International SEMATECH Wafer Probe Benchmarking Project

Project Update
At
2001 Southwest Test Workshop

By
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Probe Project Chair

Outline

Background

2000 Accomplishments

2001 Plans / Status

Wrap-up

Background: SEMATECH

- International SEMATECH Mission
  - Members will gain manufacturing advantage through cooperative work on **SE**miconductor **MA**nufacturing **TECH**nology
- Members (13)
  - Advanced Micro Devices
  - Agere Systems
  - Conexant
  - Hewlett-Packard
  - Hyundai
  - Infineon
  - IBM
  - Motorola
  - Philips
  - STMicroelectronics
  - Texas Instruments
  - Intel
  - TSMC

Background: Overview

- Projects Organized 2Q2000
- ESC Adopted Member Company Proposal
  - Wafer Probe AND Test Benchmarking
  - Open To All 13 International SEMATECH Member Companies
    - Custom Funded: Dues

Background: Overview

- Custom Funded Projects
  - SEMATECH: Legal, Technical & Administrative Support
  - Members: Technical Data & Information, Know-how & Direction

Background: Objective

- Improve Member Company Wafer Probe Operations
- Determine & Share Best Practices
- Develop Roadmaps
- Provide Supplier Guidance

Background: Benefit

- Project Members: Value
  - World Class Operations, Methods & Practices
  - Survey Results
- SEMATECH Members: Awareness
  - Annual Reports
  - Focus Group Output
- Industry: Guidance
  - Roadmaps, Guidelines & Standards

Background: Approach

- On A Pre-Competitive Basis
  - Benchmark Metrics
  - Identify Best in Class
  - Share Best Practices
  - Validate Industry Roadmap Directions
  - Communicate Consensus Requirements to Suppliers

Background: Activities

- Benchmark Surveys…..About 2/Year
  - Mini-Surveys…..At Any Time
- F2F Meetings…..Quarterly
  - At Member Company Location
  - Tour & Presentations
- Conference Calls…..Bi-Weekly
- Topic Specific Focus/Study Groups…..As Needed

Background: Practices

- Survey Results
  - Only Participants Receive
  - Confidentiality
  - Exception Made For Charts at 2001 SWTW
- Annual Report to All International SEMATECH Members
- Industry Guidance: Publicly Available
  - sematech.org/public/docubase/techrpts.htm
- New Project Members
  - Join at Conclusion of a Benchmark Survey

Background: Participants

2000 Accomplishments

- Completed 1st Benchmarking Survey
- Conducted 3 F2F Meetings
  - Tours
  - Member Practices / Vital Topic Presentations
  - Networking
- Completed 5 Mini-Surveys

Accomplishments: Survey #1

- 1st Benchmarking Survey
  - 25 Question Sets
  - 4 Groups (Categories)

PP/S	Probe Performance/Specifications
PE/P	Probing Environment/Process
P	Product
P/M	Process/Mfg. Floor

Accomplishments: Survey ?'s

Question Number	GROUP	QUESTION	SolderBumps	Standard Wire-bond	Fine Pitch (<75uM eff)
1	P	What are the smallest pad opening dimension (state as X/Y) that you probe? U/M=microns	N/A		
2	P	What is the smallest bump diameter you probe? U/M=microns		N/A	N/A
3	P	Of all the parts you probe, what is the highest average power consumption? U/M=watts			
4	P/M	What percent of wafers do you pre-clean before test? U/M=%			
5	P/M	Specify the parameters & specifications of your probe card storage environment (e.g.: clean room class, temperature (*C), humidity (%), nitrogen pressure (psi), other (specify/identify)			
6.1	P/M	How do you establish the reference point for prober over-travel? Select from: 1. Plane based upon average z of all probes used for PTPA. 2. Electrically based on average of first and last contact. 3. Other (please specify)			
6.2	P/M	For vertical probes, what is the minimum and maxium over-travel that you use beyond the reference point (state as min/max) ? U/M=mils			
6.3	P/M	For cantilever probes, what is the minimum and maxium over-travel that you use beyond the reference point (state as min/max) ? U/M=mils			
6.4	P/M	For membrane probes, what is the minimum and maxium over-travel that you use beyond the reference point (state as min/max) ? U/M=mils			
7	P/M	What determines the end-of-life (i.e. wear-out) for your probe cards e.g.: touchdown count, electronic {PCA, prober} visual inspection or other (specify/identify)?			
8	P/M	Specify the clean-room class of your test floor.			
9.1	PE/P	Do you clean probes on-line?			
9.2	PE/P	If yes, what material is used?			
9.3	PE/P	If yes, what motion is used?			
9.4	PE/P	If yes, what is the cleaning frequency? U/M=touchdowns between cleanings			

Accomplishments: Survey ?'s

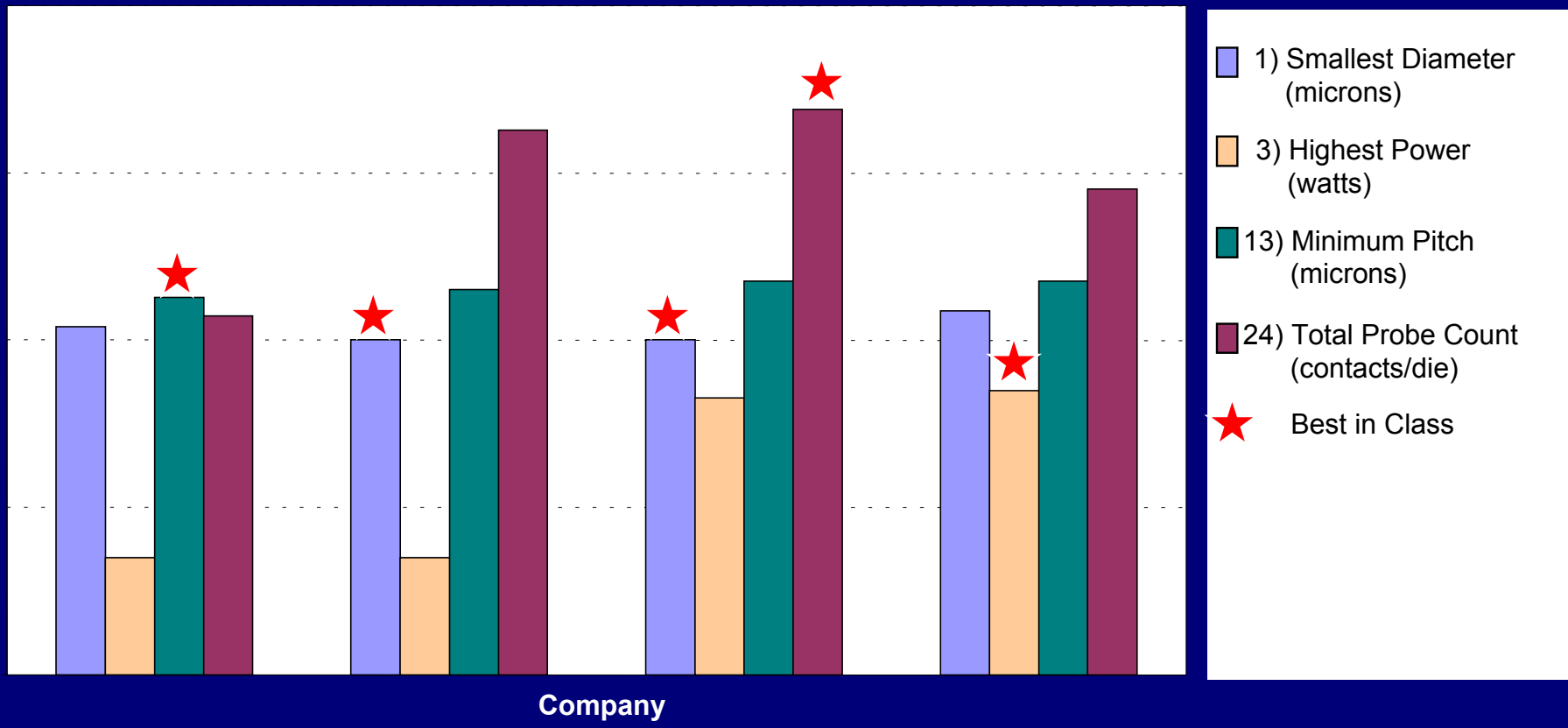
Question Number	GROUP	QUESTION	SolderBumps	Standard Wire-bond	Fine Pitch (<75uM eff)
10.1	PE/P	Do you have a formal off-line cleaning procedure?			
10.2	PE/P	If yes, what equipment is used?			
10.3	PE/P	If yes, how often do you clean? U/M=touchdowns before cleaning			
11.1	PE/P	What temperatures do you probe at in production with vertical probes (state as lowest/highest)? U/M=*C			
11.2	PE/P	What temperatures do you probe at in production with cantilever probes (state as lowest/highest)? U/M=*C			
11.3	PE/P	What temperatures do you probe at in production with membrane probes (state as lowest/highest)? U/M=*C			
12	PE/P	Probe card repair: what percent are done in-house? U/M=%			
13	PP/S	What is the minimum pitch you probe in production? U/M=microns		N/A	
14	PP/S	Multi-die probing: specify the maximum number of DUT's and contacts per DUT (state as DUT's/contacts per DUT).			
15.1	PP/S	In-coming Probes: what is the planarity specification you require for a new probe card (state as planarity with +/-)? U/M=microns			
15.2	PP/S	In-coming Probes: what is the alignment specification you require for a new probe card (state as X/Y with +/-)? U/M=microns			
15.3	PP/S	In-coming Probes: how do you verify the planarity and alignment specifications? Select from: 1. probe card analyzer 2. prober PTPA software 3. electrical contact 4. Other (please specify)			
16.1	PP/S	In-use (production) Probes: what is the planarity specification allowable before refurbishing (state as planarity with +/-)? U/M=microns			
16.2	PP/S	In-use (production) Probes: what is the alignment specification allowable before refurbishing (state as planarity with +/-)? U/M=microns			

Accomplishments: Survey ?'s

Question Number	GROUP	QUESTION	SolderBumps	Standard Wire-bond	Fine Pitch (<75uM eff)
17.1	PP/S	What is the maximum lifetime of a vertical probe card? (exclude probe cards whose product became obsolete) U/M= touchdowns before ceasing use			
17.2	PP/S	What is the average lifetime of a vertical probe card? (exclude probe cards whose product became obsolete) U/M= touchdowns before ceasing use			
18.1	PP/S	What is the maximum lifetime of a cantilever probe card? (exclude probe cards whose product became obsolete) U/M= touchdowns before ceasing use			
18.2	PP/S	What is the average lifetime of a cantilever probe card? (exclude probe cards whose product became obsolete) U/M= touchdowns before ceasing use			
19.1	PP/S	What is the maximum lifetime of a membrane probe card? (exclude probe cards whose product became obsolete) U/M= touchdowns before ceasing use			
19.2	PP/S	What is the average lifetime of a membrane probe card? (exclude probe cards whose product became obsolete) U/M= touchdowns before ceasing use			
20.1	PP/S	What vertical probe contact materials do you use?			
20.2	PP/S	What cantilever probe contact materials do you use?			
20.3	PP/S	What membrane probe contact materials do you use?			
21.1	PP/S	What vertical probe tip geometries do you use?			
21.2	PP/S	What cantilever probe tip geometries do you use?			
21.3	PP/S	What membrane probe tip geometries do you use?			
22.1	PP/S	Specify your target value for probe resistance. U/M=ohms			
22.2	PP/S	Specify your target value for contact resistance. U/M=ohms			
22.3	PP/S	Specify your target value for path resistance. U/M=ohms			
23	PP/S	What is your tightest needle-to-needle spacing at the knee of the probe? (applies to fine-pitch cantilever probes only) U/M=microns	N/A	N/A	
24	PP/S	What is your largest total probe count? U/M=# contacts/die			
25.1	PP/S	What fraction of the power and ground pins do you typically have probes connected to? U/M=%			
25.2	PP/S	If less than 100%, specify your depopulation algorithm.			

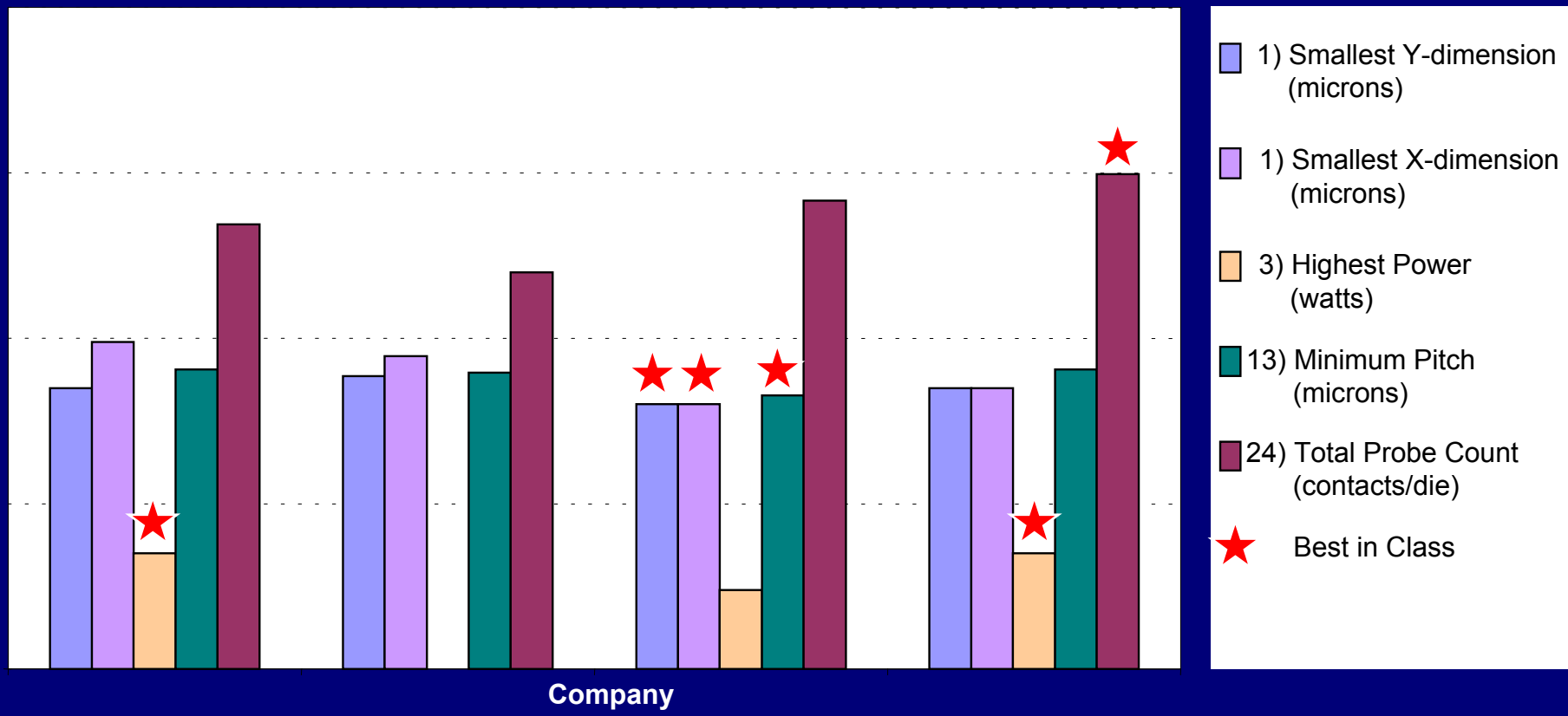
Accomplishments: Survey Data

Combined Metrics #'s 1 & 3 (P); 13 & 24 (PP/S)
Solder Bump



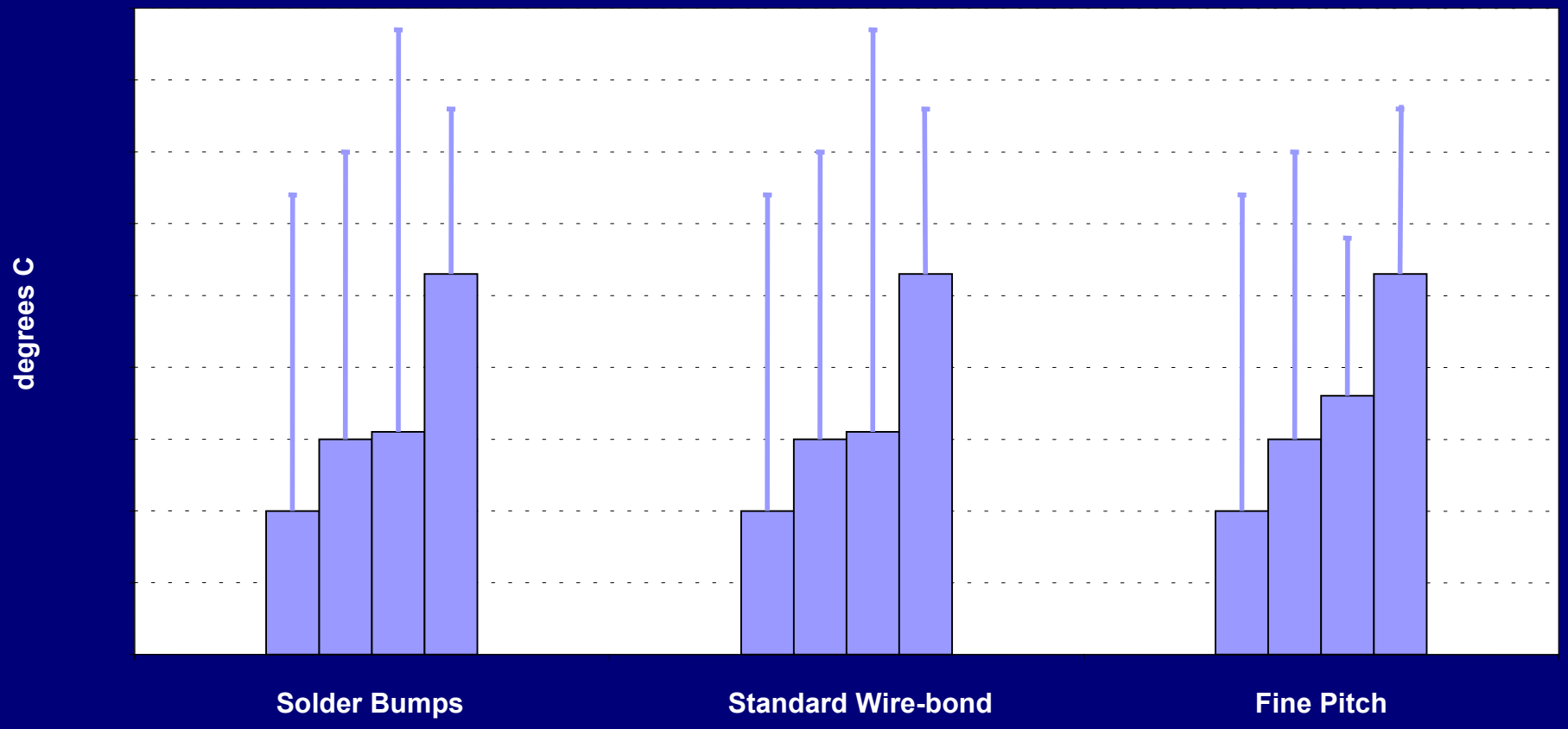
Accomplishments: Survey Data

Combined Metrics #'s 1 & 3 (P); 13 & 24 (PP/S)
Fine Pitch



Accomplishments: Survey Data

Metric # 5 - Probe Card Storage Temperature (P/M)



Accomplishments: Survey Data

Metric # 9 - On-line Cleaning? (PE/P)

	Solder Bumps	Standard Wire-bond	Fine Pitch
	Yes	Yes	Yes
material	ceramic	ceramic	gel pad
motion	z	z	z
frequency	100 touchdowns	100 touchdowns	100 touchdowns
	Yes	Yes	Yes
material	Brush and 3M 3u (pink) paper	3M 1u (yellow) paper and 3M 3u (pink) paper	Brush and 3M 3u (pink) paper
motion	X & Y 25um Z 40um	vertical 5um OD	vertical 5um OD
frequency	50 touchdowns	100 to 2000 touchdowns more often if needed	100 to 2000 touchdowns more often if needed
	Yes	Yes	Yes
material	9um (blue) paper	9um (blue) paper	9um (blue) paper
motion	Orbital	z stroke	z stroke
frequency	500 to 15,000 touchdowns	500 to 15,000 touchdowns	500 to 15,000 touchdowns
	Yes	Yes	Yes
material	tacky abrasive	tacky abrasive	tacky abrasive
motion	rectangular	rectangular	rectangular
frequency	varies dramatically between products and probe areas	varies dramatically between products and probe areas	varies dramatically between products and probe areas

Accomplishments: F2F Meetings

- 2000 SWTW
  - Initiate Survey #1 Question Set Development
- IBM - Burlington, VT.
  - Test Floor / Probe Area Tour
  - Draft Review of Survey #1 Question Set
  - Member Current Practices Presentations
- SEMATECH
  - Review & Explore Survey #1 Results

Accomplishments: Methods

- Current Methods/Vital Topic Presentations
  - Probe Group(s) Organization
  - Probe Card Selection Process
  - Multi-DUT Probing

Accomplishments: Mini-Surveys

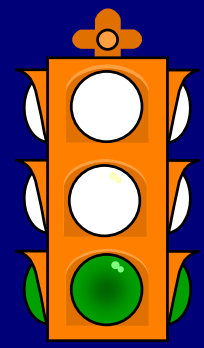
- Mini-Surveys
  - Test Floor/System Cooling
  - Re-Probe Percentage
  - Wafer Probe Outsourcing Percentage
  - Probe Suppliers
  - Manufacturing Probe Sites

Accomplishments - Testimonials

- "Each company is quite open in discussion on numerous topics which in other forums would be kept confidential…..”
- "I used benchmark survey results as support to management for a cost saving program I was developing…..”
- "Good networking and cooperation, I am amazed we all have the same problems and can solve them together….."

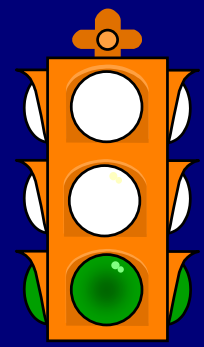
2001 Plans / Status

- Q1
  - F2F Meeting at Agere in Orlando
    - Tour & Presentations
    - Supplier Engagement - Probe Roadmap
  - Survey #2 Question Set Development



DONE

- Q2
  - F2F Meeting at SWTW
    - Probe Roadmap Draft - Open Meeting
    - Survey #2 Results



DONE

2001 Plans / Status: Survey #2

2001 Midyear Wafer Probe Benchmarking Survey Questions

Click here for GUIDELINES

Please complete as fully as possible. Enter data and/or select from multiple choices provided (enter ALL options USED). If you choose OTHER,please add explanation under COM under COMMENTS.

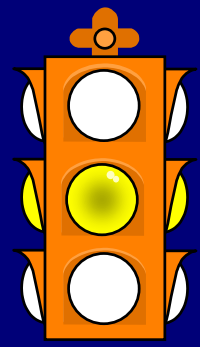
Category	No.	Question	Card Type / Pad Type	Cantilever FinePitch <75um	Cantilever Standard Wirebond	Cantilever Bump (Array)	Vertical FinePitch <75um	Vertical Standard Wirebond	Vertical Bump (Array)	Membrane FinePitch <75um	Membrane FinePitch <75um	Membrane Standard Wirebond	Membrane Bump (Array)
Technical Parameters	1	What size(µm) is the minimum pad opening(x,y) or bump (diameter) ?											
	2	What size(µm) is the min. pad/bump pitch probed in production? Where appropriate,input both inline and staggered.	Inline										
			Staggered										
	3	What type & configuration of multi-dut cards are used for pad type? Enter # DUTs											
	4	What is the maximum probe count ? Single DUT / Multi DUT											
	5	What temperatures (°C) do you probe at in production ? a) <=0 b) Amb c) =>85 d) =>125 e) =>150											
	6	What PAD materials do you probe ? a) **Al**/Si/Cu b) Cu c) Au d) other											
		What BUMP materials do you probe ? a) **Pb**/Sn b) **Sn**/Pb c) other											
	7	Are there active structures under the pads / bumps ? Y / N											
Performance and Maintenance	8	What card "performance versus specification" issues are experienced ? a) planarity b) alignment c) tip diam. d) c-res. e) # of t/downs f) temp g) other											
	9	What checks are used to verify cards meet spec. before use? a) analyser b) µscope c) electrical d) hot chuck e) other	New card										
			Used card										
	10	What equipment do you use for alignment checks ? a) pcard an'lys'r b) probe mark an'lys'r c) µscope d) prober e) hot chuck e) other											
	11	What method is used to adjust planarity if out of specification ? a) mechanical bending b) lapping c) tip reshaping d) other											
	12	What ONLINE card cleaning methods are used ? a) abrasive pad b) disc c) brush d) gel pad e) other											
	13	What OFFLINE card cleaning methods are used ? a) chemical b) mechanical c) commercial equipt used (specify)											
	14	What is the ONLINE cleaning frequency ? a) typical # of touchdowns (enter #) b) never											

2001 Plans / Status: Survey #2

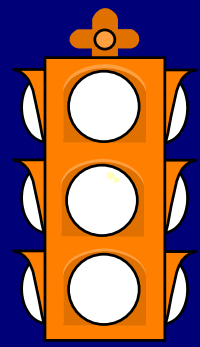
Category	No.	Question	Card Type	Cantilever			Vertical			Membrane		
			Pad Type	FinePitch <75um	Standard Wirebond	Bump (Array)	FinePitch <75um	Standard Wirebond	Bump (Array)	FinePitch <75um	Standard Wirebond	Bump (Array)
Quality	15	Is bump distortion or pad metal penetration(exposed oxide) allowable? Y / N										
	16	What is the max. allowable probe mark area(μm^2) or % of pad opening										
	17	What is the max. allowable number of touchdowns on a die ?										
	18	What methods are used to control the # of touchdowns ? a) prober control(smart indexing) b) test prog control c) none d) other										
	19	Do you perform automatic probe mark analysis? a) Online b) Offline c) None										
	20	How frequently do you experience uneven probe marks ? (i.e. marks that are markedly different across the die) as: % of wafers tested										
	21	What are the main issues testing at elevated temperatures ? stability of a) temp b) card c) prober d) mech i/f or e) heat dissipation										
Manufacturing	22	What set-up control methodologies are used ? eg accuracy of a) indexing b) o/drive c) PTP align't or chuck d) planarity e) speed or f) other										
	23	What criteria determine when to interrupt testing ? (i.e. for card cleaning) a) # of touchdowns b) yield c) bin limits d) meas'd parameters e) other										
	24	What is the max. allowable overdrive (µm) used - to protect probes										
		What is the ref. point a) first contact b) last contact c) average d) other										
	25	Which prober/model has most probe to pad alignment issues with card type? a) EG / model b) TSK / model c) TEL(KLA) / model d) other / model										
	26	How long (mins) does a production operator take to do a product change - over? i.e. from completion of last product to start testing of next product										
	27	What methods are used to prevent exceeding max.V,I,Power limits of cards ? a) prog controlled clamps b) overload protection on card (eg fuses) c) none										
Cost of Probe	28	What are the key probe card cost drivers with respect to purchase price? a) pitch, b) pincount, c) NRE charges, d) quantity e) other										
	29	What are the key probe card cost drivers with respect to total COO a) cleaning freq., b) # of touchdowns, c) repair(inhouse V vendor)										
Related Processes	30	What % of total wafer test utilises "inkless" probing? Enter %		Do you have internal standards Y / N			Are you pursuing a commercial solution Y / N					

2001 Plans / Status

- Q3
  - F2F Meeting in Europe
    - Philips, Infineon & ST
  - Probe Roadmap Data Collection
- Q4
  - F2F Meeting at Motorola in Austin
    - Survey #2 Results
  - Publish Probe Roadmap



Underway



Plans

2001 Plans / Status

Explore Membership Growth Opportunities

- AMD
- Conexant
- Hewlett Packard
- Hyundai
- Intel
- TI
- TSMC

Wrap-Up

- Successful First Year
- Member Driven Project
- SEMATECH Support & Commitment
- Benchmarking Methods
  - Member Value
  - Industry Guidance
- Membership Growth

Acknowledgements

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- Thanks to the Member company principals. Their tireless efforts and collaborative spirit have made a successful 1st year for the Wafer Probe Benchmarking Project