Part Average Testing finds and rejects outlier ICs

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ICs for automotive applications must satisfy long-term reliability requirements by being insensitive to hard electromechanical stresses. Recently, some studies revealed that the long term robustness of automotive ICs is deeply related to obtaining a set of "well centered" distributions of the main parameters reported in the datasheets of the ICs. How can you be sure that the tested parts show distributions that are "totally in spec?" The answer is the PAT (part-average testing).

PAT has recently been adopted by a number of semiconductor companies, primarily to help them meet the stringent requirements of the automotive industry (Automotive Electronics Council: AEC-Q001-Rev D). Indeed, reliability studies have shown that semiconductor parts that have abnormal characteristics tend to be higher contributors to long-term quality and reliability problems. Devices that originally passed all manufacturing tests but could be considered "outliers" compared to other parts in the same population or lot are more likely to fail in the field. This is the basis for PAT, which proactively identifies these outliers for exclusion from production shipments. PAT operates by modifying the pass/fail test limits based on statistical sampling of multiple devices.

How does PAT work?
PAT is a dynamic test. Let's consider, for example, the EWS (Electrical Wafer Sort) process, the testing procedure of a silicon wafer containing ICs. This procedure is performed by a mechanical probe that makes contact to the pads of each IC on the wafer. The probe card is electrically connected through cables to the testing equipment. An automated system sequentially tests all the dice contained in the wafer. As the testing procedure proceeds, the datalog file containing the measurement results is elaborated by the software of the testing equipment to the mean (µ) and standard deviation (s). Once are known, you can identify the outlier parts that passed the test but are not in the range.

[µ–4s, µ+4s]

The parts are rejected and considered out of specifications at PAT 4 sigma test, see Figure 1.
PAT is a dynamic test process because $s$ is evaluated at each step of the wafer testing process, one wafer at a time. The strength of this test is the chance isolate and reject the outliers by mean of a slight decrease in the final testing yield. Usually the difference between the yield before and after the implementation of the PAT test is no more than 2% (Figure 2).

The primary goal of the PAT testing is, of course, customer satisfaction. That satisfaction comes at a higher cost and yield loss of test that is possible without PAT testing. But, it's it's a little price to be paid compared to having unhappy customers for you don’t want to receive an FAR (Failure Analysis Request).
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