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## The Plating Forum: The Significance of IPC ENIG Specification 4552 Rev B

The ENIG specification 4552 was issued in 2002. Since then, it has undergone a series of amendments and revisions in an attempt to meet ever-changing industry requirements. Although it started as a thickness specification that did not reference lead-free soldering or nickel corrosion, its latest iteration, 4552B, addresses all aspects of nickel corrosion.

The IPC Specification 4552B was issued in April 2021 as a performance specification. It is already having a profound effect on how the industry (suppliers, manufacturers and end users) views the ENIG surface finish. The document is a revision of its predecessor, 4552A, issued in 2017. Revision 4552A addressed nickel corrosion for the first time. It described the corrosion defects as viewed in a cross-section at 1000X magnification by coining the terms “Spike,” “Spreader Spike” and “Black Band.” It also addressed the level of corrosion and defined 3 levels. The levels were based on depth of defect and frequency of occurrence in the Field of View at 1000X magnification.

Corrosion Level	Description	Disposition
Level 1	<10 defects with <20% depth penetration	Acceptable
Level 2	defects more than Level 1 and less than Level 3	This level required resolution.
Level 3	>10 defects with >20% depth penetration	This level is rejectable

ENIG Specification 4552A went a long way in defining the defect and its evaluation. The way the specification read was; if a single Level 3 defect was encountered, the product was deemed “Rejectable.” Rejecting a production lot due to a single occurrence of a Level 3 defect in the 1000X field of view did not make any sense. There had to be a method to determine the frequency of occurrence or prevalence of corrosion in the board. This was addressed in the revised ENIG Specification 4552B.

In revision 4552B, the term “Product Rating” was introduced. Product Rating is a way to assess the frequency of occurrence or prevalence of the corrosion defect. Product Rating is determined by assessing the defect levels of multiple cross-section locations (7 for a thru hole and 5 for a single pad).

Product Rating	Corrosion investigation	Disposition
0	Defect-free, zero evidence of corrosion	<b>Acceptable</b>
1	> 60 % of evaluated locations show Level 0 or Level 1	<b>Acceptable:</b> this level of corrosion will not degrade solder joint integrity
2	Corrosion defects & frequency > Product Rating 1 but < Product Rating 3	<b>Acceptable:</b> Provided that solderability meets requirements per section 3.9
3	> 40% of evaluated locations show Level 3 defects	<b>Nonconforming:</b> This level of corrosion will degrade solder joint reliability

To arrive at a Product Rating, the product is gold stripped (4552B recommends a specific methodology for gold stripping) and examined at lower magnification (200X), where multiple holes are within the field of view. The specification states that holes or pads with the most prevalent defects are to be evaluated at 1000X per the table above. The results are tabulated and a Product Rating value is extrapolated, depending on the frequency of each of the levels.

This is a significant development in corrosion evaluation. Now there is a standardized method for corrosion evaluation that produces a Product Rating Number. Specification 4552B also addressed the disposition of the extent of corrosion.

4552 Rev B contains details on how to calibrate and qualify XRF thickness measuring equipment. It also describes how to generate “Guard Bands” for instruments that do not meet statistically acceptable repeatability.

4552 Rev B added a method to measure the phosphorous content of the EN deposit. The method uses EDXRF (Energy Dispersive X-Ray Florescence). Here, a number is generated for % Phos in the EN deposit. This number is a good indicator of the EN bath performance over its life as measured by MTOs (Metal Turn Overs). The number can also be used to establish a correlation between the occurrence of corrosion and the % Phos content of the EN deposit.

With this methodology, manufacturers can gain a good understanding of the defect. They can track it, attempt to define a root cause and eventually eliminate the defect. Products can be shipped with confidence, knowing that the product will not be rejected for ENIG corrosion.

Buyers can request that the manufacturer perform corrosion testing per 4552B and supply support documentation that the product is corrosion-free or with an acceptable level of corrosion that will not cause solderability issues.

Suppliers now have a way to evaluate the performance of products in the field. They can increase the robustness of their products and service to ensure that customers can produce acceptable ENIG finishes in different manufacturing environments. Manufacturing sites vary dramatically in level of engineering support, lab support, plater experience, equipment, QC capability, etc.

Specific examples of increasing product robustness include:

- A modified catalyst that will produce a uniform catalyzed surface
- A more corrosion-resistant electroless nickel
- A non-aggressive immersion gold
- A reduction-assisted immersion gold

For technical service, the supplier must have a team of service engineers that are well versed on nickel corrosion and are supported by an analytical lab with capable personnel that can produce Product Rating Numbers and % Phos as specified in 4552B.

The revised ENIG Specification 4552B gave the industry a tool by which manufacturers, buyers, CMs and suppliers can measure the extent of ENIG corrosion. With this measurement tool, the problem of ENIG corrosion is well on its way to be eliminated.

You can only fix a problem that you can measure.

*This column originally appeared in the November 2021 issue of PCB007 Magazine.*



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