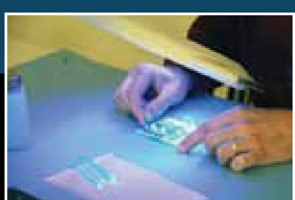
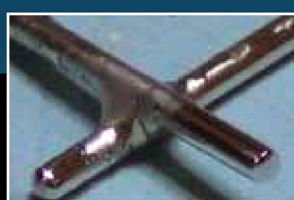
NEWS

Volume 12 • Issue 10 • September, 2014

Leading the way in electronics





DAVE'S WORLD

By: Dave Raby

September 2014

Jim & Ellen (Dad & Mom) are retiring thirty two years after we founded STI in their dining room.

I never thought I'd write that sentence. We have joked for 25+ years that I'd retire long before they ever did but the timing is correct and I applaud their decision.

I'm supposed to write about 800 words in this article but I have at least 80,000 floating around in my head and I'm not sure that's enough to do their accomplishments and contributions to STI Electronics and the industry justice.

Both of my parents were born sharecroppers in rural Madison County, Alabama. Both worked hard in cotton fields from a very young age through their high school years. Jim then joined the Navy and served on a ship at the end of the Korean War as an electronic technician. They were married after his Navy service and he went to work for Dr. Werner Von Braun's team of scientist with the Army Ballistic Missile Agency (ABMA) which soon became NASA. Jim worked on some amazing projects during his tenure with NASA coming up with test data to support the reliability of the vehicles involved in putting a man on the moon and bringing him home. Much of that test data is still used as a basis point for many specifications today. I have been encouraging Jim to write some articles describing how the data was captured.

Ellen worked a variety of jobs but by choice her primary job was wife and mother as we traveled with Jim and moved around the country several times. In 1974 Jim left NASA

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and went to work as a civilian for the Navy at China Lake, California. Consequently, this is where his name and reputation became most widely known. He spent 10 years at China Lake and was ready to try something different as was Ellen. I had graduated from college and was number 35,000 on Delta Air Lines seniority list. Being the smart person I am, I figured out fairly quickly that Delta's plans for me running the company and mine were nowhere near the same. As a result, I was ready for something different too.

DAVE'S WORLD cont.

We started Soldering Technology International as a way of conducting seminars around the country (and world) to teach people how to cost effectively build reliable hardware while meeting the government's specifications. Eventually, we began to see ways to make it a business and we all quit our real jobs to go full time. We have always been a good team. Jim is the visionary that sees today's technology and understands where it is going in the future. I am the one that says if that's what Jim sees, here's what we should be doing about it. Ellen has always been the most important one by taking what Jim sees and I say and reining us in so we don't overextend ourselves and head off in directions we shouldn't be going. Of course our roles have evolved over the years and we may switch in certain cases but the combination has worked out pretty well for over 32 years. Thirty+ years later and 60 years from the cotton fields, the former sharecroppers have made a positive influence on countless individuals and an entire industry. They have traveled the world and made friends in places most of us can only dream about. They have built a reputation that I personally, and everyone at STI, will work every day to continue. If anyone has ever earned a happy retirement, it is the two of them and I wish them a long and happy one. STI will be hosting a reception for them September 23rd, 12:30 to 1:30 pm. If you are going to be in the Madison area and would like to attend, please let me know and I will get the details to you. If you would like to send them a card or a note, please send it to STI and they will get it. They'll both remain on our board of directors and will both keep their offices as long as they'd like. They'll also keep their email addresses so please feel free to stay in touch with them.

I will be purchasing Ellen's portion of the company in the very near future. (Trivia note – There is a long story behind it, but Jim has never owned any of the company.) Our plan is that you won't see any changes due to this transition but one legal change is we will no longer be a Woman Owned Company but will continue to meet Small Business Classifications.

As always, if there is anything we can do to serve you better, please let us know. You can contact me or anyone else listed anywhere in this newsletter.

Please follow me on twitter (@daveraby) or facebook (STI Electronics).

Congratulations!

All of the employees at STI would like to wish Jim and Ellen Raby the happiest and healthiest of retirements. They will be missed greatly but we will all do our very best to carry on the reputation of STI in the same manner in which it has been for the past 32 years! Congratulations!

STI's Twist on the Ice Bucket Challenge

The employees of STI Electronics, in honor of the company's founder, Jim D. Raby, held an Ice Bucket Challenge fundraiser for the Michael J. Fox Foundation for Parkinson's Research. STI employees raised $821 in just a few days and David Raby matched the employee contribution. As a result, $1,642 was donated to the Michael J. Fox Foundation. Click here to see a video of the challenge.

For all the latest STI news and events, follow us on LinkedIn, FaceBook, and Twitter.

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CHANGES AT STI...

You may have heard of some changes at STI recently with the sale of our Distribution Department to Hisco. This does not impact Training Materials in any way and we are still here for you, as always.

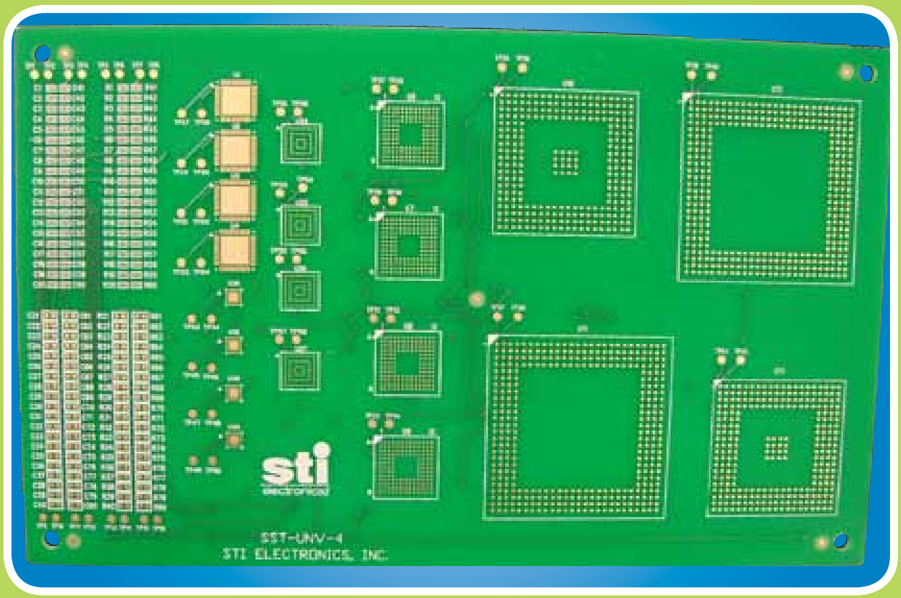
Smaller is Better

What a concept! Those of us that have been in the industry for more than a few years have observed the continuing results of the smaller is better concept. Unfortunately our unaided internal vision doesn't continue to improve with the "more than a few years" scenario.

Today we are seeing more BGA packages with ultra small sphere sizes in the 0.006" (0.15mm) range. These can be a real challenge since the scale of the related geometries are by necessity, also smaller. Solder spheres for reballing at this dimension resemble a jar of dust.

That aside, there's good rationale for the smaller is better progression. Often it is enabled by evolution and advancement of material properties that support the smaller dimensions. Ultra small BGA packages take advantage of the self aligning properties of the solder attachments during reflow to relax the exact placement burden related to the small package dimensions. Thinner packages reduce the profile of

the completed assembly. Weight is reduced due to less molding material. Board X/Y real-estate is reduced with the elimination of lead frames since the die size is the package size. Electrical



performance gains a big boost due to reduced inductance from the internal wire bonds, lead frames, leads and necessary larger board interconnects.

But that's all design considerations, what about the assembly soldering and production? Unfortunately assembly production operations often need to live with what makes the product successful during design – in this case smaller. The true innovation challenge is how can we make this work. The smaller the sphere, the faster oxidation degrades solderability. Accurate mask registration is a must to prevent solder opens or shorts. Along with this, trace registration must be accurate or the sphere can miss the termination. Microvias will likely be necessary for routing to internal connections rather than traditional vias or via in pad. Vision and X-Ray capability will be necessary for assessment of the production operation success.

Smaller is better and as always we have related challenges that make production operations interesting. STI Training Materials will do all we can to keep you ready for the future challenges.

Recently we created a new Process Evaluation Kit for very fine pitch evaluation. The new kit contains 01005 chips and MLF/QFN components in addition to the usual BGA and QFP components. Please contact us if you are interested in pursuing "Smaller is Better".

New Revisions for J-STD-001 and IPC-A-610 are released for print. We will have them in stock as soon as they become available. The latest revision is now "F" with the training program updates to follow soon. Please stay in touch for the latest progress.

Our feature Hands-On Training Kit for this newsletter edition is the J-STD Certification Training Kit available in either tin lead or lead free. A favorite among the industry for many facets of Hands-On solder skill training.

Mention this article and receive a 10% discount during the publication month.

TRAINING SERVICES

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Solder Wetting Basics

By: Ray Cirimele, Master Instructor
STI Electronics, Inc.

This month STI's Training Services Department is featuring an article about "Solder Wetting Basics". This article will explain what good wetting is and how to achieve it. Over the years we have gotten many questions regarding this topic. We hope this article is informative and helpful.

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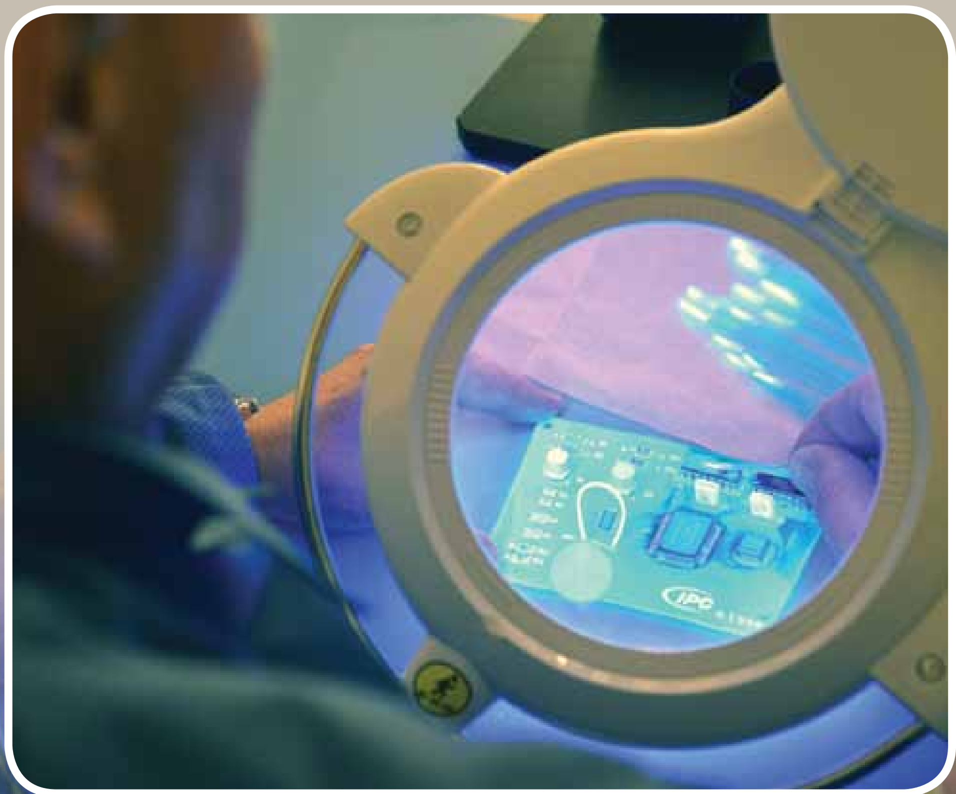
Background

Many of us have heard the statement "the most important characteristic of a reliable solder connection is "good wetting".

IPC J-STD-001 and IPC-A-610 include criteria for the degree of wetting or the percentage of area wetted. IPC J-STD-001 even includes one clause (4.18A) that explains what constitutes acceptable wetting, however, it never explains what the mechanisms of wetting are or what is needed to achieve acceptable wetting.



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The goal of this article is to explain what good wetting is and how to achieve it. We'll provide examples of poor wetting and explain why it poses a risk to long term reliability. To make this goal easier to achieve, we are going to explain the terms solderability, wetting, and intermetallics, and why they are important to us as we strive to achieve the highest quality solder connections for our customers.

Solderability

Let's start by discussing the term solderability. The solderability of a material is a measure of how easy or difficult it is to form a solder connection to that material. When you try to form a solder connection with wooden toothpicks (Figure 1) you have an example of poor solderability. When you try to form a solder connection with freshly tinned copper leads (Figure 2) you get an example of good solderability. It will be very difficult to achieve acceptable wetting even if you have a great process. This also means that if you start with parts that have good solderability it will make it much easier to achieve good wetting, however, a bad process can sabotage the good solderability and still result in poor wetting. In other words, poor solderability almost always results in poor wetting, but good solderability does not always lead to good wetting.

Now that we know what solderability is, we need a way to measure the solderability. There are both quantitative (objective properties) and qualitative (subjective properties) tests for solderability.

The most common qualitative test is what is known in the industry as the "dip and look" test. This test has been in use for decades. It was available in Mil-Std-202, Method 208, and then alter as IPC J-STD-002, Test A. Although the "dip and look" test has very detailed procedures in an effort to improve consistency, the post-test evaluation is where it has opportunity for subjectivity. As a simplified example of the test, a component lead would be dipped in a solder bath and when removed it would be examined for the percentage of solder coverage. Solder coverage of 95% or greater in what would be the critical area would be considered passing.

A very common quatitative solderability test is the wetting balance test (per IPC-J-STD002, 4.3) (Figure 3). The advantage of this test is it provides objective, measurable values that can be used for comparison. The only important disadvantage is it is difficult to establish a universal pass/fail value because of the amount of variables involved in the manufacturing process. A part that might have great solderability may exhibit good wetting for one manufacturer while the same part may exhibit poor wetting for another manufacturer as a result of process differences. This test measures wetting force as a function of time. As the component lead is lowered to the surface of the solder bath it encounters some initial resistance from the surface tension of the solder. Much as a

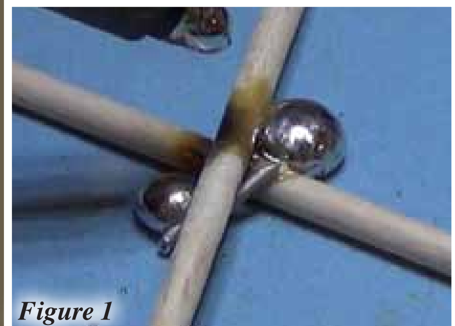


Figure 1

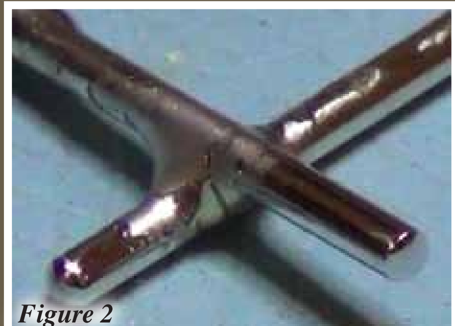


Figure 2


Figure 3

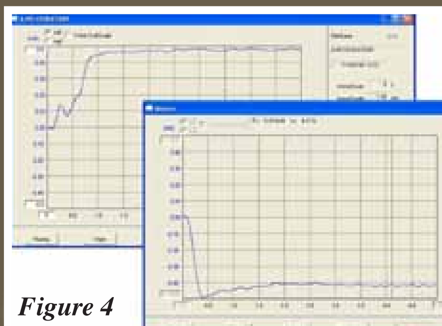


Figure 4

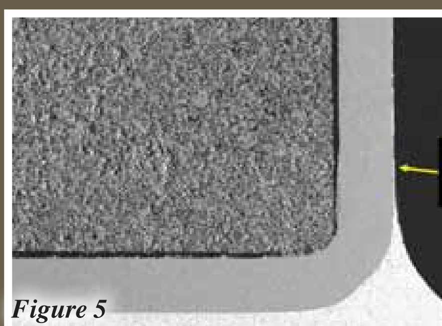


Figure 5

TRAINING SERVICES

water strider can move across the surface of water. Once wetting occurs, the initial resisting force is eleimated and a pulling force is exerted on the component lead. This is displayed as a 2 axis curve (Figure 4) with force measured in the Y axis and time measured in the X axis. As long as the lead geometries are the same, it is possible to test multiple components from different vendors and determine which one has the best solderability.

It is important to keep in mind that there are a lot of variables (solder alloy used, flux type, flux volume, ambient or inert atmosphere) in the soldering process. These variables will affect the minimum level of solderability that is necessary to achieve acceptable connections. If you have a forgiving process with a large process window even marginal solderability may work.

Wetting
Now that we've discussed solderability, let's move on to wetting. The IPC J-STD-001 document states that "The solder connection wetting angle shall not exceed 90°". So what is this wetting angle that is also known as a dihedral angle?

The contact angle is measured where the solder fillet shape makes contact with the other metal, usually copper. We will look at this as the intersection of two planes (Figure 5).

Do not confuse the fillet shape with the contact angle. You can have a concave fillet with good wetting, and a convex fillet with good wetting (Figure 6).

Acknowledgements:
Microsections, SEM Micrographs, Technical Guidance
Marietta Lemieux, STI Electronics, Inc., Manager Analytical Lab Services

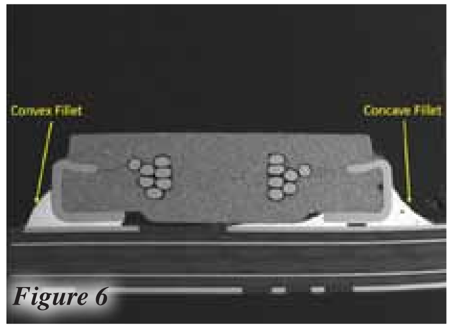
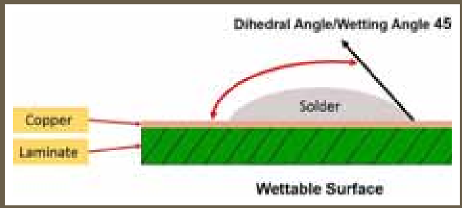
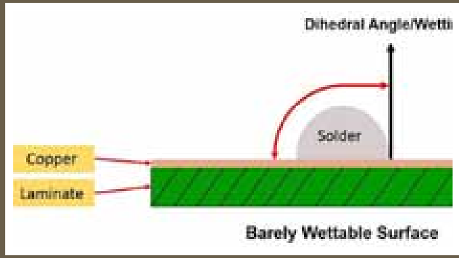
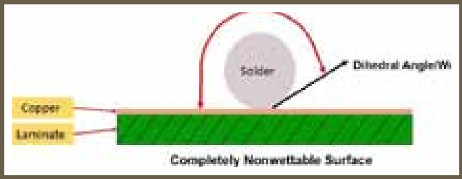
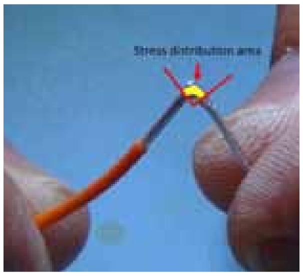


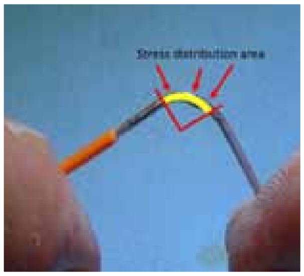
Figure 6

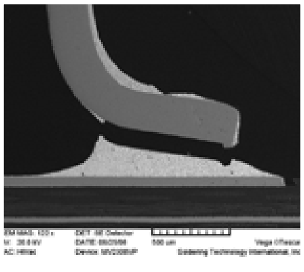


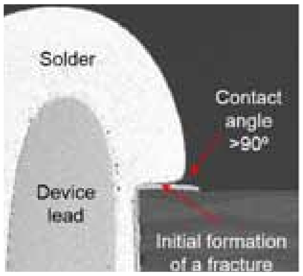


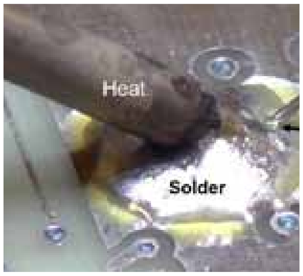


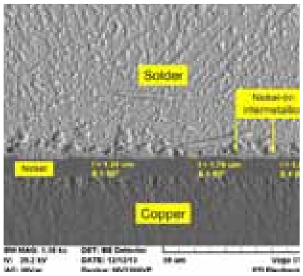


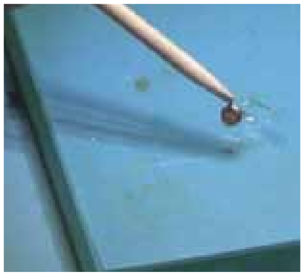


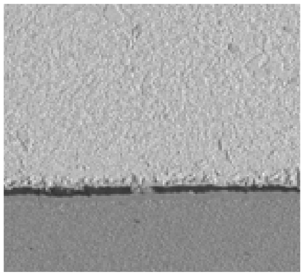












2014 Schedule

IPC J-STD-001 Training Center

J-STD-001 "Requirements for Soldered Electrical and Electronic Assemblies"

J-STD-001 Certified IPC Trainer (CIT) Certification Course - Madison, AL

December 1-5

J-STD-001 Certified IPC Trainer (CIT) Recertification Course - Madison, AL

October 29-30

November 19-20

J-STD-001 Certified IPC Trainer (CIT) Space Addendum Course - Madison, AL

October 31

November 21

J-STD-001 Certified IPC Application Specialist (CIS) Certification Course (Modules 1-6) - Madison, AL

Sept. 29 - Oct. 3

IPC/WHMA-A-620 Training Center

IPC-A-610E "Acceptability of Electronic Assemblies"

IPC-A-610 Certified IPC Trainer (CIT) Certification Course - Madison, AL

December 8-11

IPC-A-610 Certified IPC Trainer (CIT) Recertification Course - Madison, AL

October 27-28

November 17-18

IPC-A-610 Certified IPC Application Specialist (CIS) Certification Course - Madison, AL

November 12-14

IPC-A-600 Training Center

IPC-A-600E" Acceptability of Printed Boards"

IPC-A-600 Certified IPC Trainer (CIT) Certification/ Recertification Course - Madison, AL

October 15-17

2014 Schedule

IPC/WHMA-A-620 "Requirements and Acceptance for Cable and Wire Harness Assemblies"

IPC/WHMA-A-620 Training Center

IPC/WHMA-A-620 Certified IPC Trainer (CIT) Certification Course - Madison, AL

October 20-23

IPC/WHMA-A-620 Certified IPC Trainer (CIT) Recertification Course, Madison, AL

October 15-16

IPC/WHMA-A-620 B Certified IPC Trainer (CIT) Space Addendum Course - Madison, AL
Prerequisite: IPC/WHMA-A-620B CIT Certification or Recertification Course.

IPC-7711/7721 "7721B Rework, "Modification and Repair of Electronic Assemblies

IPC-7711/7721 Training Center

IPC-7711/7721 Certified IPC Trainer (CIT) Certification Course - Madison, AL

October 6-10

IPC-7711/7721 "7721B Rework, "Modification and Repair of Electronic Assemblies

IPC-7711/7721 Training Center

IPC-7711/7721 Certified IPC Trainer (CIT) Recertification Course - Madison, AL

November 13-14

IPC-7711/7721 Certified IPC Application Specialist (CIS) Certification Course - Madison, AL

December 8-16

IPC-7711/7721 Certified IPC Application Specialist (CIA) Recertification Course - Madison, AL

December 17-18

Basic Soldering - Madison, AL

September 29 - October 3

MSFC/NASA-STD-8739.1 Staking and Conformal Coating Operator/Inspector

November 3-6

To register for a class visit our website at www.stielectronicsinc.com.

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2014 Houston, Texas Schedule

IPC J-STD-001 Training Center

J-STD-001 "Requirements for Soldered Electrical and Electronic Assemblies"

J-STD-001 Certified IPC Trainer (CIT) Certification Course

November 3-7 December 1-5

J-STD-001 Certified IPC Trainer (CIT) Recertification Course

November 19-20

J-STD-001 Certified IPC Trainer (CIT) Space Addendum Course

November 14

J-STD-001 Certified IPC Application Specialist (CIS) Certification Course (Modules 1-6)

October 20-24

J-STD-001 Certified IPC Application Specialist (CIS) Recertification Course (Modules 1-5)

October 13-14 November 17-18

IPC-A-610 Training Center

IPC-A-610E "Acceptability of Electronic Assemblies"

IPC-A-610 Certified IPC Trainer (CIT) Certification Course

December 1-4

IPC-A-610 Certified IPC Trainer (CIT) Recertification Course

November 10-11 December 8-10

IPC-A-610 Certified IPC Application Specialist (CIS) Certification Course

October 28-30

To register for a class visit our website at www.stielectronicsinc.com.

2014 Houston, Texas Schedule

IPC/WHMA-A-620 "Requirements and Acceptance for Cable and Wire Harness Assemblies"

IPC/WHMA-A-620 Training Center

IPC/WHMA-A-620 Certified IPC Trainer (CIT) Recertification Course

November 12-13

December 11-12

IPC/WHMA-A-620 Certified IPC Application Specialist (CIS) Certification/Recertification Course

December 15-17

Address
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Where Is My Component?
Tolerancing in Electronics

Contact Information:
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Manufacturing Engineer
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Tolerance in manufacturing is the amount of variation in a product. It is often the observable difference between idealized computer models and tangible hardware. In Surface Mount Technology (SMT), such variation impacts all aspects of the fabrication process; from component placement and solder joint characteristics, to heat transfer parameters of the end product. Most impacts are subtle and go unnoticed, due in large part to the highly repeatable manufacturing processes of many component manufacturers and electronics assembly facilities. However, some impacts are not as subtle, and can have a significant impact on yield and/or product performance. Understanding and mitigating the susceptibility of a design to manufacturing variation is often the differentiator between producing reliable products versus production nightmares. Two major considerations in electronics packaging are component location and height.

Part location becomes critical in applications where precise component placement influences system performance. A common example is in RF circuits, where chassis contain labyrinth features to optimize shielding between certain board areas. Walls separating components from one another take on layout-specific geometry, and can have very small clearances to critical components. These components, when placed on a printed circuit board, have a tendency to shift during the solder reflow process. Particularly in SMT applications, the only locating mechanism on a part is a molten pool of solder. This means that the part can, in theory, slide to any location, during reflow. The reality is that the surface tension of the molten solder has a tendency to center component leads on the corresponding pads. In other words, wherever the pads go, so will the component leads. Figure 1 shows a component placed on a set of pads. One of the pads has been over-etched on one side. This moves the center of the pad upward in the image, which causes the part to shift upward during solder reflow. The component, consequently, has shifted away from its ideal location, as shown in the outline. For this reason, it is critical to utilize a board house that can produce accurate and precise printed circuit boards, especially as it relates to pad geometry.

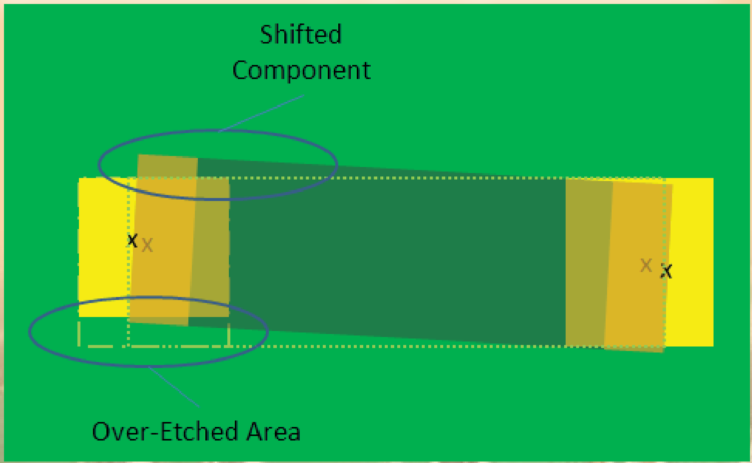

Figure 1: Shifted Component

Component height becomes a major concern in applications where it influences the heat transfer characteristics of a system. Consider an application where a processor (flip chip die) generates a considerable amount of heat, and requires a thermal path to a heat sink.

ENGINEERING SERVICES *cont. from pg. 9*

For thin thermal interfaces, thermal conductivity is driven predominantly by the thickness of the thermal interface material (TIM), rather than its material type. For example, removing a hot pan from the oven with either a sheet of paper or sheet of aluminum foil will transfer similar quantities of heat to your hand, despite the fact that paper is not a good conductor of heat. For electronics application, TIM thickness clearly varies with component thickness and heat sink dimensions, but it also varies with the thickness of the solder connection. Component thickness and heat sink dimensions are typically known and specified on component data sheets and detailed heat sink drawings, respectively. But what about the solder joint thickness? Electrical components are typically placed on a thin bed of solder paste prior to being subjected to a reflow oven. The initial paste thickness is governed by the thickness of solder paste stencils. The final solder joint thickness, however, is determined by the initial solder paste thickness, paste type, and reflow parameters used by the CCA shop. For example, a 5mil stencil allows for 5 mils of solder paste to be distributed onto the pads of a PCB. Once the flux within the paste vaporizes, the solder can reduce in volume by 50%, leaving a 2.5mil solder joint. This 2.5mil reduction in part height becomes a potential problem when small (10-30mil) TIM thicknesses are desired. When using compressible heat transfer pads, this reduction in pad height reduces that compression, which in turn reduces the thermal conductivity through the pad. Figure 2 shows a comparison between nominally and minimally compressed thermal interface materials. Depending on the pad selected, the reduction in conductivity may be significant. If this reduction has not been accounted for by a thermal analyst, thermal analysis results may be overly optimistic when compared to actual hardware. Consider a PWM Controller that dissipates 3W of thermal energy during its 10 minutes of operation. A thermal management system designed to store 1.5 of the 1.8kJ of thermal energy only stores 1.1 to 1.4kJ, leaving the remainder to drive up the component's temperature. A scenario like this can easily lead to overheated and/or failed components. The simple solution to this source of variation is to maintain known and consistent solder joint thicknesses where they are critical. Because not all shops use the same types of stencils, paste, or reflow ovens, this component standoff height can vary between assembly shops. If your thermal management system requires well-understood and maintained component connections, please do not hesitate to ask a reputable assembly shop for guidance prior to assuming final solder joint thickness.

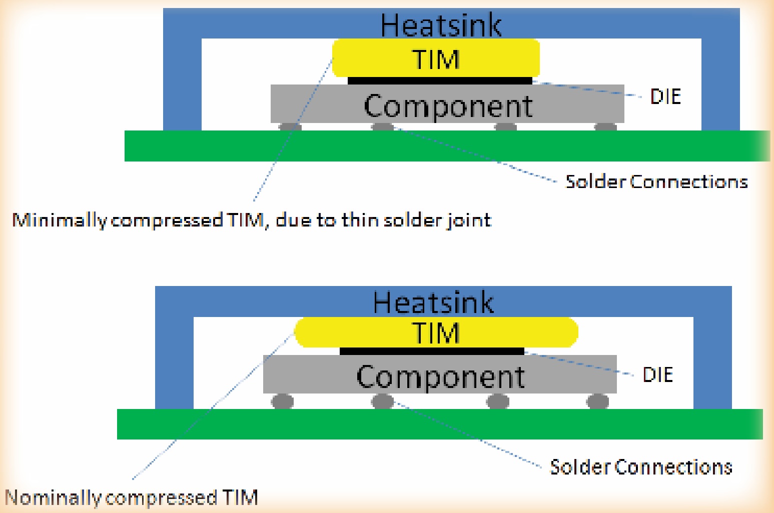

Figure 2: Thermal Interface Material Thickness Fluctuation

Jason Tynes has a book published on this same topic if you are looking for additional information. For more information click here http://www.amazon.com/Make-Fit-Introduction-Tolerance-Mechanical/dp