'True' Heights Measurement in Solder Paste Inspection (SPI)

CyberOptics White Paper – Oct. 11, 2013

Importance of True Heights Measurement

SPI equipment is routinely used in Printed Circuit Board (PCB) manufacturing to monitor and control one of the most crucial steps affecting the finished quality of circuit board. Solder paste deposition is the key process in board assembly operations using SMT techniques. Our LSM™ system was the industry's first popular method of manually inspecting solder paste; our SE systems revolutionized SMT production by offering an automated method for performing in-process 3D inspection on the assembly line. SPI systems measure the height and volume of the solder pads before the components are applied and the solder melted, and when used properly, can reduce the incidence of solder-related defects to statistically insignificant amounts. Critical to the SPI measurement is the accuracy of the height measurement because that has a direct correlation with solder volume and defects. Huang et al. (1) illustrate the importance of accurate height measurement in SPI, and conclude that accurate solder height inspection helps not only the finished quality of the product, but also reduces the inspection time required thereby positively impacting productivity and therefore the manufacturing cost.

Possible causes of Incorrect Heights

Solder paste printing is a complicated process and many factors can contribute to the true height being different than target. Primary factors include composition and rheology of the paste, stencil used and the type of squeegee and process conditions used to lay the paste down. Tarr (2) describes in detail the constituents of solder paste and several articles have been published about the importance of solder paste rheology with a good review provided by Marin and Simion-Zanescu (3). Shea (4) provides a good review of the stencil printing process, and impact of squeegee and process conditions. Pan et al. (5) demonstrate statistical importance of the stencil height and aperture size in the printing process. The authors describe the importance of 'area ratio' which is the ratio of aperture opening to the area of the sidewall of the aperture. Thicker stencil doesn't necessarily mean thicker solder print and this area ratio plays significant role. Given the complicated process involved in printing, it isn't surprising that the actual or true height of the print can be different than the conventional wisdom of print height being equal to stencil thickness or target height. In addition to these factors, with small dimensions, the actual solder print doesn't have perfect square edges, and that makes it tricky to measure height precisely. Algorithms that just do plain averaging will tend to underestimate the true height measurement.

CyberOptics SE600 True Heights vs. Competition

CyberOptics recently launched the flagship SPI system SE600. SE600 has many key features and advantages that directly benefit customers to deliver higher performance at lower total cost of ownership. Deploying years of technology leadership in sensors, SE600 sets a new bar for height accuracy measurements. Fig. 1 shows how SE600 height measurements compare with NIST certified standard, and comparison of a competitive product offering in the market. The SE600 measurement is within 2% of the NIST certified standard, whereas the competitive product is about 20% lower. For demanding applications where the specifications are stringent, competitive product is likely to have significant issues, whereas SE600 will perform very well.

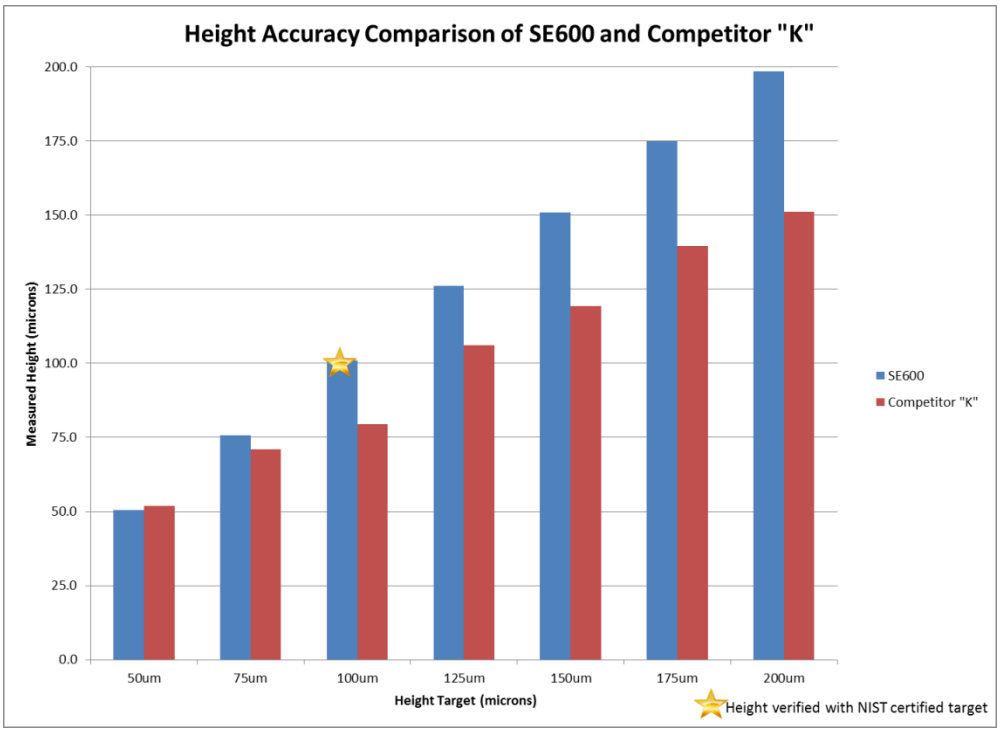

Fig. 1. Comparison of SE600 True Heights with Competitor 'K'.

The SE600 height image acquisition system is designed to accurately reflect actual solder paste shape (i.e. no filtering of the image is required to maintain performance). The height measurement algorithm is designed to accurately reflect the top of paste without being sensitive to the shape of the paste deposit. The sensor is designed without requiring any moving parts which wear with movement causing calibration drift, thus SE600 doesn't need field calibration. Field calibration can be a cause for introducing errors due to operator error and the accuracy of the sensor is in question between the calibration cycles. It is this robust design of the SE600 sensor that enables precision accuracy and therefore 'true' heights measurement.

Fig. 2 shows how SE600 sensor data compares with NIST certified height standard, and it shows very good performance, ensuring that the SE600 truly measures 'true' heights.

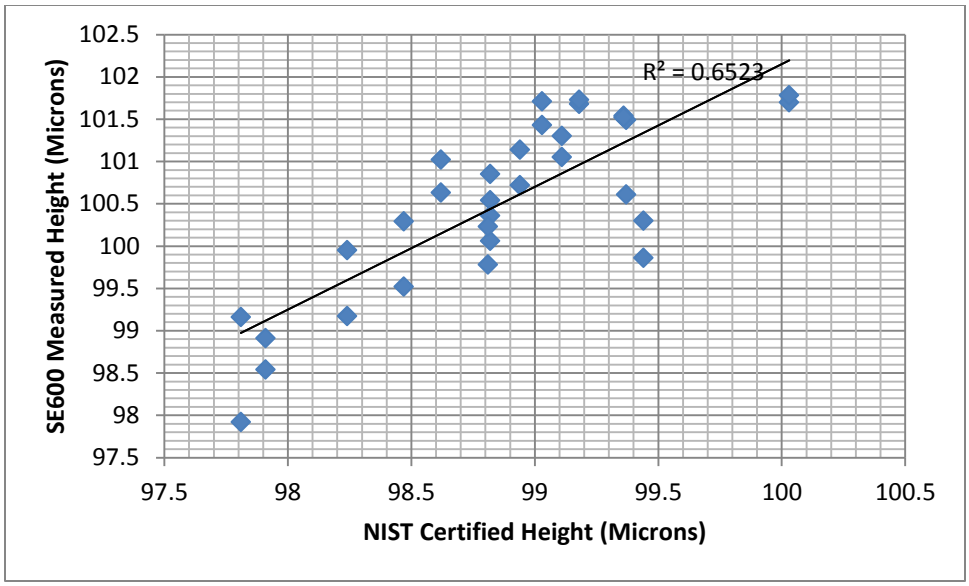

Fig. 2. Comparison of SE600 True Heights with NIST certified target.

Conclusions

It is critical to have accurate height measurements in SPI. In fact, the importance of height measurement will increase with the continuous miniaturization and density of electronic components. The SE600 sets a new bar in accuracy, is dead-on accurate with NIST certified standard, and is significantly better than competition.

References

1. Huang, CY, Lin CT, Tsai HL, Proceedings of the Firth Asia Pacific Industrial Engineering and Management Systems Conference, 10.8.1-10.8.8,2004

2. Tarr, Martin, 'Solder paste basics', *Online postgraduate courses for the electronics industry*. University of Bolton, 2010

3. Marin, A. and Simion-Zanescu, D., Hidraulica, 1-2 (17), 2005

4. Shea, Chrys, Troubleshooting the Stencil Printing Process, http://www.smta.org/chapters/files/Houston_Troubleshooting_The_Stencil_Printing_Process_-_Chrys_Shea.pdf

5. Pan, J., Tonkay, G., Storer, R., Sallade, R. and Leandri, D., IEEE Transactions on Electronics Packaging Manufacturing, 27-2, April 2004