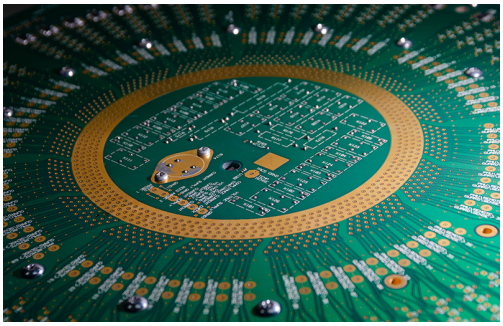
Industrial field: circuit boards, semiconductors
Operational category: manufacturing and production lines

Probe Card and IC Test Socket Testing System

Introduction

This article will describe standard end-of-line testing (aka EOL testing) and test jigs testing, the issues with that standard method, Hioki's solution to those issues. The article will end with specific functions and benefits of Hioki's suggested testing devices to convince the technician and factory decision maker to partner with Hioki by contacting Hioki for their factory test solution upgrade.



Standard EOL testing and test jigs testing

First let's start with some background of EOL and jig testing.
Semiconductor manufacturers produce an extremely large number of semiconductor products in one day. At the end of their production process, each of these semiconductors go through testing called end-of-line testing, or EOL testing. This test is done to confirm the semiconductors do in fact have the electric properties for which they are produced (e.g. a certain resistor having 5Ω of resistance).
The EOL test is done using an EOL test machines which have test jigs that make touch the semiconductor and send electricity through it to test its electric properties. Though the EOL testers have a long life-span, the jigs wear out quicker from repeated contact as well as the electricity that flows through them. If the test jigs were to stop working, it may cause faulty parts to pass the test or at the very least the production would have to be halted (i.e. downtime) causing much hassle and financial damage to the manufacturer. That is why these jigs (one of two types, probe cards or IC test sockets) must frequently be replaced with new jigs before they start to actually break.

Now that we have a decent background of semiconductor EOL tests and the jigs used, let's dive into the flow of how this test works.
Each semiconductor will go through each production phase, and at the end of the production, it will go through the EOL testing. At the EOL testing station, if nothing goes wrong, things are pretty quiet. The semiconductors pass through the tests and bad products are separated from the good. Then eventually the station livens up. This happens at the scheduled replacement of the test jigs. At this time, production (part or whole line) is halted. And skill technicians remove the old jigs and replace them with new ones. However, some of the new jigs are sometimes defective or are attached incorrectly. That is why these skilled technicians will check each jig, one by one, to with their hand-held probes to make sure they will work correctly once the EOL testing resumes.
After the jigs are replaced, the EOL machine is turned back on. And the technicians must stand guard for a certain amount of time to make sure that the jigs are operating properly. If not they must stop EOL testing again and retest the jigs.

Finally, once the EOL test has been running for a while, and the jigs' proper operation is verified, the technicians can take a breath of relief… and go back to their next job.

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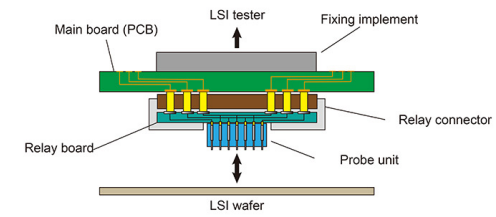
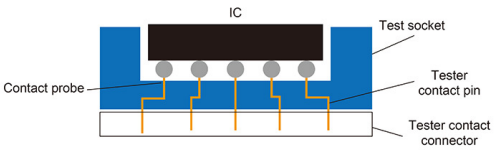
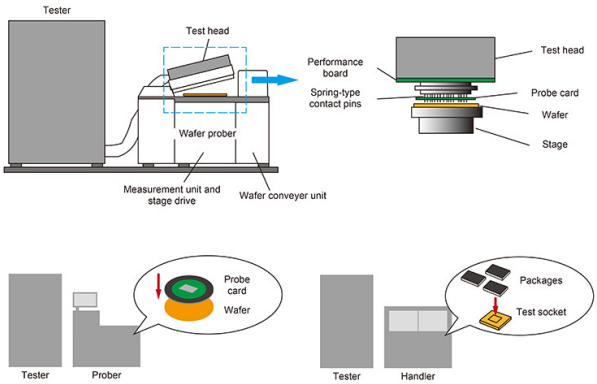
Issues with Standard EOL Testing and Jig Testing



Probe card structure



IC test socket structure



There are some issues however, with the standard EOL testing and jig testing. The issues are directly related to the difficulty of testing jigs, the mistakes that can result, and the risks and damages that these cause.

So, why do I keep saying that these technicians are skilled?
That's because the testing of these jigs is extremely difficult. Each jig is very small, so the technician must touch the probe in just the right point. Each technician must be very knowledgeable with these jigs to know where exactly to make contact with the probe. But that's not all! Not does the design and size of the jigs demand high skill, but it requires a steady hand—like that of a surgeon. Just the slightest change in pressure or position of the probe can cause incorrect test results. You can now imagine how difficult it is for the technician to keep concentration during a rushed probe replacement that also tends to take a long time due to the sheer number of probes that need replacing.

When the jigs—no—even when one jig is tested incorrectly, there are two problems that arise.
The first problem is tainted (or untrustworthy) test batches. Since they must turn the EOL machine on (and test semiconductors) to see verify proper operation of the jigs, in the event that even one of the jigs are not working properly, all of the semiconductors that went through the EOL machine cannot be trusting. In other words, any of the semiconductors may have been judged as good when they were in fact bad, or visa versa.
In such a case the whole test batch cannot be trusted. That is when the manufacturer must decide whether the time and effort it would take to retest the semiconductors is worth the profit lost by tossing them all out as defective. Speaking strictly from a profit point of view, it may be more cost effective to discard the whole batch. In the even that good products are discarded, it will directly be counted as a loss in profit to the manufacturer.

The second problem that results from an error in jig testing is the time lost.
For a manufacturer, any amount of time that part of or the whole production line is stopped (aka downtime) can and is calculated into a direct dollar (or whatever currency) amount of loss. This is because any moment not producing, is time that could have been spent producing. Thus the time spent not producing is calculated into a loss of profit like the example below.
13 minutes downtime × 350 resistors per minute × $20 per resistor = $91,000

Even the time spent on a successful jig replacement is downtime counted and calculated. That is why the technicians do their best to work quickly. However, when there are errors in testing, the time it took for the technicians to discern the error is wasted since the semiconductors that passed through the EOL testing at that time are tainted (and must be retested or discarded). Furthermore, the EOL machine must be turned off while the technicians look through to solve the issue, by repeating jig testing and figuring out the problem or deciding to attach new jigs that must again be tested. In this way, the time spent on jig test verification, jig retesting, and problems solving are all calculated into potential profit that was lost to the factory.

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Hioki Solution

Until now we have discussed the background, flow, and issues with standard EOL testing and jig testing. From hereon we will look at Hioki's solution to these issues that, if taken advantage of, can greatly benefit the manufacturer of semiconductors.

The testing flow and issues discussed above all hang on the following two assumptions.
1. Jig testing relies on skilled workers
2. Jig testing is done after the jigs are attached to the EOL test machines

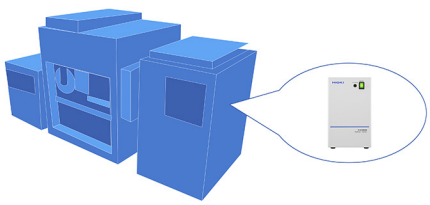
Hioki provides a simple solution to both of these assumptions, which once addressed with an alternate approach in the Hioki way, can potentially save semiconductor manufacturer millions in losses, all in a low-risk fashion.

The alternate approach is to:
1. Skill → Test the jigs by machine (not reliant on human skill)
2. Timing → Test the jigs before attaching to the EOL machines

For Most Applications: High-speed Testing and High Maintainability

Hioki's FA series testers automatically test with precision probing that surpass the accuracy and repeatability of any skilled worker. One simply places the specific jig inside the Hioki tester and clicks "start." Since the pin-board test fixture inside the device is made for the specific jig based on the dimensions and actual jig sent to Hioki, it will make contact at the right point, with the right pressure.
By performing this now-easy test before the jig replacement, not only will there be no downtime for the worst case scenario of errors in jig testing, but even the downtime spent on the best case scenario of no errors can altogether be eliminated.
Below are Hioki's FA series testers best suited for the testing of the jigs used for semiconductor EOL testing (probe cards and IC test sockets) and what make them stand out as the best for this application.

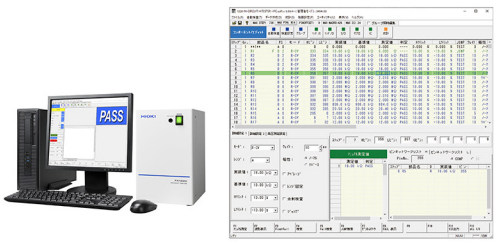
Realizing automation by embedding the system in a drive system



Realizing high-speed, high-precision testing

Model	Maximum number of pins	Test parameters	Measurement range	Measurement speed
FA1221	128 (fixed)	Multi-pin S/O test	4Ω to 400kΩ	From 0.8ms / pin
		Resistance measurement (component test)	400μΩ to 40MΩ	From 0.9ms /step
FA1220	1024 (Expandable in blocks of 128)	Multi-pin S/O test	4Ω to 400kΩ	From 0.8ms / pin
		Resistance measurement (component test)	400μΩ to 40MΩ	From 0.9ms /step

Creating test data quickly



The Short-Open Tester FA1221 and In-Circuit Tester FA1220 incorporate a circuit switch (scanner) and resistance meter into a compact enclosure that implements test sequences created using a computer software.
The following functions further make FA1221 and FA1220 the best choice for the semiconductor manufacturer.

1. Automatically discerns contact height and contact resistance values by incremental Z-axis motion of the probe
2. High-speed testing by optimized synchronization of the system's built-in scanner and measurement pin-boards
3. Quick test data output by software
4. Interoperates with external drive systems when using the internal I/O board (additional accessory)
(Please contact Hioki for more information about support for automation.)

Semiconductors are increasingly utilizing new information technologies such as the IoT and AI. Going forward, more and more manufacturing facilities are likely to face the need to achieve both higher quality and shorter test cycle times. The Short-Open Tester FA1221 and the In-Circuit Tester FA1220 hold the potential to address the needs of such facilities.

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For Applications with Difficult or Numerous Jigs: Flying Probe Testers Don't Need Test Fixtures

The FA1221 and FA1220, which were introduced in this article incorporate probe pin-boards made-to-order for the manufacturer's measurement object (e.g. jig). However, sometimes test points on a probe card are too close together, in which case it may not be possible to space the probes on the pin-board test fixture closely enough to test the probe card. This would necessitate fabricating a test fixture for each probe card, increasing running costs. In situations such as these, you may wish to consider a flying probe-type tester.

Flying Probe Testers are similar to the aforementioned FA1221 and FA1220, but instead of incorporating a pin-board test fixture designed for each test object, they incorporate probes that freely move, or *fly*, in all directions of X, Y, and Z axes. For flying probe testers, testing is made even easier. Instead of having a pin-board attached for each test object type, one simply inputs the measurement parameters (electric and physical dimensions) of the test object and push "start." For manufacturers that have many testing jigs types to test, these flying probe type testers are the ideal fit.

FLYING PROBE TESTER
FA1240-6x

FLYING PROBE TESTER
FA1817

FLYING PROBE TESTER
FA1283

Conclusion

First explaining about the standard EOL testing and test jigs testing and its issues, this article presented Hioki's solutions. It is our belief at Hioki that when the semiconductor manufacturer considers Hioki's solution, they will agree with our conclusions, leading to a desire to contact us at Hioki and partner with us.

Furthermore, just as Hioki has a solution for testing jigs meant to test semiconductors, Hioki provides a large range of testing and measurement solutions in not just the electronic components market but many, many more. We look forward to partnering with users across the globe and industries to create a better society of sustainability and prosperity.

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