



Jean-Marc Peallat

Chong Choon Hee

SPI Parameter Considerations for Tighter Tolerances

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I-CONNECT007

In an interview with *SMT Magazine*, Vi Technology's Jean-Marc Peallat, vice president global sales, and Chong Choon Hee, Asia sales application manager, speak about the solder paste inspection (SPI) challenges when it comes to tighter tolerances and finer lines and pitches in board assemblies, and the latest innovations happening in the SPI space to help customers address these issues.

Stephen Las Marias: *Jean Marc, what are the challenges that your customers face when it comes to SPI as tolerances become tighter and pitches smaller?*

Jean-Marc Peallat: Your question raises two challenges. First, with miniaturization and the need for more intelligence, PCBs are becoming very dense and therefore, pads are becoming smaller with less space in between. Traditional

SPI uses “region of interest” (ROI) surrounding the pad. This one defines the area of the measurement, where the paste deposit should be, but also the location of the z-references. With size and pitch becoming smaller, the ROI is getting very small and very close to the pad. It becomes more and more difficult to define stable references that guarantee good measurement. Also, it may come across the ROI border. For traditional SPI, this results in a bridge defect. With a large field of view, our new SPI is not using ROI surrounding pads, and is not limited or impacted when pads are getting small and close to each other.

The other challenge concerns the calculation and the setup of parameters. Traditional SPI uses tolerances defined by a percentage of the theoretical volume or height. It is like one size fits all, tolerances for 0402 will be defined the same way than as 01005. Unfortunately, the physics of the printing process is not as simple as this. Effective transfer, the ratio between theoretical volume and real deposit, varies widely

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with the pad size. When pads are very small, the deposit is only a fraction of the volume of the aperture. With our next generation of SPI, we are using a parameter called area aperture ratio, which is the key for small pads. We set up the tolerances with this area ratio. For example, the 01005 is not the same as the 0402. So our tolerances for very small pads are adapted to these pads. Moreover, process variability is greater for smaller pads, or with smaller area aperture ratio.

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Chong Choon Hee: To complete this, the traditional way is that the region of interest is around the small pads with dedicated z-references. If you use an ultra-large field of view, the system is able to take more references for measurement on a very large portion of the PCB. The compilation of all these references gives the exact z-plan of the PCB, including the warpage calculation. Therefore, when it comes down to small pad measurement, the accuracy of the system is enhanced.

Las Marias: *What about the volume of the solder?*

Peallat: When the deposits are becoming smaller, volume is key, because the shape of the deposits induces high variability of the process for very small pads. With poor transfer efficiency, shape is not consistent. Volume measurement depends on z-reference. That is where most of the SPI makers are struggling. With our technology with angled cameras, global z-reference, the measurement of the volume is a lot more accurate than others.

Chong: As the specs get smaller and smaller, the transfer efficiency is getting more difficult to

control. Right now, the trend is to have an SPI to inspect the solder volume.

Las Marias: *How does the different type of the components on the board impact the solder paste inspection process?*

Chong: For example, if you have a component and you have a volume of deposit on one side and the other side has lesser volume, there might be a pulling effect on the other side more, when you go through the reflow process.

Most likely this would result in a tombstone effect. It is important to have a co-planarity check on the volume to know whether the ratio between the pad 1 and pad 2 volumes are the same, so that they have the same pulling force. Because if there is a volume imbalance, there will most likely be a tombstoning effect.

Peallat: That is the same for the BGA. For example, when you have a 256-pad BGA, it is important to compare the volume in between the pads because if will have less volume just on one pad, it may create a void. It is very difficult to find out afterwards. You have to use X-ray, which is a very expensive technology.

If you are able to take that approach at the printing process, then you reduce the cost of repair or rework. With a big field of view, you see the whole BGA at the same time. All other SPIs are cropping the image around the unique pad and you never have the whole picture. That is the key advantage of our SPI.

Chong: Earlier, we were talking about the large field of view that we have, the more region of interest that we can locate for this referencing. If the pad field of view is smaller, it can only calculate a smaller region. If there is some difference or some disturbance in the surroundings, you may have a miscalculation.

Las Marias: *What do you think are the factors to consider when selecting an SPI solution?*

Peallat: From a measurement point of view, I will say volume measurement accuracy. If you are placing very small components, it's really the measurement of the volume. I will say the

trend in SPI is to verify the repeatability of the system. That's key. The next step is the accuracy of the system.

You can be very repeatable, and be out by 10–20% of the volume. A 10% variation on the small pad is huge. Repeatability is the foundation, but the accuracy is key for the future.

Las Marias: *Do you think we have already approached the limit as to how the tolerances can be smaller?*

Peallat: We always say that we are almost close to the minimum that we can do. What is amazing with this industry is that they always find a smaller component. Today, we are just placing 01005, but they are already looking at the next generation. I would say we are closer and closer to the limit. We will see smaller and smaller components still to come.

Las Marias: *Apart from having a larger field of view, what other innovations do you think will help your customers address their SPI issues?*

Peallat: Right, larger field of view is one. The way we set up tolerance is key as well with our area aperture ratio, which is important because you are able to select your tolerances versus the size of the pad and also the transfer efficiency. That's key. It's not the hardware or technical innovation, it's more the way we manage the process. For me, that's the second key innovation.

Chong: For us, it's how we make use of the AAR, actually doing the running of the production we collect all the measurements of everything that passed. From there, we have a historical measurement from which we can tune the upper and lower limit of the tolerance from the production batch. Then, we can optimize the printer process accordingly.

Las Marias: *What can you say about the future for SPI?*

Peallat: I would say the future for SPI is not the future for inspection. SPI is the part of the global inspection of the line. The trend, for me, is

more about using the SPI with the AOI and getting the value of the overall inspection process.

At Vi Technology, we are developing solutions that bundle both inspections. SPI is not just a step in the process, but also a step in the inspection of the board itself. We are developing software solutions that will help our customers by getting more information about the boards, not only about the SPI.

Chong: At the moment, SPI can do close loop. It will be able to work with multiple machines and share this information in a bigger database. We are working with our AOI to have a complete database so that we know the quality after printing, and how we manage the data to enhance the process in the SMT line. In the future, our database will work with other AOI equipment or coalesce all this information to provide a factory a more value-added solution. Right now, everyone is talking about the smart factory solution; we also envision being a part of that smart factory solution.

Las Marias: *SPI integrated with AOI. Wouldn't that be a bit overlapping?*

Peallat: Not at all; it's just two different steps that are complementary inspections. There are defects or trends that you see on the SPI which, combined with the information from the AOI, provides you a better view. If you close this loop, then you learn more about your process. This learning curve helps you to narrow your inspection criteria upfront and also at the last stages of the assembly. By learning all of this, you optimize your workforce around the line and your process, and you minimize your cost.

Las Marias: *Great. Thank you very much for your time.*

Peallat: Thank you. SMT