TC350™ Laminates Data Sheet

Enhanced Thermal Conductivity Ceramic Filled PTFE/Woven Fiberglass Laminate for Microwave Printed Circuits Boards

TC350™ woven fiberglass reinforced, ceramic filled, PTFE- based composites for use as a printed circuit board substrate is designed to provide enhanced heat-transfer through "Best-In-Class" thermal conductivity, while reducing dielectric loss and insertion loss. Lower losses result in higher Amplifier and Antenna Gains/Efficiencies.

The increased thermal conductivity of TC350 laminate provides higher power handling, reduces hot-spots and improves device reliability. This higher heat transfer within the substrate complements designs using coins, heat sinks or thermal vias to provide designers additional design margin in managing heat. In designs with limited thermal management options, TC350 laminate significantly improves heat transfer where the primary thermal path is through the laminate. This results in reduced junction temperatures and extends the life of active components, which is critical for improving power amplifier reliability, extending MTBF and reducing warranty costs. In addition, lower operating temperatures and chip-matching thermal expansion characteristics provide better reliability for component attachment prone to solder fatigue, solder softening and joint failure.

TC350 laminate has excellent Dielectric Constant Stability across a wide temperature range. This helps Power Amplifier and Antenna designers maximize gain and minimize dead bandwidth lost to dielectric constant drift as operating temperature changes. Dielectric constant stability is also critical to phase and impedance sensitive devices such as network transformers utilized

for impedance matching networks utilized in power amplifier circuitry or in Wilkinson Power Dividers.

TC350 laminate has low Z-Direction CTE which matches copper. This feature provides unsurpassed plated through hole reliability. TC350 laminate is a "soft substrate" and relatively insensitive to stress from vibration and impact from today's drop testing requirements.

TC350 laminate enjoys a strong bond to copper, utilizing microwave grade, low profile copper. Unlike ceramic hydrocarbons that need to utilize "toothy copper" to achieve acceptable bond, TC350 laminate utilizes relatively smooth copper. This results in even lower insertion loss due to skin effect losses of copper that are more obvious at higher RF and microwave frequencies.

Features:

- “Best in Class” Thermal Conductivity(1.0 W/mK) and Dielectric Constant Stability across Wide Temperatures (-9 ppm/ºC)
- Very Low Loss Tangent provides Higher Amplifier or Antenna Efficiency
- Priced Affordably for Commercial Applications
- Easier to drill than traditional commercial based laminates utilizingthick and dense style woven glass
- High Peel Strength for Reliable Copper Adhesion in thermally stressedapplications

Benefits:

- Heat Dissipation and Management
- Improved Processing and Reliability
- Large Panel Sizes for Multiple Circuit Layout for lowered Processing Costs

Typical Applications:

- Power Amplifiers, Filters and Couplers
- Tower Mounted Amplifiers (TMA) andTower Mounted Boosters (TMB)
- Thermally Cycled Antennas sensitiveto dielectric drift
- Microwave Combiner and Power Dividers

Typical Properties:

TC350 Laminates

Property	Units	Value	Test Method
1. Electrical Properties			
Dielectric Constant (may vary by thickness)			
@1 MHz	-	3.50	IPC TM-650 2.5.5.3
@1.8 GHz	-	3.50	RESONANT CAVITY
@10 GHz	-	3.50	IPC TM-650 2.5.5.5
Dissipation Factor			
@1 MHz	-	0.0015	IPC TM-650 2.5.5.3
@1.8 GHz	-	0.0018	RESONANT CAVITY
@10 GHz	-	0.0020	IPC TM-650 2.5.5.5
Temperature Coefficient of Dielectric	-		
TC r @ 10 GHz (-40-150°C)	ppm/ºC	-9	IPC TM-650 2.5.5.5
Volume Resistivity			
C96/35/90	MΩ-cm	$7.4x10^6$	IPC TM-650 2.5.17.1
E24/125	MΩ-cm	$1.4x10^8$	IPC TM-650 2.5.17.1
Surface Resistivity			
C96/35/90	MΩ	$3.2x10^7$	IPC TM-650 2.5.17.1
E24/125	MΩ	$4.3x10^8$	IPC TM-650 2.5.17.1
Electrical Strength	Volts/mil (kV/mm)	780 (31)	IPC TM-650 2.5.6.2
Dielectric Breakdown	kV	40	IPC TM-650 2.5.6
Arc Resistance	sec	>240	IPC TM-650 2.5.1
2. Thermal Properties			
Decomposition Temperature (Td)			
Initial	°C	520	IPC TM-650 2.4.24.6
5%	°C	567	IPC TM-650 2.4.24.6
T260	min	>60	IPC TM-650 2.4.24.1
T288	min	>60	IPC TM-650 2.4.24.1
T300	min	>60	IPC TM-650 2.4.24.1
Thermal Expansion, CTE (x,y) 50-150ºC	ppm/ºC	7, 7	IPC TM-650 2.4.41
Thermal Expansion, CTE (z) 50-150ºC	ppm/ºC	23	IPC TM-650 2.4.24
% z-axis Expansion (50-260ºC)	%	1.2	IPC TM-650 2.4.24
3. Mechanical Properties			
Peel Strength to Copper (1 oz/35 micron)			
After Thermal Stress	lb/in (N/mm)	7 (1.2)	IPC TM-650 2.4.8
At Elevated Temperatures (150ºC)	lb/in (N/mm)	9 (1.6)	IPC TM-650 2.4.8.2
After Process Solutions	lb/in (N/mm)	7 (1.2)	IPC TM-650 2.4.8
Young’s Modulus	kpsi (MPa)		IPC TM-650 2.4.18.3
Flexural Strength (Machine/Cross)	kpsi (MPa)	14/1(97/69)	IPC TM-650 2.4.4
Tensile Strength (Machine/Cross)	kpsi (MPa)	11/8(76/55)	IPC TM-650 2.4.18.3
Compressive Modulus	kpsi (MPa)		ASTM D-3410
Poisson’s Ratio	-		ASTM D-3039
4. Physical Properties			
Water Absorption	%	0.05	IPC TM-650 2.6.2.1
Density, ambient 23ºC	g/cm^3	2.30	ASTM D792 Method A
Thermal Conductivity	W/mK	0.72	ASTM D5470
Specific Heat	J/gK	0.90	ASTM D5470
Flammability	class	V0	UL-94
NASA Outgassing, 125ºC, ≤10^{-6} torr			
Total Mass Loss	%	0.02	NASA SP-R-0022A
Collected Volatiles	%	0.01	NASA SP-R-0022A
Water Vapor Recovered	%	0.01	NASA SP-R-0022A

robustness of Rogers' laminates across frequency, thus simplifying the final design process when working across EM spectrum. The stability of the dielectric constant of TC350 laminate over frequency ensures easy design transition and scalability of design.

Figure 1

Demonstrates the stability of dielectric constant across frequency. This information was correlated from data generated by using a free space and circular resonator cavity. This characteristic demonstrates the inherent

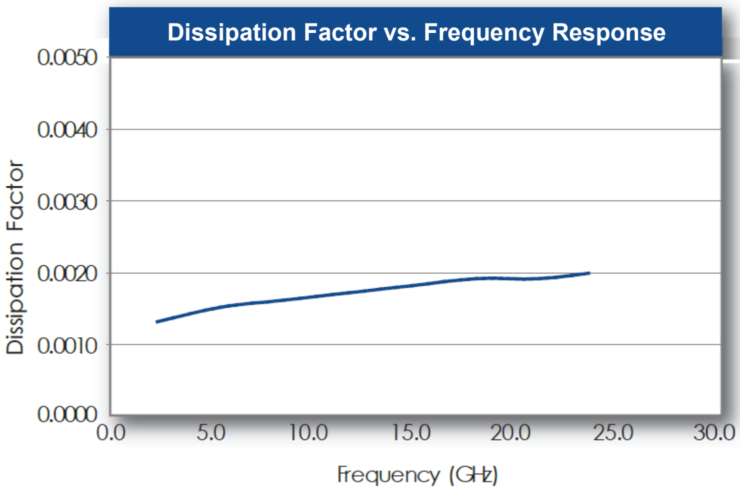

Figure 2

Demonstrates the stability of dissipation factor across frequency. This characteristic demonstrates the inherent robustness of Rogers' laminates across frequency, providing signal integrity is critical to the overall performance of the application.

Resonant Cavity Methods yielded slightly lower dissipation factor results than IPC 650-TM 2.5.5.5. Df across 1.8 GHz to 25.6 GHz averaged 0.0017 in the Z-Axis. Dielectric loss best correlates with Z-Axis (E-field perpendicular to the board) as the signal propagation down the length of the board maintains the E-Field perpendicular to the plane of the board (right hand rule), such as a microstrip or stripline design.

Material Availability:

Grade	Available Thicknesses	Standard Panel Sizes	Available Cladding
TC350	0.010" (0.25mm) ±0.0007"	18"x12" (457mm X 305mm) 18"x24" (457mm X 610mm)	½ oz. (18µm), 1 oz. (35µm) Reverse Treat electro-deposited copper Foil
	0.020" (0.51mm) ±0.0015" 0.030" (0.76mm) ±0.0020" 0.060" (1.52mm) ±0.0030"	12"x18" (305mm X 457mm) 24"x18" (610mm X 457mm)	½ oz. (18µm), 1 oz. (35µm) electrodeposited copper Foil ½ oz. (18µm), 1 oz. (35µm) Reverse Treat electro-deposited copper Foil

*Dielectric Constant may vary by test method or based on specific metal plate or composite constructions. Contact your representative with any specific questions.

The information in this data sheet is intended to assist you in designing with Rogers' circuit materials. It is not intended to and does not create any warranties express or implied, including any warranty of merchantability or fitness for a particular purpose or that the results shown on this data sheet will be achieved by a user for a particular purpose. The user should determine the suitability of Rogers' circuit materials for each application.

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