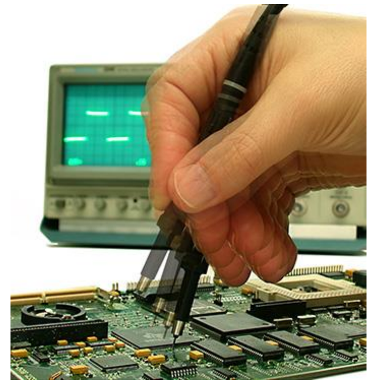
Automating Test Measurements of High Density Printed Circuit Boards

By Curtis Smith; Technical Support and Training Supervisor at Huntron, Inc.

The Challenge of Manual Probing



One of the primary challenges with making test measurements on high density, surface mount printed circuit boards (PCB) is accurately placing the test probe exactly where it is needed. With the size and pin spacing involved with current surface mounted components, probing these by hand can be an exercise in futility as you try place the test probe on the correct pin or pad without accidently short circuiting to the adjacent pin and causing more problems.

A Common Scenario

A good example of a common testing task is to take a simple voltage measurement on a live circuit board using an oscilloscope. In most cases this would be a relatively easy task. You set the oscilloscope to the desired voltage and time settings, place the probe on the circuit board and look at the waveform on the oscilloscope display. But what if you need take a simple voltage measurement at 50 points on the same circuit board? This task could be accomplished manually but if are allowing yourself one minute to identify the test point (which could be a specific pin on a complex quad flat pack (QFP) integrated circuit) , adjust the oscilloscope settings, place the probe and view the waveform you are now looking at close to one hour of effort. This is also making the assumption that you have identified and correctly placed the probe on what could be very small pads or component pins. If you are dealing with the occasional prototype circuit board, the time spent capturing test measurements may be acceptable. The issue arises when you need to test a volume of circuit boards and in today's test environment, the cost of personnel resources does not allow for expensive engineers to spend a lot of time hand probing circuit boards.

Reducing Labor Cost

When looking at using your engineering talent to manually probe circuit boards you would likely discover that any extended amount of time is cost prohibitive. One approach to reducing the cost would be to use non-engineering personnel to perform these tasks. Provided personnel with the necessary abilities are available, this would certainly reduce the cost of running repetitive test procedures and still provide useful results. However, regardless of the person running the test, the drawbacks of manual probing such as properly placing a handheld probe on small test points and doing it repeatedly can eventually cause mistakes to be made. Once mistakes occur then the test will need to be performed again and the cost savings is now reduced because of the added retest time. Other considerations are training, test documentation and turnover when non-engineering staff are utilized.

Reducing Test Time

In some cases a basic streamlining of the test procedure by reducing the number of points or measurement types can help cut minutes from the test procedure. Taking steps to eliminate mistakes such as probing readily accessible points that are large and easy to find will help reduce test time. Making changes to streamline the test are helpful but in the end, the most significant way to reduce test time is to simply probe the test points faster. Two ways to speed the testing of points on a circuit board is to use a bed-of-nails fixture or an automated flying probe system.

Bed-of-nails Test Fixtures

Bed-of-nails fixtures have the advantage of allowing very fast test scanning since each test point has a test probe or “nail” that interfaces to the circuit board. The fixture is connected through a switching matrix that interfaces to the test instrument. Software controls when each nail is connected and the measurement made.

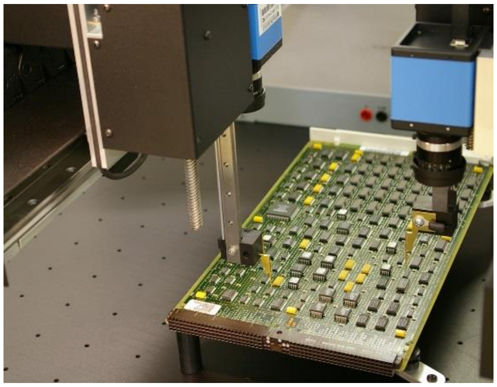
The nature of bed-of-nails test fixtures requires that each PCB type and revision have its own custom fixture so unless there is a significant volume of boards to test, then this method can be an expensive proposition.

Bed of nails fixture (image courtesy of National Instruments)

Automated Flying Probers

Another approach to automate the testing of test points on a circuit board is to use a flying probe system. Flying probe systems utilize a “flying” nail mounted on a test head that is robotically placed on the PCB test point. Flying probers can have one or multiple heads depending on the test needs and the speed required. Flying probe systems are accurate probing devices with a typical lead spacing down to 0.4mm.

Single and dual head flying probers such as those available from Huntron Inc. and Diagnosys Systems Inc. are designed for diagnostic and high precision probing where speed is not the primary test concern. These probers have a more open architecture that makes them better suited to prototype test, PCB troubleshooting and custom configurations. Different types of test instruments and probes can be used for both power on and power off testing. Custom test probes can be mounted on these systems with simple modifications. In some cases, the heads can be modified to encompass test instrumentation that needs to close to the test probe such as high frequency spectrum analysis. Additional support hardware such as power supplies and digital I/O can be easily cabled to the PCB under test to allow for power on testing.

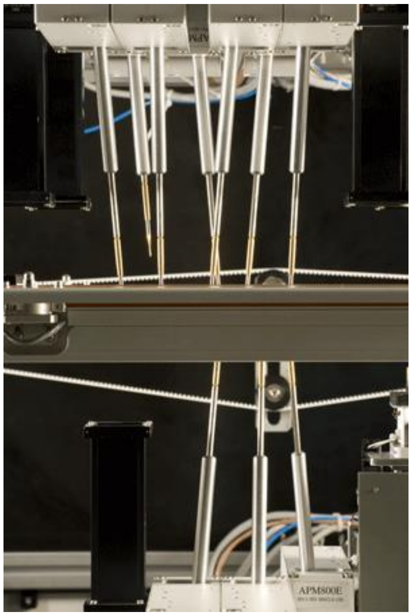


Dual head flying probe system (image courtesy of Huntron)

Single head flying probe system (image courtesy of Diagnosys Systems)

Because of the more deliberate nature of their prober movement, these single and dual head probers do not fit well into a high speed production environment. They are not designed to be used “inline” with the production process but are better suited to screen PCBs that fail production in-circuit tests (ICT).

The cost of single and dual head flying probes is typically less than high speed, multi-head production probers.



Above: High speed production flying prober testing PCB on two sides (image courtesy of Acculogic)

Multiple head flying prober such as those from Acculogic Inc. and SPEA S.p.A. are designed for production level testing where speed and multiple point testing is needed. These systems are fast, complex and usually designed to be used in-line with the PCB production process. Some of these flying probers can have upwards of 20 probes interfacing to both sides of the PCB under test. The type of testing implemented with these systems is typically power off such as impedance measurement. Getting the PCB under test to a powered state will require devoting some of the probes for those functions but will add the benefit of utilizing technologies such as boundary scan.

Of course this speed, precision and technology comes at a cost. The price of these systems start at roughly twice the cost of their single and dual head cousins and require more time for installation, maintenance and test development. But while the cost to first test is high, the final cost is brought down by the high volumes for which these systems are designed. The development time to deal with PCB revisions is also reduced when compared to a bed-of-nails fixture since the modifications are mostly changes at the software level.

Selecting the Right Hardware

When the decision to automate a test process is made, many considerations are taken into account. Testing with a bed-of-nails fixture makes sense when dealing a larger volume of PCBs of the same type and the cost is quickly recouped. The addition of more board types and revisions begins to make this approach less practical and drives the cost upward.

Flying probers begin to make sense when bed-of-nails fixtures become impractical to build or purchase but you still need to avoid the use of manual test methods. At this point the decision depends on factors such as volume, test type (power on, power off or both), instrumentation, environment (design, repair or production), speed and of course, budget.