Zoom Fixtures for ATE

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Abstract
This paper details a break-through technology for automatic test equipment (ATE) fixtures. These new fixtures address the current market needs of - "faster, cheaper, and smaller". The new fixture design decreases typical fixture turn times to between 2 and 4 days on average. Fixture prices are also significantly reduced by approximately 50% to 60%. And, the technology also provides improved pointing accuracy, for testing targets down to 0.015" diameter targets on a 0.5 mm pitch. This paper will detail how these advances were achieved and discuss the technology in detail.

Introduction
For more than 30 years, the spring test probe has been utilized as the primary means for making electrical contact with boards under test. It is likely that hundreds of millions of these gold plated assemblies have been used in In-circuit and functional testing over the years. The Pogo, as it was first named has been a useful tool, but new technology boards with ultra fine pitch and small test targets are testing and exceeding the physical limitations of this technology.

When first introduced, the probes were designed to be used on a minimum pitch of 0.100" . Over the years these probes have been miniaturized, using the same design methodology, to also include 0.075" and 0.050" center probes. Examples of these products are shown in Figure 1.

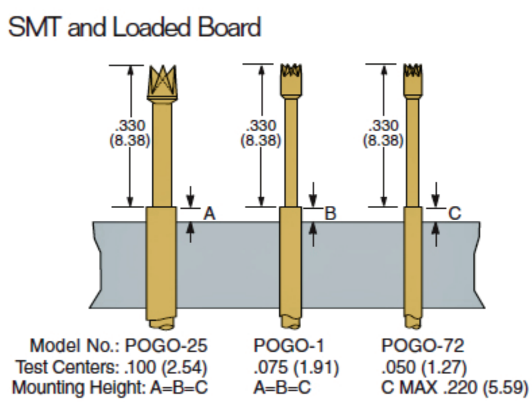


Figure 1 – Standard Spring Test Probes (Ref. 1)

By simply shrinking the existing designs, some critical parameters were degraded. The primary ones being available spring force (due to limited spring volume) and probe life. The smaller probes are also more delicate and are easily damaged and much harder to replace. And worst of all, these miniature probes are now even too large to meet the requirements of most test applications.

To alleviate the pitch problem, designs were modified slightly to allow use of these same probes on a finer pitch. This feature was achieved by eliminating the traditional receptacle, or outer barrel used to retain and seal the probe in place. Two such approaches are shown in figure 2 below. This enhancement allowed the test center spacing limit to be lowered from 0.050" to 1mm (0.0395") .

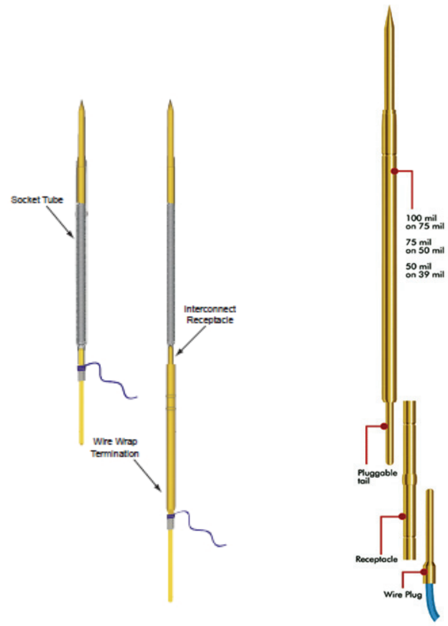
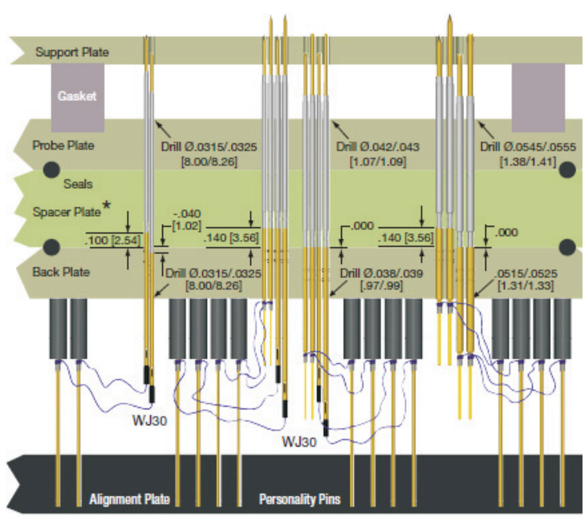


Figure 2 – Receptacle-less probes for 1mm pitch (Ref. 2 & 3)

These new probes are working for ATE test, and allow accessing on finer pitch but are extremely expensive, require expensive kit hardware, and are time consuming to wire. It also appears the lower limit has been reached for this design methodology. Primarily due to the limited spring force available and subsequent target penetration, it is doubtful smaller versions will still provide a robust and repeatable electrical contact.

End users have expressed major concerns with these new probe technologies and the trend to simply miniaturize rather than look towards the future. Leadership teams recognize that even smaller targets and pitches will need to be accessed in the very near future.

The cost of the hardware and the labor for wiring these test fixtures has risen to undesirable, and in some cases unacceptable levels. The fixture cross section in Figure 3 below shows a typical ATE test fixture and associated hardware.



Tester Interface
Figure 3 – Typical ATE fixture cross section (Ref. 4)

Note the additional plates and hardware required to support this technology. What is missing from the illustration is a depiction of the sheer mass of wires used in a typical test fixture and the wire density. The wires are especially dense in the small area under the UUT. And so it is extremely time consuming and tedious to make these wire wrapped, and wire plug connections. Once fully wired, ECOs and ECNs are very difficult to perform.

The pictures in Figures 4 and 5 show some common fixture applications used in manufacturing test, and reveal the common situation. From these figures it can be seen how cost, delivery time, and access are negatively impacted by the density and wire mass.

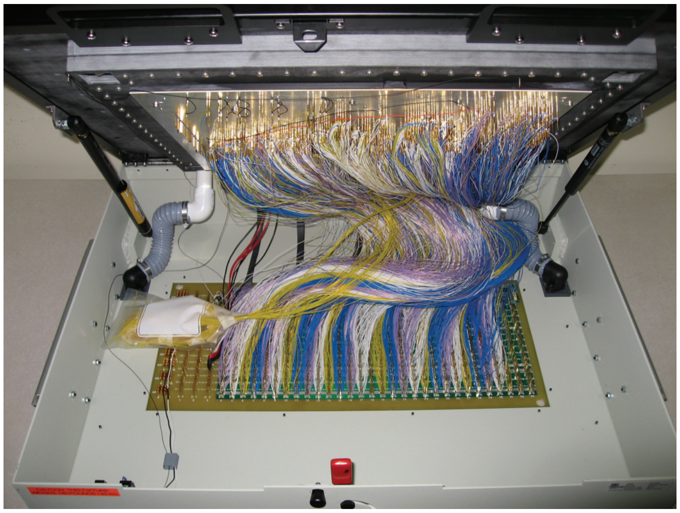


Figure 4 – Gen Rad Test fixture

Figure 5 – Dense wire wrap (Ref. 5)

Discussion of the New Methodology

The recent introduction of new ATE testers which feature universal test point electronics has allowed some exciting new opportunities for test fixture solutions. Without the limitations created by the multiplexed electronics in ATE testers, test points on the unit under test (UUT) can be assigned to the closest tester electronics. When the x-y locations become a part of the test fixture and test program process, the shortest possible connection between the tester electronics and the test target can be achieved. Many opportunities for improvements arise because of this new flexibility in tester electronics, even the potential for eliminating wires from the fixture. And in the case of ATE test, a completely new fixturing approach can be utilized.

Figure 6 depicts the cross section of this new fixture technology called Zoom (patent pending) . There are a few key elements to note; first the fixture does not contain any spring test probes for making contact with the UUT. Rather there are pins that tilt to make contact with the UUT and the tester electronics. The spring force is supplied by the probes in the tester interface, or an adapter that sits on the tester interface. Now, higher spring forces can be utilized on a very fine pitch eliminating the problems discussed above with miniature probes.

The tilt pin fixture approach, while new to ATE, has been utilized on bare board test fixtures for many years, and so it is a proven technology for making electrical contact. The simplicity of the fixture design is apparent when comparing Figure 3 to Figure 6. The complexity involved in determining the geometry of the pins, and location of the plate holes is addressed with custom software. But the savings achieved with this fixture approach can be clearly seen by the elimination of many expensive hardware items.

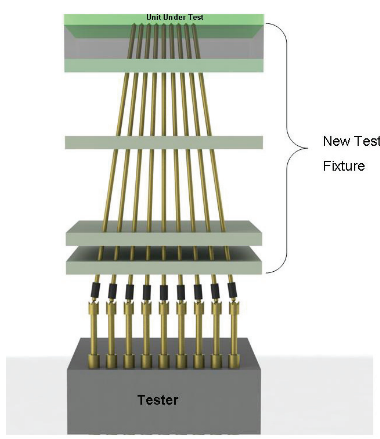


Figure 6 – Zoom Fixture cross section (patent pending)

The most expensive pieces of hardware eliminated with this design are the spring probes in the fixture. And, as noted earlier, the only spring probes are in the interface. The probes are all 8 or 10 ounce, standard 100 mil center probes. These probes will supply adequate spring force for making reliable electrical contact and they have long probe life, unlike the fragile probes used for 50 mil pitch and 1mm pitch today. Also, all probes are the same head style and spring force, so there is no reason to maintain a huge spring probe inventory, supporting various center spacing's, head styles, and spring forces. The fixture tilt pins are inexpensive and are also reusable.

The tilt pins are smaller in diameter than a probe assembly, and so they can test on a finer pitch. Instead of the current 1mm limitation, the tilt pins have proven to be reliable down to 0.5 mm (0.020") center test targets. The accuracy of the straight pin is also superior to their spring probe counter parts. Unlike the spring probe assemblies that must have internal clearances to prevent binding, while still maintaining an electrical connection, the straight pin is maintained in position by precisely drilled holes. As such, the Zoom tilt pin fixture can reliably contact test targets as small as 0.015" diameter.

In addition to the accuracy and fine pitch capability improvement, cost is also reduced dramatically. The cost reduction is achieved through the use of lower cost hardware, fewer materials, and much lower labor content. In most cases there is little or no wiring of the Zoom fixture. Wired points are only necessary when two (2) or more tester resources must be connected to a single test point, such as in a 4 wire measurement. An example showing how multiple resources are added to a single test pin is shown in Figure 7.

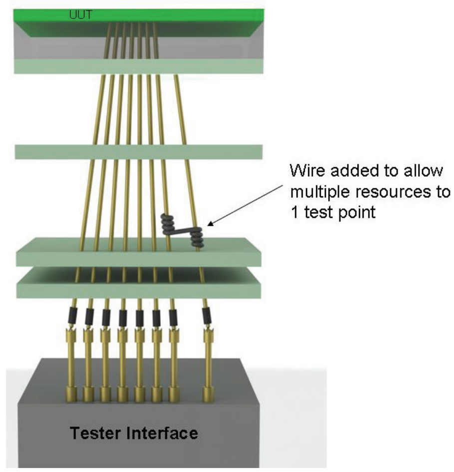


Figure 7 – multiple resources added to a single test pin (patent pending)

Lastly, due to the large reductions in manufacturing time, assembly time, and wiring time, the delivery cycle is dramatically reduced. In so doing, fixtures that used to take 2 to 3 weeks to build, can now take 2 to 4 days. This fixture solution is especially ideal for analog only testing where quick turns and low cost are required.

The effective "wire lengths" now become the length of the pin, about 3". And all off the issues with crossing wires like cross talk are eliminated. All electrical connections are the same length, as noted about 3" rather than the feet of wire that may be used in a standard ATE fixture. So there is now uniformity in the length of the signal path.

What once seemed to be a dense mass of wires now looks like numerous small jumper wires. Custom software quickly determines the appropriate connections, and the manufacturing of the plate stack. The software also addresses contact angle issues and tilts the pins appropriately so as to avoid any side load issues that could be created by the pins.

To highlight the extreme difference in the technologies, the fixture shown in Figure 4 was redesigned to utilize the Zoom technology. A top down view of the results of the Zoom connections are depicted in Figure 8 below. It can be seen that the tilted pins do not travel very far in the "x" or "y" direction to connect to their intended resource. From this plan view the connections appear to be an uncluttered series of short jumpers.

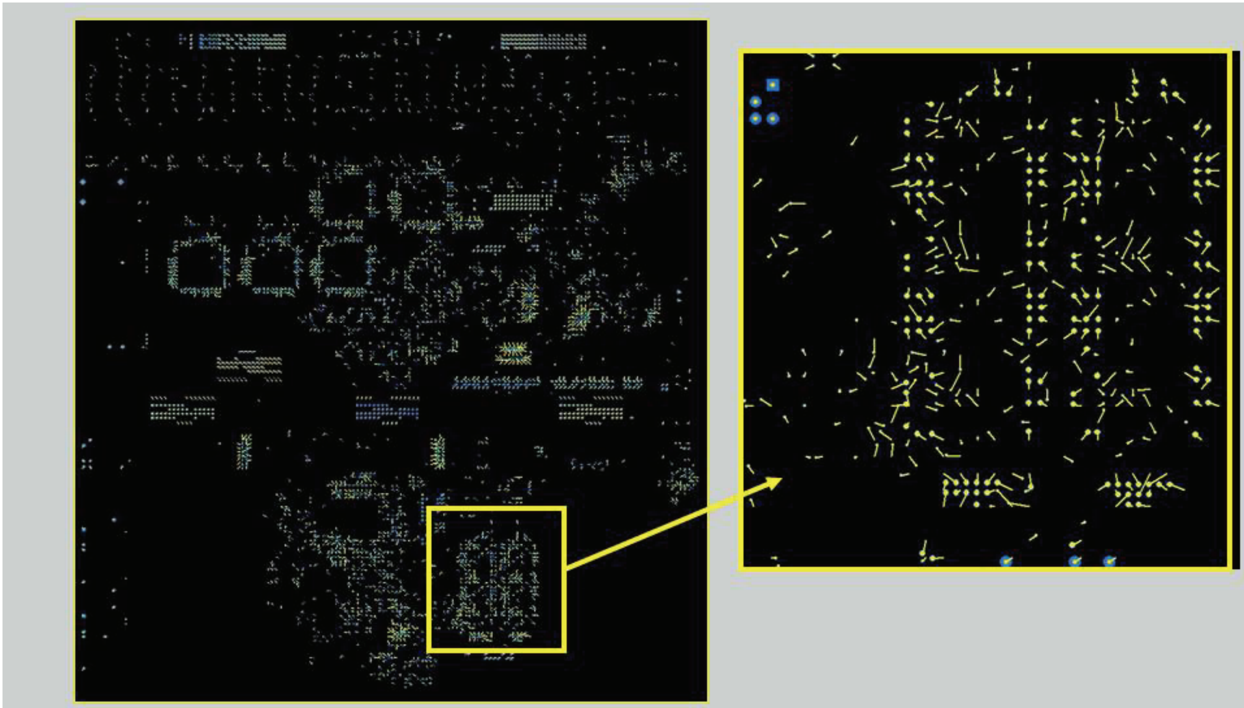


Figure 8 – Top view of pin tilting

Data & Results

The Zoom fixture technology is only applicable on testers that have universal test point electronics, sometimes referred to as un-multiplexed. They are the best choice when quick deliver, close center spacing and low costs are essential. Table 1 below can be used as a reference and as a comparison of key parameters of the two (2) fixture technologies.

Table 1 – Comparison of key parameters

Measure	**Standard Fixture Technology**	**Zoom Fixture Technology**
Smallest center spacing	1mm (.0395") pitch	0.5mm (.020") pitch
Smallest Test target	.024" target	.015" target
Delivery time	2 to 3 weeks	2 to 4 days
Fixture Cost	Average \$8 to \$10 per point	Average \$2 to \$3 per point
Tester type	Any tester	Only Un-multiplexed testers*

Conclusions & Summary

The Zoom technology offers a migration path for ATE testing of printed circuit board assemblies in the future. By allowing the accessing of smaller targets, on finer pitches using a less expensive fixture solution, this test strategy remains a long range solution for testing current and future assemblies. These fixtures address and meet the market demands for "faster, cheaper, and smaller". And, they also allow the current test strategies of ATE to remain a viable test tool for the foreseeable future.

The main hurdle for many users will be transitioning to the necessary tester hardware that allows this solution to be utilized. But the cost reductions allowed by this new fixture technology will help reduce overall test cost significantly, and so the investment in the necessary capital equipment will be offset by a quick return on the investment.

* - by building the adapter into the zoom fixture itself, any tester can be utilized

References and Figures

1. –Everett Charles Technologies, Pogo Contacts Catalog, Page 7
   http://www.ectinfo.com/file/Docs/ECT%20Contact%20Products%20Catalog8.pdf
2. – QA Technology Company, Inc., QA Catalog 2009, Page 105
3. – IDI, Focal Probes, http://www.idinet.com/Technical/focalProbe.aspx
4. – QA Technology Company, Inc., QA Catalog 2009, Page 107
5. – QA Technology Company, Inc., QA Catalog 2009, Page 101