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Semiconductor Wafer Test Workshop

ROD SCHWARTZ and MARK McLAREN
Integrated Technology Corporation

CHALLENGES IN TESTING HIGH FORCE 300mm PROBE CARD ARRAYS

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BACKGROUND

- **WHAT IS REQUIRED OF A PROBE CARD METROLOGY TOOL?**
  - **TO TEST AND VERIFY THE ELECTRICAL AND MECHANICAL CHARACTERISTICS OF A PROBE CARD**

BACKGROUND

- WHAT DOES THAT MEAN FOR THE DIFFERENT APPLICATIONS?

- PROBE CARD MFR

  - WANTS TO DEMONSTRATE TO ITS CUSTOMER THAT THE CARD HAS BEEN BUILT TO SPECIFICATION, HAS BEEN TESTED AND PASSED AND HERE IS THE DATA TO PROVE IT.

  - PRIMARY CONCERN IS THE PROBE CARD PERFORMANCE

BACKGROUND

- PROBE CARD USER
  - WANTS CONFIDENCE THAT THE CARD WILL PERFORM ACCURATELY AND RELIABLY WITHIN THE WAFER TEST ENVIRONMENT
  - THIS INVOLVES THE INFLUENCES OF THE PROBE CARD, THE WAFER PROBER AND THE TESTER TO PROBE CARD INTERFACE

BACKGROUND

- TO PROVIDE A COMPLETE SOLUTION THE METROLOGY TOOL NEEDS TO REPLICATE THE WAFER TEST ENVIRONMENT

- IN A 300mm ONE OR TWO TOUCH APPLICATION THIS HAS ITS OWN CHALLENGES

WAFER TEST ENVIRONMENT

- WAFER PROBER
- PROBE CARD
- TEST SYSTEM TO PROBE CARD INTERFACE – ELECTRICAL AND MECHANICAL

CHALLENGES

- CHUCK/STAGE ASSEMBLY
- TESTER INTERFACE DESIGN
- HIGH PROBE FORCE
- RESOURCE SWITCHING

CHALLENGES

- CHUCK/STAGE ASSEMBLY
  - HIGH FORCES
  - PRECISION MOTION VS SPEED
  - STABILITY
  - TEMPERATURE

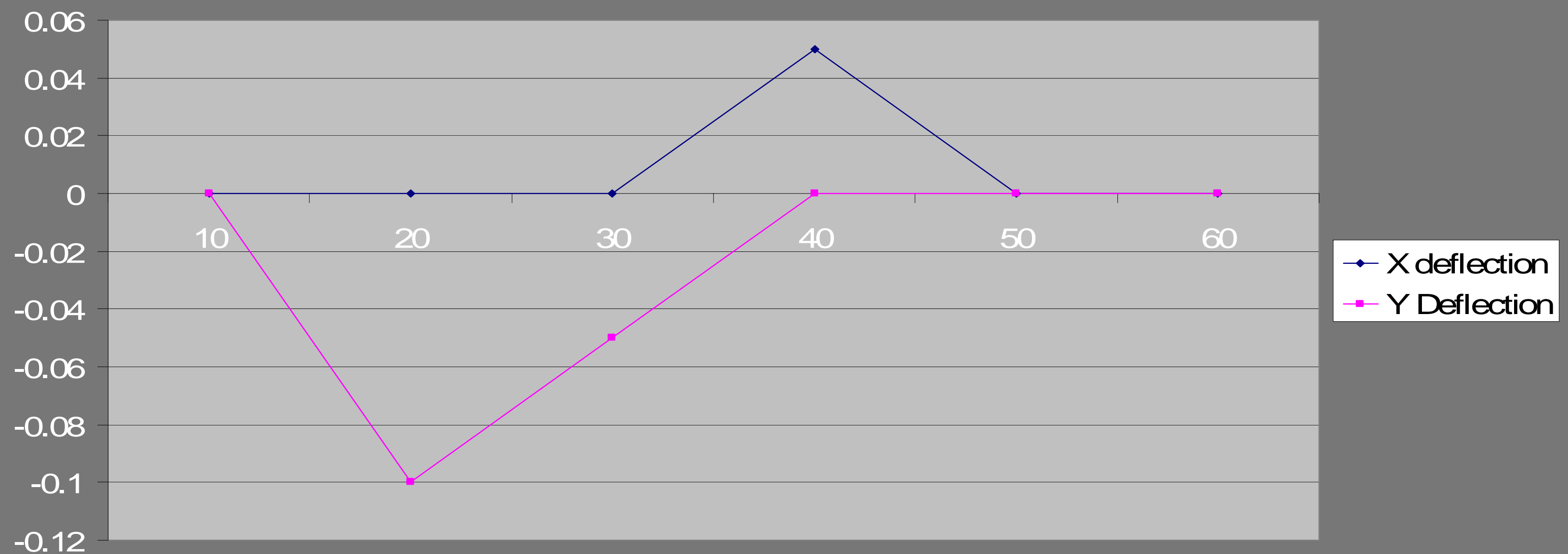
WAFER PROBER CHUCK/STAGE

- WAFER PROBER HAS A CHUCK ON AN XYZ DRIVE SYSTEM
- A 300MM SINGLE OR TWO TOUCH PROBE CARD REQUIRES ALL PROBES TO BE OVERDRIVEN AT THE SAME TIME – TOTAL PROBE FORCE MAY ALREADY BE IN THE 120 Kg. TO 180 Kg. RANGE
- IN MANY CASES IT COULD ALSO BE A HOT CHUCK SYSTEM
- MUST BE REASONABLY FAST

METROLOGY TOOL CHUCK/STAGE

- TO REPLICATE THE WAFER PROBER IT NEEDS AN XYZ STAGE WITH THE CAPABILITY TO OVERDRIVE ALL PROBES ON A MEASUREMENT CHUCK WITH UP TO 180Kg OF FORCE
- HIGH PRECISION READING OF POSITION
- AT TEMPERATURE IF THE CUSTOMER REQUIRES IT
- KEY REQUIREMENT IS STAGE STABILITY

METROLOGY TOOL CHUCK/STAGE



- EXPERIMENTAL DATA TAKEN AT ITC WITH FORCE CENTERED ON MEASUREMENT CHUCK

CHALLENGES

- TESTER INTERFACE DESIGN

TESTER INTERFACE DESIGN

- METROLOGY TOOL GOAL
  - REPLICATE THE TEST CONDITIONS
    - REFERENCE PLANE
    - MECHANICAL INTERFACE
    - ELECTRICAL INTERFACE
  - AT A “REASONABLE” COST.....

- SIMPLE RIGHT?

TESTER INTERFACE DESIGN

- WRONG! – WHY?

- EVERY TEST PLATFORM IS DIFFERENT
  - MOST USE ZIF'S…. BUT NEVER THE SAME ONE AND SOME USE POGO'S
  - ONE USES BOTH
  - EVERYONE HAS THEIR OWN IDEA ABOUT THE REFERENCE PLANE
  - THE PROBE CARD CAN BE HELD DIFFERENTLY

TESTER INTERFACE DESIGN

AND THERE'S MORE…

- PROBE CARD SIZE
  - THERE ARE ROUND ONES AND SQUARE ONES…. 480mm, 440mm, 22" SQUARE….
  - THEY MIGHT HAVE 100 CONNECTORS OR MAYBE 36

- STIFFENER DESIGN
  - COULD BE STANDARD OR…..
  - COULD BE CUSTOMER SPECIFIC
  - GETS CHANGED ALL THE TIME

TESTER INTERFACE DESIGN

AND SPEAKING OF CUSTOMERS…

- SO IT'S A 5377 - 480mm CARD 100 ADVANTEST ZIF'S?
- NO 440mm 96 ADVANTEST ZIF'S

- SO IT'S A 5377 – 440mm CARD 96 ADVANTEST ZIF'S?
- NO 480mm 100 YOKOGAWA ZIF'S

TESTER INTERFACE DESIGN

COMMON MOTHERBOARDS

- ADVANTEST T5375
- VERIGY V5400
- YOKOGAWA AL6050
- F3000

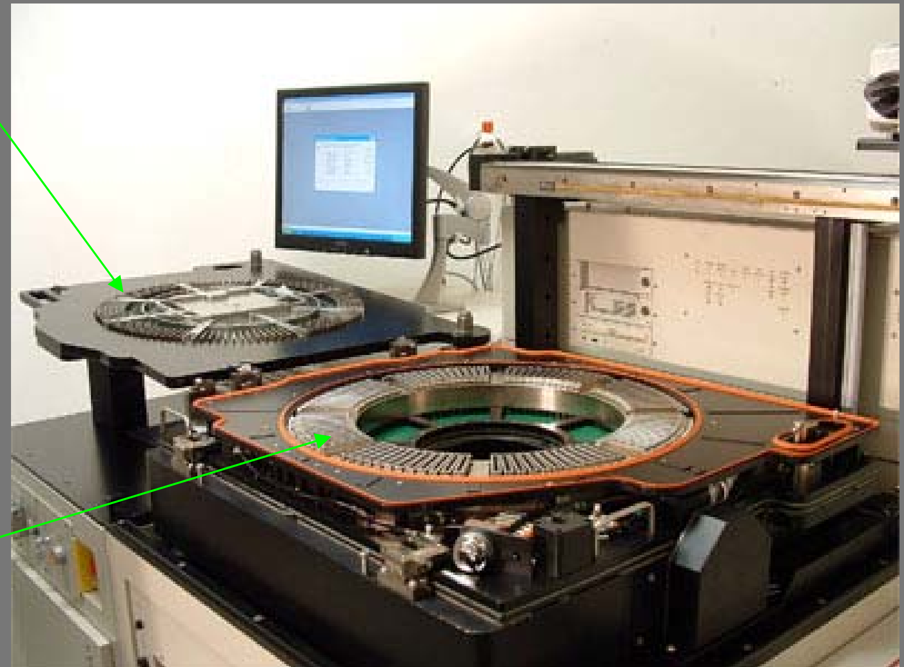
TESTER INTERFACE DESIGN

- **ADVANTEST T5375 MOTHERBOARD**

PROBE CARD IS SCREWED
TO THE RETAINER

REFERENCE SURFACE IS
FRONT SIDE OF STIFFENER

96 ADVANTEST ZIF'S

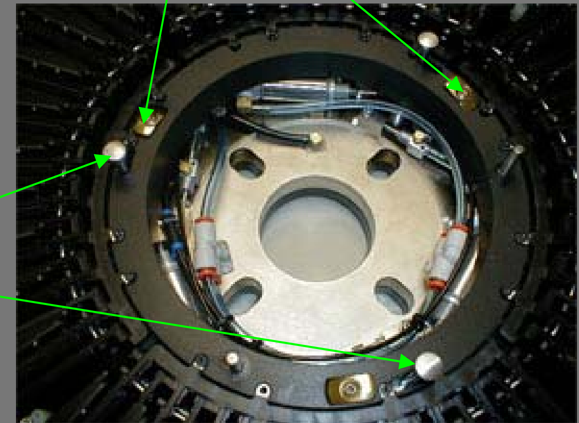


TESTER INTERFACE DESIGN

- **VERIGY V5400 MOTHERBOARD**

36 XANDEX ZIF'S

REFERENCE PLANE - THE 3 GOLD PADS

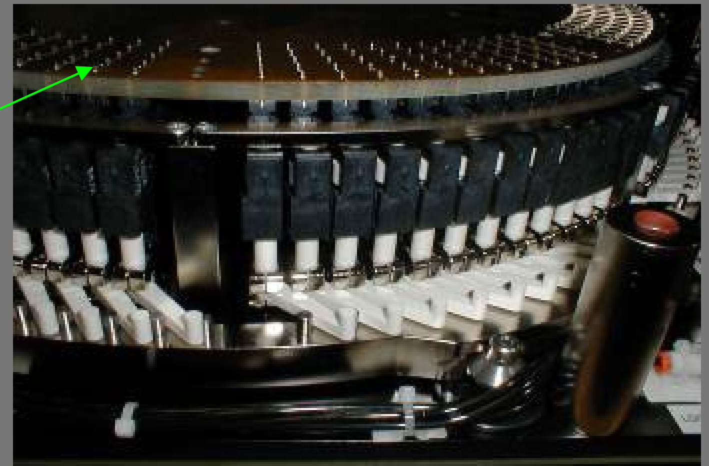


NO RETAINER, THE PROBE CARD IS LOADED DIRECTLY ONTO MOTHERBOARD AND PULLED DOWN BY "NAILS"

TESTER INTERFACE DESIGN

- **YOKOGAWA AL6050 MOTHERBOARD**

96 YOKOGAWA CONNECTORS

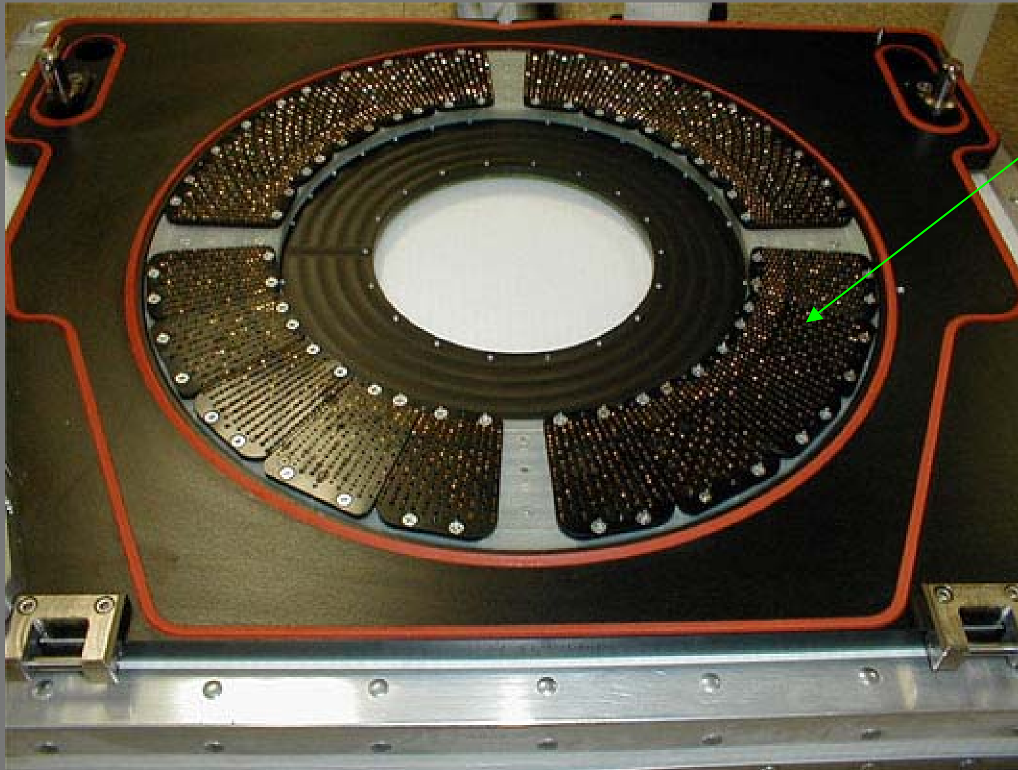


440mm PROBE CARD

REFERENCE IS FRONT OF STIFFENER

TESTER INTERFACE DESIGN

- **F3000 MOTHERBOARD**



3200 DOUBLE ENDED POGO'S

REFERENCE IS FRONT OF STIFFENER

TESTER INTERFACE DESIGN

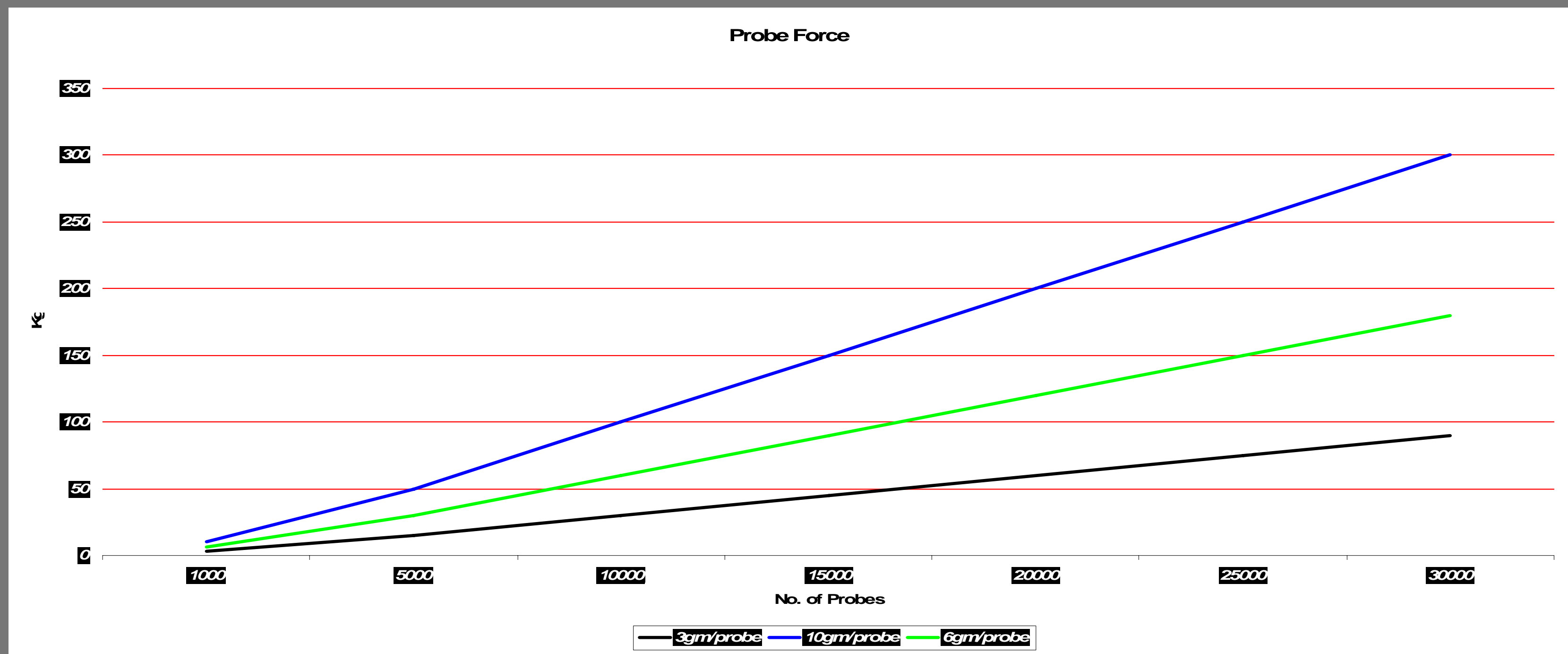
- NEWER TEST PLATFORMS – NEW CHALLENGES
- ADVANTEST T5383 – NEW CENTER DOCKING MECHANISM
- NEXTEST MAGNUM GV – LARGE SQUARE PROBED CARD, UNIQUE CENTER DOCKING MECHANISM, “FLOATING” POGO BLOCKS

CHALLENGES

- HIGH PROBE FORCE

HIGH PROBE FORCE

- TYPICAL FORCE PER PROBE
  - 3-10gms DEPENDING ON THE TECHNOLOGY



HIGH PROBE FORCE

- USING A TYPICAL PROBE FORCE OF 6gm/PROBE
  - 10000 PROBES – 60Kg
  - 20000 PROBES – 120Kg
- DATA PRESENTED BY GUNTHER BOEHM, FEINMETALL AT SWT2006
  - Z-DEFLECTION IN HIS EXPERIMENTAL SET-UP AT 120KG = 120um

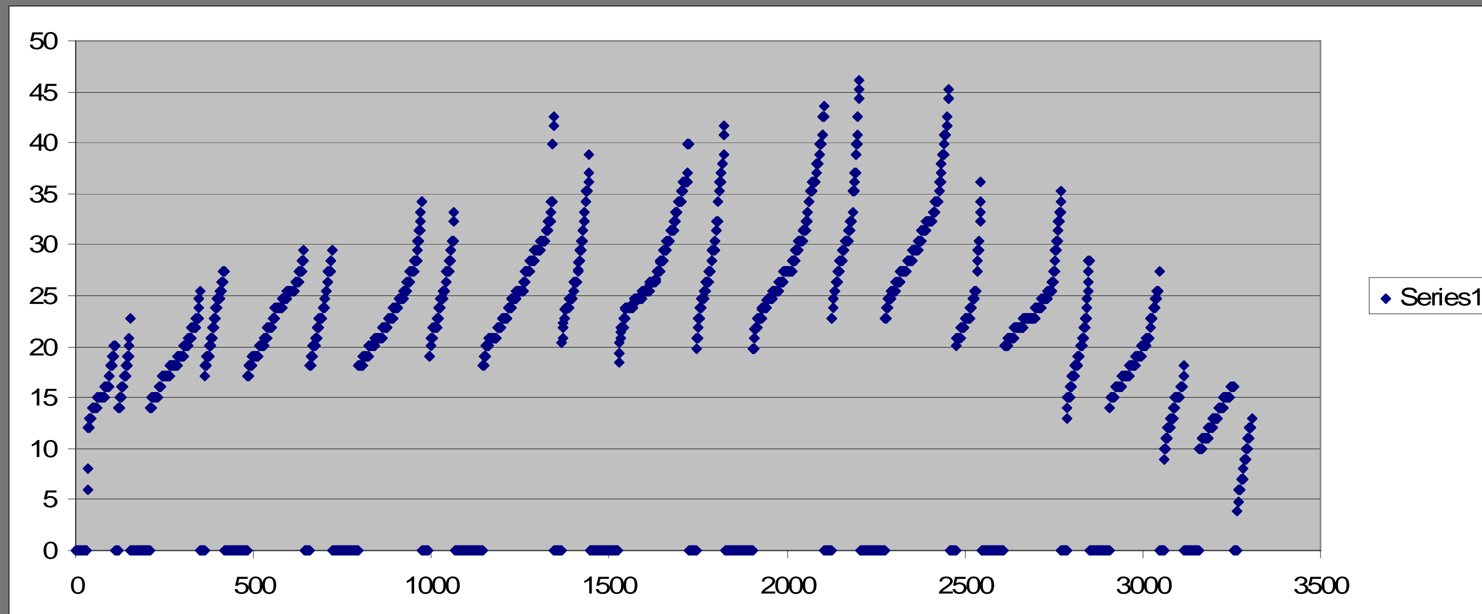
HIGH PROBE FORCE

- WHAT DOES THIS MEAN?

- A BIGGER PLANAR WINDOW FOR THE PROBE CARD*
  - SYSTEM Z DEFLECTION INCREASES WITH THE NUMBER OF PROBES TOUCHED DOWN
  - AS MORE PROBES TOUCHDOWN THERE IS A PROPORTIONAL INCREASE IN Z-DEFLECTION OF THE PROBE CARD

*Data presented by Gunther Boehm Feinmetall and from ITC Internal testing

HIGH PROBE FORCE



PLANARITY PATTERN IN A PROBE CARD WITH “SYSTEM” DEFLECTION

PLANAR WINDOW IS ABOUT 2X EXPECTED

HIGH PROBE FORCE

- SO IS THIS JUST A PLANARITY PROBLEM?
- IT STARTS WITH PLANARITY BUT IF YOU DON'T UNDERSTAND THE TRUE PLANAR WINDOW…
  - ALIGNMENT, SCRUB AND CRES WILL ALL SEE SOME IMPACT
  - THE PROBES AT THE TOP OF THE WINDOW WILL SHORT SCRUB AND MAY HAVE HIGHER CRES AS A RESULT

HIGH PROBE FORCE

- BUT IT IS JUST A METROLOGY TOOL PROBLEM…. RIGHT?
- NO
  - THIS IS HAPPENING ON THE TEST FLOOR IN THE WAFER PROBE SET-UP
  - IT'S WHY IT IS IMPORTANT THAT THE TEST INTERFACE IS ACCURATELY REPLICATED ON THE METROLOGY TOOL

HIGH PROBE FORCE

- CAN WE COMPENSATE FOR IT?
  - EVEN IF YOU COULD WHY WOULD YOU?
- PROBE CARD MFR
  - WE NEED TO MEET THE SPEC. SO WE CAN SHIP
- PROBE CARD USER
  - WE NEED THE CARD BACK ON THE LINE

HIGH PROBE FORCE

- IS IT POSSIBLE TO CHARACTERIZE THE SYSTEM DEFLECTIONS?
  - PROVIDING THE METROLOGY TOOL IS REPLICATING THE TESTER INTERFACE IT MAY BE POSSIBLE
  - BUT ITS UNLIKELY - EACH TEST PLATFORM, PROBE COUNT, PROBE CARD, STIFFENER, WAFER PROBER, ... WOULD NEED TO ADDRESSED

CHALLENGES

- RESOURCE SWITCHING

RESOURCE SWITCHING

- I HAVE A 20,000 PIN PROBE CARD SO I NEED 20,000 TEST CHANNELS ON MY METROLOGY TOOL.. RIGHT?
- NO
  - IN A TYPICAL 300mm PROBE CARD APPLICATION AS MANY AS 50% OR MORE OF THE PROBES WILL BE 'BUSSED' PROBES – POWERS AND GNDS
  - 6,000 TO 8,000 TEST CHANNELS IS SUFFICIENT FOR NOW
  - 10 – 12,000 WILL BE NEEDED VERY SOON

RESOURCE SWITCHING

- TYPICALLY THE TEST SYSTEM WILL NOT HAVE ENOUGH TEST CHANNELS TO TEST THE WHOLE WAFER IN ONE HIT
- TO OVERCOME THIS, BUT STILL ONLY DO ONE TOUCHDOWN THE PROBE CARD CAN HAVE HUNDREDS OR POTENTIALLY THOUSANDS OF SWITCHES ON IT
- SO, I HAVE A 20,000 PIN PROBE CARD WITH 800 SWITCHES
- THE SWITCHES WILL ALWAYS BE DRIVEN FROM THE SAME EDGE ON THE PROBE CARD… RIGHT?

RESOURCE SWITCHING

NO

- EXPERIENCE SHOWS THAT THE SWITCHES CAN BE DRIVEN FROM MANY DIFFERENT EDGES
- ALSO WITH MORE DIE NOW BEING CONTACTED IN ONE TOUCHDOWN MORE SWITCHING OF RESOURCES IS NEEDED....

RESOURCE SWITCHING

WHAT DOES THAT MEAN?

- TRADITIONALLY THE SWITCH ON A PROBE CARD HAS BEEN A RELAY, WITH SO MANY NOW REQUIRED REAL ESTATE AND WEIGHT ARE ISSUES
- SOLUTION - USE A SOLID STATE SWITCH SUCH AS A POWER MOSFET
- A SOLID STATE SWITCH WILL NEED TO BE DRIVEN BY THE METROLOGY TOOL IN A DIFFERENT WAY TO A RELAY

CONCLUSIONS

- THERE IS NO SIMPLE ANSWER
- IF YOU WANT TO KNOW HOW THE PROBE CARD WILL BEHAVE IN THE “WAFER TEST SYSTEM” THE METROLOGY TOOL NEEDS TO REPLICATE THE SYSTEM AS CLOSELY AS POSSIBLE, MECHANICALLY AND ELECTRICALLY

REFERENCES

- PROBER STABILITY WITH LARGE PROBING ARRAY AND HIGH PINCOUNT
  BY GUNTHER BOEHM, FEINMETALL

  SWTWS JUNE 2006

ACKNOWLEDGEMENTS

- LEE SIPLER, GARETH EDMONDSON AND WILSON OHL – ITC FIELD APPLICATIONS ENGINEERS