NCAB Group | Seminar no. 13

Reliability, IPC & NCAB

Content

1. What is reliability?

Bad reliability can be caused when:

- Those within the supply chain have low knowledge / interest of the product
- Decision are made within manufacturing without being based upon fact
- There is bad process control – leads to very clear errors or “almost errors” (difficult to detect!)
- Specifications are unclear
- Focus on price instead of cost

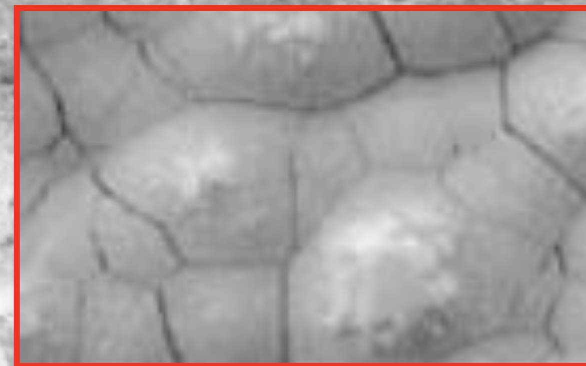
RELIABILITY

An example of how bad reliability can cost

208 pieces of a 10 layer board

- Sourced: Directly within Europe
- Criteria: Shortest lead time
- Price: Unknown.

Result = Suspected black pad



COST OF THE CLAIM

€300,000

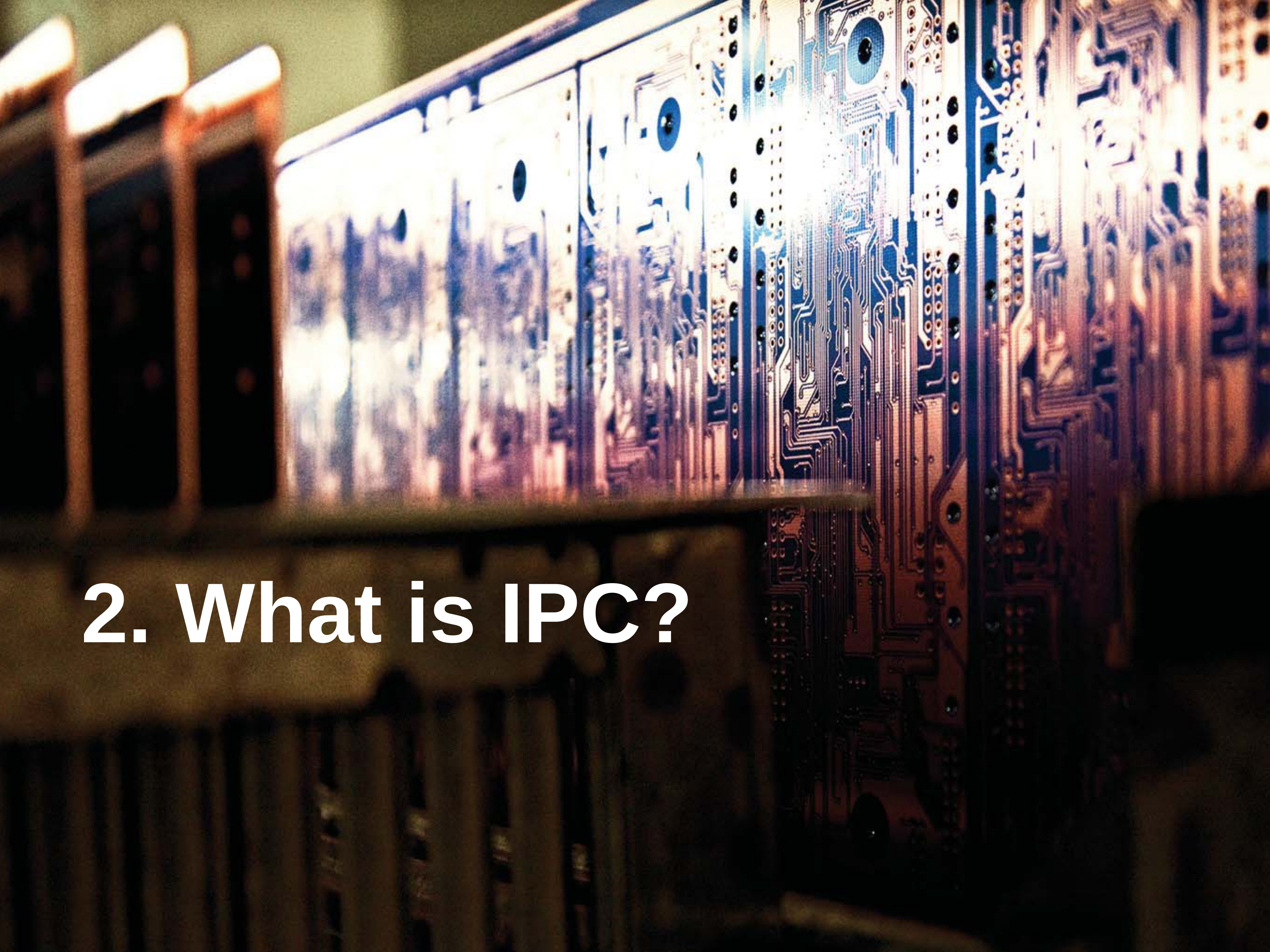
RELIABILITY

Good reliability more likely to be achieved when:

- There is good process control within the process.
- Those involved in the supply chain know the product demands and the necessary conditions for manufacture.
- There is a correct and clear specification.
- The producer is transparent about the level of delivery, design factors and construction process.

Good reliability is secured by

- Selecting a ‘serious’ and well-known producer.
- Making decisions based upon fact.
- Specifications relate to the demand of the end product – know what does and does not affect the functionality of the product.
- Refer to a well-known and updated standard, whilst ensuring it is understood and followed.
- Learning and understanding the demands.



2. What is IPC?

IPC

The organization

- Founded in 1957, IPC is basically a non commercial, member-driven, standard organization.
- Originally the meaning of IPC was “the Institute of Printed Circuits” but IPC is now referenced by “Association Connecting Electronic Industries” and covers most fields in electronics.
- It is an organization with thousands of members.

Why standards?

When ordering an apple, you expect an apple and not a banana!

For whom?

For everyone who wishes to receive what is expected (no surprises!) they should know what is defined as expected.

Example:

We all have probably bought something, which not lived up to our expectations!

The consequences can be extremely costly as well as 'painful'!

What is the first principle of “zero defects”?

Conformance to requirements

”Every product has a requirement, a specification, a description of what is expected. When this is met, it has achieved quality. Assuming that the requirement actually describes what the customer really expects or needs.”

defined by P. Crosby

Standards

- Help to secure that we / the customer gets what is expected through defining exactly what is acceptable – there of minimizing risks.
- Make the conversation between customer & suppliers through a common understanding.
- Are capable of securing different quality or reliability levels.
- Enables a correct and compatible cost level.

It goes for everything – from the size of a breakfast egg to the strength of a wing on an aircraft!

3. IPC & NCAB

Why IPC?

NCAB has chosen IPC as the base standards for PCB's since 2004.

As mentioned earlier, IPC is a "living" organization and is updating and releasing new standards on a frequent basis.

This is even more important now, with the fast development of the electronics industry.

IPC Standards are specified into three classes:

Class 1: General Electronic Products

- Consumer products, some computer and computer peripherals
- Cosmetic imperfection are not important
- Major requirement is function of the completed printed board.

1

IPC Standards are specified into three classes:

Class 2: Dedicated Service Electronic Products

- Communication equipment, sophisticated business machines, and instruments
- High performance and extended life is required, and for which uninterrupted services is desired, but is not critical.
- Certain cosmetic imperfections are allowed.

2

IPC Standards are specified into three classes:

Class 3: High Reliability Electronic Products

- Continue performance is critical
- Life support
- Equipment downtime cannot be tolerated
- Often used for: Medical, military, aerospace, automotive

3

Do you need to specify a higher classification of IPC with advanced constructions or designs (i.e. class 3)?

No, IPC:s different classes have nothing to do with how advanced the boards are, but rather with the reliability demands that are placed upon the end product.

A higher IPC classification does not necessary relate to advanced boards or designs, but it should always relate to, or be considered for boards or designs, that have advanced purposes!

Consider the two PCB´s below

2 Layer PCB

Standard FR4 material (IPC 4101/ 21)

Tin lead finish.

Purpose: Control board for coolant system in Nuclear power station

8 Layer HDI Flex rigid PCB

High performance FR4 (IPC 4101/126)

ENIG finish with hard gold ‘hot pluggable contacts.

Purpose: Camcoder.

IPC & NCAB

The standards and demands can be divided into three parts:

1 **Design and Capability driven**

2 **Process-control driven**

3 **Verification driven**

1

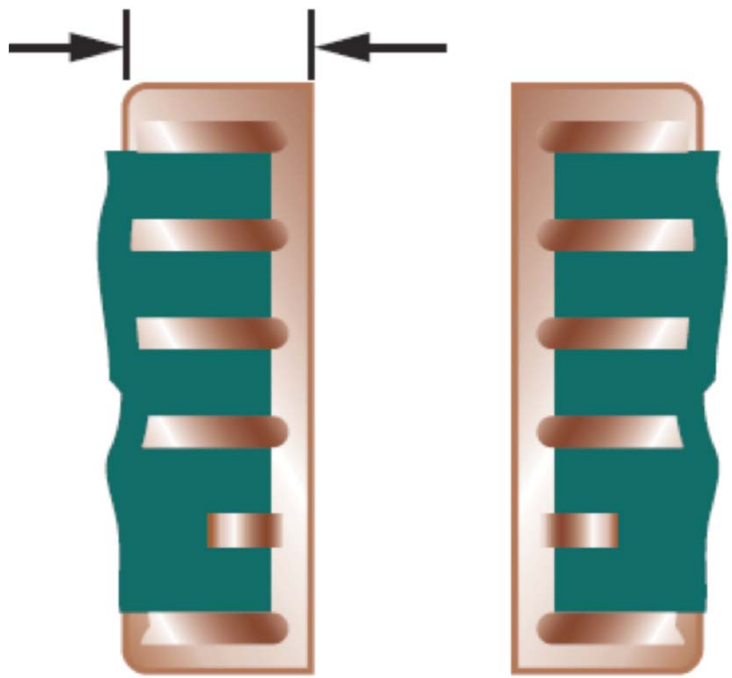
IPC & NCAB

Design and capacity driven

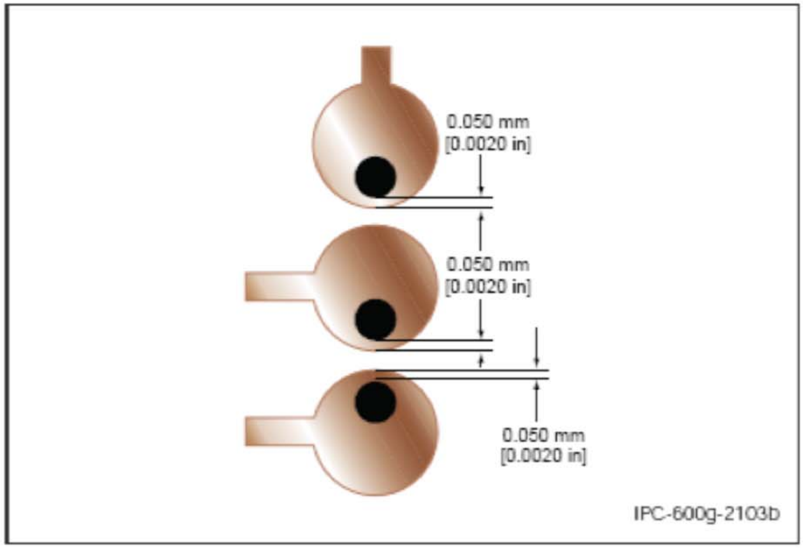
- Annular rings
- Conductor imperfections

IPC & NCAB

Annular rings Measurement of External Annular Ring



Conductor imperfections



Acceptable – Class 3

- Holes are not centered in the lands, but the annular ring measures 0.050 mm [0.0020 in] or more.
- The minimum external annular ring may have 20% reduction of the minimum annular ring at the measurement area due to defects such as pits, dents, nicks, pinholes, or splay.

2

IPC & NCAB

Process-control driven

- Drilling and plating quality
- Surface finish thicknesses

Surface finish thickness

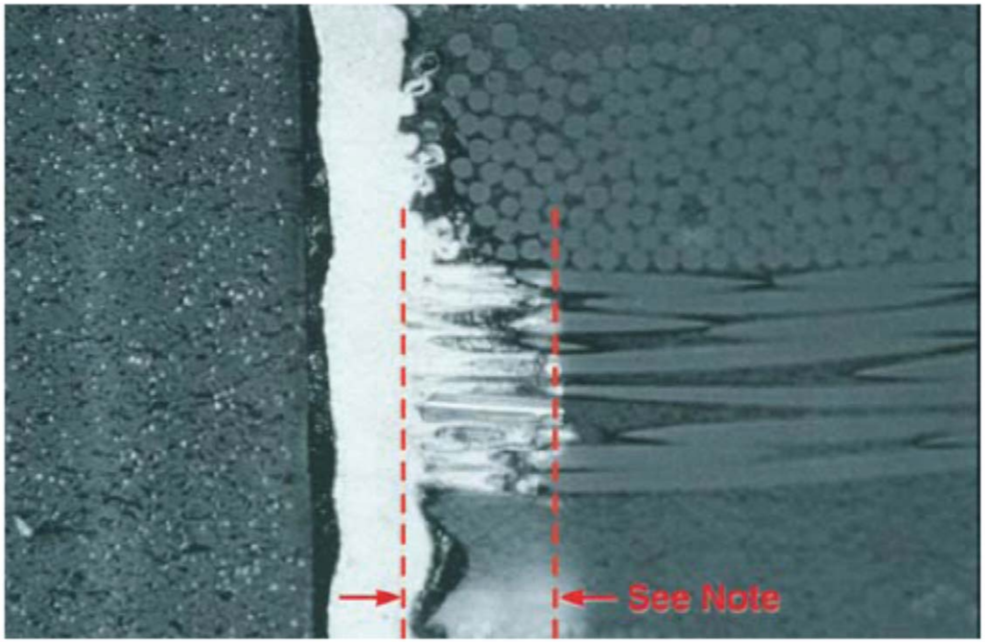


Figure 3313b

Acceptable - Class 3

- Wicking does not exceed 80 µm [3,150 µin].

Acceptable - Class 2

- Wicking does not exceed 100 µm [3,937 µin].

Acceptable - Class 1

- Wicking does not exceed 125 µm [4,921 µin].

Drilling and plating quality

Table 3-12 External Conductor Thickness after Plating

Weight[1,4]	Absolute Cu Min. (IPC-4562 less 10% reduction) (µm) [µin]	Plus minimum plating for Class 1 and 2 (20 µm) [787 µin][2]	Plus minimum plating for Class 3 (25 µm) [984 µin][2]	Maximum Variable Processing Allowance Reduction[3] (µm) [µin]	Minimum Surface Conductor Thickness after Processing (µm) [µin]	
					Class 1 & 2	Class 3
1/8 oz.	4.60 [181]	24.60 [967]	29.60 [1,165]	1.50 [59]	23.1 [909]	28.1 [1,106]
1/4 oz.	7.70 [303]	27.70 [1,091]	32.70 [1,287]	1.50 [59]	26.2 [1,031]	31.2 [1,228]
3/8 oz.	10.80 [425]	30.80 [1,213]	35.80 [1,409]	1.50 [59]	29.3 [1,154]	34.3 [1,350]
1/2 oz.	15.40 [606]	35.40 [1,394]	40.40 [1,591]	2.00 [79]	33.4 [1,315]	38.4 [1,512]
1 oz.	30.90 [1,217]	50.90 [2,004]	55.90 [2,201]	3.00 [118]	47.9 [1,886]	52.9 [2,083]
2 oz.	61.70 [2,429]	81.70 [3,217]	86.70 [3,413]	3.00 [118]	78.7 [3,098]	83.7 [3,295]
3 oz.	92.60 [3,646]	112.60 [4,433]	117.60 [4,630]	4.00 [157]	108.6 [4,276]	113.6 [4,472]
4 oz.	123.50 [4,862]	143.50 [5,650]	148.50 [5,846]	4.00 [157]	139.5 [5,492]	144.5 [5,689]

Note 1. Starting foil weight of design requirement per procurement documentation.

Note 2. Process allowance reduction does not allow for rework processes for weights below 1/2 oz. For 1/2 oz. and above, the process allowance reduction allows for one rework process.

Note 3. Reference: Min. Cu Plating Thickness
Class 1 = 20 µm [787 µin] Class 2 = 20 µm [787 µin] Class 3 = 25 µm [984 µin]

Note 4. For copper foil above 4 oz., utilize the formula provided in 3.6.2.13.

3

IPC & NCAB

Verification driven

- To make sure or to demonstrate that the demands have been fulfilled.

IPC 6012 (Rigid), IPC 6013 (Flexible), IPC 6016 (HDI)

Table 4.2 Sampling Plan

Table 4.3 Acceptance Testing and Frequency

Table 4.3 Part “Structural Integrity Verification (Microsection)”, describes the verification level and amount of microsectioning needed.

IPC & NCAB / VERIFICATION DRIVEN

Sampling Plan

Table 4-2 C=0 Sampling Plan (Sample Size for Specific Index Value[1])

Lot Size	Class 1			Class 2			Class 3			
	2.5[1]	4.0[1]	6.5[1]	1.5[1]	2.5[1]	4.0[1]	0.10[1]	1.0[1]	2.5[1]	4.0[1]
1-8	5	3	3	**	5	3	**	**	5	3
9-15	5	3	3	8	5	3	**	13	5	3
16-25	5	3	3	8	5	3	**	13	5	3
26-50	7	7	5	8	7	7	**	13	7	7
51-90	11	8	5	13	11	8	**	13	11	8
91-150	11	9	6	19	11	9	125	19	11	9
151-280	13	10	7	19	13	10	125	29	13	10
281-500	16	11	9	21	16	11	125	29	16	11
501-1200	19	15	11	27	19	15	125	34	19	15
1201-3200	23	18	13	35	23	18	125	42	23	18
3201-10,000	29	22	15	38	29	22	192	50	29	22
10,001-35,000	35	29	15	46	35	29	294	60	35	29

Note 1. Index Value is associated to the A.Q.L. value. If a particular product is determined to be "critical" by the user and a smaller index value is required, the user **shall** designate the requirement in the procurement document and should state the "critical" requirement on the master drawing. **Denotes inspect entire lot.

IPC & NCAB / VERIFICATION DRIVEN

Acceptance Testing & Frequency

Structural Integrity After Stress Types 3-6 (Microsection)[3]							
Plating integrity	3.6.2.1		A and B or A/B	Sample (2.5)	Sample (1.5)	Sample (0.1)	Per Panel
Laminate voids	3.6.2.3		A and B or A/B	Sample (2.5)	Sample (1.5)	Sample (0.1)	Per Panel
Etchback/ negative etchback	3.6 3.6.2.6 3.6.2.8		A and B or A/B	Sample (2.5)	Sample (1.5)	Sample (0.1)	Per Panel
Annular ring and Breakout (internal)	3.6 3.6.2.9		A and 2B or 2 A/B	Sample (2.5)	Sample (1.5)	Sample (0.1)	Per panel[4,5]
Lifted lands	3.6.2.10		A and B or A/B	Sample (2.5)	Sample (1.5)	Sample (0.1)	Per Panel
Hole plating thickness	3.6 3.6.2.11		A and B or A/B	Sample (2.5)	Sample (1.5)	Sample (0.1)	Per Panel
Surface plating and conductor thickness	3.6 3.6.2.11 3.6.2.13		A and B or A/B	Sample (2.5)	Sample (1.5)	Sample (0.1)	Per Panel
Copper foil thickness (internal)	3.6 3.6.2.12		A and B or A/B	Sample (2.5)	Sample (1.5)	Sample (0.1)	Per Panel
Metal core spacing	3.6.2.14		A and B or A/B	Sample (2.5)	Sample (1.5)	Sample (0.1)	Per Panel
Dielectric thickness	3.6 3.6.2.15		A and B or A/B	Sample (2.5)	Sample (1.5)	Sample (0.1)	Per Panel
Material Fill of Blind and Buried Vias	3.6.2.16		A and B or A/B	Sample (6.5)	Sample (4.0)	Sample (2.5)	Per Panel
Structural Integrity After Stress Type 2 (Microsection)[8]							

Acceptance Testing & Frequency

Note 1. Number in parentheses is the AQL level.

Note 2. Measurement location must be 30% larger than collimated source.

Note 3. All via structures shall be represented in the thermally stressed evaluations. Unique construction (e.g., blind, buried, unfilled through-hole, filled through-hole, etc.) and plating steps define a via structure.

Note 4. For Class 2 product, the degree of breakout may be assessed by methods other than horizontal microsection.

Note 5. The A and B or 2 A/B test coupons **shall** be taken from opposite corners of the manufacturing panel and in opposing axes (one in the "x" axis and the other in the "y" axis).

Note 6. For Type 1 and Type 2 printed boards, visual or AOI inspection may be used in lieu of electrical testing.

Note 7. PTH solderability testing not required for Type 2 double-sided printed boards without PTHs.

Note 8. MIcrosectioning for PTH evaluation not required for Type 2 double-sided printed boards without PTHs.

IPC & NCAB / VERIFICATION DRIVEN

Structual Integrity Verification (Microsection)

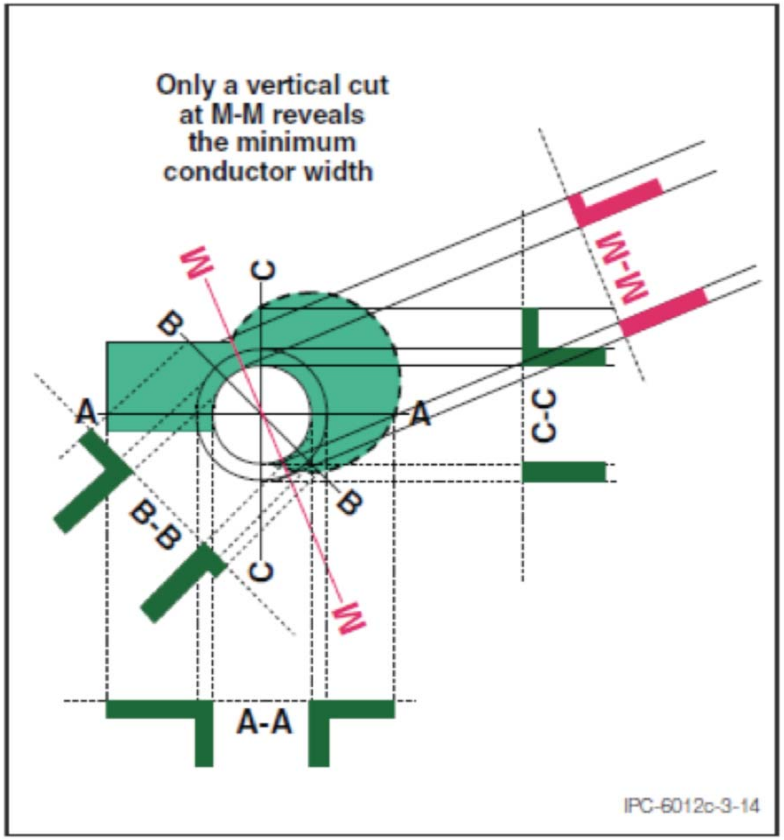


Figure 3-14 Microsection Rotations for Breakout Detection

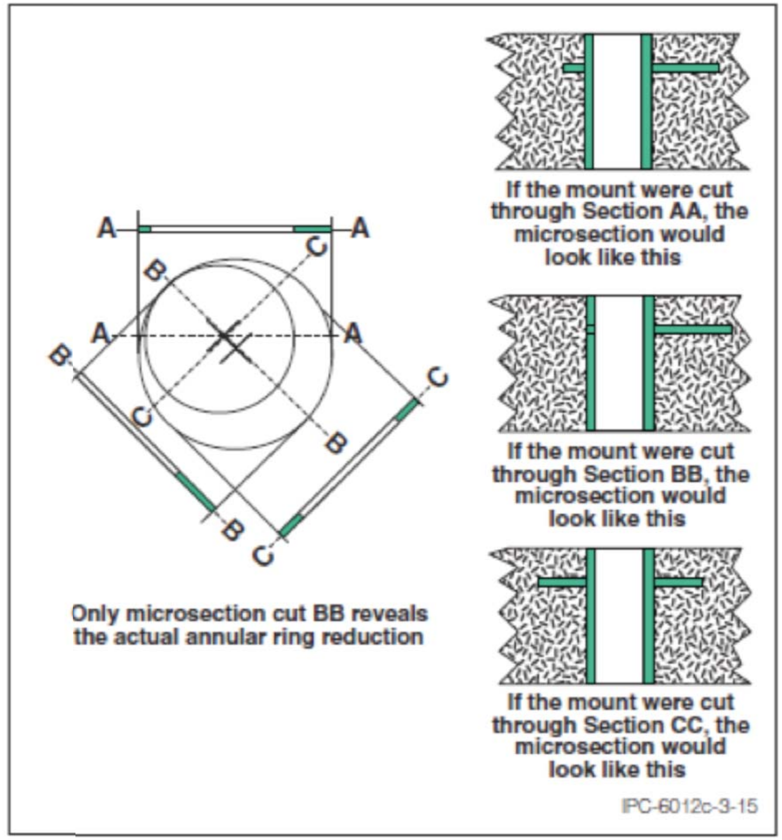
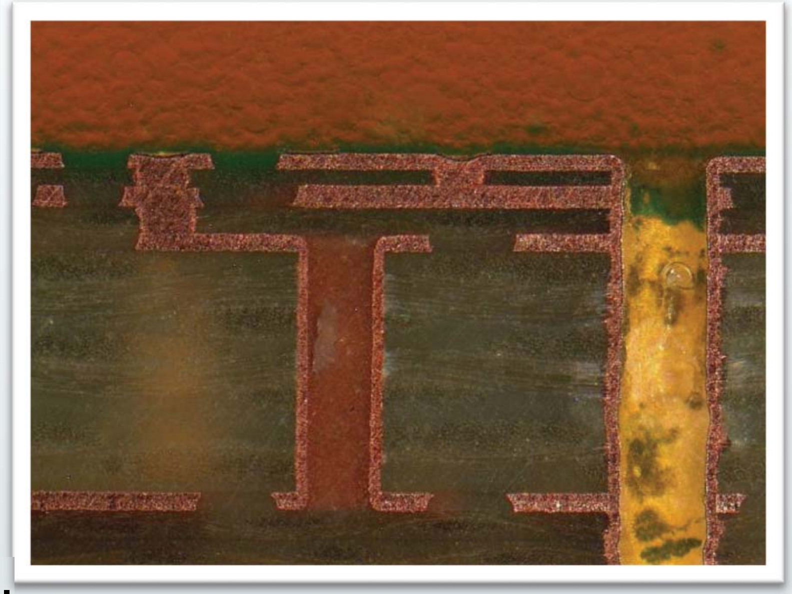


Figure 3-15 Comparison of Microsection Rotations

Verification – Inspection / Microsections

An example:

When a production volume of 91-150 production panels of a 4 layer board, the checking of internal annular rings for class 3 demands 250 micro-Sectioning.



Note

This is verification on a product level – not to be mixed up with process control.

IPC & NCAB

Does this approach / need make sense?

Yes, but only for extreme purposes or applications.

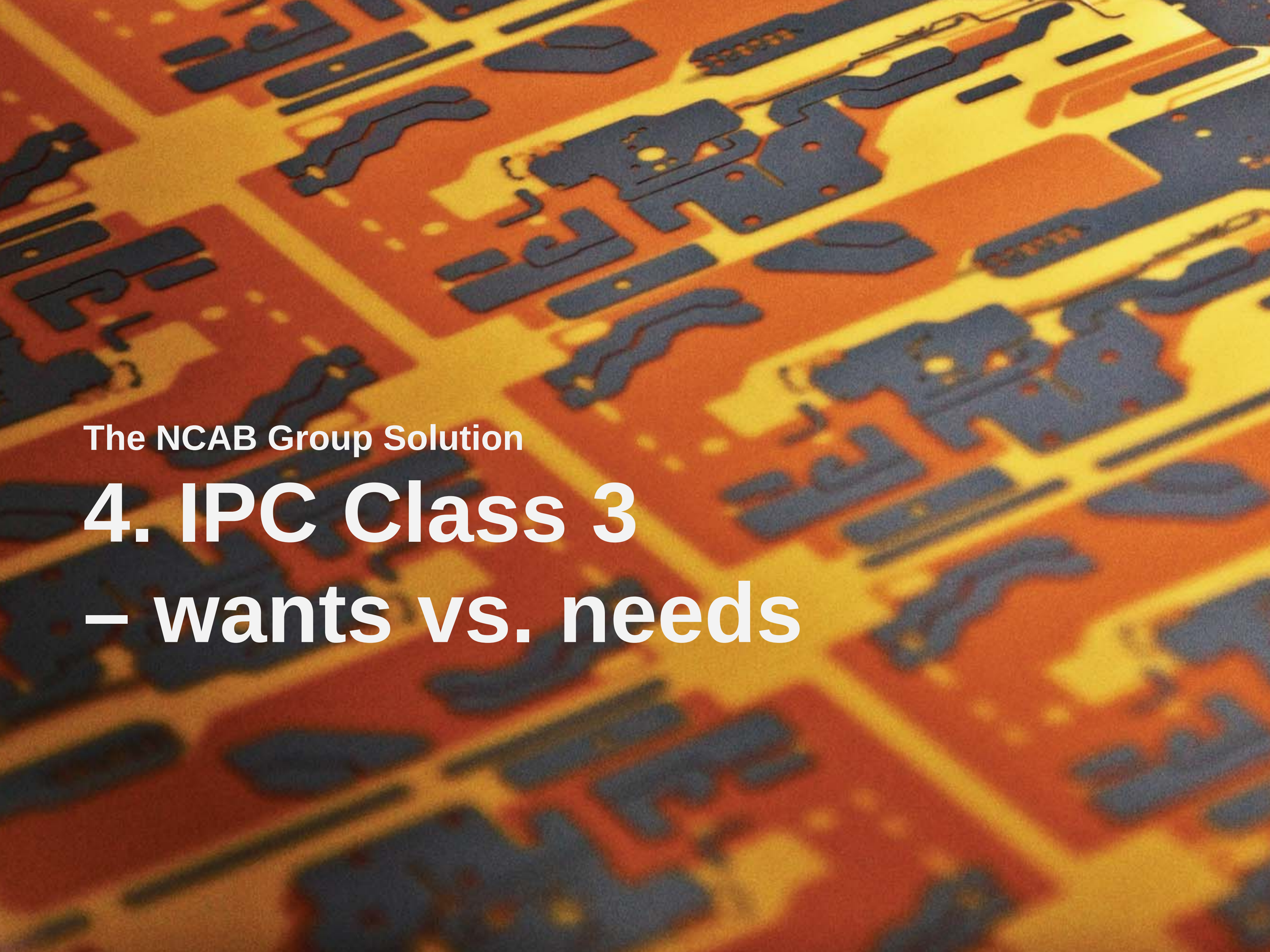
Verification vs. Process control

It is very important to understand the difference between verification on a product level and process control.

Process control is performed to secure the quality on different processes – such as plating parameters for example.

The verification on a product level is performed to verify that the process controls have worked well – more frequently with more demanding end-use conditions.

Good reliability is secured by having a good balance between verification on a product level and verification of the process. It cannot be achieved by sorting or screening on a product level.



The NCAB Group Solution

4. IPC Class 3 – wants vs. needs

IPC CLASS 3 WANTS VS. NEEDS

The NCAB Group Solution

We can consider some base elements of the standards and adopt an AABUS approach.

AABUS – As Agree Between User and Supplier

This is the NCAB solution to balance the wants vs. needs question.

NCAB offers three different levels of IPC Class 3 boards

NCAB Level 1

- Full verification according to IPC-6012 table 4-2, 4-3
- Meeting end customer demands
- Limited supply chain options
- Extremely high cost
- Recommended for product with extreme demands (nuclear, deep sea, avionics applications)

1

NCAB offers three different levels of IPC Class 3 boards

NCAB Level 2

Production and verification according to IPC A 600, IPC 6012, micro-sectioning according to table 4-2 and 4-3 AQL 4.0. Except for less than 26 m-panels, two micro-sections per production batch applies.

- Meeting the majority of main end customers demands (also high reliability)
- Fairly cost effective
- Dual sourcing possible / less limitations on supply chain
- Recommended for product with very high demands (medicine, industrial)

2

NCAB offers three different levels of IPC Class 3 boards

NCAB Level 3

Production and verification according to IPC A 600, IPC 6012, two micro-sections/production batch.

- Meeting a specific end customers demands
- Cost effective
- Multi sourcing possible
- Recommended for most products (industrial, automotive)

3

List of Factories Approved for Class 1, 2 and 3

IPC Class 3 Factory	Level 1	Level 2	Level 3	Procedure implemented since
Fastprint		X	X	July 2010
FastPCB				Not implemented
JHK	X	X	X	December 2009
Founder		X	X	December 2009
MFS		X	X	December 2009
Lucky Star			X	February 2010
Suntak			X	February 2010
Approved only for IPC Class 1 & 2				
Jove				Not approved for IPC Class 3

Conclusions

Conclusions

- Good / qualitative sourcing is essential.
- Make sure all involved within the supply chain (internal and external) clearly knows and understands the demands.
- Be prepared to pay correct price – lowest price does NOT equal lowest total cost!
- Ensure that you are using a specification that is understandable and correct.
- Refer to well-known standards where applicable
- Choose a realistic process of verification on a product level based on the demands on the end product.

Do not over specify. This is as important as not under specifying.


RoHS
Questions?

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- Cost drivers in PCB production
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- IMS - Insulated Metal Substrate
- Rigid-flex
- NCAB Group PCB Specification
- Impedance controlled boards
- DFM – Design For Manufacturing
- IPC vs. Perfag
- Reliability, IPC & NCAB
- Material for lead-free production
- Technical advice
- NCAB Group Laboratory