Chapter 4

Functional testing result and discussion

4.1 Functional testing

In the course of doing this functional testing evaluation, we found that due to the complexity of the die, it is very difficult to pin-point the actual cause of failure, whether it is due to the presence of FM on the die or some internal wafer problem. Even with the current reject criteria, functional testing of 'good' units result in test yields of about 95%. To determine the actual cause of a functional test failure, a device has to be sent for failure analysis to Motorola's Failure Analysis Lab in Oakhill, Texas, United States of America.

Not able to afford the time it takes to send units for failure analysis in Texas, we decided to concentrate more on analyzing devices that have FM on the post. We feel that this is more within our ability to analyze. Table 4.1a is a summary of all the units collected, tested, passed and failed, for each FM reject category.

'Total % passed' (marked as item 1 in the Table 4.1a) is the percentage of units tested that passed the functional test. '% Tested' (marked as item 2 in Table 4.1a) is the percentage of units collected that has been tested.

On the average, the results do not look encouraging. Only 77.88% of the Foreign on post rejects passed the functional testing, almost 18% lower than the normal test fallout. We would expect that if FM on post rejects were as good as assembly-good units, then the test yield would be close to 95%, which is the normal test yield. To test this assumption, we collected more units, without discrimination between FM on post

categories, and sent them through functional testing as though the units were a normal production lot.

	collected	tested	Passed	failed	% passed
burnt particle on post	40	19	16	3	84.21
amber on post	1	1	1		100.00
tadpole on post	47	26	19	7	73.08
stain on post	49	15	13	2	86.67
leech on post	7	4	4		100.00
burnt fibre on post	24	14	9	5	64.29
palm sweat on post	2	1	1		100.00
melted fibre on post	11	5	5		100.00
TOTAL	270	104	81	23	77.88 [1]
%		38.52 [2]			

Table 4.1a : Summary of Functional testing.

Within 2 weeks we managed to collect 62 FM reject units. These units were labeled and put through the normal assembly process of sealing, marking and lead finishing before being sent for functional testing. The results are shown in Table 4.1b.

	Qty	%
Good	52	83.9%
Bin 5 rejects	8	12.9%
Bin 6 rejects	1	1.6%
Bin 3 rejects	1	1.6%

Table 4.1b Results of indiscriminate testing

The 10 rejects were re-tested to obtain the detailed datalog reports. It was found that Bin 5 rejects were functional, therefore would be more related to wafer defects and not the presence of FM on the post. The detailed analysis shows failures for many functions possibly indicating damaged die or contact problems. These units were decapped to find out if the contact problems were due to the presence of FM.

4.2 Failure and FM Location Correlation.

A sample of the Datalog Report, the report generated by the functional test machines containing information on what tests were run and its results, is given in Appendix B. From these reports, we found out the functions at which the device failed. Using the pin assignment diagram shown in Figure 2.6.2a, we found the physical locations of the failure in terms of the quadrants assigned in Figure 2.6.1a. Unit #68 for example, failed at functions A14, which is located between quadrant p9 and p10. Table 4.2 compares the FM location and the physical location of the functional failure. Since we were looking only at FM on post, all quadrants have suffix 'p'.

Part id	FM	FM location	Test Failure	Failure location
68	Tadpole on post(bridging)	p3	Bin5	p10/9
70	Burnt fiber on post(bridging)	p3	Bin10	p4
84	Tadpole on post	p2	Bin10	p9/10
88	Tadpole on post(bridging)	p9	Bin10	p1/p2
134	Tadpole on post	p8	Bin7	p11-2,p4-7,p9
141	Stain on post	p8	Bin7	p4-1
144	Burn particle on post	p3	Bin10	p5/6
147	Burnt fiber on post(bridging)	p5	Bin7	p2/5/6

Table 4.2 FM and Test Failure location correlation

Aside from unit numbers 134 and 147, all the units showed that the failure locations do not correlate with the FM locations. Unit numbers 137 and 147 have multiple failure locations. Since the FM were located at only one quadrant and not any of the other failure locations, we have to conclude that that the failures are not solely or at all due to the presence of FM. Multiple functional failures would usually mean a wafer related problem.

4.3 Reliability Testing.

81 units of those that passed the first functional test were sent to 100 cycles of Temperature Cycling. After returning for Temperature Cycling, the units were sent to functional testing again.

4.3.1 Functional Reliability Testing

Table 4.3.1 presents the results of the functional testing on temperature cycled units. The percentage of units that passed the functional testing is 92.64%, which is quite close to a normal testing yield. This result is considered to be good considering the units have gone through 100 temperature cycles and usually these units would have functional test yields of about 90% on average, due to handling and stress.

Therefore it could be concluded that even after 100 temperature cycles, the units with FM were still performing up to par with units without FM.

	Collected	tested	Passed	failed	% passed
burnt particle on post	16	16	14	2	87.5
amber on post	1	1	1		100
tadpole on post	19	19	18	1	94.7
stain on post	13	13	12	1	92.3
leech on post	4	4	4		100
burnt fibre on post	9	9	8	1	88.88
palm sweat on post	1	1	1		100
melted fibre on post	5	5	5		100
TOTAL	68	68	63	5	92.64
%		100			

Table 4.3.1 Results of Functional Testing on Temperature Cycled units.

4.3.2 Failure and FM Location Correlation

3 of the units that failed functional testing had failed for visual mechanical reasons, i.e. the leads were bent, which is a common failure for units that has gone through a high degree of handling. The test operators had attempted to repair the bent leads and re-test the units, but the effort was futile. Therefore, only 2 of the failed units actually failed electrical/functional testing. Comparing the failure location as indicated in the datalog report and the actual location of the FM as recorded earlier, we found that none of the failure location and FM location matched.

4.3.3 PIND Test.

Due to the unavailability of the PIND tester equipment, we were unable to conduct this test. If the test were conducted and we were to find failures, the units

should be decapped to find out if the failure is due to the detachment of the formerly attached FM or of other reasons (such as lifted or disconnected wires). If all the units were to pass the PIND test, it would mean that the attached FM would not pose any direct reliability problems on the device's performance throughout its lifetime.