
VIRTUAL EVENT
TestConX™
Presentation Archive
May 3-7, 2021
TestConX.org
© 2021 TestConX– Image: tonda / iStock

Production Wafer Probe of 77-81 GHz Automotive Radar Applications

Jason Mroczkowski (Cohu)
Marty Cavegn (Cohu)
Jory Twitchell (NXP)

TestConX
Virtual Event • May 3 - 7, 2021

NXP

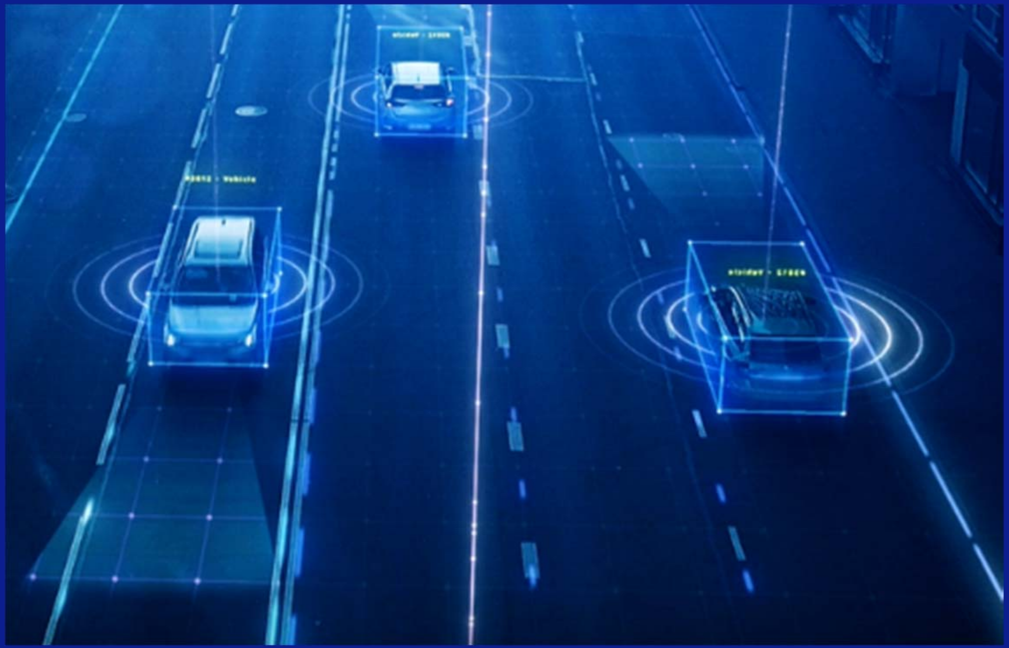
Cohu

Outline

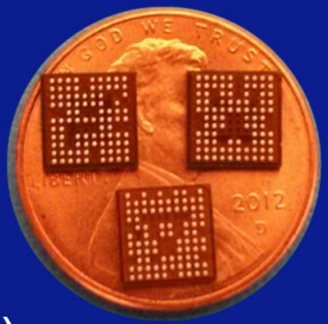
- **Introduction**
  - **Automotive Radar device and testing trend**
- **Benefits and challenges in testing the new generation of devices**
- **Testing requirements and options**
  - Pogo with PCB Stealth (patent pending)
  - xWave with Stealth (patent pending)
    - Advantages
    - Modification to the standard xWave
- **Test results**
  - Initial and current
- **Improvements along the way**
- **Next and ongoing steps**
- **Summary/Conclusion**

Introduction

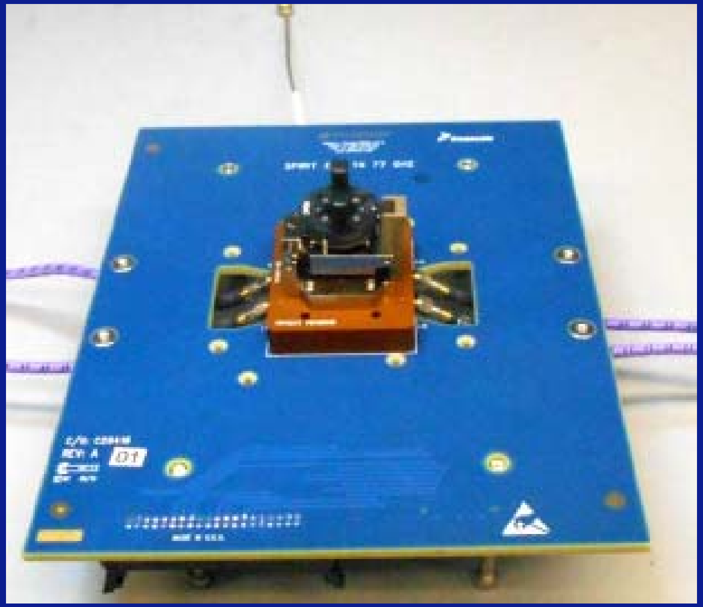
- **Automotive Radar has been used since 2007**
  - First generation (Approximately 2007 – 2013)
    - 28 GHz
    - Short range
    - Limited functionality
  - Second generation (Approximately 2014 – 2018)
    - 80 GHz – improved resolution
    - Longer range
    - Increased functionality
- **Now entering a third generation** (2019-TBD)
  - 80 GHz
  - Longest range
  - Increased performance and functionality
  - Lower cost
  - New testing challenges



Challenges with the Second Generation



- **Second generation (Presented by Brian Nakai at BiTS 2017)**
  - Devices packaged in traditional formats (i.e. BGA, QFN, etc.)
  - Multiple packages for receiver (RX), transmitter (TX) and voltage controller (VCO)
  - Packages combined into module
  - Testing required at multiple levels (wafer, film frame, package, transceiver module)
    - About 15 tests, many of them repetitive
  - mmWave Automated Test Equipment (ATE)
    - Expensive new
    - Difficult to get repeatable results due to sensitivity
    - Extensive set-up due to calibration
    - *Basically, need an RF Lab on your test floor with RF engineers to keep it going!*

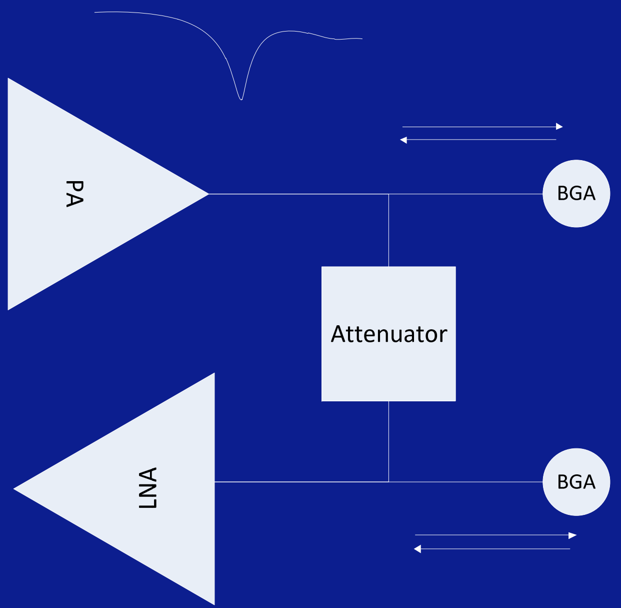


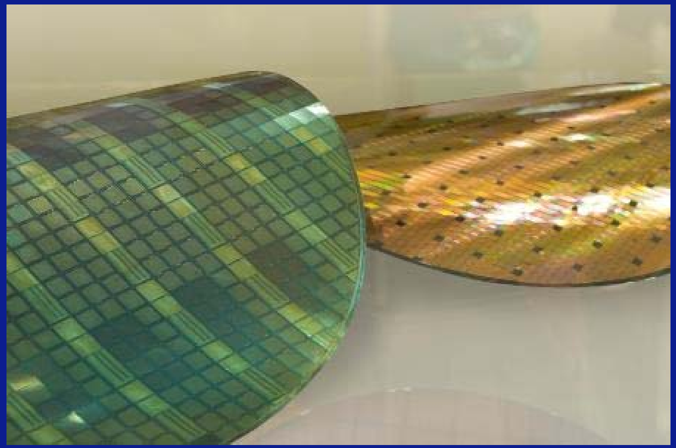
Benefits in Testing the New Generation

- **Third generation**
  - Die level integration of receiver (RX), transmitter (TX) and voltage controller (VCO)
  - Packages no longer required
  - Testing required at wafer with fine pitch without RF and redistributed wafer test at speed WLCSP
    - Ambient, hot, cold, fewer total tests and less repetition (4 total)
- **Built-in Self Test (BIST)**
  - BIST allows die to do internal testing
  - Eliminates need for expensive mmWave test equipment
  - Better fit with standard wafer test environment
- **Multi-site testing**
  - Higher throughput

Challenges in Testing the New Generation

- **Built-in Self Test (BIST)**
  - Requires the I/O for the high frequency signals to be properly terminated while still providing a path for sourcing a DC voltage to the DUT.
  - New functionality in the test hardware/probehead
  - Dual frequency ranges to optimize with differing absorption requirements
- **Wafer/WLCSP testing**
  - Smaller target
  - More sensitive to coplanarity
  - Temperature sensitivity
- **Integration of the three devices into one die**
  - More complex test program

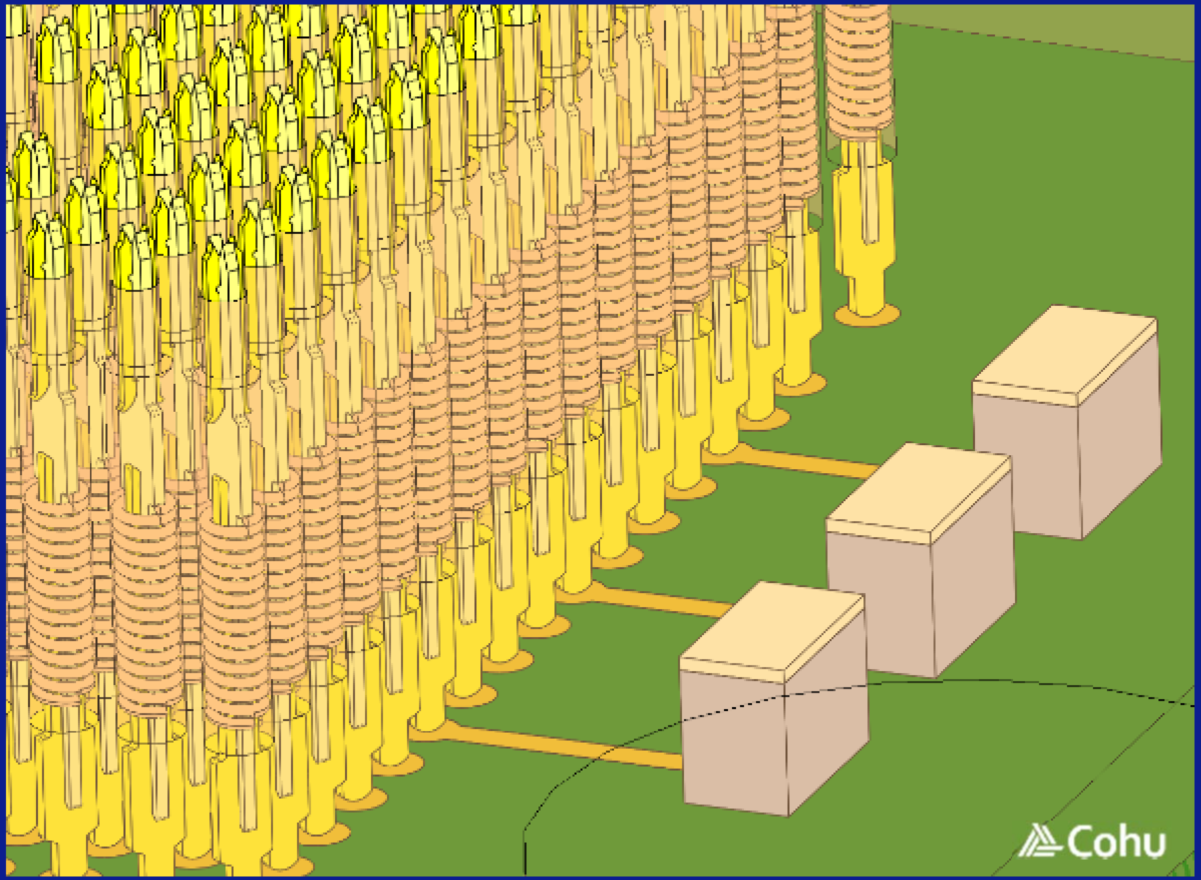




Challenges in Testing the New Generation (cont.)

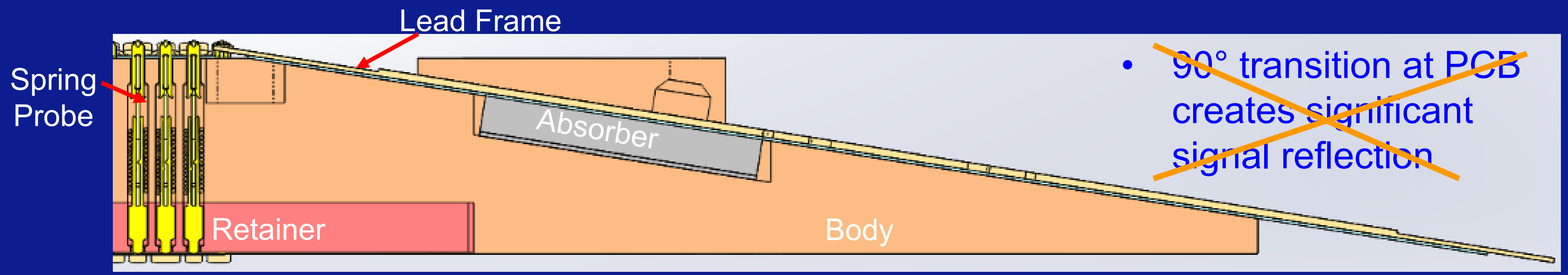
- **Multi Site Testing**
  - Coplanarity challenges
    - Reduction of forces
    - Adding support for PCB (Bridge Beam)
  - Site to site alignment
  - Site to site variation
  - CTE
- **Contact Technology – Dual**
  - Spring Probes for standard signals
  - Leadframe for RF frequency signals
- **Production Worthy Solution**

Test Solutions – Absorber on PCB



- Initially considered Solution
- Pogo Pins with Trace to termination on PCB (SMT resistor or absorber)
- 90° transition at PCB creates significant signal reflection before termination

Test Solutions – Prototype Build Leadframe with PCB Connection



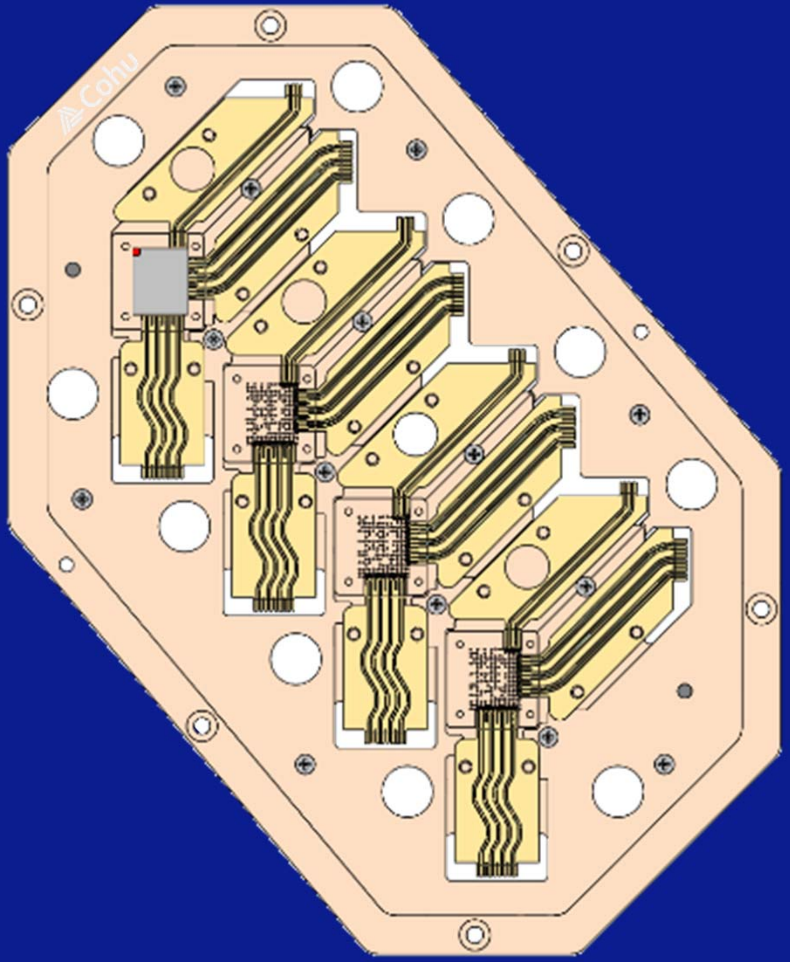
Issues Solved

- Straight leadframe with shallow angle connection to PCB reduces reflections
- Absorber attenuates signal

New Issues

- Tolerances of absorber create mechanical bowing issues
- Initial leadframe mechanics require larger than planned overdrive

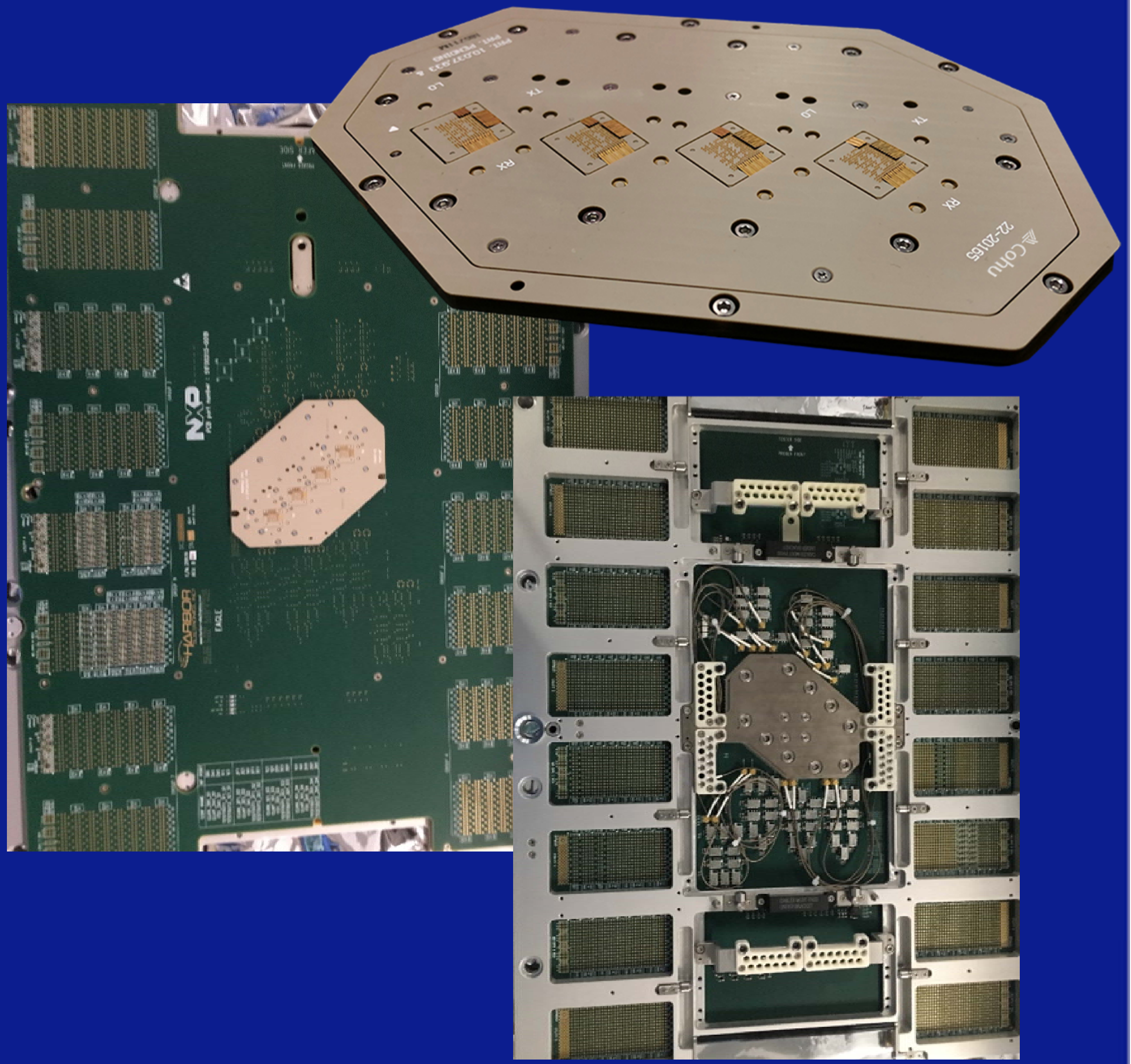
Test Solutions – Prototype Build
Leadframe with PCB Connection – Multi-site



- Multi-site required some new thinking with leadframes fanning out at 45° from three sides
- Quad-site Diagonal skipped die
- Angled 25mm leadframes

Challenges in Prototype Build

- **Bowing of probehead**
  - Additional mounting locations required
  - Reduction of force applied by absorbers – more compliant second layer
  - Redesign of components to add rigidity
- **Coplanarity of PCB**
  - Stiffener in original design
  - Added adjustable support beam to coplanarize
- **Logistics across engineering and production sites**
  - Probe Card Stiffener compatibility
  - Good yield and contact in original engineering site
  - Inconsistencies once installed in production site

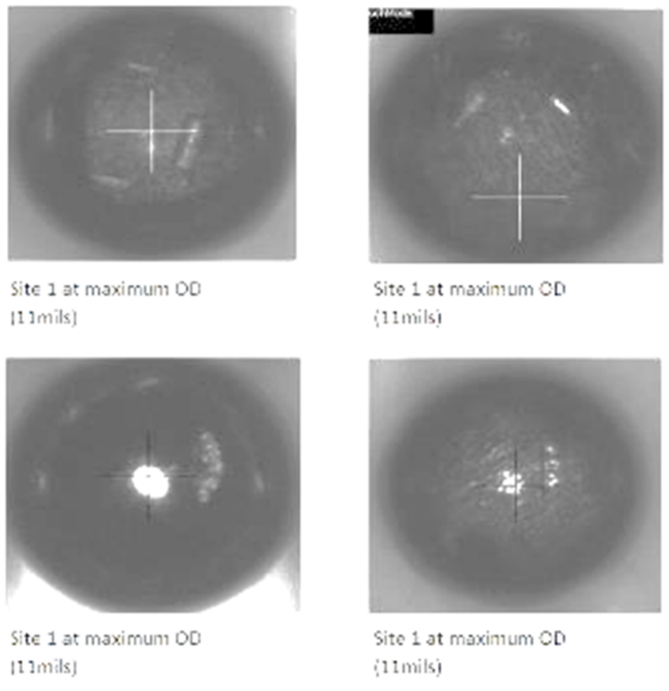


Field Results - Initial Production with Prototype Build

OD	Ambient 1 POGO	Ambient 1 LEADFARME	Ambient 2 POGO	Ambient 2 LEADFARME	Ambient 3 POGO	Ambient 3 LEADFARME	Ambient 4 POGO	Ambient 4 LEADFARME	HOT 1 POGO	HOT 1 LEADFARME	HOT 2 POGO	HOT 2 LEADFARME	HOT 3 POGO	HOT 3 LEADFARME	HOT 4 POGO	HOT 4 LEADFARME	COLD 1 POGO	COLD 1 LEADFARME	COLD 2 POGO	COLD 2 LEADFARME	COLD 3 POGO	COLD 3 LEADFARME	COLD 4 POGO	COLD 4 LEADFARME
11																				L		L		
10																		L						L
9		L						L																
8				L		L														F				
7																		F				F		F
6																			L					
5				F				F								L					L			
4		F				F											L						L	
3	L		L		L		L			L		L		L										
2																			F		F		F	
1																	F							
0			F		F		F					F				F								
-1	F									F				F										
-2											L				L									
-3									L				L											
-4											F		F		F									
-5									F															
-6																								
-7																								
-8																								
-9																								
-10																								

Lead frame's probing window

POGO's Probing window



Site 1 at maximum OD (11mils)

Site 1 at maximum OD (11mils)

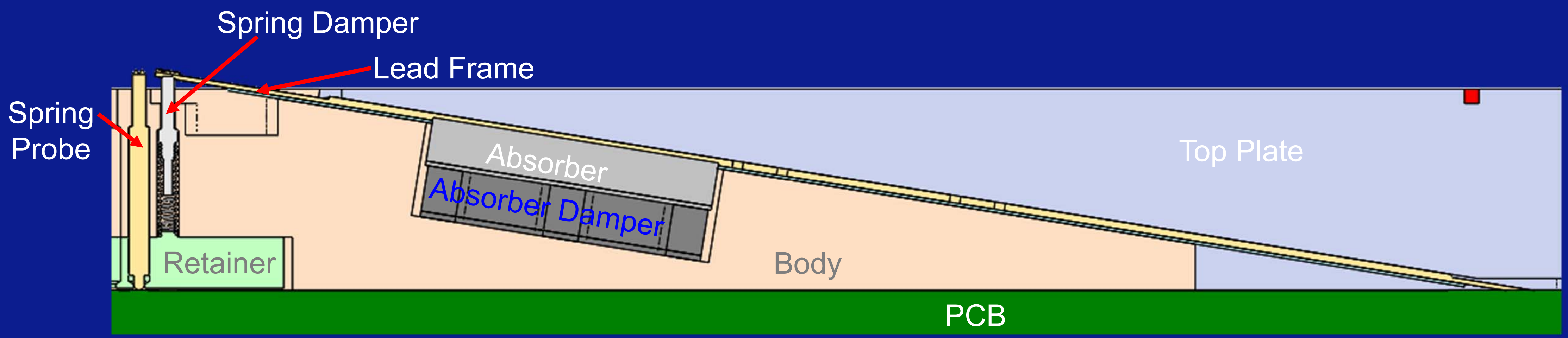
Site 1 at maximum OD (11mils)

Site 1 at maximum OD (11mils)

Total overdrive of about 11 mils to achieve continuity

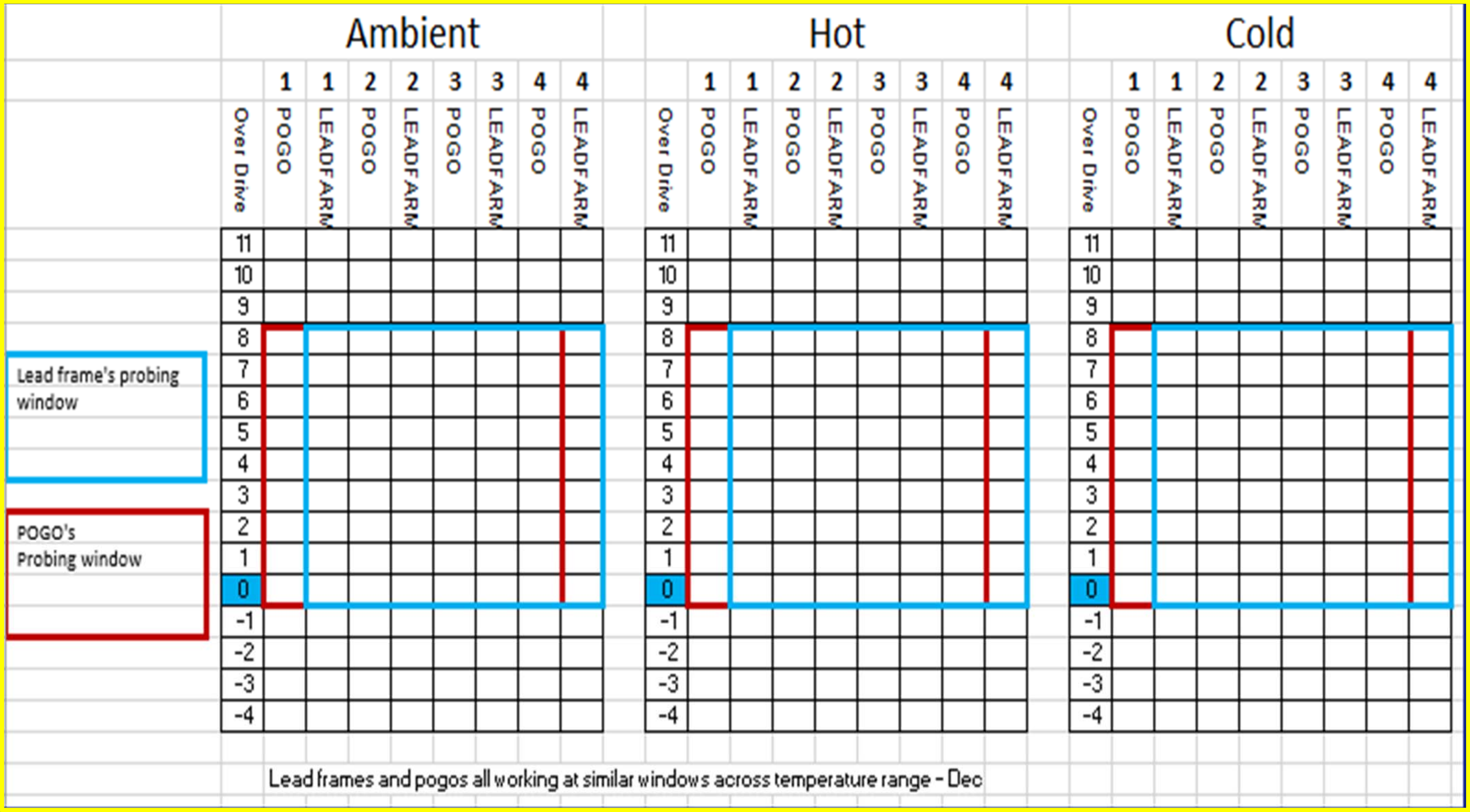
Successful but window was limited and production team wanted improvements

Test Solutions – Production Build



- Spring damper to better support leadframes
- Absorber damper to add compliance/reduce bowing of top plate

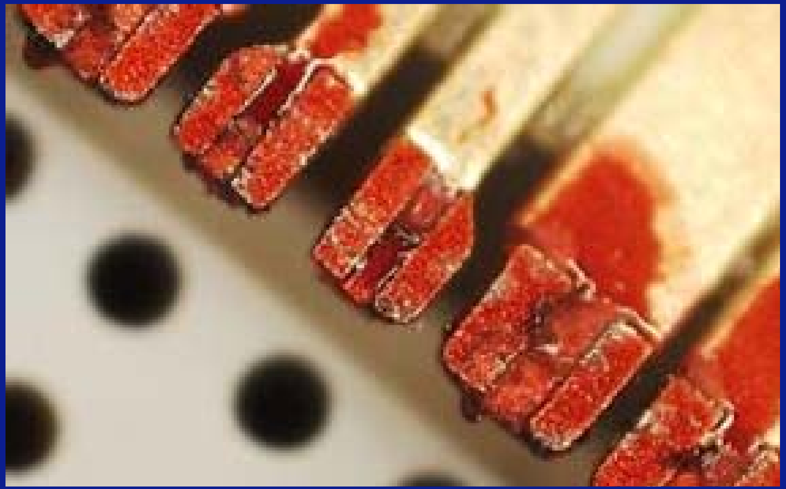
Field Results – Improved Production



- Full continuity at all temps at 8 mils of overdrive
- Max overdrive of 13 mils allowed
- 5 mil working window
- Production team approved for release

Field Results – Ongoing Concerns

- Over 250,000 insertions on the first probe head
- In-Situ cleaning as angled leadframes are more difficult to clean than pogo pins or flat leadframes – reviewing new cleaning media
- Absorber system may degrade over time and require repair/improvement



Strengths

- Excellent RF performance over a broad range of frequencies
- Long life
- Individual probe / lead frame replacement
- Multi-site capability (material CTE Match)
- Large compliance window

Weakness

- Complex to balance multiple contact technologies on one DUT
- Some limits on the number and location of RF signals
- In-situ cleaning is difficult
- May need maintenance on absorption system over time

Next Steps

- Project has moved to production and additional test cells are being deployed to meet end user demand! (13 probe heads shipped to date)
- Testing in-situ cleaning media and methods under investigation
- Testing life performance of absorption system (resolved)
- Better control of force on leadframes with modifications to support system (future projects)
- Have improved tolerance capabilities and geometries on leadframes
- Have implemented better PCB pad compatible geometries

Summary/Conclusion

- Advances in IC design architectures and contacting methods make high volume test of automotive radar RF devices production capable with test resources already available on production floors.
- Demonstrated Production worthy quad-site tri-temp Probecard solution for 77GHz automotive radar wafter test applications with BIST
- Thank you to NXP for the opportunity and collaboration to make it happen!

With Thanks to Our Sponsors!

Premier

Cohu

Emeritus

Johnstech®

Honored

GLOBAL INNOVATION ISC

WIN SOLUTION

TSE

With Thanks to Our Sponsors!

Distinguished

BACKER HOTWATT

Innovative Circuits Engineering, INC

JMT

Nidec SV TCL

R&D Altanova®

UIGreen 和林科技

Exhibitor

ELES

MJC

PHOENIX TEST ARRAYS
High Performance Contacts

smiths interconnect
bringing technology to life

With Thanks to Our Sponsors!

Industry Partners

MEPTEC THE NEXT GENERATION

SWTEST PROBE TODAY, FOR TOMORROW

Publication Sponsor

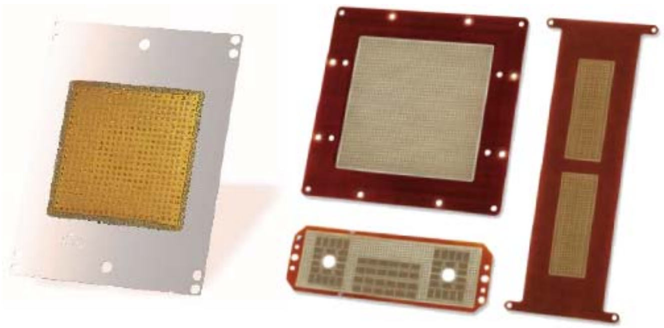
Chip Scale Review®
ChipScaleReview.com
The Future of Semiconductor Packaging

GLOBAL INNOVATION

ISC Global No.1! Total Test Solution Provider!

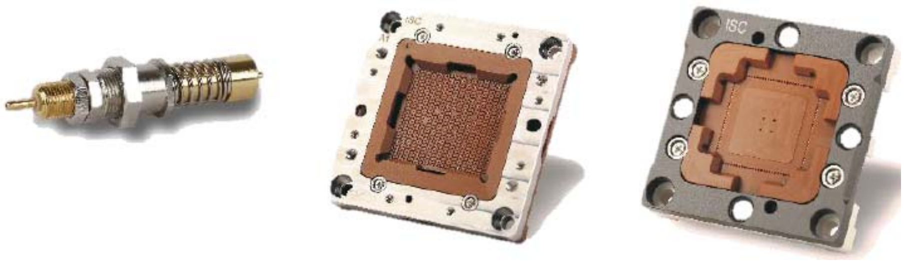
ELASTOMET SOCKET & INTERPOSERS

- High performance and competitive price
- High speed & RF device capability
- Various customized design to meet challenge requirement



POGO SOCKET SOLUTIONS

- Excellent gap control & long lifespan
- High bandwidth & low contact resistance

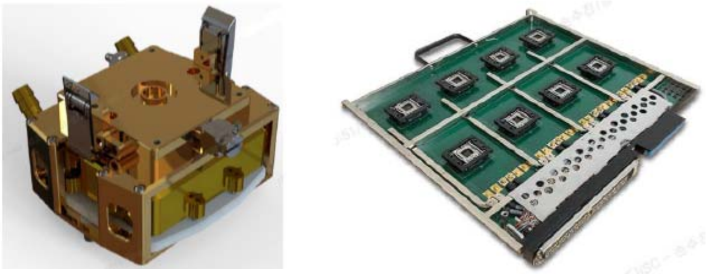


THERMAL CONTROL UNIT

- Extreme active temperature control
- Safety auto shut-down temperature monitoring of the device & thermal control unit
- Full FEA analysis & Price competitiveness

BURN-IN SOLUTIONS

- Direct inserting on the board without soldering
- Higher performance BIB solution

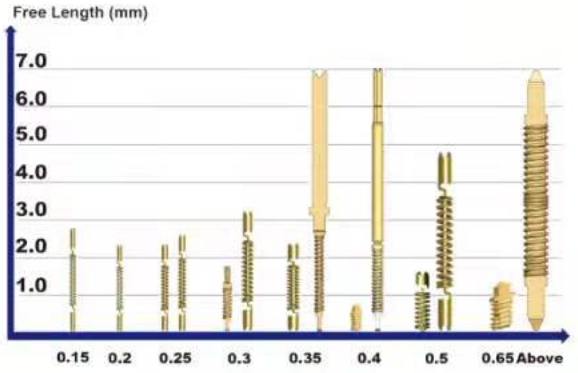


CONTACT
ISC CO., LTD

ISC HQ	ISC International	
Seong-nam, Korea	Silicon-valley, CA	**Tel**: +82-31-777-7675 / **Fax**: +82-31-777-7699 **Email**: sales@isc21.kr / **Web**: www.isc21.kr

IWIN Co., Ltd. The test probe for high signal integrity at extremely high speed test

Spring probe by stamping



250 kinds of spring probe pin

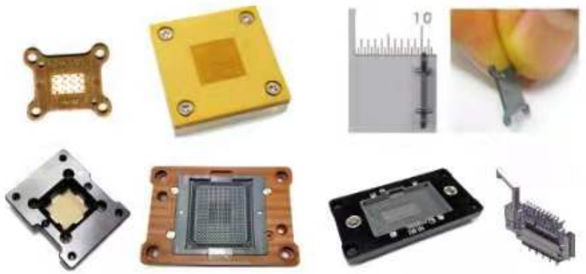
300 kinds of test socket (44,000 Pin count socket possible)

One piece spring probe

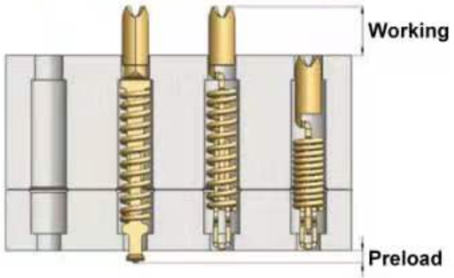
Three piece spring probe

High speed product → 0.63mm free length spring probe pin available

Finest Pitch → 0.15mm Pitch



Spring probe by stamping

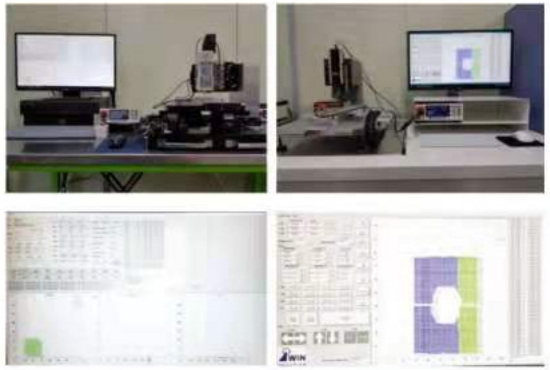


Patented

Pitch(mm)	Free Length(mm)	Current Carrying(Amps)
0.15/0.2/0.25	2.17~	0.5~
0.3	1.5~	1.5~
0.35	2.08~	1.8~
0.4	0.8~	2.5~
0.5	1.5~	3.0~
0.65	1.13~	9.0~
0.8	3.14~	3.0~

Automation

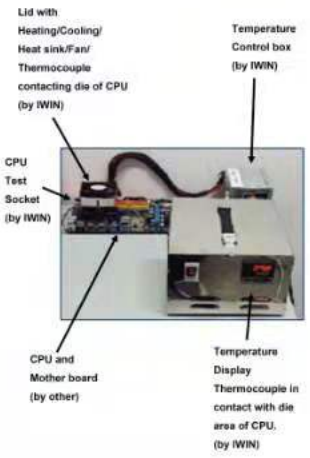
Pin assembly and Quality control



Top Figure: Socket CRES, Force, Stroke test
Bottom Figure: Data displayed

Top Figure: Socket CRES test
Bottom Figure: Data display 5,903 pins socket

Socket and Lid



Pin assembly

(Fully automated machines)

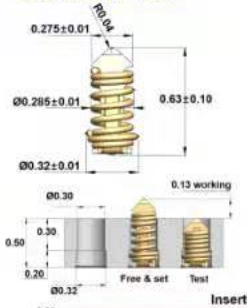
- Stamped piece parts attached to a reel fed into the assembly machine

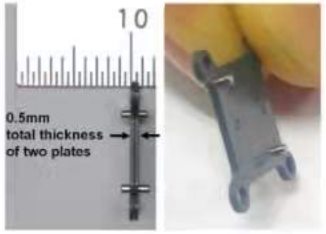
- Assembled pins can be attached to a reel, or, supply in separate for socket assembly.

Spring probe pins for High speed

Extremely short spring probes by stamping

Design approach





Homepage. www.iwinsn.com Tel. +82-10-6417-7580 E-mail. aj@iwinsn.com

High Performance Probe solution

www.testconx.org