

# Trolitax<sup>®</sup> Data sheet of copper-clad laminates for printed circuits NEMA LI 1 1969

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Data sheet of copper-clad laminates for printed circuits

**NEMA LI 1**

Property	Testmethod	Test condition	Unit	GRADE FR 2					GRADE FR 3		GRADE G 10		GRADE FR 4		
				Required values Grade FR 2	TROLITAX DN 7019	TROLITAX DN 8018	TROLITAX DN 8020	TROLITAX DN 8021	Required values Grade FR 3	TROLITAX DN 8302	Required values Grade G 10	TROLITAX DN 9001 <sup>1)</sup>	Required values Grade FR 4	TROLITAX DN 9002 <sup>1)</sup>	
					Typical values*) for 1,6 mm = 1/16 inch	Typical values*) for 1,6 mm = 1/16 inch	Typical values*) for 1,6 mm = 1/16 inch	Typical values*) for 1,6 mm = 1/16 inch		Typical values*) for 1,6 mm = 1/16 inch		Typical values*) for 1,6 mm = 1/16 inch		Typical values*) for 1,6 mm = 1/16 inch	
1. Flexural strength, lengthwise crosswise	NEMA LI 1 10.18 (ASTM D790)	A	psi	12,000 min.av. 10,500 min.av.	20,000 17,000	20,000 17,000	19,000 16,000	19,000 16,000	20,000 min.av. 16,000 min.av.	21,300 18,500	60,000 min.av. 50,000 min.av.	64,000 54,000	60,000 min.av. 50,000 min.av.	70,000 64,000	
2. Tensile strength, lengthwise crosswise	DIN 53455	A A	psi psi	— —	11,400 11,400	11,400 11,400	11,400 11,400	11,400 11,400	— —	16,000 14,200	— —	45,000 36,000	— —	45,000 36,000	
3. Izod impact strength, lengthwise crosswise	NEMA LI 1 6.08 (ASTM D256)	E48/50 E48/50	ft-lb/in ft-lb/in	— —	— —	— —	— —	— —	— —	— —	7.0 min. 5.5 min.	9.0 7.0	7.0 min. 5.5 min.	9.0 7.0	
4. Water absorption	NEMA LI 1 10.15 (ASTM D229)	D24/23	%	0.75 max.av.	0.55	0.65	0.65	0.6	0.65 max.av.	0.4	0.25 max.av.	0.15	0.25 max.av.	0.15	
5. Surface resistance	NEMA LI 1 10.14	C96/35/90	ohms	10 <sup>7</sup> min.	10 <sup>11</sup>	10 <sup>11</sup>	5x10 <sup>10</sup>	5x10 <sup>10</sup>	10 <sup>10</sup> min.	5x10 <sup>10</sup>	10 <sup>10</sup> min.	5x10 <sup>11</sup>	10 <sup>10</sup> min.	5x10 <sup>11</sup>	
6. Volume resistivity	NEMA LI 1 10.14	C96/35/90	ohm cm	10 <sup>10</sup> min.	10 <sup>12</sup>	10 <sup>12</sup>	5x10 <sup>11</sup>	5x10 <sup>12</sup>	10 <sup>11</sup> min.	10 <sup>12</sup>	10 <sup>12</sup> min.	5x10 <sup>12</sup>	10 <sup>12</sup> min.	5x10 <sup>12</sup>	
7. Dielectric constant at 1 mhz	NEMA LI 1 10.17 (ASTM D 150)	A D24/23 D48/50	—	— — — max.av.	— — 4.8	— — 5.0	— — 5.0	— — 4.7	— max.av. 4.8 max.av. — max.av.	4.2 4.3 4.8	— max.av. 5.4 max.av. — max.av.	5.0 5.0 5.0	— max.av. 6.4 max.av. — max.av.	5.0 5.0 5.0	
8. Dissipation factor at 1 mhz	NEMA LI 1 10.17 (ASTM D 150)	D48/50 D24/23	—	— max.av.	0.045	0.045	0.05	0.045	— max.av. 0.040 max.av.	0.040 0.035	— max.av. 0.035 max.av.	0.022 0.020	— max.av. 0.035 max.av.	0.022 0.020	
9. Electrolytic corrosion, anode cathode	DIN 53489	C96/40/92 C96/40/92	—	—	AN 1.2—1.4	AN—AB 1.2—1.6	AN—AB 1.4—1.6	AN 1.2—1.4	—	AN 1.2—1.4	—	A 1.0	—	A 1.0	
10. Dielectric breakdown parallel, step by step	NEMA LI 1 10.16 (ASTM D229)	A D48/50	kV kV	— 15 min.av.	— 30	— 30	— 18	— 20	— 30 min.av.	45 40	45 min.av. 40 min.av.	50 45	45 min.av. 40 min.av.	50 45	
11. Peel strength after solder float	NEMA LI 1 10.12	A	lbs/in	6 min.	9	9	9	9	8 min.	9	8 min.	10	8 min.	10	
12. Solder float at 260 °C (500 °F)	NEMA LI 1 10.11	A	sec	5 min.	10	10	10	10	10 min.	20	20 min.	>90	20 min.	>90	
13. Oven blister test at 140 °C at 120 °C	NEMA LI 1 10.09	A A	min min	— 30	— >30	— >30	— >30	— >30	— 60	— >60	60	>60	60	>60	
14. Solvent resistance (trichlorethylene) Resistance against caustic soda	NEMA LI 1 10.10	A	min	2	3	3	3	4	2	10	2	>10	2	>10	
15. Flammability	ASTM D 635	A	sec	15 max.av.	8	10	13	13	15 max.	7	—	10	15 max.av.	1	
16. Warp after stoving	—	E1/80	%	—	<0.5	<1	<1	<0.5	—	<0.5	—	<0.25	—	<0.25	
17. Punching holes	—	—	°C	—	50—60	23—35	23	23	—	23	—	23	—	23	
18. Shearing	—	—	°C	—	50—60	23—35	23	23	—	23	—	23	—	23	
19. Blanking	—	—	°C	—	40	35	23	23	—	—	—	23	—	23	
<b>Thickness and Tolerances</b>				FR 2 and FR 3					G 10 and FR 4						
Nominal thickness including copper				1—ounce copper one side		1—ounce copper two sides		2—ounce copper one side		2—ounce copper two sides		1—ounce copper one and two sides		2—ounce copper one and two sides	
1/32	0.031	NEMA LI 1 — 10.02	inch	± 0.004		± 0.0045		± 0.0045		± 0.0045		± 0.0065		± 0.0065	
3/64	0.046			± 0.005		± 0.0055		± 0.0055		± 0.0055		± 0.0075		± 0.0075	
1/16	0.062			± 0.0055		± 0.006		± 0.006		± 0.006		± 0.0075		± 0.0075	
3/32	0.093			± 0.007		± 0.0075		± 0.0075		± 0.0075		± 0.009		± 0.009	

**Test conditions**

A = tested as received  
 E 1/105 = after conditioning of 1 hour in oven at 105 °C  
 D 24/23 = after conditioning of 24 hours in water at 23 °C  
 C 96/35/90 = after conditioning of 96 hours at 35 °C and 90 % r.h.  
 C 96/40/92 = after conditioning of 96 hours at 40 °C and 92 % r.h.

D 48/50 = after conditioning of 48 hours in water at 50 °C  
 E 1/80 = after conditioning of 1 hour in oven at 80 °C  
 min. av. = minimum average  
 max. av. = maximum average

<sup>1)</sup> Approved in accordance with MIL-P-13949 by MBL  
<sup>2)</sup> Only NEMA Standard values are guaranteed

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