TACONIC
Finding a better way

TSM-DS3Dimensionally Stable Low Loss Laminate

TSM-DS3 is a thermally stable, industry leading low loss core (Df = 0.0011 at 10 GHz) that can be manufactured with the predictability and consistency of the best fiberglass reinforced epoxies. TSM-DS3 is a ceramic-filled reinforced material with very low fiberglass content (~ 5%) that rivals epoxies in fabricating large format complex multilayers.

TSM-DS3 was developed for high power applications (thermal conductivity = 0.65 W/M*K) where it is necessary for the dielectric material to conduct heat away from other heat sources in a PWB design. TSM-DS3 was also developed to have very low coefficients of thermal expansion for demanding thermal cycling.

A TSM-DS3 core combined with *fast*Rise™27 (Df = 0.0014 at 10 GHz) prepreg is an industry leading solution for the lowest possible dielectric losses that can be attained at epoxy-like 420˚F fabrication temperatures. The low insertion losses of TSM-DS3/*fast*Rise™27 are only rivaled by fusion bonding (the melting of pure Teflon® laminates from 550˚F to 650˚F). Fusion bonding is expensive, it causes excessive material movement and it puts stress on plated through holes. For complex multilayers, the price of poor yield drives up the final material cost. *fast*Rise™27 enables the sequential lamination of TSM-DS3 at a low 420˚F with consistency and predictability that reduces cost.

For microwave applications, the low x, y and z CTE values assure that critical spacings between traces in filters and couplers have very low movement with temperature. TSM-DS3 can be used with very low profile copper foils yielding a smooth copper edge between coupled lines.

Registration over many layers is critical for yield and variations in copper weight and copper etching across a panel can cause non-linear movement. Non-linear movement over large panels leads to a lack of registration of the drilled hole to the pad and possibly open circuits.

TSM-DS3 is compatible with Ticer® and OhmegaPly® resistive foils.

TSM-DS3 is not recommended for tight pitch digital designs (≤ 1 mm pitch). It is also not recommended for lines and spaces less than 4 mils).

Benefits & Applications:

- **Industry best Df (Df = 0.0011 @10 GHz)**
- **High thermal conductivity (0.65 W/M*K)**
- **Low (~5%) fiberglass content**
- **Dimensional stability rivals epoxy**
- **Enables large format high layer count PWBs**
- **Builds complex PWBs in yield with consistency and predictability**
- **Temperature stable Dk +/- 0.25% (-30 to 120ºC)**
- **Compatible with resistive foils**

- **Couplers**
- **Phased Array Antennas**
- **Radar Manifolds**
- **mmWave Antenna/Automotive**
- **Oil Drilling**
- **Semiconductor/ATE Testing**

North & South America
Taconic - Headquarters
Petersburgh, NY 12138
Tel: 518-658-3202 / 1-800-833-1805
addinfo@4taconic.com

Europe/Middle East/Australia
Taconic International Ltd.
Republic of Ireland
Tel: +353-44-9395600
add@4taconic.com

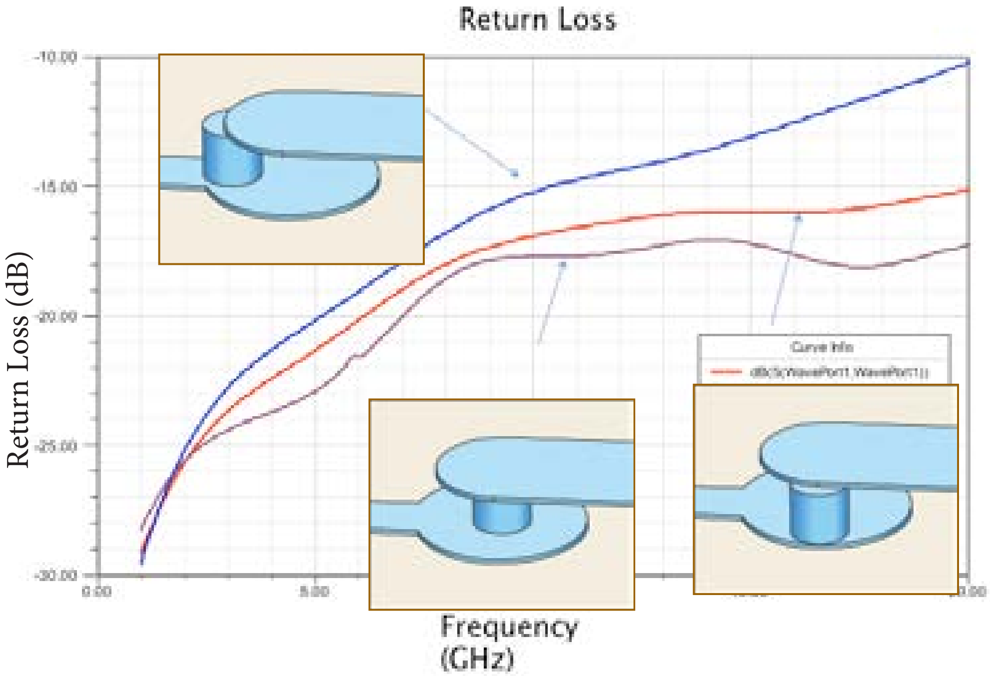
Asia
Korea Taconic Company
Republic of Korea
Tel: +82-31-704-1858
sales@taconic.co.kr

China
Taconic Advanced Material (Suzhou) Co., Ltd.
Suzhou City, China
Tel: +86-512-8718-9678
tssales@taconic.co.kr

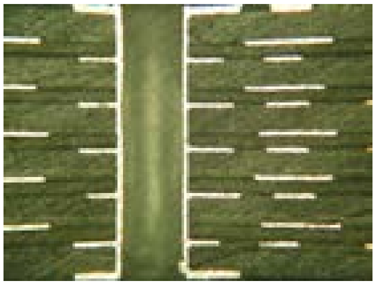
An ISO 9001 Registered Company
www.taconic-add.com
Commercial and Government Entity (CAGE) Code: 1C6Q9

TSM-DS3 Dimensionally Stable Low Loss Laminate

HFSS Simulation of 50 ohm microstrip to stripline via transition



Good Registration Around Pads



The HFSS simulation above conceptually shows the degraded performance of a 50 ohm microstrip to stripline transmission line with poor via registration.

RF designers have known for many years that registration affects the insertion loss/return loss of RF transmission lines using a stripline design. Poor via transitions cripple high frequency stripline designs over 10 GHz resulting in discontinuities from the targeted 50 or 100 ohms.

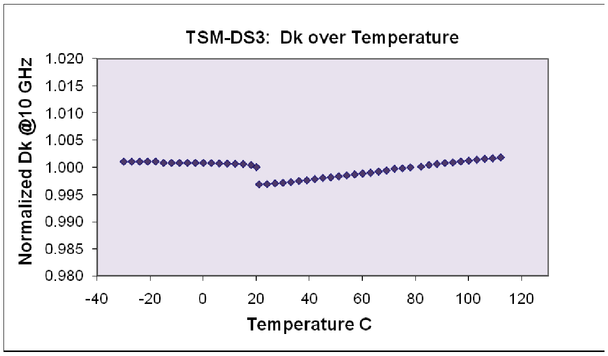
Signal performance is related to:

- The number and spacing of ground vias
- The size of ground via pads
- The distance from the drilled signal via pad to the ground vias
- The alignment of the drilled via to the center of the pad

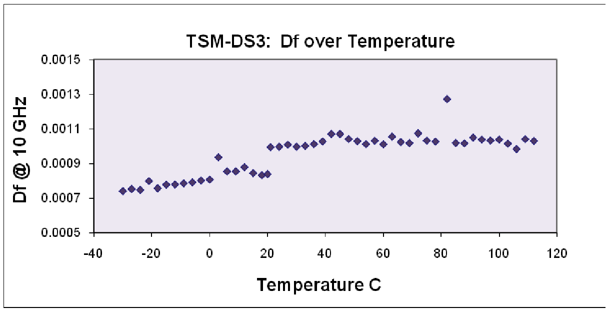
The following factors affect poor registration:

- Movement of the material core after etching and lamination
- Drill wander
- Prepreg flow
- Scaling factors, pinning techniques and non-linear movement

TSM-DS3 Dimensionally Stable Low Loss Laminate

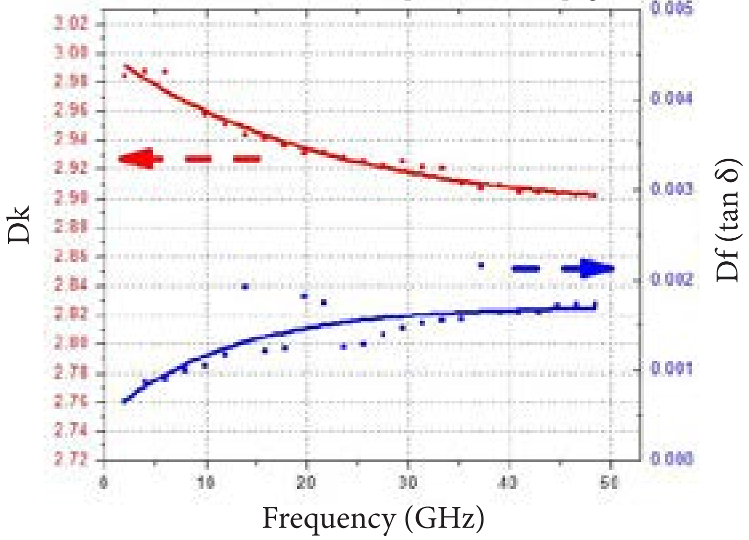


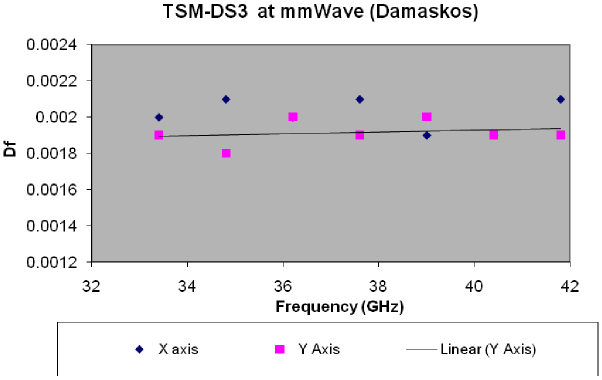
The TSM-DS3 dielectric constant shows a +/- 0.2% deviation with temperature.



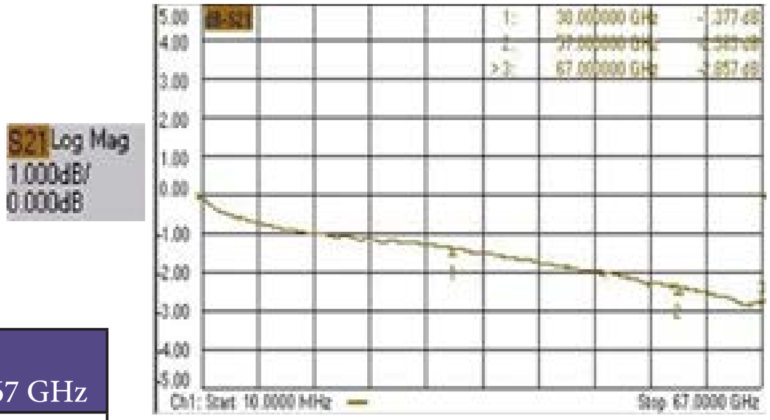
The dissipation factor varies from 0.0007 - 0.0011 over a typical application temperature range.

Ring Resonator Properties vs. Frequency on TSM-DS3-0010. (Test set up as shown on page 4).





Insertion loss comparison of TSM-DS3 vs. a synthetic rubber hydrocarbon laminate. Test vehicle shown below using Southwest Connectors.

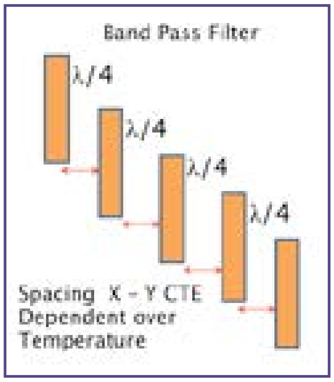


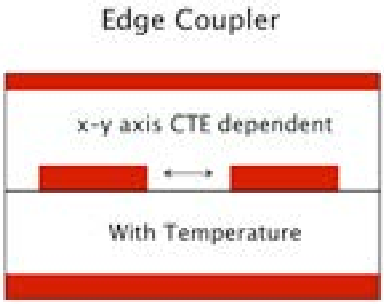
Insertion Loss (dB) - TSM-DS3

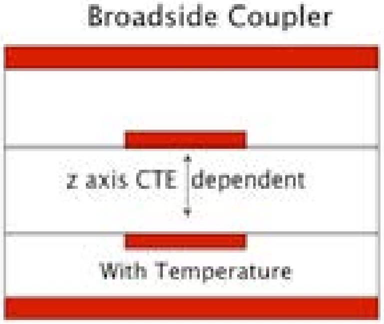
INSERTION LOSS - Loss Per Inch Item	30 GHz	57 GHz	67 GHz
TSM-DS3 (Dk = 3.0) Dielectric 5 mils Trace Width = 12 mils	-1.0380dB	-2.386 dB	-2.861 dB
Synthetic Rubber Hydrocarbon (Dk=3.38) Dielectric 8 mils Trace Width = 17 mils	-2.023 dB	-3.553 dB	-4.150 dB

TSM-DS3 Dimensionally Stable Low Loss Laminate

TSM-DS3 is especially suited for couplers and filters where the coupler spacing is affected by temperature extremes. The low x-y CTE values of 10/16 (x/y) ppm/°C assure good control over the spacing between coupled lines in an edge coupler or a band pass filter. The low z axis CTE of 23 ppm/°C (RT to 125 °C) assures a low increase in dielectric thickness in a broadside coupler.



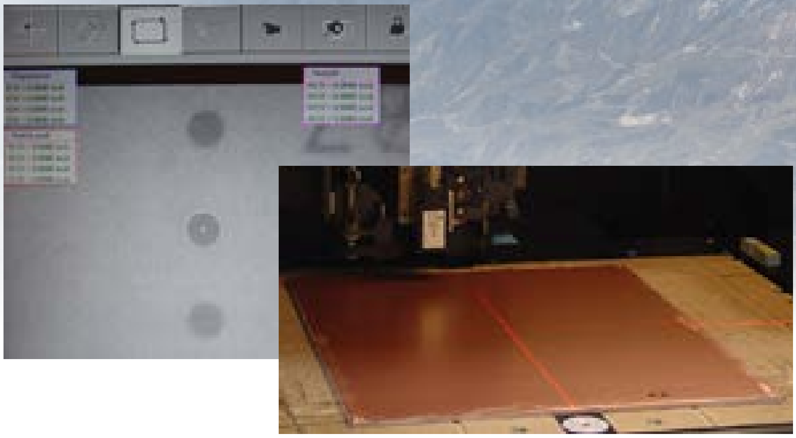




Scaling Factors (TSM-DS3)

Scaling Factors	X (mils/inch)	Y (mils/inch)
Industry Standard Epoxy, 10 mil core	0.4 - 0.5*	0.4 - 0.5*
TSM-DS3, 10 mil core	< 0.4*	< 0.4*
Industry Standard Epoxy, 5 mil core	~ 1.0	~ 1.0
TSM-DS3, 5 mil core	~ 1.0	~ 1.0

*As measured by Harbor Electronics



Dimensional movement as measured by an x-ray for multilayer drilling registration (Harbor Electronics)

TSM-DS3 Typical Values

Property	Test Method	Unit	Value	Unit	Value
Dk @ 10 GHz	IPC-650 2.5.5.5.1 (Modified)		3.00		3.00
T_cK (-30 to 120 °C)	IPC-650 2.5.5.5.1 (Modified)	ppm	5.4	ppm	5.4
Df @ 10 GHz	IPC-650 2.5.5.5.1 (Modified)		0.0011		0.0011
Dielectric Breakdown	IPC-650 2.5.6 (ASTM D 149)	kV	47.5	kV	47.5
Dielectric Strength	ASTM D 149 (Through Plane)	V/mil	548	V/mm	21,575
Arc Resistance	IPC-650 2.5.1	Seconds	226	Seconds	226
Moisture Absorption	IPC-650 2.6.2.1	%	0.07	%	0.07
Flexural Strength (MD)	ASTM D 790/ IPC-650 2.4.4	psi	11,811	N/mm^2	81
Flexural Strength (CD)	ASTM D 790/ IPC-650 2.4.4	psi	7,512	N/mm^2	51
Tensile Strength (MD)	ASTM D 3039/IPC-650 2.4.19	psi	7,030	N/mm^2	48
Tensile Strength (CD)	ASTM D 3039/IPC-650 2.4.19	psi	3,830	N/mm^2	26
Elongation at Break (MD)	ASTM D 3039/IPC-650 2.4.19	%	1.6	%	1.6
Elongation at Break (CD)	ASTM D 3039/IPC-650 2.4.19	%	1.5	%	1.5
Young's Modulus (MD)	ASTM D 3039/IPC-650 2.4.19	psi	973,000	N/mm^2	6,708
Young's Modulus (CD)	ASTM D 3039/IPC-650 2.4.19	psi	984,000	N/mm^2	6,784
Poisson's Ratio (MD)	ASTM D 3039/IPC-650 2.4.19		0.24		0.24
Poisson's Ratio (CD)	ASTM D 3039/IPC-650 2.4.19		0.20		0.20
Compressive Modulus	ASTM D 695 (23°C)	psi	310,000	N/mm^2	2,137
Flexural Modulus (MD)	ASTM D 790/IPC-650 2.4.4	kpsi	1,860	N/mm^2	12,824
Flexural Modulus (CD)	ASTM D 790/IPC-650 2.4.4	kpsi	1,740	N/mm^2	11,996
Peel Strength (CV1)	IPC-650 2.4.8 Sec 5.2.2 (TS)	lbs/in	8	N/mm	1.46
Thermal Conductivity (unclad)	ASTM F 433/ASTM 1530-06	W/M*K	0.65	W/M*K	0.65
Dimensional Stability (MD)	IPC-650 2.4.39 Sec. 5.4 (After Bake)	mils/in.	0.21	mm/M	0.21
Dimensional Stability (CD)	IPC-650 2.4.39 Sec. 5.4 (After Bake)	mils/in.	0.20	mm/M	0.20
Dimensional Stability (MD)	IPC-650 2.4.39 Sec. 5.5 (TS)	mils/in.	0.15	mm/M	0.15
Dimensional Stability (CD)	IPC-650 2.4.39 Sec. 5.5 (TS)	mils/in.	0.10	mm/M	0.10
Surface Resistivity	IPC-650 2.5.17.1 Sec. 5.2.1 (ET)	Mohms	2.3 x 10^6	Mohms	2.3 x 10^6
Surface Resistivity	IPC-650 2.5.17.1 Sec. 5.2.1 (HC)	Mohms	2.1 x 10^7	Mohms	2.1 x 10^7
Volume Resistivity	IPC-650 2.5.17.1 Sec. 5.2.1 (ET)	Mohms/cm	1.1 x 10^7	Mohms/cm	1.1 x 10^7
Volume Resistivity	IPC-650 2.5.17.1 Sec. 5.2.1 (HC)	Mohms/cm	1.8 x 10^8	Mohms/cm	1.8 x 10^8
CTE (x axis) (RT to 125°C)	IPC-650 2.4.41/TMA	ppm/°C	10	ppm/°C	10
CTE (y axis) (RT to 125°C)	IPC-650 2.4.41/TMA	ppm/°C	16	ppm/°C	16
CTE (z axis) (RT to 125°C)	IPC-650 2.4.41/TMA	ppm/°C	23	ppm/°C	23
Density (Specific Gravity)	ASTM D 792	g/cm^3	2.11	g/cm^3	2.11
Hardness	ASTM D 2240 (Shore D)		79		79
T_d (2% Weight Loss)	IPC-650 2.4.24.6 (TGA)	°C	526	°C	526
T_d (5% Weight Loss)	IPC-650 2.4.24.6 (TGA)	°C	551	°C	551

ET - Elevated Temperature
HC - Humidity Conditioning
TS - Thermal Stress

TSM-DS3 is not recommended for tight pitch digital designs (≤ 1 mm pitch). It is also not recommended for lines and spaces less than 4 mils.

All reported values are typical and should not be used for specification purposes. In all instances, the user shall determine suitability in any given application.

TSM-DS3 Dimensionally Stable Low Loss Laminate

Designation	Dk
TSM-DS3	3.0 +/-0.05

Typical Thicknesses* Inches	Typical Thicknesses* mm
0.0050, 0.0100, 0.0200	0.13, 0.25, 0.51
0.0300, 0.0600, 0.0900	0.76, 1.52, 2.29

*Other thicknesses in increments of 5 mils available upon request.

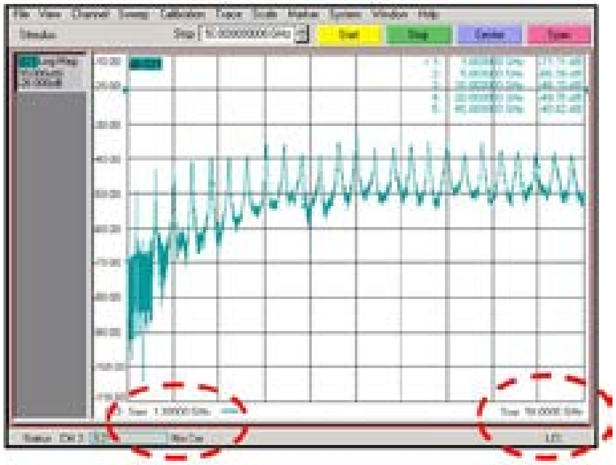
Available Sheet Sizes Inches	Available Sheet Sizes mm
12 x 18	304 x 457
16 x 18	406 x 457
18 x 24	457 x 610
16 x 36	406 x 914
24 x 36	610 x 914
18 x 48	457 x 1220

Available Copper Cladding

Copper Designation	Surface Roughness R_{MS} Treated side		Surface Roughness R_{MS} Untreated side		Description	Thickness	
	Microinches	Microns	Microinches	Microns		Mils	Microns
RH	12	0.3	12	0.3	Rolled-Annealed ½ oz	0.7	17.5
R1	10	0.3	7	0.2	Rolled-Annealed 1 oz	1.4	35.0
CFH	19	0.5	14	0.35	Electrodeposited ½ oz	0.7	17.5
CF1	12	0.32	13	0.33	Electrodeposited 1 oz	1.4	35.0
CLH	13	0.3	20	0.5	Reverse Treated Electrodeposited ½ oz	0.7	17.5
CL1	13	0.3	25	0.6	Reverse Treated Electrodeposited 1 oz	1.4	35.0
CVH (CH)	27	0.7	11	0.3	Very Low Profile Electrodeposited ½ oz	0.7	17.5
CV1 (C1)	25	0.6	11	0.3	Very Low Profile Electrodeposited 1 oz	1.4	35.0
C2	77	2.0	8	0.2	Electrodeposited 2 oz	2.8	70.0

Measurememt Instrument and Captured Results

Agilent E8364A PNA Network Analyzer and Universal test fixture 3830 K (by ANRITSU) were used for ring resonator testing.



An example of our part number is: **TSM-DS3-0050-CV1/CV1 - 18" x 24" (457 mm x 610 mm)**

RoHS
WEEE
Compliant

rev. 5/13