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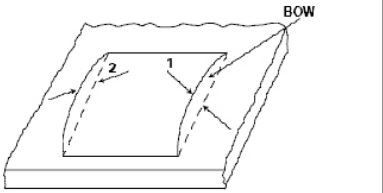
## The myth of bow and twist testing

In my trainings I feel that many times people are confused about the testing and acceptability levels of bow and twist as described in the various IPC documents.

Basically for the PCB manufacturer we find the information in the IPC-A-600 and IPC-6012 documents. The assembly department should take a look in the IPC-A-610 or IPC-J-STD-001. And the proper way of measuring is described in IPC-TM-650, test method 2.4.22.

For the PCB manufacturer the process is quite straightforward, perform some measurements (length, width or diagonal size and the deviation from the flat surface), and then calculate according to the above mentioned test method 2.4.22 to find the percentage of bow or twist and finally compare this value with the criteria from one of the above mentioned documents to see if it is a matter of scrap or deliver.

**Bow and Twist** Bow, twist, or any combination thereof, shall be determined by physical measurement and percentage calculation in accordance with IPC-TM-650, Method 2.4.22. Panels containing multiple boards that are assembled in panel form and later separated shall be assessed in panel form.



With constraining force applied to both corners of the same edge. 1 & 2 deflection from surface plane.

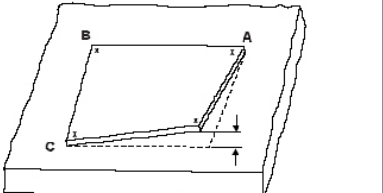
IPC-600g-211a

**Acceptable - Class 1, 2, 3**

- For printed boards using surface mount components, the bow and twist shall be 0.75% or less.
- For all other boards, bow and twist shall be 1.50% or less.

**Nonconforming - Class 1, 2, 3**

- Defects either do not meet or exceed above criteria.



With constraining force applied to one corner only.

IPC-600g-211b

Bow and twist criteria from IPC-A-600G standard

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For the assembler it is a bit more difficult, at least that is what many of them think. Of course the IPC-A-610D gives the criteria, but it should be noted that the percentages here are for reference purposes only and the main idea is that the four "knock-out" criteria, Form, Fit, Function and Reliability should always be respected.

So basically even with a twist percentage of less than 0,75% an assembly could be scrap, or on the opposite with a higher value combined with high assembly tolerances it might not be a problem. And of course the less amount of bow or twist we face the better. The values in IPC-A-610 might be used for incoming goods inspection, but if the PCB's do have a deviation which exceeds these the board supplier should have scrapped them already.

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**10 Printed Circuit Boards and Assemblies**

**10.2.7 Laminate Conditions – Bow and Twist**

**Acceptable - Class 1,2,3**

- Bow and twist does not cause damage during post solder assembly operations or end use. Consider "Form, Fit and Function" and product reliability.

**Defect - Class 1,2,3**

- Bow and twists causes damage during post solder assembly operations or end use.

**Note:** Bow and twist after solder should not exceed 1.5% for through-hole and 0.75% for surface mount printed board applications (See IPC-TM-650, 2.4.22).

**Figure 10-29**  
 1. Bow  
 2. Points A, B and C are touching base  
 3. Twist

*Bow and twist criteria from IPC-A-610D standard*

It gets even more exciting when the IPC-6012B is specified and the customer has specified product class 3A (yes this exists) in his procurement document. Because then the manufacturer has to peep into the table on page 29, the table with supplementary requirements for Space and military avionics applications to find that now his boards will have to be scrapped when they exceed 0,5 % bow or twist.



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Requirement Attribute	IPC-6012B Section	Class 3/A Exception Requirement	Inspection/ Test Method	Conformance per Coupon or per Board	Remarks
Solderability - Surface	3.3.6	8 hour steam surface Mount only per J-STD-003	IPC-J-STD-003	Per Panel	1 EA - C Coupon
Solderability - Plated-Through Hole	3.3.6		-		
Plating Adhesion	3.3.7		IPC-TM-650 Method 2.4.1	Per Panel	1 - C Coupon
Edge Board Contacts	3.3.8		Measurement	Per Board	
Lifted Lands	3.3.4		Visual	Per Board	
Workmanship	3.3.9		Visual	Per Board	
Dimensional	3.4		-	-	
Hole Size and Hole Pattern Accuracy	3.4.1		Measurement	Per Board	
Annular Ring	3.6.2.9 3.4.2	Unsupported holes - 0.38 mm [0.015 in] minimum Internal/External Plated-Through Holes - 0.051 mm [0.002 in] minimum allow 20% reduction unless already at 0.051 mm [0.002 in]	Visual or Microsection	Per Panel	4 - F Coupons (Optional)
Solderable Annular Ring (External)	N/A		Measurement	Per Board	
Bow and Twist	3.4.3	0.5%	IPC-TM-650 Method 2.4.22	Per Board	

Specific criteria for Class 3A from IPC-6012B standard

If we perform a training, either at our own facility, regional or within your company it is obvious that these (and many more) issues are discussed by our trainers as well. So why not enroll for one of our upcoming trainings in your neighbourhood or call for a solution to have a training within your own facilities.

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