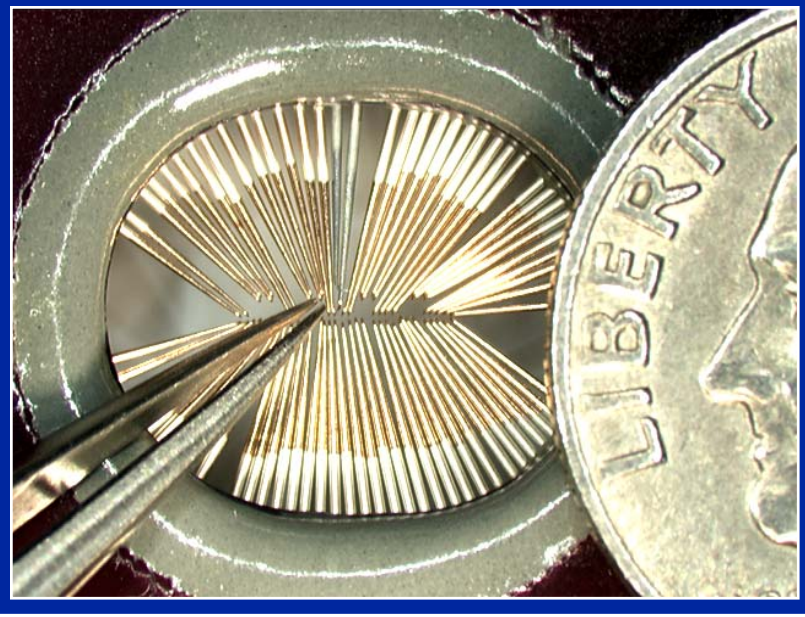
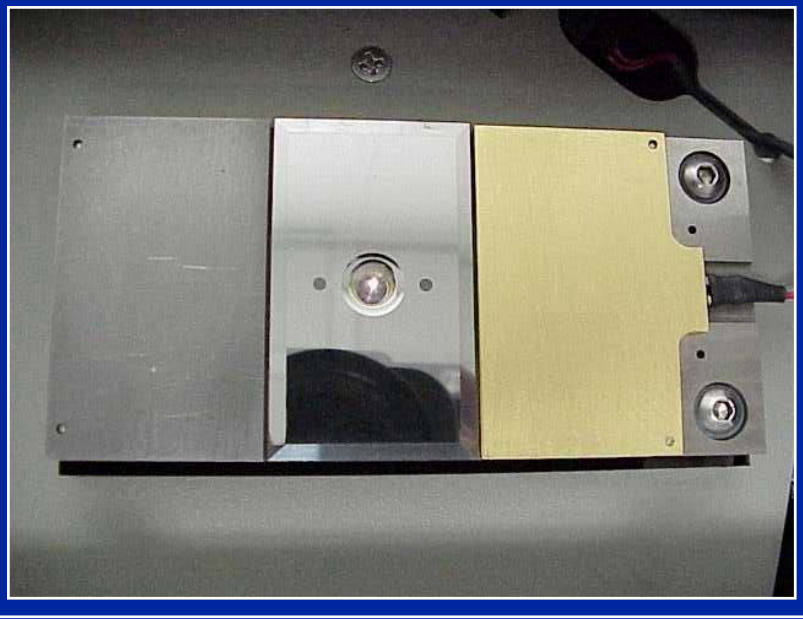
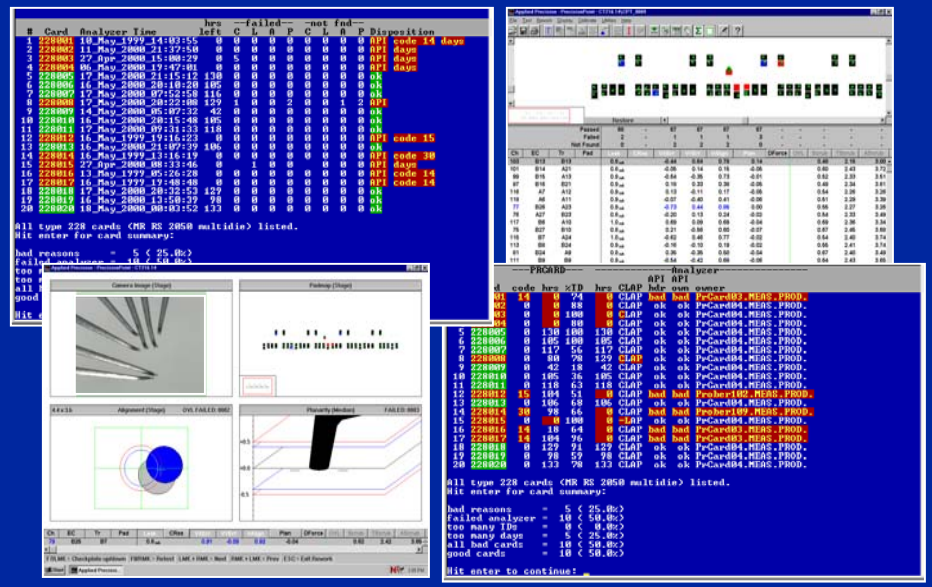
Distribution and Integrity of Probe Card Analyzer Data







Scott Dobbins
Seagate Technology

Southwest Test Workshop
Monday 4 June 2001

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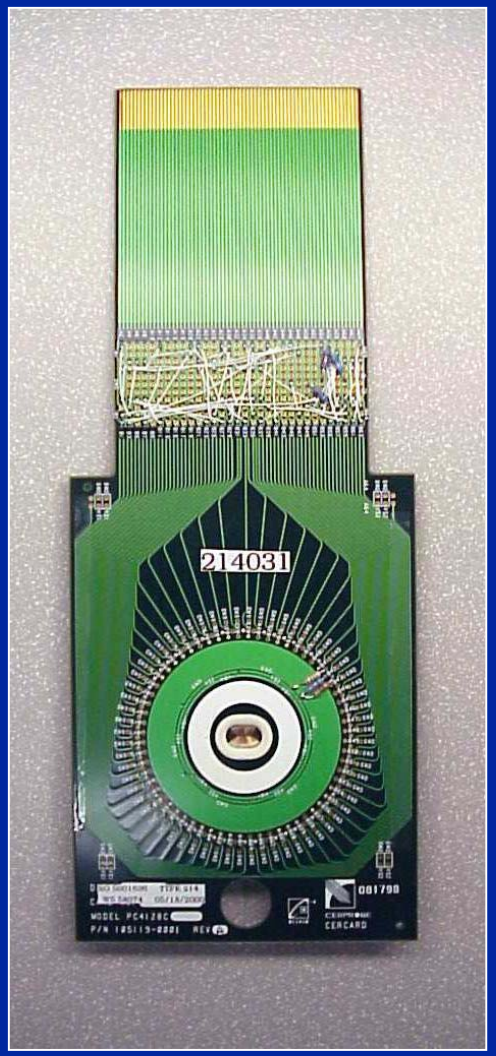
Information, the way you want it.

Overview

- Problem statement
- Solution summary
- Wafer probing at Seagate
- Data integrity risks
- Key improvements
- Results



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Problem Statement

At any given time, the factory has hundreds of probe cards on hand.

Cards are repaired and used on multiple shifts, 24/7.

There is a chance that non-conforming probe cards will make it to the test floor and cause scrap.

How do we minimize that chance?

tester

probe cards

analyzer

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Solution Summary

An automatic system moves the results of a probe card analyzer directly to the tester.

The particular probe card is sensed by both the analyzer and tester to ensure data integrity.

The system has eliminated inadvertent use of non-conforming probe cards on the test floor.

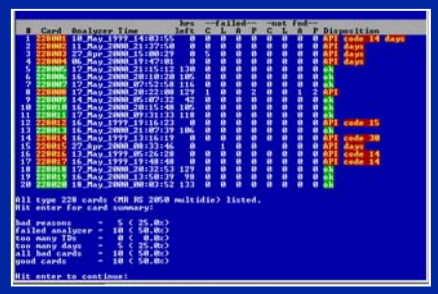
tester

card repair

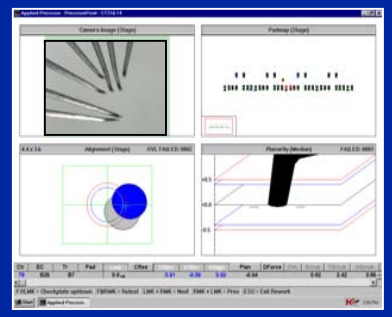
probe card

computer network

analyzer



probe card database



analyzer data

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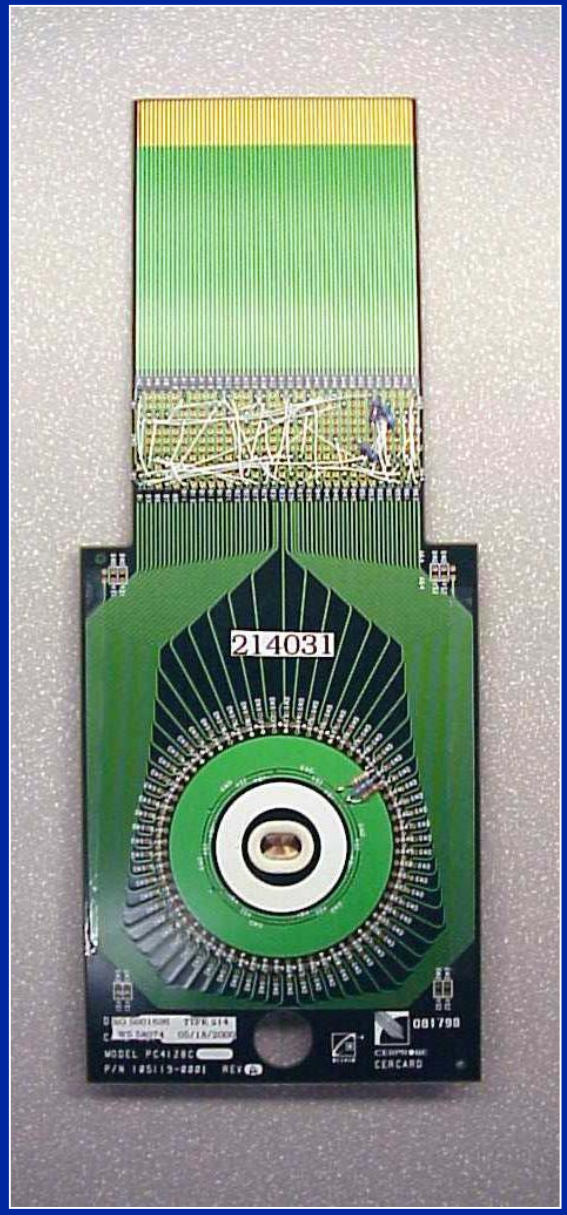
Wafer Probing at Seagate/Recording Head Operations

- The read/write heads for disc drives are probed in wafer form. A wafer can contain tens of thousands of heads.
- The large number of heads to be probed requires several hundred probe cards in various configurations.
- Though the number of probes per card is relatively small, the tip density and frequency of touchdowns is high.
- Keeping track of the repair status of each probe card is critical to the quality of the test operations.



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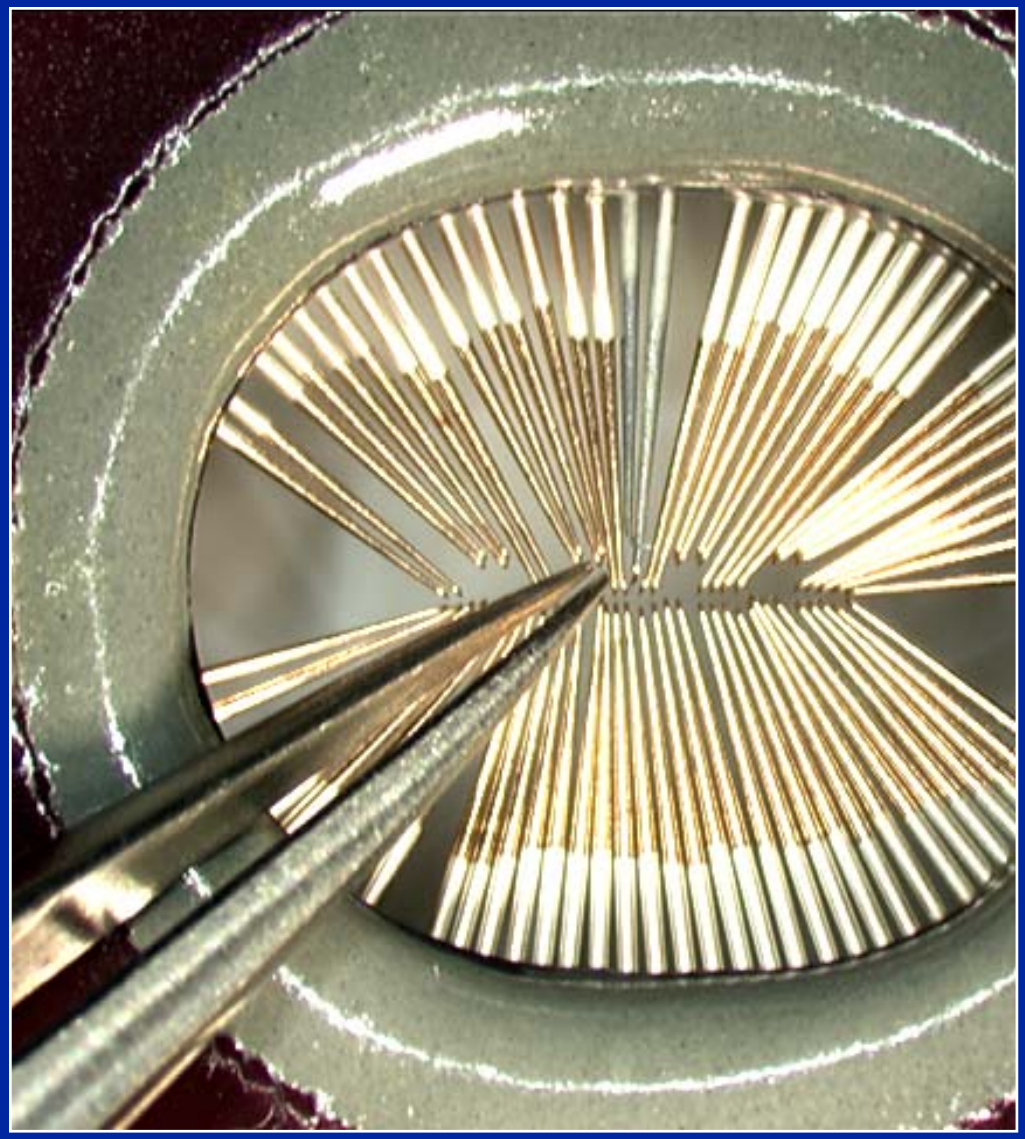
Probe Card Fit for Use?

How do we verify a probe card is fit for use?



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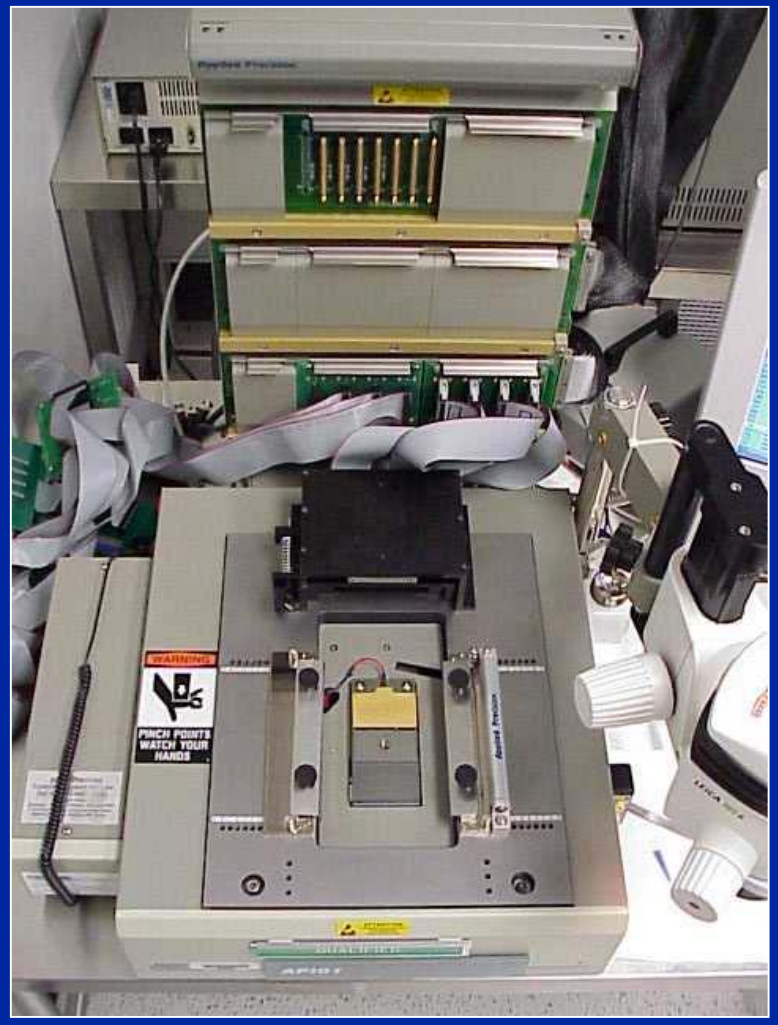
Probe Card Analyzer

In order to verify a probe card is fit for use, it is tested on a probe card analyzer.

The analyzer measures critical physical and electrical probe card parameters:

- Contact resistance
- Leakage current
- Alignment
- Planarity



Applied Precision model PRV2 probe card analyzer

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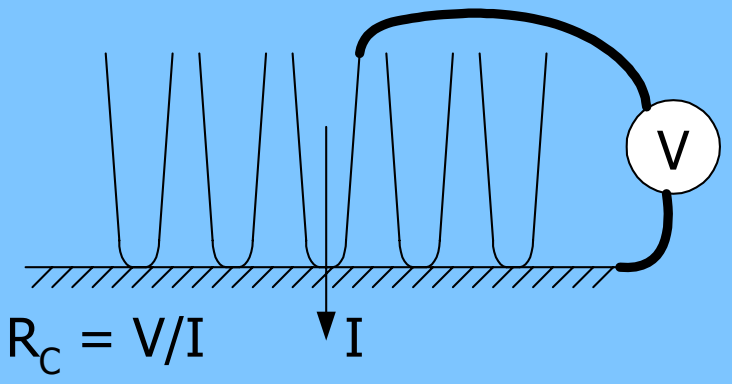
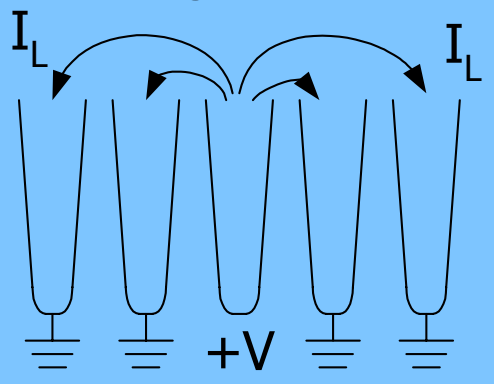
Probe Card Analyzer Tests

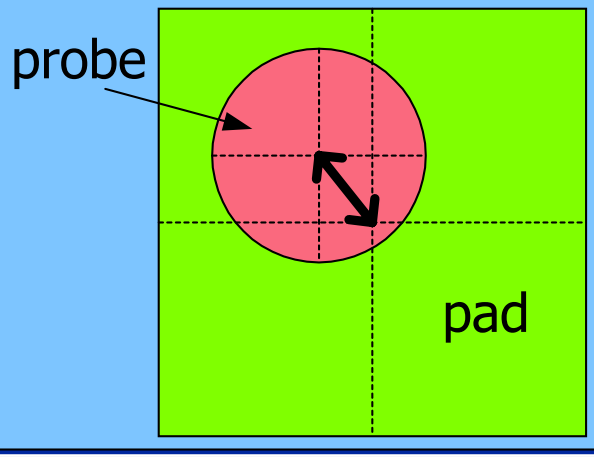
Contact Resistance



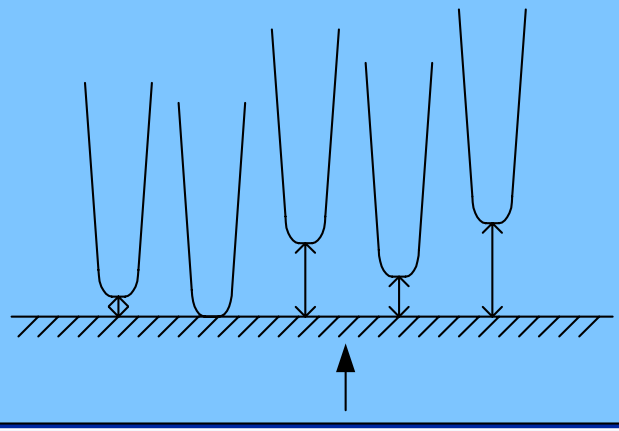
Leakage Current



X-Y Alignment



Planarity



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Probe Cards Used on Test Floor

After analyzer verification, conforming probe cards are sent from card repair to the test floor where they will be used.

The world is happy… what could go wrong??

Seagate recording head wafer test station

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Data Integrity Risk- Cards Unsorted

Segregating good cards from bad cards- necessary but not sufficient.

Factors that increase chance of cards being out of place:

- Large number of cards in a given area
- Poor communication at shift changeovers
- Insufficient training

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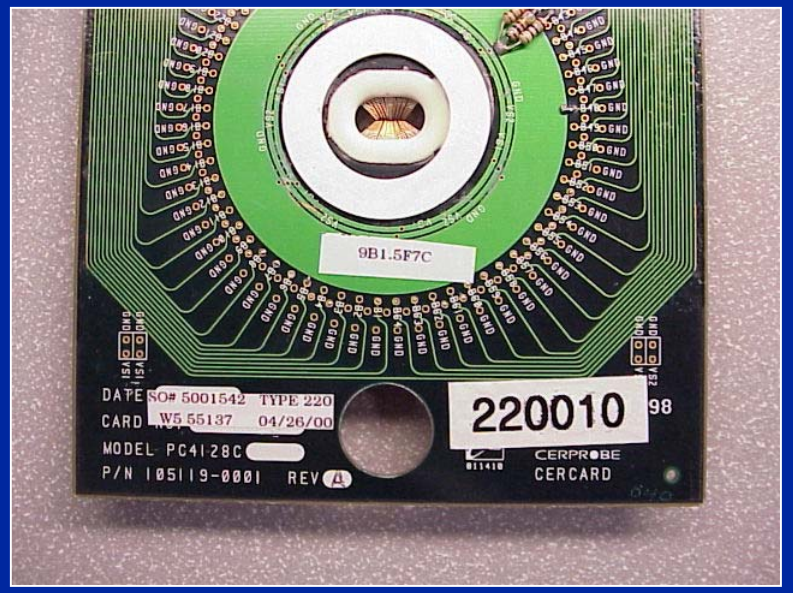
Data Integrity Risk- ID Entered Incorrectly

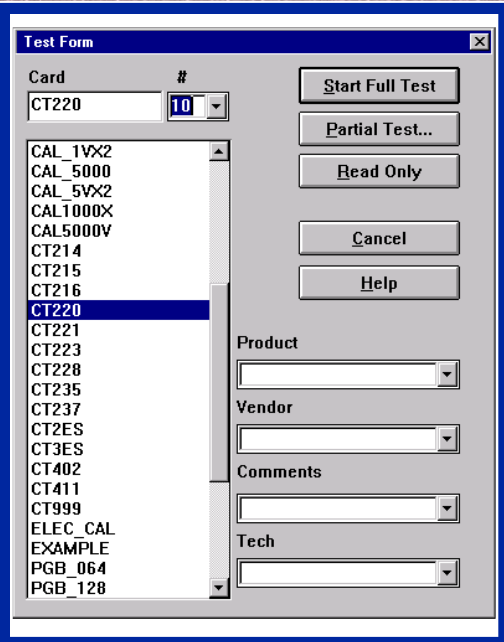
Each probe card is given a unique 6-digit ID number.

This number must be entered

- at the card analyzer
- at the wafer tester

If the IDs are entered incorrectly, analyzer data and/or probe data will be linked to the wrong card number.





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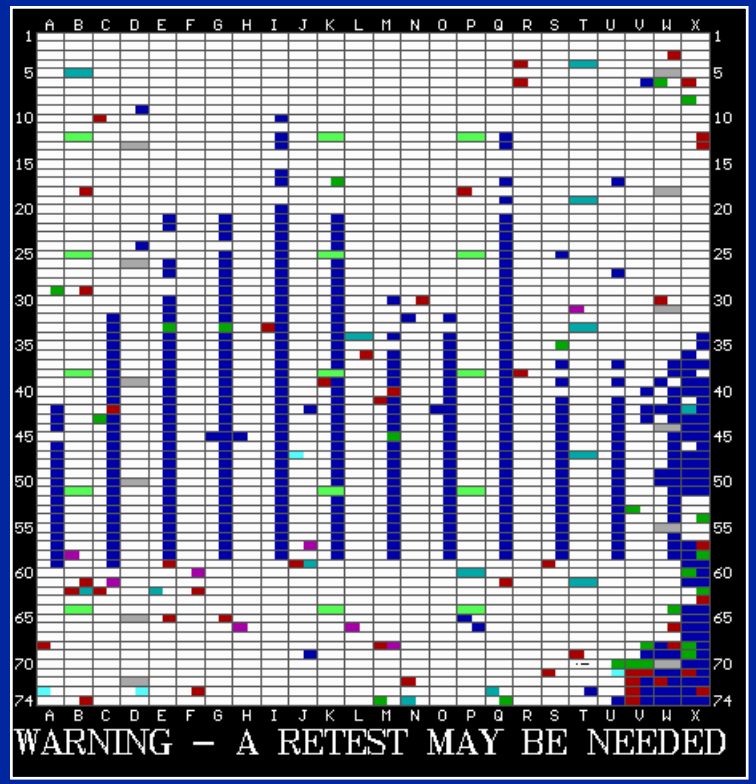
Misprobe Can Result

With data mismatch, a non-conforming probe card can fall through the cracks, get to the test floor.

The columnar pattern in this wafer map shows the effect of misprobe due to such a card.



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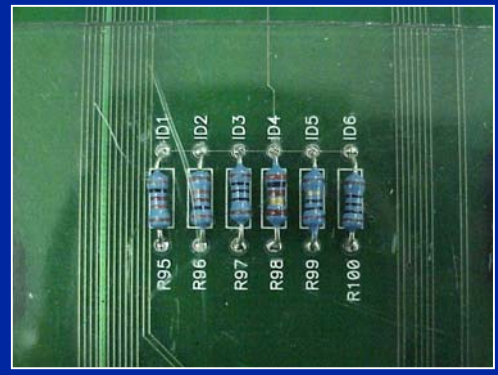
Key Improvements

Key changes made to improve data integrity:

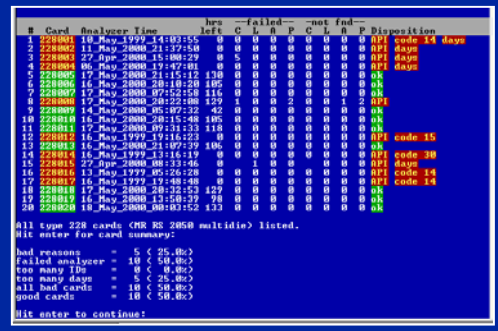
- Error-proof data entry at analyzer
- Error-proof data entry at tester
- Analyzer summary file
- Probe card database




```
Card Name: CT214    Card s/n: 31    Test#: 3
Date: 05/01/2000
Last Test Start Time: 10:30:30    End Time: 10:31:56
File Name: CT214.31\CPT_0003
Product:
Vendor:
Comments:
Tech:

Card ID
ID#     CHANNELS        RESISTANCE (ohms)
1       46,33           103
2       45,33           37.4
3       44,33           1009
4       20,33           13.5
5       19,33           302
6       18,33           33.2

Test Results
PASS     FAIL      NF        TEST TYPE
 60        0        0        Leakage
 57        3        0        Contact Resistance
 59        1        0        Vision Alignment
 57        3        0        Planarity
-------------------------------------
233        7        0        Totals
```



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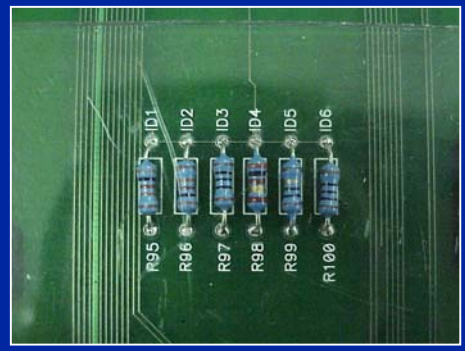
Error-Proof Data Entry: Card ID Resistors

d (digit) Value	Target Value = 10**(d/2 + 1) (Ohms)	Actual Resistor Value (Ohms)	Lower Limit = 10**(d/2 + 0.75) (Ohms)	Upper Limit = 10**(d/2 + 1.25) (Ohms)
< (short)	-	-	minus infinity	5.62
0	10.0	10	5.62	17.8
1	31.6	33	17.8	56.2
2	100	100	56.2	178
3	316	330	178	562
4	1.00 k	1 k	562	1.78 k
5	3.16 k	3.3 k	1.78 k	5.62 k
6	10.0 k	10 k	5.62 k	17.8 k
7	31.6 k	33 k	17.8 k	56.2 k
8	100 k	100 k	56.2 k	178 k
9	316 k	330 k	178 k	562 k
> (open)	-	-	562 k	plus infinity



214031

100 Ω 33 Ω 1000 Ω 10 Ω 330 Ω 33 Ω

- Six resistors are placed on each probe card.
- Each resistor represents a digit in the six-digit card ID.
- ID digits are encoded according to the table above.
- Resistor values are spaced on a log scale to minimize readback error.

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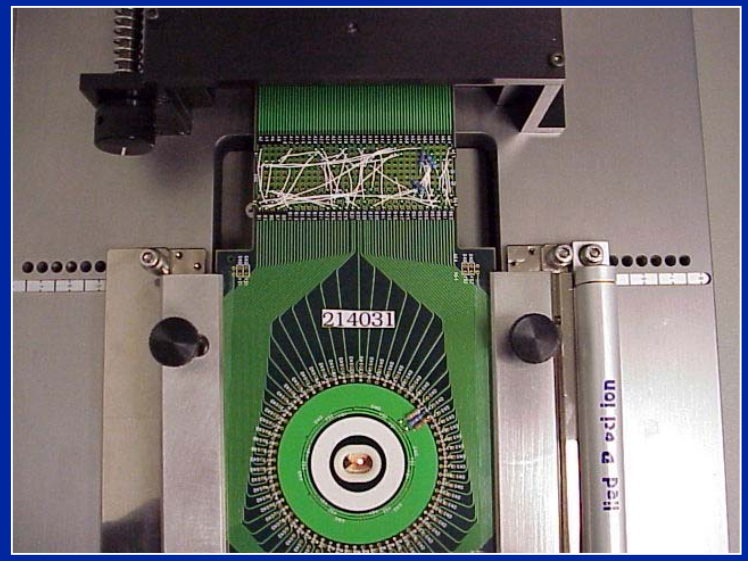
ID Readback at Probe Card Analyzer

- On request from Seagate, Applied Precision wrote a version of analyzer software with the resistor reading feature.
- Channels to be read are specified in the card's reference file.
- ID channels are scanned.
- Analyzer software writes resistance values to a file.
- User-written software decodes resistance values into digits.
- Card ID is automatically derived with no chance of operator error.



RES	CHANNELS
103.1	RES46,33
37.4	RES45,33
1009.6	RES44,33
13.5	RES20,33
302.5	RES19,33
33.2	RES18,33

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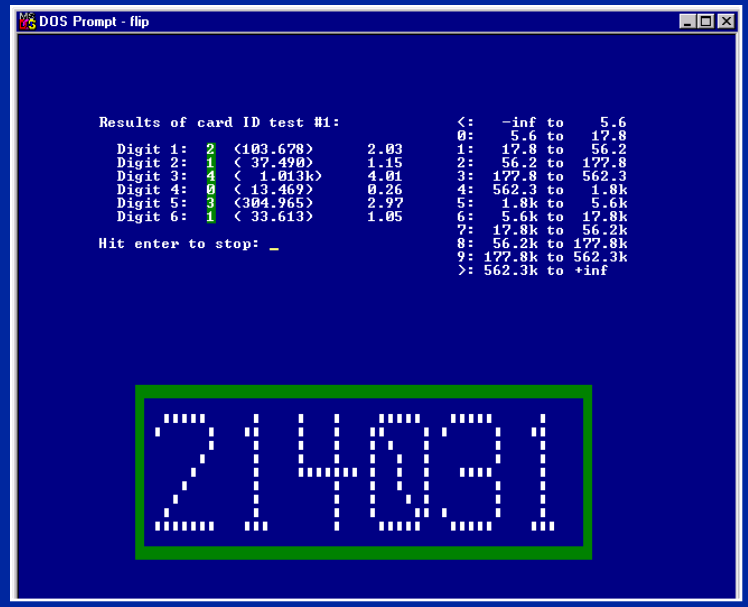
ID Readback at Wafer Tester

- Wafer tester contains six dedicated channels to measure card ID resistors.
- Operator plugs probe card into tester.
- ID channels are scanned.
- Tester software decodes resistance values into digits.
- Card ID is automatically derived with no chance of operator error.



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Analyzer Summary File

- On request from Seagate, Applied Precision wrote a version of analyzer software with the summary file feature.
- The summary file contains analyzer results for each test performed, as well as the ID resistor values.

```
Card Name: CT214    Card s/n: 31    Test#: 3
Date: 05/01/2000
Last Test Start Time: 10:30:30    End Time: 10:31:56
File Name: CT214.31\CPT_0003
Product:
Vendor:
Comments:
Tech:

Card ID
ID#     CHANNELS        RESISTANCE (ohms)
1       46,33           103
2       45,33           37.4
3       44,33           1009
4       20,33           13.5
5       19,33           302
6       18,33           33.2

Test Results
PASS     FAIL      NF        TEST TYPE
 60        0        0        Leakage
 57        3        0        Contact Resistance
 59        1        0        Vision Alignment
 57        3        0        Planarity
-------------------------------------
233        7        0        Totals
```


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Analyzer Summary File

- For each card tested, a summary file is written to a network drive.
- Software on the tester reads the summary file.
- The software determines if the card can be used for probing:
  - Date/time of analyzer testing
  - Results of analyzer tests
  - Card IDs read by analyzer and tester match

```
Card Name: CT214    Card s/n: 31    Test#: 3
Date: 05/01/2000
Last Test Start Time: 10:30:30    End Time: 10:31:56
File Name: CT214.31\CPT_0003
Product:
Vendor:
Comments:
Tech:

Card ID
ID#     CHANNELS        RESISTANCE (ohms)
1       46,33           103
2       45,33           37.4
3       44,33           1009
4       20,33           13.5
5       19,33           302
6       18,33           33.2

Test Results
PASS     FAIL      NF        TEST TYPE
 60        0        0        Leakage
 57        3        0        Contact Resistance
 59        1        0        Vision Alignment
 57        3        0        Planarity
-------------------------------------
233        7        0        Totals
```

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Summary File- ID Mismatch

```
Card Name: CT214     Card s/n: 31
Test#: 3
Date: 05/01/2000
Last Test St   Time: 10:30:30
File Name  CT214.31 CPT_0003
Product:
Vendor:
Comments:
Tech:

Card ID
ID#      CHANNELS          RESISTANCE
1        46,33             103
2        45,33             37.4
3        44,33             1009
4        20,33             13.5
5        19,33             302
6        18,33             33.2
```

mouse

```
Card Name: CT220     Card s/n: 11
Test#: 5
Date: 05/20/2001
Last Test St   Time:  8:45:12
File Name  CT220.11 CPT_0005
Product:
Vendor:
Comments:
Tech:

Card ID
ID#      CHANNELS          RESISTANCE
1        46,33             100
2        45,33             101
3        44,33             13.2
4        20,33             13.4
5        19,33             104
6        18,33             337
```

resistors

214031 = 214031
No error

220011 ≠ 220023
Data entry error

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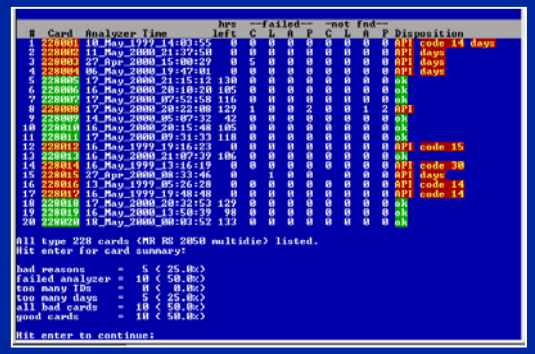
Probe Card Database

- Software gives visibility to probe card status
- Single or multiple probe card views
- Displays conforming/non-conforming status
- Also displays:
  - Elapsed time since analyzer testing
  - Accumulated touchdowns since analyzer testing
  - Last use of card- operator, location, time
  - Operator comments
- Allows an operator to disable a card for special cause; instantly disallows use of card across all testers



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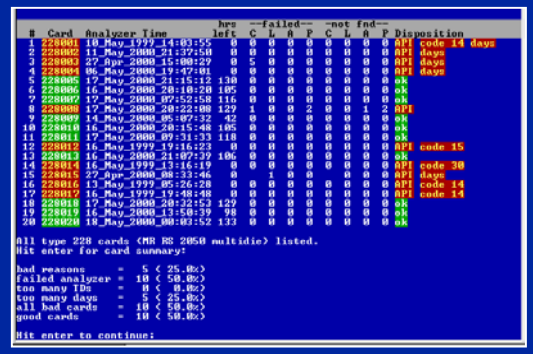
Probe Card Database- Disposition

The following parameters are specified for each probe card:

- Analyzer info
  - Hours since last analyzer test
  - Results of each analyzer test (C, L, A, P)
  - Summary file security
- Touchdowns (TDs) since last test
- ID mismatch condition
- Special cause marked by operator



All probe card parameters must conform to specs. If not, software disallows use.

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Multiple Card View

#	Card	Analyzer Time	hrs left	--failed-- C	L	A	P	-not fnd- C	L	A	P	Disposition
1	228001	10_May_1999_14:03:55	0	0	0	0	0	0	0	0	0	API code 14 days
2	228002	11_May_2000_21:37:50	0	0	0	0	0	0	0	0	0	API days
3	228003	27_Apr_2000_15:00:29	0	5	0	0	0	0	0	0	0	API days
4	228004	06_May_2000_19:47:01	0	0	0	0	0	0	0	0	0	API days
5	228005	17_May_2000_21:15:12	130	0	0	0	0	0	0	0	0	ok
6	228006	16_May_2000_20:10:20	105	0	0	0	0	0	0	0	0	ok
7	228007	17_May_2000_07:52:58	116	0	0	0	0	0	0	0	0	ok
8	228008	17_May_2000_20:22:08	129	1	0	0	2	0	0	1	2	API
9	228009	14_May_2000_05:07:32	42	0	0	0	0	0	0	0	0	ok
10	228010	16_May_2000_20:15:48	105	0	0	0	0	0	0	0	0	ok
11	228011	17_May_2000_09:31:33	118	0	0	0	0	0	0	0	0	ok
12	228012	16_May_1999_19:16:23	0	0	0	0	0	0	0	0	0	API code 15
13	228013	16_May_2000_21:07:39	106	0	0	0	0	0	0	0	0	ok
14	228014	16_May_1999_13:16:19	0	0	0	0	0	0	0	0	0	API code 30
15	228015	27_Apr_2000_08:33:46	0		1	0	0		0	0	0	API days
16	228016	13_May_1999_05:26:28	0	0	0	0	0	0	0	0	0	API code 14
17	228017	16_May_1999_19:48:48	0	0	0	0	0	0	0	0	0	API code 14
18	228018	17_May_2000_20:32:53	129	0	0	0	0	0	0	0	0	ok
19	228019	16_May_2000_13:50:39	98	0	0	0	0	0	0	0	0	ok
20	228020	18_May_2000_00:03:52	133	0	0	0	0	0	0	0	0	ok

All type 228 cards (MR RS 2050 multidie) listed.
Hit enter for card summary:

bad reasons	=	5	(25.0%)
failed analyzer	=	10	(50.0%)
too many TDs	=	0	(0.0%)
too many days	=	5	(25.0%)
all bad cards	=	10	(50.0%)
good cards	=	10	(50.0%)

Hit enter to continue:

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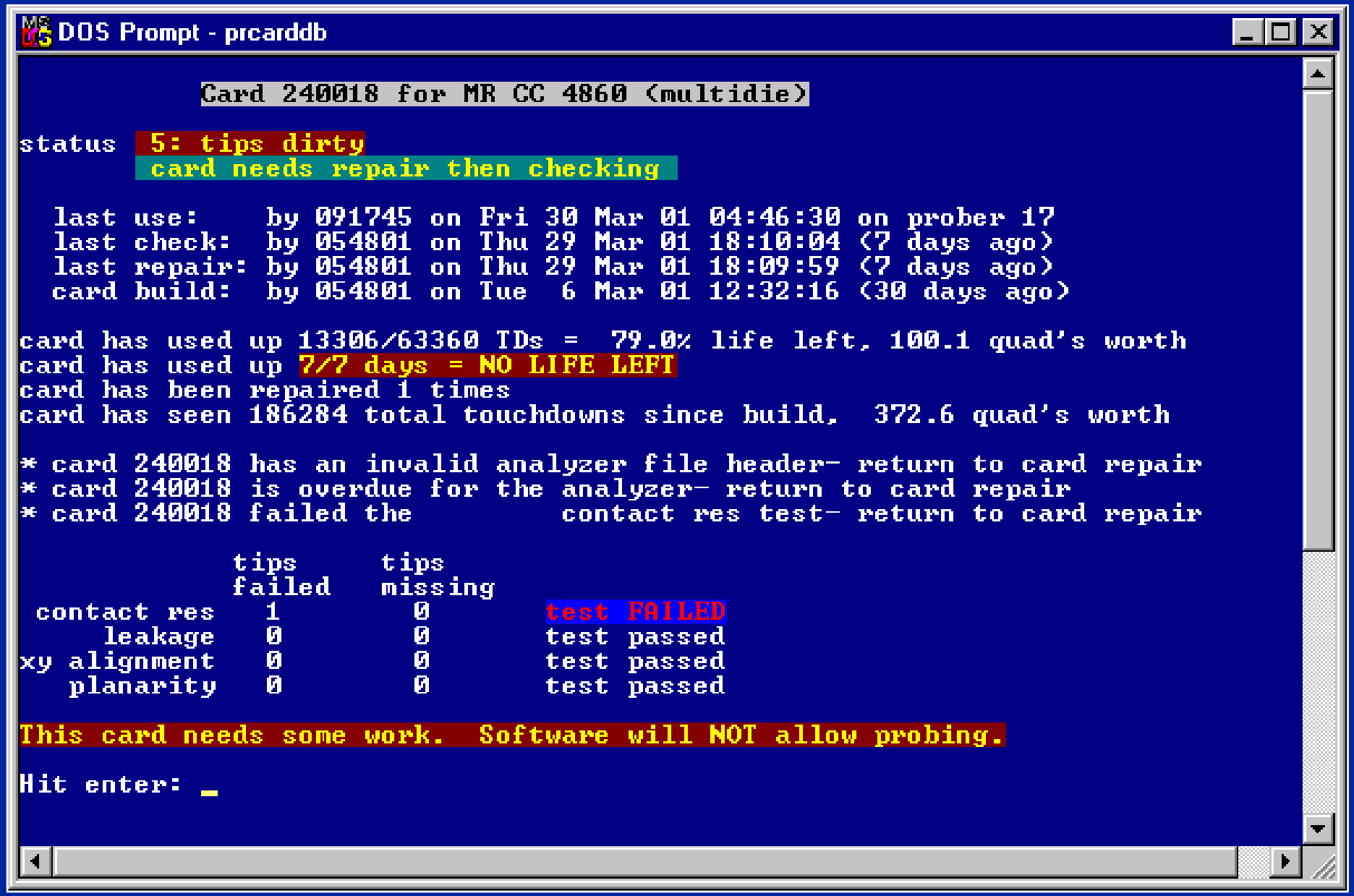
Single Card View



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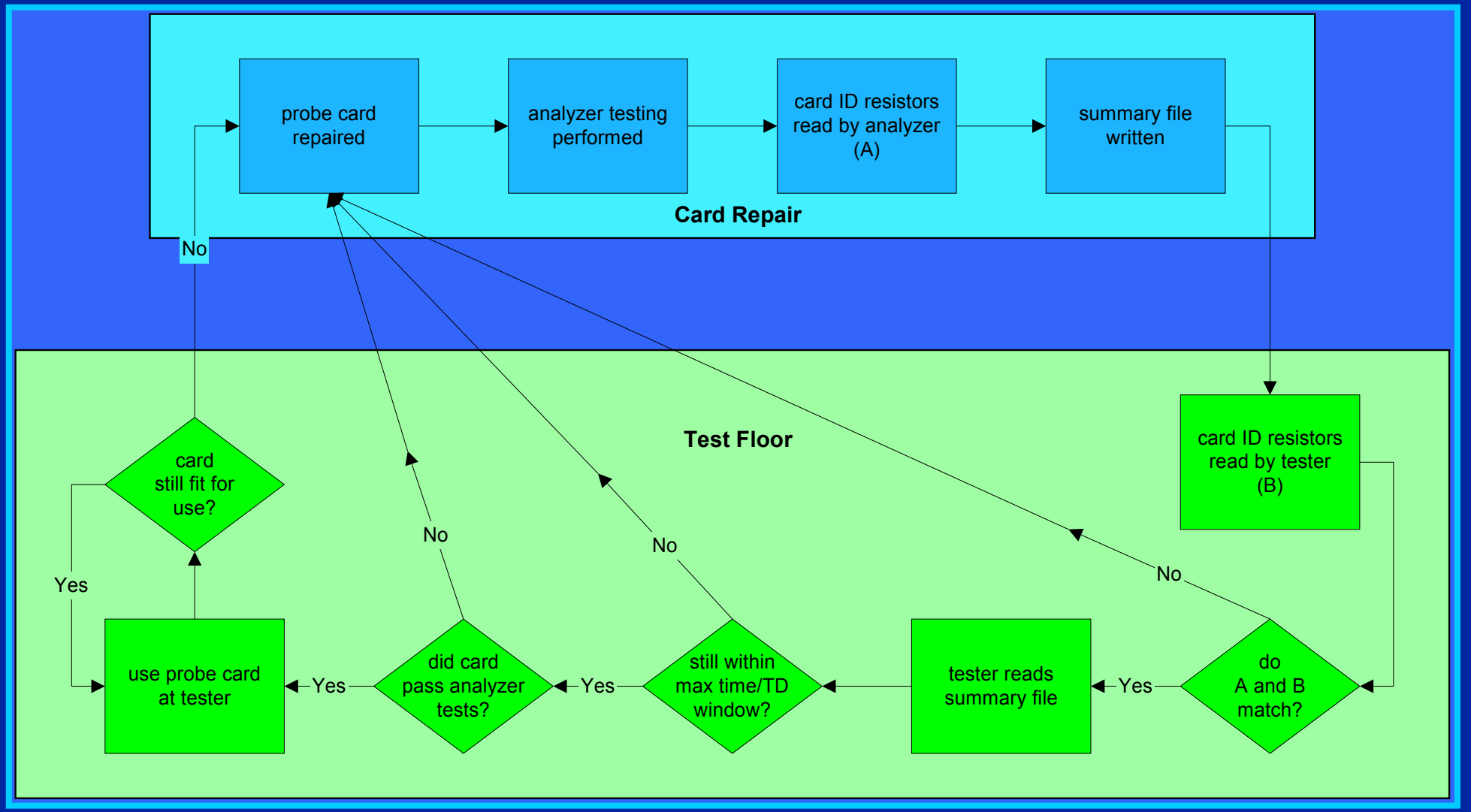
Process Flow



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Result

- Before start of project, analyzer data entry error rate assumed to be ~ 1%.
- After software was implemented, error rate was found to be significantly > 1%.
- Feedback from system has continuously driven error rate down.
- Some level of human error will continue, but it will no longer contribute to card-induced misprobe.

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Thank You

Thanks to Bob Heiligenberg and Kjell Lundberg at Applied Precision for their efforts on the custom analyzer software.

Isolated traces

make happy faces.

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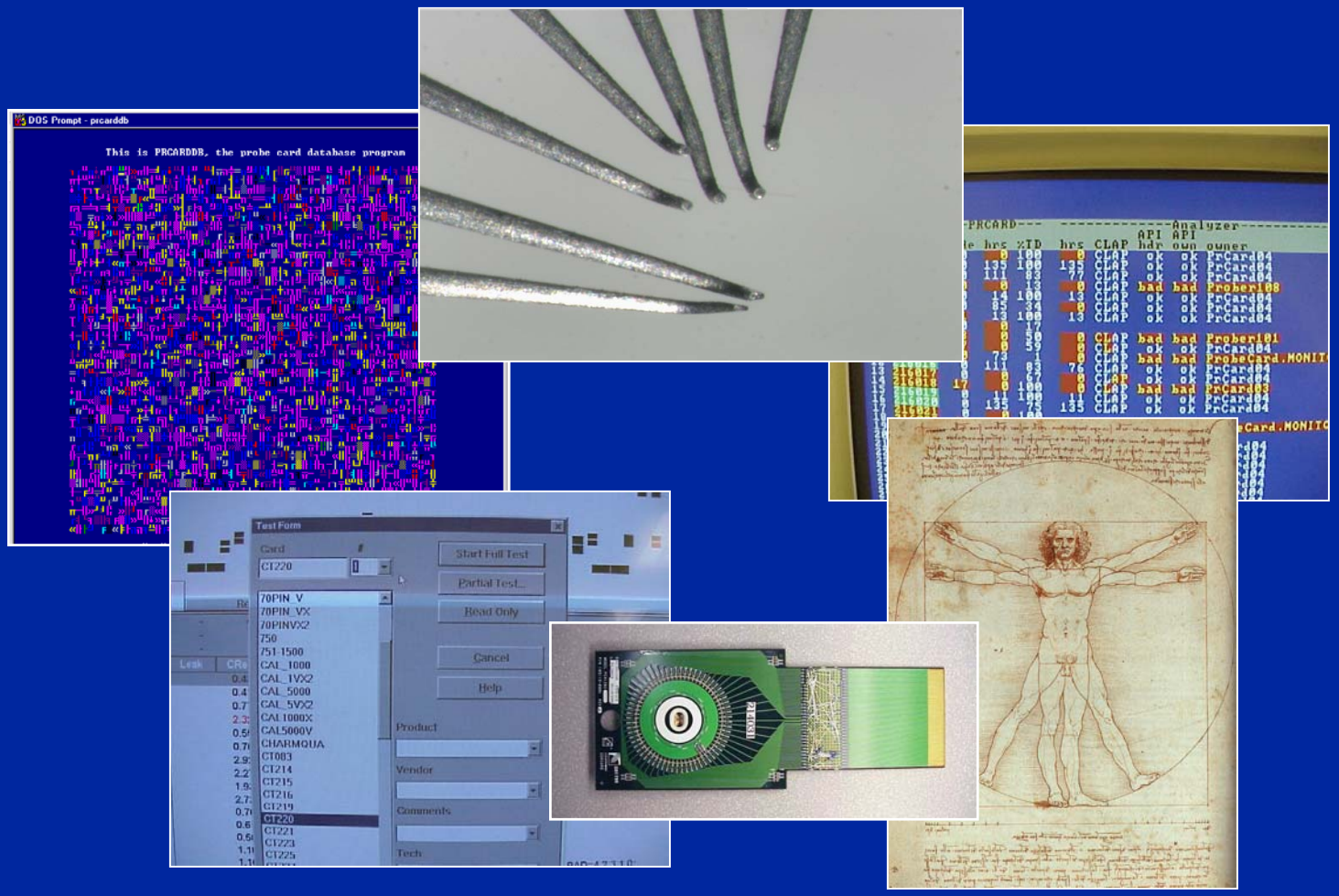
Questions?



Feel free to contact me at
scott.d.dobbins@seagate.com / 952-844-7145

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