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WARP & TWIST TOLERANCES AND TEST METHODS STANDARD GRADE FR4 (G10) AND AT7000™

Automatic Test Equipment (A.T.E.) Industry Specific Testing

The following information is provided in an effort to make simple the test standards and methods used to determine the twist and bow of FR4 (commonly referred as G10). References used are Mil-I-24768/24 and NEMA (formula to ASTM: Volume 27. Plastics: General methods of testing, nomenclature, Section D-229).

GENERAL: Warp is stated in terms of the lateral dimensions (length and width) and twist is stated in terms of the dimension from one corner to the diagonally opposite corner.

NEMA: (Standard 11-16-1989) Tolerance measures begin with sheets measuring 36 inches in width as manufactured. These values apply only to sheets as manufactured and do not apply to cut panels.

Formula:

$$D_X = \frac{\left\{\frac{L_x}{2}\right\}}{36\,(36)} \qquad \frac{\left\{\frac{L_x}{2}\right\}^2 \times D_{36}}{(36)}$$

Flatness tolerance % deviation for a particular thickness (based on 36" length)

L_X = Length for which flatness tolerance is being calculated.
D_X - Flatness tolerance corresponding to length, L_X

MIL I 24768/27: Warp and twist are measured in terms of percentages of lateral dimension:

.062 to .125	=	+/- 2.50%
.126 to .250	=	+/- 1.00%
.251 to .750	=	+/- 0.50%
.751 to max	=	+/- 0.25%

Example: A .375 x 16.00 x 20.00 should have no more than:

- .080" maximum allowable along the 16" dimension
- .100" bow along the 20" dimension (.00188 x 20)
- .128" bow along the diagonal (.00188 x 25.6125)

AT7000™ SPECIFICATIONS

Because of its unique configuration, AT7000™ can boast superior flatness amongst the properties that make it the material of choice for use in test fixtures. Below are the *maximum* we allow for bow and twist.

Thickness	Maximum Allowable Bow & Twist Per Inch
.177 to .200	.0025
.201 to .500	.0025
.500 to .999	.0025

Universally used methods of laminating glass epoxy sheets can only reduce the inherent internal stresses found in all laminated sheet products. Therefore, the relative flatness of an uncut sheet can only be relied upon as an indication of twist and bow in a cut-to-size panel. There are no published NEMA specifications for warp and twist after a full sheet is cut.

TEST METHOD

Inspector should have a granite surface at least 1" larger than the largest panel to be tested and a set of calibrated gauge pins. Both the granite surface and both sides of the FR4 panel must be free of dust and debris.

1. Determine the maximum allowable bow and twist from above.
2. Lay the panel on the granite surface (ESD panels must have the ESD side face up).
3. Without putting any downward pressure on the panel under test, run the appropriate gauge pin along the entire perimeter of the panel attempting to have it slip under the panel without lifting it from the surface.




A WORD OR TWO ABOUT SANDING

No guarantees are made for flatness (bow & twist) when a panel is sanded on one side as uneven surface tensions are created and bow and twist is more likely to occur when only on side is sanded. However, when two sides are sanded, surface tension is left equal and flatness does not change significantly. It neither eliminates nor amplifies bow & twist. Sanding also does not reduce an existing bow as the sanding roller follows the contour of the sheet as it is sanded and any pressure is released after the roller passes. Sanding does however bring the thickness to a closer tolerance. While sanding one side does not always enhance parallelism, sanding two sides does.