

## HIGH PRESSURE LAMINATES - PROPERTIES

| Nema Grades | FR4         | FR5         | G3          | G7          | G9          | G10         | G11         | X        | XX       | XXX      | C, CE    | L, LE    |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|----------|----------|----------|----------|----------|
| Substrate   | glass cloth | glass cloth | glass cloth | glass cloth | glass cloth | glass cloth | glass cloth | paper    | paper    | paper    | canvas   | linen    |
| resin       | epoxy       | epoxy HT    | phenolic    | silicone    | melamine    | epoxy       | epoxy HT    | phenolic | phenolic | phenolic | phenolic | phenolic |
| <b>Cost</b> | \$\$\$      | \$\$\$      | \$\$        | \$\$\$      | \$\$        | \$\$        | \$\$        | \$       | \$       | \$       | \$       | \$       |

### MECHANICAL

|  |        |        |        |        |        |        |        |        |        |        |           |             |
|--|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----------|-------------|
| <b>Tensile Strength (lengthwise, PSI)</b>                | 40,000 | 40,000 | 23,000 | 23,000 | 37,000 | 40,000 | 40,000 | 20,000 | 16,000 | 15,000 | 9,000     | 12,500      |
| <b>Compressive Strength (flatwise PSI)</b>               | 60,000 | 60,000 | 50,000 | 45,000 | 70,000 | 68,000 | 60,000 | 36,000 | 34,000 | 32,000 | 39,000    | 37,000      |
| <b>Flexural Strength (.125" lengthwise PSI)</b>          | 55,000 | 55,000 | 20,000 | 20,000 | 55,000 | 55,000 | 55,000 | 25,000 | 15,000 | 13,500 | 17,000    | 16,500      |
| <b>Flexural Modulus of Elasticity (lengthwise, kPSI)</b> | 2,700  | 2,800  | 1,500  | 1,400  | 2,500  | 2,700  | 2,800  | 1,800  | 1,400  | 1,300  | 1,000     | 1,000       |
| <b>IZOD Impact (lengthwise ft-lb/in of notch)</b>        | 7      | 7      | 6.5    | 6.5    | 7      | 7      | 7      | 0.55   | 0.4    | 0.4    | 2.1 / 1.6 | 1.35 / 1.25 |
| <b>Rockwell Hardness M scale</b>                         | 110    | 114    | 100    | 100    | 120    | 111    | 112    | 110    | 105    | 110    | 104       | 105         |
| <b>Specific Gravity</b>                                  | 1.85   | 1.85   | 1.65   | 1.68   | 1.9    | 1.8    | 1.8    | 1.36   | 1.34   | 1.32   | 1.36      | 1.34        |
| <b>Bond Strength (in lbs.)</b>                           | 2000   | 1600   | 850    | 650    | 1700   | 2000   | 1600   | 700    | 800    | 950    | 1800      | 1600        |
| <b>Water Absorption (.125" thick, % per 24 hrs)</b>      | 0.15   | 0.15   | 2      | 0.35   | 0.7    | 0.15   | 0.15   | 3.3    | 1.3    | 0.95   | 2.5 / 1.6 | 1.6 / 1.3   |

### ELECTRICAL

|   |        |        |      |        |           |        |        |      |       |       |      |       |
|---|--------|--------|------|--------|-----------|--------|--------|------|-------|-------|------|-------|
| <b>Dielectric Strength (volt/mil .125" thick)</b>         | 350    | 350    | 450  | 250    | 275       | 350    | 350    | 360  | 360   | 320   | 220  | 220   |
| <b>Dissipation Factor (condition A, 1 megacycle-max)</b>  | 0.025  | 0.025  | --   | 0.003  | 0.017     | 0.025  | 0.025  | ---- | 0.045 | 0.038 | ---- | 0.055 |
| <b>Dielectric Constant (condition A, 1 megacycle-max)</b> | 5.2    | 5.2    | ---- | 4.2    | 7.80/7.20 | 5.2    | 5.2    | ---- | ----  | ----  | ---- | ----  |
| <b>Insulation Resisitant (Megohms at Condition C)</b>     | 200000 | 200000 | ---- | 100000 | 10000     | 200000 | 200000 | ---- | 60    | 1000  | ---- | ----  |
| <b>Arc Resistance - Sec.</b>                              | ----   | ----   | ---- | 180    | 180       | ----   | ----   | ---- | ----  | ----  | ---- | ----  |

### TEMPERATURE/FLAMABILITY

|   |       |       |     |       |         |       |      |      |      |      |         |         |
|---|-------|-------|-----|-------|---------|-------|------|------|------|------|---------|---------|
| <b>Flamability</b>  | 94V-O |       |     | 94V-O | 94V-O   | 94V-O | 94HB | 94HB | 94HB | 94HB | 94HB    | 94HB    |
| <b>Coefficient of Thermal Expansion (cm/cm-°C X 10-5)</b> | 1     | 1     | 1.8 | 1     | 1       | 0.9   | 0.9  | 2    | 2    | 2    | 2       | 2       |
| <b>Temp Index Electrical - °C .062" and over</b>          | 130   | 170   | 140 | 170   | ---     | 130   | 170  | 130  | 140  | 140  | 115     | 115     |
| <b>Temp Index Mechanical - °C .062" and over</b>          | 140   | 180   | 170 | 220   | 140     | 140   | 180  | 130  | 140  | 140  | 125     | 125     |
| Mil-I-24768   | 27    | 28    | 18  | 17    | 1       | 2     | 3    | 12   | 11   | 10   | 16, 14  | 15, 13  |
| MIL - Type  | GEE-F | GEB-F | GPG | GSG   | GMG/GME | GEE   | GEB  | PBM  | PBG  | PBE  | FBM/FBG | FBI/FBE |