TACONIC
Finding a better way

TSM-DS Family of Dimensionally Stable Low Loss Laminates

The TSM-DS family is comprised of thermally stable, industry leading low loss cores (Df = 0.0010 / 0.0011 [DS/DS3] at 10 GHz) that can be manufactured with the predictability and consistency of the best fiberglass reinforced epoxies. The TSM-DS family is ceramic-filled reinforced materials with very low fiberglass content (~ 5%) that rival 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.

The TSM-DS family of cores 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-DS/*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-DS 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. The TSM-DS family can be used with very low profile copper foils yielding a smooth copper edge between coupled lines.

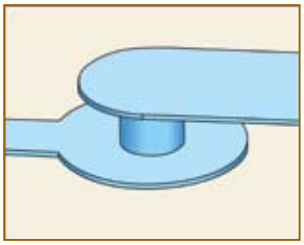
Registration over many layers is critical for yield and variations in copper weight and copper etching across a panel can cause non-linear movement. Non-linear movement over large panels leads to a lack of registration of the drilled hole to the pad and possibly open circuits.

The TSM-DS family is compatible with Ticer® and OhmegaPly® resistive foils.

Benefits & Applications:

- **Industry best Df (Df = 0.0010 / 0.0011 [DS/DS3] @10 GHz)**
- **High thermal conductivity (DS3 = 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 +/- 0.35% (-30 to 120°C)**
- **Compatible with resistive foils**

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



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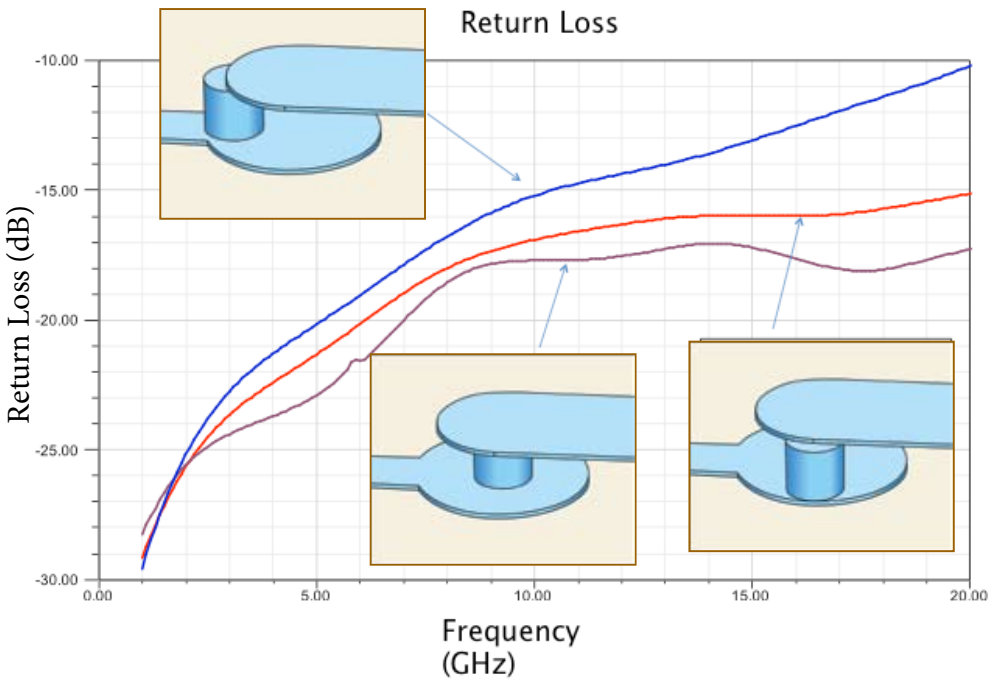
TSM-DS Family of Dimensionally Stable Low Loss Laminates

HFSS Simulation of 50 ohm microstrip to stripline via transition



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:

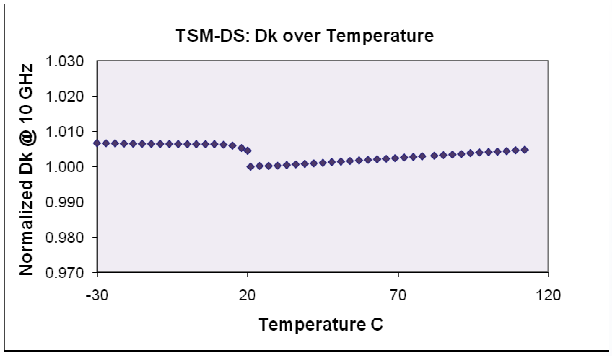
- The number and spacing of ground vias
- The size of ground via pads
- The distance from the drilled signal via pad to the ground vias
- The alignment of the drilled via to the center of the pad

The following factors affect poor registration:

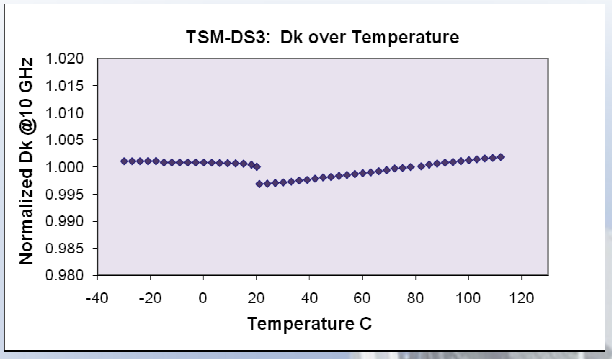
- Movement of the material core after etching and lamination
- Drill wander
- Prepreg flow
- Scaling factors, pinning techniques and non-linear movement

The TSM-DS family is designed to:

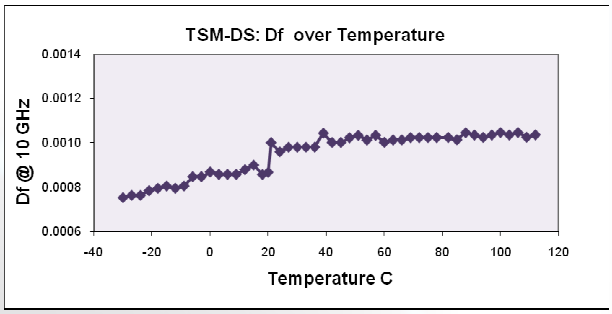
- Meet the registration needs for high layer count (20+), fine pitch, large format PWBs (22" x 28")
- Meet/exceed the registration performance of epoxy



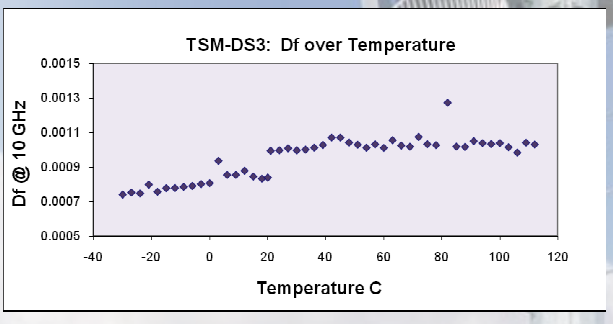
The TSM-DS dielectric constant shows a +/- 0.35% deviation with temperature.



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

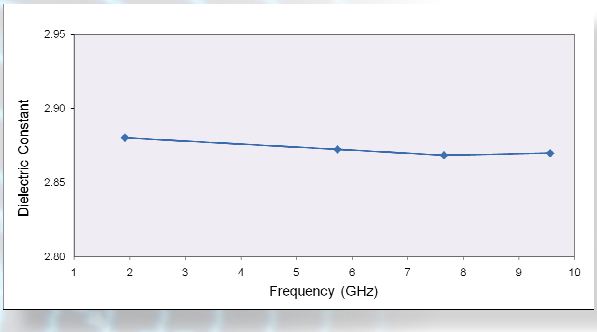


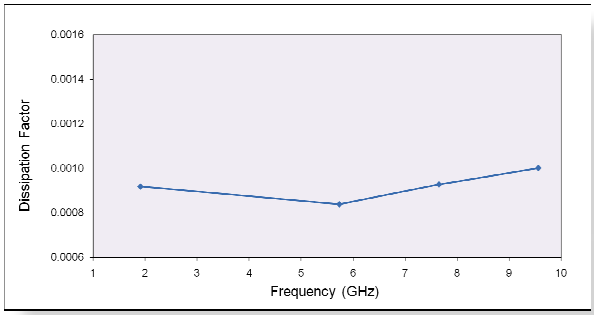
The dissipation factor varies from 0.0008 - 0.0010 over a typical application temperature range.

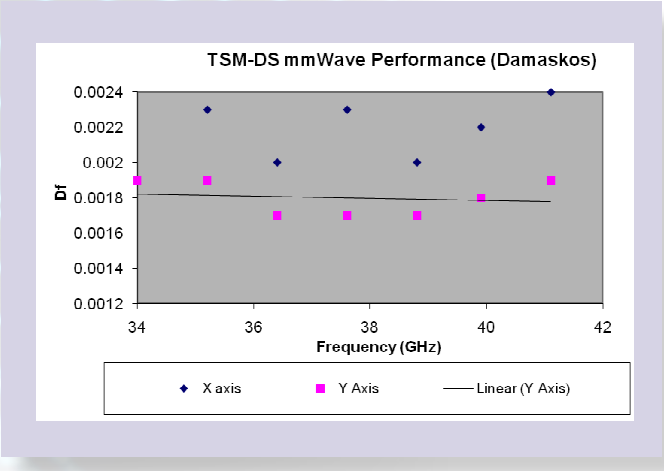


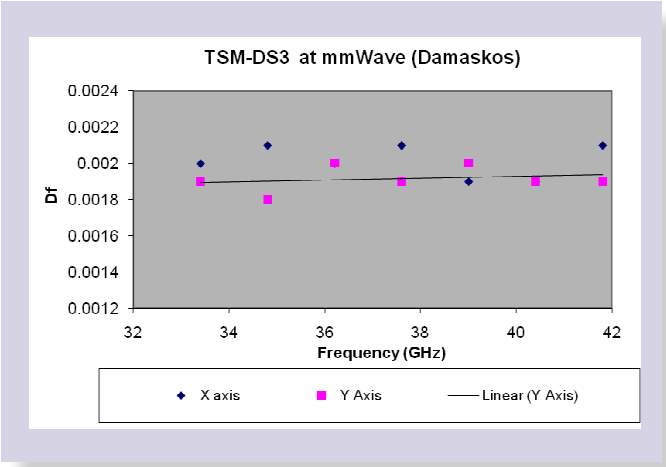
The dissipation factor varies from 0.007 - 0.0011 over a typical application temperature range.

The dielectric constant and dissipation factor of TSM-DS is very flat over frequency reflecting the low (~ 5%) fiberglass content.



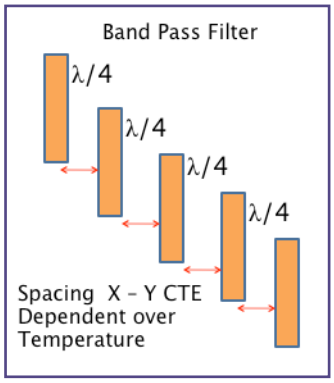


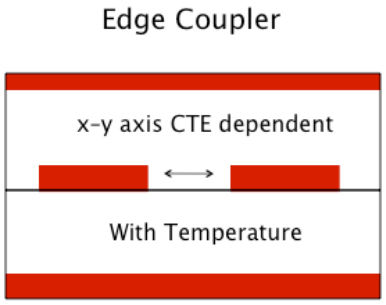


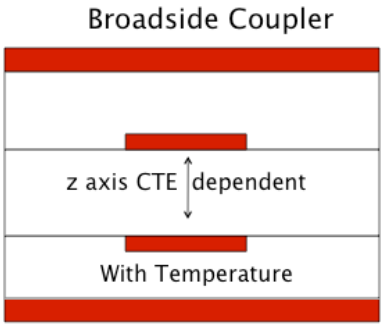


TSM-DS Family of Dimensionally Stable Low Loss Laminates

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.



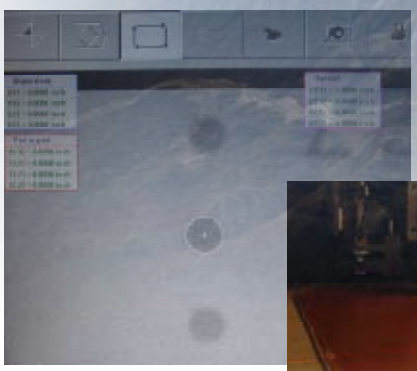


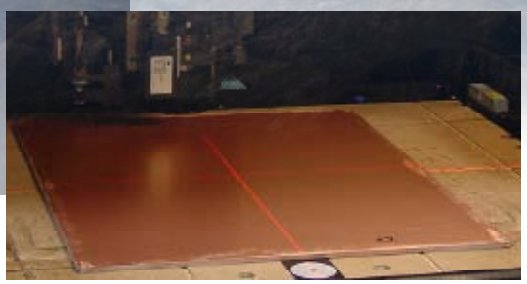


Scaling Factors (TSM-DS)

Scaling Factors	X (mils/inch)	Y (mils/inch)
Industry Standard Epoxy, 10 mil core	0.4 - 0.5*	0.4 - 0.5*
TSM-DS, 10 mil core	< 0.4*	< 0.4*
Industry Standard Epoxy, 5 mil core	~ 1.0	~ 1.0
TSM-DS, 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-DS Typical Values							
Property	Test Method	Unit	Value		Unit	Value	
			DS	DS3		DS	DS3
Dk @ 10 GHz	IPC-650 2.5.5.5.1 (Modified)		2.85	3.00		2.85	3.00
T_cK (-30 to 120 °C)	IPC-650 2.5.5.5.1 (Modified)	ppm	13.2	5.4	ppm	13.2	5.4
Df @ 10 GHz	IPC-650 2.5.5.5.1 (Modified)		0.0010	0.0011		0.0010	0.0011
Dielectric Breakdown	IPC-650 2.5.6 (ASTM D 149)	kV	65	47.5	kV	65	47.5
Dielectric Strength	ASTM D 149 (Through Plane)	V/mil	679	548	V/mm	26,732	21,575
Arc Resistance	IPC-650 2.5.1	Seconds	254	226	Seconds	254	226
Moisture Absorption	IPC-650 2.6.2.1	%	0.04	0.07	%	0.04	0.07
Flexural Strength (MD)	ASTM D 790/ IPC-650 2.4.4	psi	15,100	11,811	N/mm^2	104	81
Flexural Strength (CD)	ASTM D 790/ IPC-650 2.4.4	psi	8,300	7,512	N/mm^2	57	51
Tensile Strength (MD)	ASTM D 3039/IPC-650 2.4.19	psi	11,100	7,030	N/mm^2	76	48
Tensile Strength (CD)	ASTM D 3039/IPC-650 2.4.19	psi	4,400	3,830	N/mm^2	30	26
Elongation at Break (MD)	ASTM D 3039/IPC-650 2.4.19	%	2.6	1.6	%	2.6	1.6
Elongation at Break (CD)	ASTM D 3039/IPC-650 2.4.19	%	2.0	1.5	%	2.0	1.5
Young's Modulus (MD)	ASTM D 3039/IPC-650 2.4.19	psi	750,000	973,000	N/mm^2	5,171	6,708
Young's Modulus (CD)	ASTM D 3039/IPC-650 2.4.19	psi	600,000	984,000	N/mm^2	4,136	6,784
Poisson's Ratio (MD)	ASTM D 3039/IPC-650 2.4.19		0.21	0.24		0.21	0.24
Poisson's Ratio (CD)	ASTM D 3039/IPC-650 2.4.19		0.16	0.20		0.16	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	1,870	1,860	N/mm^2	12,893	12,824
Flexural Modulus (CD)	ASTM D 790/IPC-650 2.4.4	kpsi	1,420	1,740	N/mm^2	9,790	11,996
Peel Strength (CV1)	IPC-650 2.4.8 Sec 5.2.2 (TS)	lbs/in	8	8	N/mm	1.46	1.46
Thermal Conductivity	ASTM F 433/ASTM 1530-06	W/M*K	0.45	0.65	W/M*K	0.45	0.65
Dimensional Stability (MD)	IPC-650 2.4.39 Sec. 5.4 (After Bake)	mils/in.	-0.06	0.21	mm/M	-0.06	0.21
Dimensional Stability (CD)	IPC-650 2.4.39 Sec. 5.4 (After Bake)	mils/in.	0.15	0.20	mm/M	0.15	0.20
Dimensional Stability (MD)	IPC-650 2.4.39 Sec. 5.5 (TS)	mils/in.	-0.16	0.15	mm/M	-0.16	0.15
Dimensional Stability (CD)	IPC-650 2.4.39 Sec. 5.5 (TS)	mils/in.	0.07	0.10	mm/M	0.07	0.10
Surface Resistivity	IPC-650 2.5.17.1 Sec. 5.2.1 (ET)	Mohms	5.6×10^7	2.3×10^6	Mohms	5.6×10^7	2.3×10^6
Surface Resistivity	IPC-650 2.5.17.1 Sec. 5.2.1 (HC)	Mohms	1.1×10^8	2.1×10^7	Mohms	1.1×10^8	2.1×10^7
Volume Resistivity	IPC-650 2.5.17.1 Sec. 5.2.1 (ET)	Mohms/cm	3.8×10^8	1.1×10^7	Mohms/cm	3.8×10^8	1.1×10^7
Volume Resistivity	IPC-650 2.5.17.1 Sec. 5.2.1 (HC)	Mohms/cm	7.2×10^8	1.8×10^8	Mohms/cm	7.2×10^8	1.8×10^8
CTE (x axis) (RT to 125°C)	IPC-650 2.4.41/TMA	ppm/°C	11	10	ppm/°C	11	10
CTE (y axis) (RT to 125°C)	IPC-650 2.4.41/TMA	ppm/°C	18	16	ppm/°C	18	16
CTE (z axis) (RT to 125°C)	IPC-650 2.4.41/TMA	ppm/°C	57	23	ppm/°C	57	23
Density (Specific Gravity)	ASTM D 792	g/cm^3	2.12	2.11	g/cm^3	2.12	2.11
Hardness	ASTM D 2240 (Shore D)		77	79		77	79
T_d (2% Weight Loss)	IPC-650 2.4.24.6 (TGA)	°C	529	526	°C	529	526
T_d (5% Weight Loss)	IPC-650 2.4.24.6 (TGA)	°C	546	551	°C	546	551

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

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.

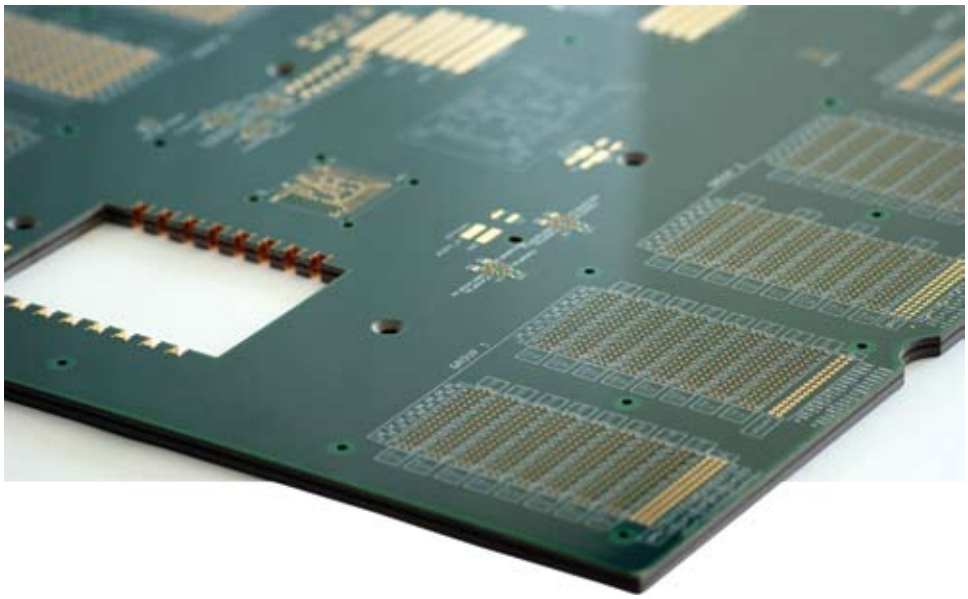
TSM-DS Family of Dimensionally Stable Low Loss Laminates

Designation	Dk
TSM-DS	2.85 +/-0.05
TSM-DS3	3.0 +/-0.05

Typical Thicknesses	
Inches	mm
0.0050	0.13
0.0100	0.25
0.0200	0.51
0.0300	0.76

Available Sheet Sizes	
Inches	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						
Designation	Weight	Copper Thickness		R_{MS} Treated Side		Description
RH	½ oz / ft²	~0.0007"	~18 µm	16 µin	0.4 µm	Rolled annealed
R1	1 oz / ft²	~0.0014"	~35 µm	11 µin	0.3 µm	Rolled annealed
CVH	½ oz / ft²	~0.0007"	~18 µm	27 µin	0.7 µm	Very low profile/Electrodeposited
CV1	1 oz / ft²	~0.0014"	~35 µm	25 µin	0.6 µm	Very low profile/Electrodeposited
CLH (SH)	½ oz / ft²	~0.0007"	~18 µm	13 µin	0.3 µm	Reverse treated/Electrodeposited
CL1 (S1)	1 oz / ft²	~0.0014"	~35 µm	13 µin	0.3 µm	Reverse treated/Electrodeposited
C2	2 oz / ft²	~0.0028"	~70 µm	77 µin	2.0 µm	Electrodeposited



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

RoHS WEEE Compliant

rev. 5/11