

# SEMATECH's Probes Project 98 & Beyond

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# Probes Plan 98 & Beyond

- **Probes objective**

- Assess and Demonstrate Area Array Probe Industry's ability to support the following by

Q2 1999

- 150 um pitch
- 800 MHz test frequency frequency
- 110 watts of power
- 2400 pads

Q2 2001

- 130 um pitch
- 900 MHz test
- 130 watts of power
- 3000 pads

- **Approach**

- Work on Probe Industry Infrastructure
- Focus is on white paper and demonstrations
  - Small pin count focused on technology demonstrations
- Production worthiness issues must be driven by MC

# What is the Major Roadmap Issue

- **Power & Ground Management**

- $V = L(DI/DT)$  or solve for inductance  $L = V (DT/DI)$

- Power/Grd Pin

- 100 MHz example IF  $DT = 10$  Ns,  $DI = 200$  ma and  $V = 125$  MV (5% of 2.5 volt) Then L would need to be 6.25 NH

- 1 GHz example IF  $DT = 1$  Ns,  $DI = 200$  ma and  $V = 75$  MV (5% of 1.5v) Then L would need to be 375 PH

- Signal I/O return path

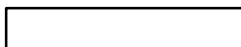
- 100 MHz example IF  $T_r = .15/100$  MHz,  $DI = 20$  ma,  $V = 250$  MV (10% of 2.5 V) Then L would need to be 18.75 NH

- 1 GHz example IF  $T_r = .15/1$  GHz,  $DI = 20$  ma,  $V = 150$  MV (10% of 1.5 V) Then L would need to be 1.125 NH

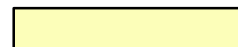
## Area Array Roadmap Challenges For Wafer Sort

Features	1997	1999	2001	2003	2006	2009	2012
Technology Generation (nm)	250	180	150	130	100	70	50
# of Chip I/O's (pad's)							
High performance	1450	2000	2400	3000	4000	5400	7300
cost performance	800	975	1195	1460	1970	2655	3585
Chip Frequency (Mhz)							
<i>Chip-to-board high performance</i>	750	1,200	1,400	1,600	2,000	2,500	3,000
Chip-to-board Peripheral Buses	250	480	785	885	1,035	1,285	1,540
Power Supply Voltage	1.8-2.5	1.5-1.8	1.2-1.5	1.2-1.5	0.9-1.2	0.6-0.9	0.5-0.6
Maximum Power (watts)	70	90	110	130	160	170	175
Maximum Current (amps)	40	60	90	110	180	185	350
<i>Pad Pitch (um)</i>	250	180	150	130	100	70	50
Probe Alignment (um)	+/- 12.5	+/-9.0	+/-7.5	+/-6.5	+/-5.0	+/-3.5	+/-2.5
Probe Planarity (um)	50	36	30	26	20	14	10
Maximum Force/probe (gm)	<20	< 15	<15	<15	<10	<10	<10
Prober chuck (lb's)	60	66	79	99	88	119	161
<i>Maximum inductance/probe (ph)</i>	600	313	214	188	113	60	42
<i>Cost/touch down (cents)</i>	2.9	4.0	4.8	6.0	8.0	10.8	14.6
<i>Cost/unit (cents)</i>	5.3	7.3	8.7	10.9	14.5	19.6	26.5

Solutions Exist



Solutions Being Pursued

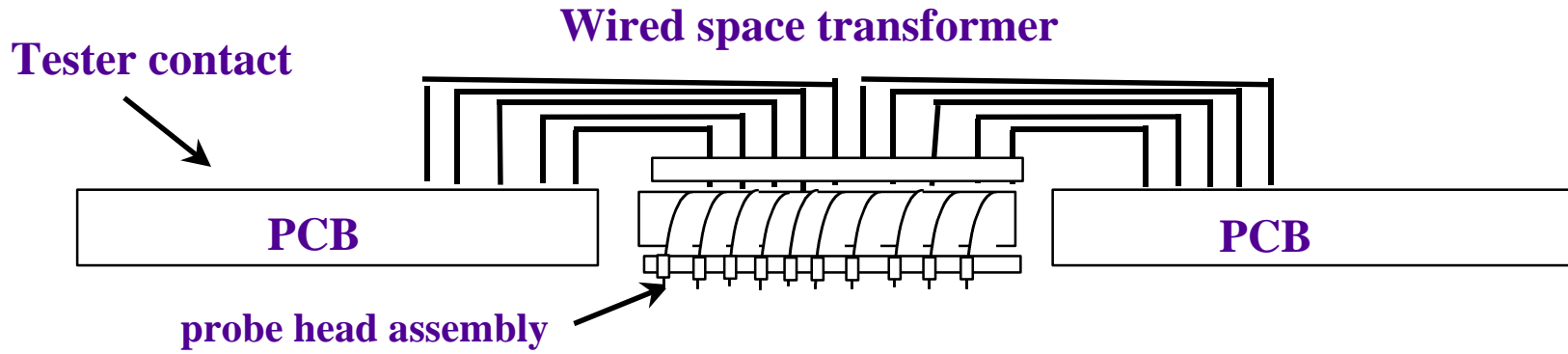


No Known solutions

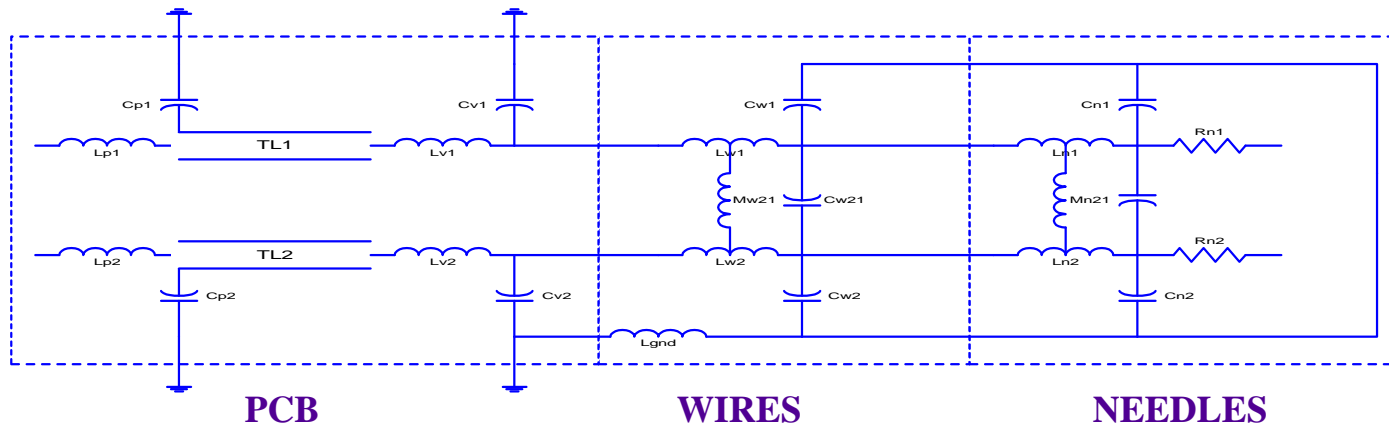


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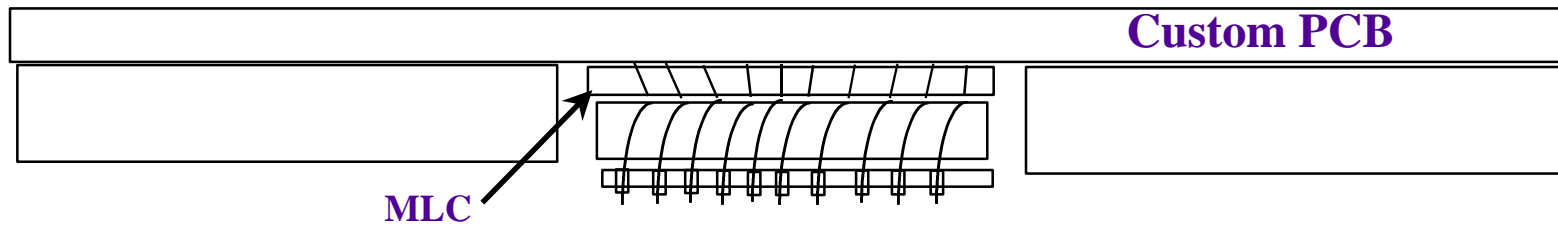
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**Area Array Probe Electrical Model**



**Ceramic space transformer**



# Area Array Probe Assessment

- **Major issues 1999 and beyond**
  - Probe industry not addressing future technology requirements
    - Suppliers not working to a roadmap
    - Space transformer will require a substrate technology with a pitch below 225 um and sufficient mechanical properties
    - Power/Gnd management needs to greatly improve to meet high frequencies di/dt requirements
  - Commercial challenges for area array
    - Small industry ` \$400 million in 97
    - Immaturity of supplier base
      - Engineering capability
      - Industry manufacturing capacity and ability to ramp untested
    - Industry capital investment
      - Can not afford analysis equipment

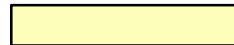
**Table 2**  
**SEMATECH'S PTAB Area Array Probing Specifications (Preliminary rev 0.0)**

	Features	1997	1999	2001	2003	2006	2009	2012
APT#	Technology Generation (nm)	250	180	150	130	100	70	50
1	Max. # of pad's	1450	2000	2400	3000	4000	5400	7300
2	Number of test sites	4	4	4	4	4	4	4
	<b>Overall Sort Frequency (MHz)</b>	100	<b>200</b>	<b>400</b>	<b>500</b>	<b>500</b>	<b>500</b>	<b>500</b>
3	Signal length matching (Ps)	1,000	500	250	200	200	200	200
4	Signal I/O bandwidth(MHz)	350	700	1,400	1,750	1,750	1,750	1,750
5	Cross-talk (dB)	-3	-3	-3	-3	-3	-3	-3
6	Matched impedance (+/- %)	2	2	2	2	2	2	2
7	<b>Pad Pitch (um)</b>	250	<b>180</b>	<b>150</b>	<b>130</b>	<b>100</b>	<b>70</b>	<b>50</b>
	Solder bump width (um)	125	90	75	65	50	35	25
	Solder bump height (um)	100	72	60	52	40	28	20
8	Solder bump damage (%)	20	20	20	20	20	20	20
9	<b>Probe Alignment (um)</b>	+/- 12.5	<b>+/-9.0</b>	<b>+/-7.5</b>	<b>+/-6.5</b>	<b>+/-5.0</b>	<b>+/-3.5</b>	<b>+/-2.5</b>
10	Probe Planarity (um)	50	36	30	26	20	14	10
	Maximum Force/probe (gm)	<20	< 15	<15	<15	<10	<10	<10
	Prober chuck (LB's)	60	66	79	99	88	119	161
11	<b>Maximum inductance/probe (ph)</b>	5,000	<b>2,000</b>	<b>750</b>	<b>600</b>	<b>450</b>	<b>300</b>	<b>250</b>
12	<b>Current carrying capacity (ma)</b>	>250	<b>&gt;250</b>	<b>&gt;250</b>	<b>&gt;250</b>	<b>&gt;250</b>	<b>&gt;250</b>	<b>&gt;250</b>
13	Signal path resistance (ohms)	<1	<1	<1	<1	<1	<1	<1
14	<b>Cost/touch down (cents)</b>	2.9	<b>4.0</b>	4.8	6.0	8.0	10.8	14.6
15	Lifetime touchdowns (K)	1,000	1,000	1,000	1,000	1,000	1,000	1,000
16	Temperature range(°C)	0 to 85	0 to 85	0 to 100	0 to 100	0 to 125	0 to 125	0 to 125

Solutions Exist



Solutions Being Pursued



No Known solutions



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## Area Array Probe Card Development

### A&P Project Model

97 NTRS Technology

Strategic Technology focus

Pitch development focus

A&P Project model

### Array Probes Focus Areas

Probe Technology

Sort Frequency

Cu/low k impact

Bump Probe Temperature

Probes to bump  
Placement accuracy

Probe needle size and material

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