

# Multilayer TPG/TLG

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Epoxy Based Bromine Free Prepregs & Laminates

Homogeneous Laminates for  
High Speed Data Transmission

Enables Manufacture of 20+ Layer  
PWBs at FR-4 Temperatures & Pressures

Foil Laminations for  
Controlled Thickness RF Multilayers

Alternative to Thermoplastic Films in  
Military Multilayer Printed Circuit Boards

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**TACONIC**

An ISO 9001:2000 Registered Company

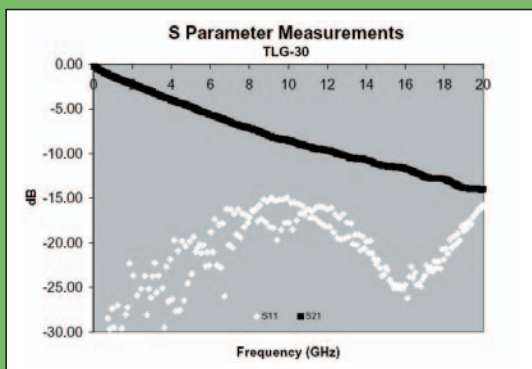
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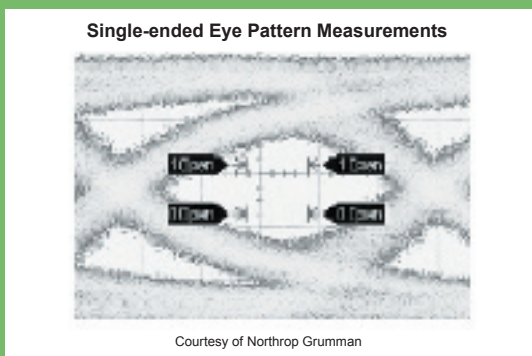
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# APPLICATIONS

## High Speed Digital RF Multilayer Military



S parameter measurements by Northrop Grumman at 12.5 gbps using a six layer test vehicle on a 16" transmission line (0.010" wide).



Courtesy of Northrop Grumman

Single-ended eye pattern measurements by Northrop Grumman at 12.5 gbps using a six layer test vehicle on a 16" transmission line (0.010" wide). 185 mVolts of eye height.

# Multilayer TPG/TLG

TPG/TLG-29&30 were designed to have reduced electrical loss and improved ease of fabrication. TPG/TLG-29&30 are based on BT/epoxy/woven fiberglass/pfpe components.

TPG/TLG-29&30 offer the following benefits to high speed designs due to the reduced dielectric constant:

- Faster signal propagation speed/reduced propagation delay
- Thinner cores reduce overall multilayer thickness
- Wider traces/thinner spacings between edge coupled pairs reduce crosstalk
- Attenuation is proportional to the square root of dielectric constant x frequency x dissipation factor

TPG/TLG-29&30 offer the following additional features:

- Reduced loss at higher frequencies resulting in lower rise-time degradation
- More uniform construction resulting in less dielectric variation within the prepreg and laminate
- Reduced z-axis expansion (less temperature dependent dielectric constant variation)
- Improved prepreg flow for buried and blind via applications where through holes are not desired
- Impedance variation along a 24" microstrip of +/- 0.5 ohms

TPG/TLG-29&30 have the following benefits standard to the TacPreg/TacLam family of products:

- Good copper adhesion with flat reverse treated foils
- The ability to laminate at conventional FR-4 temperatures enabling Taconic to offer these products with FR-4 like economies of scale
- TPG/TLG-29&30 is dimensionally stable due to the woven glass design and shows predictable movement when laminated at FR-4 conditions

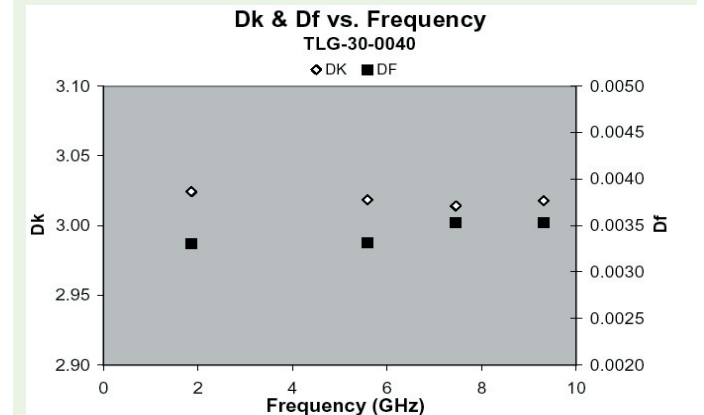
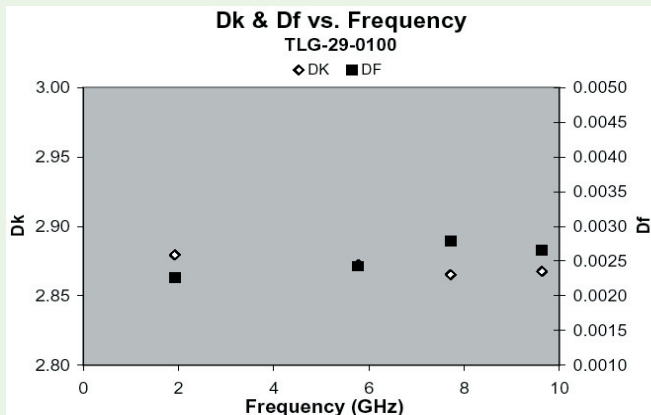
### Electrical Testing

Electrical testing was performed by Northrop Grumman (Springfield, MO) on a six layer board. A via connected layer one to layer five to minimize stub effects for single-ended eye pattern measurements. The 16" stripline transmission lines used a line width of 0.010", 1.0 oz copper, and a dielectric spacing of approximately 0.016" between ground planes. Signals were launched via SMA connectors. The via structure capacitance was tuned to look like a 50 ohm transmission line by adjusting the size and shape of the antipad geometry. The loss of the SMA launches and via are well understood by launching signals directly in and out of the via with the SMA pins mounted vertically. The S21 parameter measurements suggest a 0.5 db/inch insertion loss at 10 GHz and 0.875 db/inch at 20 GHz. For digital measurements, rise times ranged between 40 to 70 picoseconds using a non return to zero pseudo random bit pattern. 500 mVolt swings were used. The eye heights for 10 and 12.5 gbps were 264 and 185 mVolts respectively.

## TPG/TLG-29&30 Typical Values

Property	Test Method	Unit	Value		Unit	Value	
Material Tested			TLG-29 (0.0100")	TPG-30 (0.0050")		TLG-29 (0.0100")	TPG-30 (0.0050")
Dielectric Constant @ 10 GHz	IPC-TM-650 2.5.5.5.1		2.87	3.00		2.87	3.00
Dissipation Factor @ 10 GHz	IPC-TM-650 2.5.5.5.1		0.0027	0.0038		0.0027	0.0038
Moisture Absorption	IPC-TM-650 2.6.2.1	%	0.14	0.13	%	0.14	0.13
Dielectric Breakdown	IPC-TM-650 2.5.6	kV	43	54	kV	43	54
Dielectric Strength	ASTM D 149	V/mil	680	860	V/mm	26,772	33,858
Volume Resistivity	IPC-TM-650 2.5.17.1 (Humidity Conditioning)	Mohm/cm	9.8 x 10 <sup>7</sup>	7.7 x 10 <sup>8</sup>	Mohm/cm	9.8 x 10 <sup>7</sup>	7.7 x 10 <sup>8</sup>
Surface Resistivity	IPC-TM-650 2.5.17.1 (Humidity Conditioning)	Mohm	8.78 x 10 <sup>6</sup>	1.08 x 10 <sup>9</sup>	Mohm	8.78 x 10 <sup>6</sup>	1.08 x 10 <sup>9</sup>
Flexural Strength (MD)	ASTM D 790	psi	10,200	19,900	N/mm <sup>2</sup>	70.3	137.2
Flexural Strength (CD)	ASTM D 790	psi	8,800	14,900	N/mm <sup>2</sup>	60.7	102.7
Tensile Strength (MD)	ASTM D 3039	psi	5,600	12,700	N/mm <sup>2</sup>	38.6	87.6
Tensile Strength (CD)	ASTM D 3039	psi	4,400	8,200	N/mm <sup>2</sup>	30.3	56.5
Poisson's Ratio	ASTM D 3039		0.26	0.22		0.26	0.22
Peel Strength (1.0 oz ED - CV1)	IPC-TM-650 2.4.8	lbs/ linear inch	13		N/mm	2.3	
Peel Strength (1.0 oz reverse treated foil - CL1)	IPC-TM-650 2.4.8	lbs/ linear inch	7		N/mm	1.3	
Dimensional Stability	IPC-TM-650 2.4.39 (after etch)	ppm (warp/fill)	86/108	98/99	ppm (warp/fill)	86/108	98/99
Density (Specific Gravity)	ASTM D 792	g/cm <sup>3</sup>	2.07	2.02	g/cm <sup>3</sup>	2.07	2.02
Thermal Conductivity	ASTM F 433	W/m/K	0.31	0.25	W/m/K	0.31	0.25
T300	IPC-TM-650 2.4.24.1	minutes	>60		minutes	>60	
CTE (x-y)	ASTM D 3386 (30 - 100°C)	ppm	21-23	21-23	ppm	21-23	21-23
CTE (z)	ASTM D 3386 (30 - 100°C)	ppm	23	28	ppm	23	28
		%	0.16	0.20	%	0.16	0.20
CTE (z)	ASTM D 3386 (30 - 280°C)	ppm	135	108	ppm	135	108
		%	3.4	2.7	%	3.4	2.7
Attenuation @ 10 GHz (SH RTF 1/2 oz foil)	50 ohm microstrip,	dB/in	0.13	0.16	dB/in	0.13	0.16
Attenuation @ 20 GHz (SH RTF 1/2 oz foil)	79.6 mil TW (TLG-29-0100)		0.28	0.32		0.28	0.32
Attenuation @ 30 GHz (SH RTF 1/2 oz foil)	71.2 mil TW (TLG-30-0050)		0.43	0.48		0.43	0.48
Resin Flow (TPG)	IPC-TM-650 2.3.17	%		24	%		24
Outgassing (% TML)*	ASTM E 595*	%	0.08		%	0.08	
Outgassing (% CVCN)*	ASTM E 595*	%	0.01		%	0.01	
Outgassing (% WVR)*	ASTM E 595*	%	0.06		%	0.06	
Flammability Rating	UL 94		V-0			V-0	

\*As reported by NASA. See [http://outgassing.nasa.gov/og\\_disclaimer.html](http://outgassing.nasa.gov/og_disclaimer.html).



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.

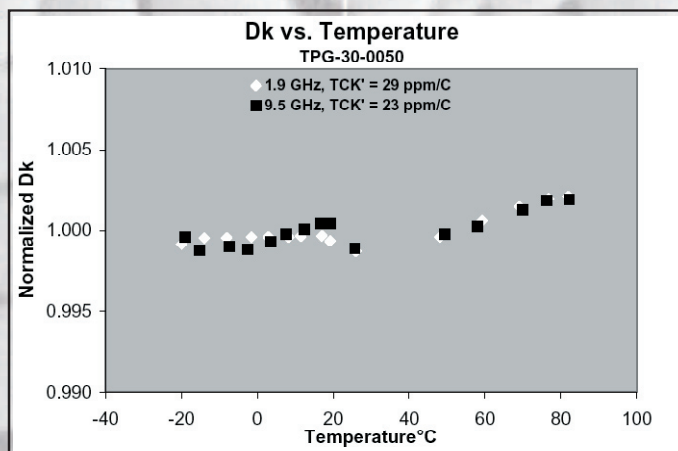
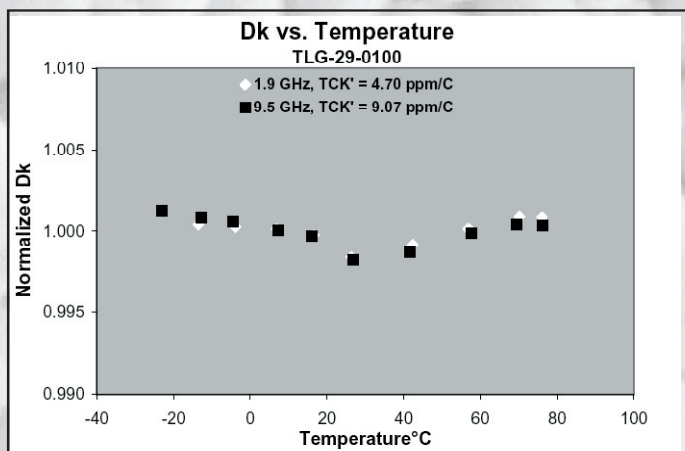
# How To Order

Designation - Laminates	Dielectric Constant	Typical Thicknesses
TLG-29	2.87	Increments of 0.0100"
TLG-30	3.00	Increments of 0.0040"

Designation - Prepregs	Dielectric Constant	Typical Thicknesses
TPG-30	3.00	0.0045", 0.0050"
TPG-35	3.50	0.0045"

Available Sheet Sizes	
12" x 18"	304 mm x 457 mm
16" x 18"	406 mm x 457 mm
18" x 24"	457 mm x 610 mm
16" x 36"	406 mm x 914 mm
24" x 36"	610 mm x 914 mm

Available Copper Cladding						
Designation	Weight	Copper Thickness		R <sub>MS</sub> Treated Side		Description
SH (CLH)	1/2 oz/ft <sup>2</sup>	~0.0007"	~18 μm	13 μin	0.3 μin	Reverse treated / Electrodeposited
S1 (CL1)	1 oz/ft <sup>2</sup>	~0.0014"	~35 μm	13 μin	0.3 μin	Reverse treated / Electrodeposited
HH (CH)	1/2 oz/ft <sup>2</sup>	~0.0007"	~18 μm	27 μin	0.7 μin	Electrodeposited
H1 (C1)	1 oz/ft <sup>2</sup>	~0.0014"	~35 μm	64 μin	1.6 μin	Electrodeposited



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