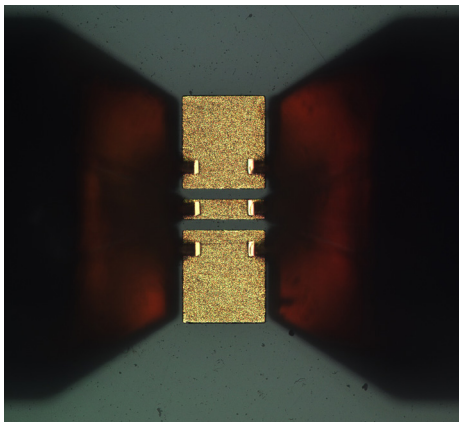
AC2-2 Calibration Substrate

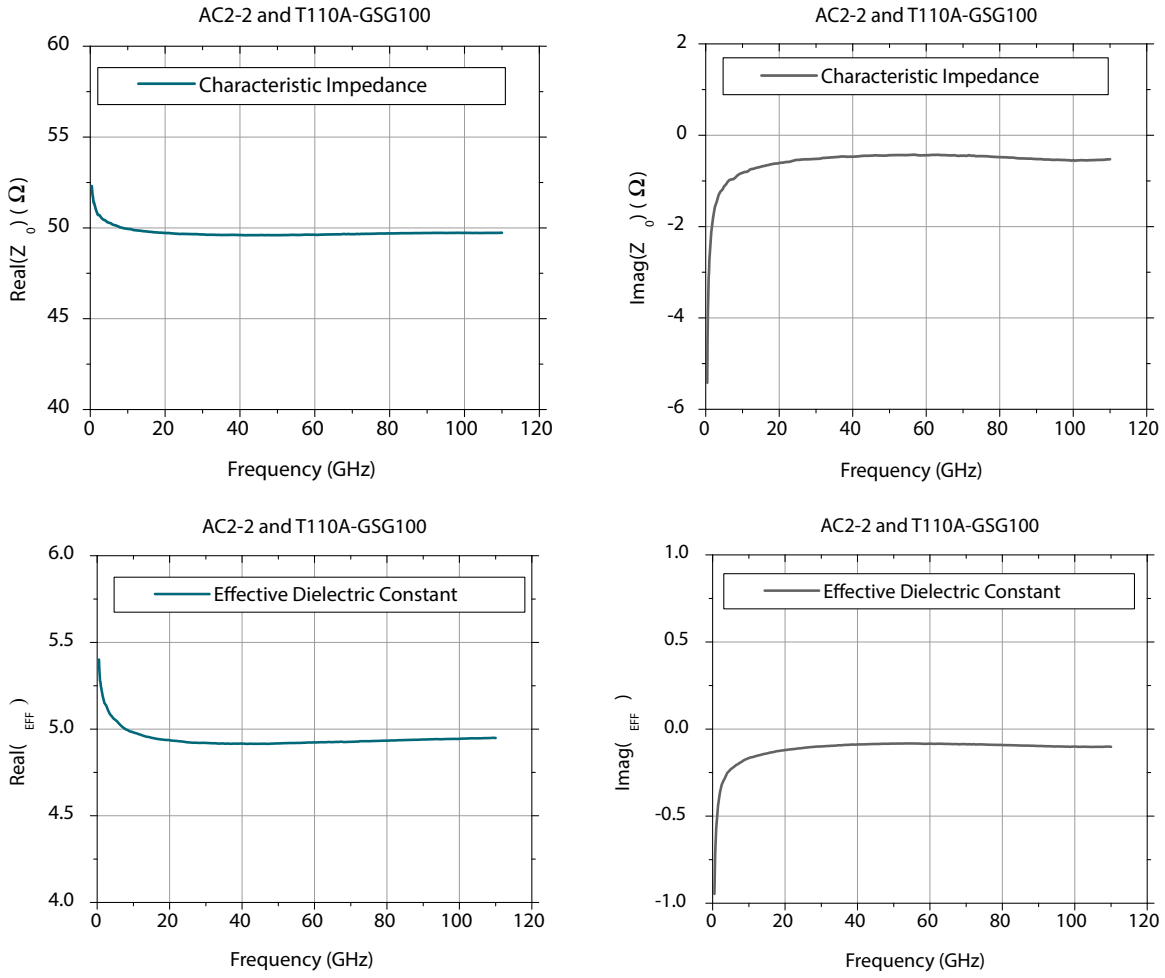
AC2-2 calibration substrate is designed to provide accurate probe tip calibration of MPI TITAN™ RF probe family with ground-signal-ground (GSG) probe tips configuration and accommodates 100 to 250 µm probe pitch variation.

It supports industry standard short-open-load-thru (SOLT) calibration method, as well as advanced line-reflect-match (LRM), and thru-reflect-line (TRL). AC2-2 contains 26 groups of the lumped standard elements, as well as the full set of coplanar transmission lines for multiline TRL calibration from 5 to 110 GHz.



T110A-GSG100 probes in separation on the AC2-2 thru standard after 10 µm overtravel contact.

TYPICAL ELECTRICAL FIGURES



Typical characteristic impedance and the effective dielectric constant of the AC2-2 line standard measured using the method of National Institute of Standard and Technologies (NIST, Bolder, CO, USA) [1, 2].

SUBSTRATE CHARACTERISTICS

Material	Alumina
Size	16.5 x 12.5 mm
Thickness	635 µm
Design or standards	Coplanar
Probe configuration	GSG
Supported probe pitch	100 to 250 µm
Number of lumped standard groups	26
Number of calibration and verification lines	5
Calibration verification elements	yes
Supported calibration methods	SOLT, LRM, SOLR, TRL and multiline TRL
Typical resistance of the load	50 Ω
Typical load trimming accuracy error	± 0.3 %
Open standard	Au pads on substrate
Ruler scale	0 to 3 mm
Ruler step size	100 µm
Recommended overtravel for TITAN™ probes	10 µm

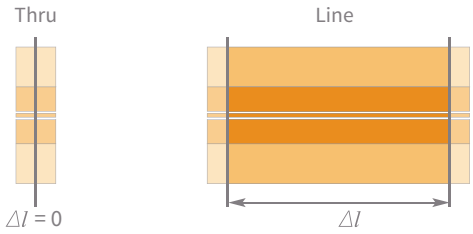
ELECTRICAL CHARACTERISTICS OF CPW LINE STANDARDS

Nominal capacitance per unit length, pF/cm	1.492
Nominal characteristic impedance @20 GHz	50 Ω
Effective dielectric constant @20 GHz, real part	4.94
Effective velocity factor @20 GHz	0.45
Parameters of the simplified model of line losses	
Reference loss, dB	0.34
Reference delay, ps	25.5
Reference frequency, GHz	20
Electrical length of line, ps	
Thru	1.10
Line 1 (0309)	3.00
Line 2 (0409)	6.50
Line 3 (0509)	13.00
Line 4 (0809)	25.50
Line 5 (0101)	38.50

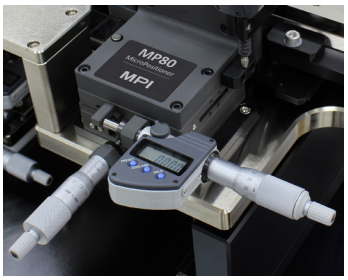
MULTI-LINE TRL

The Multi-line TRL calibration kit can be easily designed and fabricated using the same semiconductor process as the DUT. Customized ”On-wafer“ multi-line TRL calibration kits eliminate the need for de-embedding the DUT measurement results from parasitic impedances of the device contact pads. The Multi-line TRL is the only method that delivers trustable calibration results at measurement frequencies above 110 GHz.

The TRL algorithm always treats the thru standards as a zero-length line. The length of each next line standards Δl is, therefore, defined with the respect to the length of the thru. When operating the MPI MP80-DX, the operator simply needs to zero-out the digital micrometer after the initial adjustment of the RF probes, i.e., on the thru standard. Next, the distance between RF probes can be easily re-adjusted to the required value of Δl with the precision better than 1 µm. As a result, MP80-DX has boosted the accuracy and repeatability of the multi-line TRL system calibration even for inexperienced operators while reducing set up times.



The TRL definition of the Δl for line standards



The MP80-DX MicroPositioner with the digital micrometer on the X axes.

Standard type, (Name)	Physical length, µm	Effective length l, µm	Δl, µm
Thru	200	150	0
Line 1	450	400	250
Line 2	900	850	700
Line 3	1800	1750	1600
Line 4	3500	3450	3300
Line 5	5250	5200	5050

PLANARIZATION PROBE

MPI TITAN™ RF probes deliver excellent and real time visibility of the tip contacts, due to the unique protrusion tip design. Accurate positioning of the RF probe on calibration standards or DUT pads is now even possible for un-experienced operators.

TITAN™ probes are very robust; however, excessive over travel can damage them. Use care when lowering probe. To planarize the probe, we recommend using the bare gold area of the calibration substrate or the dedicated contact substrate PN TCS-1 (Figure 1).

While monitoring the probe under a high resolution microscope, adjust the Z height to bring the probe into contact with the surface. The probe is in contact with surface when the probe tips begin to skate forward. After contacting the surface, raise the probe and check the probe marks. If the probe tips are parallel to surface, you should see a uniform probe mark for each tip (Figure 2). If the probe tips are not parallel to surface (Figure 3), rotate planarity knob on positioner and recheck probe marks (Figure 4). This may take several attempts.

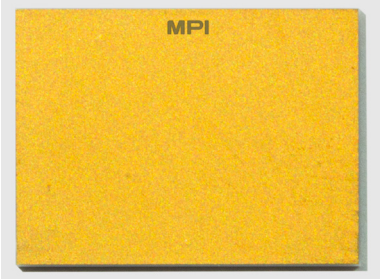


Figure 1. TITAN™ Probe contact substrate TCS-1.

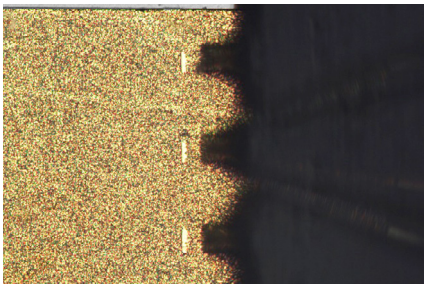


Figure 2. Image of probe marks of Planarized probe.

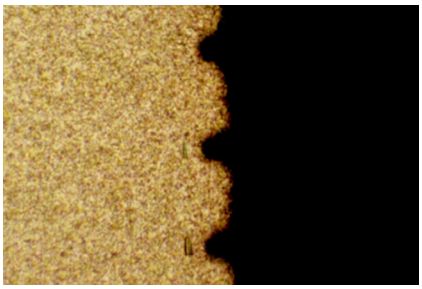


Figure 3. Image of probe that is not parallel to surface.

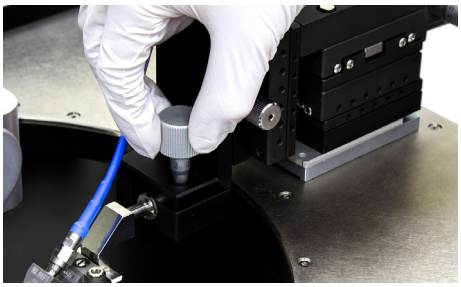
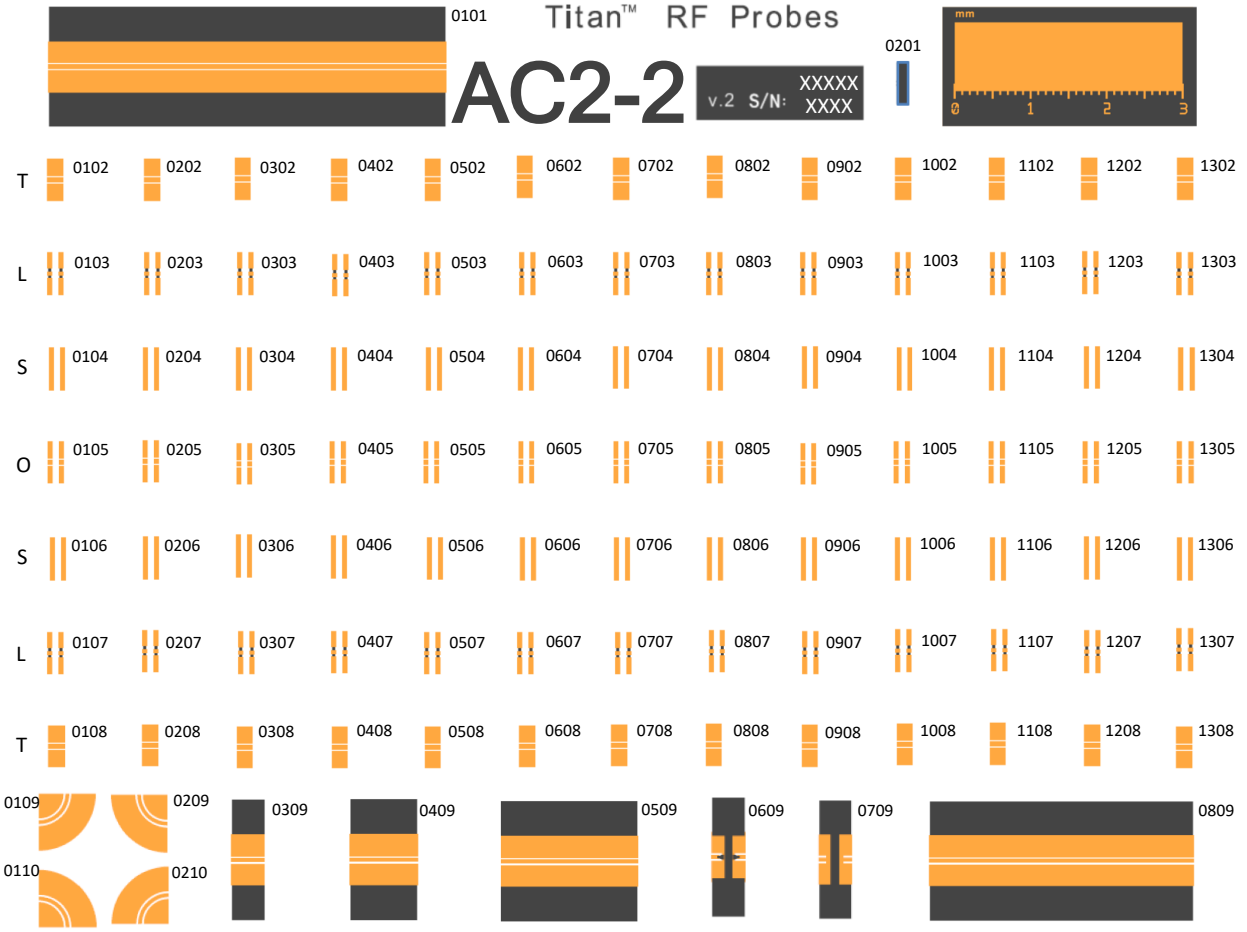
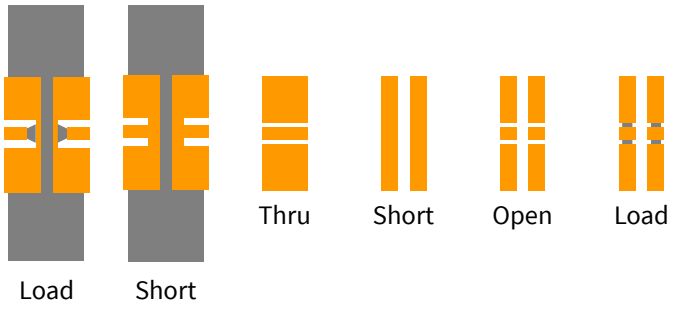


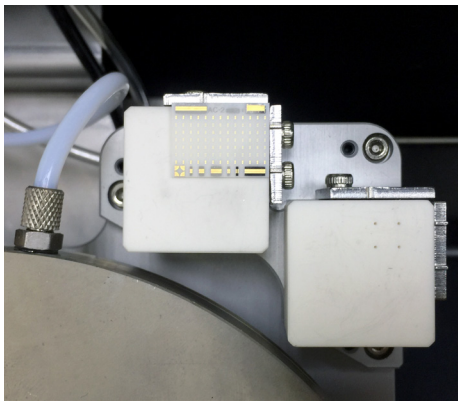
Figure 4. Planarization of TITAN™ Probes.

SUBSTRATE LAYOUT



**Location reference elements are marked blue.*





AC2-2 calibration substrate on the ceramic AUX chuck of TS150-THZ manual probe system.

THRU STANDARDS

Name	Type	X µm	Y µm	Location Reference	Spacing µm	Length µm
0102	THRU	-11250	-1250	0201	150	200
0202	THRU	-10000	-1250	0201	150	200
0302	THRU	-8750	-1250	0201	150	200
0402	THRU	-7500	-1250	0201	150	200
0502	THRU	-6250	-1250	0201	150	200
0602	THRU	-5000	-1250	0201	150	200
0702	THRU	-3750	-1250	0201	150	200
0802	THRU	-2500	-1250	0201	150	200
0902	THRU	-1250	-1250	0201	150	200
1002	THRU	0	-1250	0201	150	200
1102	THRU	1250	-1250	0201	150	200
1202	THRU	2500	-1250	0201	150	200
1302	THRU	3750	-1250	0201	150	200
0108	THRU	-11250	-8750	0201	150	200
0208	THRU	-10000	-8750	0201	150	200
0308	THRU	-8750	-8750	0201	150	200
0408	THRU	-7500	-8750	0201	150	200
0508	THRU	-6250	-8750	0201	150	200
0608	THRU	-5000	-8750	0201	150	200
0708	THRU	-3750	-8750	0201	150	200
0808	THRU	-2500	-8750	0201	150	200
0908	THRU	-1250	-8750	0201	150	200
1008	THRU	0	-8750	0201	150	200
1108	THRU	1250	-8750	0201	150	200
1208	THRU	2500	-8750	0201	150	200
1308	THRU	3750	-8750	0201	150	200

LINE STANDARDS

Name	Type	X µm	Y µm	Location Reference	Spacing µm	Length µm	ΔI	Note
0309	LINE1	-8825	-7750	0201	400	450	250	For Multi-TRL
0409	LINE2	-7270	-7750	0201	850	900	700	For Multi-TRL
0509	LINE3	-5240	-7750	0201	1750	1800	1600	For Multi-TRL
0809	LINE4	440	-7750	0201	3450	3500	3300	For Multi-TRL
0101	LINE5	-11250	250	0201	5200	5250	5050	For Multi-TRL
0609	Load	-2480	-7750	0201	400	450		
0709	Short	-1030	-7750	0201	400	450		

LOAD STANDARDS

Name	Type	X µm	Y µm	Location Reference	Spacing µm
0103	LOAD	-11250	-2500	0201	150
0203	LOAD	-10000	-2500	0201	150
0303	LOAD	-8750	-2500	0201	150
0403	LOAD	-7500	-2500	0201	150
0503	LOAD	-6250	-2500	0201	150
0603	LOAD	-5000	-2500	0201	150
0703	LOAD	-3750	-2500	0201	150
0803	LOAD	-2500	-2500	0201	150
0903	LOAD	-1250	-2500	0201	150
1003	LOAD	0	-2500	0201	150
1103	LOAD	1250	-2500	0201	150
1203	LOAD	2500	-2500	0201	150
1303	LOAD	3750	-2500	0201	150
0107	LOAD	-11250	-7500	0201	150
0207	LOAD	-10000	-7500	0201	150
0307	LOAD	-8750	-7500	0201	150
0407	LOAD	-7500	-7500	0201	150
0507	LOAD	-6250	-7500	0201	150
0607	LOAD	-5000	-7500	0201	150
0707	LOAD	-3750	-7500	0201	150
0807	LOAD	-2500	-7500	0201	150
0907	LOAD	-1250	-7500	0201	150
1007	LOAD	0	-7500	0201	150
1107	LOAD	1250	-7500	0201	150
1207	LOAD	2500	-7500	0201	150
1307	LOAD	3750	-7500	0201	150

SHORT STANDARDS

Name	Type	X µm	Y µm	Location Reference	Spacing µm
0104	SHORT	-11250	-3750	0201	150
0204	SHORT	-10000	-3750	0201	150
0304	SHORT	-8750	-3750	0201	150
0404	SHORT	-7500	-3750	0201	150
0504	SHORT	-6250	-3750	0201	150
0604	SHORT	-5000	-3750	0201	150
0704	SHORT	-3750	-3750	0201	150
0804	SHORT	-2500	-3750	0201	150
0904	SHORT	-1250	-3750	0201	150
1004	SHORT	0	-3750	0201	150
1104	SHORT	1250	-3750	0201	150
1204	SHORT	2500	-3750	0201	150
1304	SHORT	3750	-3750	0201	150
0106	SHORT	-11250	-6250	0201	150
0206	SHORT	-10000	-6250	0201	150
0306	SHORT	-8750	-6250	0201	150
0406	SHORT	-7500	-6250	0201	150
0506	SHORT	-6250	-6250	0201	150
0606	SHORT	-5000	-6250	0201	150
0706	SHORT	-3750	-6250	0201	150
0806	SHORT	-2500	-6250	0201	150
0906	SHORT	-1250	-6250	0201	150
1006	SHORT	0	-6250	0201	150
1106	SHORT	1250	-6250	0201	150
1206	SHORT	2500	-6250	0201	150
1306	SHORT	3750	-6250	0201	150

OPEN STANDARDS

Name	Type	X µm	Y µm	Location Reference	Spacing µm
0105	OPEN	-11250	-5000	0201	150
0205	OPEN	-10000	-5000	0201	150
0305	OPEN	-8750	-5000	0201	150
0405	OPEN	-7500	-5000	0201	150
0505	OPEN	-6250	-5000	0201	150
0605	OPEN	-5000	-5000	0201	150
0705	OPEN	-3750	-5000	0201	150
0805	OPEN	-2500	-5000	0201	150
0905	OPEN	-1250	-5000	0201	150
1005	OPEN	0	-5000	0201	150
1105	OPEN	1250	-5000	0201	150
1205	OPEN	2500	-5000	0201	150
1305	OPEN	3750	-5000	0201	150

REFERENCES

[1] 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.

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

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