PCB Testing Goes Socketless

by Matt Parker and Jeff Smith, QA Technology

As technology advances, more and more electronic components that do bigger and better things are hitting the market. At the same time, the size of the PCB is shrinking. While circuit board designers could resolve the issue by building multiple boards into products to accommodate the additional components, they instead are opting to squeeze them onto a single PCB.

To fit more components in a smaller area, designers have no choice but to decrease the size and spacing of test targets commonly used in bed-of-nails fixtures. These test targets, namely, component leads, test pads, and via holes, allow electrical access to the UUT. The challenge is to hit these smaller targets and still achieve accurate test results. To accomplish this, it is only logical that test probes also need to be smaller.

As test targets shrink, the benefits of socketless probing technology grow.

While other types of ATE, including flying probers, X-ray, built-in self-test (BIST), boundary scan software, and optical inspection, combine to enhance the testing of high-density PCBs, the bed-of-nails fixture continues to offer the best combination of speed and test coverage in a high-volume manufacturing environment. But, as with any technology, there's always room for improvement.

Since the beginning of automated PCB testing, designers have pushed fixture and probe manufacturing companies to build a better bed-of-nails fixture. However, any new product innovations must be balanced with design for test (DFT) guidelines that have evolved over time to keep pace with the latest advances in PCB and fixture manufacturing. The challenge is getting everyone in the design, manufacturing, and test departments to coordinate their efforts and agree upon the guidelines.

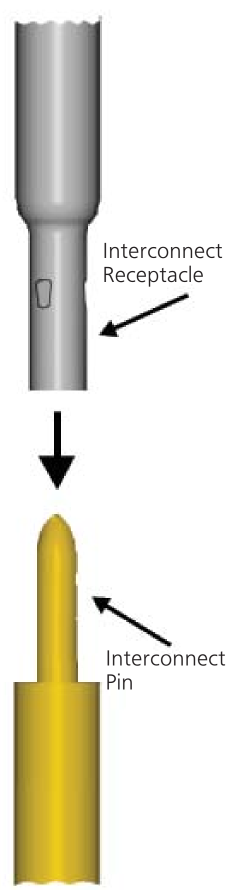

Figure 1. Socketless Probe

The Smaller the Probe, the Higher the Price

Spring probes conventionally used in bed-of-nails test fixtures are held in place by a socket, which is permanently mounted in the fixture probe plate and wired to the test system. For decades, the conventional probe has produced reliable results when used on 0.100″ centers.

But as the size of circuit boards continues to shrink, the demand grows for smaller probes to use on 0.075″, 0.050″, and even 0.039″ centers. Smaller-diameter probes, however, are not only costly to manufacture, they also are less robust, easier to damage, harder to maintain, and tend to need replacing more often than larger probes, all of which drive up test costs. Smaller probes also offer fewer tip-style and spring-force options.

A Socketless Solution

While the concept of socketless probing isn't new, the technology wasn't widely used throughout the industry until smaller test targets started calling for the use of smaller, more delicate test probes. Now, socketless technology is widely recognized for its capability to use larger, longer-lasting probes on high-density PCBs. This is made possible by joining two parts: a probe and a termination pin.

In the example shown in **Figure 1**, the interconnect pin at the top of the

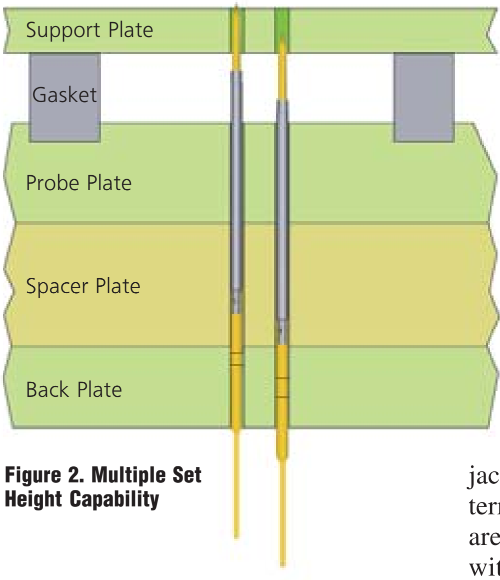

Figure 2. Multiple Set Height Capability

termination fits securely into the modified interconnect receptacle at the bottom of the probe tube. Because the termination pin is mounted directly beneath the socketless probe, it stays within the diameter of the probe tube while still providing a reliable electrical connection to the test fixture and performing all the functions of a stand-ard socket.

A Bevy of Benefits

Compared with conventional probes, the benefits of using socketless probe technology in bed-of-nails test fixtures are many:

- Higher probe-pointing accuracy due to the elimination of the single-press ring socket.
- A lower per-point cost, currently less than that of a conventional probe, for 0.075″, 0.050″, and 0.039″ centers.
- The use of larger, more robust probes less prone to damage in a production environment, resulting in fewer maintenance issues.
- More tip styles and spring-force options with the use of larger probes on closer centers.
- Long-stroke socketless probes for dual-level testing on 50-mil centers.

All these benefits combine to increase productivity and lower the overall cost of testing high-density circuit boards with closely spaced test points.

Built to be Compatible

Socketless probes also score high in compatibility since they now can be used in every standard, in-circuit, and functional test fixture. This includes fixtures for GenRad, Agilent Technologies, and Teradyne test systems, whether pneumatic, mechanical, or vacuum type.

Wiring methods for socketless fixtures offer just as many options as conventional ones, including wire-wrap posts, wire jacks, and precrimped and wireless terminations. The probes, which now are readily available, also work well with the wide range of test targets found on PCBs because they can be set at various heights (**Figure 2**).

Just as conventional sockets can be set lower for probes that test component leads, so can the termination pins in a socketless fixture. By lowering these pins, attached probes test the leads and still achieve the recommended travel distance, which is approximately two-thirds of their maximum stroke potential.

To successfully probe a 0.050″ connector lead, for example, termination pins must be set 0.050″ lower than probes designed to hit test pads or vias. The capability to adjust heights for various test targets helps guarantee proper probe travel for each point in the fixture.

Designed for Flexibility

Compared to smaller conventional probes used in high-density PCB testing, socketless probes offer more choices for probing test targets. Due to their larger size, socketless probes accommodate a wider range of tip styles in copper-beryllium and hardened steel as well as higher spring forces.

When the choice is made to use socketless technology, test fixtures generally are designed to house only socketless probes. However, if there is a high ratio of larger to smaller center probes, it may be more cost-effective to mix conventional and socketless probes. In some cases, small areas of larger socketless probes may be added to a conventional fixture to replace areas of smaller probes like those typically found under ball grid arrays, high-density connectors, and other closely centered test points (**Figure 3**).

Regardless of their position on the fixture plate, whenever conventional probes and sockets and socketless probes are mix-mounted, vacuum leaks may result between the two systems. To prevent such leaks, simple gaskets and similar sealing methods can be incorporated into the design (**Figure 4**).

Maintenance Made Easy

Easy maintenance and repair are important factors when considering the use of any technology. However, these aren't considerations when comparing conventional and socketless technologies since replacing dull, worn out probes is just as easy in both types of fixtures.

In the socketless design, probes sit atop termination pins that are permanently mounted and wired into

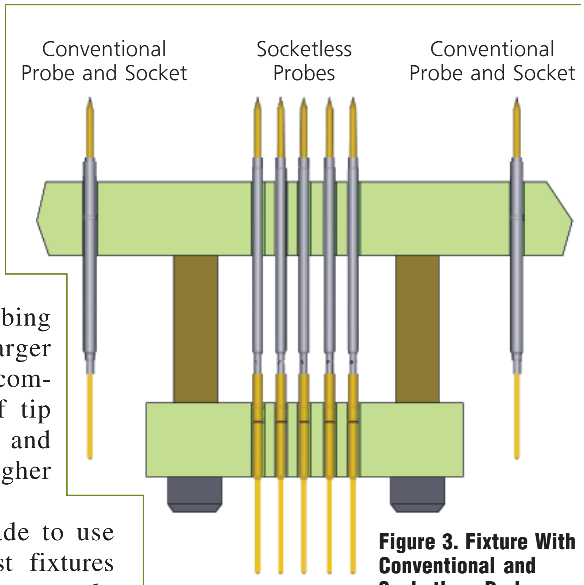

Figure 3. Fixture With Conventional and Socketless Probes

a fixture, making the probes especially easy to replace. These pins are designed to withstand a high number of probe replacements while still maintaining a reliable electrical path. However, when damaged, they can be removed and replaced, using special termination insertion and extraction tools, just as easily as conventional sockets.

Probing Ahead

Today, conventional probes and sockets are the most commonly used products in bed-of-nails test fixtures. But as more components crowd onto smaller PCBs, test targets continue to shrink, and center-to-center spacing decreases, the need to use smaller-diameter probes will keep driving up the cost of test.

Hence, socketless probing—through its use of larger probes on smaller centers—will become an increasingly popular alternative. Today, a growing number of fixture houses and PCB manufacturing companies use socketless probe technology and recommend socketless design solutions wherever appropriate. Plus, with more improvements on the way, there is little doubt that socketless probing will continue to universally benefit PCB designers, fixture houses, and end users alike.

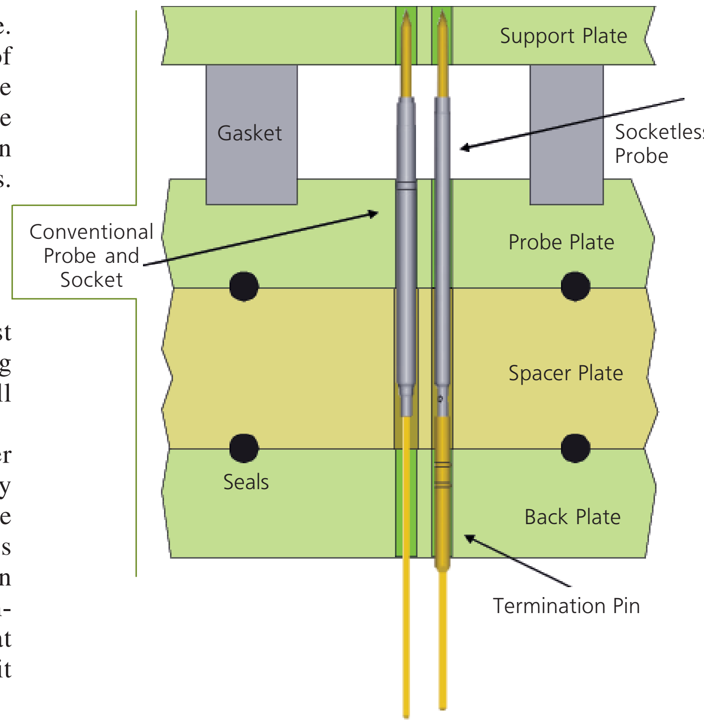

Figure 4. Typical Vacuum Fixture Sealing Techniques

About the Authors

Matt Parker has been with QA Technology for seven years, the first four as an applications engineer and now as product engineer. He is a graduate of the University of New Hampshire with a B.S. in engineering and received a patent for the X Probe socketless technology. 603-601-0182, e-mail: mparker@qatech.com

Jeff Smith joined QA Technology as the eastern regional sales manager in 2002. He has 18 years experience working in the ATE test fixture industry as fixture kit division manager at Test Point 1, fixturing manager at Automated Test Engineering, sales manager with Quality One Test Fixturing, and as vice president of WirePro Fixture Products-East. Mr. Smith was awarded a patent related to improving double-sided PCB test-fixture technology. 603-601-0166, e-mail: jsmith@qatech.com

QA Technology, 110 Towle Farm Rd., Hampton, NH 03842

EE