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# Nand 60 series MicroMate ( $\mu$ M2) Testing

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## **Intern Information**

**University: Old Dominion University**

**Major: Electrical Engineering**

**Graduated (BS): May, 2009**

**Internship Site: Micron Technology**

**Micron Department: Yield Enhancement**





## Background

### Nextesting Vs. MicroMate Electrical Testing

- ▶ Nextest primarily used for Nand 60 series testing
- ▶  $\mu$ M2 primarily utilized for DRAM testing
- ▶  $\mu$ M2 60 series Nand tests were unverified

### MicroMate Advantages:

- ▶ Entire chip testing
- ▶ Testing speed
- ▶ The  $\mu$ M2 is a Micron-specific tool
- ▶ Simpler GUI operation



## Project Goals



- ▶ Verify functionality of  $\mu$ M2 tester for various electrical tests.
- ▶ Determine further capability on new NAND series wafers
- ▶ Communicate with PE to implement additional tests
- ▶ Create/Update a comprehensive uM2 instructional document for use in YE lab
- ▶ Train Nand engineers and technicians to run tests using the MicroMate

### Verification Process:

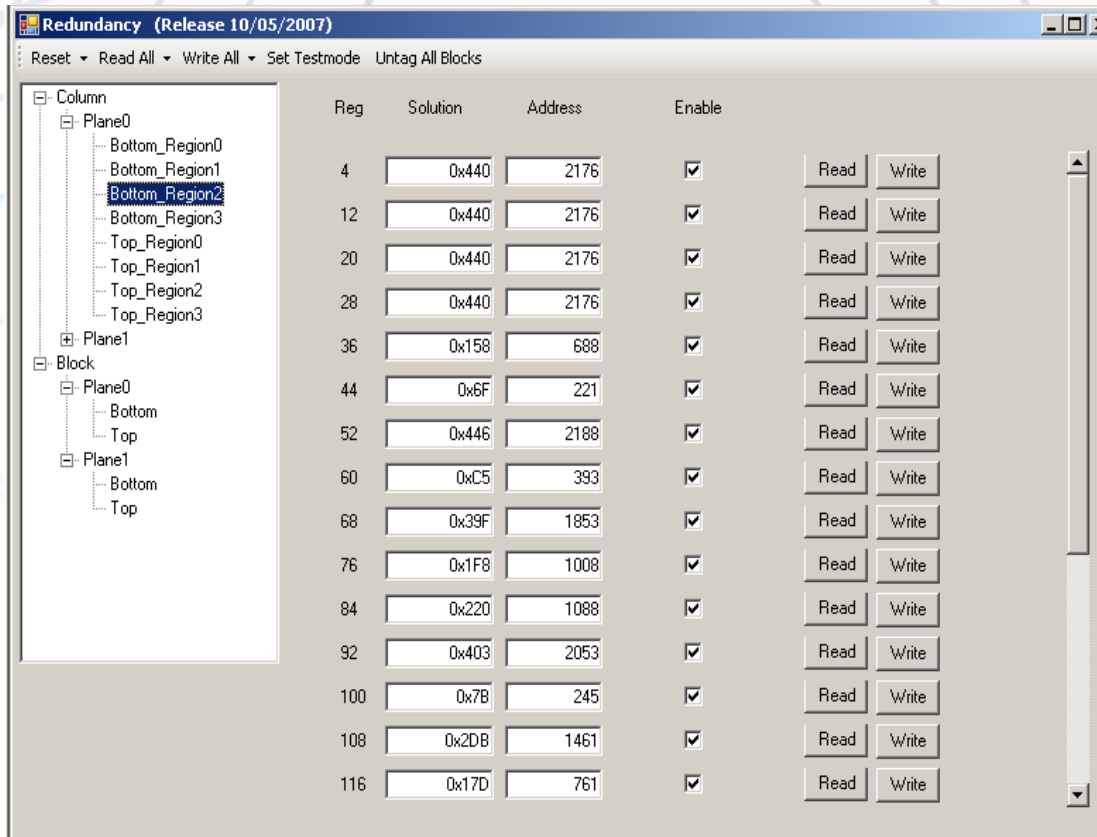
- ▶ Probe Data verification
- ▶ Nextest failure correlation
- ▶ Cell/string current measurements
- ▶ Deprocessing and failure analysis



# Identified $\mu$ M2 Software Errors

## “Write All” Function

- The program did not reset solution values for ALL repair columns and blocks using the “Write All” Function.



The screenshot shows the 'Redundancy (Release 10/05/2007)' application window. The interface includes a menu bar with 'Reset', 'Read All', 'Write All', 'Set Testmode', and 'Untag All Blocks'. A tree view on the left shows a hierarchy of 'Column' and 'Block' structures. The main area is a table with columns for 'Reg', 'Solution', 'Address', and 'Enable'. Each row also has 'Read' and 'Write' buttons. The 'Bottom\_Region2' column is highlighted in the tree view.

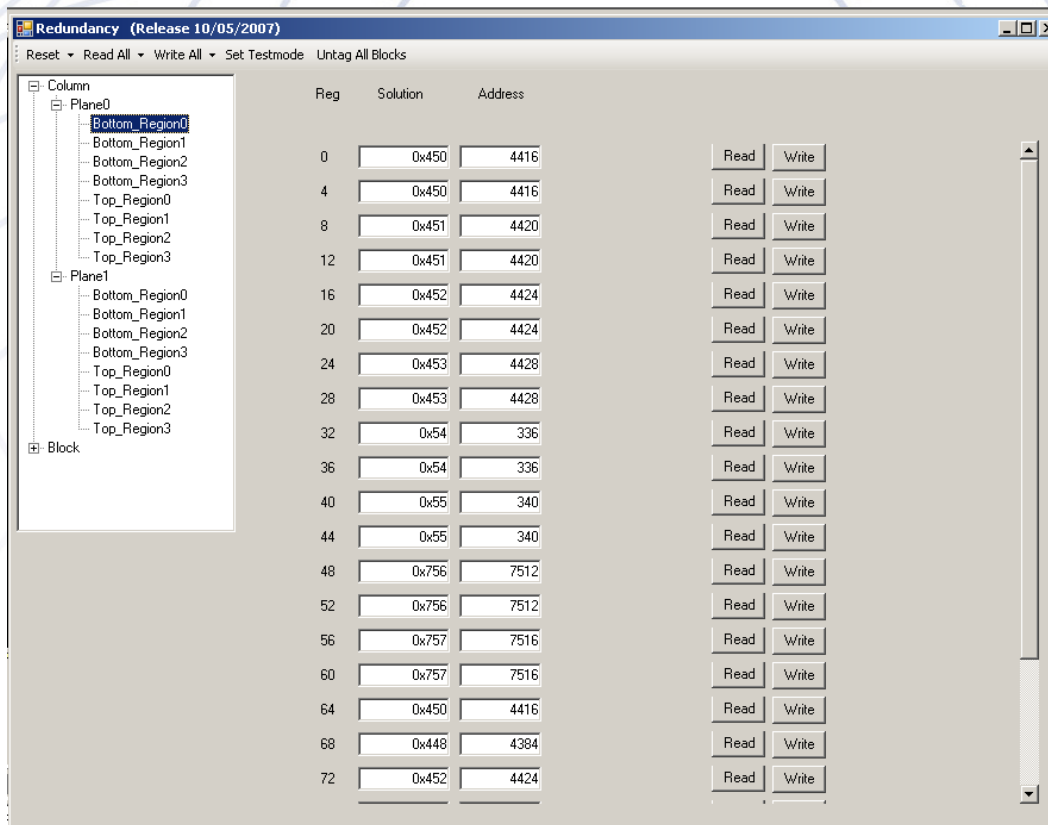
Reg	Solution	Address	Enable	Read	Write
4	0x440	2176	<input checked="" type="checkbox"/>	Read	Write
12	0x440	2176	<input checked="" type="checkbox"/>	Read	Write
20	0x440	2176	<input checked="" type="checkbox"/>	Read	Write
28	0x440	2176	<input checked="" type="checkbox"/>	Read	Write
36	0x158	688	<input checked="" type="checkbox"/>	Read	Write
44	0x6F	221	<input checked="" type="checkbox"/>	Read	Write
52	0x446	2188	<input checked="" type="checkbox"/>	Read	Write
60	0xC5	393	<input checked="" type="checkbox"/>	Read	Write
68	0x39F	1853	<input checked="" type="checkbox"/>	Read	Write
76	0x1F8	1008	<input checked="" type="checkbox"/>	Read	Write
84	0x220	1088	<input checked="" type="checkbox"/>	Read	Write
92	0x403	2053	<input checked="" type="checkbox"/>	Read	Write
100	0x7B	245	<input checked="" type="checkbox"/>	Read	Write
108	0x2DB	1461	<input checked="" type="checkbox"/>	Read	Write
116	0x17D	761	<input checked="" type="checkbox"/>	Read	Write

- After performing the “Read All columns,” only the first four registers displayed the reset solutions instead of all the registers as expected.

# Identified $\mu$ M2 Software Errors

## “Reset” Solution Sequence

- The “Reset” function solution sequence repeated a single solution instead of a “plus-four” sequence. The CORRECTED output sequence is shown below.



Redundancy (Release 10/05/2007)

Reset Read All Write All Set Testmode Untag All Blocks

Column	Reg	Solution	Address		
Plane0					
Bottom_Region0	0	0x450	4416	Read	Write
Bottom_Region1					
Bottom_Region2	4	0x450	4416	Read	Write
Bottom_Region3					
Top_Region0	8	0x451	4420	Read	Write
Top_Region1					
Top_Region2	12	0x451	4420	Read	Write
Top_Region3					
Plane1					
Bottom_Region0	16	0x452	4424	Read	Write
Bottom_Region1					
Bottom_Region2	20	0x452	4424	Read	Write
Bottom_Region3					
Top_Region0	24	0x453	4428	Read	Write
Top_Region1					
Top_Region2	28	0x453	4428	Read	Write
Top_Region3					
Block	32	0x54	336	Read	Write
	36	0x54	336	Read	Write
	40	0x55	340	Read	Write
	44	0x55	340	Read	Write
	48	0x756	7512	Read	Write
	52	0x756	7512	Read	Write
	56	0x757	7516	Read	Write
	60	0x757	7516	Read	Write
	64	0x450	4416	Read	Write
	68	0x448	4384	Read	Write
	72	0x452	4424	Read	Write



# Identified $\mu$ M2 Software Errors

## Probe data Correlation

Redundancy (Release 10/05/2007)

Reset - Read All - Write All - Set Testmode - Untag All Blocks

Column	Reg	Solution	Address	Read	Write
Plane0					
Bottom_Region0					
Bottom_Region1					
Bottom_Region2					
Bottom_Region3					
Top_Region0	2	0x244	2320	Read	Write
Top_Region1	6	0x24A	2344	Read	Write
Top_Region2	10	0x431	4676	Read	Write
Top_Region3					
Plane1					
Bottom_Region0	14	0x493	4132	Read	Write
Bottom_Region1					
Bottom_Region2	18	0x444	4388	Read	Write
Bottom_Region3					
Top_Region0	22	0x4B1	4804	Read	Write
Top_Region1					
Top_Region2	26	0x4B0	4852	Read	Write
Top_Region3					
Block					
	30	0xF0	960	Read	Write
	34	0x440	4404	Read	Write
	38	0x43	292	Read	Write
	42	0x68	748	Read	Write
	46	0x6	300	Read	Write
	50	0x71C	7280	Read	Write
	54	0x763	7884	Read	Write
	58	0x74E	7480	Read	Write
	62	0x74F	7484	Read	Write
	66	0x224	2192	Read	Write
	70	0x219	2148	Read	Write
	74	0x47F	4604	Read	Write
	78	0x434	4688	Read	Write
	82	0x454	4432	Read	Write
	86	0x4E8	4524	Read	Write
	90	0x4E1	4996	Read	Write
	94	0x67	540	Read	Write

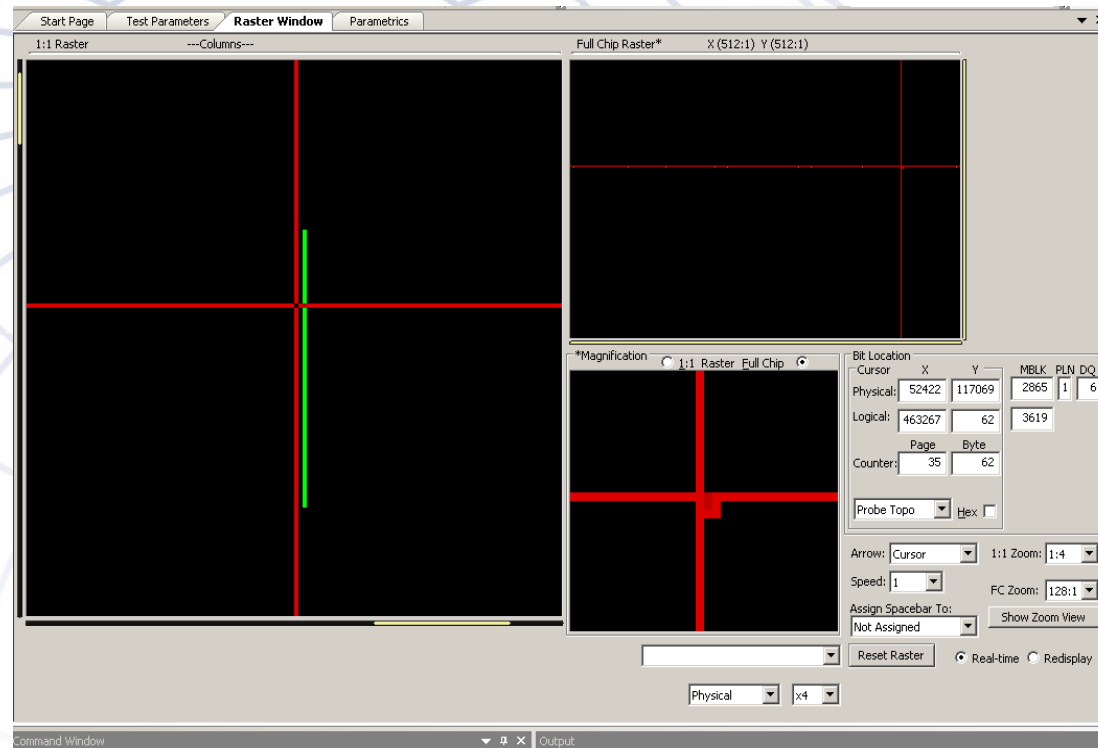
```
12:45683683.6703766.0.3766-11.FPP.00L68A.W21S.log0
ColSol: RedUsed= 86, DomainIndex= 69, DDC=BOT, Block= 28, RegionWord=1454, DomainWord= 363, PhyWord= 910,
Bits= 1, Bin= E, Solution= 816b
ColSol: RedUsed= 87, DomainIndex= 93, DDC=BOT, Block= 0, RegionWord=3931, DomainWord= 982, PhyWord= 737,
Bits= 16384, Bin= X, Solution= 83d6
ColSol: RedUsed= 88, DomainIndex= 22, DDC=BOT, Block= 0, RegionWord=1564, DomainWord= 391, PhyWord= 61,
Bits= 16384, Bin= X, Solution= 8187
ColSol: RedUsed= 89, DomainIndex= 46, DDC=BOT, Block= 0, RegionWord= 349, DomainWord= 87, PhyWord= 738,
Bits= 16384, Bin= X, Solution= 9057
ColSol: RedUsed= 90, DomainIndex= 70, DDC=BOT, Block= 0, RegionWord=3974, DomainWord= 993, PhyWord= 831,
Bits= 16384, Bin= X, Solution= 83e1
ColSol: RedUsed= 91, DomainIndex= 94, DDC=BOT, Block= 0, RegionWord=3855, DomainWord= 963, PhyWord= 575,
Bits= 16384, Bin= X, Solution= 83c3
ColSol: RedUsed= 92, DomainIndex= 23, DDC=BOT, Block= 0, RegionWord=1004, DomainWord= 251, PhyWord=1045,
Bits= 16384, Bin= m, Solution= 80fb
ColSol: RedUsed= 93, DomainIndex= 47, DDC=BOT, Block= 0, RegionWord= 229, DomainWord= 57, PhyWord= 484,
Bits= 16384, Bin= X, Solution= 8039
ColSol: RedUsed= 94, DomainIndex= 71, DDC=BOT, Block= 0, RegionWord=1566, DomainWord= 391, PhyWord= 61,
Bits= 16384, Bin= X, Solution= 8187
ColSol: RedUsed= 95, DomainIndex= 95, DDC=BOT, Block= 0, RegionWord= 231, DomainWord= 57, PhyWord= 484,
Bits= 16384, Bin= X, Solution= 8039
ColSol: RedUsed= 96, DomainIndex= 96, DDC=TOP, Block= 5398, RegionWord=1008, DomainWord= 252, PhyWord=1055,
Bits= 72, Bin= E, Solution= 80fc
ColSol: RedUsed= 97, DomainIndex= 120, DDC=TOP, Block= 4262, RegionWord=1289, DomainWord= 322, PhyWord= 562,
Bits= 32, Bin= D, Solution= 8442
ColSol: RedUsed= 98, DomainIndex= 144, DDC=TOP, Block= 4886, RegionWord=2562, DomainWord= 640, PhyWord= 5,
Bits= 1, Bin= E, Solution= 8280
ColSol: RedUsed= 99, DomainIndex= 168, DDC=TOP, Block= 4356, RegionWord=2119, DomainWord= 529, PhyWord= 148,
Bits= 1, Bin= E, Solution= 8211
ColSol: RedUsed= 100, DomainIndex= 97, DDC=TOP, Block= 6232, RegionWord=4356, DomainWord=1089, PhyWord=1089,
Bits= 24, Bin= B, Solution= 8441
ColSol: RedUsed= 101, DomainIndex= 121, DDC=TOP, Block= 4262, RegionWord=1049, DomainWord= 262, PhyWord= 52,
Bits= 32, Bin= B, Solution= 8106
ColSol: RedUsed= 102, DomainIndex= 145, DDC=TOP, Block= 4786, RegionWord=3170, DomainWord= 792, PhyWord= 210,
Bits= 1, Bin= E, Solution= 8318
ColSol: RedUsed= 103, DomainIndex= 169, DDC=TOP, Block= 4302, RegionWord=2851, DomainWord= 712, PhyWord= 617,
Bits= 1, Bin= E, Solution= 82c8
ColSol: RedUsed= 104, DomainIndex= 98, DDC=TOP, Block= 5912, RegionWord=4360, DomainWord=1090, PhyWord=1091,
Bits= 16, Bin= B, Solution= 8442
ColSol: RedUsed= 105, DomainIndex= 122, DDC=TOP, Block= 4186, RegionWord=3633, DomainWord= 908, PhyWord= 109,
Bits= 32, Bin= B, Solution= 838c
ColSol: RedUsed= 106, DomainIndex= 146, DDC=TOP, Block= 4530, RegionWord= 378, DomainWord= 94, PhyWord= 798,
Bits= 1, Bin= E, Solution= 805e
ColSol: RedUsed= 107, DomainIndex= 170, DDC=TOP, Block= 4254, RegionWord=3599, DomainWord= 899, PhyWord= 31,
Bits= 1, Bin= E, Solution= 8383
ColSol: RedUsed= 108, DomainIndex= 99, DDC=TOP, Block= 6616, RegionWord=4364, DomainWord=1091, PhyWord=1093,
Bits= 24, Bin= E, Solution= 8443
ColSol: RedUsed= 109, DomainIndex= 123, DDC=TOP, Block= 4186, RegionWord=3649, DomainWord= 912, PhyWord= 143,
Bits= 32, Bin= B, Solution= 8390
ColSol: RedUsed= 110, DomainIndex= 147, DDC=TOP, Block= 4426, RegionWord=4366, DomainWord=1091, PhyWord=1094,
```





# Identified $\mu$ M2 Software Errors

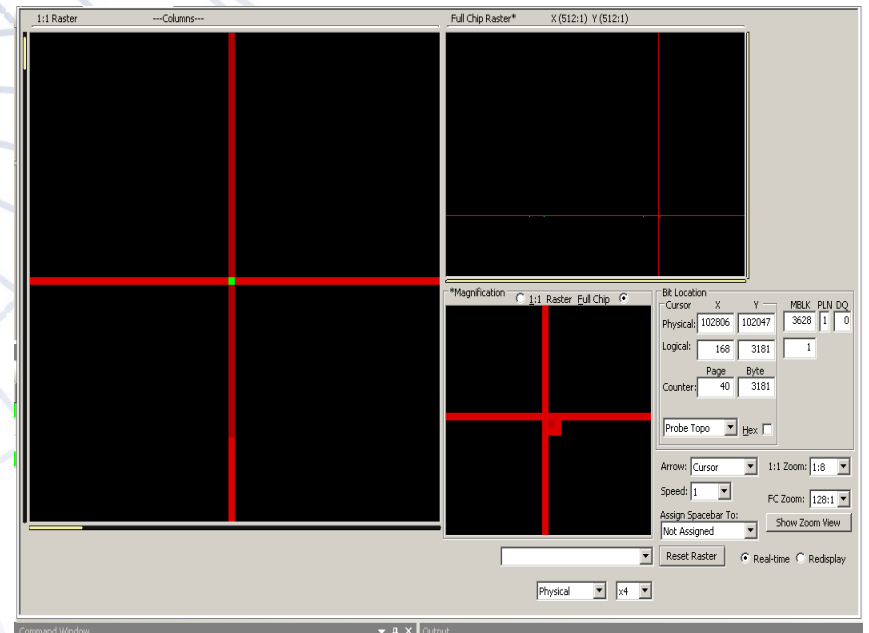
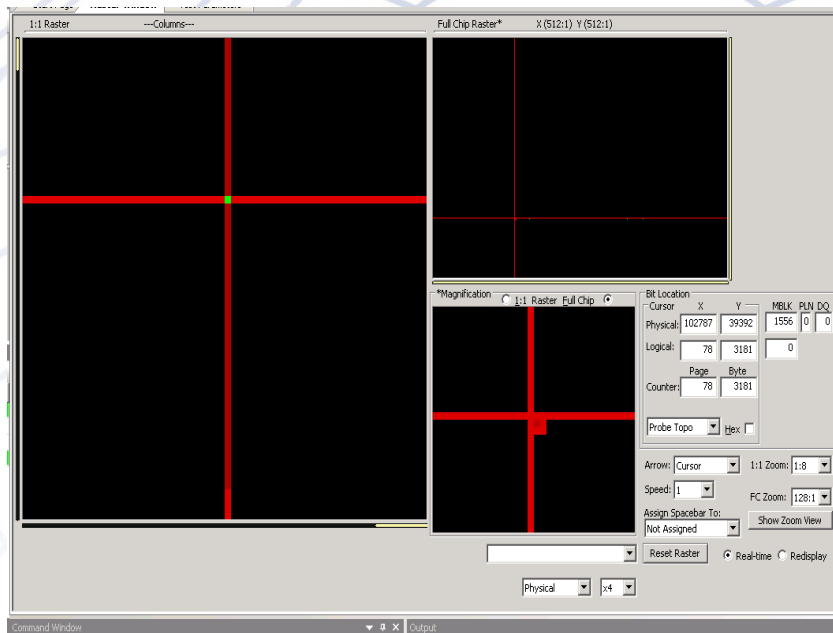
False failure captures:





# Identified $\mu$ M2 Software Errors

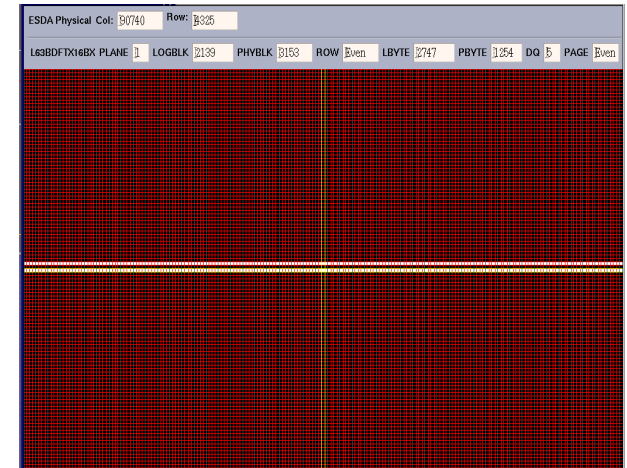
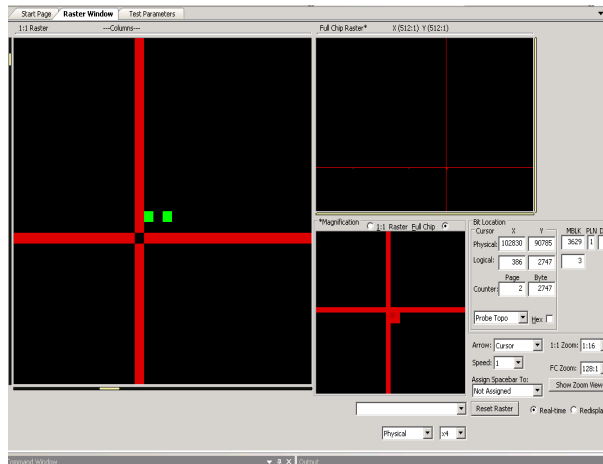
Result duplication:



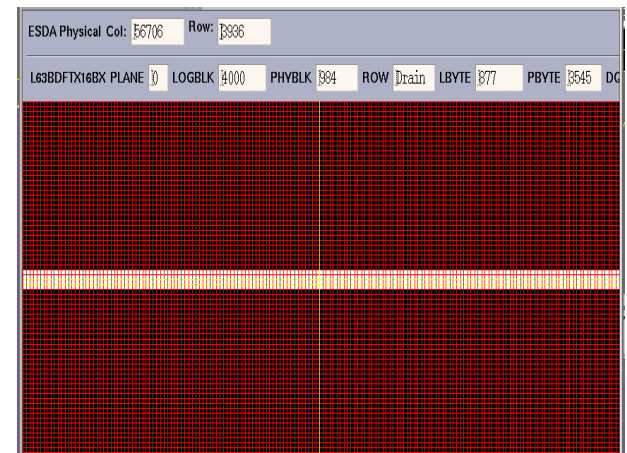
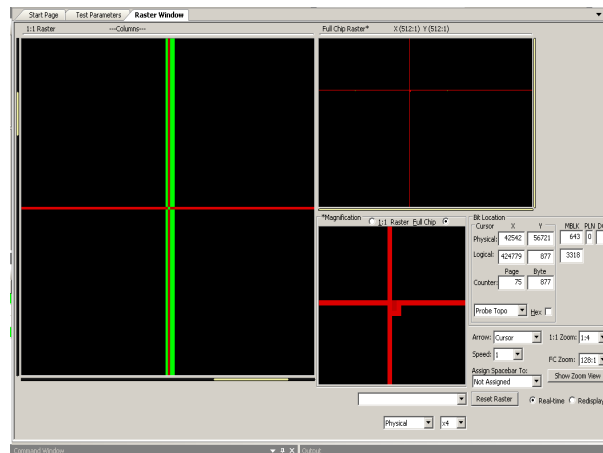
# 60 series Part Type I Results:

## Verified Tests:

The top images on the right show bitline fails in the  $\mu$ M2 and the related probe output data.



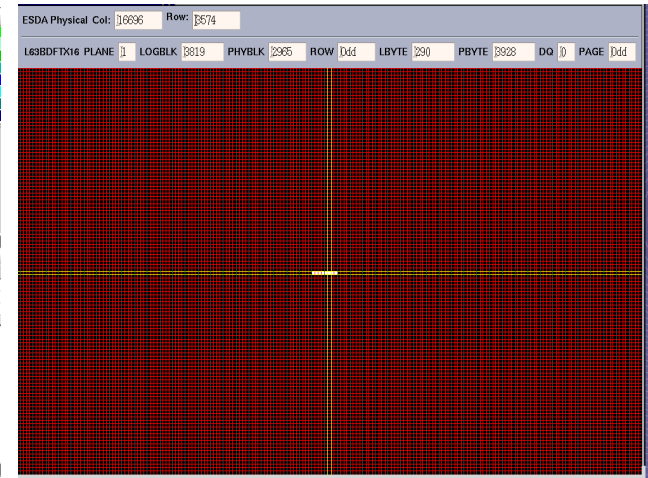
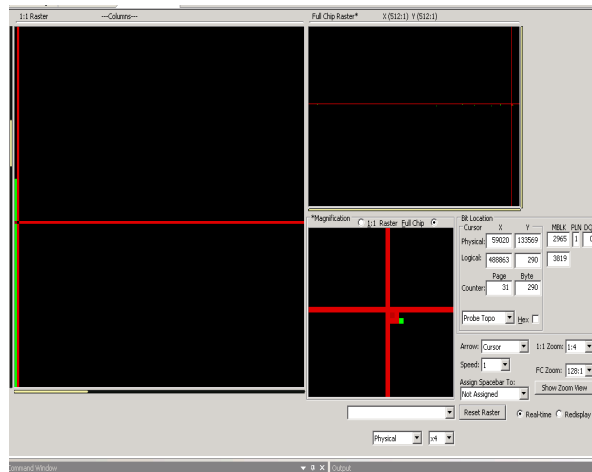
The bottom two Images show further failing bitlines but from a different defect.



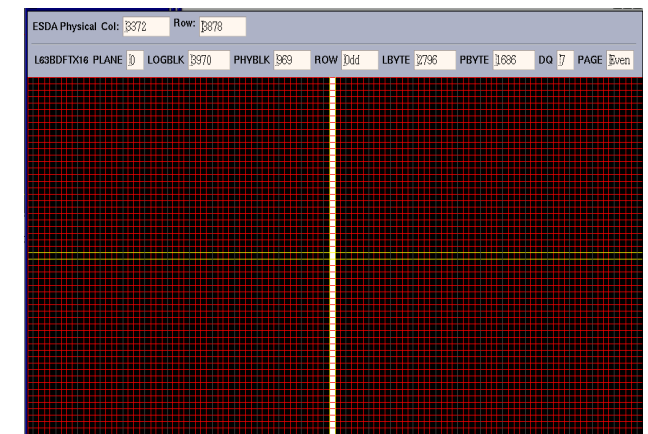
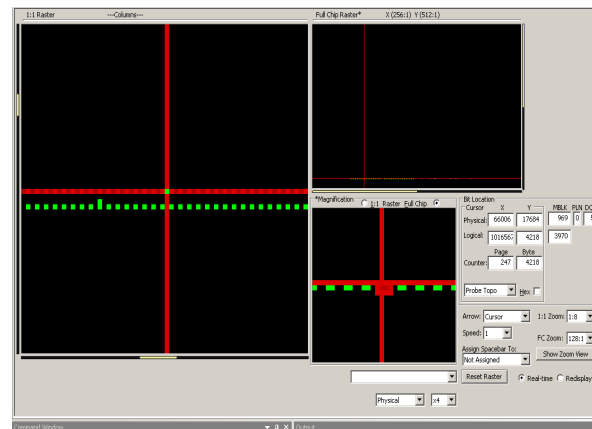
# 60 series Part Type I Results:

## Verified Tests:

The images to the right shows a verified fail related to a drainline in the  $\mu$ M2 with matching probe data location.



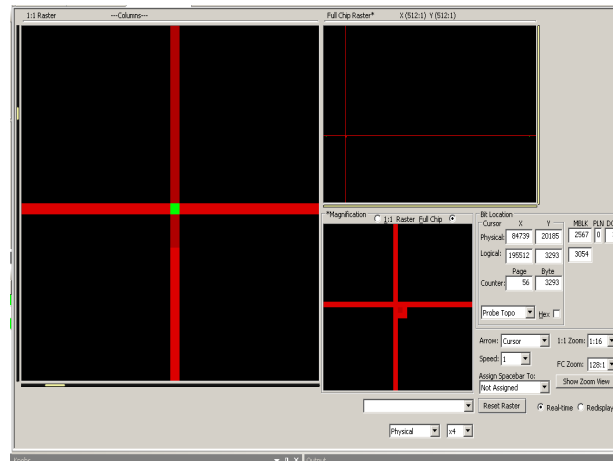
Images to the right display a verified wordline fail in the  $\mu$ M2 and the data verification.



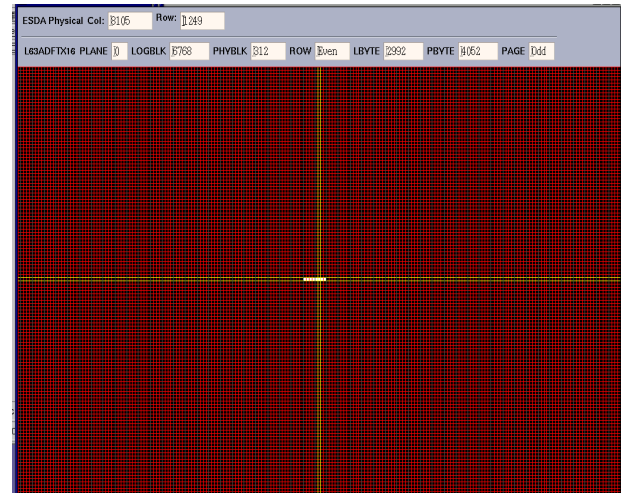
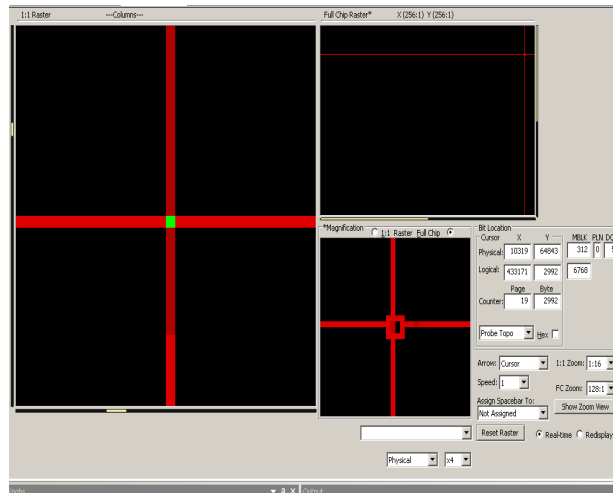
# 60 series Part Type II Results:

## Verified Tests:

The images to the right show an example of a bitline fail in the  $\mu\text{M}2$  and the matching byte correlated with probe data.



A drain related fail is displayed in the bottom-left image ( $\mu\text{M}2$ ). The blocks and column affected are displayed (bottom-right image).



# Conclusions:

- ▶ The MicroMate is applicable for Nand 60 series testing
- ▶ Testing time for a range of blocks is greatly reduced when compared to the Nextest (testing is between 1-2 minutes). Furthermore, a greater range of blocks and even the entire chip can be tested in less time.
- ▶ The GUI interface makes it easier to carry out multiple Bins due to ease in setting up and altering framework variables, test configuration and test patterns.