Session 6

Wednesday 3/12/14 8:00am

INTERCONNECTOLOGY: IT'S WHAT WE DO

Last Year's BiTS workshop introduced the benefits from the Interconnectology approach of collaboration across the supply chain from device design to test. This session focuses on interconnect designs and advancements. As contactor design has had to evolve to address shrinking pads and decreasing pitches, there's lower contact force. The first presenter then asks whether contact pressure has become more meaningful than contact force. The second presentation details the development of long-life stamped spring probes in response to challenging technology roadmaps, all at a cost that includes maintenance and replacement costs. Next up is a paper on validations sockets (used for post-silicon validation and are quite different from test sockets). This paper brings awareness to these sockets and their challenges to encourage industry collaboration for solving future post-silicon validation interconnect challenges. The session concludes with an exploration of crosstalk sources and discusses solutions and emerging technologies, including costs, to reduce crosstalk. See? It's all about Interconnectology.

This Paper

Long Life / Stamped Spring Probe Development
Samuel Pak, A.J. Park—IWIN Co. Ltd.

Validation Interconnect Socket – Application and Future Challenges
Ashok Kabadi—Intel Corporation

Crosstalk Mitigation in ATE Socket-Device Interface Boards
Thomas P. Warwick—R&D Altanova, Inc.

Long Life / Stamped Spring Probe Development

Samuel Pak IWIN Co, Ltd.
AJ Park IWIN Co, Ltd

2014 BiTS Workshop
March 9 - 12, 2014

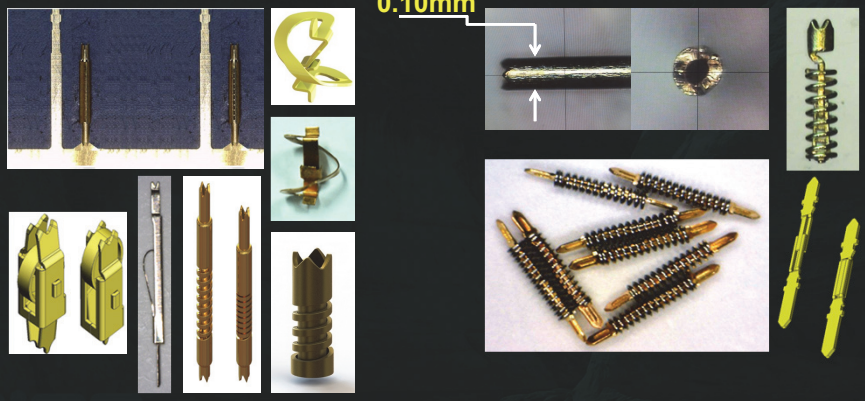
Content

- Update Previous presentations
- Design considerations for a long life pin
- Mechanical life vs. Contact resistance
- Destructive tests and lessons learned
- Life test with actual device loading
- RF and Impedance performance
- Summaries and the next step

Previous Presentation Summary

One Piece Spring Probe

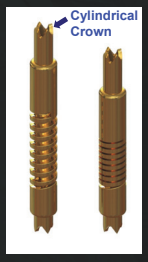
Three Pieces Spring Probes

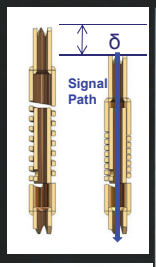


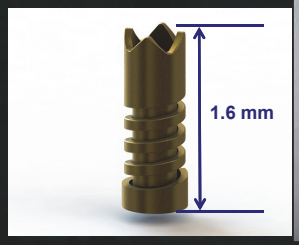
Note : Refer to BiTS 2013 presentation for details and how to make

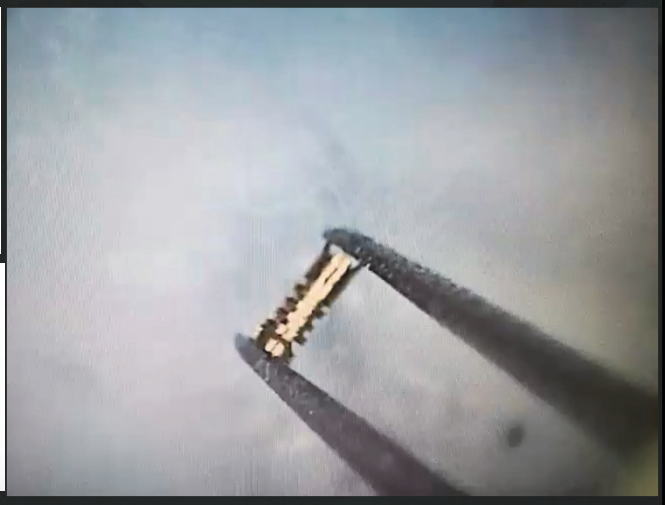
Previous Presentation Update

One piece Spring Probe – Motion picture









Low Cost Version

Design Consideration to Increase the Life of Spring Probe

- Special alloy for crown tip and pin body
- High hardness carbon coat on tips
- Tip shape to eliminate contamination
- Pin design to maximize space for spring
- Pin shape enabling bigger spring diameter

Design Considerations Spring Design

Working stroke

δ ∝ D^3 (spring diameter)

∝ reverse of d^3 (wire diameter)

∝ number of turns

Spring force

F ∝ d^3

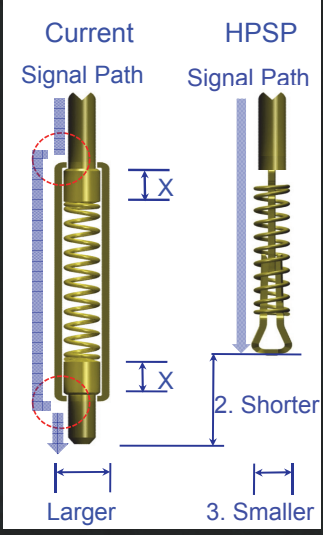
∝ reverse of D^3

∝ Travelling distance

Design Considerations Spring Design

- Bigger spring diameter enables to increase stress ratio greatly
- For a longer life design, stress ratio should be lower than 30%
- To improve the stress ratio, number of turns should be increased.
- For high working temperature, above 130 degree C, music wire or Be-Cu shall not be chosen.

Chosen Pin for the Test



Part No of pin to be tested: HPSP33465C4

HPSP platform outlines

1. Stable Signal path by pinched sliding
2. Enabling Short length, 1.2mm, good for high speed application
3. Enabling Small diameter, good for finer pitch, 0.15mm pitch
4. High current carrying, 4.5 Amps in 0.4mm pitch, 3.3mm length pin
5. 0.8mm traveling in 3.3 mm length
6. Progressive stamping enabling low cost

Test Settings and Measurements

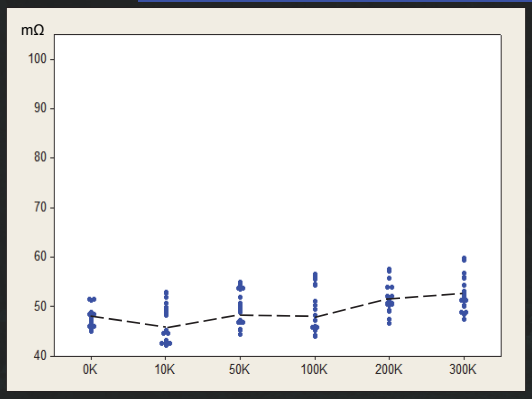
Device used for testing: FBGA 216
Pins tried this time: HPSP33465C4

1. Reliability test (Mechanical) 300ku of insertions
2. Life test (Actual device loading) 150ku of insertions
3. Destructive test for 20 pins 2 millions of insertions
4. Current carrying capacity
5. Signal quality data (Impedance, RF performance)

Durability Test – 300k Cycles

Gold plating 0.4μ thick

Test condition
Cycle number : 300,000 times
Contacted electrode: Au plate
Stroke: 0.27mm (Preloaded 0.05mm)



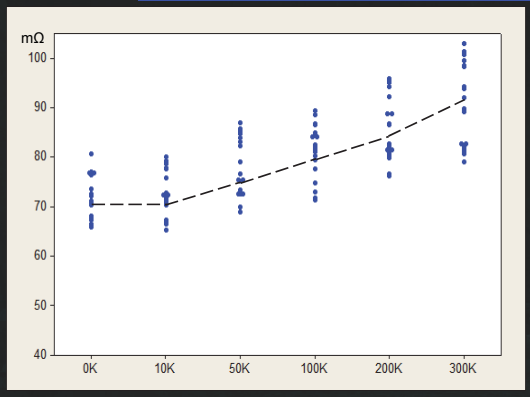
Unused

300k

Durability Test – 300k Cycles

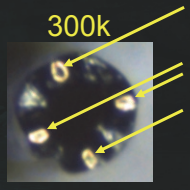
Tough Conductive Coating on tip

Test condition
Cycle number : 300,000 times
Contacted electrode: Au plate
Stroke: 0.45mm (Preloaded 0.15mm)



Unused

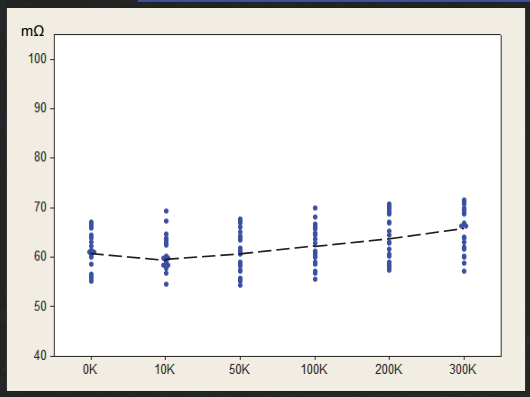
300k



Durability Test – 300k Cycles

Upper plunger by Pd alloy (No gold plating)

Test condition
Cycle number : 300,000 times
Contacted electrode: Au plate
Stroke: 0.40mm (Preloaded 0.15mm)

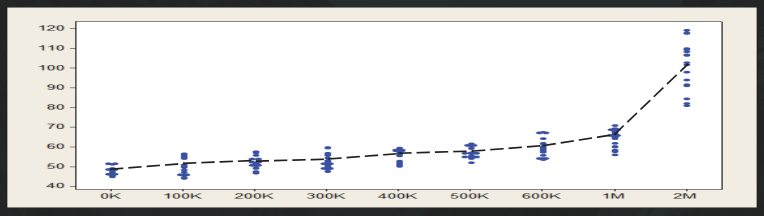


Unused

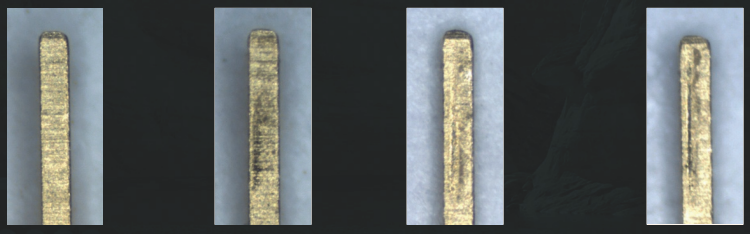
300k

Destructive Test

HPSP33465C4



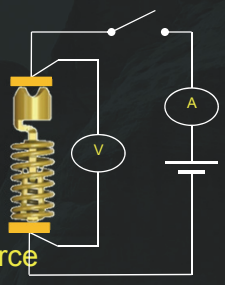
Sliding surface condition



Unused 300K 600K 2M

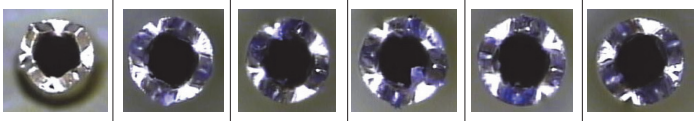
Current Carrying Capacity Measuring

* Test condition: Ambient temp (25 Degree C)
* Test method: Started from 1Amp and increase 1 Amp by every one minute
* Measure allowable current carrying:
  - Any change in mechanical condition, Contact force
  - Burn
  - Permanent deflection

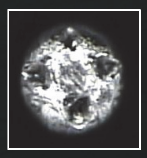


Product	HPSP33465	HPSP51113
Overall Length	4.65mm	1.13mm
Current Carrying Capacity	4.5A	8.1A

Life Test Report From S Company

		(Contact Stroke : 0.3mm Device 0.15mm PCB)	Contact test					
			Initial	50K	90K	110K	130K	150K
Life time Test	1	Top Damage						
	2	Pin Force [g]	21.31	22.07	21.79	21.91	21.95	21.64
	3	Resistance [mΩ]	62.12	80.89	80.13	106.54	104.14	107.43

Note:
1. Checked spring force and CRES at every10k insertions
2. CRES showed stable thru out the test period
3. Stopped test due to open failure at 150ku insertions



Ball mark Acceptable

RF Performance and Impedance Check By S Customer

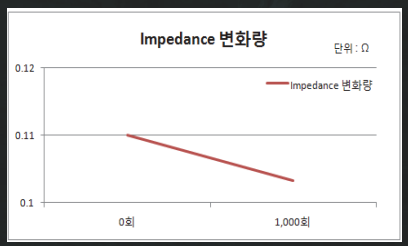
RF Performance test & Pin Impedance check

■ Test Method

- Same Module Device package use → RF Performance test and Impedance Check(RF Test time 1K)
- RF Performance test result : Up to 1K RF Performance → CPK 133 Secure
- Every testing item → SPEC Margin secure
- After 1K test POGO Pin Impedance check → average 0.01Ω

Pin Impedance check

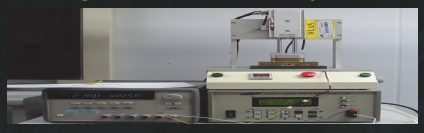
Pin No#	0 time	1K
A1	0.09	0.08
A4	0.09	0.07
A8	0.13	0.14
B2	0.07	0.06
F8	0.08	0.11
J8	0.15	0.14
M1	0.18	0.14
M8	0.08	0.07
N7	0.08	0.07
P1	0.11	0.11
P7	0.15	0.14
P8	0.11	0.11
Average	0.11	0.10
Min	0.07	0.06
Max	0.18	0.14



Impedance Check According to Durability Test By S Customer

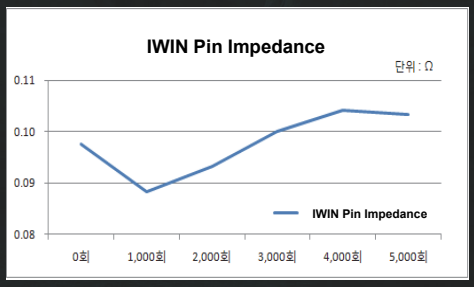
■ Testing Method

Pusher pressure 0.35MPA, pushing time 30sec every 1,000 times, each IWIN Pin Impedance check



■ IWIN Pin Impedance check → **Average 0.01Ω**

Pin No#	0 times	1K	2K	3K	4K	5K
A1	0.12	0.11	0.12	0.12	0.12	0.11
A4	0.05	0.08	0.10	0.10	0.10	0.09
A8	0.07	0.06	0.06	0.07	0.11	0.09
B2	0.10	0.09	0.09	0.09	0.09	0.09
F8	0.09	0.07	0.08	0.09	0.09	0.08
J8	0.13	0.11	0.10	0.13	0.12	0.11
M1	0.07	0.05	0.06	0.07	0.07	0.09
M8	0.08	0.07	0.07	0.09	0.10	0.1
N7	0.08	0.08	0.08	0.07	0.09	0.1
P1	0.14	0.13	0.14	0.13	0.13	0.12
P7	0.15	0.12	0.11	0.12	0.10	0.12
P8	0.09	0.09	0.11	0.12	0.13	0.14
Average	0.10	0.09	0.09	0.10	0.10	0.10
Min	0.05	0.05	0.06	0.07	0.07	0.08
Max	0.15	0.13	0.14	0.13	0.13	0.14



RF Performance Check By S Customer

1) RF Performance Check CPK 1.33 Secure

Test Item	Ch	Current Pin	IWIN PIN
TX Power	Ch 1	1.24	1.35
	Ch 7	1.47	1.37
	Ch 13	1.43	1.39
EVM	Ch 1	3.39	6.14
	Ch 7	3.44	4.90
	Ch 13	3.70	4.59
50dBr Mask _L	Ch 1	8.62	6.32
	Ch 7	9.04	7.47
	Ch 13	7.78	7.93
30dBr Mask _L	Ch 1	3.46	3.23
	Ch 7	3.50	3.43
	Ch 13	3.50	3.43
30dBr Mask _R	Ch 1	3.77	3.56
	Ch 7	3.78	3.68
	Ch 13	3.82	3.94
50dBr Mask _R	Ch 1	6.21	6.81
	Ch 7	9.24	6.36
	Ch 13	6.15	7.45

2.4㎓ 11b

	Ch	Current Pin	IWIN PIN
TX Power	Ch 1	1.32	1.71
	Ch 7	1.36	1.75
	Ch 13	1.37	2.06
EVM	Ch 1	1.65	1.92
	Ch 7	1.59	1.86
	Ch 13	1.36	1.99
40dBr Mask _L	Ch 1	5.37	5.06
	Ch 7	6.02	5.95
	Ch 13	5.97	5.98
28dBr Mask _L	Ch 1	4.09	3.22
	Ch 7	3.92	3.66
	Ch 13	3.98	3.68
20dBr Mask _L	Ch 1	4.89	3.41
	Ch 7	5.00	4.72
	Ch 13	5.34	4.62
20dBr Mask _R	Ch 1	4.31	4.19
	Ch 7	5.54	4.45
	Ch 13	4.37	4.94
28dBr Mask _R	Ch 1	3.73	3.61
	Ch 7	6.02	3.10
	Ch 13	3.70	3.57
40dBr Mask _R	Ch 1	8.35	7.89
	Ch 7	5.53	7.44
	Ch 13	7.70	6.60

2.4㎓ 11g

	Ch	Current Pin	IWIN PIN
TX Power	Ch 36	1.50	1.63
	Ch 100	1.41	1.54
	Ch 161	1.35	1.54
EVM	Ch 36	1.39	1.90
	Ch 100	1.37	1.97
	Ch 161	1.34	1.38
40dBr Mask _L	Ch 36	4.69	1.91
	Ch 100	3.37	3.10
	Ch 161	4.78	4.16
28dBr Mask _L	Ch 36	3.28	1.60
	Ch 100	3.47	2.72
	Ch 161	2.54	1.72
20dBr Mask _L	Ch 36	3.73	1.64
	Ch 100	4.71	2.64
	Ch 161	3.23	2.10
20dBr Mask _R	Ch 36	3.67	1.66
	Ch 100	3.27	3.41
	Ch 161	2.09	2.05
28dBr Mask _R	Ch 36	3.41	1.66
	Ch 100	3.26	3.19
	Ch 161	1.96	1.85
40dBr Mask _R	Ch 36	5.06	1.92
	Ch 100	4.23	3.91
	Ch 161	4.75	4.33

5㎓ 11a

Summary

- Life test with semiconductor chip loaded, by S company ; Spring probe with cylindrical crown survived until 150k times of insertion while ordinary pins survived only around 35 k times of insertion.
- Special alloy, 300k times of insertion ; CRES 61 milli-ohm in the beginning, relatively high, and gradually increased. Survived up to 300k times insertion.
- High hardness carbon coating , 300k times of insertion ; CRES 75 milli-ohm in the beginning, and rapidly increased up to 90 milli-ohm. Observed segregations of carbon coat, and dust contamination.
- Destructive test , 2 million times of insertion ; Erosion of tip shape and damages on sliding surface, but the structure itself is OK.