Spring probe pins enabling extremely high speed -1db @ 80 GHz

Samuel Pak
AJ Park
IWIN Co., Ltd.

TestConX™
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IWIN SOLUTION

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- Test pins for high speed test
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  - Shorter pin/Longer pin for high frequency
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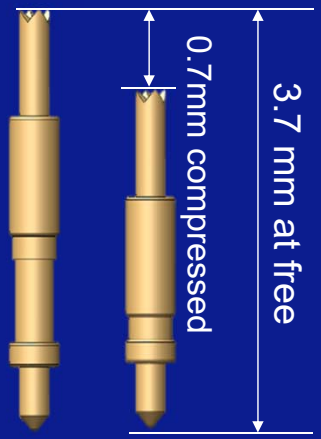
Introduction

- The shorter pin demonstrates high performance. In case of small scale packages, the shorter is preferred for high speed test. There are spring probe pins with 0.83mm length, or shorter, in mass production.
- There are cases that require longer traveling distance and high performance at the same time. In other words, longer pins are needed for high speed test applications.
- Coax socket would be one option, but it also requires high performance spring probe to make it work as needed. Additionally, coax design may cause difficulty in impedance matching due to increase in capacitance between metal body and PCB.

Extremely high speed probe pin

Shorter spring probe for smaller packages

Longer spring probe for larger packages and higher speeds



Very short pin is better for extreme high speed but has limitations on the pin count. For large scale/high pin count, custom longer pin designs are needed to tune for the specific frequency applications that require simulations/ experiments

-1dB@80Ghz Possible ?

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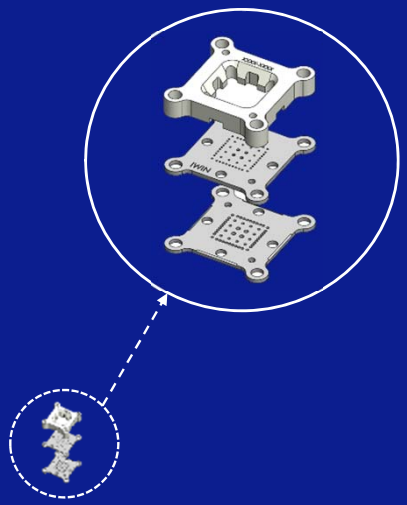
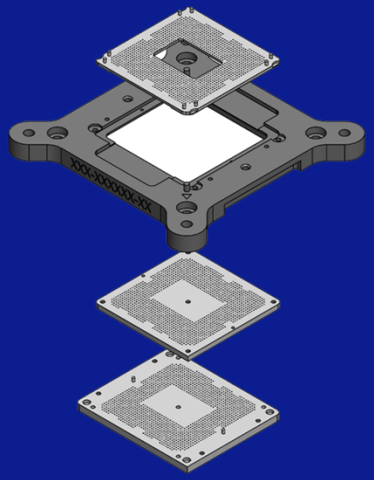
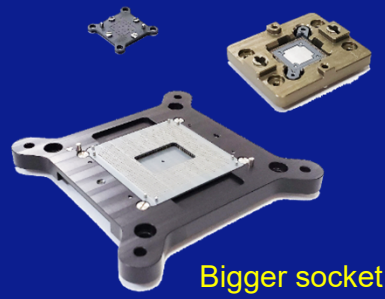
Various sockets for high speed test



For small scale package/
Low pin count
0.83mm long pin can be used



For large scale package/
High pin count
Custom longer pin is needed



Pictures of actual test sockets

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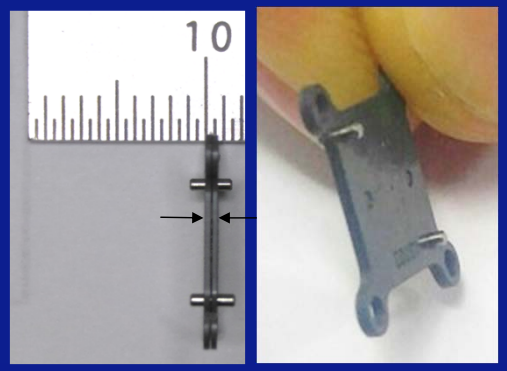
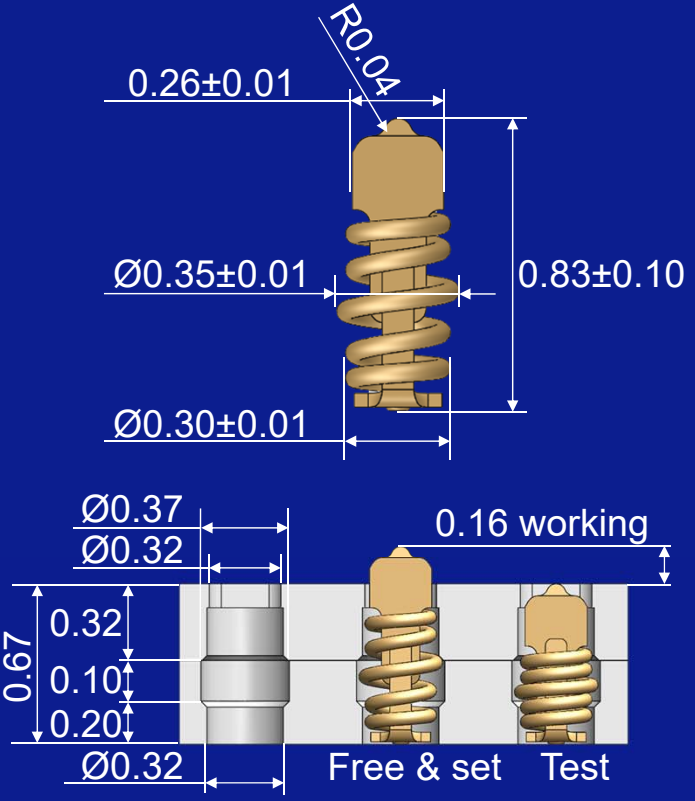
Case study for a Shorter pin

Quiz: Why shorter pin is good for high speed test ?
What is the length limit to be considered as a short pin ?

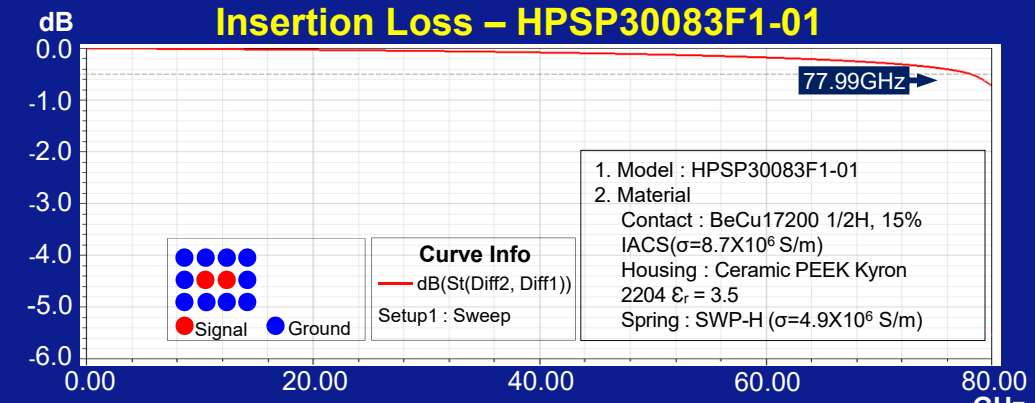


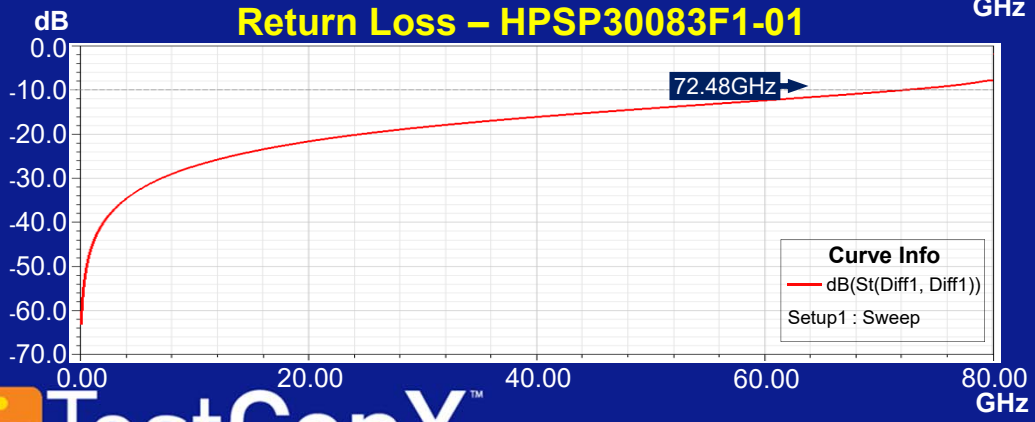
0.67 mm
Total thickness
of socket

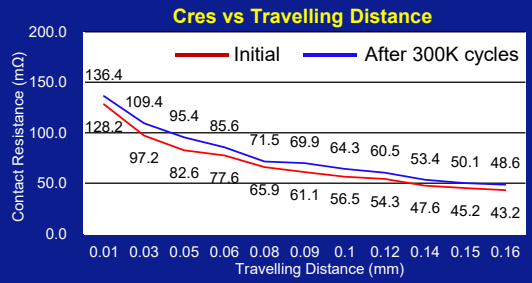
HPSP28083F1-01, Spring probe pin
067 mm test height, Gold plated BeCu

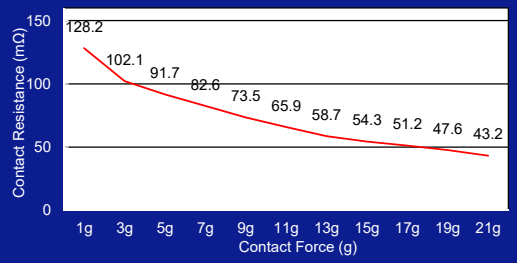


Test sockets with a shorter pin









Current Carrying Capacity

Current	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
1.0A	OK	OK	OK	OK	OK
1.5A	OK	OK	OK	OK	OK
2.0A	OK	OK	OK	OK	OK
2.5A	OK	OK	OK	OK	OK
3.0A	OK	OK	C/F Changed	C/F Changed	OK
3.5A	C/F Changed	C/F Changed			C/F Changed

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Longer pin but good for high frequency

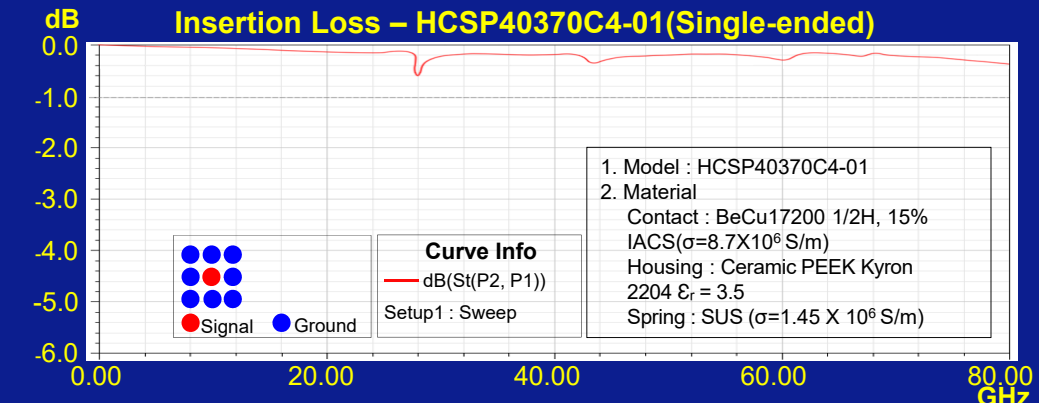
Challenges:

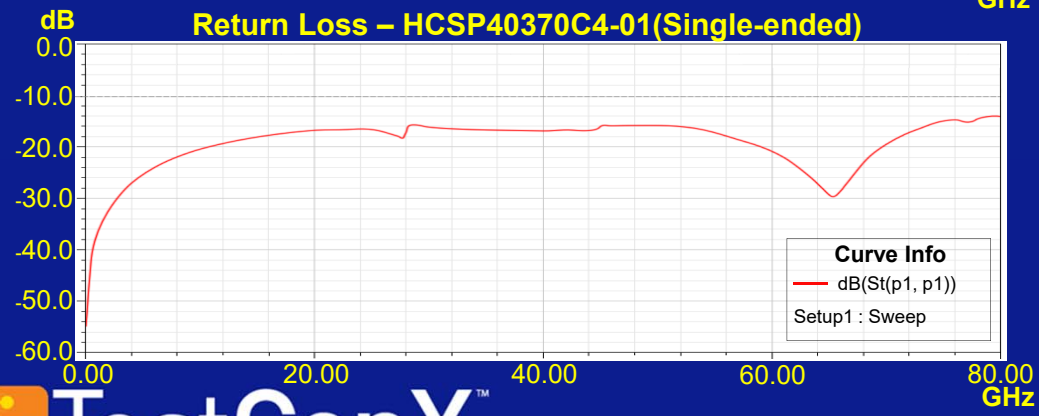
- Larger packages with high pin count need longer pins with longer traveling distance.
- But longer pins cannot demonstrate good performance at high frequency test.
- Are there any longer pins still good for extremely high frequency test ? Very challenging problem. If it would be possible to design a large socket with a pin shorter than 1.6mm -- Problem will be solved

Lesson learned:

- Longer traveling distance needs more turns of spring : A major disadvantage but can be overcome.
- Spring outside of signal path or Spring inside of signal path : Either case could be considered. Outer spring is preferred for a narrower pitch. Inner spring is preferred for a wider pitch.
- Length of pin : Close relationship with sectional area of the pin, impedance matching effort critical.
- Success rate : Pitch wider than 0.5mm results in increase success rate – Easier for differential signaling pattern but difficult for combination of differential and single ended signaling pattern.

Test socket with a longer pin – Case study





Current progress

- Patent filed and PCT
- Complete HFSS Simulation
- Complete pin design
- Stamping tool for piece parts underway
- Mechanical spec
  - Pin free length 3.7mm
  - 18 grams @ 0.7mm travel
  - Designed for high pin count
  - Two kinds of tip shape
    - 4 tips crown for BGA
    - Cone tip for LGA

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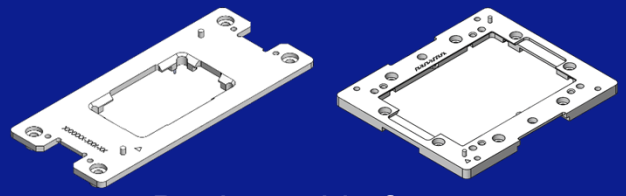
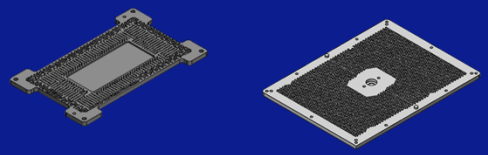
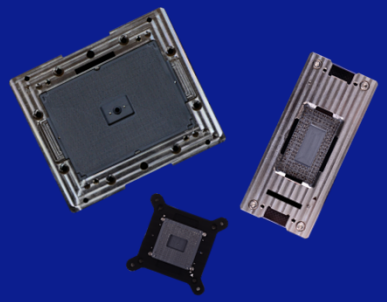
One piece housing design for high speed test



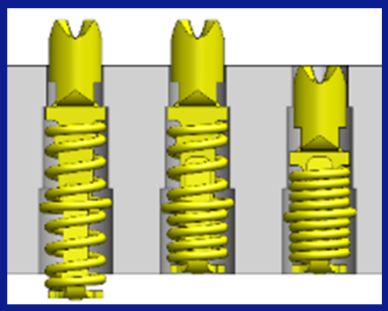
Device guide frames



One piece housing with pins inserted (No bottom housing)



Pictures



Free Set Test

Under consideration -- one piece housing for high speed

- Pin position stable. This could be critical factor for high speed test
- Easier to accommodate a shorter pin
- Manufacturing cost : Less housing cost, Less assembly cost

Cavity design
One piece housing does not need bottom housing

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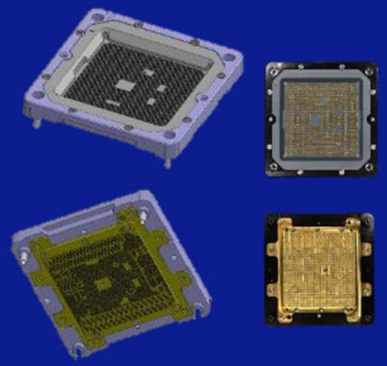
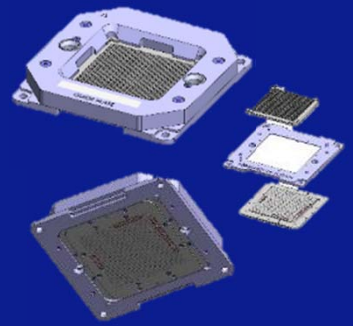
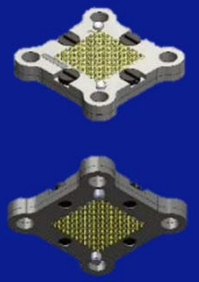
Consideration of Coax socket



Coax socket with isolation inserts



Partial coax sockets



Coax socket without any isolation insert

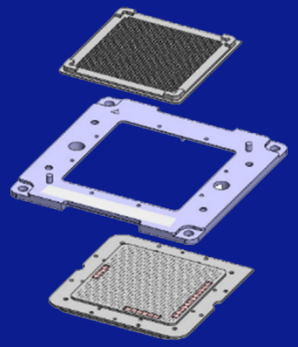
- Coax socket is helpful to reduce cross talk. For high frequency application, selection of high performance pin is essential.
- Partial Coax socket is recommended to prevent negative impact and reduce manufacturing cost
- Full coax design may cause difficulty in impedance matching due to increase in capacitance. Need isolation wall and/or air space between metal socket body and PCB to match impedance.

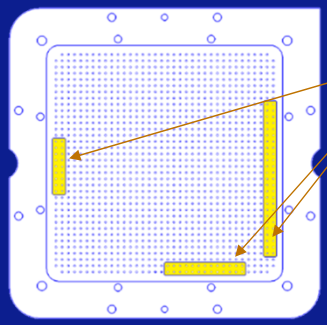
Partial coax socket

Floating base

Frame

Socket body

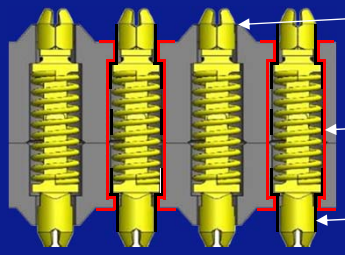




Partial coax at only high speed zone

Normal socket at all other low speed zone

Coax socket design for a finer pitch – Under development



Top/bottom tips of socket body gold plated (Grounding) – Yellow color

Inside of hole for signal pins shall have isolation coating – **Red color**

Side contact part of spring probe pin shall have isolation coating – **Black color**

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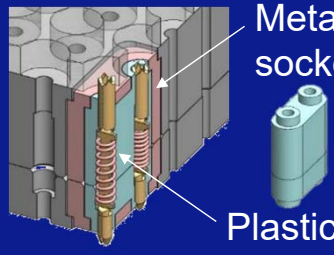
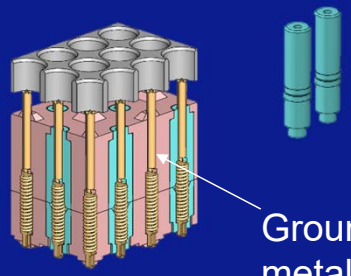
For Differential signaling

Shall not have metal isolation wall between signal pins

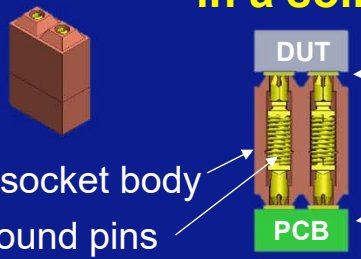


For Single ended signaling

Shall have metal wall (grounded wall) between signal pins



Ground pins need to be embedded in a solid ground pad



Summary

- The shorter pin demonstrates good performance at high frequency in general.
- 0.67mm test height pin, or shorter, is available in the market. Already in mass production for a “Reputed company”, in North America and another country. The pins demonstrated high performance and long life.
- Pin for a large scale/high pin count socket : Customized socket/pin design is needed based on signaling pattern, such as differential, or single ended.
- One piece probe pins in one piece housing has some advantages for high frequency test and cost management.
- Partial Coax socket is recommended if Coax socket is needed.

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