

**Technical data sheet of industrial rigid laminated sheets based on epoxy resins (page 1 of 8)**

1. The statements are requirements to Norm 60893-3-2 IEC:2003; (German version EN 60893-3-2:2004)
2. A dash "-" signifies that there is no requirement.
3. All statements are not binding. No liability is accepted for any injury, loss, damage arising from the use of this information.
4. The following abbreviations are used at this pages.

Resin	
EP	Epoxy resin

Reinforcement	
CC	Woven cotton cloth
CP	Cellulosic paper
GC	Woven glass cloth
GM	Glass mat
PC	Woven polyester fibre cloth

5. Similar norms:

	EP CC 301	EP CP 201	EP GC 201	EP GC 202	EP GC 203	EP GC 204	EP GC 205	EP GC 306	EP GC 307	EP GC 308	EP GM 201	EP GM 202	EP GM 203	EP GM 204	EP GM 305	EP GM 306	EP PC 301
DIN 7735		HP 2361.1	Hgw 2372	Hgw 2372.1	Hgw 2372.4		Hgw 2370.4										
Nema		FR3	G 10	FR 4	G 11	FR 5											

## Technical data sheet of industrial rigid laminated sheets based on epoxy resins (page 2 of 8)

Table 1; Types of the sheets; Norm EN 60893-3-2 IEC:2003 (German version EN 60893-3-2:2004)				
Types			Applications and distinguishing characteristics (note 1)	
Resin	Reinforcement	Serial number		
EP	CC	301	Mechanical and electrical applications. Good resistance to electrical tracking, good wear and chemical resistance (fine weave) (note 2)	
	CP	201	Electronic applications. Good stability of electrical properties in high humidity. Low flammability.	
	GC	201	201	Mechanical, electrical and electronic applications. Extremely high mechanical strength at moderate temperature. Very good stability of electrical properties in high humidity.
		202	202	Similar to type EP GC 201. Low flammability.
		203	203	Similar to type EP GC 201. High mechanical strength at elevated temperature.
		204	204	Similar to type EP GC 203. Low flammability.
		205	205	Similar to type EP GC 203, but with roving cloth.
		306	306	Similar to type EP GC 203, but with improved tracking indices.
		307	307	Similar to type EP GC 205, but with improved tracking indices.
		308	308	Similar to type EP GC 203, but with improved thermal endurance properties.
	GM	201	201	Mechanical and electrical applications. Extremely high mechanical strength at moderate temperature. Very good electrical properties in high humidity.
		202	202	Similar to type EP GM 201. Low flammability.
		203	203	Similar to type EP GM 201. High mechanical strength at elevated temperature.
		204	204	Similar to type EP GM 203. Low flammability.
		305	305	Similar to type EP GM 203, but with improved thermal endurance properties.
		306	306	Similar to type EP GM 305, but with improved tracking indices.
	PC	301	301	Electrical and mechanical applications. Good resistance to SF6 (coarse weave) (note 2)

Note 1: It should not be inferred from the contents of Table 1 that laminates of any particular type are necessarily unsuitable for applications other than those listed for them, or that specific laminates will be suitable for all applications within in the wide description given.

Note 2: Fabric weaves of type PC and CC reinforcements: These values are only for information. They are not to be considered as specification values. In general, the finer weave materials have better machining characteristics.

	Mass per unit area g/m <sup>2</sup>	Thread count cm <sup>-1</sup>
Coarse weave	> 130	≤ 30
Fine weave	≤ 130	> 30
Very fine weave	≤ 125	> 38

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## Technical data sheet of industrial rigid laminated sheets based on epoxy resins (page 3 of 8)

Table 2; Tolerances on thickness (test method: see IEC 60893-2, 4.1), Norm EN 60893-3-2 IEC:2003 (German version EN 60893-3-2:2004)						
nominal thickness mm	Tolerance (all types) +/- mm					
	EP CC 301	EP CP 201	EP GC 201; 202; 203 204; 306; 308	EP GC 205; 307	EP GM 201; 202; 203 204; 305; 306	EP PC 301
0,40	—	0,07	0,10	—	—	—
0,50	—	0,08	0,12	—	—	—
0,60	—	0,09	0,13	—	—	—
0,80	0,16	0,10	0,16	—	—	—
1,00	0,18	0,12	0,18	—	—	—
1,20	0,19	0,14	0,20	—	—	0,21
1,50	0,19	0,16	0,24	—	0,30	0,24
2,00	0,22	0,19	0,28	—	0,35	0,28
2,50	0,24	0,22	0,33	—	0,40	0,33
3,00	0,30	0,25	0,37	0,50	0,45	0,37
4,00	0,34	0,30	0,45	0,60	0,50	0,45
5,00	0,39	0,34	0,52	0,70	0,55	0,52
				for EP GC 205 u. 307 only + for values 6 mm and more		
6,00	0,44	0,37	0,60	1,60	0,60	0,60
8,00	0,52	0,47	0,72	1,90	0,70	0,72
10,00	0,60	—	0,82	2,20	0,80	0,82
12,00	0,68	—	0,94	2,40	0,90	0,94
14,00	0,74	—	1,02	2,60	1,00	1,02
16,00	0,80	—	1,12	2,80	1,10	1,12
20,00	0,93	—	1,30	3,00	1,30	1,30
25,00	1,08	—	1,50	3,50	1,40	1,50
30,00	1,22	—	1,70	4,00	1,45	1,70
35,00	1,34	—	1,95	4,40	1,50	1,95
40,00	1,47	—	2,10	4,80	1,55	2,10
45,00	1,60	—	2,30	5,10	1,65	2,30
50,00	1,74	—	2,45	5,40	1,75	2,45
60,00	2,02	—	—	5,80	1,90	—
70,00	2,32	—	—	6,20	2,00	—
80,00	2,62	—	—	6,60	2,20	—
90,00	2,92	—	—	6,80	2,35	—
100,00	3,22	—	—	7,00	2,50	—

Where the nominal thickness is not one of the preferred thicknesses listed, then the tolerance for the next higher preferred nominal thickness shall apply.  
Other tolerances may be agreed between the supplier and the purchaser.

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## Technical data sheet of industrial rigid laminated sheets based on epoxy resins (page 4 of 8)

Thickness d in mm	Lenght of straight edge in mm	
	1000	500
$3 < d \leq 6$	10	2,5
$6 < d \leq 8$	8	2
$8 < d$	6	1,5

## Technical data sheet of industrial rigid laminated sheets based on epoxy resins (page 5 of 8)

Table 4; Tolerances on width of cut strips; (minus tolerances only); Norm EN 60893-3-2 IEC:2003 (German version EN 60893-3-2:2004)						
Nominal thickness d in mm	Nominal width in mm, (all types)					
	3 < b ≤ 50	50 < b ≤ 100	100 < b ≤ 160	160 < b ≤ 300	300 < b ≤ 500	500 < b ≤ 600
0,40	0,50	0,50	0,50	0,60	1,00	1,50
0,50	0,50	0,50	0,50	0,60	1,00	1,50
0,60	0,50	0,50	0,50	0,60	1,00	1,50
0,80	0,50	0,50	0,50	0,60	1,00	1,00
1,00	0,50	0,50	0,50	0,60	1,00	1,00
1,20	0,50	0,50	0,50	1,00	1,20	1,20
1,50	0,50	0,50	0,50	1,00	1,20	1,20
2,00	0,50	0,50	0,50	1,00	1,20	1,50
2,50	0,50	1,00	1,00	1,50	2,00	2,50
3,00	0,50	1,00	1,00	1,50	2,00	2,50
4,00	0,50	2,00	2,00	3,00	4,00	5,00
5,00	0,50	2,00	2,00	3,00	4,00	5,00

Unilateral, all-negative tolerances are nominally applied to the width of cut strips, and are given in the above table. Other tolerances may be agreed between purchaser and supplier.

## Technical data sheet of industrial rigid laminated sheets based on epoxy resins (page 6 of 8)

Property	IEC 60893-2 subclause	Unit	Min. or Max.	Thickness of sheet to which test is applicable mm	Type																	
					EP CC 301	EP CP 201	EP GC 201	EP GC 202	EP GC 203	EP GC 204	EP GC 205	EP GC 306	EP GC 307	EP GC 308	EP GM 201 Note 1	EP GM 202 Note 1	EP GM 203 Note 1	EP GM 204 Note 1	EP GM 305 Note 1	EP GM 306 Note 1	EP PC 301	
Flexural strength	5.1	Mpa	Min.	≥ 1,5	135	110	340	340	340	340	340	340	340	340	340	320	320	320	320	320	320	110
Charpy impact strength    to lamination Note 3	5.4.2	kJ/m <sup>2</sup>	Min.	≥ 5	3,5	—	33	33	33	33	50	33	50	33	50	50	50	50	50	50	50	130
Izod impact strength ⊥ to lamination Note 3	5.4.3	kJ/m <sup>2</sup>	Min.	≥ 5	6,5	—	34	34	34	34	54	35	55	35	55	55	55	55	55	55	55	145
Electrical strength at 90 °C in oil ⊥ to lamination	6.1	kV/mm	Min.	≤ 3	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6	Table 6
Breakdown voltage at 90 °C in oil    to lamination	6.1	kV	Min.	> 3	35	20	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	55
Insulation resistance. after immersion in water	6.3	M Ω	Min.	All	1x10 <sup>3</sup>	1x10 <sup>4</sup>	5x10 <sup>4</sup>	5x10 <sup>4</sup>	5x10 <sup>4</sup>	5x10 <sup>4</sup>	1x10 <sup>4</sup>	5x10 <sup>4</sup>	1x10 <sup>4</sup>	5x10 <sup>4</sup>	5x10 <sup>3</sup>	5x10 <sup>3</sup>	5x10 <sup>3</sup>	5x10 <sup>3</sup>	5x10 <sup>3</sup>	5x10 <sup>3</sup>	5x10 <sup>3</sup>	1x10 <sup>2</sup>
Proof tracking index	6.4	—	Min.	—	—	—	—	—	—	—	—	—	500	—	—	—	—	—	—	—	500	—
Thermal endurance Note 4	7.1	TI	Min.	≥ 3	—	—	—	—	—	—	—	—	—	180	—	—	—	—	—	180	180	—
Flammability Note 5	7.2	Kategorie		3	—	V-0	—	V-0	—	V-0	—	—	—	—	—	V-0	—	V-0	—	—	—	—
Water absorption	8.2	mg	Max.	All	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7	Table 7

Note 1: For all EP-GM-types, compliance with this standard is not required for the outer 13 mm strip from the edges of the untrimmed sheets.

Note 2: Flexural strength measured at 150 °C+3 K after 1 h at 150 °C+3 K not be less than 50 % of the specified value.

Note 3: Conformance with the requirement for either Charpy or Izod test constitutes, in this respect, conformance with this specification.

Note 4: The thermal endurance test is regarded as a classification test for types EPGC308, EPGM305 and EPGM306. The test is not normally regarded as a production control test.

Note 5: The small-scale laboratory test used in this standard for assigning a flammability category is primarily for monitoring consistency of production of laminates. The results so obtained should not in any circumstances be considered as an overall indication of the potential fire hazards presented by these laminates under actual conditions of use.

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## Technical data sheet of industrial rigid laminated sheets based on epoxy resins (page 7 of 8)

Table 6; Electric strength at 90 °C in oil $\perp$ to lamination (1-min-proof test or 20 s step by step test) (kV/mm) (Note 1); Norm EN 60893-3-2 IEC:2003 (German version EN 60893-3-2:2004)																		
Type	Mean measured thickness of test specimens in mm (Note 2)																	
	0,40	0,50	0,60	0,70	0,80	0,90	1,00	1,20	1,40	1,50	1,80	2,00	2,20	2,40	2,50	2,60	2,80	3,00
EP CC 301	—	—	—	—	10,00	9,60	9,20	8,60	8,20	8,00	7,40	7,10	6,80	6,50	6,40	6,20	5,60	5,00
EP CP 201	19,00	18,20	17,60	17,10	16,60	16,20	15,80	15,20	14,70	14,50	13,90	13,60	13,40	13,30	13,30	13,20	13,00	13,00
EP GC 201	16,90	16,10	15,60	15,20	14,80	14,50	14,20	13,70	13,20	13,00	12,20	11,80	11,40	11,10	10,90	10,80	10,50	10,20
EP GC 202	16,90	16,10	15,60	15,20	14,80	14,50	14,20	13,70	13,20	13,00	12,20	11,80	11,40	11,10	10,90	10,80	10,50	10,20
EP GC 203	16,90	16,10	15,60	15,20	14,80	14,50	14,20	13,70	13,20	13,00	12,20	11,80	11,40	11,10	10,90	10,80	10,50	10,20
EP GC 204	16,90	16,10	15,60	15,20	14,80	14,50	14,20	13,70	13,20	13,00	12,20	11,80	11,40	11,10	10,90	10,80	10,50	10,20
EP GC 205	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9,00
EP GC 306	16,90	16,10	15,60	15,20	14,80	14,50	14,20	13,70	13,20	13,00	12,20	11,80	11,40	11,10	10,90	10,80	10,50	10,20
EP GC 307	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9,00
EP GC 308	16,90	16,10	15,60	15,20	14,80	14,50	14,20	13,70	13,20	13,00	12,20	11,80	11,40	11,10	10,90	10,80	10,50	10,20
EP GM 201	—	—	—	—	—	—	—	—	12,30	12,00	11,00	10,50	10,00	9,80	9,60	9,40	9,20	9,00
EP GM 202	—	—	—	—	—	—	—	—	12,30	12,00	11,00	10,50	10,00	9,80	9,60	9,40	9,20	9,00
EP GM 203	—	—	—	—	—	—	—	—	12,30	12,00	11,00	10,50	10,00	9,80	9,60	9,40	9,20	9,00
EP GM 204	—	—	—	—	—	—	—	—	12,30	12,00	11,00	10,50	10,00	9,80	9,60	9,40	9,20	9,00
EP GM 305	—	—	—	—	—	—	—	—	12,30	12,00	11,00	10,50	10,00	9,80	9,60	9,40	9,20	9,00
EP GM 306	—	—	—	—	—	—	—	—	12,30	12,00	11,00	10,50	10,00	9,80	9,60	9,40	9,20	9,00
EP PC 301	—	—	—	—	—	—	—	13,70	13,20	13,00	12,20	11,80	11,40	11,10	10,90	10,80	10,50	10,20

Note 1: The two test are alternatives. A material meeting either requirements shall be deemed to comply with the specification to electric strenght at 90 °C in oil,  $\perp$  to laminations.

Note 2: If the arithmetic mean of the measured values of thickness of the test specimen lies between two values of thickness shown in the aboce table, the limit shall be obtained by interpolation. If the arithmetic mean of the measured values of thickness is below the minimum thickness for which a limit is given, the electric strenght limit appropriate to the minimum thickness shall apply. If the nominal thickness is 3 mm and the arithmetic mean measured thickness exceeds 3 mm, the limit for 3 mm shall apply.

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## Technical data sheet of industrial rigid laminated sheets based on epoxy resins (page 8 of 8)

Table 7; Limits for water absorption in mg; Norm EN 60893-3-2 IEC:2003 (German version EN 60893-3-2:2004)																					
Type	Mean measured thickness in mm of test specimens (note 1)																				
	0,4	0,5	0,6	0,8	1	1,2	1,6	2	2,5	3	4	5	6	8	10	12	14	16	20	25	22,5 (Note 2)
EP CC 301	—	—	—	67	69	71	76	80	85	90	100	110	118	135	149	162	175	186	202	219	263
EP CP 201	30	31	31	33	35	37	41	45	50	55	60	68	76	90	—	—	—	—	—	—	—
EP GC 201	17	17	17	18	18	18	19	20	21	22	23	25	27	31	34	38	41	46	52	61	73
EP GC 202	17	17	17	18	18	18	19	20	21	22	23	25	27	31	34	38	41	46	52	61	73
EP GC 203	17	17	17	18	18	18	19	20	21	22	23	25	27	31	34	38	41	46	52	61	73
EP GC 204	17	17	17	18	18	18	19	20	21	22	23	25	27	31	34	38	41	46	52	61	73
EP GC 205	—	—	—	—	—	—	—	—	—	22	23	25	27	31	34	38	41	46	52	61	73
EP GC 306	17	17	17	18	18	18	19	20	21	22	23	25	27	31	34	38	41	46	52	61	73
EP GC 307	—	—	—	—	—	—	—	—	—	22	23	25	27	31	34	38	41	46	52	61	73
EP GC 308	17	17	17	18	18	18	19	20	21	22	23	25	27	31	34	38	41	46	52	61	73
EP GM 201	—	—	—	—	—	—	25	26	27	28	29	31	33	35	40	44	48	55	60	70	90
EP GM 202	—	—	—	—	—	—	25	26	27	28	29	31	33	35	40	44	48	55	60	70	90
EP GM 203	—	—	—	—	—	—	25	26	27	28	29	31	33	35	40	44	48	55	60	70	90
EP GM 204	—	—	—	—	—	—	25	26	27	28	29	31	33	35	40	44	48	55	60	70	90
EP GM 305	—	—	—	—	—	—	25	26	27	28	29	31	33	35	40	44	48	55	60	70	90
EP GM 306	—	—	—	—	—	—	25	26	27	28	29	31	33	35	40	44	48	55	60	70	90
EP PC 301	—	—	—	—	—	130	135	140	145	150	160	170	180	200	220	240	260	280	320	370	440

Note 1: If the arithmetic mean of measured values of thickness of the test specimen lies between two values of thickness shown in the above table, the limit shall be obtained by interpolation. If the arithmetic mean of the measured values of thickness is below the minimum thickness for which a limit is given, the water absorption limit appropriate to the minimum thickness shall apply. If the nominal thickness is 25 mm and the arithmetic mean measured thickness exceeds 25 mm, the limit for 25 mm shall apply.

Note 2: Sheets of nominal thicknesses greater than 25 mm shall be machined to a relatively smooth surface on one face to a thickness of 22,5 ± 0,3 mm