



## TC350™ Plus Laminates

TC350™ Plus laminates are ceramic filled PTFE-based woven glass reinforced composite materials providing a cost effective, high performance, thermally enhanced material for the circuit designer. With a thermal conductivity of 1.24W/mK, this next generation PTFE-based laminate is ideally suited for higher power microwave and industrial heating applications requiring higher maximum operating temperatures, low circuit losses, and excellent thermal dissipation within the circuit board. Additionally, the advanced filler system used enables the composite to have much improved mechanical drilling performance when compared with other competitive laminates. This will result in lower manufacturing costs during circuit board fabrication.

The standard TC350 Plus laminates are offered with a smooth ( $R_q = 1.0\mu\text{m}$ ) electrodeposited copper foil cladding to reduce insertion loss and RF heating of conductors within the circuit. Resistive foil and metal plate options are available upon request. TC350 Plus laminates are available in thicknesses from 0.010" to 0.060" to address higher power design needs.

The woven glass reinforcement combined with the high filler content of the laminate affords excellent dimensional stability. Other key features of the laminate include low z-axis CTE (38ppm/°C) for excellent plated through hole reliability, low loss tangent of 0.0017 at 10 GHz to enable low loss designs, low moisture absorption of 0.05% to ensure stable performance in a range of operating environments, high dielectric strength of 650 V/mil to ensure good z-axis insulation between conductor layers, and UL 94 V-0 flammability performance to enable the use of the material in commercial applications.

TC350 Plus laminates are used in a range of applications including Amplifiers, Combiners, Power Dividers, Couplers, and Filters. Applicable markets range from Commercial and Consumer to Defense and Aerospace.



Data Sheet

### Features and Benefits:

High Thermal Conductivity of 1.24 W/(mK)

- Improved Thermal Dissipation Enabling Lower Operating Temperatures for High Power Applications

Low Loss Tangent of 0.0017 at 10 GHz

- Excellent High Frequency Performance

Very Low Profile and Thermally Stable ED Copper Foil ( $R_q = 1.0\mu\text{m}$ )

- Very Low Insertion Loss and Reduced RF Heat Generation of Conductors

Advanced Filler Systems

- Improved Drilling Performance When Compared to Competitive Materials

### Typical Applications:

- High Power RF and Microwave Power Amplifiers
- High Power Amplifiers for Industrial Heating Applications
- Passive Components such as Couplers, Filters and Power Dividers

Standard Thicknesses	Standard Panel Sizes	Standard Claddings
0.010" (0.252mm) +/- 0.0007" 0.020" (0.508 mm) +/- 0.0015" 0.030" (0.762 mm) +/- 0.0020" 0.060" (1.524 mm) +/- 0.0030"	12" X 18" (305mm X 457mm) 24" X 18" (610mm X 457mm)	Reverse Treated Electrodeposited Copper Foil ½ oz. (18µm) SH/SH 1 oz. (35µm) S1/S1
*Additional non-standard thicknesses available from 0.010" - 0.060" in increments of 0.005"	*Additional panel sizes available	*Additional cladding weights are available

\*Contact Customer Service or Sales Engineering to inquire about additional available product configurations

TC350 Plus Property	Typical Value <sup>(1)</sup>	Units	Test Conditions		Test Method
<b>Electrical Properties</b>					
Dielectric Constant, ( $\epsilon_r$ ) (process)	3.50	-	23C @ 50% RH	10 GHz	IPC TM-650 2.5.5.5
Dielectric Constant (design)	3.62		C-24/23/50	10 GHz	Microstrip Differential Phase Length
Dissipation Factor (process)	0.0017	-	23C @ 50% RH	10 GHz	IPC TM-650 2.5.5.5
Thermal Coefficient of Dielectric Constant	-42	ppm/°C	50°C to 150°C	10 GHz	IPC TM-650 2.5.5.5
Volume Resistivity	$9.4 \times 10^{11}$	Mohm-cm	C-96/35/90		IPC TM-650 2.5.17.1
Surface Resistivity	$3.3 \times 10^{12}$	Mohm	C-96/35/90		IPC TM-650 2.5.17.1
Electrical Strength (dielectric strength)	650	V/mil			IPC TM-650 2.5.6.2
Dielectric Breakdown	38.9	kV	D-48/50	X/Y direction	IPC TM-650 2.5.6
Comparative Tracking Index	0/600	class/volts	C-40/23/50		UL-746A, ASTM D3638
<b>Thermal Properties</b>					
Decomposition Temperature (Td)	500	°C	2hrs @ 105°C	5% Weight Loss	IPC TM-650 2.3.40
Coefficient of Thermal Expansion	10	X	ppm/°C	-55°C to 288°C	IPC TM-650 2.4.41
	9	Y			
	38	Z			
Thermal Conductivity	1.24	W/(mK)		Z direction	ASTM D5470
<b>Mechanical Properties</b>					
Copper Peel Strength after Thermal Stress	0.70 (4.0)	N/mm (lbs/in)	10s @288°C	35 $\mu$ m foil	IPC TM-650 2.4.8
Flexural Strength MD CMD	75.2 (10.9) 64.8 (9.4)	MPa (ksi)	25°C +/- 3°C		ASTM D790
Tensile Strength MD CMD	49.0 (7.1) 46.2 (6.7)	MPa (ksi)	23°C/50RH		ASTM D3039/ D3039-14
Flex Modulus MD CMD	7791 (1130) 7171 (1040)	MPa (ksi)	25°C +/- 3°C		IPC-TM-650 Test Method 2.4.4
Dimensional Stability (MD/CMD)	0.05/0.15	mils/inch	after etch + bake		IPC-TM-650 2.4.39a
<b>Physical Properties</b>					
Flammability	V-0	-		-	UL94
Moisture Absorption	0.05	%	E1/105 +D48/50		IPC TM-650 2.6.2.1
Density	2.22	g/cm <sup>3</sup>	C-24/23/50		ASTM D792
Specific Heat Capacity	0.80	J/g°C	2 hours at 105°C		ASTM E2716
Nasa Outgassing	0.02/<0.01	%		TML/CVCM	ASTM E595

(1) Typical values are a representation of an average value for the population of the property. For specification values contact Rogers Corp.

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