

**THERMOSET INDUSTRIAL LAMINATE PROPERTIES**

*Minimum Values*

Properties	NEMA grades reinforcements resin binders	G10,FR4 glass cloth epoxy	G11,FR5 glass cloth epoxy HT	G5,G9 glass cloth melamine	G7 glass cloth silicone	GPO 1 glass mat polyester	GPO 3 glass mat polyester	X paper phenolic	XX paper phenolic	XXX paper phenolic	C,CE canvas phenolic	L,LE linen phenolic
<b>Tensile strength</b>												
lengthwise, psi		40,000	40,000	37,000	23,000	12,000	11,000	20,000	16,000	15,000	9,500	12,500
crosswise, psi		35,000	35,000	30,000	18,000	—	—	16,000	13,000	12,000	7,500	8,750
<b>Compressive strength</b>												
flatwise, psi		60,000	60,000	70,000	45,000	40,000	30,000	36,000	34,000	32,000	37,000	37,000
edgewise, psi		35,000	35,000	25,000	14,000	—	—	19,000	23,000	25,500	23,500	25,000
<b>Flexural strength</b>												
lengthwise, psi		55,000	55,000	55,000	23,000	23,000	20,000	25,000	15,000	13,500	17,000	15,000
crosswise, psi		45,000	45,000	35,000	20,000	—	—	22,000	14,000	11,800	15,000	13,750
<b>Modulus of elasticity in flex × 10<sup>-3</sup></b>												
lengthwise, psi		2,700	2,700	2,500	1,400	—	—	1,800	1,400	1,300	950	1,050
crosswise, psi		2,200	2,200	2,000	1,200	—	—	1,300	1,100	1,000	850	850
<b>Shear strength (psi)</b>												
		19,000	19,000	20,000	17,000	—	—	12,000	11,000	10,000	11,500	11,750
<b>Impact, Izod</b>												
flatwise, ft-lb/in of notch		7	7	12	8.5	—	—	4	1.3	1	3.2,2.3	2.5,1.8
edgewise, ft-lb/in of notch		5.5	5.5	8	7.5	—	—	0.5	0.35	0.35	1.9,1.4	1.1,1
<b>Hardness, Rockwell M</b>												
		110	110	120	100	—	—	110	105	110	104	105
<b>Specific gravity</b>												
		1.82	1.82	1.9	1.68	1.8	1.85	1.36	1.34	1.32	1.35	1.34
<b>Coefficient of thermal expansion</b>												
cm/cm-°C×10 <sup>-5</sup>		1.82	1.82	1.9	1.68	1.8	1.85	1.36	1.34	1.32	1.35	1.34
<b>Water absorption</b>												
.062" thk, % per 24 hrs		0.25	0.25	0.8	0.3	0.35	0.4	6	2	1.4	4.4,2.2	2.5,1.95
.125" thk, % per 24 hrs		0.15	0.15	0.7	0.2	—	—	3.3	1.3	0.95	2.5,1.6	1.6,1.3
.500" thk, % per 24 hrs		0.10	0.10	0.4	0.15	—	—	1.1	0.55	0.45	1.2,0.75	0.9,0.7
<b>Dielectric strength (V/mil)</b>												
perpendicular to laminations; short												
.062" thk		500	500	400	400	370	400	700	700	650	200,500	200,500
.125" thk		400	400	350	350	—	—	500	500	470	150,360	150,360
<b>Dissipation factor</b>												
condition A, 1 megacycle		0.025	0.025	0.017	0.003	—	—	0.06	0.045	0.038	0.1,0.055	0.1,0.055
<b>Dielectric constant</b>												
condition A, 1 megacycle		5.2	5.2	7.12	4.2	—	—	6	5.5	5.3	—, 5.8	—, 5.8
<b>Insulation resistance</b>												
Condition: 96 hrs @ 90% relative humidity (in megaohms)		200,000	200,000	10,000	200,000	—	—	—	—	—	—	—
<b>Flame resistance</b>												
Underwriter Labs, Classification		94V-0	94V-0	94V-0	94V-0	94HB	94V-0	94HB	94HB	94HB	94HB	94HB
<b>Bond strength (lbs)</b>												
		2,000	1,600	1,700	650	—	—	700	800	950	1,800	1,600
<b>Max operating temperature</b>												
approx. °F continuous		285	300	285	465	265	265	285	285	285	265	265
sheet mil spec: Mil-I-24768 / __		2,GEE	3,GEB	8,GMG	17	4	6	12	11	10	16,FBM	15,FBI
type		27,GEE-F	28,GEB-F	1,GME	GSG	GPO1	GPO3	PBM	PBG	PBE	14,FBG	13,FBE