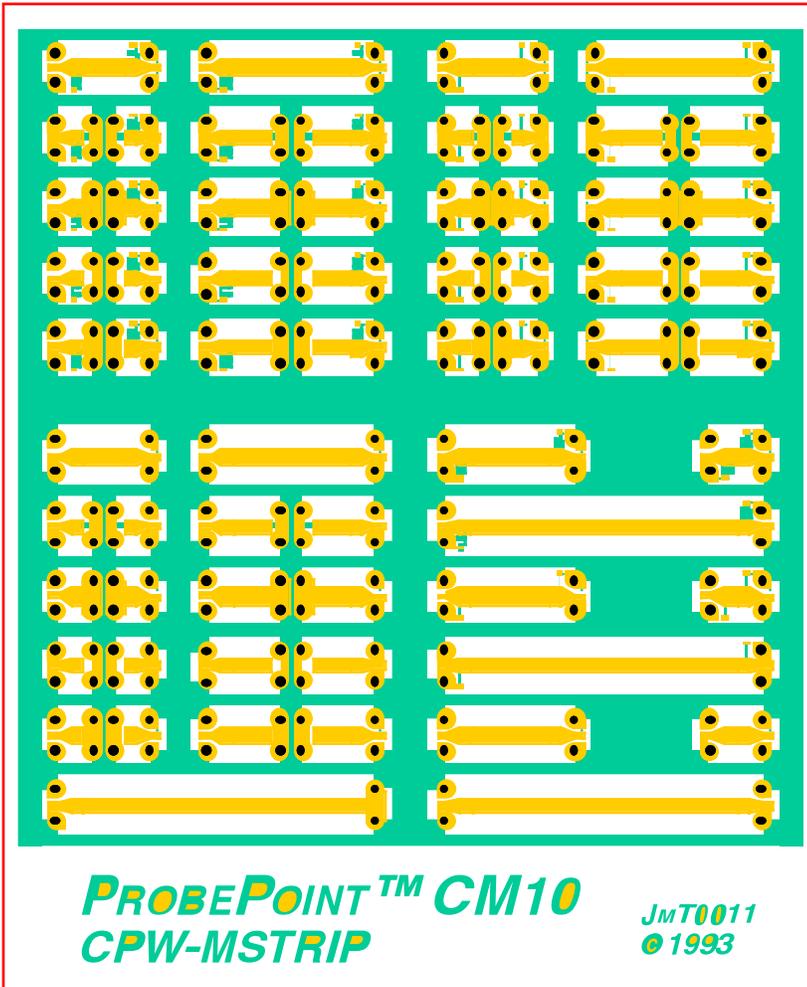
Size 20 X 525 X 640 mils

Features

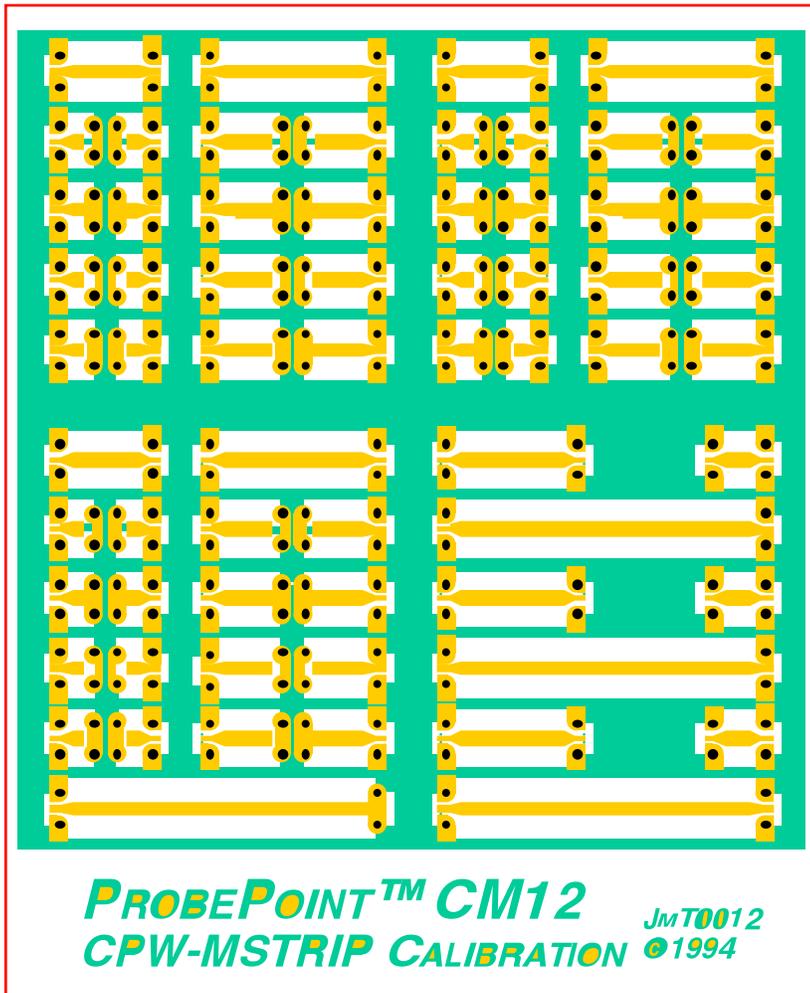
- Compatible to coplanar probes
125μ to 250μ pitch
- Flexible to various calibration methods:
 - SOLT
 - LRM
 - LRL
 - TRL
- Laser trimmed resistors - ±1%
- Controlled impedance transition
- High quality backside vias

Benefits

- Direct Calibration
- High repeatability
- High accuracy calibration
- Low cost
- User flexibility



Coplanar Probe Calibration Substrate



This substrate contains calibration structures useful in the establishment of electrical measurement numerical corrections terms for CPW probes. This is useful for measurements of fine geometry electrical components using network and time domain analysis. A variety of microwave structures which support the popular calibration methods are available to calibrate coplanar probes of both the 'blade' and coaxial variety. There are three complete sets of calibration structures.

Z₀ 50Ω nominal

Frequency range >50 GHz

Metalization

Front/Back Au

Resistors TaN

Size 20 X 525 X 640 mils

Features

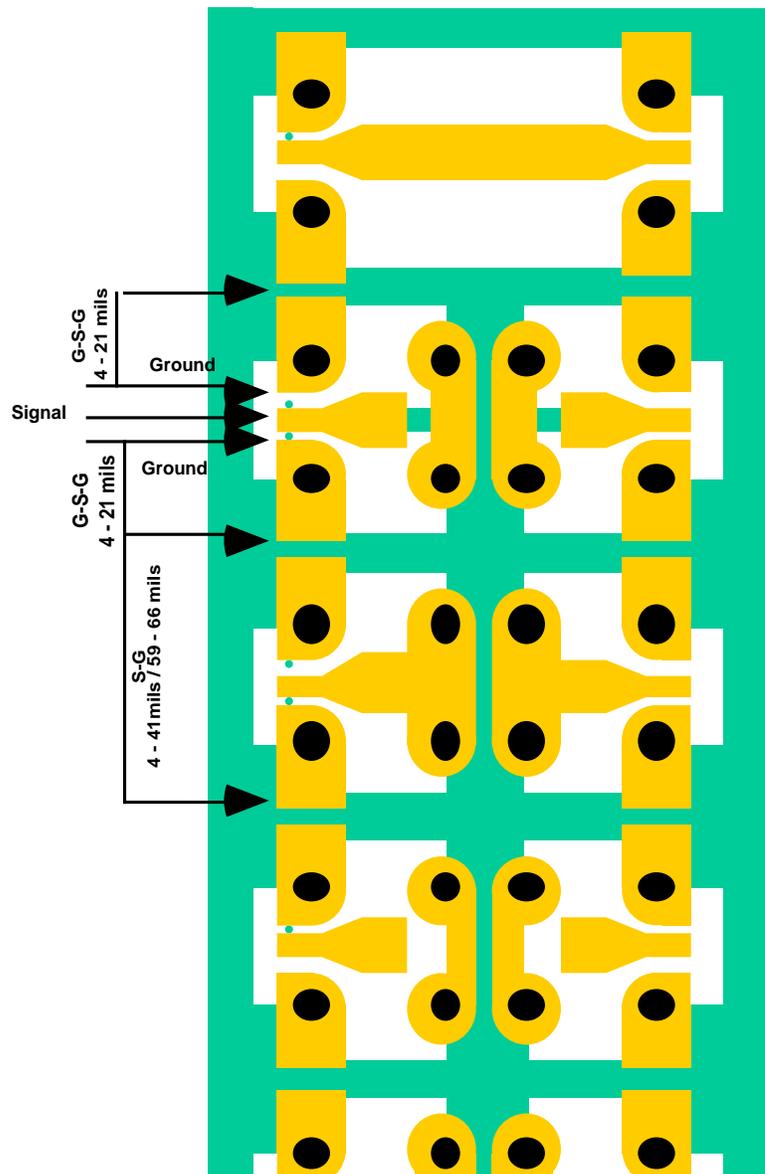
- Compatible to an extremely wide variety coplanar probe pitch dimensions.
- Flexible to various calibration methods:
 - SOLT
 - LRM
 - LRL
 - TRL
- Laser trimmed resistors - ±1%
- Controlled impedance transition
- High quality backside vias
- Applicable for wide pitch CPW probe calibration

Benefits

- Direct Calibration in a microstrip environment.
- High repeatability
- High accuracy calibration
- Low cost
- User flexibility

Probe Pitch Calibration Range

- G-S-G
125-500 μm
- S-G (rectangular)
125-1025 μm
(4 - 41 mils)
1225 - 1650 μm
(49 - 66 mils)
- S-G (angled position)
125-1700 μm
(4 - 68 mils)



Calibration Kit - optional

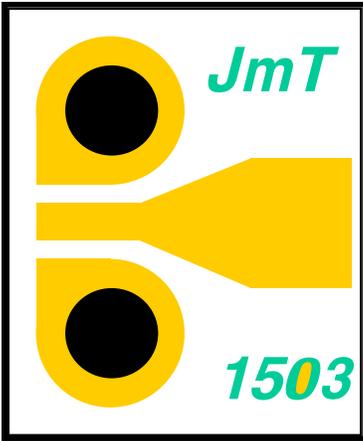
- HP8510 description of calibration constants and structures.

Application

With the optional CM12-Cal Kit, the CM12 calibration substrate can be used to perform calibration on a wide range of CPW probe pitches. This range is from 125 to 500 μm for G-S-G probes. S-G probes with pitches from 125 to 1025 μm and 1225 to 1650 μm can be calibrated with the probe approach position restricted to rectangular placement. The full pitch range, from 125 to 1700 μm , can be achieved by an angular approach to the calibration patterns for the S-G probes.

The normal limitations of wide pitch coplanar calibration standards are avoided with the application of small well decoupled microstrip circuit structures. This results in broadband resonate free calibration.

ProbePoint™ 1503 Test Interface Circuit - Coplanar to Microstrip



Test adapter and interface substrate for microstrip type active and passive components. Useful as a contact for test of devices which have a nominal “back-side ground.”

Zo 50Ω

Metalization

Front/Back Au
Resistors TaN

Size 15 X 38 X 46 mils

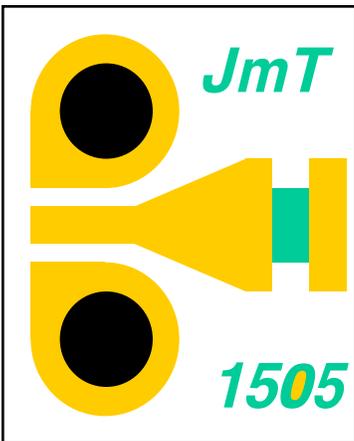
Features

- Compatible to coplanar probes 125μ to 450μ pitch
- Controlled impedance transition
- High quality backside vias
- Calibration Substrate available

Benefits

- High precision
- High repeatability
- High accuracy measurements
- Calibration structures available
- Low cost test tooling

ProbePoint™ 1505 Test Interface Circuit - Coplanar to Microstrip with Series Resistor



Test adapter and interface substrate for microstrip type active and passive components. Useful as a contact for test of devices which have a nominal “back-side ground.” Series resistor in signal path can be used to stabilize the bias conditions of high gain bipolar and FET devices.

Zo 50Ω

Series Resistor 25Ω ± .5Ω

Metalization

Front/Back Au
Resistors TaN

Size 15 X 38 X 46 mils

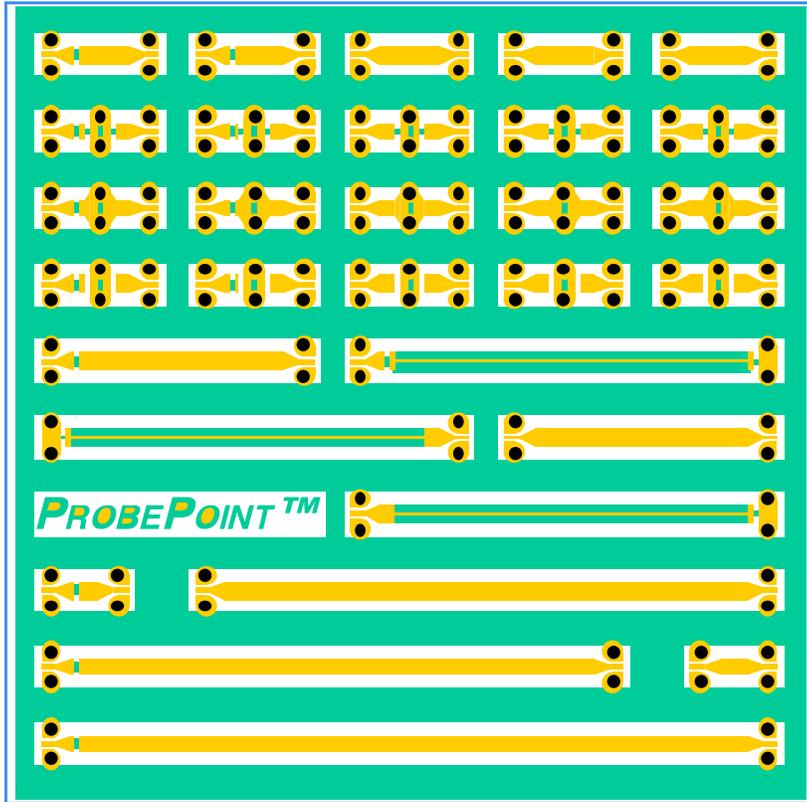
Features

- Compatible to coplanar probes 125μ to 450μ pitch
- Series Resistor in signal path for stable bias and precise high frequency measurements
- Controlled impedance transition
- High quality backside vias
- Calibration Substrate available

Benefits

- High precision
- High repeatability
- High accuracy measurements
- Calibration structures available
- Low cost test tooling

ProbePoint™ CM15 Calibration Substrate - Coplanar to Microstrip (15 mil)



This substrate contains calibration structures to be used in the establishment of measurement corrections terms for measurements using network and time domain analysis. A variety of microwave structures which support the popular calibration methods are available for all the ProbePoint™ 15 Test Interface Circuits. This allows direct calibration to the microstrip bond pad side of the ProbePoint™ Test Interface Structures. Calibration substrate is 'bonded' to 10 mil thick backing plate for mechanical ruggedness.

Zo	50Ω nominal
Metalization	
Front/Back	Au
Resistors	TaN
Size	25 X 630 X 630 mils

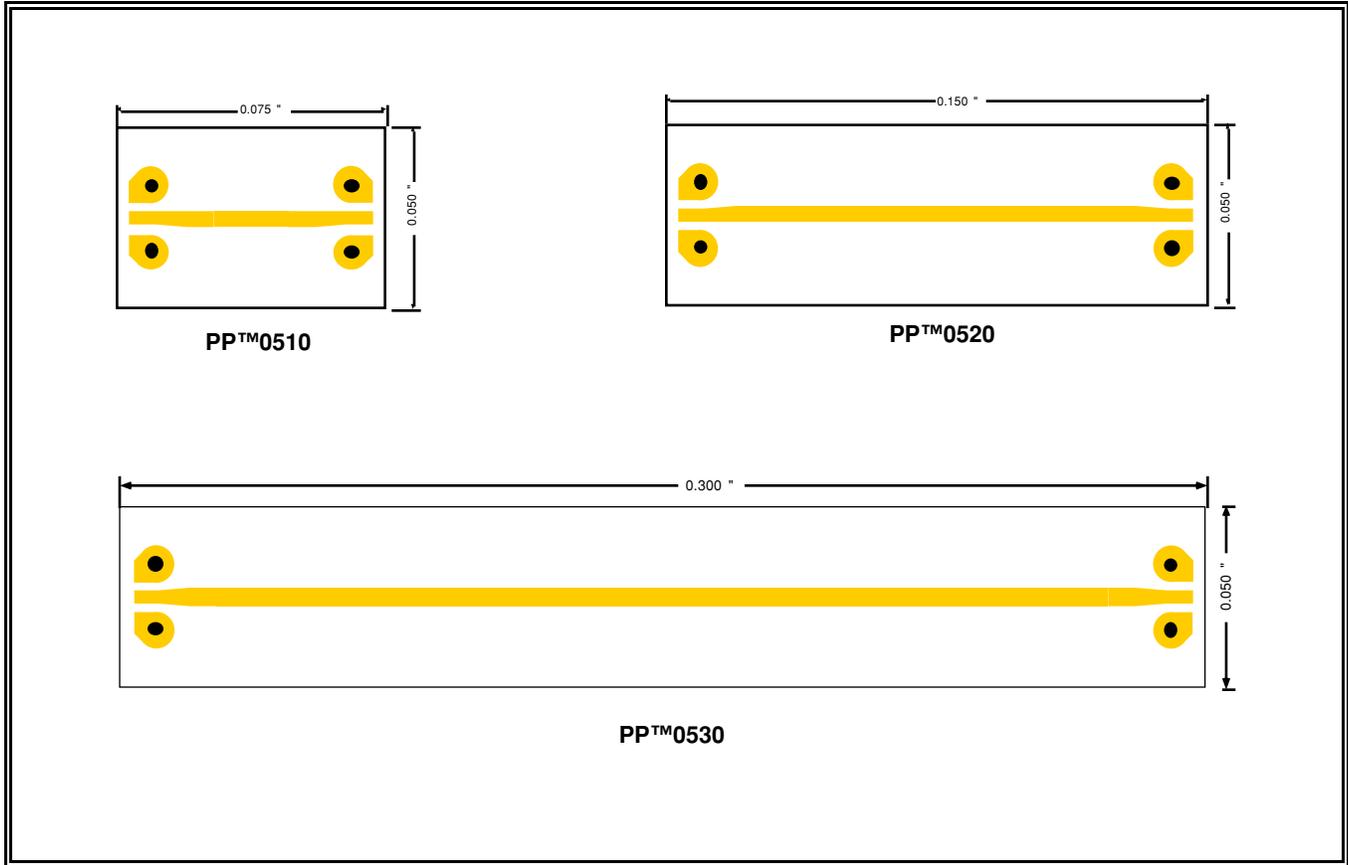
Features

- Compatible to coplanar probes
 125μ to 450μ pitch
- Flexible to various calibration methods:
 - SOLT
 - LRM
 - LRL
 - TRL
- Laser trimmed resistors - ±1%
- Controlled impedance transition
- High quality backside vias
- Calibrates and corrects for Series resistance of PP™ 1505 adapter substrates.

Benefits

- Direct Calibration
- High repeatability
- High accuracy calibration
- Low cost
- User flexibility

ProbePoint™ 05x0 Test Interface Circuit - Coplanar to Microstrip Transmission Lines



Transmission line structures for use in the test and characterization of packages and in the assembly of multichip microwave modules. These precision transmission line structure offer the flexibility of coplanar top side contacts to the microstrip circuit environments. A binary length related family of high frequency, high performance transmission lines.

Z ₀	50Ω
Transmission Line Length	
PP™0510	65 mils
PP™0520	140 mils
PP™0530	290 mils

Metalization	
Front/Back	Au

Size	
PP™0510	50 X 75 X 5 mils
PP™0520	50 X 150 X 5 mils
PP™0530	50 X 300 X 5 mils

Features

- Compatible to coplanar probes
 125μ to 250μ pitch
- Compatible with lead frames and packages
- “Known” Transmission lines
- Controlled impedance transition
- High quality backside via’s
- Precision in package “Thru” lines
- Compatible with ProbePoint™ adapter substrates

Benefits

- High precision
- High repeatability
- High accuracy measurements
- Low cost test tooling