Introduction to Probe Cards

How They are Built & Tested
PROBE CARDS & PROCESS COURTESY OF CERPROBE
Design & Layout
DIE PAD CONFIGURATIONS

\[ \leq 500 \text{ mils on each side} \quad > 500 \text{ mils on any side} \quad \text{Multi-D} \]

(1a) (1b) (1c) (1d)

These configurations typically use standard rings

These configurations typically require semicustom or custom rings

Figure 1: Die and Ring Configuration Examples
BONDING PADS

Figure 2: Bond Pad Pitch and Size

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Figure 3: PCB and Epoxy Ring Assembly
EDGE SENSOR TYPES

2-Wire
Left-Hand E/S

2-Wire
Right-Hand E/S

Isolated 2-Wire
Left-Hand E/S

Isolated 3-Wire E

Figure 4: Edge Sensors
PROBE TO PAD POSITIONING

- Total Scrub
- Bond Pad Metalization
- Probe Tip Diameter
- Scrub

- Probe Tip Location at Touchdown
- Probe Tip Location at Maximum Overdrive
- Target (Pad Center)
- Passivation Opening
PROBE FANOUT ANGLE

- Bond Pads
- Ring
- Fanout Angle
- Probes

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Wire Bend
Wire Bend - Replacement Probes
Ring Build & Fixture

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Ring Assembly
COMPLETED PROBE RING
Completed Probe Ring
Measuring Contact Force
PCB Counterbore
Isolative Sleeving

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Probe Attachment
Probe Card on Build Plate
Probe Card Sanding Station
Alignment to Wafer
Planarization
Multi-dut Probe Card
Multiple Probe Layers
Cantilever Area Array
Area Array (top)
Ceramic Blade Probe Card
Building a Blade Card

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Cobra Probe Card
Cobra probe card
PROBILT PB3000 MOTHERBOARD
PURPOSE OF TESTING

- SCREEN TO SPECIFICATION LIMITS
- ESTABLISH SPC
- ESTABLISH LIFETIME GUIDELINES
- ESTABLISH REPAIR CYCLES
- IDENTIFY POTENTIAL PROBLEMS
- IDENTIFY POTENTIAL IMPROVEMENTS
TEST PARAMETERS

ALIGNMENT
TIP
DIAMETER
PLANARITY
GRAM
FORCE
CONTACT
RESISTANCE
EXTERNAL
CAPACITOR
EXTERNAL
RESISTOR
LEAKAGE
CURRENT
ALIGNMENT & TIP DIAMETER

- INSURE PAD CONTACT
- INSURE NO PASSIVATION DAMAGE
- ALLOW MAX. SET-UP TOLERANCE
- AGING MONITOR
- LIMIT FORCE/UNIT AREA
ALIGNMENT TO PAD

XP

P1x

CP

P2x

CS

TB2

TB1

TC

S

PASSIVATION

SAFETY AREA

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TIP DIAMETER

- LIFETIME INDICATOR
- “TRUE POSITION” TOLERANCING ELIMINATES NEED FOR MAXIMUM LIMIT, EXCEPT FOR EOL
- FORCE / UNIT AREA
PLANARIZATION

- INSURE GOOD CONTACT
- LIMIT SCRUB LENGTH (BENDING BEAMS)
- CONTROL SCRUB DEPTH
- LIMIT TIP FORCE
CONTACT RESISTANCE

- LIMIT $R_{\text{MAX}}$ FOR DC PATHS
- LIMIT SWITCHING TIME CONSTANTS
- CHECK FOR CONTAMINATION
- CHECK PATH RESISTANCE
- CR (W) TYP - 300 to 500 mOHMS
- CR (BeCu) TYP - 100 TO 300 mOHMS
LEAKAGE CURRENT

- ADDS TO CIRCUIT LEAKAGE
- DETECTION OF SHORTS
- AFFECTS SWITCHING TIMES
- GENERAL CONTAMINATION DETECTION
CONTACT FORCE

- CONTACT RESISTANCE
- SCRUB DEPTH CONTROL
- FORCE PER UNIT AREA
- GENERAL QUALITY CONTROL
- AGING MONITOR
- PROBE GEOMETRY MONITOR
- PROBE RETENTION MONITOR
COMPONENTS

- VERIFY PRESENCE/ABSENCE
- VERIFY COMPONENT VALUE
- DETECT AGING
- DETECT OTHER CHANGES
PROBER
OVERDRIVE REFERENCE

- FIRST CONTACT
- EDGE SENSOR
- PROFILER
- VISUAL
Wafer Probe

Equipment

Prober
Test System
Interface
Probe Card
Wafer Handling

Product

Metalized Wafers
“Probing”: Checking for the Good & Bad

In-Process (Parametric Testing):
– When wafers are being built
– Checking for possible problems

At the End (Etest, Sorting):
– When wafers are done
– Etest checks test patterns
  • Process Parameters
– Sort identifies good/bad parts
  • Functional Test
  • Parametric Test
  • Clock Speed, Temperature, etc.
Probe Cards

Shapes
- Square to Round

Sizes
- 4” to 16”

Probe Tips
- Various Metalurgy, Types and Sizes
Probe Tips

Types
– Cantilever
– Vertical
– Membrane

Size
– .8 to 4 mils

Quantity
– 10 to 2000

Materials
– Tungsten
– WR
– Paliney
– BeCu
Wafer Contact Point

Chips may have Different Contact Points

Al pads
Au pads
Solder bumps
Tabs or Tape

Critical Parameters
Alignment
Contact Resistance
Pad Damage
Probe Technology Selection

Dependent on Contact Point Technology

Cantilever Beam Probes

Peripheral Pads
Al or Au Pads
Solder Bumps (Limited)
Tabs or Tape

Vertical (Cobra)
Array Patterns
Solder Bumps (Flat Tips)
Al or Au Pads (Pointed Tips)
Q: How close do we need to put the probe in the pad?
A: Within +/- 10 microns in x and y directions

Q: How small is a micron?
A: If an inch was football field, a micron would be a blade of grass.
Types of Testers

Configured for Specific Technology

Memory, uProcessor, Linear, etc.

Clock Speeds >100 MHz

Rise Times <250 pS

Parallel Testing of Memory Devices (8-32 Chips)

Every Interface is Different - NO STANDARDS!

Test Head Configurations

Direct Dock

Cabled
Test Head Docking

Cabled Interface

Drive/Sense Electronics in Tester Mainframe
Cables (COAX or Shielded Linear) to pogos
Test Interface is only pogo pins to Probe Card
Slower (Clock Rate) than Direct Docking

Direct Docking

Drive/Sense Electronics in Test Head
Test Head sits Directly on the Interface
Soft or Hard Docking - Force/Weight
Highest Speeds Available
Direct Docking to Tester
(Courtesy Cerprobe Corporation)
Wafer Handling

Loading may be Manual or Automatic

Manual Loading

Use Tweezer or Vacuum Wand

Possible Damage or Breakage

Cleanliness (Particles, Contamination)

Very Slow

Automatic Loading

Cassette Wafer Holders

One or Multiple Cassettes

Wafer Automatically Transferred to Chuck

Faster, Cleaner, Safer
Wafer Alignment (1)

Align Probe Tips to Pads

X,Y Position

Theta (Rotation)

Overdrive (Z Axis)

Manual Alignment

Rotate Chuck/Wafer to be on Prober X,Y Axes

Rotate Probe Card (if required)

Position Probe Tips to Touch Down on Pads

Set Overdrive to 1.0 to 4.0 mils (Type Dependent)
Wafer Alignment (2)

Automatic Alignment

Prober Aligns Wafer Using Targets
Probe Card Theta not Usually Required
Wafer Loader Aligns Wafer from Cassette
Upward Looking Camera to see Probe Tips
Downward Looking Camera to see Pads
Can Readjust Alignment During Probing