

PTFE/Woven Fiberglass Laminates: Microwave Printed Circuit Board Substrates

CuClad® laminates are woven fiberglass/PTFE composite materials for use as printed circuit board substrates. Using precision control of the fiberglass/PTFE ratio, CuClad laminates offer a range of choices from the lowest dielectric constant and loss tangent to a more highly reinforced laminate with better dimensional stability.

The woven fiberglass reinforcement in CuClad products provides greater dimensional stability than non-woven fiberglass reinforced PTFE based laminates of similar dielectric constants. The consistency and control of the PTFE coated fiberglass cloth allows Arlon to offer a greater variety of dielectric constants and produces a laminate with better dielectric constant uniformity than comparable non-woven fiberglass reinforced laminates. These properties make CuClad an attractive choice for filters, couplers and low noise amplifiers.

CuClad laminates are crossplied (alternating layers of coated fiberglass plies are oriented 90° to each other). This provides true electrical and mechanical isotropy in the XY plane, a feature unique to CuClad. No other woven or nonwoven fiberglass reinforced PTFE based laminates make this claim. Designers have found this degree of isotropy critical in some phased array antenna applications.

CuClad 217 ($\epsilon_r=2.17, 2.20$) uses a low fiberglass/PTFE ratio to provide the lowest dielectric constant and dissipation factor available in fiberglass reinforced PTFE based laminates. Together, these properties offer faster signal propagation and higher signal/noise ratios.

CuClad 233 ($\epsilon_r=2.33$) uses a medium fiberglass/PTFE ratio to balance lower dielectric constant and improved dissipation factor without sacrificing mechanical properties.

CuClad 250 ($\epsilon_r=2.40-2.60$) uses a higher fiberglass/PTFE ratio to provide mechanical properties approaching those of conventional substrates. Better dimensional stability and lower thermal expansion in all directions are other significant benefits. The electrical properties of CuClad 250GT and CuClad 250GX are tested at 1MHz and 10GHz respectively.

For critical performance applications, CuClad products may be specified with an “LX” testing grade; this designates that each sheet will be tested individually, and a test report will be issued with the order

Availability:

CuClad laminates are supplied with 1/2, 1 or 2 ounce electrodeposited copper on both sides. Other copper weights and rolled copper foil are available. CuClad is available bonded to a heavy metal ground plane. Aluminum, brass or copper plates also provide an integral heat sink and mechanical support to the substrate.

When ordering CuClad products please specify dielectric constant, thickness, cladding, panel size and any other special considerations. Available master sheet sizes include 36" x 36" in a crossplied configuration and 36" x 48" in a parallel plied configuration.

Typical Properties: CuClad® PTFE/Woven Fiberglass Laminates

Properties	Test Method	Condition	Typical Values CuClad 217	Typical Values CuClad 233	Typical Values CuClad 250
Dielectric Constant @10GHz	IPC TM-650 2.5.5.5	C23/50	2.17, 2.20	2.33	2.40 to 2.60
Dielectric Constant @1MHz	IPC TM-650 2.5.5.3	C23/50	2.17, 2.20	2.33	2.40 to 2.60
Dissipation Factor @10GHz	IPC TM-650 2.5.5.5	C23/50	0.0009	0.0013	0.0022
Dissipation Factor @1MHz	IPC TM-650 2.5.5.3	C23/50	0.0008	0.0009	0.0010
Thermal Coefficient of E _r (ppm/°C)	IPC TM-650 2.5.5.5 Adapted	-10°C to +140°C	-151	-171	-170
Peel Strength (lbs per inch)	IPC TM-650 2.4.8	After Thermal Stress	14	14	14
Volume Resistivity (MΩ-cm)	IPC TM-650 2.5.17.1	C96/35/90	2.3 x 10 ⁸	8.0 x 10 ⁸	1.8 x 10 ⁹
Surface Resistivity (MΩ)	IPC TM-650 2.5.17.1	C96/35/90	3.4 x 10 ⁶	2.4 x 10 ⁶	1.5 x 10 ⁸
Arc Resistance (seconds)	ASTM D-495	D48/50	> 180	> 180	> 180
Tensile Modulus (kpsi)	ASTM D-638	A, 23°C	275, 219	510, 414	725, 572
Tensile Strength (kpsi)	ASTM D-882	A, 23°C	8.8, 6.6	10.3, 9.8	26.0, 20.5
Compressive Modulus (kpsi)	ASTM D-695	A, 23°C	237	276	342
Flexural Modulus (kpsi)	ASTM D-790	A, 23°C	357	371	456
Dielectric Breakdown (kv)	ASTM D-149	D48/50	> 45	> 45	> 45
Specific Gravity (g/cm ³)	ASTM D-792 Method A	A, 23°C	2.23	2.26	2.31
Water Absorption (%)	MIL-S-13949H 3.7.7 IPC TM-650 2.6.2.2	E1/105 + D24/23	0.02	0.02	0.03
Coefficient of Thermal Expansion (ppm/°C)	IPC TM-650 2.4.24 Mettler 3000 Thermomechanical Analyzer	0°C to 100°C			
X Axis			29	23	18
Y Axis			28	24	19
Z Axis			246	194	177
Thermal Conductivity (W/mK)	ASTM E-1225	100°C	0.261	0.258	0.254
Outgassing	NASA SP-R-0022A				
Total Mass Loss (%)	Maximum 1.00%	125°C, ≤ 10 ⁻⁶ torr	0.01	0.01	0.01
Collected Volatile Condensable Material (%)	Maximum 0.10%		0.01	0.01	0.00
Water Vapor Regain (%)			0.00	0.00	0.00
Visible Condensate (±)			NO	NO	NO
Flammability UL File E 80166	UL 94 Vertical Burn IPC TM-650 2.3.10	C48/23/50, E24/125	meets requirements of UL94V-0	meets requirements of UL94V-0	UL94V-0

Data based on 0.062" dielectric thickness, exclusive of metal cladding except where indicated by test method. Results listed above are typical properties; they are not to be used as specification limits. The above information creates no expressed or implied warranties. The properties of CuClad Series laminates may vary depending on the application.

The information and data contained herein are believed reliable, but all recommendations or suggestions are made without guarantee. You should thoroughly and independently test materials for any planned applications and determine satisfactory performance before commercialization. Furthermore, no suggestion for use, or material supplied shall be construed as a recommendation or inducement to violate any law or infringe any patent.



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