

# **PCB Manufacturing and Rework Quality Assurance Testing**

## ***New Price, Performance and Value Criteria for X-Ray Inspection Systems***

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### **Benefits of X-Ray Inspection - Background**

PCB x-ray inspection has graduated from mere acceptance to absolute requirement by many electronics OEMs today. This situation has come about for some very good reasons: First, lack of alternative test access by other quality inspection methodologies; second, X-ray inspection can be used to improve process performance and board quality while reducing scrap and the expense of warranty returns thereby providing cost reductions throughout the entire product lifecycle; and third, every aspect of a delivered product — cost, functionality and customer satisfaction levels — affect future business and bottom line revenue. Because of these benefits, having x-ray inspection has become a competitive advantage, to the extent that more and more OEMs are favoring or even requiring CM and circuit board rework/repair shops to have in-house x-ray inspection capabilities.

There are several points to be aware of when exploring new price, performance and value criteria for x-ray inspection systems:

### **X-Ray Basic Facts**

It is generally known that manual x-ray inspection is ideal for high-mix, low-volume manufacturing environments — yet not so commonly understood is that almost any x-ray inspection system can recognize more than 90 percent of all typical manufacturing and rework errors such as bridging, missing parts, voids, insufficient/excess solder and linear misalignments — whether the inspection systems cost \$50,000 or \$500,000. Therefore, price does not necessarily offer any true benefits in this area.

### **The Physics of X-rays Remain the Same**

Over the past decade, practically nothing in the way of x-ray technology advancements has occurred which hasn't increased system costs and/or complexity while providing truly nominal benefits to the end user.

An example of this would be “the myth of nanofocus,” simple physics dictates that if you want to penetrate a dense package or board, you have to drive the tube with more current — consequently, no more nanofocus. Technically speaking, the nanofocus spot size grows to microfocus size as the power to penetrate materials of relative density and/or thickness is increased. In addition, essentially all systems are nearly equal in resolution below 40X magnification regardless of spot size. This is due to the unsharpness effect of x-rays when distributed across a broader image detection area relative to source-to-object distance, and object-to-detector distance.

### **Some Features May Not Be Benefits**

Many x-ray inspection system/software embellishments have come to pass as result of selling features against the competition instead of selling solutions that fit a customer's needs.

One example of this is three-dimensional visualization (rendering) software. Some can take up to eight minutes or more to render a 3-D graphic of an x-ray view. A great marketing tool, but impractical — ask anyone who has used or owns this capability just how often they use it during an actual inspection.

Fully-loaded systems with advanced features such as complex programmable motion mechanics and automated software-driven analysis algorithms are another unnecessary extra. Aside from requiring a significant investment in time and internal resources to develop and manage test applications, they are excellent tools, but what is really necessary, practical and efficient when it comes to manufacturing or rework quality verification?

### **What is Necessary?**

Perhaps the most important and principal qualifying question with respect to any test system or test application is board handling and “does it fit?” There are many definitions of this, but fundamentally, board size and angular manipulation are of key importance.

Board handling with respect to size can be broken down into two parts: First, machine loadable board size and second, inspectable board test area. Loadable size is fairly self-explanatory — does the board fit into a sample holder within the machine. Whereas, “inspectable board test area” refers to what percentage of the board can be viewed/tested without rotating the sample. This is often missing from or misleading in many system specifications, but it is a notable criteria and will ultimately affect the speed of performing a full inspection, if the board must be rotated and reloaded to complete testing.

Angular board manipulation refers to the ability of a sample holder to position the inspection object to present oblique (off axis) viewing to reveal electrical solder connection shape, size and position with respect to pads on the component site. A rotation angle from 0 to 30 degrees is ideal for this application. Manual or mechanical board manipulation will influence cost of the machine but makes little difference in the effectiveness of the inspection.

Software: For all x-ray systems, image processing software has a direct impact on speed, accuracy and repeatable analysis results. Typical software packages include basic image quality enhancement tools such as: image averaging and visual improvement filters. By way of this collective "image processing," visual detail is improved, thereby making it easier for an operator to quickly identify specific gross and subtle anomalies. Additionally, other software tools such as data collection, measurement and analysis reporting tools, provide interactive diagnostics that further isolate, quantify and document faults for corrective action. It should be noted that most users only use the minimal tools needed to get the job done, and as mentioned previously, some features are not essentially useful or considered necessary.

#### **How are Most Systems Being Used Today?**

More than 20 years of x-ray inspection experience working with a variety of x-ray inspection technologies has repeatedly illustrated that commonly what the end-user needs and will use are the minimal tools necessary to get the job done quickly, easily and efficiently for fast assessment of the process, the assembly or rework verification.

Furthermore, when asked, most end-users reply that they utilize their inspection systems on average only about eight hours per work week to perform process verification and random quality sampling spot checks. For lack of a better analogy, many systems are being used like a microwave oven. In short, pop in a board, fly it around under live x-rays using a large field-of-view to examine as much of the board as possible at one time. Yes, even many of the fully automated systems with all the bells and whistles are being used this way — which brings us to the "value" proposition.

#### **Ensuring Value**

Capital equipment buyers and specifiers alike have become educated, frugal shoppers. This is not as much a philosophical shift as it is a bottom-line driven requirement to remain competitively and economically efficient. In short, buy what you need and what you will actually use for the right price. The system should be operationally simplistic to facilitate ease-of-use and low-cost ownership, while comfortably but not excessively satisfying application performance requirements.

This situation has caused some x-ray inspection equipment manufacturers (like FocalSpot, Inc.) to rethink system design and to focus on providing systems that are designed for application usefulness without loading down the system with extras that provide little value to the end user.

#### **About FocalSpot, Inc.**

FocalSpot, Inc. is a premier provider of SMT Inspection and Rework equipment for the electronics manufacturing industry. FocalSpot designs and markets affordable x-ray inspection systems worldwide and exclusively distributes DEN-ON advanced lead-free rework solutions in North and South America, Canada and Mexico.

Why FocalSpot, Inc. and why now? FocalSpot, Inc. is a relatively new company formed in 2003 by industry veterans whose origins and experience come from such industry leaders as Hewlett-Packard, GenRad, Teradyne, Nicolet Imaging Systems (NIS) and Sierra Research & Technology (SRT). FocalSpot, Inc. has evolved to meet the demands of a recovering electronics marketplace, offering a new generation of affordable, high-value inspection and rework products and full-service solutions.

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