



MANUFACTURERS OF
ELECTRICAL INSULATION MATERIALS

INSULATING COMPONENTS FOR
POWER SYSTEMS EQUIPMENT

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MATERIAL DATA SHEET

Item:	NEMA Grade FR4 Glass Epoxy Laminate		
Description:	NEMA Grade FR4 materials are continuous filament woven fiberglass sheets bonded with flame resistant epoxy resin. The material has the ability to maintain excellent mechanical, electrical, and physical properties at elevated temperature to 130°C. TGC FR4 is UL, RoHS, and REACH certified to ensure reliability, safety, and consistency. (UL File No. E339275)		
Standards:	NEMA LI-1 Grade FR4 IEC 60893 EP GC 202		
Availability:	Laminate Sheets:	Thickness:	English Units 0.010" to 5.0" SI Units 0.125 mm to 127 mm
		Standard Sheet Sizes:	48" x 120" 122cm x 305cm
	Convolute Tubing:	Available in nearly any custom size of inside and outside diameter per customer requirements.	
	Fabricated Parts:	The Gund Company custom fabricates insulation materials to the exact specifications and drawings of our customers	

Key Characteristics	Units - English (SI)	Typical Values
Standard Color		Green ¹
Specific Gravity	lb/in ³ (g/cc)	1.9

¹Custom colors available upon request

NEMA LI-1 FR4 Required Properties

Key Characteristics	Test Method	Units	NEMA Required	Typical Values
Breakdown Voltage Condition A (0.062") Condition D-48/50	ASTM D-229	kV	45 min 40 min	66 65
Permittivity @ 1MHz Condition A (0.062") Condition D-48/50	ASTM D-229	unitless	5.2 max 5.4 max	4.4 4.5
Dissipation Factor @ 1MHz Condition A (0.062") Condition D-48/50	ASTM D-229	unitless	0.025 max 0.035 max	0.014 0.015
IZOD Impact Strength LW CW	ASTM D-229	ft.-lb/in Notched	7.0 min 5.5 min	13 12
Flexural Strength (0.062") LW CW	ASTM D-790	ksi (MPa)	60.0 (414) min 50.0 (345) min	80 (552) 70 (483)
Bonding Strength (0.500") LW CW	ASTM D-229	Lb (kg)	2000 (907) 1,600 (725) min	2,500 (1,133) 1,900 (862)
Moisture Absorption (0.125")	ASTM D-570	%	0.15 max	0.10
Flammability Rating	UL94	Class	V-I	V-0

All of the information, suggestions, and recommendations pertaining to the properties and uses of the products herein are based upon tests and data believed to be accurate; however, the final determination regarding the suitability of any material described herein for the use contemplated, the manner of such use, and whether the use infringes any patents is the sole responsibility of the user. There is no warranty, expressed or implied, including, without limitation warranty of merchantability or fitness for a particular purpose. Under no circumstances shall we be liable for incidental or consequential loss or damage.

IEC 60893-3-2 EPGC 202 Required Properties

Key Characteristics	Test Method	Units	IEC Required	Typical Values
Flexural Strength	ISO 179	MPa	340 min	560
Charpy Impact Strength	--	kJ/m ²	33 min	49
Perpendicular Electric Strength (90°C in Oil, 1.5mm)	--	kV/mm	13 min	25
Parallel Breakdown Voltage (Stepped, 90°C in Oil, 3mm)	--	kV	35 min	>45
Insulation Resistance (after Water Immersion)	--	MΩ	5(10) ⁴	>10 ⁷
Flammability Rating	UL94	Class	V-0	V-0
Moisture Absorption (1.5mm)	--	mg	19 max	13

Additional Engineering Properties

Key Characteristics	Test Method	Units - English (SI)	Typical Values
Tensile Strength (0.125") LW	ASTM D638	ksi (MPa)	62 (430)
Compressive Strength, Flatwise (0.500")	ASTM D695	ksi (MPa)	66 (455)
Flexural Modulus (0.062") LW CW	--	ksi (GPa)	2,900 (20) 2,600 (18)
Shear Strength (punch type, 0.062")	ASTM D732	psi (MPa)	21,500 (148)
Coefficient of Thermal Expansion	--	" / " / °C x 10 ⁻⁶	15
Temperature Index	--	°C	130
Glow Wire Flame Index & Ignition Temperature	IEC 60695-2-12	°C	960
Hot Wire Ignition	UL 746A	Sec	120
High Current Arc Ignition (3mm)	UL 746A	Arcs	120
Arc Resistance (0.125")	ASTM D495	Sec	140
Comparative Tracking Index (.125")	ASTM D3638*	V	230
Dielectric Strength Condition A	ASTM D149	V/mil	635
Volume Resistivity (0.062")	ASTM D257	Ω – cm	3(10) ¹⁵
High Voltage Arc Resistance	UL 746A	Sec	300
High Voltage Arc Tracking Rate	UL 746A	mm/min	0

*ASTM D3638 & IEC 112 are the same test method - IEC 60112 is slightly different, but the result is similar

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