Auto-Z Test Cell Software Solution

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Abstract

As the industry drives to optimize production new hardware solutions are introduced that overcome performance bottle necks in the test cell. One recent case is the Verigy DirectDock™ hardware solution for wafer sort. Verigy has also developed test cell software solutions that together with the hardware provide an even higher level of optimization in production. The Auto-Z module is a new addition to Verigy's production optimization services (VPOS). Together the unique value of the combined hardware and software solution provides the best possible test results consistently to wafer sort production floors.

1. Introduction

In the past year, the direct docking solution has been introduced for wafer sort (WS) testing to achieve better signal integrity, better coverage of testing in WS, and further reduce the cost of the signaling hardware. The direct docking solution requires very good quality of the prober setup especially for the over-drive (OD) and Z height setting. In the past this setting is done manually and depends on the setup engineer's experience, so the results can be inconsistent and also time consuming to achieve the best setting. If the improper setting is applied, this will also impact the probe needle lifetime and also might result in unacceptable probe mark on the pad, and even damage the device under test (DUT).

To resolve these issues, Verigy has worked with our customers to introduce the Auto Z setup solution. This solution is currently operational in several foundry customers and we continue to enhance it with new features. This paper will explain the needs and benefits to the industry of the Auto Z solution and the structure of the current solution on 93K with TEL prober, and how it operates. The paper will also cover the further enhancement on the Auto Z usage on the die based SPC to achieve the "Auto Z setup on the fly" concept that is not possible to do by manual setup.

2. Industry Trend & Challenges

Several trends in the semiconductor industry are driving the requirements for introduction and adoption of advanced hardware solutions in production:

1. Device fab process is getting more and more complex (SOC, 3D IC, TSV..)
2. Smaller die size but with high pin count result in small pad
3. New assembling technology to fulfill faster, powerful but smaller IC (SiP, wafer level packaging)

The challenge of decreasing die sizes and dimensions will be the contact of the pad and also the probe card needle lifetime control. This will increase the difficulty for the engineer or operator to setup the prober contact and be time consuming to ensure the contact setting is correct. Also the manual setting process will be inconsistent and will increase the complexity to identify yield problems and cause shorter lifetime of probe card.

3. Supported Environment

The following describes the currently supported environment for the Auto-Z software solution:

Prober Type	– TEL
SmarTest Version	– All on Linux
OS	– RHEL3 & RHEL5 (32 Bits)
Multi-Site	– 1~8 Sites

4. Generic Auto-Z Process Flow

The following process shows a generic operation of Auto Z is executed in production. The goal of the Auto-Z software solution is to:

1) Automate the manual process
2) Automate recording of the result for offline analysis and correlation
3) Provide flexibility to execute in an automated SPC flow

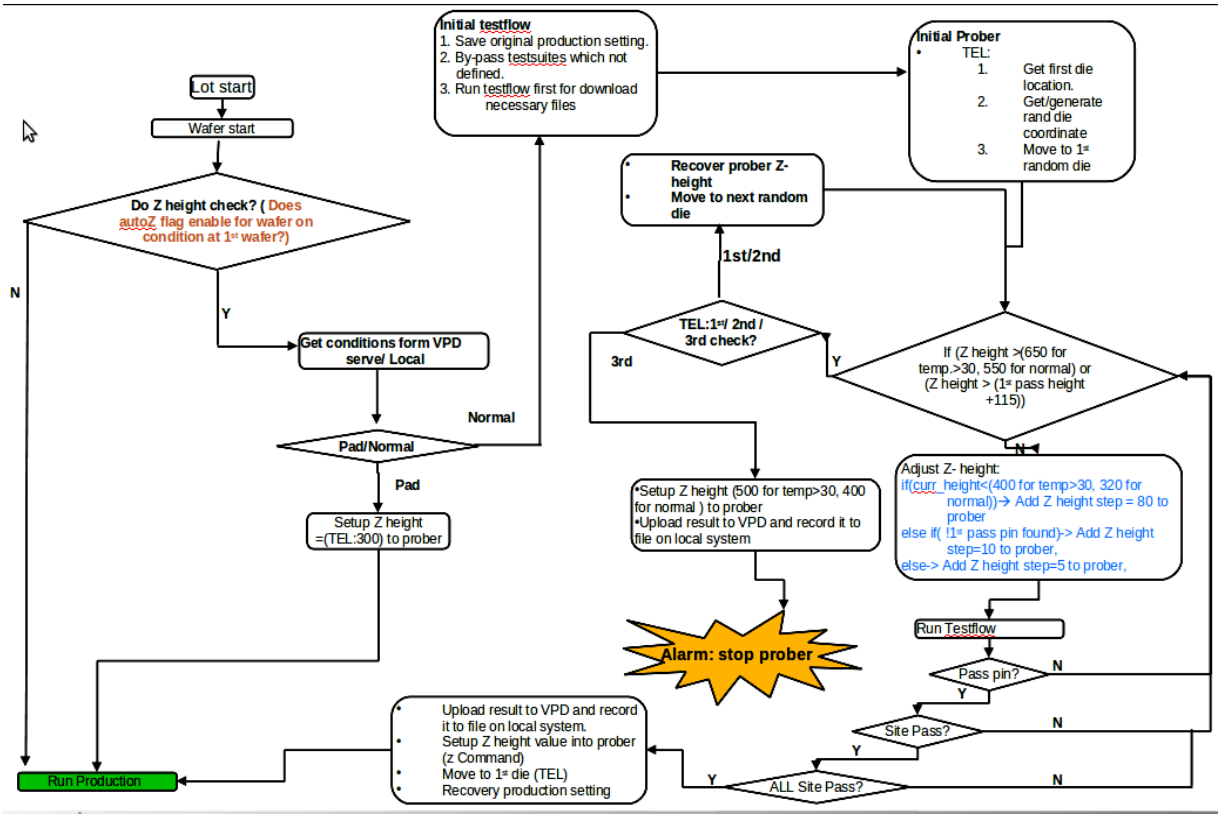


Figure 1. Auto-Z process flow diagram

The most complex part is the logic to determine the final Z height setting, so basically the user will provide the initial value, stepping size, minimum and maximum Z value, and contact window limit. Then we will run the Opens and Shorts (O/S) test and adjust the Z by the preset step size and look for Z height of the first pin pass to all pins pass. These two values determine the contact window and also the final Z height during the run. If the adjustment is over the limit, the auto Z will report an error and then stop.

5. Software Design

The components of the Auto-Z software are summarized in the Diagram 2 below and then a brief description of how each function as a complete solution will be provided.

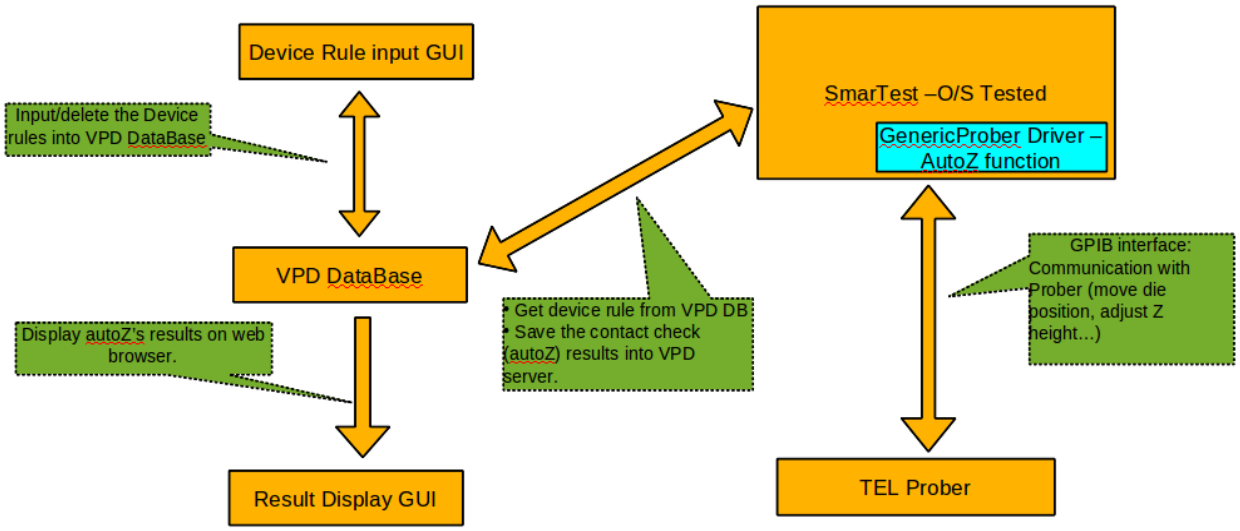


Diagram 2. Auto-Z software components

The solution comprises two GUI (Graphic User Interface) modules, one database (Mysql Enterprise), and new driver functions to interface with the TEL prober.

5.1. Prober Driver

The prober driver needs to be modified to include new control methods represented in the Auto-Z process diagram. This is necessary to automate the tasks performed manually today in the existing flow.

- Query the VPD DB auto Z rule by device if the driver receives an SRQ:0x6c
- Save all adjusted result into VPD DB.
- Adjust the Prober's Z height at the first die contacted automatically.
- Disable data log during auto Z function executed.
- Bypass all test suites except pre-setup and O/S test suites before execute DEVICE_TEST (1st die_start)

5.2. Device Rule Input UI

The Device Rule Inpu UI is used to configure the Prober Type or enable/disable the Auto Z function and be able to set the Auto Z running criteria. The user also is able to setup the O/S testsuites and any pre-run testsuites required to perform the Auto Z. The reason to define pre-run testsuites is because some devices need to be configured into a certain state or some hardware setup needs to be done before the O/S testsuite. An example using the UI is included in Diagram 3 below.

- AutoZ rule input
  - TestProgram name
  - Rpober type
  - Z height initial value
  - Step value
  - Max. value
  - Site Diff. value
  - OD Value
  - Pre setup test suite name
  - O/S test suite name
  - User Flag
- Update rule to VPD DB
- Delete rule in VPD DB

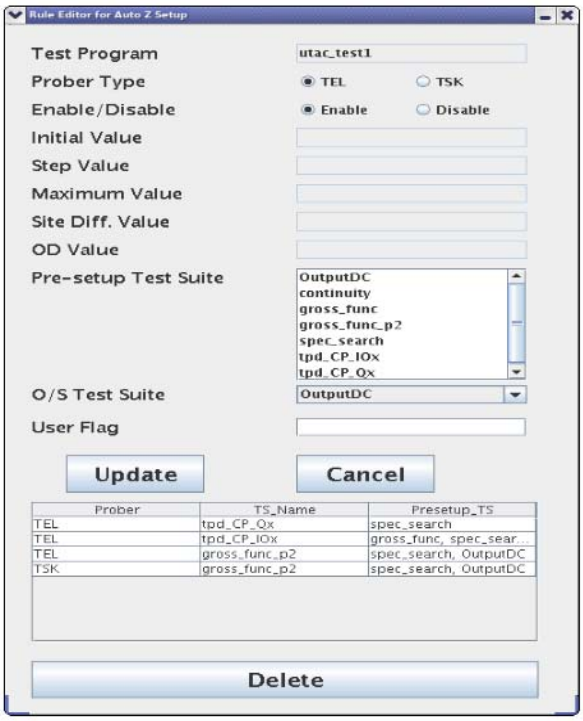


Diagram 3. Device Rule Input UI

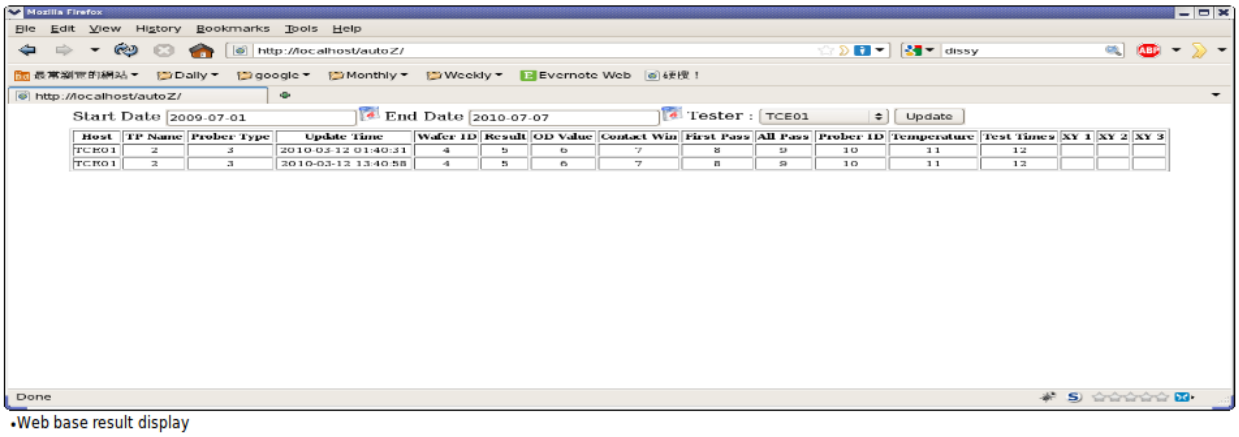
5.3. VPD Database

The VPD (Verigy Production Dashboard) has been extended to support storage of the Auto-Z results. Users across the organization can then access the results for offline historical analysis. Users can then generate reports from the DB or through other applications.

Two new tables were added. The first is the AutoZ_Rule table to store the Auto Z execution criteria by device, including the initial value and step. For a detailed list please refer to Auto Z process flow description. The second table is the AutoZ_Result and stores the Auto Z execution result for further analysis. The solution also includes a report that displays the results by device and will be described next.

5.4. Result Display UI

A web interface has been developed to display the result summary. Users also can develop their own result reporting by querying the VPD database.



- Web base result display
- Query information by time and hostname.
- Display:
  - Host name : Tester host name
  - TP name : Test Program name
  - Prober Type : Prober type(TEL)
  - Update time : Contact check (AutoZ) completed time
  - Wafer ID : the Wafer ID
  - Result: Contact check Pass/Fail
  - OD Value : Over Drive value
  - Contact Window : Contact window=(all pass – first pass)
  - First pass : Z height for first pass pins existed
  - All Pass : Z height for All pass
  - Prober ID : Prober ID
  - Temperture : The setup temperature on Prober
  - XY1 position : Die position for 1st die contact check.
  - XY2 position : Die position for 2nd die contact check.
  - XY3 position : Die position for 3th die contact check.

Diagram 5. Results display UI

5.5. SmarTest Integration and Execution

In the Auto Z solution, the opens and shorts test will be executed before production automatically and also must be executed during production. This requires that no test program reload occurs, in which case we use the application model file control to satisfy the requirement. In addition, two steps for controlling the testsuite flags are involved. First is to record the current testsuite flags setting and disable all except the pre-setup testsuite and the selected O/S testsuites. After the Auto Z is excuted, all of the original testsuite flags setting will be restored for production.

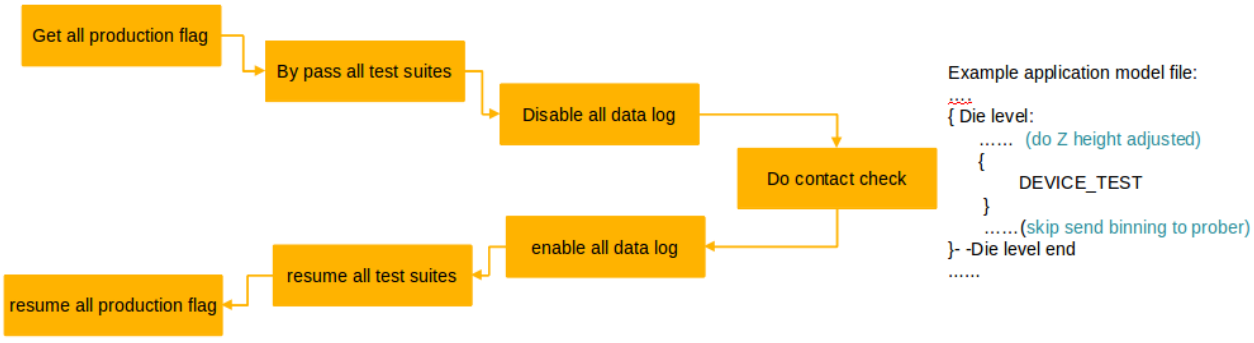


Diagram 6. SmarTest execution diagram

All prober communication will be skipped during the die level running, only the contact check commands are executed.

6. Conclusion

The Auto-Z solution provides full automation of the setup process and enhances the DirectDock hardware solution performance in production while easily integrating with the target environment. No test program changes or MES changes are required for the solution to be deployed, reducing the risk and complexity of integration. Finally, the solution is an example of how VPD can be expanded and extended where conventional MES or automation solutions were not designed to fulfill.

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