



## PHENOLIC / LAMINATE

### Also Known As (common industry trade names):

Acculam Epoxyglas G-10/FR-4 . Acculam Epoxyglas G-II/FR-5  
Acculam Phenolfab L/LE . Acculam Phenokraft . Acculam Phenolfab C/CE  
Acculam Phenolon NI . Acculam Polymat . Acculam Polymat HT .  
Acculam Siliglas G7 . Bakelite . Industrial Laminate . Fila Wound . Franklin Fibre  
Micarta . Nevamar . Norplex . Pennite . Spauldite . Synthane . Thermosets  
C . CE . L . LE . G-5 . G-7 . G-9 . G-10 . G-11 . FR-4 . XXX . XX . Paper

### Material Information:

Phenolics are a laminated plastic created by the impregnation of layers of a substrate with a resin then formed utilizing heat and pressure. The resins are generally Phenolic, silicone, melamine or epoxies while the substrate materials range from paper and cotton to glass. The resulting material is extremely versatile and used in a variety of applications. The notable properties of laminates include impressive resistance to shock, heat, stress, and corrosive chemicals. Phenolics are able to be machined, drilled, punched, sanded, tapped, turned, milled, sheared and cut. The dielectric properties make this an excellent insulator which is used in applications from electrical transformers to circuit boards.

Unlike other groups of plastic materials, thermoset plastic industrial laminates have their own standards which are published by NEMA (National Electrical Manufacturers Association). In concert with member manufacturers, NEMA standards are set and "minimum values" published.

The most commonly used NEMA thermoset laminate grades are as follows:

- C, CE (Canvas Cotton-Cloth Reinforced Phenolic) Medium weave cloth
- G-10 / FR-4 (Glass-Cloth Reinforced Epoxy) . G-11 / FR-5 (like G-10 but higher temp)
- G-5 / G-9 (Glass-Cloth Reinforced Melamine) . G-7 (Glass Cloth Reinforced Silicone)
- GPO-1, GPO-2, GPO-3 (Glass-Mat Reinforced Polyester) .
- L, LE (Linen Cotton-Cloth Reinforced Phenolic) Fine weave cloth
- X, XX, XXX (Paper Reinforced Phenolic / the number of X's the better the electrical properties.)

### Characteristics / Enhancements / Varieties - Available Grades:

**Paper Phenolic:** Paper is commonly used in applications where low cost is important. Though the material retains excellent electrical properties there is a noticeable loss in mechanical properties as compared to other grades. (x, xx, xxx, xxpc, etc.)

**Cotton Phenolic:** Cotton is used in applications where mechanical strength and machinability is important. Cotton phenolics are readily available in the two most popular grades CE, a course weave fabric, and LE a fine weave fabric gives nice machined finish. (C, CE, L, LE, etc.)

**Glass Epoxys:** Glass Epoxy is noted for its extremely low moisture absorption, high heat resistance, along with excellent mechanical and electrical properties. Most common grades include G-10 and G-11.

**Other available grades:** Glass with Silicone, Glass with Melamine, Nylon, Phenolic

### Standard Shapes and Sizes (please call for custom sizes not listed):

Sheet: 36" x 48", 48" x 48", 48" x 96" and 48" x 120"

Rod: Different sizes in various grades - Please Call

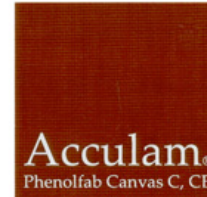
Tube: Different sizes in various grades - Please Call

Film: Specialty applications only

Dallas, Texas (Corporate Offices)  
Houston, Texas  
Brandon, Mississippi

phone 800-782-1836 / 214-239-3870  
phone 800-282-4388 / 713-979-0660  
phone 800-457-8623 / 601-825-7919

fax 214-239-3871  
fax 713-979-0664  
fax 601-825-7109



## Acculam® Phenolfab Canvas C, CE Product Data Sheet

### Product Description

Acculam® Phenolfab C/ CE is a laminate sheet comprised of a phenolic resin binder and woven canvas (cotton) substrate. It qualifies to NEMA C & CE and MIL-I-24768/14/16.

### Typical Applications

This material is characterized by good mechanical properties and toughness. It has higher impact strength than NEMA XX grades. Its good machining qualities, moisture resistance and excellent wear resistance can be used in a wide variety of applications.

Typical Properties	Typical Value	Units
<b>Physical Data</b>		
Specific Gravity/Density	1.36	g/cm <sup>3</sup>
Water Absorption - .125"	< 1.6	%
Temperature Index	125 \ 257	°C \ °F
Rockwell Hardness	105	M scale
Bond Strength	1800 \ 817	lbs \ kgs
Flexural Strength-LW-A-.125"	> 17,000 \ 117	PSI \ MPa
Flexural Strength-CW-A-.125"	> 16,000 \ 110	PSI \ MPa
Izod Impact Strength-LW	> 1.60	ft-lbs/in
Izod Impact Strength-CW	> 1.40	ft-lbs/in
Compressive Strength-Flatwise	> 39,000 \ 270	PSI \ MPa
<b>Electrical Data</b>		
Dielectric Breakdown-A	> 35	kV
Dielectric Breakdown-D48/50	> 2.5	kV

Accurate provides this data as information only and does not imply any warranty for its use or application.



•18 Morris Place  
Yonkers, NY 10705, USA

•33 Tech Park Drive  
E. Falmouth, MA 02536, USA

001 (914) 476-0700 - phone  
001 (914) 476-0533 - facsimile  
sales@acculam.com - e-mail

Dallas, Texas (Corporate Offices)  
Houston, Texas  
Brandon, Mississippi

phone 800-782-1836 / 214-239-3870  
phone 800-282-4388 / 713-979-0660  
phone 800-457-8623 / 601-825-7919

fax 214-239-3871  
fax 713-979-0664  
fax 601-825-7109



## Acculam® Phenolkraft Paper X, XX Product Data Sheet

### Product Description

Acculam® Phenolkraft X/ XX - Laminate sheet comprised of a phenolic resin binder and a saturating kraft (paper) substrate. It qualifies to NEMA X/XX and MIL-I-24768/11/12.

### Typical Applications

This is a general purpose grade with good mechanical and electrical insulating properties. Its versatility, good machining characteristics and lower cost encourage its applications as switch plates, barriers, terminal strips, washers and other electrical components.

### Typical Properties

#### Physical Data

Typical Properties	Typical Value	Units
Specific Gravity/Density	1.36	g/cm <sup>3</sup>
Water Absorption - .125"	< 1.30	%
Temperature Index	140 \ 284	°C \ °F
Rockwell Hardness	110	M scale
Bond Strength	> 800 \ 363	lbs \ kgs
Flexural Strength-LW-A-.125"	> 25,000 \ 172	PSI \ MPa
Flexural Strength-CW-A-.125"	> 22,000 \ 152	PSI \ MPa
Izod Impact Strength-LW	> .55	ft-lbs/in
Izod Impact Strength-CW	> .50	ft-lbs/in
Compressive Strength-Flatwise	> 34,000 \ 234	PSI \ MPa

#### Electrical Data

Dielectric Breakdown-A	> 40	kV
Dielectric Breakdown-D48/50	> 5.0	kV
Permittivity-A	< 5.50	
Permativity-D24/23	< 6.00	
Dissipation Factor-A	< .045	
Dissipation Factor-D24/23	< .050	

Accurate provides this data as information only and does not imply any warranty for its use or application.



•18 Morris Place  
Yonkers, NY 10705, USA

•33 Tech Park Drive  
E. Falmouth, MA 02536, USA

001 (914) 476-0700 - phone  
001 (914) 476-0533 - facsimile  
sales@acculam.com - e-mail

Dallas, Texas (Corporate Offices)  
Houston, Texas  
Brandon, Mississippi

phone 800-782-1836 / 214-239-3870  
phone 800-282-4388 / 713-979-0660  
phone 800-457-8623 / 601-825-7919

fax 214-239-3871  
fax 713-979-0664  
fax 601-825-7109