TERADYNE FLYING PROBER 1004: ERICSSON WIRELESS COMMUNICATION'S APPLICATION AND RESULTS

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A B S T R A C T

We needed to replace a functional/in-circuit test with a more robust solution that would rely totally on in-circuit test. The board has no test pads for a traditional fixtured test therefore component leads had to be used for test points. We evaluated the Teradyne Flying Prober 1004 to determine if it was capable of testing a board with primarily 0402 discrete components and 20-mil pitch ICs. We knew this board was pushing the limits of FP technology. We decided that if it could reliably test a board of this design, then it would be suitable for other scenarios we envision such as prototype runs and low volume production.

INTRODUCTION:

We are currently testing a portable radio board using a so-called Functional/In-circuit test (FICT). It has access to approximately 10% of the board's components using a bed of nails fixture and does a basic functional test on the processors and other higher level Asics. It was written 4-5 years ago and there is no documentation to support it. The test needs to be replaced with something that could be supported and that would aid the technicians in troubleshooting the boards since the current test has no diagnostic capability. We also needed a tool to improve our surface mount process by giving us real-time data.

The purpose of this report is to: 1) show some of the problems we encountered during the machine evaluation, 2) how we implemented our test solution and 3) how much we saved by the improvement in our product quality. Our evaluation plan did have some limitations such as the lack of automated data collection and my lack of experience with in-circuit test.

PURPOSE OF THE FLYING PROBER:

The original problem was the out of date and unsupportable FICT. It had to be replaced but the board was too small to have test nodes and that rule-out conventional ICT. The only option was to go to Flying Prober Technology and use component leads as test points. The flying prober gives us a more thorough test because it has access to most of the nets and reduces troubleshoot time because the failures are described in detail.

IMPLEMENTATION:

The bi-directional SMEMA interface (created for Ericsson) gives us the flexibility of putting the flying prober in-line in a TEE-configuration. This allows us to do 100% testing or test only a board when the FP is available. If it is busy either testing another board being used for program development, then the board goes on through the remainder of the process.

A function that was added for Ericsson was 'Bad Board Sensing'. We purchase 100% tested PWBs from our vendor, but we accept panels that have bad boards in them. This saves us about 10% in board costs. The FP could not automatically skip these boards and each test had to be changed manually. We requested that the bad boards be automatically skipped and Teradyne delivered a solution within 2 weeks. This may be an odd feature, but it shows how responsive Teradyne has been to our requests.

There are many factors in successful and repeatable testing. After many weeks of chasing consistent failures due to poor contact between test probe and test point, we learned:

1. Probe on the solder, not on the metallic lead. The probe cannot penetrate the lead and has a greater tendency to slip off the lead than the softer solder;
2. A poorly controlled SMT process will allow components to float around on SMT pads, causing your targets to 'move';
3. It is preferable to select the probe(s) that will engage the part from the end without having to pass over the part body to get to its lead. For tall parts, the probes are at enough of an angle that they will hit and glance off of the part body and miss the target;
4. The hardness of the flux used in the soldering process will affect probe contact. As the board cools after reflow soldering, the flux gets progressively harder until it causes contact failures. I have determined that after 36 hours the flux we are currently using is too hard to probe through. We are experimenting with a new 'probe-able' flux that remains at the consistency of petroleum jelly (Indium Corp. NC-SMQ 92)
5. Periodic probe cleaning needs to be investigated to reduce the possibility of contaminate build-up on the probe tip and the associated contact failures that may cause.
6. Limit probes to 200,000 hits. After that the probes are dull enough to slide off of the smaller targets and cause contact failures.

THROUGHPUT IMPROVEMENT:

Another concern we have with using the flying prober in-line is throughput. Since the flying prober contacts almost every net on the board, the larger the board, the longer the test. This board has 479 tests on the bottom (71 seconds) and 369 tests on the top (55 seconds). For a panel of six boards, it takes 426 seconds or 7.1 minutes for the bottom side and 330 seconds or 5.5 minutes for the top side test. As you can see, this is a long time for a test compared to the time required building the board. With a board being completed every two minutes, it does not take long before a huge bottleneck is created in front of your tester.

We have several ideas to reduce test time. They are:

1. Test only one of each part number. This will eliminate many tests if you are mainly concerned with checking that the correct part reels were put into the A/I machines;
2. For multiple board panels, test only the number of boards that allows you to keep pace with the rest of the SMA line. For example, if it takes one minute to test a board and the SMA line completes a six-board panel every two minutes, only test two boards of each panel. An audit test.
3. Another alternative is to use FIFO buffers and allow them to fill faster than the tester can test them. This would work best with smaller quantities of boards. For large numbers, the size of the buffers required would be prohibitive.
4. The last idea is to work in concert with the AOI (Automated Optical Inspection) engineers to develop a truly complimentary solution. AOI can detect solder bridges and misplaced components in milliseconds. Why should I spend seconds doing the same tests? The flying prober can check component polarity and value while the AOI cannot. Optimize your test/process control system as a whole, not as separate pieces of the puzzle. Time and equipment are too expensive to be used duplicating efforts. We are pursuing this path now.

DATA:

During the evaluation, we tested approximately 2500 transceiver boards. An actual count was not kept due to the multiple re-tests required during the debug phase of program generation. Also, the boards did not have serial numbers.

1. Impact on Production:

   During the time period of FW40-48:

   a. Failure rates in the final radio assembly area dropped by 6%;
   b. Only 10 transceiver boards that PASSED the FP failed during radio test and only 3 of them failed due to A/I-related problems. In the same period of time, 1983 radios went through troubleshoot finding 895 errors caused by the A/I Area;
   c. 7296 radios were shipped from the PRISM area.
2. Impact on SMA production:
   a. It takes 6 minutes to test one side of a six-board panel. This is about 3 times longer than it takes to build the board and will be the bottleneck in the flow-line. Using an audit mode, we can test 2 boards per panel or every third panel. With an additional buffer magazine, it will be possible to test nearly 100% of the boards.
   b. The Flying Prober will give us enough data to provide real-time statistical process control for the SMA line since the Flying Prober can communicate with the new QS2 data collection system.
   c. With the real-time feedback the FP gives to the operators of the SMA line, the improvement in yields should be obvious from the data shown above.

COST ANALYSIS:
The only reason a company would purchase a machine like this is if it can pay for itself in a short period of time. I did some cost analysis work for the Ericsson management to justify the purchase of the Flying Prober. This is the core of the analysis. The cost numbers are approximate due to confidentiality concerns.

In 1998 we produced 25,000 radio boards. Of these, there were approximately 9000 failures at functional test. This breaks down to about 180 repairs per week. During the eight-week evaluation of the Flying Prober, we shipped 4800 radio boards that did not pass through the prober. There were 900 failures at board functional test in this lot at a repair cost of $17,000. During the same time period, 2500 boards were tested on the Flying Prober. There were three (3) failures at board test at a repair cost of $56.46.

Bottom Line: If all of the boards had been tested on the Flying Prober, then the number of boards to be repaired would have dropped from: 903 units
To: an estimated 10 units

Saving an estimated: $17,000 in 2 months.
Over one year that is: $102,000

This is a two-year return on investment using the machine on only one product.

CONCLUSION:
We needed a sound solution that would rely totally on in-circuit test methods because lack of resources prevents us from rewriting the current Functional/In-circuit test. Unfortunately the board has no test pads for a traditional fixtured test. This opened the door into Flying Prober Technology. We evaluated the Teradyne Flying Prober 1004 to determine if it was capable of testing a board with primarily 0402 discrete components and 20-mil pitch ICs. We decided that if it could reliably test a board of this design, then we could use it for other projects like prototype builds and low-volume production where it is normally not very cost effective to develop other types of test. The Flying Prober 1004 is a powerful tool for generating a quick, fixtureless product and process test.