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Final Finish Specifications Review
IPC Plating Sub-committee 4-14

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Specifications are consensus documents that are agreed upon by a panel of interested industry participants composed of suppliers, manufacturers, assembly houses and end users. The IPC Plating Sub-committee 4-14, is no exception. If there is consensus then the committee documents it in a specification. In cases where no consensus is readily arrived at, the committee undergoes its own testing in what is commonly referred to as a "Round Robin" (RR) study.

In a RR study, an agreed upon test vehicle (TV) is designed and manufactured. The TVs are then sent around to the different suppliers who deposit the agreed upon thicknesses to be investigated. The TVs are collected and the deposit thicknesses are verified and documented. The TVs are then coded. The coding is done to conceal the identity of the specific supplier, to keep the evaluation objective and to ensure it is not a comparative study between different suppliers. This is followed by sending the TVs around again to the different testing sites that test for the desired attribute like soldering, contacting and wire bonding capabilities of the different finish thicknesses. The data is then collected sorted out and documented. At this point a new attempt at consensus is made and upon arrival the thickness specification is set.

Once the consensus is complete a draft of the document is prepared. The draft is then sent out for peer review. This is a very important step, where the committee members as well as any IPC member can review the document and write back to the committee suggesting technical or editorial changes. Anyone can take exception with the document. All comments are then reviewed and all issues are resolved before the final draft is issued. At this time the IPC takes on the task of publishing the document in its final format.

Specifications are reference documents to be called out by designers and original equipment manufacturers (OEMs). Designers may take exception with one or more items in the specification to ensure that the product meets the requirements of its intended use. The term "AAUBUS", (As Agreed upon between User and Supplier); is part of any specification.

The IPC Plating subcommittee 4-14 chaired by George Milad and Gerard O'Brien has been active since 2001, with Tom Newton as the IPC liaison. It has an extensive member list. The committee operates thru bi-weekly conference calls "Concalls" (one hour). All decisions are made in the concalls by those in attendance. The call minutes are documented and sent out to the entire membership, who act as checkers, to ensure that the committee is on track to meet its objectives. To date all committee activities have been voluntary and acknowledgement is in order for the members and equally important to the management of their companies that believe in the need for industry specification and allow for the voluntary time invested by their employees.

Since its inception the IPC Plating Sub-committee 4-14 has issued the following:
IPC-4552 ENIG Specification 2002
IPC-4552 ENIG Specification Amended 2012
IPC-4553 Immersion Silver specification 2005
IPC-4554 Immersion Tin Specification 2007
IPC-4553A Revised Immersion Silver Specification 2009
IPC-4552 Amended ENIG Specification 2011
IPC-4554 Amended Tin Specification 2011
IPC-4556 ENEPIG Specification 2013

IPC-4552 ENIG Specification (2002)

The ENIG IPC-4552 Specification was issued in 2002, at that time the idea of lead free (LF) had not taken hold in the industry and tin lead was the dominant assembly solder in use.
For thickness IPC-4552 stated:
The electroless nickel thickness shall be 3 to 6 µm [118.1 to 236.2 µin]
The minimum immersion gold thickness shall be 0.05 [1.97 µin] at four sigma (standard deviation) below the mean; the typical range is 0.075 to 0.125 µm [2.955 to 4.925 µin].

To arrive at these numbers the committee had conducted a series of test in a round robin study that included suppliers, PCB manufacturers, EMS providers and OEMs. The data collected is summarized in the appendix of the specification.

As the price of gold soared, there was pressure on the committee to revise the lower limits for ENIG. The ENIG specification was amended in 2012. The lower limit for thickness was reduced from 0.05 µm to 0.04 µm (1.6 µin), however some restrictions were added like ability to measure, and limited time from manufacturing to assembly as well as demonstrating the consistency and reproducibility of the plating process.

Presently the IPC-4552 A, ENIG Specification revision is in progress. The purpose is to reduce the lower limit of thickness as per the amendment and to determine if the restriction imposed earlier could be lifted. This entails a RR study and a full investigation to ensure that the lower limit will not create problems for the industry. In addition all testing will include LF solder and LF stressing conditions; both were not available when the initial IPC-4552 was issued.

In addition, the revision of IPC-4552 A would include the following:

- Test method for stripping Immersion gold during failure analysis.
- Test method for determining the phos content of electroless nickel
- Acceptability criteria for nickel corrosion (Black Pad)

IPC-4553 Immersion Silver specification (2005)

The specification for immersion silver was issued in 2005. At that time there were 2 distinct types of immersion silver that were commercialized. One type could only produce a thin deposit of silver and the other produced a thicker deposit. As both had market penetration the committee had to specify the two types. The initial 4553 specification stated the following for thickness of deposit:
Thin Silver: 0.05µm (2µ") minimum at -2σ from process mean as measured on a pad of area 2.25²µm (3600² mils). Typical value 0.07µm (3µ") to 0.12µm (5µ")
Thick Silver: 0.12µm (5µ") minimum at -4σ from process mean as measured on a pad of area 2.25²µm (3600² mils). Typical value of 0.2µm (8µ") to 0.3µm (12µ").

The IPC 4553 Silver specification was unique:

- There were two thicknesses specified
- There is no upper limit in the specification
- The pad size for measuring thickness was defined

IPC-4553 A Immersion Silver specification (2009)

Over the next couple of years the supply of the "Thin" silver dwindled and was replaced by the "Thick" version. It was necessary for the committee to revise the specification. The Rev A had two important revisions. The first was the elimination of the terms "Thin" and "Thick" and to specify a single thickness. The second was to set an upper limit for immersion silver thickness.
Thickness specification of immersion silver IPC-4553 A states:
0.12 µm [5 µin] minimum to 0.4 µm [16 µin] maximum at ± 4σ from process mean as measured on a pad of area 2.25 mm² or 1.5 mm X 1.5 mm [approximately 0.0036 in² or 0.060 in X 0.060 in]; typical value between 0.2 µm [8 µin] to 0.3 µm [12 µin].

IPC-4554 Immersion Tin Specification 2007

For immersion tin the committee specified a lower limit for thickness. The relatively thick value of 1 micron was chosen to ensure that enough virgin tin would be available at the surface for soldering after storage. It is well understood that tin forms an intermetallic (IMC) layer with the underlying copper, and that this layer continues to grow in thickness over time.

The immersion tin thickness will be:
1.0 µm (40µ") minimum at -4σ from process mean as measured on a pad of area 2.25²µm (3600² mils). Typical value of 1.15µm ((46µ") to 1.3µm (52µ").

The immersion tin Specification IPC-4554 was amended in 2011. The amendment addressed solderability testing and specified the allowed stress testing conditions for the deposit and the type of fluxes to be used for both tin/lead and LF testing.

IPC-4556 ENEPIG Specification 2013

This is the last specification issued by the committee. The document produced is very comprehensive and includes a wealth of information from the RR studies that were conducted. The Appendix contains a documentation of these studies; each authored by the principle who conducted the testing.

It also includes a section on the proper methods of equipment setup for a reliable measurement of very thin layers of metal deposits.

The thickness specification for ENEPIG states
Nickel: 3 to 6 µm [118.1 to 236.2 µin] at ± 4 sigma (standard deviations) from the mean. Palladium: 0.05 to 0.15 µm [2 to 12 µin] at ± 4 sigma (standard deviations) from the mean.
Gold: 0.025µm [1.2 µin] at - 4 sigma (standard deviations) below the mean.
All measurements to be taken on a nominal pad size of 1.5 mm x 1.5 mm [0.060 in x 0.060 in] or equivalent area,

IPC-4555 OSP Specification

It is noteworthy that the committee had spent considerable time working an organic solderability preservative (OSP) specification that was designated IPC-4555. After more than one year of struggling with the specification nothing was issued. There was no consensus arrived at. Mostly this was due to the wide assortment of organic products that were used for solderability preservation for the various application; each with its own thickness recommended values.

Conference call are held every other Wednesday at 11:00 am EST. All participation is welcome.