ROGERS CORPORATION

CLTE-AT™ Series Laminates Data Sheet

Excellent Dimensional Stability with High Degree of Phase Stability vs. Temperature

CLTE-AT™ laminates represent the commercial version of the CLTE™ product line. CLTE-AT laminates use the common building blocks developed with CLTE-XT™ laminates, but with some changes to make the product more affordable. This results in a higher dielectric constant (3.00) and a slightly different thickness than the CLTE-XT laminates. To maintain its lower cost base, CLTE-AT laminates have less options for copper style and panel sizes.

CLTE-AT micro dispersed ceramic PTFE composites utilize a woven fiberglass reinforcement to provide the highest degree of dimensional stability, critical in multi-layer designs. CLTE-AT laminates are in a "League of their Own" for registration when utilizing thin substrates (i.e. 0.005" and 0.010").

CLTE-AT laminates have "Best-in-Class" Insertion Loss (S21) and Loss Tangent (0.0013) in the commercial marketplace and second only to CLTE-XT laminates. During Development, Rogers focused not only in reducing Loss Tangent, but, also in reducing Conductive Losses.

The impact of copper foil roughness on conductor loss is due to increase in transmission line resistance as a result of skin effect. Rogers' CLTE-AT laminates were designed to provide a quality peel strength without having to resort to the utilization of the lossier, rougher coppers prevalent in competitive products to achieve acceptable copper adhesion.

CLTE-AT laminates have Low CTE xyz and Very Low TCEr for applications that require Electrical Phase Stability, Dk Stability, and Mechanical Stability well over a -55 to 150°C Operating Temperature. CLTE-AT laminates continue the competitive advantages of CLTE laminates (dimensional stability, low absorption of moisture and processing chemicals, ease of processability). The higher thermal conductivity of CLTE-AT laminates improve heat transfer relative to alternative materials and enable better power handling.

Applications include sensitive filter applications, collision avoidance radar, adaptive cruise control, temperature stable antennas and other microwave and RF applications.

Features:

- Ceramic/PTFE Microwave Composite
- Mechanically more robust and more dimensionally stable than alternatives
- Lowest Insertion Loss in Commercial Class
- Very Low Loss Tangent (0.0013)
- Electrical Phase Stability vs. Temperature
- High Thermal Conductivity
- Tight Dielectric Constant (±0.04) and Thickness Tolerance

Benefits:

- Excellent Thermal Stability of Dk and Df
- Phase Stability across temperature
- High Degree of Dimensional Stability required for complex, multilayer boards
- Excellent CTE in X,Y and Z

Typical Applications:

- Automotive Radar & Adaptive Cruise Control Applications
- Microwave/RF Applications
- Phase/Temperature Sensitive Antennas
- Phase Sensitive Electronic Applications
- RF and Microwave Filters

Typical Properties

Property	Units	Value	Test Method
1. Electrical Properties			
Dielectric Constant (may vary by thickness)			
@1 MHz	-	3.00	IPC TM-650 2.5.5.3
@ 10 GHz	-	3.00	IPC TM-650 2.5.5.5
Dissipation Factor			
@ 1 MHz	-	0.0013	IPC TM-650 2.5.5.3
@ 10 GHz	-	0.0013	IPC TM-650 2.5.5.5
Temperature Coefficient of Dielectric	-		
TCεr @ 10 GHz (-40-150°C)	ppm/ºC	-10	IPC TM-650 2.5.5.5
Volume Resistivity			
C96/35/90	MΩ-cm	$4.25x10^8$	IPC TM-650 2.5.17.1
E24/125	MΩ-cm		IPC TM-650 2.5.17.1
Surface Resistivity			
C96/35/90	MΩ	$2.02x10^8$	IPC TM-650 2.5.17.1
E24/125	MΩ		IPC TM-650 2.5.17.1
Electrical Strength	Volts/mil (kV/mm)		IPC TM-650 2.5.6.2
Dielectric Breakdown	kV	58	IPC TM-650 2.5.6
Arc Resistance	sec	250	IPC TM-650 2.5.1
2. Thermal Properties			
Decomposition Temperature (Td)			
Initial	°C	487	IPC TM-650 2.4.24.6
5%	°C	529	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	8, 8	IPC TM-650 2.4.41
Thermal Expansion, CTE (z) 50-150ºC	ppm/ºC	20	IPC TM-650 2.4.24
% z-axis Expansion (50-260ºC)	%		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 (1.3)	IPC TM-650 2.4.8
At Elevated Temperatures (150º)	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)	260 (1790)	IPC TM-650 2.4.18.3
Flexural Strength (Machine/Cross)	kpsi (MPa)	14.6/7.8 (101/54)	IPC TM-650 2.4.4
Tensile Strength (Machine/Cross)	kpsi (MPa)	7.0/4.4 (48/30)	IPC TM-650 2.4.18.3
Compressive Modulus	kpsi (MPa)	244	ASTM-D-3410
Poisson's Ratio	-	0.17	ASTM D-3039
4. Physical Properties			
Water Absorption	%	0.03	IPC TM-650 2.6.2.1
Density, ambient 23ºC	g/cm^3	2.06	ASTM D792 Method A
Thermal Conductivity	W/mK	0.64	ASTM E1461
Flammability	class	V-0	UL-94
NASA Outgassing, 125ºC, $\leq 10^{-6}$ torr			
Total Mass Loss	%	0,04	NASA SP-R-0022A
Collected Volatiles	%	0.00	NASA SP-R-0022A
Water Vapor Recovered	%	0.00	NASA SP-R-0022A

Laminates thicker than 0.060" are tested via IPC-TM 650 2.5.5.3 due to test fixture limits of the 2.5.5.5 Test Method Test Biasing of the IPC-TM 650 2.5.5.3 results in a 3.02 ±0.04 nominal for Quality Control.

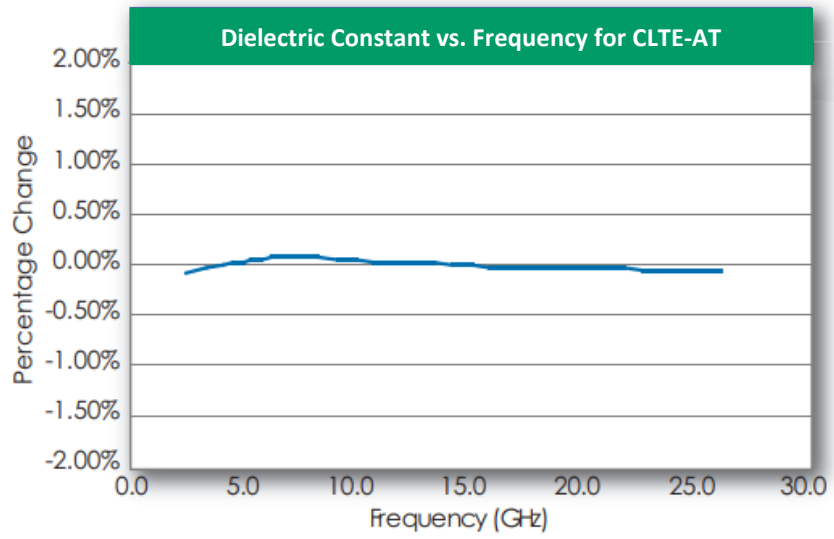

Figure 1

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

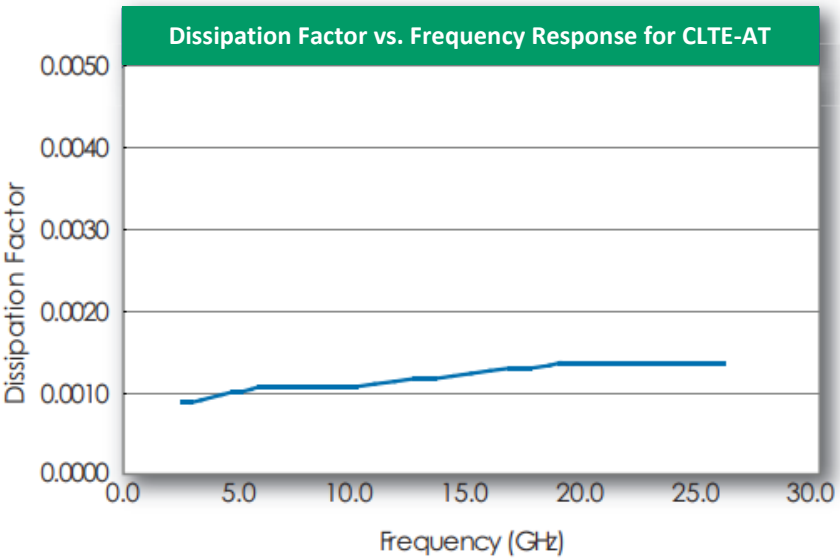

Figure 2

Demonstrates the stability of dissipation factor across frequency. This characteristic demonstrates the inherent robustness of Rogers' laminates across frequency, providing a stable platform for high frequency applications where 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 0.0011 in the Z-Axis. Dielectric loss best correlates with Z-Axis (Efield 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.

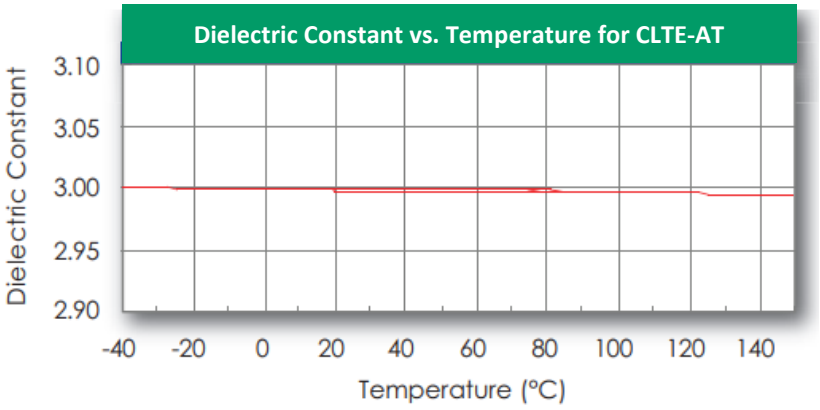

Figure 3

Dk/Temperature curve shows the unique thermal stability properties of CLTE-AT materials when thermocycled over temperature. Even over a wider temperature variation, the material retains its ultra-stable dielectric constant characteristics. This feature is critical to phase sensitive devices, and phase fed apertures that must perform over a wide temperature range.

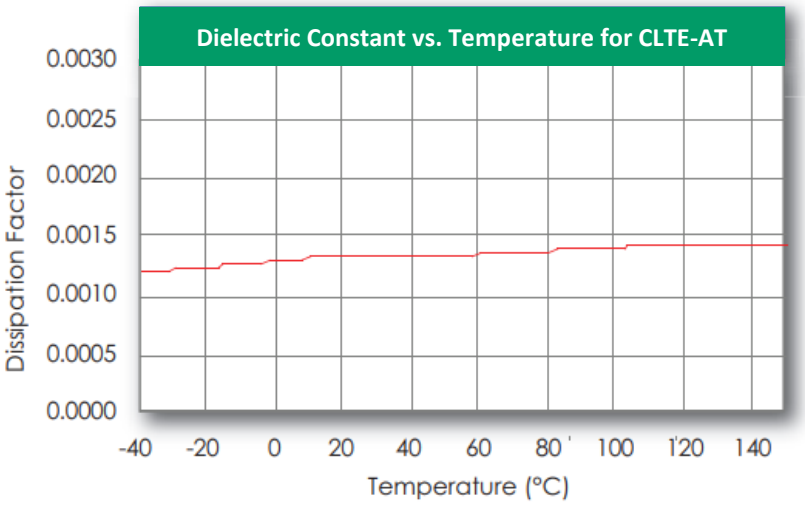

Figure 4

This Df/Temperature curve shows the unique thermal stability properties of CLTE-AT materials when thermocycled over temperature.

Material Availability

Standard Thicknesses	Standard Panel Sizes	Standard Claddings
CLTE-AT: 0.005" (0.13mm) ±0.0005" 0.010" (0.25mm) ±0.0007" 0.020" (0.50mm) ±0.0015" 0.030" (0.76mm) ±0.0020" 0.060" (1.52mm) ±0.0030" *Additional non-standard thicknesses available from 0.005" - 0.250" in varying increments	18" X 12" (457 X 305mm) 18" X 24" (457 X 610mm) *Additional panel sizes available.	**CLTE-AT:** Electrodeposited Copper Foil ½ oz. (18µm) *HH/HH* 1 oz. (35µm) *H1/H1* Reverse Treated Electrodeposited Copper Foil ½ oz. (18µm) *SH/SH* 1 oz. (35µm) *S1/S1* *Additional claddings, such as resistive foil and rolled copper, are available.

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